

Technical Memorandum
(Private Driveway Culvert Crossing)
Terra Ridge North
Colorado Springs, Colorado 80908

Prepared for:
El Paso County, CO

On Behalf of:
Phillip S. and Jennifer Miles
PO Box 88461
Colorado Springs, CO 80908
719-352-8886

Prepared by:
Lodestar Engineering, LLC
PO Box 88461
Colorado Springs, CO 80908
Phillip Shay Miles, PE
719-352-8886

May 20, 2024
PCD File# SF2239

ENGINEER'S STATEMENT:

The attached technical memorandum was prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said technical memorandum 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 memorandum.

Signature: _____ Date: _____

Phillip Shay Miles, PE
Registered Professional Engineer State of Colorado No.40462

DEVELOPER'S STATEMENT:

I, the owner/developer, have read and will comply with all of the requirements specified in this technical memorandum.

Name of Owner/Developer: Phillip S. Miles

Authorized Signature: _____ Date: _____

Title: Owner

Address: 15630 Fox Creek Lane, Colorado Springs, CO 80908

EL PASO COUNTY:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

County Engineer / ECM Administrator

Date

Conditions:

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1. Purpose

The purpose of this Technical Memorandum for Terra Ridge North is to quantify runoff tributary to a drainageway that runs through the project and determine the size of proposed culvert pipes under a private driveway during the major rainfall event (100-year design storm) generated by off-site and on-site areas. The result of the analysis is intended to revise and supersede the culvert design approved in the Final Drainage Report for Terra Ridge North.

2. General Description

The Terra Ridge North property (Project) is a 52.67-acre single-family development consisting of 13 lots and a public street (Fox Creek Lane) located within Black Forest, Colorado in El Paso County. The project consists of a public street, detention pond, and new home construction and associated site elements typical of single-family residential large lot development. The property is bounded by Ridgeview Acres to the north, Whispering Hills Estates to the west Wildwood Village to the east, and Terra Ridge Estates to the south. All lots surrounding the subject property are all zoned RR-5. The entire parcel lies within unincorporated El Paso County and is currently zoned RR-2.5. Access to the site is from Fox Creek Lane. The existing site is covered with native grasses with a few randomly located ponderosa pines. The topography of the site is rolling hills with one drainageway extending from south to north through the property.

3. Hydrologic Analysis

The JR Engineering Terra Ridge Filing No. 2 report shows flows entering the project site with a Q100yr value of 369cfs (JR Design Point 5). The Terra Ridge North report used these calculated values (and input data found in the JR report) to determine the flows (432cfs) at the culvert crossing location (Lodestar Design Point 4) with the use of the Rational Method. Refer to approved Terra Ridge North Final Drainage Report for additional information. As stated in the Terra Ridge North report, the primary source of runoff is from offsite watershed areas (basins OS1 and OS2) which consist of large lot single family subdivision development improvements with homes, driveways, sheds, and various outbuildings. That same land use is proposed for the Terra Ridge North development project.

It is commonly known that the Rational Method is overly conservative compared to other such methods for peak flow determination for large watersheds. As such, this different computational method was chosen which we feel more closely estimates the peak flows at this location. Stormwater runoff was determined using USGS “Streamstats” regression equation method software and was calculated for proposed conditions for the 100-yr (major) recurrence. The newly calculated peak flow value of 184cfs was used for the hydraulic analysis.

4. Hydraulic Analysis

Hydraulic modeling software was needed for the culvert design to accurately model a parabolic overflow weir (driveway sag curve). USDOT Federal Highway Administration

(FHWA) Culvert Analysis Program HY-8, version 7.6. The roadway and culvert geometric model were based on the approved construction plans for the development. Refer to the plan and profile exhibits in Appendix B. The culverts have been designed so there will not be any overtopping of the driveway during the 100yr storm event by providing ~0.5' of freeboard. To route the flows under the proposed driveway, Dual 48" CMP culverts are proposed. Refer to appendix B calculations for additional information.

5. Conclusion/Recommendations

The Technical Memorandum for Terra Ridge North was prepared using the El Paso County Engineering Criteria Manual, and the El Paso County Drainage Criteria Manual. This property will receive stormwater runoff from parcels to the west, south and east. The approved report for the development determined flows reaching the crossing was overly conservative. The revised culvert design is based on a hydrologic model which uses a regression analysis methodology. The culvert design contained herein is meant to supersede that of the approved Final Drainage Report. The unnamed drainageway is not a FEMA regulated floodplain. No adverse downstream impacts are anticipated as a result of the proposed culvert installation.

6. References

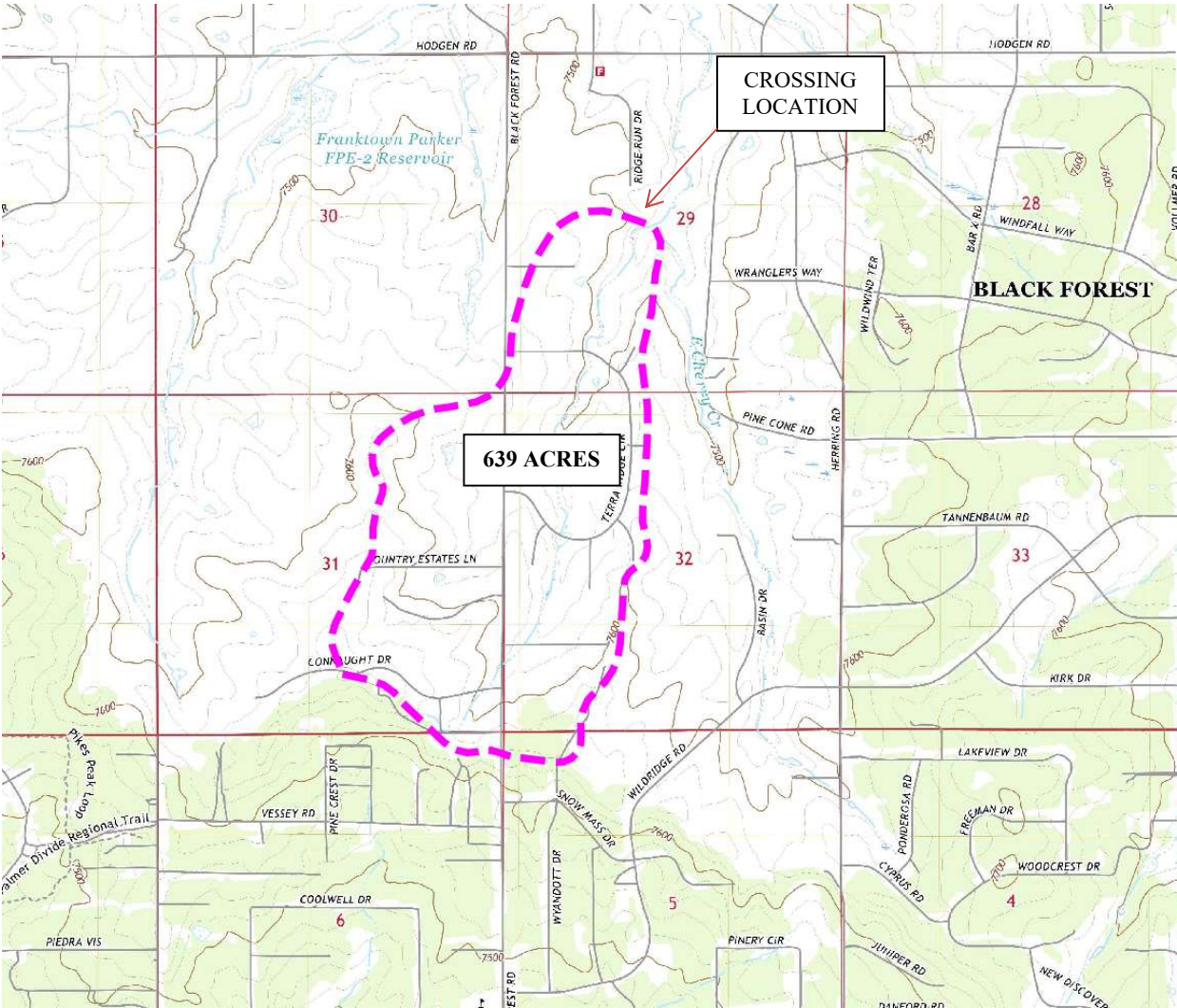
1. Engineering Criteria Manual, El Paso County, December 2016
2. Drainage Criteria Manual, Volumes I and II, El Paso County and City of Colorado Springs, Vol 1, 1991 and Vol 2, 2002
3. Drainage Criteria Manual, Chapter 6, Volume 1 Update, October 2018
4. Final Drainage Report for Terra Ridge North, Lodestar Engineering, LLC, February 2023
5. Final Drainage Report for Terra Ridge Filing No. 1, JR Engineering, April 1997.
6. Final Drainage Report for Terra Ridge Filing No. 2, JR Engineering, June 1999.
7. United States Geological Survey (USGS) Topographic Quadrangle Map

Appendix A
Maps

VICINITY MAP
(Source: Google Earth)
Not To Scale



BASIN MAP
(Source: USGS Quadrangle)
Not To Scale



Appendix B
Calculations

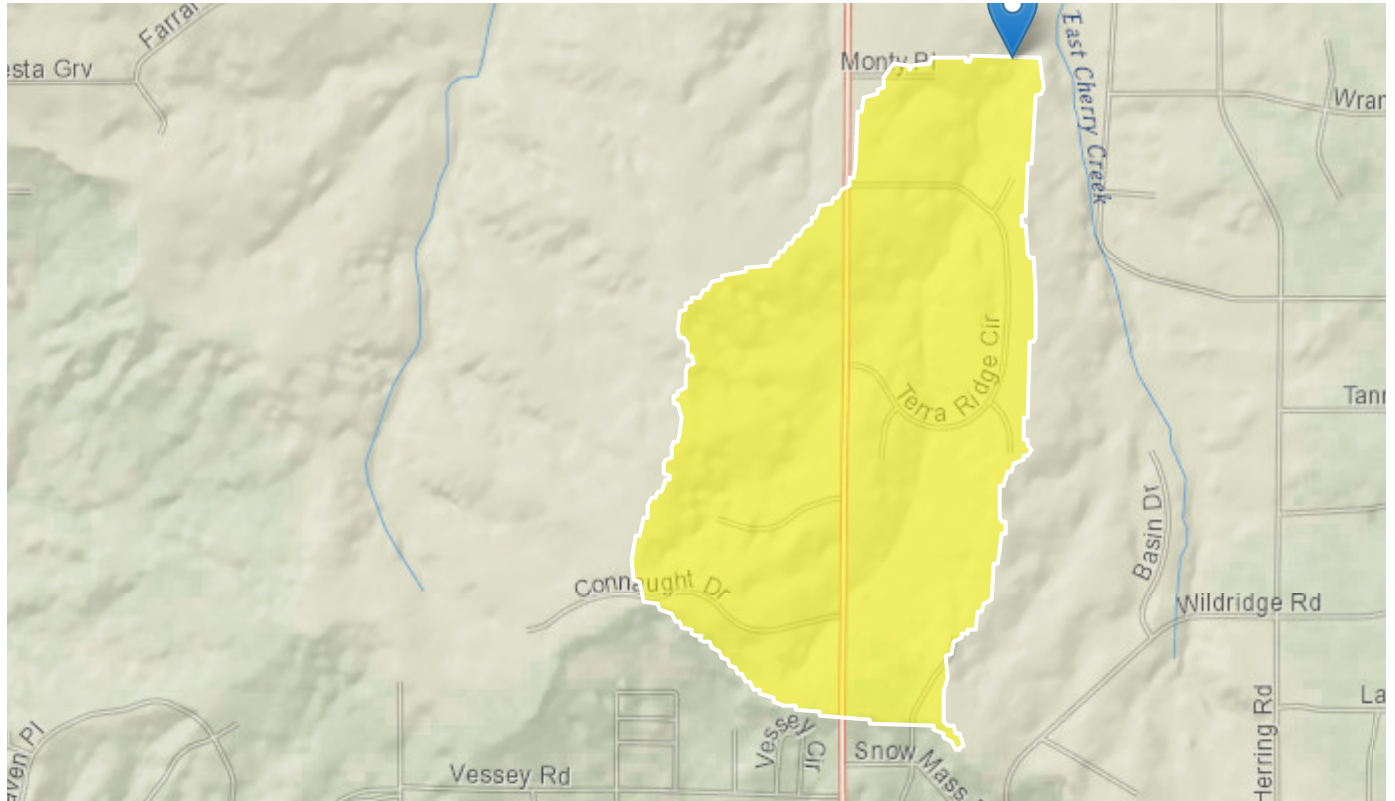
Terra Ridge North - StreamStats Report

Region ID: CO

Workspace ID: CO20240520020314140000

Clicked Point (Latitude, Longitude): 39.06253, -104.69331

Time: 2024-05-19 20:03:34 -0600



[+ Collapse All](#)

➤ Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	6	perc
CSL1085LFP	Change in elevation divided by length between points 10 and 85 percent of distance along the longest flow path to the basin divide, LFP from 2D grid	94.7	feet
DRNAREA	Area that drains to a point on a stream	0.97	sq:
EL7500	Percent of area above 7500 ft	94	perc
ELEV	Mean Basin Elevation	7572	feet

Parameter Code	Parameter Description	Value	Unit
ELEVMAX	Maximum basin elevation	7690	feet
I24H100Y	Maximum 24-hour precipitation that occurs on average once in 100 years	5	inch
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index	1.91	inch
I6H100Y	6-hour precipitation that is expected to occur on average once in 100 years	3.84	inch
I6H2Y	Maximum 6-hour precipitation that occurs on average once in 2 years	1.38	inch
LAT_OUT	Latitude of Basin Outlet	39.062571	deg
LC11BARE	Percentage of barren from NLCD 2011 class 31	0	perc
LC11CRPHAY	Percentage of cultivated crops and hay, classes 81 and 82, from NLCD 2011	0	perc
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	6	perc
LC11FOREST	Percentage of forest from NLCD 2011 classes 41-43	4.3	perc
LC11GRASS	Percent of area covered by grassland/herbaceous using 2011 NLCD	52.3	perc
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	5.9	perc
LC11SHRUB	Percent of area covered by shrubland using 2011 NLCD	37.4	perc
LC11SNOIC	Percent snow and ice from NLCD 2011 class 12	0	perc
LC11WATER	Percent of open water, class 11, from NLCD 2011	0	perc
LC11WETLND	Percentage of wetlands, classes 90 and 95, from NLCD 2011	0	perc
LFPLENGTH	Length of longest flow path	2.1	mile
LONG_OUT	Longitude of Basin Outlet	-104.693292	deg
MINBELEV	Minimum basin elevation	7460	feet
OUTLETELEV	Elevation of the stream outlet in feet above NAVD88	7464	feet
PRECIP	Mean Annual Precipitation	20.16	inch
RCN	Runoff-curve number as defined by NRCS (http://policy.nrcs.usda.gov/OpenNonWebContent.aspx?content=17758.wba)	63.34	dim

Parameter Code	Parameter Description	Value	Unit
RUNCO_CO	Soil runoff coefficient as defined by Verdin and Gross (2017)	0.27	dim
SSURGOA	Percentage of area of Hydrologic Soil Type A from SSURGO	0	perc
SSURGOB	Percentage of area of Hydrologic Soil Type B from SSURGO	100	perc
SSURGOC	Percentage of area of Hydrologic Soil Type C from SSURGO	0	perc
SSURGOD	Percentage of area of Hydrologic Soil Type D from SSURGO	0	perc
STATSCLAY	Percentage of clay soils from STATSGO	16.3	perc
STORNHD	Percent storage (wetlands and waterbodies) determined from 1:24K NHD	0.4	perc
TOC	Time of concentration in hours	2.36	hou

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Foothills Region Peak Flow 2016 5099]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.97	square miles	0.6	2850
I6H100Y	6 Hour 100 Year Precipitation	3.84	inches	2.38	4.89
STATSCLAY	STATSGO Percentage of Clay Soils	16.3	percent	9.87	37.5
OUTLETELEV	Elevation of Gage	7464	feet	4290	8270

Peak-Flow Statistics Flow Report [Foothills Region Peak Flow 2016 5099]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	ASEp
50-percent AEP flood	10.8	ft ³ /s	117

Statistic	Value	Unit	ASEp
20-percent AEP flood	31.2	ft ³ /s	87
10-percent AEP flood	53.3	ft ³ /s	80
4-percent AEP flood	92.9	ft ³ /s	80
2-percent AEP flood	132	ft ³ /s	83
1-percent AEP flood	184	ft ³ /s	88
0.5-percent AEP flood	245	ft ³ /s	94
0.2-percent AEP flood	343	ft ³ /s	104

Peak-Flow Statistics Citations

Kohn, M.S., Stevens, M.R., Harden, T.M., Godaire, J.E., Klinger, R.E., and Mommandi, A., 2016, Paleoflood investigations to improve peak-streamflow regional-regression equations for natural streamflow in eastern Colorado, 2015: U.S. Geological Survey Scientific Investigations Report 2016–5099, 58 p. (<http://dx.doi.org/10.3133/sir20165099>)

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Application Version: 4.20.1

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 184.00 cfs

Design Flow: 184.00 cfs

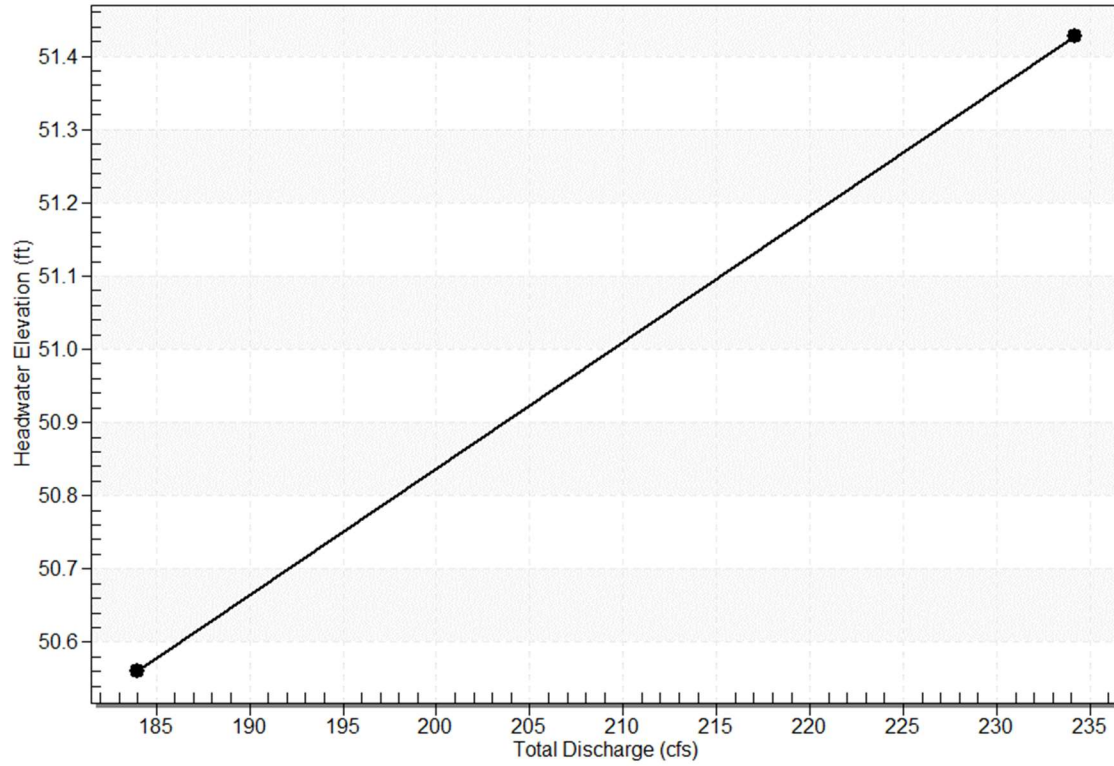
Maximum Flow: 184.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Terra Ridge

Headwater Elevation (ft)	Total Discharge (cfs)	Dual 48" CMP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
50.56	184.00	184.00	0.00	1
51.00	198.10	198.10	0.00	Overtopping

Rating Curve Plot for Crossing: Terra Ridge

Total Rating Curve
Crossing: Terra Ridge



Culvert Data: Dual 48" CMP

Table 1 - Culvert Summary Table: Dual 48" CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
184.00 cfs	184.00 cfs	50.56	5.46	5.329	7-M2c	4.00	2.91	2.91	1.21	9.40	3.82

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

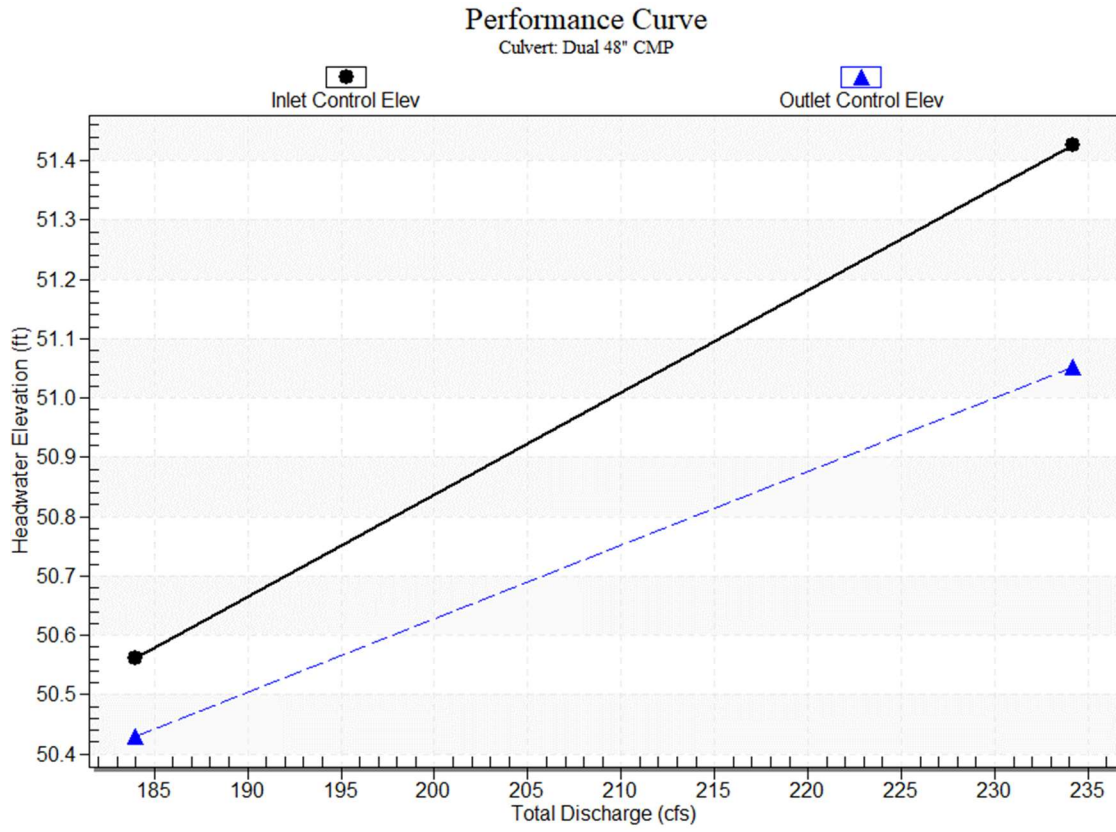
Inlet Elevation (invert): 45.10 ft,

Outlet Elevation (invert): 44.60 ft

Culvert Length: 45.00 ft,

Culvert Slope: 0.0111

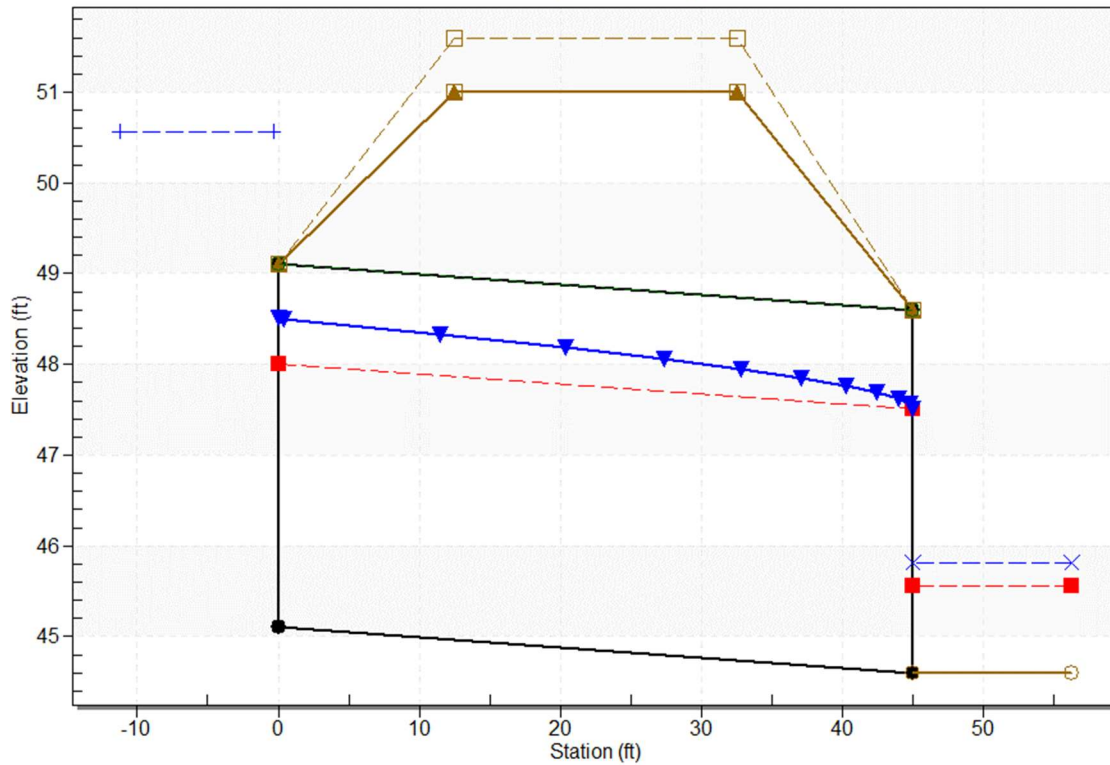
Culvert Performance Curve Plot: Dual 48" CMP



Water Surface Profile Plot for Culvert: Dual 48" CMP

Crossing - Terra Ridge, Design Discharge - 184.0 cfs

Culvert - Dual 48" CMP, Culvert Discharge - 184.0 cfs



Site Data - Dual 48" CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.01 ft

Inlet Elevation: 45.10 ft

Outlet Station: 45.01 ft

Outlet Elevation: 44.60 ft

Number of Barrels: 2

Culvert Data Summary - Dual 48" CMP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Tailwater Data for Crossing: Terra Ridge

Table 2 - Downstream Channel Rating Curve (Crossing: Terra Ridge)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
184.00	45.81	1.21	3.82	0.83	0.68

Tailwater Channel Data - Terra Ridge

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 30.00 ft

Side Slope (H:V): 8.00 (.:1)

Channel Slope: 0.0110

Channel Manning's n: 0.0400

Channel Invert Elevation: 44.60 ft

Roadway Data for Crossing: Terra Ridge

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section

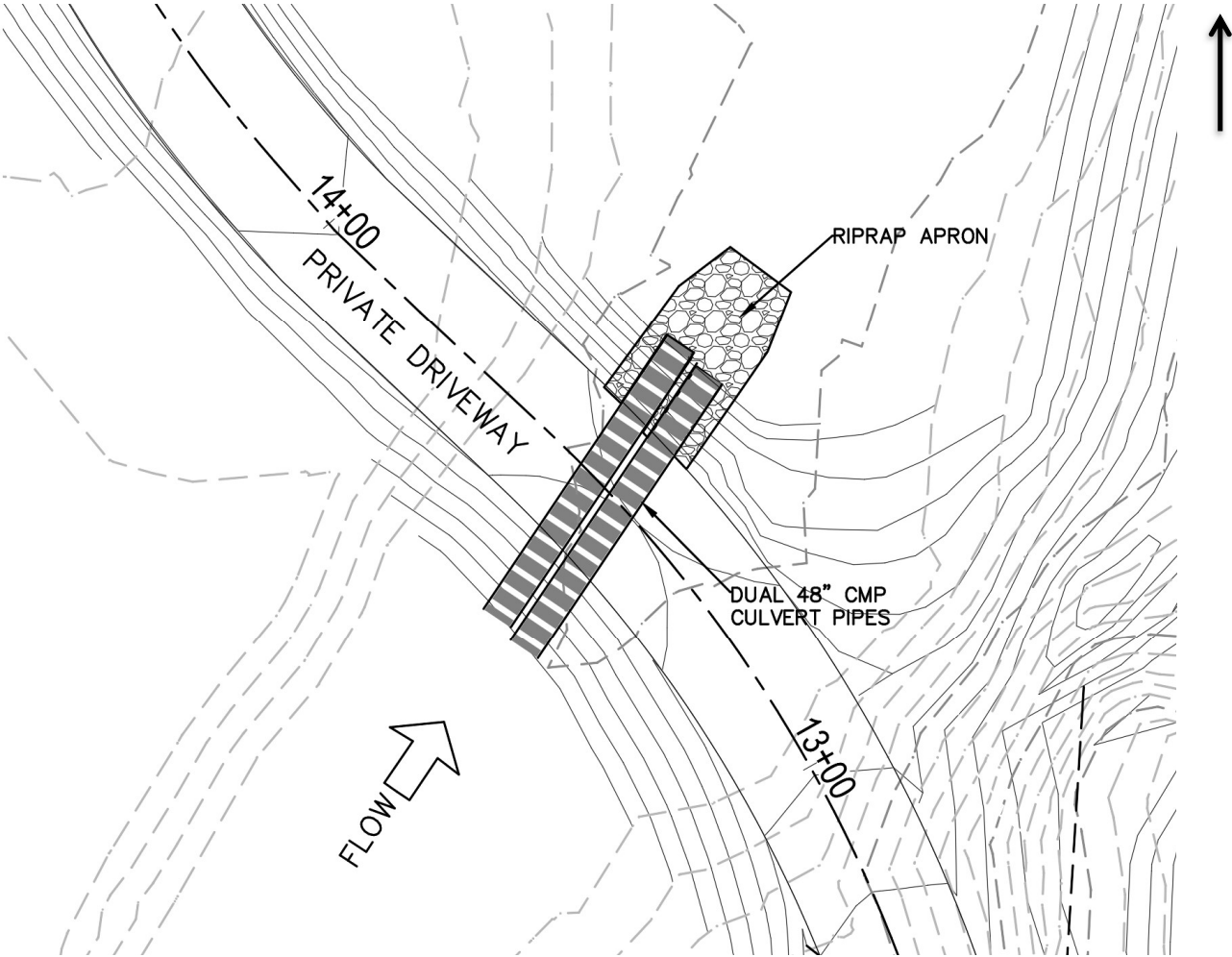
Coord No.	Station (ft)	Elevation (ft)
0	-80.00	51.49
1	-60.00	51.40
2	-20.00	51.24
3	0.00	51.00
4	20.00	51.25
5	40.00	51.38
6	60.00	51.59

Roadway Surface: Gravel

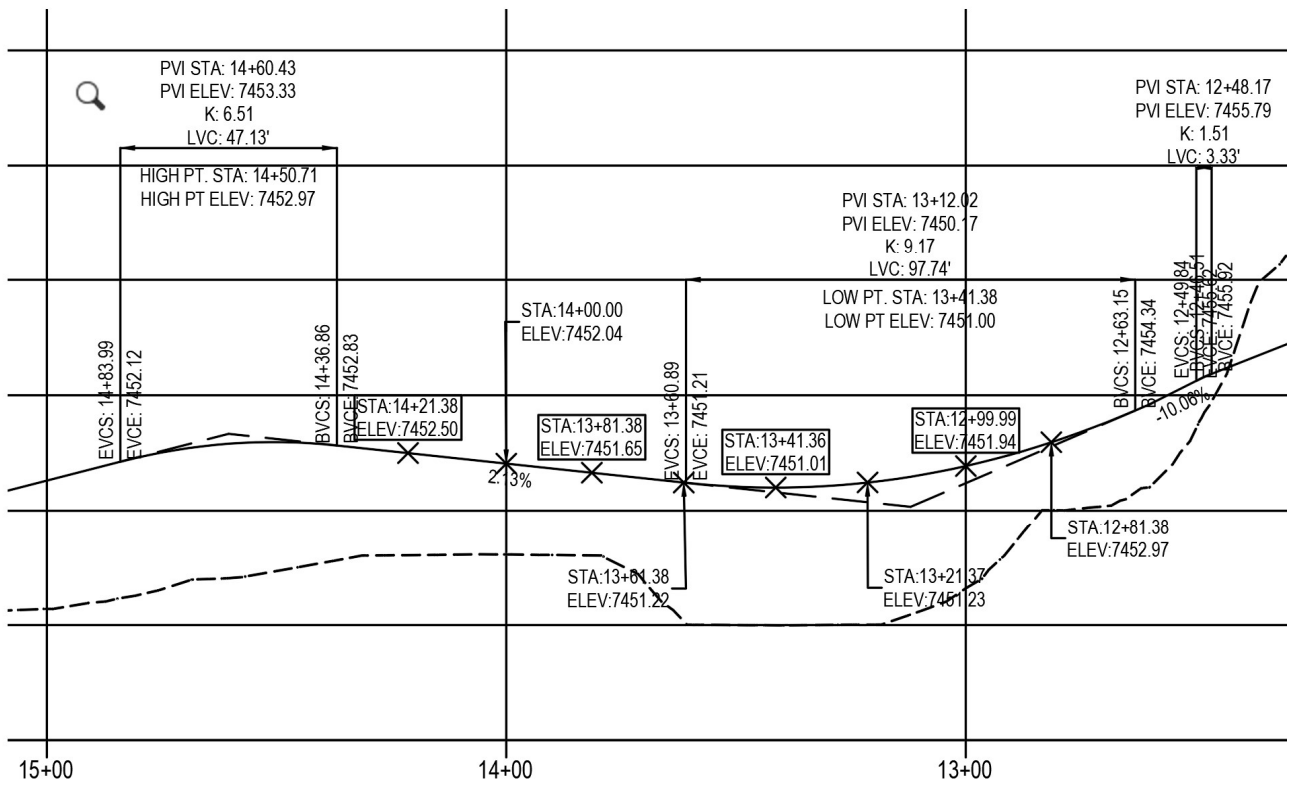
Roadway Top Width: 20.00 ft

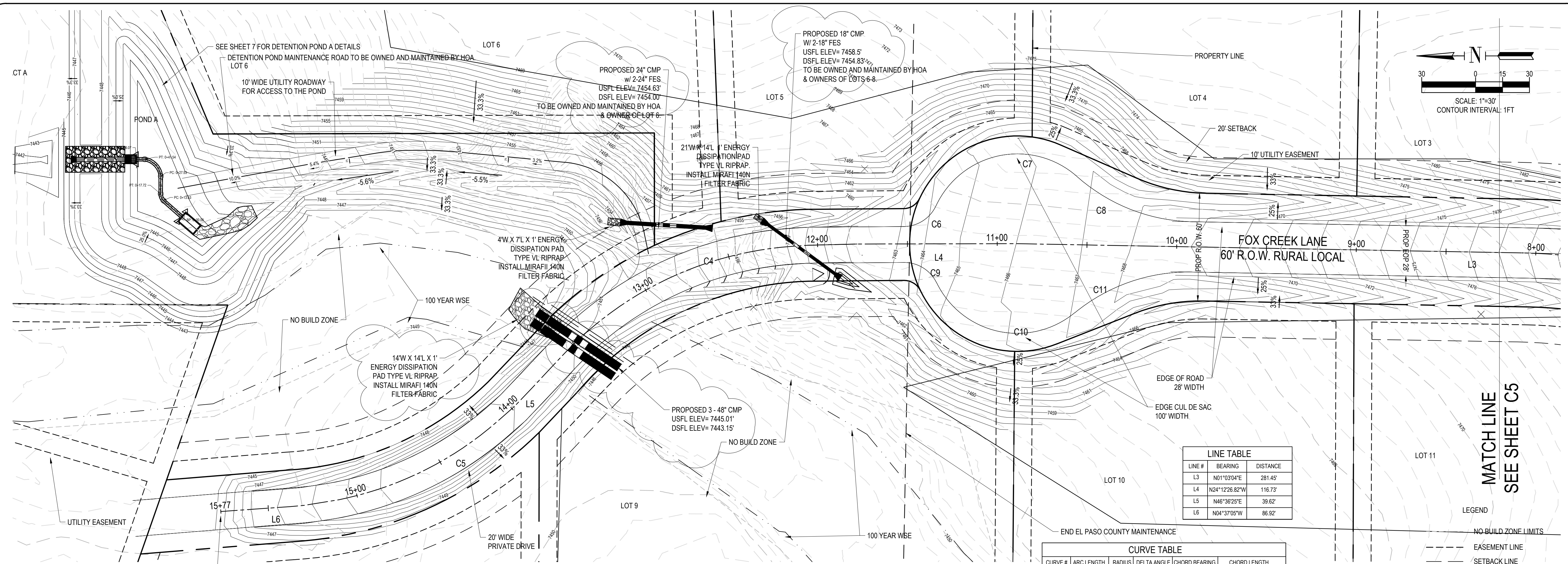
Appendix C
Exhibits

PLAN VIEW
(Source: Terra Ridge North Construction Drawings)
Not To Scale



PROFILE VIEW – Looking Downstream
(Source: Terra Ridge North Construction Drawings)
Not To Scale





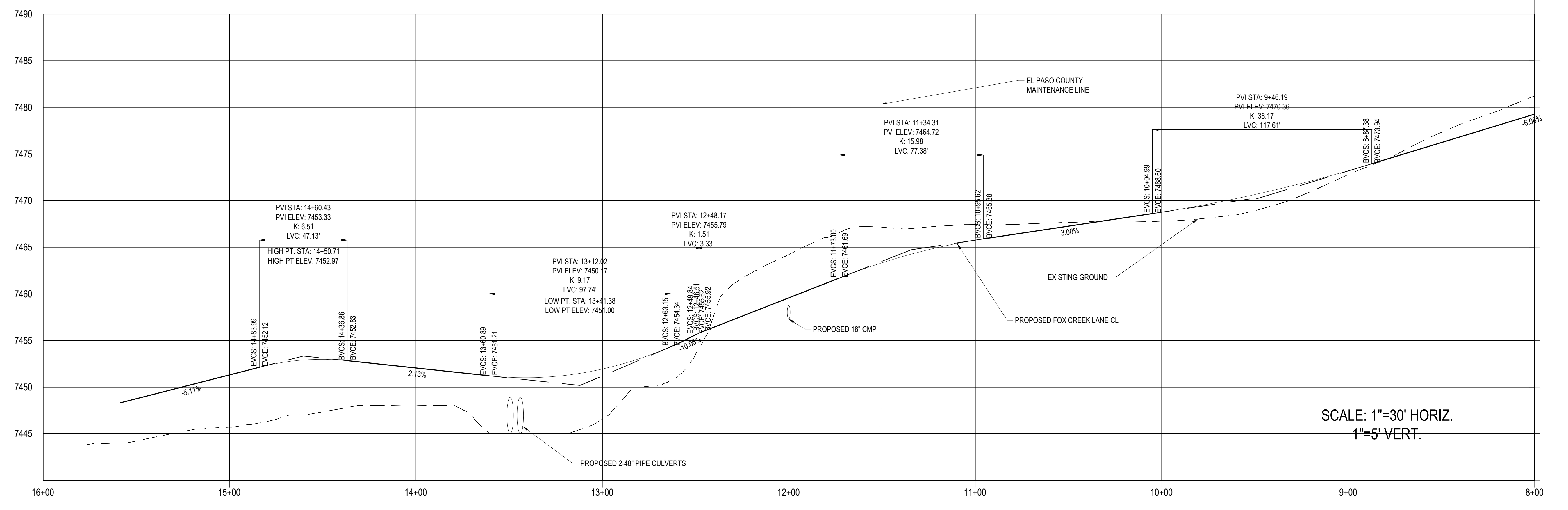
LINE TABLE

LINE #	BEARING	DISTANCE
L3	N01°03'04"E	281.45'
L4	N24°12'26.82"W	116.73'
L5	N46°36'25"E	39.62'
L6	N04°37'05"W	86.92'

CURVE TABLE

CURVE #	ARC LENGTH	RADIUS	DELTA ANGLE	CHORD BEARING	CHORD LENGTH
C4	153.73'	194.9'	45.21'	N24°12'26.82"W	149.78'
C5	139.22'	193.88'	41.14'	S23°47'16.17"E	136.25'
C6	22.56'	20.00'	64.62'	S32°44'37.65"E	21.38'
C7	93.05'	50.00'	106.62'	S11°44'39.75"E	80.19'
C8	70.79'	100.00'	40.56'	S21°19'48.31"W	69.32'
C9	22.56'	20.00'	64.62'	N31°52'45.39"E	21.38'
C10	90.49'	50.00'	103.70'	N12°20'30.18"E	78.64'
C11	70.75'	100.00'	40.54'	N19°13'22.23"W	69.28'

FOX CREEK LANE STATION 8+00 TO 11+49'
PRIVATE DRIVEWAY STATION 11+49' TO 15+77'



ISSUED

REVISIONS

6/6/24 24" CMP MATL CHANGE
6/6/24 18" CMP MATL CHANGE
3/6/24 2-48" CMP SIZE & CTT CHANGE

TERRA RIDGE NORTH
15630 FOX CREEK LANE
COLORADO SPRINGS, COLORADO

EL PASO COUNTY DEVELOPMENT
REPLAT TERRA RIDGE LOTS 5 & 6 W/ 11 LOTS IN
TERRA RIDGE NORTH
PLAN AND PROFILE

C6
SHEET NO.