PRELIMINARY OFFSITE DRAINAGE ANALYSIS
HYDROLOGY AND HYDRAULICS

5150 UNIVERSITY AVENUE

SAN DIEGO, CA

PREPARED FOR:

INTEGRAS PARTHNERS

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Sherman Oaks, CA 91403

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Date Prepared: February 11, 2023

Mellor R. Landy RCE 81085 Exp 9/30/2023

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1.0 INTRODUCTION

The purpose of this study is to quantify the total runoff generated in the 100-year storm event for the drainage basin contributing to the existing 30-inch RCP storm drain that conveys runoff through the proposed project site. The analysis also analyzes existing pipe hydraulics and proposed storm drain layouts to determine the available capacity and hydraulic grade line to support to proposed development of the site.

1.1 Project Location

The project is located at 5150 University Avenue, at the northwest corner of 52nd Street and University Avenue the City of San Diego, County of San Diego, and State of California.

1.1.1 Vicinity Map

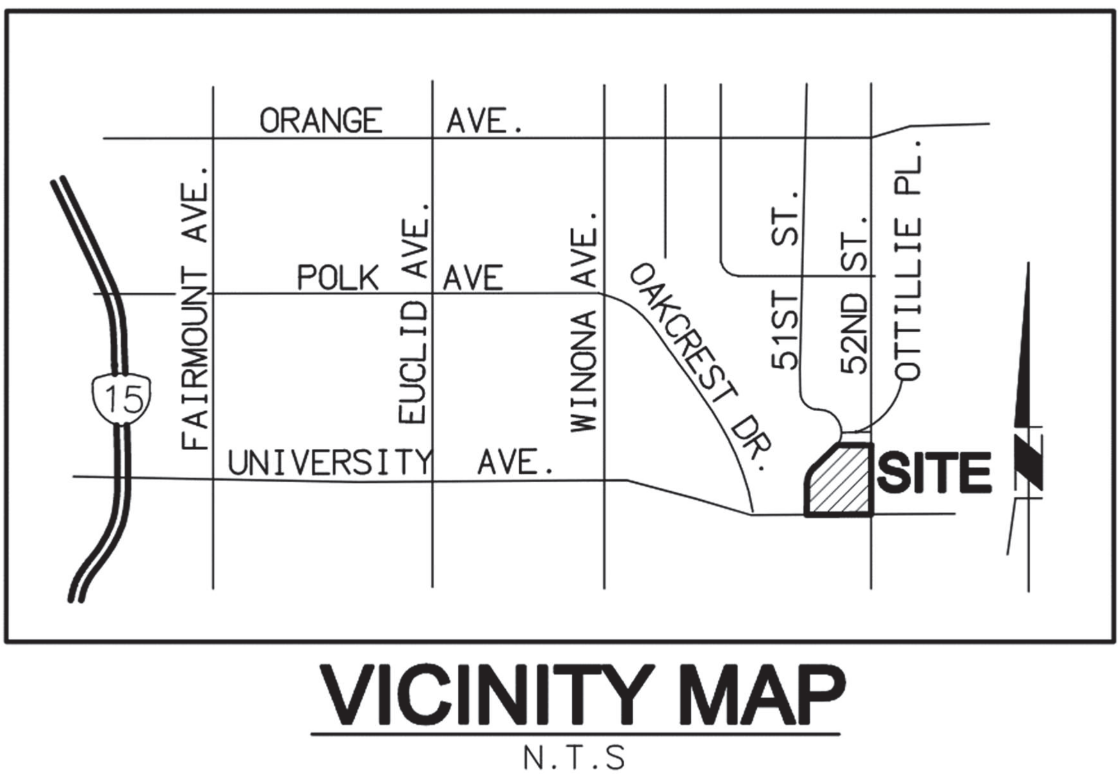


Figure 1-1: Vicinity Map

2.0 DECLARATION OF RESPONSIBLE CHARGE

I hereby declare that I am the Civil Engineer of Work for this project, that I have exercised responsible charge over the design of the project as defined in Section 6703 of the Business and Professions Code, and that the design is consistent with current standards.

I understand that the check of the project design reports and calculations by the City of San Diego is confined to review only and does not relieve me, as Engineer of Work, of my responsibilities for project design.

Mellor R. Landy, P.E. 81085, Exp. 9-30-2023 Date

3.0 PROJECT DESCRIPTION

3.1 Drainage Basin Description

The pipe segment of interest in this analysis is a 30-inch RCP storm drain that crosses the project site at 5150 University Avenue, draining flows from east to west from 52nd Street to the subgrade portion of the Home Avenue Channel at 51st Street.

The overall drainage basin contributing runoff to this storm drain encompasses roughly 67.2 Acres. The land-use through this area is a mix of commercial, multi-family residential and park/open space with the Colina Park Golf Course and Colina Del Sol Park. The drainage basin is roughly bounded by Orange Avenue to the north, Wightman Street to the south, 54th Street to the east and 52nd Street to the west. Additional areas west of 52nd Street, along University Avenue also contribute runoff to the storm drain system

3.2 Existing Infrastructure Description and Drainage Pattern

Runoff from the drainage basin can be generally broken into the northern sub basin and the southern sub basin. These two drainage sub basins are roughly separated by 52nd Place, at the low point of the overall drainage basin.

Runoff from the northly sub basin generally flows from northeast, to southwest. Runoff drains within the gutter along Orange Avenue where it is collected within an existing 18-inch RCP storm drain by the existing curb inlets. The 18-inch RCP drains collected runoff southerly, and discharges onto the Colina Park Golf Course (Node 104). Runoff from the golf course and existing park follows the overall northeast to southwest drainage pattern, flowing via sheet flow and through undefined drainage pathways through the park and eventually being collected by an 18-inch RCP storm drain within the golf course (Node 107). This storm drain conveys runoff to the southwest, where it confluences with the main storm drain infrastructure within 52nd Street.

Runoff from the southern sub basin generally drains from southeast to northwest. Runoff drains along the existing curb and gutter until it is collected via a series of catch basins and curb inlets. The most upstream inlet falls within the existing alley between Rex Avenue to the north and Wightman Street to the south. Runoff is collected within an existing 18-inch RCP storm drain and conveyed north, towards University Avenue. Here, a series of curb inlets collects runoff from University Avenue and the surrounding areas, and confluences with the flow from upstream areas. The existing system downstream from the confluence at University Avenue is a 24-inch RCP storm drain. This 24-inch storm drain conveys collected runoff northwesterly to the confluence with the northern sub basin system. Beyond this confluence (Node 127), the storm drain transitions to a 30-inch RCP, which is the segment of interest of this study.

4.0 METHOD OF ANALYSIS

Since the project area is less than 1 square mile, the study utilized the rational method, in accordance with the City of San Diego Drainage Design Manual (City of San Diego, 2017). The following provides excerpts from the Drainage Design Manual.

Rational Method and Modified Rational Method

A.1. Rational Method (RM)

The Rational Method (RM) is a mathematical formula used to determine the maximum runoff rate from a given rainfall. It has particular application in urban storm drainage where it is used to estimate peak runoff rates from small urban and rural watersheds for the design of storm drains and drainage structures. The RM is recommended for analyzing the runoff response from drainage areas for watersheds less than 0.5 square miles. It should not be used in instances where there is a junction of independent drainage systems or for drainage areas greater than approximately 0.5 square mile in size. In these instances, the Modified Rational Method (MRM) should be used for junctions of independent drainage systems in watersheds up to approximately 1 square mile in size (see Section A.2); or the NRCS Hydrologic Method should be used for watersheds greater than approximately 1 square mile in size (see Appendix B).

A1.1. Rational Method Formula

The RM formula estimates the peak rate of runoff at any location in a watershed as a function of the drainage area (A), runoff coefficient (C), and rainfall intensity (I) for a duration equal to the time of concentration (Tc), which is the time required for water to flow from the most remote point of the basin to the location being analyzed. The RM formula is expressed in Equation A-1.

Equation A-1. RM Formula Expression

$$Q = C\ I\ A$$

where: Q =

peak discharge, in cubic feet per second (cfs)

C	=	runoff coefficient expressed as that percentage of rainfall which becomes surface runoff (no units); Refer to Appendix A.1.2
I	=	average rainfall intensity for a storm duration equal to the time of concetrnatation (T_c) of the contributing draiange area, in inches per hour; Refer to Appendix A.1.3 and Appendix A.1.4
A	=	drainage area contributing to the design location, in acres

Combining the units for the expression CIA yields:

$$\left(\frac{1\text{ acre} \times \text{inch}}{\text{hour}}\right)\left(\frac{43{,}560\text{ ft}^2}{\text{acre}}\right)\left(\frac{1\text{ foot}}{12\text{ inches}}\right)\left(\frac{1\text{ hour}}{3{,}600\text{ seconds}}\right) \Rightarrow 1.008\text{ cfs}$$

For practical purposes, the unit conversion coefficient difference of 0.8% can be ignored.

The RM formula is based on the assumption that for constant rainfall intensity, the peak discharge rate at a point will occur when the raindrop that falls at the most upstream point in the tributary drainage basin arrives at the point of interest.

Unlike the MRM (discussed in Appendix A.2) or the NRCS hydrologic method (discussed in Appendix B), the RM does not create hydrographs and therefore does not add separate subarea hydrographs at collection points. Instead, the RM develops peak discharges in the main line by increasing the Tc as flow travels downstream.

Characteristics of, or assumptions inherent to, the RM are listed below:

1. The discharge resulting from any I is maximum when the I lasts as long as or longer than the Tc.
2. The storm frequency of peak discharges is the same as that of I for the given Tc.
3. The fraction of rainfall that becomes runoff (or the runoff coefficient, C) is independent of I or precipitation zone number (PZN) condition (PZN Condition is discussed in the NRCS method).
4. The peak rate of runoff is the only information produced by using the RM.

A.1.2. Runoff Coefficient

The runoff coefficients are based on land use (see Table A–1). Soil type "D" is used throughout the City of San Diego for storm drain conveyance design. An appropriate runoff coefficient (C) for each type of land use in the subarea should be selected from this table and multiplied by the percentage of the total area (A) included in that class. The sum of the products for all land uses is the weighted runoff coefficient. Good engineering judgment should be used when applying the values presented in Table A–1, as adjustments to these values may be appropriate based on site-specific characteristics.

Table A-1. Runoff Coefficients for Rational Method

Land Use	Runoff Coefficient (C)
	Soil Type (1)
Residential:	
Single Family 50% Impervious	0.55
Multi–Units 65% Impervious	0.70
Mobile Homes	0.65
Rural (lots greater than ½ acre)	0.45
Commercial (2)	
80% Impervious	0.85
Industrial (2)	
90% Impervious	0.95

Note:

(1) Type D soil to be used for all areas.

(2) Where actual conditions deviate significantly from the tabulated imperviousness values of 80% or 90%, the values given for coefficient C, may be revised by multiplying 80% or 90% by the ratio of actual imperviousness to the tabulated imperviousness. However, in no case shall the final coefficient be less than 0.50. For example: Consider commercial property on D soil.

Actual imperviousness	=	50%
Tabulated imperviousness	=	80%
Revised C = (50/80) x 0.85	=	0.53

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

A.1.3. Rainfall Intensity

The rainfall intensity (I) is the rainfall in inches per hour (in/hr.) for a duration equal to the Tc for a selected storm frequency. Once a particular storm frequency has been selected for design and a Tc calculated for the drainage area, the rainfall intensity can be determined from the Intensity-Duration-Frequency Design Chart (Figure A-1).

5.0 HYDROLOGIC ANALYSIS CALCULATIONS AND RESULTS

5.1 Calculation Methods

The analysis was performed using Advanced Engineering Software (AES), which has built-in capabilities to perform Modified Rational Method Calculations. The inputs included the subarea acreage, land-use, flow length, and representative elevations of the site. The program calculates the time of concentration and corresponding intensity to determine the peak flow rates. The user must also input a "code" value which signifies what type of hydrologic/hydraulic computation is to be performed. A summary of the specific codes is provided below in Table 5-1.

Per the City of San Diego Drainage Design Manual Table A-1, based on soil type D, the runoff coefficient used in the hydrologic calculations corresponded to a commercial development with varying percentages of impervious area. By using a weighted calculation based on the tabulated and actual impervious percentages and runoff coefficients, the pre- and post-project C values were determined and entered directly into the hydrologic model.

Table 5-1: AES Code Summary Table	
Code Number	Function
0	Enter Comment
1	Confluence Analysis at Node
2	Initial Subarea Analysis
3	Pipe/Box/Culvert Traveltime (Computer Sized)
4	Pipe/Box/Culvert Traveltime (User Sized)
5	Open Channel Traveltime
6	Streetflow Analysis Through Subarea
7	User-Specified Hydrology Data at Node
8	Addition of Subarea Runoff To Main Stream
9	V-Gutter Flow Through Subarea
10	Copy Main-Stream Data onto A Memory Bank
11	Confluence A Memory Bank with The Main-Stream Memory
12	Clear A Memory Bank
13	Clear The Main Stream
14	Copy A Memory Bank onto The Main-Stream Memory
15	Hydrologic Data Bank Storage Functions
16	User-Specified Source Flow at A Node

The AES hydrologic analysis calculates runoff intensity as a function of the time of concentration. In order to develop a curve corresponding to the City of San Diego intensity-duration values, the eight (8) pairs of values shown in Table 5-2 were manually input into the model for the 100-year storm event.

Table 5-2: AES Intensity-Duration Pairs	
Time of Concentration (min)	Intensity (inches/hour)
5	4.4
7	3.9
10	3.5
15	2.9
20	2.5
30	2.0
60	1.3
120	0.86

5.2 Calculation Limitations and Assumptions

The hydrologic calculations performed in this analysis have some limitations and are limited solely to the maximum peak flow rates that are expected to be generated during the 100-year storm event. The analysis assumes all runoff will eventually reach the downstream extent of the model and will not be limited by existing under-sized infrastructure or be collected within low-lying areas such as ponds within the golf courses or other localized depressions.

The goal of this analysis was to determine the peak runoff flow rates that could be expected to reach the project site and be collected within the existing 30-inch RCP storm drain crossing 5150 University Avenue.

The analysis was performed based on the following assumptions:

- Runoff would all eventually be routed to the downstream extent of the analysis
- Undersized storm drain facilities would convey runoff at a velocity corresponding to full-depth flow despite potential pressurization in certain areas
- Manning's n-value of 0.013 was used for all pipe segments
- No assumed ponding or flow attenuation from golf course ponds or localized depressions
- Storm drain invert elevations based on GIS data available from SanGIS when no as-built or record plans were available.

5.3 Drainage Basin Runoff Summary

The complete output from the AES modified rational method analysis for the hydrologic analysis is provided as an appendix to this report. A summary of the pre-project calculated peak flow rates are provided in Table 5 3.

Table 5-3: Pre-project hydrologic analysis summary						
Node	Area (ac)	Flow Length (ft)	Weighted C-Value	Tc (mins)	Intensity (in/hr)	Q (cfs)
103	4.9	585	0.85	5.5	4.2	17.8
107	21.6	1480	0.54	9.4	3.6	42.3
108	36.2	1925	0.52	10.0	3.5	66.5
116	2.8	653	0.70	5	4.4	8.6
117	2.4	430	0.85	5	4.4	8.9
120	7.7	1568	0.75	6.6	4.0	23.4
123	10.5	1893	0.74	7.1	3.9	30.2
113	46.8	2040	0.57	10.2	3.5	93.6
130	4.6	620	0.70	7.6	3.8	12.4
131	14.6	1245	0.70	10.0	3.5	35.9
135	17.5	1305	0.70	10.5	3.5	44.2
127	67.2	2175	0.64	10.7	3.4	146.2

The segment of interest on the project site occurs downstream of Node 127, which is the 30-inch RCP storm drain crossing 52nd Street and continuing west through the property at 5150 University Avenue.

The total flow of 146.2 cubic-feet per second, assumes all upstream facilities are sized appropriately and all runoff reaches the 30-inch RCP through the storm drain network. In other terms, this maximum flow rate represents ultimate conditions in which all undersized upstream facilities have been improved to provide adequate capacity for anticipated peak flows. A truncated hydraulic analysis of the existing system was also performed to determine the capacity of the existing system and to determine the existing hydraulic grade line in the 30-inch RCP storm drain on the project site.

6.0 HYDRAULIC ANALYSIS

6.1 Existing Storm Drain Hydraulic Analysis

The hydraulic analysis performed in this study focused on the 30-inch RCP storm drain draining through the property located at 5150 University Avenue. The analysis incorporates the two main tributary pipes that collect runoff from the areas north east of the property, as well as the areas south of the property rather than modeling the entirety of the existing storm drain infrastructure.

Modeling Methodology

The existing storm drain network was first modeled by utilizing record plan information, where available, and supplementing the analysis with GIS data available by the City of San Diego. This model was imported into the Autodesk Storm and Sanitary Analysis (S&S Analysis). S&S Analysis performs energy-based, standard-step methods to compute the hydraulic profile. The calculations utilize Bernoulli's Energy Equation and Manning's Equation to determine pipe losses.

Once the existing storm drain system was modeled in S&S Analysis, known flows (Qs) were input for each junction as external inflows as calculated with the hydrology analysis. The following assumptions were used in the modeling:

- All RCP pipes had a Manning's Roughness, n, of 0.013
- No inlet flow calculations performed, known Qs from hydrology analysis were user-defined in each pipe segment
- Tailwater condition is set to the crown of the outlet pipe, El = 230.09 ft
- All junctions are modeled as a 4'x4' catch basin
- Pipe flow upstream of the three (3) main tributary pipes were ignored
- It was assumed the pipe could drain full Q100

Pre-Project Hydraulic Analysis Results

Based on the hydraulic analysis, the existing 30-inch RCP storm drain within the property is undersized to accommodate the entire 146.2 cubic-feet per second peak flow rates. The pipe segment would be under pressure in this location, and it is likely significant ponding in upstream inlets and low-lying areas would occur during the high-intensity 100-year storm event.

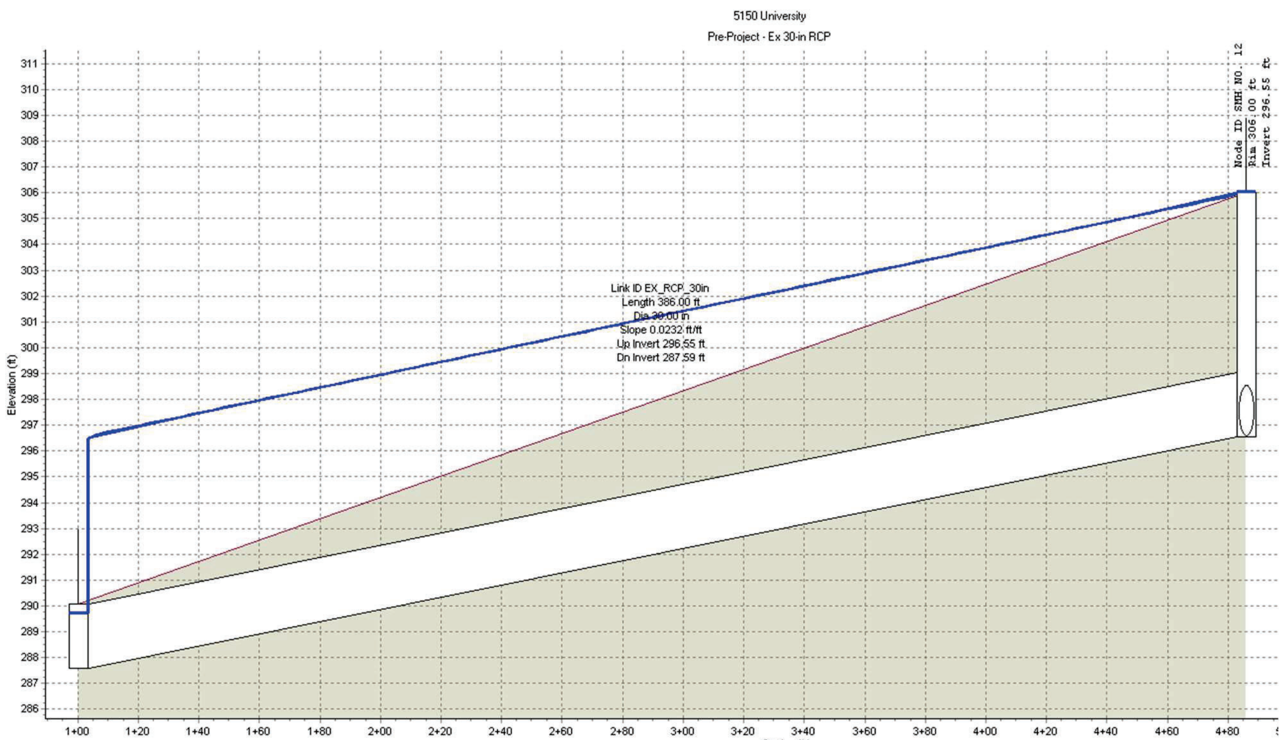


Figure 6-1: Pre-Project Hydraulic Profile (S&S Analysis)

The output profile above shows in blue, the calculated HGL of the 30-inch RCP storm drain per the hydraulic analysis. As-constructed, the existing 30-inch RCP storm drain does not have capacity to accommodate the anticipated peak flow rate of 142.6 cubic-feet-per-second. Additionally, the hydraulic analysis determined the capacity of this system to be only 64.4 cubic-feet per second as shown in the output in the following figure.

Station (ft)

Node ID:	Out-1EX_RCP_30in	SMH NO. 12
Rim (ft):		306.00
Invert (ft):	287.59	296.55
Min Pipe Cover (ft):		6.95
Max HGL (ft):	289.72	306.00
Link ID:	EX_RCP_30in	
Length (ft):	386.00	
Dia (in):	30.00	
Slope (ft/ft):	0.0232	
Up Invert (ft):	296.55	
Dn Invert (ft):	287.59	
Max Q (cfs):	64.44	
Max Vel (ft/s):	13.59	
Max Depth (ft):	2.31	

Figure 6-2: Hydraulic Capacity of 30-inch RCP Storm Drain (S&S Analysis)

It should also be noted, though outside the scope of this analysis, the upstream 24-inch RCP and 18-inch RCP storm drains appear to be undersized as well, resulting in pressurized flow in the existing storm drain system and likely ponding in low-lying areas. The complete Storm Sewer model and results is provided as an appendix to this report.

6.2 Proposed Storm Drain Hydraulic Analysis

The scope of this project is limited to the improvements downstream of the junction of the southern drainage sub basin, and the northern sub basin, where the existing 30-inch RCP storm drain begins and drains west across 52nd Street, onto the project property. The analysis assumes all flow will reach this downstream system.

The project proposes to upsize (to a 45-inch RCP storm drain) and re-route the existing 30-inch RCP storm drain system south along 52nd Street, and then westerly along the southerly property boundary and then tie into the existing box culvert potion of the Home Avenue channel.

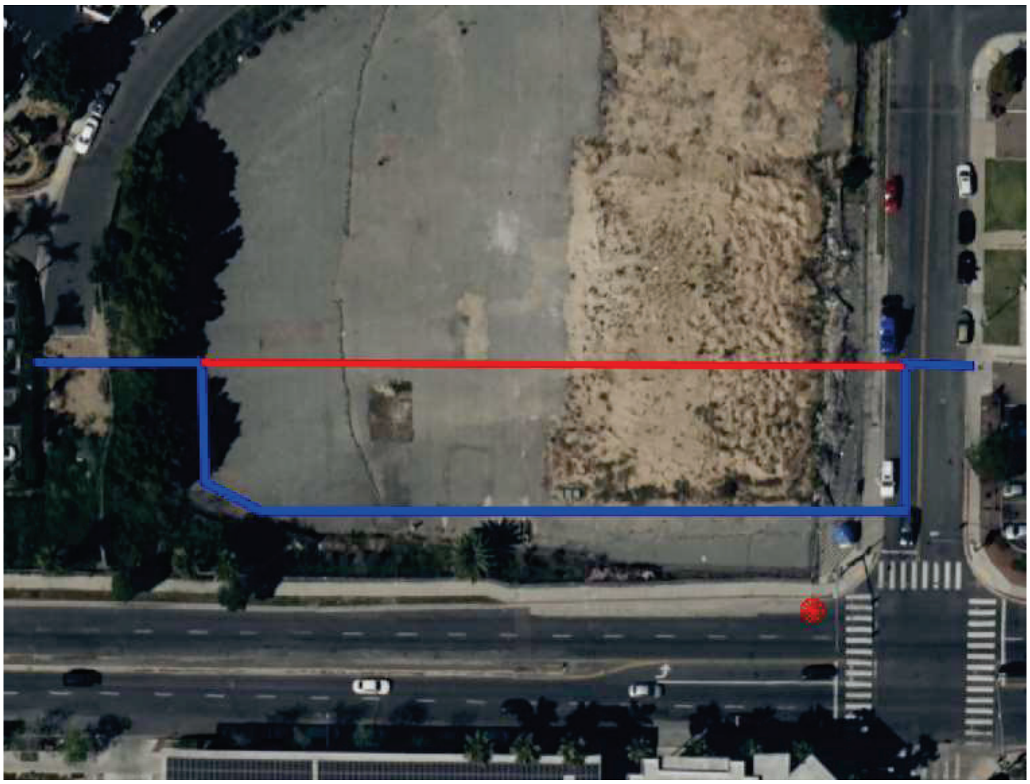


Figure 6-3: Proposed Re-alignment and upsized RCP Storm Drain (blue)

The proposed alignment and 48-inch storm drain infrastructure will also be designed to accommodate additional on-site flows. The on-site drainage system is analyzed in the study entitled *Preliminary Drainage Analysis for University Self Storage* dated June 5, 2020 by NOVA Engineering. The on-site system proposes to connect to the 48-inch RCP storm drain at nodes 201 (0.33 cfs), 206 (0.32 cfs) and at node 210 (6.51 cfs). The hydraulic analysis incorporates these flows into the preliminary design using "known Qs" for the pipe segments in the Storm Sewers program.

Post-Project Hydraulic Analysis

Based on the hydraulic analysis performed on the proposed drainage system and improvements, the 48-inch RCP will provide adequate conveyance capacity for anticipated peak flows from the 100-year storm event. The hydraulic design was performed in two scenarios: The first truncated the model models the calculated 146.2 cubic-feet-per-second as an external inflow at the upstream limit of the proposed 48-inch RCP, and a second scenario modeling the upstream system that confluences flows within the proposed 48-inch RCP storm drain.

Post-Project Truncated Hydraulic Analysis Results

The truncated analysis models only the proposed 48-inch RCP storm drain with all calculated peak flows from the 100-year storm event as inflows at the upstream junction. This analysis was performed to ensure the proposed 48-inch RCP has adequate capacity should all upstream storm drain facilities be upsized to accommodate the anticipated peak flows.

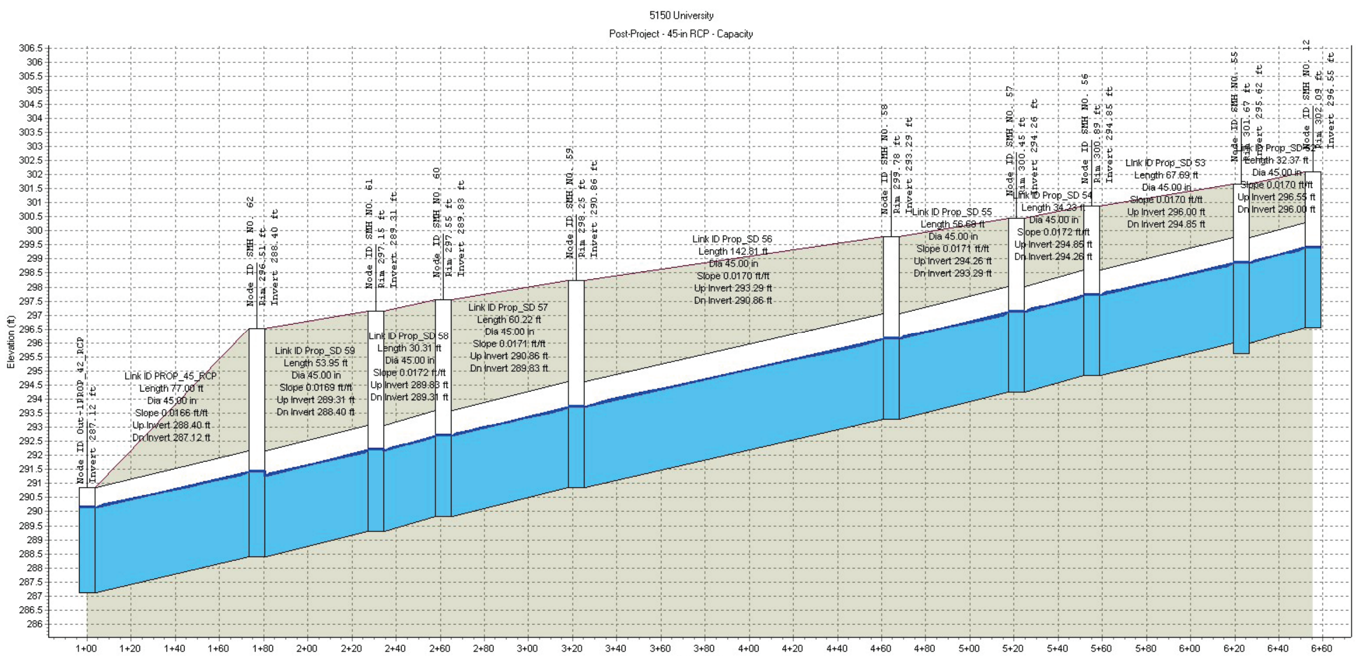


Figure 6-4: Post-Project, 48-inch RCP, Hydraulic Profile (S&S Analysis) – Capacity Analysis

The results of the hydraulic analysis show the proposed 48-inch RCP storm drain will have adequate capacity to convey anticipated peak flows from the 100-year storm event, in the event all upstream drainages can be adequately drained to the system. Current upstream storm drain infrastructure is undersized, resulting in decreased flow rates reaching this downstream system.

The truncated model represents future build-out conditions in which all undersized, upstream infrastructure has been replaced.

Post-Project Current Upstream Conditions Hydraulic Analysis Results

The second post-project scenario incorporates the modeling of upstream undersized facilities to determine the actual anticipated peak flows that will be seen within the proposed 48-inch RCP, prior to upsizing any upstream facilities. If these undersized facilities are taken into account, the max flow rate within the 48-inch RCP system is less than 80 cubic-feet-per-second based on the hydraulic model results.

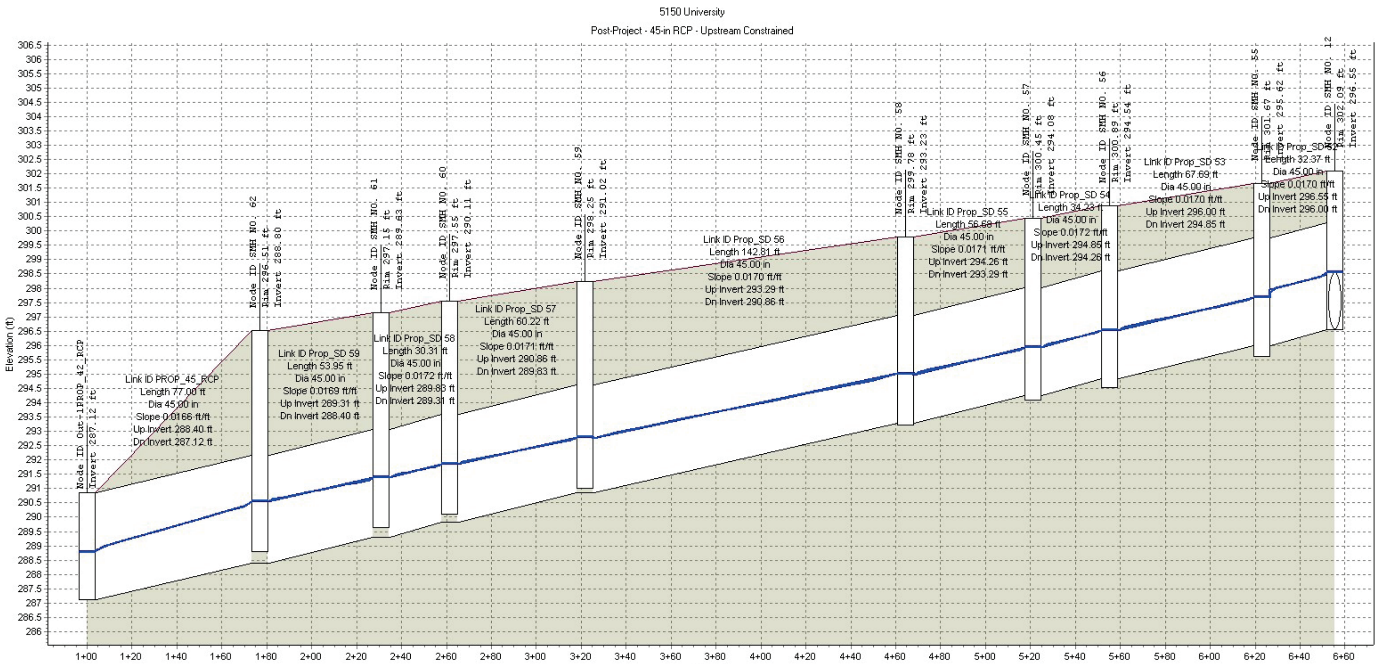


Figure 6-5: Post-Project, 45-inch RCP, Hydraulic Profile (S&S Analysis) – Upstream Limitations

7.0 CONCLUSION AND RECOMMENDATIONS

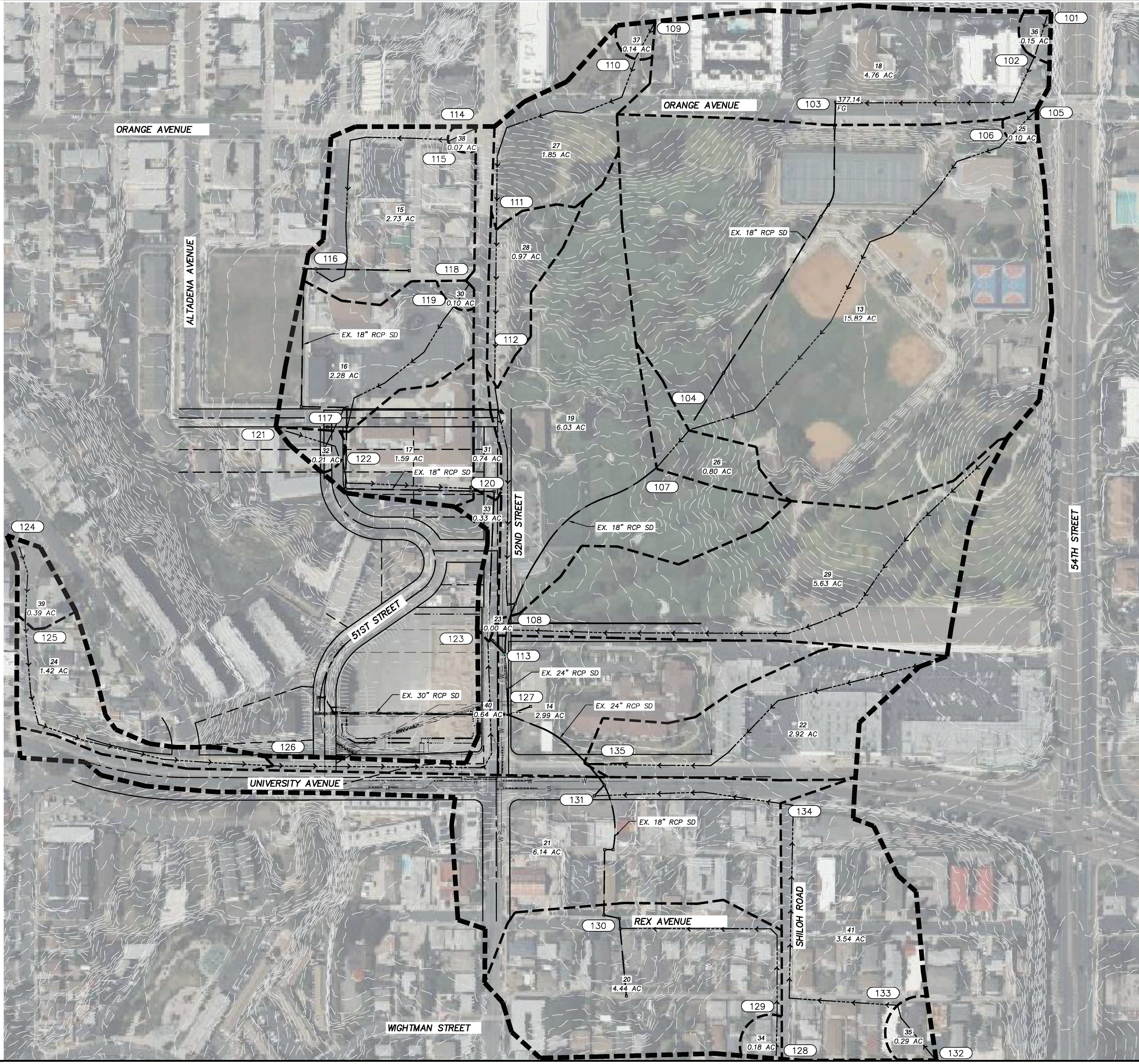
Overall, the hydrologic analyses in this report demonstrate the existing storm drain facilities are not adequately sized to accommodate anticipated peak runoff flow rates from the 100-year storm event. An approximate 150 cubic-feet-per-second runoff flow rate is anticipated from the total 67.2 acre drainage basin.

Based on the hydraulic analyses performed as part of this study, it was determined the existing 30-inch RCP storm drain crossing the subject property at 51510 University Avenue does not have the required capacity to convey anticipated peak flows. The proposed realignment of this system, and upsizing to a 48-inch RCP storm drain facility will provide adequate capacity to convey peak flows in the ultimate build out conditions where all upstream facilities are also sized to accommodate peak flows from the 100-year storm event. The analysis of the upstream portion of this system was not included as part of this study.

Appendix A: Hydrology Maps

Pre-Project Hydrology Map

Post-Project Hydrology Map



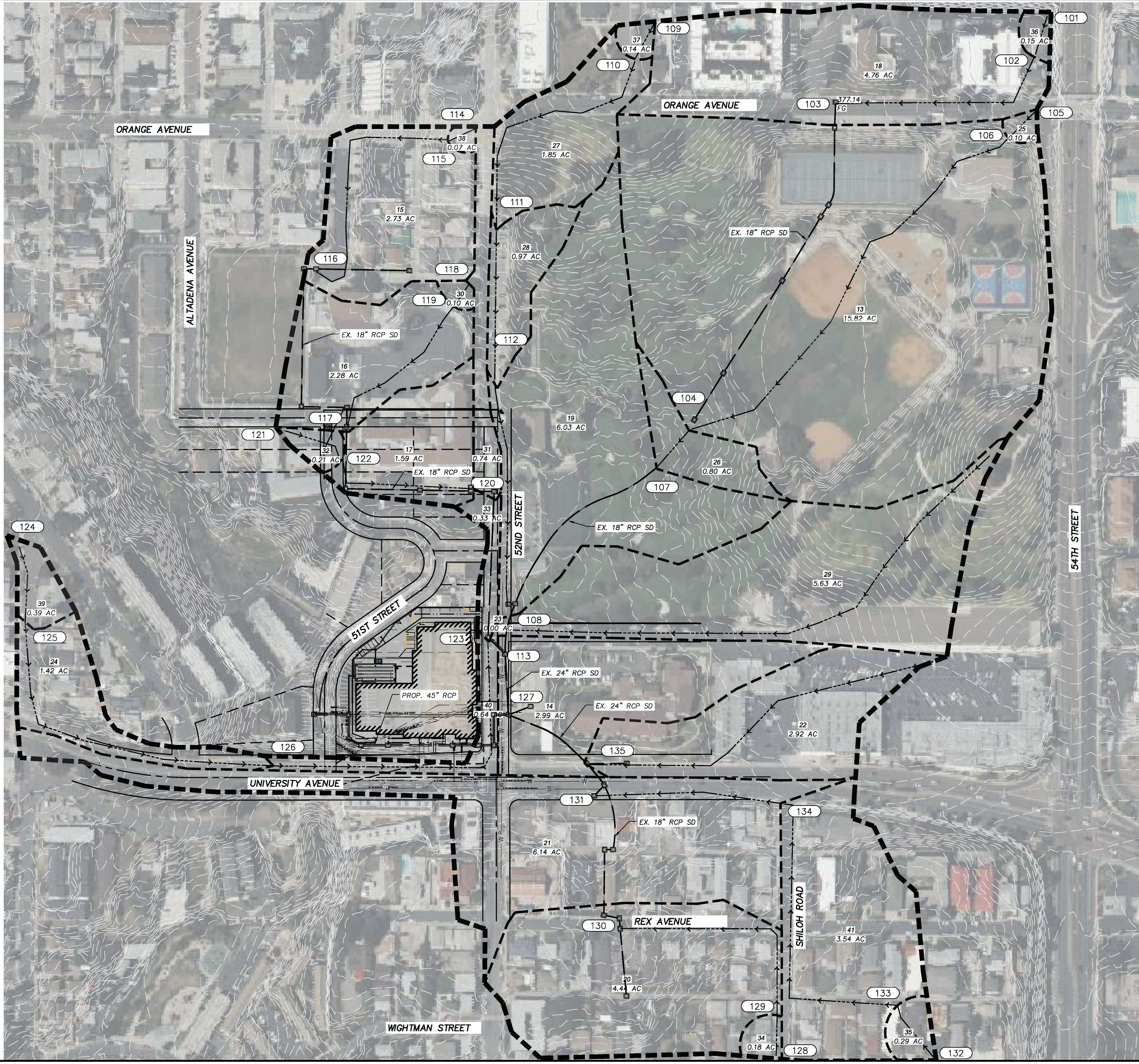
LEGEND

DRAINAGE BASIN
DRAINAGE SUBBASIN
FLOW PATH
EX STORM DRAIN
NODE CALL OUT 101
AREA CALL OUT 13 0.10 AC

N
SCALE: 1"= 100'
0 100' 200' 300'

NOVA Engineering

PRE-PROJECT HYDROLOGY MAP



LEGEND

DRAINAGE BASIN	
DRAINAGE SUBBASIN	
FLOW PATH	
EX/PROP STORM DRAIN	
NODE CALL OUT	101
AREA CALL OUT	13 0.10 AC

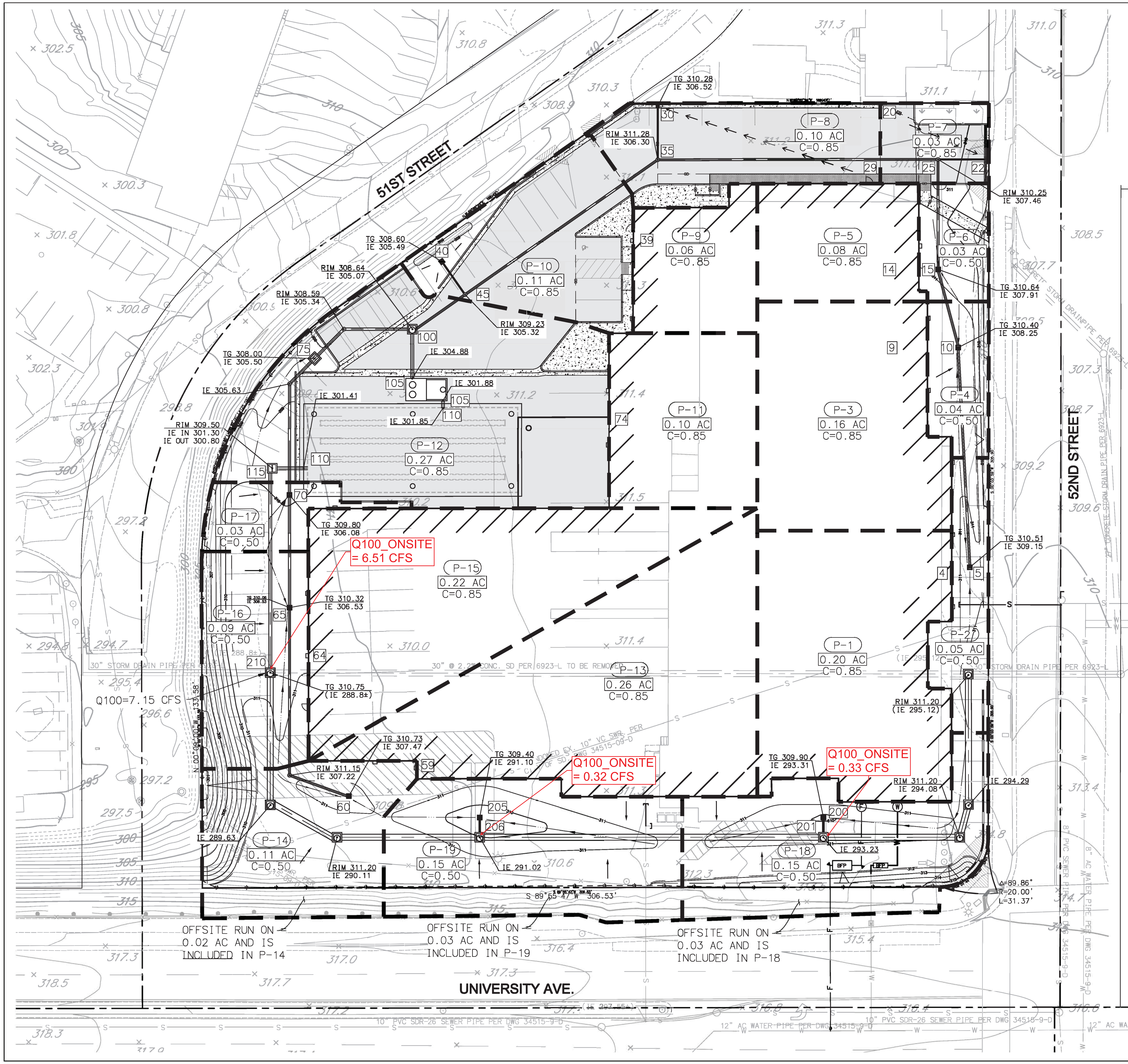
POST-PROJECT HYDROLOGY MAP

N

SCALE: 1"= 100'

0 100' 200' 300'

NOVA Engineering



C-VALUE NOTE:

(1) TYPE D TO BE USED FOR ALL AREAS

(2) LAND USE FOR DEVELOPED AREAS: COMMERCIAL (80% IMPERVIOUS); ASSOCIATED COEFFICIENT, C: 0.85 PER TABLE A-1 'RUNOFF COEFFICIENTS FOR RATIONAL METHOD OF CITY OF SAN DIEGO DRAINAGE DESIGN MANUAL.

(3) WHERE ACTUAL CONDITIONS DEVIATE SIGNIFICANTLY FROM THE TABULATED IMPERVIOUSNESS VALUE OF 80%, THE VALUE GIVEN FOR COEFFICIENT C, MAY BE REVISED BY MULTIPLYING 80% BY THE RATIO OF ACTUAL IMPERVIOUSNESS TO THE TABULATED IMPERVIOUSNESS. HOWEVER, IN NO CASE SHALL THE FINAL COEFFICIENT BE LESS THAN 0.50.

LEGEND

IMPROVEMENT	REFERENCE	SYMBOL
RATIONAL METHOD NODE NUMBER		1
PROPOSED DRAINAGE BASIN BOUNDARY		
DRAINAGE BASIN DESIGNATOR		P-1
HYDROLENGTH		
PROP BUILDING		
FINISH SPOT ELEVATION		FS 310.30
MATCH EXISTING SPOT ELEVATION		(FS 308.80)
FINISH MINOR CONTOUR		311
FINISH MAJOR CONTOUR		310
GRADE BREAK		GB
LIMITS OF GRADING (DAYLIGHT LINE)		
PROP CONCRETE PAVING	1/C2.0	
PROP AC PAVING	2/C2.0	
PROP CURB	3/C2.0	
PROP CURB AND GUTTER	4/C2.0	
PROP EARTHEN SWALE	6/C2.0	
PROP TYPE A-4 CLEANOUT	D-09	
PROP CATCH BASIN	7/C2.0	
PROP STORM DRAIN CLEANOUT	8/C2.0	
PROP STORM DRAIN		
PROP TRENCH DRAIN	9/C2.0	
PROP WEIR STRUCTURE	10,11/C2.0	
PROP MODULAR WETLAND SYSTEM	14/C2.1	

EXISTING IMPROVEMENT LEGEND

EX WATER	W
EX SEWER	S
EX STORM DRAIN	
EX GAS	G
EX COMMUNICATION	COMM
EX CABLE/TELEVISION	CATV
EX CONTOUR	310
EX BUILDING	
EX SPOT ELEVATION	(344.7±)
EX LANDSCAPE	
PROPERTY/RIGHT-OF-WAY LINE	
STREET CENTER LINE	

SCALE: 1"=20'

DRAINAGE STUDY PROPOSED CONDITIONS EXHIBIT FOR UNIVERSITY SELF STORAGE

NOVA
NOVA ENGINEERING
4373 VIEWRIDGE AVENUE, SUITE A
SAN DIEGO, CA 92123 (619) 296-1010
EMAIL: Sgierlichs@nova-eng.com

DESIGNER: M.D.D
DRAWN: M.D.D
DATE: 1/28/2021
JOB NO.: 6044

Appendix B: Pre-Project AES Analysis

100-Year Pre-Project AES Hydrologic Analysis

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____________________________________________________________________________
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            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
            Reference: SAN DIEGO COUNTY FLOOD CONTROL DISTRICT
                         2003,1985,1981 HYDROLOGY MANUAL
         (c) Copyright 1982-2012 Advanced Engineering Software (aes)
             Ver. 18.2 Release Date: 05/08/2012  License ID 1503

                           Analysis prepared by:

                            LANDMARK CONSULTING
                         9555 GENESEE AVE, STE 200
                            SAN DIEGO, CA 92121
                               (858) 587-8070

 ************************** DESCRIPTION OF STUDY **************************
* 5150 UNIVERSITY AVE - 100-YEAR HYDROLOGIC ANALYSIS                       *
* PRE-PROJECT FLOW TO 30-INCH RCP SD                                       *
*                                                                          *
 **************************************************************************

  FILE NAME: 5150PRE.DAT
  TIME/DATE OF STUDY: 15:41 02/06/2023
----------------------------------------------------------------------------
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
----------------------------------------------------------------------------
  USER SPECIFIED STORM EVENT(YEAR) = 100.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =   6.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.90
  RAINFALL-INTENSITY ADJUSTMENT FACTOR = 1.000
  *USER SPECIFIED:
  NUMBER OF [TIME,INTENSITY] DATA PAIRS =  8
   1)   5.000;  4.400
   2)   7.000;  3.900
   3)  10.000;  3.500
   4)  15.000;  2.900
   5)  20.000;  2.500
   6)  30.000;  2.000
   7)  60.000;  1.300
   8) 120.000;  0.860
  SAN DIEGO HYDROLOGY MANUAL "C"-VALUES USED FOR RATIONAL METHOD
  NOTE: ONLY PEAK CONFLUENCE VALUES CONSIDERED
  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     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   20.0     15.0    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 =  5.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*

****************************************************************************
  FLOW PROCESS FROM NODE    101.00 TO NODE    102.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    85.00
  UPSTREAM ELEVATION(FEET) =    396.00
  DOWNSTREAM ELEVATION(FEET) =    395.50
  ELEVATION DIFFERENCE(FEET) =      0.50
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    3.864
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    51.76
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.56
  TOTAL AREA(ACRES) =      0.15   TOTAL RUNOFF(CFS) =      0.56

****************************************************************************
  FLOW PROCESS FROM NODE    102.00 TO NODE    103.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  395.50  DOWNSTREAM ELEVATION(FEET) =  377.00
  STREET LENGTH(FEET) =   500.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =      9.20
```

```
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.39
    HALFSTREET FLOOD WIDTH(FEET) =   13.12
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.01
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.95
  STREET FLOW TRAVEL TIME(MIN.) =   1.66   Tc(MIN.) =    5.53
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.268
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.850
  SUBAREA AREA(ACRES) =    4.76      SUBAREA RUNOFF(CFS) =   17.27
  TOTAL AREA(ACRES) =        4.9        PEAK FLOW RATE(CFS) =      17.81

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.47   HALFSTREET FLOOD WIDTH(FEET) =  17.04
  FLOW VELOCITY(FEET/SEC.) =  5.89   DEPTH*VELOCITY(FT*FT/SEC.) =   2.75
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    103.00 =     585.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    103.00 TO NODE    104.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   373.90  DOWNSTREAM(FEET) =   325.80
  FLOW LENGTH(FEET) =   790.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS  11.4 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  15.16
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      17.81
  PIPE TRAVEL TIME(MIN.) =   0.87    Tc(MIN.) =    6.40
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    104.00 =    1375.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    104.00 TO NODE    104.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.40
  RAINFALL INTENSITY(INCH/HR) =   4.05
  TOTAL STREAM AREA(ACRES) =     4.91
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     17.81

****************************************************************************
  FLOW PROCESS FROM NODE    105.00 TO NODE    106.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
```

```
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5300
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    85.00
  UPSTREAM ELEVATION(FEET) =    392.00
  DOWNSTREAM ELEVATION(FEET) =    384.00
  ELEVATION DIFFERENCE(FEET) =      8.00
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    4.481
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.23
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.23

+--------------------------------------------------------------------------+
| ACTUAL IMPERVIOUS = 50%                                                  |
| WEIGHTED C = 0.53                                                        |
| 0.85 * (50%/80%)                                                         |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    106.00 TO NODE    104.00 IS CODE =  51
----------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    384.00  DOWNSTREAM(FEET) =    325.80
  CHANNEL LENGTH THRU SUBAREA(FEET) =   995.00   CHANNEL SLOPE =  0.0585
  CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =  10.000
  MANNING'S FACTOR = 0.040   MAXIMUM DEPTH(FEET) =   2.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.655
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .4500
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      13.40
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   3.81
  AVERAGE FLOW DEPTH(FEET) =   0.39   TRAVEL TIME(MIN.) =   4.36
  Tc(MIN.) =    8.84
  SUBAREA AREA(ACRES) =    15.82       SUBAREA RUNOFF(CFS) =   26.02
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.451
  TOTAL AREA(ACRES) =       15.9         PEAK FLOW RATE(CFS) =      26.21

  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.55   FLOW VELOCITY(FEET/SEC.) =   4.51
  LONGEST FLOWPATH FROM NODE    105.00 TO NODE    104.00 =    1080.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    104.00 TO NODE    104.00 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.) =    8.84
  RAINFALL INTENSITY(INCH/HR) =   3.66
  TOTAL STREAM AREA(ACRES) =    15.92
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     26.21

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       17.81     6.40        4.051          4.91
      2       26.21     8.84        3.655         15.92

  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       36.79     6.40       4.051
      2       42.29     8.84       3.655

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      42.29   Tc(MIN.) =    8.84
  TOTAL AREA(ACRES) =       20.8
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    104.00 =    1375.00 FEET.

******************************************************************************
  FLOW PROCESS FROM NODE    104.00 TO NODE    107.00 IS CODE =  51
------------------------------------------------------------------------------
  >>>>>COMPUTE TRAPEZOIDAL CHANNEL FLOW<<<<<
  >>>>>TRAVELTIME THRU SUBAREA (EXISTING ELEMENT)<<<<<
==============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =    325.80  DOWNSTREAM(FEET) =    324.00
  CHANNEL LENGTH THRU SUBAREA(FEET) =   105.00   CHANNEL SLOPE =  0.0171
  CHANNEL BASE(FEET) =    5.00   "Z" FACTOR =  10.000
  MANNING'S FACTOR = 0.040   MAXIMUM DEPTH(FEET) =   2.00
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.584
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .4500
  S.C.S. CURVE NUMBER (AMC II) =   0
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      42.93
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   3.28
  AVERAGE FLOW DEPTH(FEET) =   0.92   TRAVEL TIME(MIN.) =   0.53
  Tc(MIN.) =    9.37
  SUBAREA AREA(ACRES) =     0.80       SUBAREA RUNOFF(CFS) =    1.29
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.541
  TOTAL AREA(ACRES) =       21.6         PEAK FLOW RATE(CFS) =      42.29
```

```
  END OF SUBAREA CHANNEL FLOW HYDRAULICS:
  DEPTH(FEET) =  0.91   FLOW VELOCITY(FEET/SEC.) =   3.28
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    107.00 =    1480.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    107.00 TO NODE    108.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   322.00  DOWNSTREAM(FEET) =   303.90
  FLOW LENGTH(FEET) =   445.00   MANNING'S N =  0.013
  ASSUME FULL-FLOWING PIPELINE
  PIPE-FLOW VELOCITY(FEET/SEC.) =  11.37
  (PIPE FLOW VELOCITY CORRESPONDING TO FULL PIPE CAPACITY FLOW)
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      42.29
  PIPE TRAVEL TIME(MIN.) =   0.65    Tc(MIN.) =   10.02
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    108.00 =    1925.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    108.00 TO NODE    108.00 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.) =   10.02
  RAINFALL INTENSITY(INCH/HR) =   3.50
  TOTAL STREAM AREA(ACRES) =    21.63
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     42.29

****************************************************************************
  FLOW PROCESS FROM NODE    109.00 TO NODE    110.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    90.00
  UPSTREAM ELEVATION(FEET) =    398.00
  DOWNSTREAM ELEVATION(FEET) =    397.00
  ELEVATION DIFFERENCE(FEET) =      1.00
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    3.412
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    61.67
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
```

```
 100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
 NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
 SUBAREA RUNOFF(CFS) =      0.52
 TOTAL AREA(ACRES) =      0.14   TOTAL RUNOFF(CFS) =      0.52

****************************************************************************
 FLOW PROCESS FROM NODE    110.00 TO NODE    111.00 IS CODE =  62
----------------------------------------------------------------------------
 >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
 >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
 UPSTREAM ELEVATION(FEET) =  397.00  DOWNSTREAM ELEVATION(FEET) =  356.00
 STREET LENGTH(FEET) =   575.00   CURB HEIGHT(INCHES) =  6.0
 STREET HALFWIDTH(FEET) = 20.00

 DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
 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) =       2.85
   STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
   STREET FLOW DEPTH(FEET) =  0.26
   HALFSTREET FLOOD WIDTH(FEET) =    6.73
   AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.00
   PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.30
 STREET FLOW TRAVEL TIME(MIN.) =   1.92   Tc(MIN.) =    5.33
  100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.318
 *USER SPECIFIED(SUBAREA):
 USER-SPECIFIED RUNOFF COEFFICIENT = .5800
 S.C.S. CURVE NUMBER (AMC II) =   0
 AREA-AVERAGE RUNOFF COEFFICIENT =  0.599
 SUBAREA AREA(ACRES) =    1.85      SUBAREA RUNOFF(CFS) =    4.63
 TOTAL AREA(ACRES) =        2.0        PEAK FLOW RATE(CFS) =       5.15

 END OF SUBAREA STREET FLOW HYDRAULICS:
 DEPTH(FEET) = 0.30   HALFSTREET FLOOD WIDTH(FEET) =   8.90
 FLOW VELOCITY(FEET/SEC.) =  5.66   DEPTH*VELOCITY(FT*FT/SEC.) =   1.72
 LONGEST FLOWPATH FROM NODE    109.00 TO NODE    111.00 =     665.00 FEET.

+--------------------------------------------------------------------------+
| ACTUAL IMPERVIOUSNESS = 55%                                              |
| WEIGHTED C = 0.58                                                        |
| C = 0.85 * (55%/80%)                                                     |
+--------------------------------------------------------------------------+
```

```
****************************************************************************
  FLOW PROCESS FROM NODE    111.00 TO NODE    112.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  356.00  DOWNSTREAM ELEVATION(FEET) =  328.00
  STREET LENGTH(FEET) =   330.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =       6.30
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =    9.37
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    6.33
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.99
  STREET FLOW TRAVEL TIME(MIN.) =   0.87   Tc(MIN.) =    6.20
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.101
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5800
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.593
  SUBAREA AREA(ACRES) =    0.97      SUBAREA RUNOFF(CFS) =    2.31
  TOTAL AREA(ACRES) =        3.0        PEAK FLOW RATE(CFS) =       7.20

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.33   HALFSTREET FLOOD WIDTH(FEET) =   9.95
  FLOW VELOCITY(FEET/SEC.) =  6.49   DEPTH*VELOCITY(FT*FT/SEC.) =   2.11
  LONGEST FLOWPATH FROM NODE    109.00 TO NODE    112.00 =     995.00 FEET.

+--------------------------------------------------------------------------+
| ACTUAL IMPERVIOUSNESS = 55%                                              |
| WEIGHTED C = 0.58                                                        |
| C = 0.85 * (55%/80%)                                                     |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    112.00 TO NODE    108.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
```

```
============================================================================
  UPSTREAM ELEVATION(FEET) =  328.00  DOWNSTREAM ELEVATION(FEET) =  310.00
  STREET LENGTH(FEET) =   485.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =      12.95
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.43
    HALFSTREET FLOOD WIDTH(FEET) =   14.99
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.47
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    2.33
  STREET FLOW TRAVEL TIME(MIN.) =   1.48   Tc(MIN.) =    7.67
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.810
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .5000
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.531
  SUBAREA AREA(ACRES) =    6.03      SUBAREA RUNOFF(CFS) =   11.49
  TOTAL AREA(ACRES) =        9.0        PEAK FLOW RATE(CFS) =      18.17

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.47   HALFSTREET FLOOD WIDTH(FEET) =  17.16
  FLOW VELOCITY(FEET/SEC.) =  5.93   DEPTH*VELOCITY(FT*FT/SEC.) =   2.79
  LONGEST FLOWPATH FROM NODE    109.00 TO NODE    108.00 =    1480.00 FEET.

+--------------------------------------------------------------------------+
| ACTUAL IMPERVIOUSNESS = 30%                                              |
| WEIGHTED C = 0.50                                                        |
| C = 0.85 * (30%/80%) - > USE 0.50 MIN                                    |
+--------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE    108.00 TO NODE    108.00 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.) =    7.67
  RAINFALL INTENSITY(INCH/HR) =   3.81
```

```
  TOTAL STREAM AREA(ACRES) =     8.99
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     18.17

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       42.29    10.02        3.497         21.63
      2       18.17     7.67        3.810          8.99

  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       56.99     7.67       3.810
      2       58.97    10.02       3.497

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      58.97   Tc(MIN.) =   10.02
  TOTAL AREA(ACRES) =       30.6
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    108.00 =    1925.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    108.00 TO NODE    108.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.497
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .4500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.5244
  SUBAREA AREA(ACRES) =    5.63   SUBAREA RUNOFF(CFS) =    8.86
  TOTAL AREA(ACRES) =       36.2   TOTAL RUNOFF(CFS) =      66.48
  TC(MIN.) =   10.02

****************************************************************************
  FLOW PROCESS FROM NODE    108.00 TO NODE    113.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   303.90  DOWNSTREAM(FEET) =   301.10
  FLOW LENGTH(FEET) =   115.00   MANNING'S N =  0.013
  ASSUME FULL-FLOWING PIPELINE
  PIPE-FLOW VELOCITY(FEET/SEC.) =   8.80
  (PIPE FLOW VELOCITY CORRESPONDING TO FULL PIPE CAPACITY FLOW)
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      66.48
```

```
  PIPE TRAVEL TIME(MIN.) =   0.22    Tc(MIN.) =   10.24
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    113.00 =    2040.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    113.00 TO NODE    113.00 IS CODE =  10
----------------------------------------------------------------------------
  >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE    114.00 TO NODE    115.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7000
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    63.00
  UPSTREAM ELEVATION(FEET) =    382.00
  DOWNSTREAM ELEVATION(FEET) =    376.00
  ELEVATION DIFFERENCE(FEET) =      6.00
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    2.696
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.22
  TOTAL AREA(ACRES) =      0.07   TOTAL RUNOFF(CFS) =      0.22

****************************************************************************
  FLOW PROCESS FROM NODE    115.00 TO NODE    116.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  376.00  DOWNSTREAM ELEVATION(FEET) =  332.00
  STREET LENGTH(FEET) =   590.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =       4.42
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.29
    HALFSTREET FLOOD WIDTH(FEET) =    8.25
```

```
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.53
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.61
  STREET FLOW TRAVEL TIME(MIN.) =   1.78   Tc(MIN.) =    4.47
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7000
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.700
  SUBAREA AREA(ACRES) =    2.73      SUBAREA RUNOFF(CFS) =    8.41
  TOTAL AREA(ACRES) =        2.8        PEAK FLOW RATE(CFS) =       8.62

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.35   HALFSTREET FLOOD WIDTH(FEET) =  11.01
  FLOW VELOCITY(FEET/SEC.) =  6.49   DEPTH*VELOCITY(FT*FT/SEC.) =   2.25
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    116.00 =     653.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    116.00 TO NODE    117.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   325.90  DOWNSTREAM(FEET) =   320.70
  FLOW LENGTH(FEET) =   450.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS  12.2 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.74
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =       8.62
  PIPE TRAVEL TIME(MIN.) =   1.11    Tc(MIN.) =    5.59
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    117.00 =    1103.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    117.00 TO NODE    117.00 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.) =    5.59
  RAINFALL INTENSITY(INCH/HR) =   4.25
  TOTAL STREAM AREA(ACRES) =     2.80
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      8.62

****************************************************************************
  FLOW PROCESS FROM NODE    118.00 TO NODE    119.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
```

```
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    55.00
  UPSTREAM ELEVATION(FEET) =    344.00
  DOWNSTREAM ELEVATION(FEET) =    336.00
  ELEVATION DIFFERENCE(FEET) =      8.00
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    1.549
  WARNING: THE MAXIMUM OVERLAND FLOW SLOPE, 10.%, IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.37
  TOTAL AREA(ACRES) =      0.10   TOTAL RUNOFF(CFS) =      0.37

****************************************************************************
  FLOW PROCESS FROM NODE    119.00 TO NODE    117.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  336.00  DOWNSTREAM ELEVATION(FEET) =  327.00
  STREET LENGTH(FEET) =   375.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =       4.64
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.29
    HALFSTREET FLOOD WIDTH(FEET) =    7.96
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.09
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.88
  STREET FLOW TRAVEL TIME(MIN.) =   2.03   Tc(MIN.) =    3.57
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.850
  SUBAREA AREA(ACRES) =    2.28      SUBAREA RUNOFF(CFS) =    8.53
  TOTAL AREA(ACRES) =        2.4        PEAK FLOW RATE(CFS) =      8.90

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.34   HALFSTREET FLOOD WIDTH(FEET) =  10.60
```

```
  FLOW VELOCITY(FEET/SEC.) =  3.59   DEPTH*VELOCITY(FT*FT/SEC.) =   1.21
  LONGEST FLOWPATH FROM NODE    118.00 TO NODE    117.00 =     430.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    117.00 TO NODE    117.00 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.) =    3.57
  RAINFALL INTENSITY(INCH/HR) =   4.40
  TOTAL STREAM AREA(ACRES) =     2.38
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      8.90

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1        8.62     5.59        4.253          2.80
      2        8.90     3.57        4.400          2.38

  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       14.42     3.57       4.400
      2       17.23     5.59       4.253

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      17.23   Tc(MIN.) =    5.59
  TOTAL AREA(ACRES) =        5.2
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    117.00 =    1103.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    117.00 TO NODE    120.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   320.70  DOWNSTREAM(FEET) =   311.60
  FLOW LENGTH(FEET) =   465.00   MANNING'S N =  0.013
  ASSUME FULL-FLOWING PIPELINE
  PIPE-FLOW VELOCITY(FEET/SEC.) =   7.89
  (PIPE FLOW VELOCITY CORRESPONDING TO FULL PIPE CAPACITY FLOW)
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      17.23
  PIPE TRAVEL TIME(MIN.) =   0.98    Tc(MIN.) =    6.57
```

```
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    120.00 =    1568.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    120.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    6.57
  RAINFALL INTENSITY(INCH/HR) =   4.01
  TOTAL STREAM AREA(ACRES) =     5.18
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     17.23

****************************************************************************
  FLOW PROCESS FROM NODE    121.00 TO NODE    122.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   140.00
  UPSTREAM ELEVATION(FEET) =    331.00
  DOWNSTREAM ELEVATION(FEET) =    327.00
  ELEVATION DIFFERENCE(FEET) =      4.00
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    2.899
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    83.57
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      0.79
  TOTAL AREA(ACRES) =      0.21   TOTAL RUNOFF(CFS) =      0.79

****************************************************************************
  FLOW PROCESS FROM NODE    122.00 TO NODE    120.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  327.00  DOWNSTREAM ELEVATION(FEET) =  320.00
  STREET LENGTH(FEET) =   322.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =       3.76
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.33
    HALFSTREET FLOOD WIDTH(FEET) =   10.07
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.32
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.09
  STREET FLOW TRAVEL TIME(MIN.) =   1.62   Tc(MIN.) =    4.52
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.850
  SUBAREA AREA(ACRES) =    1.59      SUBAREA RUNOFF(CFS) =    5.95
  TOTAL AREA(ACRES) =        1.8        PEAK FLOW RATE(CFS) =       6.73

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.38   HALFSTREET FLOOD WIDTH(FEET) =  12.82
  FLOW VELOCITY(FEET/SEC.) =  3.82   DEPTH*VELOCITY(FT*FT/SEC.) =   1.46
  LONGEST FLOWPATH FROM NODE    121.00 TO NODE    120.00 =     462.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    120.00 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.) =    4.52
  RAINFALL INTENSITY(INCH/HR) =   4.40
  TOTAL STREAM AREA(ACRES) =     1.80
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      6.73

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       17.23     6.57        4.008          5.18
      2        6.73     4.52        4.400          1.80

  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       22.42     4.52       4.400
     2       23.36     6.57       4.008

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      23.36   Tc(MIN.) =    6.57
  TOTAL AREA(ACRES) =        7.0
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    120.00 =    1568.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    120.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.008
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7956
  SUBAREA AREA(ACRES) =    0.74   SUBAREA RUNOFF(CFS) =    2.52
  TOTAL AREA(ACRES) =        7.7   TOTAL RUNOFF(CFS) =      24.62
  TC(MIN.) =    6.57

****************************************************************************
  FLOW PROCESS FROM NODE    120.00 TO NODE    123.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   311.60  DOWNSTREAM(FEET) =   301.80
  FLOW LENGTH(FEET) =   325.00   MANNING'S N =  0.013
  ASSUME FULL-FLOWING PIPELINE
  PIPE-FLOW VELOCITY(FEET/SEC.) =   9.79
  (PIPE FLOW VELOCITY CORRESPONDING TO FULL PIPE CAPACITY FLOW)
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      24.62
  PIPE TRAVEL TIME(MIN.) =   0.55    Tc(MIN.) =    7.12
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    123.00 =    1893.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    123.00 TO NODE    123.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.884
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7978
  SUBAREA AREA(ACRES) =    0.33   SUBAREA RUNOFF(CFS) =    1.09
```

```
  TOTAL AREA(ACRES) =        8.1   TOTAL RUNOFF(CFS) =      24.94
  TC(MIN.) =    7.12

****************************************************************************
  FLOW PROCESS FROM NODE    123.00 TO NODE    123.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    7.12
  RAINFALL INTENSITY(INCH/HR) =   3.88
  TOTAL STREAM AREA(ACRES) =     8.05
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     24.94

****************************************************************************
  FLOW PROCESS FROM NODE    124.00 TO NODE    125.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   170.00
  UPSTREAM ELEVATION(FEET) =    352.00
  DOWNSTREAM ELEVATION(FEET) =    348.00
  ELEVATION DIFFERENCE(FEET) =      4.00
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    2.998
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    78.53
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.400
  NOTE: RAINFALL INTENSITY IS BASED ON Tc = 5-MINUTE.
  SUBAREA RUNOFF(CFS) =      1.46
  TOTAL AREA(ACRES) =      0.39   TOTAL RUNOFF(CFS) =      1.46

****************************************************************************
  FLOW PROCESS FROM NODE    125.00 TO NODE    126.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  348.00  DOWNSTREAM ELEVATION(FEET) =  320.00
  STREET LENGTH(FEET) =   760.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =       3.95
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.31
    HALFSTREET FLOOD WIDTH(FEET) =    9.19
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.11
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.27
  STREET FLOW TRAVEL TIME(MIN.) =   3.08   Tc(MIN.) =    6.08
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.129
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.850
  SUBAREA AREA(ACRES) =    1.42      SUBAREA RUNOFF(CFS) =    4.98
  TOTAL AREA(ACRES) =        1.8        PEAK FLOW RATE(CFS) =       6.35

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.35   HALFSTREET FLOOD WIDTH(FEET) =  11.24
  FLOW VELOCITY(FEET/SEC.) =  4.60   DEPTH*VELOCITY(FT*FT/SEC.) =   1.61
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE    126.00 =     930.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    126.00 TO NODE    123.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  320.00  DOWNSTREAM ELEVATION(FEET) =  310.00
  STREET LENGTH(FEET) =   750.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =       7.31
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.42
    HALFSTREET FLOOD WIDTH(FEET) =   14.64
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    3.23
```

```
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.35
  STREET FLOW TRAVEL TIME(MIN.) =   3.87   Tc(MIN.) =    9.95
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.507
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.850
  SUBAREA AREA(ACRES) =    0.64      SUBAREA RUNOFF(CFS) =    1.91
  TOTAL AREA(ACRES) =        2.4        PEAK FLOW RATE(CFS) =       7.30

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.42   HALFSTREET FLOOD WIDTH(FEET) =  14.64
  FLOW VELOCITY(FEET/SEC.) =  3.23   DEPTH*VELOCITY(FT*FT/SEC.) =   1.35
  LONGEST FLOWPATH FROM NODE    124.00 TO NODE    123.00 =    1680.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    123.00 TO NODE    123.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =    9.95
  RAINFALL INTENSITY(INCH/HR) =   3.51
  TOTAL STREAM AREA(ACRES) =     2.45
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      7.30

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       24.94     7.12        3.884          8.05
      2        7.30     9.95        3.507          2.45

  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       30.17     7.12       3.884
      2       29.82     9.95       3.507

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      30.17   Tc(MIN.) =    7.12
  TOTAL AREA(ACRES) =       10.5
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    123.00 =    1893.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    123.00 TO NODE    113.00 IS CODE =  41
```

```
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   301.80  DOWNSTREAM(FEET) =   301.10
  FLOW LENGTH(FEET) =    53.00   MANNING'S N =  0.013
  ASSUME FULL-FLOWING PIPELINE
  PIPE-FLOW VELOCITY(FEET/SEC.) =   6.48
  (PIPE FLOW VELOCITY CORRESPONDING TO FULL PIPE CAPACITY FLOW)
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      30.17
  PIPE TRAVEL TIME(MIN.) =   0.14    Tc(MIN.) =    7.26
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    113.00 =    1946.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    113.00 TO NODE    113.00 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       30.17     7.26       3.866       10.50
  LONGEST FLOWPATH FROM NODE    114.00 TO NODE    113.00 =    1946.00 FEET.

  ** MEMORY BANK #  1 CONFLUENCE DATA **
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
      1       66.48    10.24       3.471       36.25
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    113.00 =    2040.00 FEET.

  ** PEAK FLOW RATE TABLE **
  STREAM    RUNOFF       Tc      INTENSITY
  NUMBER     (CFS)     (MIN.)   (INCH/HOUR)
      1      77.29       7.26        3.866
      2      93.57      10.24        3.471

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      93.57   Tc(MIN.) =   10.24
  TOTAL AREA(ACRES) =       46.8

****************************************************************************
  FLOW PROCESS FROM NODE    113.00 TO NODE    113.00 IS CODE =  12
----------------------------------------------------------------------------
  >>>>>CLEAR MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE    113.00 TO NODE    127.00 IS CODE =  41
```

```
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   297.30  DOWNSTREAM(FEET) =   296.50
  FLOW LENGTH(FEET) =   135.00   MANNING'S N =  0.013
  ASSUME FULL-FLOWING PIPELINE
  PIPE-FLOW VELOCITY(FEET/SEC.) =   5.26
  (PIPE FLOW VELOCITY CORRESPONDING TO FULL PIPE CAPACITY FLOW)
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      93.57
  PIPE TRAVEL TIME(MIN.) =   0.43    Tc(MIN.) =   10.67
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    127.00 =    2175.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    127.00 TO NODE    127.00 IS CODE =  10
----------------------------------------------------------------------------
  >>>>>MAIN-STREAM MEMORY COPIED ONTO MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE    128.00 TO NODE    129.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7000
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =    90.00
  UPSTREAM ELEVATION(FEET) =    358.00
  DOWNSTREAM ELEVATION(FEET) =    357.00
  ELEVATION DIFFERENCE(FEET) =      1.00
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    5.652
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    66.11
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.237
  SUBAREA RUNOFF(CFS) =      0.53
  TOTAL AREA(ACRES) =      0.18   TOTAL RUNOFF(CFS) =      0.53

****************************************************************************
  FLOW PROCESS FROM NODE    129.00 TO NODE    130.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  357.00  DOWNSTREAM ELEVATION(FEET) =  329.00
  STREET LENGTH(FEET) =   530.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00
```

```
  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =       6.48
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.28
    HALFSTREET FLOOD WIDTH(FEET) =    7.72
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    4.53
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.27
  STREET FLOW TRAVEL TIME(MIN.) =   1.95   Tc(MIN.) =    7.60
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.820
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7000
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.700
  SUBAREA AREA(ACRES) =    4.44      SUBAREA RUNOFF(CFS) =   11.87
  TOTAL AREA(ACRES) =        4.6        PEAK FLOW RATE(CFS) =      12.35

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.33   HALFSTREET FLOOD WIDTH(FEET) =  10.30
  FLOW VELOCITY(FEET/SEC.) =  5.24   DEPTH*VELOCITY(FT*FT/SEC.) =   1.74
  LONGEST FLOWPATH FROM NODE    128.00 TO NODE    130.00 =     620.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    130.00 TO NODE    131.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   324.10  DOWNSTREAM(FEET) =   306.50
  FLOW LENGTH(FEET) =   365.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  18.0 INCH PIPE IS   9.7 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  12.76
  GIVEN PIPE DIAMETER(INCH) =  18.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      12.35
  PIPE TRAVEL TIME(MIN.) =   0.48    Tc(MIN.) =    8.08
  LONGEST FLOWPATH FROM NODE    128.00 TO NODE    131.00 =     985.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    131.00 TO NODE    131.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
```

```
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =    8.08
  RAINFALL INTENSITY(INCH/HR) =   3.76
  TOTAL STREAM AREA(ACRES) =     4.62
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     12.35

****************************************************************************
  FLOW PROCESS FROM NODE    132.00 TO NODE    133.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
============================================================================
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7000
  S.C.S. CURVE NUMBER (AMC II) =   0
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   150.00
  UPSTREAM ELEVATION(FEET) =    361.00
  DOWNSTREAM ELEVATION(FEET) =    360.50
  ELEVATION DIFFERENCE(FEET) =      0.50
  URBAN SUBAREA OVERLAND TIME OF FLOW(MIN.) =    6.414
  WARNING: INITIAL SUBAREA FLOW PATH LENGTH IS GREATER THAN
           THE MAXIMUM OVERLAND FLOW LENGTH =    50.00
           (Reference: Table 3-1B of Hydrology Manual)
           THE MAXIMUM OVERLAND FLOW LENGTH IS USED IN Tc CALCULATION!
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  4.046
  SUBAREA RUNOFF(CFS) =      0.82
  TOTAL AREA(ACRES) =      0.29   TOTAL RUNOFF(CFS) =      0.82

****************************************************************************
  FLOW PROCESS FROM NODE    133.00 TO NODE    134.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  360.50  DOWNSTREAM ELEVATION(FEET) =  324.00
  STREET LENGTH(FEET) =   685.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =       5.39
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.32
```

```
    HALFSTREET FLOOD WIDTH(FEET) =    9.72
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.07
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.63
  STREET FLOW TRAVEL TIME(MIN.) =   2.25   Tc(MIN.) =    8.67
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.678
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7000
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.700
  SUBAREA AREA(ACRES) =    3.54      SUBAREA RUNOFF(CFS) =    9.11
  TOTAL AREA(ACRES) =        3.8        PEAK FLOW RATE(CFS) =       9.86

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.38   HALFSTREET FLOOD WIDTH(FEET) =  12.47
  FLOW VELOCITY(FEET/SEC.) =  5.89   DEPTH*VELOCITY(FT*FT/SEC.) =   2.21
  LONGEST FLOWPATH FROM NODE    132.00 TO NODE    134.00 =     835.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    134.00 TO NODE    131.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  2 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) =  324.00  DOWNSTREAM ELEVATION(FEET) =  314.00
  STREET LENGTH(FEET) =   410.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 20.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =  15.00
  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) =      17.38
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.49
    HALFSTREET FLOOD WIDTH(FEET) =   18.33
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    5.00
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    2.46
  STREET FLOW TRAVEL TIME(MIN.) =   1.37   Tc(MIN.) =   10.03
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.496
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .7000
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT =  0.700
  SUBAREA AREA(ACRES) =    6.14      SUBAREA RUNOFF(CFS) =   15.03
  TOTAL AREA(ACRES) =       10.0        PEAK FLOW RATE(CFS) =      24.40
```

```
  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.53   HALFSTREET FLOOD WIDTH(FEET) =  21.31
  FLOW VELOCITY(FEET/SEC.) =  5.28   DEPTH*VELOCITY(FT*FT/SEC.) =   2.78
  *NOTE: INITIAL SUBAREA NOMOGRAPH WITH SUBAREA PARAMETERS,
         AND L =  410.0 FT WITH ELEVATION-DROP =  10.0 FT, IS   18.9 CFS,
         WHICH EXCEEDS THE TOP-OF-CURB STREET CAPACITY AT NODE    131.00
  LONGEST FLOWPATH FROM NODE    132.00 TO NODE    131.00 =    1245.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    131.00 TO NODE    131.00 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.) =   10.03
  RAINFALL INTENSITY(INCH/HR) =   3.50
  TOTAL STREAM AREA(ACRES) =     9.97
  PEAK FLOW RATE(CFS) AT CONFLUENCE =     24.40

  ** CONFLUENCE DATA **
  STREAM     RUNOFF       Tc      INTENSITY      AREA
  NUMBER      (CFS)     (MIN.)   (INCH/HOUR)    (ACRE)
      1       12.35     8.08        3.756          4.62
      2       24.40    10.03        3.496          9.97

  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       32.00     8.08       3.756
      2       35.90    10.03       3.496

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      35.90   Tc(MIN.) =   10.03
  TOTAL AREA(ACRES) =       14.6
  LONGEST FLOWPATH FROM NODE    132.00 TO NODE    131.00 =    1245.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    131.00 TO NODE    135.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   306.50  DOWNSTREAM(FEET) =   305.50
  FLOW LENGTH(FEET) =    60.00   MANNING'S N =  0.013
```

```
  ASSUME FULL-FLOWING PIPELINE
  PIPE-FLOW VELOCITY(FEET/SEC.) =   8.82
  (PIPE FLOW VELOCITY CORRESPONDING TO FULL PIPE CAPACITY FLOW)
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      35.90
  PIPE TRAVEL TIME(MIN.) =   0.11    Tc(MIN.) =   10.15
  LONGEST FLOWPATH FROM NODE    132.00 TO NODE    135.00 =    1305.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    135.00 TO NODE    135.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.482
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.7250
  SUBAREA AREA(ACRES) =    2.92   SUBAREA RUNOFF(CFS) =    8.64
  TOTAL AREA(ACRES) =       17.5   TOTAL RUNOFF(CFS) =      44.21
  TC(MIN.) =   10.15

****************************************************************************
  FLOW PROCESS FROM NODE    135.00 TO NODE    127.00 IS CODE =  41
----------------------------------------------------------------------------
  >>>>>COMPUTE PIPE-FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>USING USER-SPECIFIED PIPESIZE (EXISTING ELEMENT)<<<<<
============================================================================
  ELEVATION DATA: UPSTREAM(FEET) =   305.50  DOWNSTREAM(FEET) =   296.50
  FLOW LENGTH(FEET) =   205.00   MANNING'S N =  0.013
  DEPTH OF FLOW IN  24.0 INCH PIPE IS  19.3 INCHES
  PIPE-FLOW VELOCITY(FEET/SEC.) =  16.32
  GIVEN PIPE DIAMETER(INCH) =  24.00    NUMBER OF PIPES =   1
  PIPE-FLOW(CFS) =      44.21
  PIPE TRAVEL TIME(MIN.) =   0.21    Tc(MIN.) =   10.36
  LONGEST FLOWPATH FROM NODE    132.00 TO NODE    127.00 =    1510.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE    127.00 TO NODE    127.00 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       44.21    10.36       3.457       17.51
  LONGEST FLOWPATH FROM NODE    132.00 TO NODE    127.00 =    1510.00 FEET.

  ** MEMORY BANK #  1 CONFLUENCE DATA **
```

```
  STREAM     RUNOFF      Tc      INTENSITY     AREA
  NUMBER      (CFS)    (MIN.)   (INCH/HOUR)   (ACRE)
     1       93.57    10.67       3.420       46.75
  LONGEST FLOWPATH FROM NODE    101.00 TO NODE    127.00 =    2175.00 FEET.

  ** PEAK FLOW RATE TABLE **
  STREAM    RUNOFF       Tc      INTENSITY
  NUMBER     (CFS)     (MIN.)   (INCH/HOUR)
     1     135.04      10.36        3.457
     2     137.30      10.67        3.420

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =     137.30   Tc(MIN.) =   10.67
  TOTAL AREA(ACRES) =       64.3

****************************************************************************
  FLOW PROCESS FROM NODE    127.00 TO NODE    127.00 IS CODE =  12
----------------------------------------------------------------------------
  >>>>>CLEAR MEMORY BANK # 1 <<<<<
============================================================================

****************************************************************************
  FLOW PROCESS FROM NODE    127.00 TO NODE    127.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
   100 YEAR RAINFALL INTENSITY(INCH/HOUR) =  3.420
  *USER SPECIFIED(SUBAREA):
  USER-SPECIFIED RUNOFF COEFFICIENT = .8500
  S.C.S. CURVE NUMBER (AMC II) =   0
  AREA-AVERAGE RUNOFF COEFFICIENT = 0.6357
  SUBAREA AREA(ACRES) =    2.99   SUBAREA RUNOFF(CFS) =    8.69
  TOTAL AREA(ACRES) =       67.2   TOTAL RUNOFF(CFS) =     146.20
  TC(MIN.) =   10.67
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       67.2  TC(MIN.) =     10.67
  PEAK FLOW RATE(CFS)   =     146.20
============================================================================
============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

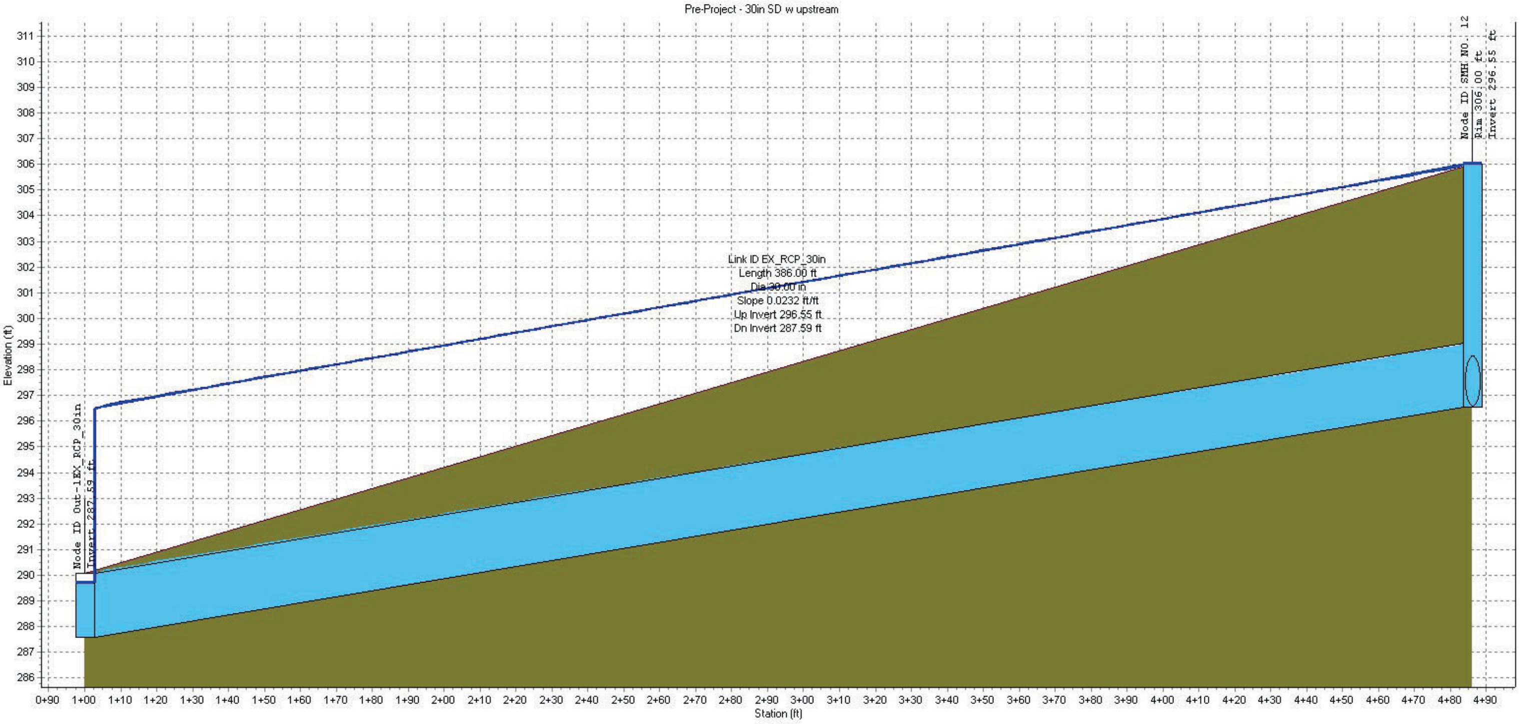
Appendix C: Pre-Project S&S Analysis Hydraulics

Pre-project Hydraulic Analysis – With Upstream System

Pre-project Hydraulic Analysis – 30-inch RCP Only

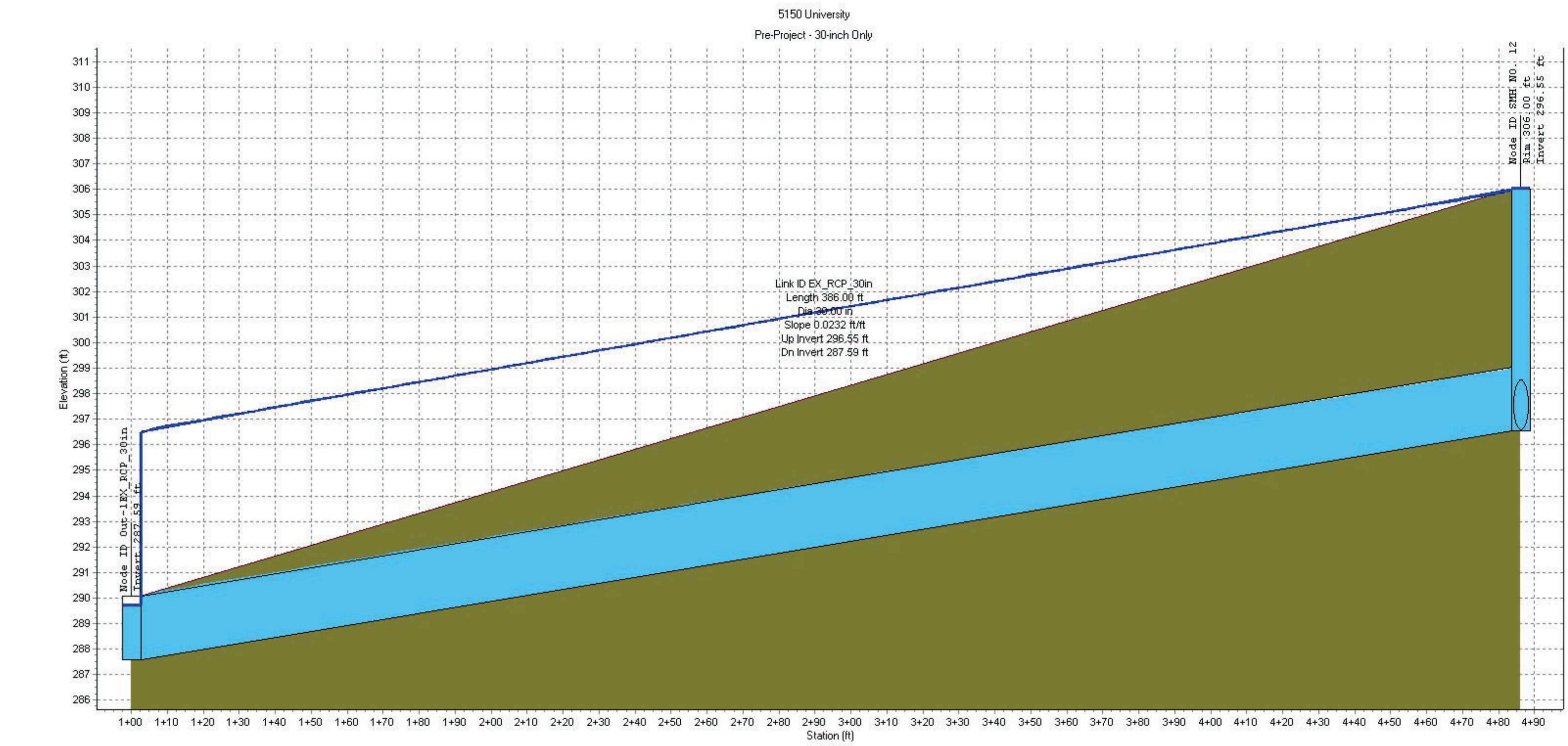
5150 University

Pre-Project - 30in SD w upstream



Node ID:		SMH NO. 12
Rim (ft):		306.00
Invert (ft):	287.59	296.55
Min Pipe Cover (ft):		6.95
Max HGL (ft):	289.72	306.00
Link ID:	EX_RCP_30in	
Length (ft):	386.00	
Dia (in):	30.00	
Slope (ft/ft):	0.0232	
Up Invert (ft):	296.55	
Dn Invert (ft):	287.59	
Max Q (cfs):	64.44	
Max Vel (ft/s):	13.59	
Max Depth (ft):	2.31	

Autodesk Storm and Sanitary Analysis



Node ID:		SMH NO. 12
Rim (ft):		306.00
Invert (ft):	287.59	296.55
Min Pipe Cover (ft):		6.95
Max HGL (ft):	289.72	306.00

Link ID:	EX_RCP_30in
Length (ft):	386.00
Dia (in):	30.00
Slope (ft/ft):	0.0232
Up Invert (ft):	296.55
Dn Invert (ft):	287.59
Max Q (cfs):	64.44
Max Vel (ft/s):	13.59
Max Depth (ft):	2.31

Autodesk Storm and Sanitary Analysis

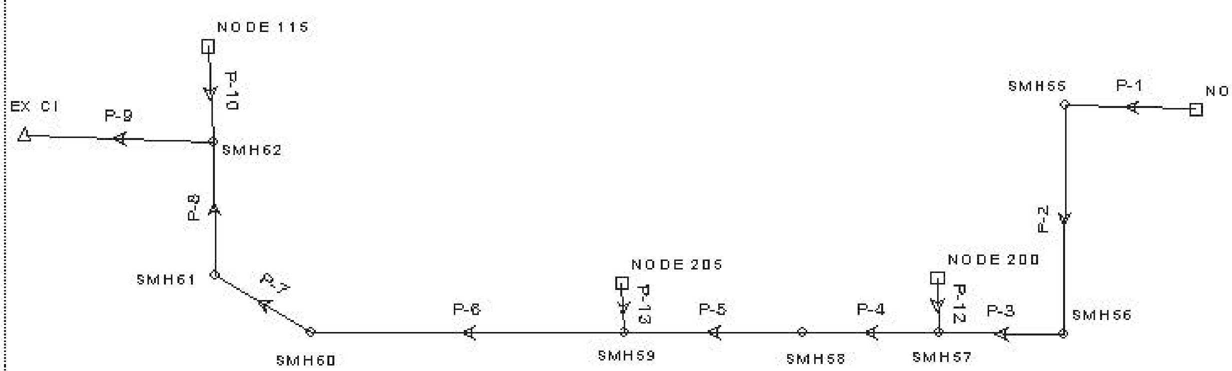
Appendix D: Post-Project S&S Analysis Hydraulics

Post-project Hydraulic Analysis – With Upstream

System Post-project Hydraulic Analysis – 48-inch RCP

Only

Scenario: Base



	Label	Upstream Node	Downstream Node	Length (ft)	Upstream Inlet Area (acres)	Upstream Inlet Rational Coefficient	Upstream Inlet CA (acres)	Upstream Calculated System CA (acres)	Upstream Inlet Rational Flow (cfs)	Section Size	Full Capacity (cfs)	Average Velocity (ft/s)	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)
P-6	P-6	SMH59	SMH60	60.22	N/A	N/A	N/A	0.00	N/A	48 inch	187.85	16.54	290.86	289.83	0.017104
P-7	P-7	SMH60	SMH61	30.31	N/A	N/A	N/A	0.00	N/A	48 inch	188.14	16.56	289.83	289.31	0.017156
P-8	P-8	SMH61	SMH62	53.95	N/A	N/A	N/A	0.00	N/A	48 inch	186.55	16.44	289.31	288.40	0.016867
P-9	P-9	SMH62	EX CI	77.00	N/A	N/A	N/A	0.00	N/A	48 inch	185.19	16.47	288.40	287.12	0.016623
P-10	P-10	NODE 115	SMH62	15.10	0.00	0.00	0.00	0.00	0.00	12 inch	23.32	25.44	300.80	288.40	0.821192
P-1	P-1	NODE 127	SMH55	32.37	0.00	0.00	0.00	0.00	0.00	48 inch	187.23	16.48	296.55	296.00	0.016991
P-2	P-2	SMH55	SMH56	67.69	N/A	N/A	N/A	0.00	N/A	48 inch	187.22	16.48	296.00	294.85	0.016989
P-3	P-3	SMH56	SMH57	34.23	N/A	N/A	N/A	0.00	N/A	48 inch	188.58	16.58	294.85	294.26	0.017236
P-4	P-4	SMH57	SMH58	56.68	N/A	N/A	N/A	0.00	N/A	48 inch	187.90	16.53	294.26	293.29	0.017114
P-5	P-5	SMH58	SMH59	142.81	N/A	N/A	N/A	0.00	N/A	48 inch	187.36	16.50	293.29	290.86	0.017016
P-12	P-12	NODE 200	SMH57	8.60	0.00	0.00	0.00	0.00	0.00	6 inch	2.39	1.68	295.00	294.08	0.106977
P-13	P-13	NODE 205	SMH59	7.80	0.00	0.00	0.00	0.00	0.00	6 inch	1.28	1.63	291.10	290.86	0.030769

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
NODE 115	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00
NODE 127	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00
NODE 200	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00
NODE 205	Generic Inlet	Generic Default 100%	0.00	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: EX CI

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P-9	1	48 inch	Circular	77.00	153.36	16.47	292.02	290.15
P-8	1	48 inch	Circular	53.95	146.85	16.44	292.88	292.02
P-10	1	12 inch	Circular	15.10	6.51	25.44	301.77	292.02
P-7	1	48 inch	Circular	30.31	146.85	16.56	293.40	292.42
P-6	1	48 inch	Circular	60.22	146.85	16.54	294.43	292.81
P-13	1	6 inch	Circular	7.80	0.32	1.63	294.45	294.43
P-5	1	48 inch	Circular	142.81	146.53	16.50	296.86	294.43
P-4	1	48 inch	Circular	56.68	146.53	16.53	297.83	296.28
P-3	1	48 inch	Circular	34.23	146.20	16.58	298.42	297.83
P-12	1	6 inch	Circular	8.60	0.33	1.68	297.85	297.83
P-2	1	48 inch	Circular	67.69	146.20	16.48	299.57	297.80
P-1	1	48 inch	Circular	32.37	146.20	16.48	300.12	299.10

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
EX CI	153.36	291.12	287.12	287.12
SMH62	153.36	296.51	292.02	292.02
SMH61	146.85	297.15	292.88	292.88
NODE 115	6.51	309.50	301.77	301.77
SMH60	146.85	297.55	293.40	293.40

SMH59	146.85	298.25	294.43	294.43
NODE 205	0.32	309.40	294.45	294.45
SMH58	146.53	299.78	296.86	296.86
SMH57	146.53	300.45	297.83	297.83
SMH56	146.20	300.89	298.42	298.42
NODE 200	0.33	309.90	297.85	297.85
SMH55	146.20	301.67	299.57	299.57
NODE 127	146.20	302.09	300.12	300.12

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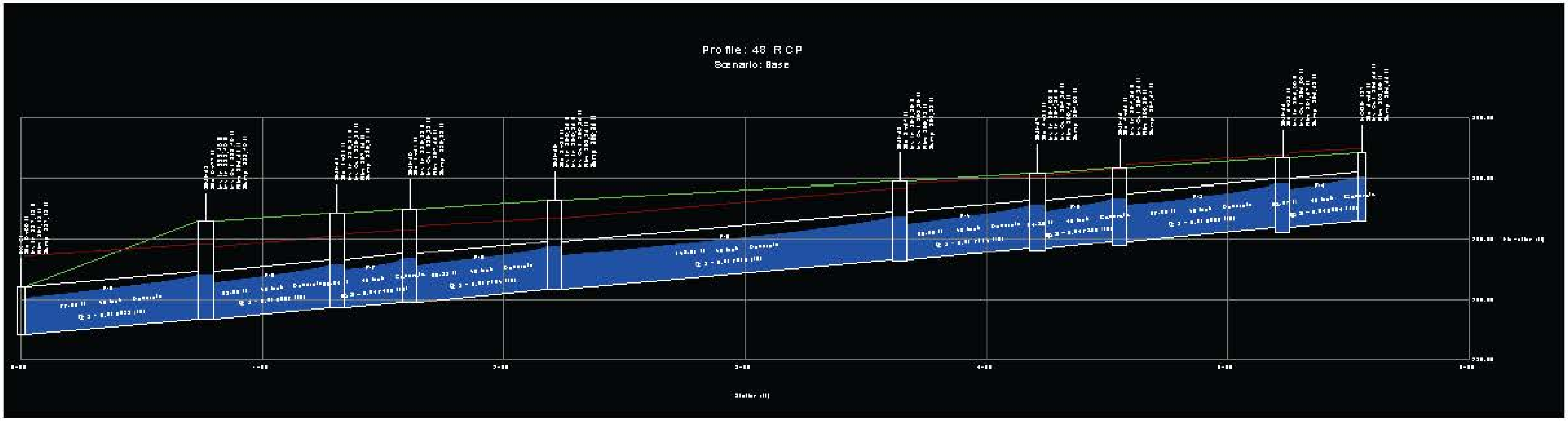
Profile: 48 RCP
Scenario: Base