

## Case Research



## Abbreviated Water and Sewer Needs



## Archaeological Report

# Wolf Springs Ranch

NWC 94<sup>th</sup> Street and Cactus Blvd  
Scottsdale Arizona 85260

## Final Sewer Basis of Design Report

June 7, 2018

SHG Job No. TEG1603-000

**Accepted For:**  
City of Scottsdale  
Water Resources Department  
9379 E. San Salvador  
Scottsdale, Arizona

By: R. SACKS  
Date: 7/13/18

### Submitted by:

#### The Empire Group

6617 N Scottsdale Road, Ste. 101  
Scottsdale, AZ 85250



### Prepared By:

Slater Hanifan Group, Inc.  
11201 N. Tatum Blvd., Suite 250  
Phoenix, AZ 85028  
Phone: 602-687-9664  
Contact: Patrick Lowry

**14-PP-2017**  
**06/27/18**

#### A. Introduction

The proposed development consists of 40 single-family residential units covering 20 acres located in Scottsdale, Arizona. The project has a gross density of 2.0 du/ac. The site is located on the northwest corner of N. 94th Street and East Cactus Road. The Site is within the southeast quarter of Section 18 in Township 3 North, Range 5 East of the Gila and Salt River Base and Meridian, City of Scottsdale, Maricopa County, Arizona. Refer to the Vicinity Map in Appendix A for the project location.

#### B. Design Documentation

The infrastructure sewer lines and unit daily flows for this project have been determined using the City of Scottsdale Design Standards & Policies Manual (DS&PM).

#### C. Existing Conditions

The existing site encompasses approximately 20 acres of developed land on ground that slopes generally to the south and west. The existing zone for the property is R1-18 PRD. The existing Site is used as an equestrian facility and school. The existing low site outfall is located at the southwest corner of the project at the corner of 93rd Street and Cactus. An existing 8" sewer line is located west of the site in 93rd Street and conveys flow south to a 24" sewer main located in Cactus Road that conveys flows west. 144 lots north of this project contribute flow to the 8-inch line in 93rd Street.

#### D. Sewer flows summary

Per the City of Scottsdale DS&PM residential sewer demand for an 8-inch pipe is 100 gpd per person and a peaking factor of 4. The average day sewer flow for the 40 units (2.5 people per) is 10,000 gpd with a peaking flow of 40,000 gpd. The existing flows from 144 lots to the north are 36,000 gpd with a peaking flow of 144,000 gpd. The existing 8-inch line in 93rd Street with a slope of 0.0033 ft/ft flowing at 65% full has a capacity of 343,900 gpd. (See table in Section H).

The existing 8-inch sewer line in 93rd Avenue was analyzed for the peak flow of 184,000 gpd (127.78 gpm). The results are presented in Appendix C and show a d/D ratio of 0.45, less than the allowed 0.65.

#### E. Wastewater Collection System

The project is located within the City of Scottsdale Wastewater Service Area. Four runs of 8-inch PVC pipes will be installed within the proposed roadways and utility easements throughout the project. The 8-inch sewer lines will convey sewer flows from the 40 units to the existing 8-inch sewer line located in 93rd street west of the project. Existing manholes will be tied into to make the connection to the existing 8-inch sewer line. Individual 4-inch sewer laterals will service each residential unit. Flows from the development ultimately outfall to a 24-inch sewer main located in E. Cactus Road and is conveyed to a City of Scottsdale reclamation facility. See Appendix B – Utility Site Map

#### F. Design Considerations

All sewer lines will be designed using Manning's equation assuming pipe flowing full using a manning's "n" value of 0.013. Pipe sizes will be designed such that the peak flow will not exceed a depth of flow to pipe diameter ratio of 0.65 (d/D).

G. Minimum Slopes

Per the City of Scottsdale DS&PM a minimum full flow velocity of 2.5 feet per second will be used to determine the minimum slope for each pipe segment. The maximum velocity will be limited to 10 fps at estimated peak flow.

H. Peaking Factor

The City of Scottsdale requires a sewer line to be designed to account for a peak flow scenario. A peaking factor is applied to the average day flows. A peaking factor of 4 was used for this parcel per the Engineer Design Standards and Policy Manual. Please see the table below for sewer flow calculations.

Development	2.5 persons per DU (P)	*Average Day (100gpcpd x P)	Peaking Factors (Average Day x 4)
Project	100	10,000	40,000

*\* 100 gallons per person and a peaking factor of 4.  $100 \times (100) = 10,000\text{gpd} \times 4 = 40,000\text{gpd}$*

I. Conclusion

The project sewer design described within this Sewer Basis of Design Report was designed to collect and convey the wastewater flow under peak flow conditions. The 8-inch line in 93<sup>rd</sup> street has enough capacity to convey this project. The wastewater will ultimately be conveyed and treated at a City of Scottsdale Reclamation Facility.

- ❖ Approx. 1,300 LF of 8-inch PVC sewer line,
- ❖ Manhole Tap connections to the existing 8-inch sewer main.
- ❖ Individual 4" Sewer laterals (40)

J. References

- ❖ City of Scottsdale Design Standards & Policies Manual (DS&PM).
- ❖ City of Scottsdale Geographic Information Systems Quarter Section Maps 31-50 and 30-50

K. Appendices

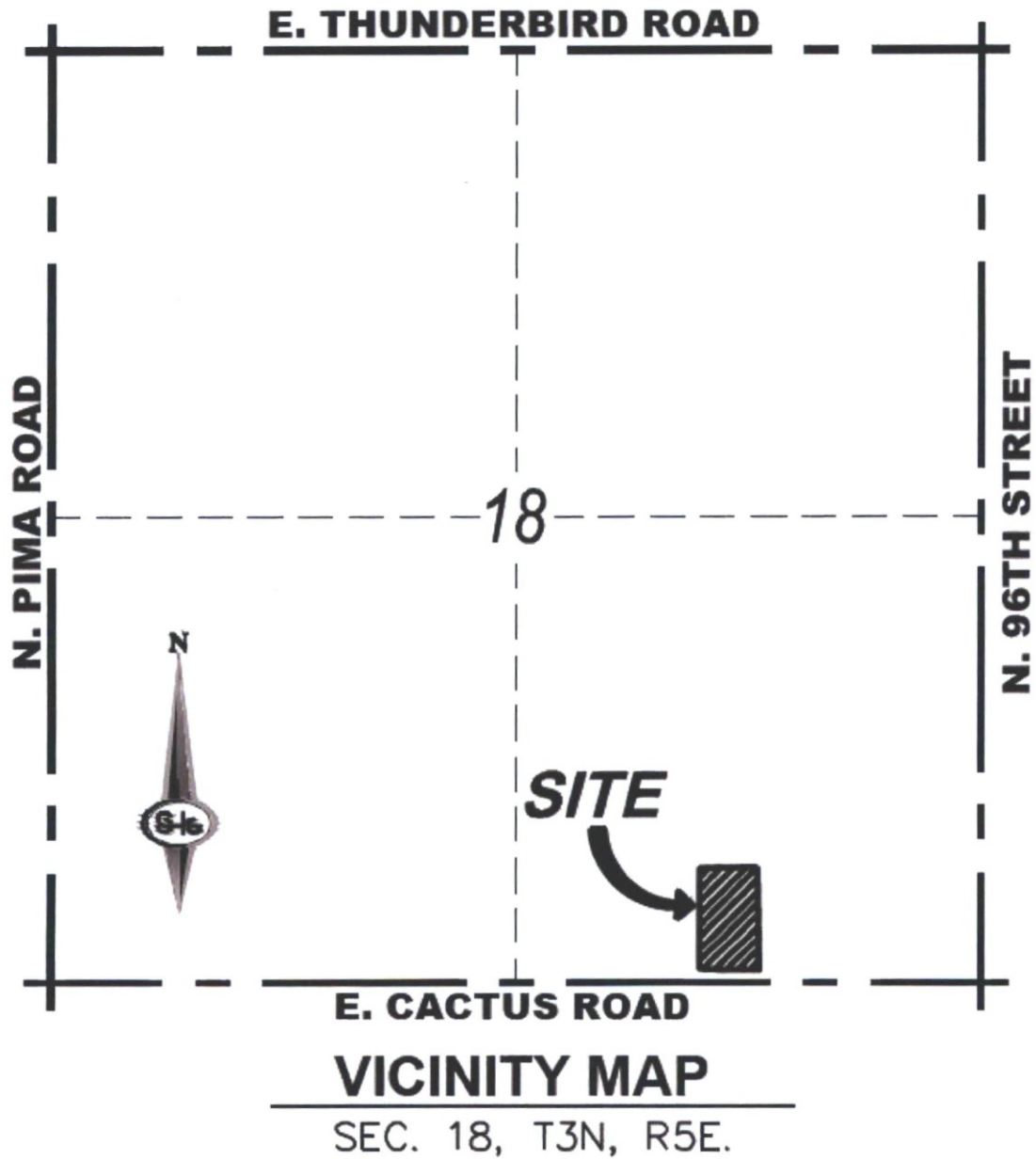
Appendix A – Vicinity Map

Appendix B –Utility Site Map

Appendix C – 93<sup>rd</sup> Avenue Pipe Capacity Check



Appendix A – Vicinity Map





**Appendix B –Utility Site Map**

NO.	DESCRIPTION	DATE	BY	APP

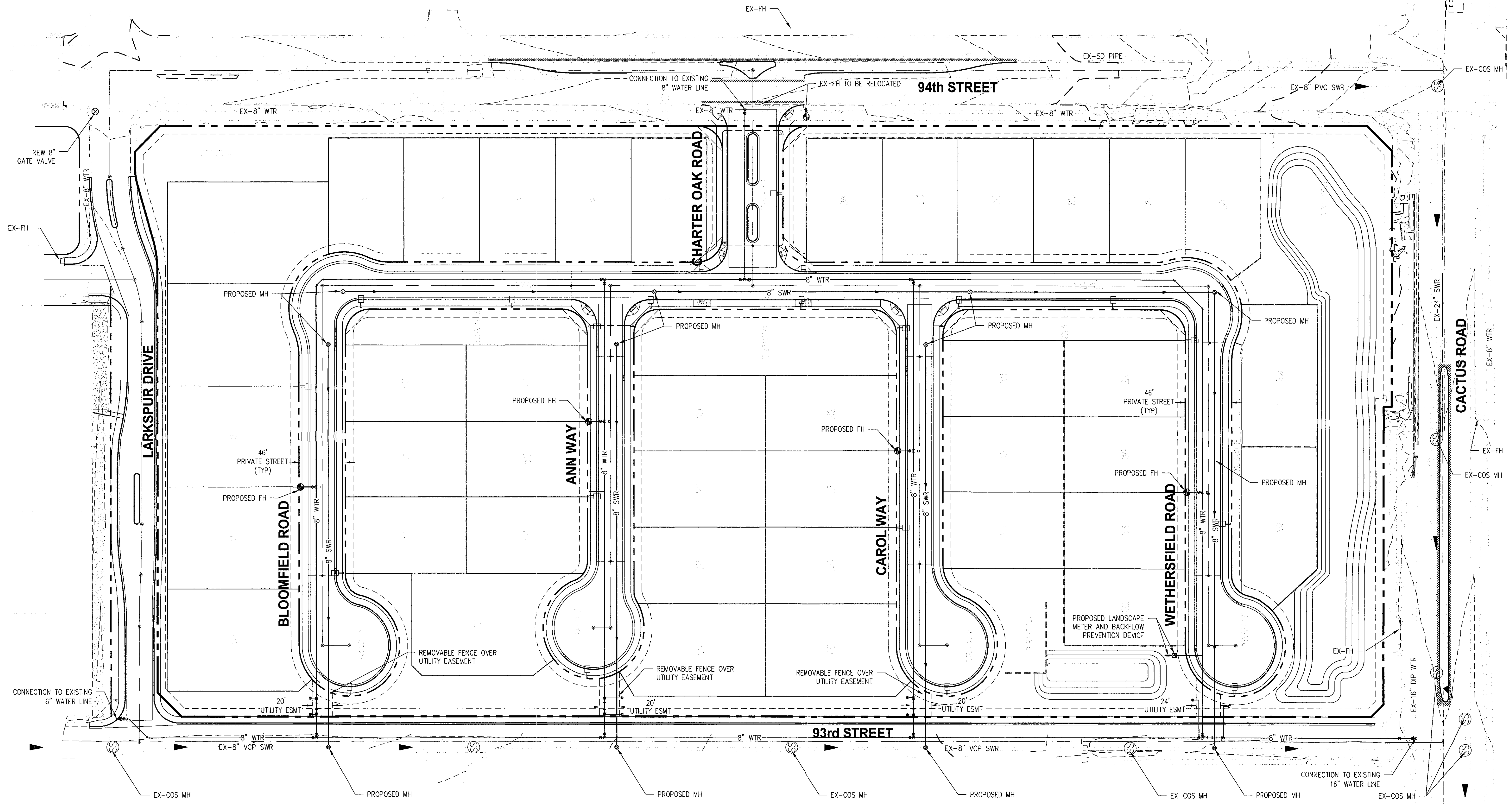
SCOTTSDALE, AZ

**THE EMPIRE GROUP**  
**WOLF SPRINGS RANCH**  
**UTILITY MAP**

SECTION 18  
 TOWNSHIP 3 NORTH  
 RANGE 5 EAST

DATE: 06/07/2018  
 DRAFTER: SB  
 DESIGNER: JP  
 CHECKED: RT  
 PROJECT NO.  
**TEG1603-000**

**EX01**  
 SHEET 1 OF 1



- LEGEND**
- PROPOSED FIRE HYDRANT
  - PROPOSED 8" PVC WATER
  - PROPOSED LANDSCAPE METER
  - PROPOSED BACKFLOW PREVENTION DEVICE
  - PROPOSED WATER VALVE
  - PROPOSED WATER CAP
  - PROPOSED 8" PVC SEWER
  - PROPOSED SEWER MANHOLE
  - EXISTING FIRE HYDRANT
  - EXISTING 16" WATER
  - EXISTING NP WATER
  - EXISTING SEWER
  - EXISTING SEWER MANHOLE
  - EXISTING WATER VALVE
  - EXISTING STREET LIGHT

Contact Arizona 811 at least two full working days before you begin excavation.  
**ARIZONA 811**  
 Call 811 or click Arizona811.com

L:\1603-000\_wolf\_springs\_ranch\water - sewer\water\_report\1603000\_utility\_plan-final.dwg 6/7/2018 3:45 PM Gabriel Romero





**Appendix C – 93<sup>rd</sup> Avenue Pipe Capacity Check**

## Project Description

File Name ..... 93rd Ave Pipe Check.SPF

## Project Options

Flow Units ..... GPM  
Elevation Type ..... Elevation  
Hydrology Method ..... EPA SWMM  
EPA SWMM Infiltration Method ..... SCS Curve Number  
Link Routing Method ..... Steady Flow  
Enable Overflow Ponding at Nodes ..... YES  
Skip Steady State Analysis Time Periods ..... NO

## Analysis Options

Start Analysis On ..... Dec 21, 2016 00:00:00  
End Analysis On ..... Dec 22, 2016 00:00:00  
Start Reporting On ..... Dec 21, 2016 00:00:00  
Antecedent Dry Days ..... 0 days  
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss  
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss  
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss  
Routing Time Step ..... 30 seconds

## Number of Elements

	Qty
Rain Gages .....	0
Subbasins.....	0
Nodes.....	2
<i>Junctions</i> .....	1
<i>Outfalls</i> .....	1
<i>Flow Diversions</i> .....	0
<i>Inlets</i> .....	0
<i>Storage Nodes</i> .....	0
Links.....	1
<i>Channels</i> .....	0
<i>Pipes</i> .....	1
<i>Pumps</i> .....	0
<i>Orifices</i> .....	0
<i>Weirs</i> .....	0
<i>Outlets</i> .....	0
Pollutants .....	0
Land Uses .....	0

## Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft <sup>2</sup> )	Peak Inflow (gpm)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	93rd-MH	Junction	100.33	110.00	100.33	110.00	0.00	127.78	100.63	0.00	9.37	0 00:00	0.00	0.00
2	93rd-Outfall	Outfall	100.00					127.78	100.30					

## Link Summary

SN Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (gpm)	Design Flow Capacity (gpm)	Peak Flow/Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/Total Depth Ratio	Total Time Reported Surcharged (min)	Reported Condition
1	93rd-Sewer Pipe	93rd-MH	93rd-Outfall	100.00	100.33	100.00	0.3300	8.000	0.0130	127.78	311.57	0.41	1.89	0.30	0.45	0.00	Calculated

# Wolf Springs Ranch

NWC 94<sup>th</sup> Street and Cactus Blvd  
Scottsdale Arizona 85260

## Final Water Basis of Design Report

July 24, 2018  
SHG Job No.TEG1603-000

### Submitted by:

**The Empire Group**  
6617 N Scottsdale Road, Ste. 101  
Scottsdale, AZ 85250

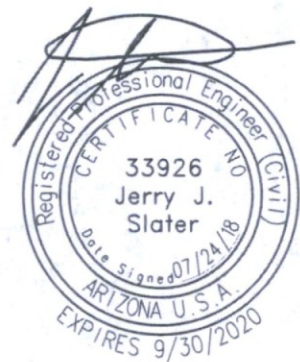
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City of Scottsdale  
Water Resources Department  
9379 E. San Salvador  
Scottsdale, Arizona

By: R SACKS  
Date: 7/30/18

### Prepared By:

Slater Hanifan Group, Inc.  
11201 N. Tatum Blvd., Suite 250  
Phoenix, AZ 85028  
Phone: 602-687-9664  
Contact: Jerry Slater, P.E.

Assisted by: Nastaran (Nancy) Afnani, P.E.



A. Introduction

The proposed development consists of 40 single-family residential units covering 20 acres located in Scottsdale, Arizona. The project has a gross density of 2.0 du/ac. The site is located on the northwest corner of N. 94th Street and East Cactus Road. The Site is within the southeast quarter of Section 18 in Township 3 North, Range 5 East of the Gila and Salt River Base and Meridian, City of Scottsdale, Maricopa County, Arizona. Refer to the Vicinity Map in Appendix A for the project location.

B. Design Documentation

The infrastructure water lines and unit daily demands requirements for this project have been determined using the City of Scottsdale Design Standards & Policies Manual (DS&PM).

C. Existing Conditions

The existing site encompasses approximately 20 acres of developed land on ground that slopes generally to the south and west. The existing zone for the property is R1-18 PRD. The existing Site is used as an equestrian facility and school. The existing low site outfall is located at the southwest corner of the project at the corner of 93rd Street and Cactus. An 8-inch Water line is located adjacent to the site in 94<sup>th</sup> Street and an 8" stub is located at the NEC of 93<sup>rd</sup> Street and Cactus Road. A 16-inch and 8-inch water line are located in Cactus Road. A 6-inch water line is located north of the site on Larkspur Lane.

D. Proposed Conditions

The project will connect to the existing water system at several locations using an 8-inch water line. The first connection will be at the east side of the site to the existing 8-inch water line located in 94<sup>th</sup> Street. An 8-inch pipe is proposed to connect the existing 16-inch pipe at the intersection of Cactus Rd and 93<sup>rd</sup> St to the existing 6-inch pipe at the intersection of Larkspur Dr and 93<sup>rd</sup> St. The onsite water system will be connected to this proposed 8-inch pipe at four (4) different locations. The water system layout including water mains, fire hydrant locations is showed in Appendix 'B' – Utility Site Map.

E. Existing Water Meters

Approximately ten water meters exist on site. One meter will be used for irrigation. The remaining meters will be abandoned and a fee credit will be requested. An inventory of water meters and appurtenances will be provided in the final report.

F. Fire Hydrant Locations

There are six existing fire hydrants located near the property and will provide limited fire protection for the project. In addition 4 proposed fire hydrant locations have been proposed throughout the site to provide the appropriate coverage for fire protection. The project meets the allowed 1,200 feet spacing of fire hydrants and 600 feet hose length as defined in section 6-1.502 of the City of Scottsdale DS&PM. See Appendix 'B' – Utility Site Map for further detail.

**G. Computations**

According to the City of Scottsdale DS&PM, Residential with a 2 to 2.9 DU per acre assume 470.4 gpd per unit. The City of Scottsdale requires water lines to be designed to account for Average Day (ADD), Max Day (MDD), Peak Hour (PHD), and Max Day plus Fire Flow (FFD). Please see the table below for water demand calculations.

Development	Dwelling Units (du)	Average Day Demand (ADD) 470.4 gpd X 40 du (gpd)	Max Day Demand ADD X 2 (gpd)	Peak Hour Demand ADD X 3.5 (gpd)
Single Family	40	18,816	37,632	65,856

*\* Per City of Scottsdale DS&PM 6-1.404: The peaking factors are 2 times the average day for maximum day, and 3 1/2 times the average day for peak hour*

**H. Summary**

The information presented in this study is at a planning level only and should not be considered the final design of the proposed water system. Details of the proposed waterlines will require refinement once the flow test is performed, land plan is confirmed, and finished floor elevations are determined. If any further changes to the land plan should occur, including in densities or pipeline routing, the study shall be reevaluated to verify whether revisions to the infrastructure are required.

- ❖ Forty (40) water services and meters.
- ❖ Approx. 4,200 LF of 8-inch water line located within the proposed roadway and utility easements.
- ❖ One (1) landscape water meter (utilize existing water meter if possible).

The project will be designed to meet fire flow requirements of maintaining 30 PSI when using the max day plus the fire flow of 1,000 gpm (section 6-1.502) at final design.

- ❖ ADD: min pressure of 56.6 psi (J-7), max pressure of 60.6 psi (J-18),
- ❖ MDD: min pressure of 56.6 psi (FH-1), max pressure of 60.6 psi (J-18),
- ❖ PHD: min pressure of 56.6 psi (FH-1), max pressure of 60.6 psi (J-18),
- ❖ FFD: min pressure of 38.9 psi (FH-1), max pressure of 48.4 psi (J-18).

**I. References**

- ❖ City of Scottsdale Design Standards & Policies Manual (DS&PM).
- ❖ City of Scottsdale Geographic Information Systems Quarter Section Maps 31-50

**J. Appendices**

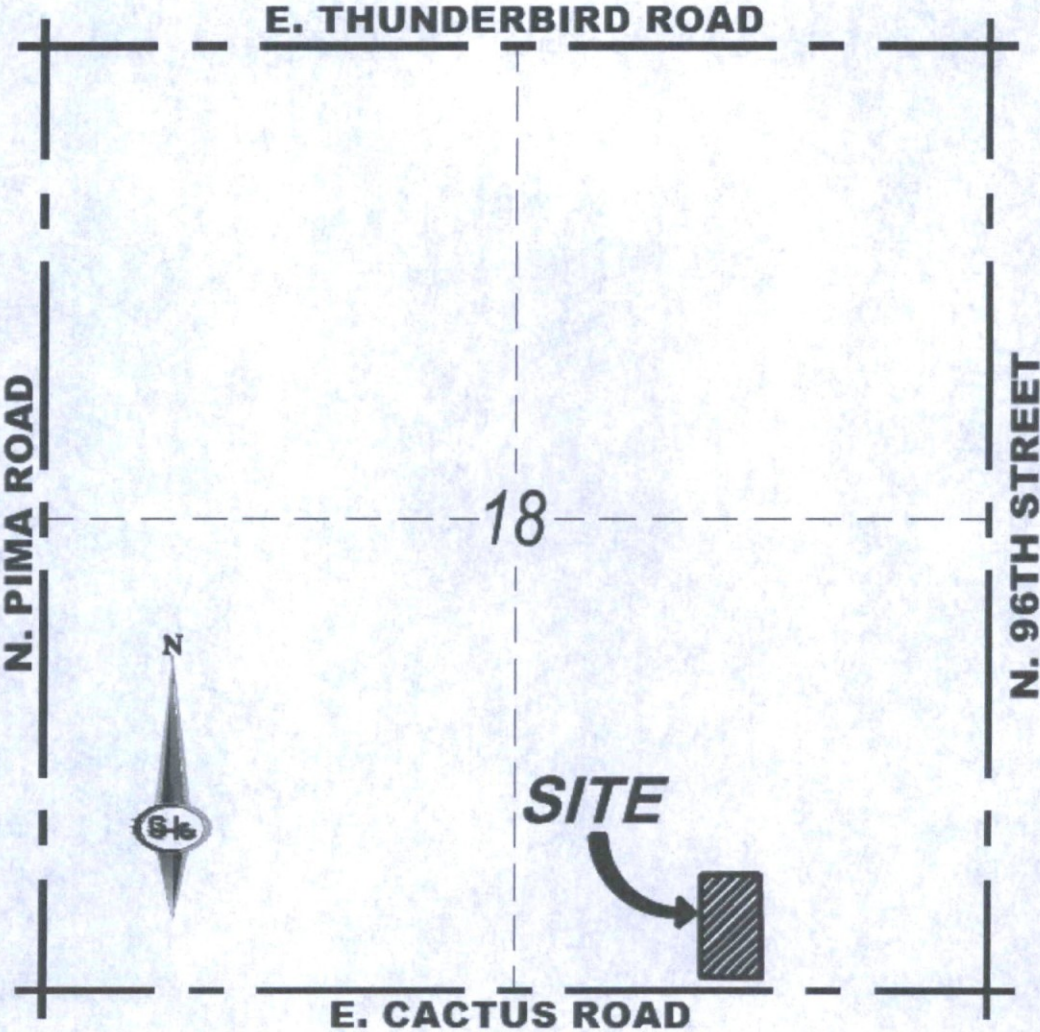
Appendix 'A' – Vicinity Map & Site Plan

Appendix 'B' – Utility Site Map

Appendix 'C' – C.O.S. Water Pressure Zone Map / Water Service Area Map

Appendix 'D' – Flow Test + Node Map + WaterCAD Data Tables

Appendix A - Vicinity Map



**VICINITY MAP**

SEC. 18, T3N, R5E.

**Appendix B - Utility Site Map**

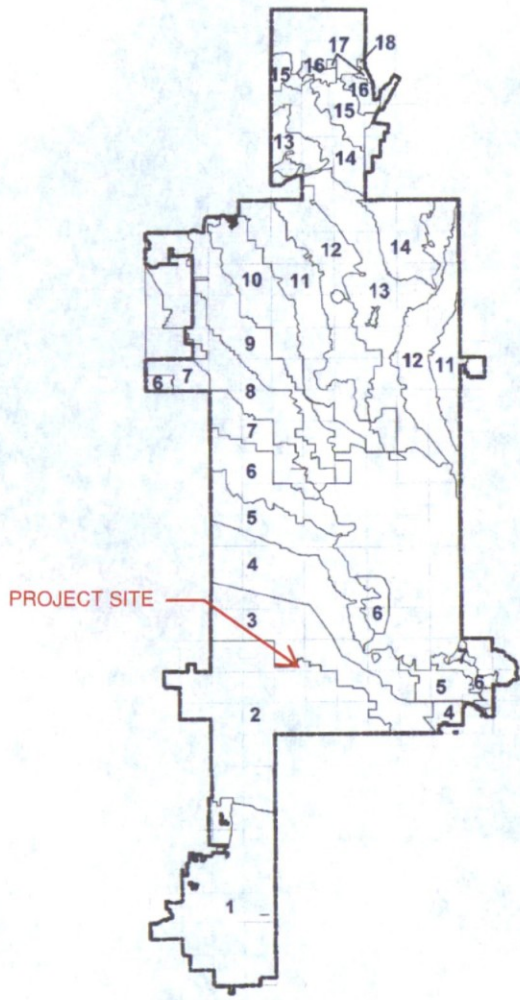
(See attached)



Appendix C- C.O.S. Water Pressure Zone Map / Water Service Area Map



FIGURE 6.1-1 WATER SERVICE AREAS



Zone	Ground Elevation Range (Ft.)
1	1180-1280
1A	1250-1330
2A	1280-1330
2	1330-1440
3	1440-1550
4	1510-1650
4E	1550-1650
5	1650-1790
5E	1650-1750
6	1790-1920
6E	1750-1934
7	1920-2050
7E	1934-2065
8	2050-2180
8E	2065-2200
9	2180-2310
10	2310-2440
11,11E	2440-2570
12,12E	2570-2700
13	2700-2830
14	2830-2960
15	2960-3090

FIGURE 6.1-3 PRESSURE ZONE MAP

**Appendix D – Flow Test + Node Map + WaterCAD Data Tables**



# Flow Test Summary

Project Name: EJFT 18164  
Project Address: 12100 N 94th St, Scottsdale, AZ 85260  
Date of Flow Test: 2018-07-12  
Time of Flow Test: 7:28 AM  
Data Reliable Until: 2019-01-12  
Conducted By: Eder Cueva & Tayler Lynch (EJ Flow Tests) 602.999.7637  
Witnessed By: Jared Berry (City of Scottsdale) 602.541.4942  
City Forces Contacted: City of Scottsdale (602.541.4942)  
Permit Number: C55824

**Note** Scottsdale requires a max static pressure of 72 psi for safety factor

## Raw Flow Test Data

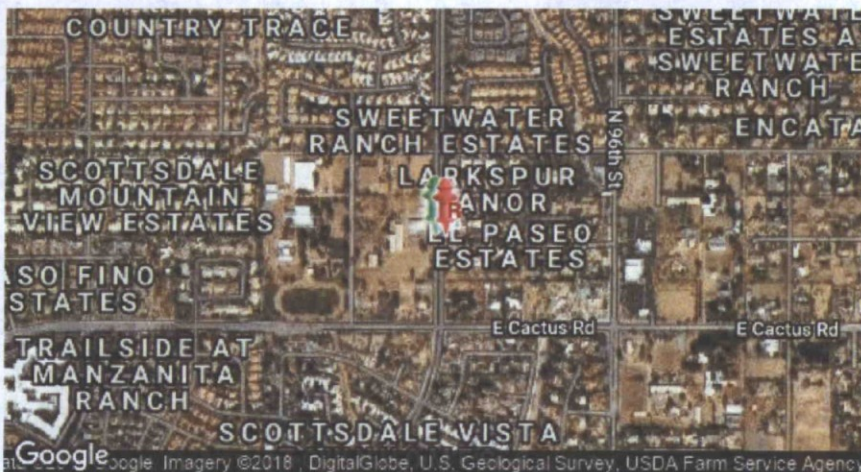
Static Pressure: 64.0 PSI  
Residual Pressure: 47.0 PSI  
Flowing GPM: 1,343  
GPM @ 20 PSI: 2,244

## Data with a 10 % Safety Factor

Static Pressure: 57.6 PSI  
Residual Pressure: 40.6 PSI  
Flowing GPM: 1,343  
GPM @ 20 PSI: 2,061

## Hydrant F<sub>1</sub>

Pitot Pressure (1): 16 PSI  
Coefficient of Discharge (1): 0.9  
Hydrant Orifice Diameter (1): 2.5 inches  
Pitot Pressure (2): 16 PSI  
Coefficient of Discharge (2): 0.9  
Hydrant Orifice Diameter (2): 2.5 inches



 Static-Residual Hydrant

 Flow Hydrant

Distance Between F<sub>1</sub> and R  
86 ft (measured linearly)

Static-Residual Elevation  
1417 ft (above sea level)

Flow Hydrant (F<sub>1</sub>) Elevation  
1419 ft (above sea level)

Elevation & distance values are approximate

EJ Flow Tests, LLC

21505 North 78th Ave. | Suite 130 | Peoria, Arizona 85382 | (602) 999-7637 | www.ejengineering.com  
John L. Echeverri | NICET Level IV 078493 SME | C-16 FP Contractor ROC 271705 AZ | NFPA CFPS 1915  
www.flowtestsummary.com

### Static-Residual Hydrant



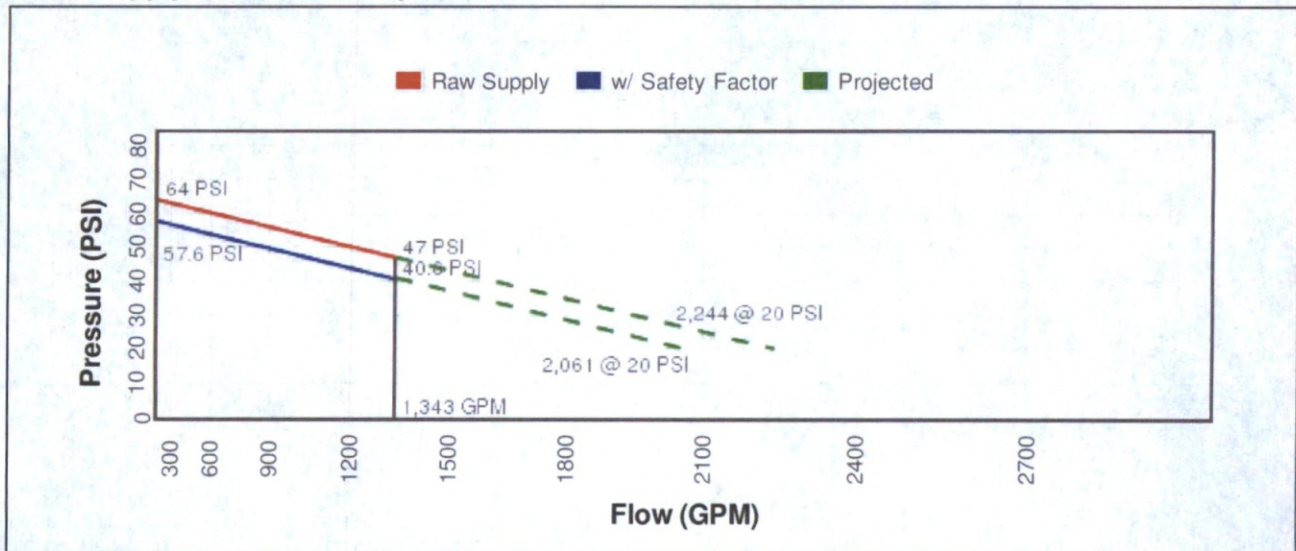
### Flow Hydrant (only hydrant F1 shown for clarity)



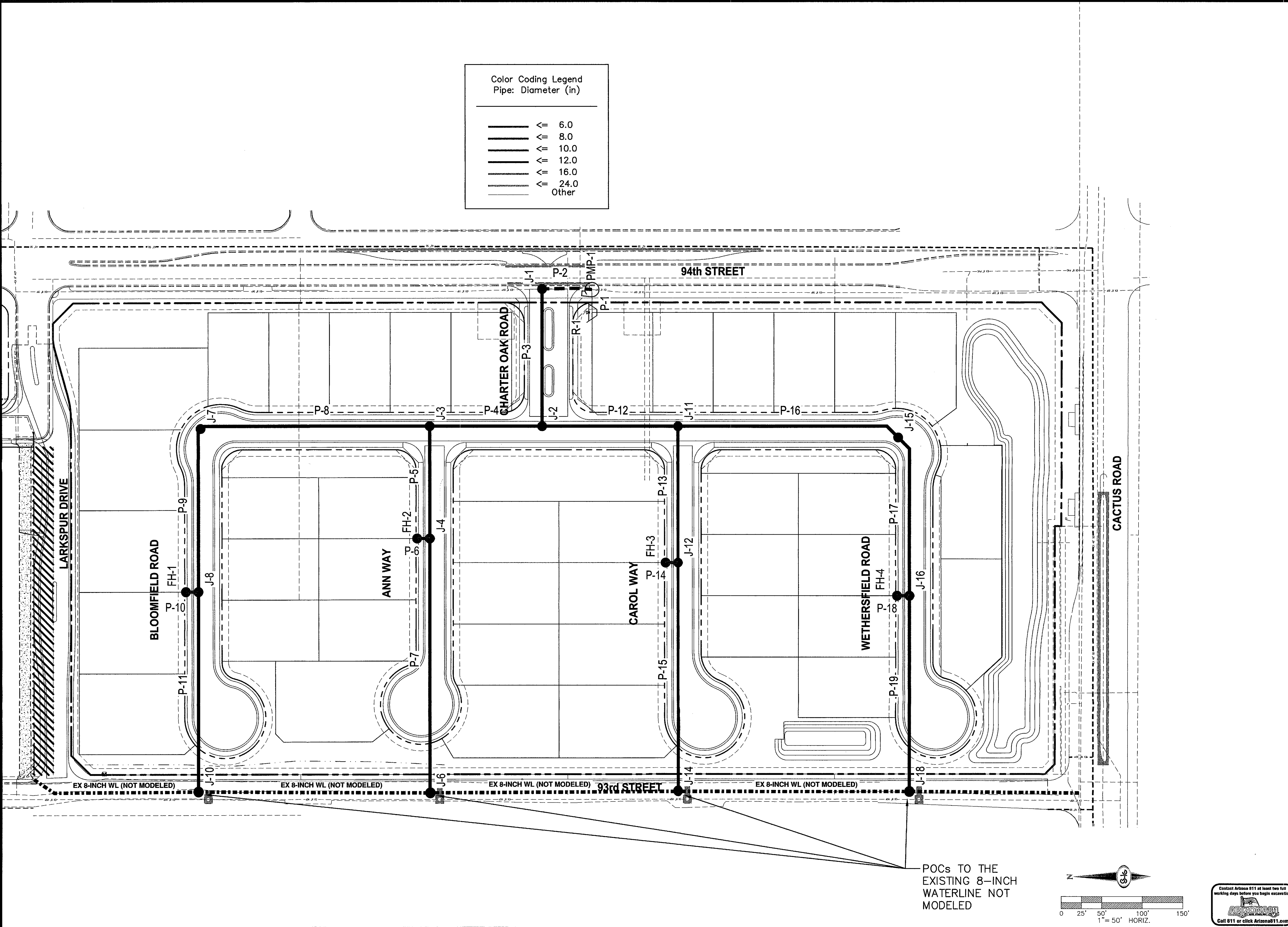
### Approximate Project Site



### Water Supply Curve $N^{1.85}$ Graph

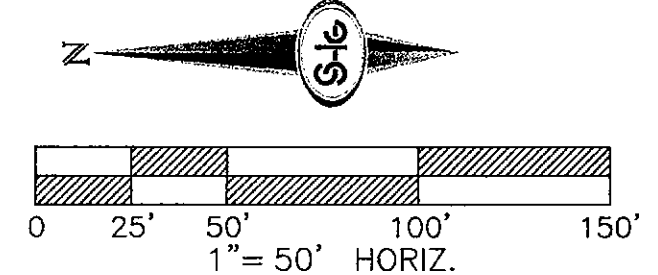


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Color Coding Legend	
Pipe: Diameter (in)	
	6.0
	8.0
	10.0
	12.0
	16.0
	24.0
	Other

POCs TO THE EXISTING 8-INCH WATERLINE NOT MODELED



<b>SLATER HANIFAN GROUP</b> <small>CONSULTING ENGINEERS &amp; PLANNERS 11201 N. TATUM BOULEVARD #250, PHOENIX, AZ 85028 PHONE (602) 687-9864</small>	<small>NO.</small> <small>DATE</small> <small>BY</small> <small>APP. DATE</small>	<small>DESCRIPTION</small>	
<b>THE EMPIRE GROUP</b> <b>WOLF SPRINGS RANCH</b> <b>NODE MAP</b>	<small>SECTION 9 TOWNSHIP 2 NORTH RANGE 5 EAST</small>	<small>SCOTTSDALE, AZ</small>	<small>DATE:</small> 07/19/2018 <small>DRAFTER:</small> CK <small>DESIGNER:</small> NA <small>CHECKED:</small> NA <small>PROJECT NO.</small> <b>TEG1603-000</b>
			<small>SHEET 1 OF 1</small>

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Junction Table**

**Active Scenario: Average Day**

Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
J-7	1,419.20	1.09	1,550.05	56.6
FH-1	1,419.20	0.00	1,550.05	56.6
J-8	1,418.20	1.09	1,550.05	57.0
J-10	1,417.80	1.09	1,550.05	57.2
FH-2	1,417.19	0.00	1,550.05	57.5
J-3	1,417.10	1.09	1,550.05	57.5
J-4	1,416.10	1.09	1,550.05	58.0
J-1	1,416.00	0.00	1,550.05	58.0
J-2	1,415.90	0.00	1,550.05	58.0
J-6	1,415.70	1.09	1,550.05	58.1
FH-3	1,415.20	0.00	1,550.05	58.3
J-11	1,415.20	1.09	1,550.05	58.3
J-12	1,414.80	1.09	1,550.05	58.5
J-14	1,413.60	1.09	1,550.05	59.0
FH-4	1,413.30	0.00	1,550.05	59.2
J-15	1,412.50	1.09	1,550.05	59.5
J-16	1,410.80	1.09	1,550.05	60.2
J-18	1,409.90	1.09	1,550.05	60.6

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Pipe Table**

**Active Scenario: Average Day**

Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Hazen- Williams C	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P-1	28	R-1	PMP-1	48.0	130.0	13.07	0.00	0.00
P-2	62	PMP-1	J-1	8.0	130.0	13.07	0.08	0.00
P-3	168	J-1	J-2	8.0	130.0	13.07	0.08	0.00
P-4	139	J-2	J-3	8.0	130.0	6.54	0.04	0.00
P-5	139	J-3	J-4	8.0	130.0	2.18	0.01	0.00
P-6	16	J-4	FH-2	6.0	130.0	0.00	0.00	0.00
P-7	311	J-4	J-6	8.0	130.0	1.09	0.01	0.00
P-8	284	J-3	J-7	8.0	130.0	3.27	0.02	0.00
P-9	202	J-7	J-8	8.0	130.0	2.18	0.01	0.00
P-10	15	J-8	FH-1	6.0	130.0	0.00	0.00	0.00
P-11	246	J-8	J-10	8.0	130.0	1.09	0.01	0.00
P-12	168	J-2	J-11	8.0	130.0	6.54	0.04	0.00
P-13	169	J-11	J-12	8.0	130.0	2.18	0.01	0.00
P-14	16	J-12	FH-3	6.0	130.0	0.00	0.00	0.00
P-15	281	J-12	J-14	8.0	130.0	1.09	0.01	0.00
P-16	278	J-11	J-15	8.0	130.0	3.27	0.02	0.00
P-17	201	J-15	J-16	8.0	130.0	2.18	0.01	0.00
P-18	15	J-16	FH-4	6.0	130.0	0.00	0.00	0.00
P-19	241	J-16	J-18	8.0	130.0	1.09	0.01	0.00

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Pump Table**

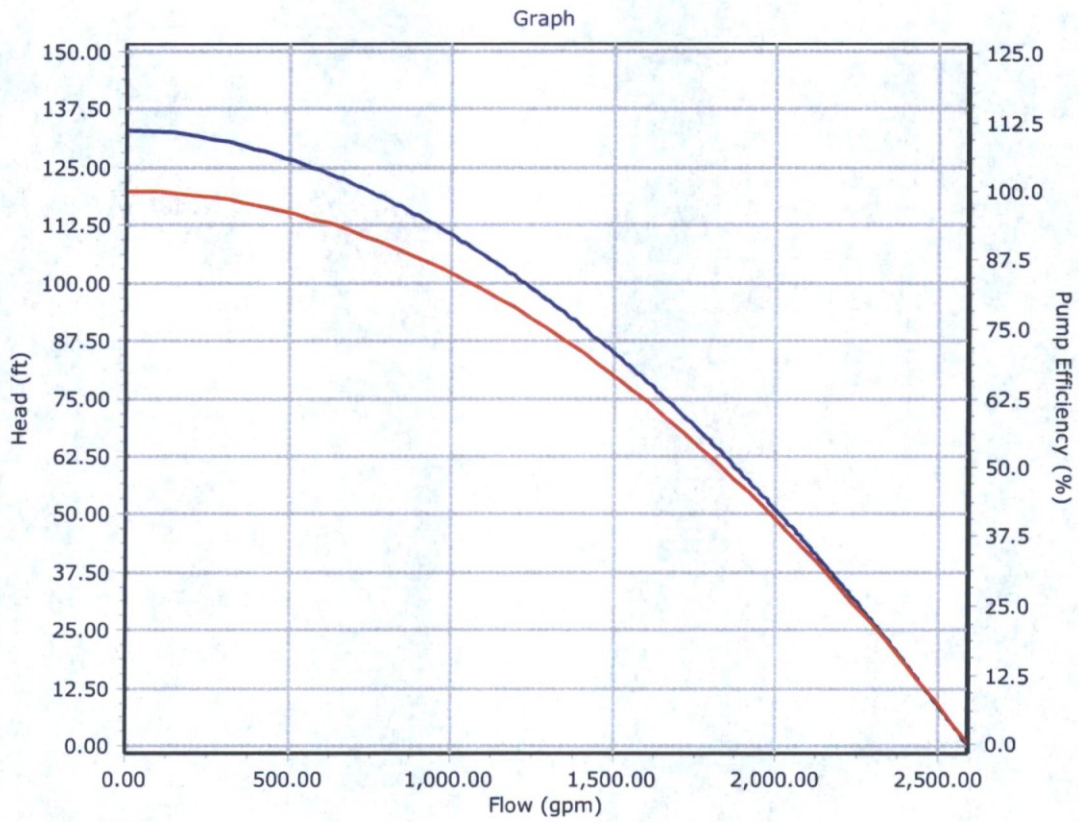
**Active Scenario: Average Day**

Label	Elevation (ft)	Pump Status	Hydraulic Grade (Suction) (ft)	Hydraulic Grade (Discharge) (ft)	Flow (Total) (gpm)	Pump Head (ft)
PMP-1	1,417.00	On	1,417.00	1,550.05	13.07	133.05

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**  
**Pump Definition Detailed Report: Pump Definition - 1**  
**Active Scenario: Average Day**

Element Details			
ID	126	Notes	
Label	Pump Definition - 1		
Pump Definition Type			
Pump Definition Type	Standard (3 Point)	Design Head	113.42 ft
Shutoff Flow	0.00 gpm	Maximum Operating Flow	1,343.00 gpm
Shutoff Head	133.06 ft	Maximum Operating Head	93.79 ft
Design Flow	924.18 gpm		
Pump Efficiency Type			
Pump Efficiency Type	Best Efficiency Point	Motor Efficiency	100.0 %
BEP Efficiency	100.0 %	Is Variable Speed Drive?	False
BEP Flow	0.00 gpm		
Transient (Physical)			
Inertia (Pump and Motor)	0.000 lb·ft <sup>2</sup>	Specific Speed	SI=25, US=1280
Speed (Full)	0 rpm	Reverse Spin Allowed?	True

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**  
**Pump Definition Detailed Report: Pump Definition - 1**  
**Active Scenario: Average Day**



**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Reservoir Table**

**Active Scenario: Average Day**

Label	Elevation (ft)	Flow (Out net) (gpm)	Hydraulic Grade (ft)
R-1	1,417.00	13.07	1,417.00

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Junction Table**

**Active Scenario: Max Day**

Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
FH-1	1,419.20	0.00	1,550.02	56.6
J-7	1,419.20	2.18	1,550.02	56.6
J-8	1,418.20	2.18	1,550.02	57.0
J-10	1,417.80	2.18	1,550.02	57.2
FH-2	1,417.19	0.00	1,550.02	57.5
J-3	1,417.10	2.18	1,550.02	57.5
J-4	1,416.10	2.18	1,550.02	57.9
J-1	1,416.00	0.00	1,550.03	58.0
J-2	1,415.90	0.00	1,550.02	58.0
J-6	1,415.70	2.18	1,550.02	58.1
FH-3	1,415.20	0.00	1,550.02	58.3
J-11	1,415.20	2.18	1,550.02	58.3
J-12	1,414.80	2.18	1,550.02	58.5
J-14	1,413.60	2.18	1,550.02	59.0
FH-4	1,413.30	0.00	1,550.02	59.2
J-15	1,412.50	2.18	1,550.02	59.5
J-16	1,410.80	2.18	1,550.02	60.2
J-18	1,409.90	2.18	1,550.02	60.6

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Pipe Table**

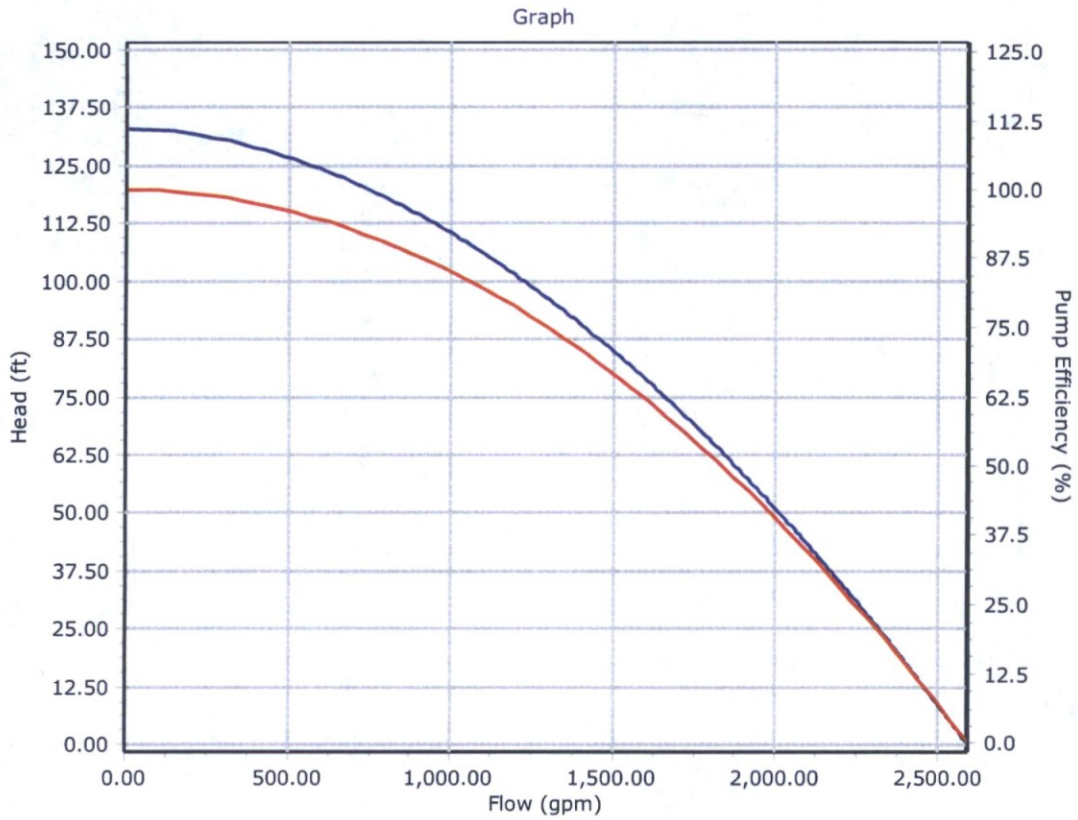
**Active Scenario: Max Day**

Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Hazen- Williams C	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P-1	28	R-1	PMP-1	48.0	130.0	26.14	0.00	0.00
P-2	62	PMP-1	J-1	8.0	130.0	26.14	0.17	0.00
P-3	168	J-1	J-2	8.0	130.0	26.14	0.17	0.00
P-4	139	J-2	J-3	8.0	130.0	13.07	0.08	0.00
P-5	139	J-3	J-4	8.0	130.0	4.36	0.03	0.00
P-6	16	J-4	FH-2	6.0	130.0	0.00	0.00	0.00
P-7	311	J-4	J-6	8.0	130.0	2.18	0.01	0.00
P-8	284	J-3	J-7	8.0	130.0	6.53	0.04	0.00
P-9	202	J-7	J-8	8.0	130.0	4.36	0.03	0.00
P-10	15	J-8	FH-1	6.0	130.0	0.00	0.00	0.00
P-11	246	J-8	J-10	8.0	130.0	2.18	0.01	0.00
P-12	168	J-2	J-11	8.0	130.0	13.07	0.08	0.00
P-13	169	J-11	J-12	8.0	130.0	4.36	0.03	0.00
P-14	16	J-12	FH-3	6.0	130.0	0.00	0.00	0.00
P-15	281	J-12	J-14	8.0	130.0	2.18	0.01	0.00
P-16	278	J-11	J-15	8.0	130.0	6.53	0.04	0.00
P-17	201	J-15	J-16	8.0	130.0	4.36	0.03	0.00
P-18	15	J-16	FH-4	6.0	130.0	0.00	0.00	0.00
P-19	241	J-16	J-18	8.0	130.0	2.18	0.01	0.00

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**  
**Pump Definition Detailed Report: Pump Definition - 1**  
**Active Scenario: Max Day**

Element Details			
ID	126	Notes	
Label	Pump Definition - 1		
Pump Definition Type			
Pump Definition Type	Standard (3 Point)	Design Head	113.42 ft
Shutoff Flow	0.00 gpm	Maximum Operating Flow	1,343.00 gpm
Shutoff Head	133.06 ft	Maximum Operating Head	93.79 ft
Design Flow	924.18 gpm		
Pump Efficiency Type			
Pump Efficiency Type	Best Efficiency Point	Motor Efficiency	100.0 %
BEP Efficiency	100.0 %	Is Variable Speed Drive?	False
BEP Flow	0.00 gpm		
Transient (Physical)			
Inertia (Pump and Motor)	0.000 lb·ft <sup>2</sup>	Specific Speed	SI=25, US=1280
Speed (Full)	0 rpm	Reverse Spin Allowed?	True

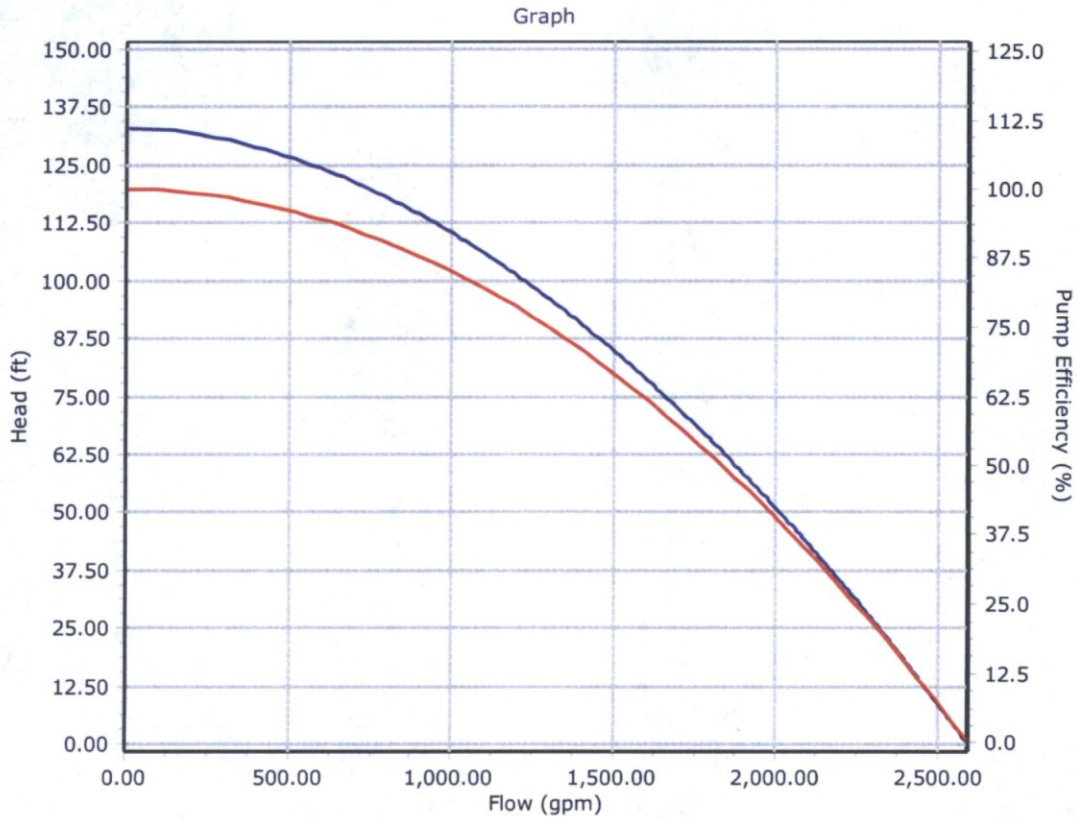
**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**  
**Pump Definition Detailed Report: Pump Definition - 1**  
**Active Scenario: Max Day**



**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**  
**Pump Definition Detailed Report: Pump Definition - 1**  
**Active Scenario: Max Day**

Element Details			
ID	126	Notes	
Label	Pump Definition - 1		
Pump Definition Type			
Pump Definition Type	Standard (3 Point)	Design Head	113.42 ft
Shutoff Flow	0.00 gpm	Maximum Operating Flow	1,343.00 gpm
Shutoff Head	133.06 ft	Maximum Operating Head	93.79 ft
Design Flow	924.18 gpm		
Pump Efficiency Type			
Pump Efficiency Type	Best Efficiency Point	Motor Efficiency	100.0 %
BEP Efficiency	100.0 %	Is Variable Speed Drive?	False
BEP Flow	0.00 gpm		
Transient (Physical)			
Inertia (Pump and Motor)	0.000 lb·ft <sup>2</sup>	Specific Speed	SI=25, US=1280
Speed (Full)	0 rpm	Reverse Spin Allowed?	True

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg  
 Pump Definition Detailed Report: Pump Definition - 1  
 Active Scenario: Max Day**



**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Reservoir Table**

**Active Scenario: Max Day**

Label	Elevation (ft)	Flow (Out net) (gpm)	Hydraulic Grade (ft)
R-1	1,417.00	26.14	1,417.00

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Junction Table**

**Active Scenario: Peak Hour**

Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
FH-1	1,419.20	0.00	1,549.96	56.6
J-7	1,419.20	3.81	1,549.96	56.6
J-8	1,418.20	3.81	1,549.96	57.0
J-10	1,417.80	3.81	1,549.96	57.2
FH-2	1,417.19	0.00	1,549.97	57.4
J-3	1,417.10	3.81	1,549.97	57.5
J-4	1,416.10	3.81	1,549.97	57.9
J-1	1,416.00	0.00	1,549.98	58.0
J-2	1,415.90	0.00	1,549.97	58.0
J-6	1,415.70	3.81	1,549.96	58.1
FH-3	1,415.20	0.00	1,549.96	58.3
J-11	1,415.20	3.81	1,549.96	58.3
J-12	1,414.80	3.81	1,549.96	58.5
J-14	1,413.60	3.81	1,549.96	59.0
FH-4	1,413.30	0.00	1,549.96	59.1
J-15	1,412.50	3.81	1,549.96	59.5
J-16	1,410.80	3.81	1,549.96	60.2
J-18	1,409.90	3.81	1,549.96	60.6

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Pipe Table**

**Active Scenario: Peak Hour**

Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Hazen- Williams C	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P-1	28	R-1	PMP-1	48.0	130.0	45.74	0.01	0.00
P-2	62	PMP-1	J-1	8.0	130.0	45.74	0.29	0.00
P-3	168	J-1	J-2	8.0	130.0	45.74	0.29	0.01
P-4	139	J-2	J-3	8.0	130.0	22.87	0.15	0.00
P-5	139	J-3	J-4	8.0	130.0	7.62	0.05	0.00
P-6	16	J-4	FH-2	6.0	130.0	0.00	0.00	0.00
P-7	313	J-4	J-6	8.0	130.0	3.81	0.02	0.00
P-8	284	J-3	J-7	8.0	130.0	11.43	0.07	0.00
P-9	202	J-7	J-8	8.0	130.0	7.62	0.05	0.00
P-10	15	J-8	FH-1	6.0	130.0	0.00	0.00	0.00
P-11	246	J-8	J-10	8.0	130.0	3.81	0.02	0.00
P-12	168	J-2	J-11	8.0	130.0	22.87	0.15	0.00
P-13	169	J-11	J-12	8.0	130.0	7.62	0.05	0.00
P-14	16	J-12	FH-3	6.0	130.0	0.00	0.00	0.00
P-15	281	J-12	J-14	8.0	130.0	3.81	0.02	0.00
P-16	278	J-11	J-15	8.0	130.0	11.43	0.07	0.00
P-17	201	J-15	J-16	8.0	130.0	7.62	0.05	0.00
P-18	15	J-16	FH-4	6.0	130.0	0.00	0.00	0.00
P-19	241	J-16	J-18	8.0	130.0	3.81	0.02	0.00

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Pump Table**

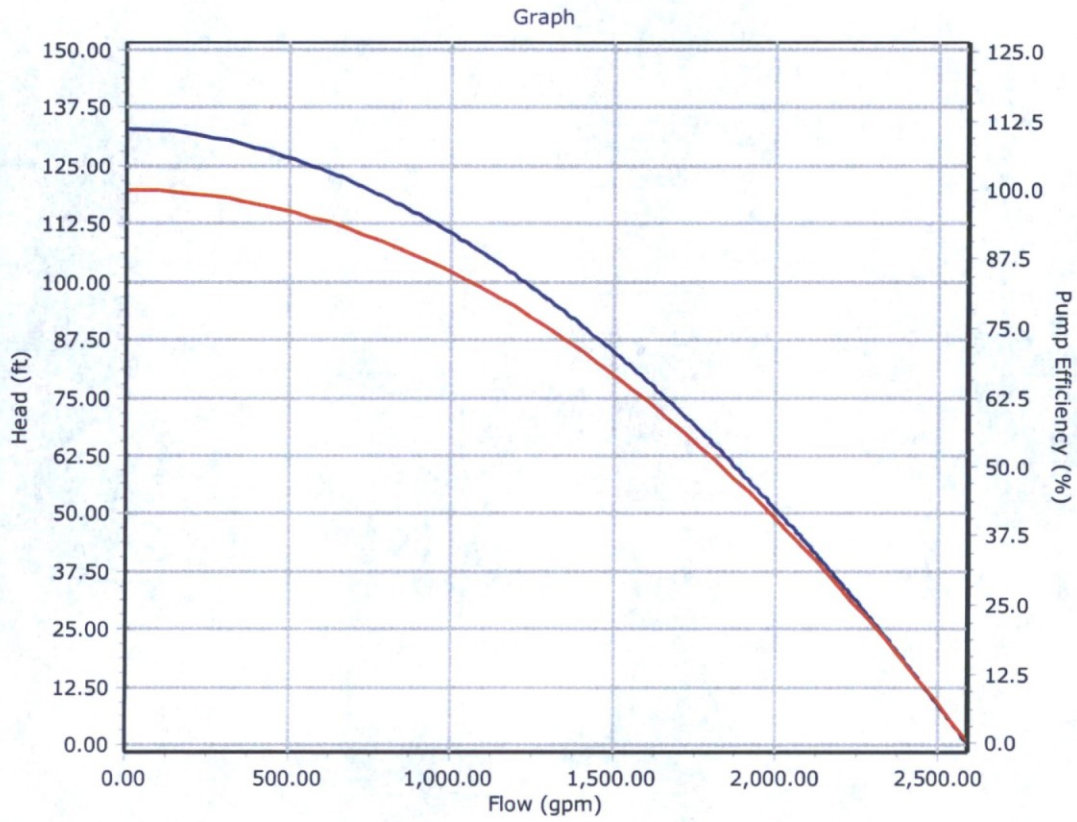
**Active Scenario: Peak Hour**

Label	Elevation (ft)	Pump Status	Hydraulic Grade (Suction) (ft)	Hydraulic Grade (Discharge) (ft)	Flow (Total) (gpm)	Pump Head (ft)
PMP-1	1,417.00	On	1,417.00	1,549.98	45.74	132.98

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**  
**Pump Definition Detailed Report: Pump Definition - 1**  
**Active Scenario: Peak Hour**

Element Details			
ID	126	Notes	
Label	Pump Definition - 1		
Pump Definition Type			
Pump Definition Type	Standard (3 Point)	Design Head	113.42 ft
Shutoff Flow	0.00 gpm	Maximum Operating Flow	1,343.00 gpm
Shutoff Head	133.06 ft	Maximum Operating Head	93.79 ft
Design Flow	924.18 gpm		
Pump Efficiency Type			
Pump Efficiency Type	Best Efficiency Point	Motor Efficiency	100.0 %
BEP Efficiency	100.0 %	Is Variable Speed Drive?	False
BEP Flow	0.00 gpm		
Transient (Physical)			
Inertia (Pump and Motor)	0.000 lb·ft <sup>2</sup>	Specific Speed	SI=25, US=1280
Speed (Full)	0 rpm	Reverse Spin Allowed?	True

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**  
**Pump Definition Detailed Report: Pump Definition - 1**  
**Active Scenario: Peak Hour**



**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Reservoir Table**

**Active Scenario: Peak Hour**

Label	Elevation (ft)	Flow (Out net) (gpm)	Hydraulic Grade (ft)
R-1	1,417.00	45.74	1,417.00

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**Fire Flow Node FlexTable: Fire Flow Report**

**Active Scenario: Worst Case**

Label	Fire Flow (Needed) (gpm)	Pressure (Residual Lower Limit) (psi)	Pressure (Calculated Residual) (psi)	Pressure (Calculated System Lower Limit) (psi)	Junction w/ Minimum Pressure (System)	Hydraulic Grade (ft)
FH-1	1,000.00	0.0	38.9	39.8	J-8	1,550.02
FH-4	1,000.00	0.0	41.3	42.8	J-16	1,550.02
FH-2	1,000.00	0.0	42.5	43.3	FH-1	1,550.02
FH-3	1,000.00	0.0	42.9	43.6	J-12	1,550.02

# 180718 TEG1603-000 Wolf Springs Ranch Model.wtg

## FlexTable: Junction Table

### Active Scenario: Max Day + 1000 FF

Label	Elevation (ft)	Demand (gpm)	Hydraulic Grade (ft)	Pressure (psi)
FH-1	1,419.20	1,000.00	1,509.09	38.9
J-8	1,418.20	2.18	1,510.24	39.8
J-10	1,417.80	2.18	1,510.24	40.0
J-7	1,419.20	2.18	1,513.96	41.0
FH-2	1,417.19	0.00	1,519.22	44.1
J-3	1,417.10	2.18	1,519.22	44.2
J-4	1,416.10	2.18	1,519.22	44.6
J-6	1,415.70	2.18	1,519.22	44.8
J-2	1,415.90	0.00	1,521.82	45.8
FH-3	1,415.20	0.00	1,521.82	46.1
J-11	1,415.20	2.18	1,521.82	46.1
J-12	1,414.80	2.18	1,521.82	46.3
J-14	1,413.60	2.18	1,521.82	46.8
FH-4	1,413.30	0.00	1,521.82	46.9
J-1	1,416.00	0.00	1,525.04	47.2
J-15	1,412.50	2.18	1,521.82	47.3
J-16	1,410.80	2.18	1,521.82	48.0
J-18	1,409.90	2.18	1,521.82	48.4

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Pipe Table**

**Active Scenario: Max Day + 1000 FF**

Label	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Hazen- Williams C	Flow (gpm)	Velocity (ft/s)	Headloss (ft)
P-1	28	R-1	PMP-1	48.0	130.0	1,026.14	0.18	0.00
P-2	62	PMP-1	J-1	8.0	130.0	1,026.14	6.55	1.18
P-3	168	J-1	J-2	8.0	130.0	1,026.14	6.55	3.22
P-4	139	J-2	J-3	8.0	130.0	1,013.07	6.47	2.60
P-5	139	J-3	J-4	8.0	130.0	4.36	0.03	0.00
P-6	16	J-4	FH-2	6.0	130.0	0.00	0.00	0.00
P-7	311	J-4	J-6	8.0	130.0	2.18	0.01	0.00
P-8	284	J-3	J-7	8.0	130.0	1,006.53	6.42	5.26
P-9	202	J-7	J-8	8.0	130.0	1,004.36	6.41	3.72
P-10	15	J-8	FH-1	6.0	130.0	1,000.00	11.35	1.14
P-11	246	J-8	J-10	8.0	130.0	2.18	0.01	0.00
P-12	168	J-2	J-11	8.0	130.0	13.07	0.08	0.00
P-13	169	J-11	J-12	8.0	130.0	4.36	0.03	0.00
P-14	16	J-12	FH-3	6.0	130.0	0.00	0.00	0.00
P-15	281	J-12	J-14	8.0	130.0	2.18	0.01	0.00
P-16	278	J-11	J-15	8.0	130.0	6.53	0.04	0.00
P-17	201	J-15	J-16	8.0	130.0	4.36	0.03	0.00
P-18	15	J-16	FH-4	6.0	130.0	0.00	0.00	0.00
P-19	241	J-16	J-18	8.0	130.0	2.18	0.01	0.00

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Pump Table**

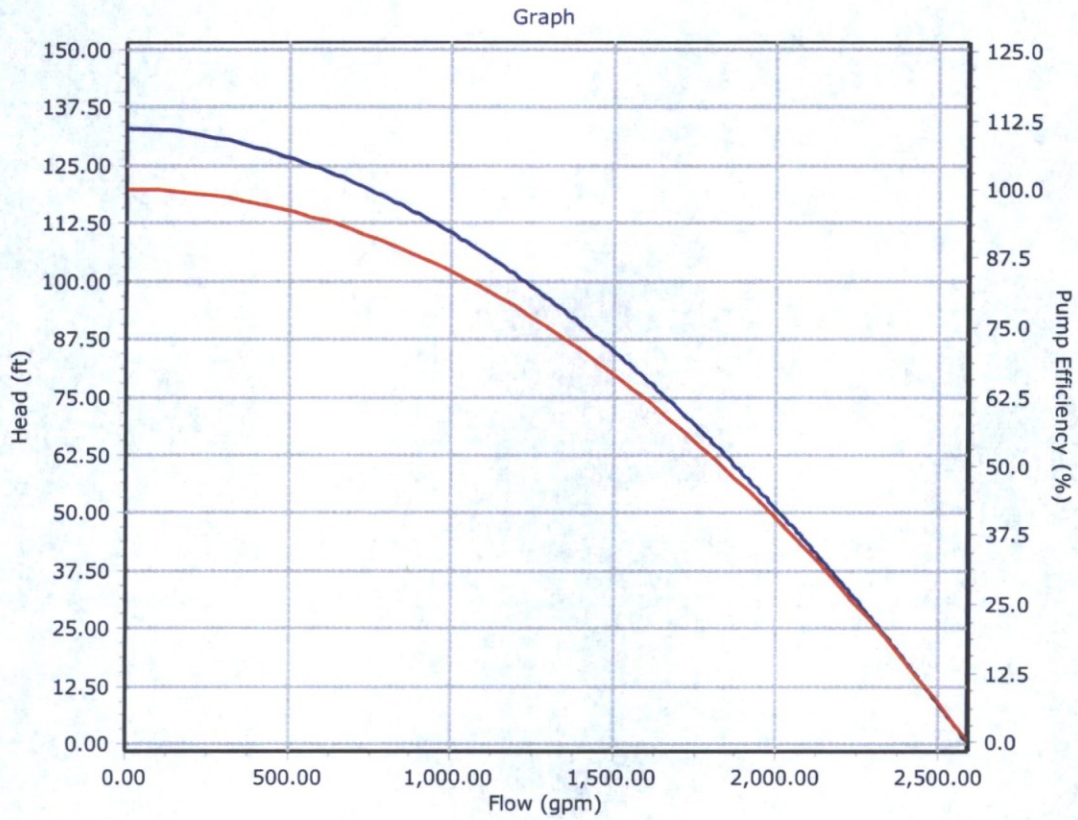
**Active Scenario: Max Day + 1000 FF**

Label	Elevation (ft)	Pump Status	Hydraulic Grade (Suction) (ft)	Hydraulic Grade (Discharge) (ft)	Flow (Total) (gpm)	Pump Head (ft)
PMP-1	1,417.00	On	1,417.00	1,526.22	1,026.14	109.22

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**  
**Pump Definition Detailed Report: Pump Definition - 1**  
**Active Scenario: Max Day + 1000 FF**

Element Details			
ID	126	Notes	
Label	Pump Definition - 1		
Pump Definition Type			
Pump Definition Type	Standard (3 Point)	Design Head	113.42 ft
Shutoff Flow	0.00 gpm	Maximum Operating Flow	1,343.00 gpm
Shutoff Head	133.06 ft	Maximum Operating Head	93.79 ft
Design Flow	924.18 gpm		
Pump Efficiency Type			
Pump Efficiency Type	Best Efficiency Point	Motor Efficiency	100.0 %
BEP Efficiency	100.0 %	Is Variable Speed Drive?	False
BEP Flow	0.00 gpm		
Transient (Physical)			
Inertia (Pump and Motor)	0.000 lb·ft <sup>2</sup>	Specific Speed	SI=25, US=1280
Speed (Full)	0 rpm	Reverse Spin Allowed?	True

**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**  
**Pump Definition Detailed Report: Pump Definition - 1**  
**Active Scenario: Max Day + 1000 FF**



**180718 TEG1603-000 Wolf Springs Ranch Model.wtg**

**FlexTable: Reservoir Table**

**Active Scenario: Max Day + 1000 FF**

Label	Elevation (ft)	Flow (Out net) (gpm)	Hydraulic Grade (ft)
R-1	1,417.00	1,026.14	1,417.00



## Drainage Reports

# Preliminary Drainage Report for

## WOLF SPRINGS RANCH

Scottsdale, AZ

June 26, 2018



### Prepared For:

The Empire Group, LLC  
6617 N. Scottsdale Road  
Suite 101  
Scottsdale, AZ 85250

### Prepared By:

SHG Inc.  
11201 N. Tatum Blvd. #250  
Phoenix, Arizona 85028  
[www.shg-inc.com](http://www.shg-inc.com)  
jlockett@shg-inc.com

### SHG Job Number:

TEG1603-000

### COS Case Number:

14-PP-2017

Plan # \_\_\_\_\_  
Case # 14-PP-2017  
S # \_\_\_\_\_  
Accepted  
Corrections  
Reviewed By MP Date 7/18/18



14-PP-2017  
06/27/18

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# Appendices

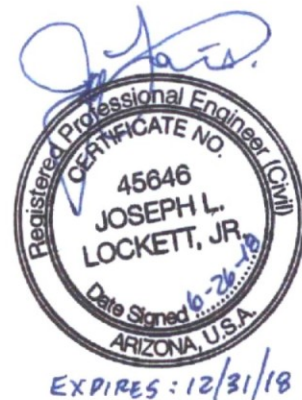
- Appendix A: Hydrology
- Appendix B: Hydraulics
- Appendix C: Stormwater Retention
- Appendix D: 93<sup>rd</sup> Street Normal Depth Calculations

# Figures

- Figure 1A: Vicinity Map
- Figure 1B: USGS Quadrangle Map
- Figure 2: Existing Site Map
- Figure 3: FEMA FIRMette

# Exhibits (at back of Appendices)

- Exhibit 1: USGS Quad Map
- Exhibit 2: FEMA FIRMette
- Exhibit 3A: Offsite Drainage Map
- Exhibit 3B: Existing Condition Drainage Map
- Exhibit 3C: 93<sup>rd</sup> Street Drainage
- Exhibit 4: Proposed Condition Drainage Map



# 1. Introduction

The Empire Group, LLC has retained Slater Hanifan Group (SHG) to prepare preliminary construction documents for a proposed 40 lot residential development known as Wolf Springs Ranch, herein referred to as the Site. The Site is located west of 94<sup>th</sup> Street and north of Cactus Road in Scottsdale, Arizona. Figure 1A shows a Site Vicinity Map.

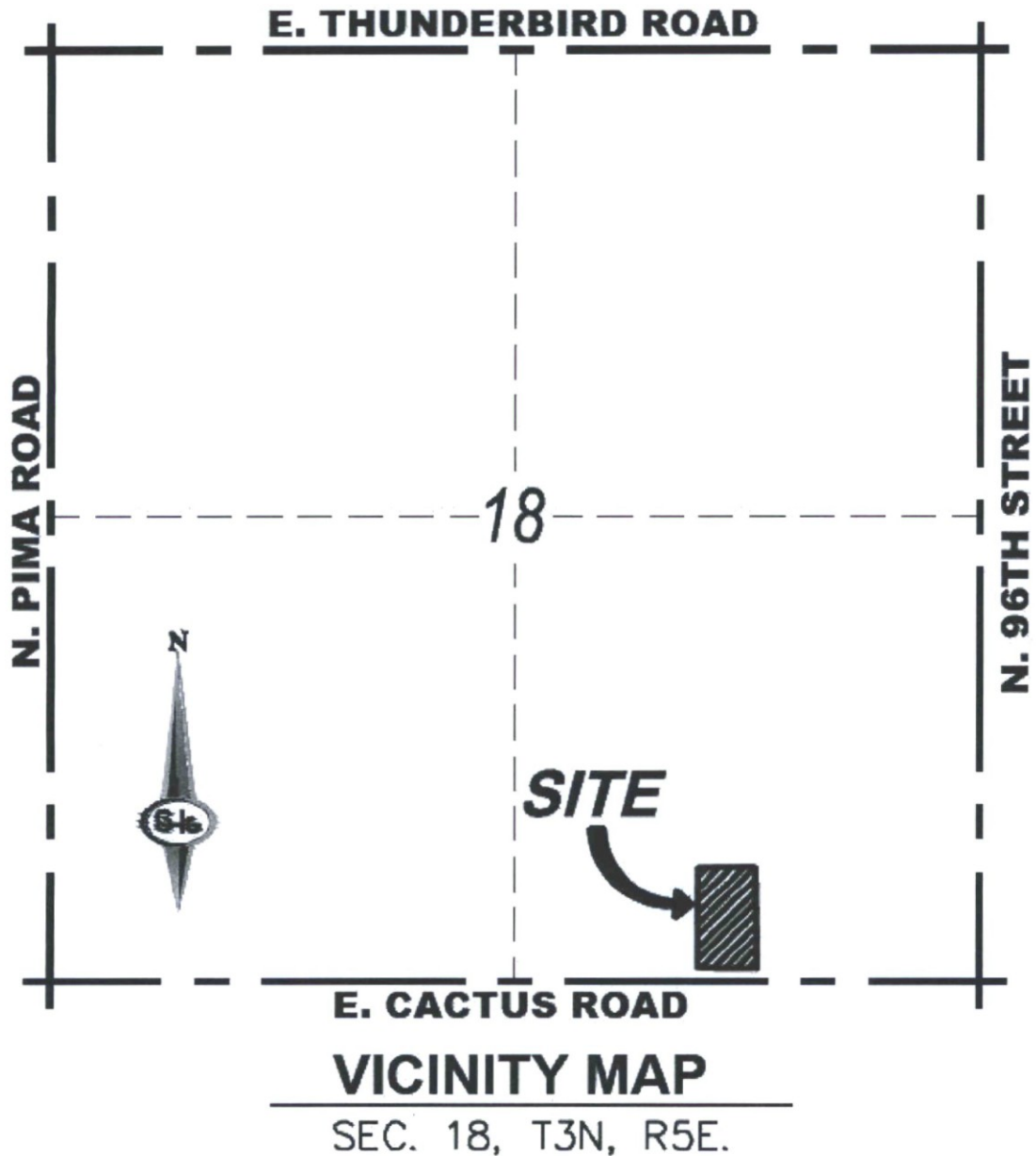


Figure 1A – Vicinity Map

The purpose of this report is to document the preliminary drainage requirements and supporting design calculations for the proposed Wolf Springs Ranch development.

## 2. Location

The Site is currently developed land located at the northwest corner of Cactus Road and 94<sup>th</sup> Street in Scottsdale, Arizona. The Site drains from north to south. The Site lies immediately south of the existing Sweetwater Ranch development. **Figure 1B** shows a portion of the USGS Quad map on which the Site falls. The Site is within the southeast quarter of Section 18 in Township 3 North, Range 5 East of the Gila and Salt River Base and Meridian, Maricopa County, Arizona.

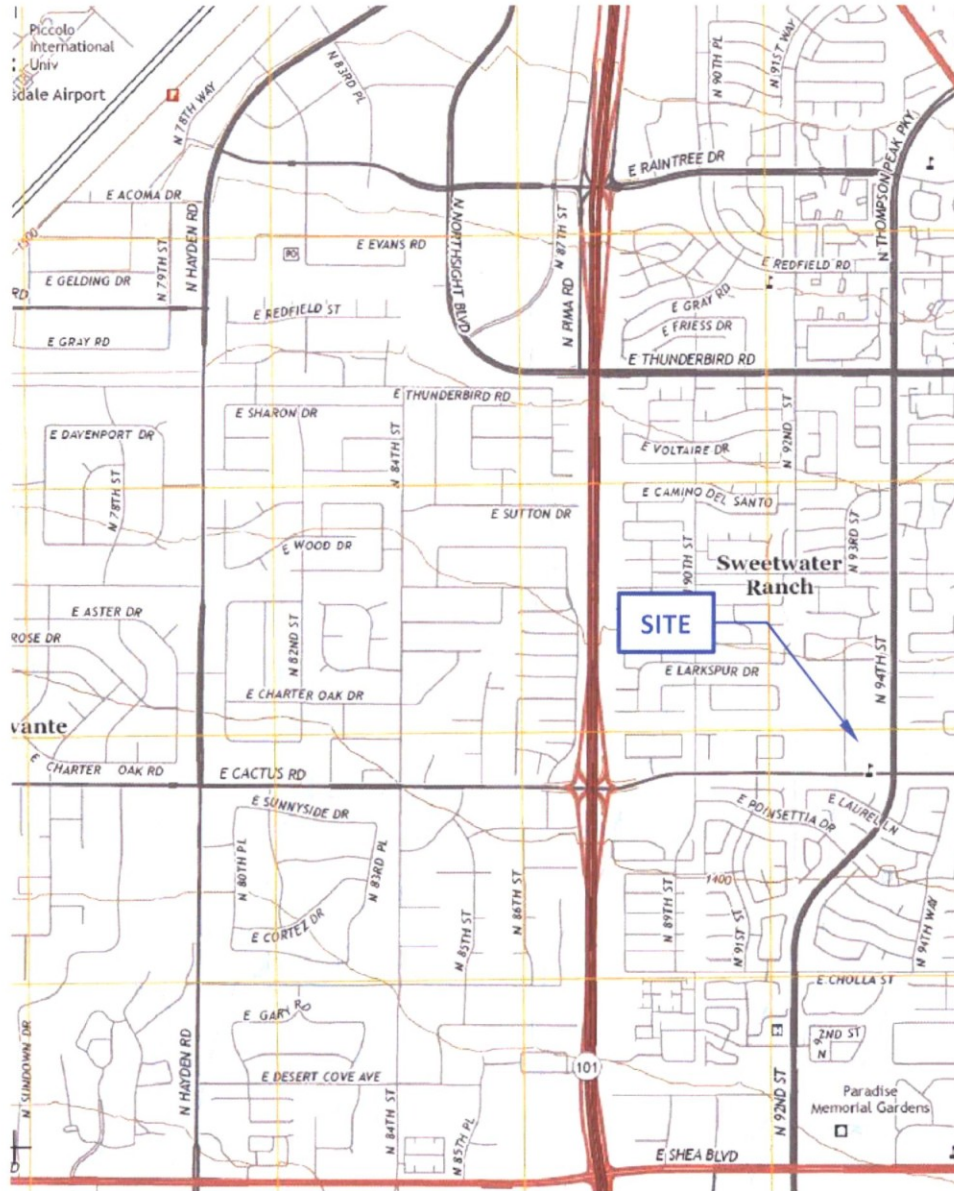


Figure 1B – USGS Quad Map

### 3. Site Description & Proposed Development

The Site encompasses approximately 20 acres of developed land on ground that slopes generally to the south and west. The existing Site is used as residential, an equestrian facility, and school. The existing low site outfall is located at the southwest corner of the project at the corner of 93<sup>rd</sup> Street and Cactus.



Figure 2 – Existing Site

As shown in **Figure 2**, drainage across the existing Site is characterized by grades that begin at the north end of the Site and drain to the south and southwest.

### 3.1. *Existing Studies*

At the time of drafting this Drainage Report, no existing drainage studies have been located that support the design of the developments surrounding the Site.

However, the basis of design for the existing Cactus Road stormdrain is needed to determine the feasibility of the onsite drainage outfall of the first-flush basin.

### 3.2. *Purpose of Report*

The purpose of this report is to document the preliminary drainage requirements for the proposed Wolf Springs Ranch development. This preliminary drainage report follows the drainage standards as established by the City of Scottsdale.

## 4. FEMA Floodplain Classification

The proposed Wolf Springs Ranch Site is located within the Federal Emergency Management Agency's (FEMA) Special Flood Hazard Area (SFHA) "Zone X (Shaded)" as shown on the FEMA Flood Insurance Rate Map (FIRM) Panel 04013C1760L (Figure 3, below). The effective date for this FIRM Panel was October 16, 2013.

The definition of "Zone X (Shaded)" is:

"Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or within drainage areas less than 1 square mile; and areas protected by levees from the 1% annual chance flood."

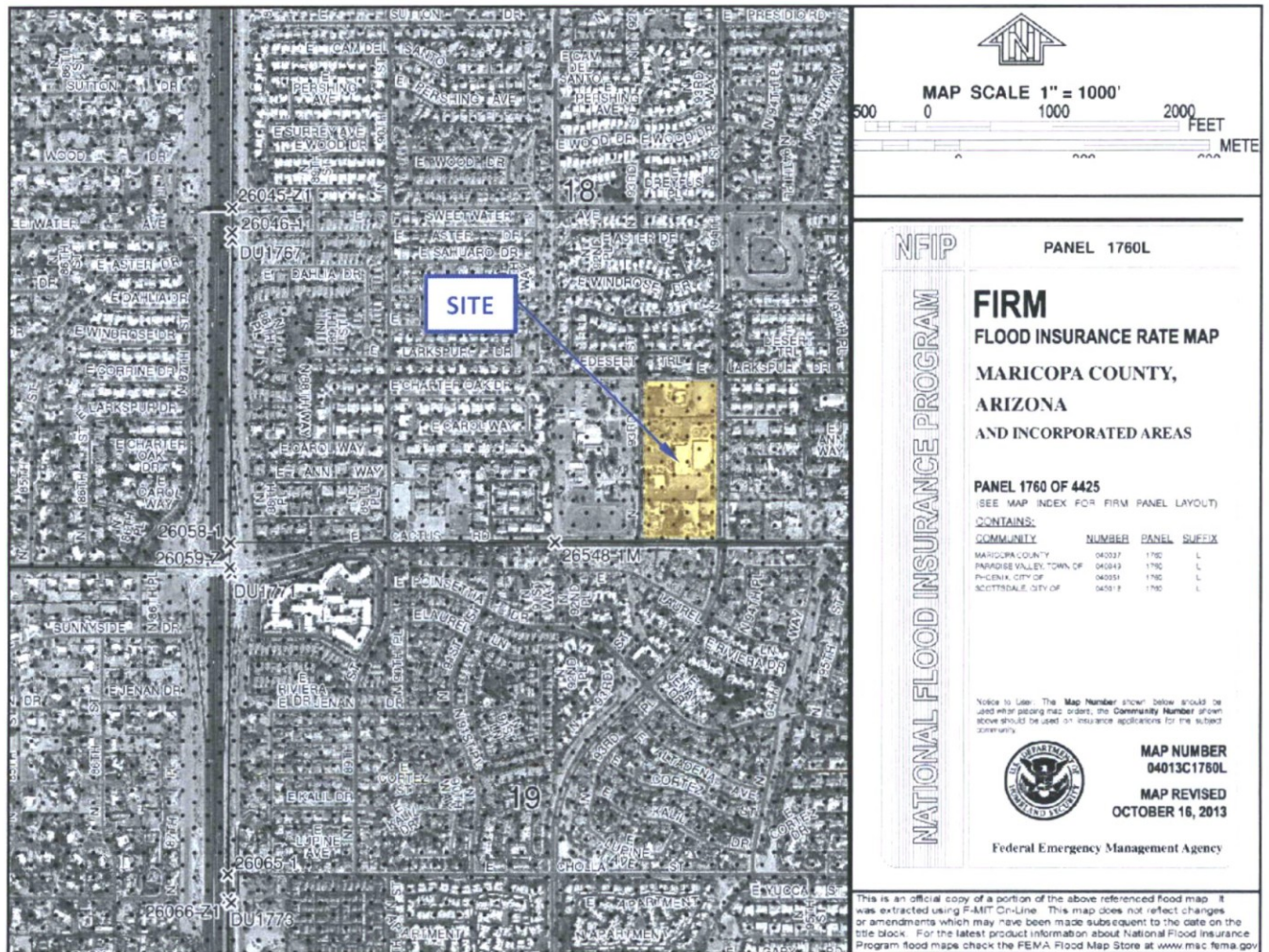


Figure 3 – FEMA FIRMette

## 5. Drainage Design

### 5.1. *Proposed Development*

The Empire Group, LLC proposes a 40-lot residential development on a net 16.8 -acre site. The project work includes lot grading, roadway infrastructure and basin grading for a development with proposed R1-18 PRD zoning. A portion of the onsite stormwater is collected in catch basins in the local streets and directed to a first-flush retention basin provided at the southwest corner of the Site.

Stormwater retention design for the Site has been granted the option by the City of Scottsdale to retain the greater of either the first-flush volume or the pre-vs-post C Value based 100-year volume, while also maintaining project outfall discharges for the 10 and 100 year events to be less than the pre-development condition discharges for the same frequencies.

### 5.2. *Design Standards*

Onsite drainage for the proposed Site will be designed to conform to the *City of Scottsdale Design Standards and Policies Manual* and the *Flood Control District of Maricopa County's Drainage Design Manual for Maricopa County, Arizona, Volume 1, Hydrology* and *Volume II, Hydraulics*.

## 6. Offsite Drainage

The Site is bounded to the north by several developments, some of which have existing retention storage (for reference, see **Exhibit 3A - Offsite Drainage Map**). However, the two developments immediately north of the Site, Sagewood and Sweetwater Ranch Estates do not appear to have retention provided onsite. Therefore, it is estimated that the 100-year flow from these two developments outfalls into 93<sup>rd</sup> Street at the northwest corner of the Site. 93<sup>rd</sup> Street, west of the Site is partially improved and does not have curb and gutter with the exception of a short reach at the far south end near Cactus Road.

Minor offsite flows also impact the Site from the north-east corner at 94<sup>th</sup> Street and Larkspur. The existing section of Larkspur between 94<sup>th</sup> Street and 93<sup>rd</sup> Way is believed to receive a minor amount of offsite flow because of the existing catch basin and storm drain system in 94<sup>th</sup> Street. The catch basin on the north curb return of Larkspur and 94<sup>th</sup> Street is believed to intercept a majority of the flow that would otherwise turn the corner onto Larkspur and drain west. Currently, flows that may bypass the 94<sup>th</sup> Street catch basin and runoff generated on Larkspur drain west to a valley gutter at the intersection of Larkspur and 93<sup>rd</sup> Way. This flow then crosses the Larkspur/93<sup>rd</sup> Way intersection via the valley gutter and enters the above mentioned concrete alley/channel. The channel drains to the west toward 93<sup>rd</sup> Street.

**Larkspur (north):** The proposed realignment of Larkspur along the northern boundary of Wolf Springs will be designed to have capacity to convey the bypass from the 94<sup>th</sup> Street catch basin as well as the runoff generated on Larkspur itself. With the Larkspur realignment, the existing valley gutter is to be removed and replaced such that flows are directed down the new roadway north gutter line and not toward the concrete channel. The conveyance capacity of the new Larkspur roadway section is to provide the same as that of the existing concrete channel. Therefore, the proposed plan is to remove the concrete channel from the back of lots 42-44 while maintaining that portion of the channel that abuts Lot 41 (on account of the non-authorization from that property owner). At the downstream end of Lot 41's portion of the channel, the channel will be terminated and what residual flows that collect there are to be routed out (south) to the new roadway ROW through a curb-cut/scupper. Further, where the channel is to be removed, this area will be graded/landscaped to drain toward the new roadway ROW.

**93<sup>rd</sup> Street (northwest corner):** Flows that reach 93<sup>rd</sup> Street from Sweetwater Ranch Estates and Sagewood, both north of the Site, are partially conveyed within the street corridor between private properties on the east and west sides of the street. The properties to the west have a view fence that aligns roughly 7 feet west of the west ROW line. The properties on the east (subject Site) have similar walls and some have no wall, but in general are higher than the existing street grade. The existing 10 and 100-year flows do not appear to be contained in the 50-foot street ROW but are contained within the overall corridor. For reference, see **Exhibit 3C, Sheets 1 and 2** and **Appendix D** for normal depth calculations showing the existing and proposed 10 and 100-year flow depths in 93<sup>rd</sup> Street (Sections A-A through H-H). It is important to note that any improvements made to the east side of 93<sup>rd</sup> Street in support of the Wolf Springs development will not diminish the existing capacity of the street corridor to convey flows. Further, the finished floor elevations on the west side of the Site will be required to be elevated sufficiently to be at least 1-foot above the estimated 100-yr water surface in the 93<sup>rd</sup> Street corridor.

Through technical discussions regarding 93<sup>rd</sup> Street offsite flows, the City of Scottsdale is not requiring this project to mitigate existing 100-year flow depths in 93<sup>rd</sup> Street that exceed 8-inches. A copy of the letter of justification and communication from the City is included in this report and should be included in the design drainage report for this project as well.

**94<sup>th</sup> Street (east):** The Site is bounded to the east by 94<sup>th</sup> Street which appears to have stormdrain infrastructure in place that intercepts flows in the roadway. Preliminarily, it is assumed that the stormdrain has capacity for approximately the 10-yr storm. The finished floor elevations on the east side of the Site will be required to be above the estimated 100-yr flow depth in 94<sup>th</sup> Street.

## 7. Onsite Hydrology

### 7.1. Methodology

The Rational Method was used to generate peak discharges for the on-site areas and will be used for inlet design in final design. Sub-basins were delineated based on the preliminary Site layout. The Flood Control District of Maricopa County (FCDMC) DDMSW program was used to estimate peak flows for this report.

### 7.2. Parameters

**T<sub>c</sub>**: Times of concentration were set to a minimum of 10 minutes.

**Land Use**: The proposed Site consists of R1-18 residential land use and local roadway with retention areas at the south and west edges of the project along 93<sup>rd</sup> Street and Cactus Road. The Rational method C values used for the project are:

Table 1 – Rational Method C Values

Land Use	C <sub>10</sub>	C <sub>100</sub>
<b>Existing Condition</b>		
R1-35 PRD	0.40	0.62
<b>Proposed Condition</b>		
R1-18 PRD	0.43	0.64
Paved/Hardscape	0.95	0.95
Landscape/Basins	0.20	0.30

**Rainfall**: The 10-year and 100-year return frequency rainfall intensities are based on the NOAA Atlas 14 rainfall data in the localized area.

Based on this data, peak discharges were determined for each of the drainage areas. The rainfall used as the basis for the Hydrologic data are provided in **Appendix A. Exhibit 3B – Existing Condition Drainage Map** indicates the existing condition drainage patterns and existing peak discharges for the Site. **Exhibit 4- Proposed Condition Drainage Map** shows the overall proposed drainage concept for the site, including the contributing drainage areas, flow patterns, peak discharges, and required/provided storage volumes for the retention basin.

## 8. Hydraulics

### 8.1. Methodology

A spreadsheet was used to estimate the street capacity of the proposed local streets. The spreadsheet takes into account the proposed typical street width from face of curb to face of curb, the depth of flow to top of curb (for 4 or 6-inch curbs), cross-slope, and assumed Manning's n value for pavement. The output tabulates the street capacity based on varying longitudinal slope of the roadway. The capacity assumes a water surface at the specified top of curb height (4 or 6-inches). The calculation is attached in **Appendix B**.

For this preliminary design, an AutoCAD Storm and Sanitary Analysis (SSA) model was assembled to roughly depict the routing of 10 and 100 year flows through the Site. The model routes flows through inlets, conveying them through various pipe systems (18-inch minimum) and small swales to the two retention areas (Basins 1 and 2-3) on the Site. The stormwater storage basins store the first-flush volume in the first foot of the basin. An orifice was placed at the outlet of each basin, above the first-flush volume elevation, that bleeds off the 10 and 100-year volumes that collect in the basins. The basins are sized in an attempt to attenuate the incoming 10 and 100-year volumes to allow for lower discharges to be drained out to the Cactus Road storm drain. Output for the 10 and 100-year storm models is included in **Appendix B**. The output includes a schematic of the system and 10 and 100-year tabular output for each node of the model.

The existing condition hydrology and preliminary SSA analysis for the proposed condition 10 and 100-year frequencies were compared. The following table summarizes the discharges for the existing and proposed condition:

**Table 2 - Pre-vs-Post 10 and 100-year Discharges at Site Outfall**

Contributing Area(s)	Q <sub>10</sub> (cfs)	Q <sub>100</sub> (cfs)
Existing Condition at SW Corner of Site	25	50
Proposed Condition Bleed-off at SW Corner of Site	1	21

The above results indicate that the first-flush retention basin and its bleed-off structure at the outlet of the retention basin sufficiently reduces the combined proposed condition 10 and 100-year peak discharges such that they are less than the existing condition peak discharges for the same frequencies.

Based upon preliminary review of available storm drain infrastructure information for Cactus Road, the Site may be able to bleed off to the existing Cactus Road catch basin at the southwest corner of the Site. The preliminary stormdrain design contained herein supports gravity bleed-off to the existing catch-basin on Cactus Road and 93<sup>rd</sup> Street.

The final hydraulic calculations to assess sizing of inlets, stormdrains, basin emergency spillway weir, etc. will be provided with the final drainage report.

As described in **Section 6**, normal depth hydraulic calculations for the existing and proposed condition 10 and 100-year offsite flows in 93<sup>rd</sup> Street were prepared for this study. The output is included in **Appendix D** and is shown graphically on **Exhibit 3C**. The calculations demonstrate that the existing conditions flow depths at each cross section exceed 8-inches in depth in most cases. The proposed condition calculations, with an improved east side of 93<sup>rd</sup> Street, show that the flow depth will be reduced and in some cases remains the same, but not reduced to the typical 8-inch depth that the City would normally require. Reducing the offsite flow depth to 8-inches would require a substantial stormdrain system be put in place in 93<sup>rd</sup> Street; intercepting and conveying approximately 100 of the existing 170 cfs offsite 100-year flow.

Through technical discussions regarding this, the City of Scottsdale is not requiring this project to mitigate existing 100-year flow depths in 93<sup>rd</sup> Street that exceed 8-inches. A copy of a letter of justification and email communication from the City is also included in **Appendix D** and should be included in the design drainage report for this project as well.

## 9. Storm Water Storage

This project is a redevelopment project located within the City of Scottsdale. The City has granted the option to retain the larger either the first-flush volume or the pre-vs-post C Value based 100-year volume.

**Comparison of Volumes:** The first-flush and differential C volumes were calculated for each area of the Site. The first-flush volume was calculated by the following equation, where A is the area of the subbasin and P is the first one-half inch of rainfall:

$$V_{FF} = A\left(\frac{P}{12}\right)$$

The differential 100-year volume ( $V_{PP}$ ) was also calculated for the where C is the difference between the weighted C value for the proposed development condition and the existing condition C value. A 100-year C for the existing condition Site was estimated as rural residential ( $C_{100} = 0.53$ ) and the overall proposed development C value, weighted by land use, was estimated as  $C_{100} = 0.63$ . Therefore, the differential C is  $0.63 - 0.53 = 0.10$ . The  $V_{PP}$  was estimated by the following equation where P is the rainfall depth in inches, A is the area, and C is the differential C, as described above:

$$V_{PP} = CA\left(\frac{P}{12}\right)$$

See **Appendix C** for the calculations. A summary of the compared first-flush and 100-year volume is summarized in **Table 3**, below:

**Table 3 - On-Site First Flush vs Pre-vs-Post C 100-Yr, 2-Hr Retention Comparison**

Contributing Area(s)	Area (ac)	FF Volume (ac-ft)	Pre-vs-Post C Volume (ac-ft)
DA-1	2.57	0.11	0.07
DA-2	4.65	0.19	0.11
DA-3	2.84	0.12	0.05
DA-4	2.66	0.11	0.04
DA-5	3.37	0.14	0.00
DA-LARK	0.77	0.03	0.04
<b>Total</b>	<b>16.85</b>	<b>0.70</b>	<b>0.27</b>

As noted in the above table, the greater of the first-flush and pre-vs-post volume is the first-flush. Therefore, the first-flush is to be retained on-site.

As noted in the hydraulics section, based upon review of the as-built Cactus Road storm drain improvements plans, it appears that the retention basin can bleed-off to the existing catch basin at the southwest corner of the Site. The catch basin is located at the northeast curb return of Cactus Road and 93<sup>rd</sup> Street.

## **10. Minimum Finished Floors**

All finished floors are to be set at least 14 inches above the Site outfall and 12 inches above the 100-year water surface of adjacent retention basins and 100-year conveyances. The ultimate outfall for the Site is to be considered for design based upon the emergency spillway crest elevation of the retention basins.

## **11. Maintenance**

Ongoing maintenance of the drainage systems are required to preserve the design integrity and function. Failure to provide adequate maintenance can prevent the drainage systems from performing in accordance with their design intent. It is the responsibility of the Wolf Springs Ranch Community Association to provide maintenance and to ensure the drainage structures on the Site are functioning as intended. A regular maintenance program is required for the drainage system to function and maintain the level of protection provided with the intent of the design presented herein.

## 12. Conclusions

The following conclusions have been reached as a result of this preliminary drainage investigation, in support of the proposed Wolf Springs Ranch development:

- This preliminary drainage report was prepared in accordance with the recommendations and design parameters from the *City of Scottsdale DS&PM* and the *Flood Control District of Maricopa County's Drainage Design Manual for Maricopa County, Arizona, Volume 1, Hydrology and Volume II, Hydraulics*.
- The first-flush volume is greater than the pre-vs-post C volume for the Site. Therefore, the required first-flush retention volume for all of the Wolf Springs Ranch development is to be held within Retention Basin 1.
- The 10 and 100-year onsite storm runoff will be designed to be conveyed through inlets, swales, and storm drains to Retention Basin 1.
- A considerable offsite flow exists in 93<sup>rd</sup> Street today. The east half of 93<sup>rd</sup> Street is proposed to be improved with pavement, curb and gutter, sidewalk, and landscaping. It has been demonstrated in this report that the improvements to 93<sup>rd</sup> Street will not increase the 10 or 100-year water surface elevations that exist today. While the existing and proposed condition *depth* exceeds 8-inches in many cases, the proposed condition *water surface elevations (WSELs)* will either meet the existing condition WSELs or be below them based upon the overall reduction in composite Manning's n value on the east half of the street and as a result improved conveyance provided in the proposed condition.

The City of Scottsdale is not requiring this project to reduce the existing flow depth condition in 93<sup>rd</sup> Street. However, the improvements to the east half of the street will reduce the flow depth mildly, so that the proposed condition is not worse than the existing condition.

The 93<sup>rd</sup> Street offsite flows are not to flow into the Site. Proposed grading along the west edge of the Site, east of 93<sup>rd</sup> Street, is to prevent the estimated 170 cfs from intermingling with onsite drainage.

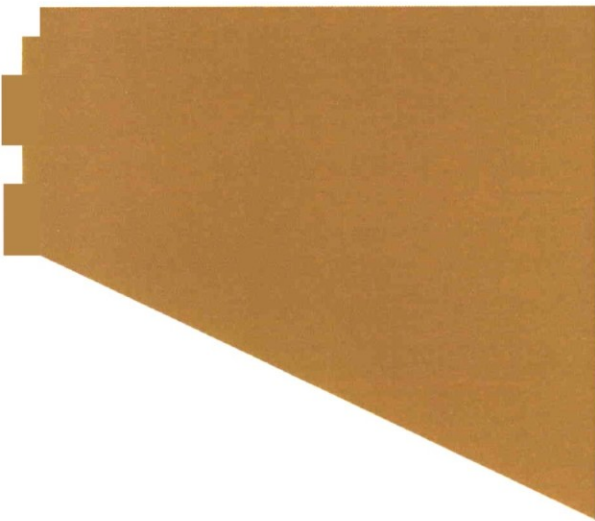
- The final design of hydraulic structures and systems will be based on generally accepted engineering practices and in accordance with the City of Scottsdale requirements.

## 13. References

1. City of Scottsdale, Cactus Road Improvements - Loop 101 to 96<sup>th</sup> Street, (As-built plans), January 2008.
2. City of Scottsdale, City of Scottsdale Design Standards and Policies Manual, January 2010.
3. Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map, Panel 04013C1760L, October 16, 2013.
4. Flood Control District of Maricopa County, Drainage Design Manual for Maricopa County, Arizona, Volume I - Hydrology, 2011.
5. Flood Control District of Maricopa County, Drainage Design Manual for Maricopa County, Arizona, Volume I - Hydraulics, 2011.



## Appendix A: Hydrology

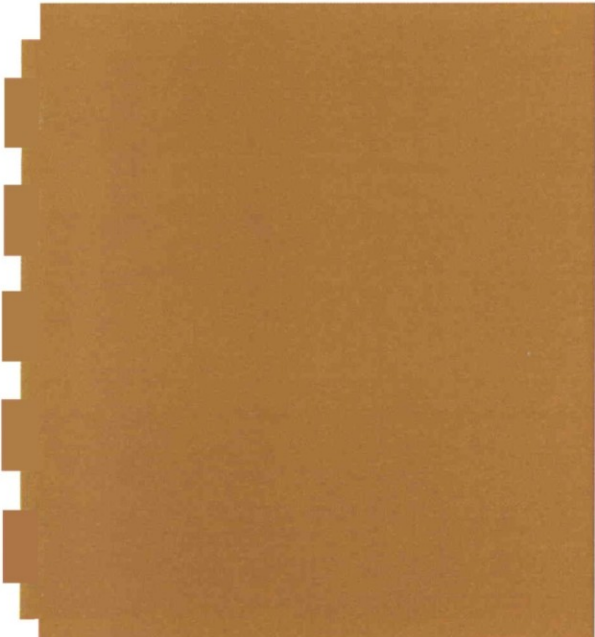


Rainfall (NOAA14)

On-Site Rational Method

Existing Conditions

Proposed Conditions



Flood Control District of Maricopa County  
 Drainage Design Management System  
**RAINFALL DATA**  
 Project Reference: TEG-1603-000

ID	Method	Duration	2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
<b>DEFAULT</b>	NOAA14	5 MIN	0.248	0.335	0.403	0.493	0.563	0.635
	NOAA14	10 MIN	0.378	0.511	0.613	0.751	0.857	0.966
	NOAA14	15 MIN	0.469	0.633	0.760	0.931	1.063	1.198
	NOAA14	30 MIN	0.631	0.852	1.024	1.253	1.431	1.613
	NOAA14	1 HOUR	0.781	1.055	1.267	1.551	1.771	1.996
	NOAA14	2 HOUR	0.905	1.206	1.437	1.752	1.990	2.238
	NOAA14	3 HOUR	0.992	1.297	1.540	1.879	2.148	2.427
	NOAA14	6 HOUR	1.176	1.503	1.764	2.120	2.396	2.684
	NOAA14	12 HOUR	1.307	1.652	1.921	2.285	2.565	2.854
	NOAA14	24 HOUR	1.536	1.985	2.343	2.837	3.227	3.635

## Weighted C Calculations

$C_{\text{Landscaping}}$	$C_{\text{lots}}$	$C_{\text{paved}}$	P (100-Yr, 2-hr) (in)
0.30	0.64	0.95	2.256

Drainage Area Number	Total Area	Total Area	Landscaping/ Basin Area	Lot Area	Paving Area	Weighted C
DA-1	111986	2.57	9398	80644	21944	0.67
DA-2	202693	4.65	37423	111922	53348	0.66
DA-3	123540	2.84	21753	81799	19988	0.63
DA-4	115654	2.66	26206	70182	19266	0.61
DA-5	146580	3.37	69661	54727	22192	0.53
DA-LARK	33719	0.77	7762	0	25957	0.80

**Total**

734172  
16.9

172203

399274

162695

**0.63**  
PROJECT WEIGHTED C

**0.53**  
PRE-PROJECT C

Flood Control District of Maricopa County  
 Drainage Design Management System  
 LAND USE  
 Project Reference: TEG-1603-000

Sub Basin	Land Use Code	Area (acres)	Area (%)	Kb	Runoff Coefficient C						Description
					2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	
<b>Major Basin ID: 01</b>											
CP23	COS TRANS	8.80	100.0	0.034	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>8.800</b>	<b>100.0</b>								
CP34	COS TRANS	11.80	100.0	0.033	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>11.800</b>	<b>100.0</b>								
DA-1	COS LS	0.22	8.6	0.074	0.20	0.20	0.20	0.20	0.25	0.30	City of Scottsdale, Landscaping
	COS R1-18	1.85	72.0	0.074	0.43	0.43	0.43	0.43	0.58	0.64	City of Scottsdale, R1-18
	COS TRANS	0.50	19.5	0.037	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>2.570</b>	<b>100.1</b>								
DA-1 E	110	16.08	100.0	0.032	0.42	0.42	0.42	0.46	0.50	0.53	Rural Residential (<= 1/5 du per acre)
		<b>16.080</b>	<b>100.0</b>								
DA-2	COS LS	0.86	18.5	0.071	0.20	0.20	0.20	0.20	0.25	0.30	City of Scottsdale, Landscaping
	COS R1-18	2.57	55.3	0.071	0.43	0.43	0.43	0.43	0.58	0.64	City of Scottsdale, R1-18
	COS TRANS	1.22	26.2	0.036	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>4.650</b>	<b>100.0</b>								
DA-3	COS LS	0.50	17.6	0.074	0.20	0.20	0.20	0.20	0.25	0.30	City of Scottsdale, Landscaping
	COS R1-18	1.88	66.2	0.074	0.43	0.43	0.43	0.43	0.58	0.64	City of Scottsdale, R1-18
	COS TRANS	0.46	16.2	0.037	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>2.840</b>	<b>100.0</b>								
DA-4	COS LS	0.60	22.6	0.074	0.20	0.20	0.20	0.20	0.25	0.30	City of Scottsdale, Landscaping

\* Non default value

Flood Control District of Maricopa County  
 Drainage Design Management System  
 LAND USE  
 Project Reference: TEG-1603-000

Sub Basin	Land Use Code	Area (acres)	Area (%)	Kb	Runoff Coefficient C						Description
					2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	
<b>Major Basin ID: 01</b>											
	COS R1-18	1.61	60.8	0.074	0.43	0.43	0.43	0.43	0.58	0.64	City of Scottsdale, R1-18
	COS TRANS	0.44	16.6	0.037	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>2.650</b>	<b>100.0</b>								
DA-5	COS LS	1.60	47.5	0.073	0.20	0.20	0.20	0.20	0.25	0.30	City of Scottsdale, Landscaping
	COS R1-18	1.26	37.4	0.073	0.43	0.43	0.43	0.43	0.58	0.64	City of Scottsdale, R1-18
	COS TRANS	0.51	15.1	0.037	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>3.370</b>	<b>100.0</b>								
DA-LAR	COS LS	0.18	23.1	0.082	0.20	0.20	0.20	0.20	0.25	0.30	City of Scottsdale, Landscaping
	COS TRANS	0.60	76.9	0.041	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>0.780</b>	<b>100.0</b>								
OFF-1	COS R1-18	3.70	9.9	0.058	0.43	0.43	0.43	0.43	0.58	0.64	City of Scottsdale, R1-18
	COS R1-7	33.60	90.1	0.030	0.51	0.51	0.51	0.51	0.64	0.94	City of Scottsdale, R1-7
		<b>37.300</b>	<b>100.0</b>								
OFF-2	COS TRANS	5.50	100.0	0.035	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>5.500</b>	<b>100.0</b>								
OFF-3	COS TRANS	3.30	100.0	0.037	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement
		<b>3.300</b>	<b>100.0</b>								
OFF-4	COS TRANS	3.00	100.0	0.037	0.95	0.95	0.95	0.95	0.95	0.95	City of Scottsdale, pavement

\* Non default value

Flood Control District of Maricopa County  
 Drainage Design Management System  
 LAND USE  
 Project Reference: TEG-1603-000

Sub Basin	Land Use Code	Area (acres)	Area (%)	Kb	Runoff Coefficient C						Description
					2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	

**Major Basin ID: 01**

	3.000	100.0
--	-------	-------

\* Non default value

Flood Control District of Maricopa County  
 Drainage Design Management System  
 SUB BASINS  
 Project Reference: TEG-1603-000

ID	Sub Basin Data						Sub Basin Hydrology Summary						
	Area (acres)	Length (ft)	USGE	DSGE	Slope (ft/mi)	Kb	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	
<b>Major Basin ID: 01</b>													
DA-1 E	16.1	1,328	1,421.00	1,408.00	51.7	0.032	Q (cfs)	13.6	19.7	24.4	33.4	41.4	49.5
							C	0.42	0.42	0.42	0.46	0.50	0.53
							CA (ac)	6.75	6.75	6.75	7.40	8.04	8.52
							Volume (ac-ft)	0.3226	0.4057	0.4621	0.6142	0.7613	0.9102
							Tc (min)	13	11	10	10	10	10
							i (in/hr)	2.02	2.92	3.62	4.51	5.15	5.81
DA-LAR	0.8	565	1,421.00	1,417.00	37.4	0.050	Q (cfs)	1.3	1.8	2.2	2.7	3.1	3.6
							C	0.78	0.78	0.78	0.78	0.79	0.80
							CA (ac)	0.60	0.60	0.60	0.60	0.61	0.62
							Volume (ac-ft)	0.0273	0.0331	0.0405	0.0496	0.0570	0.0662
							Tc (min)	11	10	10	10	10	10
							i (in/hr)	2.14	3.05	3.67	4.51	5.15	5.81
DA-1	2.6	535	1,420.00	1,416.00	39.5	0.067	Q (cfs)	2.6	3.8	4.7	5.9	8.2	10.0
							C	0.51	0.51	0.51	0.51	0.62	0.67
							CA (ac)	1.31	1.31	1.31	1.31	1.59	1.72
							Volume (ac-ft)	0.0622	0.0790	0.0899	0.1085	0.1508	0.1839
							Tc (min)	13	11	10	10	10	10
							i (in/hr)	2.01	2.91	3.61	4.51	5.15	5.81
DA-2	4.7	1,060	1,418.00	1,410.00	39.8	0.062	Q (cfs)	4.1	5.9	7.3	9.5	13.4	16.5
							C	0.52	0.52	0.52	0.52	0.62	0.66
							CA (ac)	2.42	2.42	2.42	2.42	2.88	3.07
							Volume (ac-ft)	0.1410	0.1768	0.2014	0.2376	0.3129	0.3641
							Tc (min)	19	16	15	14	13	12
							i (in/hr)	1.69	2.44	3.03	3.93	4.65	5.38
DA-3	2.8	490	1,418.00	1,415.00	32.3	0.068	Q (cfs)	2.6	3.8	4.7	6.0	8.5	10.4
							C	0.47	0.47	0.47	0.47	0.58	0.63

\* Non default value

Flood Control District of Maricopa County  
 Drainage Design Management System  
 SUB BASINS  
 Project Reference: TEG-1603-000

ID	Sub Basin Data						Sub Basin Hydrology Summary						
	Area (acres)	Length (ft)	USGE	DSGE	Slope (ft/mi)	Kb	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	
<b>Major Basin ID: 01</b>													
							CA (ac)	1.33	1.33	1.33	1.33	1.65	1.79
							Volume (ac-ft)	0.0641	0.0811	0.0925	0.1103	0.1563	0.1912
							Tc (min)	13	12	11	10	10	10
							i (in/hr)	1.98	2.87	3.57	4.51	5.15	5.81
DA-4	2.7	510	1,417.00	1,413.00	41.4	0.068	Q (cfs)	2.5	3.6	4.5	5.5	7.8	9.4
							C	0.46	0.46	0.46	0.46	0.57	0.61
							CA (ac)	1.22	1.22	1.22	1.22	1.52	1.62
							Volume (ac-ft)	0.0575	0.0722	0.0827	0.1011	0.1434	0.1729
							Tc (min)	13	11	10	10	10	10
							i (in/hr)	2.05	2.95	3.67	4.51	5.15	5.81
DA-5	3.4	435	1,411.00	1,406.00	60.7	0.067	Q (cfs)	3.1	4.1	5.0	6.1	8.3	10.4
							C	0.40	0.40	0.40	0.40	0.48	0.53
							CA (ac)	1.35	1.35	1.35	1.35	1.62	1.79
							Volume (ac-ft)	0.0570	0.0754	0.0919	0.1122	0.1526	0.1912
							Tc (min)	10	10	10	10	10	10
							i (in/hr)	2.26	3.05	3.67	4.51	5.15	5.81
OFF-1	37.3	2,170	1,430.00	1,417.00	31.6	0.033	Q (cfs)	29.3	42.9	53.7	68.6	102.0	171.4
							C	0.50	0.50	0.50	0.50	0.63	0.91
							CA (ac)	18.65	18.65	18.65	18.65	23.50	33.94
							Volume (ac-ft)	1.1530	1.4594	1.6787	1.9426	2.7196	4.3179
							Tc (min)	21	19	17	15	15	14
							i (in/hr)	1.57	2.30	2.88	3.68	4.34	5.05
OFF-2	5.5	970	1,437.00	1,430.00	38.1	0.035	Q (cfs)	10.7	15.4	19.1	23.6	26.9	30.4
							C	0.95	0.95	0.95	0.95	0.95	0.95
							CA (ac)	5.23	5.23	5.23	5.23	5.23	5.23
							Volume (ac-ft)	0.2479	0.3115	0.3547	0.4340	0.4946	0.5590
							Tc (min)	13	11	10	10	10	10
							i (in/hr)	2.04	2.94	3.65	4.51	5.15	5.81

\* Non default value

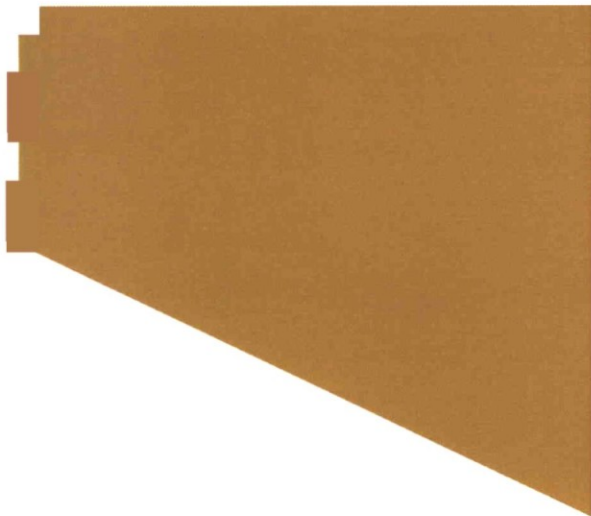
Flood Control District of Maricopa County  
 Drainage Design Management System  
 SUB BASINS  
 Project Reference: TEG-1603-000

ID	Sub Basin Data						Sub Basin Hydrology Summary						
	Area (acres)	Length (ft)	USGE	DSGE	Slope (ft/mi)	Kb	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	
<b>Major Basin ID: 01</b>													
OFF-3	3.3	1,310	1,430.00	1,422.00	32.2	0.037	Q (cfs)	5.6	8.1	10.2	13.1	15.4	17.8
							C	0.95	0.95	0.95	0.95	0.95	0.95
							CA (ac)	3.14	3.14	3.14	3.14	3.14	3.14
							Volume (ac-ft)	0.1709	0.2145	0.2476	0.2891	0.3200	0.3502
							Tc (min)	17	14	13	12	11	11
							i (in/hr)	1.79	2.58	3.25	4.18	4.90	5.66
OFF-4	3.0	1,280	1,422.00	1,410.00	49.5	0.037	Q (cfs)	5.5	8.0	10.0	12.8	14.7	16.6
							C	0.95	0.95	0.95	0.95	0.95	0.95
							CA (ac)	2.85	2.85	2.85	2.85	2.85	2.85
							Volume (ac-ft)	0.1416	0.1780	0.2041	0.2377	0.2703	0.3052
							Tc (min)	14	12	11	10	10	10
							i (in/hr)	1.94	2.82	3.52	4.49	5.15	5.81
CP23	8.8	2,225	1,437.00	1,422.00	35.6	0.034	Q (cfs)	13.2	19.3	24.2	30.8	36.4	42.4
							C	0.95	0.95	0.95	0.95	0.95	0.95
							CA (ac)	8.36	8.36	8.36	8.36	8.36	8.36
							Volume (ac-ft)	0.5146	0.6495	0.7476	0.8665	0.9638	1.0604
							Tc (min)	21	18	17	15	14	14
							i (in/hr)	1.58	2.31	2.89	3.69	4.36	5.07
CP34	11.8	3,510	1,437.00	1,410.00	40.6	0.033	Q (cfs)	15.4	23.0	29.1	37.7	44.4	51.3
							C	0.95	0.95	0.95	0.95	0.95	0.95
							CA (ac)	11.21	11.21	11.21	11.21	11.21	11.21
							Volume (ac-ft)	0.7561	0.9685	1.1184	1.3102	1.4533	1.5848
							Tc (min)	27	23	21	19	18	17
							i (in/hr)	1.37	2.05	2.60	3.36	3.96	4.58

\* Non default value

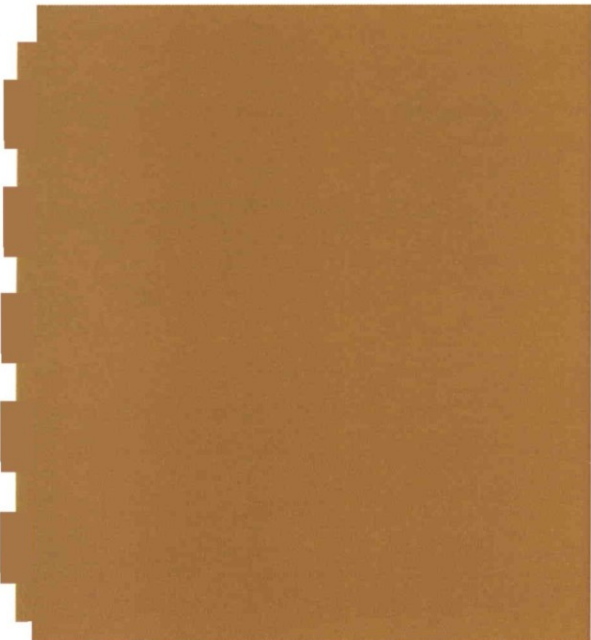


## Appendix B: Hydraulics



Street Capacity

Preliminary 10 and 100-year SSA model output



Description: Calculation of Street Flow Conveyance Capacity  
 Date: 03/13/17  
 References: Federal Highway Administration, Hydraulic Engineering Circular No. 12, "Drainage of Highway Pavements", March 1984

**10 Year Flows**

**Known Values:**

Depth of Flow = 0.33 ft  
 Cross Slope = 0.02 ft/ft  
 Street Width (F/C to F/C) = 28 ft  
 Manning's "n" Value = 0.015

**Calculated Values:**

Referenced Equations:  
 $Q = 0.56 * (S_x^{1.67}) * (S^{0.5}) * (T^{2.67}) / n$  for flow below crown (FHWA Procedure)  
 $Q = 1.486 * A * (R^{0.67}) * (S^{0.5}) / n$  for flow above crown (Manning's equation)  
 where Q = flow rate, cfs  
        $S_x$  = cross slope, ft/ft  
       S = longitudinal slope, ft/ft  
       T = width of flow, ft  
       A = conveyance area, sq ft  
       R = hydraulic radius, ft

Longitudinal Slope (ft/ft)	Conveyance Area (ft <sup>2</sup> )	Velocity (fps)	Hydraulic Capacity (cfs)	Half-Street Hydraulic Capacity (cfs)
0.0020	5.32	1.43	8	4
0.0025	5.32	1.60	9	5
0.0030	5.32	1.76	9	5
0.0035	5.32	1.90	10	6
0.0040	5.32	2.03	11	6
0.0045	5.32	2.15	11	6
0.0050	5.32	2.27	12	7
0.0055	5.32	2.38	13	7
0.0060	5.32	2.48	13	7
0.0065	5.32	2.58	14	8
0.0070	5.32	2.68	14	8
0.0075	5.32	2.78	15	8
0.0080	5.32	2.87	15	9
0.0085	5.32	2.96	16	9
0.0090	5.32	3.04	16	9
0.0095	5.32	3.12	17	9
0.0100	5.32	3.21	17	10
0.0105	5.32	3.28	17	10
0.0110	5.32	3.36	18	10
0.0115	5.32	3.44	18	10
0.0120	5.32	3.51	19	11
0.0125	5.32	3.58	19	11
0.0130	5.32	3.65	19	11
0.0135	5.32	3.72	20	11
0.0140	5.32	3.79	20	11
0.0145	5.32	3.86	21	12
0.0150	5.32	3.93	21	12
0.0155	5.32	3.99	21	12
0.0160	5.32	4.05	22	12
0.0165	5.32	4.12	22	12
0.0170	5.32	4.18	22	13
0.0175	5.32	4.24	23	13
0.0180	5.32	4.30	23	13
0.0185	5.32	4.36	23	13
0.0190	5.32	4.42	24	13
0.0195	5.32	4.48	24	14
0.0200	5.32	4.53	24	14
0.0205	5.32	4.59	24	14
0.0210	5.32	4.64	25	14
0.0215	5.32	4.70	25	14
0.0220	5.32	4.75	25	14
0.0225	5.32	4.81	26	15
0.0230	5.32	4.86	26	15
0.0235	5.32	4.91	26	15
0.0240	5.32	4.97	26	15
0.0245	5.32	5.02	27	15
0.0250	5.32	5.07	27	15

**Street Capacity Computations**

4" Curb

Description: Calculation of Street Flow Conveyance Capacity  
 Date: 03/13/17  
 References: Federal Highway Administration, Hydraulic Engineering Circular No. 12, "Drainage of Highway Pavements", March 1984

**100 Year Flows**

**Known Values:**

Depth of Flow = 0.67 ft  
 Cross Slope = 0.02 ft/ft  
 Street Width (F/C to F/C) = 28 ft  
 Manning's "n" Value = 0.015

**Calculated Values:**

Referenced Equations:

$Q = 0.56 * (S_x^{1.67}) * (S^{0.5}) * (T^{2.67}) / n$  for flow below crown (FHWA Procedure)

$Q = 1.486 * A * (R^{0.67}) * (S^{0.5}) / n$  for flow above crown (Manning's equation)

where

Q = flow rate, cfs

S<sub>x</sub> = cross slope, ft/ft

S = longitudinal slope, ft/ft

T = width of flow, ft

A = conveyance area, sq ft

R = hydraulic radius, ft

Longitudinal Slope (ft/ft)	Conveyance Area (ft <sup>2</sup> )	Velocity (fps)	Hydraulic Capacity (cfs)	Half-Street Hydraulic Capacity (cfs)
0.0020	14.84	2.81	42	29
0.0025	14.84	3.14	47	32
0.0030	14.84	3.44	51	35
0.0035	14.84	3.71	55	38
0.0040	14.84	3.97	59	41
0.0045	14.84	4.21	62	43
0.0050	14.84	4.44	66	45
0.0055	14.84	4.65	69	48
0.0060	14.84	4.86	72	50
0.0065	14.84	5.06	75	52
0.0070	14.84	5.25	78	54
0.0075	14.84	5.43	81	55
0.0080	14.84	5.61	83	57
0.0085	14.84	5.78	86	59
0.0090	14.84	5.95	88	61
0.0095	14.84	6.11	91	62
0.0100	14.84	6.27	93	64
0.0105	14.84	6.43	95	66
0.0110	14.84	6.58	98	67
0.0115	14.84	6.73	100	69
0.0120	14.84	6.87	102	70
0.0125	14.84	7.01	104	72
0.0130	14.84	7.15	106	73
0.0135	14.84	7.29	108	74
0.0140	14.84	7.42	110	76
0.0145	14.84	7.55	112	77
0.0150	14.84	7.68	114	78
0.0155	14.84	7.81	116	80
0.0160	14.84	7.94	118	81
0.0165	14.84	8.06	120	82
0.0170	14.84	8.18	121	84
0.0175	14.84	8.30	123	85
0.0180	14.84	8.42	125	86
0.0185	14.84	8.53	127	87
0.0190	14.84	8.65	128	88
0.0195	14.84	8.76	130	89
0.0200	14.84	8.87	132	91
0.0205	14.84	8.98	133	92
0.0210	14.84	9.09	135	93
0.0215	14.84	9.20	137	94
0.0220	14.84	9.31	138	95
0.0225	14.84	9.41	140	96
0.0230	14.84	9.51	141	97
0.0235	14.84	9.62	143	98
0.0240	14.84	9.72	144	99
0.0245	14.84	9.82	146	100
0.0250	14.84	9.92	147	101

Description: Calculation of Street Flow Conveyance Capacity  
 Date: 03/13/17  
 References: Federal Highway Administration, Hydraulic Engineering Circular No. 12, "Drainage of Highway Pavements", March 1984

10 Year Flows

Known Values:

Depth of Flow = 0.5 ft  
 Cross Slope = 0.02 ft/ft  
 Street Width (F/C to F/C) = 28 ft  
 Manning's "n" Value = 0.015

Calculated Values:

Referenced Equations:

$Q = 0.56 * (S_x^{1.67}) * (S^{0.5}) * (T^{2.67}) / n$  for flow below crown (FHWA Procedure)

$Q = 1.486 * A * (R^{0.67}) * (S^{0.5}) / n$  for flow above crown (Manning's equation)

where

Q = flow rate, cfs

S<sub>x</sub> = cross slope, ft/ft

S = longitudinal slope, ft/ft

T = width of flow, ft

A = conveyance area, sq ft

R = hydraulic radius, ft

Longitudinal Slope (ft/ft)	Conveyance Area (ft <sup>2</sup> )	Velocity (fps)	Hydraulic Capacity (cfs)	Half-Street Hydraulic Capacity (cfs)
0.0020	10.08	2.18	22	13
0.0025	10.08	2.44	25	15
0.0030	10.08	2.67	27	16
0.0035	10.08	2.89	29	17
0.0040	10.08	3.09	31	19
0.0045	10.08	3.27	33	20
0.0050	10.08	3.45	35	21
0.0055	10.08	3.62	36	22
0.0060	10.08	3.78	38	23
0.0065	10.08	3.93	40	24
0.0070	10.08	4.08	41	25
0.0075	10.08	4.23	43	25
0.0080	10.08	4.36	44	26
0.0085	10.08	4.50	45	27
0.0090	10.08	4.63	47	28
0.0095	10.08	4.76	48	29
0.0100	10.08	4.88	49	29
0.0105	10.08	5.00	50	30
0.0110	10.08	5.12	52	31
0.0115	10.08	5.23	53	31
0.0120	10.08	5.35	54	32
0.0125	10.08	5.46	55	33
0.0130	10.08	5.56	56	33
0.0135	10.08	5.67	57	34
0.0140	10.08	5.77	58	35
0.0145	10.08	5.88	59	35
0.0150	10.08	5.98	60	36
0.0155	10.08	6.08	61	37
0.0160	10.08	6.17	62	37
0.0165	10.08	6.27	63	38
0.0170	10.08	6.36	64	38
0.0175	10.08	6.46	65	39
0.0180	10.08	6.55	66	39
0.0185	10.08	6.64	67	40
0.0190	10.08	6.73	68	40
0.0195	10.08	6.81	69	41
0.0200	10.08	6.90	70	41
0.0205	10.08	6.99	70	42
0.0210	10.08	7.07	71	43
0.0215	10.08	7.15	72	43
0.0220	10.08	7.24	73	44
0.0225	10.08	7.32	74	44
0.0230	10.08	7.40	75	44
0.0235	10.08	7.48	75	45
0.0240	10.08	7.56	76	45
0.0245	10.08	7.64	77	46
0.0250	10.08	7.72	78	46



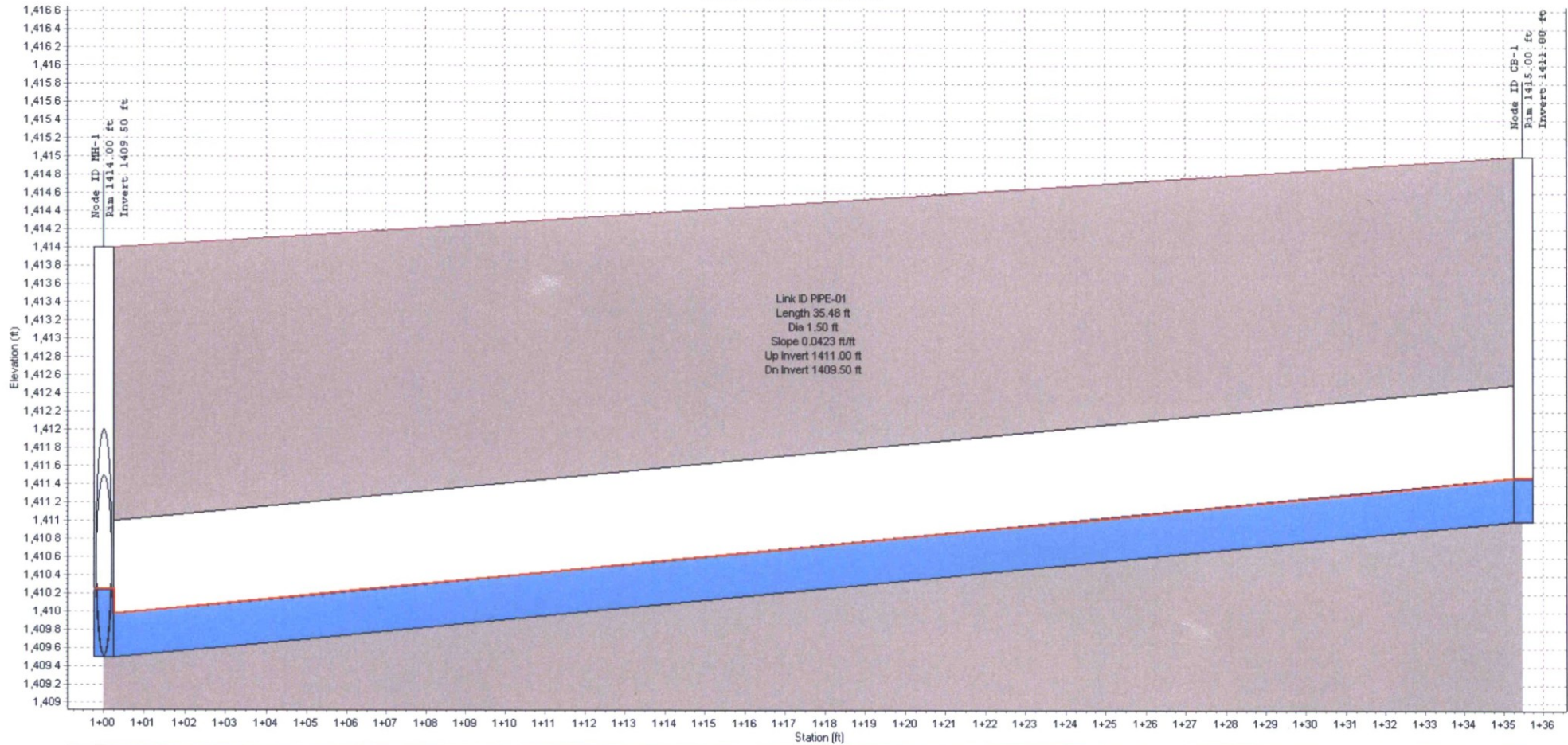
SN	Element Description ID	From (Inlet) Node	To (Outlet) Node	Length / o (ft)	Max Flow Depth / Total Depth Ratio	Total Time Surcharged (min)	Max Flow Depth (ft)	Reported Condition
1	CH-03	HW-04A	RB-1	64.895	0.19	0.00	0.58	Calculated
2	Link-30	HW-5	RB-1	19.601	0.08	0.00	0.25	Calculated
3	RB1_N	HW-03A	HW-03B	106.112	0.09	0.00	0.28	Calculated

SN	Element ID	X Coordinate	Y Coordinate	Descum GL Depth Attained (ft)	Maximum Surchage Depth Attained (ft)	Minimum Freeboard Attained (ft)	Average HGL Elevation Attained (ft)
1	Bleed-2	711158.21	944996.66	16	0.00	2.84	1403.64
2	CB-1	711188.84	945972.94	47	0.00	3.53	1411.01
3	CB-2	711199.11	945744.04	61	0.00	3.39	1408.71
4	CB-3	711186.98	945384.74	49	0.00	3.71	1406.01
5	CB-4A	711172.36	945167.77	61	0.00	2.59	1403.81
6	CB-4B	711172.36	945124.62	95	0.00	2.35	1403.72
7	CB-5	711565.75	945132.42	64	0.00	3.36	1405.51
8	CB-6A	711162.18	946224.54	35	0.00	3.65	1411.01
9	CB-6B	711161.69	946201.07	45	0.00	3.75	1410.81
10	HW-03A	711169.74	945324.69	06	0.00	1.94	1404.52
11	HW-03B	711177.34	945207.12	43	0.00	2.57	1404.01
12	HW-04A	711174.05	945092.46	95	0.00	2.05	1403.62
13	HW-5	711521.74	945035.69	62	0.00	6.78	1403.61
14	MH-1	711157.12	945957.05	74	0.00	3.76	1409.51
15	MH-2	711158.90	945726.49	91	0.00	3.59	1408.02
16	MH-3	711162.38	945371.93	06	0.00	3.94	1405.02
17	MH-5	711563.15	945036.55	64	0.00	6.36	1404.01

SN	Element Description ID	From (Inlet) Node	To (Outlet) Node	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged (min)	Max Flow Depth (ft)	Reported Condition
1	Link-12	Bleed-2	EXST CB CACT	0.01	0.08	0.00	0.16	Calculated
2	PIPE-01	CB-1	MH-1	0.21	0.31	0.00	0.47	Calculated
3	PIPE-02	CB-2	MH-2	0.35	0.41	0.00	0.61	Calculated
4	PIPE-03	CB-3	MH-3	0.23	0.33	0.00	0.49	Calculated
5	PIPE-03A	MH-3	HW-03A	0.37	0.42	0.00	1.06	Calculated
6	PIPE-03B	HW-03B	CB-4A	0.10	0.17	0.00	0.43	Calculated
7	PIPE-1	MH-1	MH-2	0.19	0.29	0.00	0.74	Calculated
8	PIPE-2	MH-2	MH-3	0.28	0.36	0.00	0.91	Calculated
9	PIPE-4A	CB-4A	CB-4B	0.17	0.24	0.00	0.61	Calculated
10	PIPE-4B	CB-4B	HW-04A	0.34	0.38	0.00	0.95	Calculated
11	PIPE-5	CB-5	MH-5	0.22	0.32	0.00	0.64	Calculated
12	PIPE-5A	MH-5	HW-5	0.21	0.31	0.00	0.62	Calculated
13	PIPE-6A	CB-6A	CB-6B	0.12	0.23	0.00	0.35	Calculated
14	PIPE-6B	CB-6B	MH-1	0.11	0.22	0.00	0.45	Calculated

# CB-1 TO MH-1 (10-YR)

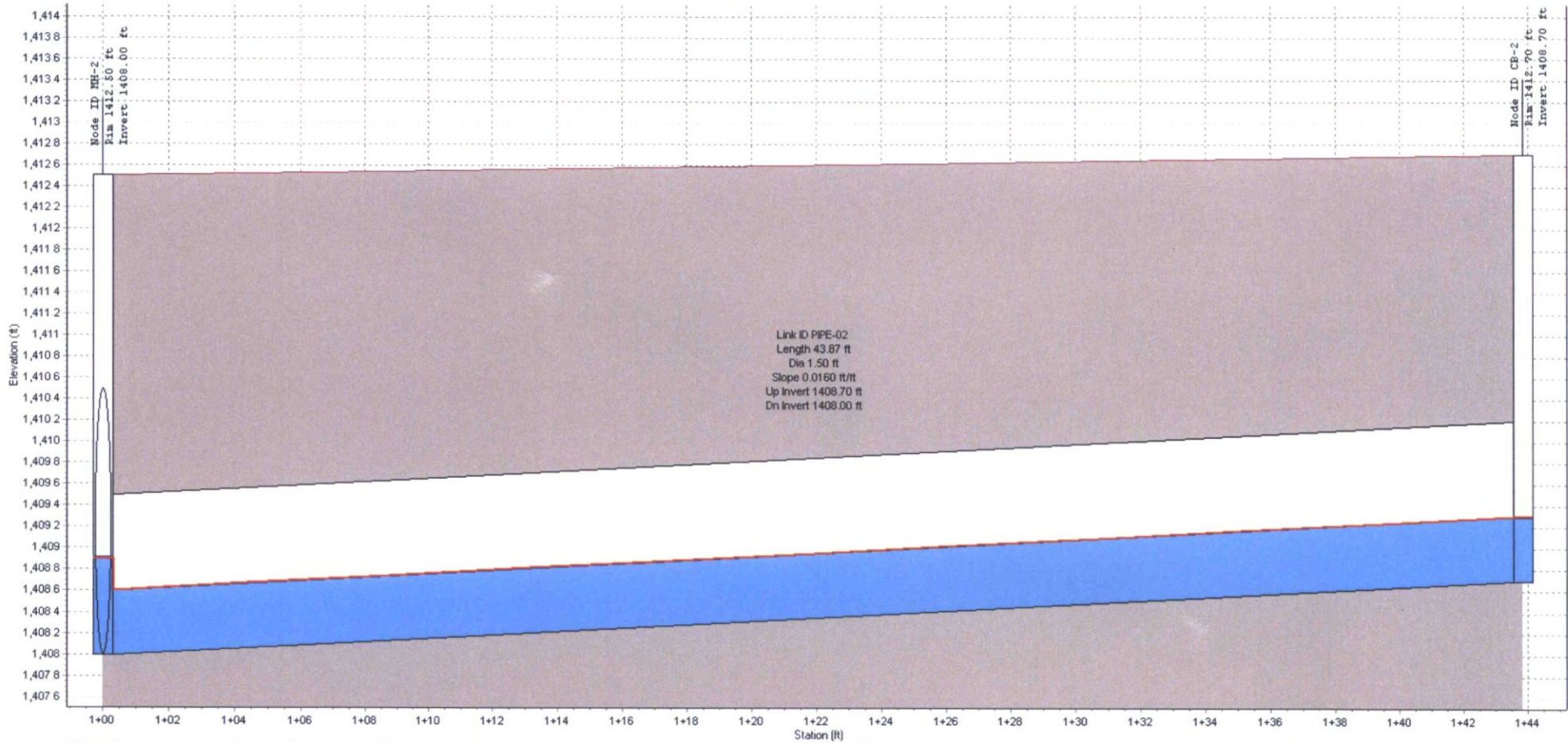
WOLFSPRINGS RANCH



Node ID:	MH-1	CB-1
Rim (ft):	1414.00	1415.00
Invert (ft):	1409.50	1411.00
Min Pipe Cover (ft):	2.00	2.50
Max HGL (ft):	1410.24	1411.47
Link ID:	PIPE-01	
Length (ft):	35.48	
Dia (ft):	1.50	
Slope (ft/ft):	0.0423	
Up Invert (ft):	1411.00	
Dn Invert (ft):	1409.50	
Max Q (cfs):	4.98	
Max Vel (ft/s):	10.51	
Max Depth (ft):	0.47	

# CB-2 TO MH-2 (10-YR)

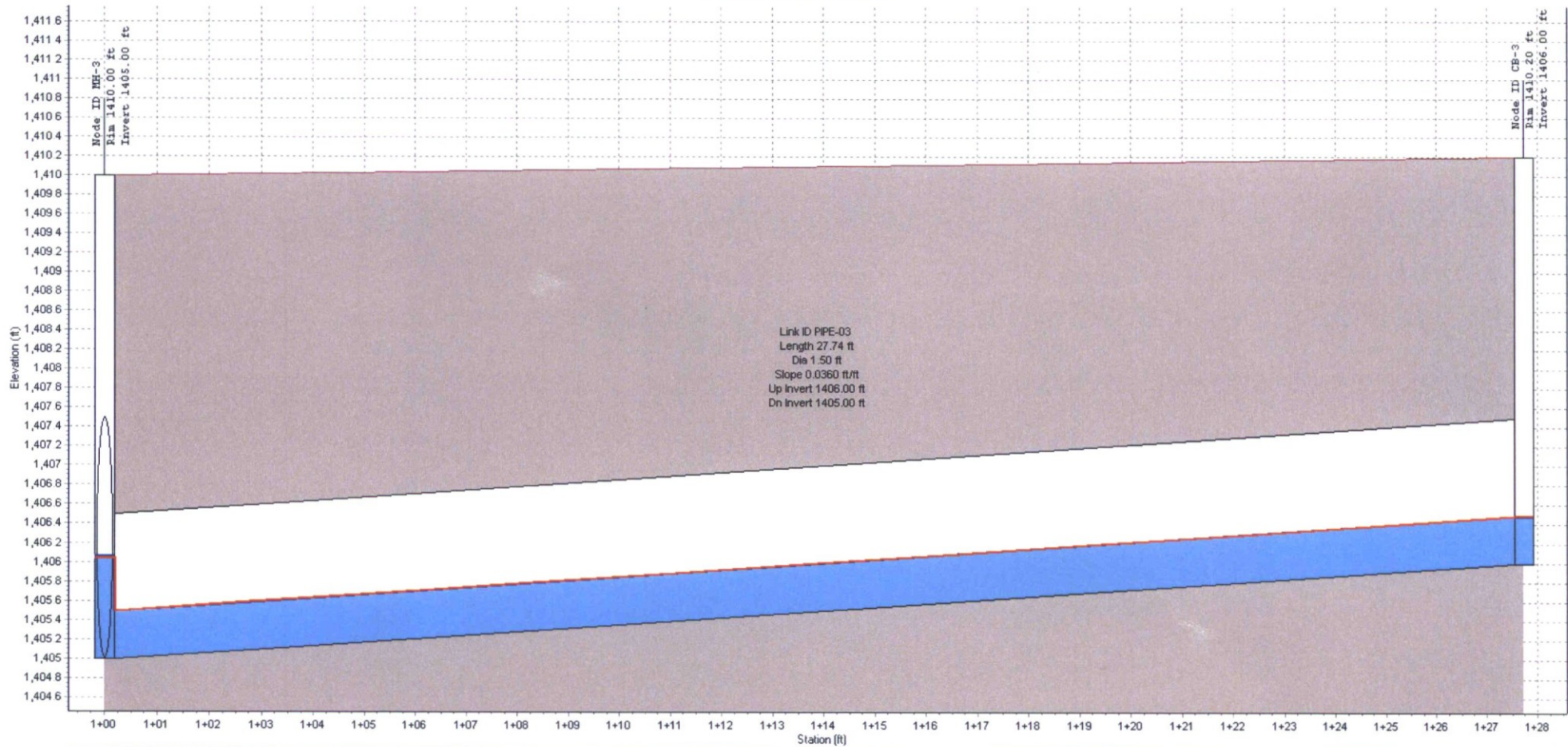
WOLFSPRINGS RANCH



Node ID:	MH-2	CB-2
Rim (ft)	1412.50	1412.70
Invert (ft)	1408.00	1408.70
Min Pipe Cover (ft)	2.00	2.50
Max HGL (ft)	1408.91	1409.31
Link ID:	PIPE-02	
Length (ft)	43.87	
Dia (ft)	1.50	
Slope (ft/ft)	0.0160	
Up Invert (ft)	1408.70	
Dn Invert (ft)	1408.00	
Max Q (cfs)	4.96	
Max Vel (ft/s)	7.38	
Max Depth (ft)	0.61	

# CB-3 TO MH-3 (10-YR)

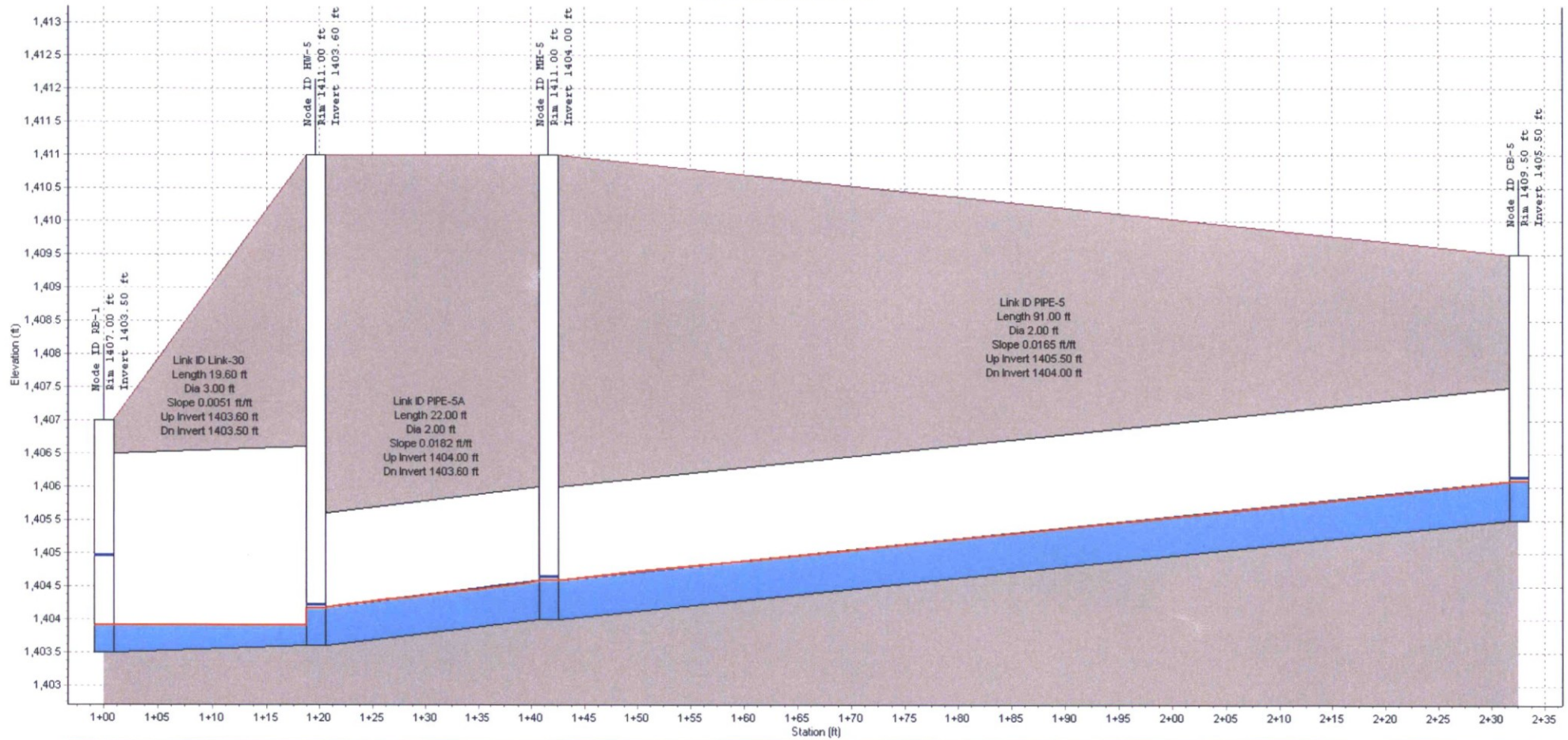
WOLFSPRINGS RANCH



Node ID:	MH-3	CB-3
Rim (ft)	1410.00	1410.20
Invert (ft)	1405.00	1406.00
Min Pipe Cover (ft)	2.50	2.70
Max HGL (ft)	1406.06	1406.49
Link ID:	PIPE-03	
Length (ft)	27.74	
Dia (ft)	1.50	
Slope (ft/ft)	0.0360	
Up Invert (ft)	1406.00	
Dn Invert (ft)	1405.00	
Max Q (cfs)	3.98	
Max Vel (ft/s)	7.93	
Max Depth (ft)	0.49	

# CB-5 TO RB-1 (10-YR)

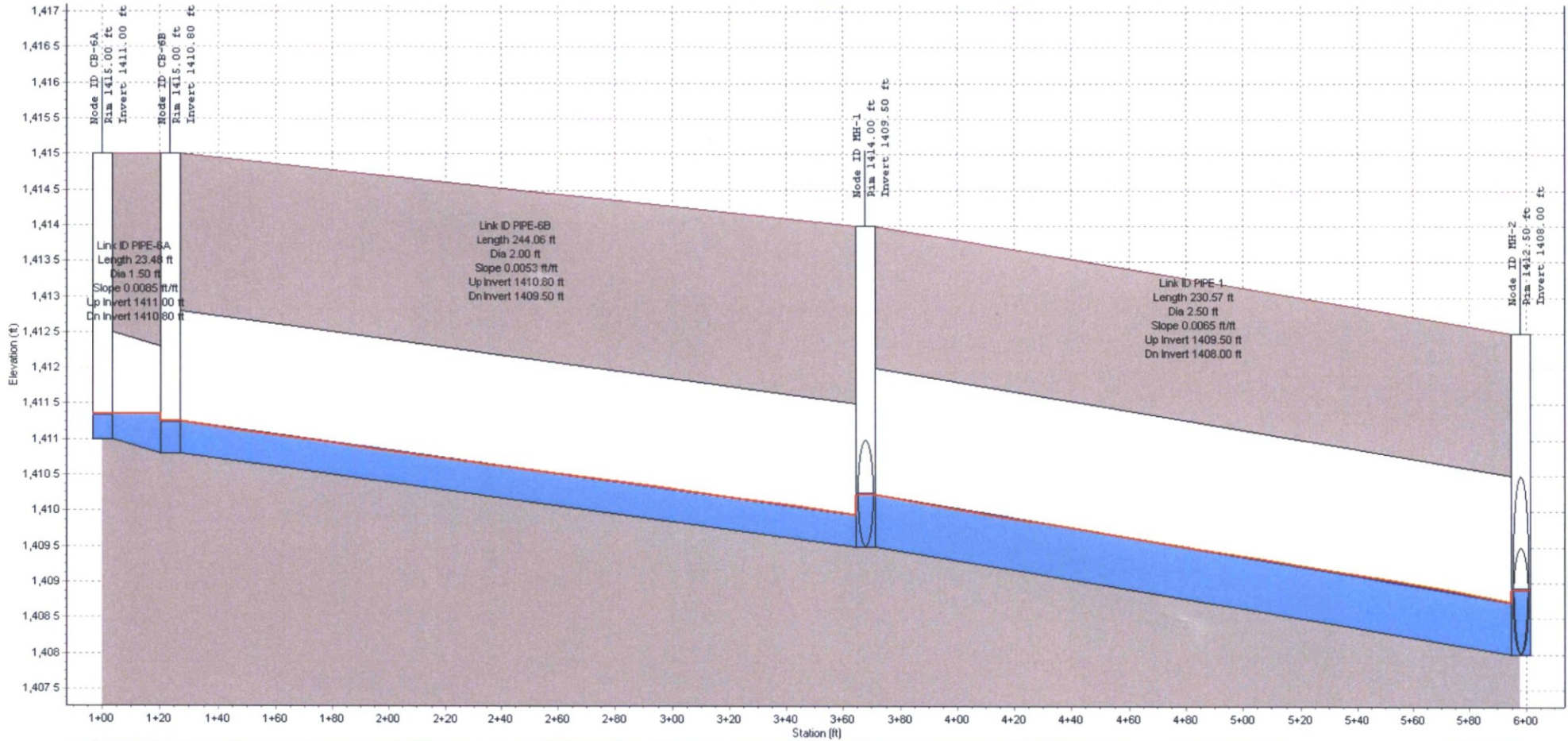
WOLFSPRINGS RANCH



Node ID:	RB-1	HW-5	MH-5	CB-5
Rim (ft)	1407.00	1411.00	1411.00	1409.50
Invert (ft)	1403.50	1403.60	1404.00	1405.50
Min Pipe Cover (ft)		4.40	5.00	2.00
Max HGL (ft)	1404.96	1404.22	1404.64	1406.14
Link ID:	Link-30	PIPE-5A	PIPE-5	
Length (ft)	19.60	22.00	91.00	
Dia (ft)	3.00	2.00	2.00	
Slope (ft/ft)	0.0051	0.0182	0.0165	
Up Invert (ft)	1403.60	1404.00	1405.50	
Dn Invert (ft)	1403.50	1403.60	1404.00	
Max Q (cfs)	6.94	6.92	6.92	
Max Vel (ft/s)	1.28	8.33	8.07	
Max Depth (ft)	0.25	0.62	0.64	

# CB-6A TO MH-2 (10-YR)

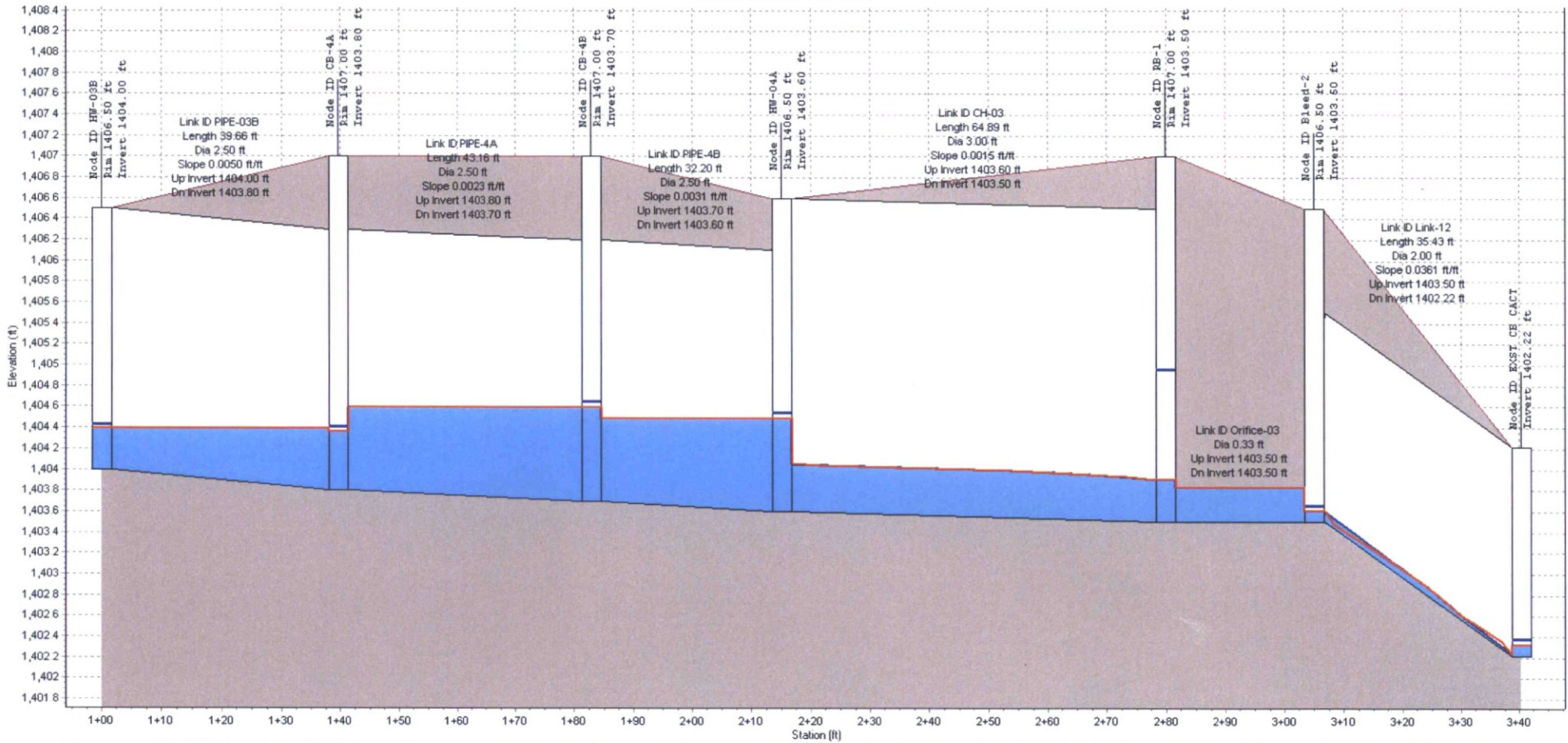
WOLFSPRINGS RANCH



Node ID:	CB-6A	CB-6B		MH-1		MH-2
Rim (ft)	1415.00	1415.00		1414.00		1412.50
Invert (ft)	1411.00	1410.80		1409.50		1408.00
Min Pipe Cover (ft)	2.50	2.20		2.00		2.00
Max HGL (ft)	1411.35	1411.25		1410.24		1408.91
Link ID:	PIPE-6A		PIPE-6B		PIPE-1	
Length (ft)	23.48		244.06		230.57	
Dia (ft)	1.50		2.00		2.50	
Slope (ft/ft)	0.0085		0.0053		0.0065	
Up Invert (ft)	1411.00		1410.80		1409.50	
Dn Invert (ft)	1410.80		1409.50		1408.00	
Max Q (cfs)	0.99		1.95		6.78	
Max Vel (ft/s)	3.19		4.15		5.64	
Max Depth (ft)	0.35		0.45		0.74	

# HW-3B TO EXST CB CACT (10-YR)

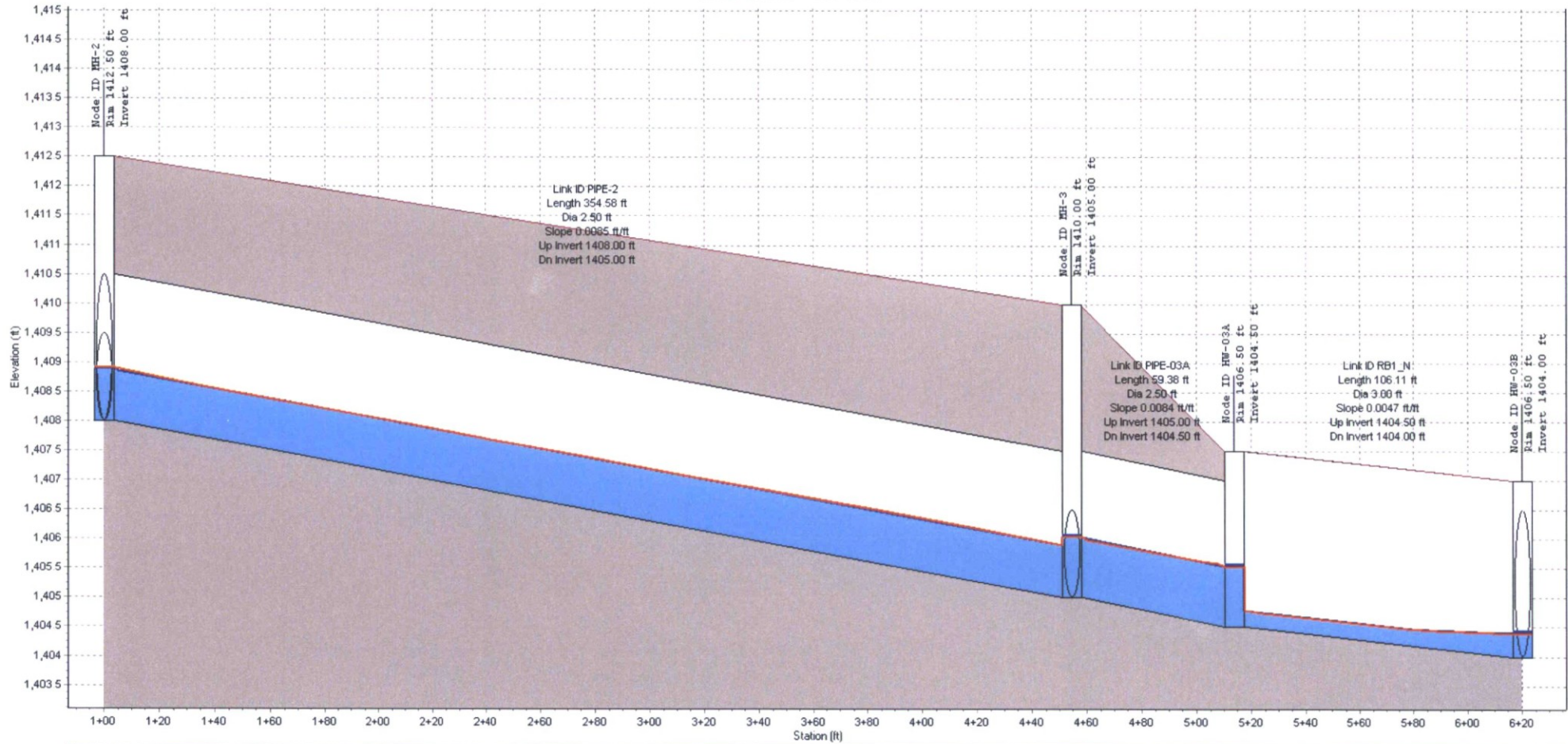
WOLFSPRINGS RANCH



Node ID:	HW-03B	CB-4A	CB-4B	HW-04A	RB-1	Bleed-2	EXST CB CACT
Rim (ft)	1406.50	1407.00	1407.00	1406.50	1407.00	1406.50	
Invert (ft)	1404.00	1403.80	1403.70	1403.60	1403.50	1403.50	1402.22
Min Pipe Cover (ft)	0.00	0.70	0.80	0.00		0.00	
Max HGL (ft)	1404.43	1404.41	1404.65	1404.55	1404.96	1403.66	1402.38
Link ID:	PIPE-03B	PIPE-4A	PIPE-4B	CH-03	Orifice-03	Link-12	
Length (ft)	39.66	43.16	32.20	64.89		35.43	
Dia (ft)	2.50	2.50	2.50	3.00	0.33	2.00	
Slope (ft/ft)	0.0050	0.0023	0.0031	0.0015		0.0361	
Up Invert (ft)	1404.00	1403.80	1403.70	1403.60	1403.50	1403.50	
Dn Invert (ft)	1403.80	1403.70	1403.60	1403.50	1403.50	1402.22	
Max Q (cfs)	15.16	17.39	19.62	19.56	0.49	0.49	
Max Vel (ft/s)	4.40	3.58	5.15	1.52	0.00	4.14	
Max Depth (ft)	0.43	0.61	0.95	0.58	0.00	0.16	

# MH-2 TO HW-3B (10-YR)

WOLFSPRINGS RANCH



Node ID:	MH-2		MH-3	HW-03A	HW-03B
Rim (ft)	1412.50		1410.00	1406.50	1406.50
Invert (ft)	1408.00		1405.00	1404.50	1404.00
Min Pipe Cover (ft)	2.00		2.50	0.00	0.00
Max HGL (ft)	1408.91		1406.06	1405.56	1404.43
Link ID:		PIPE-2		PIPE-03A	RB1_N
Length (ft)		354.58		59.38	106.11
Dia (ft)		2.50		2.50	3.00
Slope (ft/ft)		0.0085		0.0084	0.0047
Up Invert (ft)		1408.00		1405.00	1404.50
Dn Invert (ft)		1405.00		1404.50	1404.00
Max Q (cfs)		11.51		15.27	15.15
Max Vel (ft/s)		7.20		7.70	1.72
Max Depth (ft)		0.91		1.06	0.28

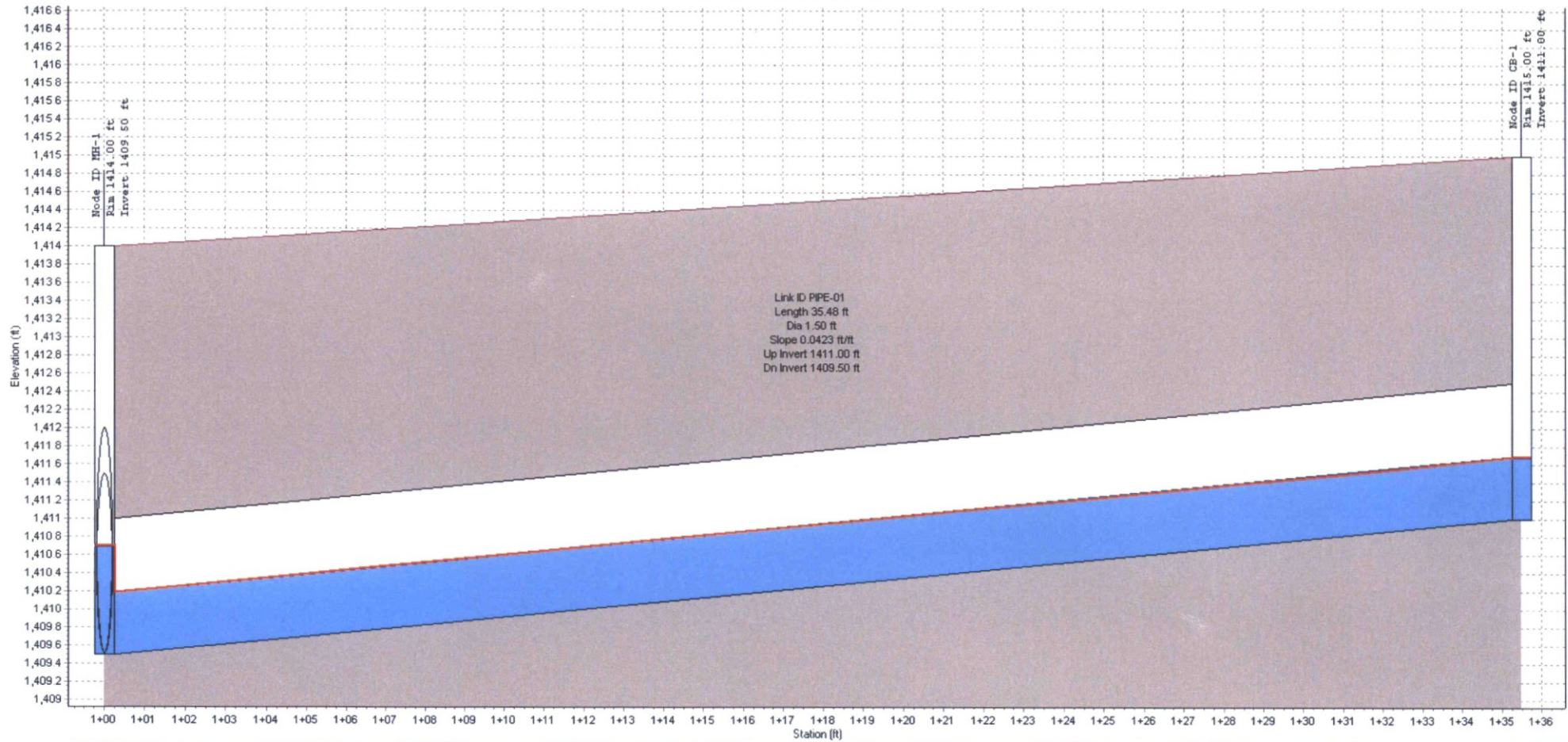
SN	Element Description ID	From (Inlet) Node	To (Outlet) Node	Len	Max Flow / Sign Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged (min)	Max Flow Depth (ft)	Reported Condition
1	CH-03	HW-04A	RB-1	64	0.12	0.31	0.00	0.92	Calculated
2	Link-30	HW-5	RB-1	19	0.03	0.14	0.00	0.43	Calculated
3	RB1_N	HW-03A	HW-03B	106	0.04	0.15	0.00	0.46	Calculated

SN	Element ID	X Coordinate	Y Coordinate	Descnum	Average HGL Elevation Attained
				ard ned (ft)	(ft)
1	Bleed-2	711158.21	944996.66	1.92	1403.69
2	CB-1	711188.84	945972.94	3.31	1411.01
3	CB-2	711199.11	945744.04	3.08	1408.71
4	CB-3	711186.98	945384.74	3.43	1406.01
5	CB-4A	711172.36	945167.77	2.15	1403.82
6	CB-4B	711172.36	945124.62	1.62	1403.73
7	CB-5	711565.75	945132.42	2.95	1405.52
8	CB-6A	711162.18	946224.54	3.17	1411.01
9	CB-6B	711161.69	946201.07	3.33	1410.81
10	HW-03A	711169.74	945324.69	1.23	1404.53
11	HW-03B	711177.34	945207.12	2.26	1404.01
12	HW-04A	711174.05	945092.46	1.32	1403.63
13	HW-5	711521.74	945035.69	3.39	1403.62
14	MH-1	711157.12	945957.05	3.30	1409.52
15	MH-2	711158.90	945726.49	3.04	1408.03
16	MH-3	711162.38	945371.93	3.23	1405.03
17	MH-5	711563.15	945036.55	3.96	1404.02

SN	Element Description ID	From (Inlet) Node	To (Outlet) Node	Design Flow Capacity (cfs)	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Max Flow Depth (ft)	Reported Condition
1	Link-12	Bleed-2	EXST CB CAC	37.27	0.57	0.54	1.08	Calculated
2	PIPE-01	CB-1	MH	23.40	0.43	0.46	0.68	Calculated
3	PIPE-02	CB-2	MH	14.37	0.69	0.61	0.92	Calculated
4	PIPE-03	CB-3	MH	17.28	0.52	0.51	0.77	Calculated
5	PIPE-03A	MH-3	HW-03	40.77	0.85	0.71	1.77	Calculated
6	PIPE-03B	HW-03B	CB-4	147.65	0.23	0.30	0.74	Calculated
7	PIPE-1	MH-1	MH	35.84	0.46	0.48	1.19	Calculated
8	PIPE-2	MH-2	MH	40.87	0.64	0.58	1.45	Calculated
9	PIPE-4A	CB-4A	CB-4	100.08	0.39	0.42	1.05	Calculated
10	PIPE-4B	CB-4B	HW-04	57.94	0.75	0.67	1.68	Calculated
11	PIPE-5	CB-5	MH	31.46	0.54	0.52	1.04	Calculated
12	PIPE-5A	MH-5	HW	33.05	0.51	0.51	1.01	Calculated
13	PIPE-6A	CB-6A	CB-6	8.40	0.59	0.55	0.83	Calculated
14	PIPE-6B	CB-6B	MH	17.89	0.38	0.43	0.86	Calculated

# CB-1 TO MH-1 (100-YR)

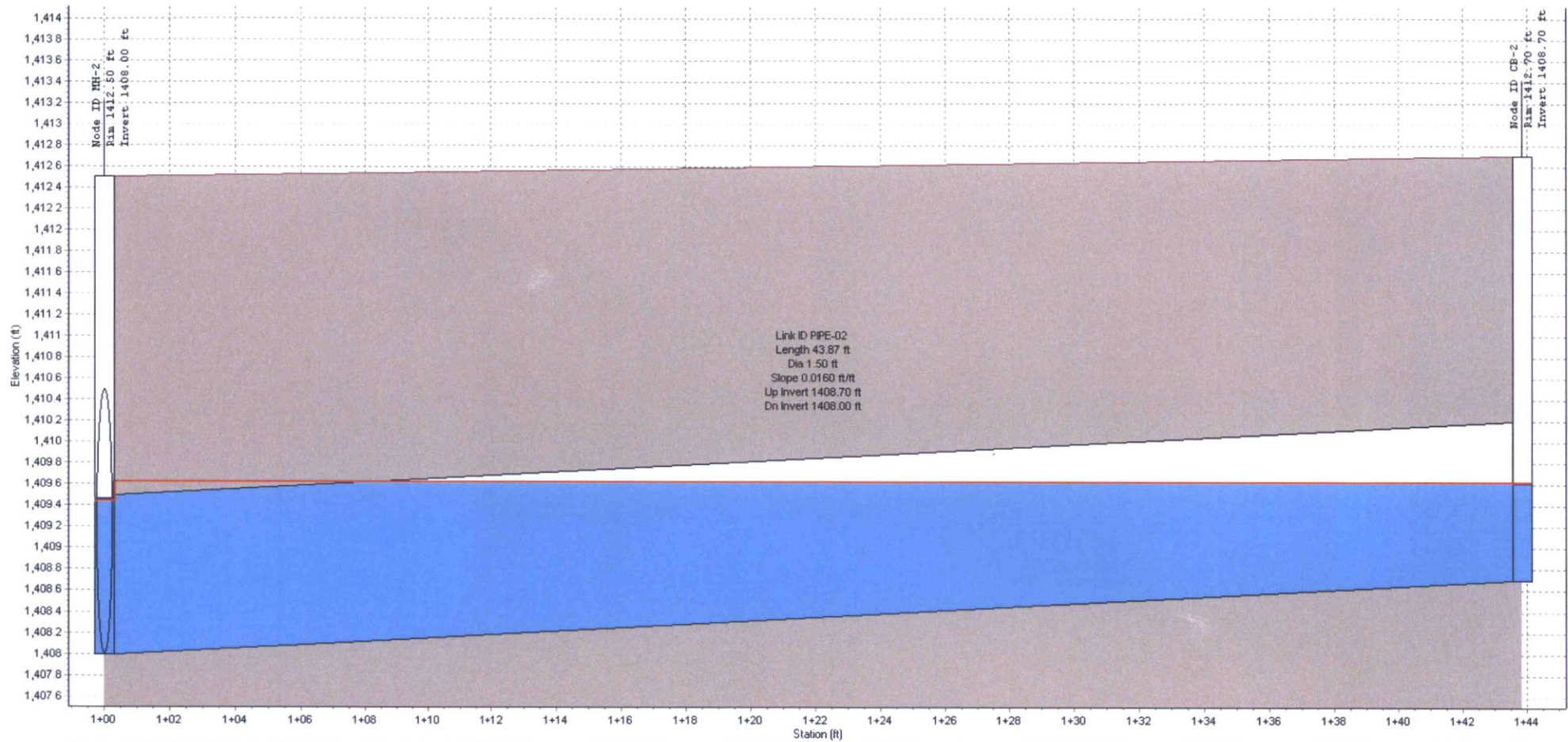
WOLFSPRINGS RANCH



Node ID:	MH-1	CB-1
Rim (ft)	1414.00	1415.00
Invert (ft)	1409.50	1411.00
Min Pipe Cover (ft)	2.00	2.50
Max HGL (ft)	1410.70	1411.69
Link ID:	PIPE-01	
Length (ft)	35.48	
Dia (ft)	1.50	
Slope (ft/ft)	0.0423	
Up Invert (ft)	1411.00	
Dn Invert (ft)	1409.50	
Max Q (cfs)	9.97	
Max Vel (ft/s)	12.69	
Max Depth (ft)	0.68	

# CB-2 TO MH-2 (100-YR)

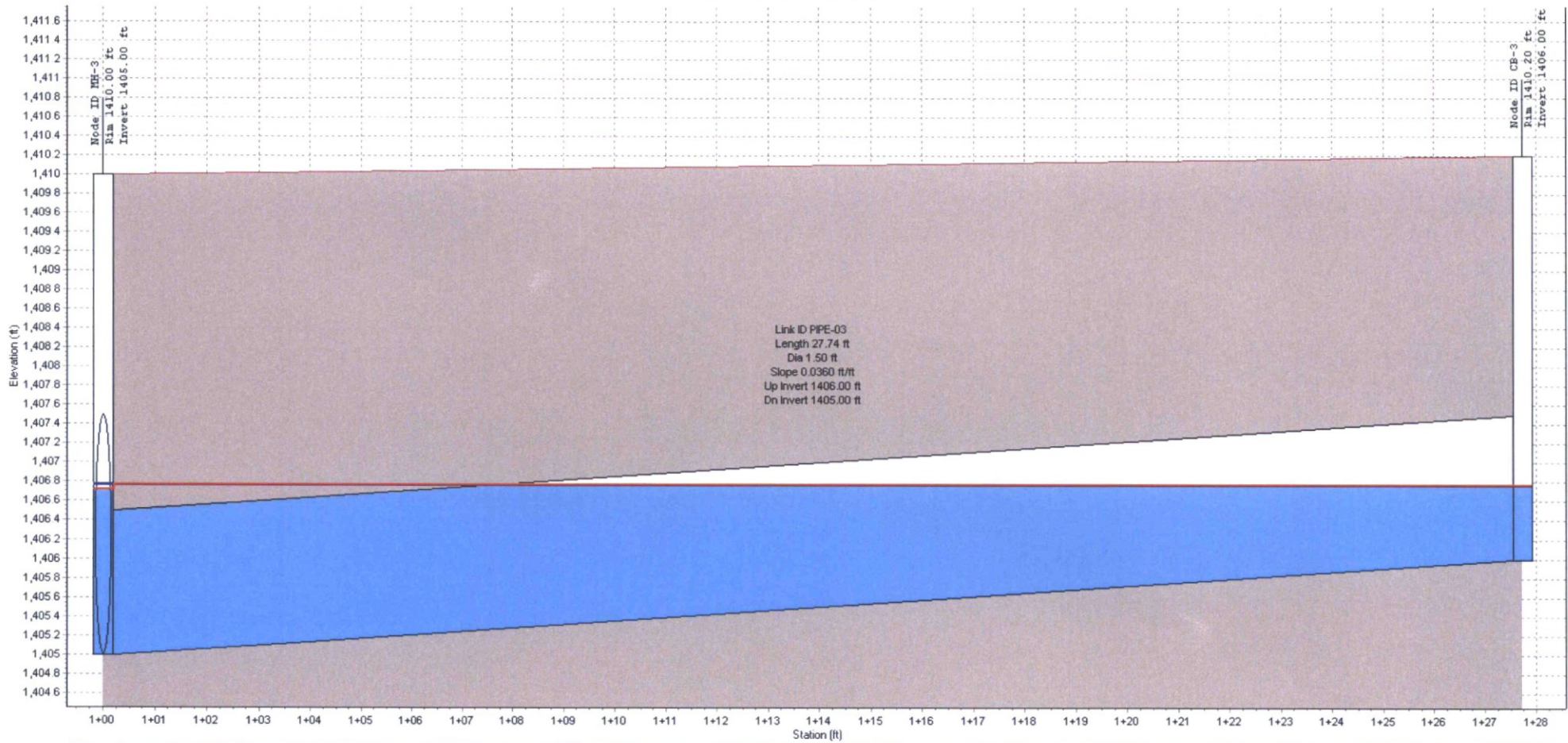
WOLFSPRINGS RANCH



Node ID:	MH-2	CB-2
Rim (ft)	1412.50	1412.70
Invert (ft)	1408.00	1408.70
Min Pipe Cover (ft)	2.00	2.50
Max HGL (ft)	1409.46	1409.62
Link ID:	PIPE-02	
Length (ft)	43.87	
Dia (ft)	1.50	
Slope (ft/ft)	0.0160	
Up Invert (ft)	1408.70	
Dn Invert (ft)	1408.00	
Max Q (cfs)	9.94	
Max Vel (ft/s)	8.78	
Max Depth (ft)	0.92	

# CB-3 TO MH-3 (100-YR)

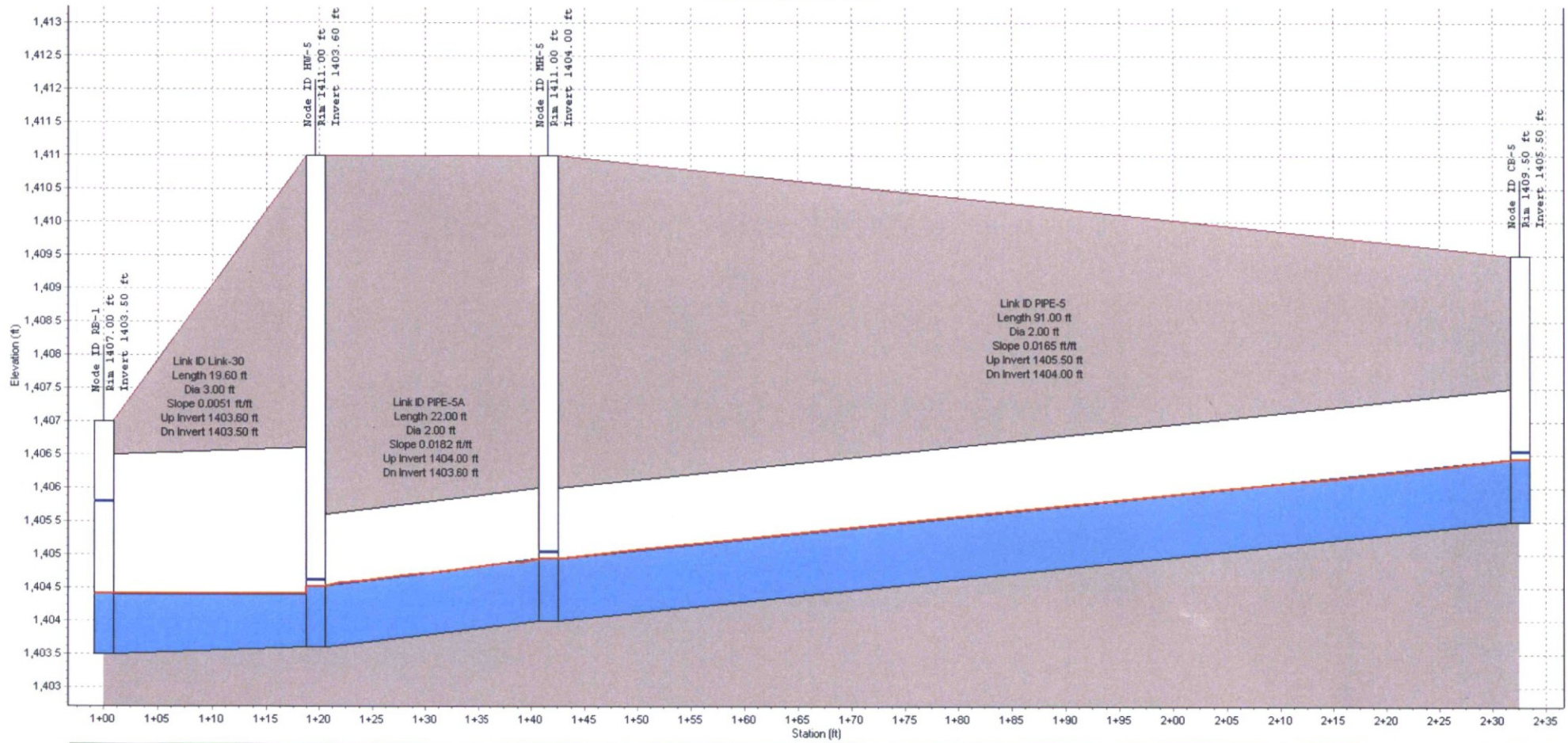
WOLFSPRINGS RANCH



Node ID:	MH-3	CB-3
Rim (ft)	1410.00	1410.20
Invert (ft)	1405.00	1406.00
Min Pipe Cover (ft)	2.50	2.70
Max HGL (ft)	1406.77	1406.77
Link ID:	PIPE-03	
Length (ft)	27.74	
Dia (ft)	1.50	
Slope (ft/ft)	0.0360	
Up Invert (ft)	1406.00	
Dn Invert (ft)	1405.00	
Max Q (cfs)	8.97	
Max Vel (ft/s)	9.86	
Max Depth (ft)	0.77	

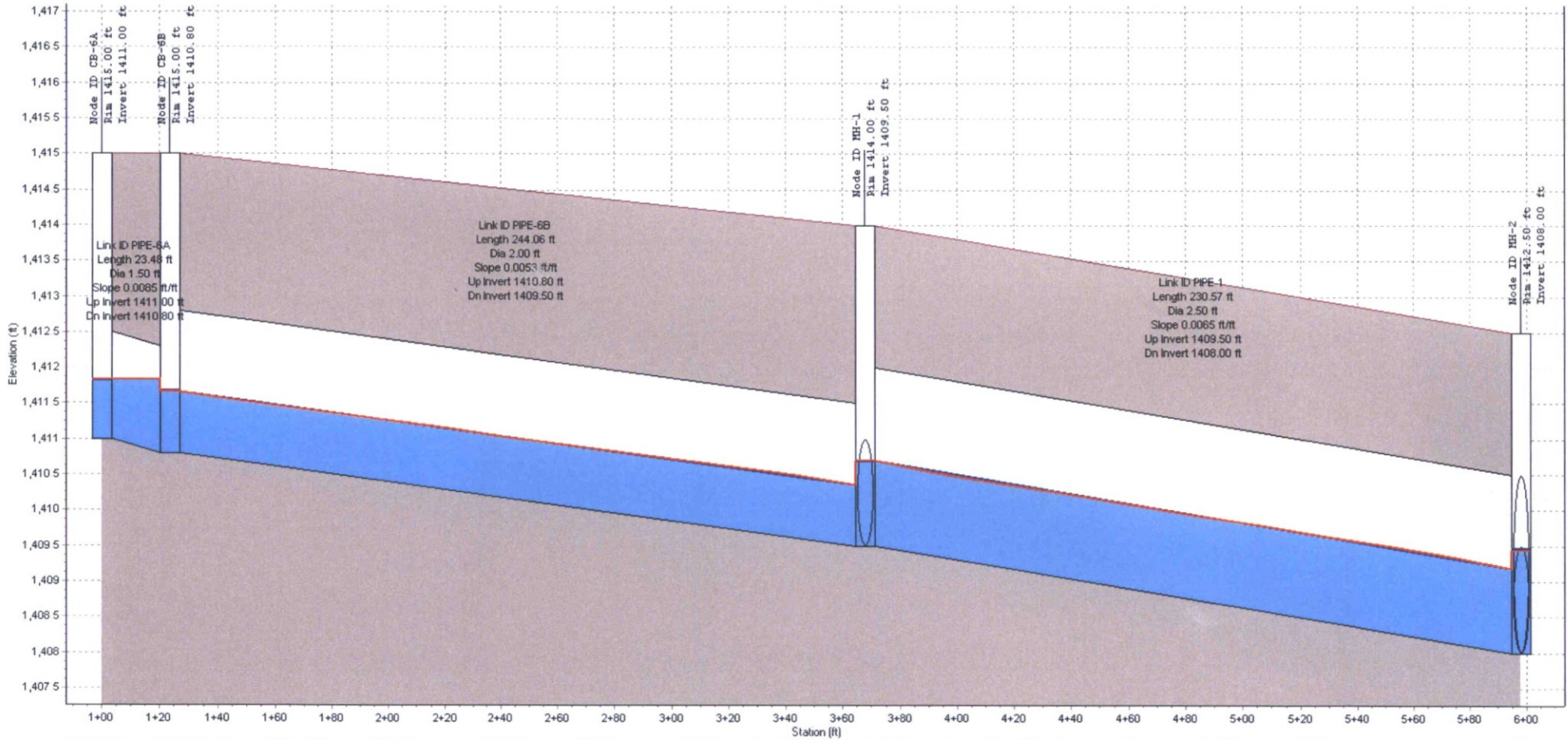
# CB-5 TO RB-1 (100-YR)

WOLFSPRINGS RANCH



Node ID:	RB-1	HW-5	MH-5	CB-5
Rim (ft)	1407.00	1411.00	1411.00	1409.50
Invert (ft)	1403.50	1403.60	1404.00	1405.50
Min Pipe Cover (ft)		4.40	5.00	2.00
Max HGL (ft)	1405.80	1404.61	1405.04	1406.55
Link ID:	Link-30	PIPE-5A	PIPE-5	
Length (ft)	19.60	22.00	91.00	
Dia (ft)	3.00	2.00	2.00	
Slope (ft/ft)	0.0051	0.0182	0.0165	
Up Invert (ft)	1403.60	1404.00	1405.50	
Dn Invert (ft)	1403.50	1403.60	1404.00	
Max Q (cfs)	16.86	16.81	16.84	
Max Vel (ft/s)	1.77	10.56	10.21	
Max Depth (ft)	0.43	1.01	1.04	

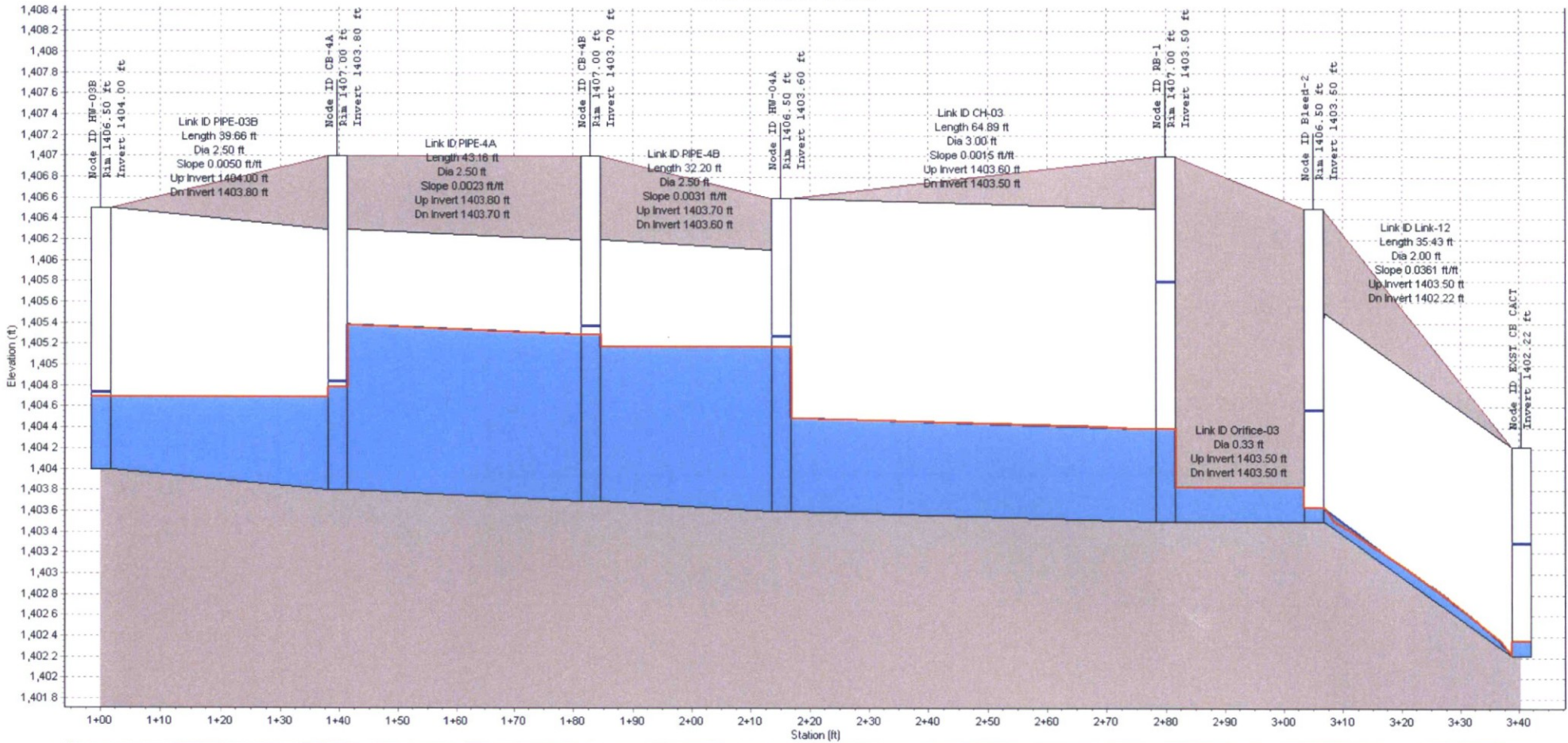
## CB-6A TO MH-2 (100-YR) WOLFSPRINGS RANCH



Node ID:	CB-6A	CB-6B		MH-1		MH-2
Rim (ft)	1415.00	1415.00		1414.00		1412.50
Invert (ft)	1411.00	1410.80		1409.50		1408.00
Min Pipe Cover (ft)	2.50	2.20		2.00		2.00
Max HGL (ft)	1411.83	1411.67		1410.70		1409.46
Link ID:	PIPE-6A		PIPE-6B			PIPE-1
Length (ft)	23.48		244.06			230.57
Dia (ft)	1.50		2.00			2.50
Slope (ft/ft)	0.0085		0.0053			0.0065
Up Invert (ft)	1411.00		1410.80			1409.50
Dn Invert (ft)	1410.80		1409.50			1408.00
Max Q (cfs)	4.97		6.86			16.50
Max Vel (ft/s)	4.95		6.25			7.20
Max Depth (ft)	0.83		0.86			1.19

# HW-3B TO EXST CB CACTUS (100-YR)

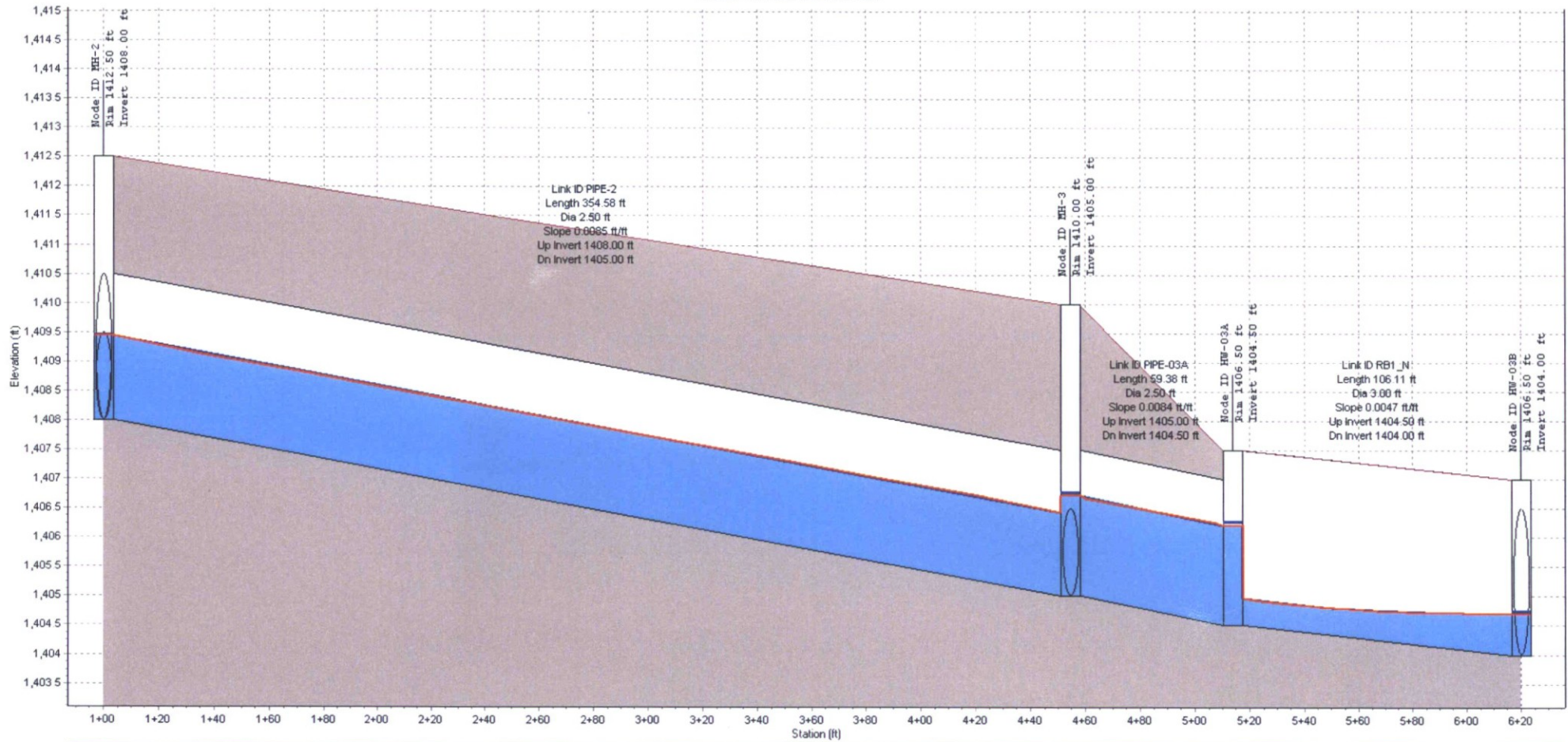
## WOLFSPRINGS RANCH



Node ID:	HW-03B	CB-4A	CB-4B	HW-04A	RB-1	Bleed-2	EXST CB CACT
Rim (ft)	1406.50	1407.00	1407.00	1406.50	1407.00	1406.50	
Invert (ft)	1404.00	1403.80	1403.70	1403.60	1403.50	1403.50	1402.22
Min Pipe Cover (ft)	0.00	0.70	0.80	0.00		0.00	
Max HGL (ft)	1404.74	1404.85	1405.38	1405.28	1405.80	1404.58	1403.30
Link ID:	PIPE-03B	PIPE-4A	PIPE-4B	CH-03	Orifice-03	Link-12	
Length (ft)	39.66	43.16	32.20	64.89		35.43	
Dia (ft)	2.50	2.50	2.50	3.00	0.33	2.00	
Slope (ft/ft)	0.0050	0.0023	0.0031	0.0015		0.0361	
Up Invert (ft)	1404.00	1403.80	1403.70	1403.60	1403.50	1403.50	
Dn Invert (ft)	1403.80	1403.70	1403.60	1403.50	1403.50	1402.22	
Max Q (cfs)	34.40	38.95	43.50	43.39	0.63	21.11	
Max Vel (ft/s)	5.82	4.64	6.49	2.00	0.00	12.23	
Max Depth (ft)	0.74	1.05	1.68	0.92	0.00	1.08	

# MH-2 TO HW-3B (100-YR)

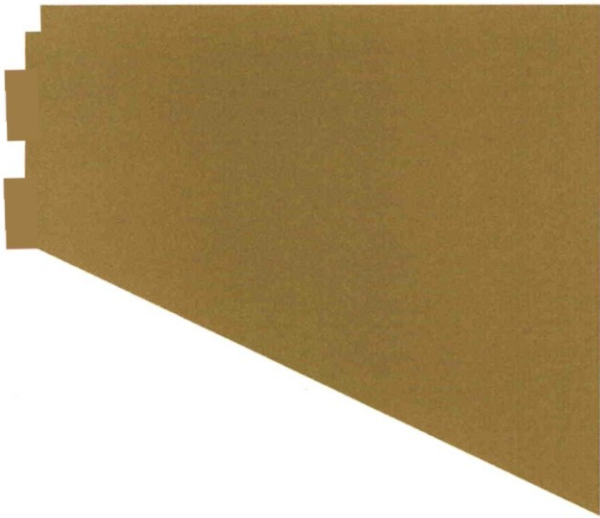
WOLFSPRINGS RANCH



Node ID:	MH-2		MH-3		HW-03A		HW-03B
Rim (ft)	1412.50		1410.00		1406.50		1406.50
Invert (ft)	1408.00		1405.00		1404.50		1404.00
Min Pipe Cover (ft)	2.00		2.50		0.00		0.00
Max HGL (ft)	1409.46		1406.77		1406.27		1404.74
Link ID:		PIPE-2		PIPE-03A		RB1_N	
Length (ft)		354.58		59.38		106.11	
Dia (ft)		2.50		2.50		3.00	
Slope (ft/ft)		0.0085		0.0084		0.0047	
Up Invert (ft)		1408.00		1405.00		1404.50	
Dn Invert (ft)		1405.00		1404.50		1404.00	
Max Q (cfs)		26.10		34.53		34.41	
Max Vel (ft/s)		8.89		9.32		2.33	
Max Depth (ft)		1.45		1.77		0.46	

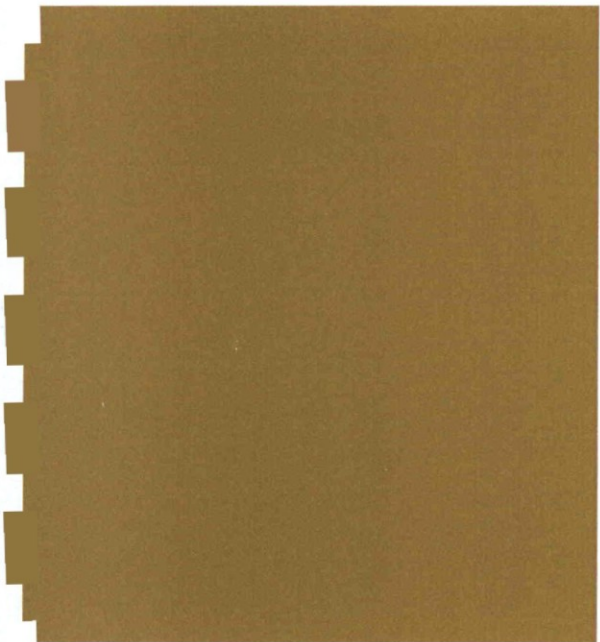


## Appendix C: Stormwater Retention



Required Volume

Drywell Calculations



## Weighted C Calculations

$C_{\text{Landscaping}}$	$C_{\text{lots}}$	$C_{\text{paved}}$	P (100-Yr, 2-hr) (in)
0.30	0.64	0.95	2.256

Drainage Area Number	Total Area	Total Area	Landscaping/ Basin Area	Lot Area	Paving Area	Weighted C
DA-1	111986	2.57	9398	80644	21944	0.67
DA-2	202693	4.65	37423	111922	53348	0.66
DA-3	123540	2.84	21753	81799	19988	0.63
DA-4	115654	2.66	26206	70182	19266	0.61
DA-5	146580	3.37	69661	54727	22192	0.53
DA-LARK	33719	0.77	7762	0	25957	0.80

**Total**

734172  
16.9

172203

399274

162695

**0.63**  
PROJECT WEIGHTED C

**0.53**  
PRE-PROJECT C

## Wolf Springs Ranch Required Retention Volume

P (100-Yr, 2-hr) (in) <sup>1</sup> =	2.256
Existing Condition 100-yr C value	0.53
Prop Cond Weighted 100-yr C value	0.63

FIRST FLUSH VOLUME VS. DIFFERENTIAL C VOLUME						
DRAINAGE AREA	TOTAL AREA (AC)	WEIGHTED C <sup>2</sup>	FIRST FLUSH VOLUME (AC-FT)	FIRST FLUSH VOLUME (FT <sup>3</sup> )	DIFFERENTIAL C VOLUME (AC-FT) <sup>3</sup>	DIFFERENTIAL C VOLUME (FT <sup>3</sup> )
DA-1	2.57	0.67	<b>0.11</b>	<b>4666</b>	0.05	2105
DA-2	4.65	0.66	<b>0.19</b>	<b>8446</b>	0.09	3811
DA-3	2.84	0.63	<b>0.12</b>	<b>5148</b>	0.05	2323
DA-4	2.66	0.61	<b>0.11</b>	<b>4819</b>	0.05	2174
DA-5	3.37	0.53	<b>0.14</b>	<b>6108</b>	0.06	2756
DA-LARK	0.77	0.80	<b>0.03</b>	<b>1405</b>	0.01	634
Total <sup>2</sup>			<b>0.70</b>	<b>30591</b>	0.32	13802

Notes: 1. Point 100-yr, 2-Hr rainfall depth per NOAA14 (FCDMC).

2. Weighted C based upon proportion of lotting, paving, and landscaping in each subbasin.

3. 100-year volume based on City of Scottsdale redevelopment policy where volume is based upon the difference in C values for post-development vs pre-development.

4. Based upon comparison of the first-flush volume and the pre-vs-post "C" volume, the first flush will be provided on the Site because it is greater.

# Wolf Springs Ranch Provided Retention Volume

## Provided Volume - Stage-Storage

Retention Basin 1

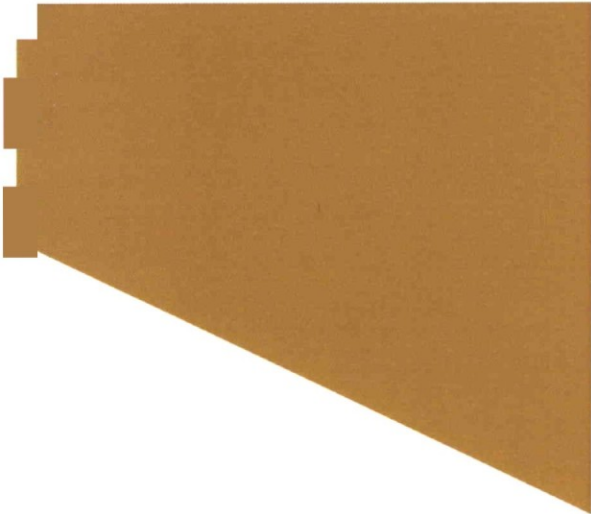
Elevation	Area	Incremental Vol	Cumulative Vol	Cumulative Vol	Depth
ft	ft <sup>2</sup>	ac-ft	ac-ft	ft <sup>3</sup>	
1403.5	17992				0
1404.5	25161	0.495	0.50	21577	1
1405.5	32732	0.665	1.16	50523	2
1406.5	40729	0.843	2.00	87254	3

Notes: 1. At the weir crest elevation of 1405.1, the basin stores **38,944 cu-ft**. The required first-flush volume is **30,591 cu-ft**.



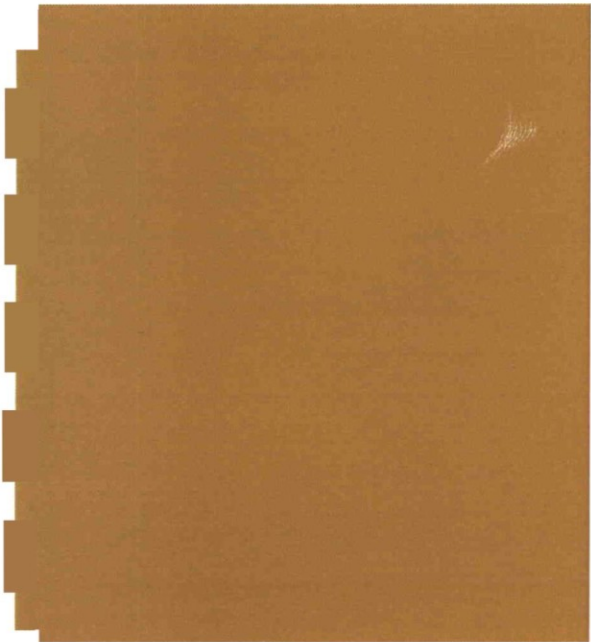


## Appendix D: 93<sup>rd</sup> Street Normal Depth Calculations



93<sup>rd</sup> Street Justification Letter  
Email communication from City of Scottsdale

*Sections A-A through H-H:*  
Existing Condition 10-year Normal depth  
Proposed Condition 10-year Normal depth  
Existing Condition 100-year Normal depth  
Proposed Condition 100-year Normal depth





June 26, 2018

Ashley Couch  
Drainage and Flood Control Program Manager  
City of Scottsdale  
3939 North Drinkwater Blvd.  
Scottsdale, AZ 85251

**Re: Wolf Springs Ranch  
Letter of Justification  
Scottsdale, AZ**

Dear Ashley,

Slater Hanifan (SHG) has been in contact with City staff to discuss the drainage condition of 93<sup>rd</sup> Street as it relates to the proposed Wolf Springs Ranch development. The purpose of this letter is to formalize the results of the discussions SHG has had with the City that deal specifically with the offsite drainage on 93<sup>rd</sup> Street. Specifically, this letter discusses the existing condition offsite flow that enters the 93<sup>rd</sup> Street corridor and flows along the west side of the Site. The existing condition of 93<sup>rd</sup> Street is a partially paved-on-grade roadway with no curb and gutter for a majority of its length from Larkspur to Cactus Road. The existing corridor conveys the offsite 100-year flow of 170 cfs at a depth that exceeds normal City standards of 8-inches or less. Therefore, the existing 93<sup>rd</sup> Street does not meet the City's 100-year flow depth requirement.

The proposed development of Wolf Springs Ranch accommodates onsite drainage per City guidelines including stormwater storage, interception and conveyance, freeboard to adjacent 100-year flow elevations, as well as bleed-off to the existing stormdrain in Cactus Road. The Site is designed to fully capture the onsite flows and route them to the retention basin at the SW corner of the Site. The basin stores the first-flush, while the freeboard in the basin provides enough attenuation to reduce the peak 10 and 100-year discharges such that post development peak discharges are less than the existing condition peak discharges before draining into the Cactus Road system. The first-flush storage bleeds off into the existing Cactus Road stormdrain system. In addition, flows offsite to the project have been demonstrated to be conveyed within the surrounding streets and do not enter the Site; nor do onsite flows intermingle with offsite flows other than the reduced peaks discharging at the Site outfall.

The proposed development is to improve the east half of 93<sup>rd</sup> Street as part of the overall improvements. Moreover, the improvements would reduce the 100-year flow depth in 93<sup>rd</sup>. The east half of the street is to include a typical cross-slope, with curb and gutter, and attached sidewalk. Based on these provisions, as well as supporting hydraulic calculations, the proposed condition of 93<sup>rd</sup> Street has been demonstrated to convey the 170 cfs at a depth that is slightly less than the existing condition, but in some cases still exceeds the typical 8-inch depth requirement.

At the City's request, SHG conducted a test model to see what size of underground piping system would be needed to intercept and convey enough flow to reduce the depth to 8-inches. This would require approximately 100 cfs be intercepted from the roadway and conveyed underground. The stormdrain needed would be on the order of 48-inches in diameter. It does not seem feasible to connect to the existing Cactus Road stormdrain because based upon as-built documents for the Cactus Road system the existing stormdrain is a 48-inch diameter pipe and is assumed to have negligible excess capacity; certainly not enough for an additional 100-cfs. The City also

asked SHG to test connecting a new 48-inch system to the existing catch basin on the west side of 93<sup>rd</sup> Street. This was modeled and does not work based on the limited capacity of the 18-inch pipe connection to the catch basin. This option would also cause the inlets of the new system to surcharge, negating the intent of the stormdrain. Therefore, we concluded that the ultimate solution for this conceptual stormdrain needs to be autonomous; one that provides full conveyance to the south side of Cactus Road without connection to existing systems. The crossing of Cactus Road alone, with a new separate 48-inch stormdrain system, has significant horizontal and vertical challenges with respect to the existing utilities within Cactus.

The traffic impact analysis (TIA) done for Wolf Springs Ranch demonstrates that there is no increase in traffic on 93<sup>rd</sup> street as a result of the project. We understand that at least a part of the 8-inch flow depth requirement is in support of traffic safety. Based on the reduction in flow depth as a result of the proposed half-street improvements, we maintain that the proposed condition is an improvement upon the existing condition and that the improvements would not worsen the situation from a traffic safety standpoint.

The development of Wolf Springs Ranch does not contribute to or worsen the existing 100-year flow depth within 93<sup>rd</sup> Street. While we understand the importance of a long-term drainage solution, we do not believe it is the burden of this project to provide that solution. Therefore, we respectfully ask that the proposed development of Wolf Springs Ranch be released from the 8-inch depth requirement in 93<sup>rd</sup> Street.

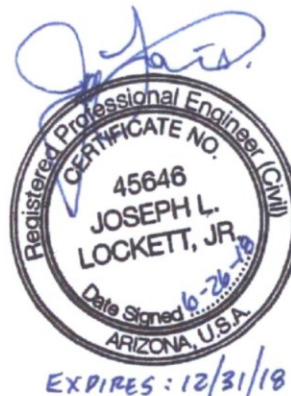
Please contact me at 602-753-4946 with any questions regarding this letter.

Sincerely,

**Slater Hanifan Group, Inc.**



Joe L. Lockett Jr., P.E., CFM  
Slater Hanifan Group, Inc.



Cc: Ms. Shelby Duplessis – The Empire Group

## Joe Lockett

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**From:** Couch, Ashley <ACouch@ScottsdaleAz.Gov>  
**Sent:** Monday, June 25, 2018 5:16 PM  
**To:** Joe Lockett  
**Cc:** Jack Moody; Niederer, Keith; Kercher, Phillip; Anderson, Richard; Rahman, Mohammad  
**Subject:** Wolf Springs Ranch

Stormwater Review Manager Rich Anderson and I have reviewed your draft letter dated June 7, 2018, requesting that the city not require the developer of Wolf Springs Ranch to construct a 48-inch storm drain in 93<sup>rd</sup> Street in order to reduce the off-site longitudinal surface flow to a maximum depth of 8 inches. The City of Scottsdale agrees with this request based on the justification you made in your letter, and based on the fact that flows will exceed this maximum depth of 8 inches only very rarely, and only for brief periods of time. Therefore, the impacts to mobility in 93<sup>rd</sup> Street are expected to be minimal and are no worse than the current condition.

Please include a copy of this signed letter in the final drainage report. Please also include it in the case drainage report, if you plan to resubmit the case drainage report. If not, we will stipulate that you include the letter in the final drainage report.

We trust that you are satisfied with the city's response to your letter. Please let us know if we may be of additional assistance.

Best regards,

C. Ashley Couch, P.E., CFM  
Drainage and Flood Control Program Manager  
Floodplain Administrator  
City of Scottsdale, Arizona  
(480) 312-4317 (phone)  
acouch@scottsdaleaz.gov  
Stormwater Management  
7447 E. Indian School Road, Suite 125  
Scottsdale, AZ 85251

## Worksheet for Section A - Exst Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope                              0.00390    ft/ft  
 Discharge                                      54.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68.00	1415.44
0+93.00	1415.44
1+00.00	1415.52
1+05.00	1415.56
1+12.40	1415.27
1+16.00	1415.20
1+24.70	1416.47

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68.00, 1415.44)	(0+93.00, 1415.44)	0.025
(0+93.00, 1415.44)	(1+05.00, 1415.56)	0.015
(1+05.00, 1415.56)	(1+24.70, 1416.47)	0.045

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth                                      0.78    ft  
 Elevation Range                              1415.20 to 1416.47 ft  
 Flow Area    27.97    ft<sup>2</sup>  
 Wetted Perimeter                                      53.92    ft

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## Worksheet for Section A - Exst Cond - 10-yr

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### Results

Hydraulic Radius	0.52	ft
Top Width	53.32	ft
Normal Depth	0.78	ft
Critical Depth	0.56	ft
Critical Slope	0.02061	ft/ft
Velocity	1.93	ft/s
Velocity Head	0.06	ft
Specific Energy	0.83	ft
Froude Number	0.47	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.78	ft
Critical Depth	0.56	ft
Channel Slope	0.00390	ft/ft
Critical Slope	0.02061	ft/ft

## Cross Section for Section A - Exst Cond - 10-yr

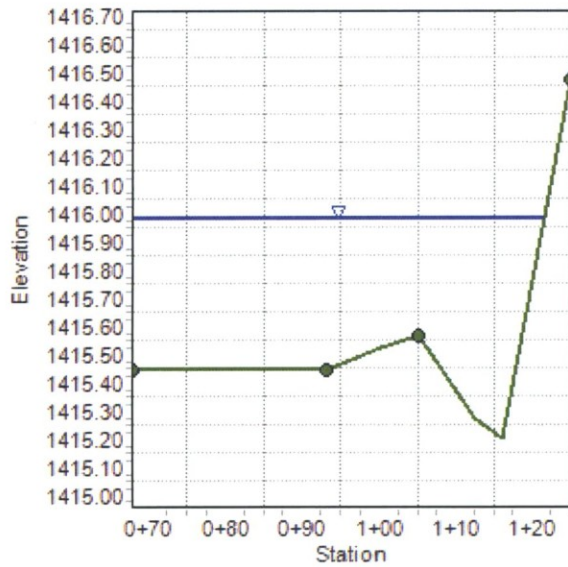
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope    0.00390    ft/ft  
Normal Depth    0.78        ft  
Discharge    54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section A - Prop Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00390    ft/ft  
 Discharge    54.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68.00	1415.44
0+93.00	1415.44
1+00.00	1415.52
1+19.25	1415.12
1+19.86	1415.09
1+20.40	1415.59
1+22.81	1415.63
1+27.68	1415.59
1+35.38	1415.59
1+39.75	1415.62
1+50.46	1416.68

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68.00, 1415.44)	(1+00.00, 1415.52)	0.025
(1+00.00, 1415.52)	(1+19.25, 1415.12)	0.015
(1+19.25, 1415.12)	(1+27.68, 1415.59)	0.013
(1+27.68, 1415.59)	(1+50.46, 1416.68)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

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## Worksheet for Section A - Prop Cond - 10-yr

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### Results

Normal Depth		0.75	ft
Elevation Range	1415.09 to 1416.68	ft	
Flow Area		28.39	ft <sup>2</sup>
Wetted Perimeter		74.63	ft
Hydraulic Radius		0.38	ft
Top Width		74.01	ft
Normal Depth		0.75	ft
Critical Depth		0.62	ft
Critical Slope		0.01516	ft/ft
Velocity		1.90	ft/s
Velocity Head		0.06	ft
Specific Energy		0.81	ft
Froude Number		0.54	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.75	ft
Critical Depth	0.62	ft
Channel Slope	0.00390	ft/ft
Critical Slope	0.01516	ft/ft

## Cross Section for Section A - Prop Cond - 10-yr

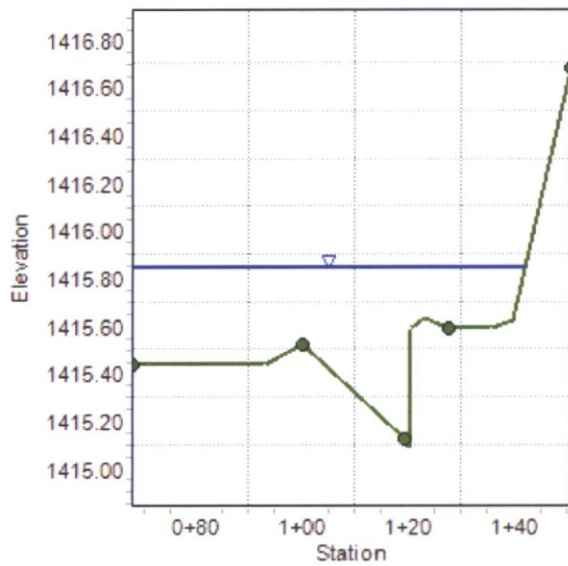
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope    0.00390    ft/ft  
Normal Depth    0.75        ft  
Discharge    54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section A - Exst Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00390    ft/ft  
 Discharge    171.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68.00	1415.44
0+93.00	1415.44
1+00.00	1415.52
1+05.00	1415.56
1+12.40	1415.27
1+16.00	1415.20
1+24.70	1416.47

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68.00, 1415.44)	(0+93.00, 1415.44)	0.025
(0+93.00, 1415.44)	(1+05.00, 1415.56)	0.015
(1+05.00, 1415.56)	(1+24.70, 1416.47)	0.045

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    1.33    ft  
 Elevation Range    1415.20 to 1416.47 ft  
 Flow Area    58.52    ft<sup>2</sup>  
 Wetted Perimeter    57.95    ft

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## Worksheet for Section A - Exst Cond - 100-yr

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### Results

Hydraulic Radius	1.01	ft
Top Width	56.70	ft
Normal Depth	1.33	ft
Critical Depth	0.94	ft
Critical Slope	0.01730	ft/ft
Velocity	2.92	ft/s
Velocity Head	0.13	ft
Specific Energy	1.46	ft
Froude Number	0.51	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.33	ft
Critical Depth	0.94	ft
Channel Slope	0.00390	ft/ft
Critical Slope	0.01730	ft/ft

## Cross Section for Section A - Exst Cond - 100-yr

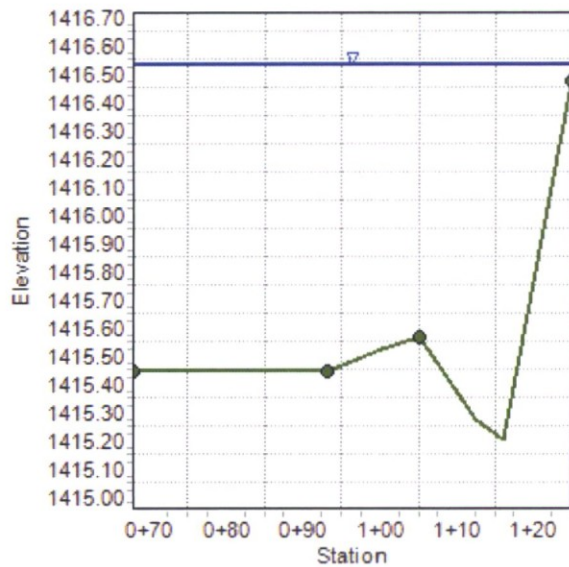
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00390    ft/ft  
Normal Depth                            1.33        ft  
Discharge                                171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section A - Prop Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00390    ft/ft  
 Discharge    171.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68.00	1415.44
0+93.00	1415.44
1+00.00	1415.52
1+19.25	1415.12
1+19.86	1415.09
1+20.40	1415.59
1+22.81	1415.63
1+27.68	1415.59
1+35.38	1415.59
1+39.75	1415.62
1+50.46	1416.68

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68.00, 1415.44)	(0+93.00, 1415.44)	0.025
(0+93.00, 1415.44)	(1+19.25, 1415.12)	0.015
(1+19.25, 1415.12)	(1+27.68, 1415.59)	0.013
(1+27.68, 1415.59)	(1+50.46, 1416.68)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

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## Worksheet for Section A - Prop Cond - 100-yr

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### Results

Normal Depth		1.15	ft
Elevation Range	1415.09 to 1416.68	ft	
Flow Area		58.34	ft <sup>2</sup>
Wetted Perimeter		79.02	ft
Hydraulic Radius		0.74	ft
Top Width		77.99	ft
Normal Depth		1.15	ft
Critical Depth		0.92	ft
Critical Slope		0.01212	ft/ft
Velocity		2.93	ft/s
Velocity Head		0.13	ft
Specific Energy		1.28	ft
Froude Number		0.60	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.15	ft
Critical Depth	0.92	ft
Channel Slope	0.00390	ft/ft
Critical Slope	0.01212	ft/ft

## Cross Section for Section A - Prop Cond - 100-yr

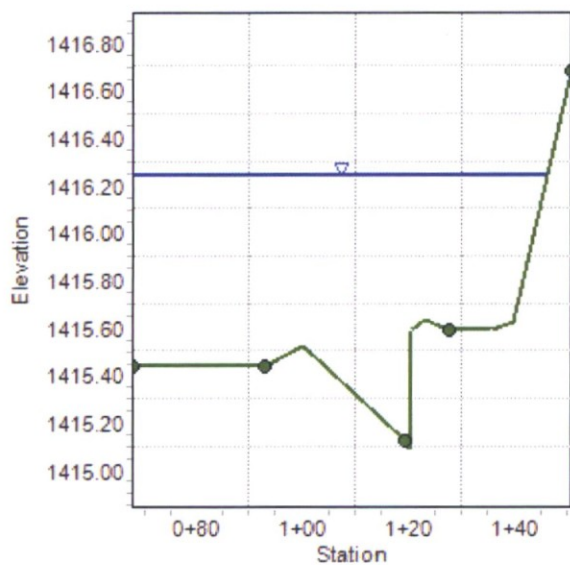
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                              0.00390    ft/ft  
Normal Depth                                1.15        ft  
Discharge                                    171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section B-B - Exst Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00850    ft/ft  
 Discharge    54.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+67.00	1413.62
0+93.50	1413.63
1+00.00	1413.80
1+05.00	1413.94
1+16.00	1414.10
1+16.30	1414.00
1+25.00	1414.17
1+40.00	1414.47
1+65.00	1414.50

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+67.00, 1413.62)	(0+93.50, 1413.63)	0.030
(0+93.50, 1413.63)	(1+16.30, 1414.00)	0.015
(1+16.30, 1414.00)	(1+65.00, 1414.50)	0.045

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    0.56    ft  
 Elevation Range    1413.62 to 1414.50 ft

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## Worksheet for Section B-B - Exst Cond - 10-yr

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### Results

Flow Area	21.82	ft <sup>2</sup>
Wetted Perimeter	59.00	ft
Hydraulic Radius	0.37	ft
Top Width	58.42	ft
Normal Depth	0.56	ft
Critical Depth	0.47	ft
Critical Slope	0.01758	ft/ft
Velocity	2.48	ft/s
Velocity Head	0.10	ft
Specific Energy	0.65	ft
Froude Number	0.71	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.56	ft
Critical Depth	0.47	ft
Channel Slope	0.00850	ft/ft
Critical Slope	0.01758	ft/ft

## Cross Section for Section B-B - Exst Cond - 10-yr

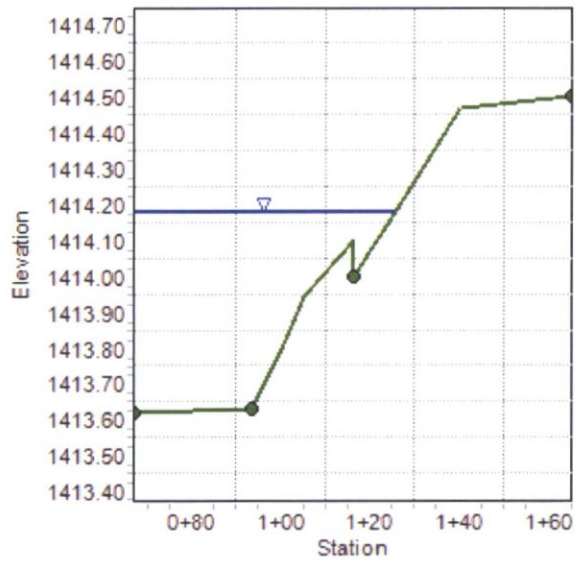
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope    0.00850    ft/ft  
Normal Depth    0.56        ft  
Discharge    54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section B-B - Prop Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00790    ft/ft  
 Discharge    54.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+67.00	1413.62
0+93.50	1413.63
1+00.00	1413.80
1+17.00	1413.45
1+18.50	1413.40
1+18.50	1413.90
1+19.00	1413.90
1+25.00	1413.90
1+40.00	1413.83
1+65.00	1415.11

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+67.00, 1413.62)	(0+93.50, 1413.63)	0.030
(0+93.50, 1413.63)	(1+17.00, 1413.45)	0.015
(1+17.00, 1413.45)	(1+25.00, 1413.90)	0.013
(1+25.00, 1413.90)	(1+65.00, 1415.11)	0.040

### Options

Current Roughness weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

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## Worksheet for Section B-B - Prop Cond - 10-yr

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### Results

Normal Depth		0.64	ft
Elevation Range	1413.40 to 1415.11	ft	
Flow Area		24.69	ft <sup>2</sup>
Wetted Perimeter		77.94	ft
Hydraulic Radius		0.32	ft
Top Width		77.01	ft
Normal Depth		0.64	ft
Critical Depth		0.56	ft
Critical Slope		0.01846	ft/ft
Velocity		2.19	ft/s
Velocity Head		0.07	ft
Specific Energy		0.71	ft
Froude Number		0.68	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.64	ft
Critical Depth	0.56	ft
Channel Slope	0.00790	ft/ft
Critical Slope	0.01846	ft/ft

## Cross Section for Section B-B - Prop Cond - 10-yr

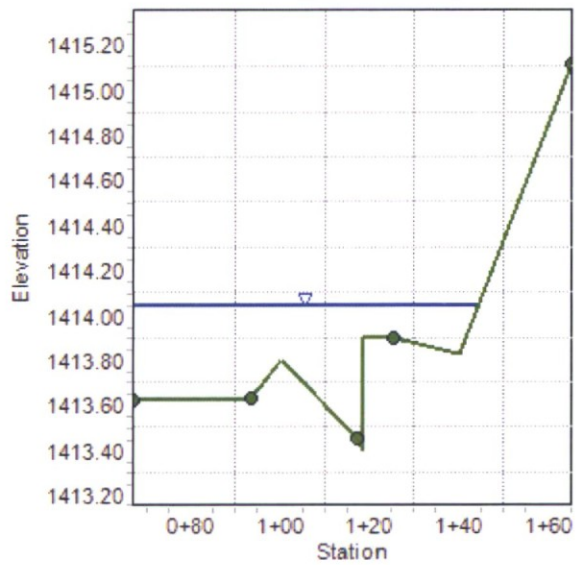
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00790    ft/ft  
Normal Depth                            0.64        ft  
Discharge                                54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section B-B - Exst Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00850    ft/ft  
 Discharge    171.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+67.00	1413.62
0+93.50	1413.63
1+00.00	1413.80
1+05.00	1413.94
1+16.00	1414.10
1+16.30	1414.00
1+25.00	1414.17
1+40.00	1414.47
1+65.00	1414.50

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+67.00, 1413.62)	(0+93.50, 1413.63)	0.030
(0+93.50, 1413.63)	(1+16.30, 1414.00)	0.015
(1+16.30, 1414.00)	(1+65.00, 1414.50)	0.045

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    1.07    ft  
 Elevation Range    1413.62 to 1414.50 ft

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## Worksheet for Section B-B - Exst Cond - 100-yr

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### Results

Flow Area	61.74	ft <sup>2</sup>
Wetted Perimeter	99.28	ft
Hydraulic Radius	0.62	ft
Top Width	98.00	ft
Normal Depth	1.07	ft
Critical Depth	0.89	ft
Critical Slope	0.02491	ft/ft
Velocity	2.77	ft/s
Velocity Head	0.12	ft
Specific Energy	1.18	ft
Froude Number	0.62	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.07	ft
Critical Depth	0.89	ft
Channel Slope	0.00850	ft/ft
Critical Slope	0.02491	ft/ft

## Cross Section for Section B-B - Exst Cond - 100-yr

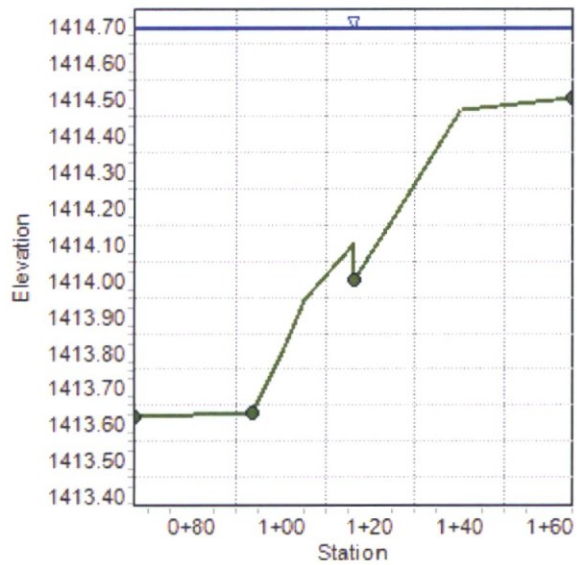
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00850    ft/ft  
Normal Depth                            1.07        ft  
Discharge                                171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section B-B - Prop Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00790    ft/ft  
 Discharge    171.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+67.00	1413.62
0+93.50	1413.63
1+00.00	1413.80
1+17.00	1413.45
1+18.50	1413.40
1+18.50	1413.90
1+19.00	1413.90
1+25.00	1413.90
1+40.00	1413.83
1+65.00	1415.11

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+67.00, 1413.62)	(0+93.50, 1413.63)	0.030
(0+93.50, 1413.63)	(1+17.00, 1413.45)	0.015
(1+17.00, 1413.45)	(1+25.00, 1413.90)	0.013
(1+25.00, 1413.90)	(1+65.00, 1415.11)	0.040

### Options

Current Roughness weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

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## Worksheet for Section B-B - Prop Cond - 100-yr

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### Results

Normal Depth		0.98	ft
Elevation Range	1413.40 to 1415.11	ft	
Flow Area		52.26	ft <sup>2</sup>
Wetted Perimeter		84.99	ft
Hydraulic Radius		0.61	ft
Top Width		83.71	ft
Normal Depth		0.98	ft
Critical Depth		0.85	ft
Critical Slope		0.01577	ft/ft
Velocity		3.27	ft/s
Velocity Head		0.17	ft
Specific Energy		1.14	ft
Froude Number		0.73	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.98	ft
Critical Depth	0.85	ft
Channel Slope	0.00790	ft/ft
Critical Slope	0.01577	ft/ft

## Cross Section for Section B-B - Prop Cond - 100-yr

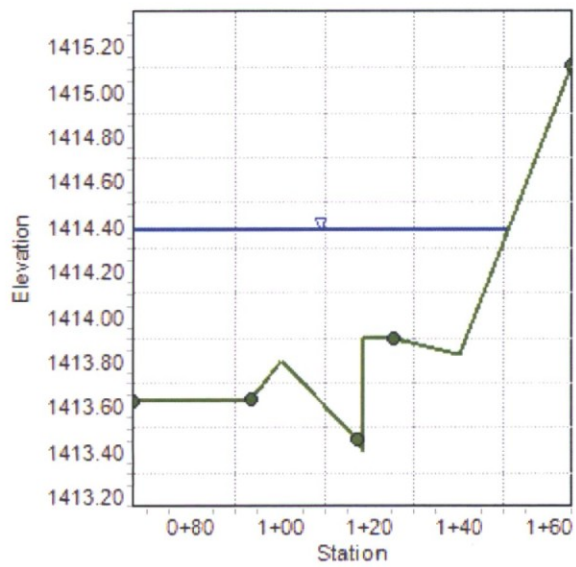
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope    0.00790    ft/ft  
Normal Depth    0.98        ft  
Discharge    171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section C-C - Exst Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00970    ft/ft  
 Discharge    54.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1411.75
0+92	1411.75
1+00	1411.81
1+16	1411.93
1+20	1411.04
1+23	1411.44
1+38	1411.96
1+54	1412.99
1+56	1413.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1411.75)	(0+92, 1411.75)	0.030
(0+92, 1411.75)	(1+16, 1411.93)	0.015
(1+16, 1411.93)	(1+56, 1413.00)	0.045

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    1.04    ft  
 Elevation Range    1411.04 to 1413.00 ft

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## Worksheet for Section C-C - Exst Cond - 10-yr

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### Results

Flow Area	24.56	ft <sup>2</sup>
Wetted Perimeter	71.92	ft
Hydraulic Radius	0.34	ft
Top Width	71.46	ft
Normal Depth	1.04	ft
Critical Depth	0.96	ft
Critical Slope	0.02416	ft/ft
Velocity	2.20	ft/s
Velocity Head	0.08	ft
Specific Energy	1.12	ft
Froude Number	0.66	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.04	ft
Critical Depth	0.96	ft
Channel Slope	0.00970	ft/ft
Critical Slope	0.02416	ft/ft





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## Worksheet for Section C-C - Prop Cond - 10-yr

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### Results

Normal Depth		0.64	ft
Elevation Range	1411.41 to 1414.60		ft
Flow Area		18.09	ft <sup>2</sup>
Wetted Perimeter		58.07	ft
Hydraulic Radius		0.31	ft
Top Width		57.56	ft
Normal Depth		0.64	ft
Critical Depth		0.63	ft
Critical Slope		0.01127	ft/ft
Velocity		2.98	ft/s
Velocity Head		0.14	ft
Specific Energy		0.78	ft
Froude Number		0.94	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.64	ft
Critical Depth	0.63	ft
Channel Slope	0.00980	ft/ft
Critical Slope	0.01127	ft/ft

## Cross Section for Section C-C - Prop Cond - 10-yr

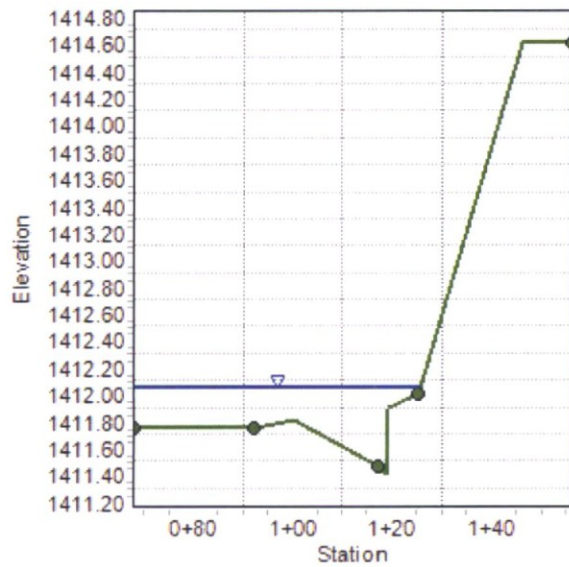
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope    0.00980    ft/ft  
Normal Depth    0.64        ft  
Discharge    54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section C-C - Exst Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00970    ft/ft  
 Discharge    171.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1411.75
0+92	1411.75
1+00	1411.81
1+16	1411.93
1+20	1411.04
1+23	1411.44
1+38	1411.96
1+54	1412.99
1+56	1413.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1411.75)	(0+92, 1411.75)	0.030
(0+92, 1411.75)	(1+16, 1411.93)	0.015
(1+16, 1411.93)	(1+56, 1413.00)	0.045

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    1.41    ft  
 Elevation Range    1411.04 to 1413.00 ft

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## Worksheet for Section C-C - Exst Cond - 100-yr

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### Results

Flow Area	51.69	ft <sup>2</sup>
Wetted Perimeter	78.14	ft
Hydraulic Radius	0.66	ft
Top Width	77.30	ft
Normal Depth	1.41	ft
Critical Depth	1.26	ft
Critical Slope	0.02038	ft/ft
Velocity	3.31	ft/s
Velocity Head	0.17	ft
Specific Energy	1.58	ft
Froude Number	0.71	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.41	ft
Critical Depth	1.26	ft
Channel Slope	0.00970	ft/ft
Critical Slope	0.02038	ft/ft



## Worksheet for Section C-C - Prop Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00980    ft/ft  
 Discharge    171.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1411.75
0+92	1411.75
1+00	1411.81
1+17	1411.47
1+19	1411.41
1+19	1411.90
1+25	1412.00
1+26	1412.09
1+46	1414.60
1+56	1414.60

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1411.75)	(0+92, 1411.75)	0.030
(0+92, 1411.75)	(1+17, 1411.47)	0.015
(1+17, 1411.47)	(1+25, 1412.00)	0.013
(1+25, 1412.00)	(1+56, 1414.60)	0.040

### Options

Current Roughness weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

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## Worksheet for Section C-C - Prop Cond - 100-yr

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### Results

Normal Depth		0.98	ft
Elevation Range	1411.41 to 1414.60		ft
Flow Area		38.00	ft <sup>2</sup>
Wetted Perimeter		61.24	ft
Hydraulic Radius		0.62	ft
Top Width		60.37	ft
Normal Depth		0.98	ft
Critical Depth		0.98	ft
Critical Slope		0.00980	ft/ft
Velocity		4.50	ft/s
Velocity Head		0.31	ft
Specific Energy		1.29	ft
Froude Number		1.00	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.98	ft
Critical Depth	0.98	ft
Channel Slope	0.00980	ft/ft
Critical Slope	0.00980	ft/ft

## Cross Section for Section C-C - Prop Cond - 100-yr

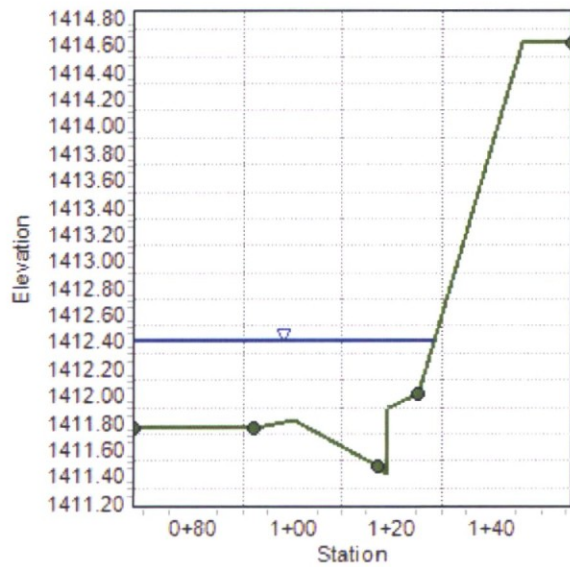
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00980    ft/ft  
Normal Depth                            0.98        ft  
Discharge                                171.00    ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section D-D - Exst Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00210    ft/ft  
 Discharge    54.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1410.62
0+90	1410.62
0+90	1410.66
1+00	1410.79
1+13	1411.01
1+21	1410.44
1+33	1411.96
1+43	1412.08

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1410.62)	(0+90, 1410.62)	0.030
(0+90, 1410.62)	(1+13, 1411.01)	0.015
(1+13, 1411.01)	(1+43, 1412.08)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    0.86    ft  
 Elevation Range    1410.44 to 1412.08 ft  
 Flow Area    33.48    ft<sup>2</sup>

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## Worksheet for Section D-D - Exst Cond - 10-yr

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### Results

Wetted Perimeter	60.36	ft
Hydraulic Radius	0.55	ft
Top Width	59.60	ft
Normal Depth	0.86	ft
Critical Depth	0.59	ft
Critical Slope	0.01784	ft/ft
Velocity	1.61	ft/s
Velocity Head	0.04	ft
Specific Energy	0.90	ft
Froude Number	0.38	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.86	ft
Critical Depth	0.59	ft
Channel Slope	0.00210	ft/ft
Critical Slope	0.01784	ft/ft

## Cross Section for Section D-D - Exst Cond - 10-yr

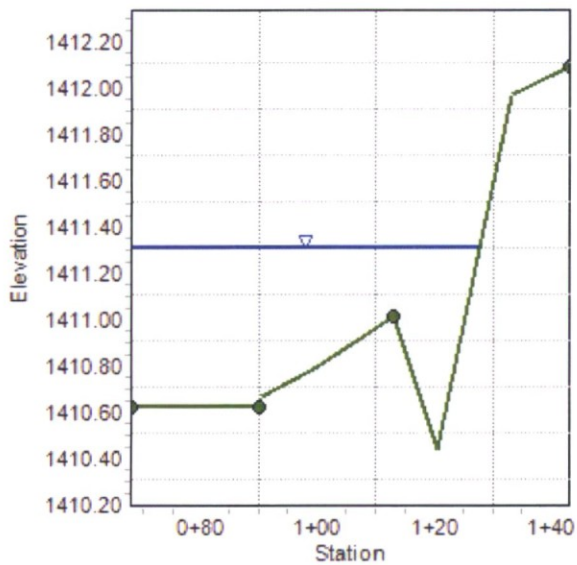
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope    0.00210    ft/ft  
Normal Depth    0.86        ft  
Discharge    54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section D-D - Prop Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00210    ft/ft  
 Discharge    54.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1410.62
0+90	1410.62
0+90	1410.66
1+00	1410.79
1+17	1410.42
1+19	1410.36
1+19	1410.86
1+25	1410.95
1+45	1412.30

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1410.62)	(0+90, 1410.62)	0.030
(0+90, 1410.62)	(1+17, 1410.42)	0.015
(1+17, 1410.42)	(1+25, 1410.95)	0.013
(1+25, 1410.95)	(1+45, 1412.30)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    0.81    ft

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## Worksheet for Section D-D - Prop Cond - 10-yr

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### Results

Elevation Range	1410.36 to 1412.30 ft	
Flow Area	29.80	ft <sup>2</sup>
Wetted Perimeter	61.09	ft
Hydraulic Radius	0.49	ft
Top Width	60.31	ft
Normal Depth	0.81	ft
Critical Depth	0.60	ft
Critical Slope	0.01190	ft/ft
Velocity	1.81	ft/s
Velocity Head	0.05	ft
Specific Energy	0.86	ft
Froude Number	0.45	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.81	ft
Critical Depth	0.60	ft
Channel Slope	0.00210	ft/ft
Critical Slope	0.01190	ft/ft

## Cross Section for Section D-D - Prop Cond - 10-yr

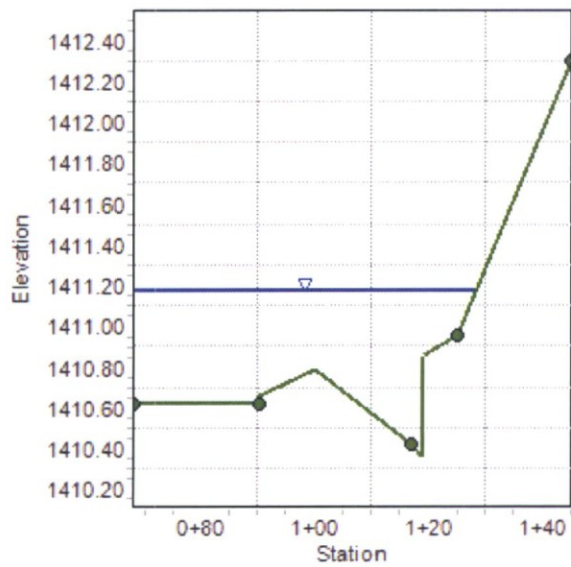
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope    0.00210    ft/ft  
Normal Depth    0.81        ft  
Discharge    54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section D-D - Exst Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope                              0.00210    ft/ft  
 Discharge                                    171.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1410.62
0+90	1410.62
0+90	1410.66
1+00	1410.79
1+13	1411.01
1+21	1410.44
1+33	1411.96
1+43	1412.08

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1410.62)	(0+90, 1410.62)	0.030
(0+90, 1410.62)	(1+13, 1411.01)	0.015
(1+13, 1411.01)	(1+43, 1412.08)	0.040

### Options

Current Roughness weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    1.46    ft  
 Elevation Range                                      1410.44 to 1412.08 ft  
 Flow Area    70.77    ft<sup>2</sup>

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## Worksheet for Section D-D - Exst Cond - 100-yr

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### Results

Wetted Perimeter	65.94	ft
Hydraulic Radius	1.07	ft
Top Width	64.54	ft
Normal Depth	1.46	ft
Critical Depth	0.94	ft
Critical Slope	0.01512	ft/ft
Velocity	2.42	ft/s
Velocity Head	0.09	ft
Specific Energy	1.55	ft
Froude Number	0.41	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.46	ft
Critical Depth	0.94	ft
Channel Slope	0.00210	ft/ft
Critical Slope	0.01512	ft/ft



## Worksheet for Section D-D - Prop Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00210    ft/ft  
 Discharge    171.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1410.62
0+90	1410.62
0+90	1410.66
1+00	1410.79
1+17	1410.42
1+19	1410.36
1+19	1410.86
1+25	1410.95
1+45	1412.30

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1410.62)	(0+90, 1410.62)	0.030
(0+90, 1410.62)	(1+17, 1410.42)	0.015
(1+17, 1410.42)	(1+25, 1410.95)	0.013
(1+25, 1410.95)	(1+45, 1412.30)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    1.39    ft

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## Worksheet for Section D-D - Prop Cond - 100-yr

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### Results

Elevation Range	1410.36 to 1412.30 ft	
Flow Area	67.17	ft <sup>2</sup>
Wetted Perimeter	70.26	ft
Hydraulic Radius	0.96	ft
Top Width	68.89	ft
Normal Depth	1.39	ft
Critical Depth	0.95	ft
Critical Slope	0.01177	ft/ft
Velocity	2.55	ft/s
Velocity Head	0.10	ft
Specific Energy	1.49	ft
Froude Number	0.45	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.39	ft
Critical Depth	0.95	ft
Channel Slope	0.00210	ft/ft
Critical Slope	0.01177	ft/ft

## Cross Section for Section D-D - Prop Cond - 100-yr

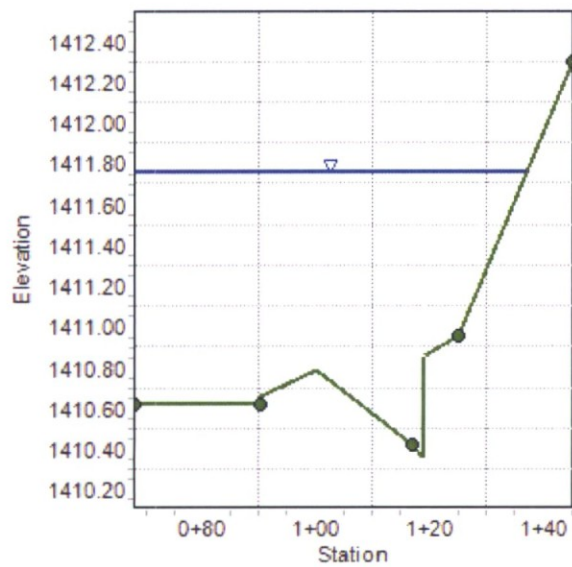
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00210    ft/ft  
Normal Depth                            1.39        ft  
Discharge                                171.00    ft<sup>3</sup>/s

### Cross Section Image





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## Worksheet for Section E-E - Exst Cond - 10-yr

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### Results

Elevation Range	1409.50 to 1410.50 ft	
Flow Area	23.92	ft <sup>2</sup>
Wetted Perimeter	63.91	ft
Hydraulic Radius	0.37	ft
Top Width	63.54	ft
Normal Depth	0.85	ft
Critical Depth	0.75	ft
Critical Slope	0.01512	ft/ft
Velocity	2.26	ft/s
Velocity Head	0.08	ft
Specific Energy	0.93	ft
Froude Number	0.65	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.85	ft
Critical Depth	0.75	ft
Channel Slope	0.00580	ft/ft
Critical Slope	0.01512	ft/ft

## Cross Section for Section E-E - Exst Cond - 10-yr

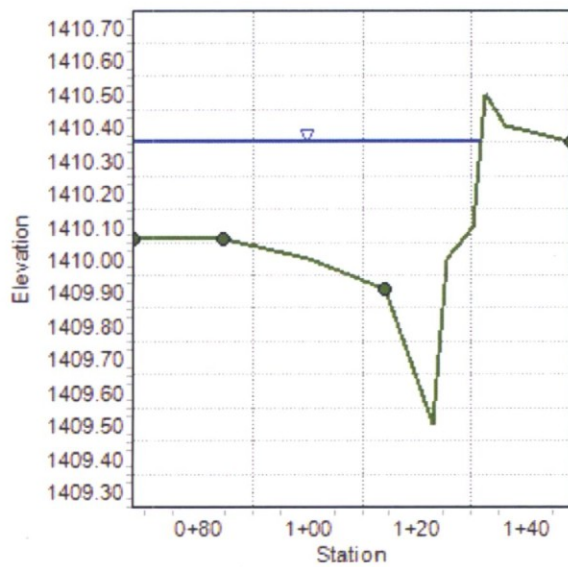
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00580    ft/ft  
Normal Depth                            0.85        ft  
Discharge                                54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section E-E - Prop Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00850    ft/ft  
 Discharge    54.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1410.06
0+85	1410.06
1+00	1410.00
1+17	1409.63
1+19	1409.60
1+19	1410.06
1+25	1410.15
1+48	1411.12

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1410.06)	(0+85, 1410.06)	0.030
(0+85, 1410.06)	(1+17, 1409.63)	0.015
(1+17, 1409.63)	(1+25, 1410.15)	0.013
(1+25, 1410.15)	(1+48, 1411.12)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    0.70    ft  
 Elevation Range    1409.60 to 1411.12 ft

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## Worksheet for Section E-E - Prop Cond - 10-yr

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### Results

Flow Area	18.87	ft <sup>2</sup>
Wetted Perimeter	60.89	ft
Hydraulic Radius	0.31	ft
Top Width	60.47	ft
Normal Depth	0.70	ft
Critical Depth	0.67	ft
Critical Slope	0.01066	ft/ft
Velocity	2.86	ft/s
Velocity Head	0.13	ft
Specific Energy	0.82	ft
Froude Number	0.90	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.70	ft
Critical Depth	0.67	ft
Channel Slope	0.00850	ft/ft
Critical Slope	0.01066	ft/ft

## Cross Section for Section E-E - Prop Cond - 10-yr

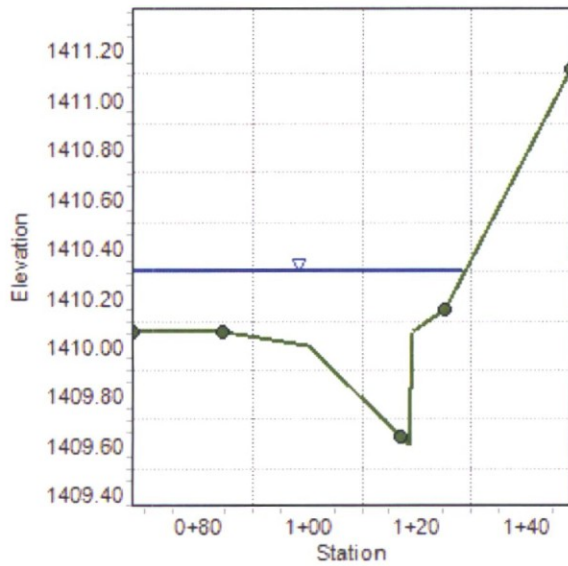
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00850    ft/ft  
Normal Depth                            0.70        ft  
Discharge                                54.00      ft<sup>3</sup>/s

### Cross Section Image





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## Worksheet for Section E-E - Exst Cond - 100-yr

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### Results

Elevation Range	1409.50 to 1410.50 ft	
Flow Area	55.10	ft <sup>2</sup>
Wetted Perimeter	81.18	ft
Hydraulic Radius	0.68	ft
Top Width	80.00	ft
Normal Depth	1.25	ft
Critical Depth	1.08	ft
Critical Slope	0.01455	ft/ft
Velocity	3.10	ft/s
Velocity Head	0.15	ft
Specific Energy	1.40	ft
Froude Number	0.66	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.25	ft
Critical Depth	1.08	ft
Channel Slope	0.00580	ft/ft
Critical Slope	0.01455	ft/ft



## Worksheet for Section E-E - Prop Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00850    ft/ft  
 Discharge    171.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1410.06
0+85	1410.06
1+00	1410.00
1+17	1409.63
1+19	1409.60
1+19	1410.06
1+25	1410.15
1+48	1411.12

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1410.06)	(0+85, 1410.06)	0.030
(0+85, 1410.06)	(1+17, 1409.63)	0.015
(1+17, 1409.63)	(1+25, 1410.15)	0.013
(1+25, 1410.15)	(1+48, 1411.12)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    1.07    ft  
 Elevation Range    1409.60 to 1411.12 ft

---

## Worksheet for Section E-E - Prop Cond - 100-yr

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### Results

Flow Area	43.15	ft <sup>2</sup>
Wetted Perimeter	70.15	ft
Hydraulic Radius	0.62	ft
Top Width	69.34	ft
Normal Depth	1.07	ft
Critical Depth	1.02	ft
Critical Slope	0.01108	ft/ft
Velocity	3.96	ft/s
Velocity Head	0.24	ft
Specific Energy	1.31	ft
Froude Number	0.89	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.07	ft
Critical Depth	1.02	ft
Channel Slope	0.00850	ft/ft
Critical Slope	0.01108	ft/ft

## Cross Section for Section E-E - Prop Cond - 100-yr

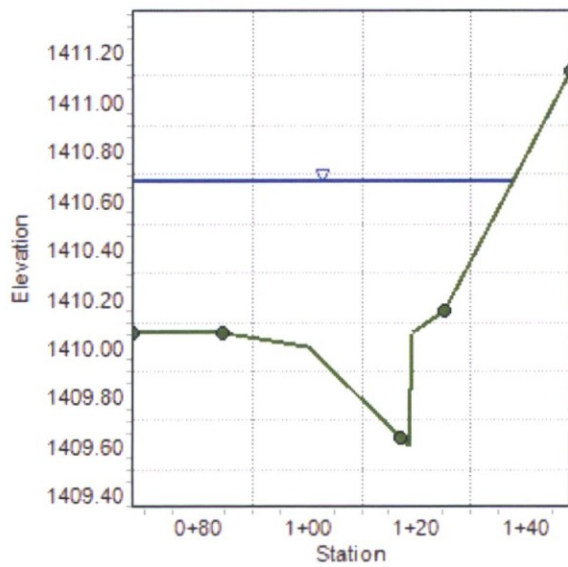
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00850    ft/ft  
Normal Depth                            1.07        ft  
Discharge                                171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section F-F - Exst Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00870    ft/ft  
 Discharge    54.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1407.68
0+83	1407.70
1+00	1408.40
1+17	1408.90
1+25	1409.40

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1407.68)	(0+83, 1407.70)	0.030
(0+83, 1407.70)	(1+17, 1408.90)	0.015
(1+17, 1408.90)	(1+25, 1409.40)	0.025

### Options

Current Roughness weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    0.67    ft  
 Elevation Range    1407.68 to 1409.40 ft  
 Flow Area    15.08    ft²  
 Wetted Perimeter    31.51    ft  
 Hydraulic Radius    0.48    ft  
 Top Width    30.82    ft

---

## Worksheet for Section F-F - Exst Cond - 10-yr

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### Results

Normal Depth	0.67	ft
Critical Depth	0.63	ft
Critical Slope	0.01084	ft/ft
Velocity	3.58	ft/s
Velocity Head	0.20	ft
Specific Energy	0.87	ft
Froude Number	0.90	
Flow Type	Subcritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.67	ft
Critical Depth	0.63	ft
Channel Slope	0.00870	ft/ft
Critical Slope	0.01084	ft/ft



## Worksheet for Section F-F - Prop Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.02460    ft/ft  
 Discharge    54.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1407.70
0+83	1407.70
1+00	1408.40
1+17	1408.10
1+19	1408.00
1+19	1408.50
1+23	1408.55
1+25	1408.63

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1407.70)	(0+83, 1407.70)	0.030
(0+83, 1407.70)	(1+17, 1408.10)	0.015
(1+17, 1408.10)	(1+23, 1408.55)	0.013
(1+23, 1408.55)	(1+25, 1408.63)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    0.51    ft  
 Elevation Range    1407.70 to 1408.63 ft

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## Worksheet for Section F-F - Prop Cond - 10-yr

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### Results

Flow Area	11.31	ft <sup>2</sup>
Wetted Perimeter	35.71	ft
Hydraulic Radius	0.32	ft
Top Width	35.10	ft
Normal Depth	0.51	ft
Critical Depth	0.62	ft
Critical Slope	0.01083	ft/ft
Velocity	4.77	ft/s
Velocity Head	0.35	ft
Specific Energy	0.86	ft
Froude Number	1.48	
Flow Type	Supercritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.51	ft
Critical Depth	0.62	ft
Channel Slope	0.02460	ft/ft
Critical Slope	0.01083	ft/ft





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## Worksheet for Section F-F - Exst Cond - 100-yr

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### Results

Normal Depth	1.15	ft
Critical Depth	1.19	ft
Critical Slope	0.00757	ft/ft
Velocity	5.13	ft/s
Velocity Head	0.41	ft
Specific Energy	1.56	ft
Froude Number	1.07	
Flow Type	Supercritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.15	ft
Critical Depth	1.19	ft
Channel Slope	0.00870	ft/ft
Critical Slope	0.00757	ft/ft

## Cross Section for Section F-F - Exst Cond - 100-yr

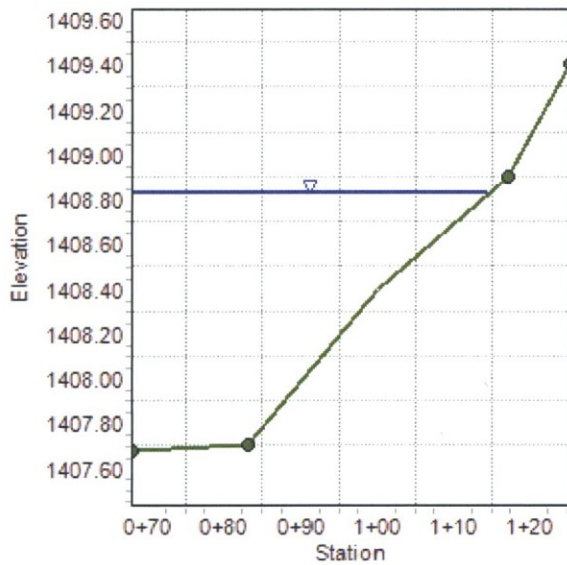
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                              0.00870    ft/ft  
Normal Depth                                1.15        ft  
Discharge                                    171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section F-F - Prop Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.02460    ft/ft  
 Discharge    171.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1407.70
0+83	1407.70
1+00	1408.40
1+17	1408.10
1+19	1408.00
1+19	1408.50
1+23	1408.55
1+25	1408.63

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1407.70)	(0+83, 1407.70)	0.030
(0+83, 1407.70)	(1+17, 1408.10)	0.015
(1+17, 1408.10)	(1+23, 1408.55)	0.013
(1+23, 1408.55)	(1+25, 1408.63)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

### Results

Normal Depth    0.80    ft  
 Elevation Range    1407.70 to 1408.63 ft

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## Worksheet for Section F-F - Prop Cond - 100-yr

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### Results

Flow Area	24.87	ft <sup>2</sup>
Wetted Perimeter	52.29	ft
Hydraulic Radius	0.48	ft
Top Width	51.26	ft
Normal Depth	0.80	ft
Critical Depth	1.03	ft
Critical Slope	0.00738	ft/ft
Velocity	6.88	ft/s
Velocity Head	0.73	ft
Specific Energy	1.54	ft
Froude Number	1.74	
Flow Type	Supercritical	

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.80	ft
Critical Depth	1.03	ft
Channel Slope	0.02460	ft/ft
Critical Slope	0.00738	ft/ft

## Cross Section for Section F-F - Prop Cond - 100-yr

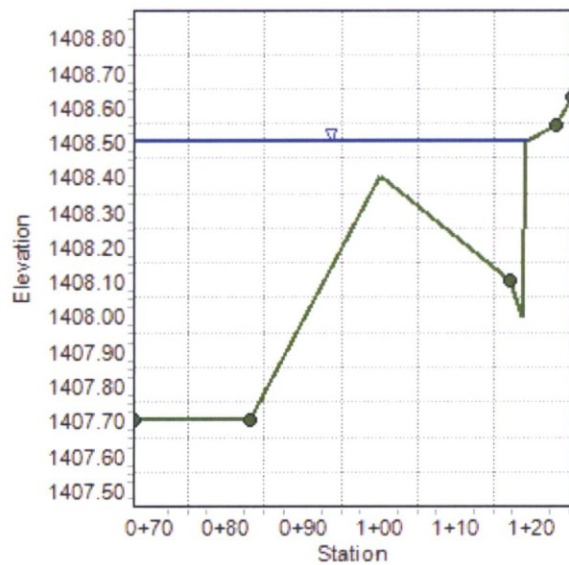
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.02460    ft/ft  
Normal Depth                            0.80        ft  
Discharge                                171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section G-G - Exst Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00330    ft/ft  
 Discharge    54.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1406.32
0+78	1406.32
0+83	1406.32
0+87	1406.35
0+88	1405.84
0+89	1405.88
1+00	1405.95
1+02	1405.96
1+16	1405.93
1+28	1406.14
1+28	1407.22
1+48	1407.10

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1406.32)	(0+78, 1406.32)	0.035
(0+78, 1406.32)	(0+89, 1405.88)	0.013
(0+89, 1405.88)	(1+16, 1405.93)	0.015
(1+16, 1405.93)	(1+48, 1407.10)	0.035

### Options

Current Roughness weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

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## Worksheet for Section G-G - Exst Cond - 10-yr

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### Results

Normal Depth		0.68	ft
Elevation Range	1405.84 to 1407.22	ft	
Flow Area		26.56	ft <sup>2</sup>
Wetted Perimeter		60.34	ft
Hydraulic Radius		0.44	ft
Top Width		59.68	ft
Normal Depth		0.68	ft
Critical Depth		0.53	ft
Critical Slope		0.01303	ft/ft
Velocity		2.03	ft/s
Velocity Head		0.06	ft
Specific Energy		0.75	ft
Froude Number		0.54	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.68	ft
Critical Depth	0.53	ft
Channel Slope	0.00330	ft/ft
Critical Slope	0.01303	ft/ft

## Cross Section for Section G-G - Exst Cond - 10-yr

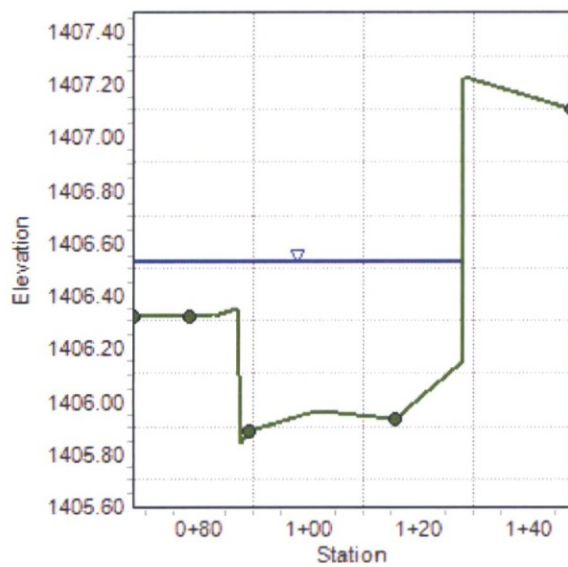
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00330    ft/ft  
Normal Depth                            0.68        ft  
Discharge                                54.00      ft<sup>3</sup>/s

### Cross Section Image





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## Worksheet for Section G-G - Prop Cond - 10-yr

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### Options

Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

### Results

Normal Depth		0.65	ft
Elevation Range	1405.84 to 1407.50		ft
Flow Area		19.25	ft <sup>2</sup>
Wetted Perimeter		51.44	ft
Hydraulic Radius		0.37	ft
Top Width		50.89	ft
Normal Depth		0.65	ft
Critical Depth		0.60	ft
Critical Slope		0.00874	ft/ft
Velocity		2.80	ft/s
Velocity Head		0.12	ft
Specific Energy		0.77	ft
Froude Number		0.80	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.65	ft
Critical Depth	0.60	ft
Channel Slope	0.00540	ft/ft
Critical Slope	0.00874	ft/ft

## Cross Section for Section G-G - Prop Cond - 10-yr

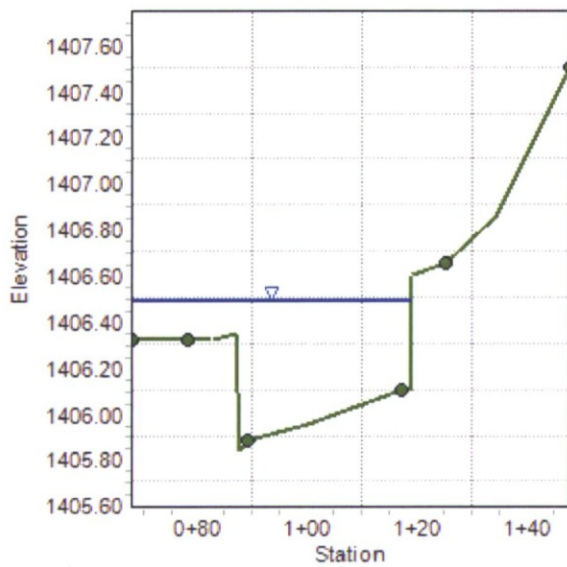
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope    0.00540    ft/ft  
Normal Depth    0.65        ft  
Discharge    54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section G-G - Exst Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope                              0.00330    ft/ft  
 Discharge                                 171.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1406.32
0+78	1406.32
0+83	1406.32
0+87	1406.35
0+88	1405.84
0+89	1405.88
1+00	1405.95
1+02	1405.96
1+16	1405.93
1+28	1406.14
1+28	1407.22
1+48	1407.10

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1406.32)	(0+78, 1406.32)	0.035
(0+78, 1406.32)	(0+89, 1405.88)	0.013
(0+89, 1405.88)	(1+16, 1405.93)	0.015
(1+16, 1405.93)	(1+48, 1407.10)	0.035

### Options

Current Roughness weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method  
 Closed Channel Weighting Method                      Pavlovskii's Method

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## Worksheet for Section G-G - Exst Cond - 100-yr

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### Results

Normal Depth		1.14	ft
Elevation Range	1405.84 to 1407.22	ft	
Flow Area		53.62	ft <sup>2</sup>
Wetted Perimeter		61.30	ft
Hydraulic Radius		0.87	ft
Top Width		59.89	ft
Normal Depth		1.14	ft
Critical Depth		0.87	ft
Critical Slope		0.01039	ft/ft
Velocity		3.19	ft/s
Velocity Head		0.16	ft
Specific Energy		1.29	ft
Froude Number		0.59	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.14	ft
Critical Depth	0.87	ft
Channel Slope	0.00330	ft/ft
Critical Slope	0.01039	ft/ft

## Cross Section for Section G-G - Exst Cond - 100-yr

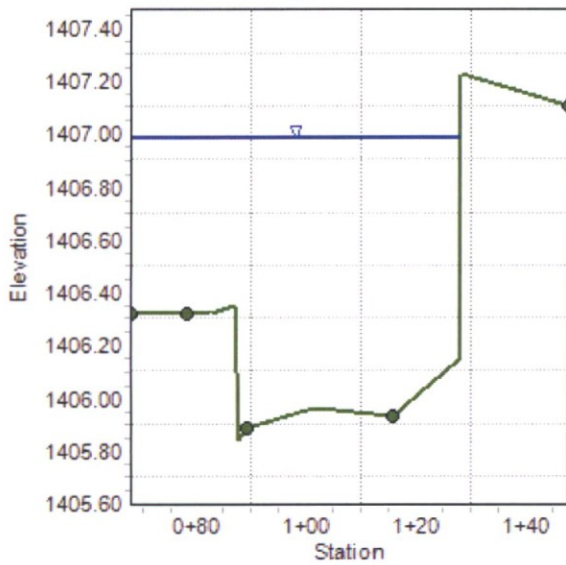
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00330    ft/ft  
Normal Depth                            1.14        ft  
Discharge                                171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section G-G - Prop Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope                              0.00540    ft/ft  
 Discharge                                    171.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1406.32
0+78	1406.32
0+83	1406.32
0+87	1406.35
0+88	1405.84
0+89	1405.88
1+00	1405.95
1+17	1406.10
1+19	1406.10
1+19	1406.60
1+25	1406.65
1+34	1406.85
1+48	1407.50

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1406.32)	(0+78, 1406.32)	0.035
(0+78, 1406.32)	(0+89, 1405.88)	0.013
(0+89, 1405.88)	(1+17, 1406.10)	0.015
(1+17, 1406.10)	(1+25, 1406.65)	0.013
(1+25, 1406.65)	(1+48, 1407.50)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method

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## Worksheet for Section G-G - Prop Cond - 100-yr

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### Options

Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

### Results

Normal Depth		1.14	ft
Elevation Range	1405.84 to 1407.50		ft
Flow Area		48.56	ft <sup>2</sup>
Wetted Perimeter		69.79	ft
Hydraulic Radius		0.70	ft
Top Width		68.70	ft
Normal Depth		1.14	ft
Critical Depth		1.00	ft
Critical Slope		0.01046	ft/ft
Velocity		3.52	ft/s
Velocity Head		0.19	ft
Specific Energy		1.33	ft
Froude Number		0.74	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.14	ft
Critical Depth	1.00	ft
Channel Slope	0.00540	ft/ft
Critical Slope	0.01046	ft/ft

## Cross Section for Section G-G - Prop Cond - 100-yr

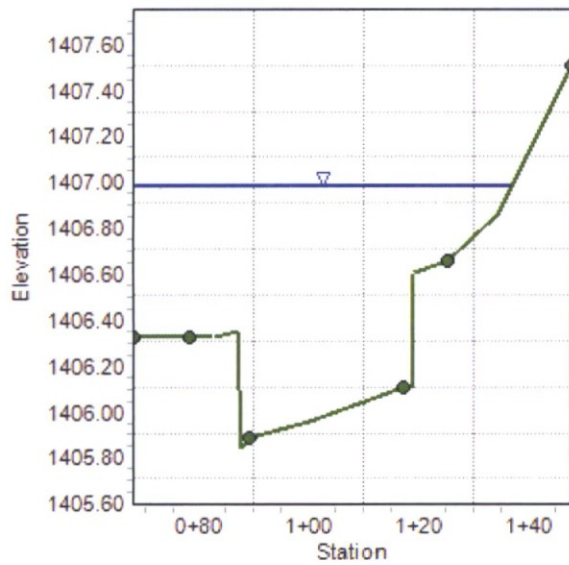
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                            0.00540    ft/ft  
Normal Depth                            1.14        ft  
Discharge                                171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section H-H - Exst Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00090    ft/ft  
 Discharge    54.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1405.93
0+78	1405.93
0+84	1405.88
0+84	1405.38
0+85	1405.40
1+00	1405.67
1+14	1405.60
1+16	1405.57
1+16	1406.07
1+25	1406.07
1+31	1406.30
1+35	1406.32

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1405.93)	(0+78, 1405.93)	0.035
(0+78, 1405.93)	(0+85, 1405.40)	0.013
(0+85, 1405.40)	(1+14, 1405.60)	0.015
(1+14, 1405.60)	(1+16, 1406.07)	0.013
(1+16, 1406.07)	(1+35, 1406.32)	0.035

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method

---

## Worksheet for Section H-H - Exst Cond - 10-yr

---

### Options

Closed Channel Weighting Method      Pavlovskii's Method

### Results

Normal Depth		1.08	ft
Elevation Range	1405.38 to 1406.32	ft	
Flow Area		42.58	ft <sup>2</sup>
Wetted Perimeter		68.38	ft
Hydraulic Radius		0.62	ft
Top Width		67.00	ft
Normal Depth		1.08	ft
Critical Depth		0.65	ft
Critical Slope		0.01398	ft/ft
Velocity		1.27	ft/s
Velocity Head		0.02	ft
Specific Energy		1.10	ft
Froude Number		0.28	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.08	ft
Critical Depth	0.65	ft
Channel Slope	0.00090	ft/ft
Critical Slope	0.01398	ft/ft



## Worksheet for Section H-H - Prop Cond - 10-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00530    ft/ft  
 Discharge    54.00    ft³/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1405.93
0+78	1405.93
0+84	1405.88
0+84	1405.38
0+85	1405.40
1+00	1405.67
1+10	1405.70
1+17	1405.83
1+19	1405.77
1+19	1406.20
1+25	1406.36
1+36	1406.40
1+39	1407.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1405.93)	(0+78, 1405.93)	0.035
(0+78, 1405.93)	(0+85, 1405.40)	0.013
(0+85, 1405.40)	(1+17, 1405.83)	0.015
(1+17, 1405.83)	(1+25, 1406.36)	0.013
(1+25, 1406.36)	(1+39, 1407.00)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method

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## Worksheet for Section H-H - Prop Cond - 10-yr

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### Options

Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

### Results

Normal Depth		0.72	ft
Elevation Range	1405.38 to 1407.00		ft
Flow Area		19.41	ft <sup>2</sup>
Wetted Perimeter		51.40	ft
Hydraulic Radius		0.38	ft
Top Width		50.89	ft
Normal Depth		0.72	ft
Critical Depth		0.67	ft
Critical Slope		0.00882	ft/ft
Velocity		2.78	ft/s
Velocity Head		0.12	ft
Specific Energy		0.84	ft
Froude Number		0.79	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.72	ft
Critical Depth	0.67	ft
Channel Slope	0.00530	ft/ft
Critical Slope	0.00882	ft/ft

## Cross Section for Section H-H - Prop Cond - 10-yr

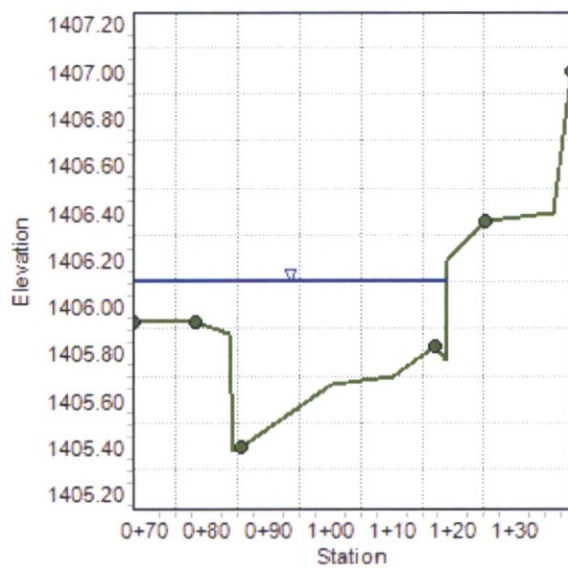
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                              0.00530    ft/ft  
Normal Depth                                0.72        ft  
Discharge                                    54.00      ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section H-H - Exst Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope                              0.00090    ft/ft  
 Discharge                                 171.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1405.93
0+78	1405.93
0+84	1405.88
0+84	1405.38
0+85	1405.40
1+00	1405.67
1+14	1405.60
1+16	1405.57
1+16	1406.07
1+25	1406.07
1+31	1406.30
1+35	1406.32

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1405.93)	(0+78, 1405.93)	0.035
(0+78, 1405.93)	(0+85, 1405.40)	0.013
(0+85, 1405.40)	(1+14, 1405.60)	0.015
(1+14, 1405.60)	(1+16, 1406.07)	0.013
(1+16, 1406.07)	(1+35, 1406.32)	0.035

### Options

Current Roughness Weighted Method                      Pavlovskii's Method  
 Open Channel Weighting Method                      Pavlovskii's Method

---

## Worksheet for Section H-H - Exst Cond - 100-yr

---

### Options

Closed Channel Weighting Method      Pavlovskii's Method

### Results

Normal Depth		1.73	ft
Elevation Range	1405.38 to 1406.32		ft
Flow Area		86.08	ft <sup>2</sup>
Wetted Perimeter		69.68	ft
Hydraulic Radius		1.24	ft
Top Width		67.00	ft
Normal Depth		1.73	ft
Critical Depth		1.03	ft
Critical Slope		0.01191	ft/ft
Velocity		1.99	ft/s
Velocity Head		0.06	ft
Specific Energy		1.79	ft
Froude Number		0.31	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.73	ft
Critical Depth	1.03	ft
Channel Slope	0.00090	ft/ft
Critical Slope	0.01191	ft/ft

## Cross Section for Section H-H - Exst Cond - 100-yr

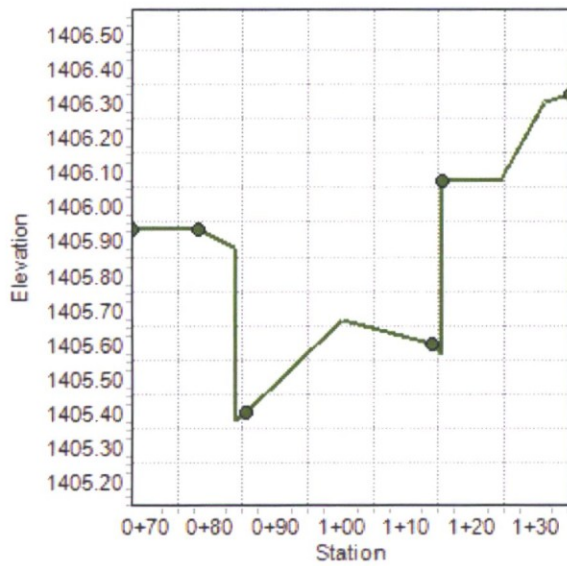
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

Channel Slope                              0.00090    ft/ft  
Normal Depth                                1.73        ft  
Discharge                                    171.00     ft<sup>3</sup>/s

### Cross Section Image



## Worksheet for Section H-H - Prop Cond - 100-yr

### Project Description

Friction Method                      Manning Formula  
 Solve For                              Normal Depth

### Input Data

Channel Slope    0.00530    ft/ft  
 Discharge    171.00    ft<sup>3</sup>/s  
 Section Definitions

Station (ft)	Elevation (ft)
0+68	1405.93
0+78	1405.93
0+84	1405.88
0+84	1405.38
0+85	1405.40
1+00	1405.67
1+10	1405.70
1+17	1405.83
1+19	1405.77
1+19	1406.20
1+25	1406.36
1+36	1406.40
1+39	1407.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+68, 1405.93)	(0+78, 1405.93)	0.035
(0+78, 1405.93)	(0+85, 1405.40)	0.013
(0+85, 1405.40)	(1+17, 1405.83)	0.015
(1+17, 1405.83)	(1+25, 1406.36)	0.013
(1+25, 1406.36)	(1+39, 1407.00)	0.040

### Options

Current Roughness Weighted Method                      Pavlovskii's Method

---

## Worksheet for Section H-H - Prop Cond - 100-yr

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### Options

Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

### Results

Normal Depth		1.22	ft
Elevation Range	1405.38 to 1407.00		ft
Flow Area		49.10	ft <sup>2</sup>
Wetted Perimeter		70.05	ft
Hydraulic Radius		0.70	ft
Top Width		68.99	ft
Normal Depth		1.22	ft
Critical Depth		1.08	ft
Critical Slope		0.01068	ft/ft
Velocity		3.48	ft/s
Velocity Head		0.19	ft
Specific Energy		1.41	ft
Froude Number		0.73	
Flow Type	Subcritical		

### GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

### GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.22	ft
Critical Depth	1.08	ft
Channel Slope	0.00530	ft/ft
Critical Slope	0.01068	ft/ft

## Cross Section for Section H-H - Prop Cond - 100-yr

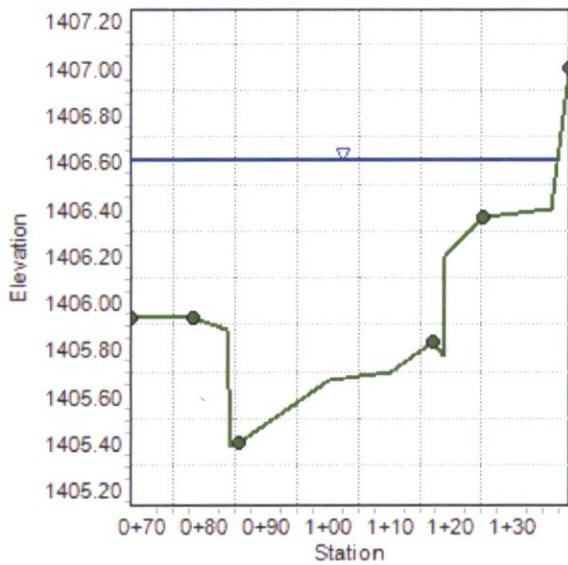
### Project Description

Friction Method                      Manning Formula  
Solve For                                Normal Depth

### Input Data

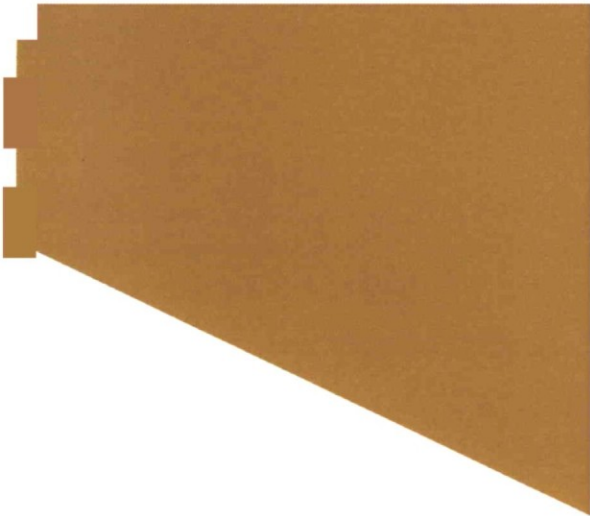
Channel Slope                            0.00530    ft/ft  
Normal Depth                            1.22        ft  
Discharge                                171.00     ft<sup>3</sup>/s

### Cross Section Image





## Exhibits



USGS Quad Map

FEMA FIRMette

Offsite Drainage Map

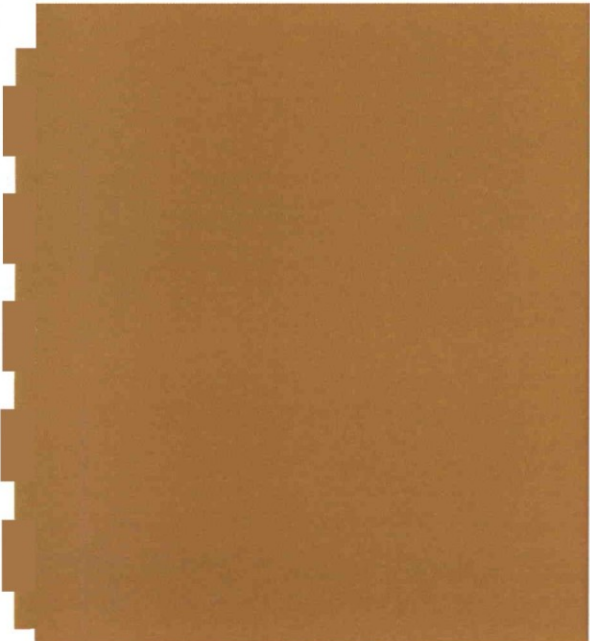
Existing Conditions Drainage Map

93<sup>rd</sup> Street Drainage

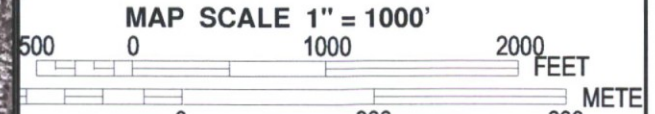
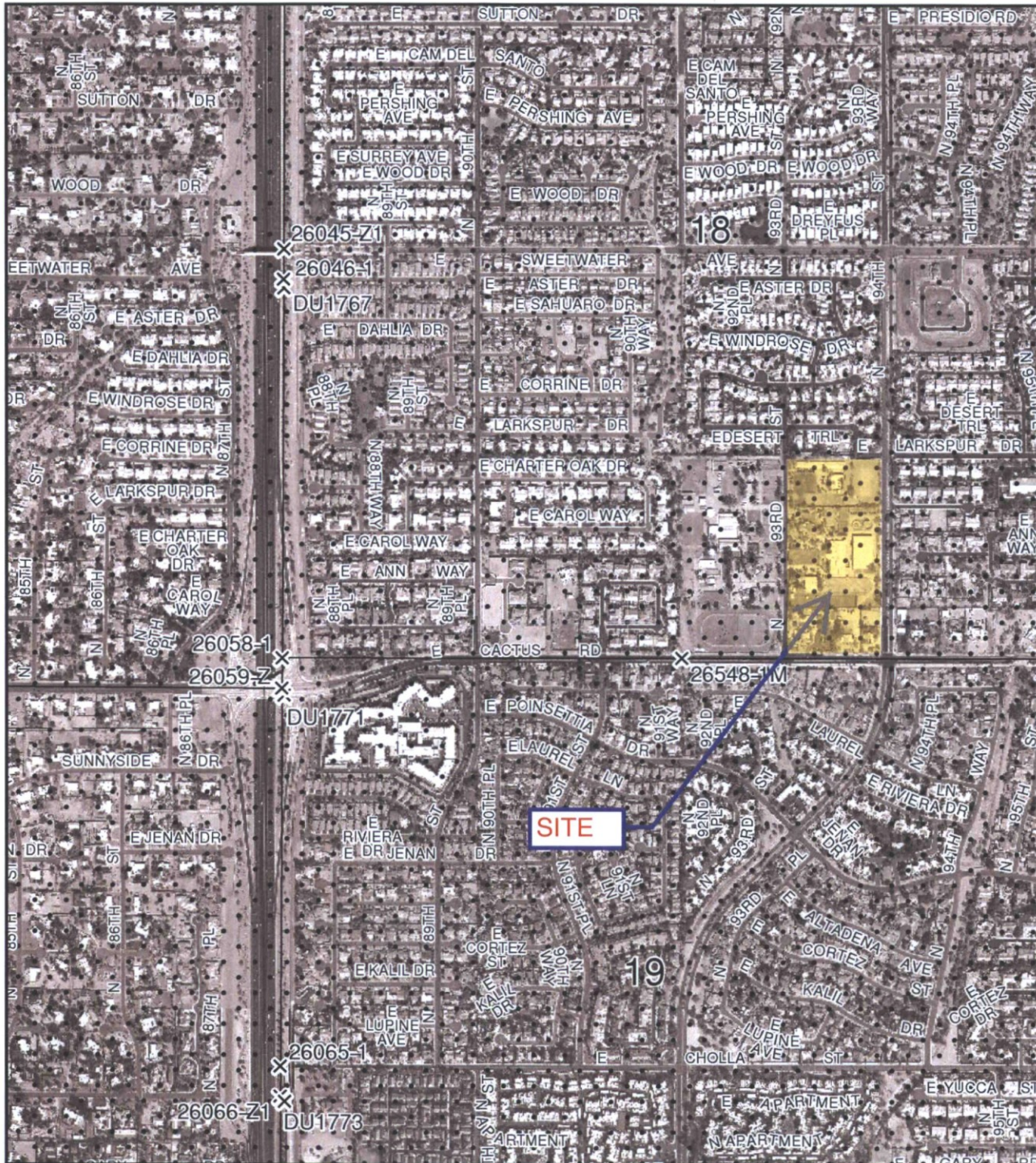
Proposed Conditions Drainage Map



*"The Benchmark of Our Profession."*







NFIP

PANEL 1760L

NATIONAL FLOOD INSURANCE PROGRAM

**FIRM**  
**FLOOD INSURANCE RATE MAP**  
**MARICOPA COUNTY,**  
**ARIZONA**  
**AND INCORPORATED AREAS**

**PANEL 1760 OF 4425**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY	040037	1760	L
PARADISE VALLEY, TOWN OF	040049	1760	L
PHOENIX, CITY OF	040051	1760	L
SCOTTSDALE, CITY OF	045012	1760	L

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



**MAP NUMBER**  
**04013C1760L**  
**MAP REVISED**  
**OCTOBER 16, 2013**

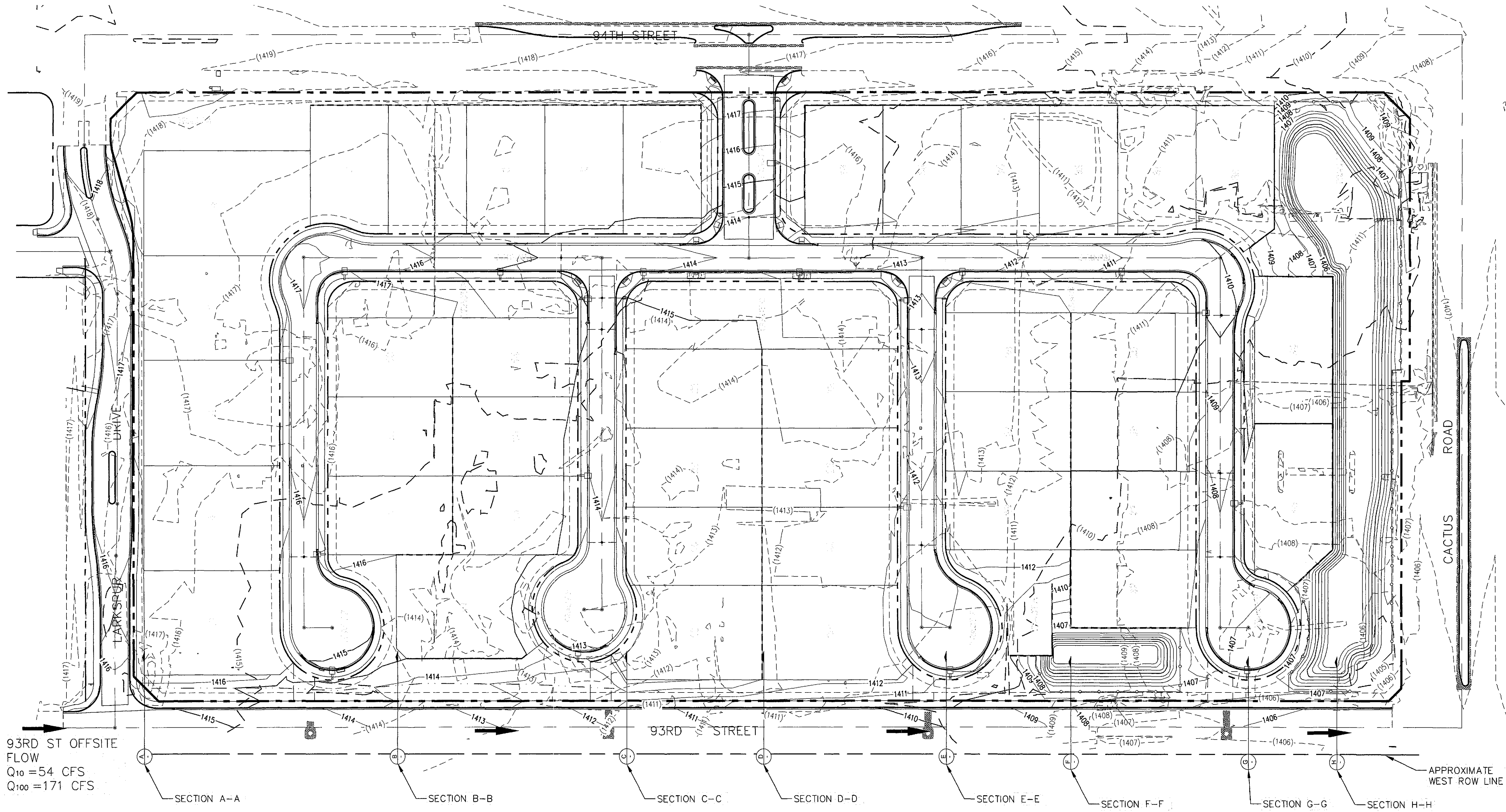
Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at [www.msc.fema.gov](http://www.msc.fema.gov)





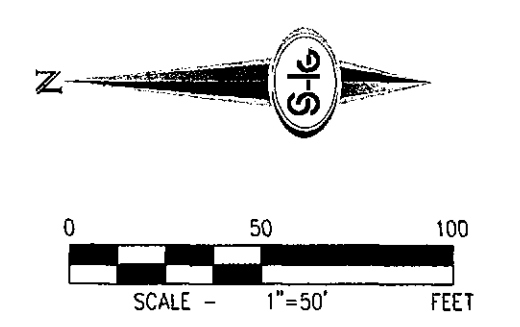




93RD ST OFFSITE  
FLOW  
Q<sub>10</sub> = 54 CFS  
Q<sub>100</sub> = 171 CFS

SECTION A-A      SECTION B-B      SECTION C-C      SECTION D-D      SECTION E-E      SECTION F-F      SECTION G-G      SECTION H-H      APPROXIMATE WEST ROW LINE

	WATER SURFACE ELEVATIONS			
	EXST 10-YR	PROP 10-YR	EXST 100-YR	PROP 100-YR
SECTION A-A	1416.0	1415.8	1416.5	1416.2
SECTION B-B	1414.2	1414.0	1414.7	1414.4
SECTION C-C	1412.1	1412.1	1412.5	1412.4
SECTION D-D	1411.3	1411.2	1411.9	1411.8
SECTION E-E	1410.4	1410.3	1410.8	1410.7
SECTION F-F	1408.4	1408.2	1408.8	1408.5
SECTION G-G	1406.5	1406.5	1407.0	1407.0
SECTION H-H	1406.5	1406.1	1407.1	1406.6



DATE	BY	APP	DATE

SCOTTSDALE, AZ NO. DESCRIPTION

**EMPIRE GROUP, LLC**  
**WOLF SPRINGS RANCH**  
**93RD STREET DRAINAGE - PLAN VIEW**

DATE: 6-12-18  
DRAFTER: JLL  
DESIGNER: JLL  
CHECKED: PL

PROJECT NO.  
**TEG1603-000**

**EX-3C**  
SHEET 1 OF 2

I:\1603-000\_wolf\_springs\_ranch\Drawings\Engineering\DWG\1603-000-05.dwg at: c:\program files\microstation\bin\msd\_b24.plt, 6/12/2018 3:49 PM Joe Lovett





DATE	BY	APP	DATE

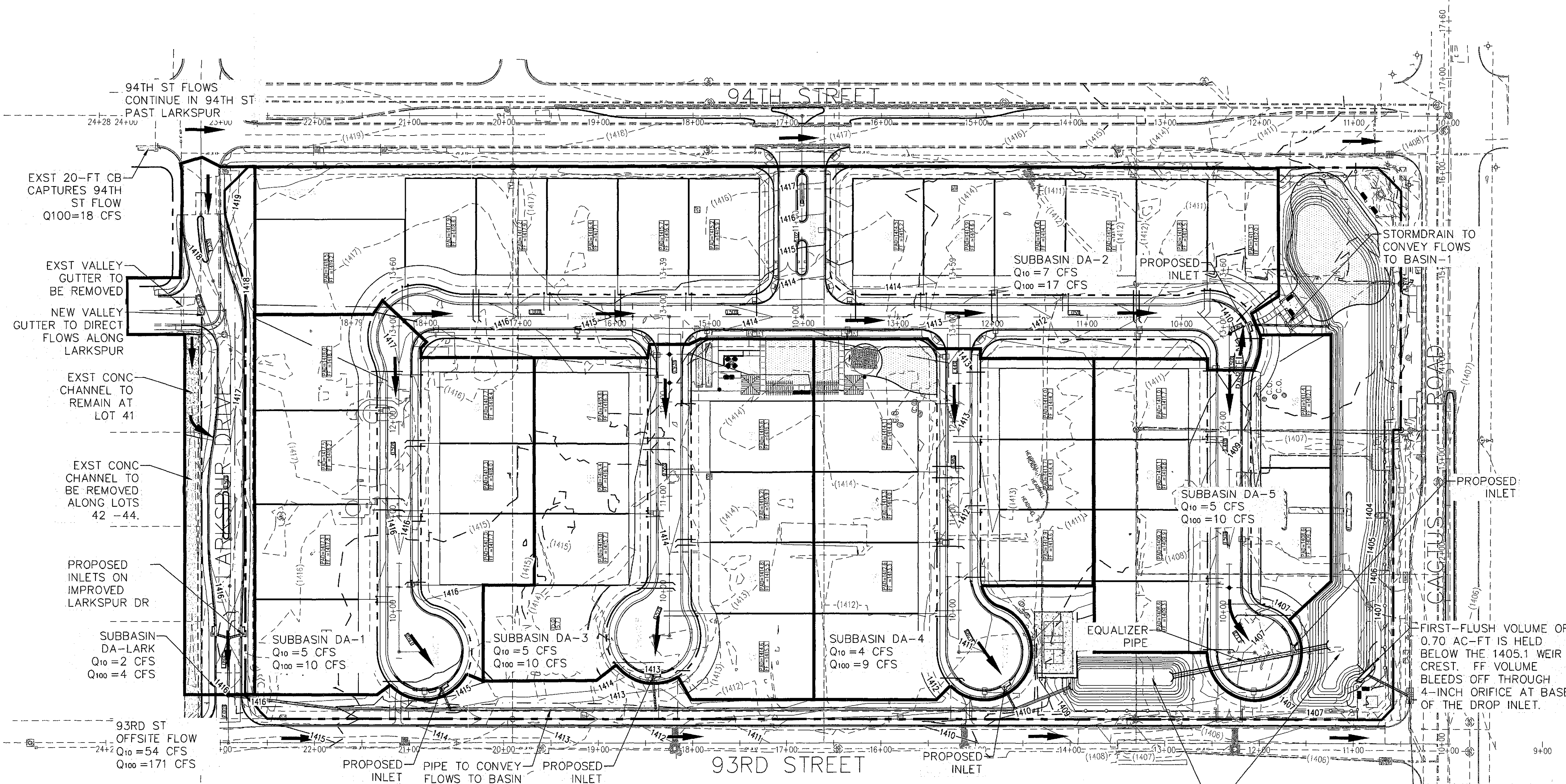
SCOTTSDALE, AZ

**EMPIRE GROUP, LLC**  
**WOLF SPRINGS RANCH**  
**PROPOSED CONDITION DRAINAGE MAP**

SEC 18  
 T33N  
 R9E

DATE: 6-12-18  
 DRAFTER: JLL  
 DESIGNER: JLL  
 CHECKED: PL  
 PROJECT NO.  
**TEG1603-000**

**EX-4**  
 SHEET 1 OF 1



94TH ST FLOWS CONTINUE IN 94TH ST PAST LARKSPUR

EXST 20-FT CB CAPTURES 94TH ST FLOW Q<sub>100</sub>=18 CFS

EXST VALLEY GUTTER TO BE REMOVED

NEW VALLEY GUTTER TO DIRECT FLOWS ALONG LARKSPUR

EXST CONC CHANNEL TO REMAIN AT LOT 41

EXST CONC CHANNEL TO BE REMOVED ALONG LOTS 42 -44.

PROPOSED INLETS ON IMPROVED LARKSPUR DR

SUBBASIN DA-LARK Q<sub>10</sub> = 2 CFS Q<sub>100</sub> = 4 CFS

93RD ST OFFSITE FLOW Q<sub>10</sub> = 54 CFS Q<sub>100</sub> = 171 CFS

PROPOSED INLET PIPE TO CONVEY FLOWS TO BASIN

PROPOSED INLET

PROPOSED INLET

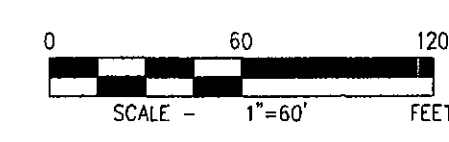
STORMDRAIN TO CONVEY FLOWS TO BASIN-1

PROPOSED INLET

FIRST-FLUSH VOLUME OF 0.70 AC-FT IS HELD BELOW THE 1405.1 WEIR CREST. FF VOLUME BLEEDS OFF THROUGH 4-INCH ORIFICE AT BASE OF THE DROP INLET.

OUTLET TO EXISTING CACTUS CB COMBINATION OF BASIN WEIR OVERTOPPING FLOW AND 4-IN ORIFICE BLEED-OFF FLOW: Q<sub>10</sub>=1 CFS Q<sub>100</sub>=21 CFS

RET BASIN 1  
 SS ADJ TO PUBLIC ROW-6:1, OTHERWISE 4:1  
 WEIR OUTLET CREST ELEVATION=1405.1  
 BOTTOM EL=1403.5  
 TOP ELEVATION=1406.5  
 VOL REQ<sub>D(FF)</sub>=30,591 CU-FT  
 VOL PROV<sub>(FF)</sub>=38,944 CU-FT  
 HWEL(10-YR)=1405.0  
 HWEL(100-YR)=1405.8



**LEGEND**

- SUB-BASIN BOUNDARIES
- FLOW DIRECTION
- FLOW PATH



I:\Veg1603-000\_wolf\_springs\_ranch\_drainage\preliminary\drainage\_map.dwg, 6/12/2018, 4:46 PM, Joe Lockett

