# Preliminary Drainage Study
# Tavern Road Gas Station
**1040 Tavern Road**
**Alpine, CA 91901**

**Project ID:**
PDS2018-STP-18-012

**Date Prepared:**
June 5th, 2019

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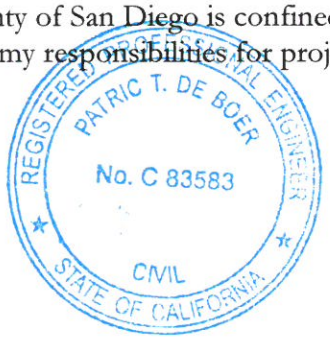
**Declaration of Responsible Charge:**
I hereby declare that I am the engineer of work for this project, that I have exercised responsible charge over the design of the project as defined in section 6703 of the business and professions code, and that the design is consistent with current standards. I understand that the check of the project drawings and specifications by the County of San Diego is confined to a review only and does not relieve me, as an engineer of work, of my responsibilities for project design.




Patric T. de Boer RCE 83583
Registration Expires 3-31-2021

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# Appendices

## Site & Project Description

This drainage study has been prepared as part of the grading plans for the proposed commercial redevelopment at the intersection Tavern Road and Victoria Park Terrace. The redevelopment includes a gas station and several restaurants. The project will be constructed with a fueling area, parking spaces and landscaped biofiltration basins to treat stormwater before it is discharged from the site.

The project is subject to hydromodification requirements and will be constructed with outlet control facilities. See Figure 2 for the existing drainage limits. See Figure 3 for the proposed drainage limits. There will be no work over waterways and the project will not involve dredged material, thus this project does not require approval under Clean Water Acts 401 or 404.

## Methodology

This drainage report has been prepared in accordance with current County of San Diego regulations and procedures. The Modified Rational Method was used to compute the anticipated peak runoff flowrates for the existing and proposed conditions. RatHydro was used to generated hydrographs based on the Rational Method results. These hydrographs were routed through storage elements in the SWMM model of the site that was generated for hydromodification compliance. The resulting peak flowrates from each storage element was input back into the Rational Method calculations and confluenced with according to the hydrology manual. See the attached calculations for particulars.

**Rational Method**

Q=CIA

Where:

Q=peak discharge, in cubic feet per second (cfs)
C=runoff coefficient, proportion of the rainfall that runs off the surface (no units)
=(0.90*(% impervious)+Cp*(1-% Impervious)) page 5, County Hydrology Manual
I =average rainfall intensity for a duration equal to the Tc for the area, (in/hr)
= 7.44*P6*Tc-0.645
A = drainage area contributing to the design location, in acres
Cp= Pervious Coefficient Runoff Value, County Hydrology Manual minimum of 0.35
Tc= Ti +Tt
Ti = Initial Time of Concentration (From table 3-2, County Hydrology Manual
Tt= Travel time of concentrated flow to Discharge Point
S= Slope of drainage course*

The following references have been used in preparation of this report:

(1) Handbook of Hydraulics, E.F. Brater & H.W. King, 6th Ed., 1976.
(2) Modern Sewer Design, American Iron & Steel Institute, 1st Ed., 1980.
(3) County of San Diego Hydrology Manual, 2003

## Existing Conditions

The existing site is an operating gas station located at the easterly side of the site. The westerly half is a fill slope and undeveloped natural hillside with existing culvert stubbing out from the hillside. The existing impervious improvements consist of building rooftop and paving. The developed portion of the site drains in two directions, with the north portion of the gas station draining to the north and the south portion draining to the south. Both portions drain to natural, unhardened slopes, which convey runoff to the two separate discharge points.

A culvert north of the site collects runoff from a 13.74 ac offsite basin that includes residential areas, public roads and industrial equipment yards. This culvert flows under Tavern Road, under a portion of the site and daylights at a headwall on the steep slope west of the gas station. The flow from this culvert is included in the confluenced flow at Discharge Pt. 1 for the existing conditions.

## Proposed Conditions

The proposed project will construct a gas station with two restaurants. The improvements will be built where the existing gas station is located. The pad will be expanded by pushing the fill slope to the west. A private storm drain system will be constructed to convey runoff to two biofiltration facilities. Both of these will have outlet control structures to store and attenuate discharge for hydromodification and flood control purposes.

The biofiltration basins will drain via an 18" storm drain to a concrete energy dissipater at the toe of the proposed fill slope west of the development.

The existing culvert for offsite flow that was described in the existing conditions will no longer daylight at the northwest end of the site, as the existing headwall will be covered with fill dirt. The pipe will be extended with new 24" RCP to the previously mentioned concrete energy disapater.

The biofiltration areas will serve as storage for flow attenuation for the 100-year storm as well as flow mitigation for hydromodification purposes. The excess volume generated by the peak of the 100 year storm will be stored in the biofiltration basin and released at an attenuated rate.

## Existing Runoff Analysis

For the existing condition calculations, the area of analysis was broken into three drainage catchments, EX-1, EX-2 & OFF-1. EX-1 contains the northerly half of the area of analysis. EX-2 contains the southerly portion of the area of analysis. OFF-1 is the offsite area that drains to the culvert under Tavern Rd. The Rational Method was used to determine the peak flow generated by each catchment. These peak flows were confluence according to the Junction Equations in the County Hydrology Manual.

Runoff coefficients were calculated by taking a weighted average of the surface types for each basin. A value of 0.90 was used for impervious surfaces and 0.35 was used for pervious surfaces.

| Basin # | Area (ac) | Impervious % | C | I (in/hr) | $Q_{100}$ (cfs) |
|---|---|---|---|---|---|
| EX-1 | 1.99 | 7% | 0.39 | 8.64 | 6.69 |
| EX-2 | 1.94 | 33% | 0.53 | 8.72 | 8.98 |
| OFF-1 | 13.74 | 11% | 0.41 | 4.51 | 25.30 |

The peak flowrate at Discharge Point #1 is **28.79 cfs** for the 100-yr storm event. This includes flow from EX-1 & OFF-1 . The peak flowrate at Discharge Point #2 is **8.98 cfs.** This includes flow from only EX-2. See the attached calculations for details.

## Proposed Runoff Analysis

For the proposed conditions calculations, the area of analysis was broken into five drainage catchments. P-1, P-2, P-3 and OFF-1 drain to Discharge Point #1. Basin P-4 drains to Discharge Point #2.

P-1, P-2 & P-3 contain the majority of the site and proposed improvements including two biofiltration basins that will be used for 100-yr flow attenuation. P-4 contains a portion of the fill slope and other offsite areas.

RatHydro was used to generate hydrographs based on the Rational Method Calculations for basins P-1 and P-2. These hydrographs were input as a time series into the SWMM model that was built for the HMP calculations. The hydrograph was then run through the modeled biofiltration systems. The outflow from the biofiltration basins was confluenced with flow from the remaining portions of the area of analysis. The confluenced flow at both discharge points were determined to be less than the existing conditions.

Runoff coefficients were calculated by taking a weighted average of the surface types for each basin. A value of 0.9 was used for impervious surfaces and 0.35 was used for pervious surfaces.

Below is a summary of the basin input data:

| Basin # | Area (ac) | Impervious % | C | Slope | $Q_{100}$ (cfs) | Mitigated $Q_{100}$ (cfs) |
|---|---|---|---|---|---|---|
| P-1 | 0.65 | 85% | 0.82 | 1% | 4.76 | *3.14 |
| P-2 | 0.77 | 81% | 0.80 | 2% | 5.49 | *2.91 |
| P-3 | 1.34 | 0% | 0.35 | 15% | 3.09 | 3.09 |
| P-4 | 1.17 | 0% | 0.35 | 9% | 2.70 | 2.70 |
| OFF-1 | 13.74 | 11% | 0.41 | 5% | 25.30 | 25.30 |

The peak flowrate with mitigation at Discharge Point #1 is **28.75 cfs** and Discharge Point #2 is **2.70 cfs** for 100-year storm event**.** See the attached calculations for details.

# Results and Conclusions

The redevelopment of the site will decrease the peak flowrate generated, despite an increase in impervious area compared to the existing condition. This is due to flattening of the average slope of the disturbed area of the site, as well as the flow attenuation that is accomplished by storage in the biofiltration basin and controlled release. The biofiltration facilities were designed to discharge the runoff at a flowrate less than the existing drainage condition. It was concluded that the redevelopment will result in a 0.04 cfs decrease in peak flow at Discharge Point #1 and a decrease of 6.27 cfs at Discharge Point #2.

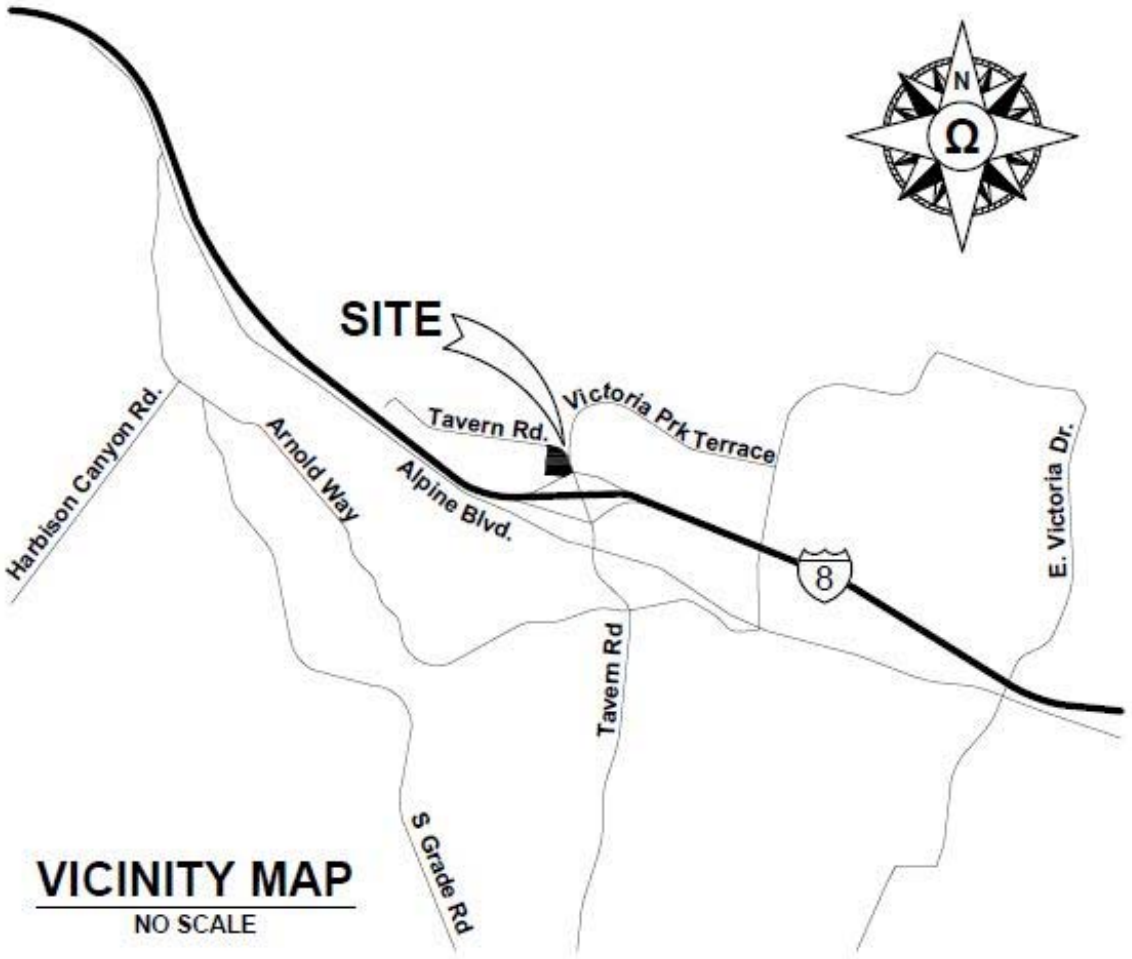
The county has indicated that it considers a reduction in flow to be a flow diversion. We do not consider this to be a flow diversion, as it does not increase flow to any offsite area by diverting flow. Additionally there are no hydrologic features such as wetlands or marshes in the vicintity of the site that would be negatively impacted by the reduced flowrate. The reduction in flow brings the downstream drainage conditions closer to predeveloped flow conditions.

Project will not place structures or housing in 100 year flood hazard area as the project is not located in a flood hazard area. The project will not expose people or structures to the risk of loss, injury or death involving flooding as a result of the failure of a levee or dam.

Project does not propose to discharge fill or dredged materials to the Waters of the State, therefore CWA 401 or 404 permits are not required. It is the opinion of Omega Engineering Consultants that the project will not cause adverse effects to the downstream facilities or receiving waters as a result of increased stormwater flowrates.

A separate Storm Water Quality Management Plan (SWQMP) has been prepared to discuss the water quality impacts for the proposed development.

Due to the measures taken to attenuate stormwater peak flow rates, it is the opinion of Omega Engineering Consultants that the project will not cause adverse effects to downstream conveyances and waterways that would be the result of increased or decreased stormwater flowrates.




**VICINITY MAP**

NO SCALE

GRAPHICAL SCALE: 1" = 60'

0 30 60 120

EX-2

SEE SEPARATE EXHIBIT FOR FULL EXTENTS

EX. CONF. PT-1
EX. 24" HEADWALL

EX-1

EX-2

VICTORIA PARK TERRACE

TAVERN ROAD

DISCHARGE PT #1
$Q_{100}$=28.79 cfs

DISCHARGE PT #2
$Q_{100}$=8.98 cfs

## LEGEND

- BASIN NUMBER — EX-#
- ONSITE DRAINAGE BASIN LIMITS
- OFFSITE DRAINAGE BASIN LIMITS
- SURFACE DRAINAGE DIRECTION
- BUILDING AREA
- PAVEMENT AREA
- PERVIOUS AREA

## DRAINAGE BASIN DATA

| BASIN # | AREA (AC) | C VALUE | $T_C$ (MINS) | $I_{100}$ (IN/HR) | $Q_{100}$ (CFS) |
|---|---|---|---|---|---|
| EX-1 | 1.99 | 0.77 | 5.3 | 8.46 | 6.69 |
| EX-2 | 1.94 | 0.53 | 5.2 | 8.72 | 8.98 |
| OFF-1 | 13.74 | 0.41 | 31.68 | 2.72 | 25.3 |

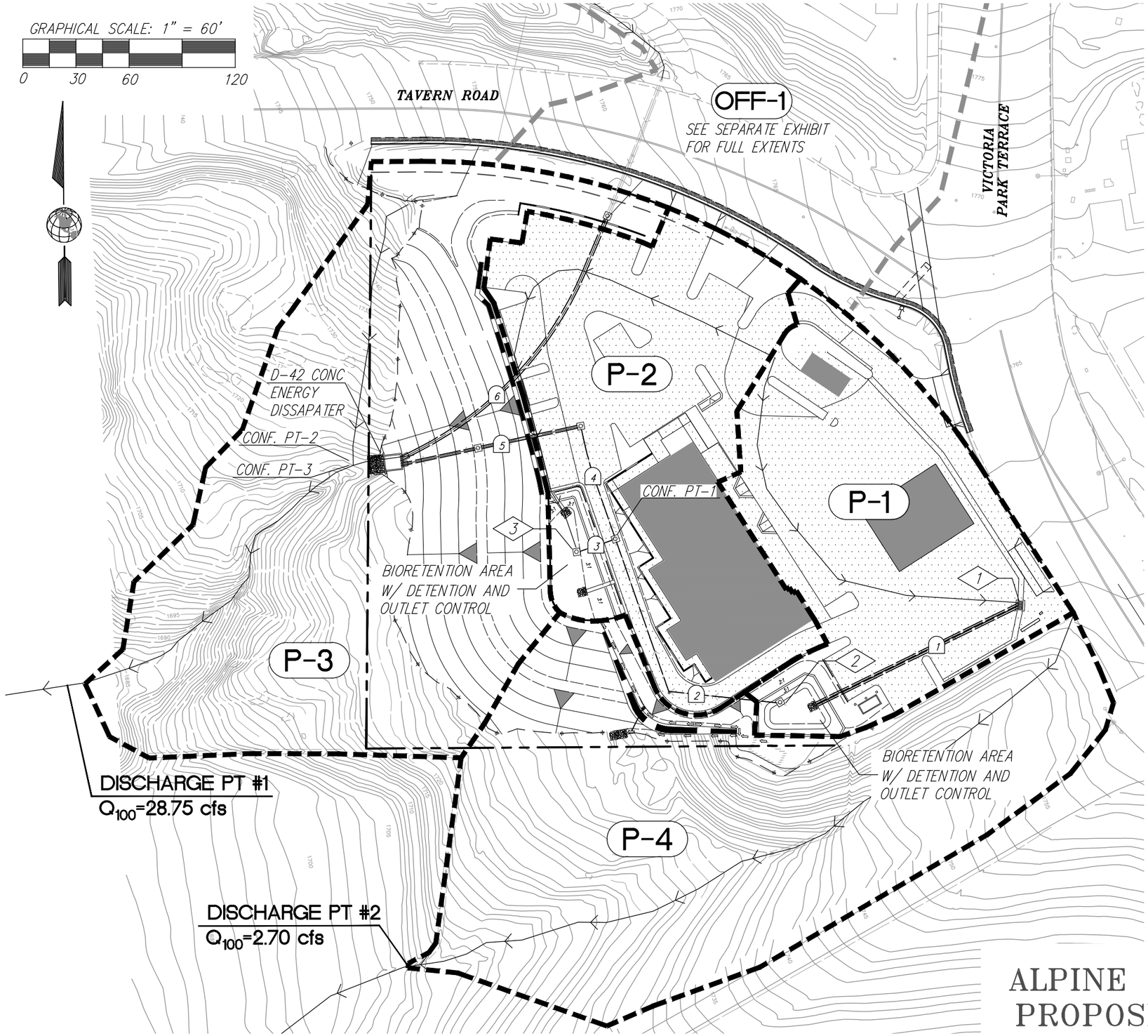
# ALPINE SHELL STATION
# EXISTING HYDROLOGY

OMEGA

EX. HYDROLOGY EXHIBIT

GRAPHICAL SCALE: 1" = 60'

0 30 60 120




## LEGEND

- BASIN NUMBER — P-#
- ONSITE DRAINAGE BASIN LIMITS
- OFFSITE DRAINAGE BASIN LIMITS
- SURFACE DRAINAGE DIRECTION
- PIPE DRAINAGE DIRECTION
- BUILDING AREA
- PAVEMENT AREA
- PERVIOUS AREA

## DRAINAGE BASIN DATA

| BASIN # | AREA (AC) | C VALUE | $T_C$ (MINS) | $I_{100}$ (IN/HR) | $Q_{100}$ (CFS) | $Q_{100}$ MITIGATED (CFS) |
|---|---|---|---|---|---|---|
| P-1 | 0.65 | 0.82 | 5.0 | 8.96 | 4.76 | 3.14 |
| P-2 | 0.80 | 0.80 | 5.0 | 8.96 | 5.49 | 2.91 |
| P-3 | 0.35 | 0.35 | 8.1 | 6.58 | 3.09 | 3.09 |
| P-4 | 0.35 | 0.35 | 8.0 | 6.62 | 2.70 | 2.70 |
| OFF-1 | 13.74 | 0.41 | 14.5 | 4.51 | 25.3 | 25.30 |

## STORM DRAIN INLETS

| ◇1 | INLET DESCRIPTION | $Q_{100}$ (CFS) |
|---|---|---|
| #1 | SDRSD G-2 INLET | 4.76 |
| #2 | V-NOTCH WEIR | 4.76 |
| #3 | V-NOTCH WEIR | 5.49 |

## DRAINAGE CONVEYANCES

| ◇X | CONVEYANCE DESCRIPTION | DEPTH/ DIAMETER | $Q_{100}$ (CFS) | $V_{100}$ (FPS) |
|---|---|---|---|---|
| #1 | 2-12" PIPES @ 0.5% MIN | 0.77 | 2.38 | 3.67 |
| #2 | 18" DIA. PIPE @ 1% MIN | 0.47 | 4.76 | 5.83 |
| #3 | 18" DIA. PIPE @ 1% MIN | 0.51 | 5.49 | 6.05 |
| #4 | 18" DIA. PIPE @ 1% MIN | 0.79 | 10.24 | 6.83 |
| #5 | 18" DIA. PIPE @ 18% MIN | 0.32 | 10.27 | 21.00 |
| #6 | 24" DIA. PIPE @ 18% MIN | 0.49 | 25.30 | 25.82 |

# ALPINE SHELL STATION
# PROPOSED HYDROLOGY

OMEGA

PROP. HYDROLOGY EXHIBIT


## LEGEND:

AREA LIMITS

DRAINAGE DIRECTION ARROW

PAVEMENT AREA

PERVIOUS AREA

**BASIN DATA**

| BASIN | AREA (ac) | C | $T_C$ (mins) | I (in/hr) | $Q_{100}$(cfs) |
|---|---|---|---|---|---|
| OFF-1 | 13.74 | 0.41 | 14.5 | 4.51 | 25.30 |

GRAPHICAL SCALE: 1" = 150'

0 75 150 350 450

# ALPINE SHELL STATION
# OFFSITE BASIN

OMEGA

OFFSITE BASIN

**ALPINE HEIGHTS SUBDIVISION**
**HYDROLOGY AND HYDRAULICS CALCS (Table No. 1)**

4/9/2019

| BASIN | AREA (SF) | AREA (AC) | % Imp | "C" Value |
|---|---|---|---|---|
| | | | | |
| **EXISTING BASINS** | | | | |
| EX-1 | 86,809 | 1.99 | 7.0% | 0.39 |
| EX-2 | 84,364 | 1.94 | 33.0% | 0.53 |
| | | | | |
| **EX. TOTAL** | **171,173** | **3.93** | 20.1% | 0.46 |
| | | | | |
| | | | | |
| **PROPOSED BASINS** | | | | |
| P-1 | 28,290 | 0.65 | 85.0% | 0.82 |
| P-2 | 33,550 | 0.77 | 81.0% | 0.80 |
| P-3 | 58,557 | 1.34 | 0.0% | 0.35 |
| P-4 | 50,776 | 1.17 | 0.0% | 0.35 |
| | | | | |
| **PROP TOTAL** | **171,173** | **3.93** | 29.9% | 0.51 |
| | | | | |
| | | | | |
| **OFFSITE BASINS** | | | | |
| **OFF-1** | 598,526 | 13.74 | 10.6% | 0.41 |
| | | | | |

| Basin Confluence | Symbol |
|---|---|
| **EX-1** | ECP#1 |
| (A-1 & A-2) | CP#1 |
| (CP#1 & A-3) | CP#2 |
| | |

(A) CP # - Proposed Confluence Point

(B) C value for bare ground is 0.35 (Table 3-1 County Hydrology Manual) (Type 'D' soil)

(C.) C value for impervious surfaces is 0.9
Basins with mixed surface type use a weighted average of these 2 values. (impervious % x 0.9)+(pervious % x 0.35)

**ALPINE SHELL STATION** 4/9/2019

**HYDROLOGY AND HYDRAULICS CALCS (Table No. 2)**

| Sub-Basin | AREA Ac. | "C" | CA | Overland flow length | Concentrated Flow Length, (ft) | S(%) (avg.) | Ti mins | Tt mins | $T_c$ mins | I in/hr | Q cfs | Q tot cfs | NOTES 85th % Storm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EX-1 | 1.99 | 0.39 | 0.77 | 60.0 | 530.0 | 14% | 3.2 | 2.1 | 5.3 | 0.20 | 0.15 | 0.15 | |
| OFF-1 | 13.74 | 0.41 | 5.61 | 100.0 | 1843.0 | 5% | 6.4 | 8.1 | 14.5 | 0.20 | 1.12 | 1.12 | |
| | | | | | | | | | 14.5 | 0.20 | | 1.28 | Ex. Confluence Pt-1 |
| | | | | | | | | | | | | **1.28** | **Discharge Pt. 1** |
| EX-2 | 1.94 | 0.53 | 1.03 | 60.0 | 515.0 | 10% | 3.2 | 2.0 | 5.2 | 0.20 | 0.21 | 0.21 | |
| | | | | | | | | | | | | **0.21** | **Discharge Pt. 2** |
| P-1 | 0.65 | 0.82 | 0.53 | 70.0 | 250.0 | 1% | 2.7 | 1.4 | 5.0 | 0.20 | 0.11 | 0.11 | |
| P-2 | 0.77 | 0.80 | 0.61 | 80.0 | 200.0 | 2% | 2.6 | 1.1 | 5.0 | 0.20 | 0.12 | 0.12 | |
| | | | | | | | | | 5.0 | 0.20 | 0.11 | 0.23 | Confluence Pt. 1 |
| P-3 | 1.34 | 0.35 | 0.47 | 100.0 | 400.0 | 15% | 6.9 | 1.2 | 8.1 | 0.20 | 0.09 | 0.09 | |
| | | | | | | | | | 8.1 | 0.20 | 0.00 | 0.24 | Confluence Pt. 2 |
| OFF-1 | 13.74 | 0.41 | 5.61 | 100.0 | 1843.0 | 5% | 6.4 | 8.1 | 14.5 | 0.20 | 1.12 | 1.12 | |
| | | | | | | | | | 14.5 | 0.20 | 0.00 | 1.36 | Confluence Pt. 3 |
| | | | | | | | | | | | | **1.36** | **Discharge Pt. 1** |
| P-4 | 1.17 | 0.35 | 0.41 | 100.0 | 320.0 | 9% | 6.9 | 1.1 | 8.0 | 0.20 | 0.08 | 0.08 | |
| | | | | | | | | | | | | **0.08** | **Discharge Pt. 2** |

**ALPINE SHELL STATION** 4/9/2019

**HYDROLOGY AND HYDRAULICS CALCS (Table No. 3)**

| Sub-Basin | AREA Ac. | "C" | CA | Overland flow length | Concentrated Flow Length, (ft) | S(%) (avg.) | Ti mins | Tt mins | $T_c$ mins | I in/hr | Q cfs | Q tot cfs | NOTES 100-Year Storm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | **P(6)= 3.4** |
| EX-1 | 1.99 | 0.39 | 0.77 | 60.0 | 530.0 | 14% | 3.2 | 2.1 | 5.3 | 8.64 | 6.69 | 6.69 | |
| OFF-1 | 13.74 | 0.41 | 5.61 | 100.0 | 1843.0 | 5% | 6.4 | 8.1 | 14.5 | 4.51 | 25.30 | 25.30 | |
| | | | | | | | | | 14.5 | 4.51 | | 28.79 | Ex. Confluence Pt-1 |
| | | | | | | | | | | | | **28.79** | **Discharge Pt. 1** |
| EX-2 | 1.94 | 0.53 | 1.03 | 60.0 | 515.0 | 10% | 3.2 | 2.0 | 5.2 | 8.72 | 8.98 | 8.98 | |
| | | | | | | | | | | | | **8.98** | **Discharge Pt. 2** |
| P-1 | 0.65 | 0.82 | 0.53 | 70.0 | 250.0 | 1% | 2.7 | 1.4 | 5.0 | 8.96 | 4.76 | 4.76 | |
| P-2 | 0.77 | 0.80 | 0.61 | 80.0 | 200.0 | 2% | 2.6 | 1.1 | 5.0 | 8.96 | 5.49 | 5.49 | |
| | | | | | | | | | 5.0 | 8.96 | 4.76 | 10.24 | Confluence Pt. 1 |
| P-3 | 1.34 | 0.35 | 0.47 | 100.0 | 400.0 | 15% | 6.9 | 1.2 | 8.1 | 6.58 | 3.09 | 3.09 | |
| | | | | | | | | | 8.1 | 8.96 | 0.00 | 9.44 | Confluence Pt. 2 |
| OFF-1 | 13.74 | 0.41 | 5.61 | 100.0 | 1843.0 | 5% | 6.4 | 8.1 | 14.5 | 4.51 | 25.30 | 25.30 | |
| | | | | | | | | | 14.5 | 8.96 | 0.00 | 30.05 | Confluence Pt. 3 |
| | | | | | | | | | | | | **30.05** | **Discharge Pt. 1** |
| P-4 | 1.17 | 0.35 | 0.41 | 100.0 | 320.0 | 9% | 6.9 | 1.1 | 8.0 | 6.62 | 2.70 | 2.70 | |
| | | | | | | | | | | | | **2.70** | **Discharge Pt. 2** |

**ALPINE SHELL STATION** 6/5/2019

**HYDROLOGY AND HYDRAULICS CALCS (Table No. 4)**

| Sub-Basin | AREA Ac. | "C" | CA | Overland flow length | Concentrated Flow Length, (ft) | S(%) (avg.) | Ti mins | Tt mins | $T_c$ mins | I in/hr | Q cfs | Q tot cfs | NOTES 100-Year Storm (mitigated) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | **P(6)= 3.4** |
| EX-1 | 1.99 | 0.39 | 0.77 | 60.0 | 530.0 | 14% | 3.2 | 2.1 | 5.3 | 8.64 | 6.69 | 6.69 | |
| OFF-1 | 13.74 | 0.41 | 5.61 | 100.0 | 1843.0 | 5% | 6.4 | 8.1 | 14.5 | 4.51 | 25.30 | 25.30 | |
| | | | | | | | | | 14.5 | 4.51 | | 28.79 | Ex. Confluence Pt-1 |
| | | | | | | | | | | | | **28.79** | **Discharge Pt. 1** |
| EX-2 | 1.94 | 0.53 | 1.03 | 60.0 | 515.0 | 10% | 3.2 | 2.0 | 5.2 | 8.72 | 8.98 | 8.98 | |
| | | | | | | | | | | | | **8.98** | **Discharge Pt. 2** |
| P-1 | 0.65 | 0.82 | 0.53 | 70.0 | 250.0 | 1% | 2.7 | 1.4 | 5.0 | 8.96 | 4.76 | 3.14 | **Mitigated flowrates** |
| P-2 | 0.77 | 0.80 | 0.61 | 80.0 | 200.0 | 2% | 2.6 | 1.1 | 5.0 | 8.96 | 5.49 | 2.91 | **Mitigated flowrates** |
| | | | | | | | | | 5.0 | 8.96 | 4.76 | 6.05 | Confluence Pt. 1 |
| P-3 | 1.34 | 0.35 | 0.47 | 100.0 | 400.0 | 15% | 6.9 | 1.2 | 8.1 | 6.58 | 3.09 | 3.09 | |
| | | | | | | | | | 8.1 | 8.96 | 0.00 | 6.84 | Confluence Pt. 2 |
| OFF-1 | 13.74 | 0.41 | 5.61 | 100.0 | 1843.0 | 5% | 6.4 | 8.1 | 14.5 | 4.51 | 25.30 | 25.30 | |
| | | | | | | | | | 14.5 | 8.96 | 0.00 | 28.75 | Confluence Pt. 3 |
| | | | | | | | | | | | | **28.75** | **Discharge Pt. 1** |
| P-4 | 1.17 | 0.35 | 0.41 | 100.0 | 320.0 | 9% | 6.9 | 1.1 | 8.0 | 6.62 | 2.70 | 2.70 | |
| | | | | | | | | | | | | **2.70** | **Discharge Pt. 2** |

**CONDUIT SIZING CALCULATIONS**

The following chart details the sizing parameters and for conduits that convey runoff on the site.
Flow parameters from *Handbook of Hydraulics, King & Brater* were used, see following page.

| | | |
|---|---|---|
| K'= Discharge factor | = | $(Q*n)/(d^{8/3}*s^{1/2})$ |
| n= Mannings coefficient | = | 0.013 for PVC & HDPE |
| d=diameter of conduit (ft) | = | per chart |
| Q= Discharge | = | based off portions of basins tributary to outlet |
| s=Minimum Pipe Slope (ft/ft) | = | per chart |
| D=depth of flow | = | From table 7-4 of the *Handbook of Hydraulics, King & Brater* See right |
| $C_a$= Flow factor | = | From table 7-14 of the *Handbook of Hydraulics, King & Brater* See right |
| A=Cross sectional area of flow | = | $C_a*d^2$ |
| V=Velocity | = | Q/A |

**Pipe Flow**

| Pipe | Tributary Areas | Q (cfs) | S (%) | d (in) | K' | D/d | $C_a$ | A (sf) | V (fps) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | P-1, 2 pipes | 2.38 | 0.5 | 12 | 0.4376 | 0.77 | 0.649 | 0.649 | 3.67 |
| 2 | P-1 | 4.76 | 1 | 18 | 0.2099 | 0.47 | 0.363 | 0.816 | 5.83 |
| 3 | P-2 | 5.49 | 1 | 18 | 0.2421 | 0.51 | 0.403 | 0.907 | 6.05 |
| 4 | P-1 & P-2 | 10.24 | 1 | 18 | 0.4515 | 0.79 | 0.666 | 1.499 | 6.83 |
| 5 | P-1 & P-2 | 10.24 | 18 | 18 | 0.1064 | 0.32 | 0.217 | 0.488 | 21.00 |
| 6 | Offsite Basin | 25.3 | 18 | 24 | 0.1221 | 0.35 | 0.245 | 0.980 | 25.82 |

Table 7-4. For Determining the Area $a$ of the Cross Section of a Circular Conduit Flowing Part Full

Let $\frac{\text{depth of water}}{\text{diameter of channel}} = \frac{D}{d}$ and $C_a$ = the tabulated value. Then $a = C_a d^2$.

| $\frac{D}{d}$ | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| .0 | .0000 | .0013 | .0037 | .0069 | .0105 | .0147 | .0192 | .0242 | .0294 | .0350 |
| .1 | .0409 | .0470 | .0534 | .0600 | .0668 | .0739 | .0811 | .0885 | .0961 | .1039 |
| .2 | .1118 | .1199 | .1281 | .1365 | .1449 | .1535 | .1623 | .1711 | .1800 | .1890 |
| .3 | .1982 | .2074 | .2167 | .2260 | .2355 | .2450 | .2546 | .2642 | .2739 | .2836 |
| .4 | .2934 | .3032 | .3130 | .3229 | .3328 | .3428 | .3527 | .3627 | .3727 | .3827 |
| .5 | .393 | .403 | .413 | .423 | .433 | .443 | .453 | .462 | .472 | .482 |
| .6 | .492 | .502 | .512 | .521 | .531 | .540 | .550 | .559 | .569 | .578 |
| .7 | .587 | .596 | .605 | .614 | .623 | .632 | .640 | .649 | .657 | .666 |
| .8 | .674 | .681 | .689 | .697 | .704 | .712 | .719 | .725 | .732 | .738 |
| .9 | .745 | .750 | .756 | .761 | .766 | .771 | .775 | .779 | .782 | .784 |

Table 7-14. Values of $K'$ for Circular Channels in the Formula

$$Q = \frac{K'}{n} d^{8/3} s^{1/2}$$

$D$ = depth of water $d$ = diameter of channel

| $\frac{D}{d}$ | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| .0 | | .00007 | .00031 | .00074 | .00138 | .00222 | .00328 | .00455 | .00604 | .00775 |
| .1 | .00967 | .0118 | .0142 | .0167 | .0195 | .0225 | .0257 | .0291 | .0327 | .0366 |
| .2 | .0406 | .0448 | .0492 | .0537 | .0585 | .0634 | .0686 | .0738 | .0793 | .0849 |
| .3 | .0907 | .0966 | .1027 | .1089 | .1153 | .1218 | .1284 | .1352 | .1420 | .1490 |
| .4 | .1561 | .1633 | .1705 | .1779 | .1854 | .1929 | .2005 | .2082 | .2160 | .2238 |
| .5 | .232 | .239 | .247 | .255 | .263 | .271 | .279 | .287 | .295 | .303 |
| .6 | .311 | .319 | .327 | .335 | .343 | .350 | .358 | .366 | .373 | .380 |
| .7 | .388 | .395 | .402 | .409 | .416 | .422 | .429 | .435 | .441 | .447 |
| .8 | .453 | .458 | .463 | .468 | .473 | .477 | .481 | .485 | .488 | .491 |
| .9 | .494 | .496 | .497 | .498 | .498 | .498 | .496 | .494 | .489 | .483 |
| 1.0 | .463 | | | | | | | | | |

# Inlet Report



## Inlet # 1, (G-2 inlet)

**Drop Grate Inlet**

| | |
|---|---|
| Location | = Sag |
| Curb Length (ft) | = -0- |
| Throat Height (in) | = -0- |
| Grate Area (sqft) | = 7.68 |
| Grate Width (ft) | = 1.92 |
| Grate Length (ft) | = 4.00 |

**Gutter**

| | |
|---|---|
| Slope, Sw (ft/ft) | = 0.086 |
| Slope, Sx (ft/ft) | = 0.086 |
| Local Depr (in) | = -0- |
| Gutter Width (ft) | = 2.00 |
| Gutter Slope (%) | = -0- |
| Gutter n-value | = -0- |

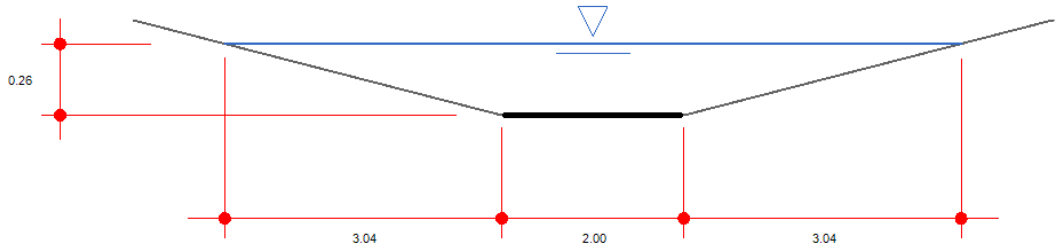
**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Q (cfs) | = 4.76 |

**Highlighted**

| | |
|---|---|
| Q Total (cfs) | = 4.76 |
| Q Capt (cfs) | = 4.76 |
| Q Bypass (cfs) | = -0- |
| Depth at Inlet (in) | = 3.14 |
| Efficiency (%) | = 100 |
| Gutter Spread (ft) | = 8.09 |
| Gutter Vel (ft/s) | = -0- |
| Bypass Spread (ft) | = -0- |
| Bypass Depth (in) | = -0- |

All dimensions in feet




Inlet Section

# Weir Report



## Inlet #2 (V-notch Weir)

**V-Notch Weir**

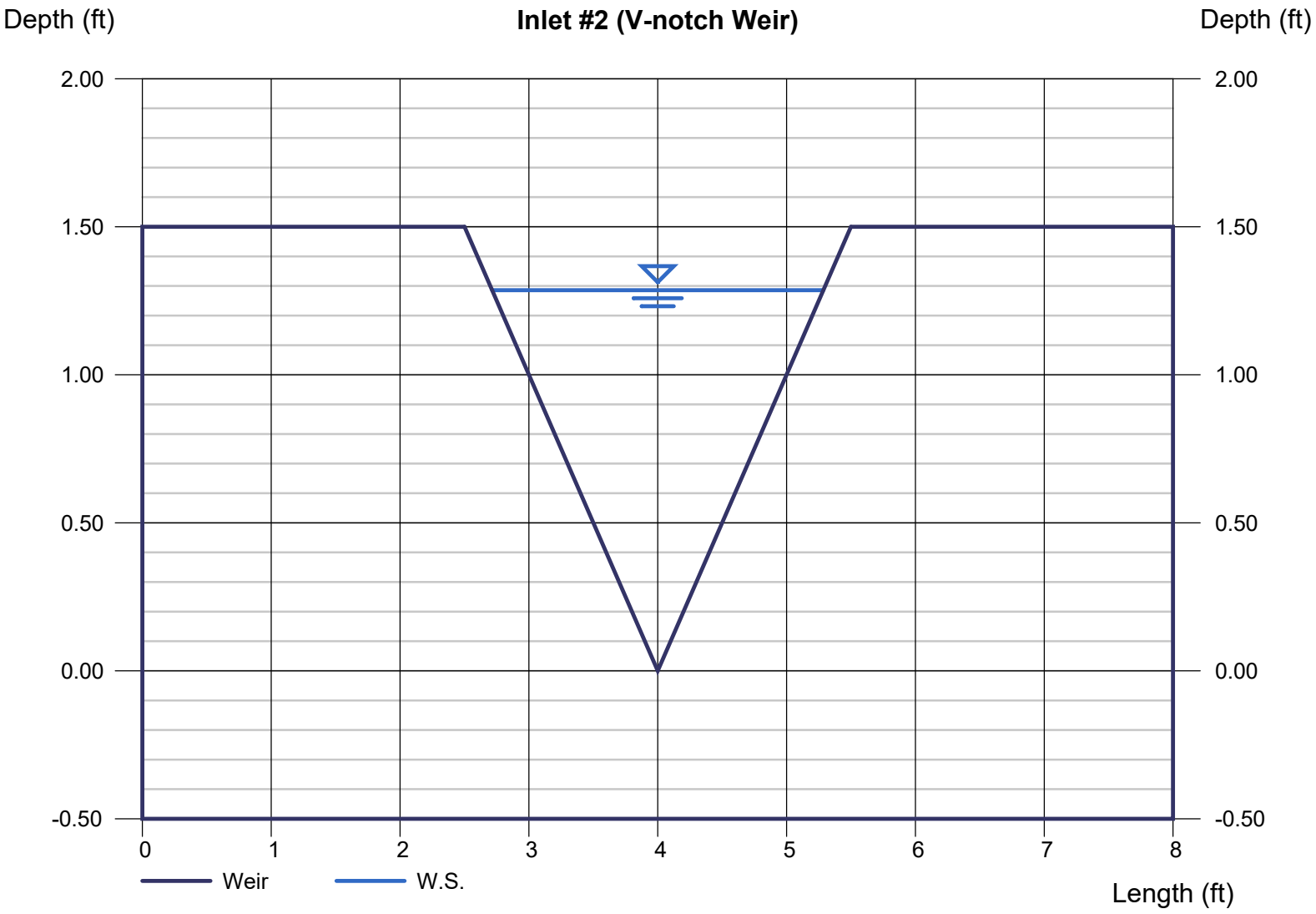
| | |
|---|---|
| Crest | = Sharp |
| Angle (Deg) | = 90 |
| Total Depth (ft) | = 1.50 |

**Calculations**

| | |
|---|---|
| Weir Coeff. Cw | = 2.54 |
| Compute by: | Known Q |
| Known Q (cfs) | = 4.76 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.29 |
| Q (cfs) | = 4.760 |
| Area (sqft) | = 1.65 |
| Velocity (ft/s) | = 2.88 |
| Top Width (ft) | = 2.57 |



# Weir Report



## Inlet #3 (V-notch Weir)

**V-Notch Weir**

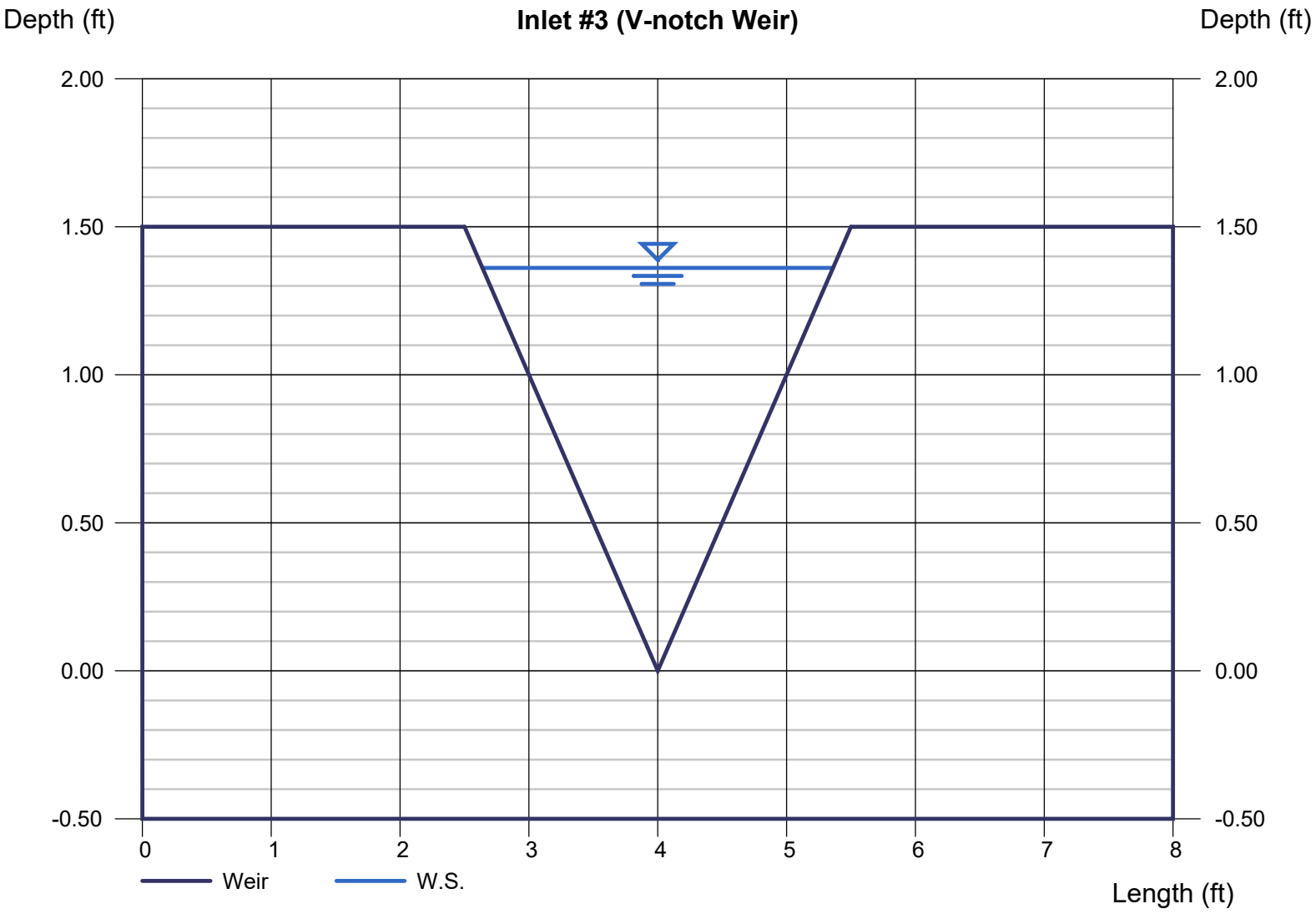
| | |
|---|---|
| Crest | = Sharp |
| Angle (Deg) | = 90 |
| Total Depth (ft) | = 1.50 |

**Calculations**

| | |
|---|---|
| Weir Coeff. Cw | = 2.54 |
| Compute by: | Known Q |
| Known Q (cfs) | = 5.49 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 1.36 |
| Q (cfs) | = 5.490 |
| Area (sqft) | = 1.85 |
| Velocity (ft/s) | = 2.96 |
| Top Width (ft) | = 2.72 |



RATIONAL METHOD HYDROGRAPH PROGRAM


BASIN A-1

RUN DATE 3/28/2018
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 5 MIN.
6 HOUR RAINFALL 3.4 INCHES
BASIN AREA 0.65 ACRES
RUNOFF COEFFICIENT 0.82
PEAK DISCHARGE 4.76 CFS

| | |
|---|---|
| TIME (MIN) = 0 | DISCHARGE (CFS) = 0 |
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| TIME (MIN) = 10 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 15 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 20 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 25 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 30 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 35 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 40 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 45 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 50 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 55 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 60 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 65 | DISCHARGE (CFS) = 0.1 |
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| TIME (MIN) = 75 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 80 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 85 | DISCHARGE (CFS) = 0.1 |
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| TIME (MIN) = 135 | DISCHARGE (CFS) = 0.2 |
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| TIME (MIN) = 145 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 150 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 155 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 160 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 165 | DISCHARGE (CFS) = 0.2 |
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| TIME (MIN) = 190 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 195 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 200 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 205 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 210 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 215 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 220 | DISCHARGE (CFS) = 0.5 |
| TIME (MIN) = 225 | DISCHARGE (CFS) = 0.6 |
| TIME (MIN) = 230 | DISCHARGE (CFS) = 0.6 |
| TIME (MIN) = 235 | DISCHARGE (CFS) = 0.9 |
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| TIME (MIN) = 245 | DISCHARGE (CFS) = 4.76 |
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| TIME (MIN) = 310 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 315 | DISCHARGE (CFS) = 0.2 |
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| TIME (MIN) = 325 | DISCHARGE (CFS) = 0.1 |
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| TIME (MIN) = 345 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 350 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 355 | DISCHARGE (CFS) = 0.1 |

RATIONAL METHOD HYDROGRAPH PROGRAM


BASIN A-Z

RUN DATE 3/28/2018
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 5 MIN.
6 HOUR RAINFALL 3.4 INCHES
BASIN AREA 0.77 ACRES
RUNOFF COEFFICIENT 0.8
PEAK DISCHARGE 5.49 CFS

| | |
|---|---|
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| TIME (MIN) = 20 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 25 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 30 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 35 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 40 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 45 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 50 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 55 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 60 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 65 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 70 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 75 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 80 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 85 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 90 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 95 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 100 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 105 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 110 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 115 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 120 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 125 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 130 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 135 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 140 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 145 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 150 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 155 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 160 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 165 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 170 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 175 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 180 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 185 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 190 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 195 | DISCHARGE (CFS) = 0.3 |
| TIME (MIN) = 200 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 205 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 210 | DISCHARGE (CFS) = 0.4 |
| TIME (MIN) = 215 | DISCHARGE (CFS) = 0.5 |
| TIME (MIN) = 220 | DISCHARGE (CFS) = 0.5 |
| TIME (MIN) = 225 | DISCHARGE (CFS) = 0.7 |
| TIME (MIN) = 230 | DISCHARGE (CFS) = 0.7 |
| TIME (MIN) = 235 | DISCHARGE (CFS) = 1.1 |
| TIME (MIN) = 240 | DISCHARGE (CFS) = 1.6 |
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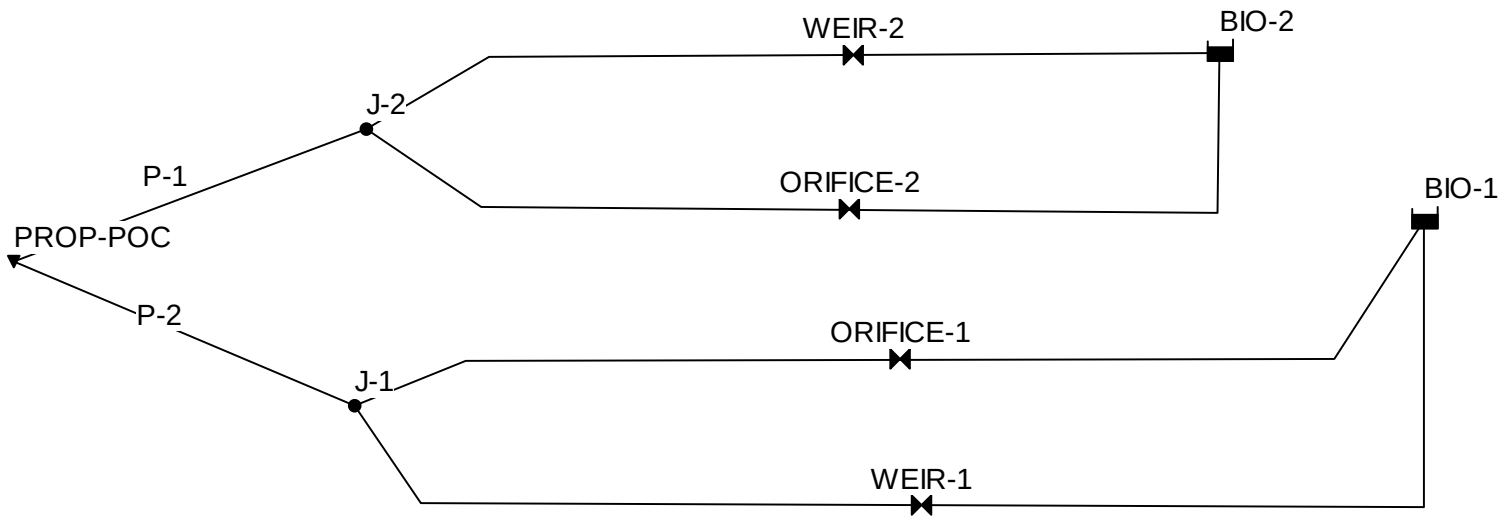
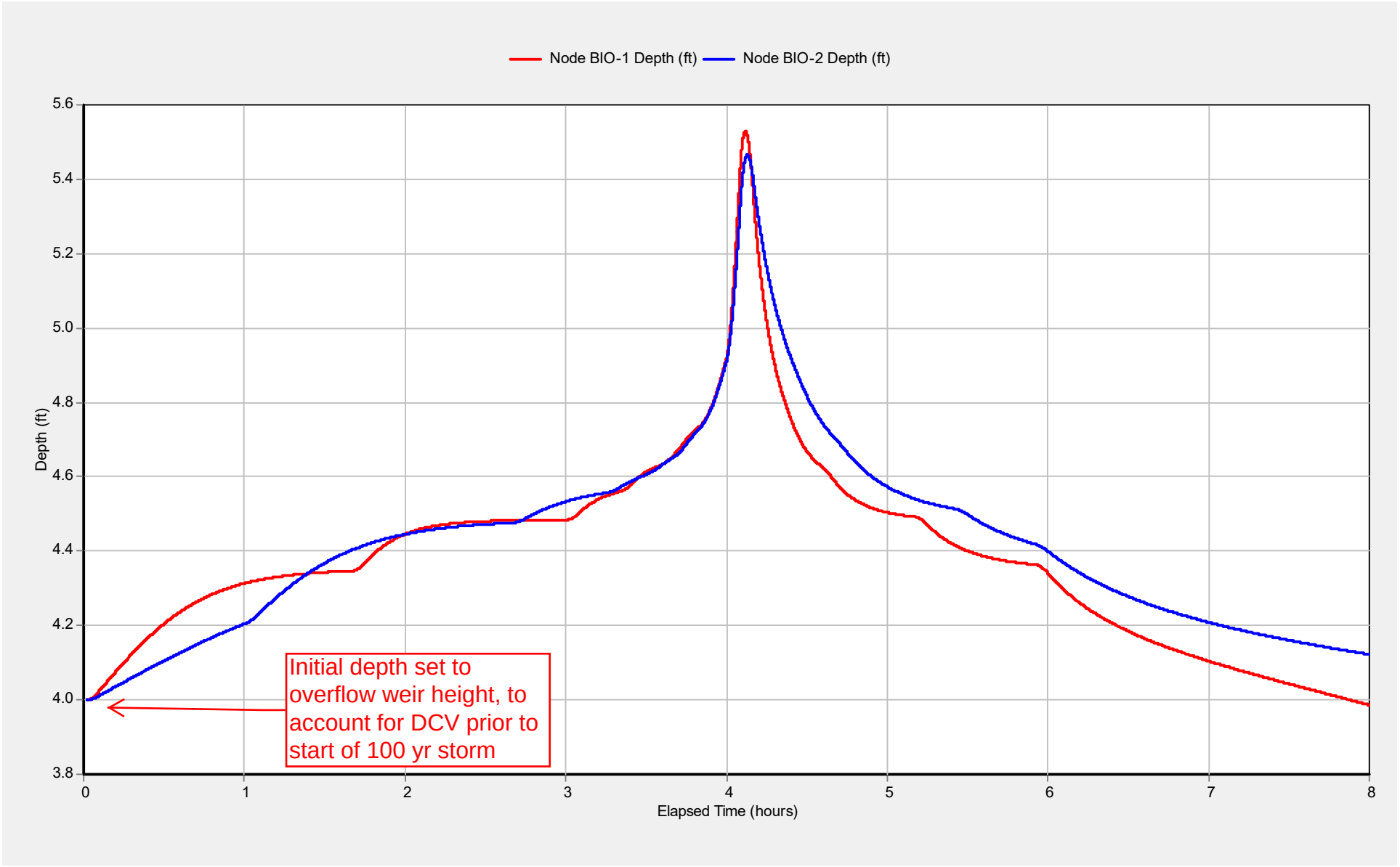
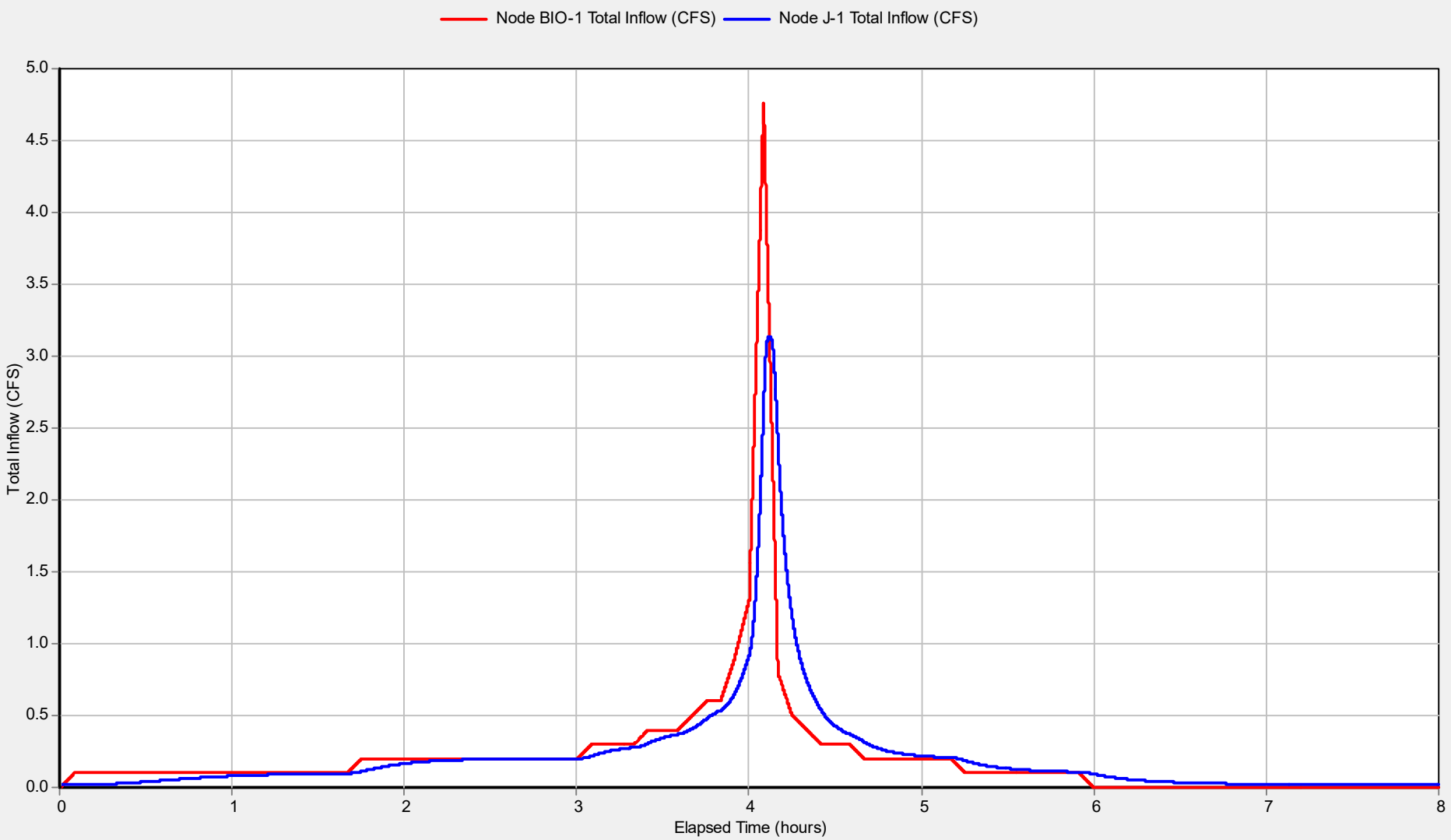
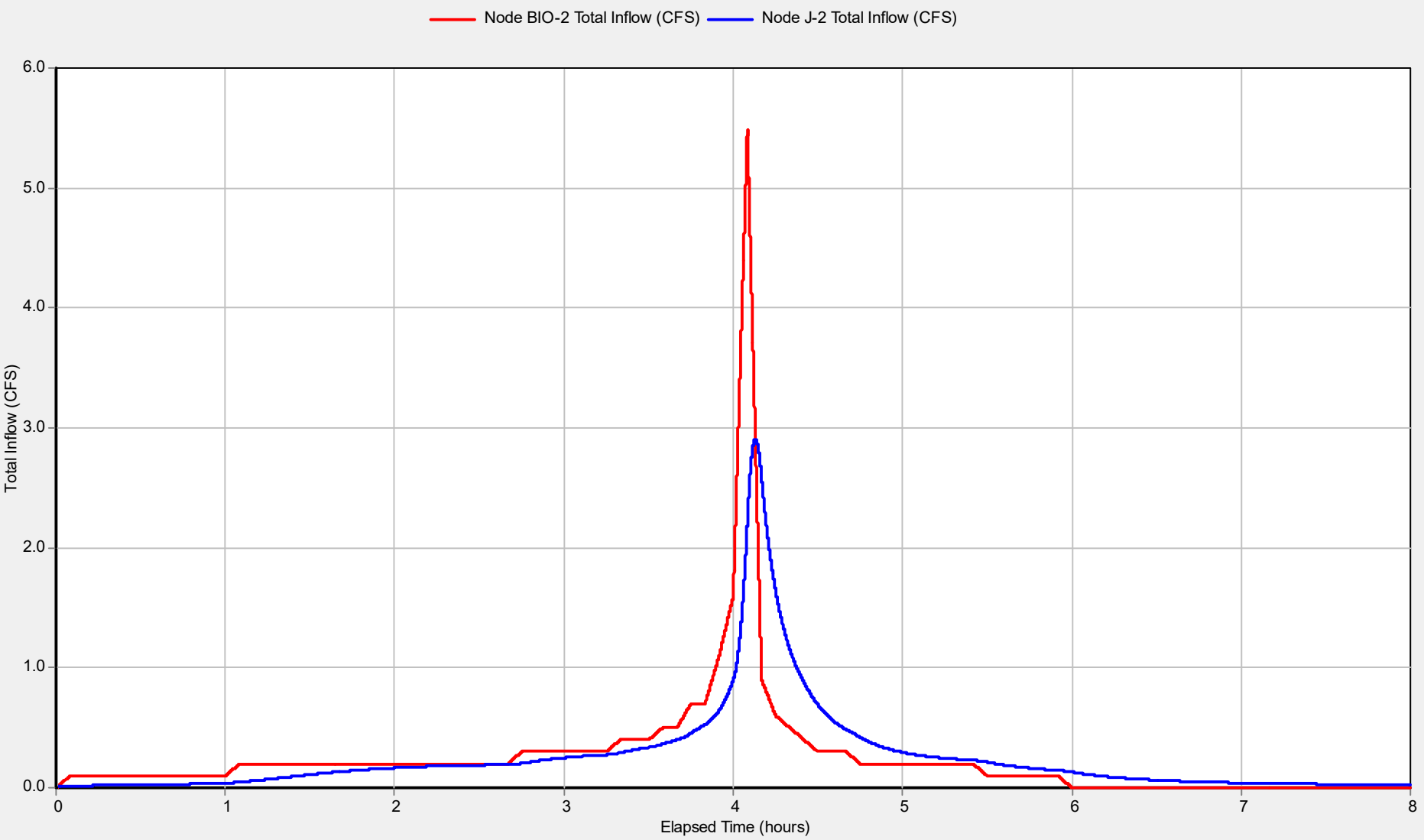
| TIME (MIN) = 325 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 330 | DISCHARGE (CFS) = 0.2 |
| TIME (MIN) = 335 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 340 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 345 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 350 | DISCHARGE (CFS) = 0.1 |
| TIME (MIN) = 355 | DISCHARGE (CFS) = 0.1 |


WEIR-2
BIO-2
J-2
P-1
ORIFICE-2
BIO-1
PROP-POC
P-2
ORIFICE-1
J-1
WEIR-1


Node BIO-1 Depth (ft)
Node BIO-2 Depth (ft)
Depth (ft)
5.6
5.4
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
0
1
2
3
4
5
6
7
8
Elapsed Time (hours)
Initial depth set to overflow weir height, to account for DCV prior to start of 100 yr storm




BMP-1, INFLOW & OUTFLOW HYDROGRAPHS




BMP-2, INFLOW & OUTFLOW HYDROGRAPHS

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

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

START_DATE           08/08/1963
START_TIME           00:00:00
REPORT_START_DATE    08/08/1963
REPORT_START_TIME    00:00:00
END_DATE             08/08/1963
END_TIME             08:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:00:01
WET_STEP             00:00:01
DRY_STEP             00:00:01
ROUTING_STEP         0:00:01

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

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
MONTHLY          0.070  0.100  0.130  0.170  0.190  0.220  0.240  0.220  0.190  0.130  0.090  0.060
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
J-1              0          0          0          0          0
J-2              0          0          0          0          0

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

```
[STORAGE]
;;Name           Elev.    MaxDepth   InitDepth  Shape      Curve Name/Params            N/A      Fevap    Psi      Ksat     IMD
;;-------------- -------- ---------- ---------- ---------- ---------------------------- -------- --------          -------- --------
BIO-1            0        6.5        4.0        TABULAR    BIO-1                        0        0
BIO-2            0        6.5        4.0        TABULAR    BIO-2                        0        0

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow   MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
P-1              J-2              PROP-POC         1          0.01       0          0          0          0
P-2              J-1              PROP-POC         1          0.01       0          0          0          0

[ORIFICES]
;;Name           From Node        To Node          Type         Offset     Qcoeff     Gated    CloseTime
;;-------------- ---------------- ---------------- ------------ ---------- ---------- -------- ----------
ORIFICE-1        BIO-1            J-1              SIDE         0          0.65       NO       0
ORIFICE-2        BIO-2            J-2              SIDE         0          0.65       NO       0

[WEIRS]
;;Name           From Node        To Node          Type         CrestHt    Qcoeff     Gated    EndCon   EndCoeff   Surcharge  RoadWidth  RoadSurf
;;-------------- ---------------- ---------------- ------------ ---------- ---------- -------- -------- ---------- ---------- ---------- ----------
WEIR-1           BIO-1            J-1              V-NOTCH      4.0        3.33       NO       0        0          YES
WEIR-2           BIO-2            J-2              V-NOTCH      4.0        3.33       NO       0        0          YES

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels    Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
P-1              DUMMY        0                0          0          0          1
P-2              DUMMY        0                0          0          0          1
ORIFICE-1        CIRCULAR     0.046875         0          0          0
ORIFICE-2        CIRCULAR     0.046875         0          0          0
WEIR-1           TRIANGULAR   1.5              1          1.0        1.0
WEIR-2           TRIANGULAR   1.5              1          1.0        1.0

[INFLOWS]
;;Node           Constituent      Time Series      Type     Mfactor  Sfactor  Baseline Pattern
;;-------------- ---------------- ---------------- -------- -------- -------- -------- --------
BIO-1            FLOW             A-1              FLOW     1.0      1.0
BIO-2            FLOW             A-2              FLOW     1.0      1.0

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
BIO-2            Storage    0          420
BIO-2                       2.0        420
BIO-2                       2.01       210
BIO-2                       3.5        210
BIO-2                       3.51       1050
BIO-2                       6.5        2100
;
BIO-1            Storage    0          170
BIO-1                       2          170
BIO-1                       2.01       85
BIO-1                       3.5        85
BIO-1                       3.51       424
```

```
BIO-1                     6          1140

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
A-1                         0:00       0
A-1                         0:05       0.1
A-1                         0:10       0.1
A-1                         0:15       0.1
A-1                         0:20       0.1
A-1                         0:25       0.1
A-1                         0:30       0.1
A-1                         0:35       0.1
A-1                         0:40       0.1
A-1                         0:45       0.1
A-1                         0:50       0.1
A-1                         0:55       0.1
A-1                         1:00       0.1
A-1                         1:05       0.1
A-1                         1:10       0.1
A-1                         1:15       0.1
A-1                         1:20       0.1
A-1                         1:25       0.1
A-1                         1:30       0.1
A-1                         1:35       0.1
A-1                         1:40       0.1
A-1                         1:45       0.2
A-1                         1:50       0.2
A-1                         1:55       0.2
A-1                         2:00       0.2
A-1                         2:05       0.2
A-1                         2:10       0.2
A-1                         2:15       0.2
A-1                         2:20       0.2
A-1                         2:25       0.2
A-1                         2:30       0.2
A-1                         2:35       0.2
A-1                         2:40       0.2
A-1                         2:45       0.2
A-1                         2:50       0.2
A-1                         2:55       0.2
A-1                         3:00       0.2
A-1                         3:05       0.3
A-1                         3:10       0.3
A-1                         3:15       0.3
A-1                         3:20       0.3
A-1                         3:25       0.4
A-1                         3:30       0.4
A-1                         3:35       0.4
A-1                         3:40       0.5
A-1                         3:45       0.6
A-1                         3:50       0.6
A-1                         3:55       0.9
A-1                         4:00       1.3
A-1                         4:05       4.76
A-1                         4:10       0.8
```

```
A-1                     4:15       0.5
A-1                     4:20       0.4
A-1                     4:25       0.3
A-1                     4:30       0.3
A-1                     4:35       0.3
A-1                     4:40       0.2
A-1                     4:45       0.2
A-1                     4:50       0.2
A-1                     4:55       0.2
A-1                     5:00       0.2
A-1                     5:05       0.2
A-1                     5:10       0.2
A-1                     5:15       0.1
A-1                     5:20       0.1
A-1                     5:25       0.1
A-1                     5:30       0.1
A-1                     5:35       0.1
A-1                     5:40       0.1
A-1                     5:45       0.1
A-1                     5:50       0.1
A-1                     5:55       0.1
A-1                     6:00       0
;
A-2                     0:00       0
A-2                     0:05       0.1
A-2                     0:10       0.1
A-2                     0:15       0.1
A-2                     0:20       0.1
A-2                     0:25       0.1
A-2                     0:30       0.1
A-2                     0:35       0.1
A-2                     0:40       0.1
A-2                     0:45       0.1
A-2                     0:50       0.1
A-2                     0:55       0.1
A-2                     1:00       0.1
A-2                     1:05       0.2
A-2                     1:10       0.2
A-2                     1:15       0.2
A-2                     1:20       0.2
A-2                     1:25       0.2
A-2                     1:30       0.2
A-2                     1:35       0.2
A-2                     1:40       0.2
A-2                     1:45       0.2
A-2                     1:50       0.2
A-2                     1:55       0.2
A-2                     2:00       0.2
A-2                     2:05       0.2
A-2                     2:10       0.2
A-2                     2:15       0.2
A-2                     2:20       0.2
A-2                     2:25       0.2
A-2                     2:30       0.2
A-2                     2:35       0.2
A-2                     2:40       0.2
```

```
A-2                     2:45       0.3
A-2                     2:50       0.3
A-2                     2:55       0.3
A-2                     3:00       0.3
A-2                     3:05       0.3
A-2                     3:10       0.3
A-2                     3:15       0.3
A-2                     3:20       0.4
A-2                     3:25       0.4
A-2                     3:30       0.4
A-2                     3:35       0.5
A-2                     3:40       0.5
A-2                     3:45       0.7
A-2                     3:50       0.7
A-2                     3:55       1.1
A-2                     4:00       1.6
A-2                     4:05       5.49
A-2                     4:10       0.9
A-2                     4:15       0.6
A-2                     4:20       0.5
A-2                     4:25       0.4
A-2                     4:30       0.3
A-2                     4:35       0.3
A-2                     4:40       0.3
A-2                     4:45       0.2
A-2                     4:50       0.2
A-2                     4:55       0.2
A-2                     5:00       0.2
A-2                     5:05       0.2
A-2                     5:10       0.2
A-2                     5:15       0.2
A-2                     5:20       0.2
A-2                     5:25       0.2
A-2                     5:30       0.1
A-2                     5:35       0.1
A-2                     5:40       0.1
A-2                     5:45       0.1
A-2                     5:50       0.1
A-2                     5:55       0.1
A-2                     6:00       0

[REPORT]
;;Reporting Options
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 0.000 0.000 10000.000 10000.000
Units      None

[COORDINATES]
```

```
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
J-1              6015.167           3854.766
J-2              6049.121           4669.650
PROP-POC         5007.881           4284.844
BIO-1            9162.311           4400.687
BIO-2            8559.061           4894.742

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
ORIFICE-1        8897.221           3995.610
ORIFICE-1        6343.384           3990.580
ORIFICE-2        8558.087           4428.006
ORIFICE-2        6388.656           4443.293
WEIR-1           9161.524           3560.503
WEIR-1           6207.571           3571.821
WEIR-2           6411.291           4884.689
```

# Appendices

# Appendix 1

# County of San Diego Hydrology Manual

*Soil Hydrologic Groups*

Orange County

Riverside County

Imperial County

Pacific Ocean

Mexico

PROJECT SITE
Soil Group D

OCEANSIDE
VISTA
CARLSBAD
ESCONDIDO
ENCINITAS
SOLANA BEACH
DEL MAR
POWAY
S.D. COU
SANTEE
SAN DIEGO
EL CAJON
LA MESA
LEMON GROVE
CORONADO
CHULA VISTA
IMPERIAL BEACH

117°30' 117°15' 117°00' 116°45' 116°30' 116°15'
33°30' 33°15' 33°00' 32°45' 32°30'

## Legend

Soil Groups

- Group A
- Group B
- Group C
- Group D
- Undetermined
- Data Unavailable

DPW GIS
Department of Public Works
Geographic Information Services

SanGIS
We Have San Diego Covered!

N W E S



3 0 3 Miles

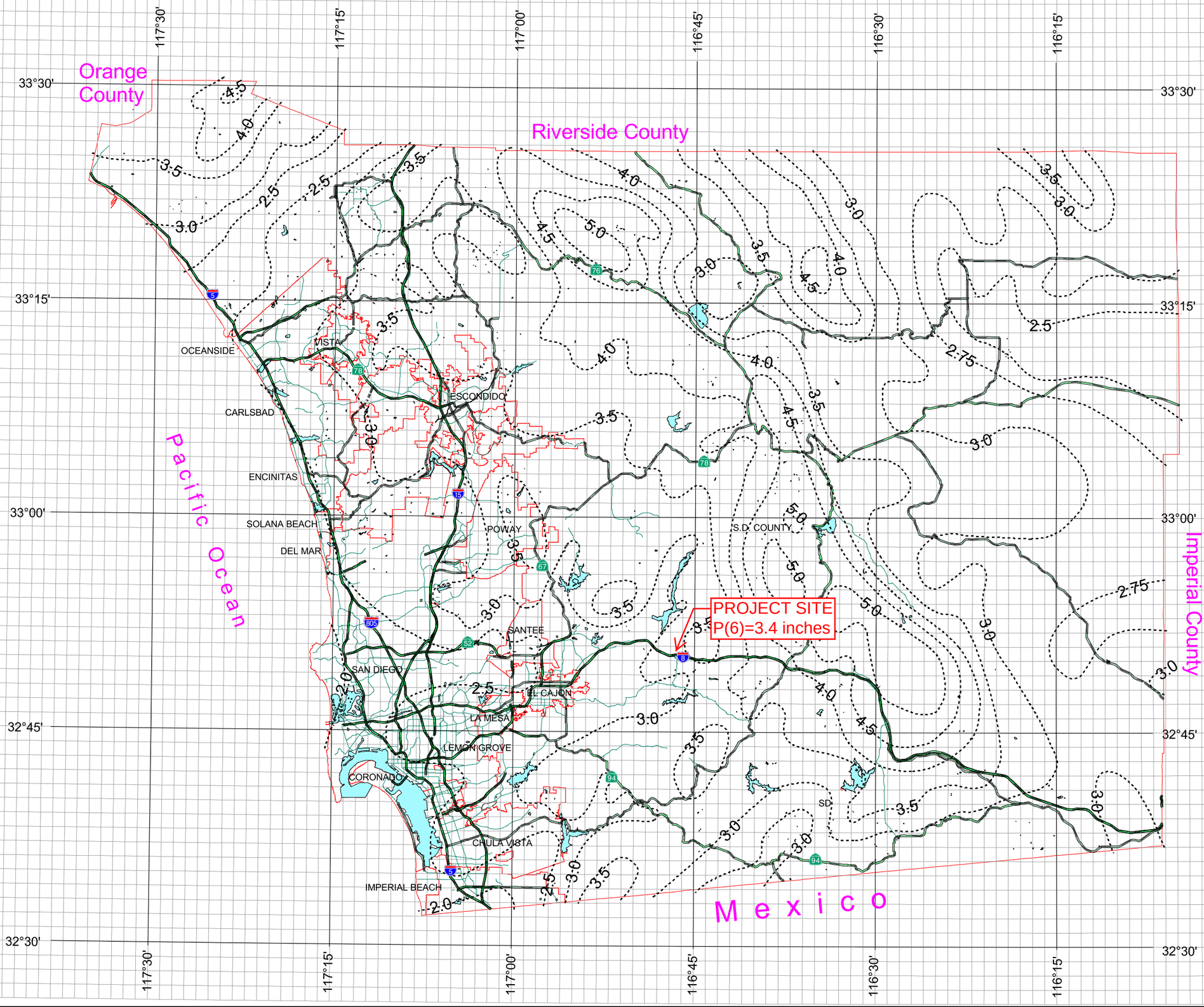
# Appendix 2

# County of San Diego Hydrology Manual

*Rainfall Isopluvials*

**100 Year Rainfall Event - 6 Hours**

Isopluvial (inches)




DPW GIS
Department of Public Works
Geographic Information Services

SanGIS
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N W E S



3 0 3 Miles

# Appendix 3

# County of San Diego Hydrology Manual

*Rainfall Isopluvials*

**100 Year Rainfall Event - 24 Hours**

Isopluvial (inches)

PROJECT SITE
P(6)=7.0 inches

Orange County

Riverside County

Imperial County

Pacific Ocean

Mexico

OCEANSIDE
VISTA
CARLSBAD
ESCONDIDO
ENCINITAS
SOLANA BEACH
DEL MAR
POWAY
S.D. COUNTY
SANTEE
SAN DIEGO
EL CAJON
LA MESA
LEMON GROVE
CORONADO
CHULA VISTA
IMPERIAL BEACH
SD

117°30' 117°15' 117°00' 116°45' 116°30' 116°15'
33°30' 33°15' 33°00' 32°45' 32°30'

DPW GIS
Department of Public Works
Geographic Information Services

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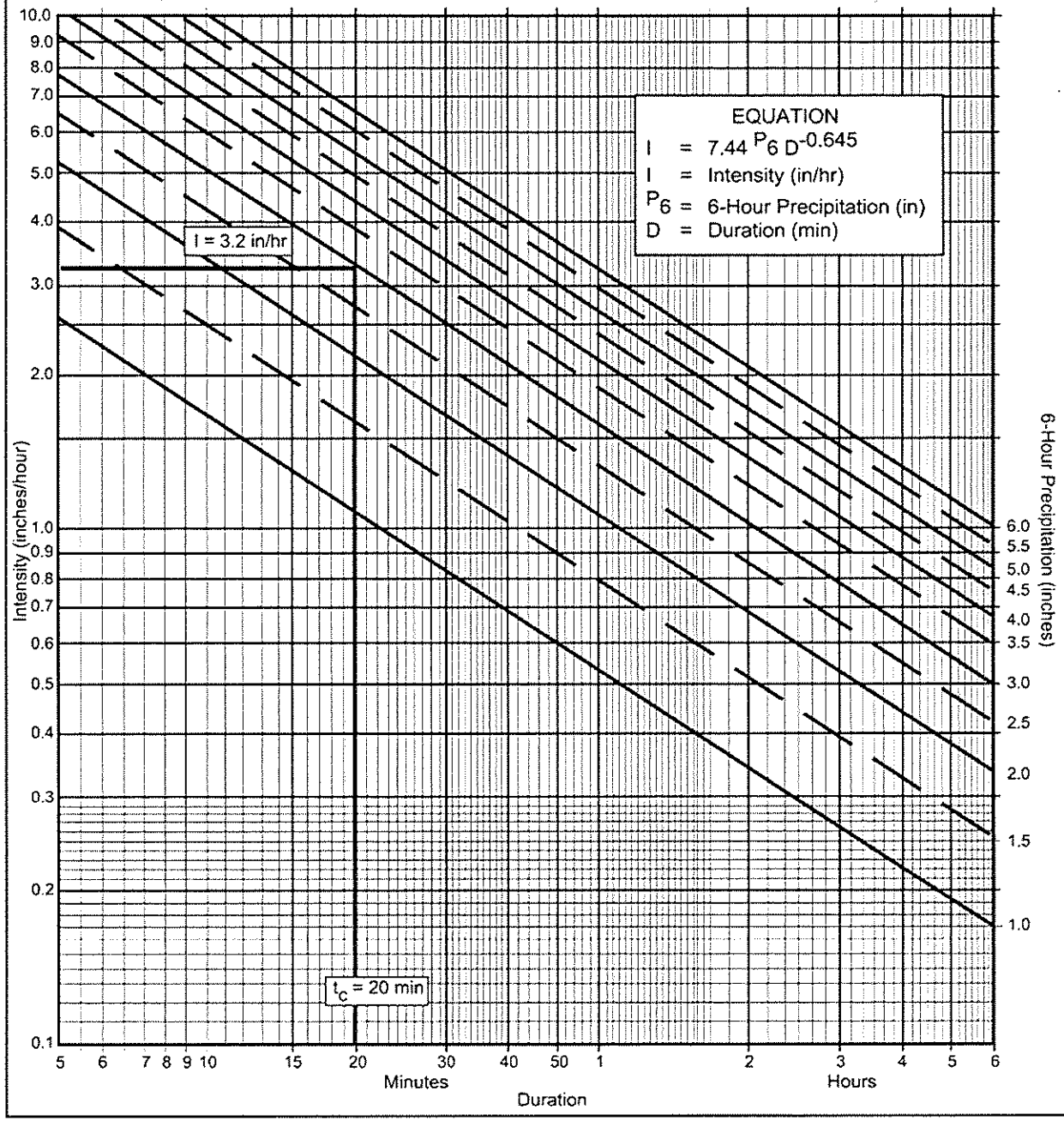
N W E S

3 0 3 Miles

# Appendix 4




**Directions for Application:**

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

**Application For**

(a) Selected frequency _____ year

(b) $P_6$ = _____ in., $P_{24}$ = _____, $\frac{P_6}{P_{24}}$ = _____ %(2)

(c) Adjusted $P_6$(2) = _____ in.

(d) $t_x$ = _____ min.

(e) I = _____ in./hr.

Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

| P6 / Duration | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 | 4 | 4.5 | 5 | 5.5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 2.63 | 3.95 | 5.27 | 6.59 | 7.90 | 9.22 | 10.54 | 11.86 | 13.17 | 14.49 | 15.81 |
| 7 | 2.12 | 3.18 | 4.24 | 5.30 | 6.36 | 7.42 | 8.48 | 9.54 | 10.60 | 11.66 | 12.72 |
| 10 | 1.68 | 2.53 | 3.37 | 4.21 | 5.05 | 5.90 | 6.74 | 7.58 | 8.42 | 9.27 | 10.11 |
| 15 | 1.30 | 1.95 | 2.59 | 3.24 | 3.89 | 4.54 | 5.19 | 5.84 | 6.49 | 7.13 | 7.78 |
| 20 | 1.08 | 1.62 | 2.15 | 2.69 | 3.23 | 3.77 | 4.31 | 4.85 | 5.39 | 5.93 | 6.46 |
| 25 | 0.93 | 1.40 | 1.87 | 2.33 | 2.80 | 3.27 | 3.73 | 4.20 | 4.67 | 5.13 | 5.60 |
| 30 | 0.83 | 1.24 | 1.66 | 2.07 | 2.49 | 2.90 | 3.32 | 3.73 | 4.15 | 4.56 | 4.98 |
| 40 | 0.69 | 1.03 | 1.38 | 1.72 | 2.07 | 2.41 | 2.76 | 3.10 | 3.45 | 3.79 | 4.13 |
| 50 | 0.60 | 0.90 | 1.19 | 1.49 | 1.79 | 2.09 | 2.39 | 2.69 | 2.98 | 3.28 | 3.58 |
| 60 | 0.53 | 0.80 | 1.06 | 1.33 | 1.59 | 1.86 | 2.12 | 2.39 | 2.65 | 2.92 | 3.18 |
| 90 | 0.41 | 0.61 | 0.82 | 1.02 | 1.23 | 1.43 | 1.63 | 1.84 | 2.04 | 2.25 | 2.45 |
| 120 | 0.34 | 0.51 | 0.68 | 0.85 | 1.02 | 1.19 | 1.36 | 1.53 | 1.70 | 1.87 | 2.04 |
| 150 | 0.29 | 0.44 | 0.59 | 0.73 | 0.88 | 1.03 | 1.18 | 1.32 | 1.47 | 1.62 | 1.76 |
| 180 | 0.26 | 0.39 | 0.52 | 0.65 | 0.78 | 0.91 | 1.04 | 1.18 | 1.31 | 1.44 | 1.57 |
| 240 | 0.22 | 0.33 | 0.43 | 0.54 | 0.65 | 0.76 | 0.87 | 0.98 | 1.08 | 1.19 | 1.30 |
| 300 | 0.19 | 0.28 | 0.38 | 0.47 | 0.56 | 0.66 | 0.75 | 0.85 | 0.94 | 1.03 | 1.13 |
| 360 | 0.17 | 0.25 | 0.33 | 0.42 | 0.50 | 0.58 | 0.67 | 0.75 | 0.84 | 0.92 | 1.00 |

**Intensity-Duration Design Chart - Example**

# Appendix 5

## Table 3-1
## RUNOFF COEFFICIENTS FOR URBAN AREAS

| Land Use | | Runoff Coefficient "C" | | | | |
|---|---|---|---|---|---|---|
| | | | Soil Type | | | |
| NRCS Elements | County Elements | % IMPER. | A | B | C | D |
| Undisturbed Natural Terrain (Natural) | Permanent Open Space | 0* | 0.20 | 0.25 | 0.30 | 0.35 |
| Low Density Residential (LDR) | Residential, 1.0 DU/A or less | 10 | 0.27 | 0.32 | 0.36 | 0.41 |
| Low Density Residential (LDR) | Residential, 2.0 DU/A or less | 20 | 0.34 | 0.38 | 0.42 | 0.46 |
| Low Density Residential (LDR) | Residential, 2.9 DU/A or less | 25 | 0.38 | 0.41 | 0.45 | 0.49 |
| Medium Density Residential (MDR) | Residential, 4.3 DU/A or less | 30 | 0.41 | 0.45 | 0.48 | 0.52 |
| Medium Density Residential (MDR) | Residential, 7.3 DU/A or less | 40 | 0.48 | 0.51 | 0.54 | 0.57 |
| Medium Density Residential (MDR) | Residential, 10.9 DU/A or less | 45 | 0.52 | 0.54 | 0.57 | 0.60 |
| Medium Density Residential (MDR) | Residential, 14.5 DU/A or less | 50 | 0.55 | 0.58 | 0.60 | 0.63 |
| High Density Residential (HDR) | Residential, 24.0 DU/A or less | 65 | 0.66 | 0.67 | 0.69 | 0.71 |
| High Density Residential (HDR) | Residential, 43.0 DU/A or less | 80 | 0.76 | 0.77 | 0.78 | 0.79 |
| Commercial/Industrial (N. Com) | Neighborhood Commercial | 80 | 0.76 | 0.77 | 0.78 | 0.79 |
| Commercial/Industrial (G. Com) | General Commercial | 85 | 0.80 | 0.80 | 0.81 | 0.82 |
| Commercial/Industrial (O.P. Com) | Office Professional/Commercial | 90 | 0.83 | 0.84 | 0.84 | 0.85 |
| Commercial/Industrial (Limited I.) | Limited Industrial | 90 | 0.83 | 0.84 | 0.84 | 0.85 |
| Commercial/Industrial (General I.) | General Industrial | 95 | 0.87 | 0.87 | 0.87 | 0.87 |

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service

# Appendix 6

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length ($L_M$)) of sheet flow to be used in hydrology studies. Initial $T_i$ values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

**Table 3-2**

**MAXIMUM OVERLAND FLOW LENGTH ($L_M$)**
**& INITIAL TIME OF CONCENTRATION ($T_i$)**

| Element* | DU/ Acre | .5% | | 1% | | 2% | | 3% | | 5% | | 10% | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $L_M$ | $T_i$ | $L_M$ | $T_i$ | $L_M$ | $T_i$ | $L_M$ | $T_i$ | $L_M$ | $T_i$ | $L_M$ | $T_i$ |
| Natural | | 50 | 13.2 | 70 | 12.5 | 85 | 10.9 | 100 | 10.3 | 100 | 8.7 | 100 | 6.9 |
| LDR | 1 | 50 | 12.2 | 70 | 11.5 | 85 | 10.0 | 100 | 9.5 | 100 | 8.0 | 100 | 6.4 |
| LDR | 2 | 50 | 11.3 | 70 | 10.5 | 85 | 9.2 | 100 | 8.8 | 100 | 7.4 | 100 | 5.8 |
| LDR | 2.9 | 50 | 10.7 | 70 | 10.0 | 85 | 8.8 | 95 | 8.1 | 100 | 7.0 | 100 | 5.6 |
| MDR | 4.3 | 50 | 10.2 | 70 | 9.6 | 80 | 8.1 | 95 | 7.8 | 100 | 6.7 | 100 | 5.3 |
| MDR | 7.3 | 50 | 9.2 | 65 | 8.4 | 80 | 7.4 | 95 | 7.0 | 100 | 6.0 | 100 | 4.8 |
| MDR | 10.9 | 50 | 8.7 | 65 | 7.9 | 80 | 6.9 | 90 | 6.4 | 100 | 5.7 | 100 | 4.5 |
| MDR | 14.5 | 50 | 8.2 | 65 | 7.4 | 80 | 6.5 | 90 | 6.0 | 100 | 5.4 | 100 | 4.3 |
| HDR | 24 | 50 | 6.7 | 65 | 6.1 | 75 | 5.1 | 90 | 4.9 | 95 | 4.3 | 100 | 3.5 |
| HDR | 43 | 50 | 5.3 | 65 | 4.7 | 75 | 4.0 | 85 | 3.8 | 95 | 3.4 | 100 | 2.7 |
| N. Com | | 50 | 5.3 | 60 | 4.5 | 75 | 4.0 | 85 | 3.8 | 95 | 3.4 | 100 | 2.7 |
| G. Com | | 50 | 4.7 | 60 | 4.1 | 75 | 3.6 | 85 | 3.4 | 90 | 2.9 | 100 | 2.4 |
| O.P./Com | | 50 | 4.2 | 60 | 3.7 | 70 | 3.1 | 80 | 2.9 | 90 | 2.6 | 100 | 2.2 |
| Limited I. | | 50 | 4.2 | 60 | 3.7 | 70 | 3.1 | 80 | 2.9 | 90 | 2.6 | 100 | 2.2 |
| General I. | | 50 | 3.7 | 60 | 3.2 | 70 | 2.7 | 80 | 2.6 | 90 | 2.3 | 100 | 1.9 |

*See Table 3-1 for more detailed description