

JR Engineering

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FINAL DRAINAGE REPORT FOR COLORADO CENTRE RESIDENTIAL FILING NO. 6

July 1998
Revised March 1999
Revised June 1999

Prepared For:

RICHMOND AMERICAN HOMES OF COLORADO, INC.
5353 North Union Boulevard, Suite 202
Colorado Springs, CO 80918
(719) 260-0684

Prepared By:

JR ENGINEERING
4935 North 30th Street
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Job No. 8132.60

JR Engineering

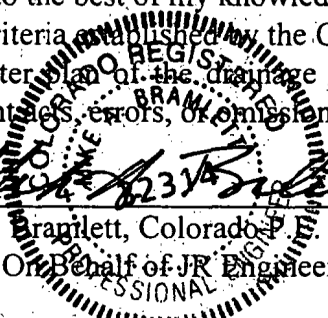
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FINAL DRAINAGE REPORT FOR COLORADO CENTRE RESIDENTIAL FILING NO. 6

DRAINAGE REPORT STATEMENT

ENGINEER'S STATEMENT:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.


Mike A. Branlett
Mike A. Branlett, Colorado P.E. #32314
For and On Behalf of JR Engineering, Ltd.

7.6.99
Date

DEVELOPER'S STATEMENT:

I, the developer, have read and will comply with all of the requirements specified in this drainage report and plan.

Business Name: Richmond American Homes of Colorado, Inc.

By: N. J. [Signature]

Title: DIVISION PRESIDENT

Address: 5353 North Union Boulevard, Suite 202

Colorado Springs, CO 80918

EL PASO COUNTY ONLY:

Filed in accordance with Section 51.1 of the El Paso Land Development Code, as amended.

John A. McCarty
John A. McCarty Director/County Engineer

7-14-99
Date

**FINAL DRAINAGE REPORT FOR
COLORADO CENTRE RESIDENTIAL FILING NO. 6**

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FINAL DRAINAGE REPORT FOR COLORADO CENTRE RESIDENTIAL FILING NO. 6

PURPOSE

This document is the final drainage report for Colorado Centre Residential Filing No. 6. The purpose of this report is to estimate anticipated storm water runoff quantities, recommend specific solutions for on-site and off-site drainage impacts resulting from development, and identify necessary improvements to safely route storm water runoff to adequate outfall facilities.

GENERAL DESCRIPTION

Colorado Centre Residential Filing No. 6 is located in Sections 3 and 10, Township 15 South, Range 65 West of the Sixth Principal Meridian in the City of Colorado Springs, County of El Paso. The site is bounded to the north by Colorado Centre Filing No. 4, to the west and south by Horizonview Drive and Bradley Road, respectively, and to the east by Jimmy Camp Creek. Proposed use of this filing is a Planned Unit Development (PUD) with 82 single family homes. The existing site drains predominantly to the southeast to Jimmy Camp Creek.

Existing zoning of this property is R-4 Residential and the site acreage is 23.59 acres. The site is currently PUD (Planned Unit Development).

EXISTING DRAINAGE CONDITIONS

The existing topography is a stabilized site graded in accordance with the Colorado Centre Residential Filing No. 4 Overlot Grading Plan, dated July 1993, by JR Engineering, Ltd. Slopes range from 25% to 1%. The average soil condition reflects Hydrologic Group "B" (Loamy Ustic Torrifluvents) in the land west of Jimmy Camp Creek and Group "A" (Ellicott loamy coarse sand) in Jimmy Camp Creek as determined by the "Soil Survey of El Paso County Area," prepared by S.C.S.

PROPOSED DRAINAGE CHARACTERISTICS

The drainage flows and patterns for Colorado Centre Residential Filing No. 6 are in general conformance with the approved M.D.D.P. for Colorado Centre Residential Phase II (approved on April 19, 1996). The basin identifiers used in this report match those found in the approved M.D.D.P.

Basin F ($Q_5 = 17$ cfs, $Q_{100} = 32$ cfs) conveys lot flows to Gunbarrel Drive. The discharge will collect at a low point in the cul-de-sac. A 15' Type R inlet sized to intercept the 100-year event will collect the runoff. The storm sewer system associated with Colorado Centre Residential Filing No. 4 (off-site storm sewer to Jimmy Camp Creek) will convey the flows to Jimmy Camp Creek. The resultant pipe flow at Design Point 6 is $Q_5 = 46$ cfs and $Q_{100} = 84$ cfs. An emergency overflow swale running along the common lot line of lots 49 and 50 will convey the 100-year storm in case of failure in the 15' Type R inlet. The swale will convey the flows to the same discharge point as the pipe into Jimmy Camp Creek.

Basin N ($Q_5 = 6$ cfs, $Q_{100} = 13$ cfs) conveys flows to a low point in Pony Gulch Way. A 5' Type R inlet sized to intercept the 100-year event will collect the runoff. The storm sewer system associated with Colorado Centre Residential Filing No. 4 (off-site storm sewer to Jimmy Camp Creek) will convey the flows to Jimmy Camp Creek.

Basin O ($Q_5 = 8$ cfs, $Q_{100} = 16$ cfs) conveys flows to a low point in the cul-de-sac of Pony Gulch Way. A 10' Type R inlet sized to intercept the 100-year event will collect the runoff. The storm sewer system associated with Colorado Centre Residential Filing No. 4 (off-site storm sewer to Jimmy Camp Creek) will convey the flows to Jimmy Camp Creek. The resultant pipe flow at Design Point 4 is $Q_5 = 58$ cfs and $Q_{100} = 94$ cfs. If failure occurs in the 10' Type R inlet, an emergency overflow swale will route the 100-year runoff along the same path as the pipe and is discharged into Jimmy Camp Creek.

Basin E ($Q_5 = 3$ cfs, $Q_{100} = 6$ cfs) will sheet flow onto Horizonview Drive in conformance with the approved MDDP. The combined flow in Horizonview Drive will be $Q_5 = 12$ cfs and $Q_{100} = 27$ cfs.

approved MDDP. The combined flow in Horizonview Drive will be $Q_5 = 12$ cfs and $Q_{100} = 27$ cfs. The street capacity of Horizonview Drive at 0.7% grade is $Q_5 = 12$ cfs and $Q_{100} = 175$ cfs. Runoff in Horizon Drive will flow south to Bradley Street where it will be directed east to Jimmy Camp Creek.

Basin G ($Q_5 = 7$ cfs, $Q_{100} = 20$ cfs) sheet flows directly into Jimmy Camp Creek along approximately 1200 feet of creek frontage.

HYDROLOGIC CALCULATIONS

The methodology and basin characteristics within this report conform to standards as set forth in the City/County Drainage Criteria Manual.

This final drainage report for Colorado Centre Residential Filing No. 6 incorporates the current (revised October 1994) criteria. The current City/County Drainage Criteria Manual requires the use of the Rational Method for small sub-basins such as those within Colorado Centre Residential Filing No. 6. At all design points, the 5-year and 100-year storms were used to size drainage facilities and verify conformance with drainage criteria.

HYDRAULIC CALCULATIONS

Inlets were sized using calculations found in the current City/County Drainage Criteria Manual. Storm sewers were calculated using Mannings' Formula in conformance with the Drainage Criteria Manual.

The combinations of public streets and storm sewer system have adequate conveyance capacity for both the 5-year and 100-year storm flows.

EROSION CONTROL PLAN

The County of El Paso Drainage Criteria Manual specifies that an erosion control plan and associated cost estimate be submitted in conjunction with the final drainage report. This site has an approved erosion control plan as submitted with the Colorado Centre Residential Filing No. 4 drainage report.

FLOODPLAIN STATEMENT

Colorado Centre Residential Filing No. 6 is within a special flood hazard area inundated by the 100-year flood, Zone AE, as determined by graphic interpretation. Floodplain information was obtained from F.E.M.A. Flood Insurance Rate Map, Map Number 08041C0769 F, effective date March 17, 1997.

CONSTRUCTION COST ESTIMATE (On-site) Public Drainage Facilities

<u>Item</u>	<u>Description</u>	<u>Quantity</u>	<u>Unit Cost</u>	<u>Total</u>
1.	Curb and Gutter (Type II)	5,850 L.F.	\$7/L.F.	\$ 40,950.00
2.	Curb and Gutter (Type I)	90 L.F.	\$7/L.F.	\$ 630.00
3.	Full Depth Asphalt	11,900 S.Y.	\$11/S.Y.	\$ 130,900.00
4.	36" x 24" Wye	1 EACH	\$1400/EA	\$ 1,400.00
5.	36" Bend	1 EACH	\$1350/EA	\$ 1,350.00
6.	24" R.C.P.	73 L.F.	\$30/L.F.	\$ 2,190.00
7.	36" R.C.P.	1,170 L.F.	\$48/L.F.	\$ 56,160.00
8.	42" R.C.P.	341 L.F.	\$65/L.F.	\$ 22,165.00
9.	5' Inlet	1 EACH	\$2800/EA	\$ 2,800.00
10.	10' Inlet	1 EACH	\$4500/EA	\$ 4,500.00
11.	15' Inlet	1 EACH	\$5000/EA	\$ 5,000.00
12.	Type I Manhole	4 EACH	\$3600/EA	\$ 14,400.00
		Sub-Total		<u>\$ 282,445.00</u>
		5% Construction Contingency		\$ 14,122.25
		10% Engineering		\$ 28,244.50
		TOTAL		<u>\$ 324,811.75</u>

EROSION AND SEDIMENT CONTROL

<u>Item</u>	<u>Description</u>	<u>Quantity</u>	<u>Unit Cost</u>	<u>Total</u>
1.	Silt Fence	1,500 L.F.	\$1/L.F.	\$ 1,500.00
2.	3 Bale Check Dam	28 EACH	\$12/EA	\$ 336.00
3.	Vehicle Tracking Control	2 EACH	\$1000/EA	\$ 2,000.00
4.	25% Maintenance and Replacement	1 LUMP SUM	\$959/L.S.	\$ 959.00
5.	Reseeding	17 ACRES	\$500/AC	\$ 8,500.00

TOTAL

\$ 13,295.00

JR Engineering cannot and does not guarantee that the construction cost will not vary from these opinions of probable construction costs. These opinions represent our best judgement as design professionals familiar with the construction industry and this development in particular.

DRAINAGE AND BRIDGE FEES:

The developer has previously constructed regional drainage improvements to Jimmy Camp Creek. These improvements are greater than the drainage fees for Colorado Centre Residential Filing No. 6. Therefore no fees will be required for Colorado Centre Residential Filing No. 6.

SUMMARY

The flows generated by this development will not adversely affect the downstream property owners. The existing and proposed street system and storm sewer facilities are able to handle the flows from this site. All streets were analyzed using Table 6-1 in the El Paso County Drainage Criteria Manual. Horizonview Drive flows are restricted to a spread of no greater than 20 feet from the flowline of the existing curb and gutter for 5-year flows which meets Type B criteria for collector or minor arterial streets. All other streets are limited to a depth of either the crownline or top of curb, whichever is the most limiting for 5-year flows according to Type A use for local or residential streets. All 100-year flows are restricted to a curb flowline depth not to exceed the right-of-way elevation. All flows generated by Filing No. 6 will be safely discharged to Jimmy Camp Creek. At the time of home construction, the home builder will be responsible for maintaining the proper lot drainage patterns as detailed in this report.

PREPARED BY:

JR Engineering



Quentin N. Armijo, E.I.
Designer Engineer II

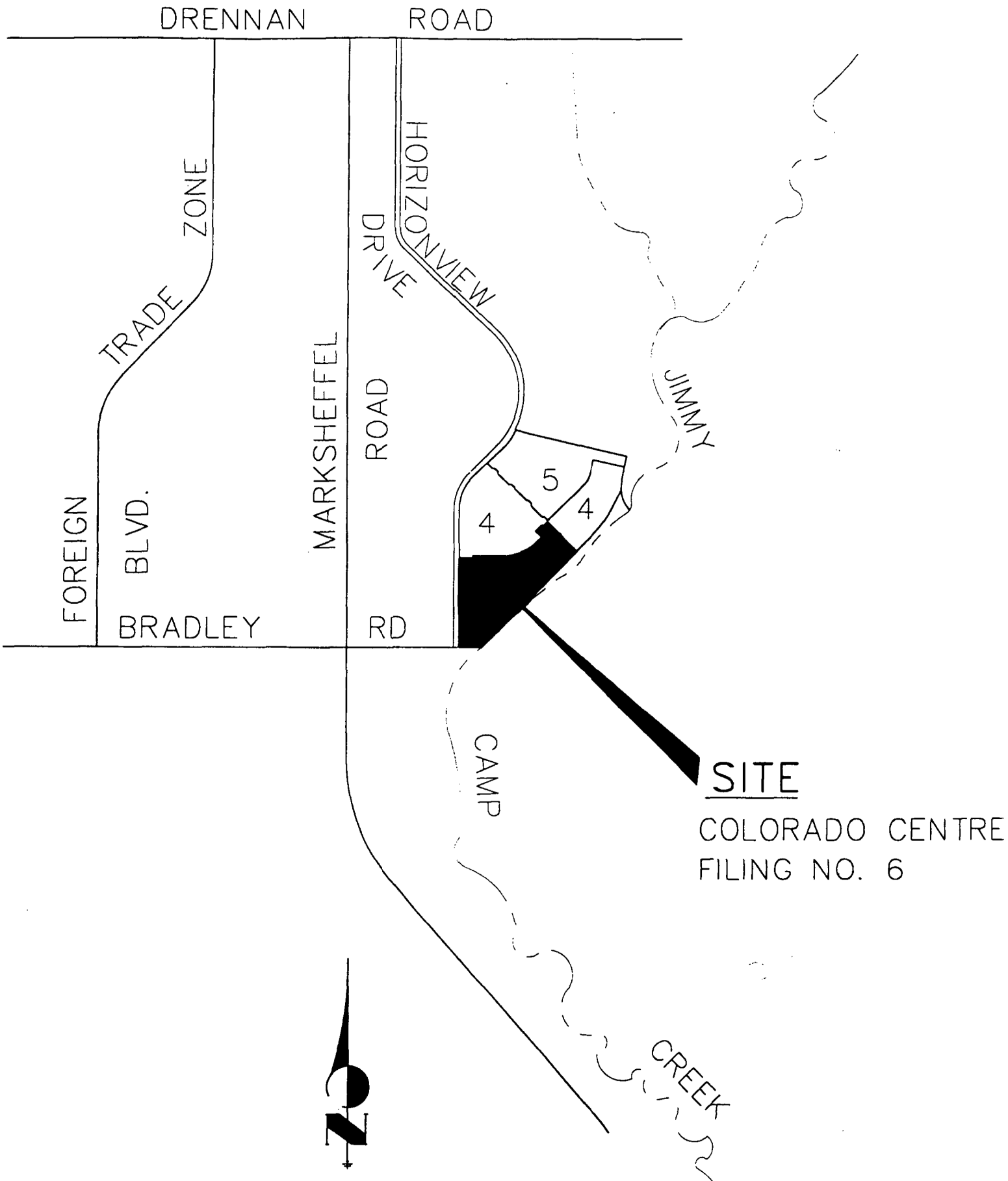
/cw/813260/drainage.doc

REFERENCES:

1. City of Colorado Springs/County of El Paso Drainage Criteria Manual, dated October 1987, revised October 1994.
2. "Master Development Drainage Plan for Colorado Centre Residential Phase II," JR Engineering, Ltd., July 22, 1993.
3. "Drainage Study for Horizonview Drive," JR Engineering, Ltd., April 1, 1986.
4. "Colorado Centre Residential Filing No. 1," JR Engineering, Ltd., March 22, 1985.
5. "Colorado Centre Residential Filing No. 2," JR Engineering, Ltd., April 19, 1985.
6. "Colorado Centre Residential Filing No. 3," JR Engineering, Ltd., July 23, 1985.
7. "Final Drainage Report and Erosion Control Plan for Colorado Centre Residential Filing No. 4," prepared by JR Engineering, Ltd.
8. "Colorado Centre Residential Filing No. 5," JR Engineering, Ltd., February 1998.
9. Flood Insurance Rate Map, Community Panel Number 08041C0769F, effective date March 17, 1998.

APPENDIX

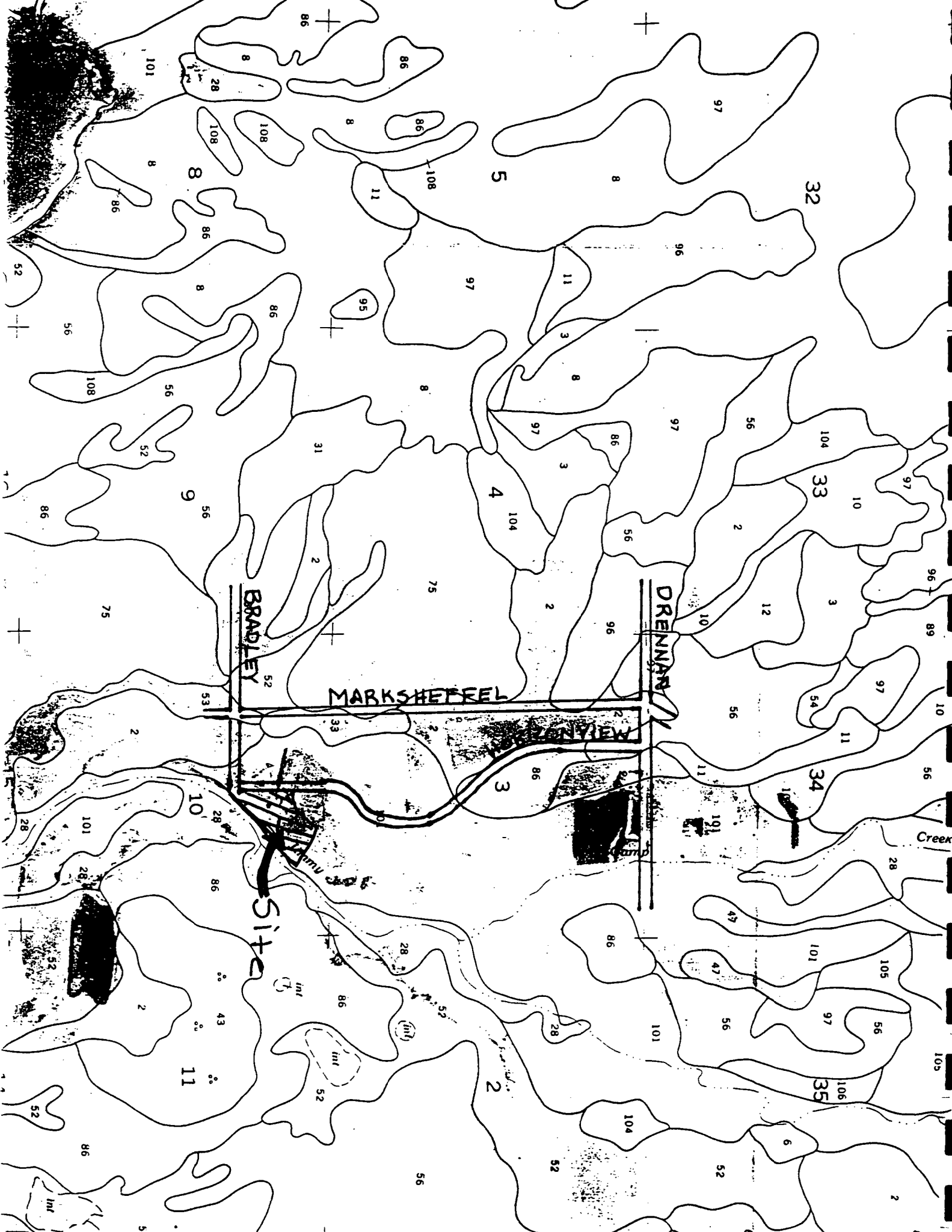
VICINITY MAP



SITE
COLORADO CENTRE
FILING NO. 6

VICINITY MAP
N.T.S.

**SOILS MAP
(S.C.S. SURVEY)**



F.E.M.A. MAP

FIRM FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

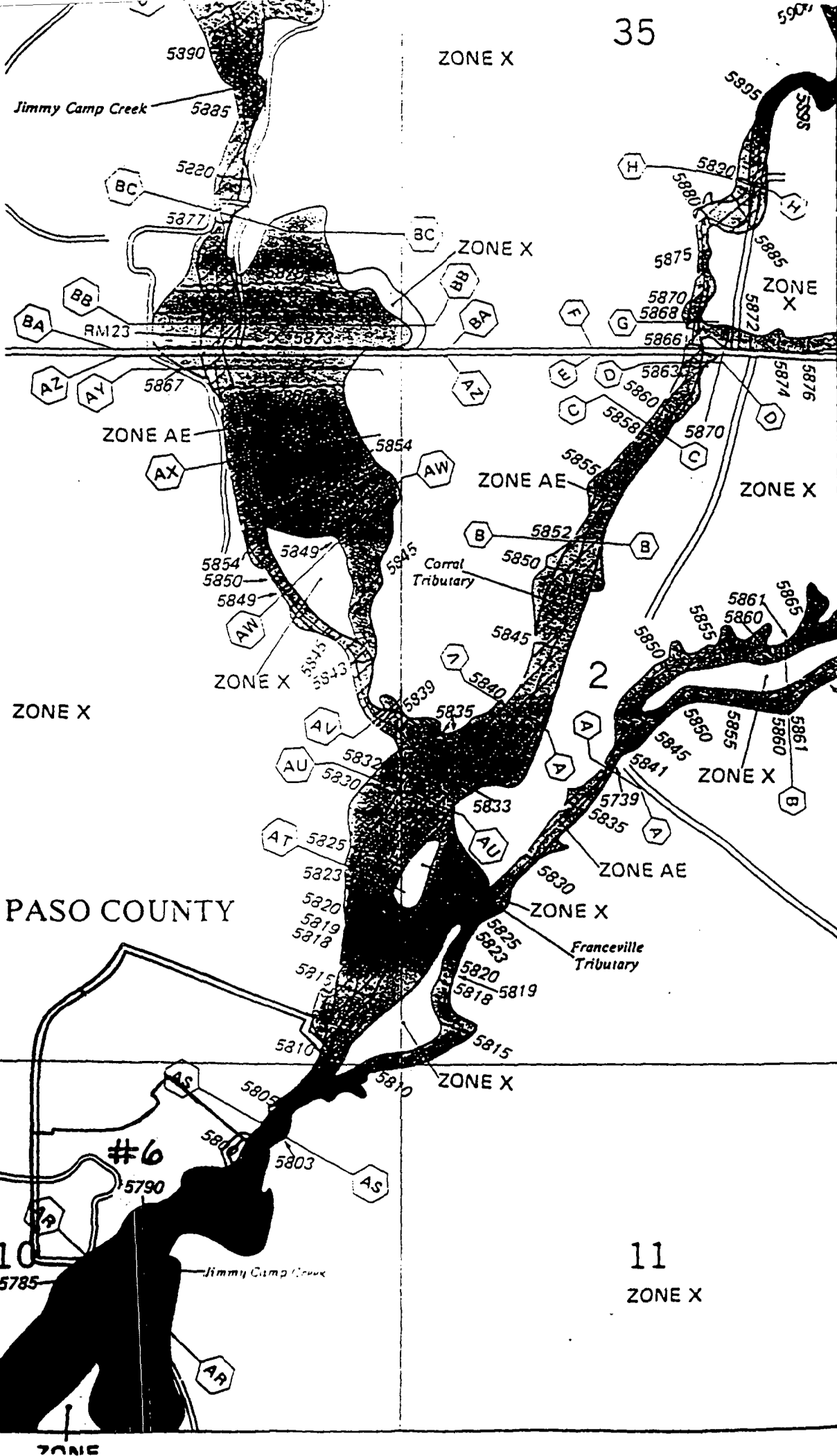
PANEL 769 OF 1300
SEE MAP INDEX FOR PANELS NOT PRINTED

COUNTY	NUMBER	PANEL	SUFFIX
COLORADO	SPRING CITY OF EL PASO COUNTY	769	F
UNINCORPORATED AREAS			

MAP NUMBER
08041C0769 F

EFFECTIVE DATE:
MARCH 17, 1997

Federal Emergency Management Agency



EL PASO COUNTY

JOINS PANEL 0313

HYDROLOGIC CALCULATIONS

RATIONAL METHOD: Q = CIA

BASIN	AREA (ACRES)	L (ft)	H (ft)	S (%)	V (fps)	Tc (min)	IS	I100	SOIL GROUP	LAND USE	CS	C100	FLOW Q5	FLOW Q100
E	1.3	25/1000	2.5	2%	2.9	12	3.8	6.5	B		0.64	0.73	3	6
F	7.5	125/820	2.5	2%	3.3	18	3.1	5.4	B		0.71	0.79	17	32
G	6.2	250	5	2%		20	2.9	5.2	B		0.40	0.63	7	20
N	3.0	125/450	2.5	2%	2.7	17	3.2	5.6	B		0.66	0.75	6	13
O	3.5	125/550	2.5	2%	3.3	17	3.2	5.6	B		0.73	0.80	8	16

JR ENGINEERING, LTD.
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 (719) 591-2593 FAX (719) 528-6613

Project: Colorado Centre Residential Filing No. 6
 Engineer: SNIR Date: 6/4/99
 Job No.: 8132.60 Page: 1

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HYDRAULIC CALCULATIONS

COLORADO CENTRE RESIDENTIAL FILLING NO. 6

HYDRAULIC GRADE LINE FOR: Pony Gulch Storm Sewer

From Station	To Station	Loss Type	Start Inv. [ft]	Pipe Dia. [ft]	D ₁	D ₂	D ₃	Pipe Flow [cfs]	Q ₁	Q ₂	Q ₃	Pipe Slope [ft/ft]	S ₁	S ₂	S ₃	Horiz Bend [°]	H.G.L. Elev. [ft]	Head Loss [ft]
1+04.36	3+19.35	1	5790.41	3.5				94				1.00%					5790.45	1.87
3+19.35	3+25.35	3	5792.56	3.5				94				1.00%					5795.22	0.07
3+19.35	3+25.35	2	5792.56	3.5				94				1.00%				38	5795.29	0.19
3+25.35	4+51.06	1	5792.76	3.5				94				1.00%					5795.49	1.10
4+51.06	4+54.06	6	5794.02	3	3.5	3.5		73	94	21		1.12%	1.00%	4.00%		42	5796.68	0.68
4+54.06	5+61.08	1	5794.52	3				73				1.12%					5797.36	1.28
5+61.08	5+61.08	6	5795.72	3	3	2		61	73	12		1.12%	1.12%	1.17%		45	5798.64	0.89
5+61.08	5+84.87	1	5795.72	3				61				1.12%					5799.53	0.20
5+84.87	5+90.87	3	5795.98	3				61				1.12%					5799.73	0.06
5+84.87	5+90.87	2	5795.98	3				61				1.12%				30	5799.79	0.13
5+90.87	6+26.27	1	5796.18	3				61				0.85%					5799.92	0.30
6+26.27	6+26.27	2	5796.48	3				61				0.85%				34	5800.22	0.14
6+26.27	7+30.82	1	5796.48	3				61				0.85%					5800.36	0.87
7+30.82			5797.37														5801.24	

Loss Type Value

friction = 1

horiz. bend = 2

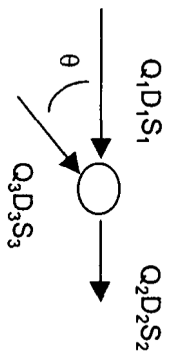
manhole = 3

transition (expansion) = 4

transition (contraction) = 5

junction = 6

Manning's n = 0.013



Calculated by: CDK

Date: 6/24/99

Checked by: _____

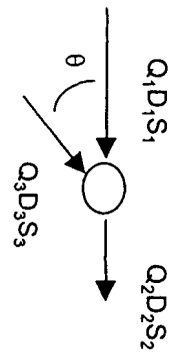
COLORADO CENTRE RESIDENTIAL FILING NO. 6

HYDRAULIC GRADE LINE FOR: Gunbarrel Drive Storm Sewer

From Station	To Station	Loss Type	Start Inv. [ft]	Pipe Dia. [ft]			Pipe Flow [cfs]			Pipe Slope [ft/ft]			Horiz Bend [°]	H.G.L. Elev. [ft]	Head Loss [ft]
				D ₁	D ₂	D ₃	Q ₁	Q ₂	Q ₃	S ₁	S ₂	S ₃			
7+72.79	9+40.69	1	5783.42	3			84			2.00%				5783.45	2.66
9+40.69	9+43.69	6	5786.78	3	3	3.5	52	84	32	1.49%	2.00%	4.00%	90	5788.97	2.91
9+43.69	10+55.70	1	5787.88	3			52			1.49%				5791.88	0.68
10+55.70	10+59.70	3	5789.55	3			52			1.49%				5792.56	0.04
10+55.70	10+59.70	2	5789.55	3			52			1.49%		45		5792.61	0.12
10+59.70	15+50.96	1	5789.55	3			52			0.91%				5792.73	2.98
15+50.96	15+54.96	3	5794.65	3			52			0.91%				5796.69	0.04
15+54.96	16+81.57	1	5795.15	3			52			0.91%				5797.19	0.77
16+81.57			5796.03											5798.07	

Loss Type Value
 friction = 1
 horiz. bend = 2
 manhole = 3
 transition (expansion) = 4
 transition (contraction) = 5
 junction = 6

Manning's n = 0.013



Calculated by: CDK
 Date: 6/25/99
 Checked by: _____

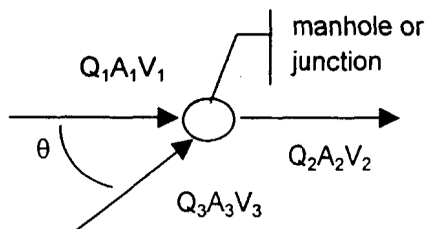
COLORADO CENTRE RESIDENTIAL FILING NO. 6

HYDRAULIC GRADE LINE EQUATIONS

<u>Junction</u>	<u>Equation</u>	<u>Taken from:</u>
friction loss	$h_f = \frac{(185 \cdot n^{2.48} \cdot L \cdot v^2)}{(D^{4.75} \cdot 2 \cdot g)}$	City of Colo Spgs & El Paso County Drainage Criteria Manual
horizontal bend	$h_b = \frac{[0.20 \cdot (\Delta/90^\circ)^{1/2} \cdot v^2]}{(2 \cdot g)}$	Los Angeles County Flood Control District Hydraulic Design Manual
manhole	$h_{mh} = \frac{(0.05 \cdot v^2)}{(2 \cdot g)}$	Los Angeles County Flood Control District Hydraulic Design Manual
transition	for: $v_2 > v_1$ (expansion) $h_t = 0.1 \cdot [(v_2^2 / (2 \cdot g)) - (v_1^2 / (2 \cdot g))]$ for: $v_1 > v_2$ (contraction) $h_t = 0.2 \cdot [(v_1^2 / (2 \cdot g)) - (v_2^2 / (2 \cdot g))]$	City of Colo Spgs & El Paso County Drainage Criteria Manual
junction	$h_L = \frac{(Q_2 v_2 - Q_1 v_1 - Q_3 v_3 \cdot \cos \theta)}{[g \cdot 1/2 \cdot (A_1 + A_2)]}$	(Thompson Equation) Los Angeles County Flood Control District Hydraulic Design Manual

Where:

- n = Manning's Coefficient
- L = length of pipe [ft]
- v = velocity [ft/s]
- D = diameter of pipe [ft]
- g = acceleration of gravity [32.2 ft/s]



PONY GULCH 42" sta. 1+04.36
Worksheet for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	PONY GULCH WAY 42"
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.013
Channel Slope	2.00 %
Diameter	42.00 in
Discharge	94.00 cfs

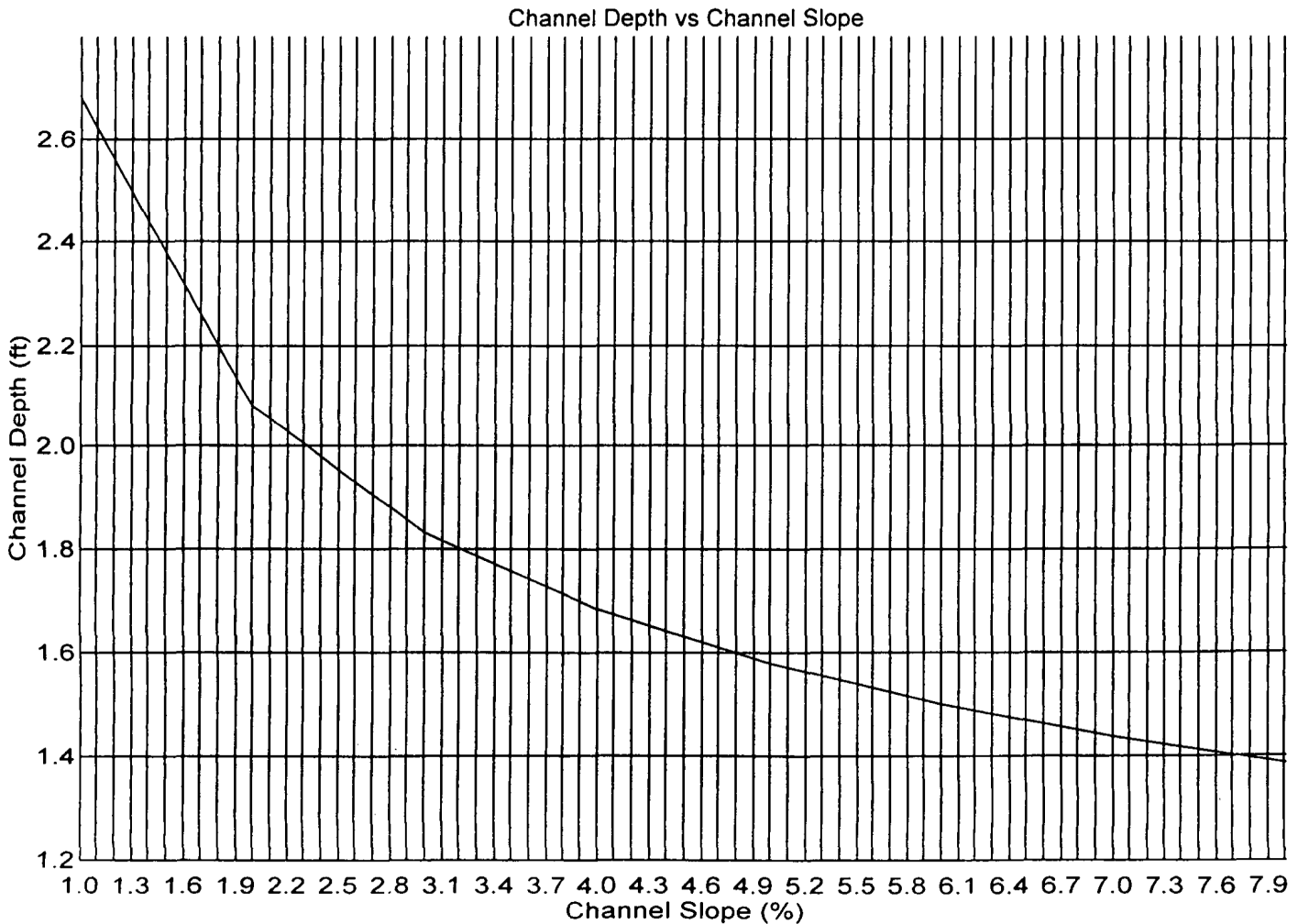
Results		
Depth	2.08	ft
Flow Area	5.95	ft ²
Wetted Perimeter	6.16	ft
Top Width	3.44	ft
Critical Depth	3.00	ft
Percent Full	59.35	
Critical Slope	0.008135	ft/ft
Velocity	15.80	ft/s
Velocity Head	3.88	ft
Specific Energy	5.96	ft
Froude Number	2.12	
Maximum Discharge	153.05	cfs
Full Flow Capacity	142.28	cfs
Full Flow Slope	0.008730	ft/ft
Flow is supercritical.		

Curve Plotted Curves for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	PONY GULCH WAY 42"
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.013
Diameter	42.00 in
Discharge	94.00 cfs

Input Data			
	Minimum	Maximum	Increment
Channel Slope	1.00	8.00	1.00 %



PONY GULCH EYEBROW PIPE STA. 4+54.06
Worksheet for Circular Channel

Project Description

Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	PONY GULCH 36" A
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data

Mannings Coefficient	0.013
Channel Slope	1.12 %
Diameter	36.00 in
Discharge	73.00 cfs

Results

Depth	2.56	ft
Flow Area	6.43	ft ²
Wetted Perimeter	7.07	ft
Top Width	2.12	ft
Critical Depth	2.70	ft
Percent Full	85.43	
Critical Slope	0.010560	ft/ft
Velocity	11.35	ft/s
Velocity Head	2.00	ft
Specific Energy	4.57	ft
Froude Number	1.15	
Maximum Discharge	75.93	cfs
Full Flow Capacity	70.58	cfs
Full Flow Slope	0.011980	ft/ft

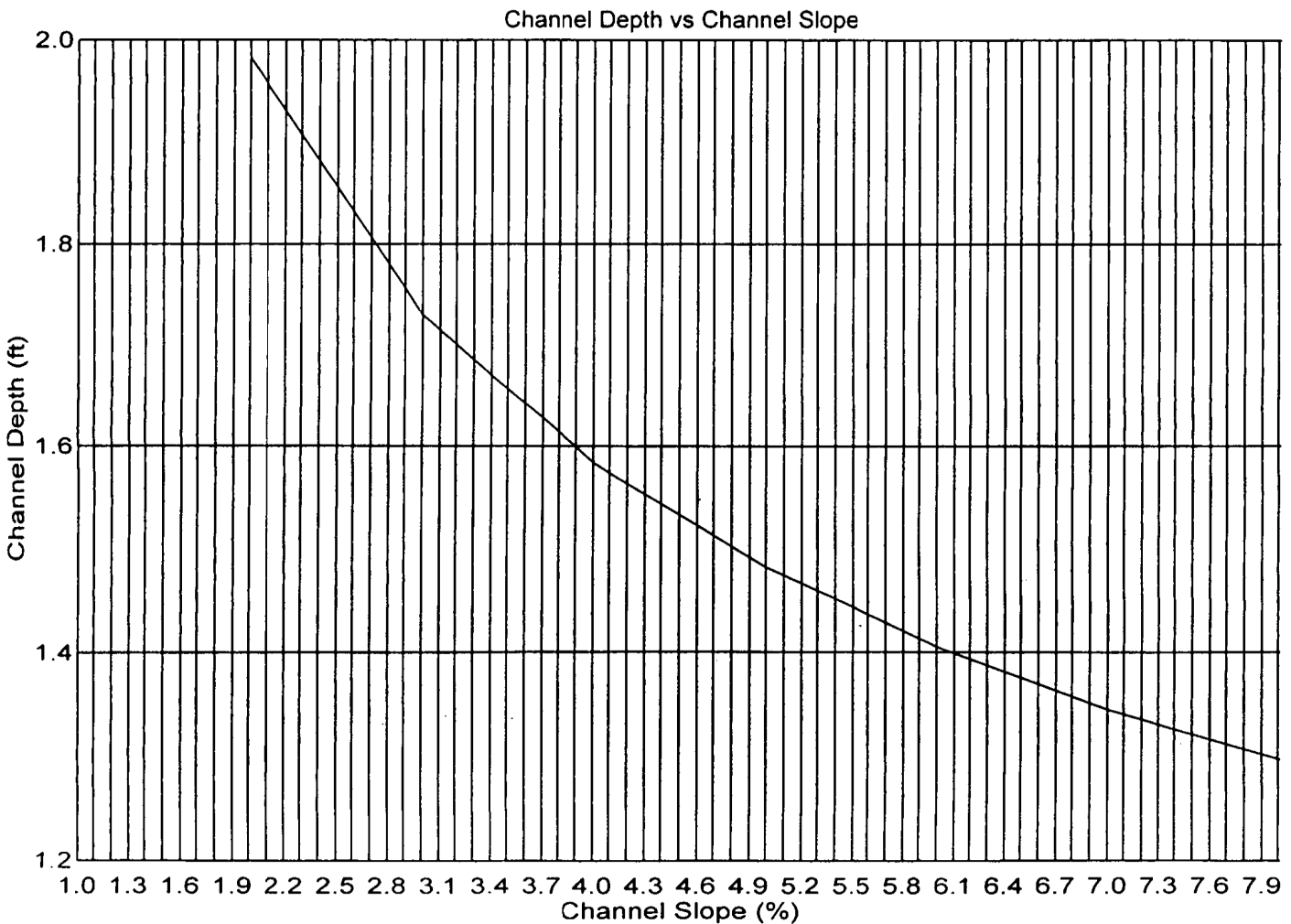
Flow is supercritical.

Curve
Plotted Curves for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	PONY GULCH 36" A
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.013
Diameter	36.00 in
Discharge	73.00 cfs

Input Data			
	Minimum	Maximum	Increment
Channel Slope	1.00	8.00	1.00 %



PONY GULCH EYEBROW PIPE STA. 5+61.08
Worksheet for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	PONY GULCH 36" A
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.013
Channel Slope	0.84 %
Diameter	36.00 in
Discharge	61.00 cfs

Results		
Depth	2.45	ft
Flow Area	6.19	ft ²
Wetted Perimeter	6.78	ft
Top Width	2.32	ft
Critical Depth	2.52	ft
Percent Full	81.77	
Critical Slope	0.008027	ft/ft
Velocity	9.86	ft/s
Velocity Head	1.51	ft
Specific Energy	3.96	ft
Froude Number	1.06	
Maximum Discharge	65.75	cfs
Full Flow Capacity	61.13	cfs
Full Flow Slope	0.008365	ft/ft
Flow is supercritical.		

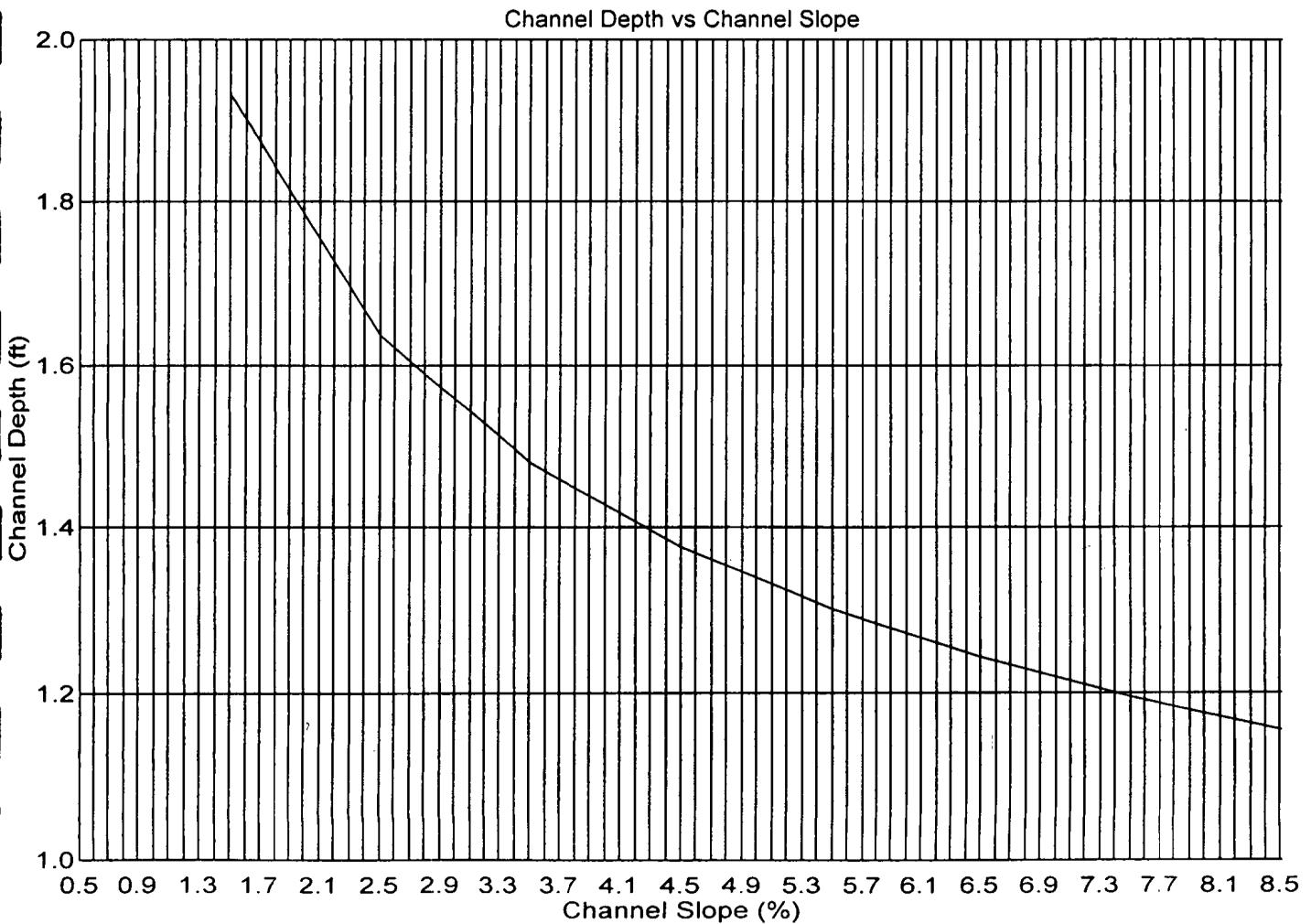
Curve

Plotted Curves for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	PONY GULCH 36" A
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.013
Diameter	36.00 in
Discharge	61.00 cfs

Input Data			
	Minimum	Maximum	Increment
Channel Slope	0.50	8.00	1.00 %



24" IN PONY GULCH PIPE STA. 0+00.00
Worksheet for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	24" IN PONY GULCH
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.013
Channel Slope	1.17 %
Diameter	24.00 in
Discharge	13.00 cfs

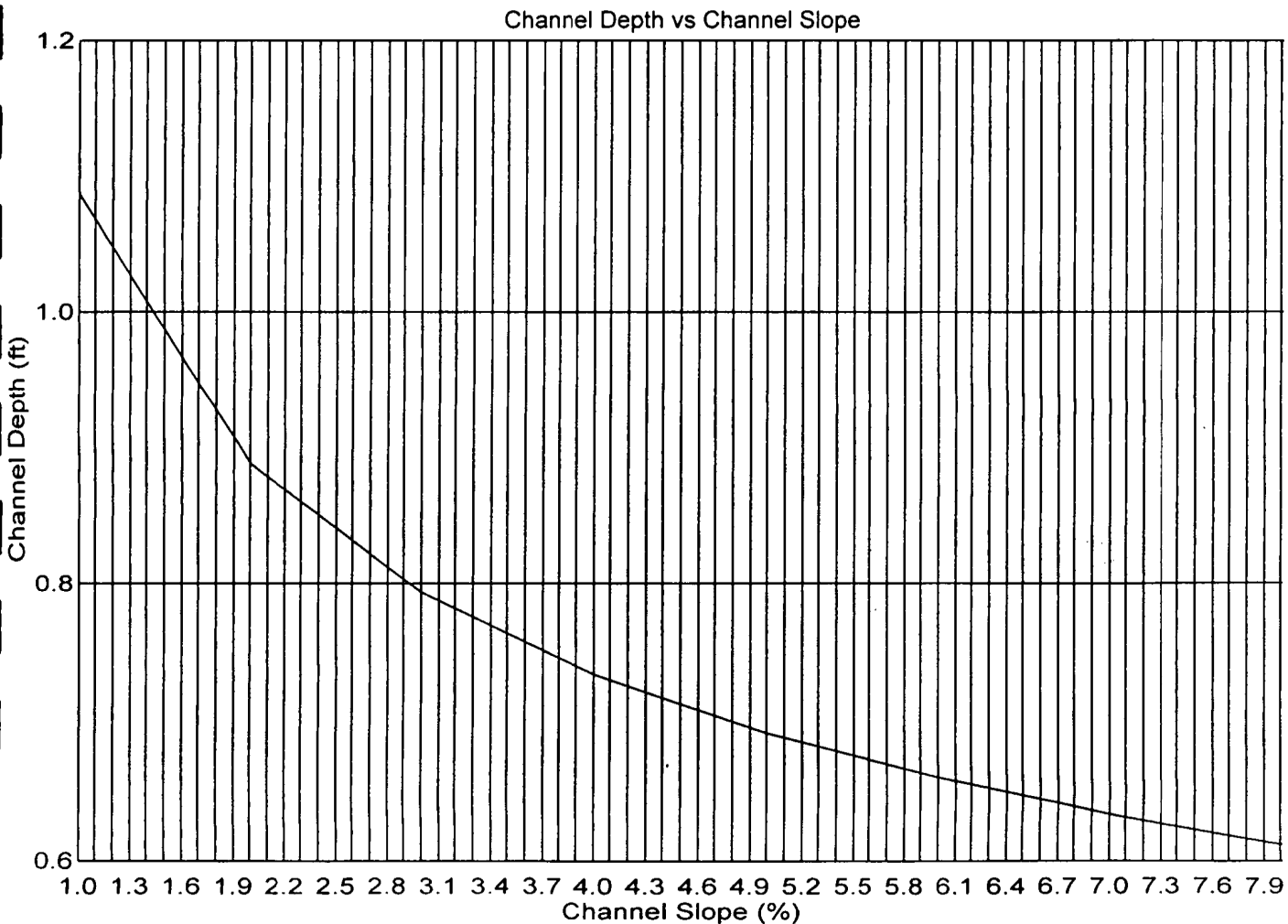
Results		
Depth	1.04	ft
Flow Area	1.64	ft ²
Wetted Perimeter	3.22	ft
Top Width	2.00	ft
Critical Depth	1.30	ft
Percent Full	51.84	
Critical Slope	0.005806	ft/ft
Velocity	7.91	ft/s
Velocity Head	0.97	ft
Specific Energy	2.01	ft
Froude Number	1.54	
Maximum Discharge	26.32	cfs
Full Flow Capacity	24.47	cfs
Full Flow Slope	0.003303	ft/ft
Flow is supercritical.		

Curve Plotted Curves for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	24" IN PONY GULCH
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.013
Diameter	24.00 in
Discharge	13.00 cfs

Input Data			
	Minimum	Maximum	Increment
Channel Slope	1.00	8.00	1.00 %



36" IN GUNBARRELL DRIVE STA. 7+72.79
Worksheet for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	Gunbarrel outfall pipe sizing
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.013
Channel Slope	2.0000 %
Diameter	3.0 ft
Discharge	84.00 cfs

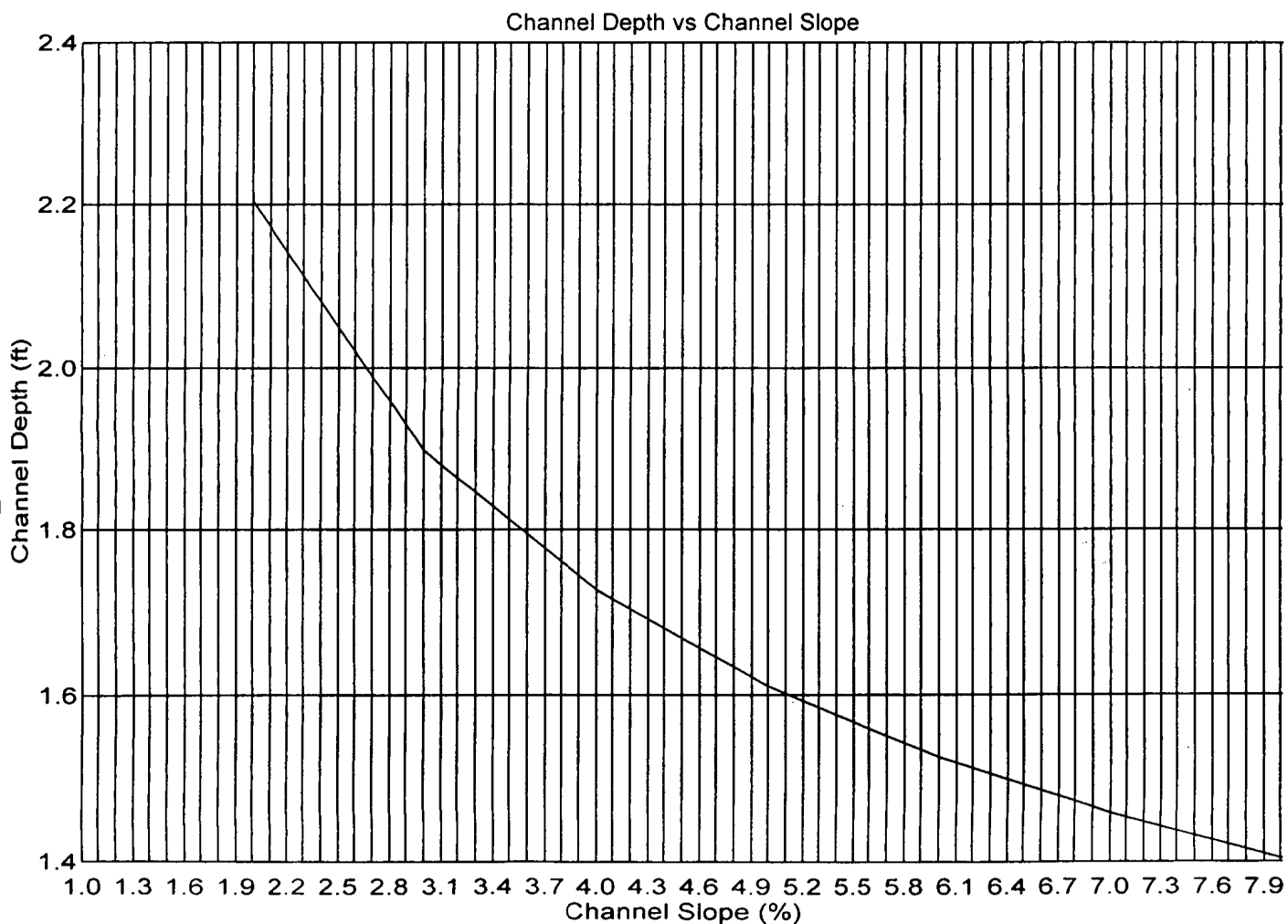
Results	
Depth	2.21 ft
Flow Area	5.57 ft ²
Wetted Perimeter	6.18 ft
Top Width	2.65 ft
Critical Depth	2.80 ft
Percent Full	73.52
Critical Slope	0.013711 ft/ft
Velocity	15.08 ft/s
Velocity Head	3.53 ft
Specific Energy	5.74 ft
Froude Number	1.83
Maximum Discharge	101.46 cfs
Full Flow Capacity	94.32 cfs
Full Flow Slope	0.015863 ft/ft
Flow is supercritical.	

Curve Plotted Curves for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	Gunbarrel outfall pipe sizing
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.013
Diameter	3.0 ft
Discharge	84.00 cfs

Input Data			
	Minimum	Maximum	Increment
Channel Slope	1.0000	8.0000	1.0000 %



36" IN GUNBARRELL DRIVE STA. 9+43.69
Worksheet for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	Gunbarrel outfall pipe sizing
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.013
Channel Slope	1.4900 %
Diameter	3.0 ft
Discharge	52.00 cfs

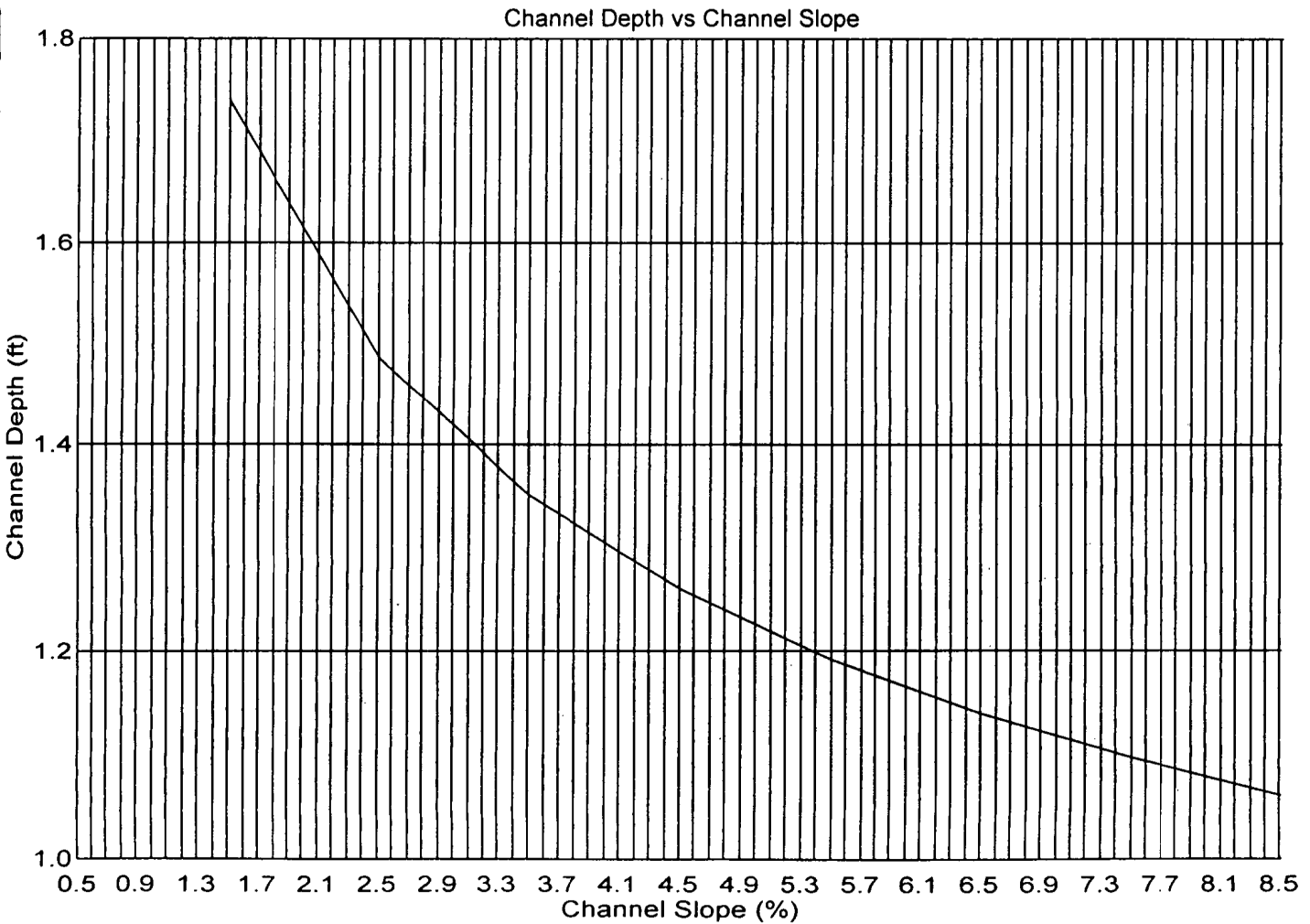
Results	
Depth	1.74 ft
Flow Area	4.26 ft ²
Wetted Perimeter	5.20 ft
Top Width	2.96 ft
Critical Depth	2.35 ft
Percent Full	58.07
Critical Slope	0.006670 ft/ft
Velocity	12.21 ft/s
Velocity Head	2.32 ft
Specific Energy	4.06 ft
Froude Number	1.80
Maximum Discharge	87.57 cfs
Full Flow Capacity	81.41 cfs
Full Flow Slope	0.006079 ft/ft
Flow is supercritical.	

Curve Plotted Curves for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	Gunbarrel outfall pipe sizing
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Constant Data	
Mannings Coefficient	0.013
Diameter	36 in
Discharge	52.00 cfs

Input Data			
	Minimum	Maximum	Increment
Channel Slope	0.5000	8.0000	1.0000 %



36" IN GUNBARRELL DRIVE STA. 10+59.70
Worksheet for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	Gunbarrel outfall pipe sizing
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.013
Channel Slope	0.9100 %
Diameter	3.0 ft
Discharge	52.00 cfs

Results	
Depth	2.06 ft
Flow Area	5.18 ft ²
Wetted Perimeter	5.86 ft
Top Width	2.78 ft
Critical Depth	2.35 ft
Percent Full	68.74
Critical Slope	0.006670 ft/ft
Velocity	10.04 ft/s
Velocity Head	1.57 ft
Specific Energy	3.63 ft
Froude Number	1.30
Maximum Discharge	68.44 cfs
Full Flow Capacity	63.62 cfs
Full Flow Slope	0.006079 ft/ft
Flow is supercritical.	

36" IN GUNBARRELL DRIVE STA. 15+54.96
Worksheet for Circular Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	Gunbarrel outfall pipe sizing
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

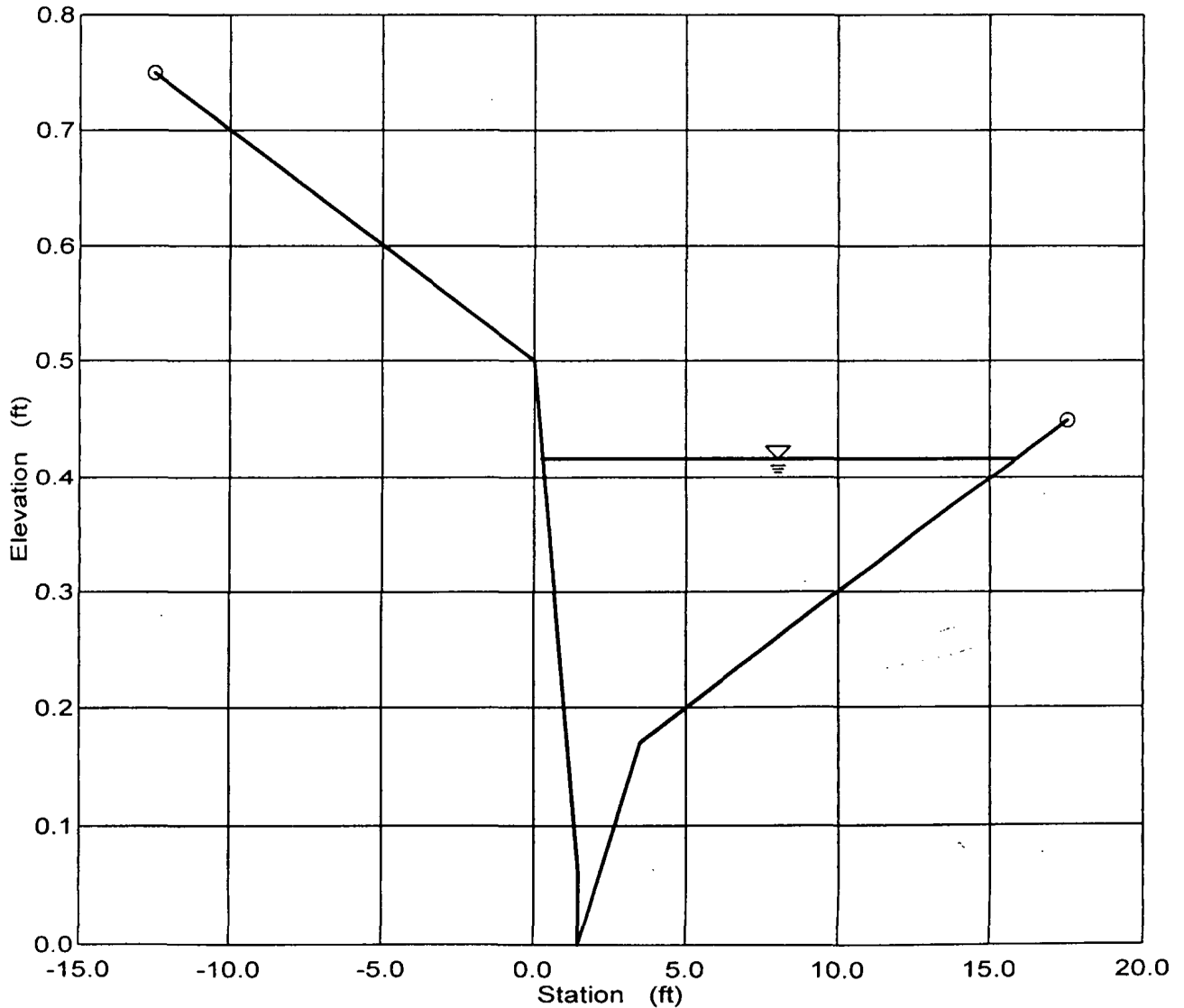
Input Data	
Mannings Coefficient	0.013
Channel Slope	0.7000 %
Diameter	3.0 ft
Discharge	52.00 cfs

Results	
Depth	2.29 ft
Flow Area	5.80 ft ²
Wetted Perimeter	6.38 ft
Top Width	2.55 ft
Critical Depth	2.35 ft
Percent Full	76.44
Critical Slope	0.006670 ft/ft
Velocity	8.97 ft/s
Velocity Head	1.25 ft
Specific Energy	3.54 ft
Froude Number	1.05
Maximum Discharge	60.03 cfs
Full Flow Capacity	55.80 cfs
Full Flow Slope	0.006079 ft/ft
Flow is supercritical.	

Cross Section
 Cross Section for Irregular Channel
GUNBARREL - 5 YEAR

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.014
Channel Slope	0.013400 ft/ft
Water Surface Elevation	0.42 ft
Discharge	8.50 cfs



Worksheet
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data

Channel Slope 0.013400 ft/ft

Elevation range: 0.00 ft to 0.75 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
-12.50	0.75	-12.50	17.50	0.014
0.00	0.50			
1.49	0.06			
1.50	0.00			
3.50	0.17			
17.50	0.45			

Discharge 8.50 cfs

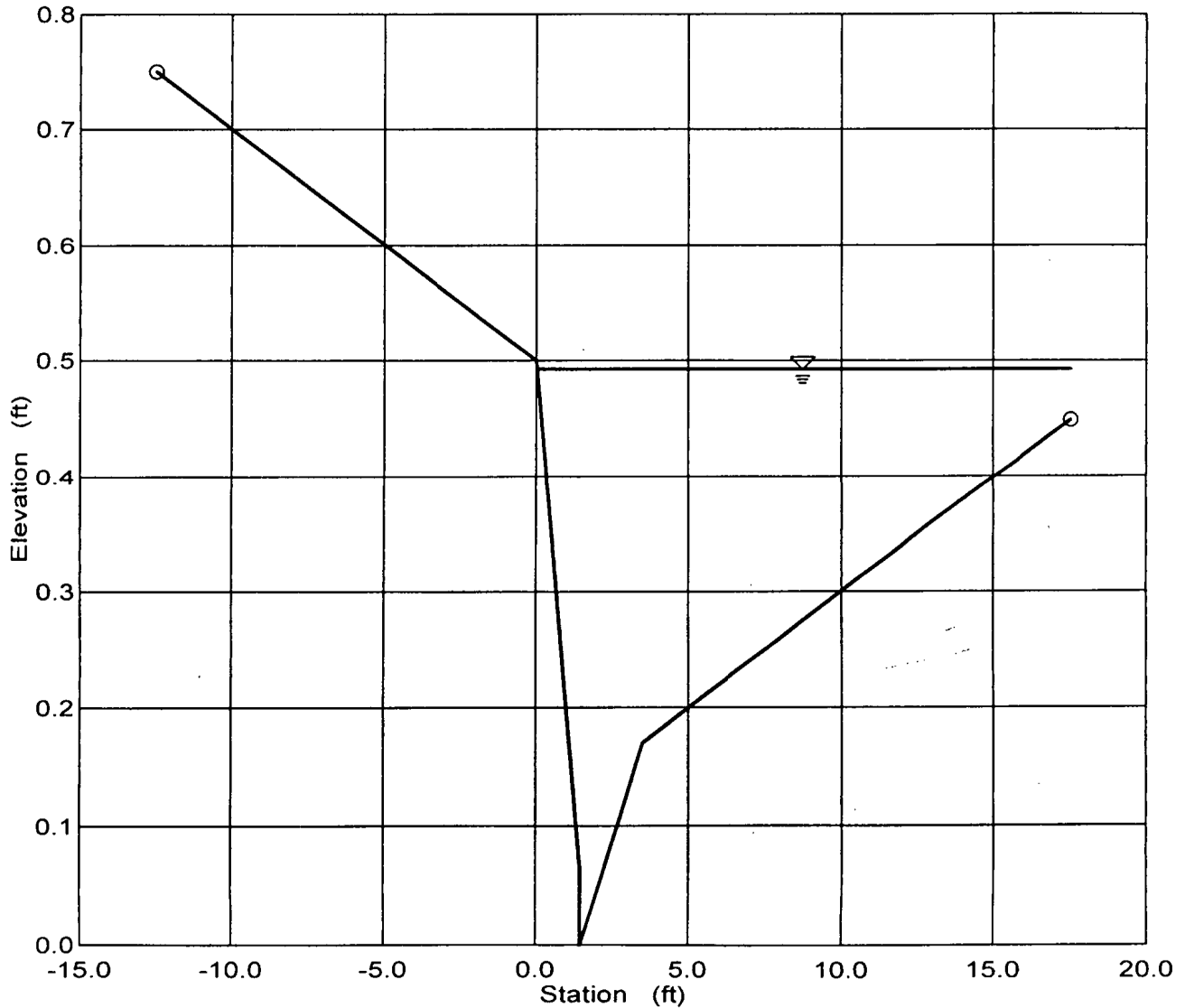
Results

Wtd. Mannings Coefficient	0.014	
Water Surface Elevation	0.42	ft
Flow Area	2.41	ft ²
Wetted Perimeter	15.69	ft
Top Width	15.58	ft
Height	0.42	ft
Critical Depth	0.48	ft
Critical Slope	0.004982	ft/ft
Velocity	3.53	ft/s
Velocity Head	0.19	ft
Specific Energy	0.61	ft
Froude Number	1.58	
Flow is supercritical.		

Cross Section
 Cross Section for Irregular Channel
GUNBARREL - 100 YEAR

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.014
Channel Slope	0.013400 ft/ft
Water Surface Elevation	0.49 ft
Discharge	16.00 cfs



Worksheet
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data				
Channel Slope	0.013400 ft/ft			
Elevation range: 0.00 ft to 0.75 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
-12.50	0.75	-12.50	17.50	0.014
0.00	0.50			
1.49	0.06			
1.50	0.00			
3.50	0.17			
17.50	0.45			
Discharge	16.00	cfs		

Results	
Wtd. Mannings Coefficient	0.014
Water Surface Elevation	0.49 ft
Flow Area	3.69 ft ²
Wetted Perimeter	17.64 ft
Top Width	17.48 ft
Height	0.49 ft
Critical Depth	0.59 ft
Critical Slope	0.004580 ft/ft
Velocity	4.33 ft/s
Velocity Head	0.29 ft
Specific Energy	0.78 ft
Froude Number	1.66
Flow is supercritical.	
Water elevation exceeds lowest end station by 0.04 ft.	

TYPE R INLET @ GUNBARREL CUL-DE-SAC

$$Q_5 = 17 \text{ cfs} + 20\% \text{ clogging} = 20 \text{ cfs}$$

$$1.7(15 + 5.4)(.5 + .25)^{1.85} = 20 \therefore \text{O.K.}$$

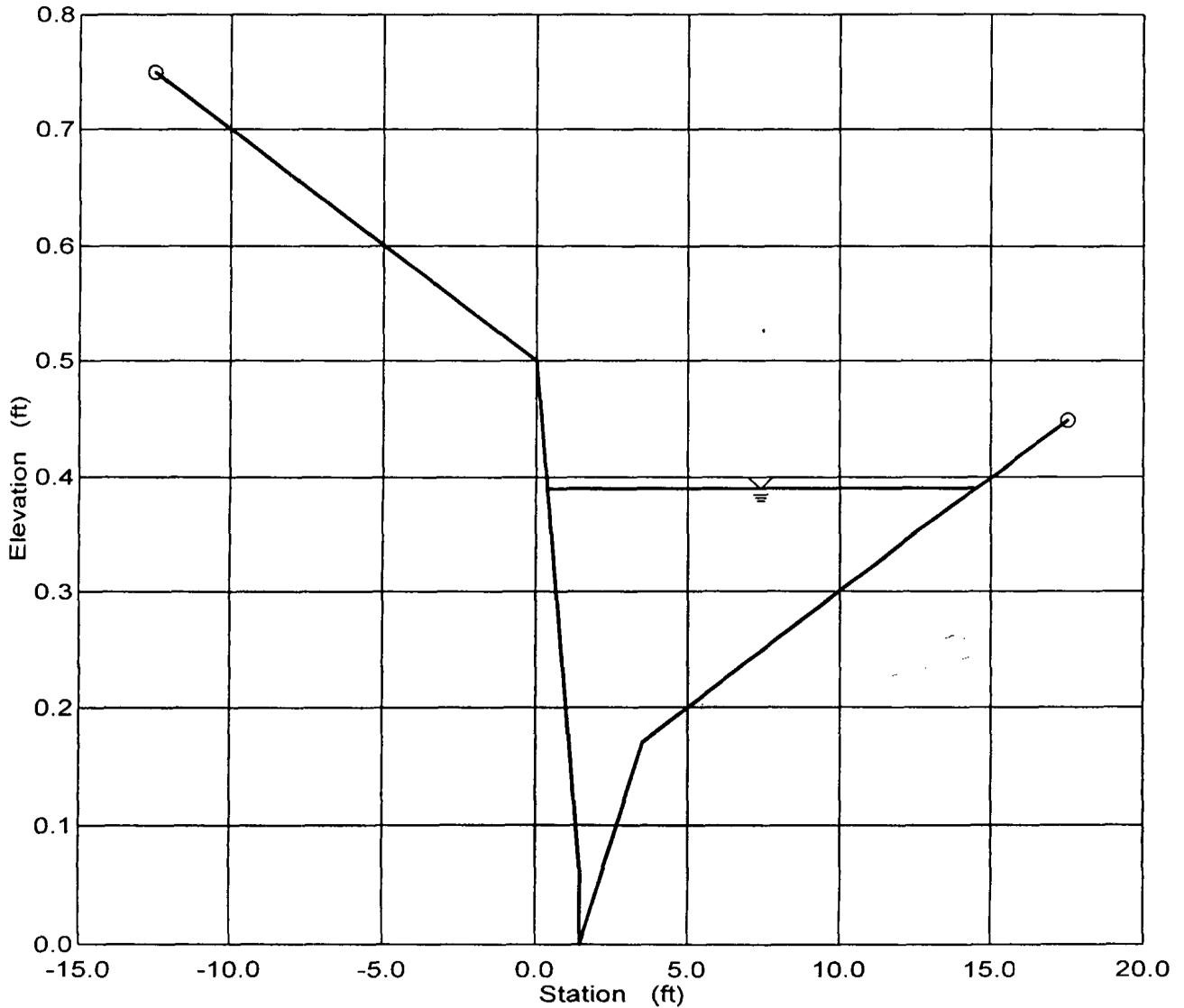
$$Q_{100} = 32 \text{ cfs} + 20\% \text{ clogging} = 38 \text{ cfs}$$

$$(1.7(15) + 6.12)(.87 + .25)^{1.85} = 39 \therefore \text{O.K.}$$

Cross Section
 Cross Section for Irregular Channel
PONY GULCH - 5 YEAR

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.014
Channel Slope	0.011000 ft/ft
Water Surface Elevation	0.39 ft
Discharge	6.00 cfs



Worksheet
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data

Channel Slope 0.011000 ft/ft
Elevation range: 0.00 ft to 0.75 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
-12.50	0.75	-12.50	17.50	0.014
0.00	0.50			
1.49	0.06			
1.50	0.00			
3.50	0.17			
17.50	0.45			
Discharge	6.00	cfs		

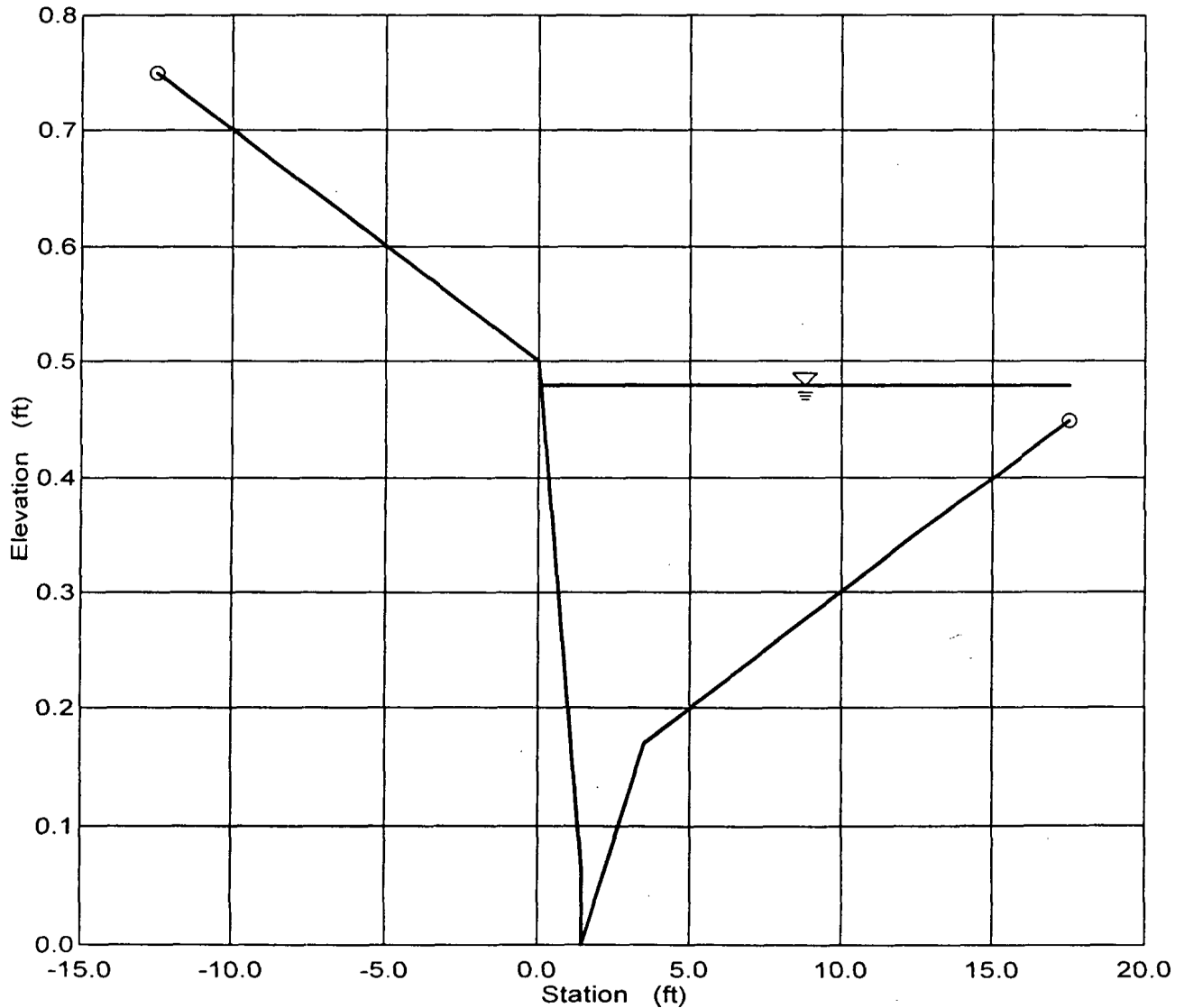
Results

Wtd. Mannings Coefficient	0.014	
Water Surface Elevation	0.39	ft
Flow Area	1.99	ft ²
Wetted Perimeter	14.18	ft
Top Width	14.07	ft
Height	0.39	ft
Critical Depth	0.43	ft
Critical Slope	0.005295	ft/ft
Velocity	3.01	ft/s
Velocity Head	0.14	ft
Specific Energy	0.53	ft
Froude Number	1.41	
Flow is supercritical.		

Cross Section
 Cross Section for Irregular Channel
PONY GULCH - 100 YEAR

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.014
Channel Slope	0.011000 ft/ft
Water Surface Elevation	0.48 ft
Discharge	13.00 cfs



Worksheet
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data				
Channel Slope	0.011000 ft/ft			
Elevation range: 0.00 ft to 0.75 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
-12.50	0.75	-12.50	17.50	0.014
0.00	0.50			
1.49	0.06			
1.50	0.00			
3.50	0.17			
17.50	0.45			
Discharge	13.00	cfs		

Results	
Wtd. Mannings Coefficient	0.014
Water Surface Elevation	0.48 ft
Flow Area	3.45 ft ²
Wetted Perimeter	17.58 ft
Top Width	17.43 ft
Height	0.48 ft
Critical Depth	0.55 ft
Critical Slope	0.004685 ft/ft
Velocity	3.76 ft/s
Velocity Head	0.22 ft
Specific Energy	0.70 ft
Froude Number	1.49
Flow is supercritical.	
<u>Water elevation exceeds lowest end station by 0.03 ft.</u>	

Pony Gulch Low Point

$$Q_5 = 6 \text{ cfs} + 20\% \text{ clogging} = 8 \text{ cfs}$$

$$\frac{1.7(5 + 5.4)(.57 + .25)^{1.85}}{17.68 \cdot 0.5875} = 10 \text{ cfs} \therefore \text{OK}$$

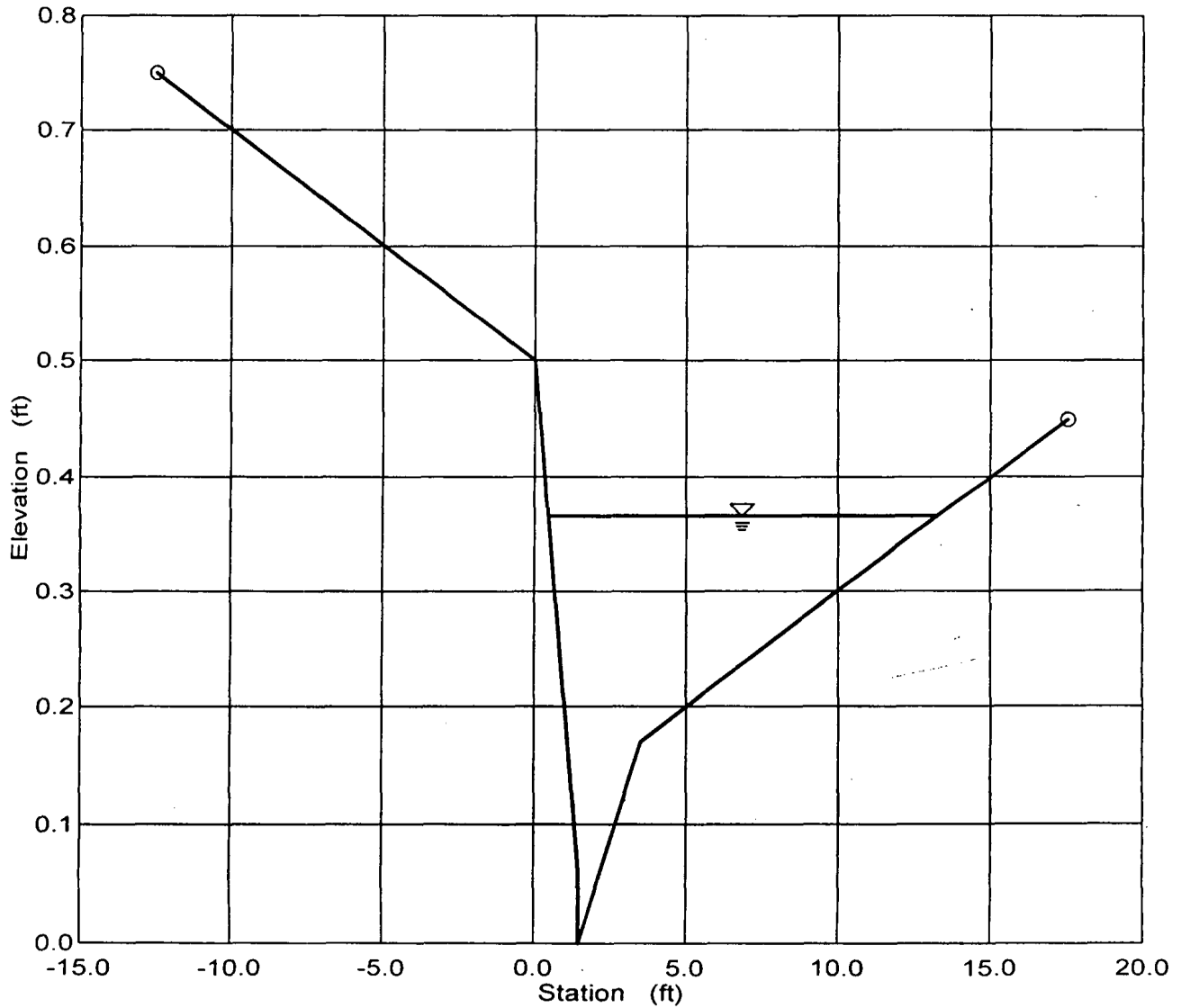
$$Q_{10} = 13 \text{ cfs} + 80\% \text{ clogging} = 16 \text{ cfs}$$

$$\frac{(1.7(5) + 6.12)(.87 + .25)}{14.62 \cdot 1.25} = 18 \text{ cfs} \therefore \text{OK}$$

Cross Section
 Cross Section for Irregular Channel
PONY GULCH EYEBROW - 5 YEAR

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.014
Channel Slope	0.008000 ft/ft
Water Surface Elevation	0.36 ft
Discharge	4.00 cfs



Worksheet
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

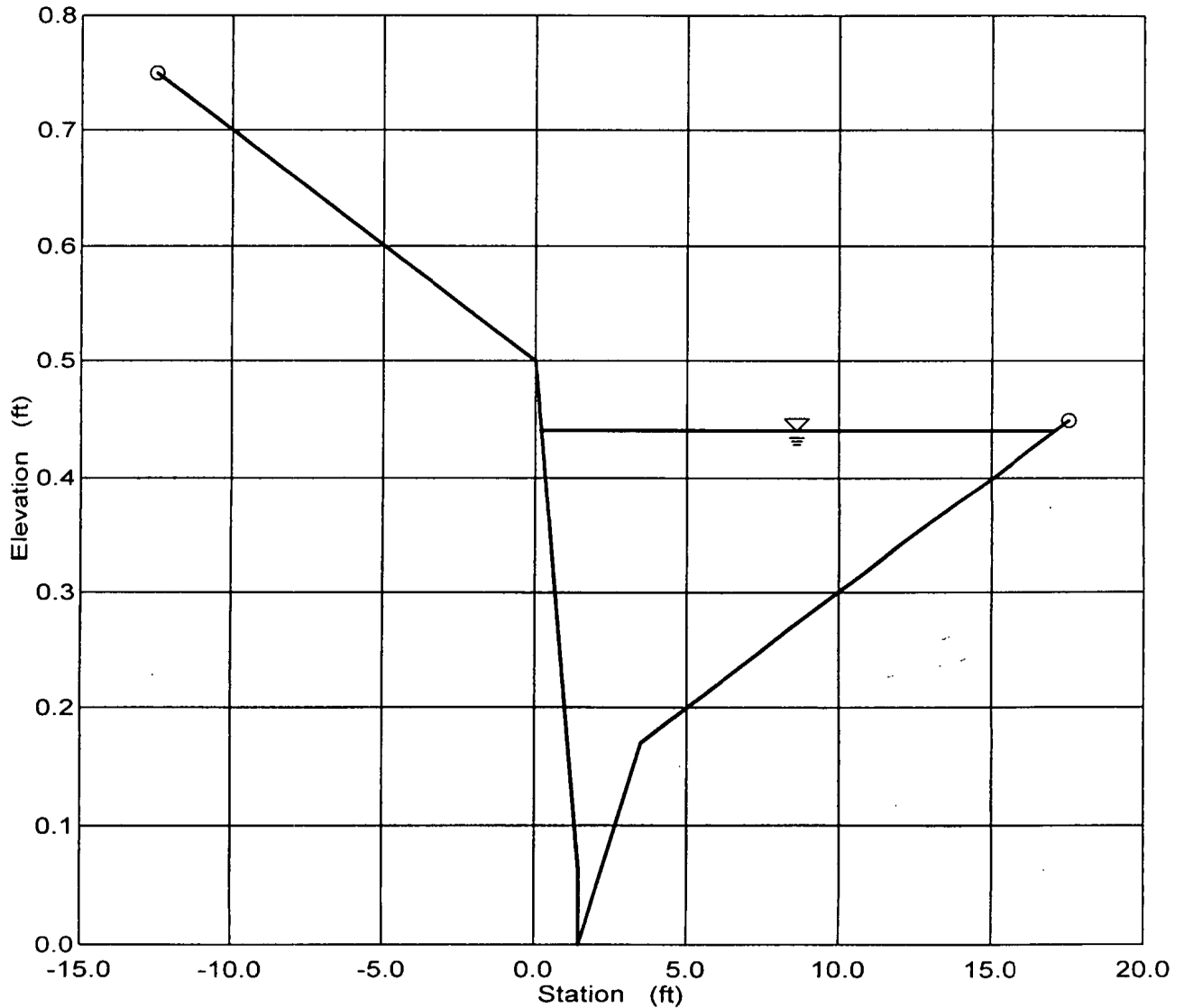
Input Data					
Channel Slope	0.008000 ft/ft				
Elevation range: 0.00 ft to 0.75 ft.					
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness	
-12.50	0.75	-12.50	17.50	0.014	
0.00	0.50				
1.49	0.06				
1.50	0.00				
3.50	0.17				
17.50	0.45				
Discharge	4.00	cfs			

Results		
Wtd. Mannings Coefficient	0.014	
Water Surface Elevation	0.36	ft
Flow Area	1.65	ft ²
Wetted Perimeter	12.81	ft
Top Width	12.71	ft
Height	0.36	ft
Critical Depth	0.38	ft
Critical Slope	0.005579	ft/ft
Velocity	2.42	ft/s
Velocity Head	0.09	ft
Specific Energy	0.45	ft
Froude Number	1.18	
Flow is supercritical.		

Cross Section
 Cross Section for Irregular Channel
POMY GULCH EYEBROW - 100 YEAR

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data	
Wtd. Mannings Coefficient	0.014
Channel Slope	0.008000 ft/ft
Water Surface Elevation	0.44 ft
Discharge	8.00 cfs



Worksheet
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	STREET FLOW DEPTH AT CURB LINE
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data

Channel Slope 0.008000 ft/ft

Elevation range: 0.00 ft to 0.75 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
-12.50	0.75	-12.50	17.50	0.014
0.00	0.50			
1.49	0.06			
1.50	0.00			
3.50	0.17			
17.50	0.45			

Discharge 8.00 cfs

Results

Wtd. Mannings Coefficient	0.014	
Water Surface Elevation	0.44	ft
Flow Area	2.80	ft ²
Wetted Perimeter	16.98	ft
Top Width	16.86	ft
Height	0.44	ft
Critical Depth	0.47	ft
Critical Slope	0.005044	ft/ft
Velocity	2.86	ft/s
Velocity Head	0.13	ft
Specific Energy	0.57	ft
Froude Number	1.24	

Flow is supercritical.

Type "R" Inlet @ Pony Gulch Eyebrow:

$$Q_5 = 3 \text{ cfs} + 20\% \text{ clogging} = 10 \text{ cfs}$$

$$1.7(10 + 5.4) / (.50 + .25)^{1.85} = 15 \text{ cfs } \text{! OK}$$

$$Q_{100} = 16 \text{ cfs} + 20\% \text{ clogging} = 20 \text{ cfs}$$

$$1.7(10) + 6.12 / (.37 + .35)^{1.85} = 23 \text{ cfs}$$

GUN BARREL OVERFLOW SWALE
Worksheet for Trapezoidal Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	GUN BARREL OVERFLOW SWALE
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.022	
Channel Slope	1.00	%
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	5.00	ft
Discharge	32.00	cfs

Results		
Depth	0.82	ft
Flow Area	6.82	ft ²
Wetted Perimeter	11.78	ft
Top Width	11.58	ft
Critical Depth	0.86	ft
Critical Slope	0.008517	ft/ft
Velocity	4.69	ft/s
Velocity Head	0.34	ft
Specific Energy	1.16	ft
Froude Number	1.08	
Flow is supercritical.		

PONY GULCH OVERFLOW SWALE
Worksheet for Trapezoidal Channel

Project Description	
Project File	x:\810000.all\813260\hydro\fm\813260.fm2
Worksheet	PONY GULCH OVERFLOW SWALE
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.022	
Channel Slope	1.00	%
Left Side Slope	4.000000	H : V
Right Side Slope	4.000000	H : V
Bottom Width	5.00	ft
Discharge	16.00	cfs

Results		
Depth	0.57	ft
Flow Area	4.17	ft ²
Wetted Perimeter	9.71	ft
Top Width	9.57	ft
Critical Depth	0.58	ft
Critical Slope	0.009451	ft/ft
Velocity	3.84	ft/s
Velocity Head	0.23	ft
Specific Energy	0.80	ft
Froude Number	1.03	
Flow is supercritical.		

DRAINAGE MAP