Drainage Study
For Batavia Self-Storage
630 N. Batavia St.
Orange, CA 92864

Date Prepared:
March 28, 2022

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

FOR PLAN CHECK
REVIEW ONLY

Patric de Boer RCE 83583
Registration Expires 3-31-2023

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Appendices

Site Project and Description

This drainage study has been prepared for the proposed redevelopment at 630 N Batavia St., Orange, CA 92864. This project proposes to construct tree self-storage buildings along with its corresponding improvements. The site is approximately 0.87 miles east of Highway 57. See Figure No. 1 for a Vicinity Map. The project site is currently fully developed with the majority of the site being impervious.

Methodology

This drainage report has been prepared in accordance with current county regulations and procedures. The Rational Method per Section D of the Orange County Hydrology Manual was used to calculate the time of concentration, Fm, intensity, and peak flowrates generated by the existing and proposed site conditions.

Soil group for the site was determined using the NRCS Hydrologic Soils Group Map from the Orange County Hydrology Manual, which is included as Appendix 1 in this report.

Precipitation intensities were determined using Figure B-3 from the Orange County Hydrology Manual included as Appendix 2 of this report.

Fp values were determined using sheet C-13 from the Orange County Hydrology Manual included as Appendix 3 of this report.

The time of concentrations were determined using Figure D-1 from the Orange County Hydrology Manual included as Appendix 4 of this report.

The grated inlet analysis and drive aisle cross section analysis were generated with Hydraflow Express, an extension for Autodesk Civil 3D. These analyses are included on Appendix 5 and 6 of this report.

Peak flow for each watershed is computed using the following equation:

Q = 0.90 * (I - Fm) * A

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

(1) Handbook of Hydraulics, E.F. Brater & H.W. King, 6th Ed., 1976.
(2) Modern Sewer Design, American Iron & Steel Institute, 1st Ed., 1980.
(3) Orange County Hydrology Manual, 1986
(4) County of Orange Local Drainage Manual, 2020

Existing Conditions

The existing site is a fully developed industrial site that is 94% impervious. The existing development consists of two existing buildings and asphalt hardscape. The pervious surfaces consist of landscape areas along the easterly frontage of the property. The existing site is underlain by type ‘B’ soil.

The entire site drains via surface flow to a low point located at the northwesterly corner of the site where it flows onto the neighboring site to the west. This point is referred to as Discharge Point # 1 in this report.

Proposed Conditions

The proposed improvements involved the demolition of the existing development and the construction of three self-storage buildings, asphalt drive aisle, landscape, and a private storm drain system. The proposed conditions will reduce the impervious percentage to 92%.

The site will drain via gutter flow towards the northwest corner of the site. During low flow treatment storms, runoff will be collected by a series of catch basins and conveyed to a storage system consisting of two 48" HDPE pipes located under the drive aisles. This treatment volume is pumped at a low rate to a treatment BMP and which discharges treated runoff to the surface where it flows offsite. This is detailed in the separately submitted water quality management plan. During peak flow conditions, the detention pipes and pump system will be over-capacitated. In these conditions runoff will surface flow directly to the northwest corner of the site and onto the neighboring property as it does in the existing conditions.

Existing Runoff Analysis

The existing site was modeled as a single drainage basin, referred to as E-1 in this report.

Below is a summary of the 100-year Rational Method Calculations for the existing conditions:

Basin #	Area (ac)	Intensity (in/hr)	Fm (in/hr)	Q_{100} (cfs)
E-1	3.06	4.16	0.017	11.42
	Discharge Point # 1			11.42

Proposed Runoff Analysis

The proposed site was modeled as a single drainage basin, referred to as P-1 in this report.

Below is a summary of the Rational Method Calculations for the proposed conditions:

Basin #	Area (ac)	Intensity (in/hr)	Fm (in/hr)	Q_{100} (cfs)
P-1	3.06	4.04	0.024	11.09
	Discharge Point # 1			11.09

Results and Conclusions

The proposed improvements result in a decrease of generated runoff during the peak of the 100-year storm. The decrease in flow is the result of decreasing the total impervious area of the site from 94% to 92% and a slight increase in the time of concentration for the proposed conditions.

The project will result in changes to the onsite drainage patterns but will maintain the existing discharge points. The project is not anticipated to contribute runoff that will exceed the capacity of the existing or planned drainage system.

The project is not located within a FEMA 100-year flood hazard zone. The is not located in an area that would expose people or structures to significant risk of loss, injury, or death involving flooding as a result of the failure of a levee or dam.

The redevelopment of the site is not anticipated to create the risk of substantial erosion on or offsite due to the decrease in calculated peak flows and the implementation of hydromodification controls.

It is the opinion of Omega Engineering Consultants that the project will not cause adverse effects to the downstream facilities or receiving waters. A separate Storm Water Quality Management Plan has been prepared to discuss the water quality impacts for the proposed development.

BASIN	AREA (SF)	AREA (AC)	a(p)	"Fm" Value
E-1	133,454	3.06	0.06	0.017
EX TOTAL	**133,454**	**3.06**	0.06	
P-1	133,454	3.06	0.08	0.024
PROP TOTAL	**133,454**	**3.06**		

Basin Confluence	Symbol

(A) "DP#1" Discharge Point Number 1

(B) a(p) is the pervious area fraction

F(p) value for B soils is 0.3 (Table C.2 OC Hydrology Manual)

EXISTING RATIONAL METHOD CALCULATION FORM

ORANGE COUNTY HYDROLOGY MANUAL	STUDY NAME: BATAVIA SELF-STORAGE 100 - YEAR STORM	Calculated By: Rogelio Ruiz Date: February 16, 2022 Checked By: Patric de Boer Date: February 16, 2022

Concentration Point	Area (acres) Sub Area	Area (acres) Total	Soil Type	Dev. Type	T(t) min	T(c) min	I in/hr	F(m) in/hr	F(m) avg.	Q Total cfs	Flow Path Length ft.	Slope ft./ft.	V ft./sec	Hydraulics and Notes
E-1	3.06	3.06	B	Comm		10.0	4.16	0.017	0.017	11.42	425	0.005		Initial Sub Area
											DP-1: Peak discharge is 11.42 cfs			

For the confluence of two streams, let T_1, I_1, Fm_1, A_1, and Q_1, be the time of concentration, rainfall intensity, area-averaged loss rate, catchment area, and peak flow rate for stream #1 while T_2, I_2, Fm_2, A_2 and Q_2 correspond to stream #2. Also, let Q_1 be less than Q_2. Finally, let T_p, A_p, and Q_p be the resulting confluence estimates for Tc, area, and peak flow rate, respectively.

T_1 is less than T_2. $A_p = A_1 + A_2$.

$$Q_p = Q_2 + \frac{(I_2 - Fm_1)}{(I_1 - Fm_1)} Q_1$$

PROPOSED RATIONAL METHOD CALCULATION FORM

ORANGE COUNTY HYDROLOGY MANUAL	STUDY NAME: BATAVIA SELF-STORAGE 100 - YEAR STORM	Calculated By: Rogelio Ruiz Date: February 16, 2022 Checked By: Patric de Boer Date: February 16, 2022

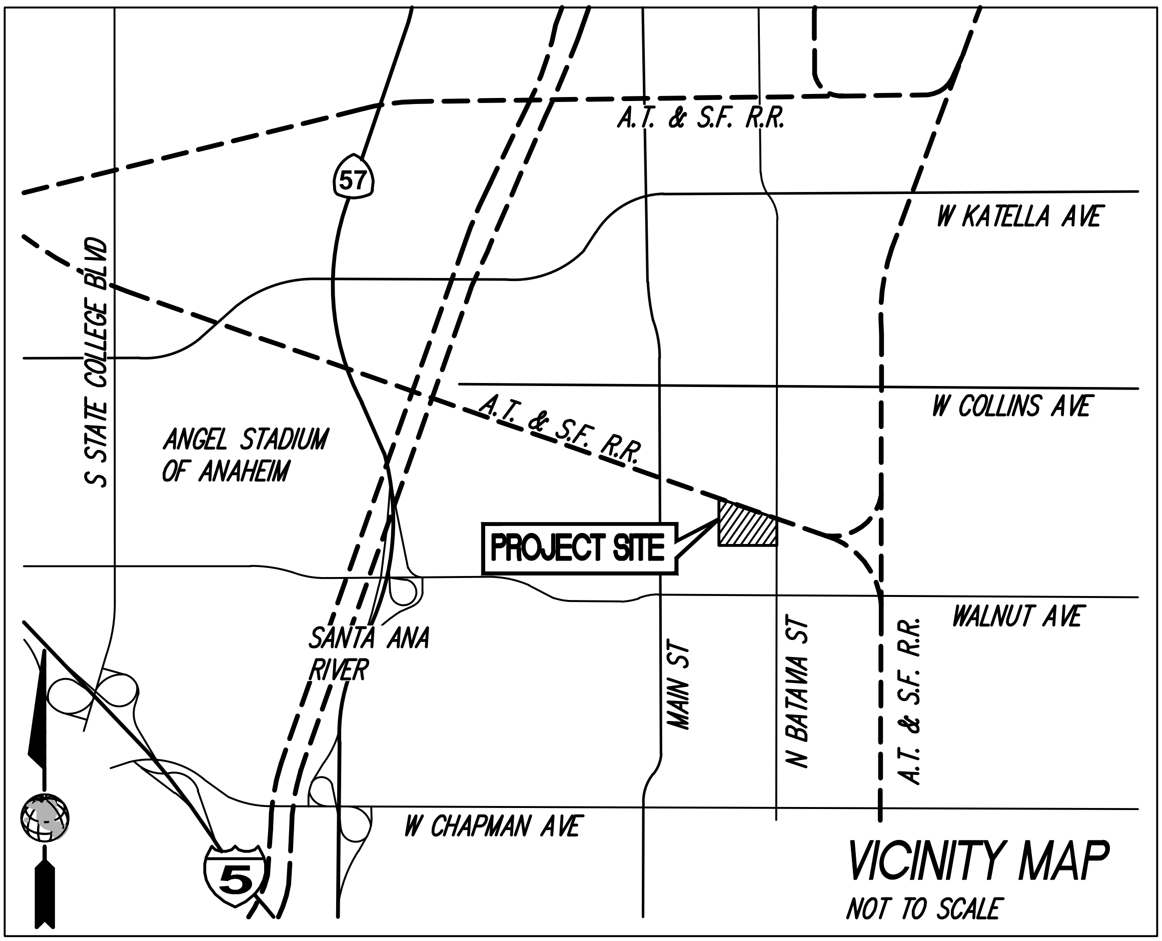
Concentration Point	Area (acres)		Soil Type	Dev. Type	T(t) min	T(c) min	I in/hr	F(m) in/hr	F(m) avg.	Q Total cfs	Flow Path Length ft.	Slope ft./ft.	V ft./sec	Hydraulics and Notes
	Sub Area	Total												
P-1	3.06	3.06	B	Comm		10.5	4.04	0.024	0.024	11.09	475	0.004		Initial Sub Area
											DP-1: Peak discharge is 11.09 cfs			

For the confluence of two streams, let T_1, I_1, Fm_1, A_1, and Q_1, be the time of concentration, rainfall intensity, area-averaged loss rate, catchment area, and peak flow rate for stream #1 while T_2, I_2, Fm_2, A_2 and Q_2 correspond to stream #2. Also, let Q_1 be less than Q_2. Finally, let T_p, A_p, and Q_p be the resulting confluence estimates for Tc, area, and peak flow rate, respectively.

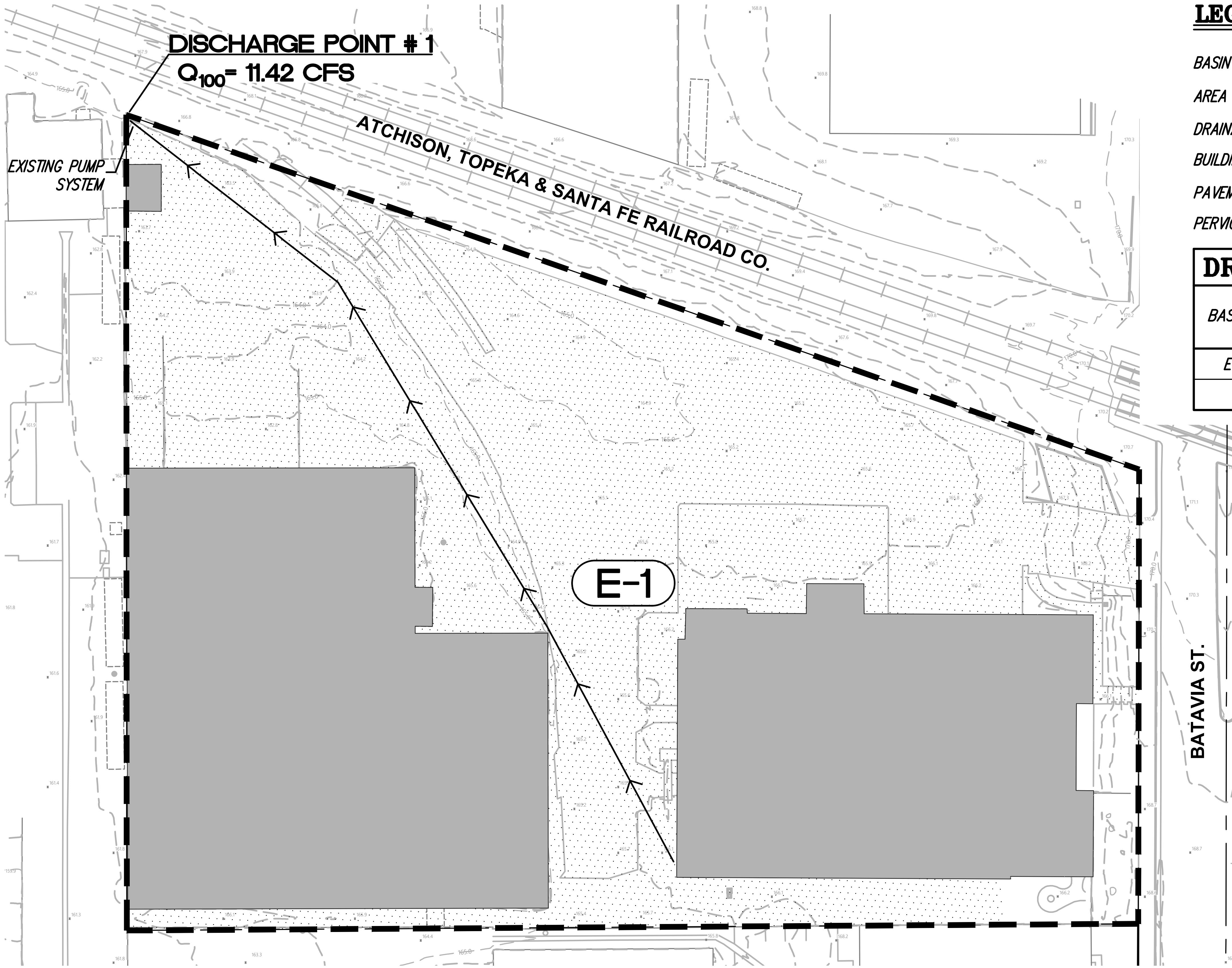
T_1 is less than T_2. $$Q_p = Q_2 + \frac{(I_2 - Fm_1)}{(I_1 - Fm_1)} Q_1$$

$A_p = A_1 + A_2$.

Figure 1



A.T. & S.F. R.R.
57
W KATELLA AVE
S STATE COLLEGE BLVD
W COLLINS AVE
A.T. & S.F. R.R.
ANGEL STADIUM
OF ANAHEIM
PROJECT SITE
WALNUT AVE
SANTA ANA
RIVER
MAIN ST
N BATAVIA ST
A.T. & S.F. R.R.
W CHAPMAN AVE
5
VICINITY MAP
NOT TO SCALE



LEGEND

BASIN NUMBER	E-#
AREA LIMITS	
DRAINAGE FLOW PATH	
BUILDING AREA	
PAVEMENT AREA	
PERVIOUS AREA	

DRAINAGE BASIN DATA

BASIN #	AREA (AC)	INTENSITY (IN/HR)	Fm (IN/HR)	Q_{100} (CFS)
E-1	3.06	4.16	0.017	11.42
–	–	–	–	–

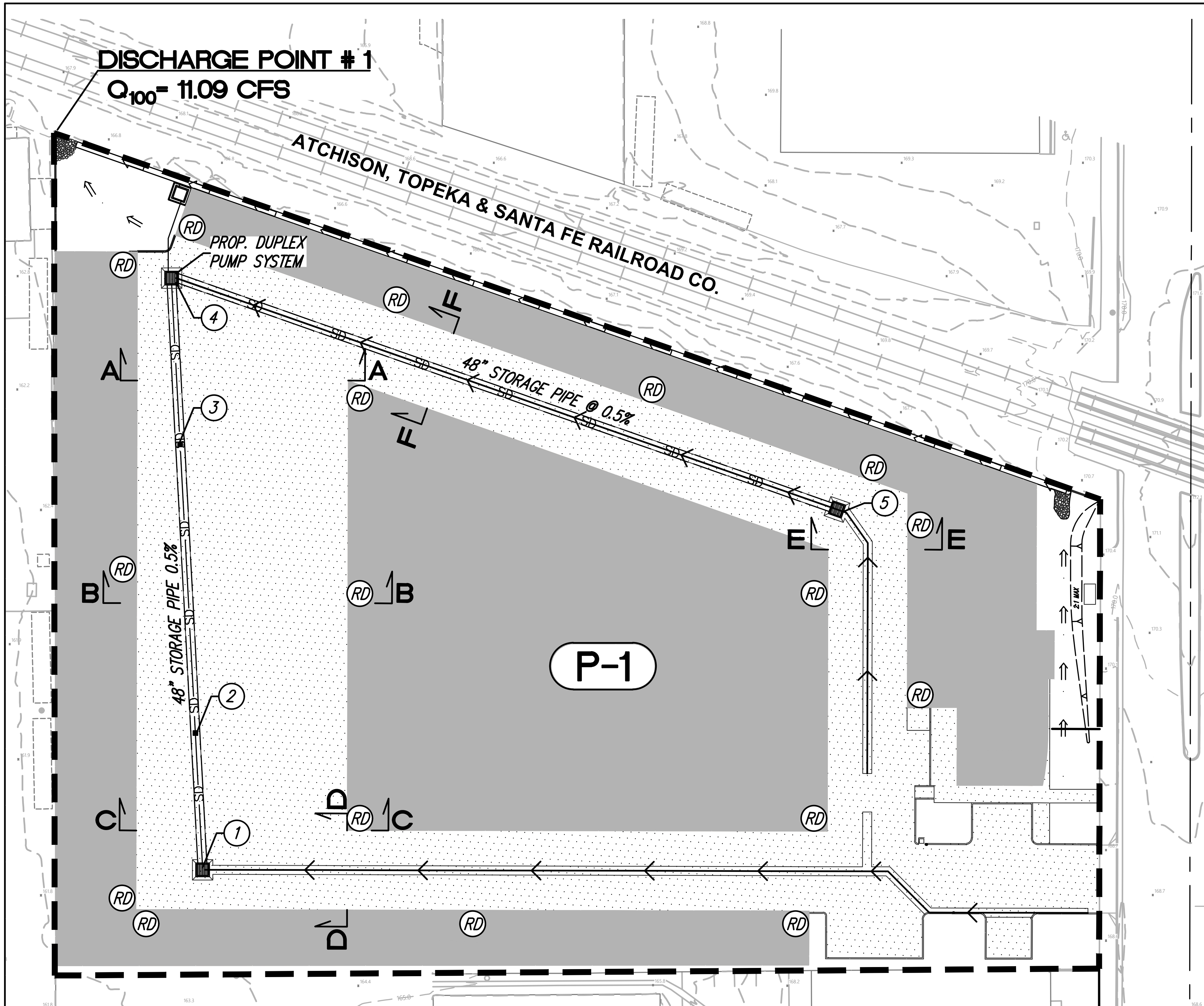
GRAPHICAL SCALE: 1" = 50'

0 25 50 100

BATAVIA SELF-STORAGE EXISTING HYDROLOGY EXHIBIT

OMEGA

EX. HYDROLOGY EXHIBIT



LEGEND

- BASIN NUMBER .... P-#
- AREA LIMITS ....
- DRAINAGE FLOW PATH ....
- BUILDING AREA ....
- PAVEMENT AREA ....
- PERVIOUS AREA ....
- ROOF DRAIN LOCATION .... RD

DRAINAGE BASIN DATA

BASIN #	AREA (AC)	INTENSITY (IN/HR)	Fm (IN/HR)	Q_{100} (CFS)
P-1	3.06	4.04	0.024	11.09
–	–	–	–	–

(X) INLET DATA TABLE

INLET #	DESCRIPTION	Q_{100} (CFS)	Q CAPTURED (CFS)	Q BYPASS (CFS)	EFFICIENCY
1	5'X5' GRATED INLET (SAG)	3.36	3.36	0.0	100%
2	2'X2' GRATED INLET (ON GRADE)	0.96	0.38	0.58	40%
3	2'X2' GRATED INLET (ON GRADE)	3.50	0.99	2.51	40%
4	5'X5' GRATED INLET (SAG)	2.32	3.69*	0.0	100%
5	5'X5' GRATED INLET (SAG)	3.03	3.03	0.0	100%

* NOTE: INLET # 4 CAPTURES IT'S TRIBUTARY FLOW IN ADDITION TO THE FLOW BYPASSED BY INLETS # 2 & 3 IN ADDITION TO THE TRIBUTARY FLOW TO INLET # 4

GRAPHICAL SCALE: 1" = 50'

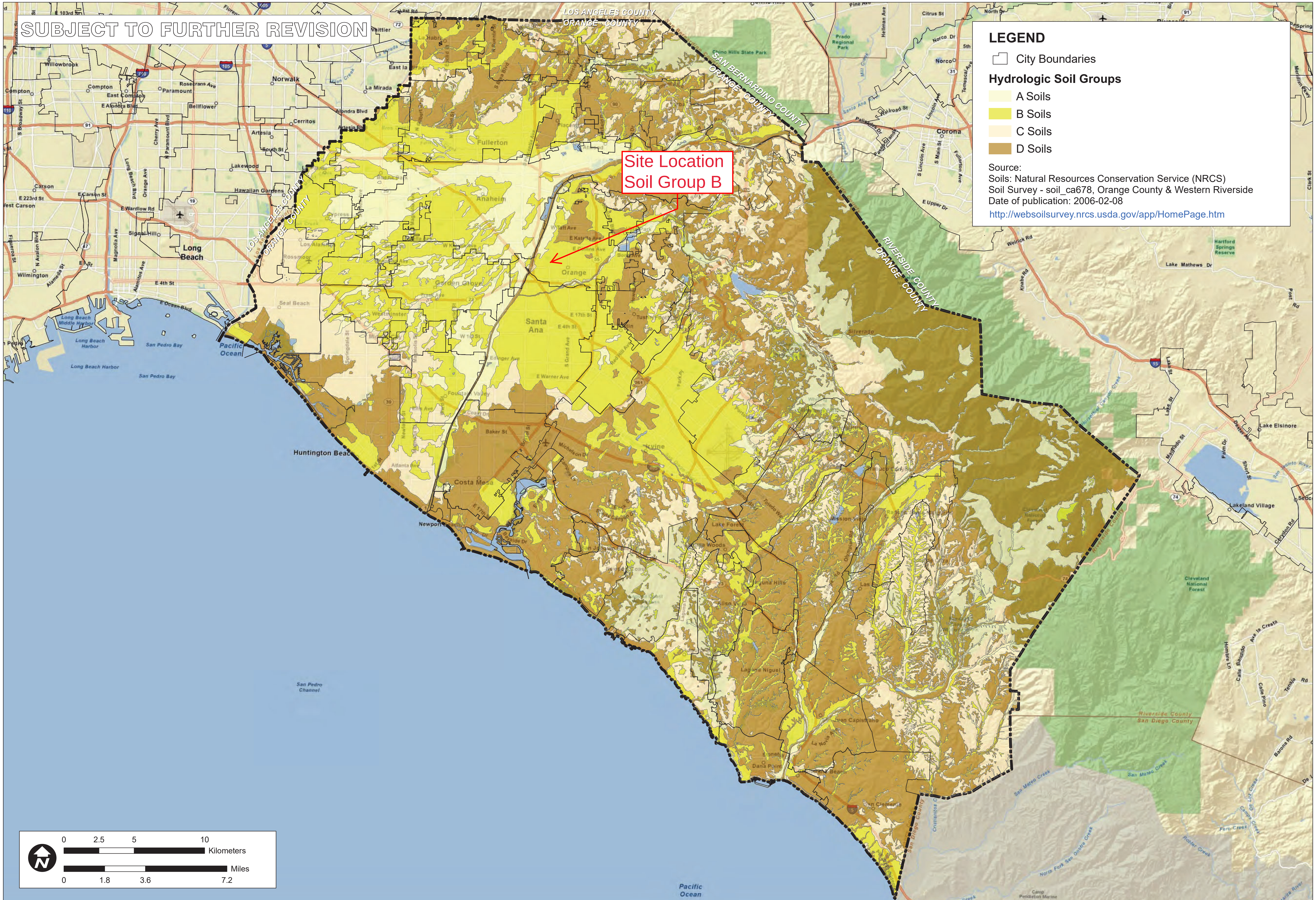
0 25 50 100

BATAVIA SELF–STORAGE PROPOSED HYDROLOGY EXHIBIT

ΩMEGA

PROP. HYDROLOGY EXHIBIT

Appendix 1



NRCS HYDROLOGIC SOILS GROUPS

TITLE

ORANGE COUNTY INFILTRATION STUDY

ORANGE CO. CA

JOB

SCALE	1" = 1.8 miles
DESIGNED	TH
DRAWING	TH
CHECKED	BMP
DATE	02/09/11
JOB NO.	9526-E

PACE Advanced Water Engineering

FIGURE

XVI-2a

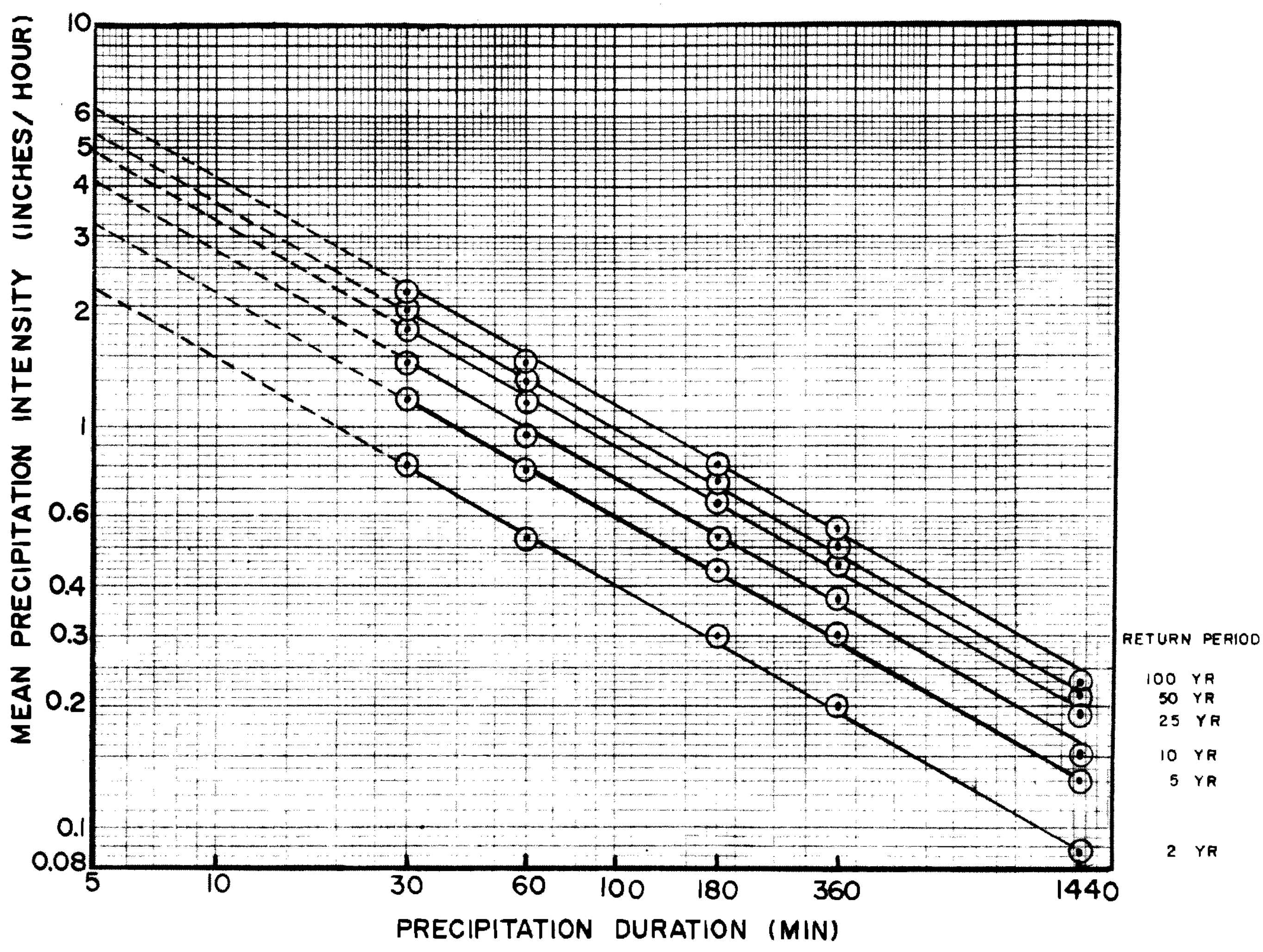
P:\9526E\6-GIS\Mxds\Reports\InfiltrationFeasability_20110215\9526E_FigureXVI-2a_HydroSoils_20110215.mxd

Appendix 2

Regression Equations: $I(t) = at^b$

(I = Intensity in inches/hour, t = duration in minutes)

Return Frequency (years)	a	b
2	5.702	-0.574
5	7.870	-0.562
10	10.209	-0.573
25	11.995	-0.566
50	13.521	-0.566
100	15.560	-0.573



ORANGE COUNTY

HYDROLOGY MANUAL

MEAN PRECIPITATION INTENSITIES FOR NONMOUNTAINOUS AREAS

Figure B-3

Appendix 3

C.6.4. Estimation of Maximum Loss Rates for Pervious Areas, F_p

Table C.2 lists the maximum loss rates (inch/hour), F_p, for pervious area as a function of soil group.

Site Conditions
Soil Group B

TABLE C.2.

MAXIMUM EFFECTIVE PERVIOUS AREA LOSS RATES (inch/hour), F_p

SOIL GROUP:	**A**	**B**	**C**	**D**
F_p:	0.40	0.30	0.25	0.20

Table C.2 reflects the model calibration assuming an F_p of 0.30 in/hr. for all the considered catchments and storm return frequencies. This mean value of F_p of 0.30 in/hr. was assigned to Hydrologic Soil Group B due to the actual average soil conditions in the reconstitution study areas. The F_p values for Hydrologic Soil Groups A, C, and D, were assigned to account for the different soil types that may be found in Orange County.

C.6.5. Estimation of Catchment Maximum Loss Rates, F_m

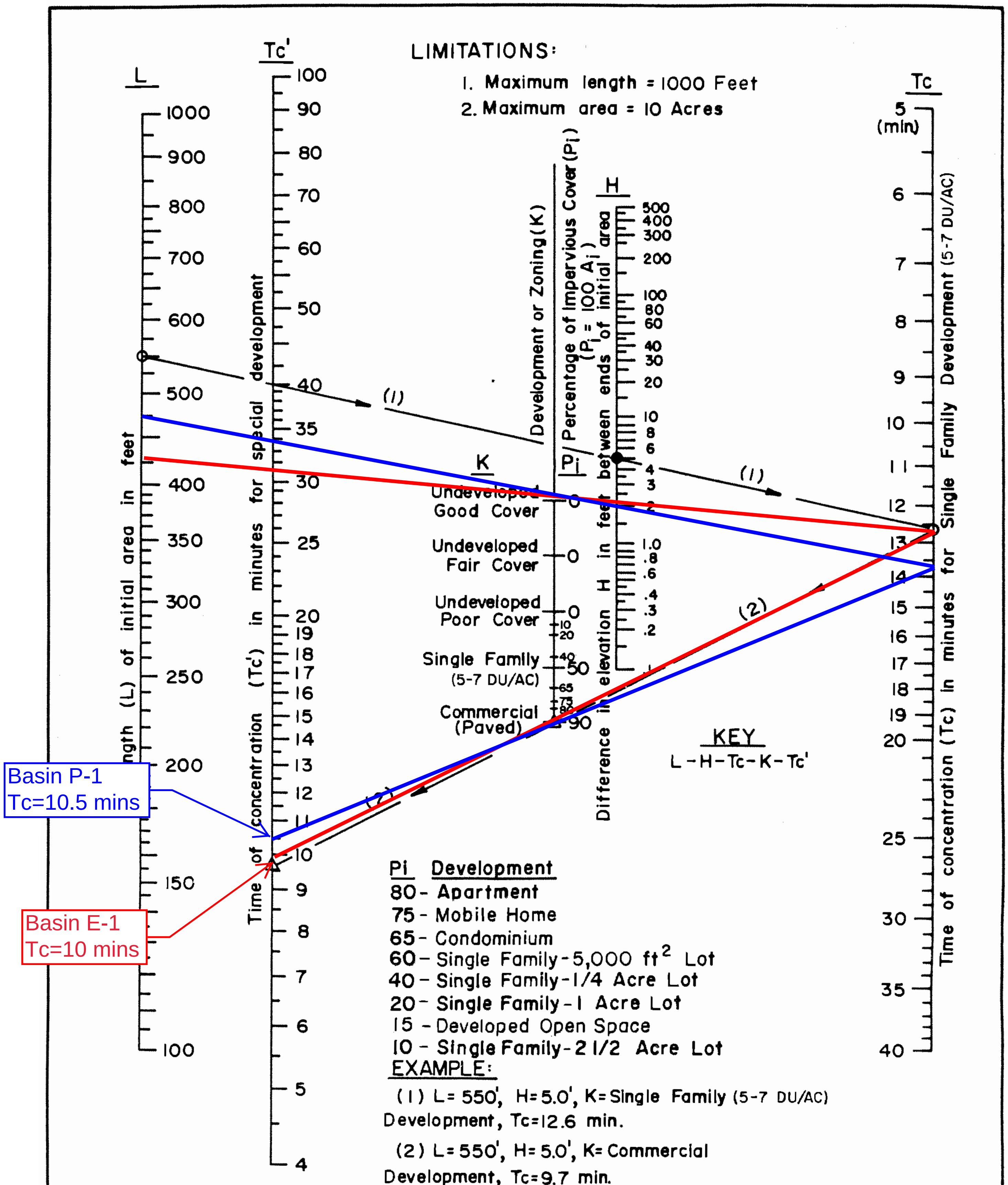
The maximum loss rate selected from Table C.2 applies to the pervious area fraction of the watershed. The loss rate assumed for an impervious surface is 0.0 inch/hour. The maximum loss rate, F_m, for a catchment is therefore given by

$$F_m = a_p F_p \tag{C.7}$$

where a_p is the pervious area fraction and F_p is the maximum loss rate for the pervious area (Section C.6.4).

Should a catchment contain several F_m values, the composite F_m value is determined as a simple area average of the several F_m values.

Appendix 4



ORANGE COUNTY

HYDROLOGY MANUAL

TIME OF CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA

Appendix 5

Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 23 2022

Grated Inlet # 1 (Sag)

Drop Grate Inlet

Location	=	Sag
Curb Length (ft)	=	-0-
Throat Height (in)	=	-0-
Grate Area (sqft)	=	9.00
Grate Width (ft)	=	5.00
Grate Length (ft)	=	5.00

Gutter

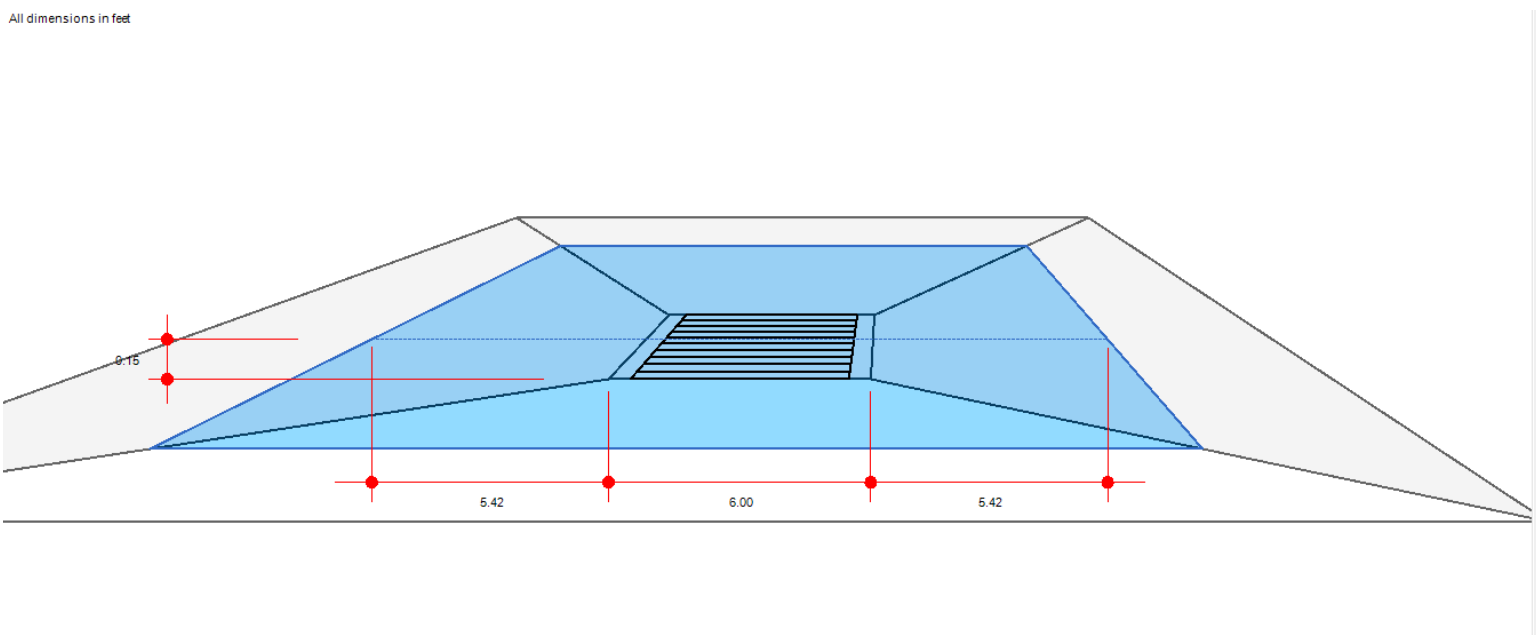
Slope, Sw (ft/ft)	=	0.027
Slope, Sx (ft/ft)	=	0.027
Local Depr (in)	=	-0-
Gutter Width (ft)	=	6.00
Gutter Slope (%)	=	-0-
Gutter n-value	=	-0-

Calculations

Compute by:		Known Q
Q (cfs)	=	3.36

Highlighted

Q Total (cfs)	=	3.36
Q Capt (cfs)	=	3.36
Q Bypass (cfs)	=	-0-
Depth at Inlet (in)	=	1.75
Efficiency (%)	=	100
Gutter Spread (ft)	=	16.83
Gutter Vel (ft/s)	=	-0-
Bypass Spread (ft)	=	-0-
Bypass Depth (in)	=	-0-



Inlet Report

Grated Inlet # 2 (On Grade)

Drop Grate Inlet

Location	=	On grade
Curb Length (ft)	=	-0-
Throat Height (in)	=	-0-
Grate Area (sqft)	=	-0-
Grate Width (ft)	=	2.00
Grate Length (ft)	=	2.00

Gutter

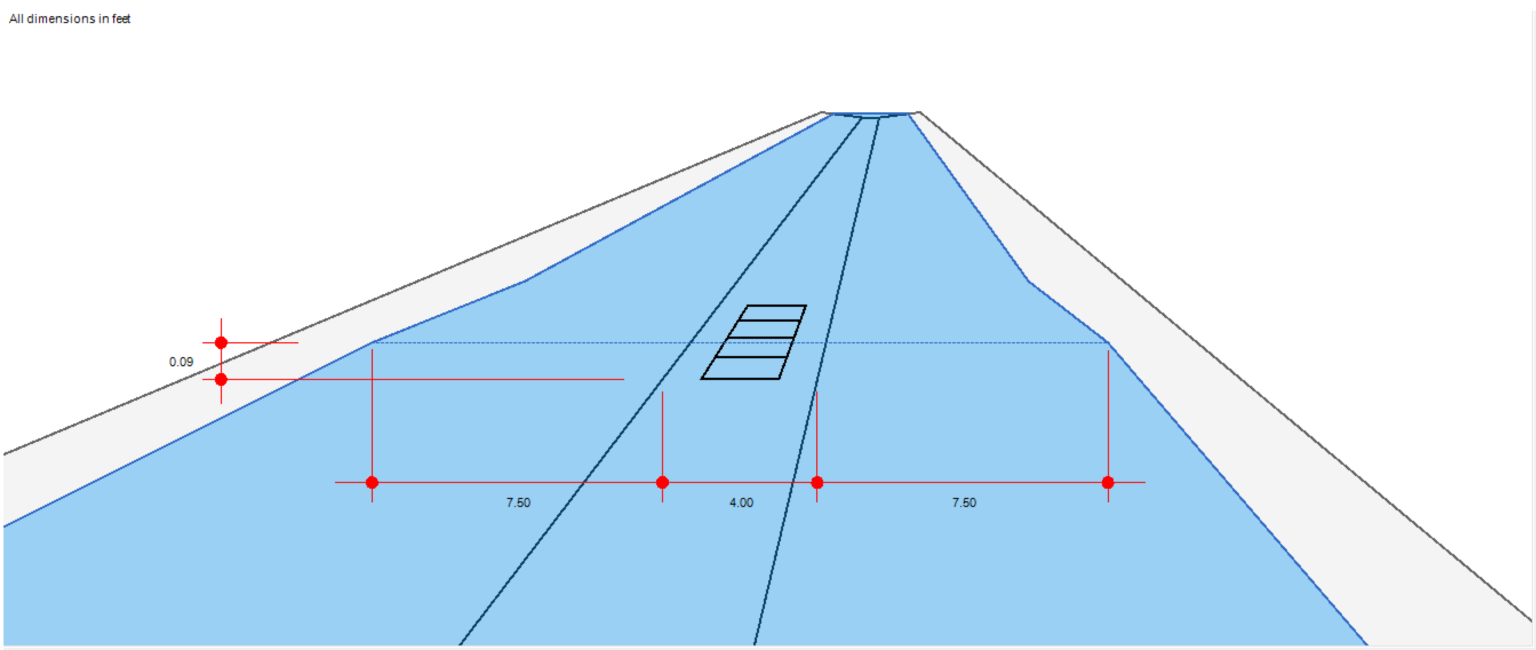
Slope, Sw (ft/ft)	=	0.012
Slope, Sx (ft/ft)	=	0.012
Local Depr (in)	=	-0-
Gutter Width (ft)	=	4.00
Gutter Slope (%)	=	0.33
Gutter n-value	=	0.013

Calculations

Compute by:		Known Q
Q (cfs)	=	0.96

Highlighted

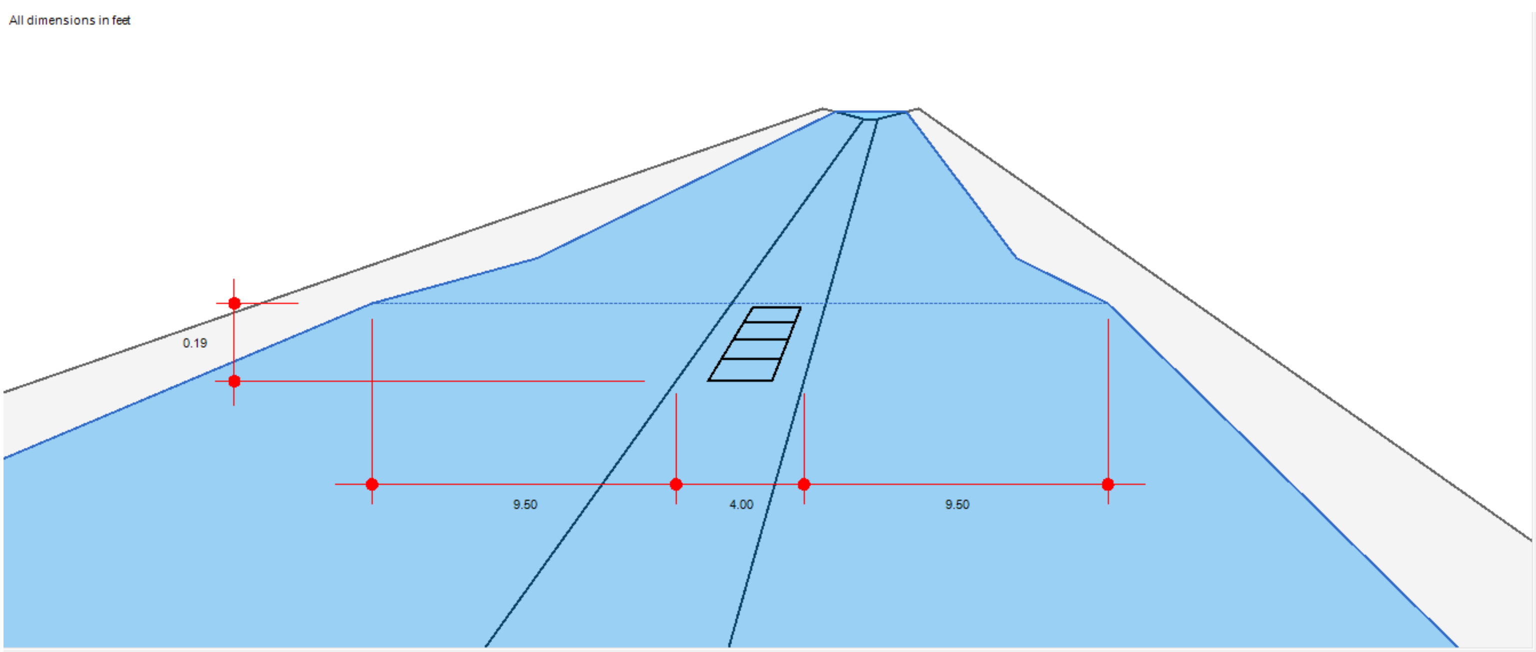
Q Total (cfs)	=	0.96
Q Capt (cfs)	=	0.38
Q Bypass (cfs)	=	0.58
Depth at Inlet (in)	=	1.08
Efficiency (%)	=	40
Gutter Spread (ft)	=	19.00
Gutter Vel (ft/s)	=	0.93
Bypass Spread (ft)	=	17.33
Bypass Depth (in)	=	0.96



Inlet Report

Grated Inlet # 3 (On Grade)

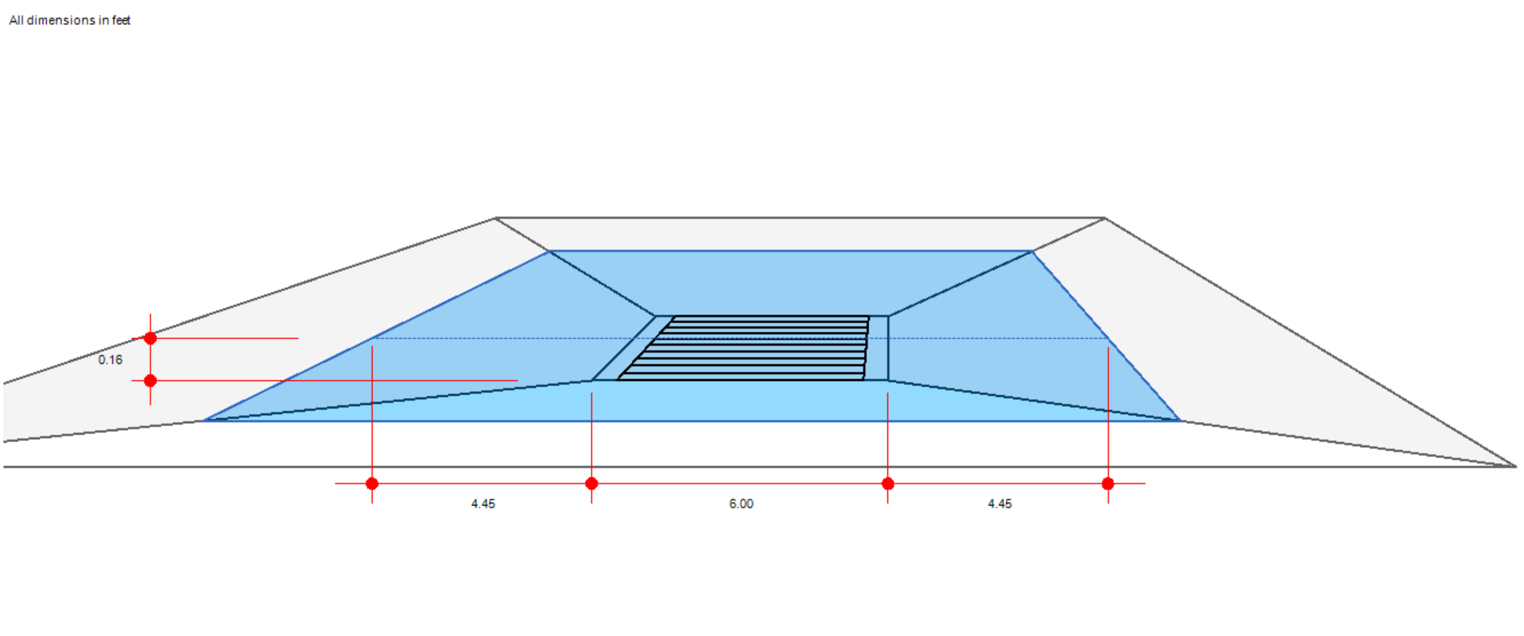
Drop Grate Inlet		**Calculations**	
Location	= On grade	Compute by:	Known Q
Curb Length (ft)	= -0-	Q (cfs)	= 3.50
Throat Height (in)	= -0-		
Grate Area (sqft)	= -0-	**Highlighted**	
Grate Width (ft)	= 2.00	Q Total (cfs)	= 3.50
Grate Length (ft)	= 2.00	Q Capt (cfs)	= 0.99
		Q Bypass (cfs)	= 2.51
Gutter		Depth at Inlet (in)	= 2.28
Slope, Sw (ft/ft)	= 0.020	Efficiency (%)	= 28
Slope, Sx (ft/ft)	= 0.020	Gutter Spread (ft)	= 23.00
Local Depr (in)	= -0-	Gutter Vel (ft/s)	= 1.36
Gutter Width (ft)	= 4.00	Bypass Spread (ft)	= 20.00
Gutter Slope (%)	= 0.34	Bypass Depth (in)	= 1.92
Gutter n-value	= 0.013		



Inlet Report

Grated Inlet # 4 (Sag)

Drop Grate Inlet		**Calculations**	
Location	= Sag	Compute by:	Known Q
Curb Length (ft)	= -0-	Q (cfs)	= 3.69
Throat Height (in)	= -0-		
Grate Area (sqft)	= 25.00	**Highlighted**	
Grate Width (ft)	= 5.00	Q Total (cfs)	= 3.69
Grate Length (ft)	= 5.00	Q Capt (cfs)	= 3.69
		Q Bypass (cfs)	= -0-
Gutter		Depth at Inlet (in)	= 1.87
Slope, Sw (ft/ft)	= 0.035	Efficiency (%)	= 100
Slope, Sx (ft/ft)	= 0.035	Gutter Spread (ft)	= 14.89
Local Depr (in)	= -0-	Gutter Vel (ft/s)	= -0-
Gutter Width (ft)	= 6.00	Bypass Spread (ft)	= -0-
Gutter Slope (%)	= -0-	Bypass Depth (in)	= -0-
Gutter n-value	= -0-		

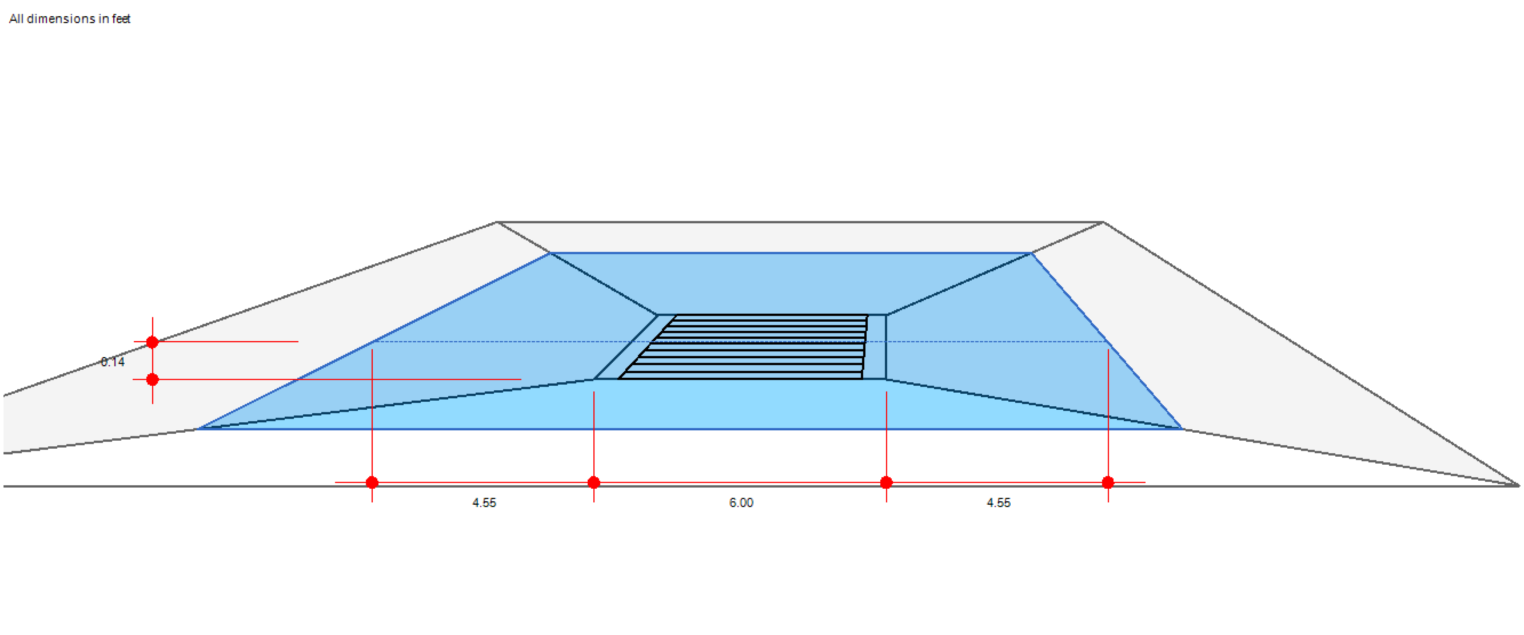


Inlet Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 23 2022

Grated Inlet # 5 (Sag)

Drop Grate Inlet		**Calculations**	
Location	= Sag	Compute by:	Known Q
Curb Length (ft)	= -0-	Q (cfs)	= 3.03
Throat Height (in)	= -0-		
Grate Area (sqft)	= 25.00	**Highlighted**	
Grate Width (ft)	= 5.00	Q Total (cfs)	= 3.03
Grate Length (ft)	= 5.00	Q Capt (cfs)	= 3.03
		Q Bypass (cfs)	= -0-
Gutter		Depth at Inlet (in)	= 1.64
Slope, Sw (ft/ft)	= 0.030	Efficiency (%)	= 100
Slope, Sx (ft/ft)	= 0.030	Gutter Spread (ft)	= 15.10
Local Depr (in)	= -0-	Gutter Vel (ft/s)	= -0-
Gutter Width (ft)	= 6.00	Bypass Spread (ft)	= -0-
Gutter Slope (%)	= -0-	Bypass Depth (in)	= -0-
Gutter n-value	= -0-		



Appendix 6

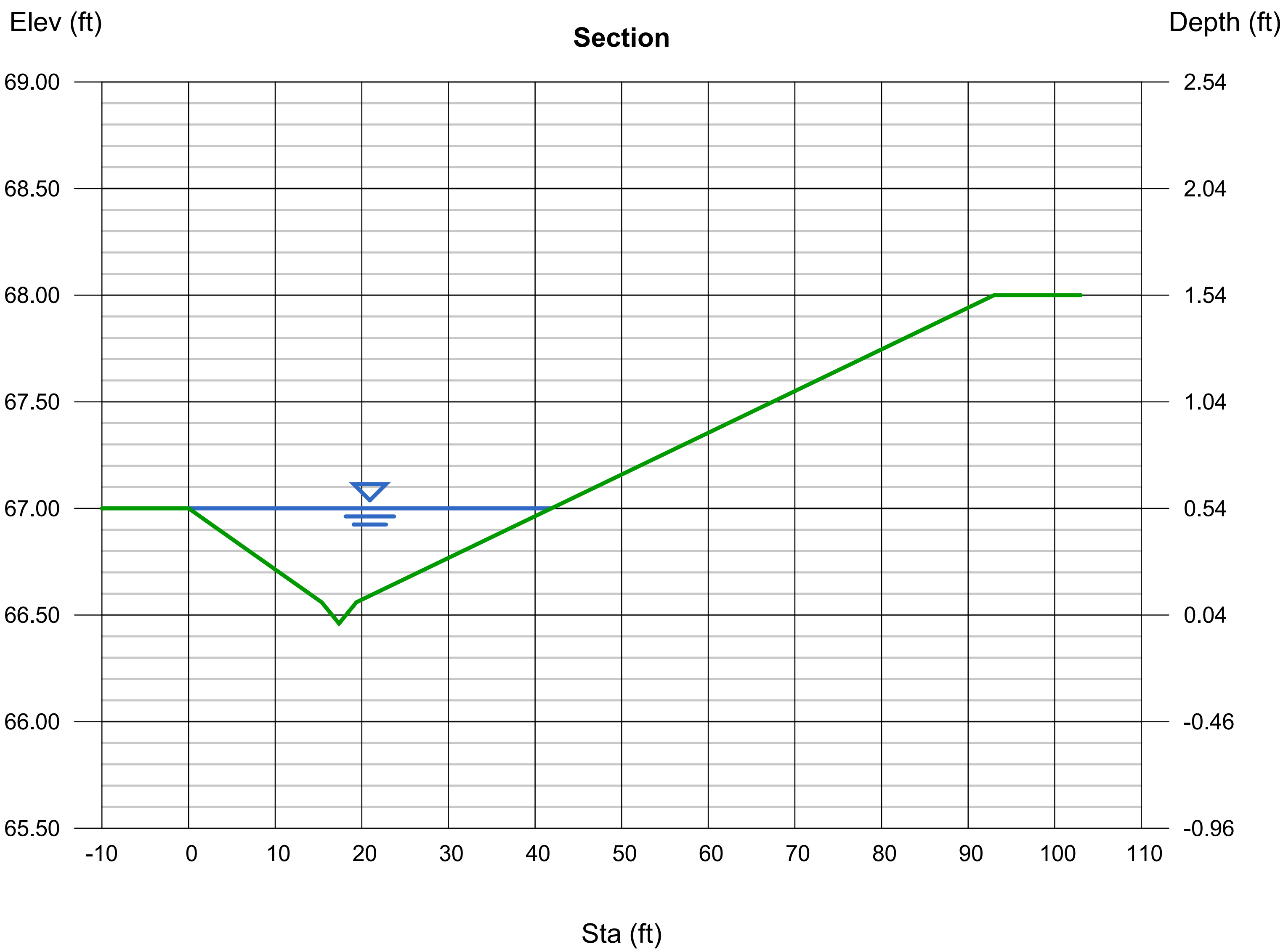
Channel Report

Section A-A, Northwest section of drive aisle

User-defined		**Highlighted**	
Invert Elev (ft)	= 66.46	Depth (ft)	= 0.54
Slope (%)	= 0.34	Q (cfs)	= 26.95
N-Value	= 0.013	Area (sqft)	= 10.29
		Velocity (ft/s)	= 2.62
Calculations		Wetted Perim (ft)	= 41.88
Compute by:	Known Depth	Crit Depth, Yc (ft)	= 0.53
Known Depth (ft)	= 0.54	Top Width (ft)	= 41.87
		EGL (ft)	= 0.65

(Sta, El, n)-(Sta, El, n)...

(0.00, 67.00)-(15.37, 66.56, 0.013)-(17.37, 66.46, 0.013)-(19.37, 66.56, 0.013)-(93.00, 68.00, 0.013)



Channel Report

Section B-B, Mid-west drive aisle

User-defined		**Highlighted**	
Invert Elev (ft)	= 66.80	Depth (ft)	= 0.50
Slope (%)	= 0.34	Q (cfs)	= 29.25
N-Value	= 0.013	Area (sqft)	= 12.10
		Velocity (ft/s)	= 2.42
Calculations		Wetted Perim (ft)	= 55.49
Compute by:	Known Depth	Crit Depth, Yc (ft)	= 0.49
Known Depth (ft)	= 0.50	Top Width (ft)	= 55.48
		EGL (ft)	= 0.59

(Sta, El, n)-(Sta, El, n)...
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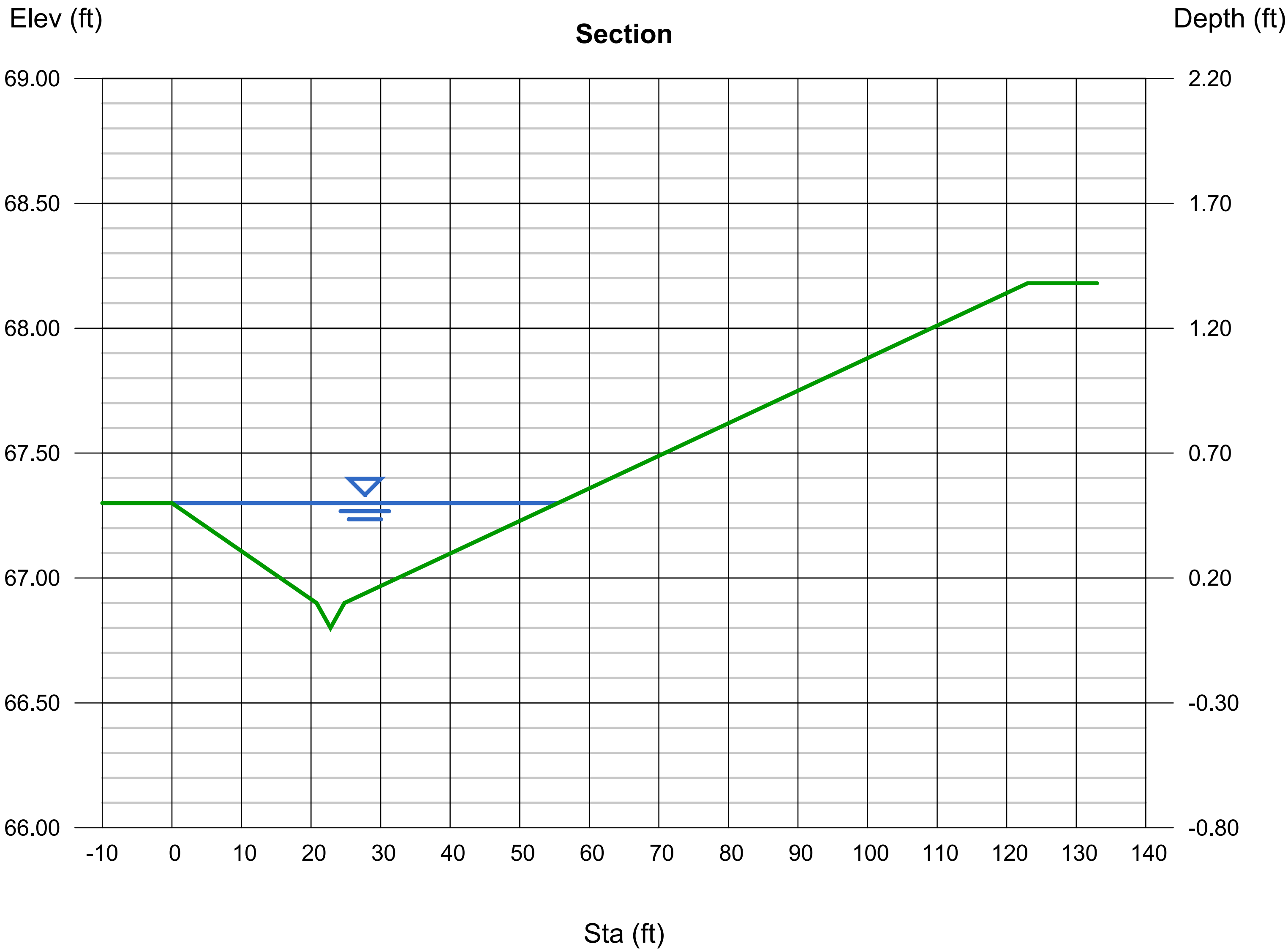


Channel Report

Section C-C, SW corner of westerly drive aisle

User-defined

Invert Elev (ft)	=	67.14
Slope (%)	=	0.34
N-Value	=	0.013

Calculations

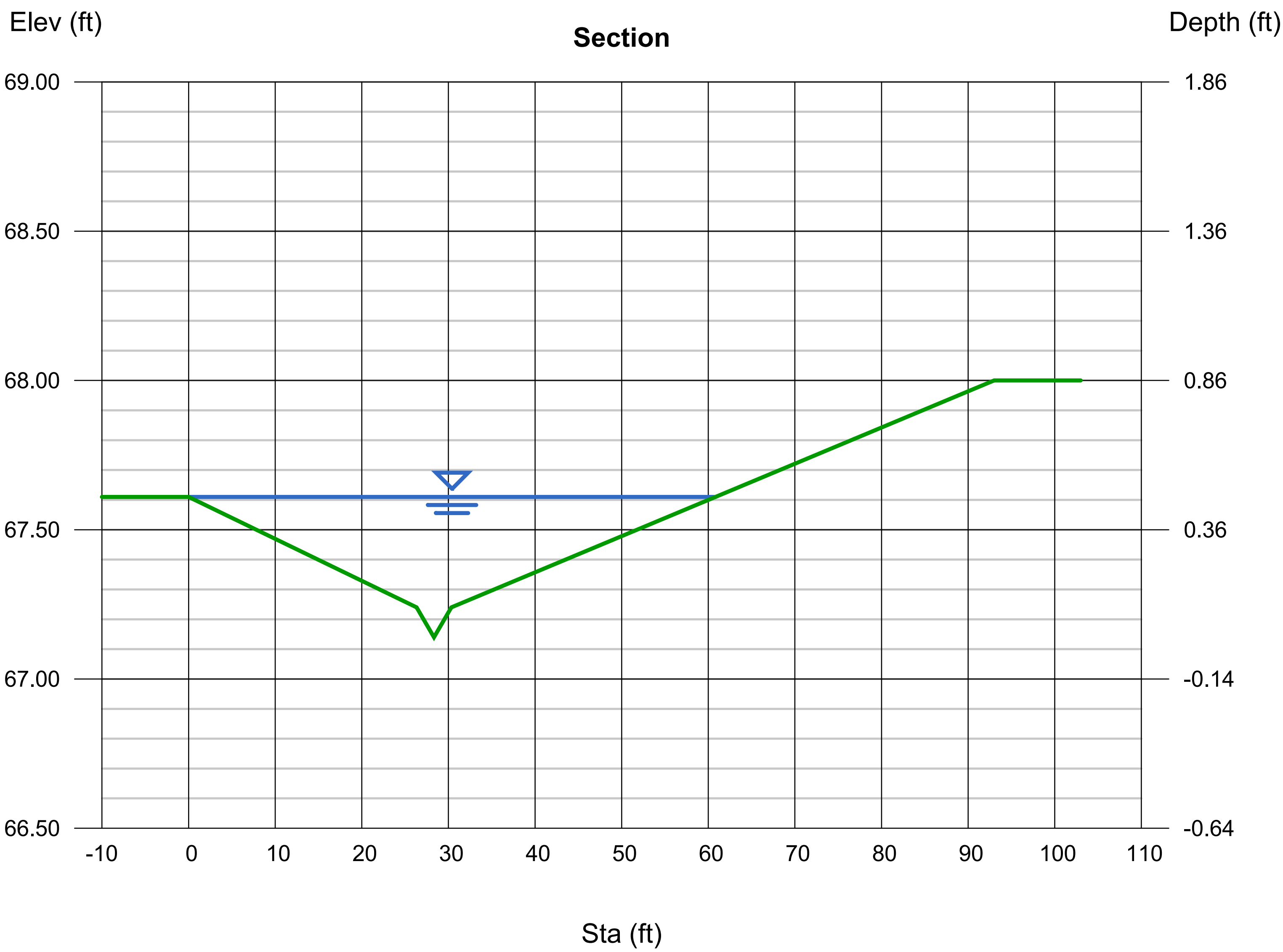
Compute by:		Known Depth
Known Depth (ft)	=	0.47

Highlighted

Depth (ft)	=	0.47
Q (cfs)	=	27.88
Area (sqft)	=	12.20
Velocity (ft/s)	=	2.29
Wetted Perim (ft)	=	60.85
Crit Depth, Yc (ft)	=	0.46
Top Width (ft)	=	60.84
EGL (ft)	=	0.55

(Sta, El, n)-(Sta, El, n)...

(0.00, 67.61)-(26.33, 67.24, 0.013)-(28.33, 67.14, 0.013)-(30.33, 67.24, 0.013)-(93.00, 68.00, 0.013)



Channel Report

Section D-D, Southerly drive aisle

User-defined

Invert Elev (ft)	=	67.55
Slope (%)	=	0.30
N-Value	=	0.013

Calculations

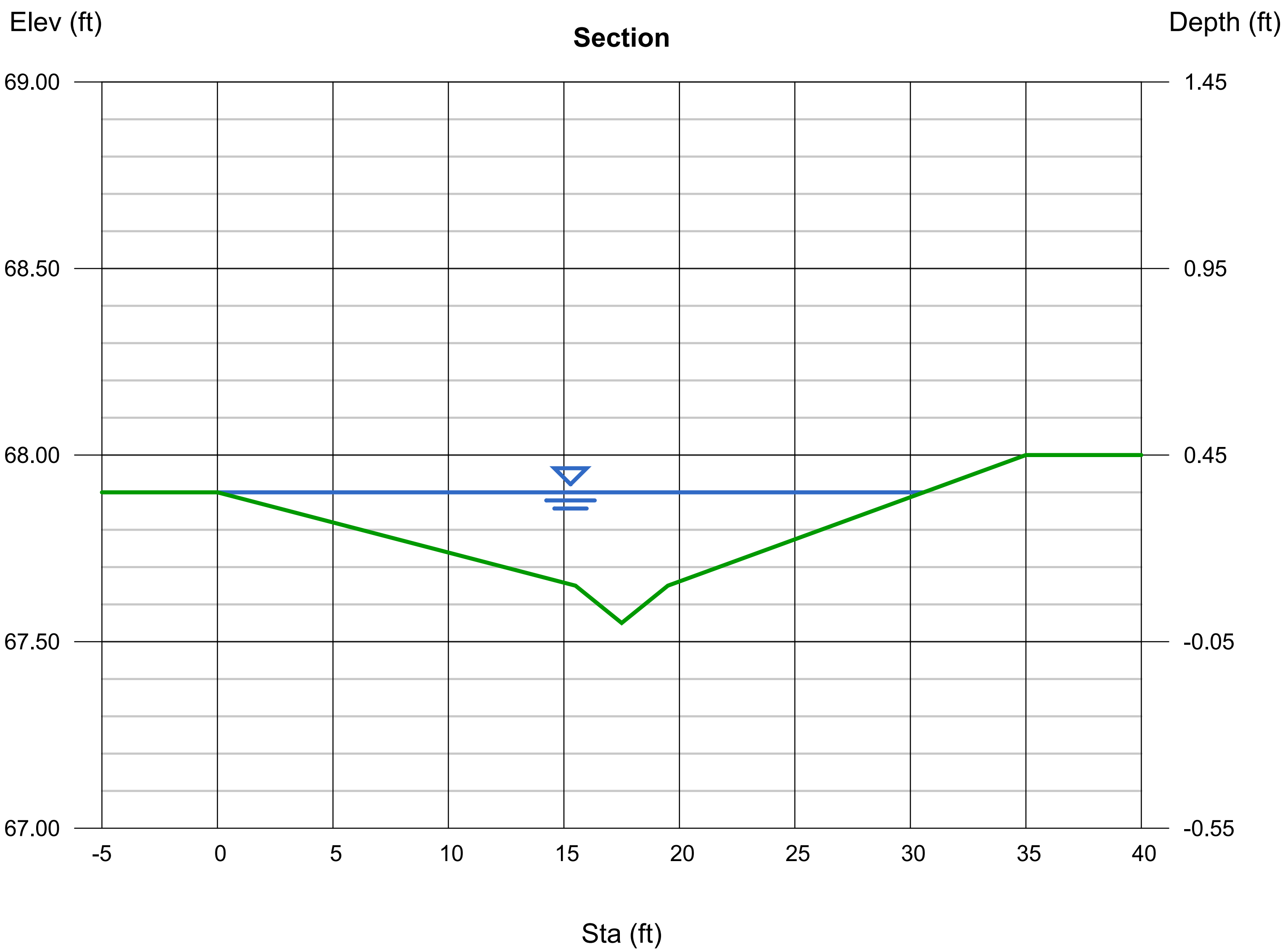
Compute by:		Known Depth
Known Depth (ft)	=	0.35

Highlighted

Depth (ft)	=	0.35
Q (cfs)	=	7.927
Area (sqft)	=	4.52
Velocity (ft/s)	=	1.75
Wetted Perim (ft)	=	30.58
Crit Depth, Yc (ft)	=	0.33
Top Width (ft)	=	30.57
EGL (ft)	=	0.40

(Sta, El, n)-(Sta, El, n)...

(0.00, 67.90)-(15.50, 67.65, 0.013)-(17.50, 67.55, 0.013)-(19.50, 67.65, 0.013)-(35.00, 68.00, 0.013)



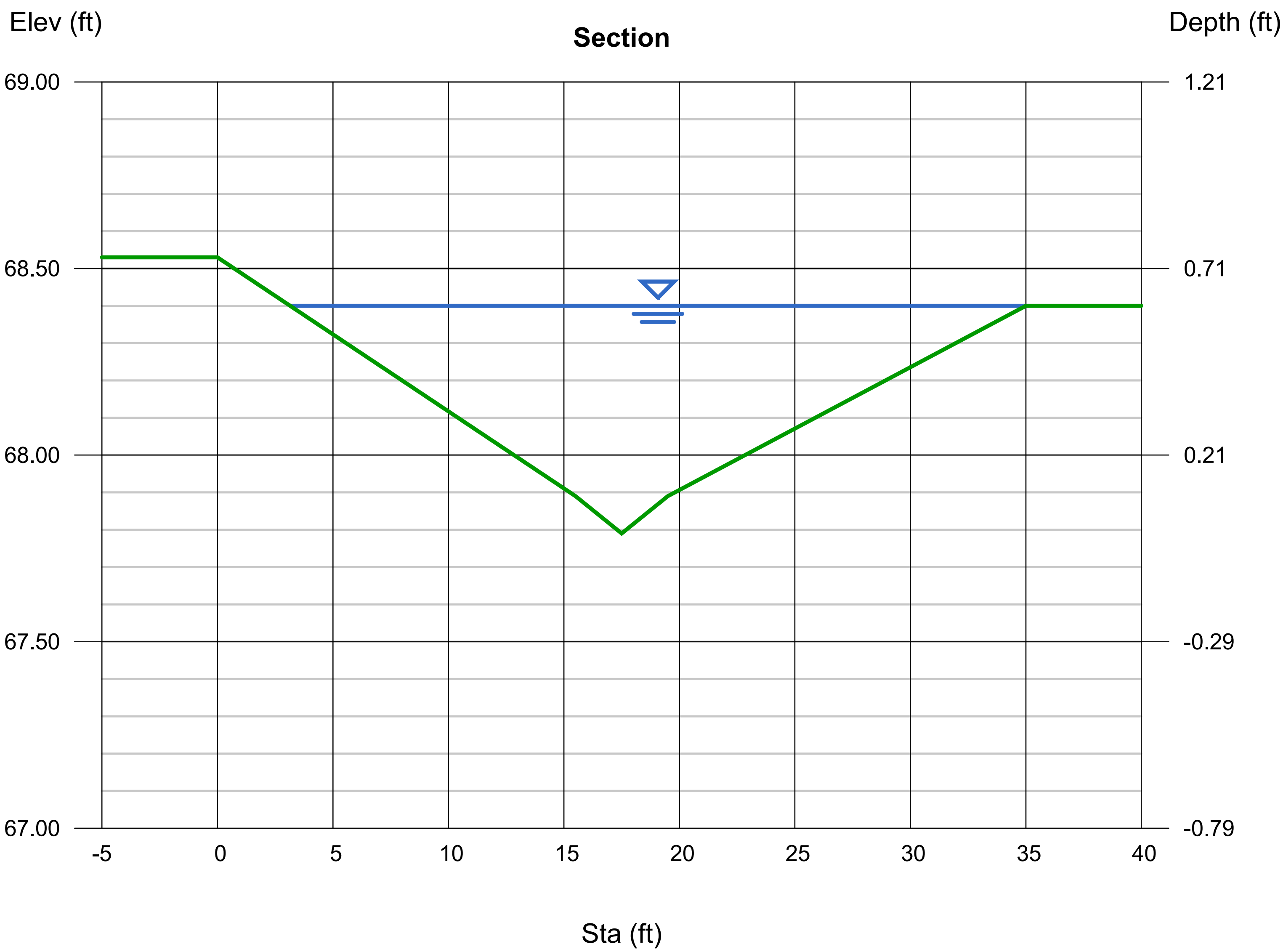
Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Feb 22 2022

Section E-E, Easterly drive aisle

User-defined		Highlighted	
Invert Elev (ft)	= 67.79	Depth (ft)	= 0.61
Slope (%)	= 0.30	Q (cfs)	= 25.85
N-Value	= 0.013	Area (sqft)	= 9.34
		Velocity (ft/s)	= 2.77
Calculations		Wetted Perim (ft)	= 31.88
Compute by:	Known Depth	Crit Depth, Yc (ft)	= 0.59
Known Depth (ft)	= 0.61	Top Width (ft)	= 31.85
		EGL (ft)	= 0.73

(Sta, El, n)-(Sta, El, n)...
(0.00, 68.53)-(15.50, 67.89, 0.013)-(17.50, 67.79, 0.013)-(19.50, 67.89, 0.013)-(35.00, 68.40, 0.013)



Channel Report

Section F-F, Northerly drive aisle

User-defined		Highlighted	
Invert Elev (ft)	= 67.26	Depth (ft)	= 0.34
Slope (%)	= 0.33	Q (cfs)	= 6.046
N-Value	= 0.013	Area (sqft)	= 3.23
		Velocity (ft/s)	= 1.87
Calculations		Wetted Perim (ft)	= 21.25
Compute by:	Known Depth	Crit Depth, Yc (ft)	= 0.33
Known Depth (ft)	= 0.34	Top Width (ft)	= 21.24
		EGL (ft)	= 0.39

(Sta, El, n)-(Sta, El, n)...
(0.00, 68.09)-(20.50, 67.36, 0.013)-(22.50, 67.26, 0.013)-(24.50, 67.36, 0.013)-(35.00, 67.60, 0.013)