IS/MND Appendix F

Hydrology Reports

PRELIMINARY HYDROLOGY AND HYDRAULIC REPORT

CAMINO LARGO
2123 N. Santa Fe Avenue
APN 159-240-07

City of Vista

Prepared for:

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August 13, 2021

W.O. 864-1154-400

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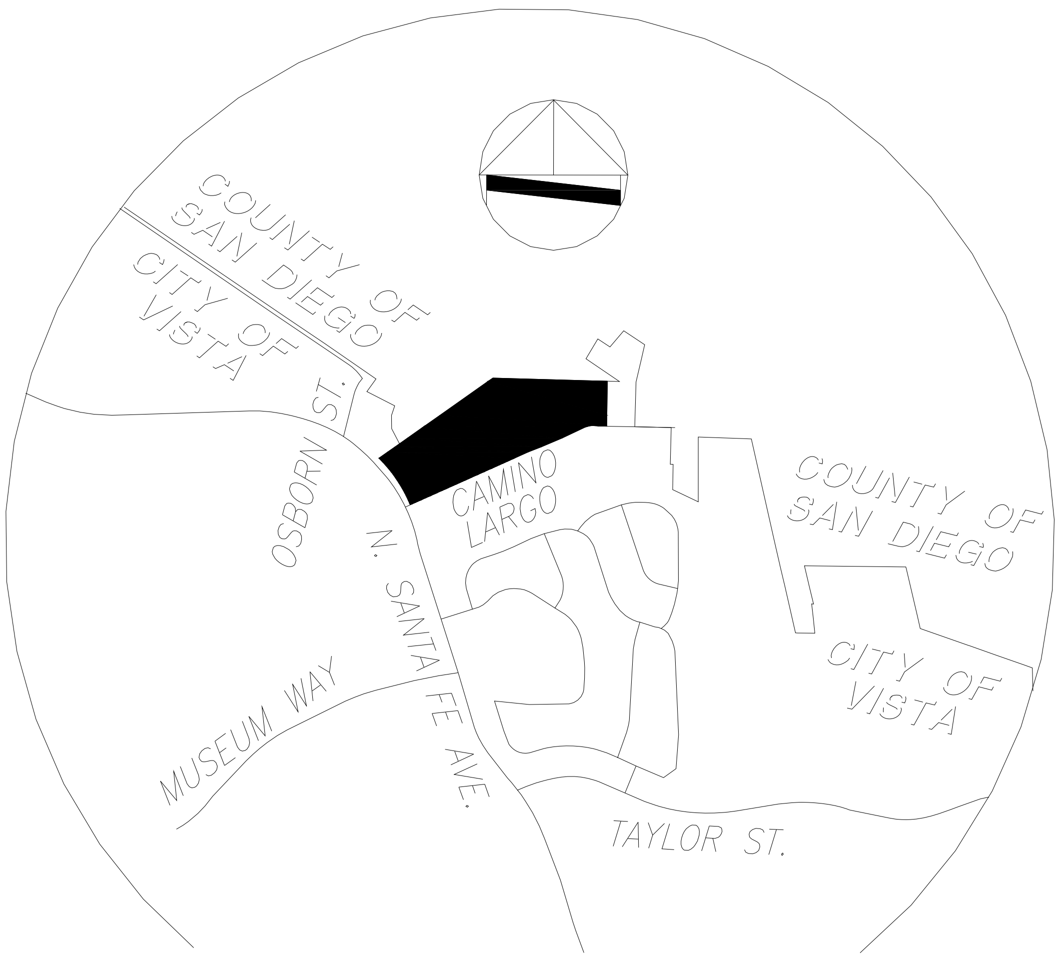
CHAPTER 1 – DISCUSSION

1.1 VICINITY MAP



VICINITY MAP

NO SCALE

1.2 PURPOSE AND SCOPE

The purpose of this report is to publish the results of hydrology and hydraulic computer analysis for the proposed Tentative Subdivision Map of Camino Largo Project in the City of Vista. The scope of this study is to analyze the results of pre-developed and post-developed condition hydrology calculations and provide recommendations as to the design and size of various hydraulic systems considered as mitigation of any potential adverse effects of the proposed project. The mitigation measures proposed will include runoff interception ditches, specific routing and bypassing of runoff from areas that will remain in their natural condition, and detention calculations and sizing to attenuate the effects of development on storm water discharge. The 100-year storm frequency will be analyzed. Information contained in this report will be referred to for the purpose of sizing treatment facilities as proposed in the associated Storm Water Quality Management Plan.

1.3 PROJECT DESCRIPTION

The Camino Largo project is located in the County of San Diego (APN 159-240-07) on the east side of North Santa Fe Avenue and north of Camino Largo at the intersection of North Santa Fe Avenue and Camino Largo. The property consists of approximately 9.30 acres.

The project site drains to two (2) Points of Compliance located near the southwest and southeast corners of the project site.

Treatment of storm water runoff from the site has been addressed in a separate report- "Priority Development Project (PDP) Storm Water Quality Management Plan (SWQMP) for Camino Largo" by BHA. Hydromodificaiton (HMP) analysis has also been presented within the SWQMP.

Per County of San Diego drainage criteria, the Modified Rational Method should be used to determine peak flowrates when the contributing drainage area is less than 1.0 square mile.

Hydraulic Modified-Puls detention basin routing of the aforementioned modified rational method hydrology was performed using the Army Corps of Engineers HEC-HMS 4.8 software.

1.4 PRE-DEVELOPMENT CONDITIONS

The project site is a hillside property dominated by an east-west trending ridge that rises approximately 66 feet above the lowest site terrain along North Santa Fe Avenue. The steepest project slopes descend to the north at 3:1(H:V) gradients. Site terrain continues to support a modest growth of native grass. Currently there is a nursery on the site, including greenhouse facilities, dirt roadways, and various storage structures. Less than 5% of the property site is impervious. The site is surrounded by undeveloped lands and single family residential homes.

The existing drainage area is divided to three (3) basins. Areas draining towards POC-1 sheet flows from the top of the ridge southerly, and then westerly along Camino Largo until discharging to the south side of Camino Largo just before North Santa Fe Ave at POC-1. Areas draining towards POC-2 sheet flows westerly off the ridge until discharging southerly over the top of the decomposed granite private road, and into a natural swale at POC-2. In Additional offsite areas northeast of the easterly boundary flows to POC-2. All drainage enters an existing stream bed to the south of Camino Largo, eventually joining at an existing culvert crossing below North Santa Fe Avenue approximately 100 feet south of the project site

Table 1 summarizes the pre-developed condition runoff information from the site. Please refer to the Pre-Developed Hydrology Exhibit for drainage patterns and areas.

TABLE 1—Summary of Pre-Developed Peak Flows

POC-ID	Drainage Area (ac)	100-Year Peak Flow (cfs)
POC-1	4.95	7.05
POC-2	4.16	6.23
Total	9.11	13.28

1.5 POST-DEVELOPMENT CONDITIONS

The Camino Largo Project proposes the development of a forty six (46) lot residential subdivision, with individual level building pads on 9.3 gross acres. The project also proposes the minor widening and improvement of the Camino Largo private drive, which will include paving, sidewalks with curb and gutter.

The graded site will include forty six (46) new residential lots with driveways and landscaping areas along five (5) streets north of Camino Largo. Approximately 59% of the property will be impervious. Biofiltration basins are proposed for the two main drainage basins for POC-1 and POC-2 that increases in the drainage discharge rate and velocity will be mitigated up to the 100-year runoff. Proposed grading has been minimized as much as possible to maintain existing slope and drainage patterns.

POC-1
There is one (1) biofiltration basin which will outlet into an existing storm drain along-side North Santa Fe Avenue south of Camino Largo and discharge from the site at POC-1.

POC-2
There is one (1) biofiltration basin, which outlets via a storm drain into a natural swale at POC-2. Additional offsite areas along the easterly boundary and towards the northeast is diverted around the development via drainage channels and rip rap, to discharge as historically over Camino Largo and sheet flow into a natural swale.

Rip rap energy dissipaters are proposed at storm drain outlets to reduce flow velocities. Post-development site flow will mimic existing drainage conditions, and will discharge from the site at below historical flow rates. The Homeowners Association will maintain the private road, storm drain system, and biofiltration basins.

Per 2003 County of San Diego criteria, runoff coefficients were assumed respectively for the developed project site dependent upon hydrologic soil class and surface land use.

Table 2 summarizes the expected cumulative 100-year peak flow rates from POC-1 and POC-2.

TABLE 2—Summary of Developed Conditions Peak Flows

POC-ID	Drainage Area (ac)	Undetained 100-Year Peak Flow (cfs)
POC-1	4.83	17.17
POC-2	5.06	17.99

Prior to discharging from the site, first flush runoff will be treated via the biofiltration based BMPs in accordance with standards set forth by the Regional Water Quality Control Board and the 2016 Vista BMP Design Manual (see "Storm Water Quality Management Plan (SWQMP) for Camino Largo" by BHA).

Two (2) LID biofiltration basins are located within the project site and are responsible for handling hydromodificaiton requirements for the project site. In post-developed conditions, the basins will have surface ponding and a riser spillway structure (see dimensions in Table 3). Flows will then discharge from the basins via the outlet structure or infiltrate through the bio-filtration layers of the facilities to the low flow orifice. The riser structures will act as a spillway such that peak flows can be safely discharged to the receiving storm drain system.

Beneath the basins' invert lies the LID biofiltration portion of the drainage facilities. Biofiltration basins in 1 and 2 are responsible for handling hydromodification requirements for POC-1 and POC-2. Basins 1 and Basin 2 will have a ponding depth of 6 inches. BMPs are comprised of an 18-inch layer of amended soil (a highly sandy, organic rich compost with an infiltration capacity of at least 5 in/hr), and a 7-inch reservoir layer of gravel for additional detention, and to accommodate the French drain system. Below the reservoir layer, the basins will include 3 inches of saturated storage. Flows will discharge from the basin via a low-flow orifice outlet within the gravel layer to the receiving storm drain system. A riser structure will be constructed within the BMP with multiple low-flow orifices and an emergency overflow, such that peak flows can be safely discharged to the storm drain system. A typical cross section of the basins is provided in Chapter 4.3.

TABLE 3—Summary Of BMP Dimensions

Biofiltration BMP	Tributary Area (Ac)	Dimensions				
		BMP Area(1) (ft^2)	Underdrain Orifice, D(2) (in)	Total Gravel Depth(3)	Riser Invert Elev,	Min. Total Surface
BMP 1	4.548	6,132	3.00	7	18	12
BMP 2	3.121	8,300	3.00	7	18	12

Notes: (1): Area of amended soil = area of gravel = area of BMP.

(2): Diameter of the orifice in gravel layer with invert at bottom of layer; tied with hydromod min threshold (50%Q2).

(3): Total depth of gravel including 3" of saturated storage located below

(4): Depth from bottom of pond to invert of emergency overflow weir.

`

TABLE 4—Summary Of BMP Dimensions

Biofiltration BMP	Lower Slot Dimensions			Upper Slot Dimensions			Emergency Weir	
	Outlet Type(1)	Invert Elev, HL(2) (in)	(#) - Width x Height (in) (3)	Outlet Type(1)	Invert Elev, HL(2) (in)	(#) - Width x Height (in)	Riser Invert Elev,	Weir Perimeter Length(5)
BMP 1	Slot	6	(1) - 58 x 3	Slot	7	(1) - 10 x 3	18	11.83
BMP 2	Slot	6	(1) - 32 x 3	Slot	7	(1) - 6 x 2	18	11.83

Notes: (1): Shape of orifice opening in riser structure.

(2): Depth from bottom of pond to invert of lower slot or weir.

(3): Number of slots and slot dimensions: For example for BMP 1: One 57-inch wide by 3-inch high slot at 6-inches above bottom of basin and one 9-inch wide by 3-inch high slot at 7-inches above bottom of basin.

(4): Depth from bottom of pont to invert of emergency overflow weir.

(5): Overflow length, the internal perimeter of the riser.

Rainfall

Precipitation has been obtained from NOAA website at the coordinates of the project (Chapter 6- References).

Rainfall was developed using the SDCHM, where the duration "t" is made equal to the time of concentration to maximize peak flow. However, longer durations up to 360 minutes are used to build the complete hyetograph (precipitation distribution for the 100-year, 6-hour storm event). The 6-hour storm is distributed according to the methodology explained in the SDCHM, where the peak precipitation starts four hours after the beginning of the storm (see intensity tables in Chapter 5 - References).

BMP 1 and BMP 2 are designed as a conjunctive use facilities. Conjunctive use facilities are designed to serve two or more purposes. BMP 1 and BMP 2 will meet both storm water management objective (pollutant & hydromodification control) and flood control objective (detention of the 100-year storm event).

HEC-HMS allows for hydrology input time steps of 1, 2, 3, 4, 5, 10, 15 & 20 minutes. Rational Method analysis input was used to determine an inflow hydrograph using the 2/3's 1/3 distribution as detailed on pages 4-2 and 4-3 of the 2003 County of San Diego Hydrology Manual. The time of concentration (Tc) used for the construction of these hydrographs was rounded to the nearest time interval that HEC-HMS could accept. The peak flow remains as per the modified rational method analysis and is not reduced (or increased) from this hydrograph development accordingly.

HEC-HMS uses an elevation-storage-discharge function to model the basin volume (stage-storage) and basin discharge (stage-discharge) relationships, the available storage volume provided by WQ units.

Rational method hydrographs, stage-storage, stage-discharge relationships and HEC-HMS model output is provided in Chapter 4 of this report.

Post-Developed Hydrograph Determination

For the post-developed condition, runoff hydrographs were generated using the Rational Method Hydrograph Procedure discussed in the Section 6 – Rational Method Hydrograph Procedure of the SDCHM. These hydrographs were then entered into the developed condition HEC-HMS model.

Model Results

The biofiltration facilities, BMP 1 and BMP 2, are sized for treatment and hydromodification of storm water runoff, resulting in decreasing the post-development 100-year peak flows. BMP 1 and BMP 2 satisfies hydromodification criteria and maintain the post-development peak flows below pre-development levels for the 6hr-100yr synthetic storm event, as shown in Table 5.

The post-developed condition peak flows calculated using modified rational method were then routed through the detention facilities on the project site in HEC-HMS. The HMS Modified-Puls results are summarized in Table 5.

TABLE 5—Summary Of Detention Basin Routing

POC-ID	Drainage Area (ac)	Undetained 100-Year Peak Flow (cfs)	Detained 100-Year Peak Flow (cfs)
POC-1	4.83	17.17	6.70
POC-2	5.06	17.99	6.17

Rational method hydrographs, stage-storage, stage-discharge relationships and HEC-HMS model output is provided in Chapter 4 of this report.

1.6 STUDY METHOD

The method of analysis was based on the Rational Method according to the San Diego County Hydrology Manual (SD HM). The Hydrology and Hydraulic Analysis were done on Hydro Soft by Advanced Engineering Software 2013. The study considers the runoff for a 100-year storm frequency.

Methodology used for the computation of design rainfall events, runoff coefficients, and rainfall intensity values are consistent with criteria set forth in the "2003 County of San Diego Drainage Design Manual." A more detailed explanation of methodology used for this analysis is listed in Chapter 6 – References of this report.

Drainage basin areas were determined from the aerial topography, City of Vista 200-scale topography Map 2030-6256, and proposed grades shown on the Tentative Subdivision Map. For the proposed condition, all pad areas were considered to include roof areas, driveways and 500 square feet for future homeowner installed hardscape such as patio areas.

The Rational Method provided the following variable coefficients:

Rainfall Intensity – Initial time of concentration (T_c) values based on Table 3-2 of the SD HM. Rainfall Isopluvial Maps from the SD HM were used to determine P_6 for 100-year storm, see References.

Rainfall Intensity = $I = 7.44x(P_6)x(Tc)^{-0.645}$

P_6 for 100 year storm =3.1-inches

Soil Type – The site consists of soils in hydrologic soil groups of Type-C and Type-D, see Web Soil Survey in the References section of this report. The line depicting the Type-C and Type-D soils has been transposed from the Web Soil Survey and included in the Existing and Proposed Hydrology Maps.

Runoff Coefficient – In accordance with the County of San Diego standards, runoff coefficients were based on land use and soil type. The soil conditions used in this study are consistent with Type-C and Type-D soil qualities. An appropriate runoff coefficient (C) for each type of land use in the subarea was selected from Table 3-1 of SD HM and multiplied by the percentage of total area (A) included in that class. The sum of the products for all land uses is the weighted runoff coefficient (∑[CA]).

For all of the landscaped areas, a runoff coefficient assuming 0% impervious was used based on the under-lying soil type, 0.30 for Type-C and 0.35 for Type-D soils. All streets and driveways were considered 95% impervious, and assigned a runoff coefficient of 0.87. All pad areas were considered 10% impervious, or 1.0 DU/acre, due to the preliminary nature of this report. At Final Grading, pad areas will also be calculated with a weighted runoff coefficient based on building footprints and final driveway areas.

The Post-Development Hydrology Exhibit shows the offsite area, proposed on-site drainage system, on-site subareas, and nodal points. Table 5 summarizes the Weighted Runoff Coefficient Calculations calculated in the existing and proposed conditions.

TABLE 5 – Weighted Runoff Coefficient Calculations by Node

Pre-Developed									
Up Node	Down Node	Total Acreage	C_1	A_1 (ac)	C_2	A_2 (ac)	C_3	A_3 (ac)	C_{comp}
100	110	0.14	0.35	0.00	0.30	0.14	0.87	0.00	0.30
110	120	0.11	0.35	0.00	0.30	0.11	0.87	0.00	0.30
120	130	4.70	0.35	2.08	0.30	2.62	0.87	0.00	0.32
200	210	0.06	0.35	0.00	0.30	0.06	0.87	0.00	0.30
210	220	3.06	0.35	1.71	0.30	1.35	0.87	0.00	0.33
230	240	0.08	0.35	0.08	0.30	0.00	0.87	0.00	0.35
240	250	0.96	0.35	0.96	0.30	0.00	0.87	0.00	0.35

Note: C-values taken from Table 3-1 of San Diego County Hydrology Manual, consistent with on-site existing soil types. See References.

Post-Developed									
Up Node	Down Node	Total Acreage	C_1	A_1 (ac)	C_2	A_2 (ac)	C_3	A_3 (ac)	C_{comp}
100	110	0.130	0.35	0.00	0.30	0.07	0.87	0.06	0.57
110	120	2.967	0.35	0.31	0.30	0.85	0.87	1.80	0.65
140	150	0.118	0.35	0.00	0.30	0.07	0.87	0.05	0.55
150	160	1.307	0.35	0.41	0.30	0.08	0.87	0.81	0.67
170	170	0.305	0.35	0.31	0.30	0.00	0.87	0.00	0.35
200	210	0.167	0.35	0.00	0.30	0.05	0.87	0.12	0.71
210	240	2.261	0.35	0.10	0.30	1.36	0.87	1.46	0.76
220	230	0.123	0.35	0.00	0.30	0.07	0.87	0.05	0.54
230	240	0.536	0.35	0.24	0.30	0.00	0.87	0.29	0.64
250	250	0.271	0.35	0.27	0.30	0.00	0.87	0.00	0.35
260	270	0.081	0.35	0.08	0.30	0.00	0.87	0.00	0.35
270	280	1.619	0.35	1.62	0.30	0.00	0.87	0.00	0.35

Note: C-values taken from Table 3-1 of San Diego County Hydrology Manual, consistent with on-site existing soil types. See References.

1.7 CONCLUSION

Table 6 below summarizes predeveloped and post-developed condition drainage areas and resultant 100-year peak flow rates at the POC discharge locations from the Camino Largo Project.

TABLE 6 - Summary of Peak Flows

Condition	Drainage Area (ac)	100-Year Peak Flow (cfs)
POC-1		
Pre-Developed	4.95	7.05
Post-Developed Undetained	4.83	17.17
Post-Developed Detained	4.83	6.70
POC-2		
Pre-Developed	4.16	6.23
Post-Developed Undetained	5.06	17.99
Post-Developed Detained	5.06	6.17

As shown in the above table, the development of the proposed Camino Largo project site will result in a net decrease of peak flow discharged from the project site at POC-1 and POC-2.

All developed runoff will receive water quality treatment in accordance with the site specific SWQMP. Additionally, POC-1 and POC-2 are HMP compliant as analyzed in the SWQMP.

Peak flow rates listed above were generated based on criteria set forth in "San Diego County Hydrology Manual" (methodology presented in Chapter 6 of this report). Rational method output is located in Chapter 3 and 4. The hydraulic calculations show that the proposed storm drain facilities can sufficiently convey the anticipated Q100 flowrate without any adverse effects. Based on this conclusion, runoff released from the proposed project site will be unlikely to cause any adverse impact to downstream water bodies or existing habitat integrity. Sediment will likely be reduced upon site development.

Final storm drain and inlet design details will be provided at the final engineering phase of the development.

1.9 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 Vista is confined to a review only and does not relieve me, as Engineer of Work, of my responsibilities for project design.

8/13/21

Bruce Rice Date
R.C.E. 60676 Expires 12/31/22

REGISTERED PROFESSIONAL ENGINEER
BRUCE L. RICE
C 60676
EXP. ______
CIVIL
STATE OF CALIFORNIA

II. EXHIBITS

PRE-DEVELOPED CONDITION HYDROLOGY EXHIBITS

&

POST-DEVELOPED CONDITION HYDROLOGY EXHIBITS


PRE-DEVELOPMENT HYDROLOGY
CAMINO LARGOI
CITY OF VISTA, CALIFORNIA
SHEET 1 OF 1
bHA, Inc.
land planning, civil engineering, surveying
5115 AVENIDA ENCINAS
SUITE "L"
CARLSBAD, CA. 92008-4387
(760) 931-8700
LEGEND
SURFACE NODE
SURFACE RUNOFF (CFS)
ELEVATION EL=347.00
CHANNEL LENGTH THRU SUBAREA L=572.00
BASIN AREA (ACRES) 2.868
RUNOFF COEFFICIENT C=0.47
POINT OF COMPLIANCE (POC) POC-1
BASIN BOUNDARY/SUB-BOUNDARY
PROJECT BOUNDARY
FLOWLINE
FLOW DIRECTION
SCALE: 1" = 40'
OFF-SITE DRAINAGE DETAIL
SCALE: 1" = 80'
SEE OFF-SITE DRAINAGE DETAIL, THIS SHEET
NORTH SANTA FE AVE
CAMINO LARGO (PRIVATE)
PROPERTY LINE
EXISTING CULVERT
EXISTING STREAM
DASHED CONTOURS ARE APPROXIMATE
TYPE C SOIL
TYPE D SOIL
COUNTY OF SAN DIEGO
CITY OF VISTA
POC-1
POC-2
100 EL=357.60
200 EL=359.50
0.139 C=0.30
0.060 C=0.30
210 0.10 EL=355.50
110 0.24 EL=353.00
3.063 C=0.33
2.28 C=0.37
0.109 C=0.30
4.704 C=0.32
120 0.38 EL=322.50
130 7.05 EL=294.00
240 6.23 EL=308.50
240 6.23 EL=309.60
1.73 C=0.35
Greenhouse
Shed
Palm Trees

K:\Civil 3D\1154\DWG\HYDRO\PROP HYDRO_SWQMP_TSM.dwg, 8/26/2021 9:49:46 AM

III. CALCULATIONS

3.1 PRE-DEVELOPVED CONDITION HYDROLOGY CALCULATIONS

100 YEAR STORM

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****************************************************************************

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                       2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2014 Advanced Engineering Software (aes)
             Ver. 21.0 Release Date: 06/01/2014  License ID 1459

                           Analysis prepared by:

                                  BHA INC.
                       5115 AVENIDA ENCINAS, SUITE L
                             CARLSBAD, CA 92008

 ************************** DESCRIPTION OF STUDY **************************
* PRE-DEVELOPED 100 YEAR HYDROLOGY                                         *
*                                                                          *
*                                                                          *
 **************************************************************************

  FILE NAME: K:\HYDRO\1154\BR-2021\1154E100.DAT
  TIME/DATE OF STUDY: 08:34 08/13/2021
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   3.100
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   3.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    110.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3000
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    357.60
  DOWNSTREAM ELEVATION(FEET) =    353.00
  ELEVATION DIFFERENCE(FEET) =      4.60
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    8.659
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.732
```

```
  SUBAREA RUNOFF(CFS) =      0.24
  TOTAL AREA(ACRES) =      0.14   TOTAL RUNOFF(CFS) =      0.24

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    120.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    353.00  DOWNSTREAM(FEET) =    322.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =   190.00   CHANNEL SLOPE =  0.1605
  CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =  10.000
  MANNING'S FACTOR = 0.040   MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.058
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3000
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.32
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.71
  AVERAGE FLOW DEPTH(FEET) =   0.04   TRAVEL TIME(MIN.) =   1.85
  Tc(MIN.) =   10.51
  SUBAREA AREA(ACRES) =     0.11       SUBAREA RUNOFF(CFS) =    0.17
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.300
  TOTAL AREA(ACRES) =        0.2         PEAK FLOW RATE(CFS) =       0.38

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.04   FLOW VELOCITY(FEET/SEC.) =   1.71
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    120.00 =     290.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    130.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  322.50  DOWNSTREAM ELEVATION(FEET) =  294.00
  STREET LENGTH(FEET) =   600.00   CURB HEIGHT(INCHES) =  8.0
  STREET HALFWIDTH(FEET) = 30.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  20.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.018
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.018

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.74
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =    8.47
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.49
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.41
  STREET FLOW TRAVEL TIME(MIN.) =   2.23   Tc(MIN.) =   12.74
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.468
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3200
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.319
  SUBAREA AREA(ACRES) =    4.70      SUBAREA RUNOFF(CFS) =    6.72
  TOTAL AREA(ACRES) =        4.9        PEAK FLOW RATE(CFS) =       7.05

  END OF SUBAREA STREET FLOW HYDRAULICS:
```

```
  DEPTH(FEET) = 0.37   HALFSTREET FLOOD WIDTH(FEET) =  11.52
  FLOW VELOCITY(FEET/SEC.) =  5.11   DEPTH*VELOCITY(FT*FT/SEC.) =   1.88
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    130.00 =     890.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    210.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3000
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    359.50
  DOWNSTREAM ELEVATION(FEET) =    355.50
  ELEVATION DIFFERENCE(FEET) =      4.00
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    9.072
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.562
  SUBAREA RUNOFF(CFS) =      0.10
  TOTAL AREA(ACRES) =      0.06   TOTAL RUNOFF(CFS) =      0.10

****************************************************************************
  FLOW PROCESS FROM NODE    210.00 TO NODE    240.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    355.50  DOWNSTREAM(FEET) =    308.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =   407.00   CHANNEL SLOPE =  0.1155
  CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =  10.000
  MANNING'S FACTOR = 0.040   MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.668
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3300
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.47
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   2.39
  AVERAGE FLOW DEPTH(FEET) =   0.09   TRAVEL TIME(MIN.) =   2.83
  Tc(MIN.) =   11.91
  SUBAREA AREA(ACRES) =     3.06       SUBAREA RUNOFF(CFS) =    4.71
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.329
  TOTAL AREA(ACRES) =        3.1         PEAK FLOW RATE(CFS) =       4.80

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.13   FLOW VELOCITY(FEET/SEC.) =   3.14
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    240.00 =     507.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    210.00 TO NODE    210.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.91
  RAINFALL INTENSITY(INCH/HR) =   4.67
  TOTAL STREAM AREA(ACRES) =     3.12
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      4.80

****************************************************************************
  FLOW PROCESS FROM NODE    220.00 TO NODE    230.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
```

```
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    397.90
  DOWNSTREAM ELEVATION(FEET) =    385.00
  ELEVATION DIFFERENCE(FEET) =     12.90
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.061
  SUBAREA RUNOFF(CFS) =      0.20
  TOTAL AREA(ACRES) =      0.08   TOTAL RUNOFF(CFS) =      0.20

****************************************************************************
  FLOW PROCESS FROM NODE    230.00 TO NODE    240.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    385.00  DOWNSTREAM(FEET) =    309.60
  CHANNEL LENGTH THRU SUBAREA(FEET) =   685.00   CHANNEL SLOPE =  0.1101
  CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =  10.000
  MANNING'S FACTOR = 0.040   MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.362
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.98
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.64
  AVERAGE FLOW DEPTH(FEET) =   0.06   TRAVEL TIME(MIN.) =   6.95
  Tc(MIN.) =   13.22
  SUBAREA AREA(ACRES) =     0.96       SUBAREA RUNOFF(CFS) =    1.47
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.350
  TOTAL AREA(ACRES) =        1.0         PEAK FLOW RATE(CFS) =       1.59

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.07   FLOW VELOCITY(FEET/SEC.) =   2.07
  LONGEST FLOWPATH FROM NODE    220.00 TO NODE    240.00 =     785.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    240.00 TO NODE    240.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   13.22
  RAINFALL INTENSITY(INCH/HR) =   4.36
  TOTAL STREAM AREA(ACRES) =     1.04
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      1.59

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        4.80    11.91        4.668          3.12
      2        1.59    13.22        4.362          1.04

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

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
```

```
     1        6.23    11.91       4.668
     2        6.07    13.22       4.362

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       6.23   Tc(MIN.) =   11.91
  TOTAL AREA(ACRES) =        4.2
  LONGEST FLOWPATH FROM NODE    220.00 TO NODE    240.00 =     785.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        4.2  TC(MIN.) =     11.91
  PEAK FLOW RATE(CFS)   =       6.23
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

3.2 POST-DEVELOPED CONDITION HYDROLOGY CALCULATIONS – UNDETAINED

100 YEAR STORM

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

             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
             Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                          2003,1985,1981 HYDROLOGY MANUAL
          (c) Copyright 1982-2014 Advanced Engineering Software (aes)
              Ver. 21.0 Release Date: 06/01/2014  License ID 1459

                           Analysis prepared by:

                                  BHA INC.
                      5115 AVENIDA ENCINAS, SUITE L
                            CARLSBAD, CA 92008


 ************************** DESCRIPTION OF STUDY **************************
 * PRE-DEVELOPED 100 YEAR HYDROLOGY WITHOUT DETENTION                       *
 *                                                                          *
 *                                                                          *
 **************************************************************************

  FILE NAME: K:\HYDRO\1154\BR-2021\1154U100.DAT
  TIME/DATE OF STUDY: 15:27 08/20/2021
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   3.100
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   3.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

+--------------------------------------------------------------------------+
| POC 1                                                                    |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    110.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5700
```

```
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    347.50
  DOWNSTREAM ELEVATION(FEET) =    345.10
  ELEVATION DIFFERENCE(FEET) =      2.40
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.797
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    91.00
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.700
  SUBAREA RUNOFF(CFS) =      0.50
  TOTAL AREA(ACRES) =      0.13   TOTAL RUNOFF(CFS) =      0.50

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    120.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  345.10  DOWNSTREAM ELEVATION(FEET) =  300.20
  STREET LENGTH(FEET) =   751.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   1.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0130
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       5.95
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =    9.27
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    6.08
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.90
  STREET FLOW TRAVEL TIME(MIN.) =   2.06   Tc(MIN.) =    8.86
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.649
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.647
  SUBAREA AREA(ACRES) =    2.97      SUBAREA RUNOFF(CFS) =   10.89
  TOTAL AREA(ACRES) =        3.1        PEAK FLOW RATE(CFS) =      11.31

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.37   HALFSTREET FLOOD WIDTH(FEET) =  12.15
  FLOW VELOCITY(FEET/SEC.) =  7.10   DEPTH*VELOCITY(FT*FT/SEC.) =   2.62
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    120.00 =     851.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    130.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   295.00  DOWNSTREAM(FEET) =   291.50
  FLOW LENGTH(FEET) =    93.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   9.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  11.60
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
```

```
  PIPE-FLOW(CFS) =      11.31
  PIPE TRAVEL TIME(MIN.) =   0.13    Tc(MIN.) =    8.99
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    130.00 =     944.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    130.00 TO NODE    130.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    8.99
  RAINFALL INTENSITY(INCH/HR) =   5.59
  TOTAL STREAM AREA(ACRES) =     3.10
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     11.31

****************************************************************************
  FLOW PROCESS FROM NODE    140.00 TO NODE    150.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    327.00
  DOWNSTREAM ELEVATION(FEET) =    318.30
  ELEVATION DIFFERENCE(FEET) =      8.70
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.814
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  8.168
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.53
  TOTAL AREA(ACRES) =      0.12   TOTAL RUNOFF(CFS) =      0.53

****************************************************************************
  FLOW PROCESS FROM NODE    150.00 TO NODE    160.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  318.30  DOWNSTREAM ELEVATION(FEET) =  294.50
  STREET LENGTH(FEET) =   436.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   1.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0130
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.64
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.28
    HALFSTREET FLOOD WIDTH(FEET) =    7.56
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.27
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.46
  STREET FLOW TRAVEL TIME(MIN.) =   1.38   Tc(MIN.) =    6.19
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.116
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6700
  S.C.S. CURVE NUMBER (AMC II) =   0
```

```
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.660
  SUBAREA AREA(ACRES) =    1.31      SUBAREA RUNOFF(CFS) =    6.23
  TOTAL AREA(ACRES) =        1.4        PEAK FLOW RATE(CFS) =       6.69

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.33   HALFSTREET FLOOD WIDTH(FEET) =   9.99
  FLOW VELOCITY(FEET/SEC.) =  6.00   DEPTH*VELOCITY(FT*FT/SEC.) =   1.96
  LONGEST FLOWPATH FROM NODE    140.00 TO NODE    160.00 =     536.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    160.00 TO NODE    170.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    294.60  DOWNSTREAM(FEET) =    291.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =    18.00   CHANNEL SLOPE =  0.1722
  CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =   0.000
  MANNING'S FACTOR = 0.014   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =       6.69
  FLOW VELOCITY(FEET/SEC.) =   8.26   FLOW DEPTH(FEET) =   0.08
  TRAVEL TIME(MIN.) =   0.04   Tc(MIN.) =    6.23
  LONGEST FLOWPATH FROM NODE    140.00 TO NODE    170.00 =     554.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    170.00 TO NODE    170.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.089
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.6054
  SUBAREA AREA(ACRES) =    0.31   SUBAREA RUNOFF(CFS) =    0.76
  TOTAL AREA(ACRES) =        1.7   TOTAL RUNOFF(CFS) =       7.42
  TC(MIN.) =    6.23

****************************************************************************
  FLOW PROCESS FROM NODE    170.00 TO NODE    170.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.23
  RAINFALL INTENSITY(INCH/HR) =   7.09
  TOTAL STREAM AREA(ACRES) =     1.73
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      7.42

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       11.31     8.99        5.595          3.10
      2        7.42     6.23        7.089          1.73

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

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       15.26     6.23       7.089
```

```
     2       17.17     8.99       5.595

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      17.17   Tc(MIN.) =    8.99
  TOTAL AREA(ACRES) =        4.8
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    170.00 =     944.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    180.00 TO NODE    185.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   285.40  DOWNSTREAM(FEET) =   284.90
  FLOW LENGTH(FEET) =   100.60   MANNING'S N =  0.013
  ASSUME FULL-FLOWING PIPELINE
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.29
  PIPE FLOW VELOCITY = (TOTAL FLOW)/(PIPE CROSS SECTION AREA)
  GIVEN PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   3
  PIPE-FLOW(CFS) =      17.17
  PIPE TRAVEL TIME(MIN.) =   0.23    Tc(MIN.) =    9.22
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    185.00 =    1044.60 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    185.00 TO NODE    190.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   284.88  DOWNSTREAM(FEET) =   280.95
  FLOW LENGTH(FEET) =    43.04   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   9.6 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  17.96
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      17.17
  PIPE TRAVEL TIME(MIN.) =   0.04    Tc(MIN.) =    9.26
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    190.00 =    1087.64 FEET.

+--------------------------------------------------------------------------+
| END POC 1                                                                |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

+--------------------------------------------------------------------------+
| POC 2                                                                    |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    210.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7100
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    347.10
  DOWNSTREAM ELEVATION(FEET) =    342.30
  ELEVATION DIFFERENCE(FEET) =      4.80
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.162
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  8.168
```

```
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.97
  TOTAL AREA(ACRES) =      0.17   TOTAL RUNOFF(CFS) =      0.97

****************************************************************************
  FLOW PROCESS FROM NODE    210.00 TO NODE    220.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  342.30  DOWNSTREAM ELEVATION(FEET) =  309.80
  STREET LENGTH(FEET) =   720.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   1.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0130
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       7.05
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.34
    HALFSTREET FLOOD WIDTH(FEET) =   10.62
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.66
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.92
  STREET FLOW TRAVEL TIME(MIN.) =   2.12   Tc(MIN.) =    6.28
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.050
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7600
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.757
  SUBAREA AREA(ACRES) =    2.26      SUBAREA RUNOFF(CFS) =   12.11
  TOTAL AREA(ACRES) =        2.4        PEAK FLOW RATE(CFS) =      12.95

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.40   HALFSTREET FLOOD WIDTH(FEET) =  13.59
  FLOW VELOCITY(FEET/SEC.) =  6.59   DEPTH*VELOCITY(FT*FT/SEC.) =   2.62
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    220.00 =     820.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    240.00 TO NODE    240.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.28
  RAINFALL INTENSITY(INCH/HR) =   7.05
  TOTAL STREAM AREA(ACRES) =     2.43
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     12.95

****************************************************************************
  FLOW PROCESS FROM NODE    230.00 TO NODE    240.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5400
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
```

```
  UPSTREAM ELEVATION(FEET) =    320.00
  DOWNSTREAM ELEVATION(FEET) =    313.80
  ELEVATION DIFFERENCE(FEET) =      6.20
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.487
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.692
  SUBAREA RUNOFF(CFS) =      0.51
  TOTAL AREA(ACRES) =      0.12   TOTAL RUNOFF(CFS) =      0.51

****************************************************************************
  FLOW PROCESS FROM NODE    240.00 TO NODE    250.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  313.80  DOWNSTREAM ELEVATION(FEET) =  309.80
  STREET LENGTH(FEET) =   240.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   1.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0130
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.65
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.26
    HALFSTREET FLOOD WIDTH(FEET) =    6.85
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.80
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.74
  STREET FLOW TRAVEL TIME(MIN.) =   1.43   Tc(MIN.) =    6.91
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.627
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6400
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.621
  SUBAREA AREA(ACRES) =    0.54      SUBAREA RUNOFF(CFS) =    2.27
  TOTAL AREA(ACRES) =        0.7        PEAK FLOW RATE(CFS) =       2.71

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   8.64
  FLOW VELOCITY(FEET/SEC.) =  3.14   DEPTH*VELOCITY(FT*FT/SEC.) =   0.94
  LONGEST FLOWPATH FROM NODE    230.00 TO NODE    250.00 =     340.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    250.00 TO NODE    250.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.91
  RAINFALL INTENSITY(INCH/HR) =   6.63
  TOTAL STREAM AREA(ACRES) =     0.66
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.71

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       12.95     6.28        7.050          2.43
```

```
    2        2.71     6.91        6.627          0.66

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

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
    1       15.42     6.28       7.050
    2       14.89     6.91       6.627

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      15.42   Tc(MIN.) =    6.28
  TOTAL AREA(ACRES) =        3.1
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    250.00 =     820.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    250.00 TO NODE    260.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    309.80  DOWNSTREAM(FEET) =    308.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =    18.00   CHANNEL SLOPE =  0.1000
  CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =   0.000
  MANNING'S FACTOR = 0.014   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =      15.42
  FLOW VELOCITY(FEET/SEC.) =   9.80   FLOW DEPTH(FEET) =   0.16
  TRAVEL TIME(MIN.) =   0.03   Tc(MIN.) =    6.31
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    260.00 =     838.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    260.00 TO NODE    260.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.027
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.6972
  SUBAREA AREA(ACRES) =    0.27   SUBAREA RUNOFF(CFS) =    0.67
  TOTAL AREA(ACRES) =        3.4   TOTAL RUNOFF(CFS) =      16.45
  TC(MIN.) =    6.31

****************************************************************************
  FLOW PROCESS FROM NODE    260.00 TO NODE    270.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   304.40  DOWNSTREAM(FEET) =   303.86
  FLOW LENGTH(FEET) =   108.00   MANNING'S N =  0.013
  ASSUME FULL-FLOWING PIPELINE
  PIPE-FLOW VELOCITY(FEET/SEC.) =  10.47
  PIPE FLOW VELOCITY = (TOTAL FLOW)/(PIPE CROSS SECTION AREA)
  GIVEN PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   2
  PIPE-FLOW(CFS) =      16.45
  PIPE TRAVEL TIME(MIN.) =   0.17    Tc(MIN.) =    6.48
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    270.00 =     946.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    270.00 TO NODE    270.00 IS CODE =   1
----------------------------------------------------------------------------
```

```
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.48
  RAINFALL INTENSITY(INCH/HR) =   6.91
  TOTAL STREAM AREA(ACRES) =     3.36
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     16.45

****************************************************************************
  FLOW PROCESS FROM NODE    280.00 TO NODE    290.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    397.90
  DOWNSTREAM ELEVATION(FEET) =    385.00
  ELEVATION DIFFERENCE(FEET) =     12.90
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.061
  SUBAREA RUNOFF(CFS) =      0.20
  TOTAL AREA(ACRES) =      0.08   TOTAL RUNOFF(CFS) =      0.20

****************************************************************************
  FLOW PROCESS FROM NODE    290.00 TO NODE    300.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    385.00  DOWNSTREAM(FEET) =    309.60
  CHANNEL LENGTH THRU SUBAREA(FEET) =   685.00   CHANNEL SLOPE =  0.1101
  CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =  10.000
  MANNING'S FACTOR = 0.040   MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.692
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.58
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   2.06
  AVERAGE FLOW DEPTH(FEET) =   0.07   TRAVEL TIME(MIN.) =   5.54
  Tc(MIN.) =   11.81
  SUBAREA AREA(ACRES) =     1.62       SUBAREA RUNOFF(CFS) =    2.66
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.350
  TOTAL AREA(ACRES) =        1.7         PEAK FLOW RATE(CFS) =       2.79

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.10   FLOW VELOCITY(FEET/SEC.) =   2.48
  LONGEST FLOWPATH FROM NODE    280.00 TO NODE    300.00 =     785.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    300.00 TO NODE    300.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.81
  RAINFALL INTENSITY(INCH/HR) =   4.69
  TOTAL STREAM AREA(ACRES) =     1.70
```

```
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.79

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       16.45     6.48        6.907          3.36
      2        2.79    11.81        4.692          1.70

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

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       17.99     6.48       6.907
      2       13.97    11.81       4.692

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      17.99   Tc(MIN.) =    6.48
  TOTAL AREA(ACRES) =        5.1
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    300.00 =     946.00 FEET.

+--------------------------------------------------------------------------+
| END POC 2                                                                |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        5.1  TC(MIN.) =      6.48
  PEAK FLOW RATE(CFS)   =      17.99
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

3.3 POST-DEVELOPED CONDITION HYDROLOGY CALCULATIONS – DETAINED

100 YEAR STORM

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

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2014 Advanced Engineering Software (aes)
             Ver. 21.0 Release Date: 06/01/2014  License ID 1459

                           Analysis prepared by:

                                  BHA INC.
                       5115 AVENIDA ENCINAS, SUITE L
                             CARLSBAD, CA 92008


 ************************** DESCRIPTION OF STUDY **************************
* POST-DEVELOPED 100 YEAR HYDROLOGY WITH DETENTION                         *
*                                                                          *
*                                                                          *
 **************************************************************************

  FILE NAME: K:\HYDRO\1154\BR-2021\1154P100.DAT
  TIME/DATE OF STUDY: 13:53 08/20/2021
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   3.100
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   3.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: USE MODIFIED RATIONAL METHOD PROCEDURES FOR CONFLUENCE ANALYSIS
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   30.0     20.0    0.018/0.018/0.020   0.67    2.00 0.0313 0.167 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

+--------------------------------------------------------------------------+
| POC 1                                                                    |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    100.00 TO NODE    110.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5700
```

```
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    347.50
  DOWNSTREAM ELEVATION(FEET) =    345.10
  ELEVATION DIFFERENCE(FEET) =      2.40
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.797
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    91.00
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.700
  SUBAREA RUNOFF(CFS) =      0.50
  TOTAL AREA(ACRES) =      0.13   TOTAL RUNOFF(CFS) =      0.50

****************************************************************************
  FLOW PROCESS FROM NODE    110.00 TO NODE    120.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  345.10  DOWNSTREAM ELEVATION(FEET) =  300.20
  STREET LENGTH(FEET) =   751.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   1.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0130
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       5.95
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =    9.27
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    6.08
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.90
  STREET FLOW TRAVEL TIME(MIN.) =   2.06   Tc(MIN.) =    8.86
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.649
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.647
  SUBAREA AREA(ACRES) =    2.97      SUBAREA RUNOFF(CFS) =   10.89
  TOTAL AREA(ACRES) =        3.1        PEAK FLOW RATE(CFS) =      11.31

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.37   HALFSTREET FLOOD WIDTH(FEET) =  12.15
  FLOW VELOCITY(FEET/SEC.) =  7.10   DEPTH*VELOCITY(FT*FT/SEC.) =   2.62
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    120.00 =     851.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    130.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   295.00  DOWNSTREAM(FEET) =   291.50
  FLOW LENGTH(FEET) =    93.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   9.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  11.60
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
```

```
  PIPE-FLOW(CFS) =      11.31
  PIPE TRAVEL TIME(MIN.) =   0.13    Tc(MIN.) =    8.99
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    130.00 =     944.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    130.00 TO NODE    130.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    8.99
  RAINFALL INTENSITY(INCH/HR) =   5.59
  TOTAL STREAM AREA(ACRES) =     3.10
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     11.31

****************************************************************************
  FLOW PROCESS FROM NODE    140.00 TO NODE    150.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    327.00
  DOWNSTREAM ELEVATION(FEET) =    318.30
  ELEVATION DIFFERENCE(FEET) =      8.70
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.814
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  8.168
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.53
  TOTAL AREA(ACRES) =      0.12   TOTAL RUNOFF(CFS) =      0.53

****************************************************************************
  FLOW PROCESS FROM NODE    150.00 TO NODE    160.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  318.30  DOWNSTREAM ELEVATION(FEET) =  294.50
  STREET LENGTH(FEET) =   436.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   1.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0130
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.64
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.28
    HALFSTREET FLOOD WIDTH(FEET) =    7.56
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.27
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.46
  STREET FLOW TRAVEL TIME(MIN.) =   1.38   Tc(MIN.) =    6.19
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.116
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6700
  S.C.S. CURVE NUMBER (AMC II) =   0
```

```
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.660
  SUBAREA AREA(ACRES) =    1.31      SUBAREA RUNOFF(CFS) =    6.23
  TOTAL AREA(ACRES) =        1.4        PEAK FLOW RATE(CFS) =       6.69

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.33   HALFSTREET FLOOD WIDTH(FEET) =   9.99
  FLOW VELOCITY(FEET/SEC.) =  6.00   DEPTH*VELOCITY(FT*FT/SEC.) =   1.96
  LONGEST FLOWPATH FROM NODE    140.00 TO NODE    160.00 =     536.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    160.00 TO NODE    170.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    294.60  DOWNSTREAM(FEET) =    291.50
  CHANNEL LENGTH THRU SUBAREA(FEET) =    18.00   CHANNEL SLOPE =  0.1722
  CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =   0.000
  MANNING'S FACTOR = 0.014   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =       6.69
  FLOW VELOCITY(FEET/SEC.) =   8.26   FLOW DEPTH(FEET) =   0.08
  TRAVEL TIME(MIN.) =   0.04   Tc(MIN.) =    6.23
  LONGEST FLOWPATH FROM NODE    140.00 TO NODE    170.00 =     554.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    170.00 TO NODE    170.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.089
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.6054
  SUBAREA AREA(ACRES) =    0.31   SUBAREA RUNOFF(CFS) =    0.76
  TOTAL AREA(ACRES) =        1.7   TOTAL RUNOFF(CFS) =       7.42
  TC(MIN.) =    6.23

****************************************************************************
  FLOW PROCESS FROM NODE    170.00 TO NODE    170.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.23
  RAINFALL INTENSITY(INCH/HR) =   7.09
  TOTAL STREAM AREA(ACRES) =     1.73
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      7.42

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       11.31     8.99        5.595          3.10
      2        7.42     6.23        7.089          1.73

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

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       15.26     6.23       7.089
```

```
     2       17.17     8.99       5.595

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      17.17   Tc(MIN.) =    8.99
  TOTAL AREA(ACRES) =        4.8
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    170.00 =     944.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    180.00 TO NODE    180.00 IS CODE =   7
----------------------------------------------------------------------------
  >>>>>USER SPECIFIED HYDROLOGY INFORMATION AT NODE<<<<<
============================================================================
  USER-SPECIFIED VALUES ARE AS FOLLOWS:
  TC(MIN) =  11.00   RAIN INTENSITY(INCH/HOUR) =  4.91
  TOTAL AREA(ACRES) =     4.83   TOTAL RUNOFF(CFS) =      6.70

****************************************************************************
  FLOW PROCESS FROM NODE    180.00 TO NODE    185.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   285.40  DOWNSTREAM(FEET) =   284.90
  FLOW LENGTH(FEET) =   100.60   MANNING'S N =  0.013
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   9.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   3.53
  GIVEN PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   3
  PIPE-FLOW(CFS) =       6.70
  PIPE TRAVEL TIME(MIN.) =   0.47    Tc(MIN.) =   11.47
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    185.00 =    1044.60 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    185.00 TO NODE    190.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   284.88  DOWNSTREAM(FEET) =   280.95
  FLOW LENGTH(FEET) =    43.04   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   5.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  13.98
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       6.70
  PIPE TRAVEL TIME(MIN.) =   0.05    Tc(MIN.) =   11.53
  LONGEST FLOWPATH FROM NODE    100.00 TO NODE    190.00 =    1087.64 FEET.

+--------------------------------------------------------------------------+
| END POC 1                                                                |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

+--------------------------------------------------------------------------+
| POC 2                                                                    |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    200.00 TO NODE    210.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
```

```
  USER-SPECIFIED RUNOFF COEFFICIENT = .7100
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    347.10
  DOWNSTREAM ELEVATION(FEET) =    342.30
  ELEVATION DIFFERENCE(FEET) =      4.80
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.162
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  8.168
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.97
  TOTAL AREA(ACRES) =      0.17   TOTAL RUNOFF(CFS) =      0.97

****************************************************************************
  FLOW PROCESS FROM NODE    210.00 TO NODE    220.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  342.30  DOWNSTREAM ELEVATION(FEET) =  309.80
  STREET LENGTH(FEET) =   720.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   1.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0130
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       7.05
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.34
    HALFSTREET FLOOD WIDTH(FEET) =   10.62
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.66
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.92
  STREET FLOW TRAVEL TIME(MIN.) =   2.12   Tc(MIN.) =    6.28
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.050
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7600
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.757
  SUBAREA AREA(ACRES) =    2.26      SUBAREA RUNOFF(CFS) =   12.11
  TOTAL AREA(ACRES) =        2.4        PEAK FLOW RATE(CFS) =      12.95

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.40   HALFSTREET FLOOD WIDTH(FEET) =  13.59
  FLOW VELOCITY(FEET/SEC.) =  6.59   DEPTH*VELOCITY(FT*FT/SEC.) =   2.62
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    220.00 =     820.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    240.00 TO NODE    240.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.28
  RAINFALL INTENSITY(INCH/HR) =   7.05
  TOTAL STREAM AREA(ACRES) =     2.43
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     12.95

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

```
  FLOW PROCESS FROM NODE    230.00 TO NODE    240.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5400
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    320.00
  DOWNSTREAM ELEVATION(FEET) =    313.80
  ELEVATION DIFFERENCE(FEET) =      6.20
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.487
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.692
  SUBAREA RUNOFF(CFS) =      0.51
  TOTAL AREA(ACRES) =      0.12   TOTAL RUNOFF(CFS) =      0.51

****************************************************************************
  FLOW PROCESS FROM NODE    240.00 TO NODE    250.00 IS CODE =  61
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STANDARD CURB SECTION USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  313.80  DOWNSTREAM ELEVATION(FEET) =  309.80
  STREET LENGTH(FEET) =   240.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   1.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0130
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.65
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.26
    HALFSTREET FLOOD WIDTH(FEET) =    6.85
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.80
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.74
  STREET FLOW TRAVEL TIME(MIN.) =   1.43   Tc(MIN.) =    6.91
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.627
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .6400
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.621
  SUBAREA AREA(ACRES) =    0.54      SUBAREA RUNOFF(CFS) =    2.27
  TOTAL AREA(ACRES) =       0.7        PEAK FLOW RATE(CFS) =       2.71

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   8.64
  FLOW VELOCITY(FEET/SEC.) =  3.14   DEPTH*VELOCITY(FT*FT/SEC.) =   0.94
  LONGEST FLOWPATH FROM NODE    230.00 TO NODE    250.00 =     340.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    250.00 TO NODE    250.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.91
```

```
  RAINFALL INTENSITY(INCH/HR) =   6.63
  TOTAL STREAM AREA(ACRES) =     0.66
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.71

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       12.95     6.28        7.050          2.43
      2        2.71     6.91        6.627          0.66

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

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1       15.42     6.28       7.050
      2       14.89     6.91       6.627

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      15.42   Tc(MIN.) =    6.28
  TOTAL AREA(ACRES) =        3.1
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    250.00 =     820.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    250.00 TO NODE    260.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    309.80  DOWNSTREAM(FEET) =    308.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =    18.00   CHANNEL SLOPE =  0.1000
  CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =   0.000
  MANNING'S FACTOR = 0.014   MAXIMUM DEPTH(FEET) =   1.00
  CHANNEL FLOW THRU SUBAREA(CFS) =      15.42
  FLOW VELOCITY(FEET/SEC.) =   9.80   FLOW DEPTH(FEET) =   0.16
  TRAVEL TIME(MIN.) =   0.03   Tc(MIN.) =    6.31
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    260.00 =     838.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    260.00 TO NODE    260.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.027
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.6972
  SUBAREA AREA(ACRES) =    0.27   SUBAREA RUNOFF(CFS) =    0.67
  TOTAL AREA(ACRES) =        3.4   TOTAL RUNOFF(CFS) =      16.45
  TC(MIN.) =    6.31

****************************************************************************
  FLOW PROCESS FROM NODE    260.00 TO NODE    260.00 IS CODE =   7
----------------------------------------------------------------------------
  >>>>>USER SPECIFIED HYDROLOGY INFORMATION AT NODE<<<<<
============================================================================
  USER-SPECIFIED VALUES ARE AS FOLLOWS:
  TC(MIN) =  12.00   RAIN INTENSITY(INCH/HOUR) =  4.64
  TOTAL AREA(ACRES) =     3.36   TOTAL RUNOFF(CFS) =      3.48

****************************************************************************
  FLOW PROCESS FROM NODE    260.00 TO NODE    270.00 IS CODE =  41
```

```
--------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
==========================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   304.40  DOWNSTREAM(FEET) =   303.86
  FLOW LENGTH(FEET) =   108.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  12.0 INCH PIPE IS   7.5 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   3.39
  GIVEN PIPE DIAMETER(INCH) =  12.00    NUMBER OF PIPES =   2
  PIPE-FLOW(CFS) =       3.48
  PIPE TRAVEL TIME(MIN.) =   0.53    Tc(MIN.) =   12.53
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    270.00 =     946.00 FEET.

**************************************************************************
  FLOW PROCESS FROM NODE    270.00 TO NODE    270.00 IS CODE =   1
--------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
==========================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   12.53
  RAINFALL INTENSITY(INCH/HR) =   4.52
  TOTAL STREAM AREA(ACRES) =     3.36
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      3.48

**************************************************************************
  FLOW PROCESS FROM NODE    280.00 TO NODE    290.00 IS CODE =  21
--------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
==========================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    397.90
  DOWNSTREAM ELEVATION(FEET) =    385.00
  ELEVATION DIFFERENCE(FEET) =     12.90
  SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.267
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  7.061
  SUBAREA RUNOFF(CFS) =      0.20
  TOTAL AREA(ACRES) =      0.08   TOTAL RUNOFF(CFS) =      0.20

**************************************************************************
  FLOW PROCESS FROM NODE    290.00 TO NODE    300.00 IS CODE =  51
--------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
==========================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    385.00  DOWNSTREAM(FEET) =    309.60
  CHANNEL LENGTH THRU SUBAREA(FEET) =   685.00   CHANNEL SLOPE =  0.1101
  CHANNEL BASE(FEET) =   10.00   "Z" FACTOR =  10.000
  MANNING'S FACTOR = 0.040   MAXIMUM DEPTH(FEET) =   1.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.692
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .3500
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.58
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   2.06
  AVERAGE FLOW DEPTH(FEET) =   0.07   TRAVEL TIME(MIN.) =   5.54
  Tc(MIN.) =   11.81
  SUBAREA AREA(ACRES) =     1.62       SUBAREA RUNOFF(CFS) =    2.66
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.350
  TOTAL AREA(ACRES) =        1.7         PEAK FLOW RATE(CFS) =       2.79
```

```
  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.10   FLOW VELOCITY(FEET/SEC.) =   2.48
  LONGEST FLOWPATH FROM NODE    280.00 TO NODE    300.00 =     785.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    300.00 TO NODE    300.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   11.81
  RAINFALL INTENSITY(INCH/HR) =   4.69
  TOTAL STREAM AREA(ACRES) =     1.70
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.79

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        3.48    12.53        4.516          3.36
      2        2.79    11.81        4.692          1.70

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

  ** PEAK FLOW RATE TABLE **
  STREAM     RUNOFF      Tc      INTENSITY
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)
      1        6.07    11.81       4.692
      2        6.17    12.53       4.516

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =       6.17   Tc(MIN.) =   12.53
  TOTAL AREA(ACRES) =        5.1
  LONGEST FLOWPATH FROM NODE    200.00 TO NODE    300.00 =     946.00 FEET.

+--------------------------------------------------------------------------+
| END POC 2                                                                |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        5.1  TC(MIN.) =     12.53
  PEAK FLOW RATE(CFS)   =       6.17
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
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CHAPTER 4

MODIFIED-PULS DETENTION ROUTING

4.1 RATIONAL METHOD HYDROGRAPHS

BMP 1

Q_{100yr} = 17.17 cfs

T_c = 6 min

$P_{6\ 100yr}$ = 3.1 in

C = 0.63

A = 4.827

I = $7.44*P_6*D^{-0.645}$

VOL = I*D/60

ΔVOL = $V_1 - V_0$

I (incr) = ΔVOL/T

Q = CIA

VOL = $C*P_6*A$

N	D (min)	I (in/hr)	VOL in	ΔVOL (in)	I (incr) (in\hr)	Q (cfs)	VOL (cf)	(Re-0rdered) Ordinate Sum =
0	0	0	0	0.73	7.26	17.1700	6181	0.0000
1	6	7.26	0.73	0.20	2.03	6.1607	2218	0.5620
2	12	4.64	0.93	0.14	1.44	4.3724	1574	0.5682
3	18	3.58	1.07	0.12	1.15	3.5069	1263	0.5810
4	24	2.97	1.19	0.10	0.98	2.9779	1072	0.5878
5	30	2.57	1.29	0.09	0.86	2.6144	941	0.6019
6	36	2.29	1.37	0.08	0.77	2.3464	845	0.6092
7	42	2.07	1.45	0.07	0.70	2.1390	770	0.6247
8	48	1.90	1.52	0.06	0.65	1.9727	710	0.6328
9	54	1.76	1.58	0.06	0.60	1.8359	661	0.6499
10	60	1.64	1.64	0.06	0.57	1.7210	620	0.6588
11	66	1.55	1.70	0.05	0.53	1.6228	584	0.6778
12	72	1.46	1.75	0.05	0.51	1.5378	554	0.6878
13	78	1.39	1.80	0.05	0.48	1.4632	527	0.7090
14	84	1.32	1.85	0.05	0.46	1.3973	503	0.7202
15	90	1.27	1.90	0.04	0.44	1.3384	482	0.7442
16	96	1.21	1.94	0.04	0.42	1.2855	463	0.7569
17	102	1.17	1.99	0.04	0.41	1.2376	446	0.7841
18	108	1.13	2.03	0.04	0.39	1.1940	430	0.7987
19	114	1.09	2.07	0.04	0.38	1.1541	415	0.8301
20	120	1.05	2.10	0.04	0.37	1.1175	402	0.8470
21	126	1.02	2.14	0.04	0.36	1.0837	390	0.8836
22	132	0.99	2.18	0.03	0.35	1.0523	379	0.9035
23	138	0.96	2.21	0.03	0.34	1.0232	368	0.9469

24	144	0.93	2.24	0.03	0.33	0.9961	359	0.9707
25	150	0.91	2.28	0.03	0.32	0.9707	349	1.0232
26	156	0.89	2.31	0.03	0.31	0.9469	341	1.0523
27	162	0.87	2.34	0.03	0.30	0.9245	333	1.1175
28	168	0.85	2.37	0.03	0.30	0.9035	325	1.1541
29	174	0.83	2.40	0.03	0.29	0.8836	318	1.2376
30	180	0.81	2.43	0.03	0.28	0.8648	311	1.2855
31	186	0.79	2.46	0.03	0.28	0.8470	305	1.3973
32	192	0.78	2.49	0.03	0.27	0.8301	299	1.4632
33	198	0.76	2.51	0.03	0.27	0.8140	293	1.6228
34	204	0.75	2.54	0.03	0.26	0.7987	288	1.7210
35	210	0.73	2.57	0.03	0.26	0.7841	282	1.9727
36	216	0.72	2.59	0.03	0.25	0.7702	277	2.1390
37	222	0.71	2.62	0.02	0.25	0.7569	272	2.6144
38	228	0.70	2.64	0.02	0.24	0.7442	268	2.9779
39	234	0.68	2.67	0.02	0.24	0.7319	264	4.3724
40	240	0.67	2.69	0.02	0.24	0.7202	259	6.1607
41	246	0.66	2.71	0.02	0.23	0.7090	255	17.1700
42	252	0.65	2.74	0.02	0.23	0.6982	251	3.5069
43	258	0.64	2.76	0.02	0.23	0.6878	248	2.3464
44	264	0.63	2.78	0.02	0.22	0.6778	244	1.8359
45	270	0.62	2.80	0.02	0.22	0.6681	241	1.5378
46	276	0.61	2.83	0.02	0.22	0.6588	237	1.3384
47	282	0.61	2.85	0.02	0.21	0.6499	234	1.1940
48	288	0.60	2.87	0.02	0.21	0.6412	231	1.0837
49	294	0.59	2.89	0.02	0.21	0.6328	228	0.9961
50	300	0.58	2.91	0.02	0.21	0.6247	225	0.9245
51	306	0.57	2.93	0.02	0.20	0.6168	222	0.8648
52	312	0.57	2.95	0.02	0.20	0.6092	219	0.8140
53	318	0.56	2.97	0.02	0.20	0.6019	217	0.7702
54	324	0.55	2.99	0.02	0.20	0.5947	214	0.7319
55	330	0.55	3.01	0.02	0.19	0.5878	212	0.6982
56	336	0.54	3.03	0.02	0.19	0.5810	209	0.6681
57	342	0.54	3.05	0.02	0.19	0.5745	207	0.6412
58	348	0.53	3.07	0.02	0.19	0.5682	205	0.6168
59	354	0.52	3.09	0.02	0.18	0.5620	202	0.5947
60	360	0.52	3.11	0.00	0.00	0.0000	0	0.0000

BMP 2

Q_{100yr} = 16.45 cfs

T_c = 6 min

$P_{6\ 100yr}$ = 3.1 in

C = 0.64

A = 3.359

I = $7.44*P_6*D^{-0.645}$

VOL = I*D/60

ΔVOL = $V_1 - V_0$

I (incr) = ΔVOL/T

Q = CIA

VOL = $C*P_6*A$

N	D (min)	I (in/hr)	VOL in	ΔVOL (in)	I (incr) (in\hr)	Q (cfs)	VOL (cf)	(Re-0rdered) Ordinate Sum =
0	0	0	0	0.73	7.26	16.4500	5922	0.0000
1	6	7.26	0.73	0.20	2.03	4.3551	1568	0.3973
2	12	4.64	0.93	0.14	1.44	3.0910	1113	0.4016
3	18	3.58	1.07	0.12	1.15	2.4791	892	0.4108
4	24	2.97	1.19	0.10	0.98	2.1051	758	0.4155
5	30	2.57	1.29	0.09	0.86	1.8482	665	0.4255
6	36	2.29	1.37	0.08	0.77	1.6587	597	0.4307
7	42	2.07	1.45	0.07	0.70	1.5121	544	0.4416
8	48	1.90	1.52	0.06	0.65	1.3946	502	0.4473
9	54	1.76	1.58	0.06	0.60	1.2979	467	0.4594
10	60	1.64	1.64	0.06	0.57	1.2166	438	0.4657
11	66	1.55	1.70	0.05	0.53	1.1472	413	0.4791
12	72	1.46	1.75	0.05	0.51	1.0871	391	0.4862
13	78	1.39	1.80	0.05	0.48	1.0344	372	0.5012
14	84	1.32	1.85	0.05	0.46	0.9878	356	0.5092
15	90	1.27	1.90	0.04	0.44	0.9462	341	0.5261
16	96	1.21	1.94	0.04	0.42	0.9087	327	0.5351
17	102	1.17	1.99	0.04	0.41	0.8749	315	0.5543
18	108	1.13	2.03	0.04	0.39	0.8441	304	0.5646
19	114	1.09	2.07	0.04	0.38	0.8159	294	0.5868
20	120	1.05	2.10	0.04	0.37	0.7900	284	0.5988
21	126	1.02	2.14	0.04	0.36	0.7661	276	0.6246
22	132	0.99	2.18	0.03	0.35	0.7439	268	0.6387
23	138	0.96	2.21	0.03	0.34	0.7233	260	0.6694

24	144	0.93	2.24	0.03	0.33	0.7042	253	0.6862
25	150	0.91	2.28	0.03	0.32	0.6862	247	0.7233
26	156	0.89	2.31	0.03	0.31	0.6694	241	0.7439
27	162	0.87	2.34	0.03	0.30	0.6536	235	0.7900
28	168	0.85	2.37	0.03	0.30	0.6387	230	0.8159
29	174	0.83	2.40	0.03	0.29	0.6246	225	0.8749
30	180	0.81	2.43	0.03	0.28	0.6114	220	0.9087
31	186	0.79	2.46	0.03	0.28	0.5988	216	0.9878
32	192	0.78	2.49	0.03	0.27	0.5868	211	1.0344
33	198	0.76	2.51	0.03	0.27	0.5755	207	1.1472
34	204	0.75	2.54	0.03	0.26	0.5646	203	1.2166
35	210	0.73	2.57	0.03	0.26	0.5543	200	1.3946
36	216	0.72	2.59	0.03	0.25	0.5445	196	1.5121
37	222	0.71	2.62	0.02	0.25	0.5351	193	1.8482
38	228	0.70	2.64	0.02	0.24	0.5261	189	2.1051
39	234	0.68	2.67	0.02	0.24	0.5174	186	3.0910
40	240	0.67	2.69	0.02	0.24	0.5092	183	4.3551
41	246	0.66	2.71	0.02	0.23	0.5012	180	16.4500
42	252	0.65	2.74	0.02	0.23	0.4936	178	2.4791
43	258	0.64	2.76	0.02	0.23	0.4862	175	1.6587
44	264	0.63	2.78	0.02	0.22	0.4791	172	1.2979
45	270	0.62	2.80	0.02	0.22	0.4723	170	1.0871
46	276	0.61	2.83	0.02	0.22	0.4657	168	0.9462
47	282	0.61	2.85	0.02	0.21	0.4594	165	0.8441
48	288	0.60	2.87	0.02	0.21	0.4533	163	0.7661
49	294	0.59	2.89	0.02	0.21	0.4473	161	0.7042
50	300	0.58	2.91	0.02	0.21	0.4416	159	0.6536
51	306	0.57	2.93	0.02	0.20	0.4361	157	0.6114
52	312	0.57	2.95	0.02	0.20	0.4307	155	0.5755
53	318	0.56	2.97	0.02	0.20	0.4255	153	0.5445
54	324	0.55	2.99	0.02	0.20	0.4204	151	0.5174
55	330	0.55	3.01	0.02	0.19	0.4155	150	0.4936
56	336	0.54	3.03	0.02	0.19	0.4108	148	0.4723
57	342	0.54	3.05	0.02	0.19	0.4061	146	0.4533
58	348	0.53	3.07	0.02	0.19	0.4016	145	0.4361
59	354	0.52	3.09	0.02	0.18	0.3973	143	0.4204
60	360	0.52	3.11	0.00	0.00	0.0000	0	0.0000

4.2 BASIN STORAGE AND STAGE-DISCHARGE RELATIONSHIPS

Outlet Structure for Discharge of BMP 1

Discharge vs. Elevation Table

Lower orifice		Lower Slot			Emergency Weir	
No. of orif:	0	No. of slots:	1		Invert:	1.000 ft
Dia:	3 in	Invert:	0.000 ft		B:	20.000 ft
Invert:	0.000 ft	B (width):	4.830 ft	6	V-Notch Angle	0
Area:	0.049 sf	Area:	1.208 sf			
Cg-low:	0.62	h_{slot} (height):	0.250 ft			
		Cg-low:	0.62			
Middle orifice		Upper slot				
No. of orif:	0	No. of slots:	1			
Dia:	4 in	Invert:	0.583 ft			
Invert:	0.417 ft	B (width):	0.833 ft			
Area:	0.000 sf	Area:	0.208 sf			
Cg-low:	0.62	h_{slot} (height):	0.250 ft			
		Cg-low:	0.62			

***Note: h = head above the invert of the lowest surface discharge opening.**

H (ft)	USE h* (ft)	$Q_{orifice-low}$ (cfs)	$Q_{orifice-upper}$ (cfs)	$Q_{slot-low}$ (cfs)	$Q_{slot-upper}$ (cfs)	Q_{emerg} (cfs)	Q_{tot} (cfs)
0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.583	0.083	0.000	0.000	1.220	0.000	0.000	1.220
0.667	0.167	0.000	0.000	1.725	0.210	0.000	1.936
0.750	0.250	0.000	0.000	2.113	0.298	0.000	2.411
0.833	0.333	0.000	0.000	2.742	0.365	0.000	3.107
0.917	0.417	0.000	0.000	3.245	0.473	0.000	3.718
1.000	0.500	0.000	0.000	3.679	0.560	0.000	4.239
1.083	0.583	0.000	0.000	4.067	0.635	0.000	4.702
1.167	0.667	0.000	0.000	4.422	0.702	0.000	5.123
1.250	0.750	0.000	0.000	4.750	0.763	0.000	5.513
1.333	0.833	0.000	0.000	5.056	0.819	0.000	5.876
1.417	0.917	0.000	0.000	5.346	0.872	0.000	6.218
1.500	1.000	0.000	0.000	5.620	0.922	0.000	6.542
1.583	1.083	0.000	0.000	5.881	0.970	1.491	8.342
1.667	1.167	0.000	0.000	6.132	1.015	4.219	11.365
1.750	1.250	0.000	0.000	6.372	1.058	7.750	15.180
1.833	1.333	0.000	0.000	6.604	1.099	11.932	19.635
1.917	1.417	0.000	0.000	6.828	1.139	16.675	24.643
2.000	1.500	0.000	0.000	7.045	1.178	21.920	30.143
2.083	1.583	0.000	0.000	7.255	1.215	27.623	36.093
2.167	1.667	0.000	0.000	7.460	1.252	33.749	42.460
2.250	1.750	0.000	0.000	7.659	1.287	40.270	49.216

Stage-Storage & Stage-Discharge Relationship for BMP 1

Discharge vs. Elevation Table

Gravel Porosity 0.4
Soil Porositiy 0.2

HMP orifice		
No. of orif:	0	
Dia:	4.00	"
Area:	0.0873	ft^2
Cg-low:	0.62	

Basin Dimensions		
Area:	6,135	ft^2
Perimeter	321	ft
Gravel Depth	0.58	ft
Soil Depth	1.50	ft
Mulch Depth	0.25	ft
Total Subsurface Depth	2.33	ft

Basin Depth (ft)	$Q_{HMP\ orifice}$ (cfs)	Stage Area (ft^2)	Basin Elev.	Volume (ft^3)	Basin Depth (ft)	Volume (acre-ft)	Q_{total} (cfs)
0.000	0.000	6,135	328.500	3,272	0.000	0.075	0.000
0.083	0.000	6,189	328.583	3,785	0.083	0.087	0.000
0.167	0.000	6,242	328.667	4,303	0.167	0.099	0.000
0.250	0.000	6,296	328.750	4,826	0.250	0.111	0.000
0.333	0.000	6,349	328.833	5,353	0.333	0.123	0.000
0.417	0.000	6,403	328.917	5,884	0.417	0.135	0.000
0.500	0.000	6,456	329.000	6,420	0.500	0.147	0.000
0.583	0.000	6,510	329.083	6,960	0.583	0.160	1.220
0.667	0.000	6,563	329.167	7,505	0.667	0.172	1.936
0.750	0.000	6,617	329.250	8,054	0.750	0.185	2.411
0.833	0.000	6,670	329.333	8,607	0.833	0.198	3.107
0.917	0.000	6,724	329.417	9,165	0.917	0.210	3.718
1.000	0.000	6,777	329.500	9,728	1.000	0.223	4.239
1.083	0.000	6,831	329.583	10,295	1.083	0.236	4.702
1.167	0.000	6,884	329.667	10,866	1.167	0.249	5.123
1.250	0.000	6,938	329.750	11,442	1.250	0.263	5.513
1.333	0.000	6,991	329.833	12,023	1.333	0.276	5.876
1.417	0.000	7,045	329.917	12,607	1.417	0.289	6.218
1.500	0.000	7,098	330.000	13,197	1.500	0.303	6.542
1.583	0.000	7,152	330.083	13,790	1.583	0.317	8.342
1.667	0.000	7,205	330.167	14,389	1.667	0.330	11.365
1.750	0.000	7,259	330.250	14,991	1.750	0.344	15.180

Outlet Structure for Discharge of BMP 2
Discharge vs. Elevation Table

Lower orifice		Lower Slot			Emergency Weir	
No. of orif:	0	No. of slots:	1		Invert:	1.000 ft
Dia:	3 in	Invert:	0.000 ft		B:	11.830 ft
Invert:	0.000 ft	B (width):	2.670 ft	2.25	V-Notch Angle	0
Area:	0.049 sf	Area:	0.668 sf			
Cg-low:	0.62	h_{slot} (height):	0.250 ft			
		Cg-low:	0.62			
Middle orifice		Upper slot				
No. of orif:	0	No. of slots:	1			
Dia:	4 in	Invert:	0.583 ft			
Invert:	0.417 ft	B (width):	0.500 ft	0.5		
Area:	0.000 sf	Area:	0.083 sf			
Cg-low:	0.62	h_{slot} (height):	0.167 ft			
		Cg-low:	0.62			

***Note: h = head above the invert of the lowest surface discharge opening.**

H (ft)	USE h* (ft)	$Q_{orifice-low}$ (cfs)	$Q_{orifice-upper}$ (cfs)	$Q_{slot-low}$ (cfs)	$Q_{slot-upper}$ (cfs)	Q_{emerg} (cfs)	Q_{tot} (cfs)
0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.583	0.083	0.000	0.000	0.674	0.000	0.000	0.674
0.667	0.167	0.000	0.000	0.954	0.084	0.000	1.038
0.750	0.250	0.000	0.000	1.168	0.119	0.000	1.287
0.833	0.333	0.000	0.000	1.516	0.204	0.000	1.720
0.917	0.417	0.000	0.000	1.794	0.207	0.000	2.001
1.000	0.500	0.000	0.000	2.034	0.239	0.000	2.273
1.083	0.583	0.000	0.000	2.248	0.268	0.000	2.516
1.167	0.667	0.000	0.000	2.444	0.293	0.000	2.737
1.250	0.750	0.000	0.000	2.626	0.317	0.000	2.942
1.333	0.833	0.000	0.000	2.795	0.339	0.000	3.134
1.417	0.917	0.000	0.000	2.955	0.359	0.000	3.314
1.500	1.000	0.000	0.000	3.107	0.378	0.000	3.485
1.583	1.083	0.000	0.000	3.251	0.397	0.882	4.530
1.667	1.167	0.000	0.000	3.390	0.415	2.495	6.300
1.750	1.250	0.000	0.000	3.523	0.432	4.584	8.538
1.833	1.333	0.000	0.000	3.651	0.448	7.058	11.156
1.917	1.417	0.000	0.000	3.775	0.464	9.863	14.102
2.000	1.500	0.000	0.000	3.894	0.479	12.966	17.339
2.083	1.583	0.000	0.000	4.011	0.494	16.339	20.843
2.167	1.667	0.000	0.000	4.124	0.508	19.962	24.594
2.250	1.750	0.000	0.000	4.234	0.522	23.820	28.575

Stage-Storage & Stage-Discharge Relationship for BMP 2

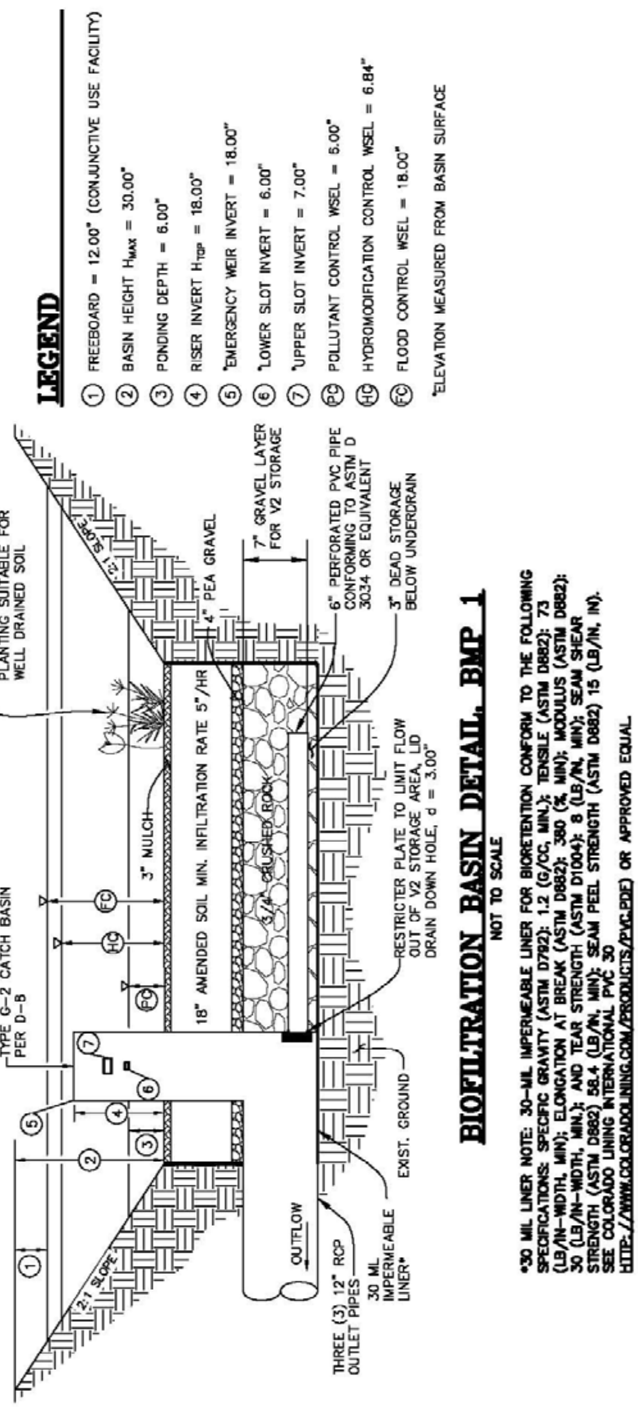
Discharge vs. Elevation Table

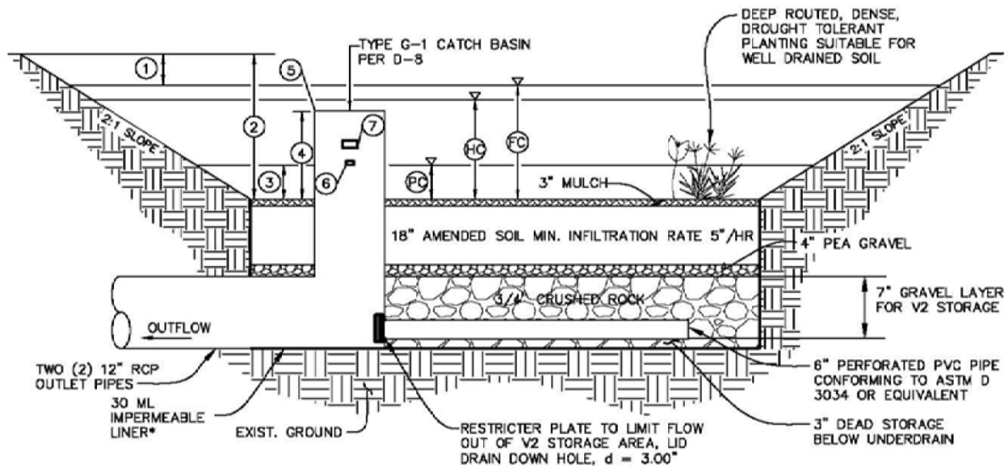
Gravel Porosity 0.4
Soil Porositiy 0.2

HMP orifice			Basin Dimensions		
No. of orif:	0		Area:	8,300	ft^2
Dia:	3.00	"	Perimeter	340	ft
Area:	0.0491	ft^2	Gravel Depth	0.58	ft
Cg-low:	0.62		Soil Depth	1.50	ft
			Mulch Depth	0.25	ft
			Total Subsurface Depth	2.33	ft

Basin Depth (ft)	$Q_{HMP\ orifice}$ (cfs)	Stage Area (ft^2)	Basin Elev.	Volume (ft^3)	Basin Depth (ft)	Volume (acre-ft)	Q_{total} (cfs)
0.000	0.000	8,300	328.500	4,427	0.000	0.102	0.000
0.083	0.000	8,357	328.583	5,118	0.083	0.118	0.000
0.167	0.000	8,413	328.667	5,810	0.167	0.133	0.000
0.250	0.000	8,470	328.750	6,502	0.250	0.149	0.000
0.333	0.000	8,527	328.833	7,193	0.333	0.165	0.000
0.417	0.000	8,583	328.917	7,885	0.417	0.181	0.000
0.500	0.000	8,640	329.000	8,577	0.500	0.197	0.000
0.583	0.000	8,697	329.083	9,268	0.583	0.213	0.674
0.667	0.000	8,753	329.167	9,960	0.667	0.229	1.038
0.750	0.000	8,810	329.250	10,652	0.750	0.245	1.287
0.833	0.000	8,867	329.333	11,343	0.833	0.260	1.720
0.917	0.000	8,923	329.417	12,035	0.917	0.276	2.001
1.000	0.000	8,980	329.500	12,727	1.000	0.292	2.273
1.083	0.000	9,037	329.583	13,418	1.083	0.308	2.516
1.167	0.000	9,093	329.667	14,110	1.167	0.324	2.737
1.250	0.000	9,150	329.750	14,802	1.250	0.340	2.942
1.333	0.000	9,207	329.833	15,493	1.333	0.356	3.134
1.417	0.000	9,263	329.917	16,185	1.417	0.372	3.314
1.500	0.000	9,320	330.000	16,877	1.500	0.387	3.485
1.583	0.000	9,377	330.083	17,568	1.583	0.403	4.530
1.667	0.000	9,433	330.167	18,260	1.667	0.419	6.300
1.750	0.000	9,490	330.250	18,952	1.750	0.435	8.538

4.3 BASIN OUTLET DETAILS





LEGEND

1. FREEBOARD = 12.00" (CONJUNCTIVE USE FACILITY)
2. BASIN HEIGHT H_{MAX} = 30.00"
3. PONDING DEPTH = 6.00"
4. RISER INVERT H_{TOP} = 18.00"
5. *EMERGENCY WEIR INVERT = 18.00"
6. *LOWER SLOT INVERT = 6.00"
7. *UPPER SLOT INVERT = 7.00"

PC POLLUTANT CONTROL WSEL = 6.00"

HC HYDROMODIFICATION CONTROL WSEL = 7.32"

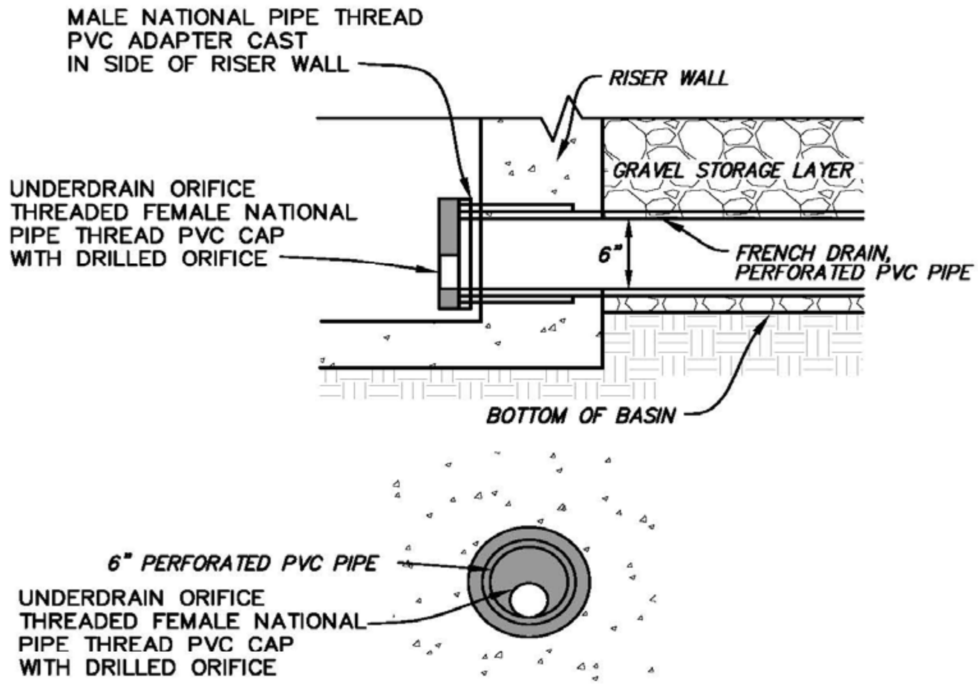
FC FLOOD CONTROL WSEL = 18.00"

*ELEVATION MEASURED FROM BASIN SURFACE

BIOFILTRATION BASIN DETAIL, BMP 2

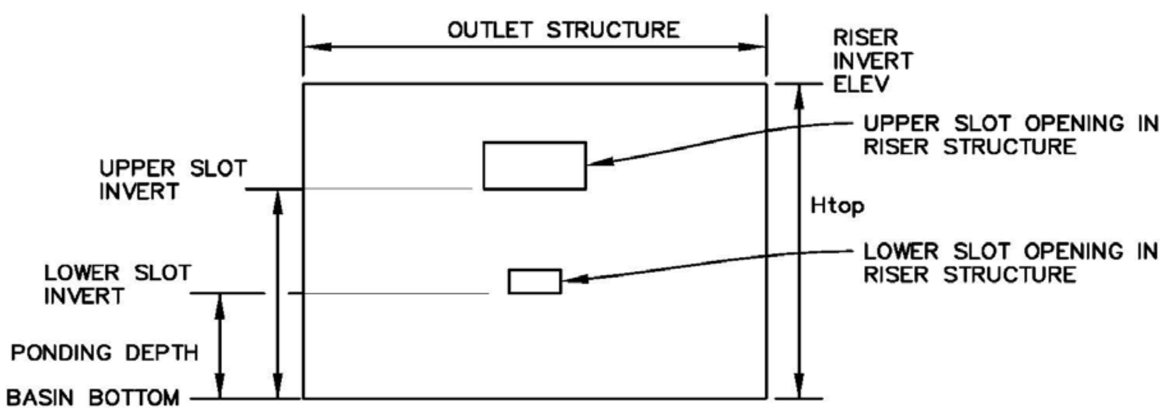
NOT TO SCALE

*30 MIL LINER NOTE: 30-MIL IMPERMEABLE LINER FOR BIORETENTION CONFORM TO THE FOLLOWING SPECIFICATIONS: SPECIFIC GRAVITY (ASTM D792): 1.2 (G/CC, MIN.); TENSILE (ASTM D882): 73 (LB/IN-WIDTH, MIN); ELONGATION AT BREAK (ASTM D882): 380 (%, MIN); MODULUS (ASTM D882): 30 (LB/IN-WIDTH, MIN.); AND TEAR STRENGTH (ASTM D1004): 8 (LB/IN, MIN); SEAM SHEAR STRENGTH (ASTM D882) 58.4 (LB/IN, MIN); SEAM PEEL STRENGTH (ASTM D882) 15 (LB/IN, IN). SEE COLORADO LINING INTERNATIONAL PVC 30 HTTP://WWW.COLORADOLINING.COM/PRODUCTS/PVC.PDF) OR APPROVED EQUAL.



RESTRICTOR CAP DETAIL BMP 1 & 2

NOT TO SCALE



OUTLET STRUCTURE DETAIL BMP 1 & 2

NOT TO SCALE

4.4 HEC-HMS MODIFIED-PULS ROUTING RESULTS

BMP 1

Project: Bmp 1
Simulation Run: Q100
Simulation Start: 31 December 1999, 24:00
Simulation End: 1 January 2000, 06:00

HMS Version: 4.8
Executed: 20 August 2021, 23:09

Global Results Summary

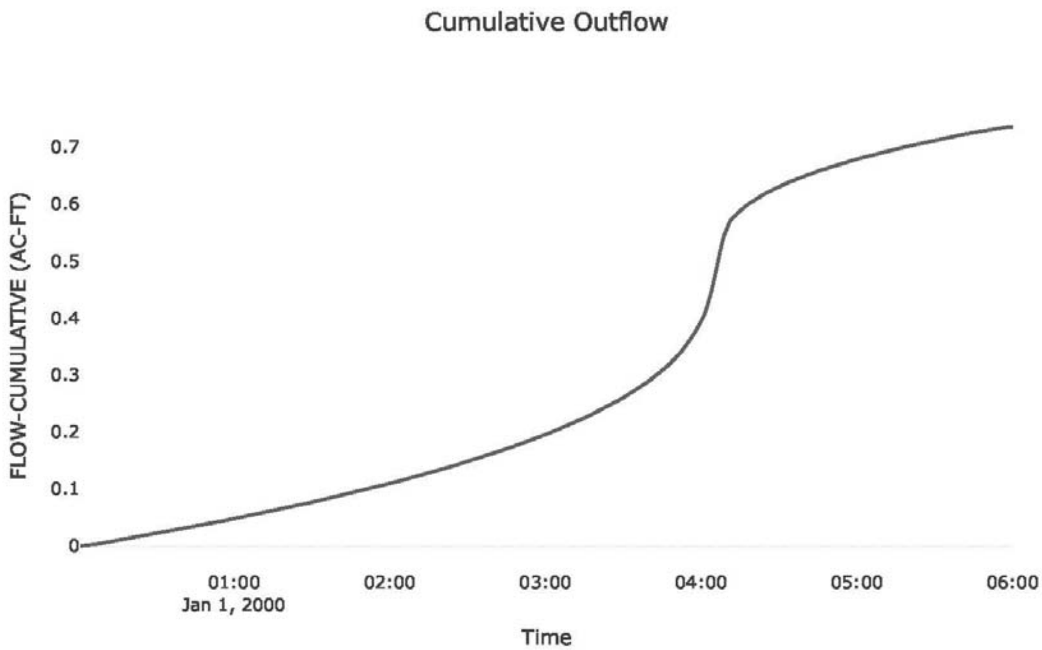
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume ()
Dma 1	Not specified	17.17	01Jan2000, 04:06	Not specified
Basin 1	Not specified	6.54	01Jan2000, 04:11	Not specified

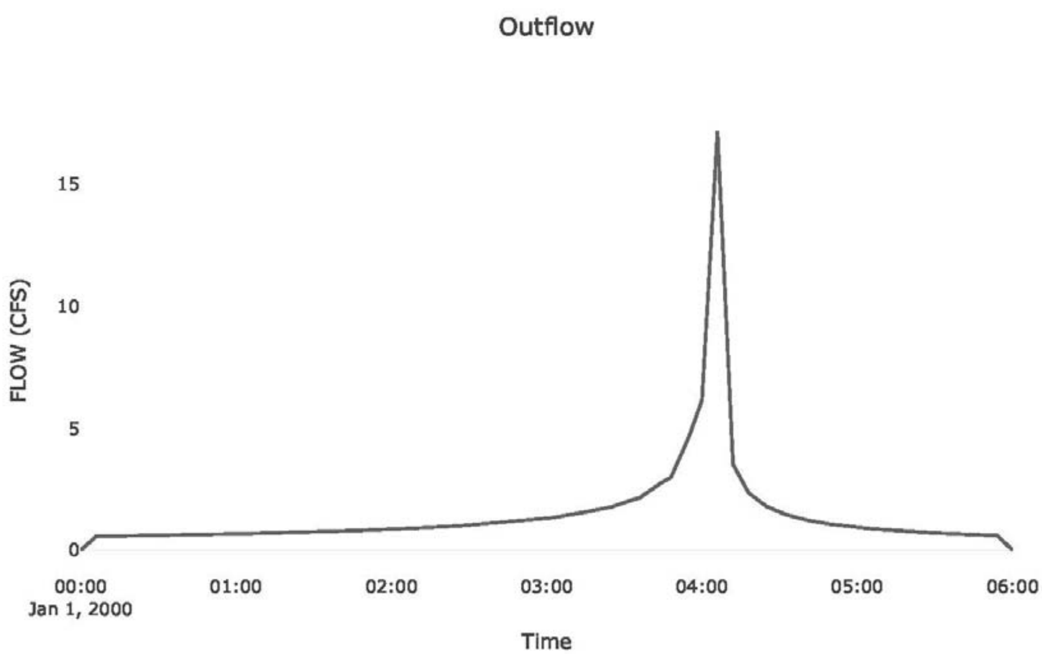
Source: DMA 1

Downstream : Basin 1
Flow Method : Gage Flow
Flow Gage : POC - 1

Results: DMA 1

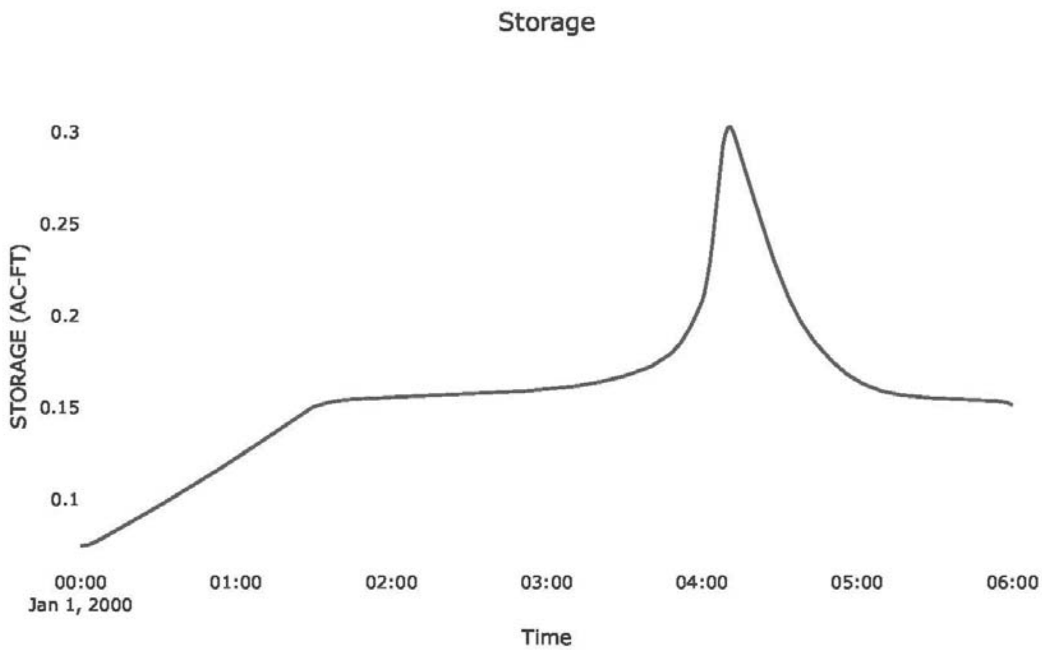
Peak Discharge (CFS)	17.17
Time of Peak Discharge	01Jan2000, 04:06

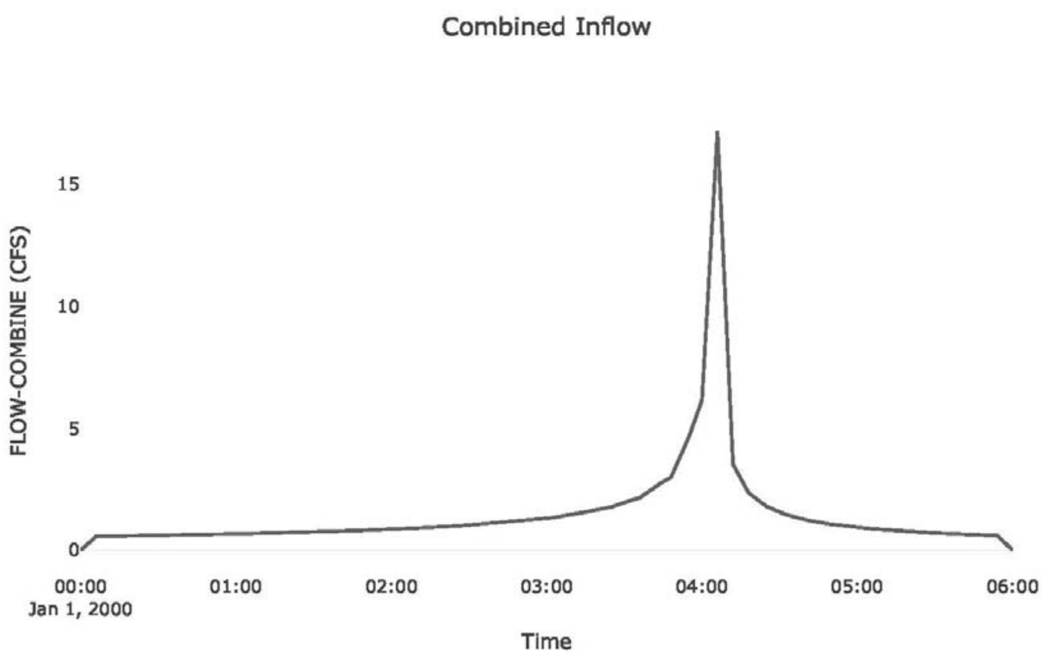

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
01:00
Jan 1, 2000
02:00
03:00
04:00
05:00
06:00
Time


Outflow
FLOW (CFS)
15
10
5
0
00:00
Jan 1, 2000
01:00
02:00
03:00
04:00
05:00
06:00
Time

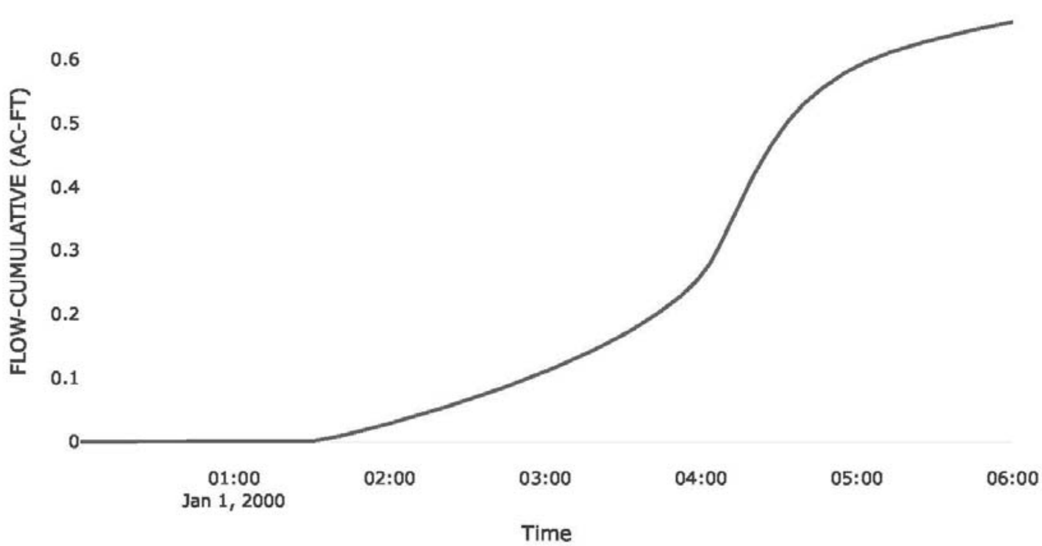
Reservoir: Basin 1

Results: Basin 1	
Peak Discharge (CFS)	6.54
Time of Peak Discharge	01Jan2000, 04:11
Peak Inflow (CFS)	17.17
Time of Peak Inflow	01Jan2000, 04:06
Inflow Volume (AC - FT)	0.74
Maximum Storage (AC - FT)	0.3
Peak Elevation (FT)	1.5
Discharge Volume (AC - FT)	0.66

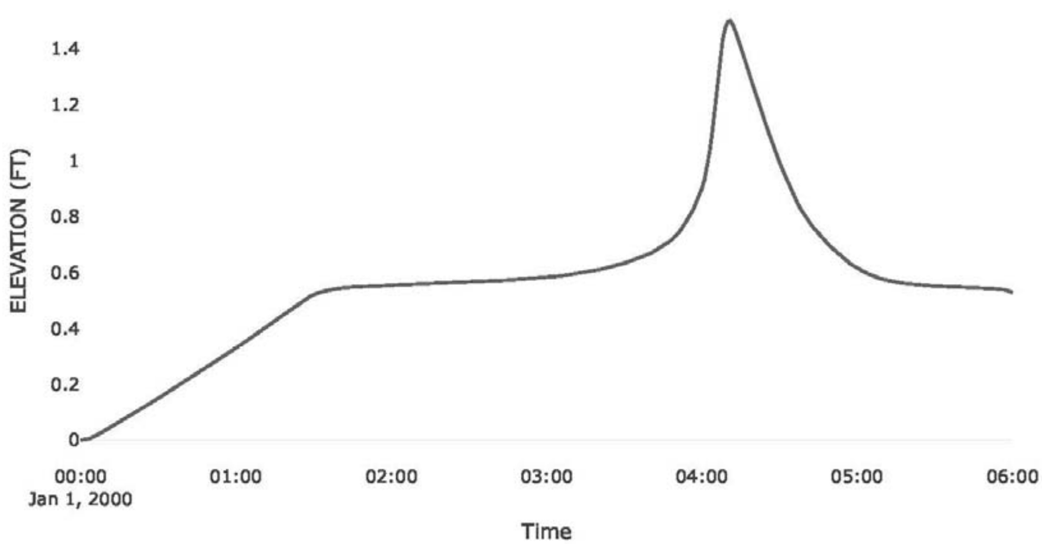

Storage
0.3
0.25
0.2
0.15
0.1
STORAGE (AC-FT)
00:00
Jan 1, 2000
01:00
02:00
03:00
04:00
05:00
06:00
Time

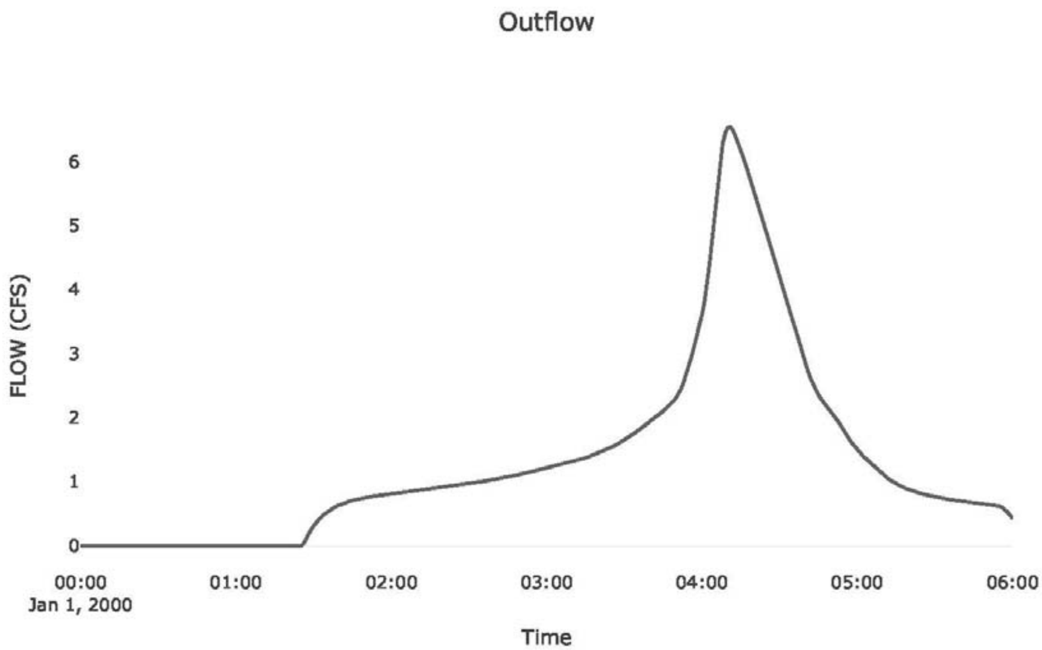

Combined Inflow
15
10
5
0
FLOW-COMBINE (CFS)
00:00
Jan 1, 2000
01:00
02:00
03:00
04:00
05:00
06:00
Time

Cumulative Outflow



Pool Elevation




Outflow
FLOW (CFS)
0
1
2
3
4
5
6
00:00
Jan 1, 2000
01:00
02:00
03:00
04:00
05:00
06:00
Time

BMP 2

Project: Bmp2
Simulation Run: Q100
Simulation Start: 31 December 1999, 24:00
Simulation End: 1 January 2000, 06:00

HMS Version: 4.8
Executed: 20 August 2021, 23:14

Global Results Summary

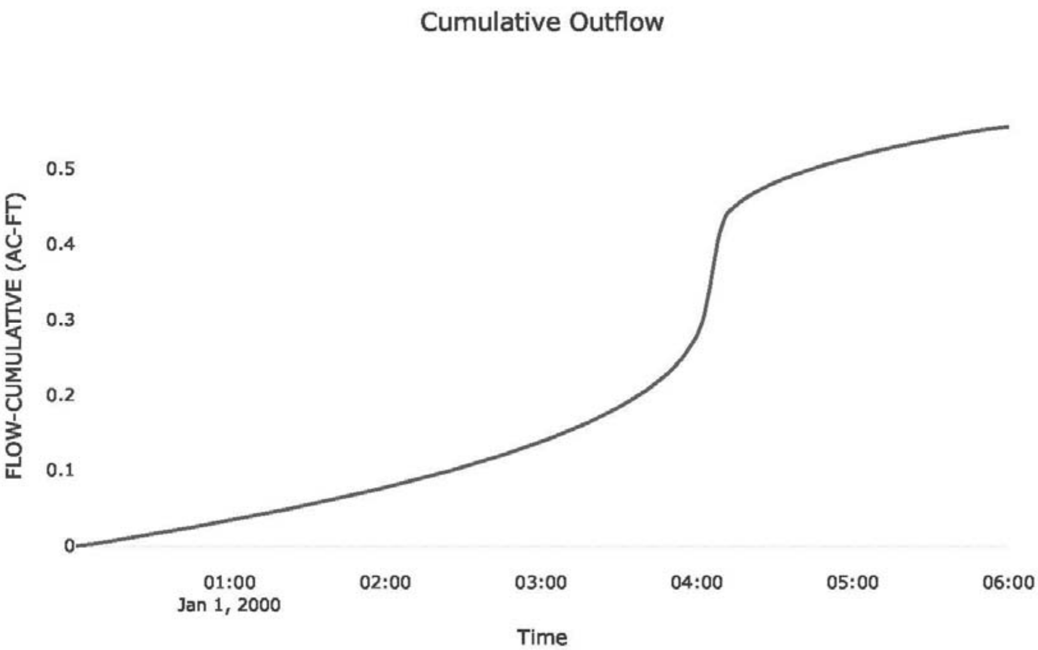
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume ()
Dma 1	Not specified	16.45	01Jan2000, 04:06	Not specified
Basin 1	Not specified	3.48	01Jan2000, 04:12	Not specified

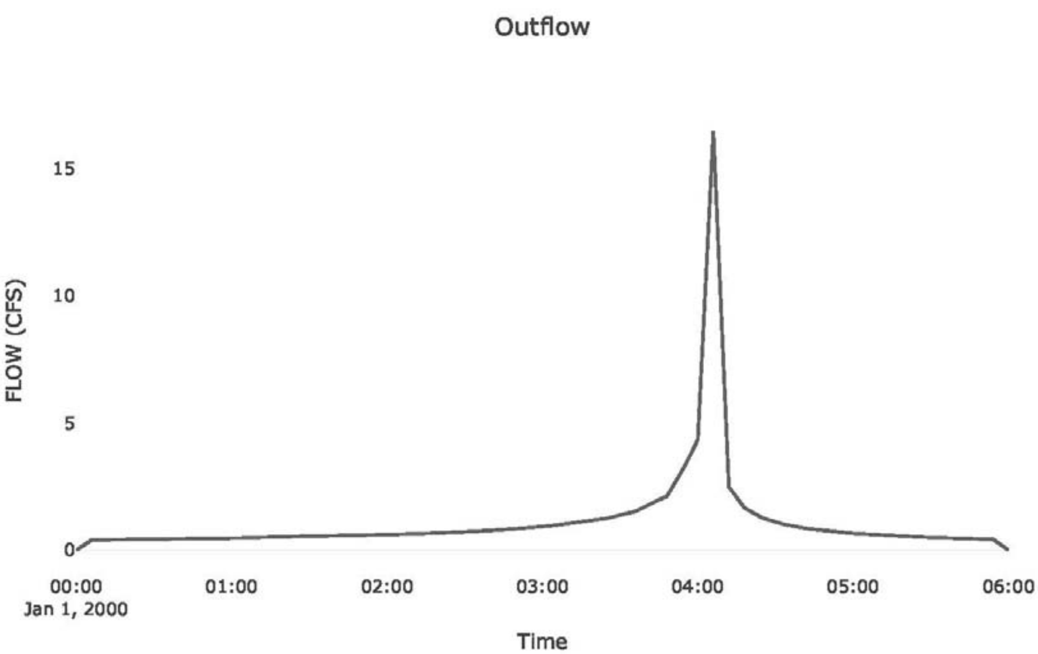
Source: DMA 1

Downstream : Basin 1
Flow Method : Gage Flow
Flow Gage : POC - 1

Results: DMA 1

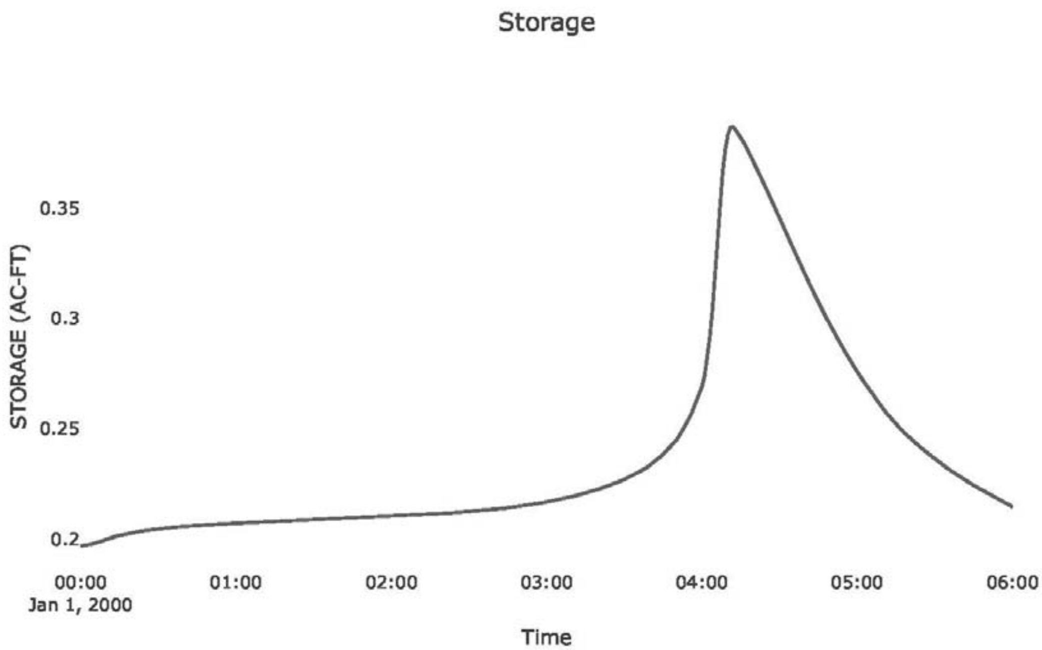
Peak Discharge (CFS)	16.45
Time of Peak Discharge	01Jan2000, 04:06

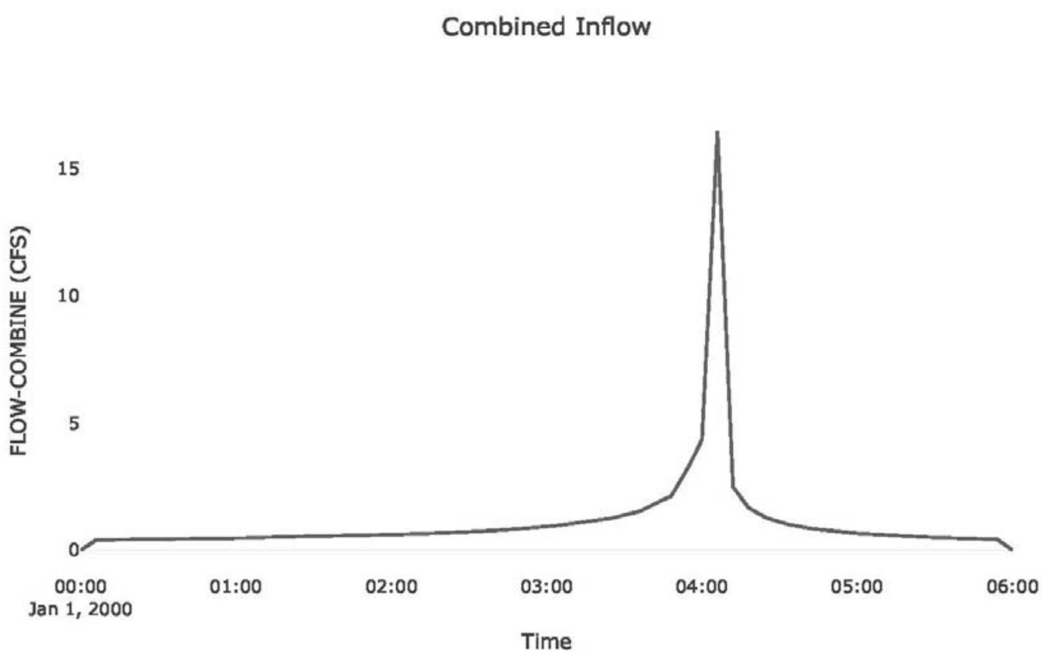

Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0.5
0.4
0.3
0.2
0.1
0
01:00
Jan 1, 2000
02:00
03:00
04:00
05:00
06:00
Time

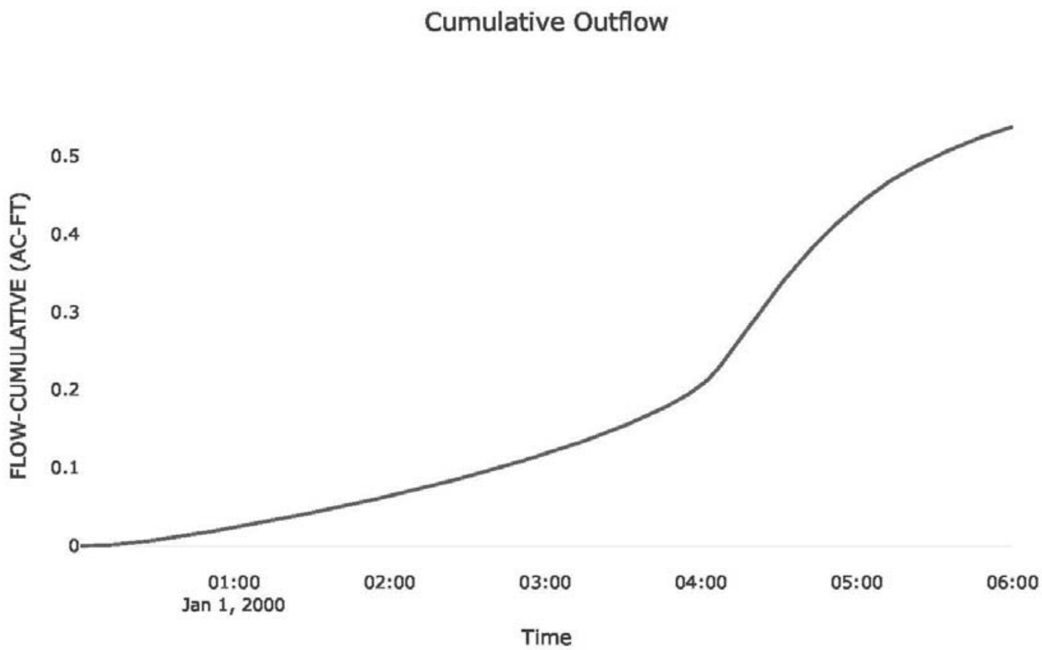

Outflow
FLOW (CFS)
15
10
5
0
00:00
Jan 1, 2000
01:00
02:00
03:00
04:00
05:00
06:00
Time

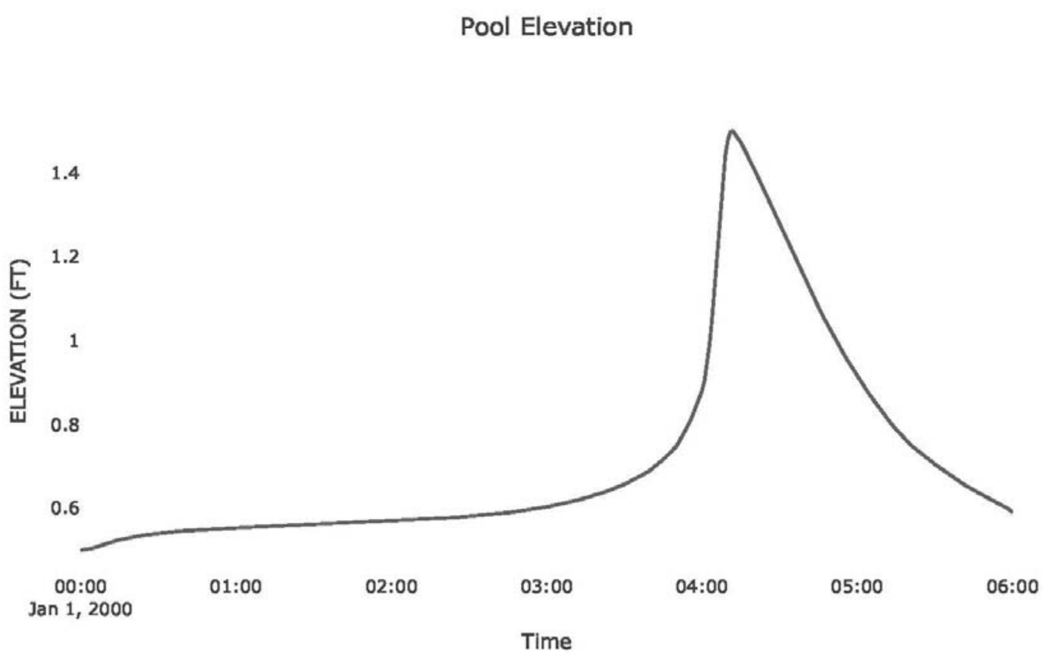
Reservoir: Basin 1

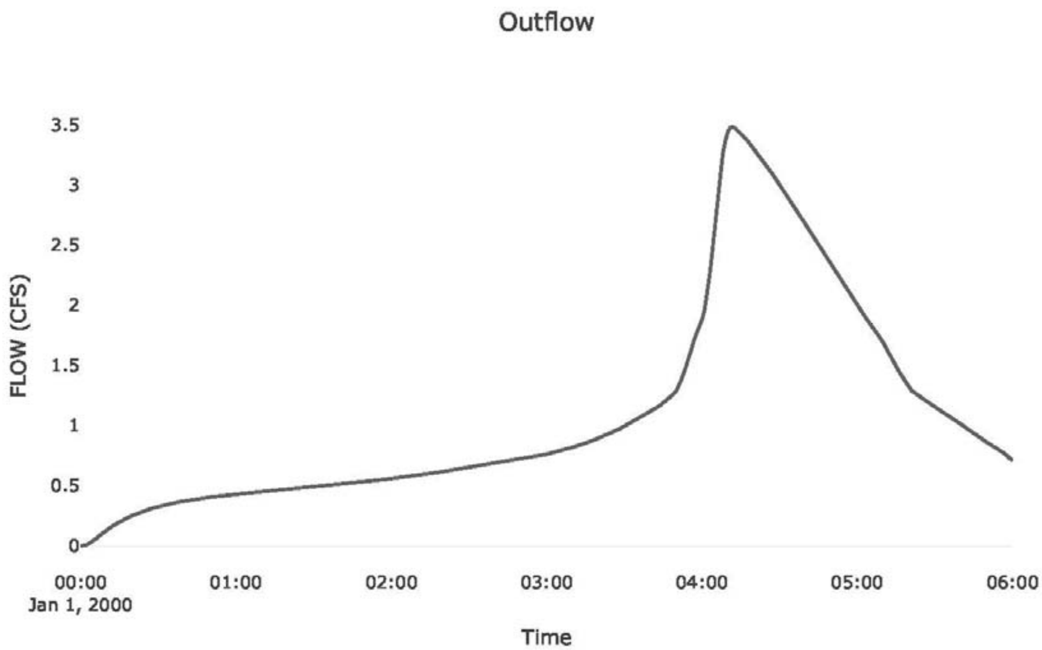
Results: Basin 1	
Peak Discharge (CFS)	3.48
Time of Peak Discharge	01Jan2000, 04:12
Peak Inflow (CFS)	16.45
Time of Peak Inflow	01Jan2000, 04:06
Inflow Volume (AC - FT)	0.56
Maximum Storage (AC - FT)	0.39
Peak Elevation (FT)	1.5
Discharge Volume (AC - FT)	0.54


Storage
STORAGE (AC-FT)
0.35
0.3
0.25
0.2
00:00
Jan 1, 2000
01:00
02:00
03:00
04:00
05:00
06:00
Time


Combined Inflow
FLOW-COMBINE (CFS)
15
10
5
0
00:00
Jan 1, 2000
01:00
02:00
03:00
04:00
05:00
06:00
Time


Cumulative Outflow
FLOW-CUMULATIVE (AC-FT)
0.5
0.4
0.3
0.2
0.1
0
01:00
Jan 1, 2000
02:00
03:00
04:00
05:00
06:00
Time


Pool Elevation
ELEVATION (FT)
1.4
1.2
1
0.8
0.6
00:00
Jan 1, 2000
01:00
02:00
03:00
04:00
05:00
06:00
Time


Outflow
3.5
3
2.5
2
1.5
1
0.5
0
FLOW (CFS)
00:00
Jan 1, 2000
01:00
02:00
03:00
04:00
05:00
06:00
Time

CHAPTER 5

HYDRAULIC ELEMENTS CALCULATIONS

5.1 CURB INLET CAPACITY CALCULATIONS

CURB INLET SIZING PER 2005 SAN DIEGO COUNTY DRAINAGE MANUAL

CURB INLET ON GRADE

EQUATION 2-2

$$Q/L_T = 0.7(a+y)^{3/2}$$

Q = interception capacity of the curb inlet (cfs)

y = depth of flow appoaching the curb inlet (ft)

a = depth of depression of curb at inlet (ft) = 0.33 ft

L_T = length of clear opening of inlet for total interception (ft)

Solve for L_W

$$L_T = \frac{Q}{0.7(a+y)^{3/2}}$$

NODE	TOTAL Q (CFS)	a (FT)	y (FT)	L_T (FT)	L_W Used (FT)
120	11.31	0.33	0.50	21.2	24.0
160	6.69	0.33	0.34	17.3	20.0

CURB INLET IN SAG
EQUATION 2-8

$$Q = C_W L_W d^{3/2}$$

$Q =$ inlet capacity (cfs)
$C_W =$ weir discharge coefficient = 3.00
$L_W =$ weir length (ft)
$d =$ depth of flow (ft)

Solve for L_W

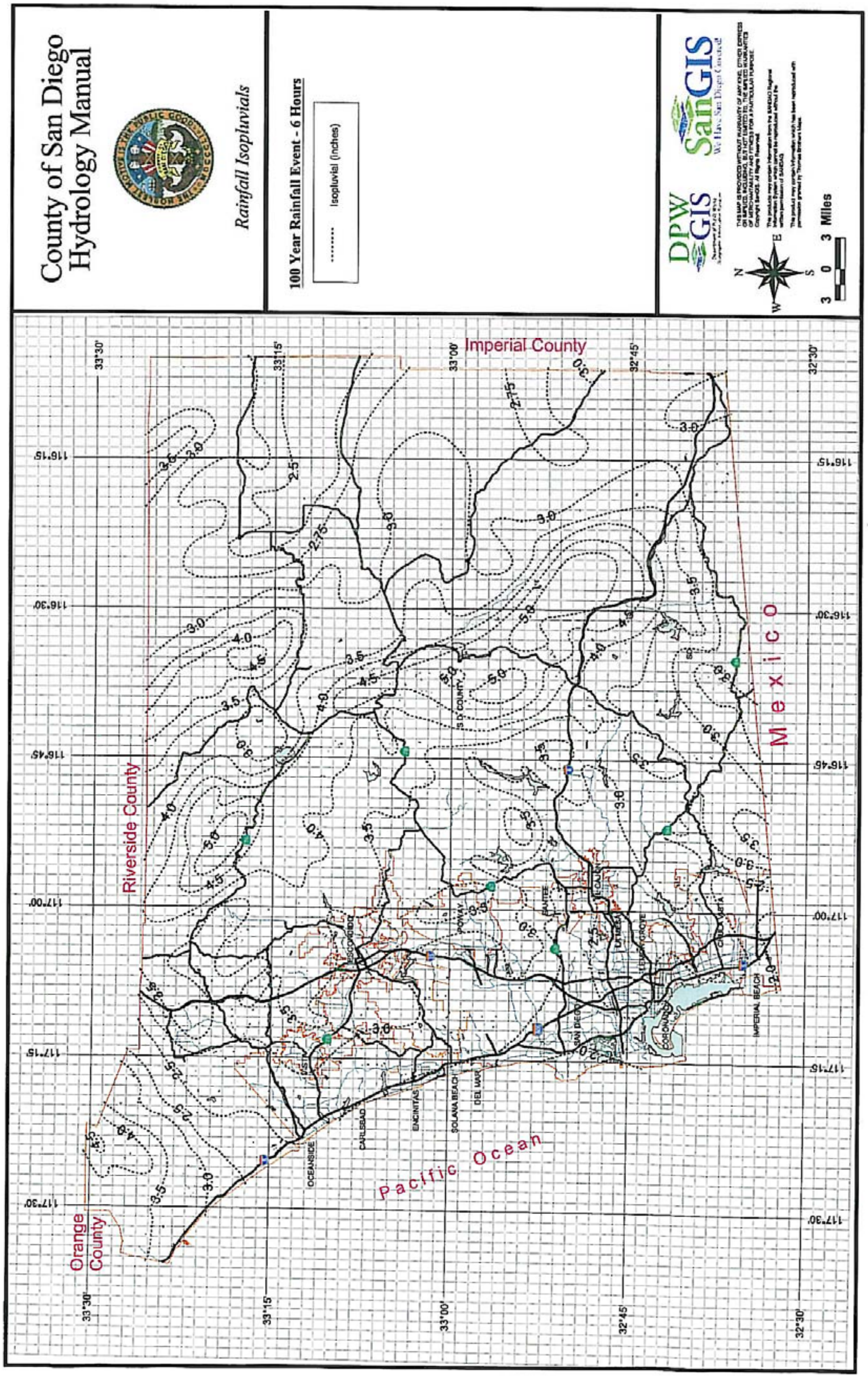
$$L_W = \frac{Q}{C_W * d^{3/2}}$$

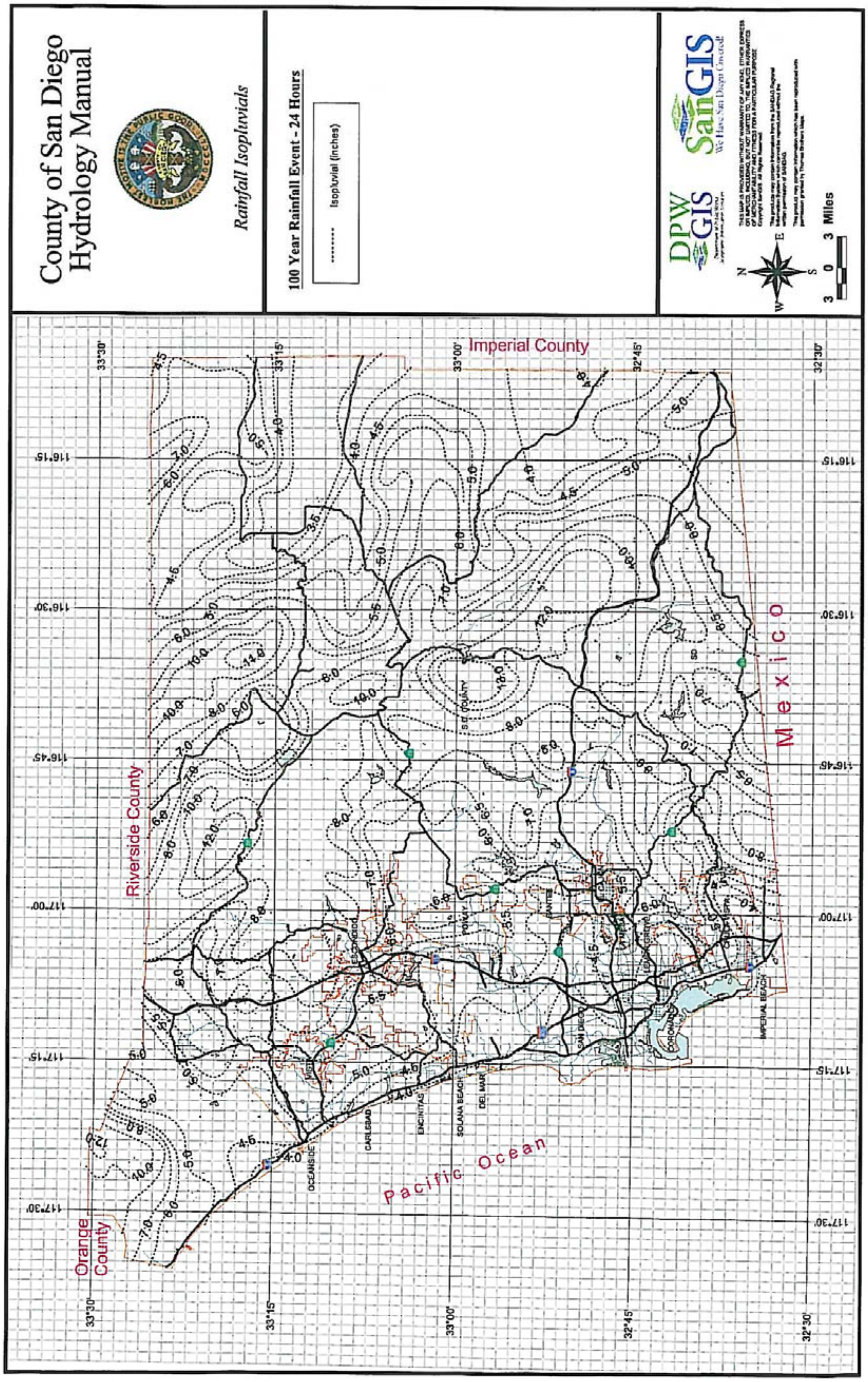
NODE	TOTAL Q (CFS)	C_W	d (FT)	L_W (FT)	L_W Used (FT)
240	15.42	3	0.83	6.8	10.0

CHAPTER 6

REFERENCES

6.1 – Methodology – Rational Method Peak Flow Determination


County of San Diego
Hydrology Manual
Rainfall Isopluvials
100 Year Rainfall Event - 6 Hours
Isopluvial (inches)
DPW GIS
SanGIS
We Have San Diego Covered!
3 0 3 Miles
Riverside County
Imperial County
Orange County
Mexico
Pacific Ocean
OCEANSIDE
CARLSBAD
ENCINITAS
SOLANA BEACH
DEL MAR
SAN DIEGO
CORONADO
IMPERIAL BEACH
CHULA VISTA
ESCONDIDO
POWAY
SANTEE
LA MESA
EL CAJON
LEMON GROVE
S.D. COUNTY
33°30'
33°15'
33°00'
32°45'
32°30'
116°15'
116°30'
116°45'
117°00'
117°15'
117°30'



County of San Diego
Hydrology Manual
Rainfall Isopluvials
100 Year Rainfall Event - 24 Hours
Isopluvial (inches)
DPW GIS
SanGIS
We Have San Diego Covered!
3 0 3 Miles
Riverside County
Imperial County
Orange County
Mexico
Pacific Ocean
OCEANSIDE
CARLSBAD
ENCINITAS
SOLANA BEACH
DEL MAR
SAN DIEGO
CORONADO
IMPERIAL BEACH

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).

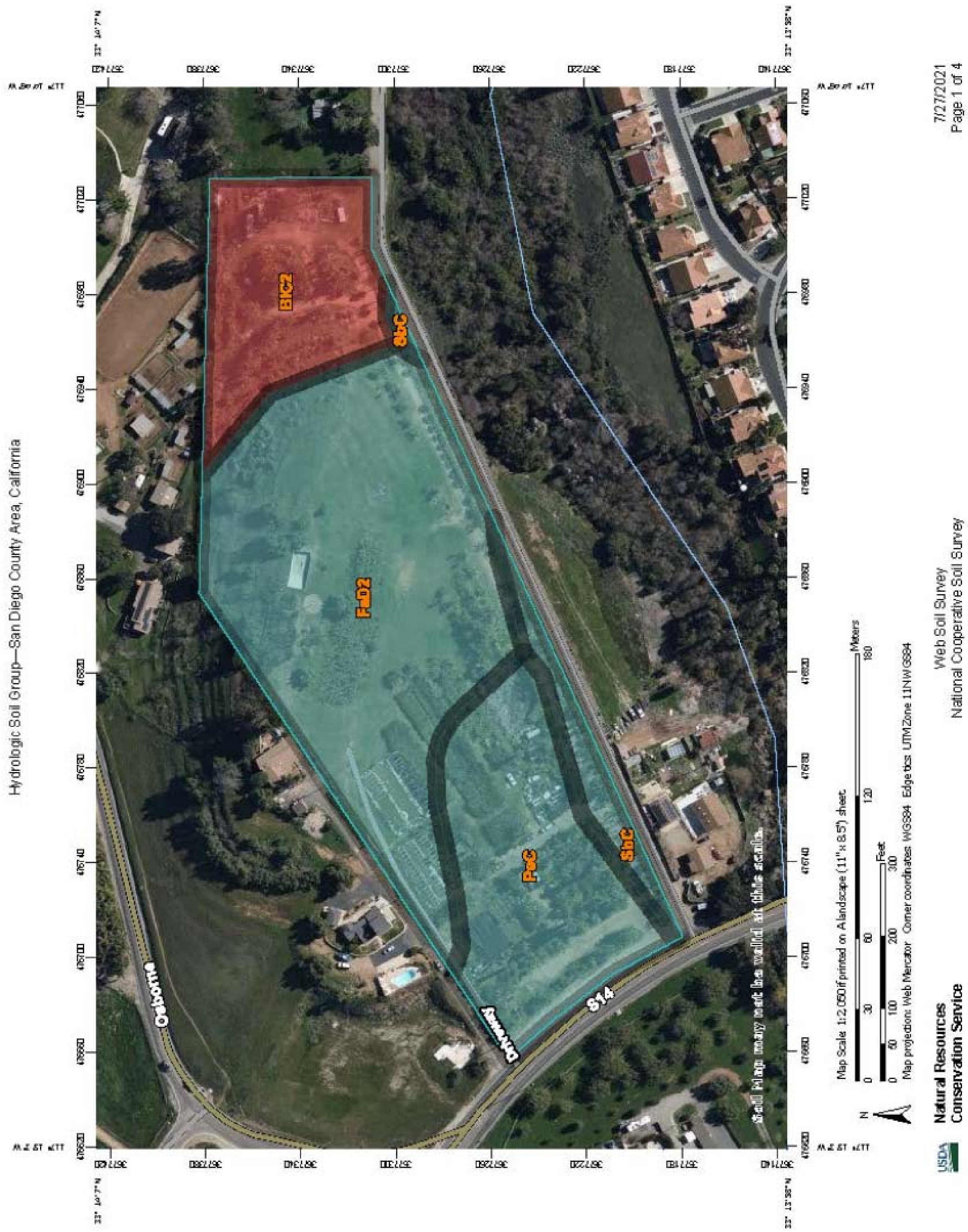
DU/A = dwelling units per acre

NRCS = National Resources Conservation Service

$$C = 0.90 \times (\% \text{ Impervious}) + C_p \times (1 - \% \text{ Impervious})$$

Where: C_p = Pervious Coefficient Runoff Value for the soil type (shown in Table 3-1 as Undisturbed Natural Terrain/Permanent Open Space, 0% Impervious). Soil type can be determined from the soil type map provided in Appendix A.

The values in Table 3-1 are typical for most urban areas. However, if the basin contains rural or agricultural land use, parks, golf courses, or other types of nonurban land use that are expected to be permanent, the appropriate value should be selected based upon the soil and cover and approved by the local agency.


Hydrologic Soil Group—San Diego County Area, California
BlC2
SbC
FaD2
PeC
SbC
Osborne
S14
Soil Map may not be valid at this scale.
Map Scale: 1:2,050 if printed on A landscape (11" x 8.5") sheet.
Meters
0 30 60 120 180
Feet
0 50 100 200 300
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84
Natural Resources
Conservation Service
Web Soil Survey
National Cooperative Soil Survey
7/27/2021
Page 1 of 4

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

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

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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

Soil Survey Area: San Diego County Area, California
Survey Area Data: Version 15, May 27, 2020

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

Date(s) aerial images were photographed: Jan 24, 2020—Feb 12, 2020

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BlC2	Bonsall sandy loam, 2 to 9 percent slopes, eroded	D	1.7	17.8%
FaD2	Fallbrook sandy loam, 9 to 15 percent slopes, eroded	C	4.8	52.1%
PeC	Placentia sandy loam, 2 to 9 percent slopes, warm MAAT, MLRA 19	C	2.3	24.4%
SbC	Salinas clay loam, 2 to 9 percent slopes	C	0.5	5.7%
Totals for Area of Interest			**9.3**	**100.0%**

Description

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

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

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

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

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

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

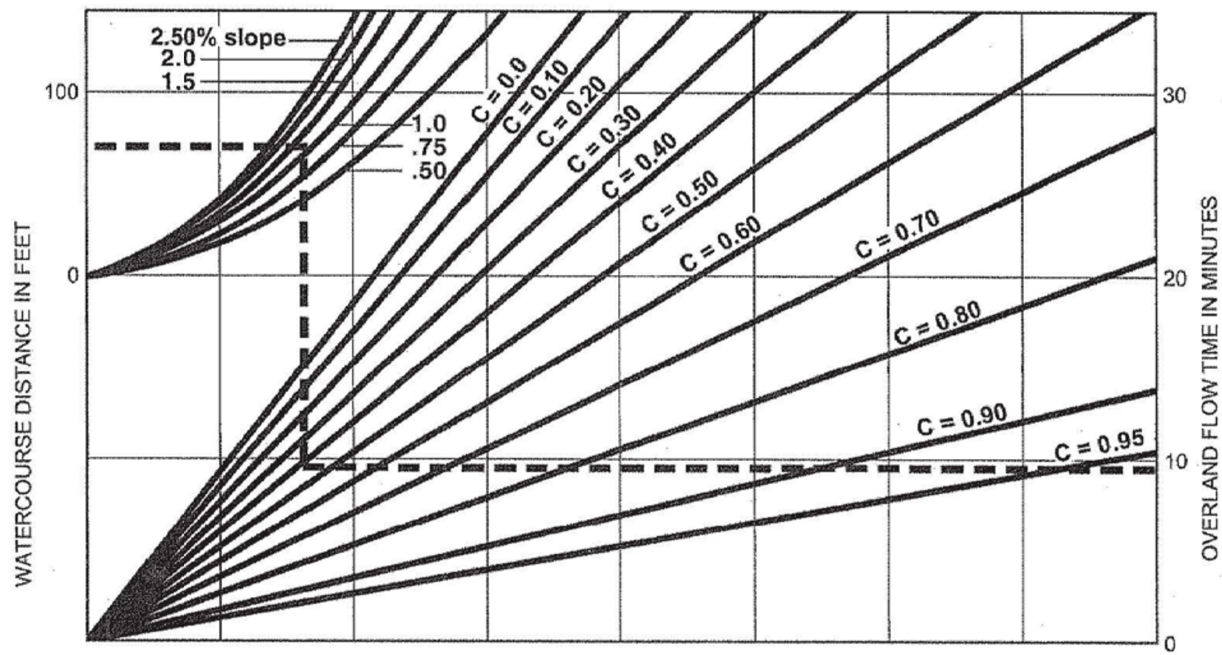
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



EXAMPLE:

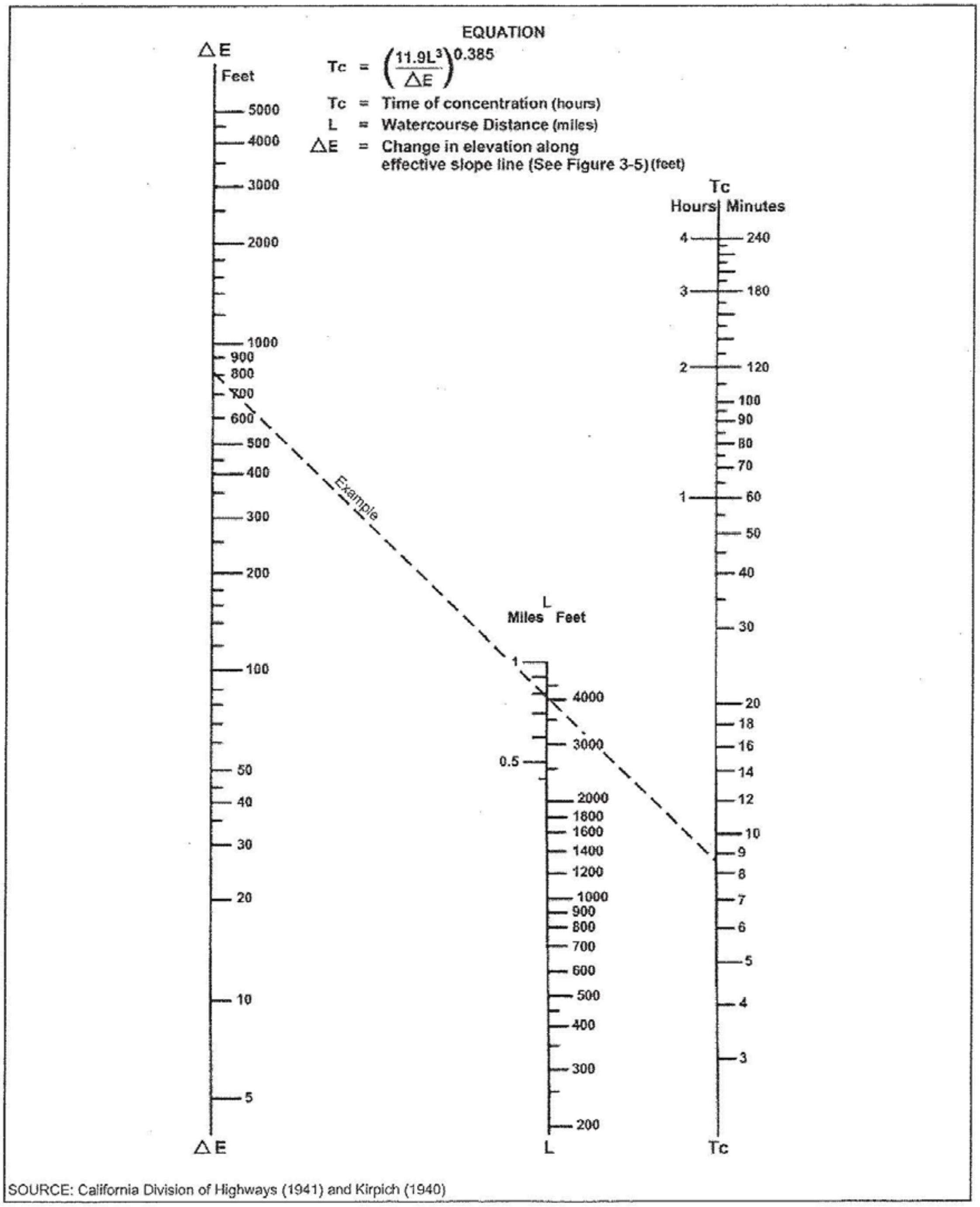
Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

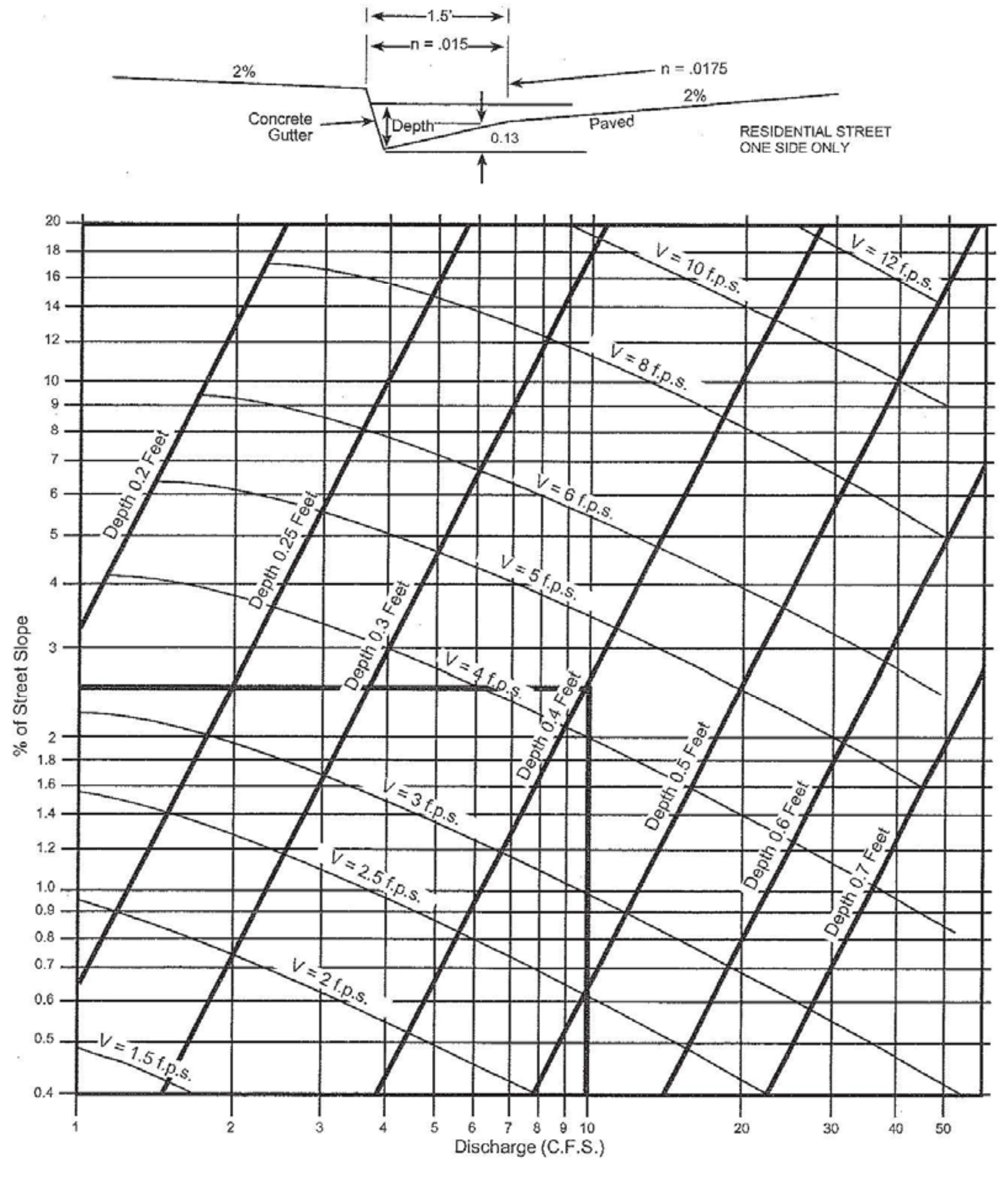
FIGURE **3-3**

Rational Formula - Overland Time of Flow Nomograph



Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

FIGURE
3-4



EXAMPLE:
Given: Q = 10 S = 2.5%
Chart gives: Depth = 0.4, Velocity = 4.4 f.p.s.

SOURCE: San Diego County Department of Special District Services Design Manual

Gutter and Roadway Discharge - Velocity Chart

FIGURE
3-6

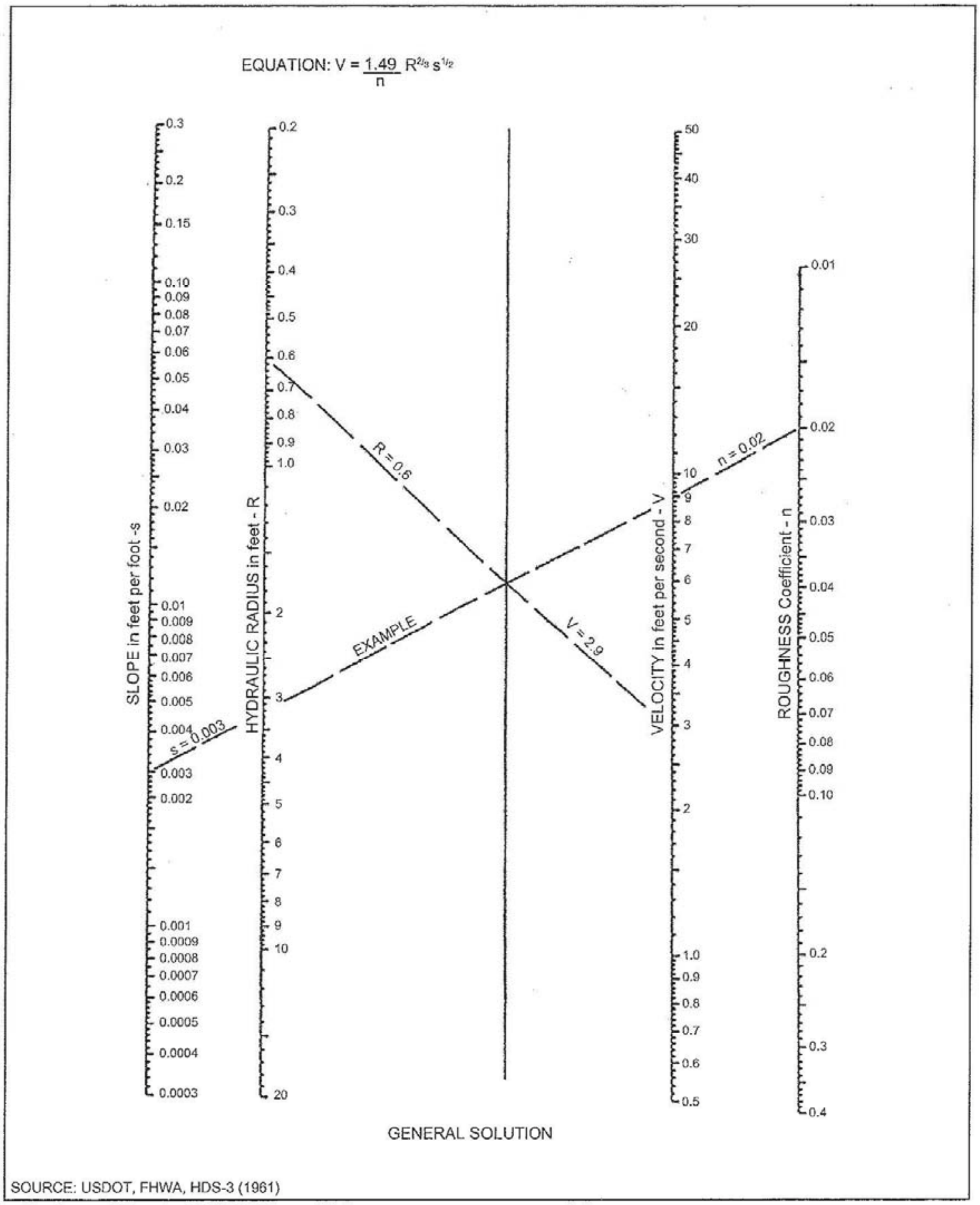
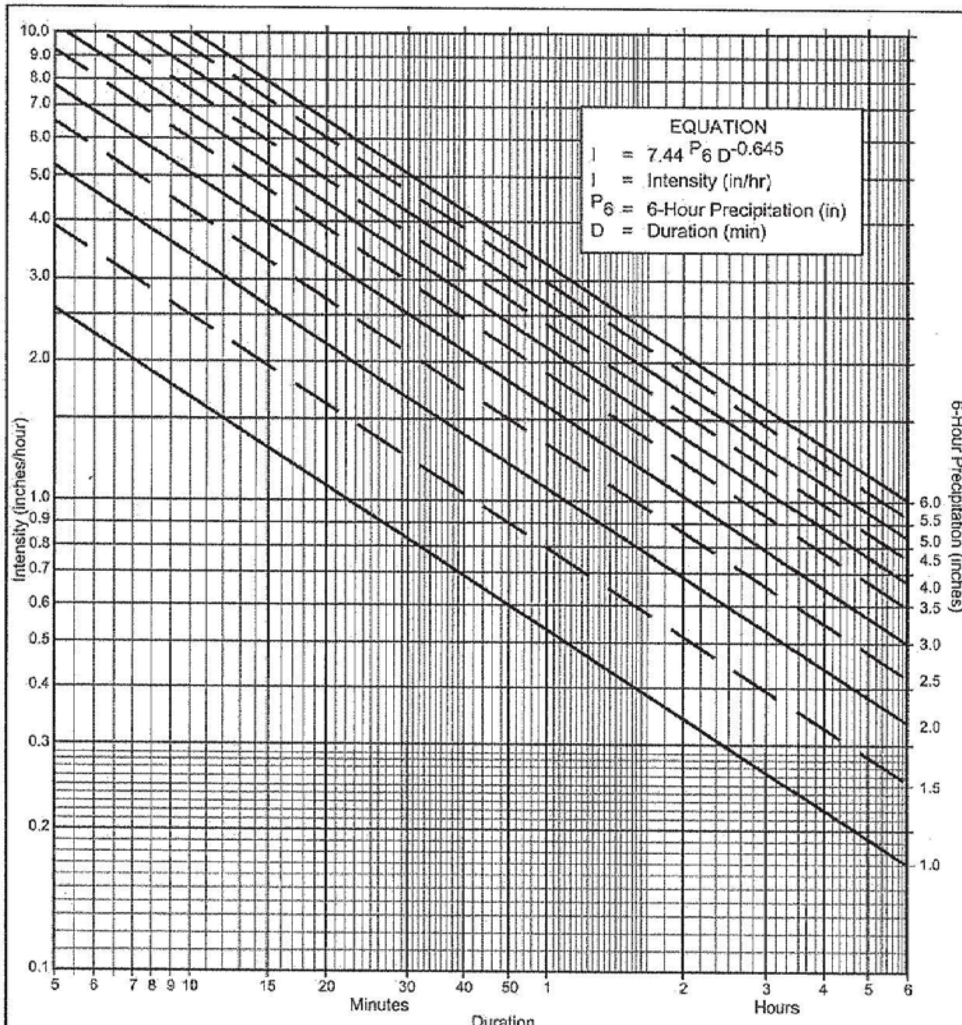


FIGURE 3-7

Manning's Equation Nomograph



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 Form:

(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	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Duration	I	I	I	I	I	I	I	I	I	I	I
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 - Template

FIGURE

3-1

3.2 DEVELOPING INPUT DATA FOR THE RATIONAL METHOD

This section describes the development of the necessary data to perform RM calculations. Section 3.3 describes the RM calculation process. Input data for calculating peak flows and T_c's with the RM should be developed as follows:

1. On a topographic base map, outline the overall drainage area boundary, showing adjacent drains, existing and proposed drains, and overland flow paths.

2. Verify the accuracy of the drainage map in the field.

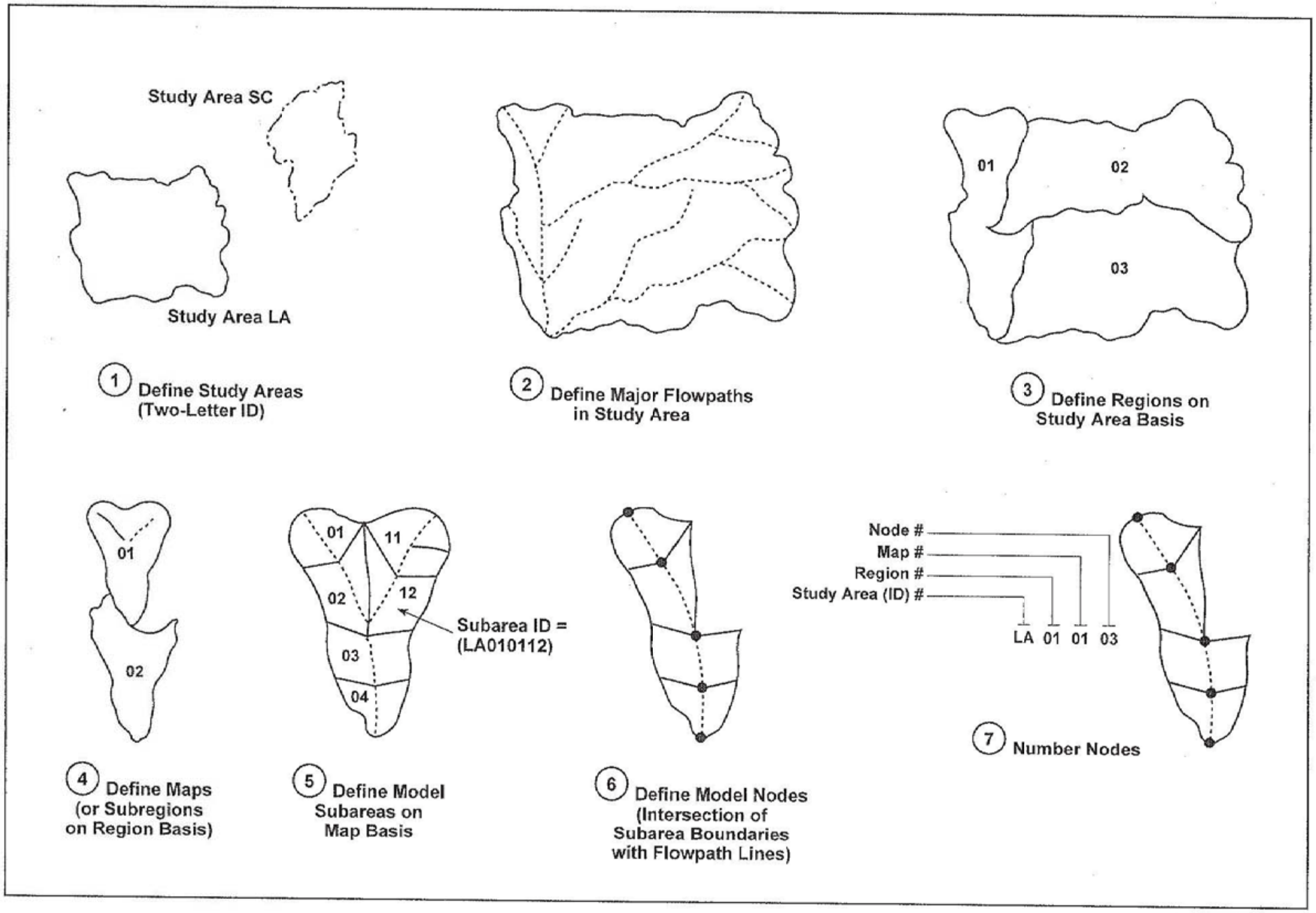
3. Divide the drainage area into subareas by locating significant points of interest. These divisions should be based on topography, soil type, and land use. Ensure that an appropriate first subarea is delineated. For natural areas, the first subarea flow path length should be less than or equal to 4,000 feet plus the overland flow length (Table 3-2). For developed areas, the initial subarea flow path length should be consistent with Table 3-2. The topography and slope within the initial subarea should be generally uniform.

4. Working from upstream to downstream, assign a number representing each subarea in the drainage system to each point of interest. Figure 3-8 provides guidelines for node numbers for geographic information system (GIS)-based studies.

5. Measure each subarea in the drainage area to determine its size in acres (A).

6. Determine the length and effective slope of the flow path in each subarea.

7. Identify the soil type for each subarea.



GIS/Hydrologic Model
Data Base Linkage Setup:
Nodes, Subareas, Links

FIGURE
3-8

8. Determine the runoff coefficient (C) for each subarea based on Table 3-1. If the subarea contains more than one type of development classification, use a proportionate average for C. In determining C for the subarea, use future land use taken from the applicable community plan, Multiple Species Conservation Plan, National Forest land use plan, etc.

9. Calculate the CA value for the subarea.

10. Calculate the $\Sigma(CA)$ value(s) for the subareas upstream of the point(s) of interest.

11. Determine P_6 and P_{24} for the study using the isopluvial maps provided in Appendix B. If necessary, adjust the value for P_6 to be within 45% to 65% of the value for P_{24}.

See Section 3.3 for a description of the RM calculation process.

3.3 Performing Rational Method Calculations

This section describes the RM calculation process. Using the input data, calculation of peak flows and T_c's should be performed as follows:

1. Determine T_i for the first subarea. Use Table 3-2 or Figure 3-3 as discussed in Section 3.1.4. If the watershed is natural, the travel time to the downstream end of the first subarea can be added to T_i to obtain the T_c. Refer to paragraph 3.1.4.2 (a).

2. Determine I for the subarea using Figure 3-1. If T_i was less than 5 minutes, use the 5 minute time to determine intensity for calculating the flow.

3. Calculate the peak discharge flow rate for the subarea, where $Q_p = \Sigma(CA)\ I$.
   In case that the downstream flow rate is less than the upstream flow rate, due to the long travel time that is not offset by the additional subarea runoff, use the upstream peak flow for design purposes until downstream flows increase again.

4. Estimate the T_t to the next point of interest.

5. Add the T_t to the previous T_c to obtain a new T_c.

6. Continue with step 2, above, until the final point of interest is reached.

Note: The MRM should be used to calculate the peak discharge when there is a junction from independent subareas into the drainage system.

3.4 Modified Rational Method (for Junction Analysis)

The purpose of this section is to describe the steps necessary to develop a hydrology report for a small watershed using the MRM. It is necessary to use the MRM if the watershed contains junctions of independent drainage systems. The process is based on the design manuals of the City/County of San Diego. The general process description for using this method, including an example of the application of this method, is described below.

The engineer should only use the MRM for drainage areas up to approximately 1 square mile in size. If the watershed will significantly exceed 1 square mile then the NRCS method described in Section 4 should be used. The engineer may choose to use either the RM or the MRM for calculations for up to an approximately 1-square-mile area and then transition the study to the NRCS method for additional downstream areas that exceed approximately 1 square mile. The transition process is described in Section 4.

3.4.1 Modified Rational Method General Process Description

The general process for the MRM differs from the RM only when a junction of independent drainage systems is reached. The peak Q, T_c, and I for each of the independent drainage systems at the point of the junction are calculated by the RM. The independent drainage systems are then combined using the MRM procedure described below. The peak Q, T_c, and I for each of the independent drainage systems at the point of the junction must be calculated prior to using the MRM procedure to combine the independent drainage systems, as these values will be used for the MRM calculations. After the independent drainage systems have been combined, RM calculations are continued to the next point of interest.

3.4.2 Procedure for Combining Independent Drainage Systems at a Junction

Calculate the peak Q, T_c, and I for each of the independent drainage systems at the point of the junction. These values will be used for the MRM calculations.

At the junction of two or more independent drainage systems, the respective peak flows are combined to obtain the maximum flow out of the junction at T_c. Based on the approximation that total runoff increases directly in proportion to time, a general equation may be written to determine the maximum Q and its corresponding T_c using the peak Q, T_c, and I for each of the independent drainage systems at the point immediately before the junction. The general equation requires that contributing Q's be numbered in order of increasing T_c.

Let Q_1, T_1, and I_1 correspond to the tributary area with the shortest T_c. Likewise, let Q_2, T_2, and I_2 correspond to the tributary area with the next longer T_c; Q_3, T_3, and I_3 correspond to the tributary area with the next longer T_c; and so on. When only two independent drainage systems are combined, leave Q_3, T_3, and I_3 out of the equation. Combine the independent drainage systems using the junction equation below:

Junction Equation: $T_1 < T_2 < T_3$

$$Q_{T1} = Q_1 + \frac{T_1}{T_2} Q_2 + \frac{T_1}{T_3} Q_3$$

$$Q_{T2} = Q_2 + \frac{I_2}{I_1} Q_1 + \frac{T_2}{T_3} Q_3$$

$$Q_{T3} = Q_3 + \frac{I_3}{I_1} Q_1 + \frac{I_3}{I_2} Q_2$$

Calculate Q_{T1}, Q_{T2}, and Q_{T3}. Select the largest Q and use the T_c associated with that Q for further calculations (see the three Notes for options). If the largest calculated Q's are equal (e.g., $Q_{T1} = Q_{T2} > Q_{T3}$), use the shorter of the T_c's associated with that Q.

This equation may be expanded for a junction of more than three independent drainage systems using the same concept. The concept is that when Q from a selected subarea (e.g., Q_2) is combined with Q from another subarea with a shorter T_c (e.g., Q_1), the Q from the subarea with the shorter T_c is reduced by the ratio of the I's (I_2/I_1); and when Q from a selected subarea (e.g., Q_2) is combined with Q from another subarea with a longer T_c (e.g., Q_3), the Q from the subarea with the longer T_c is reduced by the ratio of the T_c's (T_2/T_3).

Note #1: At a junction of two independent drainage systems that have the same T_c, the tributary flows may be added to obtain the Q_p.

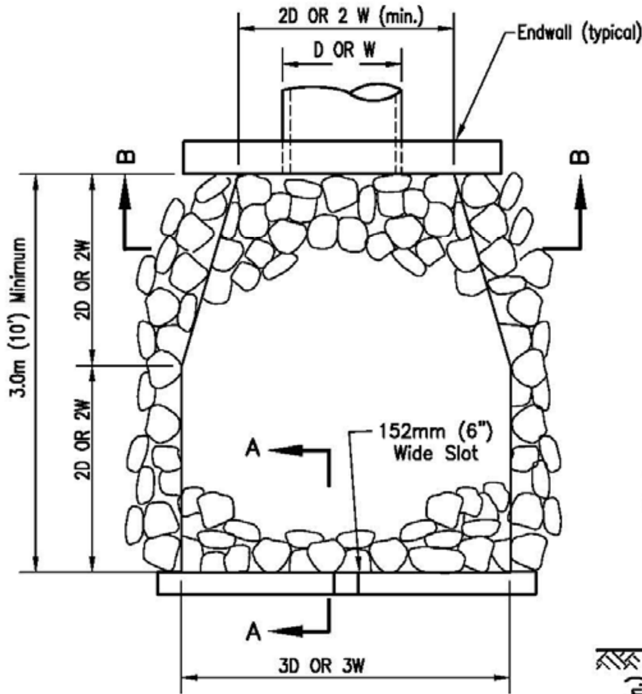
$$Q_p = Q_1 + Q_2\text{; when } T_1 = T_2\text{; and } T_c = T_1 = T_2$$

This can be verified by using the junction equation above. Let Q_3, T_3, and $I_3 = 0$. When T_1 and T_2 are the same, I_1 and I_2 are also the same, and T_1/T_2 and $I_2/I_1 = 1$. T_1/T_2 and I_2/I_1 are cancelled from the equations. At this point, $Q_{T1} = Q_{T2} = Q_1 + Q_2$.

Note #2: In the upstream part of a watershed, a conservative computation is acceptable. When the times of concentration (T_c's) are relatively close in magnitude (within 10%), use the shorter T_c for the intensity and the equation $Q = \Sigma(CA)I$.

Note #3: . An optional method of determining the T_c is to use the equation
$T_c = [(\Sigma (CA)7.44\ P_6)/Q]^{1.55}$

This equation is from $Q = \Sigma(CA)I = \Sigma(CA)(7.44\ P_6/T_c^{.645})$ and solving for T_c. The advantage in this option is that the T_c is consistent with the peak flow Q, and avoids inappropriate fluctuation in downstream flows in some cases.



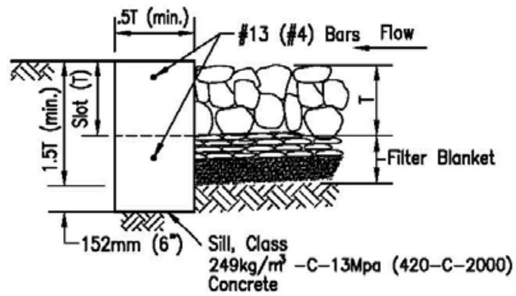
PLAN

Design Velocity m/sec (ft/sec)*	Rock Classification	T (min)
1.8–3 (6–10)	No. 2 Backing	320mm (1.1ft)
3–3.7 (10–12)	220 kg (1/4 ton)	823mm (2.7ft)
3.7–4.3 (12–14)	450 kg (1/2 ton)	1.1m (3.5ft)
4.3–4.9 (14–16)	900 kg (1 ton)	1.3m (4.4ft)
4.9–5.5 (16–18)	1.8 tonne (2 ton)	1.6m (5.4ft)

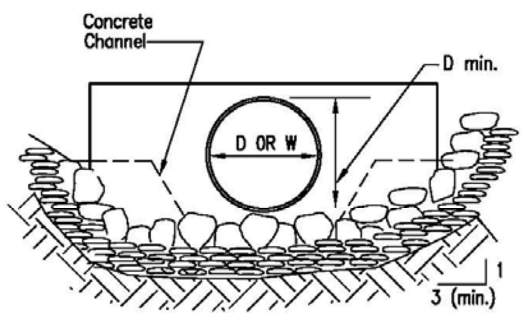
*over 5.5 mps (18 fps) requires special design

D = Pipe Diameter

W = Bottom Width of Channel



SECTION A–A



SECTION B–B

NOTES

1. Plans shall specify:
   A) Rock Class and thickness (T).
   B) Filter material, number of layers and thickness.
2. Rip rap shall be either quarry stone or broken concrete (if shown on the plans.) Cobbles are not acceptable.
3. Rip rap shall be placed over filter blanket which may be either granular material or filter fabric (woven filter slit film fabric shall not be used).
4. See Regional Supplement Amendments for selection of filter blanket.
5. Rip rap energy dissipators shall be designated as either Type 1 or Type 2. Type 1 shall be with concrete sill; Type 2 shall be without sill.

Revision	By	Approved	Date
ORIGINAL		Kercheval	12/75
Add Metric		T. Stanton	03/03
Add Rip Rap Table		S. Brady	04/06

SAN DIEGO REGIONAL STANDARD DRAWING

RIP RAP
ENERGY DISSIPATOR

RECOMMENDED BY THE SAN DIEGO REGIONAL STANDARDS COMMITTEE

04/27/2006

Chairperson R.C.E. 19246 Date

DRAWING NUMBER **D-40**

HYDROMODIFICATION SCREENING
FOR
CAMINO LARGO

September 14, 2021

Will sign and stamp upon approval

Wayne W. Chang, MS, PE 46548

ChangConsultants

Civil Engineering ◦ Hydrology ◦ Hydraulics ◦ Sedimentation

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FOR REVIEW ONLY

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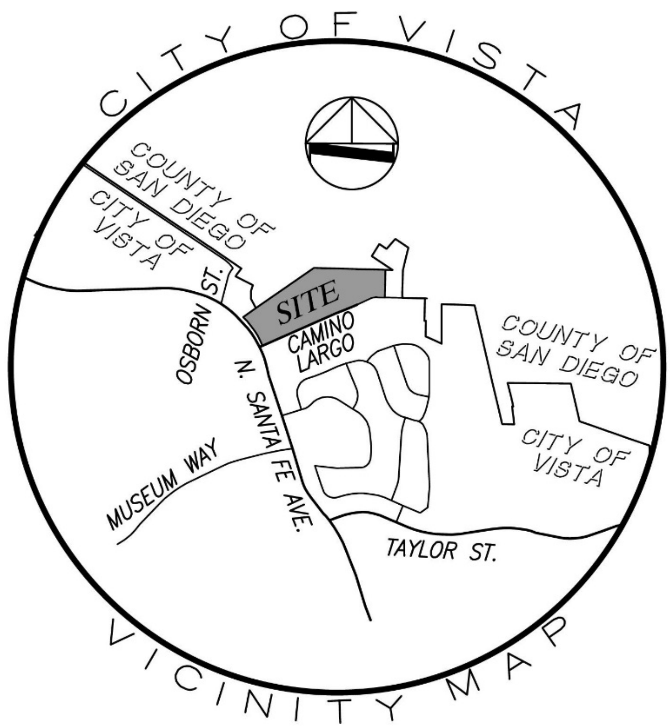
APPENDICES

MAP POCKET

INTRODUCTION

The city of Vista's June 2016, *BMP Design Manual,* outlines low flow thresholds for hydromodification analyses. The thresholds are based on a percentage of the pre-project 2-year flow (Q_2), i.e., $0.1Q_2$ (low flow threshold and high susceptibility to erosion), $0.3Q_2$ (medium flow threshold and medium susceptibility to erosion), or $0.5Q_2$ (high flow threshold and low susceptibility to erosion). A flow threshold of $0.1Q_2$ represents a natural downstream receiving conveyance system with a high susceptibility to bed and/or bank erosion. This is the default value used for hydromodification analyses and will result in the most conservative (largest) on-site facility sizing. A flow threshold of $0.3Q_2$ or $0.5Q_2$ represents downstream receiving conveyance systems with a medium or low susceptibility to erosion, respectively. In order to qualify for a medium or low erosion susceptibility rating, a project must perform a channel screening analysis based on the March 2010, *Hydromodification Screening Tools: Field Manual for Assessing Channel Susceptibility,* developed by the Southern California Coastal Water Research Project (SCCWRP). The SCCWRP results are compared with the critical shear stress calculator results from the County of San Diego's Critical Flow Calculator spreadsheet to establish the appropriate erosion susceptibility threshold of low, medium, or high.



This report provides a hydromodification screening analysis for the Camino Largo single-family residential project being designed by BHA, Inc. The 9.3-acre site currently supports a nursery and is located northeast of the intersection of North Santa Fe Avenue and Camino Largo in the city of Vista (see the Vicinity Map). The nursery will be redeveloped with 46 homes and private streets.

Under pre-project conditions, storm runoff within the project footprint generally sheet flows in a southerly direction towards Camino Largo, which is an unpaved private street. The runoff continues a short distance (100+ feet) south and enters an unnamed natural drainage course that flows in a westerly direction along the south side of Camino Largo (see the Study Area Exhibit in the map pocket). The unnamed natural drainage course crosses North Santa Fe Avenue in an arch culvert then continues northwest over 2.3 miles to a confluence with the San Luis Rey River.

Under post-project conditions, the project runoff will be treated by one of two biofiltration basins. Runoff from the easterly half of the project will enter a biofiltration basin at the southeast corner of the site. A proposed storm drain will convey the treated runoff out of the biofiltration basin and discharge towards the unnamed natural drainage course. Runoff from the westerly half of the project will enter a biofiltration basin at the southwest corner of the site. A proposed storm drain will convey the treated runoff out of the biofiltration basin and to the North Santa Fe Avenue culvert. The post-project runoff from both halves of the project will ultimately be conveyed away from the site by the unnamed natural drainage course similar to existing conditions.

The SCCWRP screening tool requires both office and field work to establish the vertical and lateral susceptibility of a downstream receiving channel to erosion. The vertical and lateral assessments are performed independently of each other although the lateral results can be affected by the vertical rating. A screening analysis was performed to assess the low flow threshold for the project's two points of compliance (POC), which are the first locations where the project's runoff discharges to natural conveyances. The first POC, labeled POC A, is at the outlet of the proposed storm drain from the southeast biofiltration basin. The second POC, labeled POC B, is at the outlet of the North Santa Fe Avenue culvert.

The initial step in performing the SCCWRP screening analysis is to establish the domain of analysis and the study reaches within the domain. This is followed by office and field components of the screening tool along with the associated analyses and results. The following sections cover these procedures in sequence.

DOMAIN OF ANALYSIS

SCCWRP defines an upstream and downstream domain of analysis, which establish the study limits. The County of San Diego's HMP specifies the downstream domain of analysis based on the SCCWRP criteria. The HMP indicates that the downstream domain is the first point where one of these is reached:

- at least one reach downstream of the first grade control point
- tidal backwater/lentic waterbody
- equal order tributary
- accumulation of 50 percent drainage area for stream systems or 100 percent drainage area for urban conveyance systems (storm drains, hardened channels, etc.).

The upstream limit is defined as:

- proceed upstream for 20 channel top widths or to the first grade control point, whichever comes first. Identify hard points that can check headward migration and evidence of active headcutting.

SCCWRP defines the maximum spatial unit, or reach (a reach is circa 20 channel widths), for assigning a susceptibility rating within the domain of analysis to be 200 meters (656 feet). If the domain of analysis is greater than 200 meters, the study area can be subdivided into smaller reaches of less than 200 meters for analysis. Most of the units in the HMP's SCCWRP analysis are metric. Metric units are used in this report only where given so in the HMP. Otherwise English units are used.

Downstream Domain of Analysis

The downstream domain of analysis location for each point of compliance (POC) was determined by assessing and comparing the four bullet items above. A POC represents the point below which a channel is natural and subject to hydromodification impacts. As discussed in the Introduction, storm runoff from the project will be treated by one of two biofiltration basins and then conveyed below the project by hardened, non-erodible storm drain pipes to natural conveyances. The two outlets into the natural conveyances are labeled POC A and POC B, respectively. A downstream domain of analysis location was selected below each POC as follows.

Per the first bullet item, the first permanent grade controls below POC A and POC B were identified during a site visit. The storm runoff from POC A flows a short distance to the unnamed natural drainage course and then continues west in the unnamed natural drainage course. The runoff reaches the North Santa Fe Avenue culvert approximately 1,000 feet downstream of POC A. The culvert is a non-erodible facility that provides a grade control for the upstream channel bed. i.e., it will prevent erosion of the upstream channel bed. This is the first permanent grade control below POC A.

The storm runoff from POC B discharges directly into the unnamed natural drainage course from the North Santa Fe Avenue culvert outlet. The runoff continues west in the unnamed natural drainage course a distance of 516 feet before reaching a road crossing with a culvert (see Figure 6). This culvert is the first permanent grade control reached below POC B.

The second bullet item criteria are based on reaching a lentic (standing or still water such as ponds, pools, marshes, lakes, lagoons, etc.) or tidal waterbody. The nearest such waterbody below POC A and POC B is the Upper Pond within Guajome Regional Park. The unnamed natural drainage course flows into the Upper Pond over 1.1 miles downstream of North Santa Fe Avenue. This lentic waterbody is further downstream from POC A and POC B than their first permanent grade controls, so the second bullet item will not govern over the first bullet item in establishing the downstream domain of analysis location for either POC.

The third bullet item is met when the natural watercourse below a POC confluences with a stream with an equal order or larger tributary area. The runoff from POC A flows 90 feet within a natural swale before confluencing with the unnamed natural drainage course. Topographic mapping indicates that the unnamed natural drainage course's watershed area at the confluence is much larger than the natural swale's watershed area. Therefore, the third bullet item criteria for POC A is met where the natural swale below POC A confluences with the unnamed natural drainage course. The confluence is closer to POC A than its downstream permanent grade control, so the third bullet item governs over the first in establishing the downstream domain of analysis location for POC A.

POC B is within the unnamed natural drainage course. Google Earth and a site visit reveal that the unnamed natural drainage course does not confluence with a larger stream between POC B and its first permanent grade control located 516 feet below POC B. Therefore, the third bullet item will not govern over the first in establishing the downstream domain of analysis location for POC B.

The fourth bullet item is met when the natural stream below a POC accumulates 50 or 100 percent drainage area for natural or urban drainage systems, respectively. Both streams below each POC are natural systems, so 50 percent applies. The Study Area Exhibit shows that the stream below POC A accumulates minor area (0.35 acres) between POC A and the confluence with the unnamed natural drainage course. The accumulated area is much less than 50 percent of the area tributary to POC A (3.29 acres). Therefore, fourth bullet item will not govern over the third in establishing the downstream domain of analysis location for POC A.

The Study Area Exhibit indicates that the unnamed natural drainage course below POC B accumulates minor area between POC B and its downstream permanent grade control. The accumulated area is much less than 50 percent of the area tributary to POC B. Therefore, the fourth bullet item will not govern over the first in establishing the downstream domain of analysis location for POC A.

Based on the above information, the downstream domain of analysis location is established by separate criteria for POC A and POC B. For POC A, the location is based on the third bullet item. The natural swale below POC A confluences with the much larger unnamed natural drainage course 90 feet downstream of POC A. This location is closer to POC A than the locations determined by the other bullet item criteria.

For POC B, the downstream domain of analysis location is based on the first bullet item. A permanent grade control occurs where the unnamed natural drainage course enters a roadway culvert below POC B. This is the first downstream domain of analysis point reached from the four bullet criteria. Per the first bullet item, the downstream domain of analysis location should be set one reach (656 feet) below the grade control. Therefore, the downstream domain of analysis location for POC B is 650 feet below the grade control.

Upstream Domain of Analysis
The hardened, non-erodible drainage facilities leading to the POC A outlet into the uppermost end of the receiving natural swale. Since the natural swale does not extend upstream of POC A, the upstream domain of analysis location for POC A is at POC A.

The North Santa Fe Avenue culvert extends upstream of POC B. In addition, the project's topographic mapping shows a rock outcropping in the unnamed natural drainage course immediately upstream of the culvert. These culvert and rocks are hard points that check headward migration in the unnamed natural drainage course. Therefore, the upstream domain of analysis location for POC B is at POC B.

Study Reaches within Domain of Analysis
After the upstream and downstream domain of analysis locations are established for POC A and POC B, the study reaches associated with each POC are identified (see the Study Area Exhibit in the map pocket). For POC A, the entire domain of analysis extends from the upstream domain of analysis location at POC A to the downstream domain of analysis location at the confluence of the natural swale below POC A with the unnamed natural drainage course. This reach extends over 90 feet and is labeled Reach 1.

For POC B, the entire domain of analysis extends from the upstream domain of analysis location at POC B to the downstream domain of analysis location 656 feet below the permanent grade control created by a roadway culvert. The domain of analysis was analyzed as two study reaches, Reach 2 and Reach 3. Reach 2 extends 516 feet from the upstream domain of analysis location at POC B to the first permanent grade control below POC B. Reach 2 extends from the first permanent grade control to a point 656 feet below the grade control. All three study reaches are within the 656 foot (200 meters) maximum reach length recommended by SCCWRP.

INITIAL DESKTOP ANALYSIS

After the domain of analysis is established, SCCWRP requires an "initial desktop analysis" that involves office work. The initial desktop analysis establishes the watershed area, mean annual precipitation, valley slope, and valley width. These terms are defined in Form 1, which is included in Appendix A. SCCWRP recommends the use of National Elevation Data (NED) to determine the watershed areas, valley slopes, and valley widths. NED data is similar to USGS quadrangle mapping.

The Reach 1 watershed area is based on BHA, Inc's. proposed condition hydrology, which determined that 3.29 acres is tributary to POC A (see Appendix A for their Post-Development Hydrology exhibit). The Study Area Exhibit shows that an additional 0.35 acres is tributary to the natural swale below POC A, so the total Reach 1 watershed area covers 3.64 acres (0.0057 square miles).

The watershed areas associated with Reach 2 and 3 were delineated from the USGS' StreamStats program, which is based on their Digital Elevation Model and a digital representation of the stream network. The StreamStats results are included in Appendix A. The watershed delineations are consistent with current USGS quadrangle mapping. Streamstats shows that the watershed areas tributary to Reach 2 and 3 are 676.46 and 739.62 acres (1.0570 and 1.1557 square miles), respectively.

The mean annual precipitation was obtained from the rain gage closest to the site. This is the Western Regional Climate Center's Vista 2NNE gage (see Appendix A). The average annual rainfall measured at the Vista 2NNE gage for the period of record is 13.09 inches.

The valley slope and valley width for Reach 1, 2, and 3 were obtained from 1-foot contour interval topographic mapping prepared for the project supplemented with SANGIS' 2014 2-foot contour interval topographic mapping. NED data was not used because it is not very accurate for these parameters. The valley slope is the longitudinal slope of the channel bed along the flow line, so it is determined by dividing the elevation difference within a study reach by the length of the flow line. The valley width is the valley bottom width dictated by breaks in the hillslope. The valley slope and valley width within Reach 1, 2, and 3 along with their watershed areas are included in Table 1.

Reach	Tributary Watershed Area, sq. mi.	Valley Slope, m/m	Valley Width, m
1	0.0057	0.0722	2.44
2	1.0570	0.0099	9.14
3	1.1557	0.0136	9.14

Table 1. Summary of Watershed Area, Valley Slope, and Valley Width

The above described values were input to a spreadsheet to calculate the simulated peak flow, screening index, and valley width index outlined in Form 1. The input data and results are tabulated in Appendix A. This completes the initial desktop analysis.

FIELD SCREENING

After the initial desktop analysis is complete, a field assessment must be performed. The field assessment is used to establish a natural channel's vertical and lateral susceptibility to erosion. SCCWRP states that although they are admittedly linked, vertical and lateral susceptibility are assessed separately for several reasons. First, vertical and lateral responses are primarily controlled by different types of resistance, which, when assessed separately, may improve ease of use and lead to increased repeatability compared to an integrated, cross-dimensional assessment. Second, the mechanistic differences between vertical and lateral responses point to different modeling tools and potentially different management strategies. Having separate screening ratings may better direct users and managers to the most appropriate tools for subsequent analyses.

The field screening tool uses combinations of decision trees and checklists. Decision trees are typically used when a question can be answered fairly definitively and/or quantitatively (e.g., d_{50} < 16 mm). Checklists are used where answers are relatively qualitative (e.g., the condition of a grade control). Low, medium, high, and very high ratings are applied separately to the vertical and lateral analyses. When the vertical and lateral analyses return divergent values, the most conservative value shall be selected as the flow threshold for the hydromodification analyses.

Vertical Stability

The purpose of the vertical stability decision tree (Figure 6-4 in the County of San Diego HMP) is to assess the state of the channel bed with a particular focus on the risk of incision (i.e., down cutting). The decision tree is included in Figure 10. The first step is to assess the channel bed resistance. There are three categories defined as follows:

1. Labile Bed – sand-dominated bed, little resistant substrate.

2. Transitional/Intermediate Bed – bed typically characterized by gravel/small cobble, Intermediate level of resistance of the substrate and uncertain potential for armoring.

3. Threshold Bed (Coarse/Armored Bed) – armored with large cobbles or larger bed material or highly-resistant bed substrate (i.e., bedrock).

Based on the photographs and site investigation, the bed material and resistance is generally within the transitional/intermediate bed category. There was no evidence of a threshold bed condition. However, some bed areas contained smaller grain sizes typically found in a labile bed.

In addition to the material size and compaction, there are several factors that establish the erodibility of a channel such as the flow rate (i.e., size of the tributary area), grade controls, channel slope, vegetative cover, channel planform, etc. The Introduction of the SCCWRP *Hydromodification Screening Tools: Field Manual* identifies several of these factors. When multiple factors influence erodibility, it is appropriate to perform the more detailed SCCWRP analysis, which is to analyze a channel according to SCCWRP's transitional/intermediate bed procedure. This requires the most rigorous steps and will generate the appropriate results given the range of factors that define erodibility. The transitional/intermediate bed procedure takes into account that bed material may fall within the labile category (the bed material size is used in SCCWRP's Form 3 Figure 4), but other factors may trend towards a less erodible condition. Dr. Eric Stein from SCCWRP, who co-authored the *Hydromodification Screening Tools: Field Manual* in the *Final Hydromodification Management Plan* (HMP), indicated that it would be appropriate to analyze channels with multiple factors that impact erodibility using the transitional/intermediate bed procedure. Consequently, this procedure was used to produce more accurate results.

Transitional/intermediate beds cover a wide susceptibility/potential response range and need to be assessed in greater detail to develop a weight of evidence for the appropriate screening rating. The three primary risk factors used to assess vertical susceptibility for channels with transitional/intermediate bed materials are:

1. Armoring potential – three states (Checklist 1)

2. Grade control – three states (Checklist 2)

3. Proximity to regionally-calibrated incision/braiding threshold (Mobility Index Threshold – Probability Diagram)

These three risk factors are assessed using checklists and a diagram (see Appendix B), and the results of each are combined to provide a final vertical susceptibility rating for the intermediate/transitional bed-material group. Each checklist and diagram contains a Category A, B, or C rating. Category A is the most resistant to vertical changes while Category C is the most susceptible.

Checklist 1 determines armoring potential of the channel bed. The channel bed along each of the three study reaches is within Category B, which represents intermediate bed material of unknown resistance or unknown armoring potential due to a surface veneer such as vegetation. The soil was probed and penetration was relatively difficult through the underlying layer. The dense, mature vegetative growth along the channel of Reach 1, 2, and 3 serve to armor the channel bed and resist vertical erosion.

Checklist 2 determines grade control characteristics of the channel bed. This is established by the spacing of the grade controls along the channel. Category B on Checklist 2 is based on a spacing of $2/S_v$ or $4/S_v$, where S_v is the channel slope. The S_v value of Reach 1, 2, and 3 are included in Form 1 results in Appendix A and summarized in Table 2. Table 2 also summarizes the $2/S_v$ or $4/S_v$ of each reach along with the length. Reach 1 and Reach 2 are both shorter than their $2/S_v$ values, so are in Category A on Checklist 2. On the other hand, Reach 3 is between its $2/S_v$ and $4/S_v$, so is in Category B.

Reach	S_v, ft/ft	$2/S_v$, feet	$4/S_v$, feet	Length, feet	Category
1	0.0722	91	182	90	A
2	0.0099	664	1,328	516	A
3	0.0136	484	967	656	B

Table 2. Checklist 2 Summary

The Screening Index Threshold is a probability diagram that depicts the risk of incising or braiding based on the potential stream power of the valley relative to the median particle diameter. The threshold is based on regional data from Dr. Howard Chang of Chang Consultants and others. The probability diagram is based on d_{50} as well as the screening index (INDEX) value determined in the initial desktop analysis (see Appendix A). The Form 1 results in Appendix A determined an INDEX of 0.0147 and 0.0196 for Reach 1 and Reach 2, respectively. SCCWRP specifies use of a US SAH-97 half-phi template gravelometer to determine d_{50} in a natural channel. This gravelometer allows a minimum d_{50} measurement of 2 millimeters. The Screening Index Threshold diagram shows that the probability of incising or braiding is less than 50 percent for a d_{50} of 2 millimeters if the INDEX value is 0.022 or less. Since the Reach 1 and Reach 2 Screening Index values are both less than the 50 percent INDEX value, Reach 1 and Reach 2 are both within Category A.

For Reach 3, d_{50} had to be determined to assess the Screening Index Threshold. d_{50} can be derived from a pebble count in which a minimum of 100 particles are obtained along transects at the site. SCCRWP states that if fines less than ½-inch thick are at a sample point, it is appropriate to sample the coarser buried substrate. The d_{50} value is the particle size in which 50 percent of the particles are smaller and 50 percent are larger. The pebble count results for Reach 3 are included in Appendix B. The results show a d_{50} of 8 millimeters. Plotting the d_{50} and screening index value on the Mobility Index Threshold diagram shows Reach 3 has a less than 50 percent probability of incising or braiding, which falls within Category A.

The overall vertical rating is determined from the Checklist 1, Checklist 2, and Mobility Index Threshold results. The scoring is based on the following values:

Category A = 3, Category B = 6, Category C = 9

The vertical rating score is based on these values and the equation:

$$\text{Vertical Rating} = [(\text{armoring} \times \text{grade control})^{1/2} \times \text{screening index score}]^{1/2}$$

Table 3 summarizes the Checklist 1, 2, and 3 values for each reach as well as their vertical rating. The results show the vertical rating for all three study reaches is less than 4.5, so these reaches have a low threshold for vertical susceptibility.

Reach	Checklist 1 (armoring)	Checklist 2 (grade control)	Checklist 3 (screening index)	Vertical Rating
1	6	3	3	3.6
2	6	3	3	3.6
3	6	6	3	4.2

Table 3. Overall Vertical Rating

<u>*Lateral Stability*</u>

The purpose of the lateral decision tree (Figure 6-5 from County of San Diego HMP included in Figure 11) is to assess the state of the channel banks with a focus on the risk of widening. Channels can widen from either bank failure or through fluvial processes such as chute cutoffs, avulsions, and braiding. Widening through fluvial avulsions/active braiding is a relatively straightforward observation. If braiding is not already occurring, the next logical step is to assess the condition of the banks. Banks fail through a variety of mechanisms; however, one of the most important distinctions is whether they fail in mass (as many particles) or by fluvial detachment of individual particles. Although much research is dedicated to the combined effects of weakening, fluvial erosion, and mass failure, SCCWRP found it valuable to segregate bank types based on the inference of the dominant failure mechanism (as the management approach may vary based on the dominant failure mechanism). A decision tree (Form 4 in Appendix B) is used in conducting the lateral susceptibility assessment. Definitions and photographic examples are also provided below for terms used in the lateral susceptibility assessment.

The first step in the decision tree is to determine if lateral adjustments are occurring. The adjustments can take the form of extensive mass wasting (greater than 50 percent of the banks are exhibiting planar, slab, or rotational failures and/or scalloping, undermining, and/or tension cracks). The adjustments can also involve extensive fluvial erosion (significant and frequent bank cuts on over 50 percent of the banks). Neither mass wasting nor extensive fluvial erosion was evident within either of the three reaches during a field investigation. As seen in the figures and topographic mapping, the channel banks are mostly gentle and heavily vegetated confirming that mass wasting and extensive fluvial erosion has not occurred.

The next step in the Form 4 decision tree is to assess the consolidation of the bank material. The banks in Reach 1, 2, and 3 were moderate to well-consolidated. This determination was made because the ground surface was difficult to penetrate with a probe. The banks were densely vegetated and/or relatively level and stable as seen in the figures. In addition, the banks showed little evidence of crumbling and were composed of relatively well-packed particles.

Form 6 (see Appendix B) is used to assess the probability of mass wasting. Form 6 identifies a 10, 50, and 90 percent probability based on the bank angle and bank height. From the topographic mapping and site investigation, the average bank angles in all three reaches are 2:1 (26.6 degrees) or flatter. Form 6 shows that the probably of mass wasting and bank failure has less than 10 percent risk for a 26.6 degree bank angle or less regardless of the bank height.

The final two steps in the Form 4 decision tree are based on the braiding risk determined from the vertical rating as well as the Valley Width Index (VWI) calculated in Appendix A. If the vertical rating is high, the braiding risk is considered to be greater than 50 percent. Excessive braiding can lead to lateral bank failure. For Reach 1, 2, and 3 the vertical rating is low, so the braiding risk is less than 50 percent. Furthermore, a VWI greater than 2 represents channels unconfined by bedrock or hillslope and, hence, subject to lateral migration. The VWI calculations in the spreadsheet in Appendix A show that VWI for Reach 1, 2, and 3 are 1.40, 0.72, and 0.70, respectively, which are all less than 2.

From the above steps, the lateral susceptibility rating is low for Reach 1, 2, and 3 (colored circles are included on the Form 4: Lateral Susceptibility Field Sheet decision tree in Appendix B showing the decision path).

CONCLUSION

The SCCWRP channel screening tools were used to assess the downstream channel susceptibility for the Camino Largo single-family residential project being designed by BHA, Inc. Storm runoff from the project will be collected by proposed on-site drainage systems, treated by one of two on-site BMPs, and conveyed off-site by storm drain pipes. A channel assessment was performed for the natural streams below each POC based on office analyses and field work. The results indicate a low threshold for vertical and lateral susceptibilities for Reach 1, 2, and 3.

The HMP requires that these results be compared with the critical stress calculator results outlined in the County of San Diego HMP. The critical stress results are included in Appendix B for the study reach using the spreadsheet provided by the County. The channel dimensions were estimated from topographic mapping and Google Earth. Based on these values, the critical stress results returned a low threshold consistent with the SCCWRP channel screening results. Therefore, the SCCWRP analyses and critical stress calculator demonstrate that a low overall threshold is applicable to the project (i.e., $0.5Q_2$).

Figure 1. Looking Downstream towards Reach 1 from Upper End near Future POC A

Figure 2. North Santa Fe Avenue Culvert Outlet at POC B


Figure 3. Looking Downstream towards Reach 2 from Upper End at POC B


Figure 4. Dense Vegetation within Middle of Reach 2

Figure 5. Looking Upstream towards Reach 2 from Lower End

Figure 6. Roadway Culvert Crossing between Reach 2 and 3 (Permanent Grade Control)

Figure 7. Looking Downstream towards Reach 3 from Upper End

Figure 8. Looking South towards Middle of Reach 3

Figure 9. Looking Upstream towards Reach 3 from Lower End

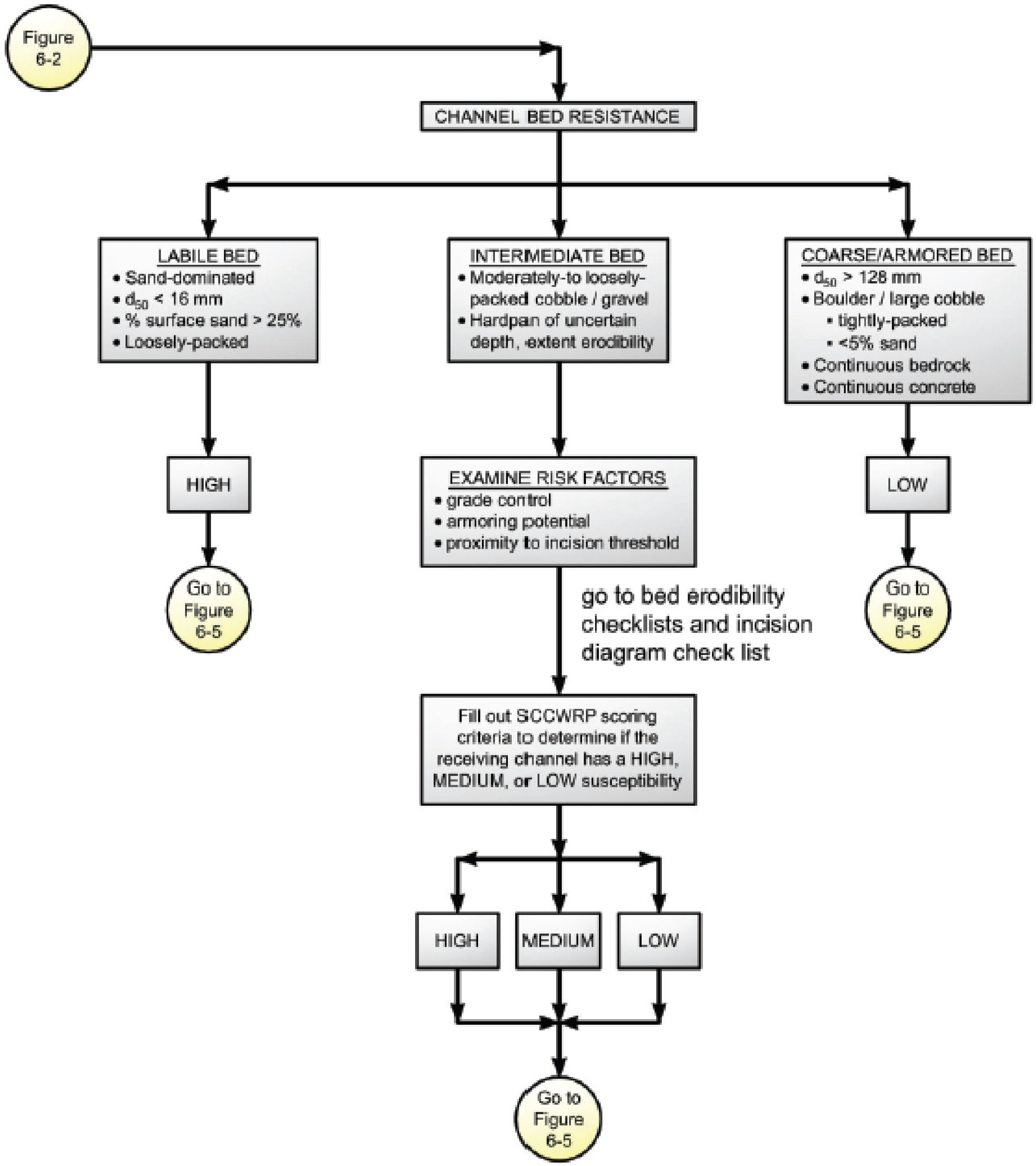


Figure 6-4. SCCWRP Vertical Susceptibility

Figure 10. SCCWRP Vertical Channel Susceptibility Matrix

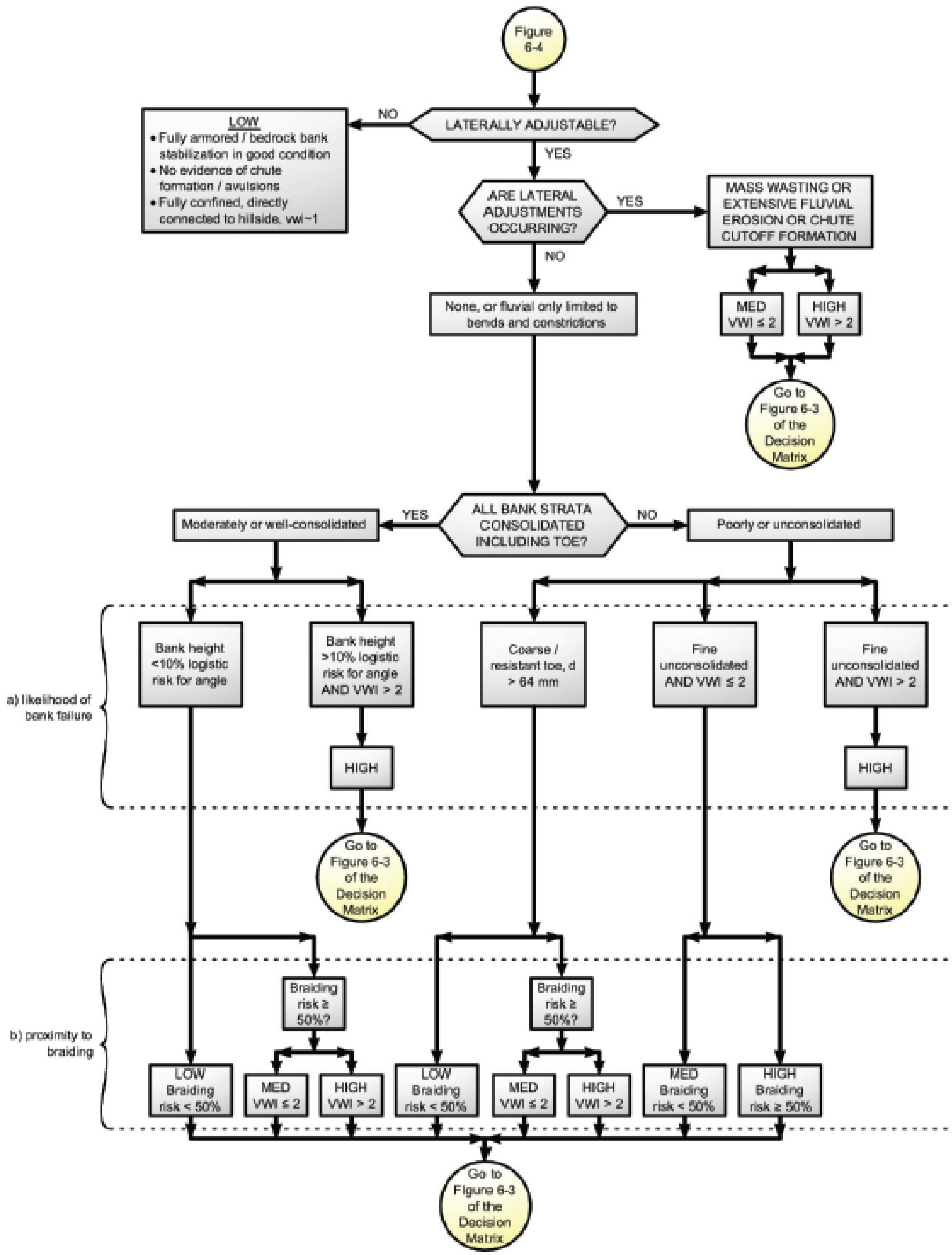


Figure 6-5. Lateral Channel Susceptibility

Figure 11. SCCWRP Lateral Channel Susceptibility Matrix

APPENDIX A

SCCWRP INITIAL DESKTOP ANALYSIS

FORM 1: INITIAL DESKTOP ANALYSIS

Complete all shaded sections.

IF required at multiple locations, circle one of the following site types:

Applicant Site / Upstream Extent / Downstream Extent

Location: Latitude: 33.23399 Longitude: -117.24926

Description (river name, crossing streets, etc.): Northeast of intersection of Camino Largo and N. Santa Fe Avenue - Unnamed Natural Drainage Course.

GIS Parameters: The International System of Units (SI) is used throughout the assessment as the field standard and for consistency with the broader scientific community. However, as the singular exception, US Customary units are used for contributing drainage area (A) and mean annual precipitation (P) to apply regional flow equations after the USGS. See SCCWRP Technical Report 607 for example measurements and "Screening Tool Data Entry.xls" for automated calculations.

Form 1 Table 1. Initial desktop analysis in GIS.

	Symbol	Variable	Description and Source	Value
Watershed properties (English units)	**A**	Area (mi^2)	Contributing drainage area to screening location via published Hydrologic Unit Codes (HUCs) and/or ≤ 30 m National Elevation Data (NED), USGS seamless server	See attached Form 1 table on next page for calculated values for each reach.
	P	Mean annual precipitation (in)	Area-weighted annual precipitation via USGS delineated polygons using records from 1900 to 1960 (which was more significant in hydrologic models than polygons delineated from shorter record lengths)	
Site properties (SI units)	**S_v**	Valley slope (m/m)	Valley slope at site via NED, measured over a relatively homogenous valley segment as dictated by hillslope configuration, tributary confluences, etc., over a distance of up to ~500 m or 10% of the main-channel length from site to drainage divide	
	W_v	Valley width (m)	Valley bottom width at site between natural valley walls as dictated by clear breaks in hillslope on NED raster, irrespective of potential armoring from floodplain encroachment, levees, etc. (imprecise measurements have negligible effect on rating in wide valleys where VWI is >> 2, as defined in lateral decision tree)	

Form 1 Tabl e 2. Simplif ied peak flo w, screening index, and valley width index. Values for this table should be calculated in the sequence shown in this table, using values from Form 1 Table 1.

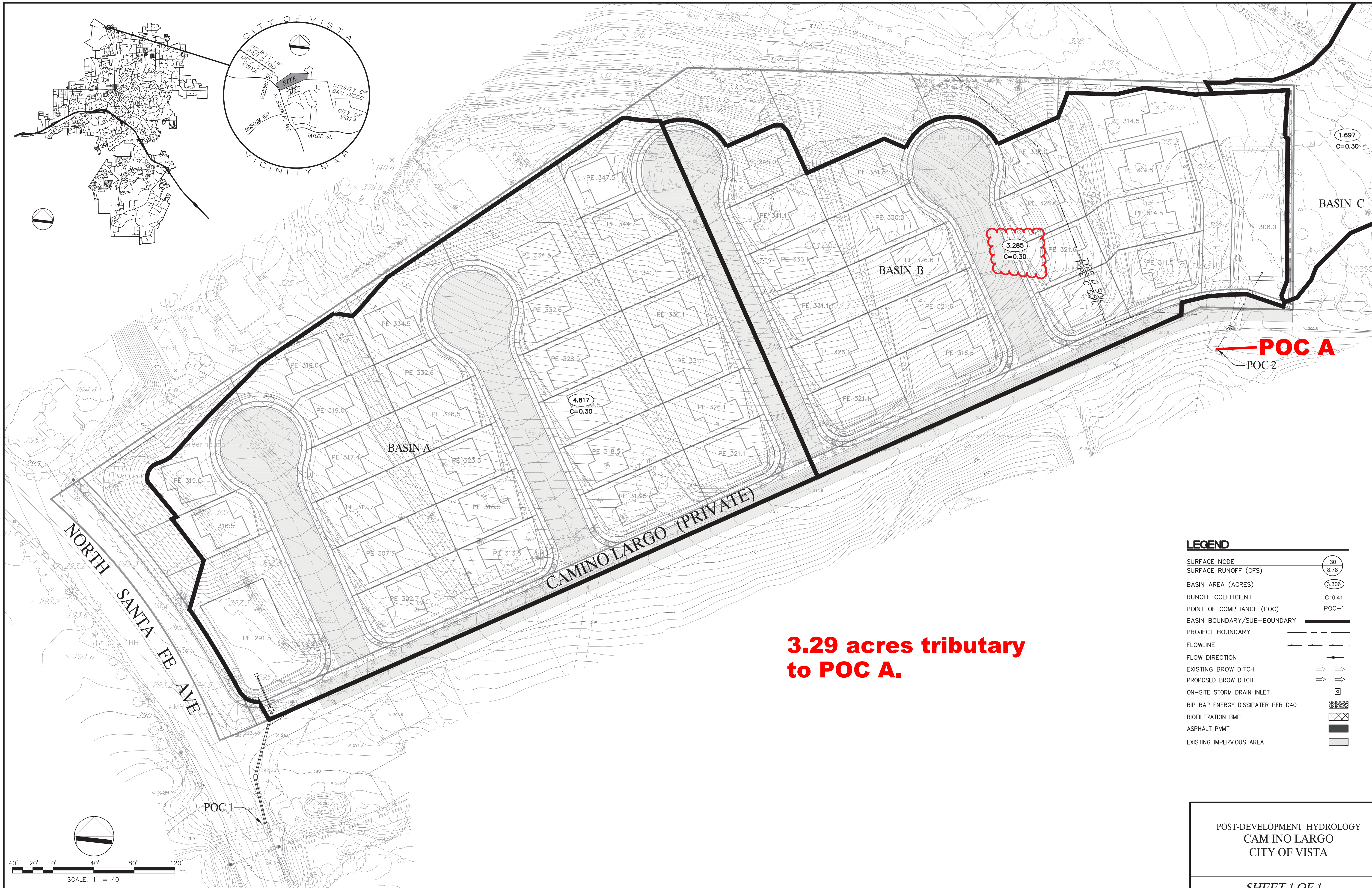
Symbol	Dependent Variable	Equation	Required Units	Value
Q_{10cfs}	10-yr peak flow (ft^3/s)	$Q_{10cfs} = 18.2 * A^{0.87} * P^{0.77}$	A (mi^2) P (in)	See attached Form 1 table on next page for calculated values for each reach.
Q_{10}	10-yr peak flow (m^3/s)	$Q_{10} = 0.0283 * Q_{10cfs}$	Q_{10cfs} (ft^3/s)	
INDEX	10-yr screening index ($m^{1.5}/s^{0.5}$)	$INDEX = S_v * Q_{10}^{0.5}$	Sv (m/m) Q_{10} (m^3/s)	
W_{ref}	Reference width (m)	$W_{ref} = 6.99 * Q_{10}^{0.438}$	Q_{10} (m^3/s)	
VWI	Valley width index (m/m)	$VWI = W_v/W_{ref}$	W_v (m) W_{ref} (m)	

(Sheet 1 of 1)

SCCWRP FORM 1 ANALYSES

Reach	Area A, sq. mi.	Mean Annual Precip. P, inches	Valley Slope Sv, m/m	Valley Width Wv, m	10-Year Flow Q10cfs, cfs	10-Year Flow Q10, cms
1	0.0057	13.09	0.0722	2.44	1.5	0.04
2	1.0570	13.09	0.0099	9.14	138.4	3.92
3	1.1557	13.09	0.0136	9.14	149.5	4.23

Reach	10-Year Screening Index INDEX	Reference Width Wref, m	Valley Width Index VWI, m/m
1	0.015	1.74	1.40
2	0.020	12.71	0.72
3	0.028	13.15	0.70

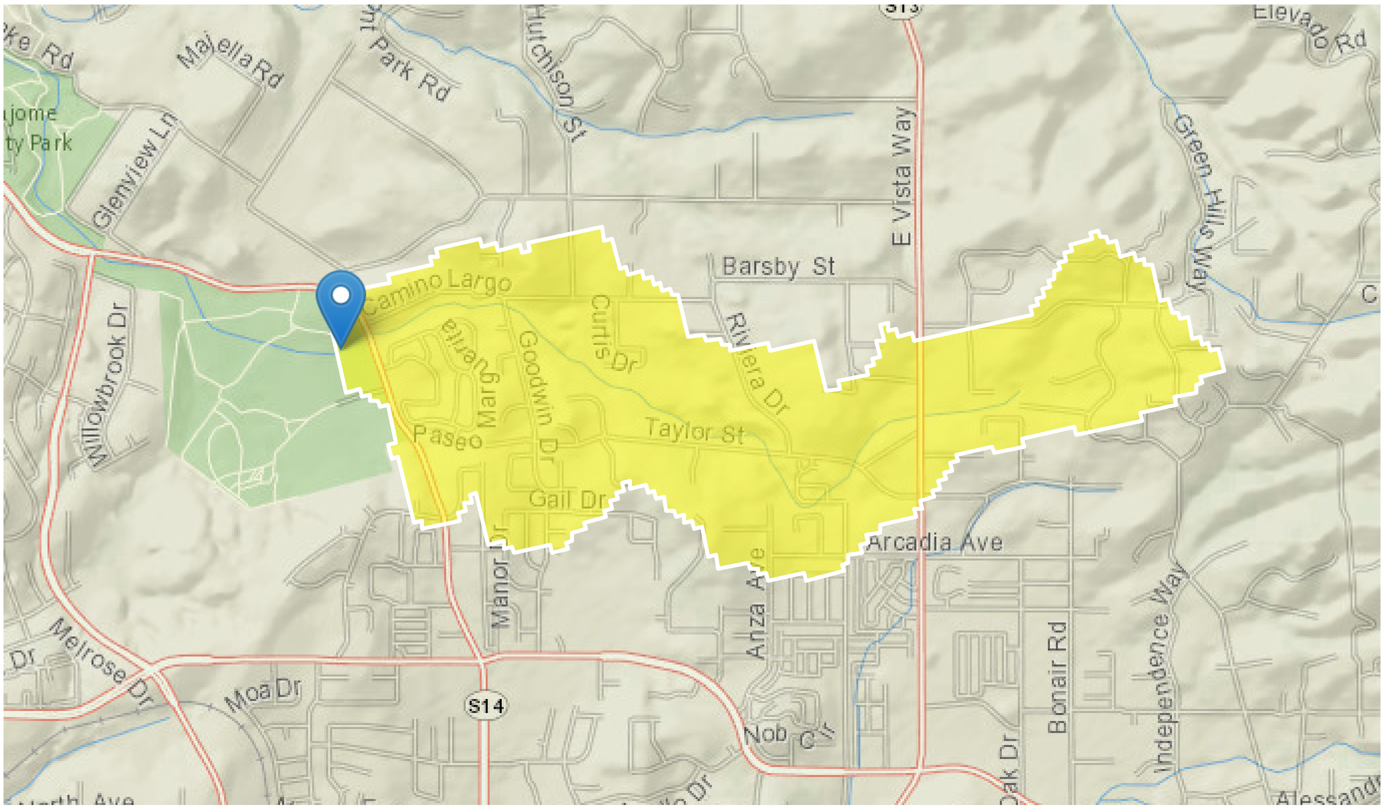


K:\Civil 3D\1154\DATA TRANSFER\TO\Wayne Chang\PRELIM-PROP HYDRO_SWQMP_TSM - Standard\HYDRO\PRELIM-PROP HYDRO_SWQMP_TSM.dwg, 8/4/2021 8:15:49 AM

Area Tributary to Reach 2

StreamStats Report

Region ID: CA
Workspace ID: CA20210804003918730000
Clicked Point (Latitude, Longitude): 33.23230, -117.25114
Time: 2021-08-03 17:39:35 -0700



Basin Characteristics

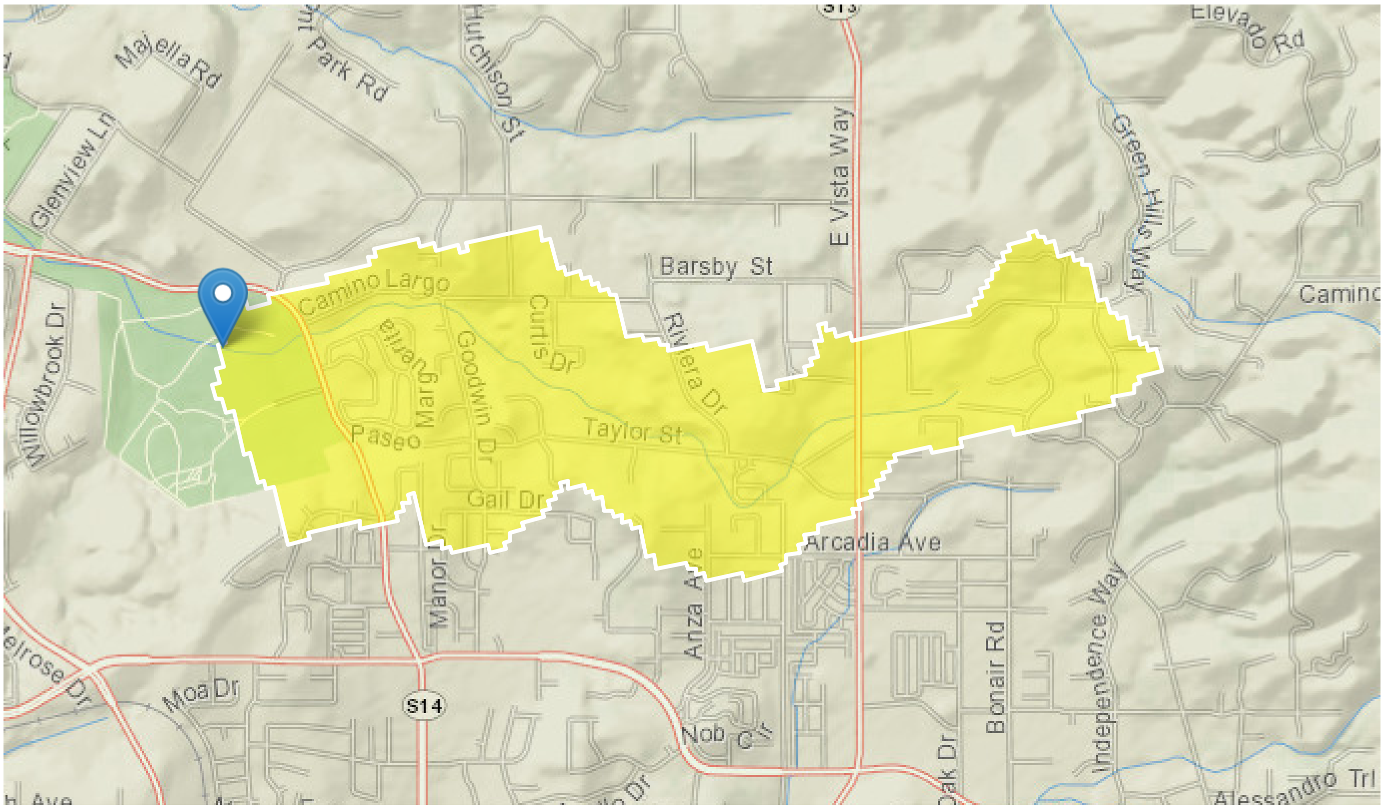
Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.0570	square miles

General Disclaimers

Area Tributary to Reach 3

StreamStats Report

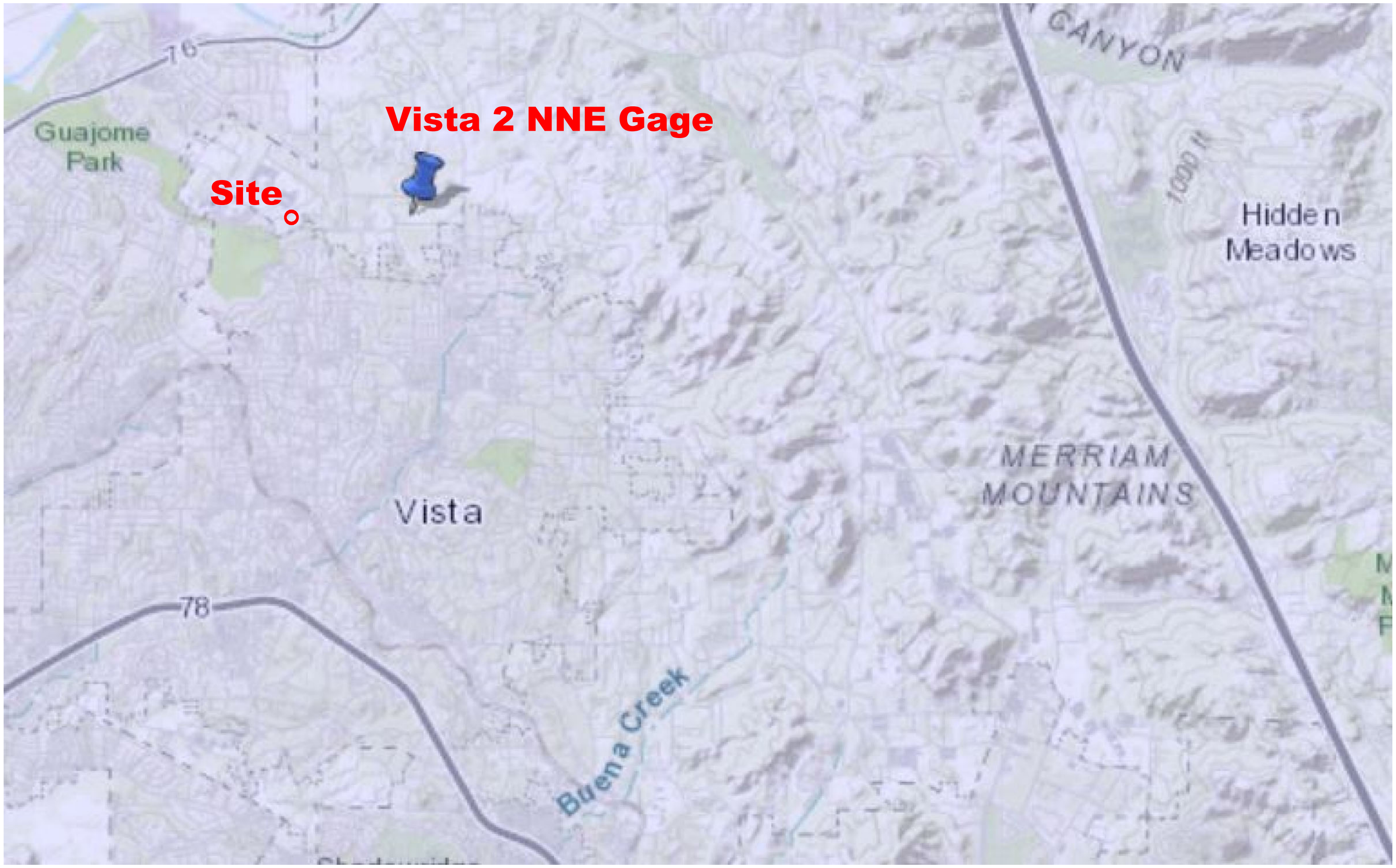
Region ID: CA
Workspace ID: CA20210804003221740000
Clicked Point (Latitude, Longitude): 33.23239, -117.25345
Time: 2021-08-03 17:32:38 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.1557	square miles

General Disclaimers



Rain Gage Location

VISTA 2 NNE, CALIFORNIA (049378)

Period of Record Monthly Climate Summary

Period of Record : 08/01/1957 to 05/12/2016

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	67.4	67.8	68.2	70.8	72.9	76.3	81.3	83.0	82.2	77.9	72.3	67.4	74.0
Average Min. Temperature (F)	44.0	45.0	46.3	48.5	53.5	56.6	60.3	61.6	60.0	55.0	48.3	44.0	51.9
Average Total Precipitation (in.)	2.76	2.55	2.24	1.05	0.22	0.11	0.06	0.07	0.25	0.54	1.40	1.83	13.09
Average Total SnowFall (in.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Percent of possible observations for period of record.
Max. Temp.: 86.6% Min. Temp.: 87% Precipitation: 87.6% Snowfall: 87.7% Snow Depth: 87.3%
Check Station Metadata or Metadata graphics for more detail about data completeness.

Western Regional Climate Center, wrcc@dri.edu

APPENDIX B

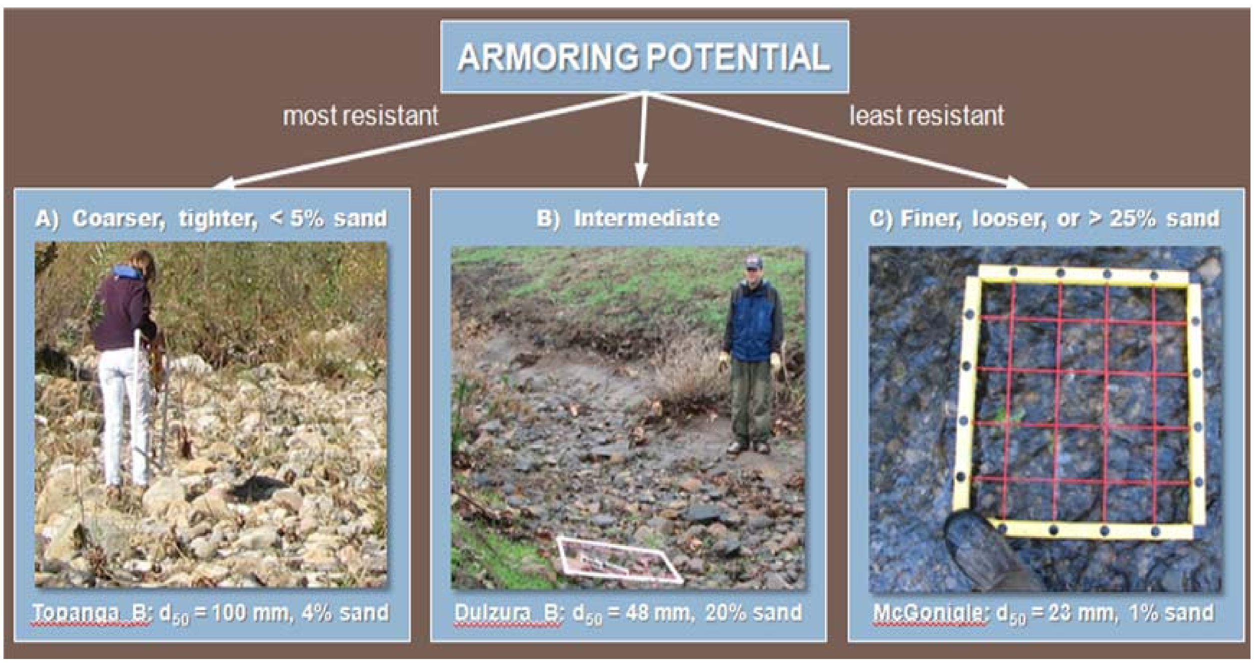
SCCWRP FIELD SCREENING DATA

Form 3 Support Materials

Form 3 Checklists 1 and 2, along with information recording in Form 3 Table 1, are intended to support the decisions pathways illustrated in Form 3 Overall Vertical Rating for Intermediate/Transitional Bed.

Form 3 Checklist 1: Armoring Potential

☐	A	A mix of coarse gravels and cobbles that are tightly packed with <5% surface material of diameter <2 mm
☒	B	Intermediate to A and C or hardpan of unknown resistance, spatial extent (longitudinal and depth), or unknown armoring potential due to surface veneer covering gravel or coarser layer encountered with probe
☐	C	Gravels/cobbles that are loosely packed or >25% surface material of diameter <2 mm



Form 3 Figure 2. Armoring potential photographic supplement for assessing intermediate beds (16 < d_{50} < 128 mm) to be used i**n conjunction with Form 3 Checklist 1.**

(Sheet 2 of 4)

REACH 1, 2, AND 3 RESULTS

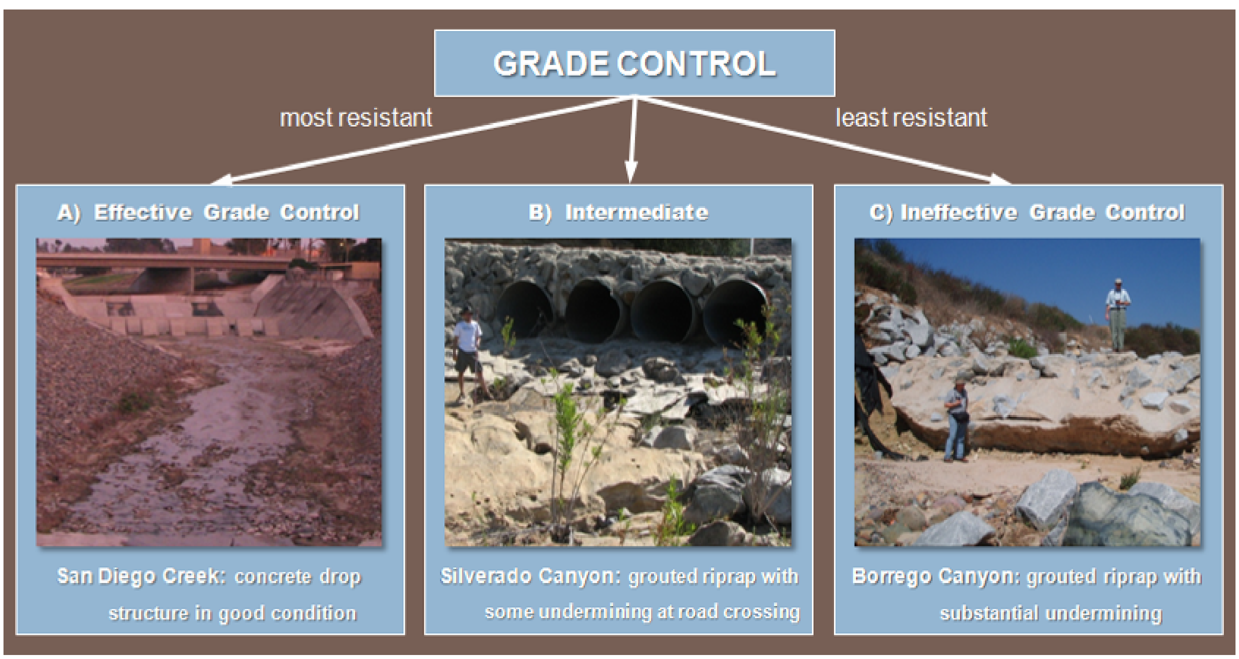
Form 3 Checklist 2: Grade Control

x A Grade control is present with spacing <50 m or $2/S_v$ m

- No evidence of failure/ineffectiveness, e.g., no headcutting (>30 cm), no active mass wasting (analyst cannot say grade control sufficient if mass-wasting checklist indicates presence of bank failure), no exposed bridge pilings, no culverts/structures undermined
- Hard points in serviceable condition at decadal time scale, e.g., no apparent undermining, flanking, failing grout
- If geologic grade control, rock should be resistant igneous and/or metamorphic; For sedimentary/hardpan to be classified as 'grade control', it should be of demonstrable strength as indicated by field testing such as hammer test/borings and/or inspected by appropriate stakeholder

x B Intermediate to A and C – artificial or geologic grade control present but spaced 2/Sv m to 4/Sv m or potential evidence of failure or hardpan of uncertain resistance

□ C Grade control absent, spaced >100 m or $>4/S_v$ m, or clear evidence of ineffectiveness



Form 3 Figure 3. Grade-control (condition) photographic supplement for assessing intermediate beds (16 < d_{50} < 128 mm) to be used in conjunction with Form 3 Checklist 2.

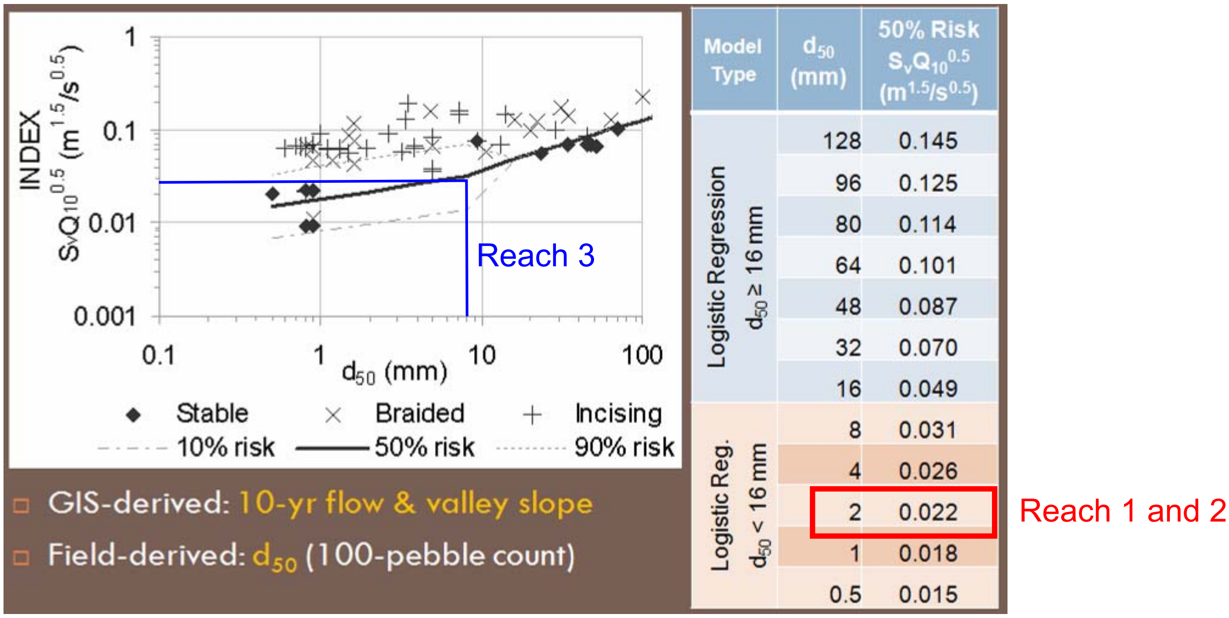
(Sheet 3 of 4)

REACH 1 AND 2 RESULTS

REACH 3 RESULTS

Regionally-Calibrated Screening Index Threshold for Incising/Braiding

For transitional bed channels (d_{50} between 16 and 128 mm) or labile beds (channel not incised past critical bank height), use Form 3 Figure 3 to determine Screening Index Score and complete Form 3 Table 1.



Form 3 Figure 4. Probability of incising/braiding based on logistic regression of Screening Index and d_{50} to be used in conjunction with Form 3 Table 1.

Form 3 Table 1. Values for Screening Index Threshold (probability of incising/braiding) to be used in conjunction with Form 3 Figure 4 (above) to complete Form 3 Overall Vertical Rating for Intermediate/Transitional Bed (below).. Screening Index Score: A = <50% probability of incision for current Q_{10}, valley slope, and d_{50}; B = Hardpan/d_{50} indeterminate; and C = $\geq$50% probability of incising/braiding for current Q_{10}, valley slope, and d_{50}.

d_{50} (mm) *From Form 2*	**S_v*$Q_{10}^{0.5}$ ($m^{1.5}/s^{0.5}$)** *From Form 1*	**S_v*$Q_{10}^{0.5}$ ($m^{1.5}/s^{0.5}$)** *50% risk of incising/braiding from table in Form 3 Figure 3 above*	**Screening Index Score (A, B, C)**

Overall Vertical Rating for Intermediate/Transitional Bed

Calculate the overall Vertical Rating for Transitional Bed channels using the formula below. Numeric values for responses to Form 3 Checklists and Table 1 as follows: A = 3, B = 6, C = 9.

$$Vertical\ Rating = \sqrt{\{(\sqrt{armoring * grade\ control}) * screening\ index\ score\}}$$

Vertical Susceptibility based on Vertical Rating: <4.5 = LOW; 4.5 to 7 = MEDIUM; and >7 = HIGH.

(Sheet 4 of 4)

REACH 1 AND 2 RESULTS

REACH 3 RESULTS

PEBBLE COUNT

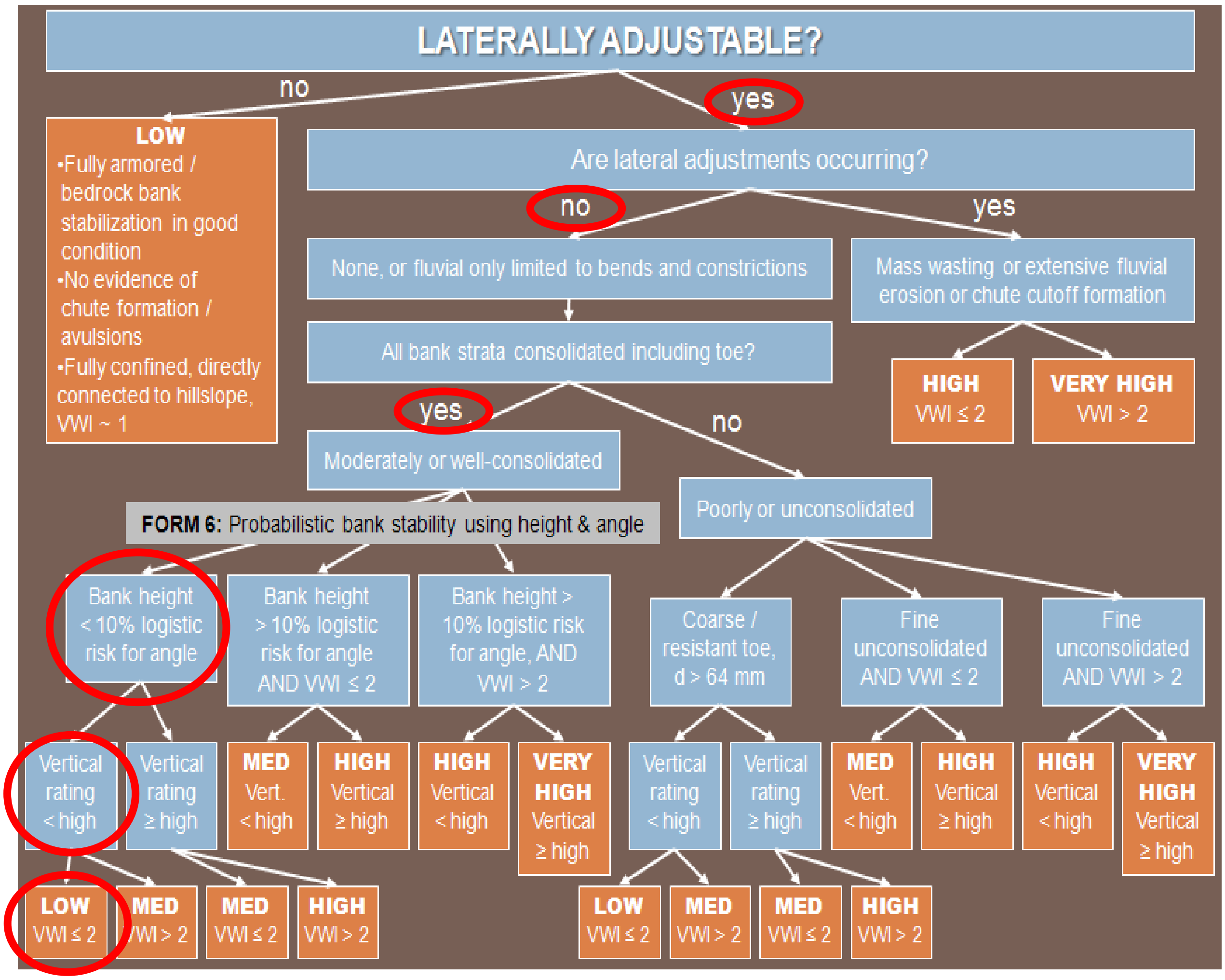
#	Reach 3 Diameter, mm
1	2
2	2
3	2
4	2
5	2
6	2
7	2
8	2
9	2.8
10	2.8
11	2.8
12	2.8
13	2.8
14	2.8
15	2.8
16	2.8
17	2.8
18	2.8
19	2.8
20	2.8
21	4
22	4
23	4
24	4
25	4
26	4
27	4
28	4
29	4
30	4
31	4
32	4
33	4
34	4
35	4
36	4
37	4
38	4
39	4
40	4
41	5.6
42	5.6
43	5.6

#	Reach 3 Diameter, mm
44	5.6
45	5.6
46	5.6
47	5.6
48	5.6
49	8
50	8
51	8
52	8
53	8
54	8
55	8
56	8
57	8
58	8
59	8
60	8
61	8
62	8
63	8
64	8
65	8
66	8
67	8
68	8
69	8
70	8
71	8
72	8
73	8
74	8
75	8
76	8
77	11
78	11
79	11
80	11
81	11
82	11
83	11
84	11
85	11
86	11
87	11
88	11

#	Reach 3 Diameter, mm
89	11
90	11
91	11
92	11
93	11
94	16
95	16
96	16
97	16
98	16
99	16
100	16

FORM 4: LATERAL SUSCEPTIBILTY FIELD SHEET

**Circle appropriate nodes/pathway for proposed site
OR use sequence of questions provided in Form 5.**



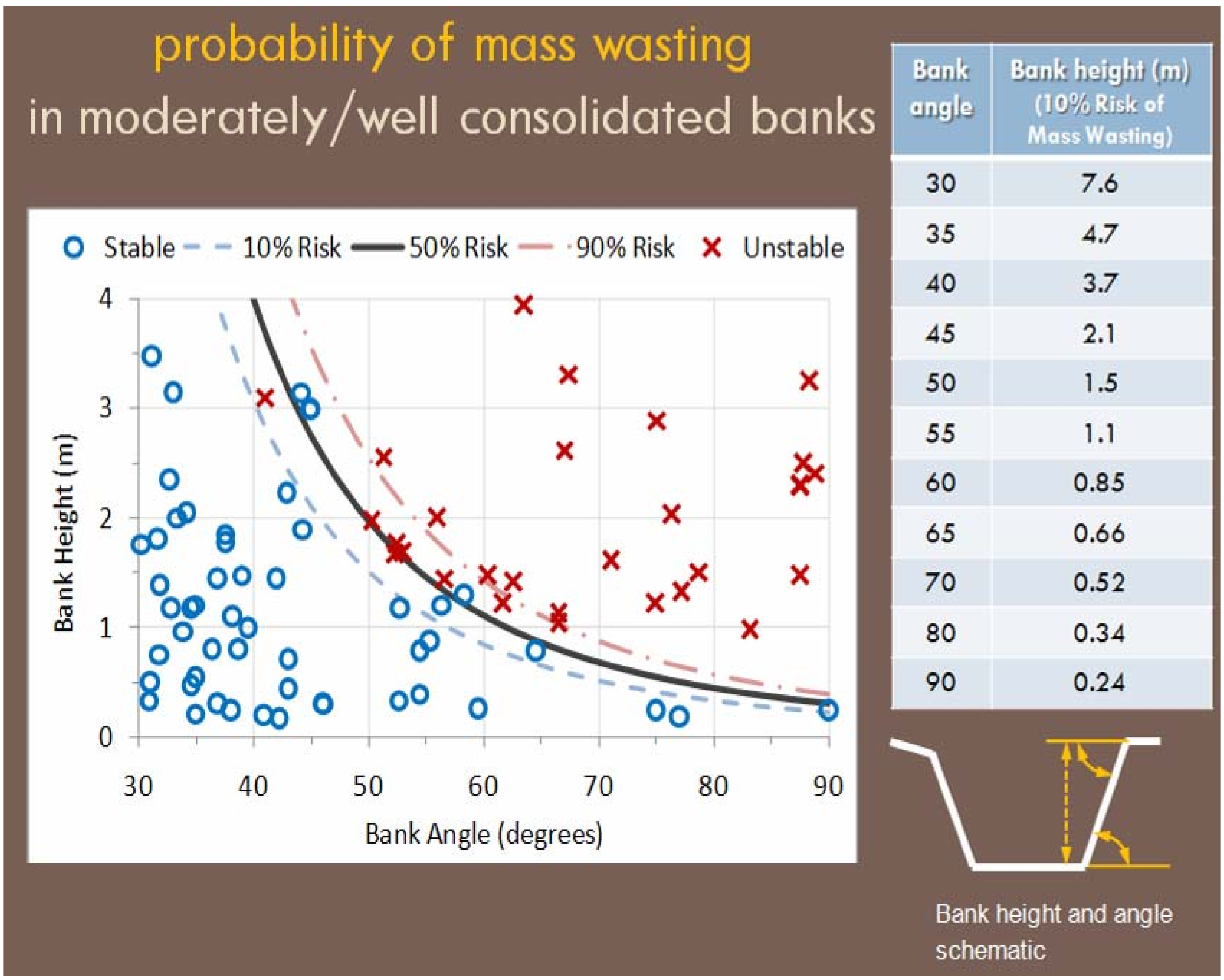
(Sheet 1 of 1)

REACH 1, 2, AND 3 RESULTS

FORM 6: PROBABILITY OF MASS WASTING BANK FAILURE

If mass wasting is not currently extensive and the banks are moderately- to well-consolidated, measure bank height and angle at several locations (i.e., at least three locations that capture the range of conditions present in the study reach) to estimate representative values for the reach. Use Form 6 Figure 1 below to determine if risk of bank failure is >10% and complete Form 6 Table 1. Support your results with photographs that include a protractor/rod/tape/person for scale.

	Bank Angle (degrees) *(from Field)*	**Bank Height (m)** *(from Field)*	**Corresponding Bank Height for 10% Risk of Mass Wasting (m)** *(from Form 6 Figure 1 below)*	**Bank Failure Risk** *(<10% Risk)* *(>10% Risk)*
Left Bank	26.6 degrees (2:1)	---	---	<10%
Right Bank	26.6 degrees (2:1)	---	---	<10%



Form 6 Figure 1. Probability Mass Wasting diagram, Bank Angle:Height/% Risk table, and Band Height:Angle schematic.

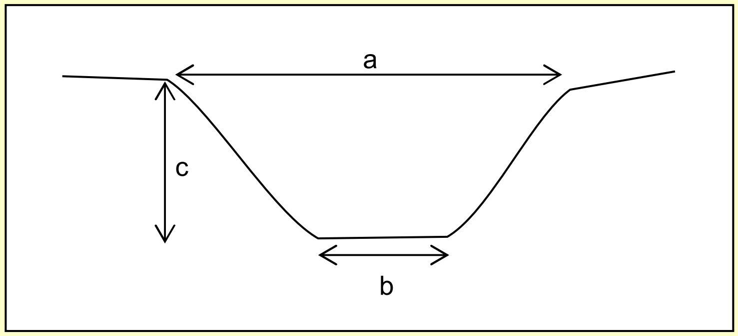
(Sheet 1 of 1)

REACH 1, 2, AND 3 RESULTS

Critical Flow Calculator

enter all values in green cells
and drop down boxes

Reach 1



Inputs

a) Receiving channel width at top of bank (ft) - see figure on right	40.0
b) Channel width at bed (ft)	8.0
c) Bank height at top of bank (ft)	1.0
Channel gradient (ft/ft)	0.0722
Receiving channel roughness	Same as above, but more stones and weeds n=0.035

Channel materials (use weakest of bed or banks). If materials are varied use weakest material covering more than 20% of channel.

- unconsolidated sandy loam 0.035 lb/sq ft
- alluvial silt (non coloidal) 0.045 lb/sq ft
- medium gravel 0.12 lb/sq ft
- alluvial silt/clay 0.26 lb/sq ft
- 2.5 inch cobble 1.1 lb/sq ft
- enter own d50 (variable)
- vegetation (bed and banks) 0.6 lb/sq ft

Select method of calculating Q2

- Input own Q2
- Calculate Q2 using USGS regression

Receiving water watershed annual precip (inches)	13.09	Receiving water watershed area at PoC (sq mi)	0.0057
Project watershed annual precipitation (inches)	13.09	Project watershed area draining to PoC (sq mi)	0.0057

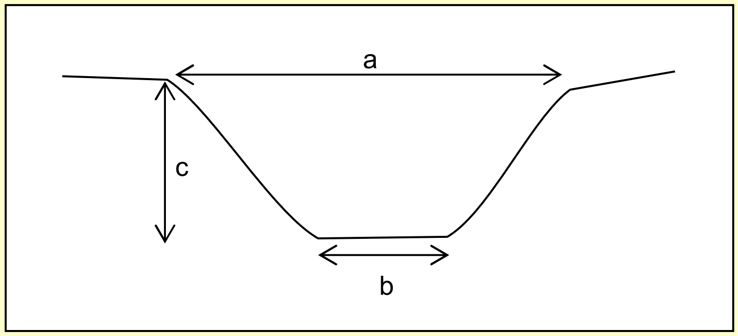
Outputs - Flow control range

Receiving water Q2	0.2	**Point of Compliance low flow rate (cfs)**	**0.1**
Project site Q2	0.2	**Low flow class**	**0.5Q2**
		Channel vulnerability	**Low**

Critical Flow Calculator

Reach 2

enter all values in green cells
and drop down boxes



Inputs

a) Receiving channel width at top of bank (ft) - see figure on right	38.0
b) Channel width at bed (ft)	30.0
c) Bank height at top of bank (ft)	2.0
Channel gradient (ft/ft)	0.0099
Receiving channel roughness	Same as above, but more stones and weeds n=0.035
Channel materials (use weakest of bed or banks). If materials are varied use weakest material covering more than 20% of channel.	unconsolidated sandy loam 0.035 lb/sq ft alluvial silt (non coloidal) 0.045 lb/sq ft medium gravel 0.12 lb/sq ft alluvial silt/clay 0.26 lb/sq ft 2.5 inch cobble 1.1 lb/sq ft enter own d50 (variable) vegetation (bed and banks) 0.6 lb/sq ft
Select method of calculating Q2	Input own Q2 Calculate Q2 using USGS regression

Receiving water watershed annual precip (inches)	13.09	Receiving water watershed area at PoC (sq mi)	1.0570
Project watershed annual precipitation (inches)	13.09	Project watershed area draining to PoC (sq mi)	1.0570

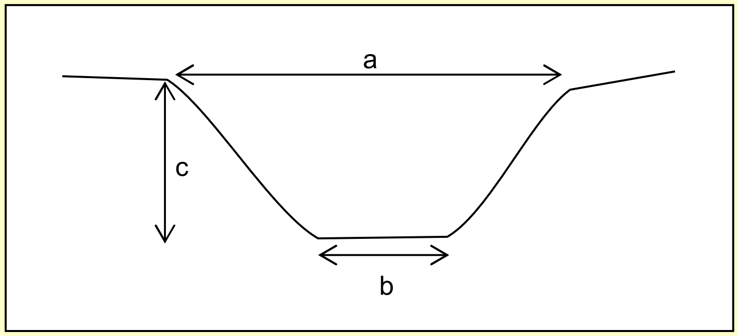
Outputs - Flow control range

Receiving water Q2	9.4	**Point of Compliance low flow rate (cfs)**	**4.7**
Project site Q2	9.4	**Low flow class**	**0.5Q2**
		Channel vulnerability	**Low**

Critical Flow Calculator

Reach 3

enter all values in green cells
and drop down boxes



Inputs

a) Receiving channel width at top of bank (ft) - see figure on right	38.0
b) Channel width at bed (ft)	30.0
c) Bank height at top of bank (ft)	2.0
Channel gradient (ft/ft)	0.0136
Receiving channel roughness	Same as above, but more stones and weeds n=0.035

Channel materials (use weakest of bed or banks). If materials are varied use weakest material covering more than 20% of channel.

- unconsolidated sandy loam 0.035 lb/sq ft
- alluvial silt (non coloidal) 0.045 lb/sq ft
- medium gravel 0.12 lb/sq ft
- alluvial silt/clay 0.26 lb/sq ft
- 2.5 inch cobble 1.1 lb/sq ft
- enter own d50 (variable)
- vegetation (bed and banks) 0.6 lb/sq ft

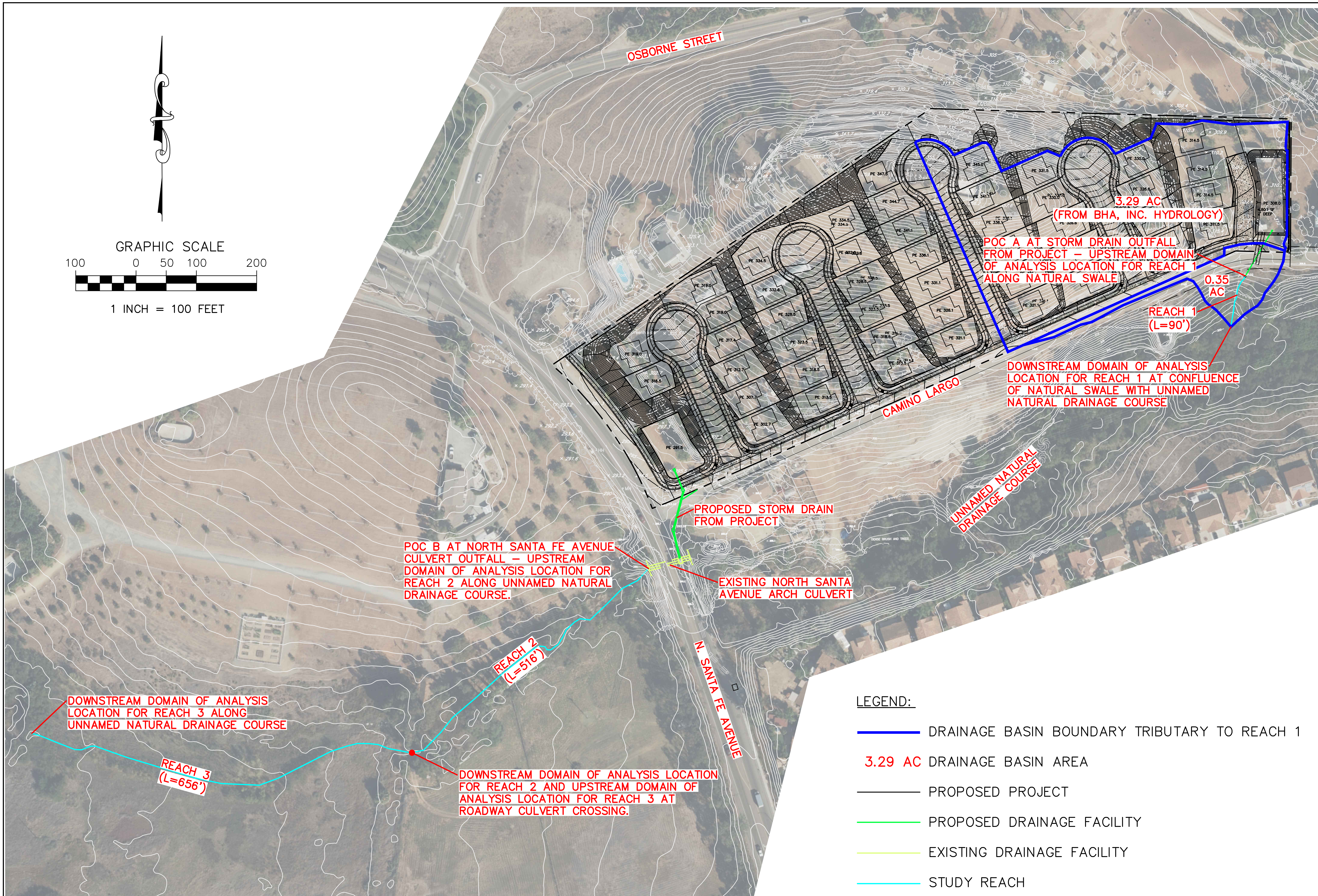
Select method of calculating Q2

- Input own Q2
- Calculate Q2 using USGS regression

Receiving water watershed annual precip (inches)	13.09	Receiving water watershed area at PoC (sq mi)	1.1557
Project watershed annual precipitation (inches)	13.09	Project watershed area draining to PoC (sq mi)	1.1557

Outputs - Flow control range

Receiving water Q2	10.0	**Point of Compliance low flow rate (cfs)**	**5.0**
Project site Q2	10.0	**Low flow class**	**0.5Q2**
		Channel vulnerability	**Low**



CAMINO LARGO
STUDY AREA EXHIBIT