

APPENDIX L
Culvert Report

Table 1 - Summary of Culvert Flows at Crossing: Rail Road Culvert

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
632.75	40.30	40.30	0.00	1
632.89	43.66	43.66	0.00	1
633.00	47.02	47.02	0.00	1
633.07	49.20	49.20	0.00	1
633.21	53.74	53.74	0.00	1
633.32	57.10	57.10	0.00	1
633.43	60.46	60.46	0.00	1
633.54	63.82	63.82	0.00	1
633.67	67.18	67.18	0.00	1
633.82	70.54	70.54	0.00	1
633.96	73.90	73.90	0.00	1
670.00	390.48	390.48	0.00	Overtopping

Rating Curve Plot for Crossing: Rail Road Culvert

Total Rating Curve Crossing: Rail Road Culvert

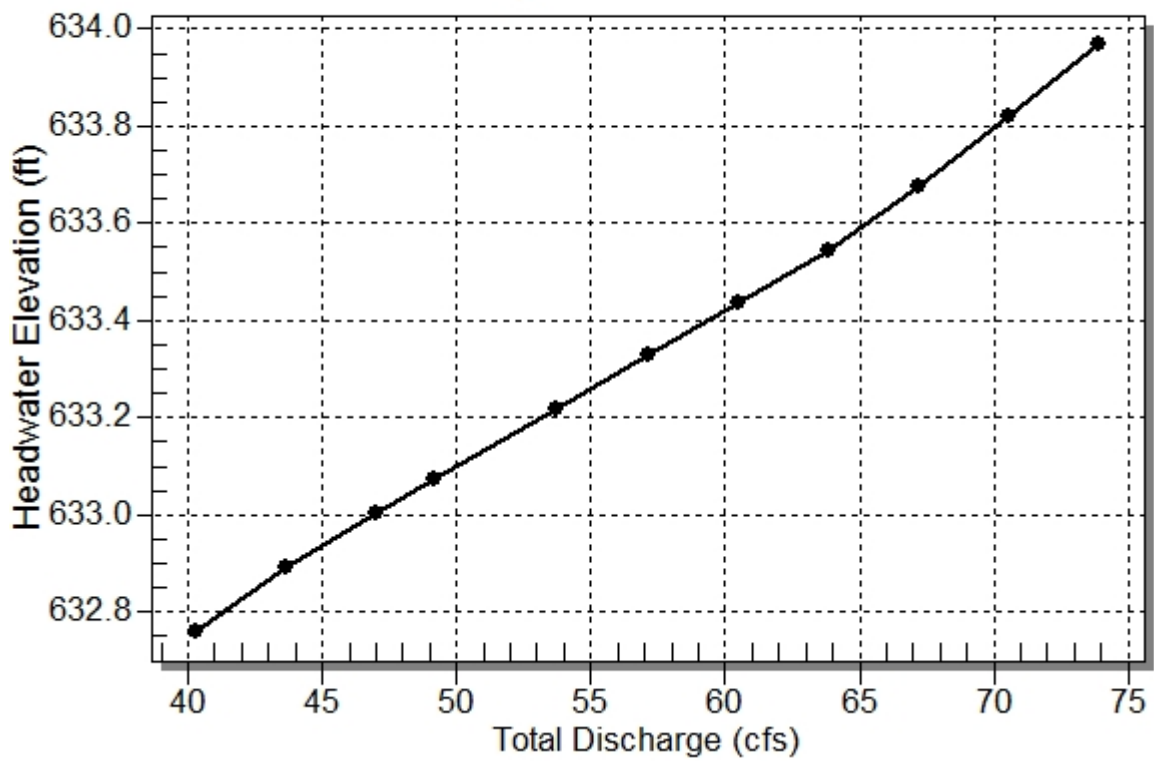


Table 2 - Culvert Summary Table: Culvert 1

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)
40.30	40.30	632.75	2.254	0.0*	1-S2n	0.763	1.620	0.772	1.761	15.997	5.197
43.66	43.66	632.89	2.388	0.0*	1-S2n	0.799	1.702	0.844	1.815	15.633	5.302
47.02	47.02	633.00	2.496	0.0*	1-S2n	0.835	1.780	0.840	1.866	16.941	5.402
49.20	49.20	633.07	2.567	0.0*	1-S2n	0.859	1.825	0.865	1.898	17.124	5.463
53.74	53.74	633.21	2.713	0.0*	1-S2n	0.908	1.921	0.970	1.962	16.445	5.585
57.10	57.10	633.32	2.821	0.0*	1-S2n	0.944	1.991	1.011	2.007	16.671	5.670
60.46	60.46	633.43	2.930	0.0*	1-S2n	0.980	2.062	0.982	2.050	18.244	5.752
63.82	63.82	633.54	3.038	0.0*	1-S2n	1.016	2.128	1.093	2.093	17.093	5.830
67.18	67.18	633.67	3.169	0.0*	1-S2n	1.051	2.188	1.131	2.133	17.256	5.905
70.54	70.54	633.82	3.316	0.0*	1-S2n	1.082	2.249	1.170	2.173	17.437	5.978
73.90	73.90	633.96	3.462	0.0*	1-S2n	1.112	2.310	1.122	2.211	19.161	6.048

* theoretical depth is impractical. Depth reported is corrected.

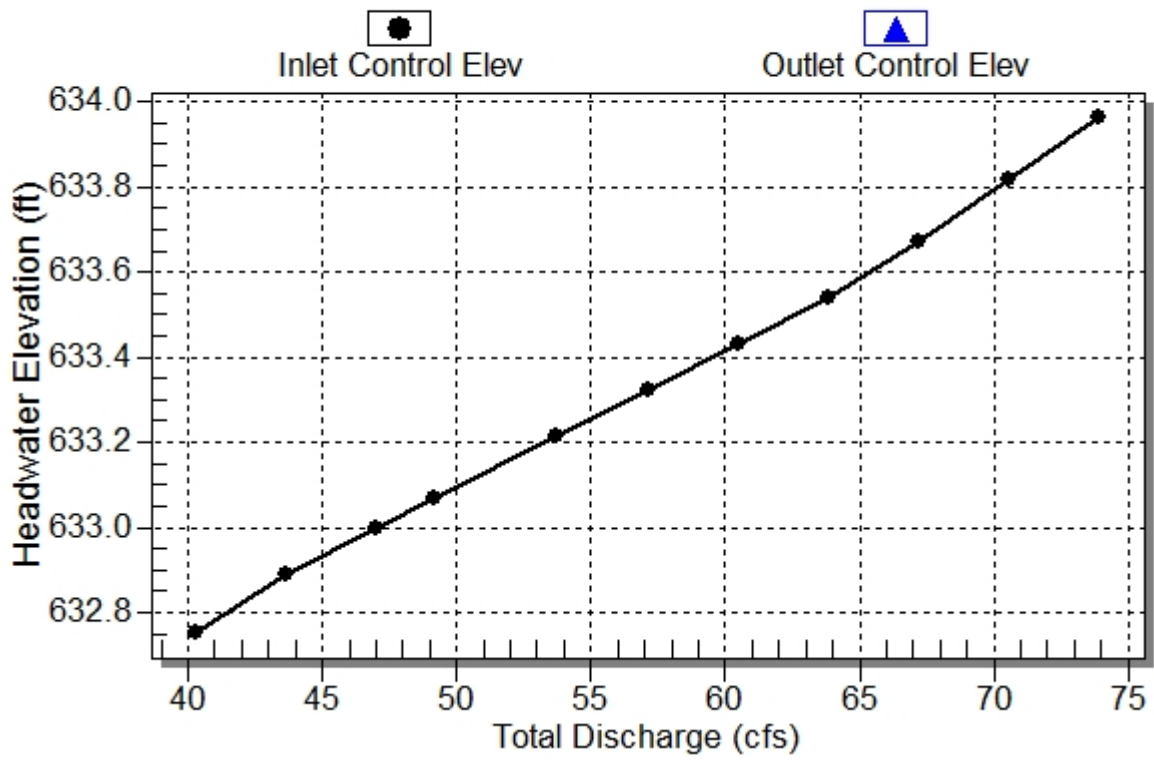
Inlet Elevation (invert): 630.50 ft, Outlet Elevation (invert): 625.10 ft

Culvert Length: 125.12 ft, Culvert Slope: 0.0432

Culvert Performance Curve Plot: Culvert 1

Performance Curve

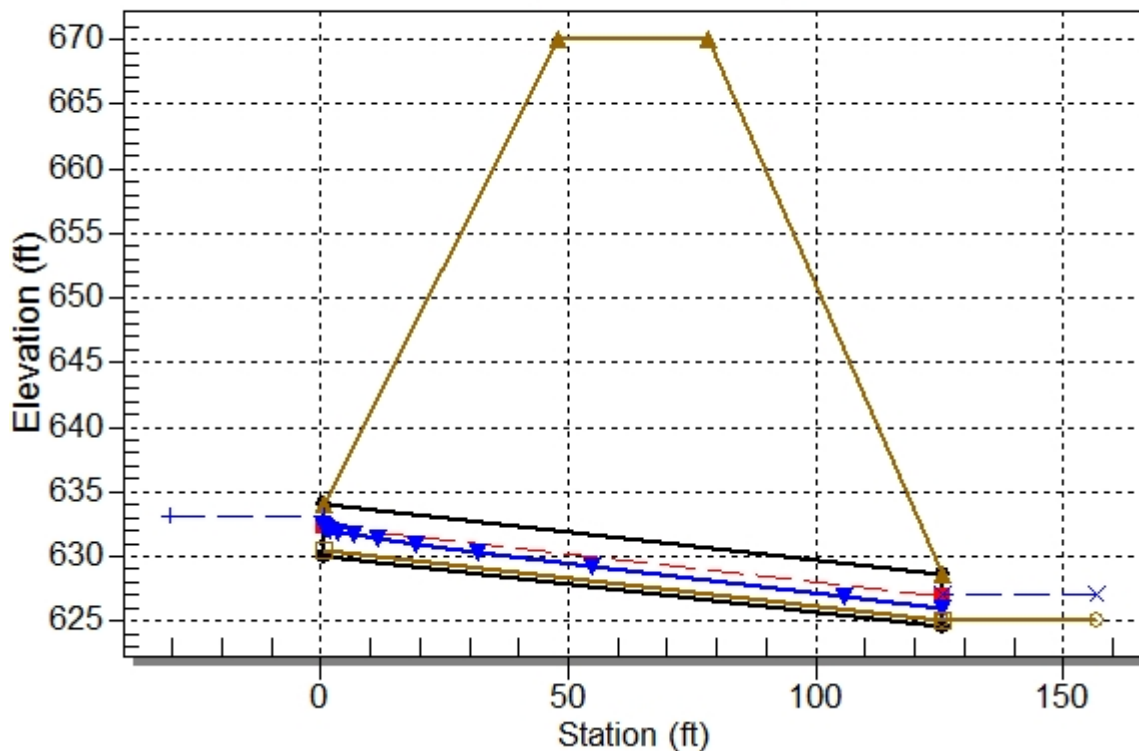
Culvert: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Rail Road Culvert, Design Discharge - 49.2 cfs

Culvert - Culvert 1, Culvert Discharge - 49.2 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 630.00 ft

Outlet Station: 125.00 ft

Outlet Elevation: 624.60 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 6.00 in

Barrel Manning's n: 0.0130 (top and sides)

Manning's n: 0.0130 (bottom)

Inlet Type: Conventional

Inlet Edge Condition: Beveled Edge

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Rail Road Culvert)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
40.30	626.86	1.76	5.20	4.40	0.98
43.66	626.91	1.81	5.30	4.53	0.98
47.02	626.97	1.87	5.40	4.66	0.99
49.20	627.00	1.90	5.46	4.74	0.99
53.74	627.06	1.96	5.58	4.90	0.99
57.10	627.11	2.01	5.67	5.01	1.00
60.46	627.15	2.05	5.75	5.12	1.00
63.82	627.19	2.09	5.83	5.22	1.00
67.18	627.23	2.13	5.91	5.32	1.01
70.54	627.27	2.17	5.98	5.42	1.01
73.90	627.31	2.21	6.05	5.52	1.01

Tailwater Channel Data - Rail Road Culvert

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.50 (1:1)

Channel Slope: 0.0400

Channel Manning's n: 0.0500

Channel Invert Elevation: 625.10 ft

Roadway Data for Crossing: Rail Road Culvert

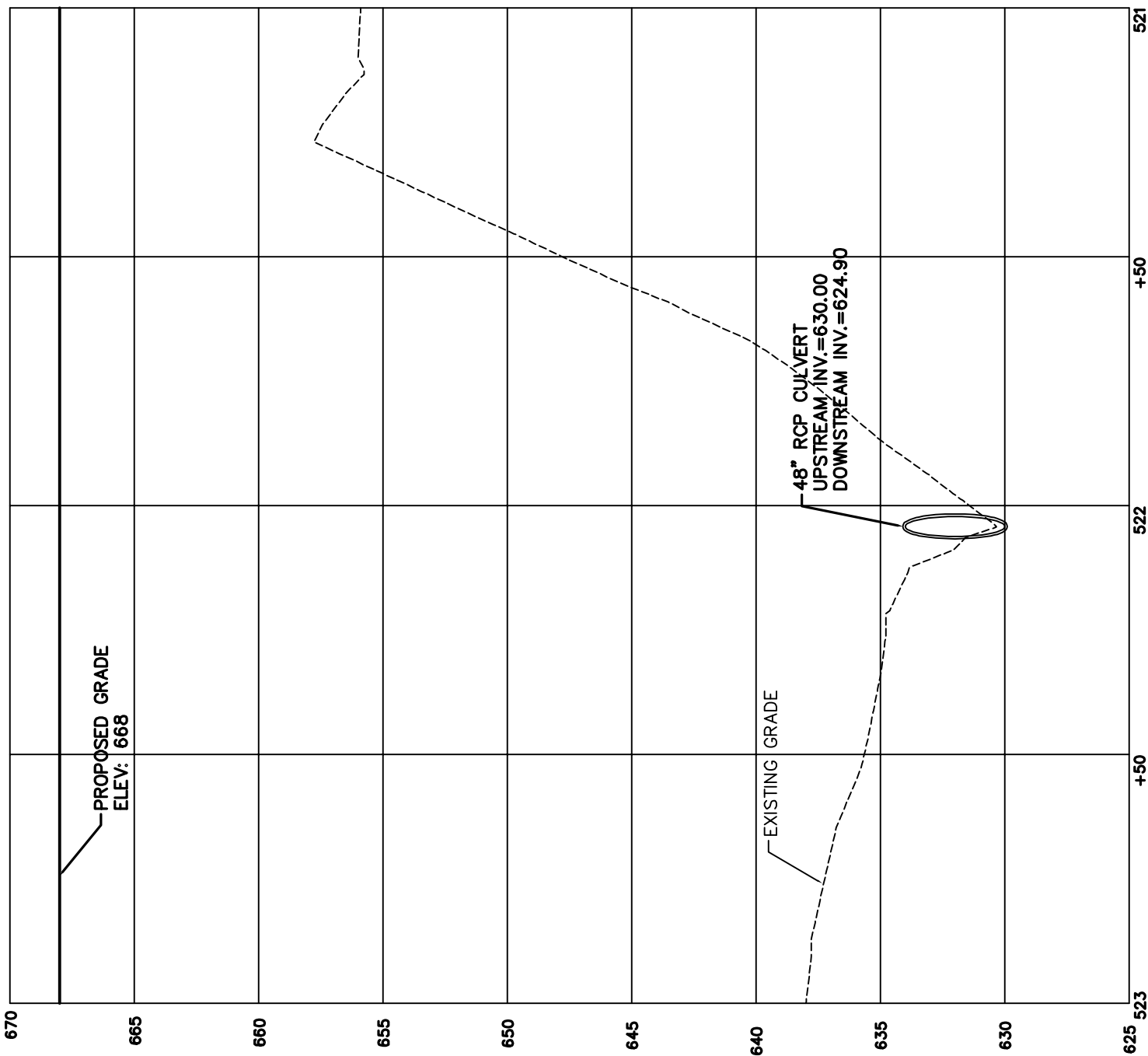
Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 300.00 ft

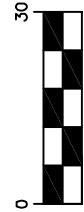
Crest Elevation: 670.00 ft

Roadway Surface: Gravel

Roadway Top Width: 30.00 ft



VERTICAL
SCALE: 1" = 6'



HORIZONTAL
SCALE: 1" = 30'



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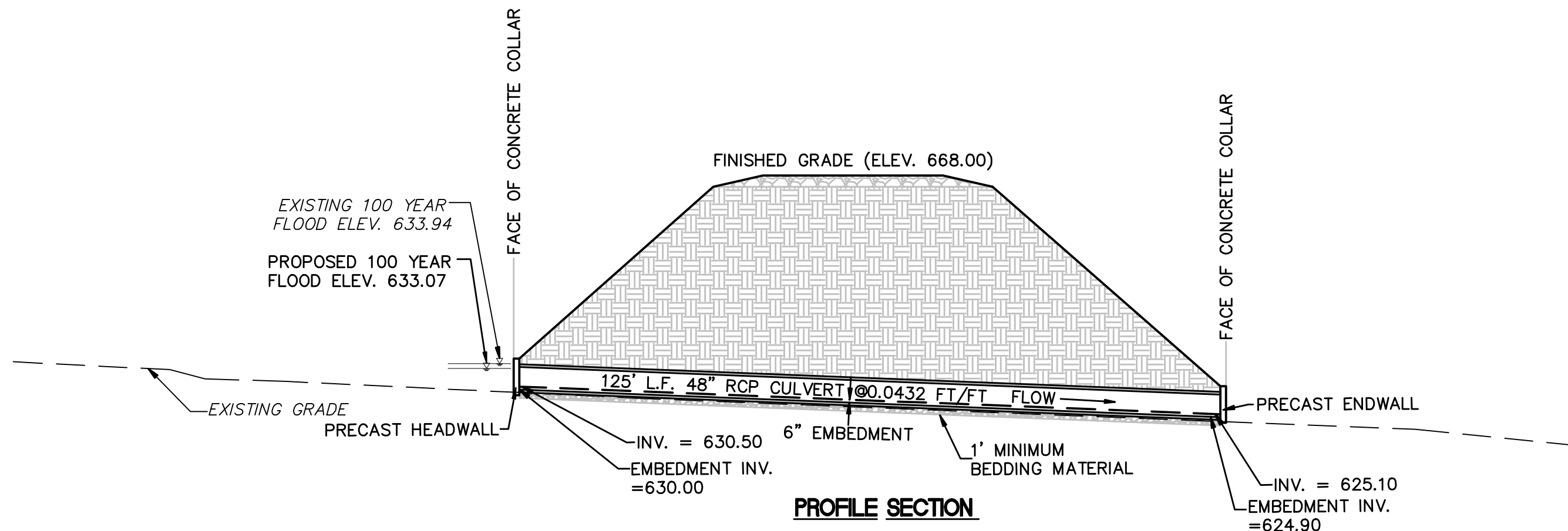
JOB No.
PPLS0902

SCALE:
AS SHOWN

DATE:
03/29/2011

SKETCH No.
1 OF 2

RAILROAD CULVERT - PROFILE




PROFILE SECTION

GRAPHIC SCALE



(IN FEET)
1 inch = 20 ft.

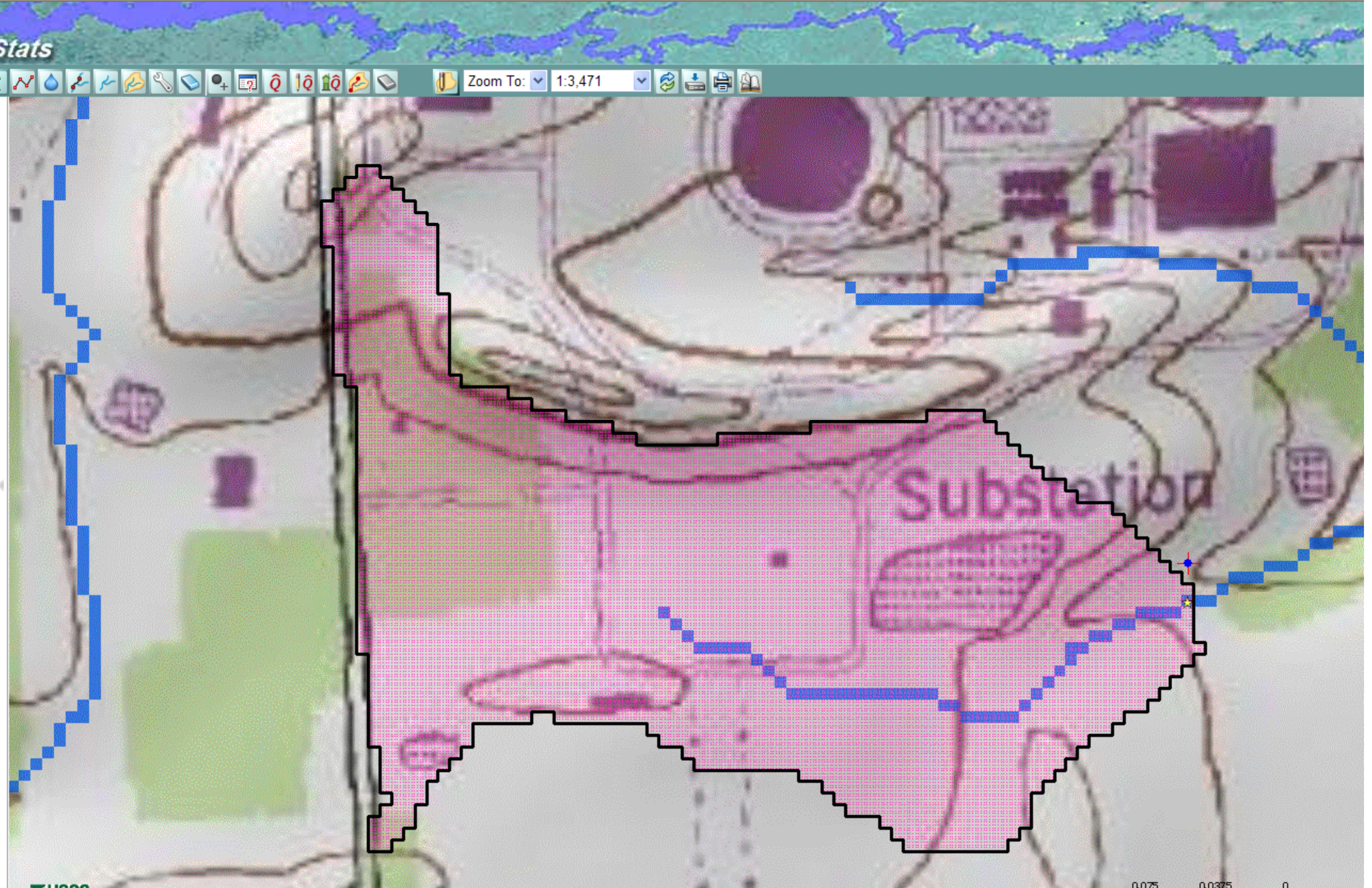
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	JOB No. PPLS0902	2 OF 2		

RAILROAD CULVERT CROSSING CROSS SECTION

USGS
Pennsylvania StreamStats

Navigation toolbar with icons for zoom, pan, and other map functions. Zoom To: 1:3,471

- Results >>
- Map Contents >>
- Navigation >>
- Overview >>





Pennsylvania StreamStats

Streamstats Ungaged Site Report

Date: Fri Oct 22 2010 15:54:09 Mountain Daylight Time
 Site Location: Pennsylvania
 NAD27 Latitude: 41.0874 (41 05 15)
 NAD27 Longitude: -76.1450 (-76 08 42)
 NAD83 Latitude: 41.0875 (41 05 15)
 NAD83 Longitude: -76.1447 (-76 08 41)
 Drainage Area: 0.086 mi²

Low Flow Basin Characteristics			
100% Low Flow Region 2 (0.086 mi ²)			
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.086 (below min value 4.93)	4.93	1280
Mean Annual Precipitation (inches)	39.000	35	50.4
Stream Density (miles per square mile)	2.68	0.51	3.1
Depth to Rock (feet)	5.600	3.32	5.65
Percent Carbonate (percent)	0.0000	0	99

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Mean/Base-flow Basin Characteristics			
100% Statewide Mean and Base Flow (0.086 mi ²)			
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.086 (below min value 2.26)	2.26	1720
Mean Basin Elevation (feet)	676	130	2700
Mean Annual Precipitation (inches)	39.000	33.1	50.4
Percent Carbonate (percent)	0.0000	0	99
Percent Forest (percent)	14.1314	5.1	100
Percent Urban (percent)	2.9703	0	89

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Peak Flow Basin Characteristics			
100% Peak Flow Region 1 (0.086 mi ²)			
Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	0.086 (below min value 1.72)	1.72	1280
Mean Basin Elevation (feet)	676	0	1960
Percent Carbonate (percent)	0.0000	0	83
Percent Urban (percent)	2.9703	0	20
Percent Storage (percent)	0.0000	0	21.2

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Low Flow Streamflow Statistics					
Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
M7D2Y	0.00461				
M30D2Y	0.00646				
M7D10Y	0.002				
M30D10Y	0.00265				
M90D10Y	0.00435				

Mean/Base-flow Streamflow Statistics					
Statistic	Flow (ft ³ /s)	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
QA	0.0865				
QAH	0.0104				
BF10YR	0.0238				
BF25YR	0.0201				
BF50YR	0.0181				

Peak Flow Streamflow Statistics					
Statistic	Flow (ft ³ /s)	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
				Minimum	Maximum
PK2	8.36		3		
PK5	16.2		6		
PK10	22.7		9		
PK50	40.3		13		
PK100	49.2		13		
PK500	73.9		14		

Trapezoidal Channel Analysis - Open Channel Flow (w/ Manning's Eq)

Client/Subject: **PPL, BELL BEND NUCLEAR POWER PLANT**

Description: **EXISTING SWALE UNDER RAIL 521+92.41**

Print Date: 25 Aug 11 9:44 PM

Prepared by: **LGB**

Project #: PPLS0902

Date: **25 Aug 11**

Checked by:
CML

Objective:

Using Manning's equation, this spreadsheet will calculate the amount of flow through a trapezoidal or triangular (b=0) channel. By inputting the channel characteristics, the flow depth will be calculated. Other flow characteristics are also computed, including the critical slope and required freeboard based on E&S manual guidelines. The last line calculates the maximum allowable velocity as indicated by the PA E&S manual.

Method:

See PA Erosion and Sedimentation Control Manual for reference.

Manning's Equation:
$$Q = \frac{1.486}{n} * A * \left(\frac{A}{P} \right)^{2/3} * \sqrt{S}$$

Given Input Data:

RAIL CROSSING STA 521+92.41	<u>Swale Calculation</u>	
Discharge, Q=	49.20	cfs
Left Side Slope =	1.0	H:1V
Right Side Slope =	1.0	H:1V
Base width of Channel, b=		feet
Bed slope, s=	0.0150	ft/ft
Available depth of channel:	4.00	feet
(OPTIONAL) Input Manning's 'n':	0.0500	
Lining Type:	Bare	

Calculate Flow Depth:

Flow depth, d= 3.44 feet

Calculated Results:

	<u>Design Acceptable?</u>	<u>V too high</u>	
Freeboard, f=	0.56		feet
Calculated Velocity, V=	4.15		fps
Flow Top Width, T=	6.88		feet
Flow Area, A=	11.84		sq ft
Wetted Perimeter, P=	9.73		feet
Hydraulic Radius, R=	1.22		feet
Shear stress on channel bottom, τ =	3.22		lbs/sf
Critical Slope, S_c =	0.0482		ft/ft
Flow stable? (no if $.7S_c < s < 1.3S_c$)=	yes		
Required Freeboard=	0.9		feet
Allowable Velocity for Lining Material=	2.5		fps

Conclusions

R-3 riprap is needed for velocity.