

**DRAINAGE STUDY
FOR
KING'S BARN**

PRELIMINARY ENGINEERING

Job Number 20040

March 29, 2024

RICK
RICK ENGINEERING COMPANY
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RICK ENGINEERING CO

**DRAINAGE STUDY
FOR
KING'S BARN**

Preliminary Engineering

Job Number 20040

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1.0 INTRODUCTION

1.1 Project Description

This drainage study presents hydrologic and hydraulic analyses for the proposed King’s Barn Project (herein referred to as the “project”). The project is located within the City of Escondido, bound by West Valley Parkway on the north, Maple Street to the West, and an alley to the South. (See Figure 1, Vicinity Map). This area has been previously covered under the “Preliminary Drainage Study for Aspire”, prepared by Touch Stone Development, Inc., on March 12, 2019 (herein referred to as the “Aspire Preliminary Drainage Study”). The results from the Aspire Preliminary Drainage Study provide the pre project drainage conditions for King’s Barn site and are utilized for the pre project analysis. The site is approximately 1.2 acres and currently consists of an existing asphalt parking lot. The project proposes the construction of a 5-story multifamily structure with parking and basement, sidewalk replacement, and curb and gutter removal

1.2 Drainage Characteristics

Pre-Project Condition

The pre-project site drains to a single point of compliance (POC), POC-1. Half the project site drains in the easterly direction, to an existing grate inlet along the eastern corner of the site. The remaining other half of the site drains in the northerly direction, to an existing grate inlet along the northern corner of the site. Flows are conveyed through the existing storm drain system and join with offsite drainage along West Valley Parkway. Drainage confluences at the cleanout located at the west corner of West Valley Parkway. Runoff from the site discharges to the concrete lined Escondido Creek, which ultimately flows west to the San Elijo Lagoon and discharges to the Pacific Ocean.

Post-Project Condition

Drainage patterns for the post-project condition will remain similar to the drainage patterns in the pre-project condition, with all drainage flowing to the POC-1 location. Drainage from the proposed multifamily structure will be directed north to a proposed modular wetland system, which treats the runoff prior to discharging it from the site. The offsite drainage surrounding the project will remain and be routed in the same manner as the existing conditions – around the development through the existing storm drain conveyance system. The proposed modular wetland system will tie into the existing curb inlet north of the project site and convey flows through the existing conveyance system along West Valley Parkway. Flows confluence at POC-1, at the cleanout located along the west corner of West Valley Parkway. Runoff from the site discharges to the concrete lined Escondido Creek, which ultimately flows west to the San Elijo Lagoon and discharges to the Pacific Ocean. It is anticipated that the peak flows from a 100-year, 6-hour storm event on the post-project site will be lower than peak flows from the pre-project site, therefore detention is not required.

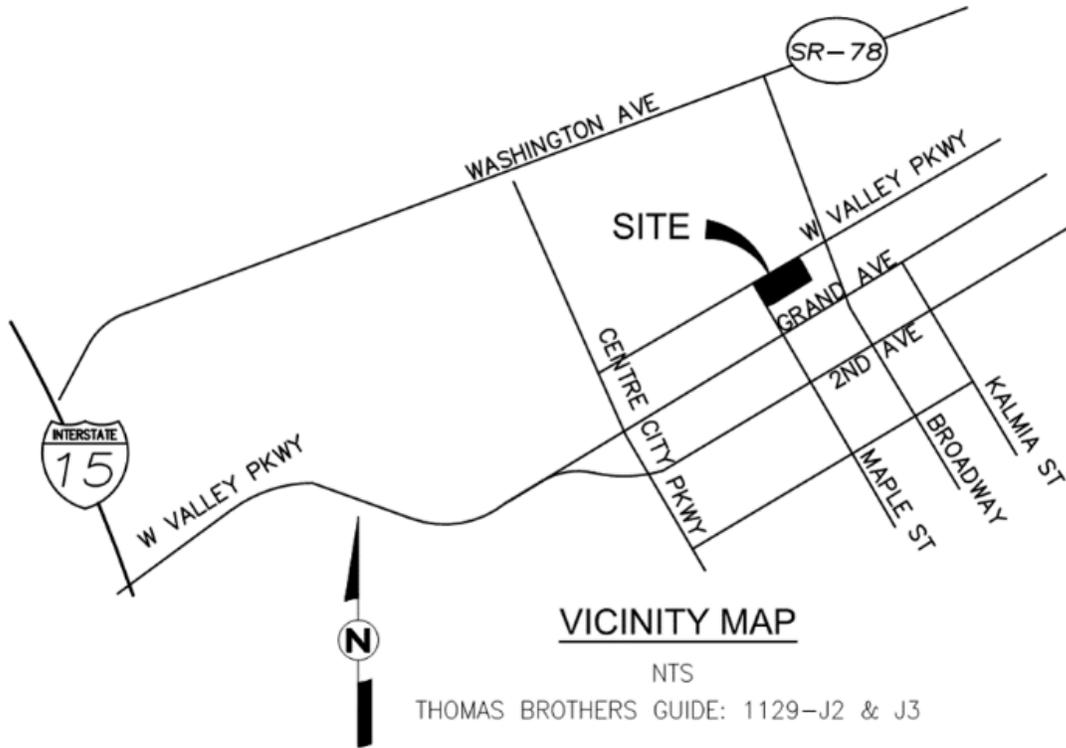
1.3 Hydrology, Hydraulics, and Detention

Hydrology, hydraulics, and detention are discussed in Sections 2.0, 3.0, and 4.0 respectively of this report.

1.4 Water Quality

Post-project storm water runoff will be managed via modular wetland system, designed pursuant to the guidelines from the City of Escondido Storm Water Design Manual, dated October 2022. The PDP SWQMP specific to the King’s Barn project is dated March 29, 2024 (or any revision made thereafter) and prepared by Rick Engineering Company.

Figure 1: Vicinity Map



2.0 HYDROLOGY

The hydrologic conditions were analyzed in accordance with the June 2003 San Diego County *Hydrology Manual*.

2.1 Methodology

To determine the peak flows at the point of compliance (POC) identified on the provided drainage study exhibits, Advance Engineering Software (AES) 2014 Rational Method computer software version 21.0 was used. The hydrologic model was developed by first dividing each major drainage basin into several subareas. The delineation of each subarea was determined so that area within each subarea is comprised of similar hydrologic features, including topography, land use, and storm drain conveyance system (e.g., urban open channel, pipe, natural open channel, etc.). Nodes were identified at the upstream and downstream extents of each subarea, and subarea hydrologic data was determined, such as the land use(s) and drainage facility geometry, elevations, and lengths. Hydrologic backup information is included in Appendix C and AES output is provided in Appendix A and B for pre and post-project conditions respectively.

Next, the hydrologic data describing each subarea were incorporated into the AES software in order to create a node-link model for each watershed. For each subarea the AES software performs calculations for the specific hydrologic process occurring in the subarea. There are 15 different hydrologic processes programmed into the software, and each process is assigned a code number that is presented on the model results. The AES Rational Method computer software hydrologic processes code numbers are described in Table 1.

Table 1: Subarea Hydrologic Processes (Codes)

Code	Subarea Type
Code 1	Confluence analysis at a node
Code 2	Initial subarea analysis
Code 3	Pipe flow travel time (computer-estimated pipe sizes)
Code 4	Pipe flow travel time (user-specified pipe size)
Code 5	Trapezoidal channel travel time
Code 6	Street flow analysis through a subarea
Code 7	User-specified information at a node
Code 8	Addition of the subarea runoff to mainline

Table 1: Subarea Hydrologic Processes (Codes)

Code	Subarea Type
Code 9	V-Gutter flow through subarea
Code 10	Copy mainstream data onto a memory bank
Code 11	Confluence a memory bank with the mainstream memory
Code 12	Clear a memory bank
Code 13	Clear the mainstream memory
Code 14	Copy a memory bank onto the mainstream memory
Code 15	Hydrologic data bank storage functions

The hydrologic conditions were analyzed in accordance with the County of San Diego’s design criteria as follows:

San Diego County Hydrology Manual, June 2003:

Design Storm:	100-year, 6-hour (for storm drain systems)
Runoff Coefficients:	Weighted Runoff Coefficients ⁽¹⁾
0% Impervious Areas	C=0.30 for Type-C soils C=0.35 for Type-D soils
100% Impervious Areas	C=0.9
Soil Type (Conservatively Applied)	“D”
Design Storm Precipitation ²	100-year, 6-hour, P=2.4 inches
Rainfall Intensity:	Based on time-intensity criteria per Section 3.0 of the County Hydrology Manual (San Diego County, 2003)

⁽¹⁾ Utilized to calculate composite ‘C’ values based on percent impervious.

⁽²⁾ Isopluvial map provided in Appendix C.

2.2 Hydrologic Results

Rational Method Results

The 100-year peak flow rate for the Pre- and Post-Project conditions are summarized in Table 2.1 below.

Table 2.1: Summary of Hydrologic Conditions

Drainage Basin ID	POC	Return Period (years)	Project Condition	Tributary Area (ac)	Time Of Concentration (minutes)	Q (cfs)
100	1	100	Pre-Project	3.7	9.7	17.9
			Post-Project		7.2	17.8

Based on the Rational Method result and a comparison of the pre-and post-project POC, it can be observed that the peak discharge rate and tributary areas to POC 1 has decreased. This decrease in peak flows indicates that there is no anticipated impact to the existing downstream drainage facilities. Refer to Appendix A and Appendix B of this report for pre- and post-project Rational Method calculations respectively, and Appendix C for backup documentation.

The location of the POC, drainage boundaries, flow patterns, and pervious/impervious areas can be found on the work maps titled, “Pre-project Drainage Study Map for King’s Barn” located in Map Pocket 1 and “Post-project Drainage Study Map for King’s Barn,” located in Map Pocket 2.

3.0 HYDRAULICS

3.1 Hydraulic Methodology and Criteria

The 100-year post-project peak flow rates determined using the Modified Rational Method was used to size the on-site storm drain system.

3.1.1 Storm Drain Sizing

Storm drain pipe sizes were determined based on a normal depth calculation to verify storm drain capacity based on Manning's equation.

$$Q = (1.486/n) A R^{2/3} S^{1/2}$$

Where:

Q = Discharge (cfs)

n = Manning's roughness coefficient

A = Cross-sectional Area of flow (sq. ft.)

R = Hydraulic radius (ft.) (where hydraulic radius is defined as the cross-section area of flow divided by the wetted perimeter, $R = A/P$)

S = Slope of pipe (ft./ft.)

The Manning's roughness coefficient "n" of 0.013 was used for the hydraulic calculations. This value is typically used for reinforced concrete pipe (RCP), polyvinyl chloride (PVC), and high-density polyethylene pipe (HDPE). The pipe sizes were evaluated based on the Rational Method flow rates with a 30% "bump up" sizing factor to account for hydraulic losses within the system.

Please refer to Appendix D for the storm drain sizes. The AES rational method results for the post-project condition are located in Appendix B of this report may be referenced for further information concerning pipe flow.

4.0 DETENTION ANALYSES

No detention analysis was conducted for this project. The project directly discharges into the concrete lined Escondido creek, which is hydromodification exempt, therefore detention is not required.

5.0 CONCLUSION

This drainage study presents the hydrologic and hydraulic analyses for the King’s Barn project. The project is a new development project located in the City of Santee. The post-project condition peak discharge rates were determined using the Rational Method based on the hydrologic methodology and criteria described in the County of San Diego Hydrology Manual, dated June 2003.

Post-project flows will be treated per the City of Escondido Storm Water Design Manual, dated October 2022. For more information on water quality sizing, please refer to the separate report titled, “Priority Development Project Storm Water Quality Management Plan (PDP SWQMP) for King’s Barn,” dated March 29th, 2024, or any revisions thereafter, and prepared by Rick Engineering Company.

Based on the Rational Method result and a comparison of the pre- and post-project POC, it can be observed that the post-project peak discharge rate has decreased. Due to the decrease in peak discharge rate, it is anticipated that there will be no adverse effects to downstream drainage characteristics/systems as a result of the project.

APPENDIX A

Modified Rational Method Output [Pre-project]

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 1261

Analysis prepared by:

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***** DESCRIPTION OF STUDY *****

- * KING'S BARN *
 - * EXISTING CONDITION 100-YR STORM EVENT *
 - * JN-20040 *
- *****

FILE NAME: KB1HE00.RAT
TIME/DATE OF STUDY: 17:39 03/27/2024

USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:

1985 SAN DIEGO MANUAL CRITERIA

USER SPECIFIED STORM EVENT(YEAR) = 100.00
6-HOUR DURATION PRECIPITATION (INCHES) = 3.300
SPECIFIED MINIMUM PIPE SIZE(INCH) = 18.00
SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED

USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL

NO.	HALF- WIDTH (FT)	CROWN TO CROSSFALL (FT)	STREET-CROSSFALL: IN- / OUT- / PARK- SIDE / SIDE / WAY	CURB HEIGHT (FT)	GUTTER-GEOMETRIES: WIDTH LIP HIKE (FT) (FT) (FT)	MANNING FACTOR (n)
1	30.0	20.0	0.018/0.018/0.020	0.67	2.00 0.0313 0.167	0.0150
2	20.0	15.0	0.020/0.020/0.020	0.50	1.50 0.0100 0.125	0.0180

GLOBAL STREET FLOW-DEPTH CONSTRAINTS:

1. Relative Flow-Depth = 0.50 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 101.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

=====

*USER SPECIFIED(SUBAREA):

INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .9000

S.C.S. CURVE NUMBER (AMC II) = 0

INITIAL SUBAREA FLOW-LENGTH(FEET) = 100.00

UPSTREAM ELEVATION(FEET) = 656.00

DOWNSTREAM ELEVATION(FEET) = 655.00

ELEVATION DIFFERENCE(FEET) = 1.00

URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) = 3.600

TIME OF CONCENTRATION ASSUMED AS 6-MIN.

100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 7.730

SUBAREA RUNOFF(CFS) = 0.70

TOTAL AREA(ACRES) = 0.10 TOTAL RUNOFF(CFS) = 0.70

FLOW PROCESS FROM NODE 101.00 TO NODE 102.00 IS CODE = 51

>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<

>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 653.00 DOWNSTREAM(FEET) = 648.00

CHANNEL LENGTH THRU SUBAREA(FEET) = 653.00 CHANNEL SLOPE = 0.0077

CHANNEL BASE(FEET) = 10.00 "Z" FACTOR = 12.000

MANNING'S FACTOR = 0.013 MAXIMUM DEPTH(FEET) = 5.00

100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 5.332

*USER SPECIFIED(SUBAREA):

INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .9000

S.C.S. CURVE NUMBER (AMC II) = 0

TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) = 3.40

TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) = 2.33

AVERAGE FLOW DEPTH(FEET) = 0.13 TRAVEL TIME(MIN.) = 4.67

Tc(MIN.) = 10.67

SUBAREA AREA(ACRES) = 1.10 SUBAREA RUNOFF(CFS) = 5.28

TOTAL AREA(ACRES) = 1.2 PEAK FLOW RATE(CFS) = 5.97

END OF SUBAREA CHANNEL FLOW HYDRAULICS:

DEPTH(FEET) = 0.17 FLOW VELOCITY(FEET/SEC.) = 2.87

LONGEST FLOWPATH FROM NODE 100.00 TO NODE 102.00 = 753.00 FEET.

FLOW PROCESS FROM NODE 102.00 TO NODE 102.00 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.) = 10.67

RAINFALL INTENSITY(INCH/HR) = 5.33

TOTAL STREAM AREA(ACRES) = 1.20

PEAK FLOW RATE(CFS) AT CONFLUENCE = 5.97

FLOW PROCESS FROM NODE 110.00 TO NODE 111.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

=====

*USER SPECIFIED(SUBAREA):

INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .9000

S.C.S. CURVE NUMBER (AMC II) = 0

INITIAL SUBAREA FLOW-LENGTH(FEET) = 50.00

UPSTREAM ELEVATION(FEET) = 652.00

DOWNSTREAM ELEVATION(FEET) = 651.00

ELEVATION DIFFERENCE(FEET) = 1.00

URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) = 2.020

TIME OF CONCENTRATION ASSUMED AS 6-MIN.

100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 7.730

SUBAREA RUNOFF(CFS) = 0.70

TOTAL AREA(ACRES) = 0.10 TOTAL RUNOFF(CFS) = 0.70

FLOW PROCESS FROM NODE 111.00 TO NODE 112.00 IS CODE = 51

>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<

>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 651.00 DOWNSTREAM(FEET) = 648.50

CHANNEL LENGTH THRU SUBAREA(FEET) = 100.00 CHANNEL SLOPE = 0.0250

CHANNEL BASE(FEET) = 10.00 "Z" FACTOR = 12.000

MANNING'S FACTOR = 0.013 MAXIMUM DEPTH(FEET) = 5.00

100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 7.225

*USER SPECIFIED(SUBAREA):

INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .9000

S.C.S. CURVE NUMBER (AMC II) = 0

TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) = 1.35

TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) = 2.51

AVERAGE FLOW DEPTH(FEET) = 0.05 TRAVEL TIME(MIN.) = 0.66

Tc(MIN.) = 6.66

SUBAREA AREA(ACRES) = 0.20 SUBAREA RUNOFF(CFS) = 1.30

TOTAL AREA(ACRES) = 0.3 PEAK FLOW RATE(CFS) = 2.00

END OF SUBAREA CHANNEL FLOW HYDRAULICS:

DEPTH(FEET) = 0.07 FLOW VELOCITY(FEET/SEC.) = 2.81

LONGEST FLOWPATH FROM NODE 110.00 TO NODE 112.00 = 150.00 FEET.

FLOW PROCESS FROM NODE 112.00 TO NODE 102.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<

>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 647.60 DOWNSTREAM(FEET) = 647.00

FLOW LENGTH(FEET) = 15.00 MANNING'S N = 0.013

ASSUME FULL-FLOWING PIPELINE

PIPE-FLOW VELOCITY(FEET/SEC.) = 10.17

PIPE FLOW VELOCITY = (TOTAL FLOW)/(PIPE CROSS SECTION AREA)

GIVEN PIPE DIAMETER(INCH) = 6.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 2.00
PIPE TRAVEL TIME(MIN.) = 0.02 Tc(MIN.) = 6.69
LONGEST FLOWPATH FROM NODE 110.00 TO NODE 102.00 = 165.00 FEET.

FLOW PROCESS FROM NODE 102.00 TO NODE 102.00 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.) = 6.69
RAINFALL INTENSITY(INCH/HR) = 7.21
TOTAL STREAM AREA(ACRES) = 0.30
PEAK FLOW RATE(CFS) AT CONFLUENCE = 2.00

** CONFLUENCE DATA **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)	AREA (ACRE)
1	5.97	10.67	5.332	1.20
2	2.00	6.69	7.207	0.30

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

** PEAK FLOW RATE TABLE **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)
1	6.42	6.69	7.207
2	7.45	10.67	5.332

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:

PEAK FLOW RATE(CFS) = 7.45 Tc(MIN.) = 10.67
TOTAL AREA(ACRES) = 1.5
LONGEST FLOWPATH FROM NODE 100.00 TO NODE 102.00 = 753.00 FEET.

FLOW PROCESS FROM NODE 102.00 TO NODE 103.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 646.00 DOWNSTREAM(FEET) = 645.77
FLOW LENGTH(FEET) = 45.00 MANNING'S N = 0.013
ASSUME FULL-FLOWING PIPELINE
PIPE-FLOW VELOCITY(FEET/SEC.) = 4.22
PIPE FLOW VELOCITY = (TOTAL FLOW)/(PIPE CROSS SECTION AREA)
GIVEN PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 7.45
PIPE TRAVEL TIME(MIN.) = 0.18 Tc(MIN.) = 10.85
LONGEST FLOWPATH FROM NODE 100.00 TO NODE 103.00 = 798.00 FEET.

```

*****
FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE = 41
-----
>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
=====
ELEVATION DATA: UPSTREAM(FEET) = 643.52 DOWNSTREAM(FEET) = 642.91
FLOW LENGTH(FEET) = 244.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 36.0 INCH PIPE IS 11.9 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 3.66
GIVEN PIPE DIAMETER(INCH) = 36.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 7.45
PIPE TRAVEL TIME(MIN.) = 1.11 Tc(MIN.) = 11.96
LONGEST FLOWPATH FROM NODE 100.00 TO NODE 104.00 = 1042.00 FEET.

*****
FLOW PROCESS FROM NODE    104.00 TO NODE    104.00 IS CODE = 10
-----
>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<
=====

*****
FLOW PROCESS FROM NODE    120.00 TO NODE    121.00 IS CODE = 21
-----
>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
=====
*USER SPECIFIED(SUBAREA):
INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .9000
S.C.S. CURVE NUMBER (AMC II) = 0
INITIAL SUBAREA FLOW-LENGTH(FEET) = 45.00
UPSTREAM ELEVATION(FEET) = 651.50
DOWNSTREAM ELEVATION(FEET) = 651.00
ELEVATION DIFFERENCE(FEET) = 0.50
URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) = 2.332
TIME OF CONCENTRATION ASSUMED AS 6-MIN.
100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 7.730
SUBAREA RUNOFF(CFS) = 0.70
TOTAL AREA(ACRES) = 0.10 TOTAL RUNOFF(CFS) = 0.70

*****
FLOW PROCESS FROM NODE    121.00 TO NODE    122.00 IS CODE = 51
-----
>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
=====
ELEVATION DATA: UPSTREAM(FEET) = 651.00 DOWNSTREAM(FEET) = 649.30
CHANNEL LENGTH THRU SUBAREA(FEET) = 375.00 CHANNEL SLOPE = 0.0045
CHANNEL BASE(FEET) = 10.00 "Z" FACTOR = 12.000
MANNING'S FACTOR = 0.013 MAXIMUM DEPTH(FEET) = 5.00
100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 5.984
*USER SPECIFIED(SUBAREA):
INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .8600

```

S.C.S. CURVE NUMBER (AMC II) = 0
TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) = 4.63
TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) = 2.14
AVERAGE FLOW DEPTH(FEET) = 0.18 TRAVEL TIME(MIN.) = 2.92
Tc(MIN.) = 8.92
SUBAREA AREA(ACRES) = 1.50 SUBAREA RUNOFF(CFS) = 7.72
TOTAL AREA(ACRES) = 1.6 PEAK FLOW RATE(CFS) = 8.41

END OF SUBAREA CHANNEL FLOW HYDRAULICS:
DEPTH(FEET) = 0.25 FLOW VELOCITY(FEET/SEC.) = 2.63
LONGEST FLOWPATH FROM NODE 120.00 TO NODE 122.00 = 420.00 FEET.

FLOW PROCESS FROM NODE 122.00 TO NODE 123.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 646.50 DOWNSTREAM(FEET) = 645.62
FLOW LENGTH(FEET) = 192.00 MANNING'S N = 0.013
ASSUME FULL-FLOWING PIPELINE
PIPE-FLOW VELOCITY(FEET/SEC.) = 4.76
PIPE FLOW VELOCITY = (TOTAL FLOW)/(PIPE CROSS SECTION AREA)
GIVEN PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 8.41
PIPE TRAVEL TIME(MIN.) = 0.67 Tc(MIN.) = 9.60
LONGEST FLOWPATH FROM NODE 120.00 TO NODE 123.00 = 612.00 FEET.

FLOW PROCESS FROM NODE 123.00 TO NODE 123.00 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.) = 9.60
RAINFALL INTENSITY(INCH/HR) = 5.71
TOTAL STREAM AREA(ACRES) = 1.60
PEAK FLOW RATE(CFS) AT CONFLUENCE = 8.41

FLOW PROCESS FROM NODE 130.00 TO NODE 131.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

=====

*USER SPECIFIED(SUBAREA):
INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .9000
S.C.S. CURVE NUMBER (AMC II) = 0
INITIAL SUBAREA FLOW-LENGTH(FEET) = 50.00
UPSTREAM ELEVATION(FEET) = 152.00
DOWNSTREAM ELEVATION(FEET) = 150.50
ELEVATION DIFFERENCE(FEET) = 1.50
URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) = 1.765

*CAUTION: SUBAREA SLOPE EXCEEDS COUNTY NOMOGRAPH
DEFINITION. EXTRAPOLATION OF NOMOGRAPH USED.
TIME OF CONCENTRATION ASSUMED AS 6-MIN.
100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 7.730
SUBAREA RUNOFF(CFS) = 0.70
TOTAL AREA(ACRES) = 0.10 TOTAL RUNOFF(CFS) = 0.70

FLOW PROCESS FROM NODE 131.00 TO NODE 132.00 IS CODE = 51

>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 650.80 DOWNSTREAM(FEET) = 648.10
CHANNEL LENGTH THRU SUBAREA(FEET) = 125.00 CHANNEL SLOPE = 0.0216
CHANNEL BASE(FEET) = 10.00 "Z" FACTOR = 12.000
MANNING'S FACTOR = 0.013 MAXIMUM DEPTH(FEET) = 5.00
100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 7.128
*USER SPECIFIED(SUBAREA):
INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .8600
S.C.S. CURVE NUMBER (AMC II) = 0
TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) = 1.61
TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) = 2.59
AVERAGE FLOW DEPTH(FEET) = 0.06 TRAVEL TIME(MIN.) = 0.80
Tc(MIN.) = 6.80
SUBAREA AREA(ACRES) = 0.30 SUBAREA RUNOFF(CFS) = 1.84
TOTAL AREA(ACRES) = 0.4 PEAK FLOW RATE(CFS) = 2.53

END OF SUBAREA CHANNEL FLOW HYDRAULICS:
DEPTH(FEET) = 0.08 FLOW VELOCITY(FEET/SEC.) = 2.92
LONGEST FLOWPATH FROM NODE 130.00 TO NODE 132.00 = 175.00 FEET.

FLOW PROCESS FROM NODE 132.00 TO NODE 123.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 647.15 DOWNSTREAM(FEET) = 646.40
FLOW LENGTH(FEET) = 24.00 MANNING'S N = 0.013
ASSUME FULL-FLOWING PIPELINE
PIPE-FLOW VELOCITY(FEET/SEC.) = 12.91
PIPE FLOW VELOCITY = (TOTAL FLOW)/(PIPE CROSS SECTION AREA)
GIVEN PIPE DIAMETER(INCH) = 6.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 2.53
PIPE TRAVEL TIME(MIN.) = 0.03 Tc(MIN.) = 6.83
LONGEST FLOWPATH FROM NODE 130.00 TO NODE 123.00 = 199.00 FEET.

FLOW PROCESS FROM NODE 123.00 TO NODE 123.00 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.) = 6.83
RAINFALL INTENSITY(INCH/HR) = 7.11
TOTAL STREAM AREA(ACRES) = 0.40
PEAK FLOW RATE(CFS) AT CONFLUENCE = 2.53

** CONFLUENCE DATA **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)	AREA (ACRE)
1	8.41	9.60	5.710	1.60
2	2.53	6.83	7.107	0.40

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

** PEAK FLOW RATE TABLE **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)
1	9.30	6.83	7.107
2	10.45	9.60	5.710

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:

PEAK FLOW RATE(CFS) = 10.45 Tc(MIN.) = 9.60
TOTAL AREA(ACRES) = 2.0
LONGEST FLOWPATH FROM NODE 120.00 TO NODE 123.00 = 612.00 FEET.

FLOW PROCESS FROM NODE 123.00 TO NODE 123.00 IS CODE = 81

>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<

=====

100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 5.710
*USER SPECIFIED(SUBAREA):
INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .8600
S.C.S. CURVE NUMBER (AMC II) = 0
SUBAREA AREA(ACRES) = 0.20 SUBAREA RUNOFF(CFS) = 0.98
TOTAL AREA(ACRES) = 2.2 TOTAL RUNOFF(CFS) = 11.43
TC(MIN.) = 9.60

FLOW PROCESS FROM NODE 123.00 TO NODE 104.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<

>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 645.29 DOWNSTREAM(FEET) = 642.91
FLOW LENGTH(FEET) = 45.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 18.0 INCH PIPE IS 9.0 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 12.97
GIVEN PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 11.43

PIPE TRAVEL TIME(MIN.) = 0.06 Tc(MIN.) = 9.65
LONGEST FLOWPATH FROM NODE 120.00 TO NODE 104.00 = 657.00 FEET.

FLOW PROCESS FROM NODE 104.00 TO NODE 104.00 IS CODE = 11

>>>>CONFLUENCE MEMORY BANK # 1 WITH THE MAIN-STREAM MEMORY<<<<<

=====

** MAIN STREAM CONFLUENCE DATA **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)	AREA (ACRE)
1	11.43	9.65	5.688	2.20

LONGEST FLOWPATH FROM NODE 120.00 TO NODE 104.00 = 657.00 FEET.

** MEMORY BANK # 1 CONFLUENCE DATA **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)	AREA (ACRE)
1	7.45	11.96	4.954	1.50

LONGEST FLOWPATH FROM NODE 100.00 TO NODE 104.00 = 1042.00 FEET.

** PEAK FLOW RATE TABLE **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)
1	17.92	9.65	5.688
2	17.41	11.96	4.954

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:

PEAK FLOW RATE(CFS) = 17.92 Tc(MIN.) = 9.65
TOTAL AREA(ACRES) = 3.7

FLOW PROCESS FROM NODE 104.00 TO NODE 104.00 IS CODE = 12

>>>>CLEAR MEMORY BANK # 1 <<<<<

=====

END OF STUDY SUMMARY:

TOTAL AREA(ACRES) = 3.7 TC(MIN.) = 9.65
PEAK FLOW RATE(CFS) = 17.92

=====

END OF RATIONAL METHOD ANALYSIS



APPENDIX B

Modified Rational Method Output [Post-project Un-detained]

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 1261

Analysis prepared by:

RICK ENGINEERING COMPANY
5620 Friars Road
San Diego, California 92110
619-291-0707 Fax 619-291-4165

***** DESCRIPTION OF STUDY *****

* KING'S BARN *
* PROPOSED CONDITION 100-YR STORM EVENT *
* JN-20040 *

FILE NAME: KB1HP00.RAT
TIME/DATE OF STUDY: 18:51 03/27/2024

USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:

1985 SAN DIEGO MANUAL CRITERIA

USER SPECIFIED STORM EVENT(YEAR) = 100.00
6-HOUR DURATION PRECIPITATION (INCHES) = 3.300
SPECIFIED MINIMUM PIPE SIZE(INCH) = 18.00
SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED

USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL

NO.	HALF- WIDTH (FT)	CROWN TO CROSSFALL (FT)	STREET-CROSSFALL: IN- / OUT- / PARK- SIDE / SIDE / WAY	CURB HEIGHT (FT)	GUTTER-GEOMETRIES: WIDTH (FT)	LIP (FT)	HIKE (FT)	MANNING FACTOR (n)
1	30.0	20.0	0.018/0.018/0.020	0.67	2.00	0.0313	0.167	0.0150
2	20.0	15.0	0.020/0.020/0.020	0.50	1.50	0.0100	0.125	0.0180

GLOBAL STREET FLOW-DEPTH CONSTRAINTS:

1. Relative Flow-Depth = 0.50 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 101.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

=====

*USER SPECIFIED(SUBAREA):

INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .9000

S.C.S. CURVE NUMBER (AMC II) = 0

INITIAL SUBAREA FLOW-LENGTH(FEET) = 100.00

UPSTREAM ELEVATION(FEET) = 654.00

DOWNSTREAM ELEVATION(FEET) = 653.00

ELEVATION DIFFERENCE(FEET) = 1.00

URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) = 3.600

TIME OF CONCENTRATION ASSUMED AS 6-MIN.

100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 7.730

SUBAREA RUNOFF(CFS) = 0.70

TOTAL AREA(ACRES) = 0.10 TOTAL RUNOFF(CFS) = 0.70

FLOW PROCESS FROM NODE 101.00 TO NODE 102.00 IS CODE = 62

>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<

>>>>(STREET TABLE SECTION # 1 USED)<<<<<

UPSTREAM ELEVATION(FEET) = 653.00 DOWNSTREAM ELEVATION(FEET) = 648.80

STREET LENGTH(FEET) = 500.00 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 = 2

STREET PARKWAY CROSSFALL(DECIMAL) = 0.020

Manning's FRICTION FACTOR for Streetflow Section(curbs-to-curbs) = 0.0150

Manning's FRICTION FACTOR for Back-of-Walk Flow Section = 0.0200

**TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) = 2.09

STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:

STREET FLOW DEPTH(FEET) = 0.28

HALFSTREET FLOOD WIDTH(FEET) = 6.72

AVERAGE FLOW VELOCITY(FEET/SEC.) = 1.75

PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) = 0.49

STREET FLOW TRAVEL TIME(MIN.) = 4.77 Tc(MIN.) = 10.77

100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 5.300

*USER SPECIFIED(SUBAREA):

INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .8600

S.C.S. CURVE NUMBER (AMC II) = 0

SUBAREA AREA(ACRES) = 0.60 SUBAREA RUNOFF(CFS) = 2.73

TOTAL AREA(ACRES) = 0.7 PEAK FLOW RATE(CFS) = 3.43

END OF SUBAREA STREET FLOW HYDRAULICS:

DEPTH(FEET) = 0.32 HALFSTREET FLOOD WIDTH(FEET) = 8.84

FLOW VELOCITY(FEET/SEC.) = 1.92 DEPTH*VELOCITY(FT*FT/SEC.) = 0.62

LONGEST FLOWPATH FROM NODE 100.00 TO NODE 102.00 = 600.00 FEET.

```

*****
FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 IS CODE = 81
-----
>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<
=====
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 5.300
*USER SPECIFIED(SUBAREA):
INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .8600
S.C.S. CURVE NUMBER (AMC II) = 0
SUBAREA AREA(ACRES) = 0.30 SUBAREA RUNOFF(CFS) = 1.37
TOTAL AREA(ACRES) = 1.0 TOTAL RUNOFF(CFS) = 4.80
TC(MIN.) = 10.77

*****
FLOW PROCESS FROM NODE    102.00 TO NODE    102.00 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.) = 10.77
RAINFALL INTENSITY(INCH/HR) = 5.30
TOTAL STREAM AREA(ACRES) = 1.00
PEAK FLOW RATE(CFS) AT CONFLUENCE = 4.80

*****
FLOW PROCESS FROM NODE    110.00 TO NODE    111.00 IS CODE = 21
-----
>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<
=====
*USER SPECIFIED(SUBAREA):
INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .9000
S.C.S. CURVE NUMBER (AMC II) = 0
INITIAL SUBAREA FLOW-LENGTH(FEET) = 50.00
UPSTREAM ELEVATION(FEET) = 100.00
DOWNSTREAM ELEVATION(FEET) = 99.00
ELEVATION DIFFERENCE(FEET) = 1.00
URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) = 2.020
TIME OF CONCENTRATION ASSUMED AS 6-MIN.
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 7.730
SUBAREA RUNOFF(CFS) = 0.70
TOTAL AREA(ACRES) = 0.10 TOTAL RUNOFF(CFS) = 0.70

*****
FLOW PROCESS FROM NODE    111.00 TO NODE    112.00 IS CODE = 51
-----
>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<
>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<
=====
ELEVATION DATA: UPSTREAM(FEET) = 100.00 DOWNSTREAM(FEET) = 97.00
CHANNEL LENGTH THRU SUBAREA(FEET) = 120.00 CHANNEL SLOPE = 0.0250
CHANNEL BASE(FEET) = 10.00 "Z" FACTOR = 12.000
MANNING'S FACTOR = 0.013 MAXIMUM DEPTH(FEET) = 5.00

```

100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 7.286
*USER SPECIFIED(SUBAREA):
INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .9000
S.C.S. CURVE NUMBER (AMC II) = 0
TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) = 3.65
TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) = 3.47
AVERAGE FLOW DEPTH(FEET) = 0.09 TRAVEL TIME(MIN.) = 0.58
Tc(MIN.) = 6.58
SUBAREA AREA(ACRES) = 0.90 SUBAREA RUNOFF(CFS) = 5.90
TOTAL AREA(ACRES) = 1.0 PEAK FLOW RATE(CFS) = 6.60

END OF SUBAREA CHANNEL FLOW HYDRAULICS:
DEPTH(FEET) = 0.13 FLOW VELOCITY(FEET/SEC.) = 4.29
LONGEST FLOWPATH FROM NODE 110.00 TO NODE 112.00 = 170.00 FEET.

FLOW PROCESS FROM NODE 112.00 TO NODE 113.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 100.00 DOWNSTREAM(FEET) = 30.00
FLOW LENGTH(FEET) = 70.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 12.0 INCH PIPE IS 3.6 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 33.41
GIVEN PIPE DIAMETER(INCH) = 12.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 6.60
PIPE TRAVEL TIME(MIN.) = 0.03 Tc(MIN.) = 6.61
LONGEST FLOWPATH FROM NODE 110.00 TO NODE 113.00 = 240.00 FEET.

FLOW PROCESS FROM NODE 113.00 TO NODE 114.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 100.00 DOWNSTREAM(FEET) = 99.00
FLOW LENGTH(FEET) = 20.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 18.0 INCH PIPE IS 6.7 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 10.99
GIVEN PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 6.60
PIPE TRAVEL TIME(MIN.) = 0.03 Tc(MIN.) = 6.64
LONGEST FLOWPATH FROM NODE 110.00 TO NODE 114.00 = 260.00 FEET.

FLOW PROCESS FROM NODE 114.00 TO NODE 102.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 100.00 DOWNSTREAM(FEET) = 99.00
FLOW LENGTH(FEET) = 16.00 MANNING'S N = 0.013

DEPTH OF FLOW IN 18.0 INCH PIPE IS 6.3 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) = 11.92
 GIVEN PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
 PIPE-FLOW(CFS) = 6.60
 PIPE TRAVEL TIME(MIN.) = 0.02 Tc(MIN.) = 6.66
 LONGEST FLOWPATH FROM NODE 110.00 TO NODE 102.00 = 276.00 FEET.

FLOW PROCESS FROM NODE 102.00 TO NODE 102.00 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.) = 6.66
 RAINFALL INTENSITY(INCH/HR) = 7.22
 TOTAL STREAM AREA(ACRES) = 1.00
 PEAK FLOW RATE(CFS) AT CONFLUENCE = 6.60

** CONFLUENCE DATA **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)	AREA (ACRE)
1	4.80	10.77	5.300	1.00
2	6.60	6.66	7.224	1.00

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

** PEAK FLOW RATE TABLE **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)
1	10.12	6.66	7.224
2	9.64	10.77	5.300

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) = 10.12 Tc(MIN.) = 6.66
 TOTAL AREA(ACRES) = 2.0
 LONGEST FLOWPATH FROM NODE 100.00 TO NODE 102.00 = 600.00 FEET.

FLOW PROCESS FROM NODE 102.00 TO NODE 103.00 IS CODE = 41

 >>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<<
 >>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 100.00 DOWNSTREAM(FEET) = 99.00
 FLOW LENGTH(FEET) = 45.00 MANNING'S N = 0.013
 DEPTH OF FLOW IN 18.0 INCH PIPE IS 10.9 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) = 9.05
 GIVEN PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
 PIPE-FLOW(CFS) = 10.12
 PIPE TRAVEL TIME(MIN.) = 0.08 Tc(MIN.) = 6.75

LONGEST FLOWPATH FROM NODE 100.00 TO NODE 103.00 = 645.00 FEET.

FLOW PROCESS FROM NODE 103.00 TO NODE 104.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) =	100.00	DOWNSTREAM(FEET) =	95.00
FLOW LENGTH(FEET) =	244.00	MANNING'S N =	0.013
DEPTH OF FLOW IN 36.0 INCH PIPE IS	8.1 INCHES		
PIPE-FLOW VELOCITY(FEET/SEC.) =	8.47		
GIVEN PIPE DIAMETER(INCH) =	36.00	NUMBER OF PIPES =	1
PIPE-FLOW(CFS) =	10.12		
PIPE TRAVEL TIME(MIN.) =	0.48	Tc(MIN.) =	7.23
LONGEST FLOWPATH FROM NODE	100.00	TO NODE	104.00 =
			889.00 FEET.

FLOW PROCESS FROM NODE 104.00 TO NODE 104.00 IS CODE = 10

>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<

FLOW PROCESS FROM NODE 120.00 TO NODE 121.00 IS CODE = 21

>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<

=====

*USER SPECIFIED(SUBAREA):

INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT =	.9000
S.C.S. CURVE NUMBER (AMC II) =	0
INITIAL SUBAREA FLOW-LENGTH(FEET) =	45.00
UPSTREAM ELEVATION(FEET) =	100.00
DOWNSTREAM ELEVATION(FEET) =	99.50
ELEVATION DIFFERENCE(FEET) =	0.50
URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =	2.332
TIME OF CONCENTRATION ASSUMED AS	6-MIN.
100 YEAR RAINFALL INTENSITY(INCH/HOUR) =	7.730
SUBAREA RUNOFF(CFS) =	0.70
TOTAL AREA(ACRES) =	0.10
TOTAL RUNOFF(CFS) =	0.70

FLOW PROCESS FROM NODE 121.00 TO NODE 122.00 IS CODE = 51

>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) =	100.00	DOWNSTREAM(FEET) =	98.00
CHANNEL LENGTH THRU SUBAREA(FEET) =	375.00	CHANNEL SLOPE =	0.0053
CHANNEL BASE(FEET) =	10.00	"Z" FACTOR =	12.000
MANNING'S FACTOR =	0.013	MAXIMUM DEPTH(FEET) =	5.00
100 YEAR RAINFALL INTENSITY(INCH/HOUR) =	6.051		

*USER SPECIFIED(SUBAREA):

INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .8600
S.C.S. CURVE NUMBER (AMC II) = 0
TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) = 4.40
TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) = 2.26
AVERAGE FLOW DEPTH(FEET) = 0.16 TRAVEL TIME(MIN.) = 2.77
Tc(MIN.) = 8.77
SUBAREA AREA(ACRES) = 1.40 SUBAREA RUNOFF(CFS) = 7.29
TOTAL AREA(ACRES) = 1.5 PEAK FLOW RATE(CFS) = 7.98

END OF SUBAREA CHANNEL FLOW HYDRAULICS:
DEPTH(FEET) = 0.23 FLOW VELOCITY(FEET/SEC.) = 2.78
LONGEST FLOWPATH FROM NODE 120.00 TO NODE 122.00 = 420.00 FEET.

FLOW PROCESS FROM NODE 122.00 TO NODE 123.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 100.00 DOWNSTREAM(FEET) = 96.00
FLOW LENGTH(FEET) = 192.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 18.0 INCH PIPE IS 9.6 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 8.36
GIVEN PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 7.98
PIPE TRAVEL TIME(MIN.) = 0.38 Tc(MIN.) = 9.15
LONGEST FLOWPATH FROM NODE 120.00 TO NODE 123.00 = 612.00 FEET.

FLOW PROCESS FROM NODE 123.00 TO NODE 123.00 IS CODE = 81

>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<

=====

100 YEAR RAINFALL INTENSITY(INCH/HOUR) = 5.886
*USER SPECIFIED(SUBAREA):
INDUSTRIAL DEVELOPMENT RUNOFF COEFFICIENT = .8600
S.C.S. CURVE NUMBER (AMC II) = 0
SUBAREA AREA(ACRES) = 0.20 SUBAREA RUNOFF(CFS) = 1.01
TOTAL AREA(ACRES) = 1.7 TOTAL RUNOFF(CFS) = 8.99
TC(MIN.) = 9.15

FLOW PROCESS FROM NODE 123.00 TO NODE 104.00 IS CODE = 41

>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<

=====

ELEVATION DATA: UPSTREAM(FEET) = 100.00 DOWNSTREAM(FEET) = 97.00
FLOW LENGTH(FEET) = 45.00 MANNING'S N = 0.013
DEPTH OF FLOW IN 18.0 INCH PIPE IS 7.3 INCHES
PIPE-FLOW VELOCITY(FEET/SEC.) = 13.28
GIVEN PIPE DIAMETER(INCH) = 18.00 NUMBER OF PIPES = 1
PIPE-FLOW(CFS) = 8.99

PIPE TRAVEL TIME(MIN.) = 0.06 Tc(MIN.) = 9.21
LONGEST FLOWPATH FROM NODE 120.00 TO NODE 104.00 = 657.00 FEET.

FLOW PROCESS FROM NODE 104.00 TO NODE 104.00 IS CODE = 11

>>>>CONFLUENCE MEMORY BANK # 1 WITH THE MAIN-STREAM MEMORY<<<<<

=====
** MAIN STREAM CONFLUENCE DATA **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)	AREA (ACRE)
1	8.99	9.21	5.863	1.70

LONGEST FLOWPATH FROM NODE 120.00 TO NODE 104.00 = 657.00 FEET.

** MEMORY BANK # 1 CONFLUENCE DATA **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)	AREA (ACRE)
1	10.12	7.23	6.856	2.00

LONGEST FLOWPATH FROM NODE 100.00 TO NODE 104.00 = 889.00 FEET.

** PEAK FLOW RATE TABLE **

STREAM NUMBER	RUNOFF (CFS)	Tc (MIN.)	INTENSITY (INCH/HOUR)
1	17.81	7.23	6.856
2	17.65	9.21	5.863

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:

PEAK FLOW RATE(CFS) = 17.81 Tc(MIN.) = 7.23
TOTAL AREA(ACRES) = 3.7

FLOW PROCESS FROM NODE 104.00 TO NODE 104.00 IS CODE = 12

>>>>CLEAR MEMORY BANK # 1 <<<<<

=====
END OF STUDY SUMMARY:

TOTAL AREA(ACRES) = 3.7 TC(MIN.) = 7.23
PEAK FLOW RATE(CFS) = 17.81

=====
END OF RATIONAL METHOD ANALYSIS



APPENDIX C

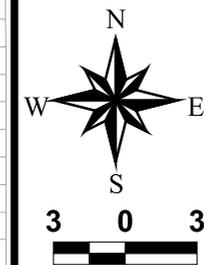
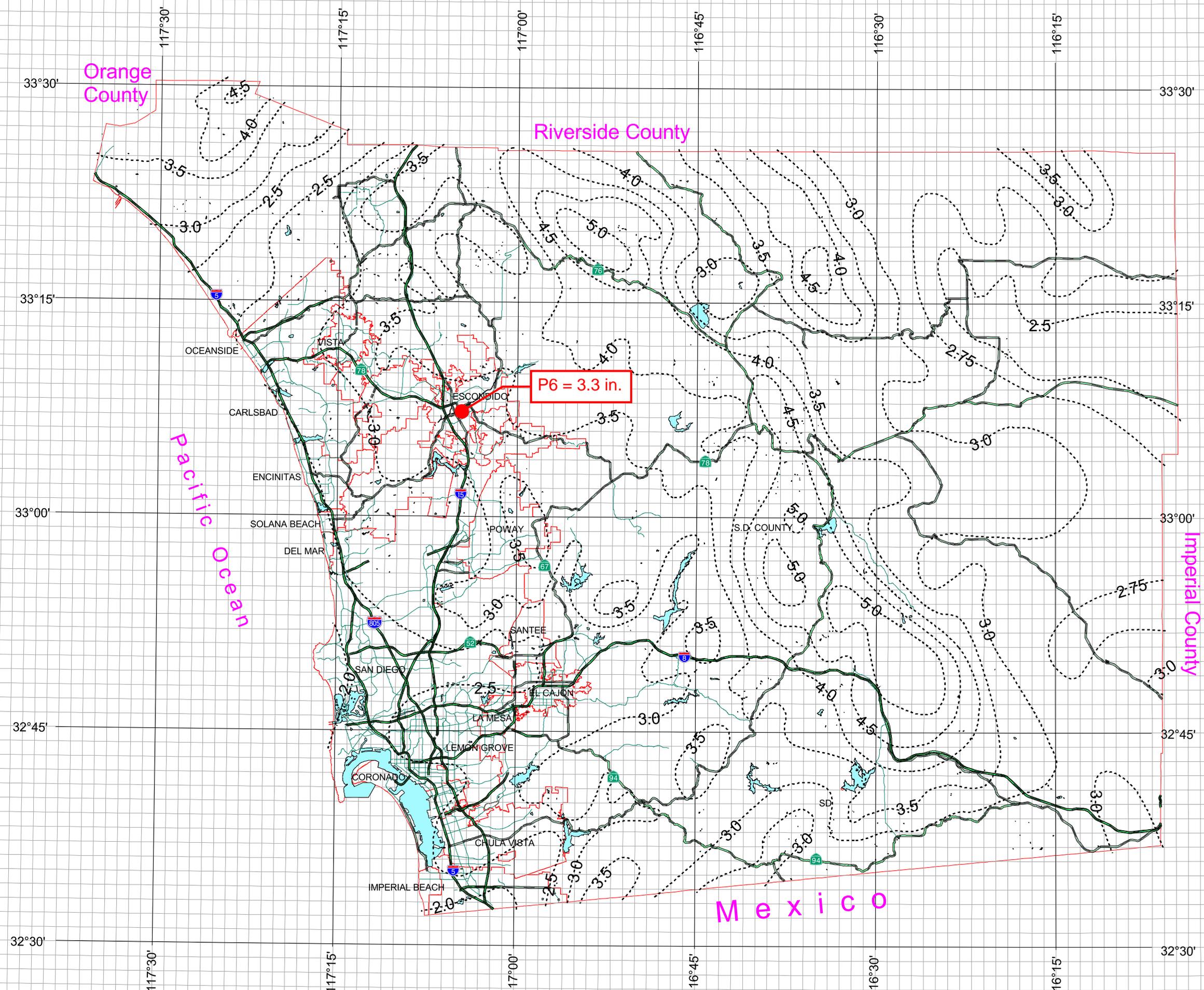
Backup for Weighted Runoff Coefficients

County of San Diego Hydrology Manual



Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours



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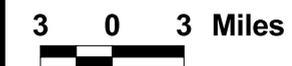
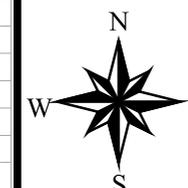
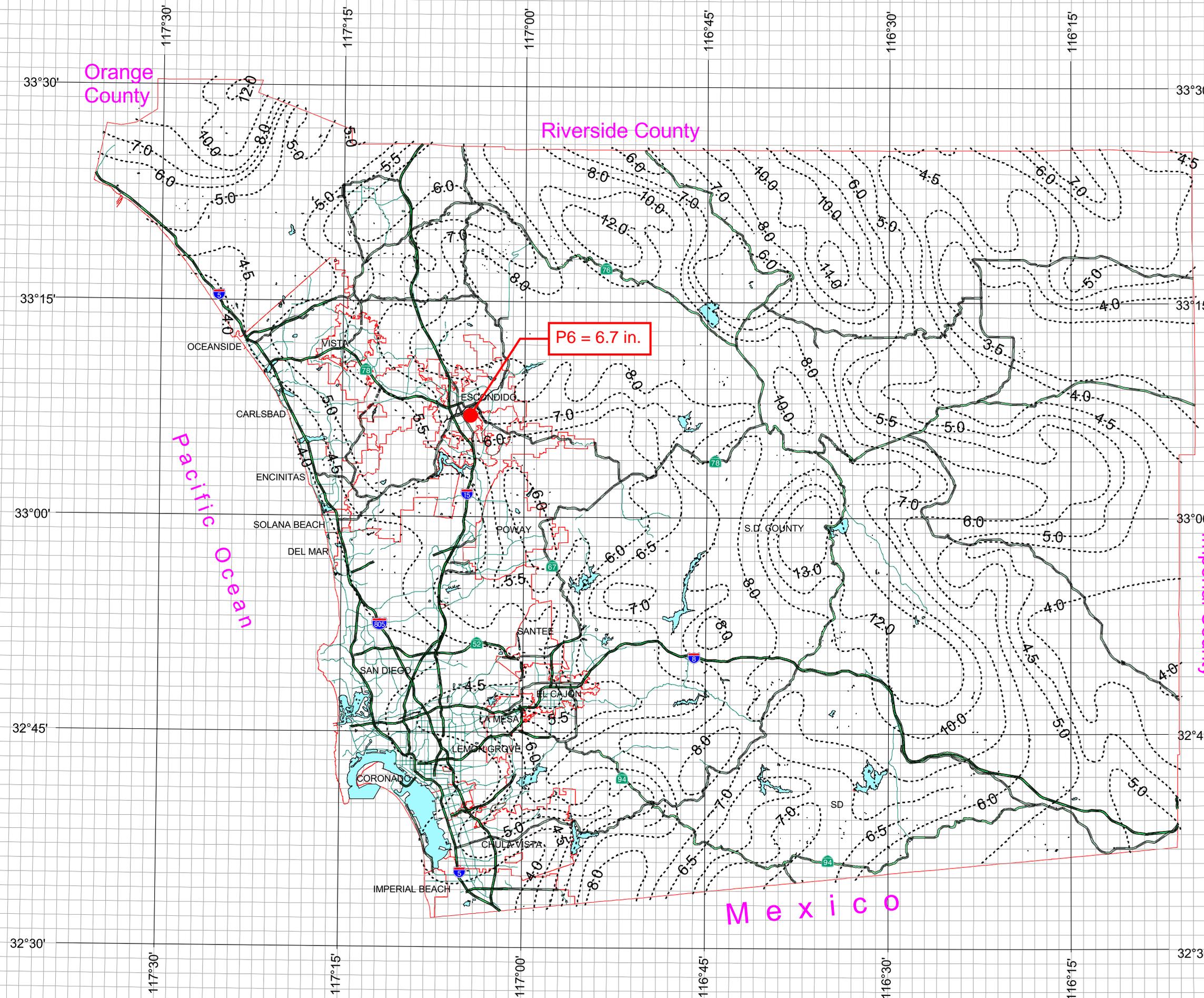
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County of San Diego Hydrology Manual



Rainfall Isopluvials

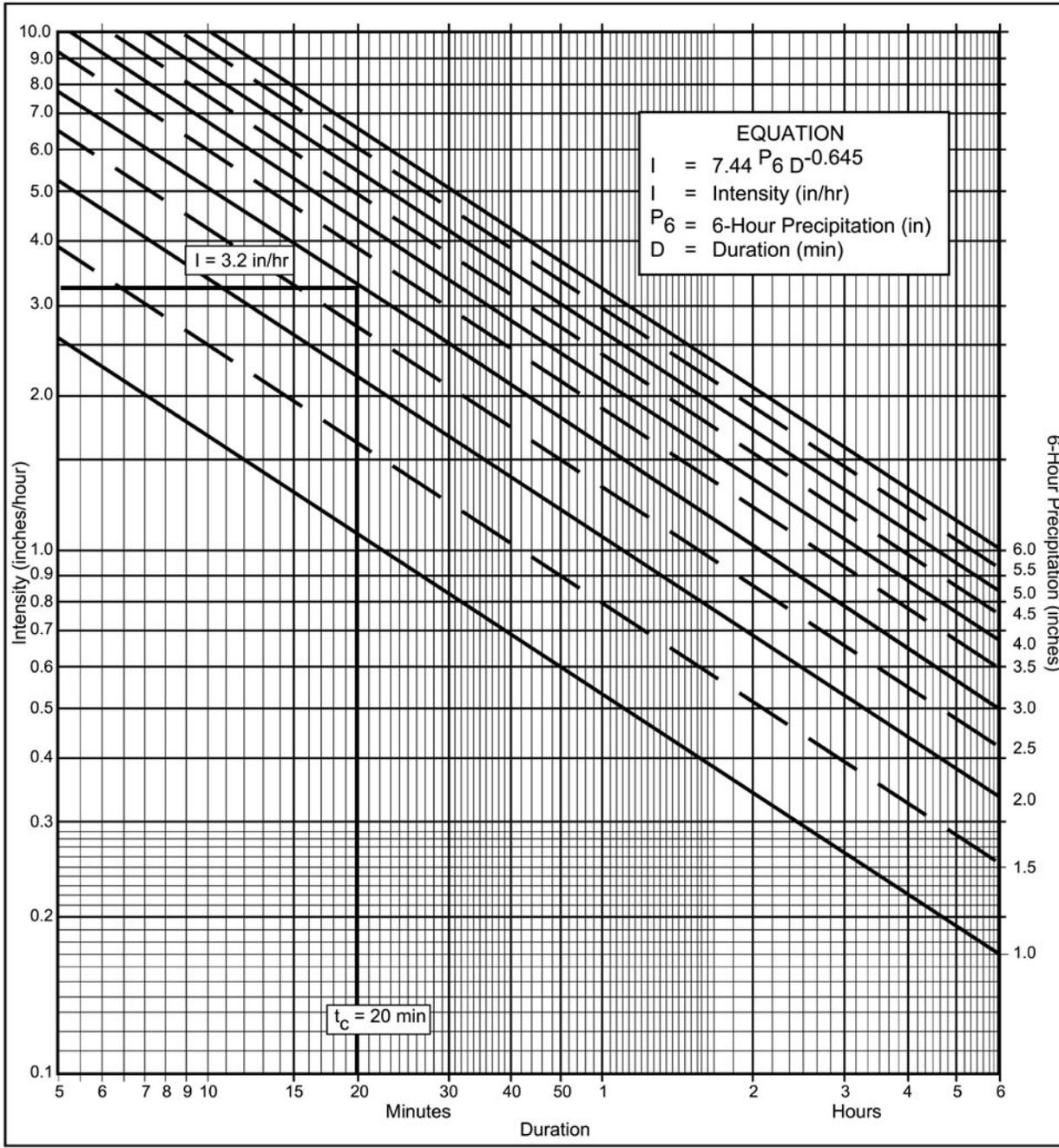
100 Year Rainfall Event - 24 Hours



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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 applicable 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 100 year
- (b) $P_6 = \underline{3.3}$ in., $P_{24} = \underline{6.7}$, $\frac{P_6}{P_{24}} = \underline{49.3}$ %⁽²⁾
- (c) Adjusted $P_6^{(2)} = \underline{n/a}$ in.
- (d) $t_x = \underline{20}$ min.
- (e) $I = \underline{3.2}$ 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 - Example

FIGURE

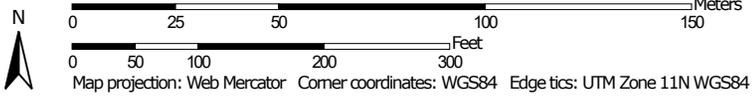
3-2

Hydrologic Soil Group—San Diego County Area, California



Soil Map may not be valid at this scale.

Map Scale: 1:1,820 if printed on A landscape (11" x 8.5") sheet.



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 19, Aug 30, 2023

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

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

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
PeC	Placentia sandy loam, 2 to 9 percent slopes, warm MAAT, MLRA 19	C	6.5	96.7%
VaB	Visalia sandy loam, 2 to 5 percent slopes	A	0.2	3.3%
Totals for Area of Interest			6.7	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

APPENDIX D

Storm Drain Sizing Calculations

Preliminary Storm Drain Size

The purpose of this table is to provide an estimated pipe size to convey the 100-year flow rates with a sizing factor.

Manning's n: 0.013

Sizing Factor (%): 30

Slope at:		1.0%		2.0%	
Q_{100} (cfs ¹)	Q_{100} with Sizing Factor (cfs ¹)	Minimum Pipe Size ² (feet)	Recommended Pipe Size (inches)	Minimum Pipe Size ² (feet)	Recommended Pipe Size (inches)
6.6	8.6	1.39	18"	1.22	18"
6.6	8.6	1.39	18"	1.22	18"

Note:

1. "cfs" = cubic feet per second.
2. Minimum pipe sizes are calculated using the Manning's equation and are based on the flow rates with 30% factor.

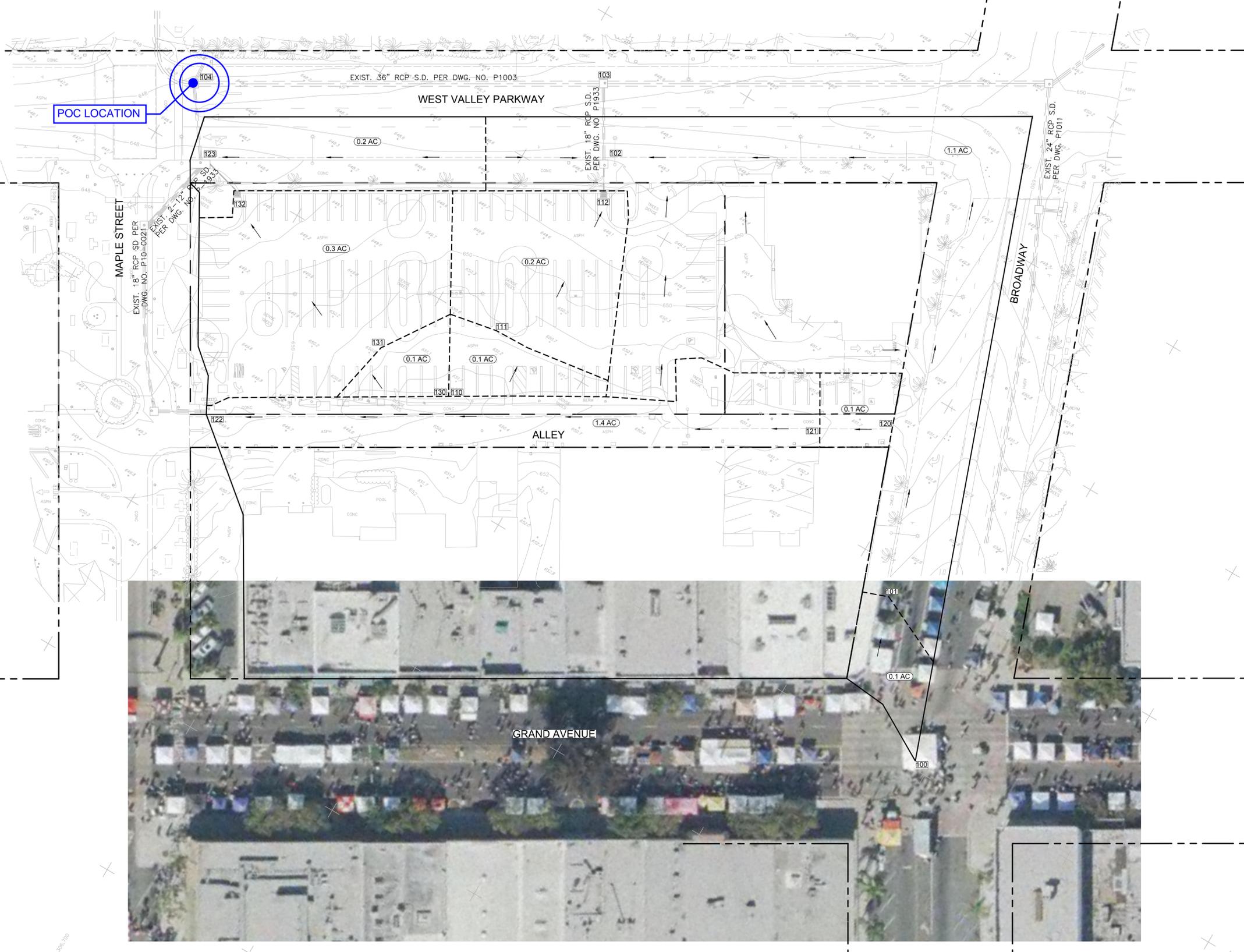
MAP POCKET 1

Drainage Study Map

for

King's Barn

[Pre-Project]

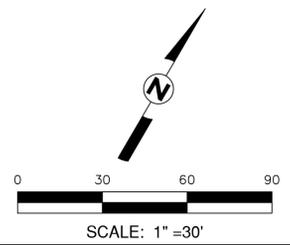


PRE-PROJECT DRAINAGE MAP FROM THE "ASPIRE PRELIMINARY DRAINAGE STUDY", PREPARED BY TOUCHSTONE DEVELOPMENT ON 3/12/2019

NOTE: THE PRE-PROJECT DRAINAGE MAP ONLY CONSIDERS LOCALIZED FLOWS IN PROXIMITY TO OUR PROJECT SITE.

LEGEND

PROPERTY BOUNDARY	---
MAJOR DRAINAGE BOUNDARY	—
MINOR DRAINAGE BOUNDARY	- - -
FLOW DIRECTION	→
NODE NUMBER	100
BASIN AREA	0.1 AC



PRE-PROJECT DRAINAGE MAP FOR ASPIRE

MAP POCKET 2

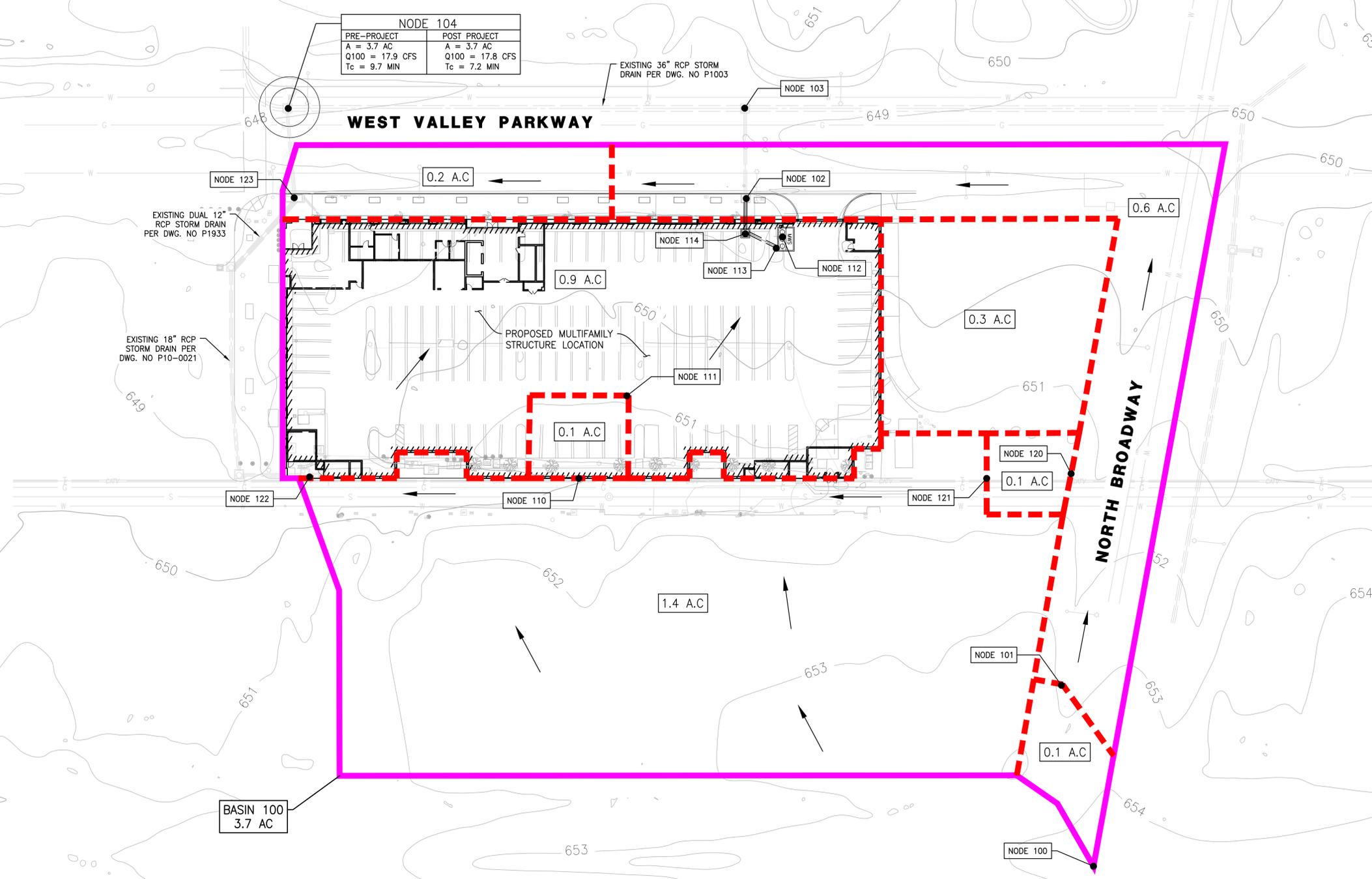
Drainage Study Map

for

King's Barn

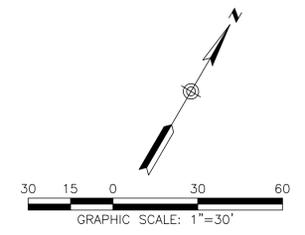
[Post-Project]

NODE 104	
PRE-PROJECT	POST PROJECT
A = 3.7 AC	A = 3.7 AC
Q100 = 17.9 CFS	Q100 = 17.8 CFS
Tc = 9.7 MIN	Tc = 7.2 MIN



LEGEND

- DRAINAGE AREA I.D. BASIN 100
X.X AC
- NODE NUMBER I.D. NODE xxx
- SUBBASIN AREA X.X A.C
- DRAINAGE BOUNDARY [Solid Magenta Line]
- SUBBASIN BOUNDARY [Dashed Red Line]
- POINT OF INTEREST [Circle with Center Dot]
- DRAINAGE FLOW ARROWS [Arrow]



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SAN DIEGO, CA 92110
619.291.0707
rickengineering.com

DRAINAGE EXHIBIT - POST PROJECT
KING'S BARN

PROJECT NO: 20040 SCALE: 1"=30'
DRAWN BY: EJS DATE: 3/29/2024

C:\RICKA\Projects\220000\20040_ValleyParkway\WaterRes\20040 - POST_DRN_EXHIBIT.dwg - plotted by: jsantos ON 2024-03-28 @ 14:58 - c:\bret_rcs_v2.tbl - ©2024 Rick Engineering Company