T·Y·LIN INTERNATIONAL
engineers | planners | scientists

D-16/D100

Subject: *Drainage Memo for Channel Road – Phase 1 (Osuna Road to Hawkins Street), Albuquerque, New Mexico*
Albuquerque Project No. 6920.91

July 30, 2012

T.Y. Lin International (TYLI) has provided this *Drainage Memo* as a supplement to the *Drainage Report, Essayons Boulevard, Osuna Road to Alameda Boulevard (Report)*, dated April 2011 and submitted to the City of Albuquerque as a part of the *Essayons Boulevard, Osuna Road to Alameda Boulevard, Feasibility Study.* This memo is intended to document the drainage design for the segment of Channel Road (formally called Essayons Boulevard) between Osuna Road and Hawkins Street. Included within this memo are the hydrologic calculations for the on-site drainage areas and the off-site watersheds that impact the project site and the hydraulic calculations that were performed to size the various drainage appurtenances for the project. A HEC-RAS model was also prepared to analyze the impacts of the Channel Road crossing on the South Pino Arroyo. These calculations can be found in Appendix A.

SITE DESCRIPTION

Channel Road is located in Albuquerque, New Mexico and will be constructed in AMAFCA's North Diversion Channel right-of-way. The roadway will extend along the east bank of the diversion channel between Osuna Road and Hawkins Street. The roadway is bounded on the east by a moderately developed industrial area. Approximately ½ mile north of Osuna Road, the South Pino Arroyo intersects Channel Road and immediately discharges into the North Diversion Channel. This crossing acts as a dividing line for the methodology used to convey the stormwater impacting the project.

PROPOSED DRAINAGE PLAN

South of the South Pino Arroyo, stormwater generated off-site is collected in a roadside ditch and is conveyed to the north before being passed beneath Channel Road in two separate culvert crossings. Both of these culverts discharge to the North Diversion Channel. Within this segment of roadway on-site generated stormwater is conveyed along the east gutter to two low points within the roadway. The roadway is drained at these locations utilizing sidewalk scuppers which discharge to the roadside ditch.

North of the South Pino Arroyo, stormwater generated both on-site and off-site are collected using two storm drain systems. These systems discharge to the North Diversion Channel near the intersection of Channel Road and Hawkins Street.

HYDROLOGIC CALCULATIONS

A hydrologic evaluation was performed using the methodology from Chapter 22 of the City Development Process Manual (DPM), Volume 2. The peak discharges for the 2-year, 10-year, and 100-year frequency design storms were calculated. As specified in the DPM the 6-hour duration for these events was utilized. These calculations along with both an on-site and off-site exhibit (Exhibit 1 and 2 respectively) showing the subbasin boundaries are included in Appendix A. Additional information can be found in the original *Report.* In addition the HEC-RAS analysis of the South Pino Crossing utilized the previously approved and published flow rates as shown in the Albuquerque Arroyos Feasibility Study dated July 1995. Pertinent information from that report and the Hydrologic Analysis of the South Pino Drainage Area (dated April 1989) are included in Appendix B.

HYDRAULIC CALCULATIONS

Inlet Capacity

Inlet capacity was calculated using Bentley FlowMaster V8i. This program calculates inlet interception capacity and spread for various types of stormwater inlets based on various roadway variables including cross-slope, pavement grade, etc. The output from the program has been included within Appendix A.

Hand calculations were also prepared for the two trench grates located at the Hawkins and Snap Roll intersection. The trench grate capacities were calculated using Chart 7 found in HEC-12, chapter 7. These calculations are conservative in nature since the curb openings located adjacent to the trench grate were ignored and only the flow captured by the grate was included. The curb openings will only improve the capacity of the trench grate/type A inlet structure.

Area Drain Capacity

Two off-site drainage areas require the use of area drains to collect runoff. These drainage areas are being drained using catchments per NMDOT Detail 623-06. The capacity of these catch basins was calculated based on the ponded depth of water above the inlet grate. The grate capacity was calculated for various ponded depths for the inlet acting as both a weir and an orifice. The lesser of these two capacities was selected as the design inlet capacity. See Appendix A for the included spreadsheet for the area drain calculations.

Storm Drain

Two storm drain systems are used to collect stormwater and convey it to the North Diversion Channel. These systems were analyzed using Bentley StormCAD V8i. A profile showing the hydraulic grade line (100-year frequency event) for the two trunklines is provided in the Appendix.

Culvert Capacity

Two culverts are used to convey stormwater from the roadside ditch to the North Diversion Channel. These culverts were sized using Bently CulvertMaster v3.3. The output from this program can be found in Appendix A.

Roadside Ditch Capacity

The capacity of the roadside ditch was calculated at 50-foot increments using Manning's equation and the designed physical features of the channel. At each section the channel has sufficient capacity to convey the 100-year offsite flows that impact the channel. A summary table for the channel geometry and resultant capacity can be found in Appendix A.

HEC-RAS

A box culvert has been designed to allow Channel Road to cross over the existing South Pino Arroyo. Transitions into and out of the box culvert have also been designed. These improvements were modeled using HEC-RAS 4.1.0 and compared to an existing condition model which was also prepared. Two 500-year flow profiles (2,000 and 4,100 cfs) were provided to TYLI by AMAFCA for use in sizing the box culvert. Output from HEC-RAS is included in the Appendix. In general, the box culvert and transitions provided increase the capacity of the South Pino Arroyo for the two flow profiles analyzed.

The existing condition and the proposed condition HEC-RAS models were also analyzed using HEC-RAS to determine their top of bank capacities. The capacity of the existing condition configuration was determined to be approximately 11,000 cfs while the proposed condition capacity is also approximately 11,000 cfs. The controlling cross sections are River Stations 1650 and 2000. At this flow rate, the water surface elevation increases for the proposed condition. However, since the flow is over two times the 500-year event the box culvert is unlikely to ever see flows this high.

Sincerely,

Eric Froberg, P.E.
Project Manager
T.Y. Lin International

ERIC J. FROBERG
NEW MEXICO
18855
PROFESSIONAL ENGINEER
7/30/12

T·Y·LIN INTERNATIONAL
engineers | planners | scientists

APPENDIX A

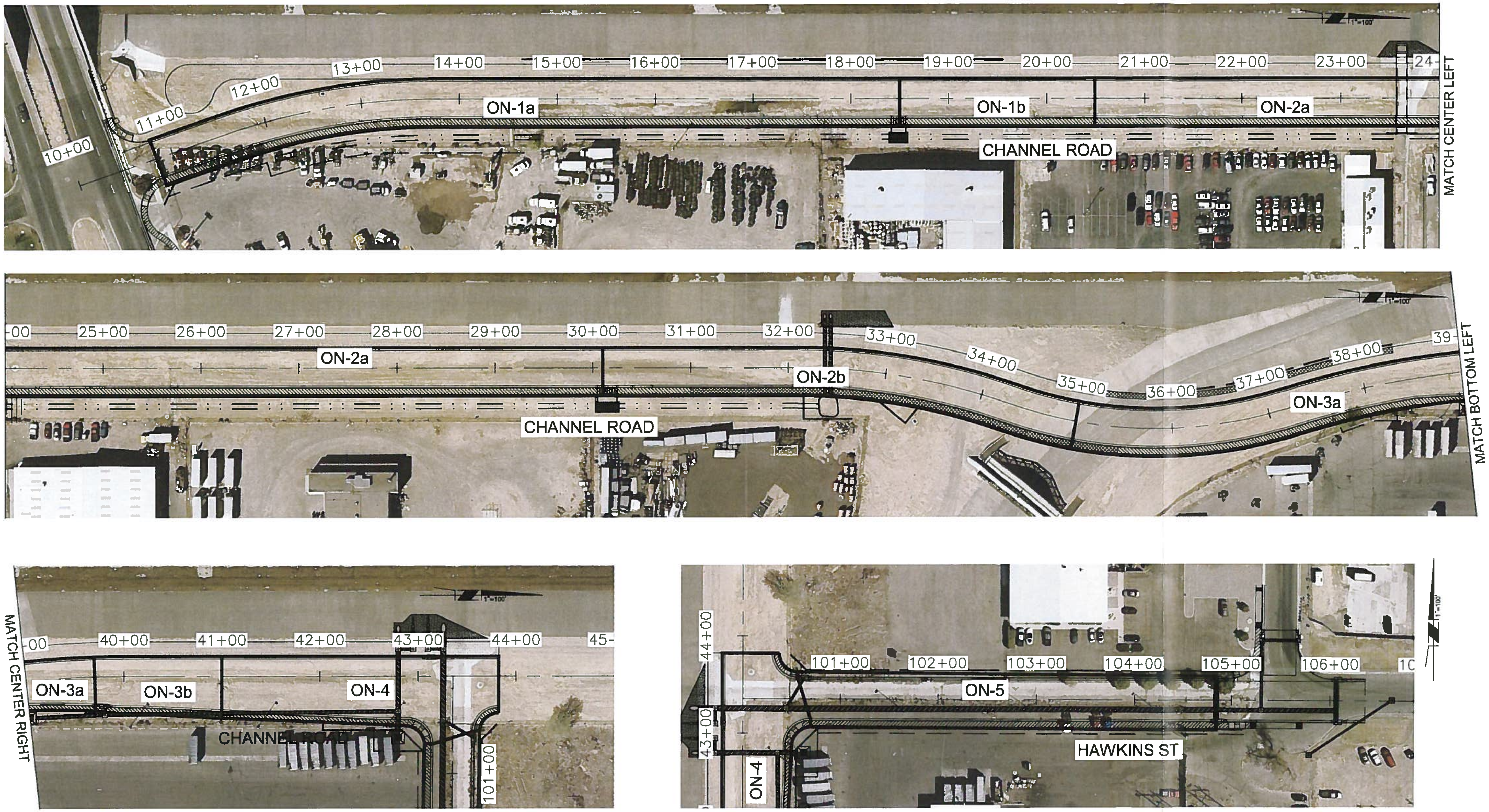


EXHIBIT 1 - ON-SITE SUBBASIN DRAINAGE MAP

T·Y· LIN INTERNATIONAL
engineers | planners | scientists
500 4th Street NW, Suite 403
Albuquerque, NM 87102

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project:	Channel Road	**Proj. Number:**	221706
Location:	Albuquerque, NM	**Proj. Engineer:**	R Strickland
Date:	May 14, 2012	**Checker:**	E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-01a

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	37700 sq.ft.	0.87 ac.
Total:	37700 sq.ft.	0.87 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_{2}$=	0.8
$C*A_{10}$=	0.8
$C*A_{100}$=	0.8

3. Peak Discharge, Q

Q_{2}=	1.6 cfs
Q_{10}=	2.7 cfs
Q_{100}=	4.1 cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project: Channel Road
Location: Albuquerque, NM
Date: May 14, 2012

Proj. Number: 221706
Proj. Engineer: R Strickland
Checker: E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-01b

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	9850 sq.ft.	0.23 ac.
Total:	9850 sq.ft.	0.23 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_2$=	0.2
$C*A_{10}$=	0.2
$C*A_{100}$=	0.2

3. Peak Discharge, Q

Q_2=	0.4 cfs
Q_{10}=	0.7 cfs
Q_{100}=	1.1 cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project: Channel Road
Location: Albuquerque, NM
Date: May 14, 2012

Proj. Number: 221706
Proj. Engineer: R Strickland
Checker: E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity
2-yr, 6-hr= 2.04
10-yr, 6-hr= 3.41
100-yr, 6-hr= 5.05

Basin ID: ON-01

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	47550 sq.ft.	1.09 ac.
Total:	47550 sq.ft.	1.09 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_2=$ 1.0
$C*A_{10}=$ 1.0
$C*A_{100}=$ 1.0

3. Peak Discharge, Q

$Q_2=$ 2.0 cfs
$Q_{10}=$ 3.4 cfs
$Q_{100}=$ 5.1 cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project:	Channel Road	**Proj. Number:**	221706
Location:	Albuquerque, NM	**Proj. Engineer:**	R Strickland
Date:	May 14, 2012	**Checker:**	E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-02a

1. Land Treatment Areas

A:	0	sq.ft.	0.00	ac.
B:	0	sq.ft.	0.00	ac.
C:	0	sq.ft.	0.00	ac.
D:	47280	sq.ft.	1.09	ac.
Total:	47280	sq.ft.	1.09	ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_2$=	1.0
$C*A_{10}$=	1.0
$C*A_{100}$=	1.0

3. Peak Discharge, Q

Q_2=	2.0	cfs
Q_{10}=	3.4	cfs
Q_{100}=	5.1	cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project:	Channel Road	**Proj. Number:**	221706
Location:	Albuquerque, NM	**Proj. Engineer:**	R Strickland
Date:	May 14, 2012	**Checker:**	E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-02b

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	24096 sq.ft.	0.55 ac.
Total:	24096 sq.ft.	0.55 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_2=$ 0.5

$C*A_{10}=$ 0.5

$C*A_{100}=$ 0.5

3. Peak Discharge, Q

$Q_2=$ 1.0 cfs

$Q_{10}=$ 1.7 cfs

$Q_{100}=$ 2.6 cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project:	Channel Road	**Proj. Number:**	221706
Location:	Albuquerque, NM	**Proj. Engineer:**	R Strickland
Date:	May 14, 2012	**Checker:**	E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-02

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	71376 sq.ft.	1.64 ac.
Total:	71376 sq.ft.	1.64 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_2$=	1.5
$C*A_{10}$=	1.5
$C*A_{100}$=	1.5

3. Peak Discharge, Q

Q_2=	3.0 cfs
Q_{10}=	5.1 cfs
Q_{100}=	7.7 cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project:	Channel Road	**Proj. Number:**	221706
Location:	Albuquerque, NM	**Proj. Engineer:**	R Strickland
Date:	May 14, 2012	**Checker:**	E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-03a

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	23449 sq.ft.	0.54 ac.
Total:	23449 sq.ft.	0.54 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_{2}$=	0.5
$C*A_{10}$=	0.5
$C*A_{100}$=	0.5

3. Peak Discharge, Q

Q_{2}=	1.0 cfs
Q_{10}=	1.7 cfs
Q_{100}=	2.5 cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project:	Channel Road	**Proj. Number:**	221706
Location:	Albuquerque, NM	**Proj. Engineer:**	R Strickland
Date:	May 14, 2012	**Checker:**	E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-03b

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	7810 sq.ft.	0.18 ac.
Total:	7810 sq.ft.	0.18 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_{2}=$	0.2
$C*A_{10}=$	0.2
$C*A_{100}=$	0.2

3. Peak Discharge, Q

$Q_{2}=$	0.3 cfs
$Q_{10}=$	0.6 cfs
$Q_{100}=$	0.8 cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project:	Channel Road	**Proj. Number:**	221706
Location:	Albuquerque, NM	**Proj. Engineer:**	R Strickland
Date:	May 14, 2012	**Checker:**	E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-03

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	31259 sq.ft.	0.72 ac.
Total:	31259 sq.ft.	0.72 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_2=$	0.7
$C*A_{10}=$	0.7
$C*A_{100}=$	0.7

3. Peak Discharge, Q

$Q_2=$	1.3 cfs
$Q_{10}=$	2.3 cfs
$Q_{100}=$	3.4 cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project:	Channel Road	**Proj. Number:**	221706
Location:	Albuquerque, NM	**Proj. Engineer:**	R Strickland
Date:	May 14, 2012	**Checker:**	E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-04

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	19977 sq.ft.	0.46 ac.
Total:	19977 sq.ft.	0.46 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_2$=	0.4
$C*A_{10}$=	0.4
$C*A_{100}$=	0.4

3. Peak Discharge, Q

Q_2=	0.9 cfs
Q_{10}=	1.4 cfs
Q_{100}=	2.2 cfs

T·Y·LIN INTERNATIONAL

On-Site Subbasin Calculations

Project:	Channel Road	**Proj. Number:**	221706
Location:	Albuquerque, NM	**Proj. Engineer:**	R Strickland
Date:	May 14, 2012	**Checker:**	E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Precipitation Zone: 2

Intensity	
2-yr, 6-hr=	2.04
10-yr, 6-hr=	3.41
100-yr, 6-hr=	5.05

Basin ID: ON-05

1. Land Treatment Areas

A:	0 sq.ft.	0.00 ac.
B:	0 sq.ft.	0.00 ac.
C:	0 sq.ft.	0.00 ac.
D:	23523 sq.ft.	0.54 ac.
Total:	23523 sq.ft.	0.54 ac.

2. Weighted C*A, Rational Coefficient*Acre

$C*A_2$=	0.5
$C*A_{10}$=	0.5
$C*A_{100}$=	0.5

3. Peak Discharge, Q

Q_2=	1.0 cfs
Q_{10}=	1.7 cfs
Q_{100}=	2.5 cfs

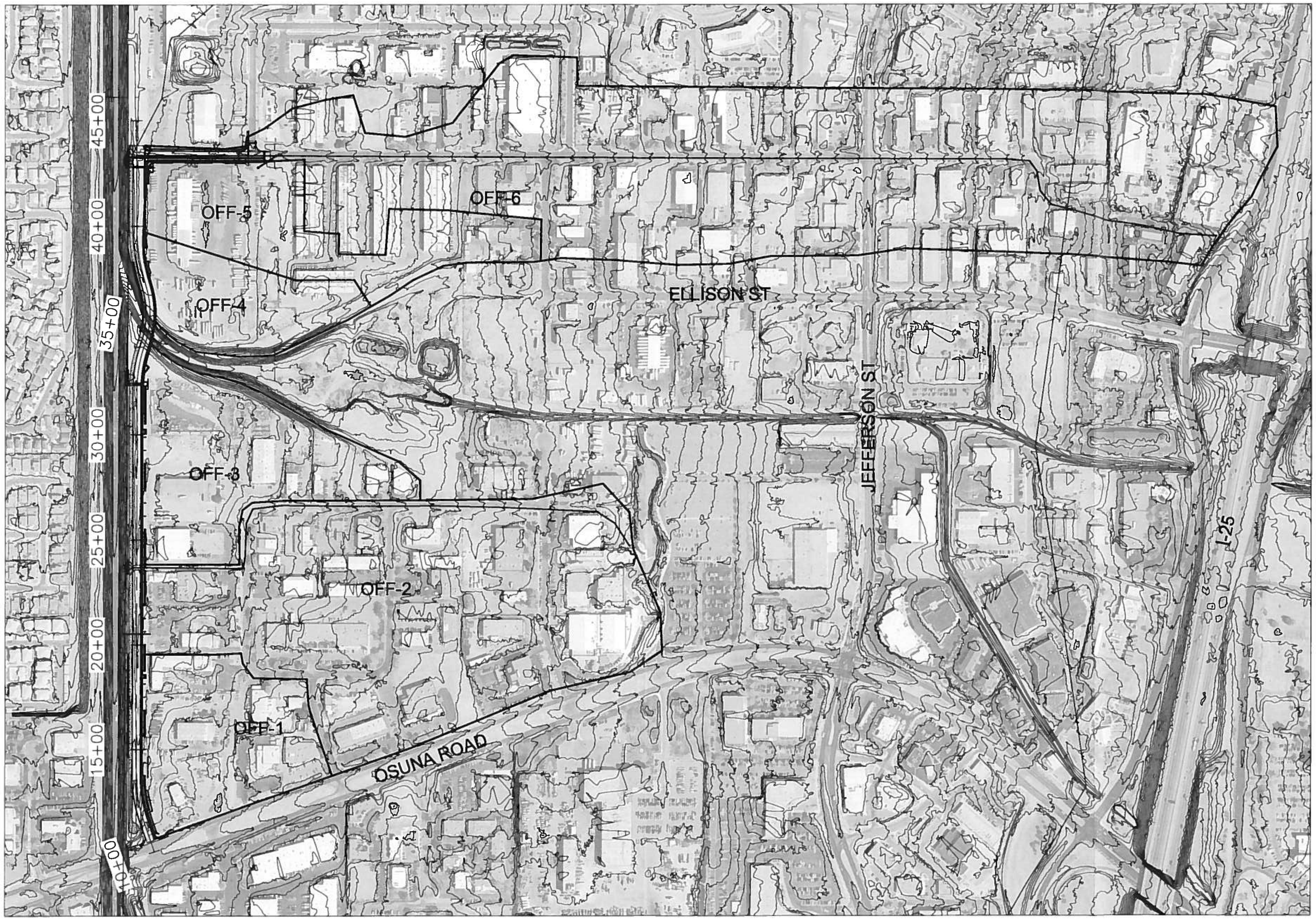


EXHIBIT 2 - OFF-SITE SUBBASIN DRAINAGE MAP

T·Y· LIN INTERNATIONAL
engineers | planners | scientists
500 4th Street NW, Suite 403
Albuquerque, NM 87102

Smaller than 40 Acres Offsite Sub Basin Calculations

Project: Channel Road
Location: Albuquerque, NM
Date: May 16, 2012

Proj. Number: 221706
Proj. Engineer: R Strickland
Checker: E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Subbasin ID	Contributing	Contributing Area (ac)	Weighted C	C x A	Q_{P2} Discharge (cfs)	Q_{P10} Discharge (cfs)	Q_{P100} Discharge (cfs)
OFF-1	578760	13.29	0.89	11.82	24	40	60
OFF-3	725216	16.65	0.89	14.82	30	51	75
OFF-4	372913	8.56	0.89	7.62	16	26	38
OFF-5	616000	14.14	0.89	12.59	26	43	64

For Zone 2 I_{100}=5.05 for Tc=0.2 hr

For Zone 2 I_{10}=3.41 for Tc=0.2 hr

For Zone 2 I_2=2.04 for Tc=0.2 hr

Weighted C=0.95(80%)+0.65(20%)=0.89

Larger than 40 Acres Offsite Sub Basin Calculations

Project: Channel Road
Location: Albuquerque, NM
Date: May 23, 2012

Proj. Number: 221706
Proj. Engineer: R Strickland
Checker: E Froberg

References: Chapter 22, Drainage, Flood Control and Erosion Control

Weighted C=0.95(80%)+0.65(20%)=0.89

Subbasin ID	Contributing	Contributing Area (ac)	Weighted C	C x A	Flowpath Length (ft)	Flowpath Slope (ft/ft)	K Convey Factor	K_N Lag Factor	L/L_{CA} Percent L To Centroid	Tc Time (hr)	I_2 intensity (in/hr)	Q_{P2} Flow (cfs)	I_{10} Intensity (in/hr)	Q_{P10} Flow (cfs)	I_{100} Intensity (in/hr)	Q_{P100} Flow (cfs)
OFF-2	2160231	49.59	0.89	44.14	2680	0.0150	3.00	N/A	N/A	0.203	2.0	89.36	3.1	137.99	5.0	222
OFF-6	3437402	78.91	0.89	70.23	5285	0.0200	3.00	N/A	N/A	0.346	1.6	111.01	2.4	171.41	3.9	275

Scupper 18+48

Project Description

Solve For	Spread		

Input Data

Discharge		5.1	cfs {ON-1a, ON-1B}
Gutter Width		2.00	ft
Gutter Cross Slope		0.06	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		12.00	ft
Opening Height		0.50	ft
Curb Throat Type	Horizontal		
Local Depression		0.00	in
Local Depression Width		0.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	13.62	ft
Depth	0.36	ft
Gutter Depression	0.09	ft
Total Depression	0.09	ft

Scupper 30+15

Project Description

Solve For	Spread		

Input Data

Discharge		7.7	cfs {ON-2a, ON-2B}
Gutter Width		2.00	ft
Gutter Cross Slope		0.06	ft/ft
Road Cross Slope		0.02	ft/ft
Curb Opening Length		16.00	ft
Opening Height		0.50	ft
Curb Throat Type	Horizontal		
Local Depression		0.00	in
Local Depression Width		0.00	ft
Throat Incline Angle		90.00	degrees

Results

Spread	15.39	ft
Depth	0.39	ft
Gutter Depression	0.09	ft
Total Depression	0.09	ft

Inlet 39+80

Project Description

Solve For	Spread		

Input Data

Discharge		3.4	cfs {ON-3a, ON-3B}
Gutter Width		2.00	ft
Gutter Cross Slope		0.06	ft/ft
Road Cross Slope		0.02	ft/ft
Local Depression		2.75	in
Local Depression Width		2.00	ft
Grate Width		2.00	ft
Grate Length		3.33	ft
Grate Type	P-50 mm x 100 mm (P-1-7/8"-4")		
Clogging		20.00	%
Curb Opening Length		7.50	ft
Opening Height		0.73	ft
Curb Throat Type	Horizontal		
Throat Incline Angle		90.00	degrees

Options

Calculation Option	Use Both		

Results

Spread		8.38	ft
Depth		0.25	ft
Gutter Depression		0.09	ft
Total Depression		0.31	ft
Open Grate Area		4.26	ft^2
Active Grate Weir Length		6.53	ft

Inlet 43+15

Project Description

Solve For	Efficiency

Input Data

Discharge	2.2	cfs {ON-4}
Slope	0.00500	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.017	
Local Depression	2.75	in
Local Depression Width	2.00	ft
Grate Width	2.00	ft
Grate Length	3.33	ft
Grate Type	P-50 mm x 100 mm (P-1-7/8"-4")	
Clogging	20.00	%
Curb Opening Length	0.00	ft

Options

Calculation Option	Use Both
Grate Flow Option	Exclude None

Results

Efficiency	66.00	%
Intercepted Flow	1.45	ft^3/s
Bypass Flow	0.75	ft^3/s
Spread	10.65	ft
Depth	0.30	ft
Flow Area	1.22	ft^2
Gutter Depression	0.09	ft
Total Depression	0.31	ft
Velocity	1.81	ft/s
Splash Over Velocity	5.68	ft/s
Frontal Flow Factor	1.00	
Side Flow Factor	0.30	
Grate Flow Ratio	0.51	
Equivalent Cross Slope	0.10028	ft/ft
Active Grate Length	2.66	ft
Length Factor	0.00	
Total Interception Length	7.81	ft

Inlet 100+61

Project Description

Solve For	Efficiency	

Input Data

Discharge	2.5	cfs {ON-5}
Slope	0.01260	ft/ft
Gutter Width	2.00	ft
Gutter Cross Slope	0.06	ft/ft
Road Cross Slope	0.02	ft/ft
Roughness Coefficient	0.017	
Local Depression	2.75	in
Local Depression Width	2.00	ft
Grate Width	2.00	ft
Grate Length	3.33	ft
Grate Type	P-50 mm x 100 mm (P-1-7/8"-4")	
Clogging	20.00	%
Curb Opening Length	0.00	ft

Options

Calculation Option	Use Both
Grate Flow Option	Exclude None

Results

Efficiency	65.28	%
Intercepted Flow	1.63	ft³/s
Bypass Flow	0.87	ft³/s
Spread	9.22	ft
Depth	0.27	ft
Flow Area	0.94	ft²
Gutter Depression	0.09	ft
Total Depression	0.31	ft
Velocity	2.67	ft/s
Splash Over Velocity	5.68	ft/s
Frontal Flow Factor	1.00	
Side Flow Factor	0.18	
Grate Flow Ratio	0.58	
Equivalent Cross Slope	0.11075	ft/ft
Active Grate Length	2.66	ft
Length Factor	0.00	
Total Interception Length	10.25	ft

T·Y·LIN INTERNATIONAL

Project: Channel Road | Job No. | Sheet: 1 of 3

Item: Trench Grate Calcs | Designer: RES | Date: 1/17/2012

Checker: | Date:

Grid: 1/10"

1. Calculate Flow Depth & Velocity (Using FlowMaster)

$Q = 275$ cfs {OFF-6} $V = 6.1$ ft/s

$d = 1.78'$ (Above Gutter) $A = 45.06$ ft^2

2. Determine Frontal Flow Across Trench Grate

2a. Avg Depth over Grate

$[(1.78-0.125)+2(1.28-0.525)+(1.28-0.125)]/4 = 0.955$ ft

2b. Area of Flow over Grate

$(40)(0.955) = 38.2$ ft^2

↑ Grate Width

2c. Frontal Flow

$(38.2)(6.1) = 233.02$ cfs

3. Determine Frontal Flow Across Type A Grate

3a. Avg Depth over Grate

$[(1.28)+(1.28-.125)]/2 = 1.22$ ft

3b. Area of Flow over Grate

$2(2)(1.22) = 4.88$ ft^2

2 Grates ↑ ↑ width

3c Frontal Flow

$(4.88)(6.1) = 29.77$ cfs

4. Determine Frontal Flow Capture Efficiency

Use Chart 7 HEC-12 (Reticuline Grate)

See Attachment #1

Trench Grate

$R_f = 0.98$

Type 'A' Grate

$R_f = 0.98$

Determine Frontal Flow Interception (Exclude Side Interception due to Inlet)

$Q_i = 0.98\,(0.75)(233.02 + 29.77) = 193.15$

↑ 25% Clogging

T·Y·LIN INTERNATIONAL

Project:	Job No.	Sheet: 2 of 3
Item:	Designer:	Date:
	Checker:	Date:
		Grid: 1/10"

6 Determine Bypass Flow

$Q_b = 275 - 193 = 82$ cfs

7. Calculate Flow Depth for Bypass

Q = 82 cfs V = 4.56 ft/s

d = 0.71 ~~ft~~ A = 17.98 ft^2

8. Determine Frontal Flow Across Trench Grate

8a [2(0.71 - .125) + 4(.71 - .575)]/4 = 0.385

8b. 40(.385) = 15.4 ft^2

8c. (15.4)(4.56) = 70.22 cfs

9. Determine Frontal Flow Across Type 'A' Grate

9a. [.71 + (.71 - .125)]/2 = 0.65 ft

9b. 2(2)(0.65) = 2.6 ft^2

9c. 2.6(4.56) = 11.9 cfs

10. Determine Frontal Flow Capture Efficiency

100% Since Velocity ≤ splashover velocity

T·Y·LIN INTERNATIONAL

Project:	Job No.	Sheet: 3 of 3
Item:	Designer:	Date:
	Checker:	Date:
		Grid: 1/10"

11. Determine Grate Size for Splashover = 4.6 ft/s
See Attachment #2
$L = 2.3$ ft

$2.3/3 = 0.76$

Therefore 3ft grate allows for 100% Capture with approximately 24% Clogging

12. Summary

The trench grates are adequately sized to capture the 27 cfs.

The calculations ignored the curb openings in the type 'A' inlets. These will provide additional capacity.

where: Q = total gutter flow

Q_w = flow in width W. ft^3/s (m^3/s)

W = width of depressed gutter or grate, ft (m)

T = total spread of water in the gutter, ft (m)

Chart 4, Section 5.2, provides a graphical solution of E_o for either straight cross slopes or depressed gutter sections.

The ratio of side flow, Q_s, to total gutter flow is:

$$\frac{Q_s}{Q} = 1 - \frac{Q_W}{Q} = 1 - E_o \qquad (8)$$

The ratio of frontal flow intercepted to total frontal flow, R_f, is expressed by Equation (9):

$$R_f = 1 - 0.09\,(V - V_o) \qquad (9)$$

where: V = velocity of flow in the gutter, ft/s (m/s)

V_o = gutter velocity where splash-over first occurs

Attachment #1

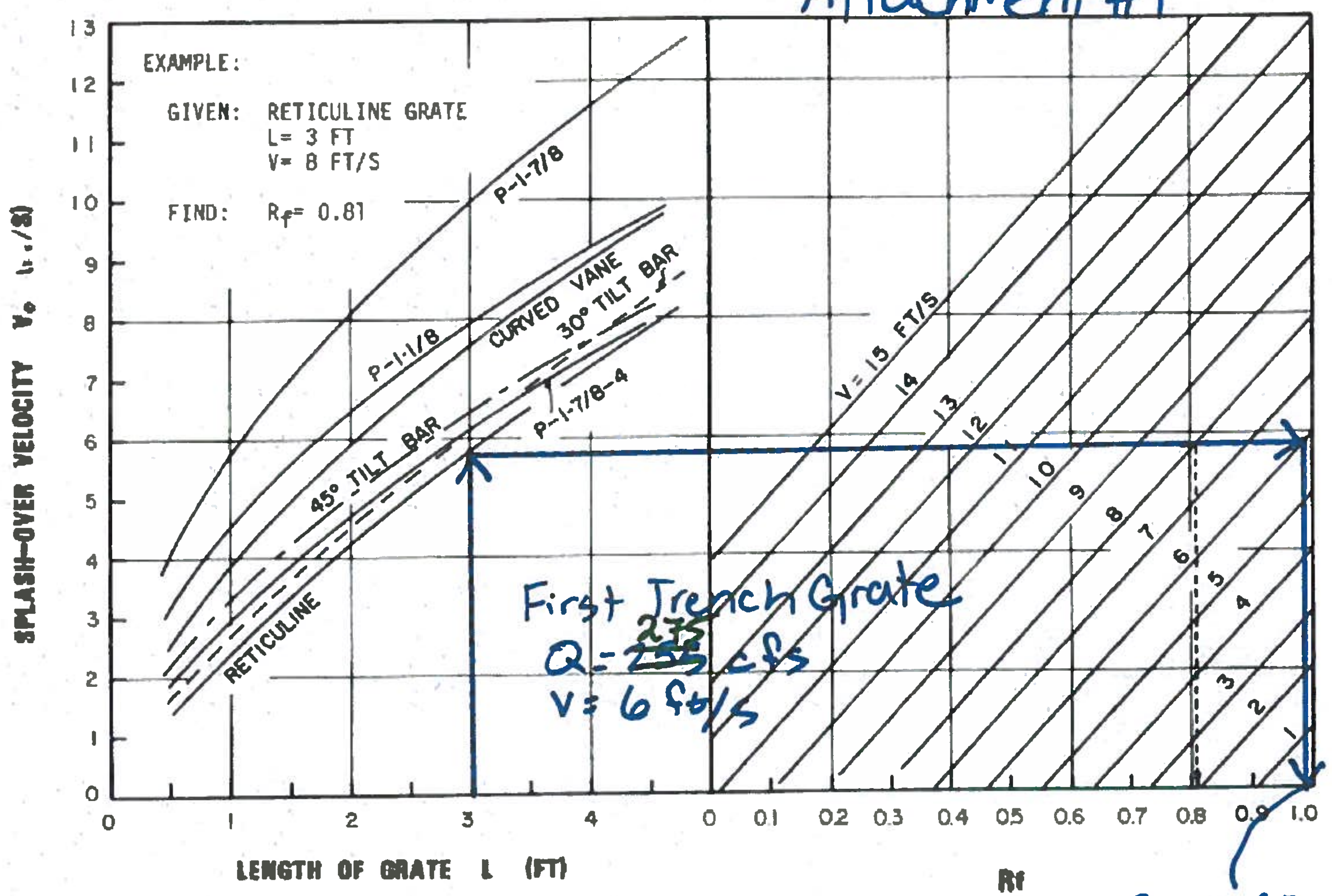


Chart 7. Grate inlet frontal flow interception efficiency.

ɜ ratio is equivalent to frontal flow interception efficiency. Chart 7 provides a solution of Equation (9) which takes nto account grate length, bar configuration and gutter velocity at which splash-over occurs. The gutter velocity needed to use Chart 7 is total gutter flow divided by the area of flow.

where: Q = total gutter flow

Q_w = flow in width W. ft^3/s (m^3/s)

W = width of depressed gutter or grate, ft (m)

T = total spread of water in the gutter, ft (m)

Chart 4, Section 5.2, provides a graphical solution of E_o for either straight cross slopes or depressed gutter sections.

The ratio of side flow, Q_s, to total gutter flow is:

$$\frac{Q_s}{Q} = 1 - \frac{Q_w}{Q} = 1 - E_o \qquad (8)$$

The ratio of frontal flow intercepted to total frontal flow, R_f, is expressed by Equation (9):

$$R_f = 1 - 0.09\,(V - V_o) \qquad (9)$$

where: V = velocity of flow in the gutter, ft/s (m/s)

V_o = gutter velocity where splash-over first occurs

Attachment # 2

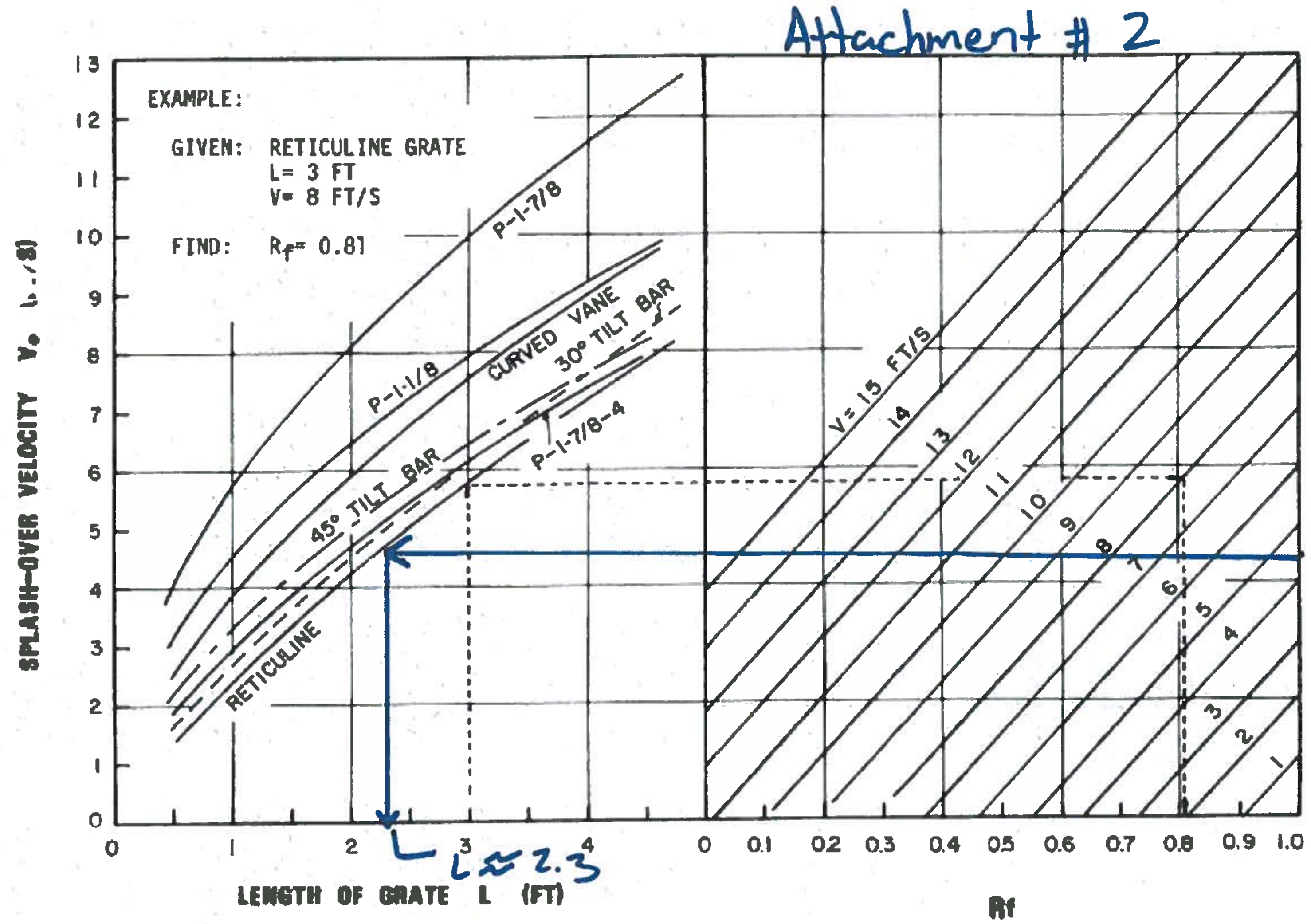


Chart 7. Grate inlet frontal flow interception efficiency.

ɜ ratio is equivalent to frontal flow interception efficiency. Chart 7 provides a solution of Equation (9) which takes nto account grate length, bar configuration and gutter velocity at which splash-over occurs. The gutter velocity needed to use Chart 7 is total gutter flow divided by the area of flow.

Hawkins Upstream of TG 1

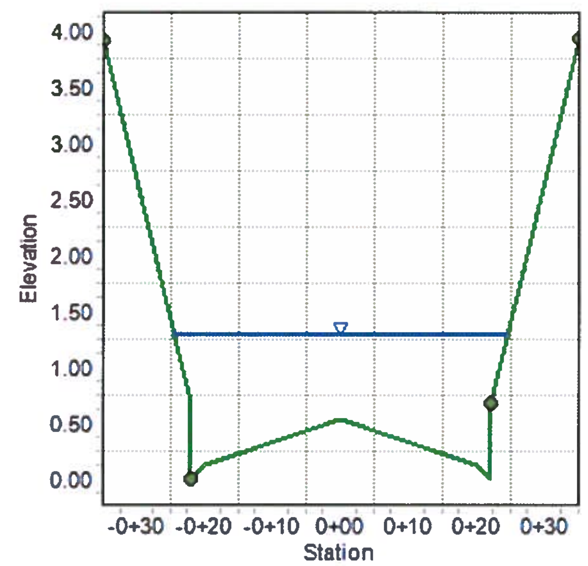
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01000	ft/ft
Normal Depth	1.28	ft
Discharge	275.0	cfs

Cross Section Image



Hawkins Upstream of TG 2

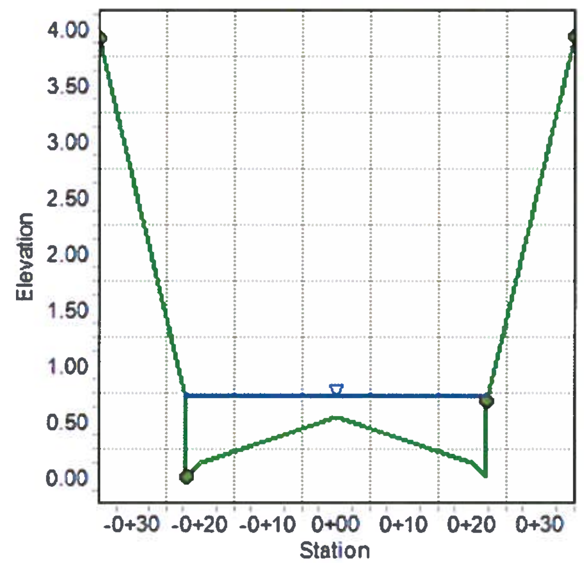
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01000	ft/ft
Normal Depth	0.71	ft
Discharge	82.0	cfs

Cross Section Image



CATCH BASIN INTERCEPTION CAPACITY

Project: Channel Road **Proj. Number:** 221706
Location: Albuquerque, NM **Proj. Engineer:** R Strickland
Date: May 14, 2012 **Checker:** E Froberg

Description: Calculation of Catch Basin Interception Capacity

Calculated Values:

$Q_i = EC_wPd^{1.5}$ Inlet Acting as a Weir

$Q_i = EC_oA_g(2gd)^{.5}$ Inlet Acting as an Orifice

Where,

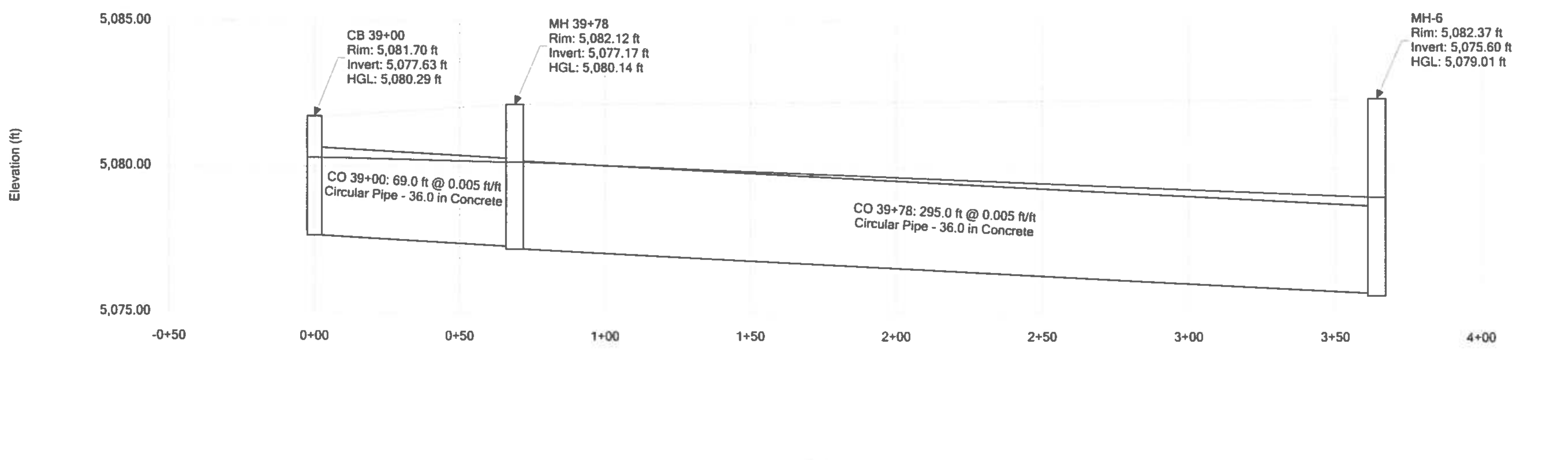
$C_w =$ 3.0
$C_o =$ 0.67
P= 20 (ft) Grate Perimeter
d= Water Depth
$A_g =$ 20 (ft^2) Grate Clear Area
g= 32.2 (ft/s^2) Gravity
E= 80% Efficiency

Catch Basin: NMDOT 623-06

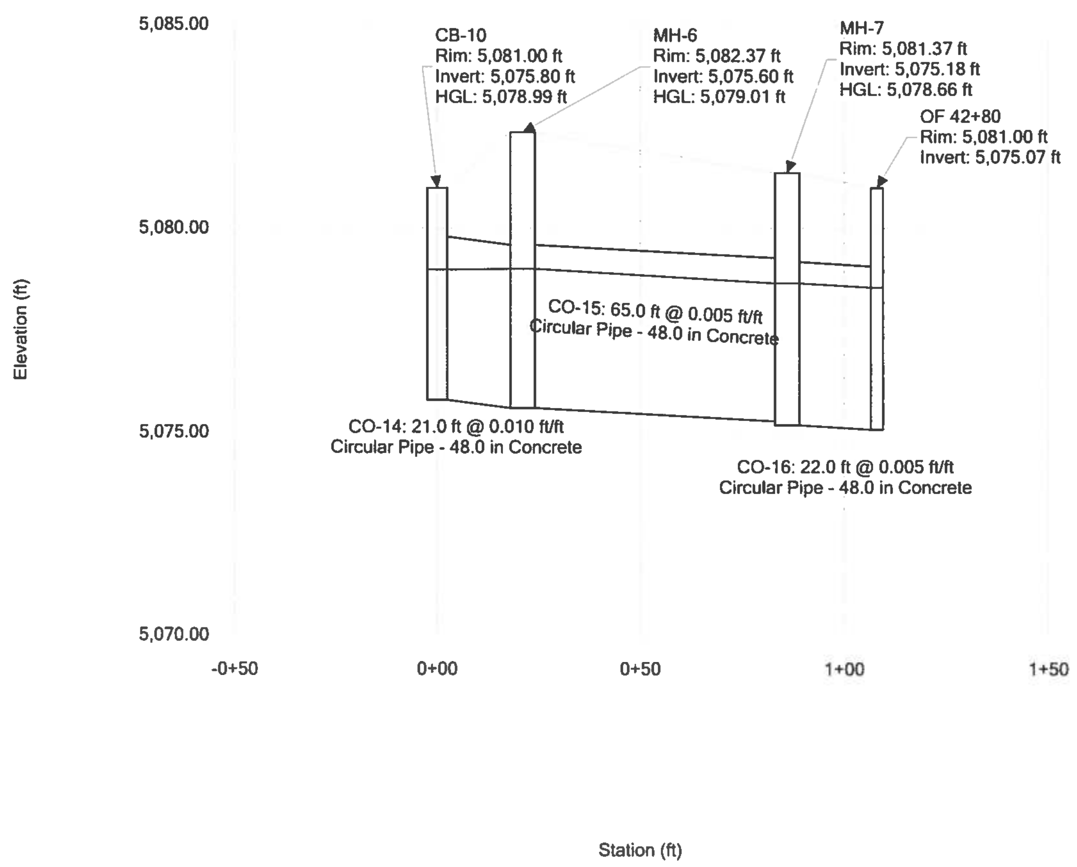
Water Depth (ft)	Grate Capacity Weir (cfs)	Grate Capacity Orifice (cfs)	Grate Interception (cfs)
0.00	0.0	0.0	0.0
0.10	1.5	27.2	1.5
0.20	4.3	38.5	4.3
0.86	38.3	79.8	38.3
1.00	48.0	86.0	48.0
1.20	63.1	94.2	63.1
1.22	64.7	95.0	64.7
1.40	79.5	101.8	79.5
1.60	97.1	108.8	97.1
1.80	115.9	115.4	115.4
2.00	135.8	121.7	121.7
2.40	178.5	133.3	133.3

Catch Basin --	Q (cfs)	Depth (ft)	Grate Elevation (ft)	Ponded Elevation (ft)
OFF-4	38	0.86	5081.7	5082.56
OFF-5	64	1.22	5081	5082.22

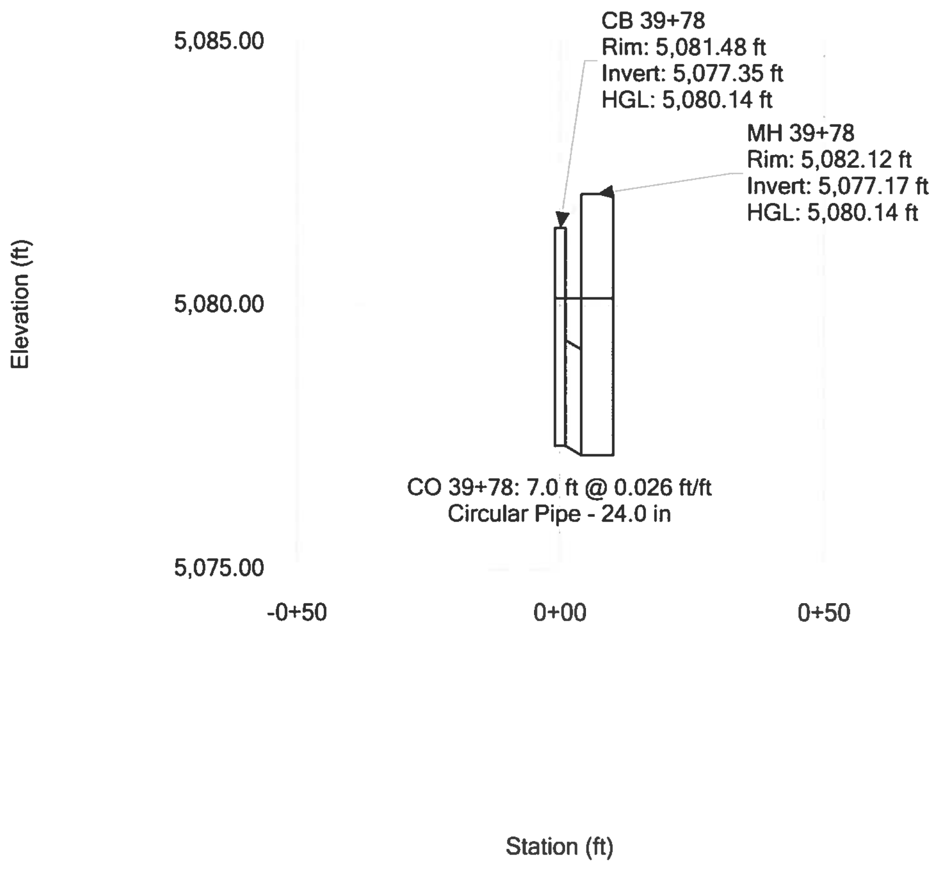
Profile Report
Engineering Profile - Channel Road 1 (Channel Road.stc)



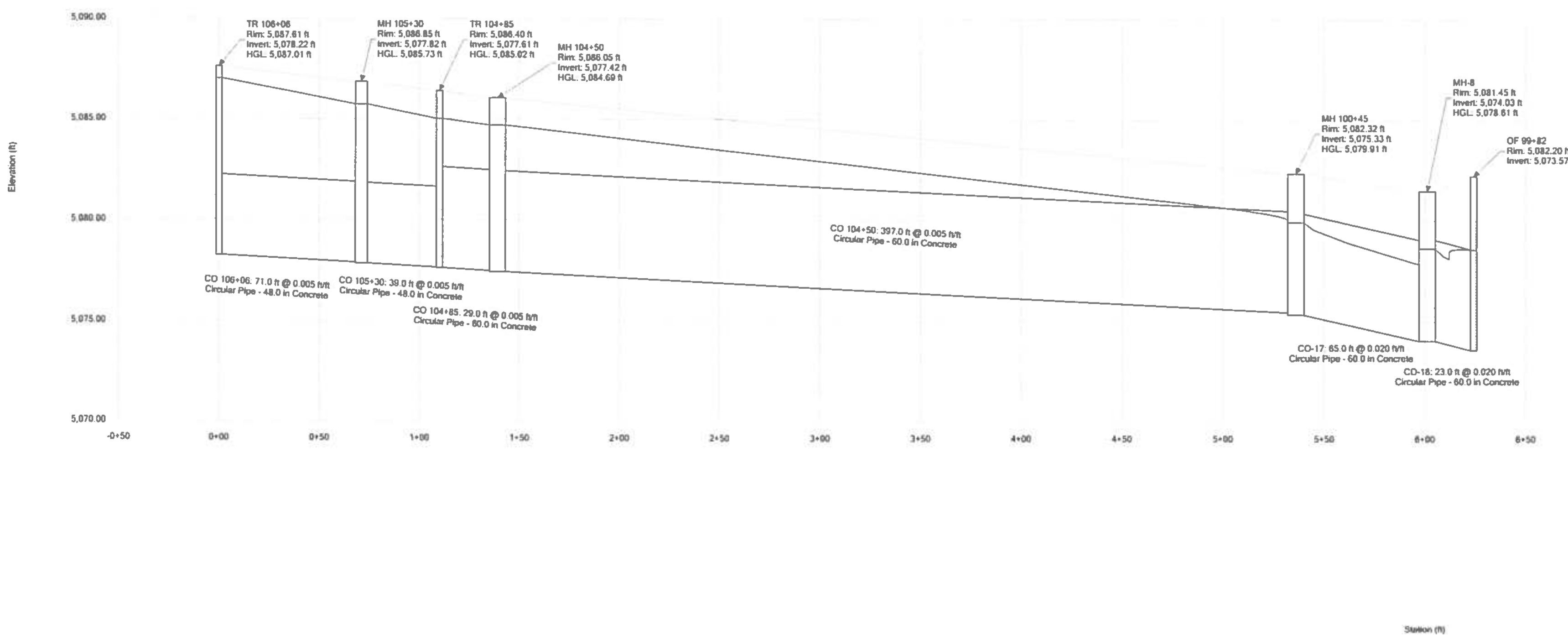
Profile Report
Engineering Profile - Channel Road 2 (Channel Road.stc)



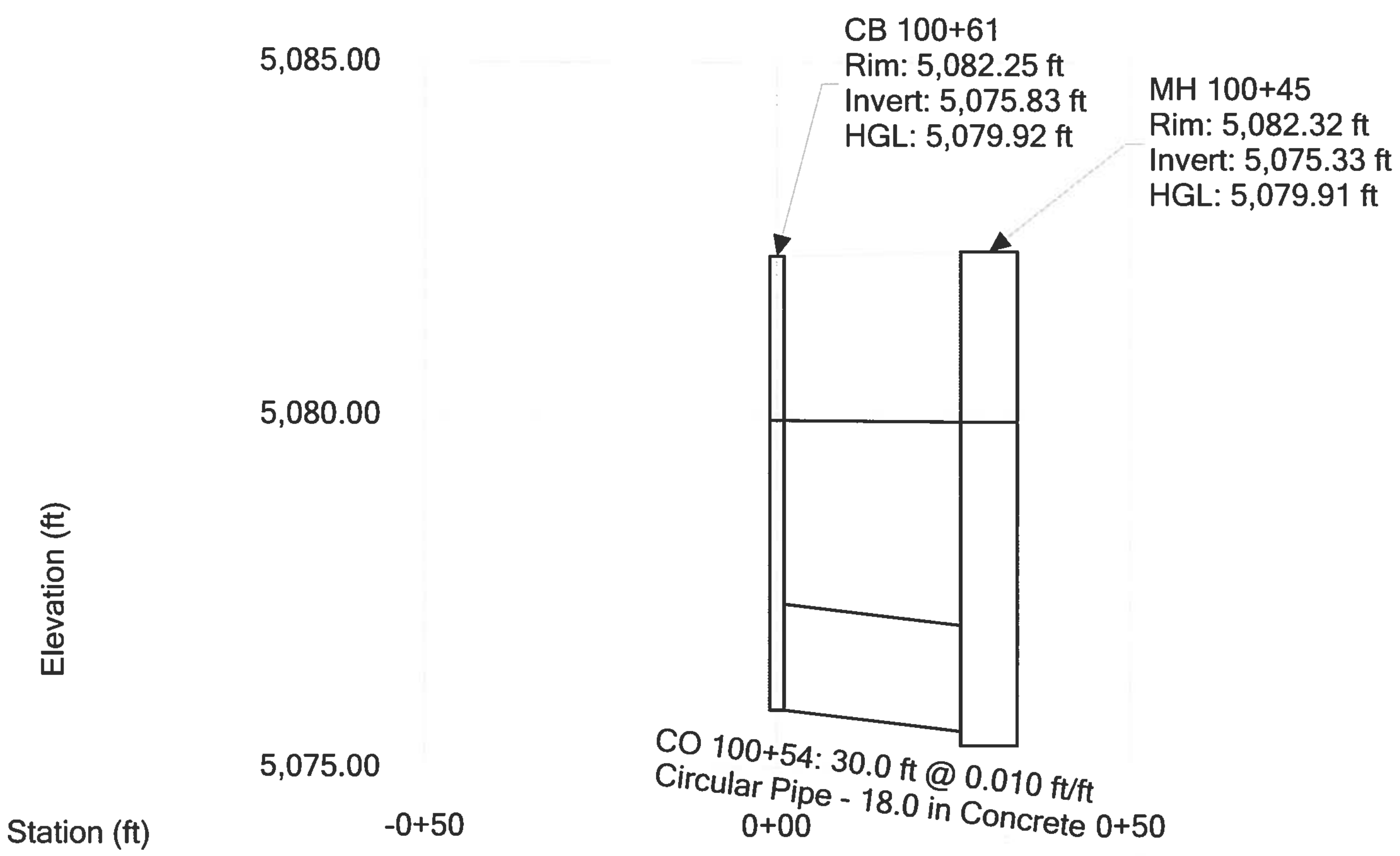
Profile Report
Engineering Profile - Channel Road Lateral (Channel Road.stc)



Profile Report
Engineering Profile - Hawkins Road 1 (Channel Road.stc)

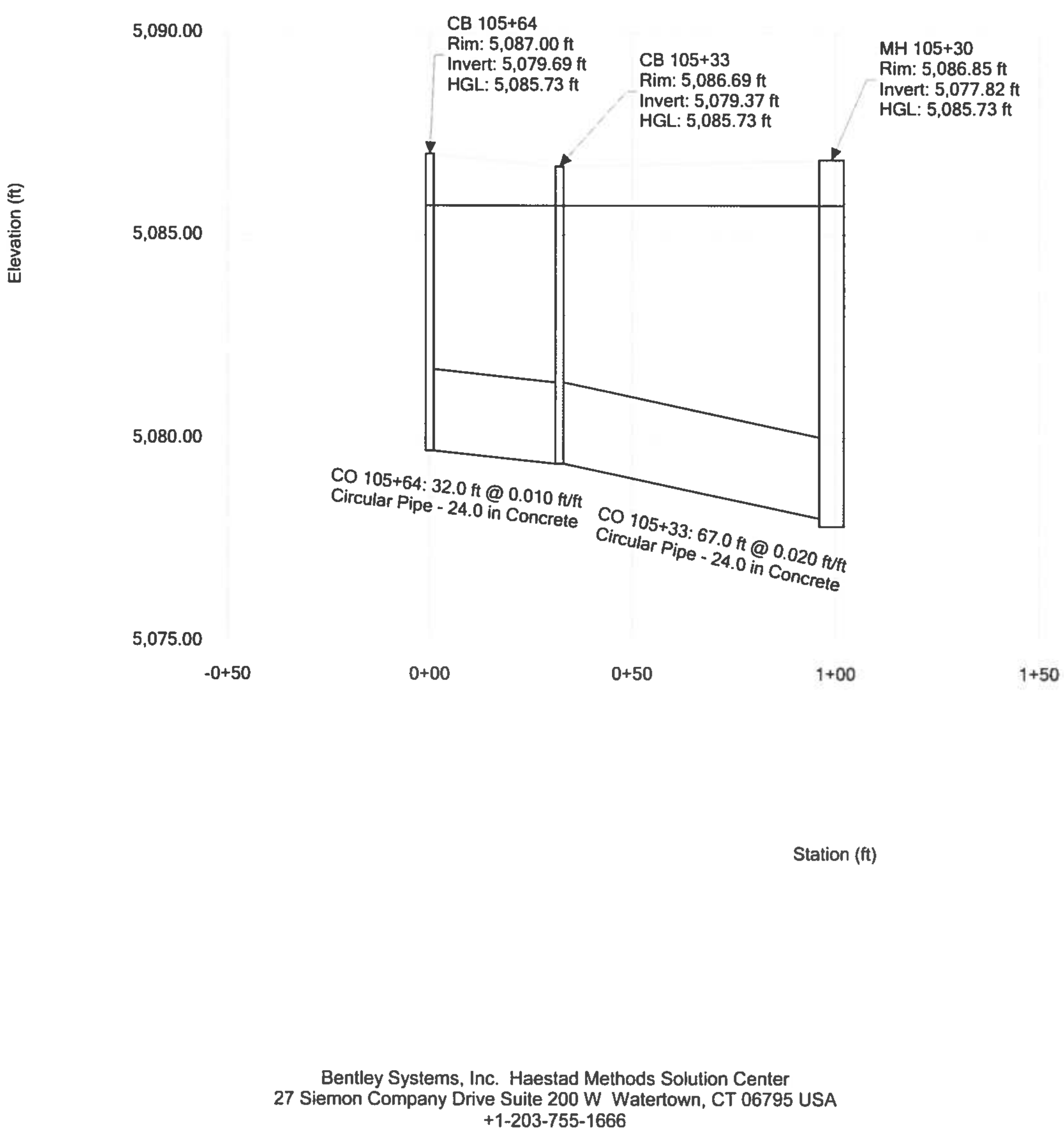


Profile Report
Engineering Profile - Hawkins Lateral (Channel Road.stc)



Profile Report

Engineering Profile - Snap Roll Lateral (Channel Road.stc)



Storm Drain, Inlet, and Manhole Summary

Project: Channel Road
Location: Albuquerque, NM
Date: May 23, 2012

Proj. Number: 221706
Proj. Engineer: R Strickland
Checker: E Froberg

Storm Drain Pipe Summary

Label	Length (ft)	Total Flow (ft^3/s)	Diameter (in)	Capacity (Full Flow) (ft^3/s)	Velocity (ft/s)	Upstream Invert (ft)	Downstream Invert (ft)	Slope (ft/ft)
CO-14	21	64	48	140.17	10.9	5,075.80	5,075.60	0.01
CO 39+00	69	38	36	48.17	7.55	5,077.63	5,077.27	0.005
CO 39+78	7	3.4	24	36.27	1.08	5,077.35	5,077.17	0.026
CO 39+78	295	41.4	36	47.08	7.51	5,077.17	5,075.70	0.005
CO-15	65	105.4	48	100.78	9.09	5,075.60	5,075.28	0.005
CO-16	22	105.4	48	101.57	9.18	5,075.18	5,075.07	0.005
CO 106+06	71	193	48	100.85	15.36	5,078.22	5,077.87	0.005
CO 105+64	32	0.15	24	22.62	0.05	5,079.69	5,079.37	0.01
CO 105+33	67	0.3	24	32.11	0.1	5,079.37	5,078.02	0.02
CO 105+30	39	193.3	48	97.58	15.38	5,077.82	5,077.64	0.005
CO 104+85	29	275.3	60	180.95	14.02	5,077.61	5,077.47	0.005
CO 104+50	397	275.3	60	183.45	14.02	5,077.42	5,075.45	0.005
CO 100+54	30	2.5	18	10.5	1.41	5,075.83	5,075.53	0.01
CO-17	65	277.8	60	368.3	20.61	5,075.33	5,074.03	0.02
CO-18	23	277.8	60	368.3	20.61	5,074.03	5,073.57	0.02

Catch Basin Summary

Label	Rim Elevation (ft)	Invert Elevation (ft)	Hydraulic Grade Line (ft)	Inlet Flow (ft^3/s)
CB 39+00	5,081.70	5,077.63	5,080.29	38
TR 106+06	5,087.61	5,078.22	5,087.01	193
TR 104+85	5,086.40	5,077.61	5,085.02	82
CB 105+64	5,087.00	5,079.69	5,085.73	0.15
CB 105+33	5,086.69	5,079.37	5,085.73	0.15
CB 100+61	5,082.25	5,075.83	5,079.92	2.5
CB 39+78	5,081.48	5,077.35	5,080.14	3.4
CB-10	5,081.00	5,075.80	5,078.99	64

Manhole Summary

Label	Rim Elevation (ft)	Invert Elevation (ft)	Diameter (in)	Hydraulic Grade Line (ft)
MH 39+78	5,082.12	5,077.17	72.00	5080.14
MH 105+30	5,086.85	5,077.82	72.00	5085.73
MH 100+45	5,082.32	5,075.33	96.00	5079.91
MH 104+50	5,086.05	5,077.42	96.00	5084.69
MH-6 (42+80, 36' Rt)	5,082.37	5,075.60	72.00	5079.01
MH-7 (42+80, 28' Lt)	5,081.37	5,075.18	72.00	5078.66
MH-8 (43+25, 28' Lt)	5,081.45	5,074.03	96.00	5078.61

Culvert Designer/Analyzer Report
23+62

Analysis Component			
Storm Event	Design	Discharge	281.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	281.00 cfs	Check Discharge	300.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-10 x 3 ft Box	281.00 cfs	5,085.50 ft	13.40 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
23+62

Component:Culvert-1

Culvert Summary

Computed Headwater Elev:	5,085.50 ft	Discharge	281.00 cfs
Inlet Control HW Elev.	5,085.50 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	5,084.95 ft	Control Type	Inlet Control
Headwater Depth/Height	1.73		

Grades

Upstream Invert	5,080.30 ft	Downstream Invert	5,079.20 ft
Length	89.90 ft	Constructed Slope	0.012236 ft/ft

Hydraulic Profile

Profile	S2	Depth, Downstream	2.10 ft
Slope Type	Steep	Normal Depth	1.83 ft
Flow Regime	Supercritical	Critical Depth	2.91 ft
Velocity Downstream	13.40 ft/s	Critical Slope	0.003179 ft/ft

Section

Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	10.00 ft
Section Size	10 x 3 ft	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	5,084.95 ft	Upstream Velocity Head	1.45 ft
Ke	0.20	Entrance Loss	0.29 ft

Inlet Control Properties

Inlet Control HW Elev.	5,085.50 ft	Flow Control	N/A
Inlet Type	90° headwall w 45° bevels	Area Full	30.0 ft²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

Culvert Designer/Analyzer Report
32+40

Analysis Component			
Storm Event	Design	Discharge	75.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	75.00 cfs	Check Discharge	100.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-36 inch Circular	75.00 cfs	5,081.41 ft	11.25 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
32+40

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	5,081.41	ft	Discharge	75.00	cfs
Inlet Control HW Elev.	5,081.22	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	5,081.41	ft	Control Type	Entrance Control	
Headwater Depth/Height	1.10				

Grades					
Upstream Invert	5,078.10	ft	Downstream Invert	5,076.59	ft
Length	84.67	ft	Constructed Slope	0.017834	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.43	ft
Slope Type	Steep		Normal Depth	1.36	ft
Flow Regime	Supercritical		Critical Depth	1.99	ft
Velocity Downstream	11.25	ft/s	Critical Slope	0.005198	ft/ft

Section				
Section Shape	Circular	Mannings Coefficient	0.013	
Section Material	Concrete	Span	3.00	ft
Section Size	36 inch	Rise	3.00	ft
Number Sections	2			

Outlet Control Properties					
Outlet Control HW Elev.	5,081.41	ft	Upstream Velocity Head	0.88	ft
Ke	0.50		Entrance Loss	0.44	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,081.22	ft	Flow Control	Unsubmerged	
Inlet Type	Square edge w/headwall		Area Full	14.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

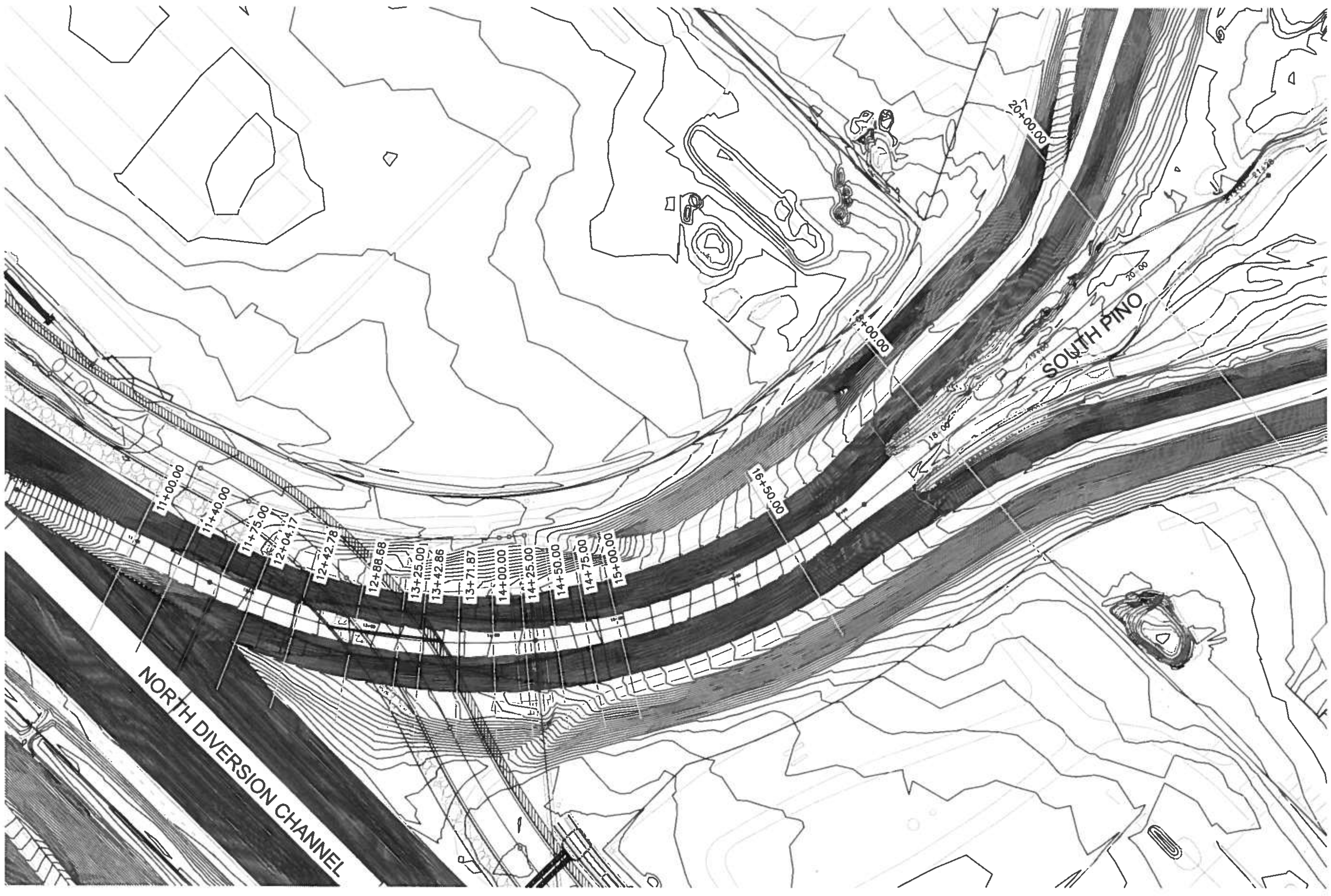
Roadside Ditch Capacity

Project: Channel Road
Location: Albuquerque, NM
Date: December 22, 2011

Proj. Number: 221706
Proj. Engineer: R Strickland
Checker: E Froberg

Mannings n-value 0.03
Channel Bottom Width 5

Station	Lt Slope	Rt Slope	Channel Depth (ft)	Channel Slope (ft/ft)	Channel 100-YR Flow (cfs)	Channel Capacity (cfs)	Full Flow Velocity (ft/s)
1250	51.34%	50%	3.2	0.025	74	432	12.0
1275	48.64%	50%	3.8	0.025	74	630	13.2
1350	36.06%	50%	2.8	0.025	74	362	11.1
1400	28.22%	50%	2.2	0.014	74	172	7.2
1450	24.06%	50%	1.9	0.005	74	77	3.9
1500	23.94%	50%	1.8	0.005	74	76	3.9
1550	23.94%	50%	1.8	0.005	74	76	3.9
1600	23.94%	50%	1.8	0.005	74	76	3.9
1650	23.94%	50%	1.8	0.005	74	76	3.9
1700	23.94%	50%	1.8	0.005	74	76	3.9
1750	23.94%	50%	1.8	0.005	74	76	3.9
1800	23.94%	50%	1.8	0.005	74	76	3.9
1850	25.56%	50%	2.0	0.005	74	86	4.0
1900	30.43%	50%	2.4	0.005	74	118	4.5
1950	36.93%	50%	2.9	0.005	74	168	5.0
2000	42.61%	50%	3.3	0.005	178	220	5.5
2050	46.67%	50%	3.6	0.005	178	261	5.7
2100	49.11%	50%	3.8	0.005	178	287	5.9
2150	49.92%	50%	3.9	0.005	281	297	6.0
2200	49.92%	50%	3.9	0.005	281	297	6.0
2250	49.92%	50%	3.9	0.005	281	297	6.0
2300	49.92%	50%	3.9	0.005	281	297	6.0
2350	49.92%	50%	3.9	0.005	281	292	6.0
2400	38.94%	50%	3.0	0.005	75	187	5.2
2450	38.94%	50%	3.0	0.005	75	187	5.2
2500	38.94%	50%	3.0	0.005	75	187	5.2
2550	38.94%	50%	2.6	0.005	75	131	4.7
2600	38.94%	50%	2.8	0.005	75	156	4.9
2650	38.94%	50%	2.7	0.005	75	141	4.8
2700	38.94%	50%	2.5	0.005	75	120	4.6
2750	38.94%	50%	2.2	0.005	75	99	4.4
2800	38.94%	50%	2.3	0.005	75	108	4.5
2850	38.94%	50%	2.5	0.005	75	125	4.7
2900	38.94%	50%	2.7	0.005	75	146	4.9
2950	38.94%	50%	2.8	0.005	75	158	5.0
3000	39.44%	50%	2.6	0.005	75	135	4.8
3050	43.44%	50%	2.8	0.005	75	157	5.0
3100	51.44%	50%	3.1	0.005	75	187	5.3
3150	50.00%	50%	3.4	0.005	75	223	5.5
3200	50.00%	50%	3.5	0.005	75	238	5.6
3250	50.00%	50%	3.5	0.005	75	230	5.6
3300	50.00%	50%	3.4	0.005	7	225	5.6



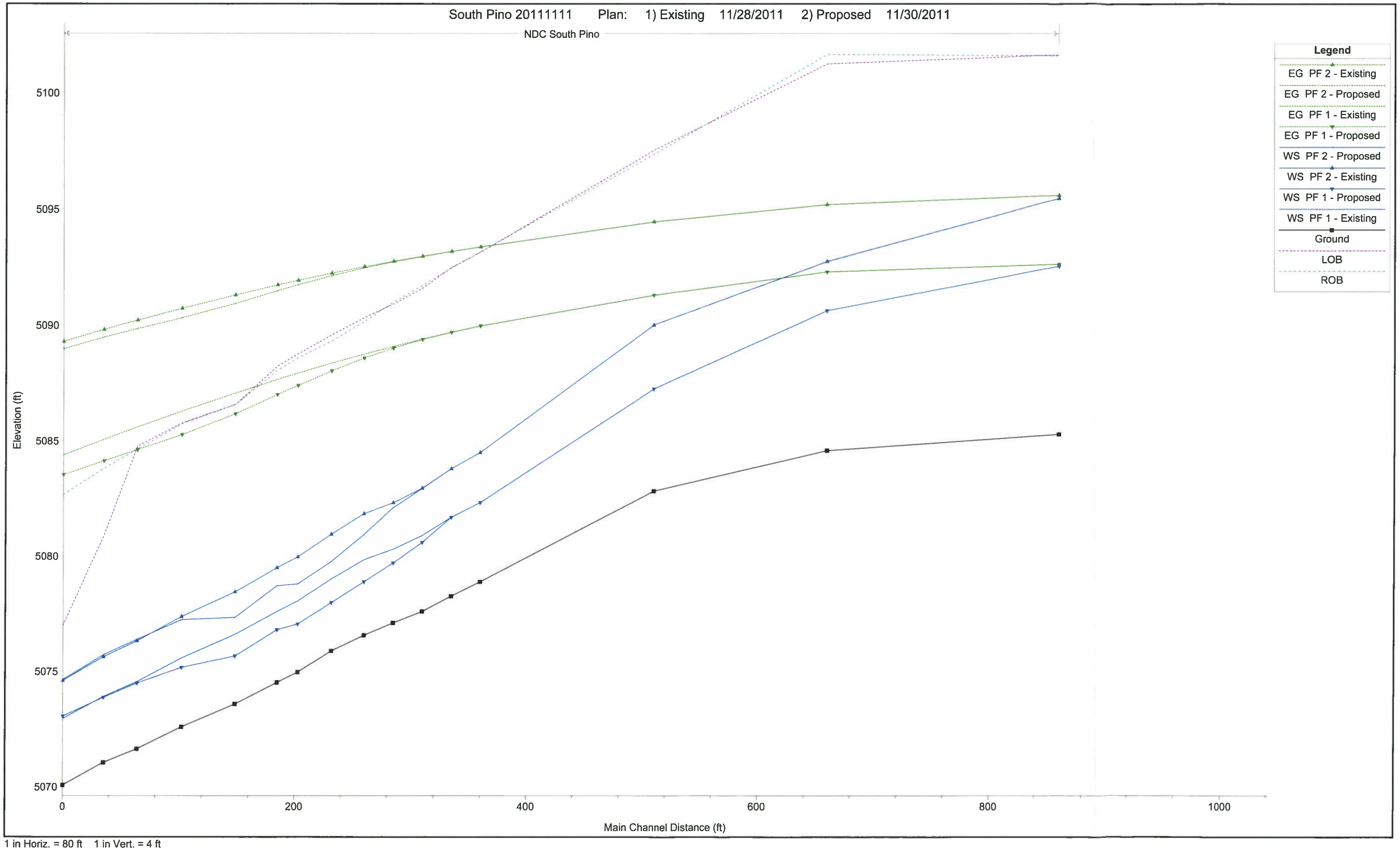
SOUTH PINO ARROYO
HEC-RAS SECTIONS

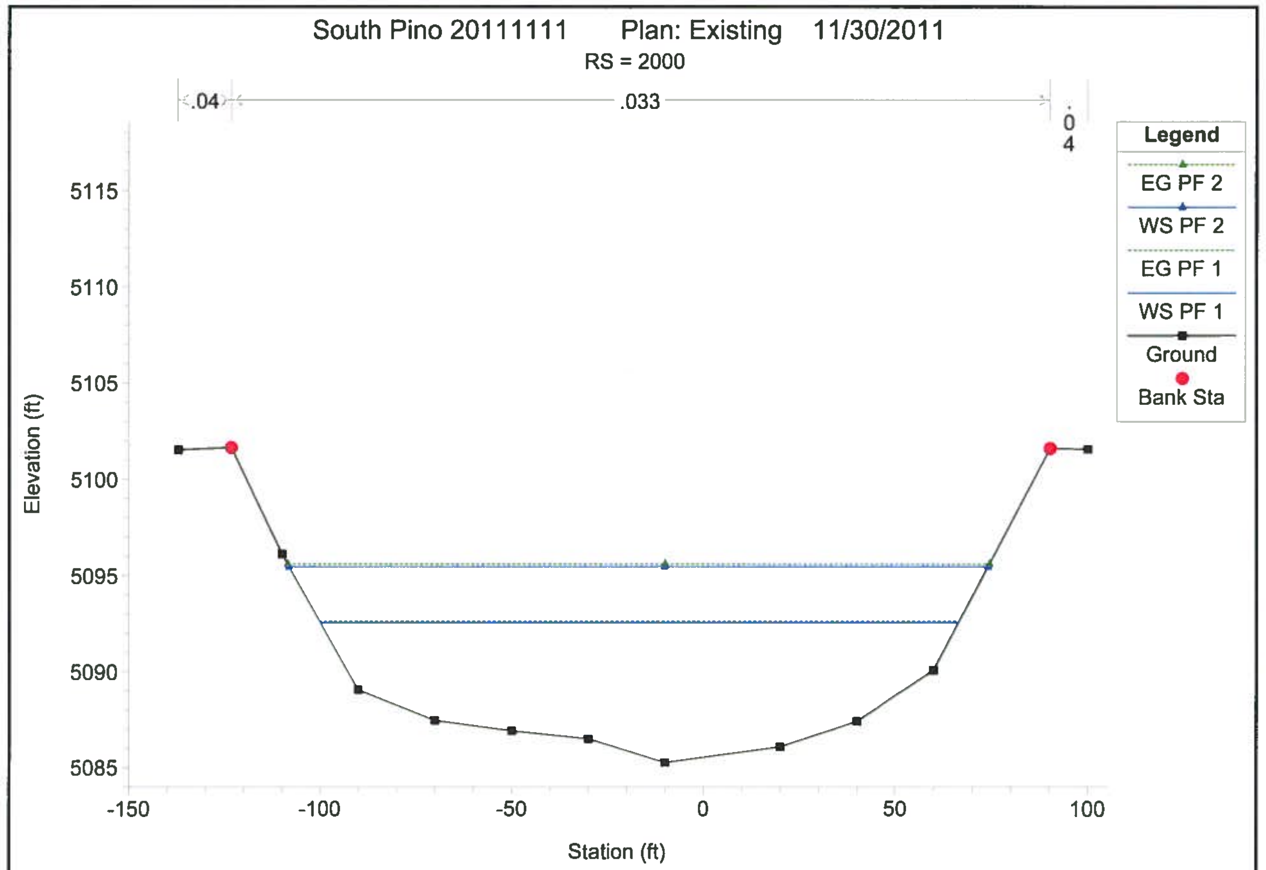
T·Y· LIN INTERNATIONAL
engineers | planners | scientists
500 4th Street NW, Suite 403
Albuquerque, NM 87102

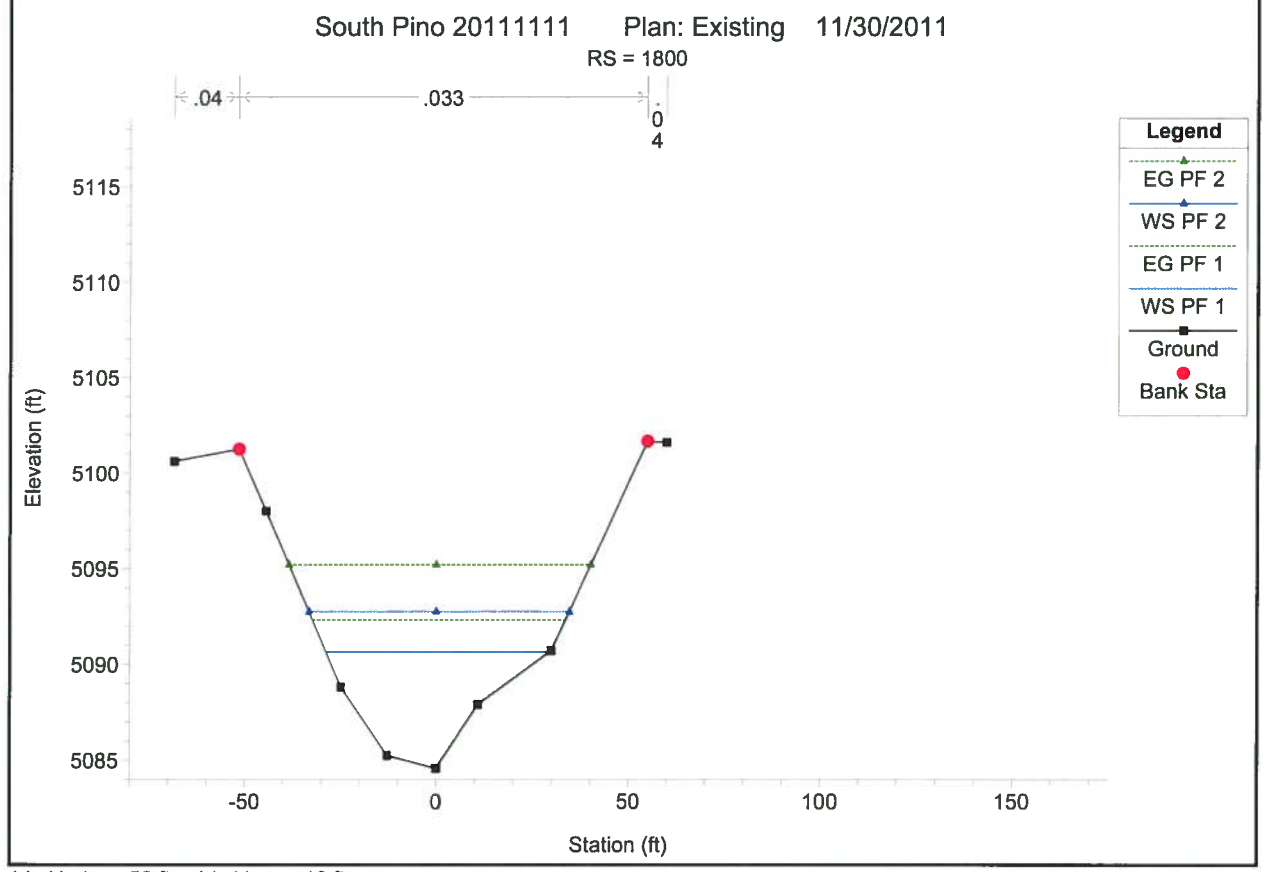
P:\221706.00 – Osuna Road City of Albuquerque\CADD\References\PROF_Channel_Road.dwg
11/23/2011 2:08:26 PM

HEC-RAS River: NDC Reach: South Pino

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W S Elev	Crit W.S.	E G Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
South Pino	2000	PF 1	Existing	2000.00	5085.27	5092 54	5088.55	5092 63	0.000295	2.31	865.90	166.37	0.18
South Pino	2000	PF 1	Proposed	2000.00	5085.27	5092 54	5088.55	5092 63	0.000295	2.31	865.90	166.37	0.18
South Pino	2000	PF 2	Existing	4100.00	5085.27	5095 46	5089.77	5095 60	0.000303	2.98	1373.85	182.26	0.19
South Pino	2000	PF 2	Proposed	4100.00	5085.27	5095.46	5089.77	5095 60	0.000303	2.98	1373.85	182.26	0.19
South Pino	1800	PF 1	Existing	2000.00	5084.57	5090.63	5090.63	5092.29	0.011080	10.36	193.04	58.10	1.00
South Pino	1800	PF 1	Proposed	2000.00	5084.57	5090.63	5090.63	5092.29	0.011084	10.36	193.02	58.10	1.00
South Pino	1800	PF 2	Existing	4100.00	5084.57	5092.74	5092.74	5095.19	0.010037	12.55	326.62	67.83	1.01
South Pino	1800	PF 2	Proposed	4100.00	5084.57	5092.74	5092.74	5095.19	0.010055	12.56	326.42	67.82	1.01
South Pino	1650	PF 1	Existing	2000.00	5082.81	5087.24	5088.49	5091.29	0.004307	16.14	123.94	37.26	1.56
South Pino	1650	PF 1	Proposed	2000.00	5082.81	5087.24	5088.48	5091.29	0.004307	16.14	123.94	37.26	1.56
South Pino	1650	PF 2	Existing	4100.00	5082.81	5090.00	5091.19	5094.44	0.002810	16.92	242.35	48.67	1.34
South Pino	1650	PF 2	Proposed	4100.00	5082.81	5090.00	5091.19	5094.44	0.002810	16.92	242.35	48.67	1.34
South Pino	1500	PF 1	Existing	2000.00	5078.87	5082.32	5084.52	5089.96	0.010586	22.18	90.16	33.20	2.37
South Pino	1500	PF 1	Proposed	2000.00	5078.87	5082.32	5084.52	5089.96	0.010586	22.18	90.16	33.20	2.37
South Pino	1500	PF 2	Existing	4100.00	5078.87	5084.48	5087.24	5093.36	0.007269	23.91	171.45	41.99	2.09
South Pino	1500	PF 2	Proposed	4100.00	5078.87	5084.48	5087.24	5093.36	0.007269	23.91	171.45	41.99	2.09
South Pino	1475	PF 1	Existing	2000.00	5078.25	5081.68	5083.94	5089.69	0.011381	22.71	88.07	33.11	2.45
South Pino	1475	PF 1	Proposed	2000.00	5078.25	5081.68	5083.94	5089.69	0.011381	22.71	88.07	33.11	2.45
South Pino	1475	PF 2	Existing	4100.00	5078.25	5083.78	5086.62	5093.17	0.007904	24.59	166.71	41.77	2.17
South Pino	1475	PF 2	Proposed	4100.00	5078.25	5083.78	5086.62	5093.17	0.007904	24.59	166.71	41.77	2.17
South Pino	1450	PF 1	Existing	2000.00	5077.55	5080.89	5083.23	5089.39	0.012372	23.40	85.46	32.70	2.55
South Pino	1450	PF 1	Proposed	2000.00	5077.58	5080.59	5083.09	5089.38	0.013181	23.79	84.08	28.84	2.46
South Pino	1450	PF 2	Existing	4100.00	5077.55	5082.94	5085.91	5092.96	0.008643	25.41	161.38	41.20	2.26
South Pino	1450	PF 2	Proposed	4100.00	5077.58	5082.93	5085.98	5092.96	0.008845	25.41	161.34	37.53	2.16
South Pino	1425	PF 1	Existing	2000.00	5077.03	5080.30	5082.70	5089.08	0.013006	23.78	84.11	32.65	2.61
South Pino	1425	PF 1	Proposed	2000 00	5077.09	5079.70	5082.11	5089.01	0.015669	24.48	81.70	31.28	2.67
South Pino	1425	PF 2	Existing	4100 00	5077.03	5082.31	5085.39	5092.75	0.009172	25.93	158.15	40.99	2.33
South Pino	1425	PF 2	Proposed	4100 00	5077.09	5082.10	5085.52	5092.73	0.008884	26.16	156.71	31.46	2.07
South Pino	1400	PF 1	Existing	2000 00	5076.50	5079.84	5082.24	5088.75	0.013139	23.95	83.50	32.29	2.62
South Pino	1400	PF 1	Proposed	2000 00	5076.55	5078.88	5081.26	5088.58	0.018331	24.99	80.03	34.34	2.88
South Pino	1400	PF 2	Existing	4100 00	5076.50	5081.84	5084.93	5092.52	0.009424	26.23	156.34	40.62	2.36
South Pino	1400	PF 2	Proposed	4100 00	5076.55	5080.93	5084.19	5092.47	0.010742	27.26	150.42	34.34	2.30
South Pino	1371 87	PF 1	Existing	2000.00	5075.84	5079.01	5081.46	5088.36	0.014284	24.55	81.48	32.39	2.73
South Pino	1371.87	PF 1	Proposed	2000.00	5075.87	5077.98	5080.33	5088.02	0.021147	25.43	78.63	37.33	3.09
South Pino	1371.87	PF 2	Existing	4100.00	5075.84	5080.94	5084.14	5092.24	0.010258	26.97	152.03	40.43	2.45
South Pino	1371.87	PF 2	Proposed	4100.00	5075.87	5079.76	5083.06	5092.13	0.012826	28.23	145.26	37.33	2.52
South Pino	1342.86	PF 1	Existing	2000.00	5074.93	5078.05	5080.57	5087.93	0.015347	25.23	79.28	31.89	2.82
South Pino	1342.86	PF 1	Proposed	2000.00	5074.95	5077.04	5079.43	5087.39	0.021977	25.82	77.47	37.01	3.14
South Pino	1342.86	PF 2	Existing	4100.00	5074.93	5079.96	5083.27	5091.93	0.011021	27.76	147.68	39.62	2.53
South Pino	1342.86	PF 2	Proposed	4100.00	5074.95	5078.79	5082.18	5091.74	0.013678	28.89	141.93	37.01	2.60
South Pino	1325	PF 1	Existing	2000.00	5074.42	5077.59	5080.15	5087.65	0.015674	25.46	78.55	31.65	2.85
South Pino	1325	PF 1	Proposed	2000.00	5074.50	5076.80	5079.24	5087.00	0.022848	25.63	78.03	34.00	2.98
South Pino	1325	PF 2	Existing	4100.00	5074.42	5079.49	5082.86	5091.73	0.011349	28.08	146.01	39.37	2.57
South Pino	1325	PF 2	Proposed	4100.00	5074.50	5078.70	5082.15	5091.48	0.015865	28.69	142.92	34.00	2.47
South Pino	1286.68	PF 1	Existing	2000.00	5073.56	5076.59	5079 19	5087 06	0.016763	25.97	77.02	31.74	2.94
South Pino	1288.68	PF 1	Proposed	2000.00	5073.57	5075.66	5078 07	5086.17	0.022435	26.02	76.87	36.86	3.18
South Pino	1288.68	PF 2	Existing	4100.00	5073.56	5078.44	5081 87	5091.30	0.012248	28.78	142.45	39.25	2.66
South Pino	1288.68	PF 2	Proposed	4100.00	5073.57	5077.33	5080 83	5090.94	0.014707	29.60	138.50	36.86	2.69
South Pino	1242.78	PF 1	Existing	2000.00	5072.54	5075.56	5078.20	5086.28	0.017342	26.27	76.13	31.65	2.98
South Pino	1242.78	PF 1	Proposed	2000.00	5072 58	5075 16	5077.69	5085.26	0.017322	25.50	78.42	30.36	2.80
South Pino	1242.78	PF 2	Existing	4100.00	5072 54	5077 36	5080.88	5090.72	0.012950	29.33	139 80	39 10	2 73
South Pino	1242.78	PF 2	Proposed	4100.00	5072 58	5077.23	5081.06	5090.32	0.011860	29.03	141 25	30 36	2 37
South Pino	1204.17	PF 1	Existing	2000.00	5071 63	5074.54	5077.19	5085.59	0.018218	26.68	74 95	31 57	3 05
South Pino	1204.17	PF 1	Proposed	2000.00	5071 63	5074.48	5077.07	5084.61	0.016324	25.55	78 28	30 30	2 80
South Pino	1204.17	PF 2	Existing	4100.00	5071 63	5076.31	5079.89	5090.21	0.013638	29.92	137 03	38 61	2 80
South Pino	1204.17	PF 2	Proposed	4100.00	5071 63	5076.37	5080.09	5089.84	0.012549	29.45	139 21	34 03	2 57
South Pino	1175	PF 1	Existing	2000.00	5070 93	5073.90	5076.56	5085.05	0.018619	26.81	74 61	31 81	3 08
South Pino	1175	PF 1	Proposed	2000.00	5071 04	5073.86	5076.52	5084.13	0.016811	25.71	77 79	30 59	2 84
South Pino	1175	PF 2	Existing	4100.00	5070 93	5075.62	5079.22	5089.80	0.014272	30.22	135 65	39 12	2 86
South Pino	1175	PF 2	Proposed	4100.00	5071 04	5075.70	5079.42	5089.47	0.013282	29.78	137 70	35 00	2 65
South Pino	1140	PF 1	Existing	2000 00	5070 07	5072 95	5075 61	5084 39	0 019871	27.14	73.69	32.51	3 18
South Pino	1140	PF 1	Proposed	2000 00	5070 07	5073 05	5075 60	5083.53	0 017510	25.97	77.00	32.98	3 00
South Pino	1140	PF 2	Existing	4100 00	5070 07	5074 59	5078 14	5089.28	0 015517	30.76	133 28	40.09	2 97
South Pino	1140	PF 2	Proposed	4100 00	5070 07	5074 63	5078.14	5088 97	0 014992	30.39	134 93	40.28	2 93

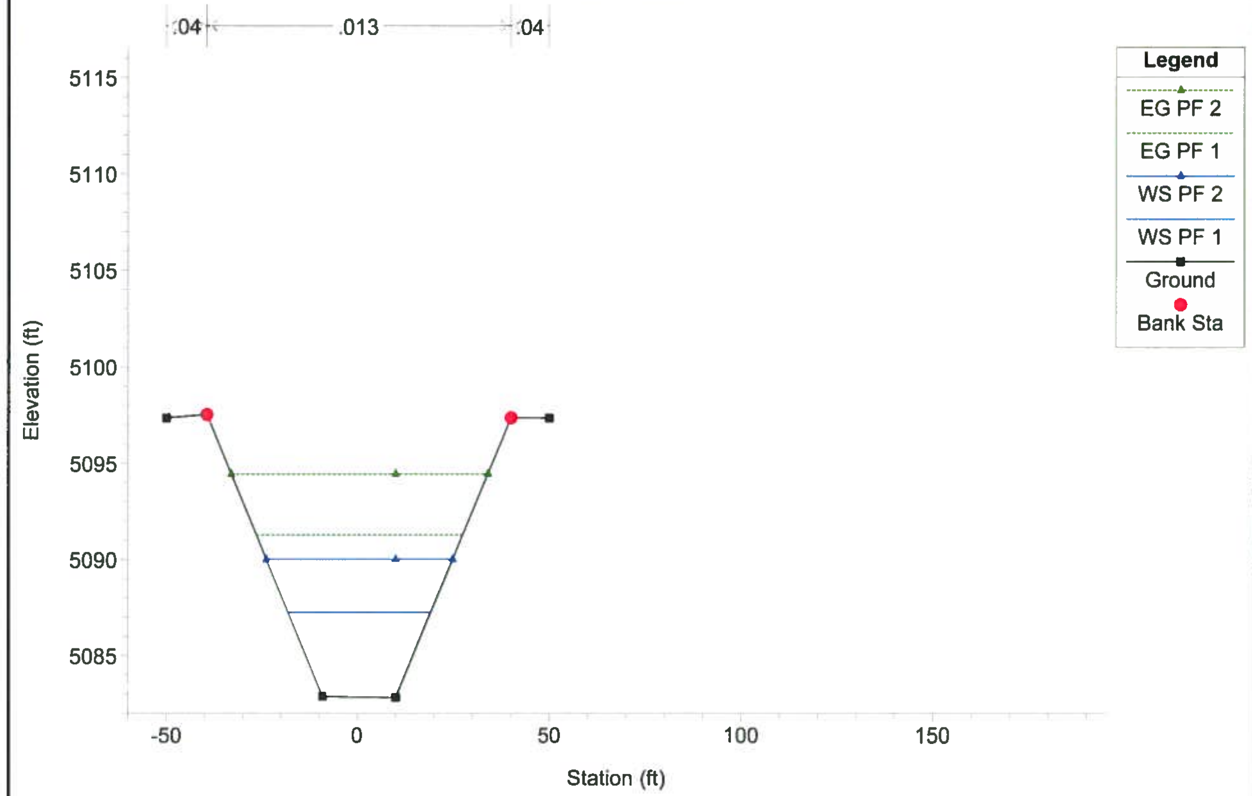

South Pino 20111111 Plan: 1) Existing 11/28/2011 2) Proposed 11/30/2011
NDC South Pino
Legend
EG PF 2 - Existing
EG PF 2 - Proposed
EG PF 1 - Existing
EG PF 1 - Proposed
WS PF 2 - Proposed
WS PF 2 - Existing
WS PF 1 - Proposed
WS PF 1 - Existing
Ground
LOB
ROB
Elevation (ft)
5100
5095
5090
5085
5080
5075
5070
0
200
400
600
800
1000
Main Channel Distance (ft)
1 in Horiz. = 80 ft 1 in Vert. = 4 ft



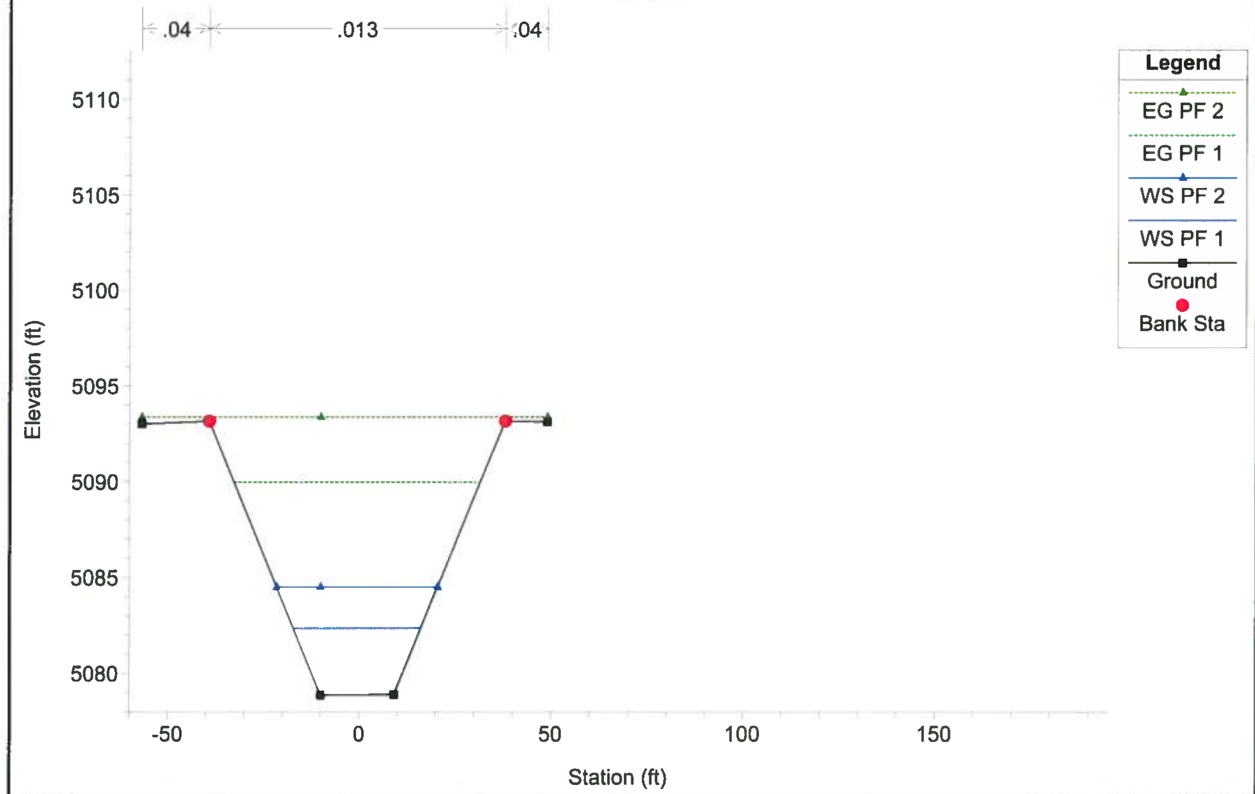


1 in Horiz. = 50 ft 1 in Vert. = 10 ft

South Pino 20111111 Plan: Existing 11/30/2011
RS = 1650



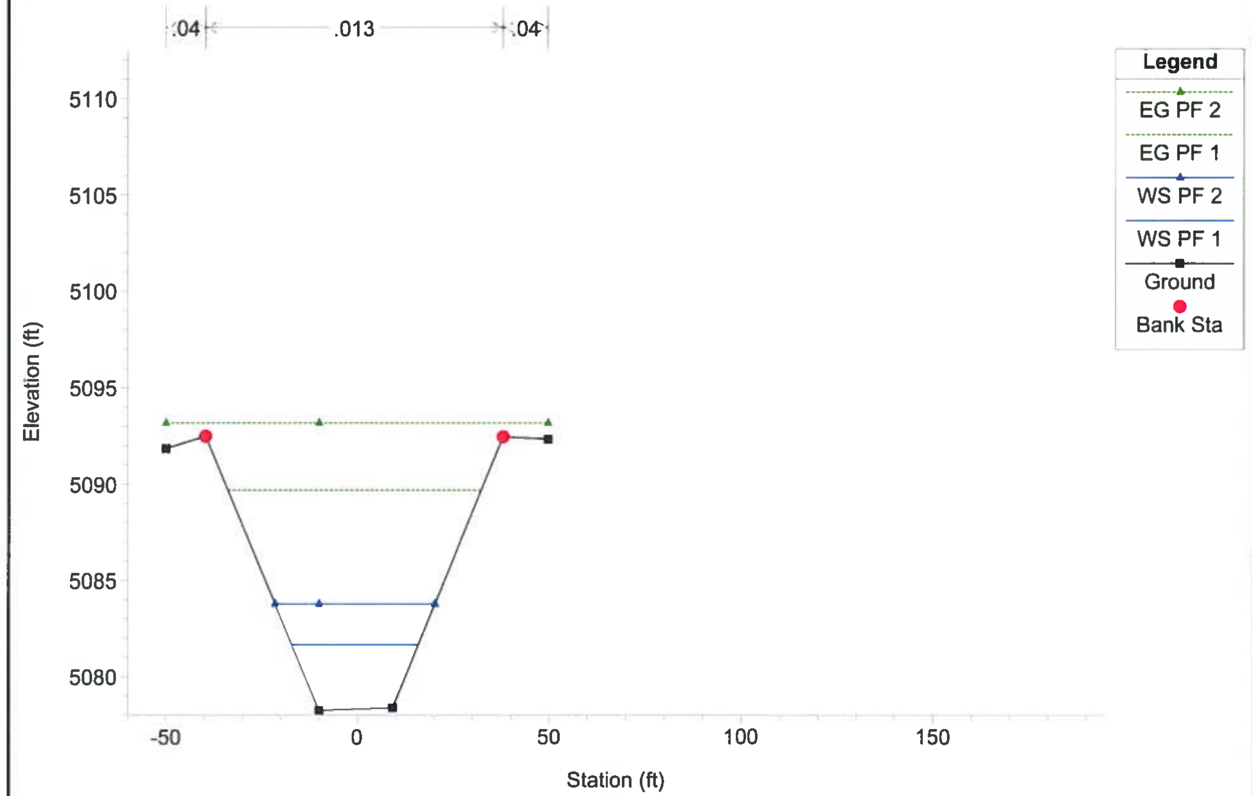
South Pino 20111111 Plan: Existing 11/30/2011
RS = 1500



1 in Horiz. = 50 ft 1 in Vert. = 10 ft

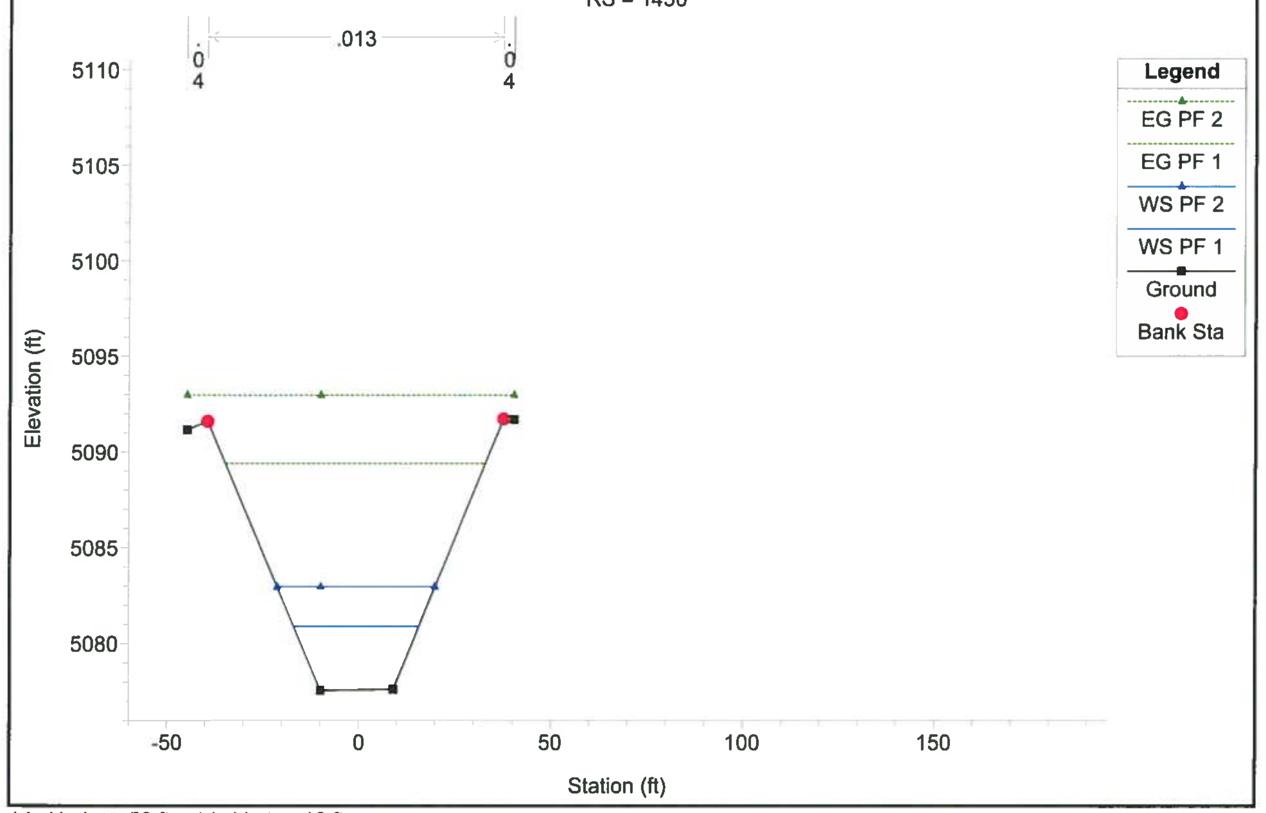
South Pino 20111111 Plan: Existing 11/30/2011

RS = 1475



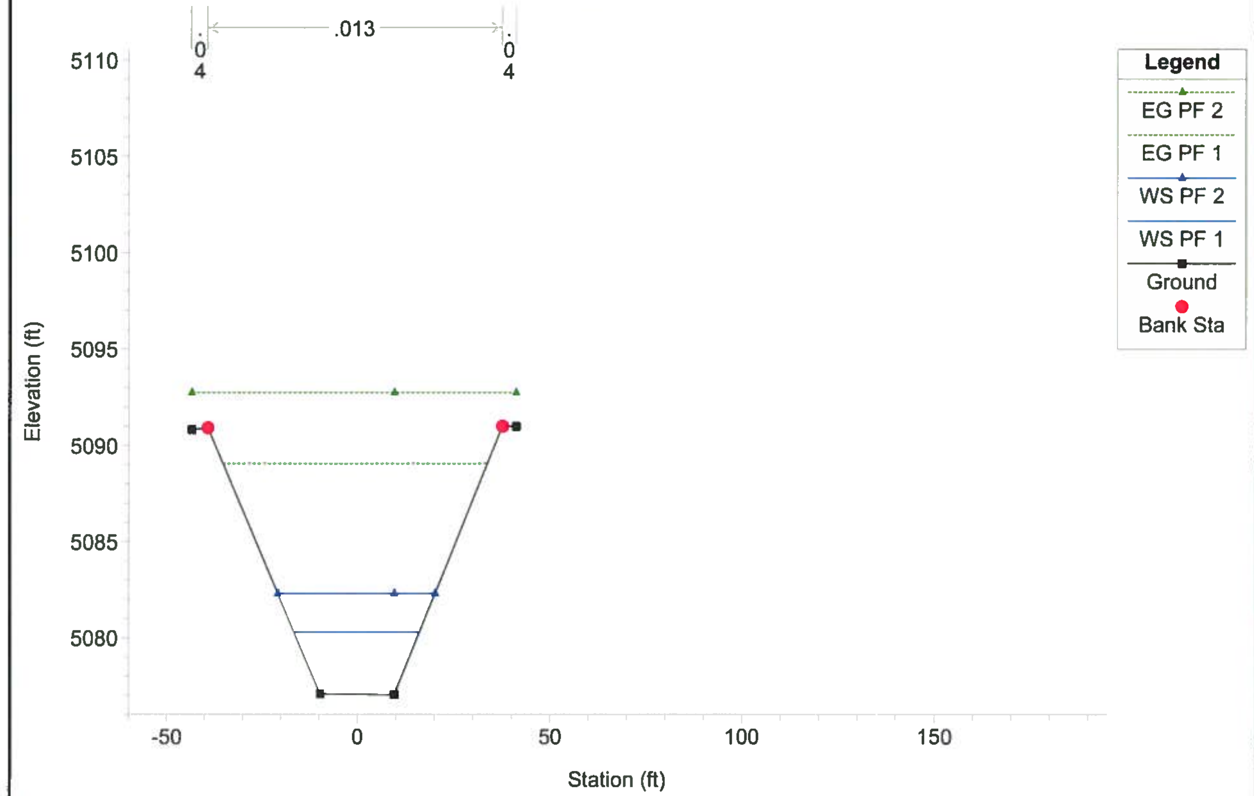
South Pino 20111111 Plan: Existing 11/30/2011

RS = 1450

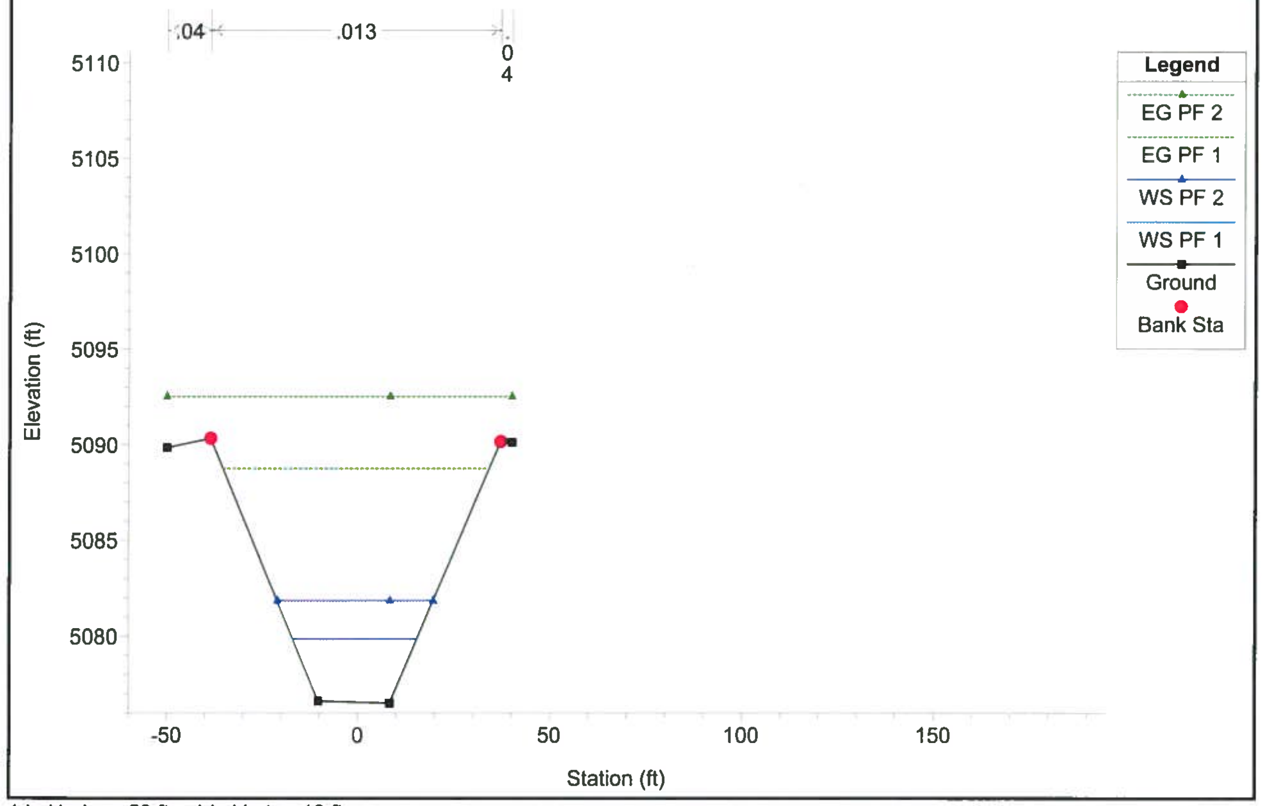


1 in Horiz. = 50 ft 1 in Vert. = 10 ft

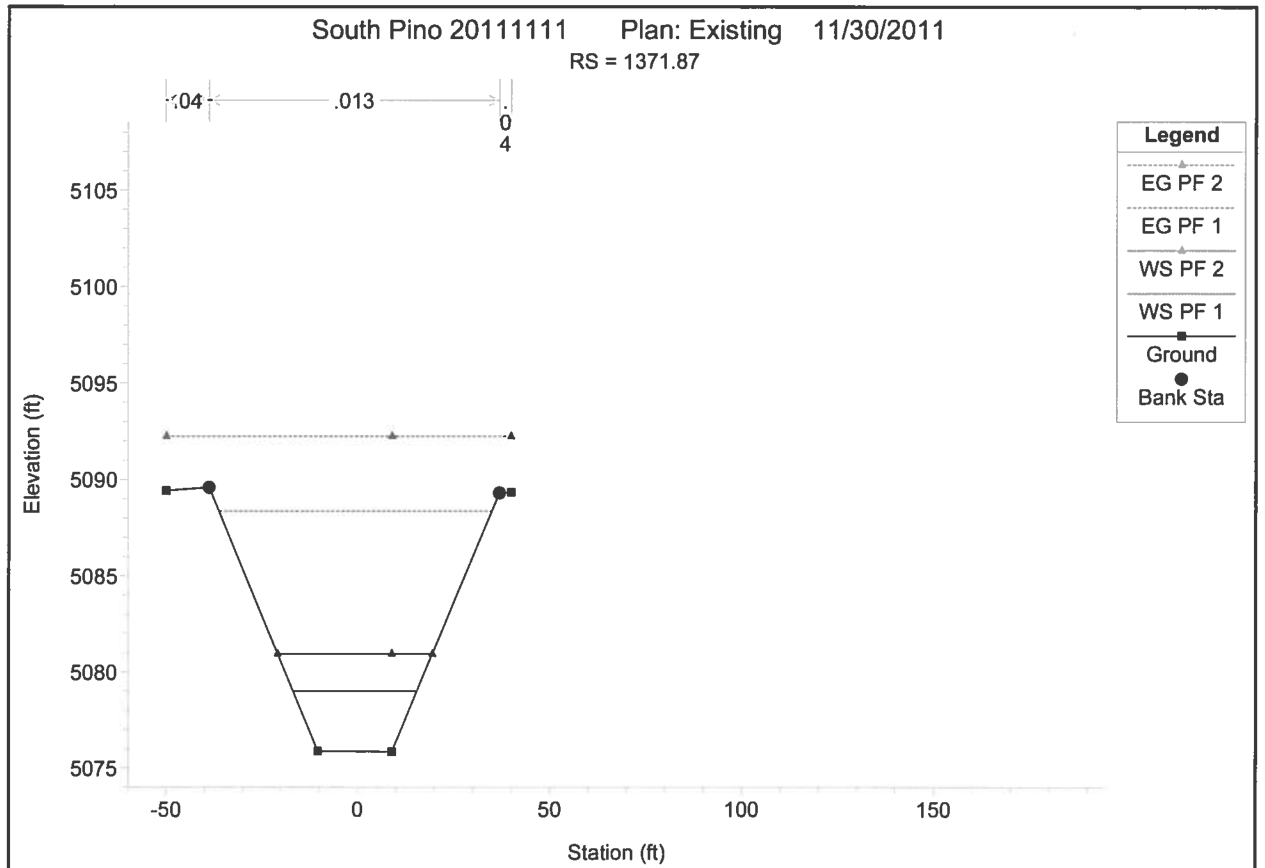
South Pino 20111111 Plan: Existing 11/30/2011
RS = 1425

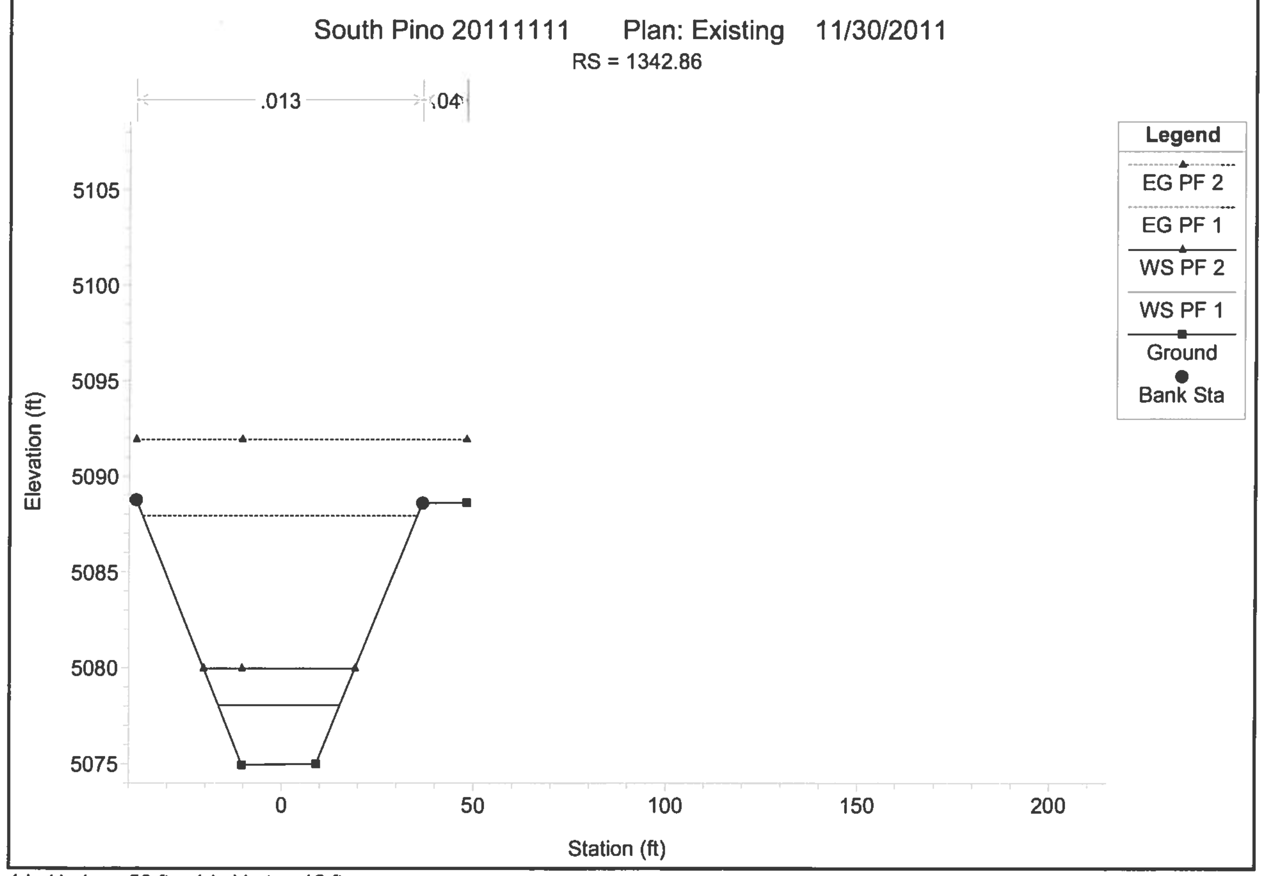


South Pino 20111111 Plan: Existing 11/30/2011
RS = 1400

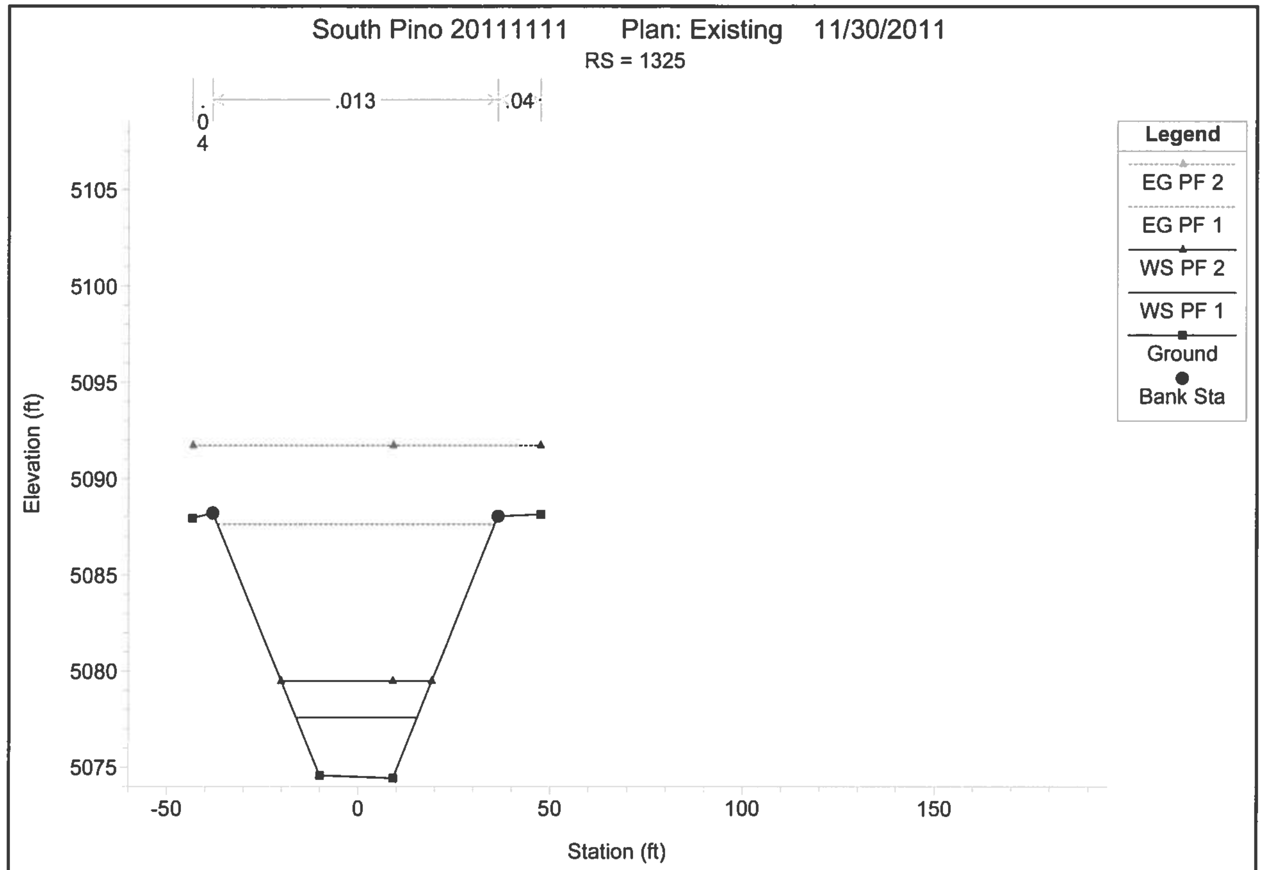


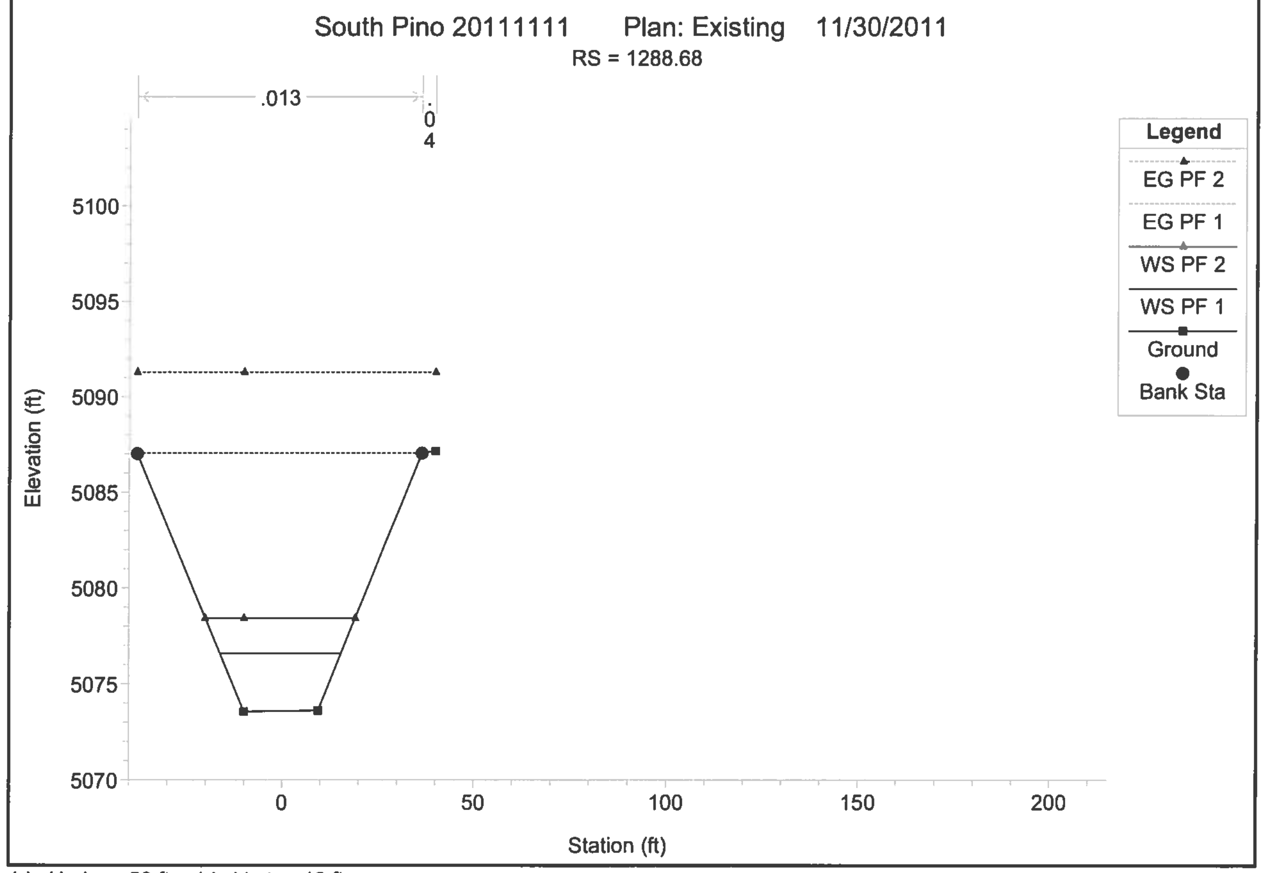
1 in Horiz. = 50 ft 1 in Vert. = 10 ft



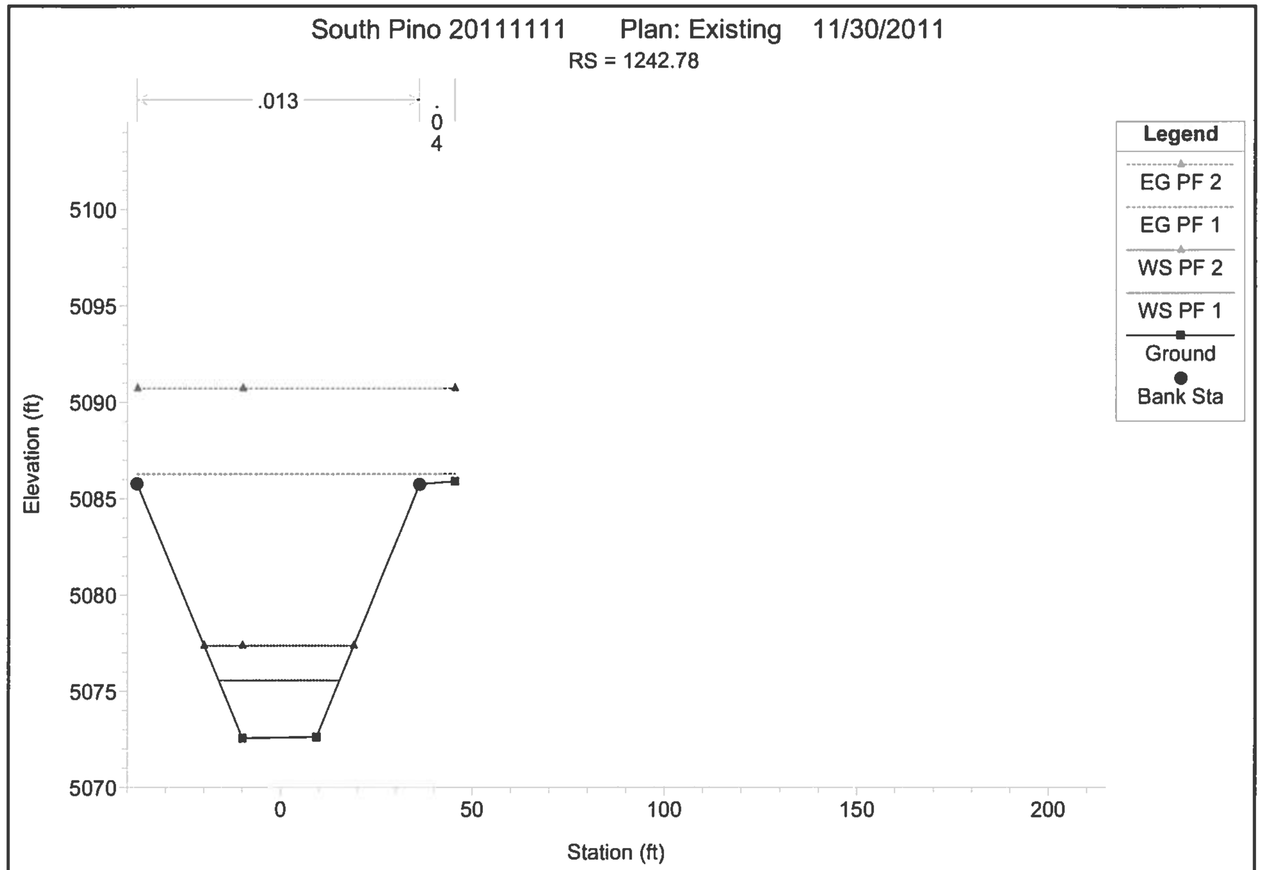


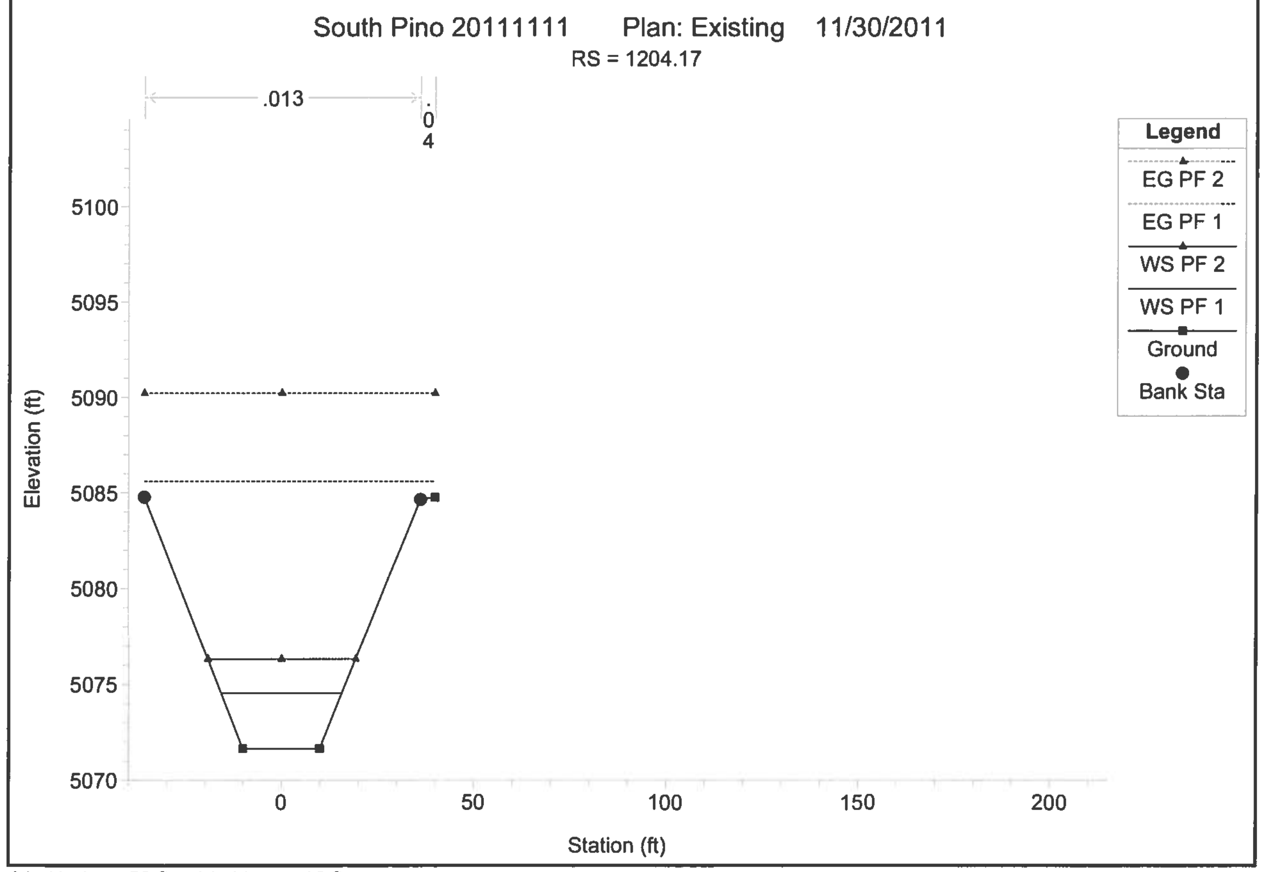
1 in Horiz. = 50 ft 1 in Vert. = 10 ft





1 in Horiz. = 50 ft 1 in Vert. = 10 ft

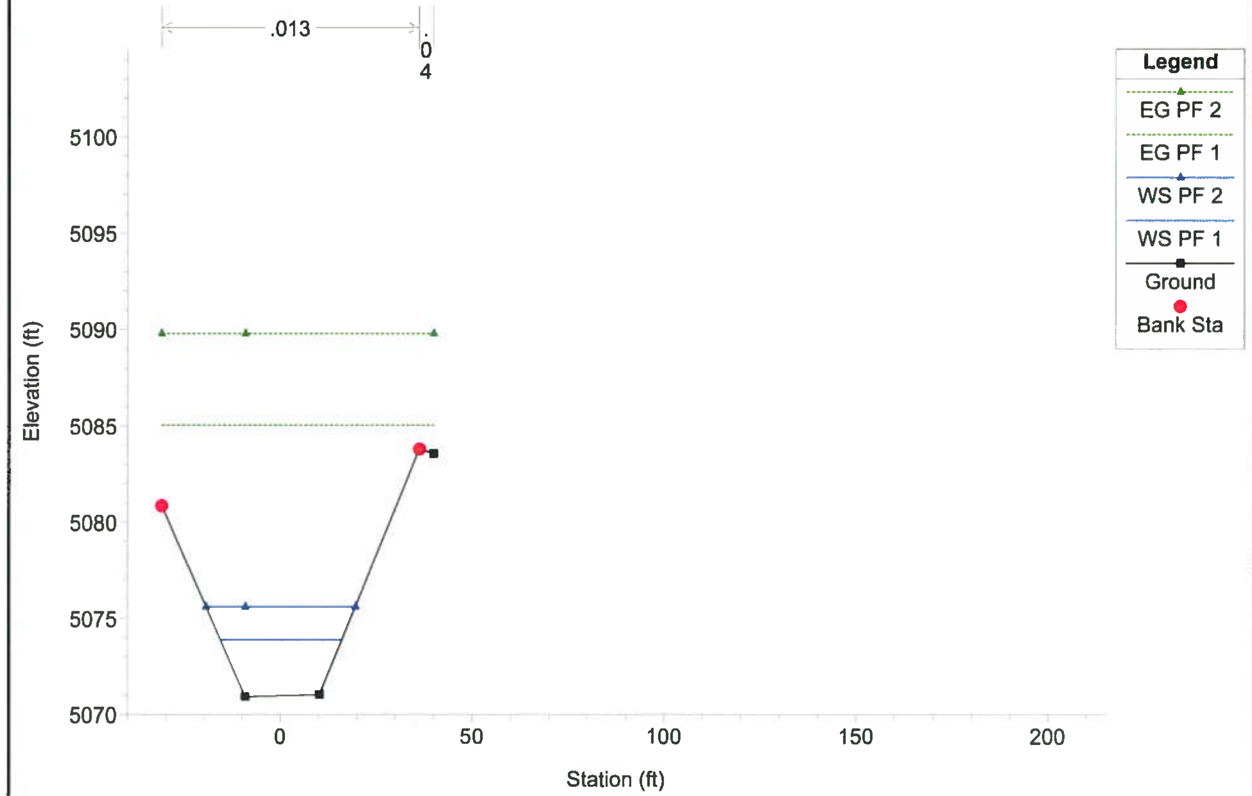




1 in Horiz. = 50 ft 1 in Vert. = 10 ft

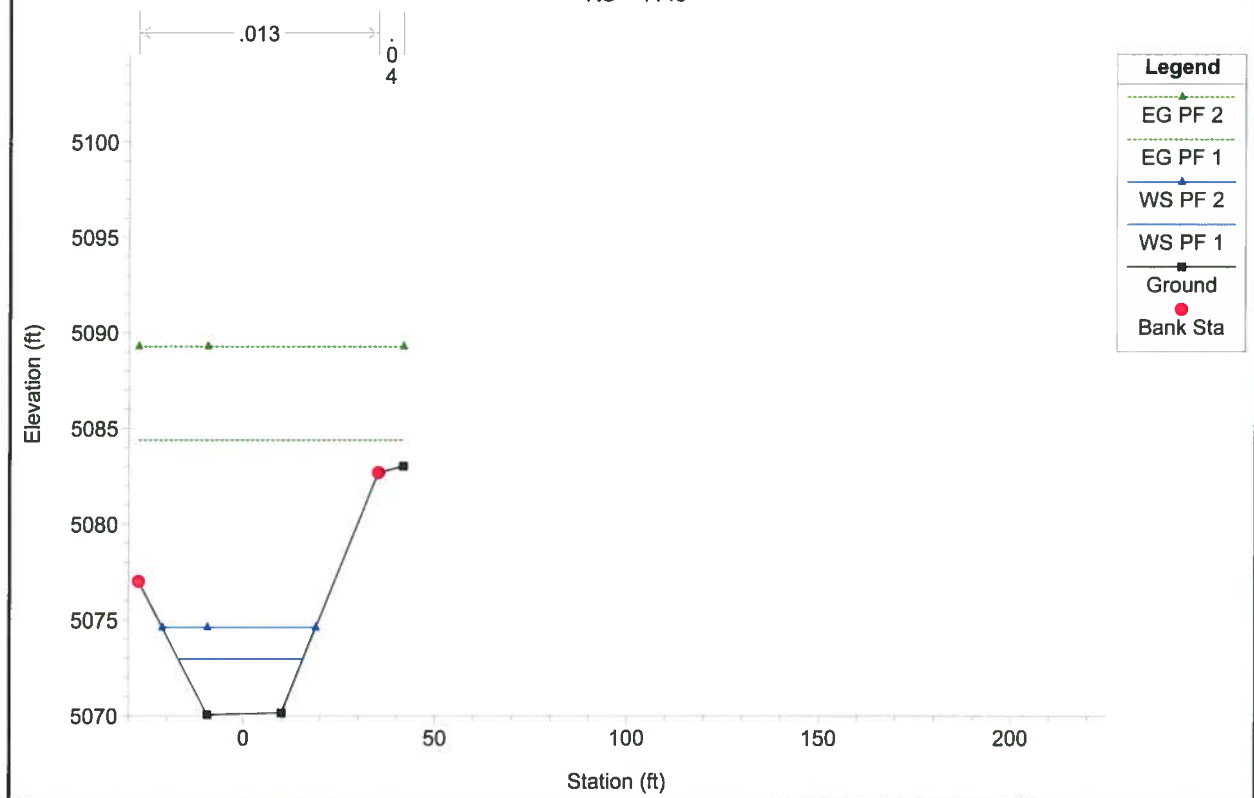
South Pino 20111111 Plan: Existing 11/30/2011

RS = 1175



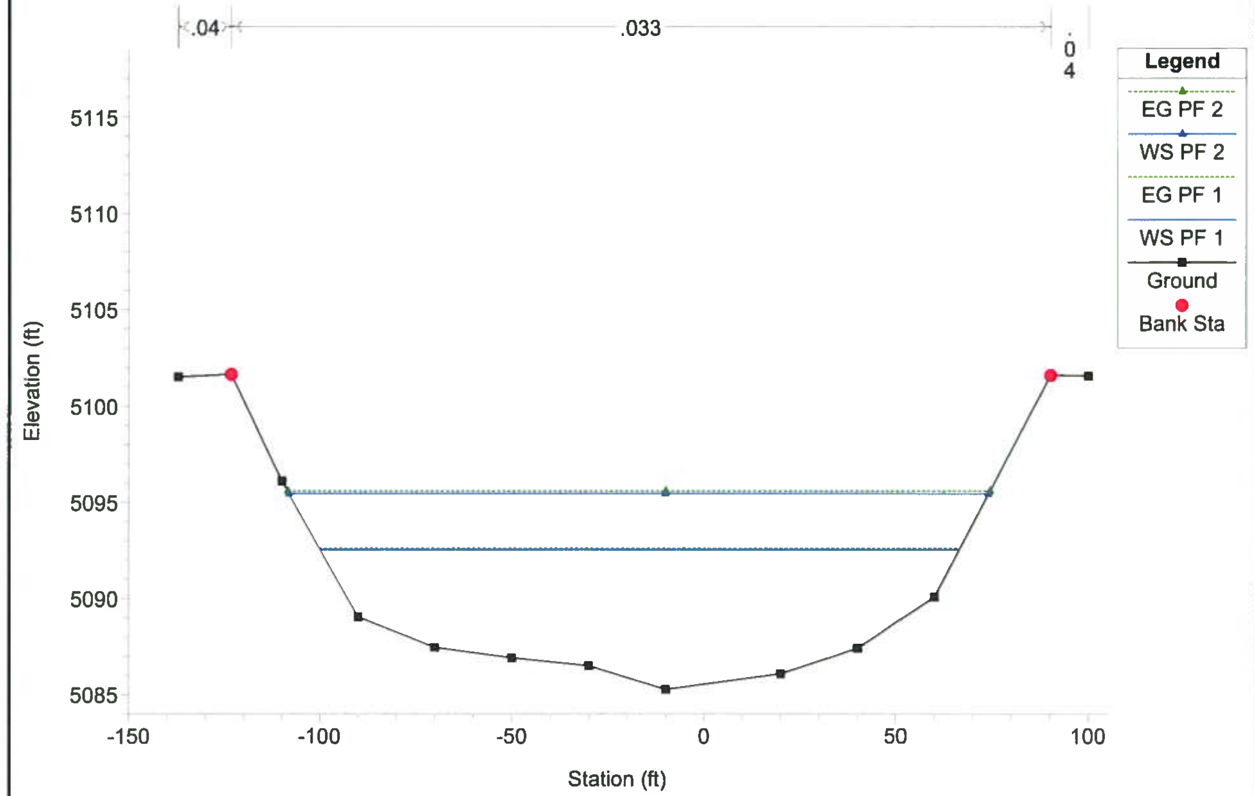
South Pino 20111111 Plan: Existing 11/30/2011

RS = 1140

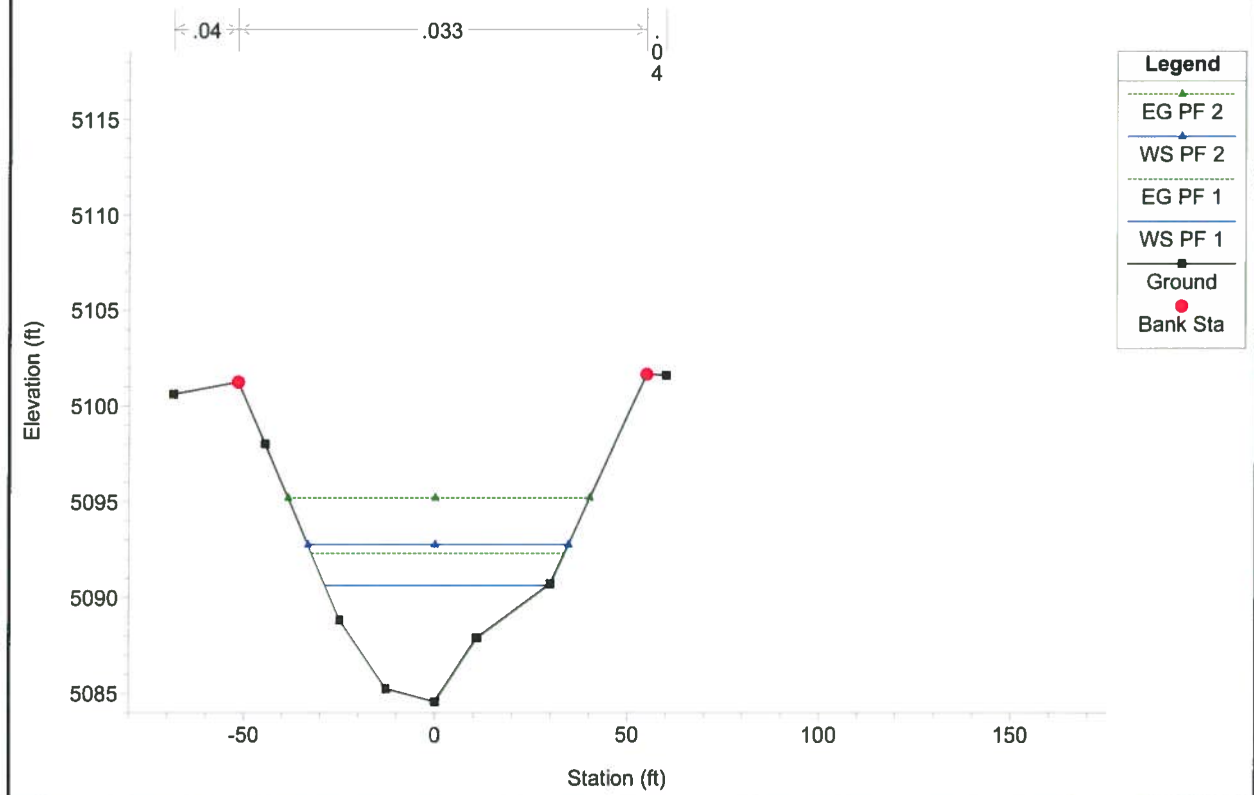


1 in Horiz. = 50 ft 1 in Vert. = 10 ft

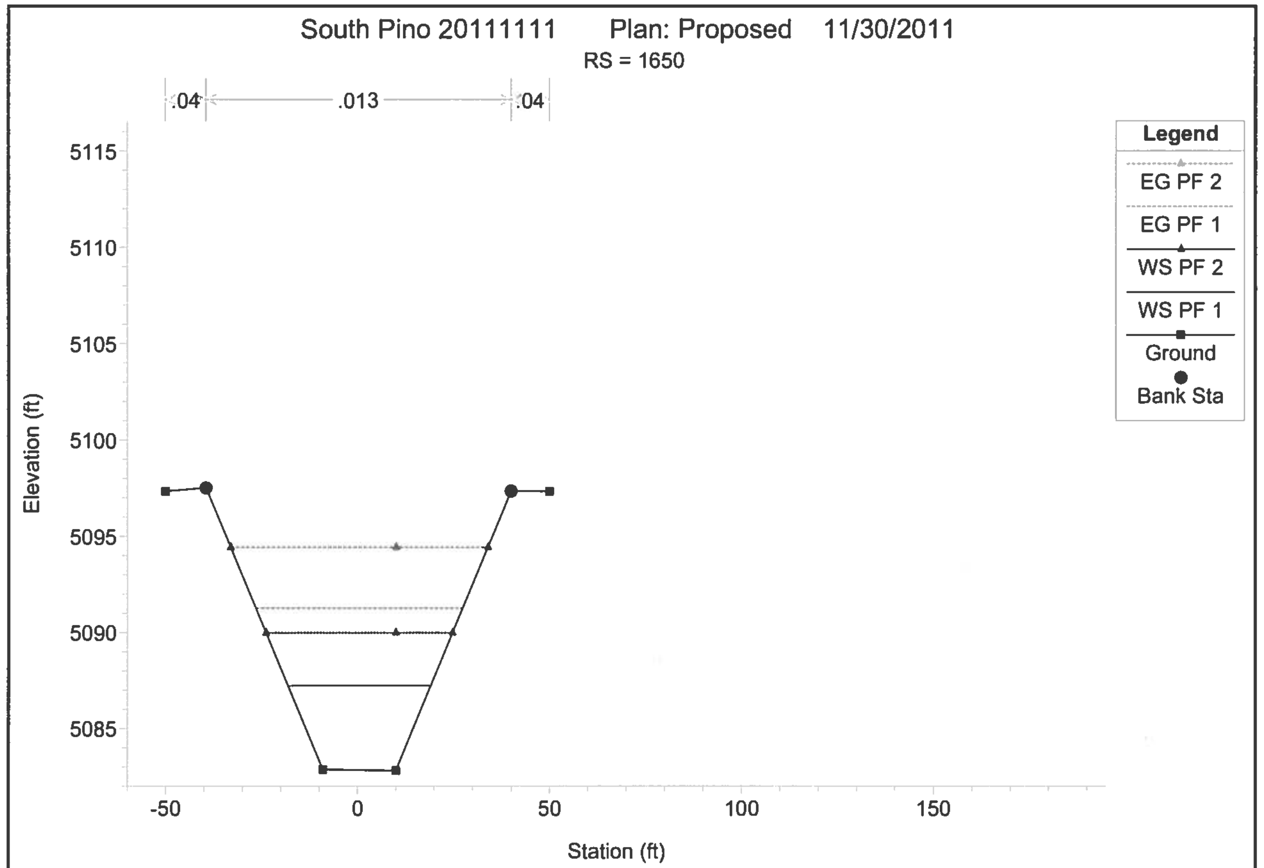
South Pino 20111111 Plan: Proposed 11/30/2011
RS = 2000

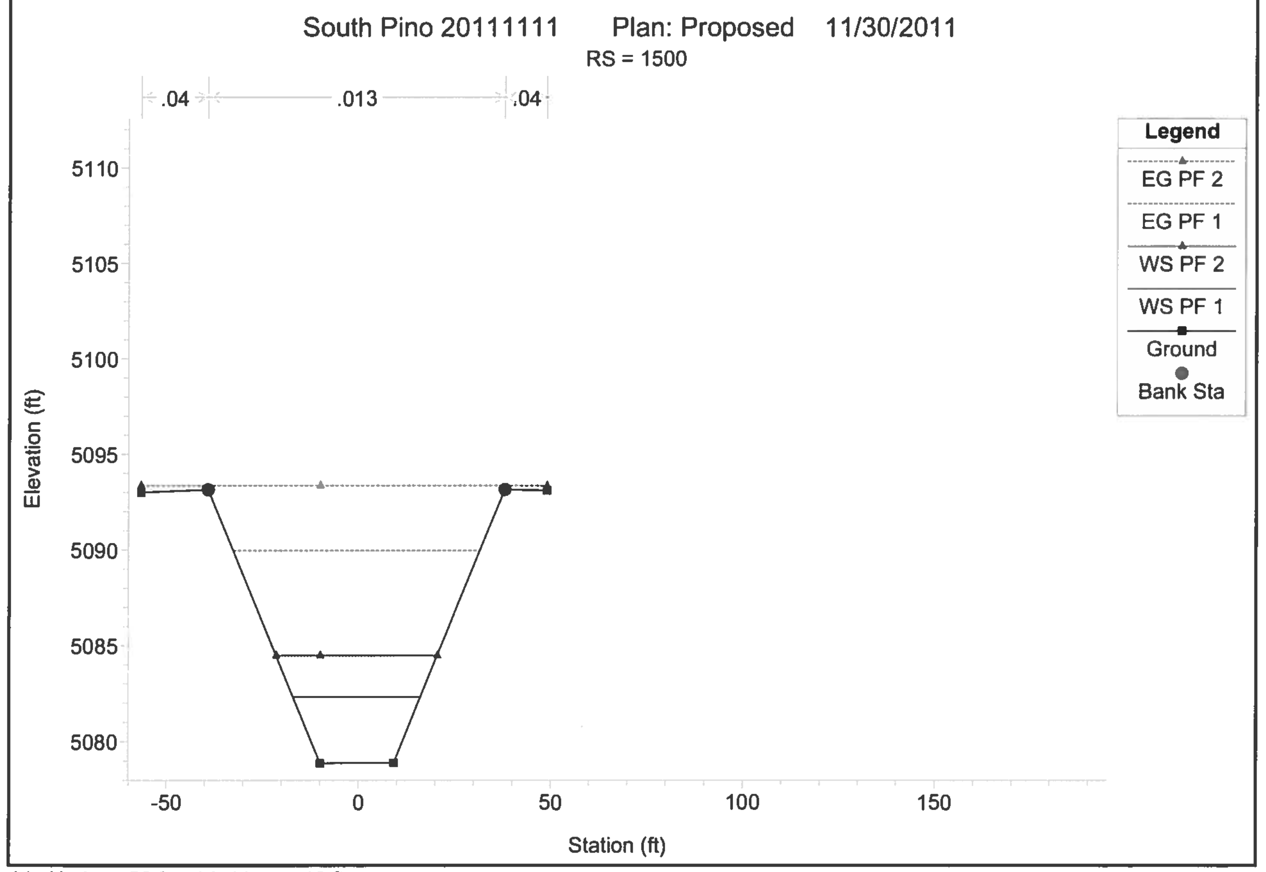


South Pino 20111111 Plan: Proposed 11/30/2011
RS = 1800



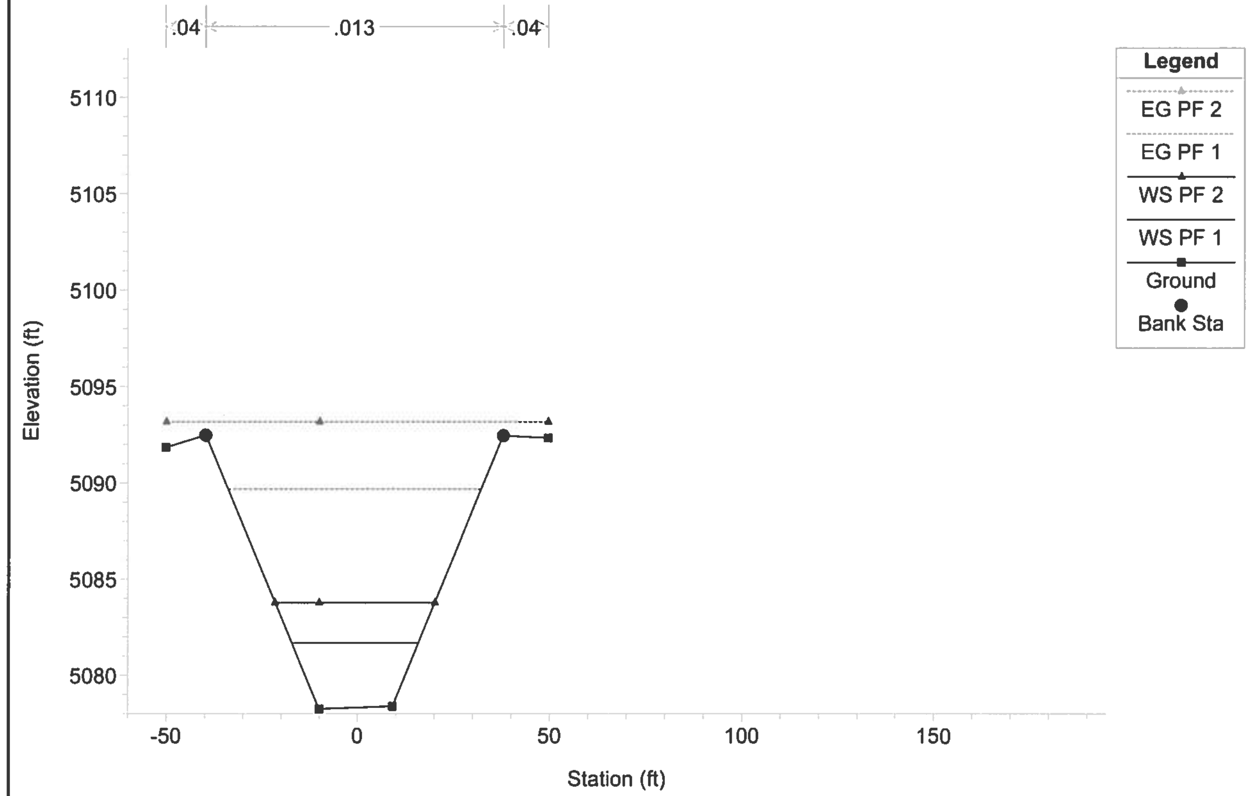
1 in Horiz. = 50 ft 1 in Vert. = 10 ft



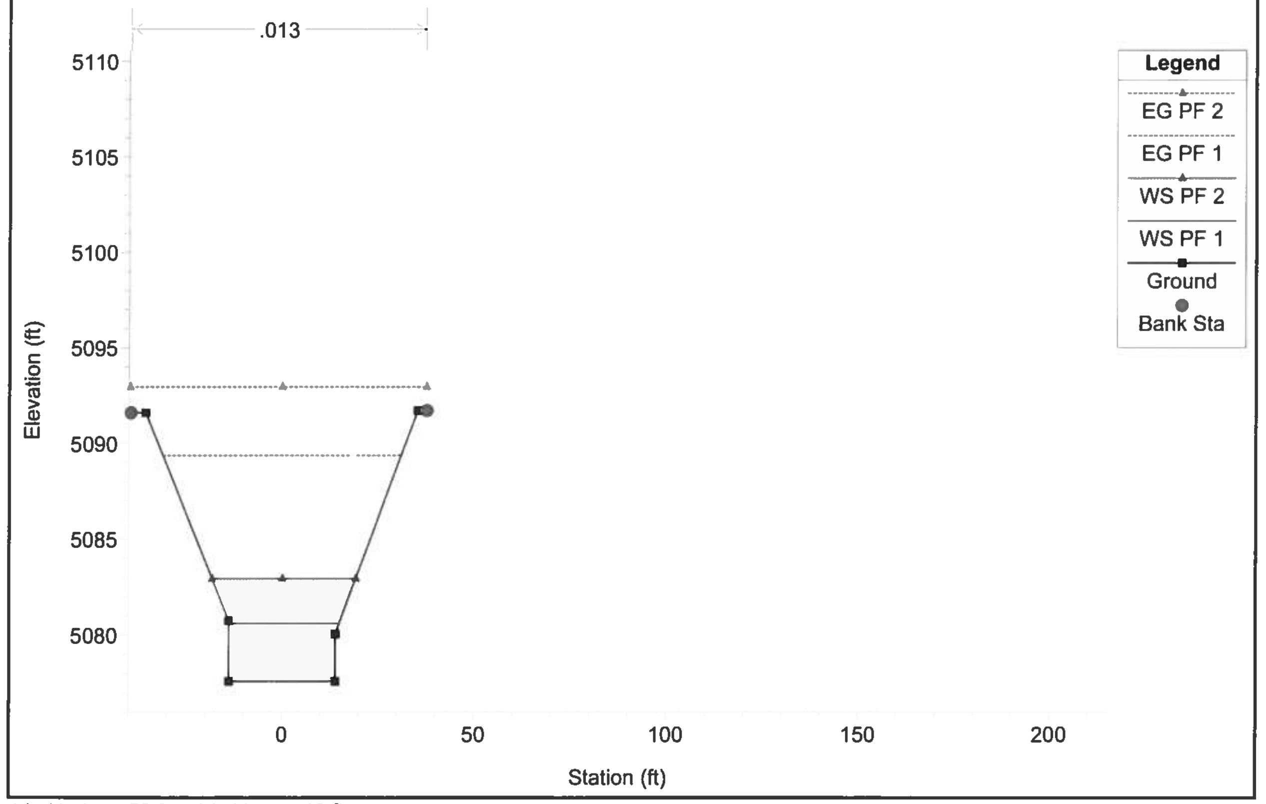


1 in Horiz. = 50 ft 1 in Vert. = 10 ft

South Pino 20111111 Plan: Proposed 11/30/2011
RS = 1475



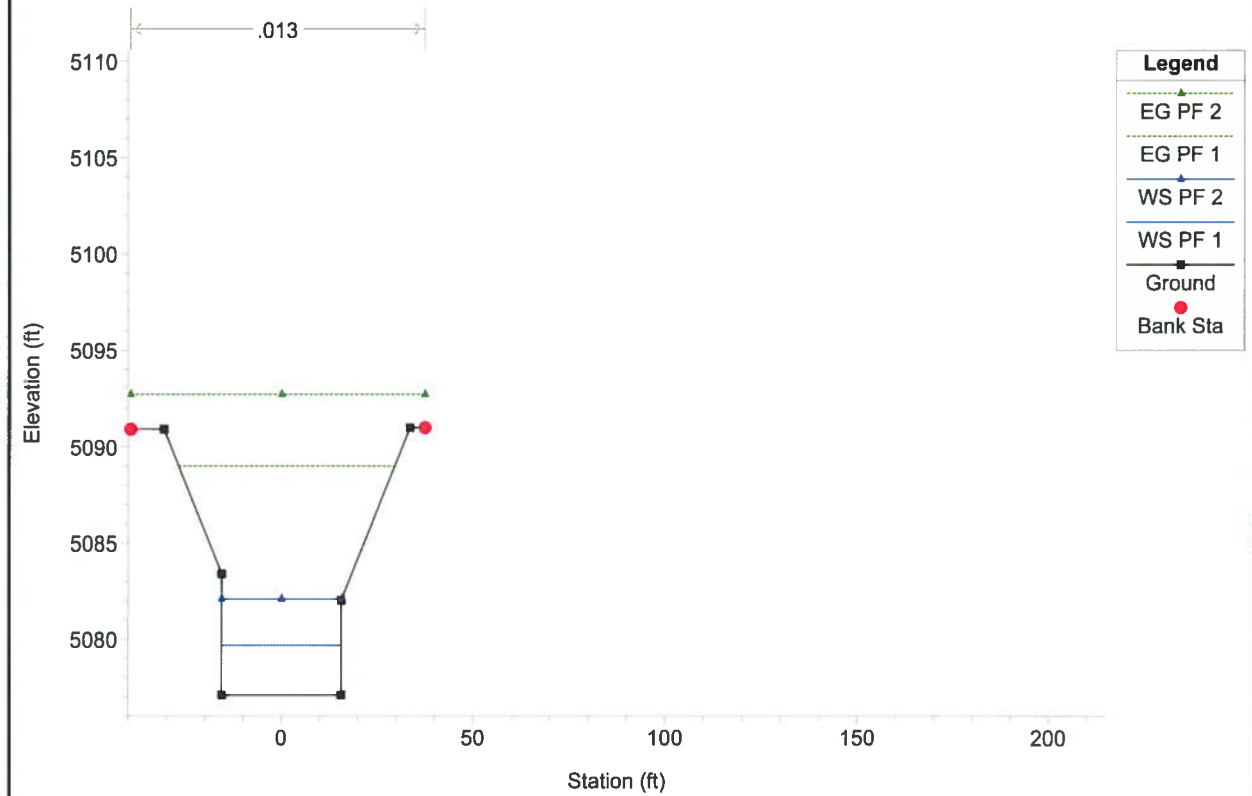
South Pino 20111111 Plan: Proposed 11/30/2011
RS = 1450



1 in Horiz. = 50 ft 1 in Vert. = 10 ft

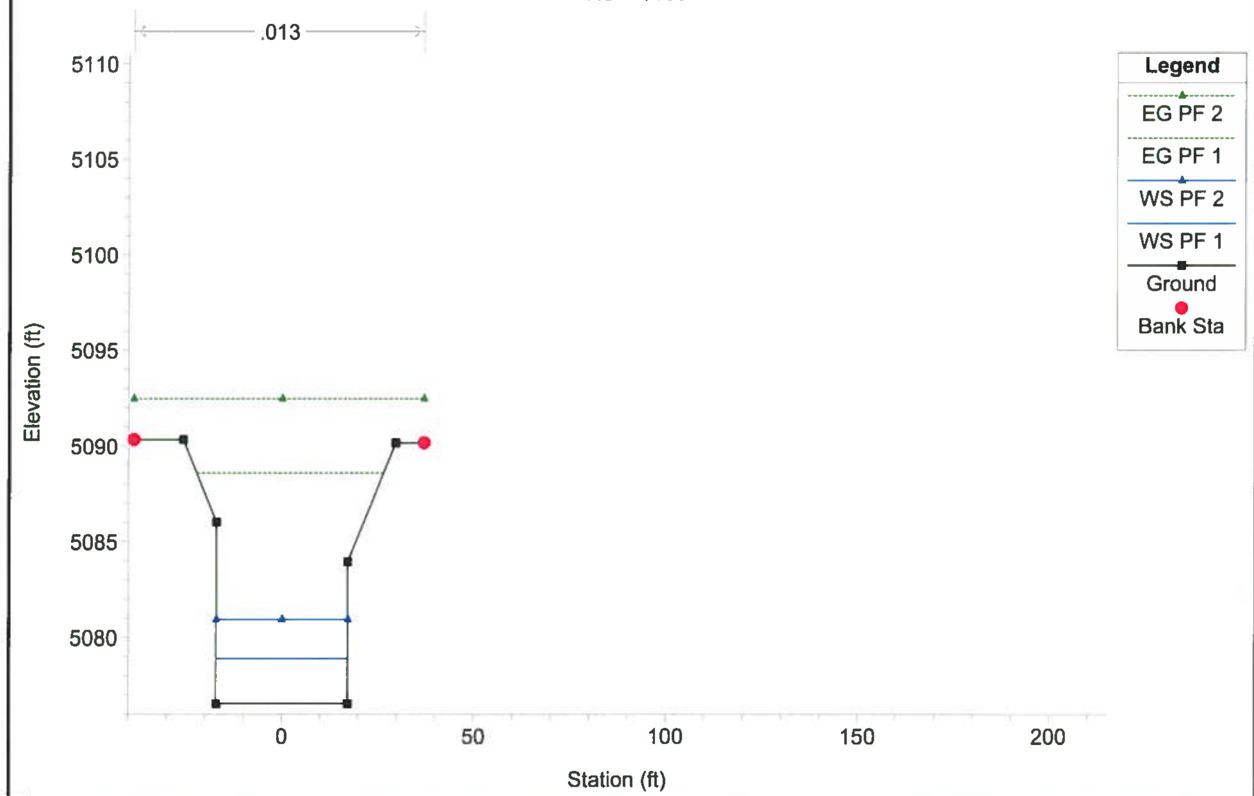
South Pino 20111111 Plan: Proposed 11/30/2011

RS = 1425



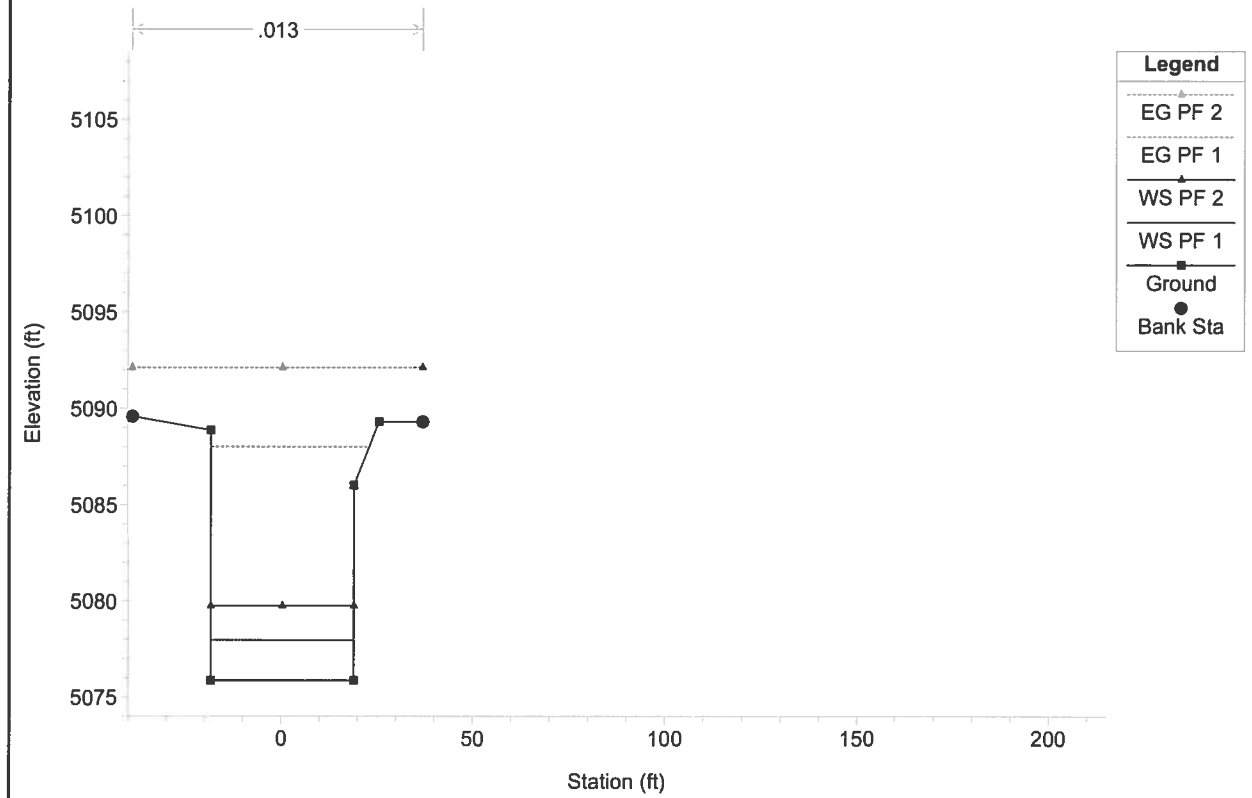
South Pino 20111111 Plan: Proposed 11/30/2011

RS = 1400

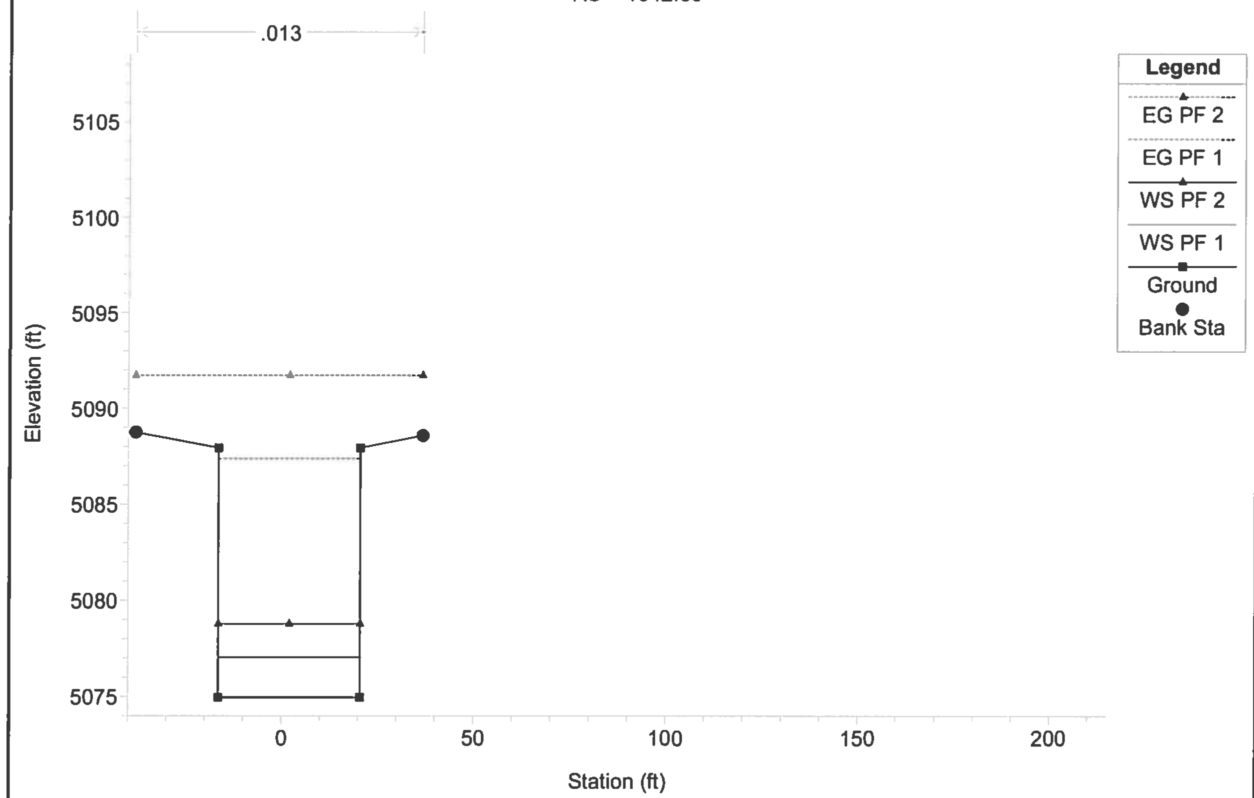


1 in Horiz. = 50 ft 1 in Vert. = 10 ft

South Pino 20111111 Plan: Proposed 11/30/2011
RS = 1371.87



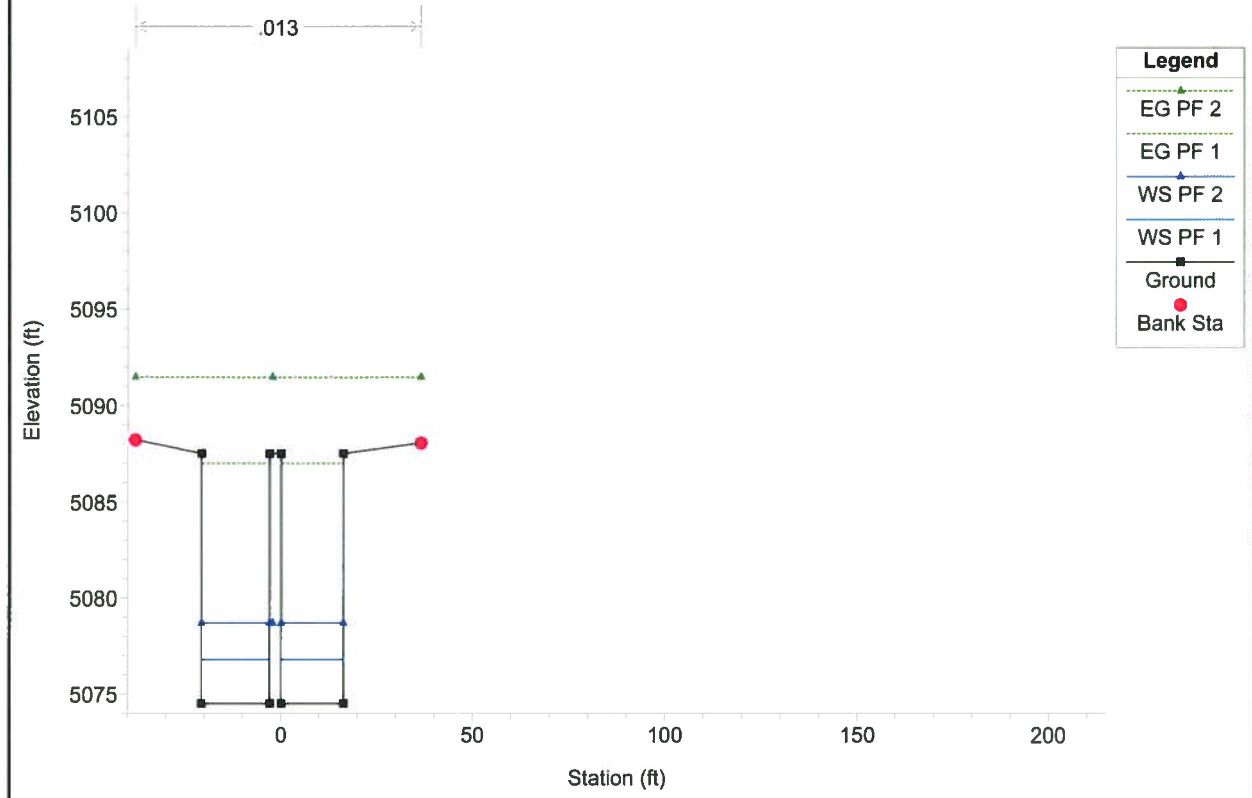
South Pino 20111111 Plan: Proposed 11/30/2011
RS = 1342.86



1 in Horiz. = 50 ft 1 in Vert. = 10 ft

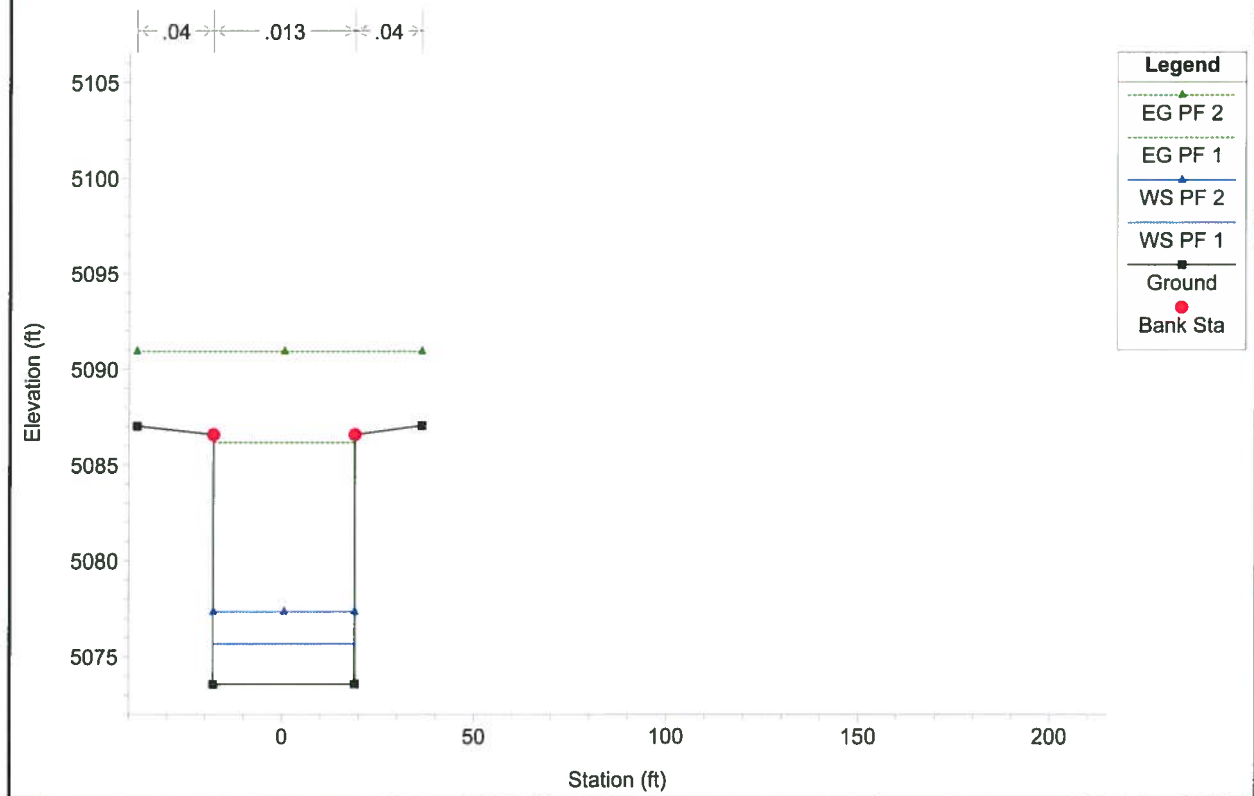
South Pino 20111111 Plan: Proposed 11/30/2011

RS = 1325

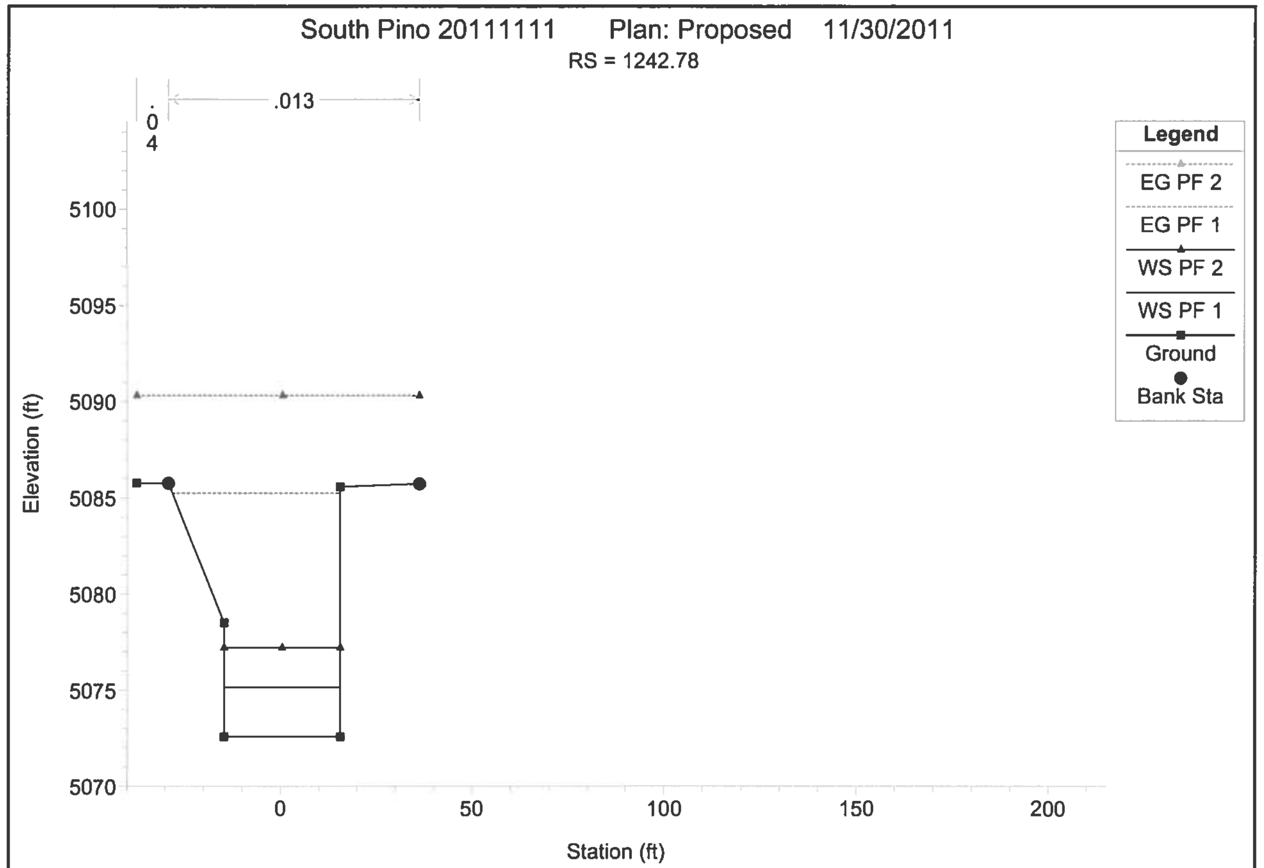


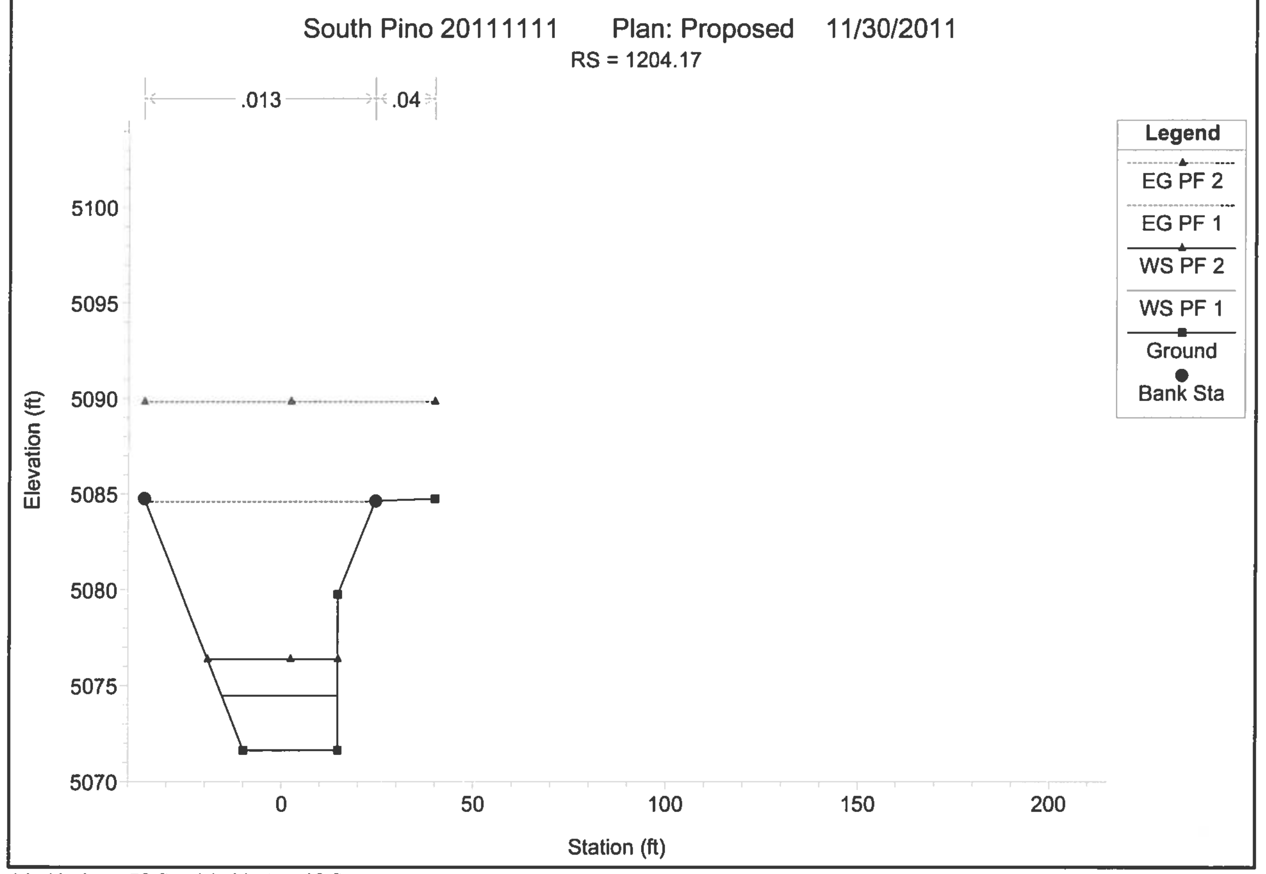
South Pino 20111111 Plan: Proposed 11/30/2011

RS = 1288.68



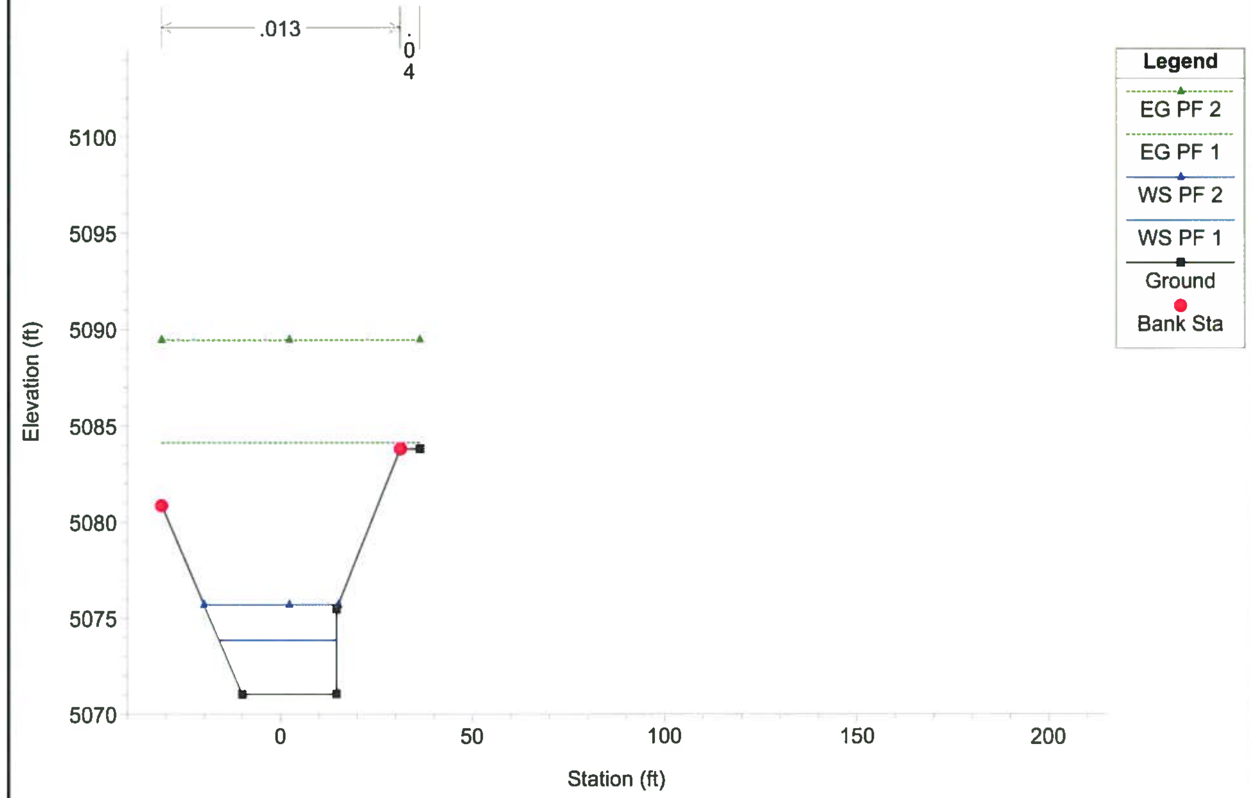
1 in Horiz. = 50 ft 1 in Vert. = 10 ft



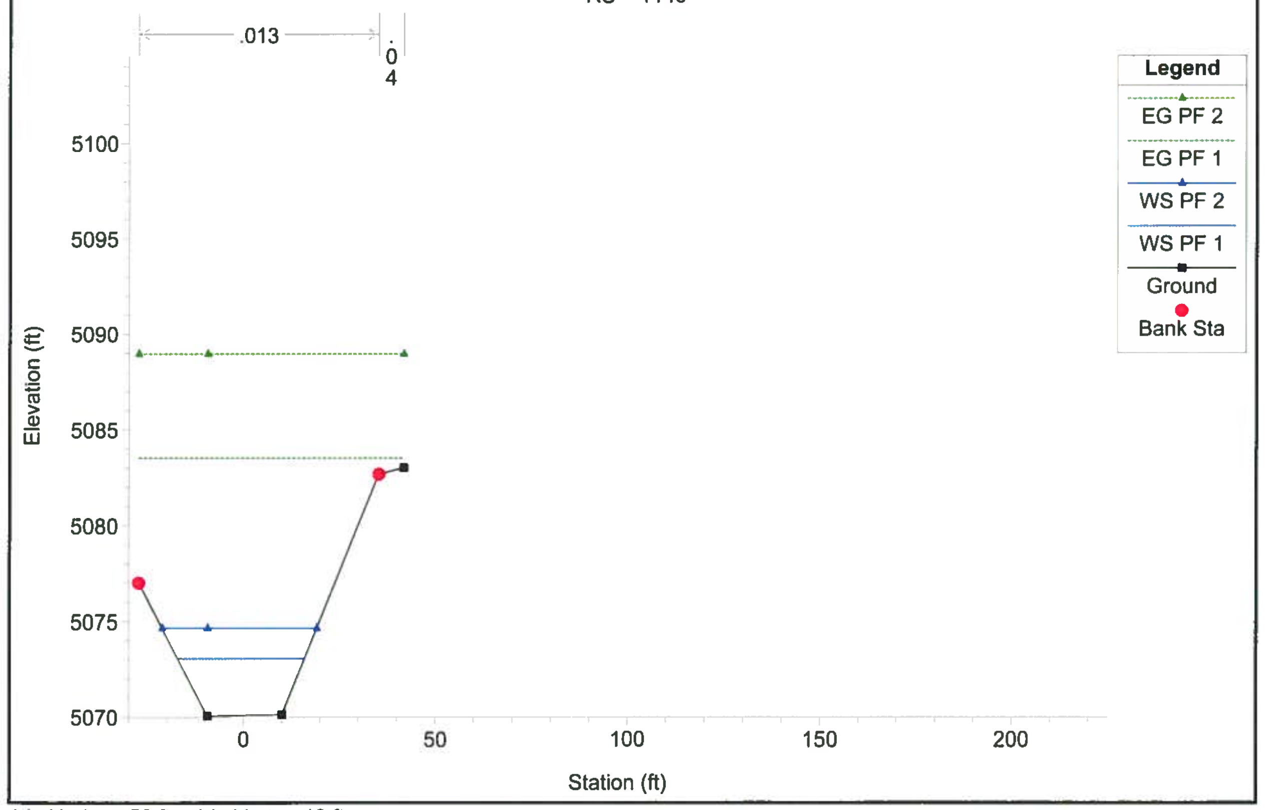


1 in Horiz. = 50 ft 1 in Vert. = 10 ft

South Pino 20111111   Plan: Proposed   11/30/2011
RS = 1175



South Pino 20111111   Plan: Proposed   11/30/2011
RS = 1140



1 in Horiz. = 50 ft   1 in Vert. = 10 ft

APPENDIX B

MODIFICATION TO EXISTING PROJECTS
(SECTION 216)

ALBUQUERQUE ARROYOS

ALBUQUERQUE, NEW MEXICO
FEASIBILITY STUDY

U.S. ARMY CORPS OF ENGINEERS
AND THE
ALBUQUERQUE METROPOLITAN ARROYO
FLOOD CONTROL AUTHORITY

July 1995

TABLE A-18

TRIBUTARY FLOWS AT THE NORTH DIVERSION CHANNEL
CENTERING #1 - FUTURE CONDITIONS

LOCATION	10.0% CHANCE (cfs)	2.0% CHANCE (cfs)	1.0% CHANCE (cfs)	0.2% CHANCE (cfs)
Campus Wash				
@ Eubank Blvd	700	1200	1400	1900
@ Kirtland Basin	900	1700	2100	2900
@ Highland Basin	900	2100	2500	3500
@ Diversion Channel	600	1800	2400	4000
Princeton Basin Pumping Station				
@ Diversion Channel	900	1400	1700	2200
Embudo Arroyo				
@ Embudo Dam	200	500	700	1000
@ Piedra Lisa Dam	80	200	200	300
@ Eubank Blvd	1200	2100	2500	3800
@ Interstate 40	4000	6300	7300	9700
@ Diversion Channel	6700	10800	12300	16100
Comanche Basin Pumping Station				
@ Diversion Channel	400	800	900	1200
Hahn Arroyo				
@ San Mateo	1300	2300	2700	3700
@ Diversion Channel	1900	3400	4100	5600
Grantline Channel @ Diversion	400	700	800	1100
Vineyard Arroyo @ Diversion	400	800	900	1300
Bear Canyon Arroyo				
@ John Robert Dam	200	800	1000	1100
@ Arroyo del Oso Dam	900	1600	1900	2700
@ Diversion Channel	600	1200	1400	1900
South Pino Arroyo				
@ South Pino Dam	200	500	700	800
@ Moon Street	400	700	900	1200
@ Diversion Channel	900	1600	2000	2700
North Pino Arroyo				
@ Louisiana Blvd	400	700	800	1100
@ Interstate 25	700	1300	1500	2100
@ Diversion Channel	800	1500	1700	2500
Domingo Baca Arroyo				
@ North Domingo Baca Dam	100	200	300	400
@ South Domingo Baca Dam	90	300	400	700
@ Interstate 25	1100	1900	2300	3200
@ Diversion Channel	1200	2100	2500	3600
La Cueva Arroyo				
@ Interstate 25	600	1100	1400	2000
@ Diversion Channel	700	1300	1500	2000
Camino Arroyo				
@ Interstate 25	500	1000	1300	18[illegible]
@ Diversion Channel	500	1100	1300	19[illegible]

TABLE A-19

TRIBUTARY FLOWS AT THE NORTH DIVERSION CHANNEL CENTERING #2 - FUTURE CONDITIONS

LOCATION	10.0% CHANCE (cfs)	2.0% CHANCE (cfs)	1.0% CHANCE (cfs)	0.2% CHANCE (cfs)
Campus Wash				
@ Eubank Blvd	400	800	1000	1400
@ Kirtland Basin	600	1100	1400	2100
@ Highland Basin	400	1300	1600	2500
@ Diversion Channel	400	900	1300	2500
Princeton Basin Pumping Station				
@ Diversion Channel	600	1200	1400	1800
Embudo Arroyo				
@ Embudo Dam	75	400	500	800
@ Piedra Lisa Dam	60	150	200	300
@ Eubank Blvd	1100	2000	2400	3800
@ Interstate 40	2400	4000	4700	6500
@ Diversion Channel	3900	7100	8500	11600
Comanche Basin Pumping Station				
@ Diversion Channel	400	700	800	1100
Hahn Arroyo				
@ San Mateo Blvd	1700	2800	3300	4500
@ Diversion Channel	2300	4000	4700	6400
Grantline Channel @ Diversion	500	900	1000	1400
Vineyard Arroyo @ Diversion	600	1000	1200	1600
Bear Canyon Arroyo				
@ John Robert Dam	600	1400	1700	1800
@ Arroyo del Oso Dam	1700	2800	3300	4400
@ Diversion Channel	1100	1900	2200	2900
South Pino Arroyo				
@ South Pino Dam	400	900	1100	1200
@ Moon Street	800	1300	1500	1900
@ Diversion Channel	1500	2600	3100	$\boxed{4100}$ Max Q_{500}
North Pino Arroyo				
@ Louisiana Blvd	700	1200	1400	1800
@ Interstate 25	1300	2100	2500	3300
@ Diversion Channel	1400	2300	2700	3700
Domingo Baca Arroyo				
@ North Domingo Baca Dam	140	300	400	500
@ South Domingo Baca Dam	160	400	600	900
@ Interstate 25	1600	2700	3200	4300
@ Diversion Channel	1600	2900	3500	4800
La Cueva Arroyo				
@ Interstate 25	600	1200	1500	2200
@ Diversion Channel	700	1400	1600	2200
Camino Arroyo				
@ Interstate 25	600	1100	1300	1900
@ Diversion Channel	600	1100	1300	1900

TABLE A-20

TRIBUTARY FLOWS AT THE NORTH DIVERSION CHANNEL CENTERING #3 - FUTURE CONDITIONS

LOCATION	10.0% CHANCE (cfs)	2.0% CHANCE (cfs)	1.0% CHANCE (cfs)	0.2% CHANCE (cfs)
Campus Wash				
@ Eubank Blvd	400	800	1000	1400
@ Kirtland Basin	600	1100	1400	2100
@ Highland Basin	400	1300	1600	2500
@ Diversion Channel	400	900	1300	2500
Princeton Basin Pumping Station				
@ Diversion Channel	600	1200	1400	1800
Embudo Arroyo				
@ Embudo Dam	60	300	400	800
@ Piedra Lisa Dam	40	130	200	300
@ Eubank Blvd	900	1600	1900	3100
@ Interstate 40	2300	3900	4500	6200
@ Diversion Channel	3800	6900	8200	11300
Comanche Basin Pumping Station				
@ Diversion Channel	400	700	800	1100
Hahn Arroyo				
@ San Mateo Blvd	1100	2100	2500	3400
@ Diversion Channel	1700	3100	3700	5200
Grantline Channel @ Diversion	400	700	800	1100
Vineyard Arroyo @ Diversion	400	800	900	1300
Bear Canyon Arroyo				
@ John Robert Dam	300	900	1100	1300
@ Arroyo del Oso Dam	1000	1800	2700	3000
@ Diversion Channel	700	1300	1900	2100
South Pino Arroyo				
@ South Pino Dam	400	900	1100	1300
@ Moon Street	600	1000	1200	1600
@ Diversion Channel	1100	2000	2400	3200
North Pino Arroyo				
@ Louisiana Blvd	600	1000	1200	1600
@ Interstate 25	1100	1800	2100	2900
@ Diversion Channel	1200	2000	2400	3300
Domingo Baca Arroyo				
@ North Domingo Baca Dam	300	500	600	800
@ South Domingo Baca Dam	300	700	800	1300
@ Interstate 25	1900	3200	3700	5000
@ Diversion Channel	2000	3400	4000	5400
La Cueva Arroyo				
@ Interstate 25	900	1700	2000	2800
@ Diversion Channel	1000	1700	2000	2900
Camino Arroyo				
@ Interstate 25	900	1700	2000	2800
@ Diversion Channel	900	1700	2000	2800

TABLE A-21

OWS AT THE NORTH DIVERSION CHANNEL RING #4 - FUTURE CONDITIONS

	10.0% CHANCE (cfs)	2.0% CHANCE (cfs)	1.0% CHANCE (cfs)	0.2% CHANCE (cfs)
	400	800	1000	1400
	600	1100	1400	2100
	400	1300	1600	2500
el	400	900	1300	2500
g Station				
el	700	1200	1400	1900
	400	800	1000	1500
	140	300	300	500
	1800	2900	3300	5100
	3200	5300	6100	8300
el	5000	8700	10000	13200
Station				
el	400	700	900	1200
	1600	2700	3200	4300
l	2300	3900	4600	6300
ersion	400	800	900	1200
sion	500	900	1000	1400
	500	1200	1500	1300
am	1100	1900	2200	3100
l	700	1300	1500	2100
	200	600	700	900
	400	800	900	1300
l	900	1700	2000	2800
	400	700	800	1100
	700	1300	1500	2200
l	800	1500	1800	2500
ca Dam	100	200	300	400
ca Dam	90	300	400	700
	1100	1900	2300	3200
	1200	2100	2500	3600
	600	1100	1400	2000
	700	1300	1500	2000
	500	1000	1300	1800
	500	1100	1300	1900

HYDROLOGIC ANALYSIS
OF THE
SOUTH PINO DRAINAGE AREA

APRIL, 1989

PREPARED FOR:

AMAFCA
2600 PROSPECT, N.E.
ALBUQUERQUE, NM 87125

PREPARED BY:

BOHANNAN-HUSTON, INC.
COURTYARD I
7500 JEFFERSON ST., N.E.
ALBUQUERQUE, NM 87109

JOB NO. 88232.05

Table 3

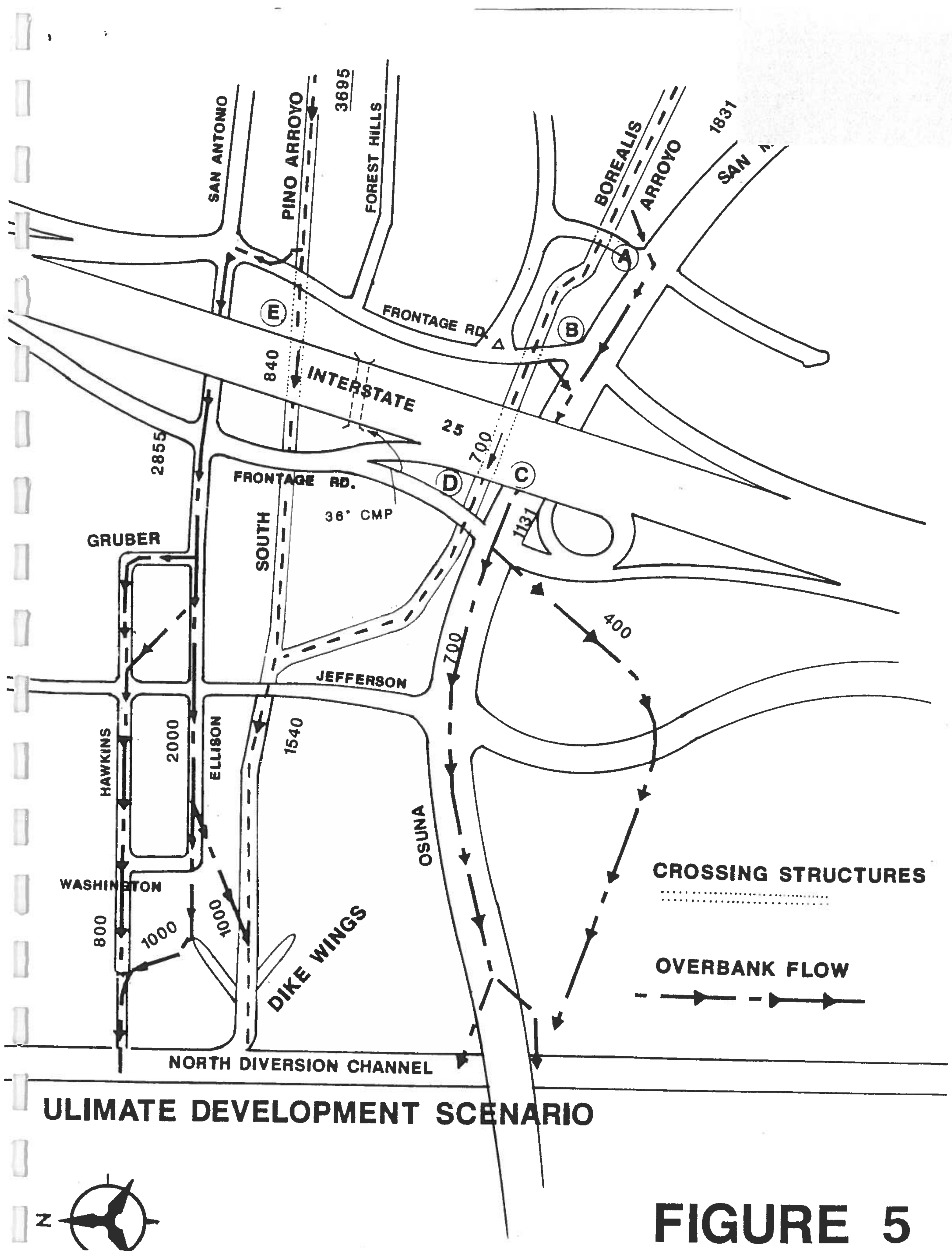
South Pino Standard Project Storm Discharges (cfs)

Location	Las Cruces Storm 1967	Las Cruces Storm 1988	Las Cruces Storm Ultimate	COE SPS 1967	COE SPS 1988	COE SPS Ultimate
S. Pino @ Tramway	4814	4845	4926	6355	6374	6429
Pino Dam Outflow	N/A	3091	3105	N/A	2599	2635
S. Pino @ I-25	5848	3641	3695	7462	2755	2862
Borealis @ I-25	1274	1831	1831	1251	1557	1557
S. Pino @ N. Div. Chan.	6910	4698	5414	8209	4533	4877

The model results presented in Table 3 assume that flows remain within the arroyo floodplains. The decrease in discharges at the North Diversion channel for the 1988 and ultimate development scenarios reflect the installation of the Pino Dam, which stores much of the flood waters and, thus, reduces the downstream peak flows.

COE SPS vs. Las Cruces SPS

A comparison of the COE SPS and the Las Cruces SPS flows at the North Diversion shows that for the 1976 scenario, the COE SPS produces approximately 20% higher flow than the Las Cruces SPS (8209 cfs vs 6910 cfs). However, for the 1988 and ultimate development scenarios, the COE SPS produces less runoff than the Las Cruces storm (4533 cfs vs 4698 cfs and 4877 cfs vs 5414 cfs). This seeming anomaly can be explained by comparing the rainfall distributions of the two storms shown in Figure 2. The synthetic COE rainfall has only one peak,



ULIMATE DEVELOPMENT SCENARIO

FIGURE 5

Five crossing structures were analyzed at I-25. They are identified as Structures A, B, C, D and E on Figure 5. Structures A, B, C and D carry flow from the Borealis Arroyo, while Structure E is located on the South Pino. The structures, all concrete box culverts, were analyzed for inlet control, as the inlets are unimproved and will choke the flow. The computed capacities are shown in Table 4 along with the SPS discharges upstream of the structures.

Table 4

Structure	**Size**	**Headwater Ft.**	**Culvert**	**Capacity cfs**	**SPS Discharge cfs**
A	2-4'x8'	4		720	1831
B	2-4'x8'	4		720	1831
C	8'x8'	3		700	1831
D	2-6'x6'	3		760	1831
E	8'x8'	4		840	3695

Obviously, the I-25 crossing structures do not have the capacity to carry the SPS flows. The Borealis flows (Structures A, B, C and D) will overflow southward to Osuna/San Mateo Boulevard where they will be directed west under I-25. Just west of I-25, the flow will split with the majority continuing westward down Osuna Road and the rest spilling south and west as shown in Figure 5. Both flows will be intercepted by the North Diversion Channel.

The South Pino overflow from Structure E will flow north to San Antonio/Ellison Road where it will turn west and cross under I-25. Figure 5 shows the likely flow paths of this flood water and the estimated peak discharges of each path. Some of the flow proceeding west on Ellison will cross northward to Hawkins via Gruber Avenue, Jefferson, Washington and interspersed driveways (approx. 800 cfs).

Ellison Road Street Flow

Some 2205 to 2855 cfs is expected down Ellison Road, depending on whether the inlet to Structure E is improved. The natural slope of the land along Ellison is to the northwest towards Hawkins Street, which appears to be constructed along the bottom of an old arroyo or swale. This natural slope carries flow away from the South Pino inlet, an undesirable phenomenon.

Flows could be encouraged to stay in Ellison by raising the elevation of the cross streets (Gruber, Jefferson and Washington) and driveways on the south side of Ellison, a comparatively minor effort. This would direct the flow to the intersection of Ellison and Washington.

Beyond this intersection, the flows would continue westward, with part of the flood flowing to the South Pino inlet and part heading northwest toward Hawkins. To capture all of the Ellison flow and direct it to the South Pino inlet would require major effort. A dike or a combination of dike and channel would be needed from the intersection to the existing dike wings. This would require obtaining a large amount of easement and probably outright purchase of valuable commercial property in the area. The benefits to property already protected from the 100-year storm may not be great enough to justify the expenditures.

Summary of Recommendations

1. Upgrade the inlets to Structures C and D to 1206 cfs by constructing hydraulically efficient approaches. Structure D must carry at least as much flow as Structure C.
2. Remove existing Structures A and B and replace with structures capable of carrying as much flow as Structure C.
3. Upgrade the inlet to Structure E to 1490 cfs by constructing a hydraulically efficient approach.
4. The in-progress design of the South Pino lined channel from Jefferson to the North Diversion inlet is adequate with its 100-year discharge capacity plus freeboard.

5. If the South Pino Channel were lined all the way to the inlet, the south bank would be outside the SPS flood plain. The south wing dike of the inlet to the North Diversion would then no longer be necessary, and could be removed.

6. Retention of the north wing dike is essential to capture and direct flows from Ellison into the North Diversion inlet of the South Pino.

7. Ellison street flows should be directed toward the South Pino inlet by raising the elevation of the cross streets (Gruber, Jefferson and Washington) and driveways on the south side of Ellison.

8. While all SPS flows at the intersection of Ellison and Washington could possibly be intercepted and directed toward the South Pino inlet of the North Diversion, it would require major land acquisition and dike work, and may not provide a favorable ratio of benefits to costs.

CONCLUSION

The computer model simulating the Standard Project Storm runoff for the South Pino Arroyo and the accompanying analysis of hydraulic structures showed that the SPS flows remain in the watershed from the headwaters in the Sandia Mountains to Interstate 25. At the Interstate, crossing structures designed to carry the 100-year flow were found to be inadequate to pass the greater SPS discharges. The resulting excess flows crossed under the Interstate via the San Mateo and San Antonio underpasses and continued west to the North Diversion in Osuna Road and Ellison Road. Some of the Ellison flows are recaptured by the wind dike of the South Pino inlet to the North Diversion channel, but the remaining Ellison flows and the Osuna Road flows enter the North Diversion on either side of the South Pino inlet (see Figure 5). The carrying capacity of the I-25 culverts can be increased, however, the proposed improvements are not adequate to carry all the SPS discharge for either the Borealis or South Pino Arroyo. Recommendations made to confine street flow to Osuna and Ellison.

The recommendations made in this report will alleviate some of the out-of-bank flows and return a portion of the escaping flows back into the South Pino watershed. However, it