DRAINAGE STUDY
For
OTAY RANCH TOWN CENTER

City of Chula Vista, California

Prepared for:

Brookfield properties
733 Eighth Avenue
San Diego, CA 92101

W.O. 3553-0002

February 08th, 2023

Hunsaker & Associates
San Diego, Inc.

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President

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STATE OF CALIFORNIA

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CHAPTER 1 - EXECUTIVE SUMMARY

1.1 Introduction

This drainage study has been prepared to assess the existing and re-developed condition peak runoff rates from the proposed Otay Ranch Town Center development for Brookfield Properties. Future drainage report will be prepared for the final engineering to design storm drain system and inlets.

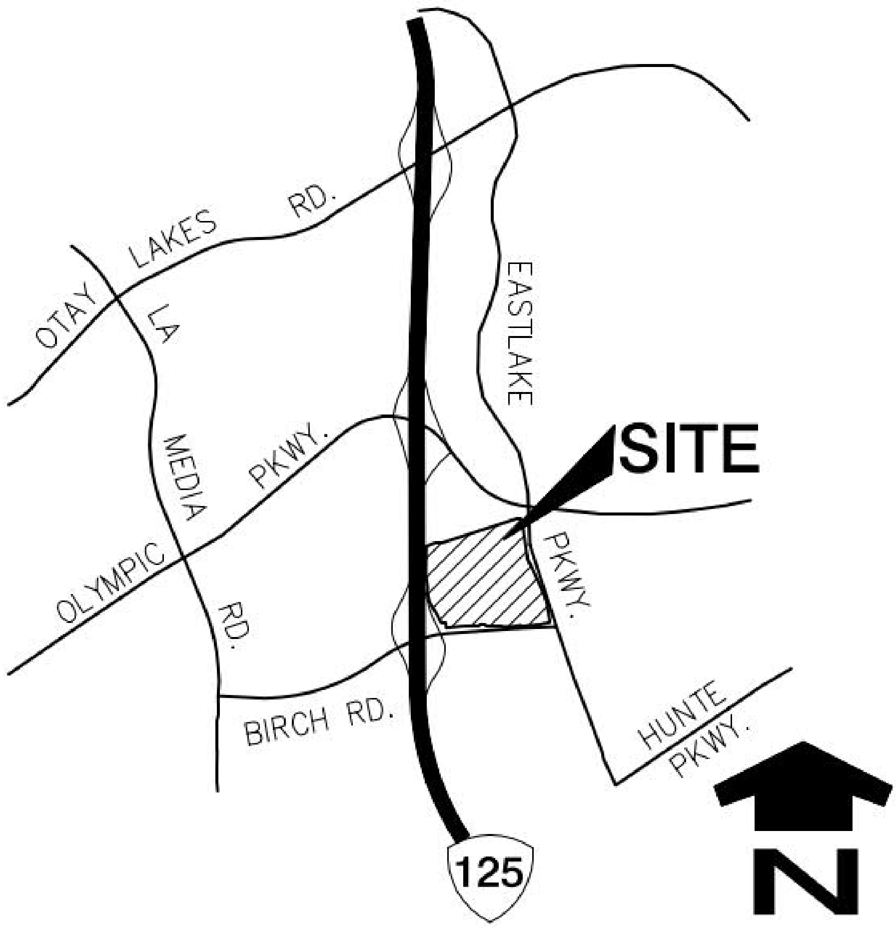
The project site is located in the eastern portion of the City of Chula Vista, California, within the Otay Ranch General Development Plan (GDP) Area. More specifically, the site is located immediately east of State Route 125 (SR-125) between Birch Road and Olympic Parkway (See Vicinity Map below). The site is within the Sectional Planning Area (SPA) known as the Freeway Commercial SPA.

The site in its exiting condition consists of surface parking, driveways, a temporary recreation center and an open space.

The re-development will predominately consist of three residential buildings with maximum of 840 residential units, associated streets, sidewalks and utility infrastructure.

The gross project area is approximately 16.59 acres including all high density residential areas. Due to the imperviousness increase associated with the development, it is anticipated that peak flows generated from the site will increase runoff downstream unless measures are made to mitigate the peak flows. These increases will need to be considered in the projects design and are addressed in this study.

An underground storage vault will be installed to mitigate the peak flows and address flow control (hydromodification) requirements for the re-developed portions of the site. All re-impervious areas constructed throughout the site will route their 85th percentile runoff through the MWS unit (proprietary biofiltration unit) BF-3-1 downstream of the storage vault. A small portion north of 2nd Street, which drains Southerly, will route its 85th percentile runoff through two flow-based MWS units (or equivalent) to address water quality requirements for this portion before discharging into the bypass storm drain. The proposed vault location is south of North Ave at the southwestern portion of the project site.



VICINITY MAP

NOT TO SCALE

Per the Flood Insurance Rate Map No. 06073C-1938G,1939G, 2176G and 2177G the site lies outside the FEMA floodplain boundary. Therefore, a Letter of Map Revision is not required. See Exhibit 3 for an overlay of the site on Flood Insurance Rate Map.

Per the City of Chula Vista drainage criteria, the Modified Rational Method can be used to determine peak design flow rates when the contributing drainage area is less than 1.0-square mile. Since the total watershed area discharging from the Otay Ranch Town Center site is less than 1.0-square mile, the AES-2015 computer software was used to model the runoff response per the Modified Rational Method.

Methodology used for the computation of design rainfall events, runoff coefficients, and rainfall intensity values are consistent with criteria set forth in the most current " "City of Chula Vista Subdivision Manual". A detailed explanation of methodology and model development used for this analysis is listed in Chapter 2 of this report.

1.2 Summary of Existing Conditions

In Existing condition, the Otay Ranch Town Center site generally flows in a southwesterly direction to be picked up by inlets and catch basins. The collected runoff is routed via three storm drain lines running from north to south to join off site of the redeveloped area and discharge to a single connection point to the public storm drain system in Birch Road.

The storm water then is conveyed to the Poggi Canyon Detention Basin for peak storm attenuation, which ultimately discharges into Otay River, 4.5 miles southwest of the study area. Refer to Exhibit 1, Existing Hydrology Map in Chapter 5 for watershed boundary associated with the project area. The watershed area delineated on the map was determined as a means of equally comparing the impact of the proposed re-development with its comparable existing condition at three connecting points to the existing storm drain.

Table 1 below summarizes the 100-year pre-development peak flows from the site in existing condition. A runoff coefficient of 0.9, 0.65 and 0.3 per the City of Chula Vista Subdivision Manual. These coefficients correspond respectfully paved area, barren slope flat for the western open area, and parks for the temporary recreation area.

TABLE 1 - Summary of Pre-Developed Flows to the Poggi Canyon

Discharge Location	Node #	Drainage Area (ac)	100-Year Peak Flow (cfs)	Tc (min)
Point of Connection to the western storm drain	17	11.02	32.07	8.85
Point of Connection to the Central storm drain	9	3.40	12.63	8.29
Point of Connection to the eastern storm drain	12	2.93	10.94	8.76

Supporting calculations for the data presented in Table 1 are located in Chapter 3 of this report. The corresponding hydrology map is Exhibit 1 in Chapter 9.

1.3 Summary of Developed Conditions

Runoff from the Otay Ranch Town Center in its re-developed condition will be collected within the proposed storm drain system, which will rout the runoff to the proposed vault and mitigate the peak flow to meet existing conditions and then connect to the existing storm drain.

See Exhibit 2, Proposed Condition Hydrology Map in Chapter 5. For water quality and hydromodification discussion and calculations, please reference the *Priority Development Project (PDP) Storm Water Quality Management Plan (SWQMP) for Otay Ranch Town Center* dated February, 2022 prepared by Hunsaker & Associates San Diego Inc.
In general, runoff from the developed site will drain south towards North Ave. Inlets placed throughout the site will collect the runoff and the storm drain will convey it towards the storm drain system. This storm drain system will convey flows to the proposed vault located south of North Ave.

Table 2 below summarizes the 100-year developed condition peak flows at the location of the connecting points to the existing storm. Runoff coefficients assumed 0.9 for the paved roads, 0.75 for dense residential per the City of Chula Vista Subdivision Manual.

TABLE 2 - Summary of Developed Flows to Otay River

Discharge Location	Node #	Drainage Area (ac)	100-Year Peak Flow (cfs)	Tc (min)
Point of Connection to the western storm drain	20	14.82	37.14	14.43
Point of Connection to the Central storm drain	6	0.36	1.32	8.42
Point of Connection to the eastern storm drain	23	2.20	8.08	9.29

Supporting calculations for the information presented in Table 2 is located in Chapter 3 and 4 of this report. The corresponding hydrology map is Exhibit 2 in Chapter 5.

1.4 Results & Recommendations

Table 3 summarizes the effects of site development at the receiving Otay River.

TABLE 3 - Summary of Pre vs. Post-Developed Flows from Otay Town Center

	PRE-DEVELOPED			POST-DEVELOPED			DIFFERENCE	
Discharge Location	**Node #**	**Drainage Area (ac)**	**100-Year Peak Flow (cfs)**	**Node #**	**Drainage Area (ac)**	**100-Year Peak Flow (cfs)**	**Area (ac)**	**100-Year Peak Flow (cfs)**
Point of Connection to the western storm drain	17	11.02	32.07	20	14.82	37.14 UNATT 21.62 ATT	+3.80	-10.45
Point of Connection to the Central storm drain	9	3.40	12.63	6	0.36	1.32	-3.04	-11.28
Point of Connection to the eastern storm drain	12	2.93	10.94	23	2.20	8.08	-0.73	-2.86
Total*		**17.35**	**55.64**		**17.38**	**32.79**	**0**	**-24.59**

*The collected runoff from the three storm drain lines discharge to a single connection point to the public storm drain system in Birch Road.

Development of Otay Ranch Town Center results in the net decrease of runoff considering the effect of the proposed detention vault.

Since the flows have been reduced for these subareas, existing flow velocities should not be exceeded once the site has been developed. Therefore, erosion is not expected at the downstream points of these subareas.

Summary:

- Drainage facilities within the site will be designed in accordance with the requirements of the Chula Vista Subdivision Manual, the San Diego County Hydrology Manual and the requirements of the San Diego Regional Water Quality Control Board.

- Development of the project site will not further degrade potential beneficial uses of downstream water bodies as designated by the Regional Water Quality Control Board, including water bodies listed on the Clean Water Section 303d list.

References

City of Chula Vista Subdivision Manual; Engineering Department and Land Development; Section 3-200, March 13, 2012

San Diego County Hydrology Manual; County of San Diego Department of Public Works Flood Control Division, June 2003

Hydromodification Management Plan prepared for County of San Diego, California, March 2015

Priority Development Project (PDP) Storm Water Quality Management Plan (SWQMP) for Otay Ranch Town Center prepared by Hunsaker and Associates, San Diego Inc., July 2022.

"Order No. R9-2013-0001, NPDES No. CAS0109266 – Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer Systems (MS4s) Draining the Watersheds of the County of San Diego, the Incorporated Cities of San Diego County, San Diego Unified Port District and the San Diego County Regional Airport Authority", California Regional Water Quality Control Board – San Diego Region.

CHAPTER 2 - METHODOLOGY

2.1 - Rational Method Model Development Summary

Computer Software Package – AES-2015

Design Storm – 50 -Year

Land Use – Multi Family

Soil Type - Hydrologic soil group D was assumed for all areas. Group D soils have very slow infiltration rates when thoroughly wetted. Consisting chiefly of clay soils with a high swelling potential, soils with a high permanent water table, soils with clay pan or clay layer at or near the surface, and shallow soils over nearly impervious materials, Group D soils have a very slow rate of water transmission.

Runoff Coefficient – In accordance with the City of Chula Vista Subdivision Manual, a runoff coefficient of 0.90 was used for fully paved areas, 0.75 for the Multi-Family Sites and dense residential, 0.65 for the barren slopes flat, 0.35 for proposed open space, and 0.30 for parks.

Method of Analysis – The Rational Method is the most widely used hydrologic model for estimating peak runoff rates. Applied to small urban and semi-urban areas with drainage areas less than 1.0 square mile, the Rational Method relates storm rainfall intensity, a runoff coefficient, and drainage area to peak runoff rate. This relationship is expressed by the equation:

Q = CIA, where:

Q = The peak runoff rate in cubic feet per second at the point of analysis.

C = A runoff coefficient representing the area - averaged ratio of runoff to rainfall intensity.

I = The time-averaged rainfall intensity in inches per hour corresponding to the time of concentration.

A = The drainage basin area in acres.

To perform a node-link study, the total watershed area is divided into subareas which discharge at designated nodes.

The procedure for the subarea summation model is as follows:

(1) Subdivide the watershed into an initial subarea (generally 1 lot) and subsequent subareas, which are generally less than 10 acres in size. Assign upstream and downstream node numbers to each subarea.

(2) Estimate an initial T_c by using the appropriate nomograph or overland flow velocity estimation.

(3) Using the initial T_c, determine the corresponding values of I. Then Q = C I A.

(4) Using Q, estimate the travel time between this node and the next by Manning's equation as applied to the particular channel or conduit linking the two nodes. Then, repeat the calculation for Q based on the revised intensity (which is a function of the revised time of concentration)

The nodes are joined together by links, which may be street gutter flows, drainage swales, drainage ditches, pipe flow, or various channel flows. The AES-2010 computer subarea menu is as follows:

SUBAREA HYDROLOGIC PROCESS

1. Confluence analysis at node.
2. Initial subarea analysis (including time of concentration calculation).
3. Pipeflow travel time (computer estimated).
4. Pipeflow travel time (user specified).
5. Trapezoidal channel travel time.
6. Street flow analysis through subarea.
7. User - specified information at node.
8. Addition of subarea runoff to main line.
9. V-gutter flow through area.
10. Copy main stream data to memory bank
11. Confluence main stream data with a memory bank
12. Clear a memory bank

At the confluence point of two or more basins, the following procedure is used to combine peak flow rates to account for differences in the basin's times of concentration. This adjustment is based on the assumption that each basin's hydrographs are triangular in shape.

(1). If the collection streams have the same times of concentration, then the Q values are directly summed,

$$Q_p = Q_a + Q_b;\ T_p = T_a = T_b$$

(2). If the collection streams have different times of concentration, the smaller of the tributary Q values may be adjusted as follows:

(i). The most frequent case is where the collection stream with the longer time of concentration has the larger Q. The smaller Q value is adjusted by the ratio of rainfall intensities.

$$Q_p = Q_a + Q_b \ (I_a/I_b);\ T_p = T_a$$

(ii). In some cases, the collection stream with the shorter time of concentration has the larger Q. Then the smaller Q is adjusted by a ratio of the T values.

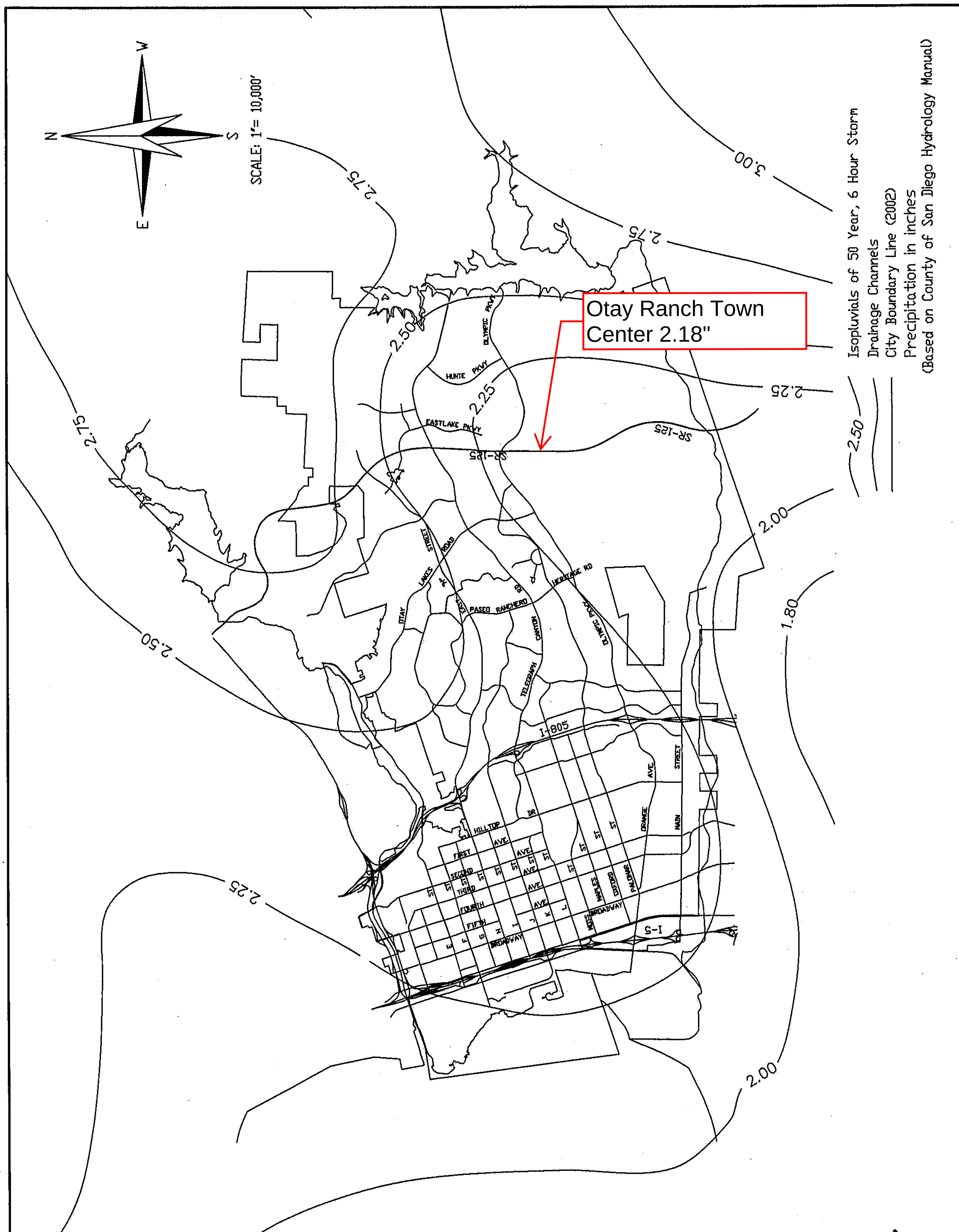
$$Q_p = Q_b + Q_a \ (T_b/T_a);\ T_p = T_b$$

CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.2 – Design Rainfall Determination

50-Year, 6-Hour Rainfall Isopluvial Maps from City of Chula Vista Design Standards – CVDS Storm Drain Design



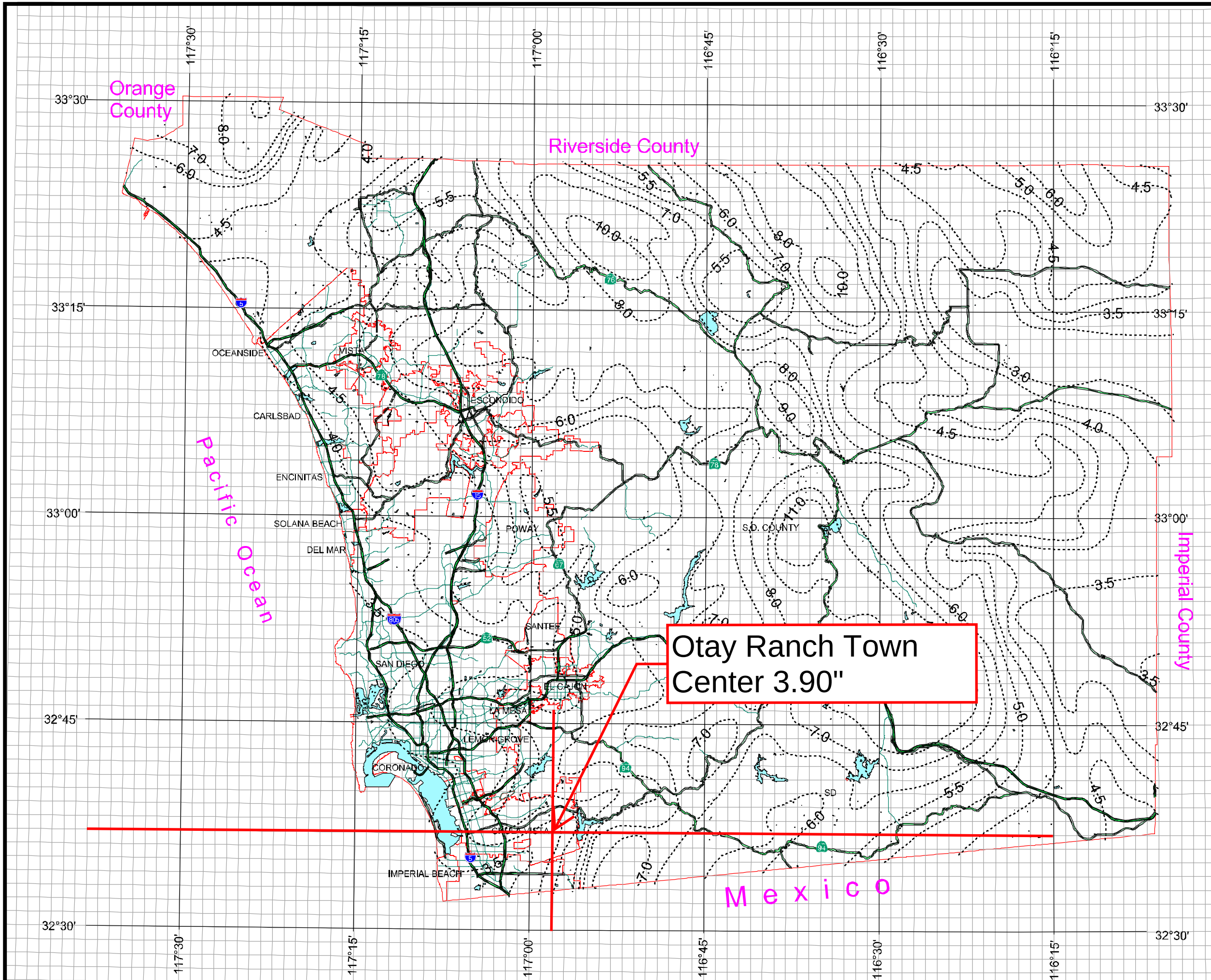
REVISION	BY	APPROVED	DATE
ORIGINAL			01/02
REVISION	CVM	C. SWANSON	11/02
REVISION	DPH	W. VALLE	11/17

CITY OF CHULA VISTA
ENGINEERING & CAPITAL PROJECTS
STANDARD DRAWING

50–YEAR, 6–HOUR PRECIPITATION

WILLIAM S. VALLE 11/21/2017
CITY ENGINEER

DRN–03



County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 24 Hours

Isopluvial (inches)

DPW GIS
Department of Public Works Geographic Information Services

SanGIS
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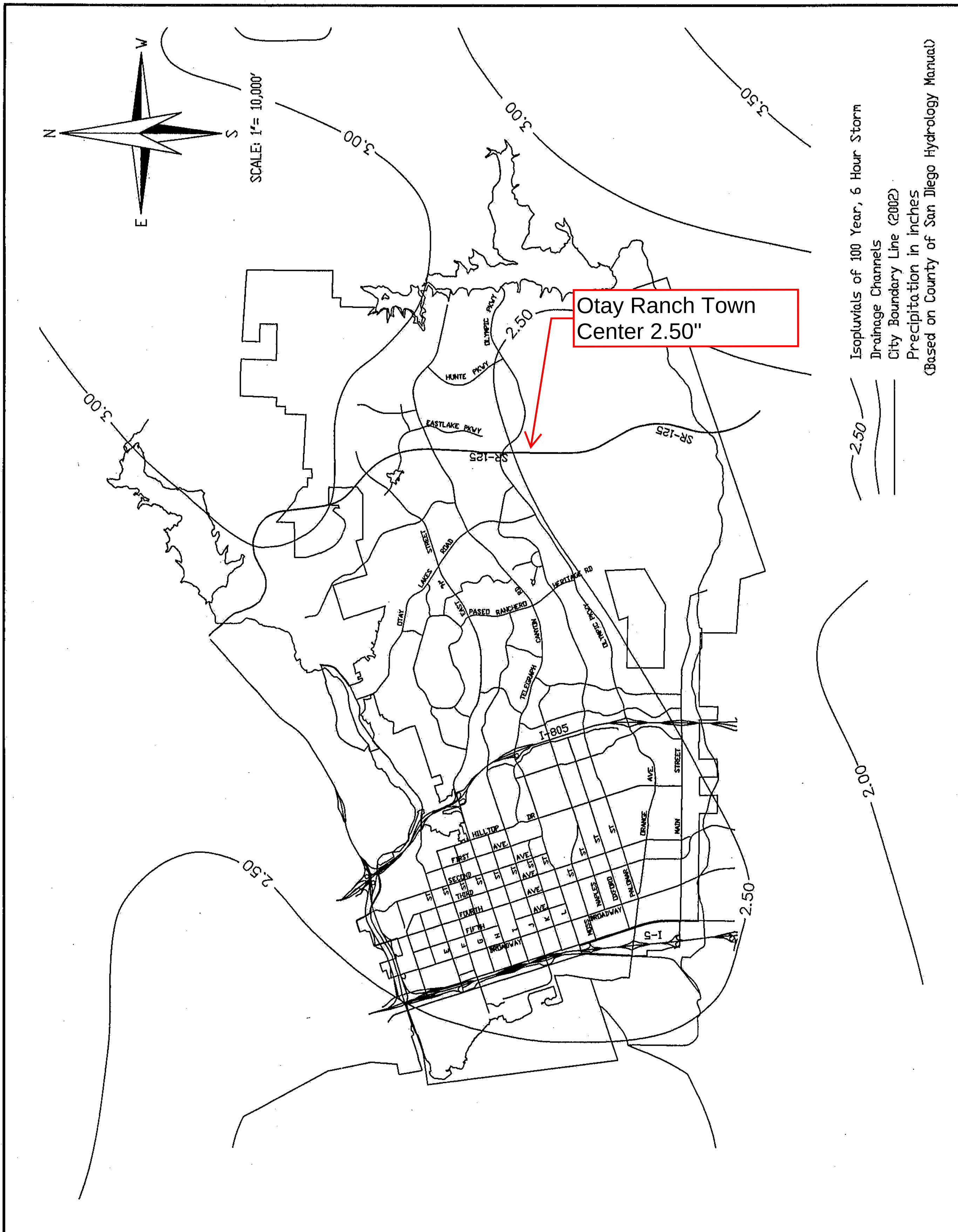
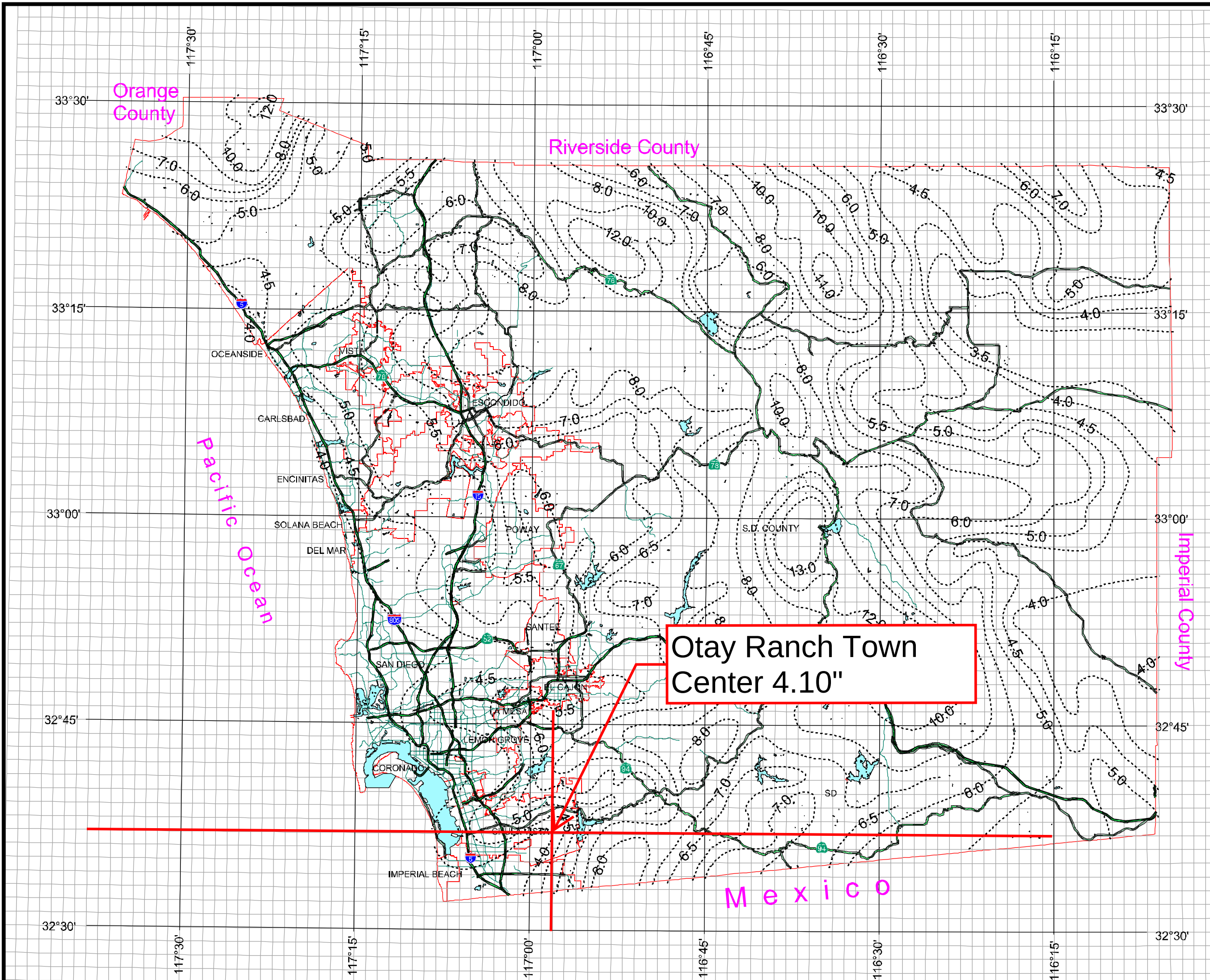
N S W E

3 0 3 Miles



REVISION	BY	APPROVED	DATE	CITY OF CHULA VISTA ENGINEERING & CAPITAL PROJECTS STANDARD DRAWING	WILLIAM S. VALLE 11/21/2017 CITY ENGINEER
ORIGINAL			01/02		
REVISION	CVM	C. SWANSON	11/02		
REVISION	DPH	W. VALLE	11/17	100-YEAR, 6-HOUR PRECIPITATION	DRN-04



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

DPW GIS
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CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.3 – Runoff Coefficient Determination

3-203.3 Rational and Modified Rational Methods

(1) The rational method equation relates storm rainfall intensity (I), a selected runoff coefficient (C) and drainage area (A) to the peak runoff rate (Q):

$$Q = CIA \text{ (Empirical Units)}$$

where:

Q = Peak runoff in cubic feet per second
C = Runoff coefficient
I = Intensity, inches per hours
A = Drainage basin area in acres

Or

$$Q=0.278CIA \text{ (Metric Units)}$$

where:

Q = Peak runoff in cubic meters per second
C = Runoff coefficient
I = Intensity in millimeters per second
A = Drainage area in square kilometers

(2) Coefficient of Runoff: Consider probable development. Use highest number of the following values:

a)	Paved Surface	0.90
b)	Commercial Area	0.85
c)	Dense Residential (R2, R3)	0.75
d)	Normal Residential (R1)	0.65
e)	Suburban Property (RE)	0.55
f)	Barren Slopes Steep	0.80
g)	Barren Slopes Hilly	0.75
h)	" " Rolling	0.70
i)	" " Flat	0.65
j)	Vegetated Slopes Steep	0.60
k)	" " Hilly	0.55
l)	" " Rolling	0.50
m)	" " Flat	0.45
n)	Farm Land	0.35
o)	Parks, Golf Courses	0.30

NOTES:

Steep =	Steep, rugged terrain with average slopes generally above 30%.
Hilly =	Hilly terrain with average slopes of 10% to 30%.
Rolling =	Rolling terrain with average slopes of 5% to 10%.
Flat =	Relatively flat land, with average slopes of 0% to 5%.
Composite =	Where drainage areas are composed of parts having different runoff characteristics, a weighted coefficient for the total drainage area may be used.

AES INPUT DATA

Node #			Area (ac)		imperviousness	C value	
From	To	code	total	impervious			
1	2	2	0.10	0.06	57.93%	0.67	*
2	3	6	0.29	0.23	80.77%	0.79	*
3	4	3					*
5	4	8	0.26	0.26	100.00%	0.90	*
4	9	3					
9	9	1					
6	7	2	0.10	0.07	65.64%	0.71	*
7	8	6	2.65	2.19	82.64%	0.80	*
8	9	3					
9	9	1					
							*
10	11	2	0.10	0.05	53.80%	0.65	*
11	12	6	2.83	2.41	85.16%	0.82	
13	14	2	0.09	0.09	100.00%	0.90	
14	17	6	5.86	5.16	88.05%	0.83	*
15	17	8	3.64		0.00%	0.30	Park (temporary recreation area)
16	17	8	1.43		0.00%	0.65	Baren Slope Flat
Total Area			17.35	10.52	60.64%		

*The runoff coeffecient for the subarea is a composite coeffecient made of the differnet runoff coefficients for the surfaces of the subarea (0.9 for paved area, 0.3 for the landscaped area(park)) per equation:

C =(C1 x A1 + C2x A2)/ A

Impervious 10.52

AES INPUT DATA							
Node #			Area (ac)		imperviousness	C value	
From	To	code	total	impervious			
1	2	2	0.10	0.06	62.25%	0.69	*
2	3	6	2.08	1.06	50.95%	0.63	*
3	7.3	3					
7	7.3	8	0.44	0.42	95.45%	0.88	
7.3	10	3					
11	10	8	3.45	2.53	73.35%	0.75	Dense Residential
10	12	3					
12	12	1					
8	9	2	0.06	0.04	73.21%	0.75	*
9	12	6	0.81	0.63	77.89%	0.78	*
12	12	1					
12	14	3					
13	14	8	2.66	1.88	70.67%	0.75	Dense Residential
14	15	3					
15	15	10					
17	18	2	0.10	0.05	50.59%	0.63	*
18	19	6	1.46	1.18	80.82%	0.79	*
16	19	8	3.66	2.92	79.90%	0.75	Dense Residential
19	15	3					
15	15	11					
15	15	12					
15	20	3					
Area to Vault			14.82	10.78	72.76%	0.7165	**
4	5	2	0.04	0.03	74.19%	0.76	*
5	6	6	0.32	0.25	78.52%	0.78	*
21	22	2	0.10	0.05	53.80%	0.65	*
22	23	6	2.10	1.87	88.87%	0.84	*
Area not to vault			2.56	2.20	85.98%	#REF!	
Total Area			17.38	13.93	70.84%		

*The runoff coeffecient for the subarea is a composite coeffecient made of the differnet runoff coefficients for the surfaces of the subarea (0.9 for paved area, 0.3 for the landscaped area(park)) per equation:

C =(C1 x A1 + C2x A2)/ A

** Weighted C value = (Ci x Ai)/ tota A

CHAPTER 2

METHODOLOGY & MODEL DEVELOPMENT

2.4 – Rainfall Intensity Determination

-Maximum Overland Flow Length & Initial Time of Concentration

-Urban Watershed Overland Time of Flow Nomograph

-Gutter & Roadway Discharge-Velocity Chart

- Manning's Equation Nomograph

-Intensity-Duration Design Chart

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

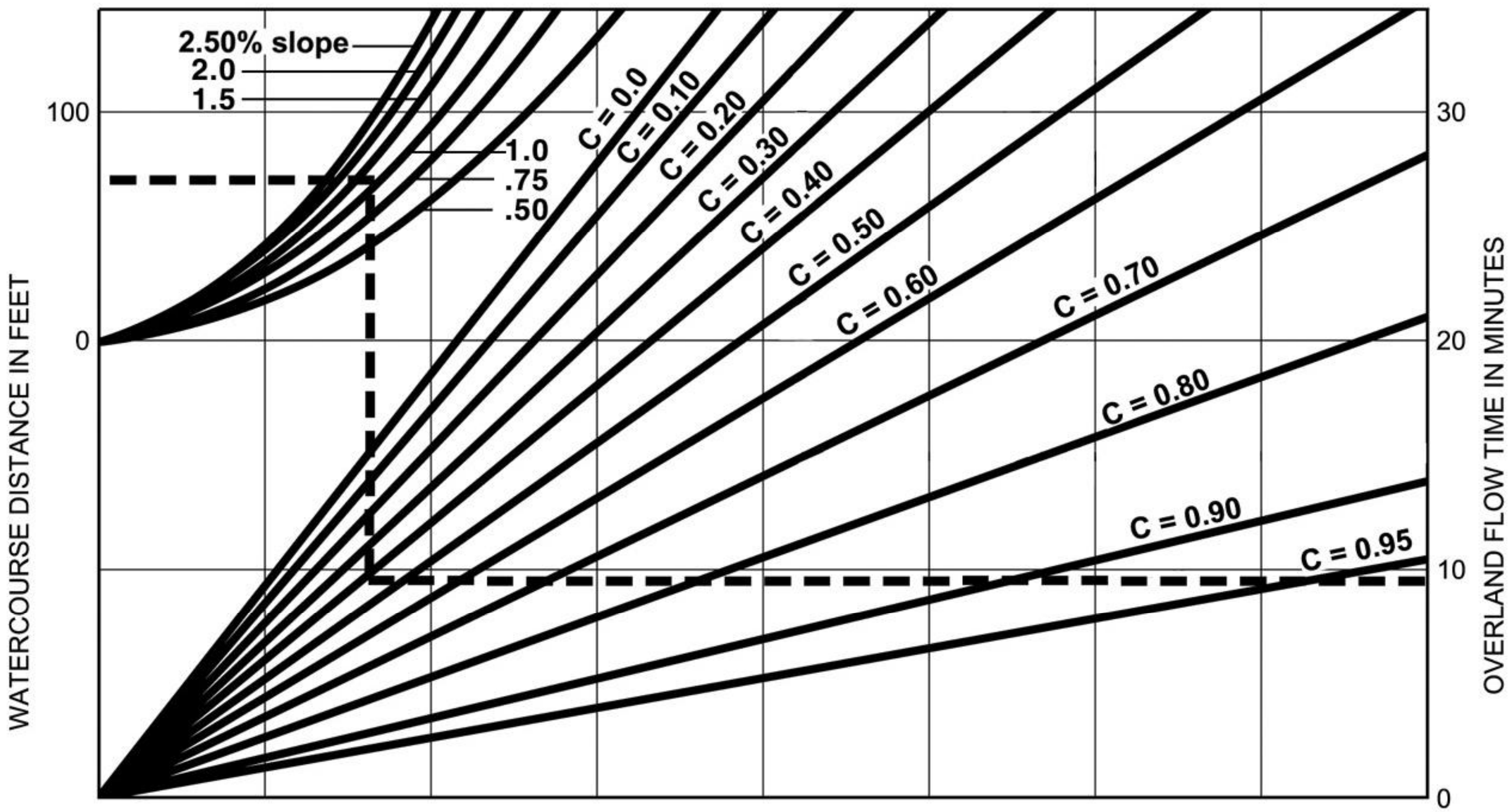
Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved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

Table 3-2

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

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

*See Table 3-1 for more detailed description



EXAMPLE:

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

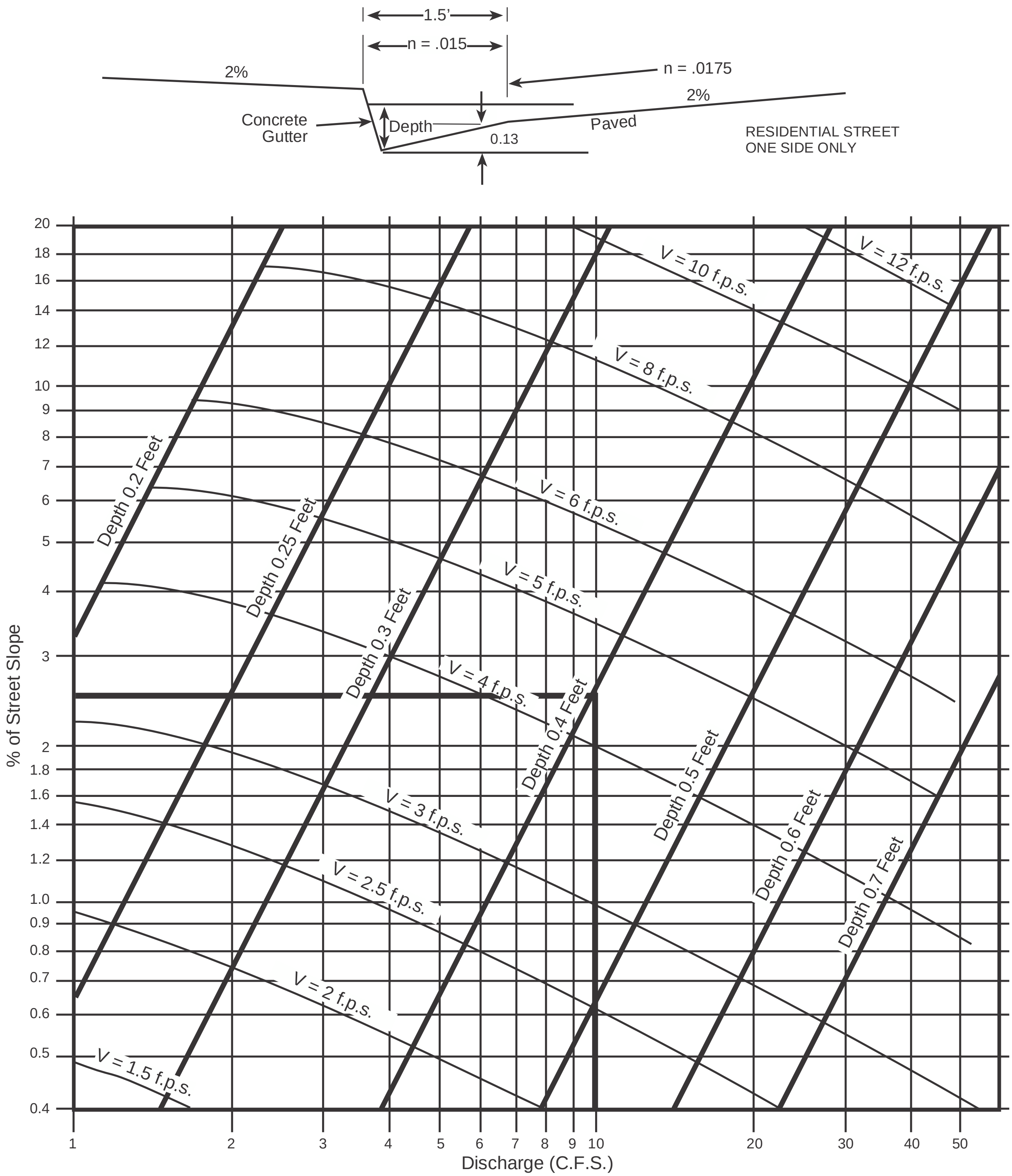
$$T = \frac{1.8\,(1.1\text{-}C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE

3-3

Rational Formula - Overland Time of Flow Nomograph



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

FIGURE 3-6

Gutter and Roadway Discharge - Velocity Chart

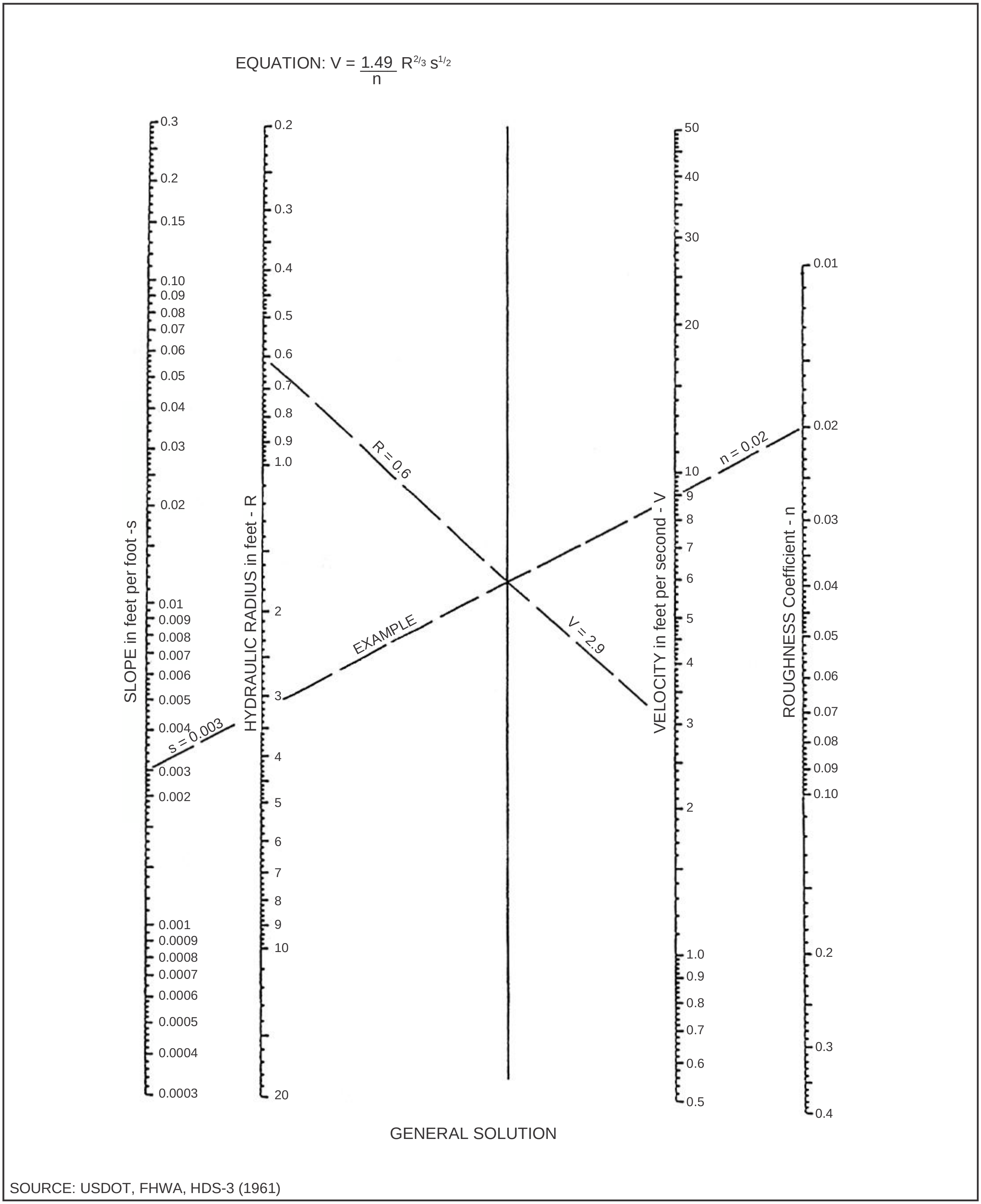
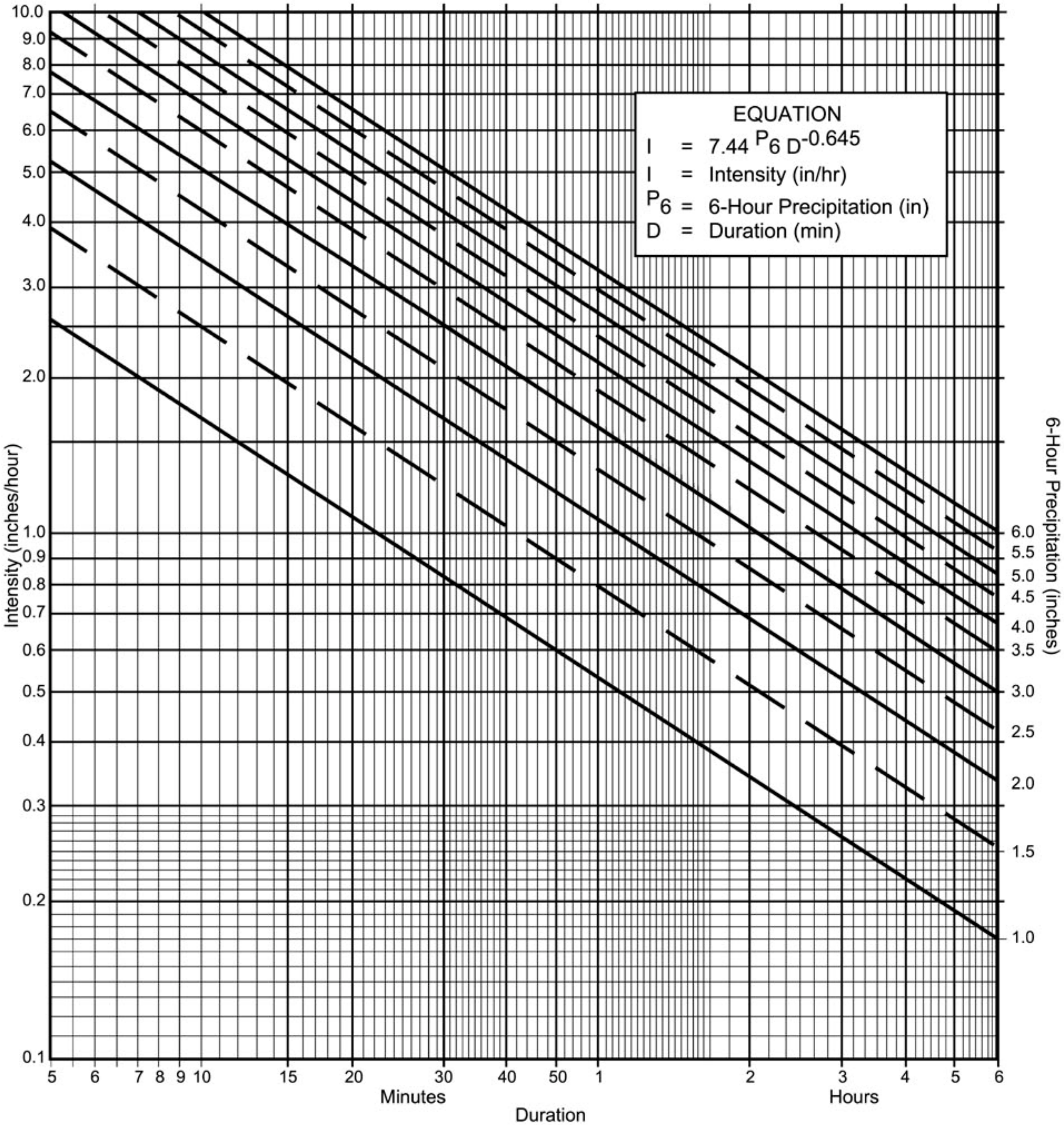


FIGURE 3-7

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 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 50 year

(b) P_6 = 2.18 in., P_{24} = 3.90, $\frac{P_6}{P_{24}} = \frac{2.18}{3.90}$ %[(2)] 56%

(c) Adjusted P_6[(2)] = 2.18 in.

(d) t_x = _______ min.

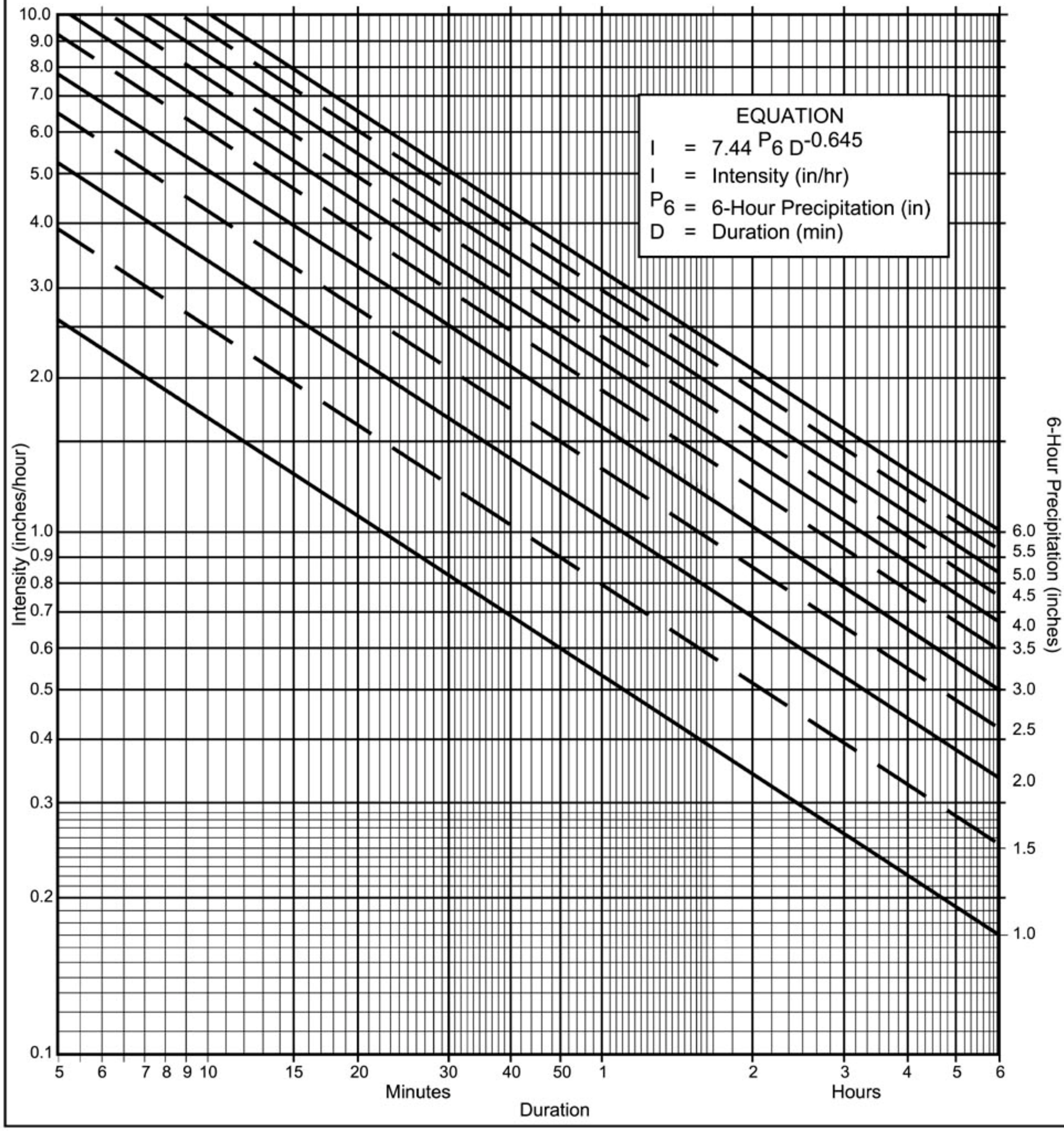
(e) I = _______ in./hr.

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



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 = 2.50 in., P_{24} = 4.10 , $\frac{P_6}{P_{24}}$ = $\frac{2.50}{4.10}$ %[(2)] 61%

(c) Adjusted P_6[(2)] = 2.50 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

GENERAL DESIGN CRITERIA
SECTION 3-200
HYDROLOGY/DRAINAGE/URBAN RUNOFF

3-200 HYDROLOGY/DRAINAGE/URBAN RUNOFF

3-201 General

This section establishes design criteria and procedures to be followed in the design of storm drain facilities.

3-201.1 Definitions

(1) Major Drainage Channel or System - A channel which drains an area in excess of 750 acres (3km2).

(2) Lateral Drainage Channel or System - A channel which drains an area in excess of 100 acres (0.40km2) but less than 750 (3km2) acres and empties into a major channel.

(3) Local Drainage Channel or System - A drainage system which collects local runoff from an area of less than 100 acres (0.40km2) and transports water to a lateral or major system.

(4) Drainage Channel or System - An open or closed conduit, improved or unimproved, designed for the purpose of collecting and transporting storm water runoff in such manner as to protect public and private property.

(5) Drainage Structure - A catch basin, outlet, inlet, headwall, spillway, energy dissipater, junction box, cleanout box, diversion box, etc., in a drainage channel or closed conduit system.

(6) Design Storm - A storm of a magnitude that may be expected to occur once during a specified number of years and resulting in the maximum storm water runoff to be anticipated once during that specified number of years.

(7) Dry Lane - A minimum street width that shall not be inundated at all times during a given design storm.

3-201.2 General Responsibility for Drainage Facilities - The developer of a proposed subdivision is required to:

(1) Accept any drainage entering a proposed subdivision and to provide adequate drainage facilities to convey all drainage on the property to discharge into, or connect to, the drainage facility into which the drainage would naturally flow;

(2) Provide on-site storm detention facilities such that the post-development flow rate for a given design storm does not exceed the pre-development flow rate at the outlet of the subdivision;

(3) Provide on-site erosion protection and desilting facilities

(4) Provide bonds for the cost of design and construction of any drainage facilities, including but not limited to off-site easements or facilities, necessary to accomplish these responsibilities.

(5) Provide all graded pads with adequate drainage facilities as approved by the City Engineer.

(6) Submit plans for all private storm drain systems for review and approval by the City Engineer.

3-201.3 Design Flows. Storm drain facilities shall be designed to convey design flows as follows:

(1) All major drainage channels shall be designed to discharge a 100-year ultimate storm, without static head;

(2) Lateral channels shall be designed to discharge a 50-year storm without static head at entrances and a 100-year ultimate storm utilizing available head without causing any damage to surrounding property;

(3) Local channels and drainage facilities within street right of ways shall be designed to discharge a 50-year storm utilizing available head without causing any property damage

(4) All storm drainage systems shall be designed so that the combination of the underground storm drain capacity and street overflow without dry-lane limitations shall convey the 100-year storm event without property damage. For tidally influenced areas the tail water assumed for this calculation shall be 16 inches higher than the highest high tide.

(5) Where a sump condition exists and excess runoff has no alternate route, special design shall be required for the protection of property.

(6) At all major intersections (with major, prime or expressways), surface drainage shall be fully intercepted by properly sized inlets. All inlets adjacent to major intersections shall be designed to intercept a 50-year storm event.

3-202 Hydrologic/Drainage/Urban Runoff Reports

Hydrology and/or drainage reports shall be submitted as required per this manual. Reports shall include the following:

3-202.1 A suitable and recent topographic map that shows the following:

(1) On-site drainage maps at a minimum scale of 1"=100' (1cm=10m)

(2) Off-site drainage maps scales may vary depending on the size of the drainage area covered by the map.

(3) Shows appropriate contours on the map for the drainage on-site and extending beyond the subdivision boundary to indicate the drainage pattern.

(4) Indicate the existing basin boundaries and existing drainage facilities.

(5) Show proposed subdivision layout, proposed drainage systems, and proposed basin layout.

(6) Show quantity of flow and time of concentration at each inlet, outlet, interceptor, point of concentration or confluence points.

(7) All drainage area labels, points of concentration labels and system designations shall be shown in the logical order corresponding to the attached calculations.

(8) Indicate all crests, sags and street intersections with flow arrows.

(9) Compare pre-development and post-development flow rates for a given design storm at the outlet(s) of the subdivision.

(10) To mitigate runoff due to development, show on-site regional detention/desilting facilities that act as treatment control structural Best Management Practices (BMPs). Temporary and permanent detention/desilting facilities shall be shown on the plans.

3-202.2 Report Calculations

(1) Hydrology studies shall use appropriate methods and show in detail the determination of basin areas, basin flows, time of concentration, and all assumptions and physical data

(2) Hydraulic studies shall show that all conduits, channels and appurtenances are adequate to handle design flows. Studies shall include entrance and exit conditions, head losses, design flows and velocities, critical depth, scouring and silting velocities, energy and hydraulic gradient lines.

(3) Hydraulic studies shall also include a profile plot for all proposed channels showing channel flow line and water surface profile and hydraulic gradient line for the design-year storm event.

(4) Detention basin calculations shall include inflow and outflow hydrographs developed using an acceptable modeling procedure.

(5) Erosion control calculations shall show that silt and debris generation will be contained on-site using proposed measures including desilting and sedimentation basins.

3-203 Hydrology

Developers draining to a river or stream will be required to use the latest adopted County Hydrology Manual to determine the flows expected at a given frequency (Q10, Q50 Q100, etc,) Infill developments will use the following Hydrology requirements. The City Engineer will determine which projects may be considered "infill" projects.

3-203.1 Previously Approved Reports

Runoff quantities; as set forth or derived from the report prepared by Lawrence, Fogg, Florer and Smith titled "A Special Study of Storm Drain Facilities" on file in the office of the City Engineer may be used in the design of drainage facilities in Chula Vista. A hydrologic study prepared and approved at General Development Plan (GDP) or Specific Planning Area (SPA) plan may be used as determined by the City Engineer.

3-203.2

For local drainage basins, storm discharge flow may be estimated based on the Rational Method or the Modified Rational Method. For all lateral and major drainage basins the SCS method, U.S. Army Corps of Engineers HEC-1 computer method or other tabular or computer method may be used upon City Engineer approval.

3-203.3 Rational and Modified Rational Methods

(1) The rational method equation relates storm rainfall intensity (I), a selected runoff coefficient (C) and drainage area (A) to the peak runoff rate (Q):

$$Q = CIA \text{ (Empirical Units)}$$

where:

Q = Peak runoff in cubic feet per second
C = Runoff coefficient
I = Intensity, inches per hours
A = Drainage basin area in acres

Or

$$Q=0.278CIA \text{ (Metric Units)}$$

where:

Q = Peak runoff in cubic meters per second
C = Runoff coefficient
I = Intensity in millimeters per second
A = Drainage area in square kilometers

(2) Coefficient of Runoff: Consider probable development. Use highest number of the following values:

a)	Paved Surface	0.90
b)	Commercial Area	0.85
c)	Dense Residential (R2, R3)	0.75

d)	Normal Residential (R1)	0.65
e)	Suburban Property (RE)	0.55
f)	Barren Slopes Steep	0.80
g)	Barren Slopes Hilly	0.75
h)	" " Rolling	0.70
i)	" " Flat	0.65
j)	Vegetated Slopes Steep	0.60
k)	" " Hilly	0.55
l)	" " Rolling	0.50
m)	" " Flat	0.45
n)	Farm Land	0.35
o)	Parks, Golf Courses	0.30

NOTES:

- Steep = Steep, rugged terrain with average slopes generally above 30%.
- Hilly = Hilly terrain with average slopes of 10% to 30%.
- Rolling = Rolling terrain with average slopes of 5% to 10%.
- Flat = Relatively flat land, with average slopes of 0% to 5%.
- Composite = Where drainage areas are composed of parts having different runoff characteristics, a weighted coefficient for the total drainage area may be used.

The runoff coefficient for a basin should be a composite coefficient made of the many different runoff coefficients for the sub-areas of the basin per equation:

$$\frac{CA_T = C_1A_1 + C_2A_2 + \ldots CnAn}{n}$$

(3) Time of Concentration (t_c = minutes) is the time required for runoff to flow from the most remote part of the watershed to the outlet point under consideration. With exceptions for limited natural watersheds, the time of concentration shall be calculated as follows:

a) $t_c = t_i + t_f$ where:

t_i = Initial time or overland flow time of concentration, the time required for runoff to flow to the first inlet or to the street gutter

t_f = Travel time of concentration, the time required for runoff to flow within street gutters to inlets, with channels or within storm drain pipes.

b) t_i may be calculated using the following natural watershed flow formula:

$$t_i = 60x\,[(11.9L^3)/H]^{0.385}$$

L = Length of water shed (miles)

H = Difference in elevation from furthermost point to the design point (feet).

If computed t_i is:	Add
Less than 5 Minutes	6 Minutes
5-10 Minutes	5 Minutes
11-15 Minutes	Use 15 Minutes
Greater than 15 Minutes	0 Minutes

NOTE: Add minutes only when using this formula.

c) or, t_i may be calculated using the following flow formula for developed areas with overland flow:

$$t_i = \frac{1.8(1.1-C)\sqrt{D}}{\sqrt{S}}$$ (in minutes)

D = Length of watercourse (feet)
S = Slope (percent)
C = Runoff coefficient

d) For limitations in using these formulas, refer to the San Diego County Hydrology Manual.

(4) **Intensity of Rainfall** (I = inches/hr.) – The rainfall intensity (I) can be calculated using the following equation:

$I = 7.44\, P_6\, D^{-0.645}$
P_6 = adjusted 6-hour storm precipitation (If P6 is not within 45% to 65% of P24, increase or decrease P6 as necessary to meet this criteria.)
D = duration in minutes (use tc)

Note: (1) This equation applies only to the 6-hour storm.
(2) The 24-hour isopluvials are available from the County. The 6-hour isopluvials are in Chula Vista Design Standards.

(5) Area of water shed (A = acres), measured using suitable topographic map.

3-203.4 Other recognized hydrologic methods to determine runoff may be used, if substantiated, and approved by the City Engineer.

3-203.5 Whenever 6-hour storm precipitation rates (10, 50 or 100-year) are used to determine rainfall intensity, the Isopluvial Maps of the City of Chula Vista shall be used.

3-204 Drainage Criteria

The storm drainage system, consisting of surface and sub-surface facilities, shall be designed of sufficient capacity, without regards to dry-lane requirements, to convey the 100-year storm event without any damage to properties.

3-204.1 Street System

(1) For local drainage systems, inlet size and spacing shall be designed to intercept a 50-year storm without exceeding the City dry lane requirements and without causing property damage.

(2) Underground storm drain facilities, pipes and appurtenances shall be designed to discharge a 50-year storm runoff in an open channel flow condition. If offsite conditions create a seal, special pipe and/or joint design may be required for pressure flow.

(3) Dry-lane Requirements – In no case shall flow (Q_{50}) exceed the top of the curb.

a) Expressways, Six-lane Prime Arterials, and Six-lane Major roads shall maintain two driving lanes dry in each direction.

b) Four-lane Major, Class I Collector and Village Entry roads shall maintain a 12-foot dry lane on each side of centerline (or raised median)

c. Class II and Class III Collector, Secondary Village Entry, Promenade and Residential Streets' flow shall not exceed the top of curb

d) Industrial streets' flow shall not exceed the top of curb.

e) Criteria for tidally influenced areas. The tail water elevations for all dry lane drainage calculations shall be performed at the highest high tide plus an anticipated 16" of sea level rise.

(4) All drainage shall be intercepted and collected at superelevated roadway transition sections where concentrated flows are not permitted to cross travel lanes under the design storm frequency for the street. Median inlets shall be designed and spaced so the lane adjacent to the median (number one lane or fast lane of traffic adjacent to the median) is free from drainage flow for the design storm frequency.

(5) Under no circumstances shall the flow on one side of given street at a set slope exceed the capacity of a 21 foot inlet (20' opening) to intercept 100% of the flow (Q_{50}).

3-204.2 Storm Drain Facilities - Specific methods of handling storm drainage are subject to detailed approval of the City Engineer based on currently accepted engineering practices supported by thorough engineering calculations. The following guidelines shall be used for work in the City of Chula Vista.

(1) The following Manning "n" factors are to be used:

a)

Pipe	n
CMP, fully bituminous coated	0.024 (Not allowed in City maintained system)
CMP, fully asphalt paved	0.018 (Not allowed in City maintained system)
CMP, invert asphalt paved	0.023 (Not allowed in City maintained system)
RCP, All	0.013
Cast in place	0.014
PVC & HDPE, ALL	0.012

b)

Channel	n
P.C.C., formed, no finish	0.015
P.C.C., trowel finish	0.013
P.C.C., float finish	0.014
Gunite, no finish	0.019
Gunite, trowel finish	0.015

c) "n" factors for other materials or type of construction shall be as approved by the City Engineer.

(2) Public storm drain pipes shall be reinforced concrete pipe (RCP) unless otherwise stated below or approved by the City Engineer. Corrugated metal pipe (CMP) shall not be used unless specifically approved by the City Engineer.

(3) Minimum pipe diameter shall be 18" (46cm), minimum "D" load rating for RCP within the right of way shall be 1500.

(4) Storm drainage must be enclosed within a closed conduit for design runoff within a street right of way or City easement that can be carried in a 42" (107cm) diameter pipe or less.

(5) Minimum grade of storm drains and culverts shall be 0.5%.

(6) Maximum grade for RCP storm drains shall be 40%. PVC pipe may be used for grades greater than 40%.

(7) Type A storm drain cleanouts shall have a minimum 6" clearance between the outside wall of pipe and inside of cleanout structure. Also, the maximum allowable skew shall not exceed 20 degrees and limit the size of pipe to 39" without an engineering detail. Any pipes that are 39" or larger shall have an engineering detail.

(8) Maximum cleanout spacing:

a) Pipe diameters equal to or less than 30" (76cm): 300 feet (91m).

b) Pipe diameters greater than 30" (76cm): 800 feet (244m).

c) Storm drains constructed on grades greater than 20% shall use concrete anchors per Regional Standard S-9 at intervals of not more than 40 feet (12m).

(9) **Storm Drain Systems** – Shall be designed to convey runoff flow from inlets to cleanouts to the system outlet. Inlets will not be allowed on any system pipe larger than 18", unless approved by the City Engineer.

(10) **Pipe Radius/Watertight Pipe**

a) The radius of pipes in curves shall be based on standard or single bevel or double bevel pipe without breaking joints and shall comply with City of San Diego Drainage Design Manual, Table 1-103.7A. Pipe bevel and length shall be shown on plans.

b) The deflection angle at the inlet or cleanout shall be indicated on the plans and shall not be more than 10 degrees, unless special design is provided by the Engineer of Work on the plans.

c) For all storm drains under pressure, where the design HGL is 1-foot above the inside top of pipe elevation, watertight joints shall be used. Watertight joints shall also be used for storm drains constructed on grades of 20% or greater. If watertight, beveled pipe is proposed the Engineer of Work shall submit evidence that the proposed pipe is readily available. Further, the use of pipe collars will not be allowed in-place of manufactured watertight joints

d) Prior to construction, the contractor shall submit lay out sheets to the City for the following cases:
   i) where horizontal and vertical curves are combined;
   ii) where beveled pipe lengths other than 4-feet or 8-feet is required to fit the curve.

(11) **Easements**:

a) Minimum width of storm drain easements shall be equal to the pipe diameter plus ten feet (3m) or a minimum of 15 feet (5m) in width, whichever is greater.

b) Minimum width of easements for improved channels shall be equal to the width of the improved channel plus ten feet (3m), or a minimum of fifteen feet (5m), whichever is greater.

c) Easements for natural channels shall include the inundation line for the design flood.

d) No fences, walls, or other construction shall be authorized within a drainage easement without the specific written approval of the City Engineer. Easement shall not split lot lines without specific written approval of the City Engineer.

e) No structures, poles, wires or other appurtenances shall extend, or pass over, the boundaries of any drainage easement without the specific written approval of the City Engineer.

f) Drainage easements for open channels shall not be included in building lot area calculations but may be included in setback requirements.

(12) **Safety fences or walls** shall be constructed alongside improved channels or as directed by the City Engineer.

(13) **Minimum freeboard** for channels and brow ditches shall be 6 inches (15cm). For supercritical velocities very close to the critical velocity, make the wall heights at least equal to the sequent depth. For curved alignments, add 1.0 foot (0.3m) above the calculated maximum superelevated water surface.

(14) **For supercritical velocities** very close to the critical velocity, make the wall heights at least equal to the sequent depth. For curved alignments, add 1.0 foot (0.3m) above the calculated maximum.

(15) **Inlets and inlet transition** shall not be placed within pedestrian crosswalks or driveways.

(16) Provide a minimum of 10 foot (3.0m) curb transition on both sides of inlets unless otherwise approved by the City Engineer.

(17) **Grates will not** be considered in calculations as capable of receiving any flow of water since they are easily clogged with debris.

(18) **Grates shall be** capable of being safely crossed by bicycles.

(19) **Permanent improved access** shall be provided for maintenance of all public drainage facilities.

(20) **Where public storm drains outlet across private property** or open space drainage facilities shall be designed to meet structural and hydraulic requirements of the City Engineer. Minimum freeboard of 6" to be maintained.

(21) **Corrugated High Density Polyethylene Pipe (HDPE) pipe**

a) The use of HDPE pipe is allowed except in the following circumstances, unless approved by the City Engineer:

1. Within roadways with more than two lanes;
2. Within 15 feet of any building structure;

3. Within 16 feet of any outlet structure
4. In conditions in which groundwater is or may be present in the trench or in soil conditions in which the trench sidewall is not stable

b) Allowable sizes are 18" to 48" diameter.
c) Pipe shall be Type S (smooth interior, corrugated outside).
d) Pipe shall meet the requirements of AASHTO Specifications M-294 and the Greenbook, and unless otherwise specified in the project plans or specifications, installation of the pipe and fittings shall be in accordance with the manufacturer's recommendations.
e) Pipe and resin producers shall be certified according to the PPI/CPPA Third Party Certification Program. All corrugated polyethylene pipe shall contain the appropriate program mark, either an official label or permanent affixation prior to shipment.
f) HDPE storm drains constructed on grades of 20% or more:
   1. Newly compacted fills require concrete anchors per SDRSD S-9, otherwise cutoff walls per SDRSD S-10 are required; both at 40' intervals.
   2. Backfill shall be rounded over the trench.
   3. No HDPE storm drain pipe is allowed on grades exceeding 65%.
g) Only concrete structures (i.e., cleanouts, inlets, catch basins, headwalls, etc.) with watertight, waterstop gaskets will be allowed for use with HDPE storm drain pipe.
h) New connections to existing HDPE pipe shall be made by constructing a storm drain cleanout structure in accordance with Regional Standard Drawing No. D-9., not lugs.
i) Manufactured, watertight mechanical connections will be considered for tying-in laterals with diameters up to one-third of the larger pipe's diameter. Said connections shall be recommended by the HDPE pipe manufacturer and be subject to the review and approval of the City Engineer.
j) Pipe joints shall conform to the following performance criteria:
   1. Watertight Joints – The joints must be certified by an independent laboratory to meet a 10.8 psi (74 kPa) laboratory test per ASTM D3212 and utilize a bell and spigot design with a gasket meeting ASTM F 477. Defective pipe joints will not be allowed.
   2. Horizontal and vertical curves shall be constructed using pre-fabricated bevels. Pipe lay sheets for pipes with horizontal and vertical curves shall be submitted to the City Engineer for review and approval prior to installation. Simultaneous horizontal and vertical curves are not permitted.
   3. Fittings used with the pipe shall not reduce or impair the overall integrity or function of the pipeline. Fittings may be molded or fabricated and shall be furnished by the pipe manufacturer.
   4. Joints may not be "pulled" to accommodate a horizontal curve. Fittings supplied by the manufacture must be used where curves are indicated on the drawings.
k) Within paved areas, cover over the top of the HDPE pipe shall not be less than 36 inches as measured from the bottom of the pavement surface layer to the top of the pipe.

l) In open space areas, the downstream 16 feet of pipe shall be reinforced concrete pipe (RCP) and shall be connected to the HDPE pipe using manufactured connectors, not lugs.

m) HDPE Storage / Installation

1. Once HDPE pipe is delivered to the installation location, it shall be installed within three months. If not installed within three months, then HDPE shall either be stored indoors or under a cover that does not allow penetration of ultraviolet light.
2. Pipe installation and field inspections shall meet the requirements of Section 207-18 of the Standard Specifications for Public Works Construction.
3. Installation shall be per the manufacturer's published recommendations with a minimum cover as specified in "Specifications and Procedures" for H-25 loading and ¾" rock envelope (Type C) per San Diego County Regional Standard Drawing S-4. Metallic locator tape shall be placed at the top of the pipe zone
4. At least two weeks prior to the installation of HDPE pipe, the contractor shall submit certification from the manufacturer that he/she has received installation training specific to the HDPE pipe to be installed before installation of the pipe will be allowed to proceed. Said certification shall include the names of individuals that have received such training.
5. At least two weeks before the installation of all horizontal and vertical curves, the contractor or permittee shall submit City Engineer-approved pipe lay sheets to the project Public Works Inspector
6. All installed HDPE pipe shall be inspected by Closed Circuit Television in accordance with the Standard Specifications for Public Works Construction, Section 306-1.4.8, "Televising Sewer Mains and Storm Drains," and the City of Chula Vista Standard Special Provisions

3-204.3 Runoff Detention Basins

(1) The rate of inflow to the storage facility (inflow hydrographs) shall be developed using an acceptable hydrologic procedure, and shall be based on the watershed conditions expected to prevail during the anticipated effective life of the structure. Permanent facilities shall assume ultimate development of the contributing areas.

(2) Detention facilities shall be designed to convey a minimum 100-year frequency storm with a minimum 1-foot (0.3m) freeboard and utilizing maximum expected siltation elevation.

(3) The maximum allowable release rate after development shall not exceed pre-development flow rates. The 10, 50, and 100 year storm events shall be analyzed when releasing flows into a natural channel or when requested by the City Engineer.

(4) Adequate energy dissipation features shall be incorporated to reduce outflow velocities to acceptable levels to avoid downstream erosion.

(5) An emergency or overflow spillway shall be provided to pass the design flow if the principal outlets become blocked.

(6) Outlet facilities shall pass all runoff from a 100-year frequency storm event within a reasonable length of time as determined by the City Engineer.

(7) The California Division of Safety of Dams has jurisdiction over detention facilities: a) meeting or exceeding 25 feet (7m) in height and storing 15 acre-feet (18,500 m^3) or more; or b) of any height storing 50 acre-feet (61,700 m^3)or more; or as determined by the State of California.

(8) Embankment slopes shall be planted to provide erosion protection as determined by the City Engineer.

(9) Developer shall be required to maintain detention facilities in accordance with conditions of tentative map approval. A maintenance schedule shall be submitted for approval by the City Engineer prior to City acceptance of permanent facilities.

(10) Drainage structures within basins shall be provided with a reinforced concrete pad for maintenance purposes. The size, shape and location of the pad will be determined/approved by the City Engineer and Deputy Director of Operations.

3-204.4 Sediment Basins - Sedimentation basins shall be designed to provide adequate storage of sufficient duration to cause deposition of transported sediment as determined by the City Engineer.

(1) Vegetation shall be planted on all slopes within the subdivision and on the embankments of the basin to avoid erosion.

(2) Elevation marks shall be placed on the outlet riser pipe to monitor sediment levels.

(3) Sedimentation basins shall be maintained per a maintenance plan approved by, or as determined by the City Engineer.

(4) Pipe outlets shall consist of a perforated vertical pipe or box-type riser connected to a horizontal pipe that extends beyond the downstream embankment or that connects to an existing storm drain system.

(5) An emergency spillway shall be provided so that the capacity of the spillway alone will convey the 100-year design flood.

(6) Basins shall be designed to retain the design flood with a minimum 2-foot (0.6m) freeboard.

(7) Desilting basin(s) shall be designed using the standard equation:

$$As = 1.2Q/Vs$$

Where: *As* is the minimum surface area for trapping soil particles of a certain size; *Vs* is the settling velocity of the design particle size chosen; and Q = C x I x A where Q is the discharge rate measured in cubic feet per second; C is the runoff coefficient; I is the average precipitation intensity for the 10-year, 6-hour rain event and A is the disturbed and undisturbed areas draining into the sediment basin in acres. The design particle size shall be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01mm) particle, whichever is the largest, and the Vs used shall be 100 percent of the calculated settling velocity.

The length is determined by measuring the distance between the inlet and the outlet; the length shall be more than twice the dimension as the width; the depth shall not be less than three feet nor greater than five feet for safety reasons and for maximum efficiency (two feet minimum of settling depth plus the depth needed for sediment storage). The sediment storage volume shall be determined using the "Basic Soil Loss" table (see below) or any other methodology approved by the City Engineer. The basin(s) shall be located on the site where it can be maintained on a year-round basis and shall be maintained on a schedule to retain the two feet minimum of settling depth.

A sediment basin shall have a means for dewatering within 3 to 7 calendar days following a storm event. Sediment basins may be fenced if safety (worker or public) is a concern, or as determined by the City Engineer.

BASIC SOIL LOSS TABLE
(in cubic yards)*

TRACT AREA (acres)	AVERAGE SLOPES					
	2%	5%	8%	10%	12%	15%
10	270	350	370	400	450	500
15	400	420	460	600	675	750
20	540	700	740	800	900	1000
40	1080	1400	1480	1600	1800	2000
80	2160	2800	2960	3200	3600	4000
100	2700	3500	3700	4000	4500	5000
150	4000	4200	4600	6000	6750	7500
200	5400	7000	7400	8000	9000	10000

* ***Engineer shall interpolate the figures listed in the tables as required.***

3-204.5 Items to be Submitted with Drainage Calculations - To ensure proper design and to simplify and expedite checking procedures, design calculations and related information are required for all drainage facilities including the following:

(1) Engineer's design calculations

(2) A suitable topographic map, which includes the subdivision and the total drainage basin with the sub-basins delineated and labeled.

(3) Calculations showing the determination of design flow, including all assumptions and physical data.

(4) Calculations showing that all conduits, channels, and appurtenances are adequate for design flows; to include entrance and exit conditions, head losses, hydraulic jumps, critical depths, scouring and silting velocities, energy line elevation at the entrance, exit, and at each junction, bend, and angle point, and any other items affecting the functioning of the facility.

(5) A profile (to scale) showing the bottom of the channel or pipe, the hydraulic grade line, and the design flow and velocity.

(6) Calculations showing that the requirements for dry lanes will be met.

(7) All assumptions and input file information for computer programs along with a list of abbreviations and symbols used.]

3-205 Storm Water Quality and Urban Runoff

Prior to approval of any and all grading, construction, and building permits for the project, the Developer shall demonstrate to the satisfaction of the City Engineer compliance with all of the applicable provisions of the following and any amendments thereto.

(1) The City of Chula Storm Water Management and Discharge Control Ordinance (Chula Vista Municipal Code Section 14.20).

(2) NPDES Municipal Permit No. CAS0108758 (San Diego Regional Water Quality Control Board Order No. R9-2007-001 or re-issuances thereof).

(3) NPDES Construction Permit No. CAS000002 (State Water Resources Control Board Order No. 2009-009-DWQ or re-issuances thereof), including modifications dated April 26, 2001, where applicable.

During project planning and design, the Developer shall incorporate effective construction and post-construction Best Management Practices and provide all necessary studies and reports as determined by the City Engineer demonstrating compliance with the applicable regulations and standards.

CHAPTER 3

HYDROLOGIC ANALYSIS

3.1 – 50-Year Existing Condition
AES Model Output

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

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2015 Advanced Engineering Software (aes)
             Ver. 22.0 Release Date: 07/01/2015  License ID 1239

                           Analysis prepared by:

                   Hunsaker & Associates San Diego, Inc.
                            9707 Waples Street
                           San Diego,  CA 92121


 ************************** DESCRIPTION OF STUDY **************************
* Otay Ranch town Center                                                   *
* 50-Year return interval                                                  *
* DLN: 1643, w.O 3553-0002                                                 *
 **************************************************************************

  FILE NAME: R:\1643\HYD\TM\DR\CALCS\AES\50\50EX.DAT
  TIME/DATE OF STUDY: 09:44 02/10/2023
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) =  50.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.180
  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: 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
  2   17.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  3   20.0     12.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  4   16.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  5   26.0     18.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  6   44.0     12.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  7   12.0      7.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150

  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      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .6700
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
  UPSTREAM ELEVATION(FEET) =    628.30
  DOWNSTREAM ELEVATION(FEET) =    627.50
  ELEVATION DIFFERENCE(FEET) =      0.80
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.447
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.435
  SUBAREA RUNOFF(CFS) =      0.36
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.36
```

```
****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  5 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  627.50  DOWNSTREAM ELEVATION(FEET) =  624.40
  STREET LENGTH(FEET) =   290.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 26.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  18.00
  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) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.85
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.24
    HALFSTREET FLOOD WIDTH(FEET) =    5.89
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.82
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.44
  STREET FLOW TRAVEL TIME(MIN.) =   2.65   Tc(MIN.) =    8.10
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.207
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7900
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.759
  SUBAREA AREA(ACRES) =    0.29      SUBAREA RUNOFF(CFS) =    0.96
  TOTAL AREA(ACRES) =        0.4        PEAK FLOW RATE(CFS) =       1.25

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.27   HALFSTREET FLOOD WIDTH(FEET) =   7.16
  FLOW VELOCITY(FEET/SEC.) =  1.97   DEPTH*VELOCITY(FT*FT/SEC.) =   0.53
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      3.00 =     350.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   619.00  DOWNSTREAM(FEET) =   607.83
  FLOW LENGTH(FEET) =   320.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   3.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.97
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       1.25
  PIPE TRAVEL TIME(MIN.) =   0.89    Tc(MIN.) =    8.99
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      4.00 =     670.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      4.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.933
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .9000
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.8155
  SUBAREA AREA(ACRES) =    0.26   SUBAREA RUNOFF(CFS) =    0.92
  TOTAL AREA(ACRES) =        0.6   TOTAL RUNOFF(CFS) =       2.08
  TC(MIN.) =    8.99

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      9.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
```

```
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   607.83  DOWNSTREAM(FEET) =   603.22
  FLOW LENGTH(FEET) =   310.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   5.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.14
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       2.08
  PIPE TRAVEL TIME(MIN.) =   1.00    Tc(MIN.) =   10.00
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      9.00 =     980.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      9.00 TO NODE      9.00 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.) =   10.00
  RAINFALL INTENSITY(INCH/HR) =   3.67
  TOTAL STREAM AREA(ACRES) =     0.65
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.08

****************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7100
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
  UPSTREAM ELEVATION(FEET) =    625.50
  DOWNSTREAM ELEVATION(FEET) =    625.00
  ELEVATION DIFFERENCE(FEET) =      0.50
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.616
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    56.67
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.329
  SUBAREA RUNOFF(CFS) =      0.38
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.38

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  6 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  625.50  DOWNSTREAM ELEVATION(FEET) =  617.00
  STREET LENGTH(FEET) =   490.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 44.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  12.00
  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) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       4.85
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.36
    HALFSTREET FLOOD WIDTH(FEET) =   11.78
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.22
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.17
  STREET FLOW TRAVEL TIME(MIN.) =   2.53   Tc(MIN.) =    8.15
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.191
```

```
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .8000
 AREA-AVERAGE RUNOFF COEFFICIENT =  0.797
 SUBAREA AREA(ACRES) =    2.65      SUBAREA RUNOFF(CFS) =    8.89
 TOTAL AREA(ACRES) =        2.8        PEAK FLOW RATE(CFS) =       9.18

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.43   HALFSTREET FLOOD WIDTH(FEET) =  15.23
 FLOW VELOCITY(FEET/SEC.) =  3.77   DEPTH*VELOCITY(FT*FT/SEC.) =   1.62
 LONGEST FLOWPATH FROM NODE      6.00 TO NODE      8.00 =     550.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   606.00  DOWNSTREAM(FEET) =   603.22
 FLOW LENGTH(FEET) =   125.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  18.0 INCH PIPE IS  10.2 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   8.85
 ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       9.18
 PIPE TRAVEL TIME(MIN.) =   0.24    Tc(MIN.) =    8.38
 LONGEST FLOWPATH FROM NODE      6.00 TO NODE      9.00 =     675.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      9.00 TO NODE      9.00 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.) =    8.38
 RAINFALL INTENSITY(INCH/HR) =   4.12
 TOTAL STREAM AREA(ACRES) =     2.75
 PEAK FLOW RATE(CFS) AT CONFLUENCE =      9.18

 ** CONFLUENCE DATA **
 STREAM     RUNOFF       Tc      INTENSITY      AREA
 NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
     1        2.08    10.00        3.673          0.65
     2        9.18     8.38        4.115          2.75

 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       10.93     8.38       4.115
     2       10.28    10.00       3.673

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      10.93   Tc(MIN.) =    8.38
 TOTAL AREA(ACRES) =        3.4
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      9.00 =     980.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     10.00 TO NODE     11.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .6500
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
 UPSTREAM ELEVATION(FEET) =    627.50
 DOWNSTREAM ELEVATION(FEET) =    627.00
 ELEVATION DIFFERENCE(FEET) =      0.50
 URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.479
```

```
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    56.67
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.859
  SUBAREA RUNOFF(CFS) =      0.32
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.32

****************************************************************************
  FLOW PROCESS FROM NODE     11.00 TO NODE     12.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  6 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  627.00  DOWNSTREAM ELEVATION(FEET) =  617.60
  STREET LENGTH(FEET) =   480.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 44.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  12.00
  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) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       4.92
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.36
    HALFSTREET FLOOD WIDTH(FEET) =   11.54
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.40
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.21
  STREET FLOW TRAVEL TIME(MIN.) =   2.35   Tc(MIN.) =    8.83
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.979
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .8200
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.814
  SUBAREA AREA(ACRES) =    2.83      SUBAREA RUNOFF(CFS) =    9.23
  TOTAL AREA(ACRES) =        2.9        PEAK FLOW RATE(CFS) =       9.49

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.43   HALFSTREET FLOOD WIDTH(FEET) =  15.05
  FLOW VELOCITY(FEET/SEC.) =  3.98   DEPTH*VELOCITY(FT*FT/SEC.) =   1.70
  LONGEST FLOWPATH FROM NODE     10.00 TO NODE     12.00 =     540.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     13.00 TO NODE     14.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .9000
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    623.60
  DOWNSTREAM ELEVATION(FEET) =    622.00
  ELEVATION DIFFERENCE(FEET) =      1.60
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    2.501
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    66.00
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.744
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.47
  TOTAL AREA(ACRES) =      0.09   TOTAL RUNOFF(CFS) =      0.47

****************************************************************************
  FLOW PROCESS FROM NODE     14.00 TO NODE     17.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
```

```
  >>>>>(STREET TABLE SECTION #  7 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  622.00  DOWNSTREAM ELEVATION(FEET) =  615.10
  STREET LENGTH(FEET) =  1000.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 12.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  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 =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      10.63
    ***STREET FLOWING FULL***
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.41
    HALFSTREET FLOOD WIDTH(FEET) =   12.00
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.52
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.04
  STREET FLOW TRAVEL TIME(MIN.) =   6.61   Tc(MIN.) =    9.11
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.900
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .8300
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.831
  SUBAREA AREA(ACRES) =    5.86      SUBAREA RUNOFF(CFS) =   18.97
  TOTAL AREA(ACRES) =        6.0        PEAK FLOW RATE(CFS) =      19.29

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.49   HALFSTREET FLOOD WIDTH(FEET) =  12.00
  FLOW VELOCITY(FEET/SEC.) =  3.18   DEPTH*VELOCITY(FT*FT/SEC.) =   1.56
  *NOTE: INITIAL SUBAREA NOMOGRAPH WITH SUBAREA PARAMETERS,
         AND L = 1000.0 FT WITH ELEVATION-DROP =   6.9 FT, IS   27.9 CFS,
         WHICH EXCEEDS THE TOP-OF-CURB STREET CAPACITY AT NODE     17.00
  LONGEST FLOWPATH FROM NODE     13.00 TO NODE     17.00 =    1100.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     17.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.900
  *USER SPECIFIED(SUBAREA):
  PARKS, GOLF COURSES RUNOFF COEFFICIENT = .3000
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.6295
  SUBAREA AREA(ACRES) =    3.64   SUBAREA RUNOFF(CFS) =    4.26
  TOTAL AREA(ACRES) =        9.6   TOTAL RUNOFF(CFS) =      23.55
  TC(MIN.) =    9.11

****************************************************************************
  FLOW PROCESS FROM NODE     16.00 TO NODE     17.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.900
  *USER SPECIFIED(SUBAREA):
  BARREN SLOPES (FLAT) RUNOFF COEFFICIENT = .6500
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.6322
  SUBAREA AREA(ACRES) =    1.43   SUBAREA RUNOFF(CFS) =    3.63
  TOTAL AREA(ACRES) =       11.0   TOTAL RUNOFF(CFS) =      27.17
  TC(MIN.) =    9.11
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       11.0  TC(MIN.) =      9.11
  PEAK FLOW RATE(CFS)   =      27.17
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

CHAPTER 3

HYDROLOGIC ANALYSIS

3.2 – 50-Year Developed Condition AES Model Output

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

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2015 Advanced Engineering Software (aes)
             Ver. 22.0 Release Date: 07/01/2015  License ID 1239

                           Analysis prepared by:

                   Hunsaker & Associates San Diego, Inc.
                             9707 Waples Street
                            San Diego,  CA 92121


 ************************** DESCRIPTION OF STUDY **************************
* Otay Ranch town Center                                                   *
* 50-year return interval                                                  *
* DLN: 1643, w.O 3553-0002                                                 *
 **************************************************************************

  FILE NAME: R:\1643\HYD\TM\DR\CALCS\AES\50\50PR.DAT
  TIME/DATE OF STUDY: 14:15 02/08/2023
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) =  50.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.180
  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: 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
  2   17.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  3   20.0     12.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  4   16.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  5   26.0     18.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  6   44.0     12.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  7   12.0      5.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  8   20.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150

  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.*

+--------------------------------------------------------------------------+
| AREA ROUTING TO THE DETENTION VAULT                                      |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .6900
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    85.00
  UPSTREAM ELEVATION(FEET) =    628.30
```

```
  DOWNSTREAM ELEVATION(FEET) =    627.60
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.917
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    56.47
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.153
  SUBAREA RUNOFF(CFS) =      0.36
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.36

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  4 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  627.50  DOWNSTREAM ELEVATION(FEET) =  616.30
  STREET LENGTH(FEET) =   740.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 16.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  10.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  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 =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.64
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.26
    HALFSTREET FLOOD WIDTH(FEET) =    6.74
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.31
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.60
  STREET FLOW TRAVEL TIME(MIN.) =   5.35   Tc(MIN.) =   11.27
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.401
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .6300
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.633
  SUBAREA AREA(ACRES) =    2.08      SUBAREA RUNOFF(CFS) =    4.46
  TOTAL AREA(ACRES) =        2.2        PEAK FLOW RATE(CFS) =       4.69

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   8.85
  FLOW VELOCITY(FEET/SEC.) =  2.60   DEPTH*VELOCITY(FT*FT/SEC.) =   0.79
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      3.00 =     825.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      7.30 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   611.80  DOWNSTREAM(FEET) =   609.50
  FLOW LENGTH(FEET) =   350.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   9.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.74
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       4.69
  PIPE TRAVEL TIME(MIN.) =   1.23    Tc(MIN.) =   12.50
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      7.30 =    1175.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      7.30 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.181
```

```
 *USER SPECIFIED(SUBAREA):
 DENSE RESIDENTIAL (R2,R3) RUNOFF COEFFICIENT = .8800
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.6743
 SUBAREA AREA(ACRES) =    0.44   SUBAREA RUNOFF(CFS) =    1.23
 TOTAL AREA(ACRES) =        2.6   TOTAL RUNOFF(CFS) =       5.62
 TC(MIN.) =   12.50

****************************************************************************
 FLOW PROCESS FROM NODE      7.30 TO NODE     10.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   609.50  DOWNSTREAM(FEET) =   608.00
 FLOW LENGTH(FEET) =   250.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  18.0 INCH PIPE IS  11.4 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   4.77
 ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       5.62
 PIPE TRAVEL TIME(MIN.) =   0.87    Tc(MIN.) =   13.37
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE     10.00 =    1425.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     11.00 TO NODE     10.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.046
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .7500
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.7173
 SUBAREA AREA(ACRES) =    3.45   SUBAREA RUNOFF(CFS) =    7.88
 TOTAL AREA(ACRES) =        6.1   TOTAL RUNOFF(CFS) =      13.26
 TC(MIN.) =   13.37

****************************************************************************
 FLOW PROCESS FROM NODE     10.00 TO NODE     12.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   608.00  DOWNSTREAM(FEET) =   607.60
 FLOW LENGTH(FEET) =    50.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  21.0 INCH PIPE IS  17.0 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.37
 ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      13.26
 PIPE TRAVEL TIME(MIN.) =   0.13    Tc(MIN.) =   13.50
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE     12.00 =    1475.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     12.00 TO NODE     12.00 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.) =   13.50
 RAINFALL INTENSITY(INCH/HR) =   3.03
 TOTAL STREAM AREA(ACRES) =     6.07
 PEAK FLOW RATE(CFS) AT CONFLUENCE =     13.26

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .7500
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
 UPSTREAM ELEVATION(FEET) =    618.60
```

```
  DOWNSTREAM ELEVATION(FEET) =    617.90
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.636
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.744
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.26
  TOTAL AREA(ACRES) =      0.06   TOTAL RUNOFF(CFS) =      0.26

****************************************************************************
  FLOW PROCESS FROM NODE      9.00 TO NODE     12.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  7 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  617.90  DOWNSTREAM ELEVATION(FEET) =  615.90
  STREET LENGTH(FEET) =   370.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 12.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  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 =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.51
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.26
    HALFSTREET FLOOD WIDTH(FEET) =    6.61
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.36
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.35
  STREET FLOW TRAVEL TIME(MIN.) =   4.54   Tc(MIN.) =    9.18
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.882
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7800
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.778
  SUBAREA AREA(ACRES) =    0.81      SUBAREA RUNOFF(CFS) =    2.45
  TOTAL AREA(ACRES) =        0.9        PEAK FLOW RATE(CFS) =       2.63

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   8.60
  FLOW VELOCITY(FEET/SEC.) =  1.53   DEPTH*VELOCITY(FT*FT/SEC.) =   0.46
  LONGEST FLOWPATH FROM NODE      8.00 TO NODE     12.00 =     430.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     12.00 TO NODE     12.00 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.) =    9.18
  RAINFALL INTENSITY(INCH/HR) =   3.88
  TOTAL STREAM AREA(ACRES) =     0.87
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.63

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       13.26    13.50        3.027          6.07
      2        2.63     9.18        3.882          0.87

  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      11.64    9.18      3.882
     2      15.31   13.50      3.027

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      15.31   Tc(MIN.) =   13.50
  TOTAL AREA(ACRES) =        6.9
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     12.00 =    1475.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     12.00 TO NODE     14.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   607.60  DOWNSTREAM(FEET) =   606.35
  FLOW LENGTH(FEET) =   250.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  27.0 INCH PIPE IS  17.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.72
  ESTIMATED PIPE DIAMETER(INCH) =  27.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      15.31
  PIPE TRAVEL TIME(MIN.) =   0.73    Tc(MIN.) =   14.23
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     14.00 =    1725.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     13.00 TO NODE     14.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.926
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7500
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7319
  SUBAREA AREA(ACRES) =    2.66   SUBAREA RUNOFF(CFS) =    5.84
  TOTAL AREA(ACRES) =        9.6   TOTAL RUNOFF(CFS) =      20.56
  TC(MIN.) =   14.23

****************************************************************************
  FLOW PROCESS FROM NODE     14.00 TO NODE     15.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   606.35  DOWNSTREAM(FEET) =   605.50
  FLOW LENGTH(FEET) =    75.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  17.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   8.23
  ESTIMATED PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      20.56
  PIPE TRAVEL TIME(MIN.) =   0.15    Tc(MIN.) =   14.38
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     15.00 =    1800.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     15.00 IS CODE =  10
----------------------------------------------------------------------------
  >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE     17.00 TO NODE     18.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .6300
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
  UPSTREAM ELEVATION(FEET) =    616.00
  DOWNSTREAM ELEVATION(FEET) =    615.50
  ELEVATION DIFFERENCE(FEET) =      0.50
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.767
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    56.67
```

```
          (Reference: Table 3-1B of Hydrology Manual)
          THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.725
  SUBAREA RUNOFF(CFS) =      0.30
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.30

****************************************************************************
  FLOW PROCESS FROM NODE     18.00 TO NODE     19.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  7 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  615.50  DOWNSTREAM ELEVATION(FEET) =  614.30
  STREET LENGTH(FEET) =   150.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 12.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  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 =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.71
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.29
    HALFSTREET FLOOD WIDTH(FEET) =    7.98
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.79
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.51
  STREET FLOW TRAVEL TIME(MIN.) =   1.39   Tc(MIN.) =    8.16
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.187
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7900
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.780
  SUBAREA AREA(ACRES) =    1.46      SUBAREA RUNOFF(CFS) =    4.83
  TOTAL AREA(ACRES) =        1.6        PEAK FLOW RATE(CFS) =       5.09

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.34   HALFSTREET FLOOD WIDTH(FEET) =  10.55
  FLOW VELOCITY(FEET/SEC.) =  2.07   DEPTH*VELOCITY(FT*FT/SEC.) =   0.70
  LONGEST FLOWPATH FROM NODE     17.00 TO NODE     19.00 =     210.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     16.00 TO NODE     19.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.187
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7500
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7589
  SUBAREA AREA(ACRES) =    3.66   SUBAREA RUNOFF(CFS) =   11.49
  TOTAL AREA(ACRES) =        5.2   TOTAL RUNOFF(CFS) =      16.59
  TC(MIN.) =    8.16

****************************************************************************
  FLOW PROCESS FROM NODE     19.00 TO NODE     15.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   605.90  DOWNSTREAM(FEET) =   605.50
  FLOW LENGTH(FEET) =    40.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  15.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.54
  ESTIMATED PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      16.59
  PIPE TRAVEL TIME(MIN.) =   0.09    Tc(MIN.) =    8.25
  LONGEST FLOWPATH FROM NODE     17.00 TO NODE     15.00 =     250.00 FEET.
```

```
****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     15.00 IS CODE =  11
----------------------------------------------------------------------------
  >>>>>CONFLUENCE MEMORY BANK # 1 WITH THE MAIN-STREAM MEMORY<<<<<
============================================================================

  ** MAIN STREAM CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
     1       16.59     8.25       4.158        5.22
  LONGEST FLOWPATH FROM NODE     17.00 TO NODE     15.00 =     250.00 FEET.

  ** MEMORY BANK #  1 CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
     1       20.56    14.38       2.906        9.60
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     15.00 =    1800.00 FEET.

  ** PEAK FLOW RATE TABLE **
  STREAM    RUNOFF       Tc      INTENSITY
  NUMBER     (CFS)     (MIN.)   (INCH/HOUR)
     1      28.38       8.25        4.158
     2      32.15      14.38        2.906

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      32.15   Tc(MIN.) =   14.38
  TOTAL AREA(ACRES) =       14.8

****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     15.00 IS CODE =  12
----------------------------------------------------------------------------
  >>>>>CLEAR MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     20.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   601.50  DOWNSTREAM(FEET) =   599.80
  FLOW LENGTH(FEET) =   140.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  27.0 INCH PIPE IS  22.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   9.28
  ESTIMATED PIPE DIAMETER(INCH) =  27.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      32.15
  PIPE TRAVEL TIME(MIN.) =   0.25    Tc(MIN.) =   14.63
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     20.00 =    1940.00 FEET.

+--------------------------------------------------------------------------+
| AREA NOT ROUTING TO THE DETENTION VAULT                                  |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7600
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
  UPSTREAM ELEVATION(FEET) =    618.60
  DOWNSTREAM ELEVATION(FEET) =    618.00
  ELEVATION DIFFERENCE(FEET) =      0.60
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.741
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    60.00
           (Reference: Table 3-1B of Hydrology Manual)
```

```
          THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.744
 NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
 SUBAREA RUNOFF(CFS) =      0.17
 TOTAL AREA(ACRES) =      0.04   TOTAL RUNOFF(CFS) =      0.17

****************************************************************************
 FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  7 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) =  618.00  DOWNSTREAM ELEVATION(FEET) =  616.50
 STREET LENGTH(FEET) =   270.00   CURB HEIGHT(INCHES) =  6.0
 STREET HALFWIDTH(FEET) = 12.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.00
 INSIDE STREET CROSSFALL(DECIMAL) =  0.020
 OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

 SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
 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 =   0.0150

   **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.69
   STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
   STREET FLOW DEPTH(FEET) =  0.21
   HALFSTREET FLOOD WIDTH(FEET) =    4.12
   AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.20
   PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.25
 STREET FLOW TRAVEL TIME(MIN.) =   3.76   Tc(MIN.) =    8.50
   50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.080
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .7800
 AREA-AVERAGE RUNOFF COEFFICIENT =  0.778
 SUBAREA AREA(ACRES) =    0.32      SUBAREA RUNOFF(CFS) =    1.02
 TOTAL AREA(ACRES) =        0.4        PEAK FLOW RATE(CFS) =       1.14

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.24   HALFSTREET FLOOD WIDTH(FEET) =   5.67
 FLOW VELOCITY(FEET/SEC.) =  1.30   DEPTH*VELOCITY(FT*FT/SEC.) =   0.31
 LONGEST FLOWPATH FROM NODE      4.00 TO NODE      6.00 =     330.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     21.00 TO NODE     22.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .6500
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
 UPSTREAM ELEVATION(FEET) =    627.60
 DOWNSTREAM ELEVATION(FEET) =    627.00
 ELEVATION DIFFERENCE(FEET) =      0.60
 URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.274
 WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
          THE MAXIMUM OVERLAND FLOW LENGTH =    60.00
          (Reference: Table 3-1B of Hydrology Manual)
          THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.961
 SUBAREA RUNOFF(CFS) =      0.32
 TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.32

****************************************************************************
 FLOW PROCESS FROM NODE     22.00 TO NODE     23.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  6 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) =  627.00  DOWNSTREAM ELEVATION(FEET) =  617.60
```

```
  STREET LENGTH(FEET) =   560.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 44.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  12.00
  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) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.70
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.34
    HALFSTREET FLOOD WIDTH(FEET) =   10.58
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.98
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.01
  STREET FLOW TRAVEL TIME(MIN.) =   3.13   Tc(MIN.) =    9.40
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.822
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .8400
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.831
  SUBAREA AREA(ACRES) =    2.10      SUBAREA RUNOFF(CFS) =    6.74
  TOTAL AREA(ACRES) =        2.2        PEAK FLOW RATE(CFS) =       6.99

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.40   HALFSTREET FLOOD WIDTH(FEET) =  13.74
  FLOW VELOCITY(FEET/SEC.) =  3.48   DEPTH*VELOCITY(FT*FT/SEC.) =   1.40
  LONGEST FLOWPATH FROM NODE     21.00 TO NODE     23.00 =     620.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        2.2  TC(MIN.) =      9.40
  PEAK FLOW RATE(CFS)   =       6.99
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

CHAPTER 3

HYDROLOGIC ANALYSIS

3.3 – 100-Year Existing Condition AES Model Output

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

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2015 Advanced Engineering Software (aes)
             Ver. 22.0 Release Date: 07/01/2015  License ID 1239

                           Analysis prepared by:

                   Hunsaker & Associates San Diego, Inc.
                             9707 Waples Street
                            San Diego,  CA 92121


 ************************** DESCRIPTION OF STUDY **************************
* Otay Ranch town Center                                                   *
* 100-Year return interval                                                 *
* DLN: 1643, w.O 3553-0002                                                 *
 **************************************************************************

  FILE NAME: R:\1643\HYD\TM\DR\CALCS\AES\100\100EX.DAT
  TIME/DATE OF STUDY: 08:32 07/27/2022
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.500
  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: 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
  2   17.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  3   20.0     12.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  4   16.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  5   26.0     18.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  6   44.0     12.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  7   12.0      7.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150

  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      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .6700
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
  UPSTREAM ELEVATION(FEET) =    628.30
  DOWNSTREAM ELEVATION(FEET) =    627.50
  ELEVATION DIFFERENCE(FEET) =      0.80
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.447
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.233
  SUBAREA RUNOFF(CFS) =      0.42
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.42
```

```
****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  5 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  627.50  DOWNSTREAM ELEVATION(FEET) =  624.40
  STREET LENGTH(FEET) =   290.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 26.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  18.00
  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) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.97
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.25
    HALFSTREET FLOOD WIDTH(FEET) =    6.35
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.87
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.47
  STREET FLOW TRAVEL TIME(MIN.) =   2.59   Tc(MIN.) =    8.03
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.852
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7900
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.759
  SUBAREA AREA(ACRES) =    0.29      SUBAREA RUNOFF(CFS) =    1.11
  TOTAL AREA(ACRES) =        0.4        PEAK FLOW RATE(CFS) =       1.44

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.28   HALFSTREET FLOOD WIDTH(FEET) =   7.67
  FLOW VELOCITY(FEET/SEC.) =  2.03   DEPTH*VELOCITY(FT*FT/SEC.) =   0.57
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      3.00 =     350.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      4.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   619.00  DOWNSTREAM(FEET) =   607.83
  FLOW LENGTH(FEET) =   320.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   3.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.24
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       1.44
  PIPE TRAVEL TIME(MIN.) =   0.85    Tc(MIN.) =    8.89
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      4.00 =     670.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      4.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.546
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .9000
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.8155
  SUBAREA AREA(ACRES) =    0.26   SUBAREA RUNOFF(CFS) =    1.06
  TOTAL AREA(ACRES) =        0.6   TOTAL RUNOFF(CFS) =       2.41
  TC(MIN.) =    8.89

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      9.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
```

```
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
==============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   607.83  DOWNSTREAM(FEET) =   603.22
  FLOW LENGTH(FEET) =   310.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   5.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.36
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       2.41
  PIPE TRAVEL TIME(MIN.) =   0.96    Tc(MIN.) =    9.85
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      9.00 =     980.00 FEET.

******************************************************************************
  FLOW PROCESS FROM NODE      9.00 TO NODE      9.00 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.) =    9.85
  RAINFALL INTENSITY(INCH/HR) =   4.25
  TOTAL STREAM AREA(ACRES) =     0.65
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.41

******************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =  21
------------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
==============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7100
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
  UPSTREAM ELEVATION(FEET) =    625.50
  DOWNSTREAM ELEVATION(FEET) =    625.00
  ELEVATION DIFFERENCE(FEET) =      0.50
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.616
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    56.67
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.112
  SUBAREA RUNOFF(CFS) =      0.43
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.43

******************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  62
------------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  6 USED)<<<<<
==============================================================================
  UPSTREAM ELEVATION(FEET) =  625.50  DOWNSTREAM ELEVATION(FEET) =  617.00
  STREET LENGTH(FEET) =   490.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 44.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  12.00
  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) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       5.59
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.38
    HALFSTREET FLOOD WIDTH(FEET) =   12.49
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.33
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.25
  STREET FLOW TRAVEL TIME(MIN.) =   2.45   Tc(MIN.) =    8.07
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.839
```

```
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .8000
 AREA-AVERAGE RUNOFF COEFFICIENT =  0.797
 SUBAREA AREA(ACRES) =    2.65      SUBAREA RUNOFF(CFS) =   10.26
 TOTAL AREA(ACRES) =        2.8        PEAK FLOW RATE(CFS) =      10.60

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.45   HALFSTREET FLOOD WIDTH(FEET) =  16.12
 FLOW VELOCITY(FEET/SEC.) =  3.90   DEPTH*VELOCITY(FT*FT/SEC.) =   1.75
 LONGEST FLOWPATH FROM NODE      6.00 TO NODE      8.00 =     550.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   606.00  DOWNSTREAM(FEET) =   603.22
 FLOW LENGTH(FEET) =   125.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  18.0 INCH PIPE IS  11.2 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   9.14
 ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      10.60
 PIPE TRAVEL TIME(MIN.) =   0.23    Tc(MIN.) =    8.29
 LONGEST FLOWPATH FROM NODE      6.00 TO NODE      9.00 =     675.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE      9.00 TO NODE      9.00 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.) =    8.29
 RAINFALL INTENSITY(INCH/HR) =   4.75
 TOTAL STREAM AREA(ACRES) =     2.75
 PEAK FLOW RATE(CFS) AT CONFLUENCE =     10.60

 ** CONFLUENCE DATA **
 STREAM     RUNOFF       Tc      INTENSITY      AREA
 NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
     1        2.41     9.85        4.253          0.65
     2       10.60     8.29        4.752          2.75

 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       12.63     8.29       4.752
     2       11.90     9.85       4.253

 COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
 PEAK FLOW RATE(CFS) =      12.63   Tc(MIN.) =    8.29
 TOTAL AREA(ACRES) =        3.4
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE      9.00 =     980.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     10.00 TO NODE     11.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .6500
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
 UPSTREAM ELEVATION(FEET) =    627.50
 DOWNSTREAM ELEVATION(FEET) =    627.00
 ELEVATION DIFFERENCE(FEET) =      0.50
 URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.479
```

```
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    56.67
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.573
  SUBAREA RUNOFF(CFS) =      0.36
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.36

****************************************************************************
  FLOW PROCESS FROM NODE     11.00 TO NODE     12.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  6 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  627.00  DOWNSTREAM ELEVATION(FEET) =  617.60
  STREET LENGTH(FEET) =   480.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 44.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  12.00
  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) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       5.68
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.37
    HALFSTREET FLOOD WIDTH(FEET) =   12.25
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.51
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.30
  STREET FLOW TRAVEL TIME(MIN.) =   2.28   Tc(MIN.) =    8.76
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.587
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .8200
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.814
  SUBAREA AREA(ACRES) =    2.83      SUBAREA RUNOFF(CFS) =   10.65
  TOTAL AREA(ACRES) =        2.9        PEAK FLOW RATE(CFS) =      10.94

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.45   HALFSTREET FLOOD WIDTH(FEET) =  15.95
  FLOW VELOCITY(FEET/SEC.) =  4.11   DEPTH*VELOCITY(FT*FT/SEC.) =   1.83
  LONGEST FLOWPATH FROM NODE     10.00 TO NODE     12.00 =     540.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     13.00 TO NODE     14.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .9000
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   100.00
  UPSTREAM ELEVATION(FEET) =    623.60
  DOWNSTREAM ELEVATION(FEET) =    622.00
  ELEVATION DIFFERENCE(FEET) =      1.60
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    2.501
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    66.00
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  6.587
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.53
  TOTAL AREA(ACRES) =      0.09   TOTAL RUNOFF(CFS) =      0.53

****************************************************************************
  FLOW PROCESS FROM NODE     14.00 TO NODE     17.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
```

```
  >>>>>(STREET TABLE SECTION #  7 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  622.00  DOWNSTREAM ELEVATION(FEET) =  615.10
  STREET LENGTH(FEET) =  1000.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 12.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  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 =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      12.49
    ***STREET FLOWING FULL***
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.43
    HALFSTREET FLOOD WIDTH(FEET) =   12.00
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.68
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.15
  STREET FLOW TRAVEL TIME(MIN.) =   6.21   Tc(MIN.) =    8.71
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.604
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .8300
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.831
  SUBAREA AREA(ACRES) =    5.86      SUBAREA RUNOFF(CFS) =   22.39
  TOTAL AREA(ACRES) =        6.0        PEAK FLOW RATE(CFS) =      22.77

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.51   HALFSTREET FLOOD WIDTH(FEET) =  12.73
  FLOW VELOCITY(FEET/SEC.) =  3.40   DEPTH*VELOCITY(FT*FT/SEC.) =   1.75
  *NOTE: INITIAL SUBAREA NOMOGRAPH WITH SUBAREA PARAMETERS,
         AND L = 1000.0 FT WITH ELEVATION-DROP =   6.9 FT, IS   32.0 CFS,
         WHICH EXCEEDS THE TOP-OF-CURB STREET CAPACITY AT NODE     17.00
  LONGEST FLOWPATH FROM NODE     13.00 TO NODE     17.00 =    1100.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     17.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.604
  *USER SPECIFIED(SUBAREA):
  PARKS, GOLF COURSES RUNOFF COEFFICIENT = .3000
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.6295
  SUBAREA AREA(ACRES) =    3.64   SUBAREA RUNOFF(CFS) =    5.03
  TOTAL AREA(ACRES) =        9.6   TOTAL RUNOFF(CFS) =      27.79
  TC(MIN.) =    8.71

****************************************************************************
  FLOW PROCESS FROM NODE     16.00 TO NODE     17.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.604
  *USER SPECIFIED(SUBAREA):
  BARREN SLOPES (FLAT) RUNOFF COEFFICIENT = .6500
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.6322
  SUBAREA AREA(ACRES) =    1.43   SUBAREA RUNOFF(CFS) =    4.28
  TOTAL AREA(ACRES) =       11.0   TOTAL RUNOFF(CFS) =      32.07
  TC(MIN.) =    8.71
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       11.0  TC(MIN.) =      8.71
  PEAK FLOW RATE(CFS)   =      32.07
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

CHAPTER 3

HYDROLOGIC ANALYSIS

3.4 – 100-Year Developed Condition AES Model Output

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

            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2015 Advanced Engineering Software (aes)
             Ver. 22.0 Release Date: 07/01/2015  License ID 1239

                           Analysis prepared by:

                   Hunsaker & Associates San Diego, Inc.
                            9707 Waples Street
                           San Diego,  CA 92121


 ************************** DESCRIPTION OF STUDY **************************
* Otay Ranch town Center                                                   *
* 50-year return interval                                                  *
* DLN: 1643, w.O 3553-0002                                                 *
 **************************************************************************

  FILE NAME: R:\1643\HYD\TM\DR\CALCS\AES\50\50PR.DAT
  TIME/DATE OF STUDY: 14:15 02/08/2023
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  2003 SAN DIEGO MANUAL CRITERIA

  USER SPECIFIED STORM EVENT(YEAR) =  50.00
  6-HOUR DURATION PRECIPITATION (INCHES) =   2.180
  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: 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
  2   17.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  3   20.0     12.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  4   16.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  5   26.0     18.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  6   44.0     12.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  7   12.0      5.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150
  8   20.0     10.0    0.020/0.020/0.020   0.50    1.50 0.0313 0.125 0.0150

  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.*

+--------------------------------------------------------------------------+
| AREA ROUTING TO THE DETENTION VAULT                                      |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .6900
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    85.00
  UPSTREAM ELEVATION(FEET) =    628.30
```

```
  DOWNSTREAM ELEVATION(FEET) =    627.60
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.917
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    56.47
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.153
  SUBAREA RUNOFF(CFS) =      0.36
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.36

****************************************************************************
  FLOW PROCESS FROM NODE      2.00 TO NODE      3.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  4 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  627.50  DOWNSTREAM ELEVATION(FEET) =  616.30
  STREET LENGTH(FEET) =   740.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 16.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  10.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  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 =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.64
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.26
    HALFSTREET FLOOD WIDTH(FEET) =    6.74
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.31
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.60
  STREET FLOW TRAVEL TIME(MIN.) =   5.35   Tc(MIN.) =   11.27
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.401
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .6300
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.633
  SUBAREA AREA(ACRES) =    2.08      SUBAREA RUNOFF(CFS) =    4.46
  TOTAL AREA(ACRES) =        2.2        PEAK FLOW RATE(CFS) =       4.69

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   8.85
  FLOW VELOCITY(FEET/SEC.) =  2.60   DEPTH*VELOCITY(FT*FT/SEC.) =   0.79
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      3.00 =     825.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      7.30 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   611.80  DOWNSTREAM(FEET) =   609.50
  FLOW LENGTH(FEET) =   350.00   MANNING'S N =  0.013
  ESTIMATED PIPE DIAMETER(INCH) INCREASED TO 18.000
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   9.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   4.74
  ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       4.69
  PIPE TRAVEL TIME(MIN.) =   1.23    Tc(MIN.) =   12.50
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE      7.30 =    1175.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      7.30 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.181
```

```
 *USER SPECIFIED(SUBAREA):
 DENSE RESIDENTIAL (R2,R3) RUNOFF COEFFICIENT = .8800
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.6743
 SUBAREA AREA(ACRES) =    0.44   SUBAREA RUNOFF(CFS) =    1.23
 TOTAL AREA(ACRES) =        2.6   TOTAL RUNOFF(CFS) =       5.62
 TC(MIN.) =   12.50

****************************************************************************
 FLOW PROCESS FROM NODE      7.30 TO NODE     10.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   609.50  DOWNSTREAM(FEET) =   608.00
 FLOW LENGTH(FEET) =   250.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  18.0 INCH PIPE IS  11.4 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   4.77
 ESTIMATED PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =       5.62
 PIPE TRAVEL TIME(MIN.) =   0.87    Tc(MIN.) =   13.37
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE     10.00 =    1425.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     11.00 TO NODE     10.00 IS CODE =  81
----------------------------------------------------------------------------
 >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.046
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .7500
 AREA-AVERAGE RUNOFF COEFFICIENT = 0.7173
 SUBAREA AREA(ACRES) =    3.45   SUBAREA RUNOFF(CFS) =    7.88
 TOTAL AREA(ACRES) =        6.1   TOTAL RUNOFF(CFS) =      13.26
 TC(MIN.) =   13.37

****************************************************************************
 FLOW PROCESS FROM NODE     10.00 TO NODE     12.00 IS CODE =  31
----------------------------------------------------------------------------
 >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
 ELEVATION DATA: UPSTREAM(FEET) =   608.00  DOWNSTREAM(FEET) =   607.60
 FLOW LENGTH(FEET) =    50.00   MANNING'S N =  0.013
 DEPTH OF FLOW IN  21.0 INCH PIPE IS  17.0 INCHES
 PIPE-FLOW VELOCITY(FEET/SEC.) =   6.37
 ESTIMATED PIPE DIAMETER(INCH) =  21.00    NUMBER OF PIPES =   1
 PIPE-FLOW(CFS) =      13.26
 PIPE TRAVEL TIME(MIN.) =   0.13    Tc(MIN.) =   13.50
 LONGEST FLOWPATH FROM NODE      1.00 TO NODE     12.00 =    1475.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     12.00 TO NODE     12.00 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.) =   13.50
 RAINFALL INTENSITY(INCH/HR) =   3.03
 TOTAL STREAM AREA(ACRES) =     6.07
 PEAK FLOW RATE(CFS) AT CONFLUENCE =     13.26

****************************************************************************
 FLOW PROCESS FROM NODE      8.00 TO NODE      9.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .7500
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
 UPSTREAM ELEVATION(FEET) =    618.60
```

```
  DOWNSTREAM ELEVATION(FEET) =    617.90
  ELEVATION DIFFERENCE(FEET) =      0.70
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.636
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.744
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.26
  TOTAL AREA(ACRES) =      0.06   TOTAL RUNOFF(CFS) =      0.26

****************************************************************************
  FLOW PROCESS FROM NODE      9.00 TO NODE     12.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  7 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  617.90  DOWNSTREAM ELEVATION(FEET) =  615.90
  STREET LENGTH(FEET) =   370.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 12.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  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 =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       1.51
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.26
    HALFSTREET FLOOD WIDTH(FEET) =    6.61
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.36
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.35
  STREET FLOW TRAVEL TIME(MIN.) =   4.54   Tc(MIN.) =    9.18
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.882
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7800
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.778
  SUBAREA AREA(ACRES) =    0.81      SUBAREA RUNOFF(CFS) =    2.45
  TOTAL AREA(ACRES) =       0.9       PEAK FLOW RATE(CFS) =       2.63

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   8.60
  FLOW VELOCITY(FEET/SEC.) =  1.53   DEPTH*VELOCITY(FT*FT/SEC.) =   0.46
  LONGEST FLOWPATH FROM NODE      8.00 TO NODE     12.00 =     430.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     12.00 TO NODE     12.00 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.) =    9.18
  RAINFALL INTENSITY(INCH/HR) =   3.88
  TOTAL STREAM AREA(ACRES) =     0.87
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      2.63

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       13.26    13.50        3.027          6.07
      2        2.63     9.18        3.882          0.87

  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       11.64    9.18       3.882
     2       15.31   13.50       3.027

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      15.31   Tc(MIN.) =   13.50
  TOTAL AREA(ACRES) =        6.9
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     12.00 =    1475.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     12.00 TO NODE     14.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   607.60  DOWNSTREAM(FEET) =   606.35
  FLOW LENGTH(FEET) =   250.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  27.0 INCH PIPE IS  17.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.72
  ESTIMATED PIPE DIAMETER(INCH) =  27.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      15.31
  PIPE TRAVEL TIME(MIN.) =   0.73    Tc(MIN.) =   14.23
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     14.00 =    1725.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     13.00 TO NODE     14.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  2.926
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7500
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7319
  SUBAREA AREA(ACRES) =    2.66   SUBAREA RUNOFF(CFS) =    5.84
  TOTAL AREA(ACRES) =        9.6   TOTAL RUNOFF(CFS) =      20.56
  TC(MIN.) =   14.23

****************************************************************************
  FLOW PROCESS FROM NODE     14.00 TO NODE     15.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   606.35  DOWNSTREAM(FEET) =   605.50
  FLOW LENGTH(FEET) =    75.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  17.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   8.23
  ESTIMATED PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      20.56
  PIPE TRAVEL TIME(MIN.) =   0.15    Tc(MIN.) =   14.38
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     15.00 =    1800.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     15.00 IS CODE =  10
----------------------------------------------------------------------------
  >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE     17.00 TO NODE     18.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .6300
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
  UPSTREAM ELEVATION(FEET) =    616.00
  DOWNSTREAM ELEVATION(FEET) =    615.50
  ELEVATION DIFFERENCE(FEET) =      0.50
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.767
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    56.67
```

```
          (Reference: Table 3-1B of Hydrology Manual)
          THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.725
  SUBAREA RUNOFF(CFS) =      0.30
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.30

****************************************************************************
  FLOW PROCESS FROM NODE     18.00 TO NODE     19.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  7 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  615.50  DOWNSTREAM ELEVATION(FEET) =  614.30
  STREET LENGTH(FEET) =   150.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 12.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
  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 =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.71
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.29
    HALFSTREET FLOOD WIDTH(FEET) =    7.98
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.79
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.51
  STREET FLOW TRAVEL TIME(MIN.) =   1.39   Tc(MIN.) =    8.16
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.187
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7900
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.780
  SUBAREA AREA(ACRES) =    1.46      SUBAREA RUNOFF(CFS) =    4.83
  TOTAL AREA(ACRES) =       1.6       PEAK FLOW RATE(CFS) =       5.09

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.34   HALFSTREET FLOOD WIDTH(FEET) =  10.55
  FLOW VELOCITY(FEET/SEC.) =  2.07   DEPTH*VELOCITY(FT*FT/SEC.) =   0.70
  LONGEST FLOWPATH FROM NODE     17.00 TO NODE     19.00 =     210.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     16.00 TO NODE     19.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.187
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7500
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7589
  SUBAREA AREA(ACRES) =    3.66   SUBAREA RUNOFF(CFS) =   11.49
  TOTAL AREA(ACRES) =       5.2   TOTAL RUNOFF(CFS) =      16.59
  TC(MIN.) =    8.16

****************************************************************************
  FLOW PROCESS FROM NODE     19.00 TO NODE     15.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   605.90  DOWNSTREAM(FEET) =   605.50
  FLOW LENGTH(FEET) =    40.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  15.8 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.54
  ESTIMATED PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      16.59
  PIPE TRAVEL TIME(MIN.) =   0.09    Tc(MIN.) =    8.25
  LONGEST FLOWPATH FROM NODE     17.00 TO NODE     15.00 =     250.00 FEET.
```

```
****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     15.00 IS CODE =  11
----------------------------------------------------------------------------
  >>>>>CONFLUENCE MEMORY BANK # 1 WITH THE MAIN-STREAM MEMORY<<<<<
============================================================================

  ** MAIN STREAM CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
      1       16.59     8.25       4.158        5.22
  LONGEST FLOWPATH FROM NODE     17.00 TO NODE     15.00 =     250.00 FEET.

  ** MEMORY BANK #  1 CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
      1       20.56    14.38       2.906        9.60
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     15.00 =    1800.00 FEET.

  ** PEAK FLOW RATE TABLE **
  STREAM    RUNOFF       Tc      INTENSITY
  NUMBER     (CFS)     (MIN.)   (INCH/HOUR)
      1      28.38       8.25        4.158
      2      32.15      14.38        2.906

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      32.15   Tc(MIN.) =   14.38
  TOTAL AREA(ACRES) =       14.8

****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     15.00 IS CODE =  12
----------------------------------------------------------------------------
  >>>>>CLEAR MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE     15.00 TO NODE     20.00 IS CODE =  31
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING COMPUTER-ESTIMATED PIPESIZE (NON-PRESSURE FLOW)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   601.50  DOWNSTREAM(FEET) =   599.80
  FLOW LENGTH(FEET) =   140.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  27.0 INCH PIPE IS  22.0 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   9.28
  ESTIMATED PIPE DIAMETER(INCH) =  27.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      32.15
  PIPE TRAVEL TIME(MIN.) =   0.25    Tc(MIN.) =   14.63
  LONGEST FLOWPATH FROM NODE      1.00 TO NODE     20.00 =    1940.00 FEET.

+--------------------------------------------------------------------------+
| AREA NOT ROUTING TO THE DETENTION VAULT                                  |
|                                                                          |
|                                                                          |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      5.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .7600
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
  UPSTREAM ELEVATION(FEET) =    618.60
  DOWNSTREAM ELEVATION(FEET) =    618.00
  ELEVATION DIFFERENCE(FEET) =      0.60
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.741
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    60.00
           (Reference: Table 3-1B of Hydrology Manual)
```

```
         THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  5.744
 NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
 SUBAREA RUNOFF(CFS) =      0.17
 TOTAL AREA(ACRES) =      0.04   TOTAL RUNOFF(CFS) =      0.17

****************************************************************************
 FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  7 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) =  618.00  DOWNSTREAM ELEVATION(FEET) =  616.50
 STREET LENGTH(FEET) =   270.00   CURB HEIGHT(INCHES) =  6.0
 STREET HALFWIDTH(FEET) = 12.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   5.00
 INSIDE STREET CROSSFALL(DECIMAL) =  0.020
 OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

 SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  2
 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 =   0.0150

   **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       0.69
   STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
   STREET FLOW DEPTH(FEET) =  0.21
   HALFSTREET FLOOD WIDTH(FEET) =    4.12
   AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.20
   PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.25
 STREET FLOW TRAVEL TIME(MIN.) =   3.76   Tc(MIN.) =    8.50
   50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.080
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .7800
 AREA-AVERAGE RUNOFF COEFFICIENT =  0.778
 SUBAREA AREA(ACRES) =    0.32      SUBAREA RUNOFF(CFS) =    1.02
 TOTAL AREA(ACRES) =       0.4        PEAK FLOW RATE(CFS) =       1.14

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.24   HALFSTREET FLOOD WIDTH(FEET) =   5.67
 FLOW VELOCITY(FEET/SEC.) =  1.30   DEPTH*VELOCITY(FT*FT/SEC.) =   0.31
 LONGEST FLOWPATH FROM NODE      4.00 TO NODE      6.00 =     330.00 FEET.

****************************************************************************
 FLOW PROCESS FROM NODE     21.00 TO NODE     22.00 IS CODE =  21
----------------------------------------------------------------------------
 >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
 *USER SPECIFIED(SUBAREA):
 PAVED SURFACE RUNOFF COEFFICIENT = .6500
 INITIAL SUBAREA FLOW-LENGTH(FEET) =    60.00
 UPSTREAM ELEVATION(FEET) =    627.60
 DOWNSTREAM ELEVATION(FEET) =    627.00
 ELEVATION DIFFERENCE(FEET) =      0.60
 URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.274
 WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
         THE MAXIMUM OVERLAND FLOW LENGTH =    60.00
         (Reference: Table 3-1B of Hydrology Manual)
         THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.961
 SUBAREA RUNOFF(CFS) =      0.32
 TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.32

****************************************************************************
 FLOW PROCESS FROM NODE     22.00 TO NODE     23.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  6 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) =  627.00  DOWNSTREAM ELEVATION(FEET) =  617.60
```

```
  STREET LENGTH(FEET) =   560.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 44.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  12.00
  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) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0150

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.70
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.34
    HALFSTREET FLOOD WIDTH(FEET) =   10.58
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.98
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.01
  STREET FLOW TRAVEL TIME(MIN.) =   3.13   Tc(MIN.) =    9.40
    50 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.822
  *USER SPECIFIED(SUBAREA):
  PAVED SURFACE RUNOFF COEFFICIENT = .8400
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.831
  SUBAREA AREA(ACRES) =    2.10      SUBAREA RUNOFF(CFS) =    6.74
  TOTAL AREA(ACRES) =        2.2        PEAK FLOW RATE(CFS) =       6.99

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.40   HALFSTREET FLOOD WIDTH(FEET) =  13.74
  FLOW VELOCITY(FEET/SEC.) =  3.48   DEPTH*VELOCITY(FT*FT/SEC.) =   1.40
  LONGEST FLOWPATH FROM NODE     21.00 TO NODE     23.00 =     620.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =        2.2  TC(MIN.) =      9.40
  PEAK FLOW RATE(CFS)   =       6.99
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

CHAPTER 4

DETENTION VAULT ANALYSIS

RATIONAL METHOD HYDROGRAPH PROGRAM

RUN DATE 2/8/2023
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 15 MIN.
6 HOUR RAINFALL 2.5 INCHES
BASIN AREA 14.82 ACRES
RUNOFF COEFFICIENT 0.7165
PEAK DISCHARGE 37.14 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 15	DISCHARGE (CFS) = 1.6
TIME (MIN) = 30	DISCHARGE (CFS) = 1.6
TIME (MIN) = 45	DISCHARGE (CFS) = 1.7
TIME (MIN) = 60	DISCHARGE (CFS) = 1.8
TIME (MIN) = 75	DISCHARGE (CFS) = 1.9
TIME (MIN) = 90	DISCHARGE (CFS) = 2
TIME (MIN) = 105	DISCHARGE (CFS) = 2.2
TIME (MIN) = 120	DISCHARGE (CFS) = 2.3
TIME (MIN) = 135	DISCHARGE (CFS) = 2.5
TIME (MIN) = 150	DISCHARGE (CFS) = 2.7
TIME (MIN) = 165	DISCHARGE (CFS) = 3.1
TIME (MIN) = 180	DISCHARGE (CFS) = 3.3
TIME (MIN) = 195	DISCHARGE (CFS) = 4.1
TIME (MIN) = 210	DISCHARGE (CFS) = 4.6
TIME (MIN) = 225	DISCHARGE (CFS) = 6.8
TIME (MIN) = 240	DISCHARGE (CFS) = 6.9
TIME (MIN) = 255	DISCHARGE (CFS) = 37.14
TIME (MIN) = 270	DISCHARGE (CFS) = 5.5
TIME (MIN) = 285	DISCHARGE (CFS) = 3.7
TIME (MIN) = 300	DISCHARGE (CFS) = 2.9
TIME (MIN) = 315	DISCHARGE (CFS) = 2.4
TIME (MIN) = 330	DISCHARGE (CFS) = 2.1
TIME (MIN) = 345	DISCHARGE (CFS) = 1.9
TIME (MIN) = 360	DISCHARGE (CFS) = 1.7
TIME (MIN) = 375	DISCHARGE (CFS) = 0

Vault – Stage Information

Stage – Storage

Stage- Discharge

Vault HMP\ Detention\ WQ
Discharge vs Elevation Table

Bottom orifice diameter:	3.50 "	Top orifice diameter:		4 "
Number:	1	Number:		0
Cg-low:	0.61	Cg-low:		0.61
invert elev:	0.00 ft	invert elev:		3.00 ft
Middle orifice diameter:	3.0 "	Emergency weir:		
number of orif:	0	Invert:	3.00 ft	
Cg-middle:	0.61	Weir Length (ft)	10.0 ft	
invert elev:	2.50 ft	Box riser	2' x 3'	

h	H/D-low	H/D-mid	H/D-top	H/D-peak	Qlow-orif	Qlow-weir	Qtot-low	Qmid-orif	Qmid-weir	Qtot-med	Qtop-orif	Qtop-weir	Qtot-top	Qpeak-top	Qtot
(ft)	-	-	-	-	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
0.25	0.86	0.00	0.00	0.00	0.11	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0924
0.50	1.71	0.00	0.00	0.00	0.19	0.25	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1946
0.75	2.57	0.00	0.00	0.00	0.25	0.32	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2542
1.00	3.43	0.00	0.00	0.00	0.30	0.35	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3023
1.25	4.29	0.00	0.00	0.00	0.34	0.78	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3437
1.50	5.14	0.00	0.00	0.00	0.38	2.67	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3806
1.75	6.00	0.00	0.00	0.00	0.41	7.88	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4142
2.00	6.86	0.00	0.00	0.00	0.45	19.28	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4454
2.25	7.71	0.00	0.00	0.00	0.47	40.97	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4744
2.50	8.57	0.00	0.00	0.00	0.50	78.48	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5018
2.75	9.43	1.00	0.00	0.00	0.53	138.93	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5278
3.00	10.29	2.00	0.00	0.00	0.55	231.32	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5526
3.25	11.14	3.00	0.75	0.30	0.58	366.64	0.58	0.00	0.00	0.00	0.00	0.00	0.00	4.16	4.7387
3.50	12.00	4.00	1.50	0.60	0.60	558.16	0.60	0.00	0.00	0.00	0.00	0.00	0.00	11.77	12.3723
3.75	12.86	5.00	2.25	0.90	0.62	821.57	0.62	0.00	0.00	0.00	0.00	0.00	0.00	21.63	22.2499
4.00	13.71	6.00	3.00	1.20	0.64	1175.20	0.64	0.00	0.00	0.00	0.00	0.00	0.00	33.30	33.9421
4.25	14.57	7.00	3.75	1.50	0.66	1640.27	0.66	0.00	0.00	0.00	0.00	0.00	0.00	46.54	47.2008
4.50	15.43	8.00	4.50	1.80	0.68	2241.01	0.68	0.00	0.00	0.00	0.00	0.00	0.00	61.18	61.8585
4.75	16.29	9.00	5.25	2.10	0.70	3004.94	0.70	0.00	0.00	0.00	0.00	0.00	0.00	77.09	77.7924
5.00	17.14	10.00	6.00	2.40	0.72	3963.05	0.72	0.00	0.00	0.00	0.00	0.00	0.00	94.19	94.9072
5.25	18.00	11.00	6.75	2.70	0.74	5149.97	0.74	0.00	0.00	0.00	0.00	0.00	0.00	112.39	113.1264
5.50	18.86	12.00	7.50	3.00	0.76	6604.23	0.76	0.00	0.00	0.00	0.00	0.00	0.00	131.63	132.3866

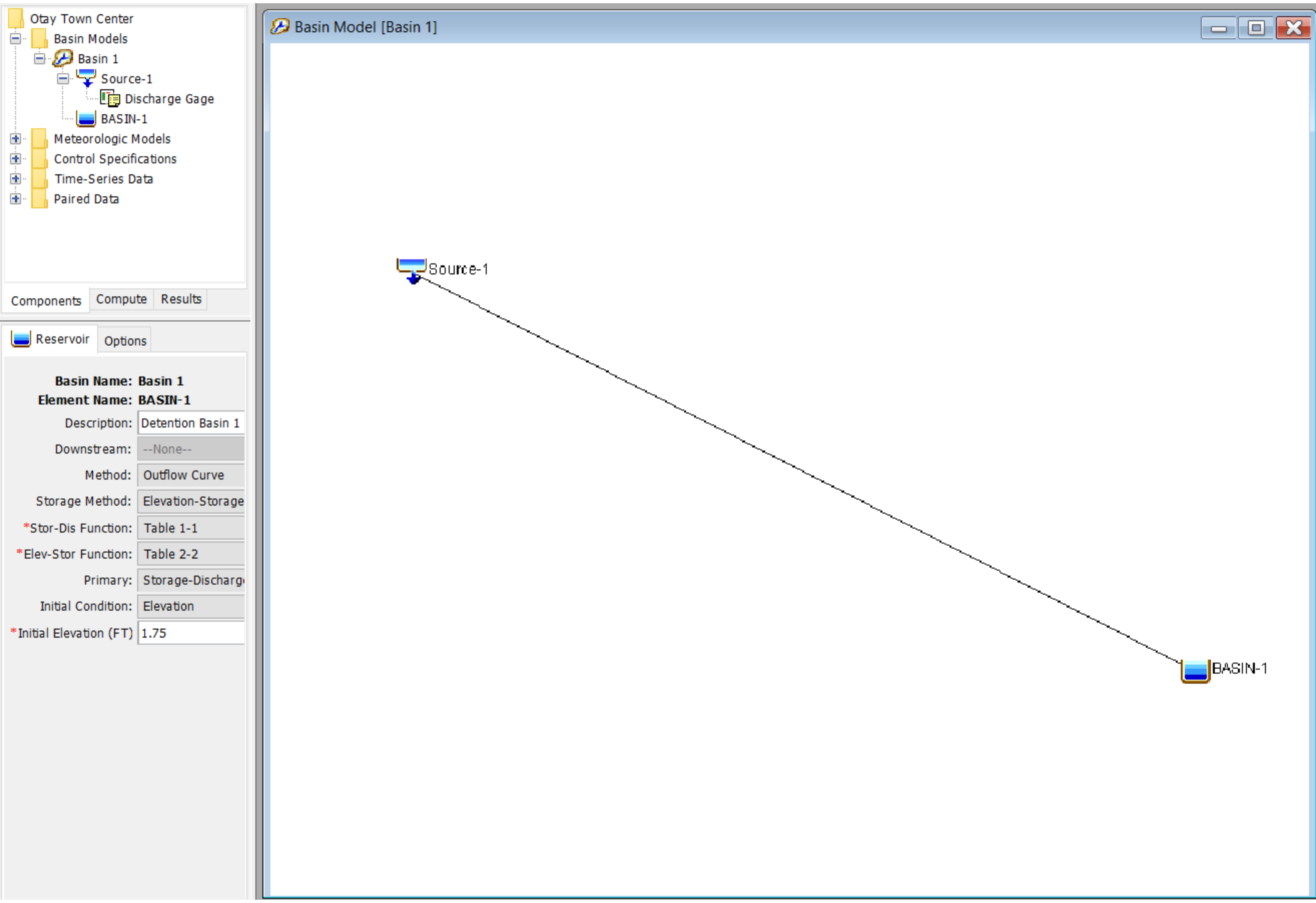
Stage Storage Vault HMP-1

Depth (ft)	Area (sq ft)	Volume (cu ft)	Volume Total (cu ft)	Storage (ac-ft)
0.00	16800			0
0.25	16800	4,200	4,200	0.096419
0.50	16800	4,200	8,400	0.192837
0.75	16800	4,200	12,600	0.289256
1.00	16800	4,200	16,800	0.385675
1.25	16800	4,200	21,000	0.482094
1.50	16800	4,200	25,200	0.578512
1.75	16800	4,200	29,400	0.674931
2.00	16800	4,200	33,600	0.77135
2.25	16800	4,200	37,800	0.867769
2.50	16800	4,200	42,000	0.964187
2.75	16800	4,200	46,200	1.060606
3.00	16800	4,200	50,400	1.157025
3.25	16800	4,200	54,600	1.253444
3.50	16800	4,200	58,800	1.349862
3.75	16800	4,200	63,000	1.446281
4.00	16800	4,200	67,200	1.5427
4.25	16800	4,200	71,400	1.639118
4.50	16800	4,200	75,600	1.735537
4.75	16800	4,200	79,800	1.831956
5.00	16800	4,200	84,000	1.928375
5.25	16800	4,200	88,200	2.024793
5.50	16800	4,200	92,400	2.121212

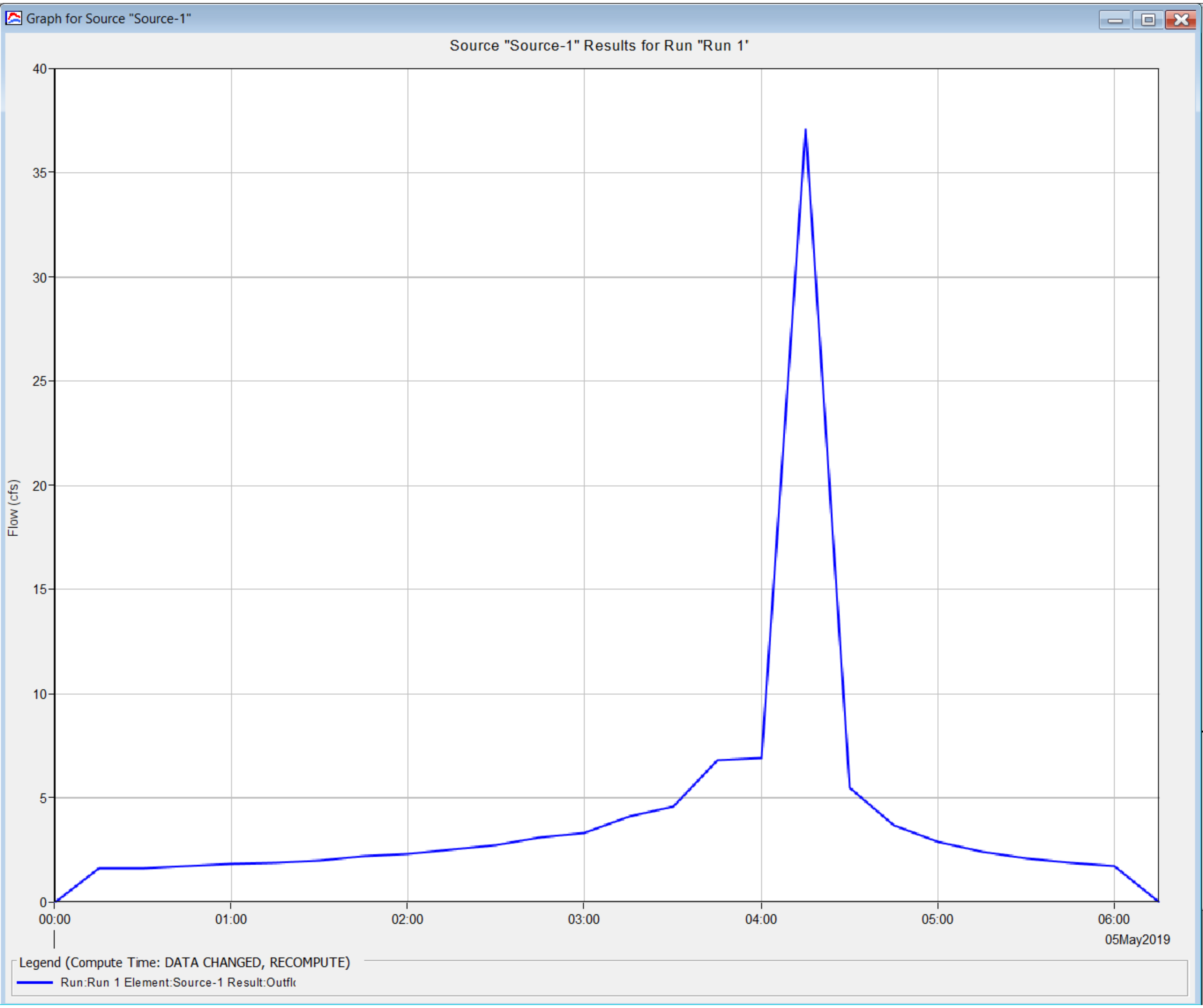
Draw Down				
Elevation	Q_{AVG} (CFS)	DV (CF)	DT (HR)	Total T
0.00				
0.25	0.0924	4200.0	12.6212	48.58
0.50	0.1946	4200.0	5.9939	35.96
0.75	0.2542	4200.0	4.5891	29.97
1.00	0.3023	4200.0	3.8596	25.38
1.25	0.3437	4200.0	3.3946	21.52
1.50	0.3806	4200.0	3.0653	18.12
1.75	0.4142	4200.0	2.8163	15.06
2.00	0.4454	4200.0	2.6196	12.24
2.25	0.4744	4200.0	2.4591	9.62
2.50	0.5018	4200.0	2.3248	7.16
2.75	0.5278	4200.0	2.2104	4.84
3.00	0.5526	4200.0	2.1114	2.63
3.25	4.7387	4200.0	0.2462	0.52
3.50	12.3723	4200.0	0.0943	0.27
3.75	22.2499	4200.0	0.0524	0.18
4.00	33.9421	4200.0	0.0344	0.12
4.25	47.2008	4200.0	0.0247	0.09
4.50	61.8585	4200.0	0.0189	0.07
4.75	77.7924	4200.0	0.0150	0.05
5.00	94.9072	4200.0	0.0123	0.03
5.25	113.1264	4200.0	0.0103	0.02
5.50	132.3866	4200.0	0.0088	0.01

100-YEAR DETENTION

HEC-HMS INPUT



Inflow Vault



HEC-HMS RESULTS

Summary Results for Reservoir "BASIN-1"

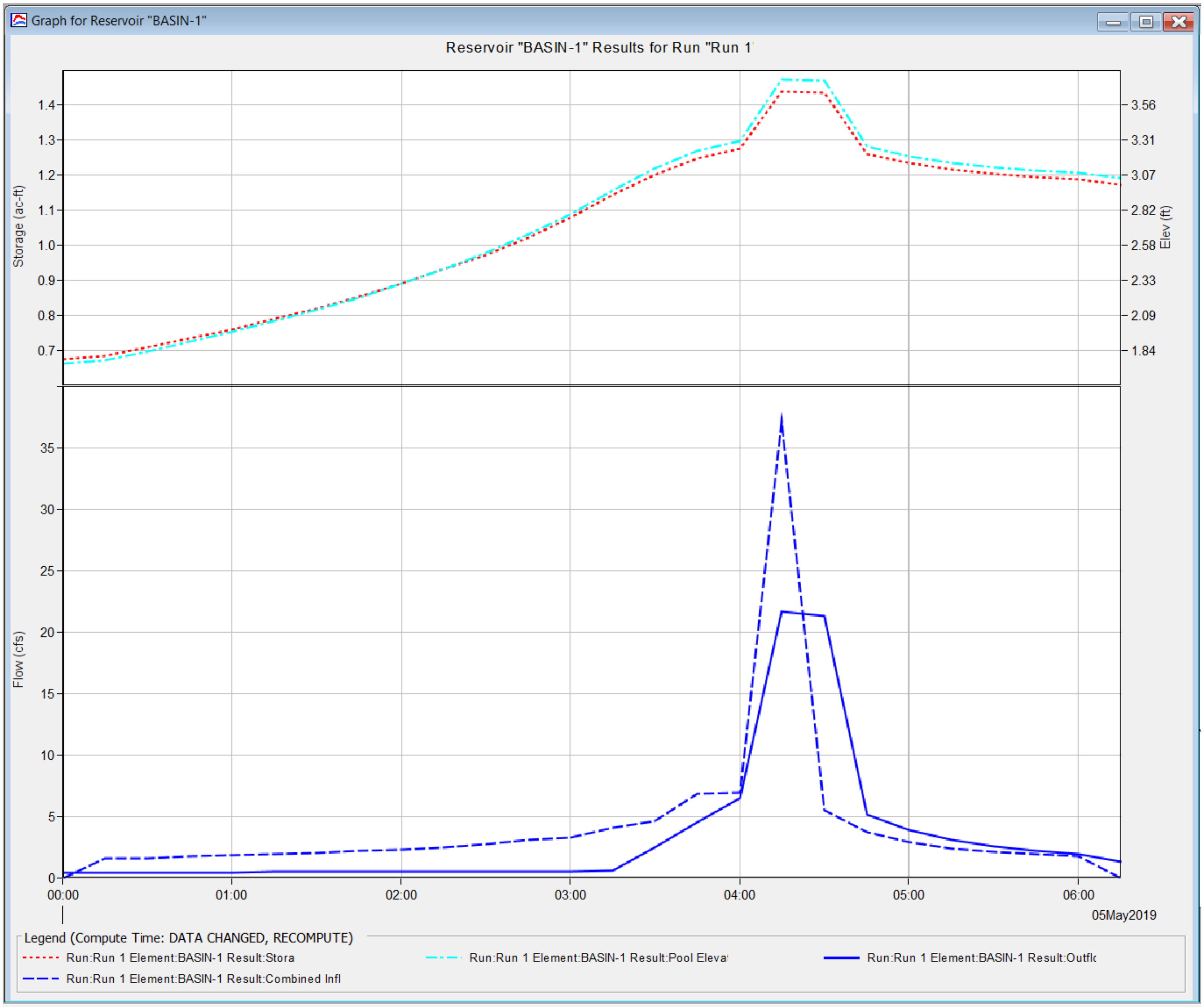
Project: Otay Town Center Simulation Run: Run 1
Reservoir: BASIN-1

Start of Run:	05May2019, 00:00	Basin Model:	Basin 1
End of Run:	05May2019, 06:15	Meteorologic Model:	Met 1
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	Control 1

Volume Units: ◯ IN ◉ ACRE-FT

Computed Results

Peak Inflow:	37.14 (CFS)	Date/Time of Peak Inflow:	05May2019, 04:15
Peak Discharge:	21.62 (CFS)	Date/Time of Peak Discharge:	05May2019, 04:15
Inflow Volume:	2.20 (ACRE-FT)	Peak Storage:	1.44 (ACRE-FT)
Discharge Volume:	1.70 (ACRE-FT)	Peak Elevation:	3.73 (FT)



Global Summary Results for Run "Run 1"

Project: Otay Town Center   Simulation Run: Run 1

Start of Run: 05May2019, 00:00   Basin Model: Basin 1
End of Run: 05May2019, 06:15   Meteorologic Model: Met 1
Compute Time: DATA CHANGED, RECOMPUTE   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: IN ACRE-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (ACRE-FT)
Source-1	0.02404	37.14	05May2019, 04:15	2.20
BASIN-1	0.02404	21.62	05May2019, 04:15	1.70

CHAPTER 5
PRELIMINARY DESILT BASIN CALCULATIONS

PROJECT NAME	Otay Town Center
WORK ORDER	3553-0002
SEDIMENT BASIN	Basin 1 : Node 11

Per Option 3, Part 8 of Section A of the State Water Resources Control Board Order No. 99-08-DWQ, sediment basins shall, at a minimum, be designed as follows:

Sediment basins shall be designed using the standard equation:

$$A_S = \frac{1.2Q}{V_S}$$

Where $\boldsymbol{A_S}$ *is the minimum surface area for trapping soil particles of a certain size;* $\boldsymbol{V_S}$ *is the settling velocity of the design particle size chosen; and* ***Q=CIA*** *where* ***Q*** *is the average discharge rate measured in cfs;* ***I*** *is the average precipitation intensity for the 10-year, 6-hour rain event; and* ***A*** *is the area draining into the sediment basin in acres.*

The design particle size shall be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm) particle, and the $\boldsymbol{V_S}$ *used shall be 100 percent of the calculated settling velocity.*

The length is determined by measuring the distance between the inlet and the outlet; the length shall be more than twice the dimension as the width; the depth shall not be less than three feet nor greater than five feet for safety reasons and for maximum efficiency (two feet of storage, two feet of capacity between storage area and riser). The basin shall be located on the site where it can be maintained on a schedule to retain the two feet of capacity.

TOTAL AREA DRAINING TO BASIN	------------>	***3.45***	**acres**	
WEIGHTED RUNOFF COEFFICIENT	------------>	***0.35***		
10-YEAR, 6-HOUR RAINFALL	------------>	***1.55***	**inches**	*(from County Isopluvial Map)*
AVG. RAINFALL INTENSITY		***0.26***	**in/hr**	
10-YEAR AVERAGE FLOW		***0.3***	**cfs**	
FINE SILT PARTICLE SIZE		***0.01***	**mm**	*(per Option 3 criteria - see above)*
SETTLING VELOCITY		***0.00024***	**ft/sec**	*(per Table 8.1 - see below)*
MINIMUM SURFACE AREA AT BASE OF THE SEDIMENT BASIN		***1560***	**ft^2**	
		or		
		0.04	**acres**	
BASIN LENGTH AT BASE		***57***	**feet**	*(Basin Length >= 2 * Basin Width)*
BASIN WIDTH AT BASE		***28***	**feet**	
BASIN BASE SURFACE AREA		***1588***	**ft^2**	*>= Minimum Base Surface Area*
		or		
		0.04	**acres**	
REQUIRED SEDIMENT STORAGE	------------>	***46.575***	**CY**	*(per Table 5-1 - see below)*
		1258	**ft^3**	
		0.03	**acre-ft**	
BOTTOM OF BASIN ELEVATION	------------->	**615**	**feet**	

TOP OF SEDIMENT STORAGE AREA	------------->	**616.5**	**feet**	*(assume 1.5 feet of sediment vol)*
SEDIMENT STORAGE DEPTH		***1.5***	**feet**	*(assume 2:1 basin side slopes)*
SEDIMENT STORAGE CAPACITY		***2776***	**ft^3**	*> Required Sediment Storage*
		or		
		103	**CY**	
		or		
		0.06	**acre-ft**	
TOP OF RISER ELEVATION		***618.5***	**feet**	*(provide 2 feet above sediment)*
BASIN DEPTH BELOW RISER		**3.5**	**feet**	*(3 <= Depth <= 5 feet)*
BASIN VOLUME UNDER RISER		***7805***	**ft^3**	
		or		
		289	**CY**	
		or		
		0.18	**acre-ft**	
100-YEAR PEAK FLOW TO BASIN	------------>	***7.95***	**cfs**	*(from Hydrology Study)*
100-YEAR HW OVER RISER	------------->	***1.21***	**feet**	*(from riser inlet spreadsheet)*
100-YEAR WSE OVER RISER		***619.71***	**feet**	
REQUIRED FREEBOARD OVER 100-YEAR WSE	------------->	***1***	**ft.**	
TOP OF BASIN ELEVATION	------------->	***620.7***	**feet**	

** Emergency spillway crest elevation shall be set at or above 100-Year WSE. The emergency spillway shall be sized to convey the 100-year runoff assuming 100% clogging of principle spillway.*

FOR BROAD-CRESTED EMERGENCY SPILLWAY WEIRS:

If the SPILLWAY OPENING =	------------->	***5***	**feet**
Then the Crest Elevation Must Be =		***620.0***	**feet**
If the CREST ELEVATION =	------------->	***619.7***	**feet**
Then the Spillway Opening Must Be =		***3.02***	**feet**

* TABLE 8.1 is from the "Erosion & Sediment Control Handbook" by Steven J. Goldman, Katharine Jackson, and Taras A. Bursztynsky; McGraw-Hill Book Company; 1986.

** TABLE 5-1 is from the "San Diego County Hydrology Manual (Draft)" prepared by the County of San Diego Department of Public Works - Flood Control Section; September 2001.

PROJECT NAME	Otay Town Center
WORK ORDER	3553-0002
SEDIMENT BASIN	Basin 2 : Node 13

Per Option 3, Part 8 of Section A of the State Water Resources Control Board Order No. 99-08-DWQ, sediment basins shall, at a minimum, be designed as follows:

Sediment basins shall be designed using the standard equation:

$$A_S = \frac{1.2Q}{V_S}$$

Where A_S *is the minimum surface area for trapping soil particles of a certain size;* V_S *is the settling velocity of the design particle size chosen; and* ***Q=CIA*** *where* ***Q*** *is the average discharge rate measured in cfs;* ***I*** *is the average precipitation intensity for the 10-year, 6-hour rain event; and* ***A*** *is the area draining into the sediment basin in acres.*

The design particle size shall be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm) particle, and the V_S *used shall be 100 percent of the calculated settling velocity.*

The length is determined by measuring the distance between the inlet and the outlet; the length shall be more than twice the dimension as the width; the depth shall not be less than three feet nor greater than five feet for safety reasons and for maximum efficiency (two feet of storage, two feet of capacity between storage area and riser). The basin shall be located on the site where it can be maintained on a schedule to retain the two feet of capacity.

TOTAL AREA DRAINING TO BASIN	------------>	2.66	acres	
WEIGHTED RUNOFF COEFFICIENT	------------>	0.35		
10-YEAR, 6-HOUR RAINFALL	------------>	1.55	inches	(from County Isopluvial Map)
AVG. RAINFALL INTENSITY		0.26	in/hr	
10-YEAR AVERAGE FLOW		0.2	cfs	
FINE SILT PARTICLE SIZE		0.01	mm	(per Option 3 criteria - see above)
SETTLING VELOCITY		0.00024	ft/sec	(per Table 8.1 - see below)
MINIMUM SURFACE AREA AT BASE OF THE SEDIMENT BASIN		1203	ft^2	
		or		
		0.03	acres	
BASIN LENGTH AT BASE		50	feet	(Basin Length >= 2 * Basin Width)
BASIN WIDTH AT BASE		25	feet	
BASIN BASE SURFACE AREA		1227	ft^2	>= Minimum Base Surface Area
		or		
		0.03	acres	
REQUIRED SEDIMENT STORAGE	------------>	35.91	CY	(per Table 5-1 - see below)
		970	ft^3	
		0.02	acre-ft	
BOTTOM OF BASIN ELEVATION	------------->	611.1	feet	

TOP OF SEDIMENT STORAGE AREA	------------->	**612.1**	**feet**	*(assume 1 feet of sediment vol)*
SEDIMENT STORAGE DEPTH		***1***	**feet**	*(assume 2:1 basin side slopes)*
SEDIMENT STORAGE CAPACITY		***1380***	**ft^3**	*> Required Sediment Storage*
		or		
		51	**CY**	
		or		
		0.03	**acre-ft**	
TOP OF RISER ELEVATION		***614.1***	**feet**	*(provide 2 feet above sediment)*
BASIN DEPTH BELOW RISER		**3**	**feet**	*(3 <= Depth <= 5 feet)*
BASIN VOLUME UNDER RISER		***5131***	**ft^3**	
		or		
		190	**CY**	
		or		
		0.12	**acre-ft**	
100-YEAR PEAK FLOW TO BASIN	------------>	***6.13***	**cfs**	*(from Hydrology Study)*
100-YEAR HW OVER RISER	------------->	***0.72***	**feet**	*(from riser inlet spreadsheet)*
100-YEAR WSE OVER RISER		***614.82***	**feet**	
REQUIRED FREEBOARD OVER 100-YEAR WSE	------------->	***1***	**ft.**	
TOP OF BASIN ELEVATION	------------->	***615.8***	**feet**	

** Emergency spillway crest elevation shall be set at or above 100-Year WSE. The emergency spillway shall be sized to convey the 100-year runoff assuming 100% clogging of principle spillway.*

FOR BROAD-CRESTED EMERGENCY SPILLWAY WEIRS:

If the SPILLWAY OPENING =	------------->	***5***	**feet**
Then the Crest Elevation Must Be =		***615.2***	**feet**
If the CREST ELEVATION =	------------->	***614.8***	**feet**
Then the Spillway Opening Must Be =		***2.31***	**feet**

* TABLE 8.1 is from the "Erosion & Sediment Control Handbook" by Steven J. Goldman, Katharine Jackson, and Taras A. Bursztynsky; McGraw-Hill Book Company; 1986.

** TABLE 5-1 is from the "San Diego County Hydrology Manual (Draft)" prepared by the County of San Diego Department of Public Works - Flood Control Section; September 2001.

PROJECT NAME	Otay Town Center
WORK ORDER	3553-0002
SEDIMENT BASIN	Basin 3 : Node 7

Per Option 3, Part 8 of Section A of the State Water Resources Control Board Order No. 99-08-DWQ, sediment basins shall, at a minimum, be designed as follows:

Sediment basins shall be designed using the standard equation:

$$A_S = \frac{1.2Q}{V_S}$$

Where A_S *is the minimum surface area for trapping soil particles of a certain size;* V_S *is the settling velocity of the design particle size chosen; and* ***Q=CIA*** *where* ***Q*** *is the average discharge rate measured in cfs;* ***I*** *is the average precipitation intensity for the 10-year, 6-hour rain event; and* ***A*** *is the area draining into the sediment basin in acres.*

The design particle size shall be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm) particle, and the V_S *used shall be 100 percent of the calculated settling velocity.*

The length is determined by measuring the distance between the inlet and the outlet; the length shall be more than twice the dimension as the width; the depth shall not be less than three feet nor greater than five feet for safety reasons and for maximum efficiency (two feet of storage, two feet of capacity between storage area and riser). The basin shall be located on the site where it can be maintained on a schedule to retain the two feet of capacity.

TOTAL AREA DRAINING TO BASIN	------------>	*0.44*	acres	
WEIGHTED RUNOFF COEFFICIENT	------------>	*0.35*		
10-YEAR, 6-HOUR RAINFALL	------------>	*1.55*	inches	(from County Isopluvial Map)
AVG. RAINFALL INTENSITY		*0.26*	in/hr	
10-YEAR AVERAGE FLOW		*0.04*	cfs	
FINE SILT PARTICLE SIZE		*0.01*	mm	(per Option 3 criteria - see above)
SETTLING VELOCITY		*0.00024*	ft/sec	(per Table 8.1 - see below)
MINIMUM SURFACE AREA AT BASE OF THE SEDIMENT BASIN		*199*	ft^2	
		or		
		0.00	acres	
BASIN LENGTH AT BASE		*21*	feet	(Basin Length >= 2 * Basin Width)
BASIN WIDTH AT BASE		*10*	feet	
BASIN BASE SURFACE AREA		*209*	ft^2	>= Minimum Base Surface Area
		or		
		0.00	acres	
REQUIRED SEDIMENT STORAGE	------------>	*5.94*	CY	(per Table 5-1 - see below)
		160	ft^3	
		0.00	acre-ft	
BOTTOM OF BASIN ELEVATION	------------->	612.6	feet	

TOP OF SEDIMENT STORAGE AREA	------------->	**613.6**	**feet**	*(assume 1 feet of sediment vol)*
SEDIMENT STORAGE DEPTH		***1***	**feet**	*(assume 2:1 basin side slopes)*
SEDIMENT STORAGE CAPACITY		***275***	**ft^3**	*> Required Sediment Storage*
		or		
		10	**CY**	
		or		
		0.01	**acre-ft**	
TOP OF RISER ELEVATION		***615.6***	**feet**	*(provide 2 feet above sediment)*
BASIN DEPTH BELOW RISER		**3**	**feet**	*(3 <= Depth <= 5 feet)*
BASIN VOLUME UNDER RISER		***1291***	**ft^3**	
		or		
		48	**CY**	
		or		
		0.03	**acre-ft**	
100-YEAR PEAK FLOW TO BASIN	------------>	***1.01***	**cfs**	*(from Hydrology Study)*
100-YEAR HW OVER RISER	------------->	***0.16***	**feet**	*(from riser inlet spreadsheet)*
100-YEAR WSE OVER RISER		***615.76***	**feet**	
REQUIRED FREEBOARD OVER 100-YEAR WSE	------------->	***1***	**ft.**	
TOP OF BASIN ELEVATION	------------->	***616.8***	**feet**	

** Emergency spillway crest elevation shall be set at or above 100-Year WSE. The emergency spillway shall be sized to convey the 100-year runoff assuming 100% clogging of principle spillway.*

FOR BROAD-CRESTED EMERGENCY SPILLWAY WEIRS:

If the SPILLWAY OPENING =	------------->	***5***	**feet**
Then the Crest Elevation Must Be =		***616.6***	**feet**
If the CREST ELEVATION =	------------->	***615.8***	**feet**
Then the Spillway Opening Must Be =		***0.38***	**feet**

* TABLE 8.1 is from the "Erosion & Sediment Control Handbook" by Steven J. Goldman, Katharine Jackson, and Taras A. Bursztynsky; McGraw-Hill Book Company; 1986.

** TABLE 5-1 is from the "San Diego County Hydrology Manual (Draft)" prepared by the County of San Diego Department of Public Works - Flood Control Section; September 2001.

PROJECT NAME	Otay Town Center
WORK ORDER	3553-0002
SEDIMENT TRAP	Sediment Trap: Node 16

Per Section SE-3 (Sediment Trap) of the California Stormwater BMP Handbook, Sediment Traps may be used on construction projects where the drainage area is less than 5 acres.

Trap should be sized to accommodate a settling zone and a sediment storage zone with a recommended minimum cvolumes of 67 CY/acre and 33 CY/acre of contributing drainage area, respectively, based ona 0.5 in. of runoff volume over a 24-hour period.

GRADED AREA TO BASIN	------------>	*3.66*	**acres**	
100-YEAR PEAK FLOW TO BASIN	------------>	*8.44*	**cfs**	
REQUIRED STORAGE CAPACITY BELOW PRINCIPLE OUTLET ELEV.		***9882***	**ft^3**	
		366	**CY**	
		0.23	**acre-ft.**	
BOTTOM OF BASIN ELEVATION	------------->	610.1	**feet**	
PRINCIPLE SPILLWAY EL.	------------->	613.6	**feet**	
DEPTH BELOW PRINCIPLE OUTLET		**3.5**	**feet**	
DESIGN BASIN BOTTOM WIDTH	------------->	30	**feet**	
DESIGN BASIN BOTTOM LENGTH		***61***	**feet**	(Length > = 2 * Width)
DESIGN STORAGE CAPACITY BELOW PRINCIPLE OUTET ELEV.		***10135***	**ft^3**	(Assume 3:1 Basin Side Slopes)
		375	**CY**	
		0.23	**acre-ft.**	
FREEBOARD ABOVE 100-YEAR WSE	------------->	*1*	**ft.**	
TOP OF BASIN ELEVATION	------------->	*614.6*	**feet**	

FOR BROAD-CRESTED EMERGENCY SPILLWAY WEIRS:

If the SPILLWAY OPENING =	------------->	*5*	**feet**	
Then the Crest Elevation Must Be =		***613.86***	**feet**	
If the CREST ELEVATION =	------------->	*613.60*	**feet**	Use 4.0' wide spillway
Then the Spillway Opening Must Be =		***3.18***	**feet**	at Elev 3.5

*• Restrict basin side slopes to 3:1 or flatter

*Any water standing for more than 72 hours will be pumped out of the basin and dispersed throughout the project over pervious areas and/or filtered and discharged to the storm drain system

Otay Town Center

DESILTING BASIN RISER SIZES

Weir Formula for Orifices & Short Tubes (free & submerged)

$Q = Ca(2gh)^{0.5}(0.85)$, where 0.85 is a reduction factor for trash rack
$Q = 0.6a(64.32h)^{0.5}(0.85)$; C = 0.6 from Table 4-10, Kings Handbook
$Q = 4.1a(h)^{0.5}$, where a = area of orifice opening, h = head (ft) above top of riser

then $h = (Q/4.1a)^2$ (Equation 1)

Weir Formula for riser acting as straight weir

$Q = CLH^{1.5}$; C = 3.3 from Equation 5-40, Kings Handbook

then $h = (Q/3.3L)^{2/3}$ (Equation 2)

Basin 1
@ Node 11 :

Q_{100} =	7.95 cfs				
Riser d =	18 in., so a =	1.767 sq. ft.;	h =	1.21 ft. (Equation 1)	
	L =	4.712 ft.;	h =	0.64 ft. (Equation 2)	
				therefore:	h = 1.21 ft.

Basin 2
@ Node 13 :

Q_{100} =	6.13 cfs				
Riser d =	18 in., so a =	1.767 sq. ft.;	h =	0.72 ft. (Equation 1)	
	L =	4.712 ft.;	h =	0.538 ft. (Equation 2)	
				therefore:	h = 0.72 ft.

Basin 3
@ Node 13 :

Q_{100} =	1.01 cfs				
Riser d =	18 in., so a =	1.767 sq. ft.;	h =	0.02 ft. (Equation 1)	
	L =	4.712 ft.;	h =	0.162 ft. (Equation 2)	
				therefore:	h = 0.16 ft.

MASS GRADING HYDROLOGY

Flows to Basin 1

100 YEAR DEVELOPED CONDITIONS HYDROLOGIC ANALYSIS

PER COUNTY OF SD ISOPLUVIAL MAPS - P_6 100 = 2.5 in

Assume Minimum Allowable TC per San Diego County Methodology - TC = 5.00 mins

Intensity - i = $7.44 P_6 D^{-0.645}$ (San Diego County Hydrology Manual)

Therefore - i = 6.59 in/hr

Using Rational Method - Q = CiA

Runoff Coefficients per San Diego County Criteria

Paved Areas = 0.82 (type D soil onsite)
n Space/Natural Area = 0.35 (type D soil onsite)

Max Tributary Area

Graded Pad Basin 1

A =	150282	sqft	Therefore		
A =	3.45	acres		Q =	CIA
i =	6.59	in/hr	Runoff =	7.95	cfs
C =	0.35				

MASS GRADING HYDROLOGY

Flows to Basin 2

100 YEAR DEVELOPED CONDITIONS HYDROLOGIC ANALYSIS

PER COUNTY OF SD ISOPLUVIAL MAPS - P_6 100 = 2.5 in

Assume Minimum Allowable TC per San Diego County Methodology - TC = 5.00 mins

Intensity - i = $7.44 P_6 D^{-0.645}$ (San Diego County Hydrology Manual)

Therefore - i = 6.59 in/hr

Using Rational Method - Q = CiA

Runoff Coefficients per San Diego County Criteria

Paved Areas = 0.82 (type D soil onsite)
n Space/Natural Area = 0.35 (type D soil onsite)

Max Tributary Area

Graded Pad Basin 1

A =	115870	sqft	Therefore		
A =	2.66	acres		Q =	CIA
i =	6.59	in/hr	Runoff =	6.13	cfs
C =	0.35				

MASS GRADING HYDROLOGY

Flows to Basin 3

100 YEAR DEVELOPED CONDITIONS HYDROLOGIC ANALYSIS

PER COUNTY OF SD ISOPLUVIAL MAPS - P_6 100 = 2.5 in

Assume Minimum Allowable TC per San Diego County Methodology - TC = 5.00 mins

Intensity - i = $7.44P_6D^{-0.645}$ (San Diego County Hydrology Manual)

Therefore - i = 6.59 in/hr

Using Rational Method - Q = CiA

Runoff Coefficients per San Diego County Criteria

Paved Areas =	0.82	(type D soil onsite)
n Space/Natural Area =	0.35	(type D soil onsite)

Max Tributary Area

Graded Pad Basin 1

A =	19166	sqft	Therefore	
A =	0.44	acres	Q =	CIA
i =	6.59	in/hr	Runoff =	1.01 cfs
C =	0.35			

MASS GRADING HYDROLOGY

Flows to Sediment Trap

100 YEAR DEVELOPED CONDITIONS HYDROLOGIC ANALYSIS

PER COUNTY OF SD ISOPLUVIAL MAPS - P_6 100 = 2.5 in

Assume Minimum Allowable TC per San Diego County Methodology - TC = 5.00 mins

Intensity - i = $7.44P_6D^{-0.645}$ (San Diego County Hydrology Manual)

Therefore - i = 6.59 in/hr

Using Rational Method - Q = CiA

Runoff Coefficients per San Diego County Criteria

Paved Areas =	0.82	(type D soil onsite)
n Space/Natural Area =	0.35	(type D soil onsite)

Max Tributary Area

Graded Pad Basin 1

A =	159430	sqft	Therefore	
A =	3.66	acres	Q =	CIA
i =	6.59	in/hr	Runoff =	8.44 cfs
C =	0.35			

Otay Town Center
LS Factor Determination

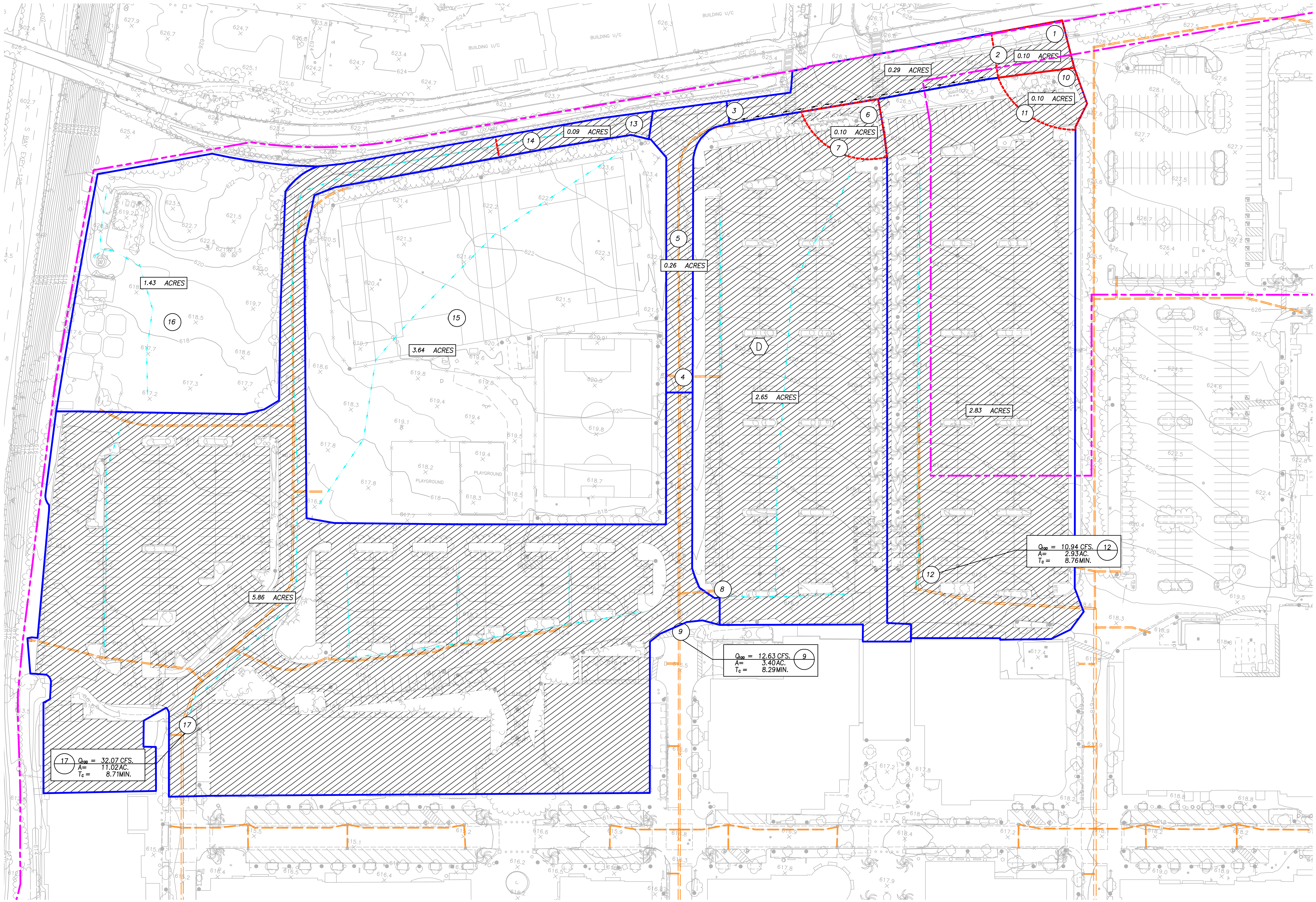
Tract Area (acres)	AVERAGE WATERSHED SLOPE (%)							
	0	1	2	5	8	10	12	15	
0	0	0	0	0	0	0	0	0	
0.44	0	5.94	11.88	15.4	16.28	17.6	19.8	22	Basin 3
2.66	0	35.91	71.82	93.1	98.42	106.4	119.7	133	Basin 2
3.45	0	46.575	93.15	120.75	127.65	138	155.25	172.5	Basin 1
10	0	135	270	350	370	400	450	500	
15	0	200	400	420	460	600	675	750	
20	0	270	540	700	740	800	900	1000	
40	0	540	1080	1400	1480	1600	1800	2000	
80	0	1080	2160	2800	2960	3200	3600	4000	
100	0	1350	2700	3500	3700	4000	4500	5000	
150	0	2000	4000	4200	4600	6000	6750	7500	
200	0	2700	5400	7000	7400	8000	9000	10000	

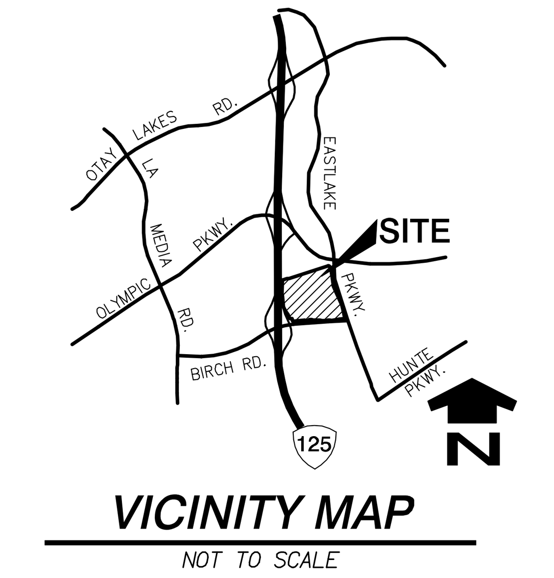
CHAPTER 6

EXHIBIT 1
EXISTING CONDITION
HYDROLOGY MAP

EXHIBIT 2
DEVELOPED CONDITION
HYDROLOGY MAP

EXHIBIT 3
OVERLAY OF FLOOD INSURANCE RATE MAP





VICINITY MAP

NOT TO SCALE

LEGEND

- PROJECT BOUNDARY
- DRAINAGE BOUNDARY
- DAYLIGHT
- INITIAL SUBAREA
- FLOW DIRECTION
- 00.00 ACRES — AREA
- EX. STORM DRAIN
- D — HYDROLOGIC SOIL TYPE
- 406 — NODE NUMBER
- EXISTING PAVED AREA

PREPARED BY:

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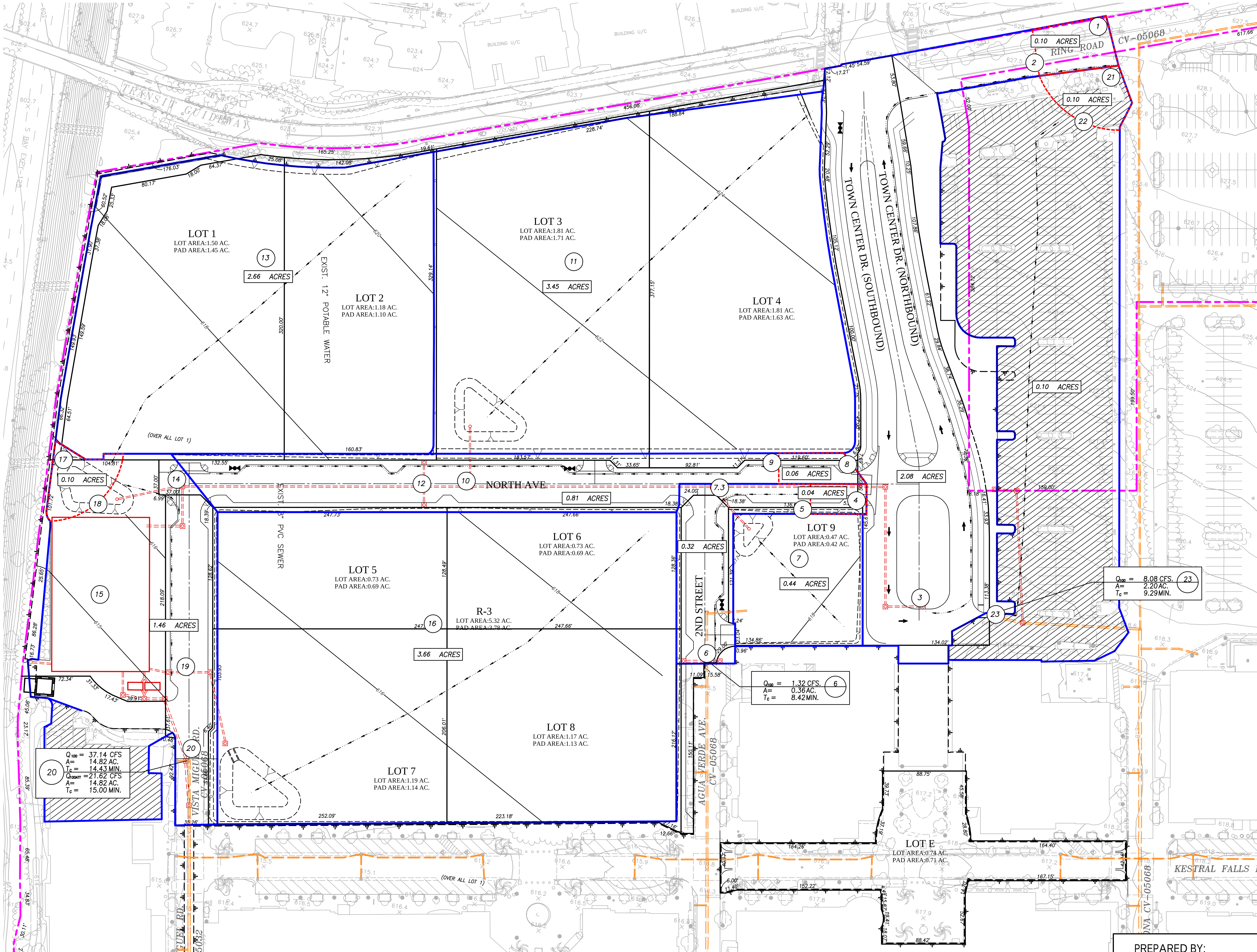
EXISTING DRAINAGE MAP

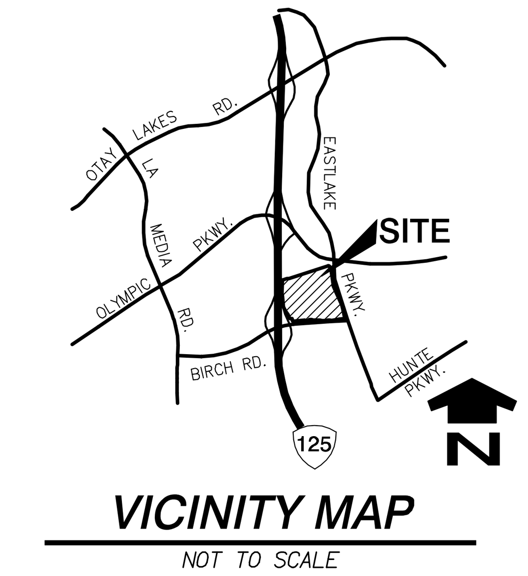
OTAY TOWN CENTER

CITY OF CHULA VISTA, CALIFORNIA

MAP 1 OF 2

W.O.# 9999-2390





LEGEND

- PROJECT BOUNDARY
- DRAINAGE BOUNDARY
- DAYLIGTH
- INITIAL SUBAREA
- PROPOSED STORM DRAIN
- EXISTING STORM DRAIN
- FLOW DIRECTION
- 00.00 ACRES — AREA
- HYDROLOGIC SOIL TYPE
- 406 — NODE NUMBER
- EXISTING IMPERVIOUS

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PROPOSED DRAINAGE MAP

OTAY TOWN CENTER

CITY OF CHULA VISTA, CALIFORNIA

MAP 2 OF 2

W.O.# 9999-2390

National Flood Hazard Layer FIRMette

FEMA

116°58'31"W 32°37'48"N

116°57'53"W 32°37'18"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- (B) 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/24/2021 at 2:04 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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