APPENDIX F.4

Design of Pit 1 Diversion Channel and Pit 2 Diversion Channel

BACKGROUND

The Meyer Draw is a large arroyo that runs through the Site between several mine waste rock stock piles (see Figure 1). The preliminary site design proposes to excavate all piles southwest of the Meyer Draw (Stockpile Area, Pile 7, Pile 6, Pile 3 and the Shale Pile) and backfill the excavated mine material into the two pits (Pit 1 and Pit 2). The backfilled waste will be covered with clean material borrowed from elsewhere on Site. Stantec designed diversion channels to capture as much surface runoff water as possible from the drainages upgradient of Pit 1 and Pit 2 to prevent this water from cascading down the pit walls and onto the backfilled waste rock material (which could cause scour of the cover material, potential exposing waste rock material and/or interrupting vegetation growth). Also, the diversion channels will minimize water volumes in the pit areas. The diversion channels utilize a combination of trapezoidal channels excavated below existing grade and berms constructed on side hills at existing grade. The diversions will direct flow around the pit areas and into the Meyer Draw channel. Sheets 12 (Diversion Channel 1) and 13 (Diversion Channel 2) of the St. Anthony Mine Closeout Plan design drawings show the diversion channel alignments.

Riprap will be installed (where necessary) to prevent scour/erosion along the diversion channel alignment. The riprap revetments will be installed with either a geotextile or granular filter system to prevent washout of the underlying soils. A properly designed filter system will be critical at this site due to the highly erosive nature of the soils. This report outlines methods used to evaluate the geometry and stability of the designed diversion channels.

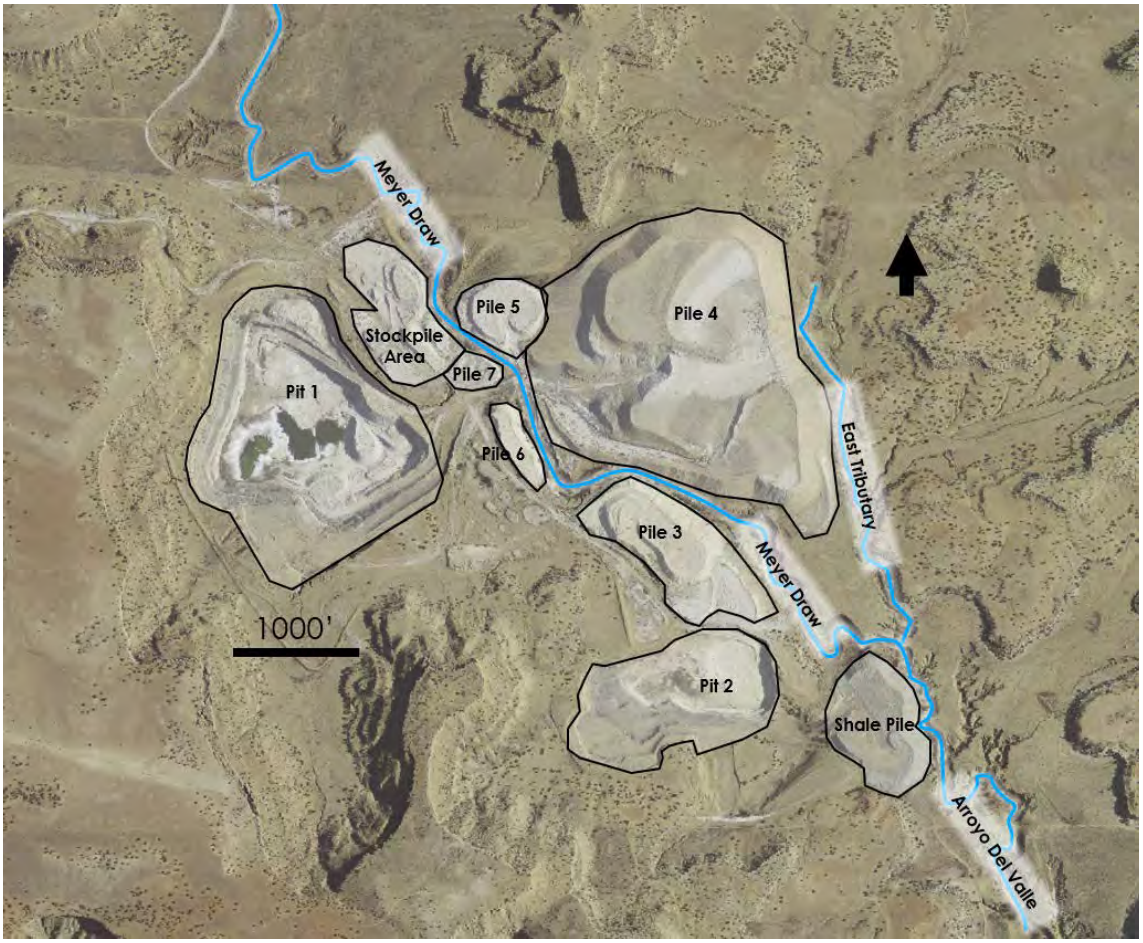

Figure 1: Project Site Existing Conditions (Photo Data: 05/31/2011)

Design Criteria

Table 1 lists criteria used to design the diversion channels.

Table 1: Diversion Channel Design Criteria

Criteria	Value
Design Flood Frequency	1/100-year event
Minimum Channel Freeboard	1.0 – feet
Minimum Riprap Stability Factor (SF)	1.4

Table 2 provides channel design parameters used to evaluate channel capacity and channel lining stability.

Table 2: Diversion Channel Design Parameters

Parameter	Pit 1 Diversion Channel				Pit 2 Diversion Channel				
Channel Station	5+00 to 8+00	8+00 to 14+00	14+00 to 27+50	27+50 to 41+00 (End)	4+50 to 10+25	10+25 to 17+50	17+50 to 22+50	22+50 to 25+85	25+85 to 28+50 (End)
Design Discharge (Q)	83 cfs	83 cfs	321 cfs	424 cfs	48 cfs	135 cfs	136 cfs	203 cfs	214 cfs
Minimum Channel Slope (S_{min})	0.098	0.008	0.005	0.043	0.004	0.039	0.048	0.037	0.037
Maximum Channel Slope (S_{max})	0.098	0.019	0.009	0.074	0.004	0.06	0.05	0.039	0.209
Channel Type	Armored Trapezoid	Armored Berm	Armored Berm	Armored Trapezoid	Armored Berm	Armored Trapezoid	Armored Trapezoid	Armored Trapezoid	Armored Trapezoid
Channel Bottom Width (B)	10 ft	0 ft	0 ft	0 ft	10 ft	10 ft	10 ft	10 ft	15 ft
Channel Side Slope Angle (Z:1)	3	3[1]	3[1]	3	3	3	3	3	3
Channel Depth (H)	2.0 ft	4.0 ft	4.0 ft	4.0 ft	2.5 ft	2.5 ft	2.5 ft	3.0 ft	3.0 ft
Design Median Riprap Diameter (D_{50d})	12 in	3 in	3 in	18 in	3 in	9 in	9 in	9 in	18 in
Riprap Specific Gravity (SG)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6

Note: cfs = cubic feet per second; ft = feet; in = inch; Z:1 = Z units horizontal to 1 unit vertical

1. Sidehill berm with native terrain forming the channel side slope opposite the berm. Native terrain side slope angle approximately equal to 0.5% or 20:1.

Methods

Riprap Sizing

Diversion channel riprap was evaluated using methods suggested by the National Resource Conservation Service (NRCS) in NEH-TS14c (NRCS, 2007).

For this evaluation Stantec assumed normal depth flow conditions, and evaluated channel hydraulics through iterative approximations of flow depth (Y) to balance the Manning's equation (Equation 1).

$$Q = \frac{1.49}{n} * A * \left(\frac{A}{P}\right)^{\frac{2}{3}} * S^{\frac{1}{2}}$$ Equation 1

Where:

Q = design discharge, cubic feet per second (see Table 2)
n = channel roughness
A = channel flow area, feet squared; given as $A = (B + Z * Y) * Y$
P = channel wetted perimeter, feet; given as $P = B + 2 * Y * \sqrt{Z^2 + 1}$
B = channel bottom width, feet (see Table 2)
Y = channel flow depth, feet
Z = channel side slope angle, Z feet horizontal to 1 foot vertical (see Table 2)
S = channel slope, feet per feet (see Table 2)

Stantec determined the channel roughness (n) using the method described by Rice et. al. (1998) (Equation 2) for all channels with a slope (S) greater than 0.02. If the channel slope was less than 0.02, Stantec used a channel roughness value equal to 0.033. This is the median value recommended in Chow (1959) for "lined or built-up channels" with a "dry rubble or riprap" lining.

$$n = 0.0292 * (D_{50d} * 25.4 * S)^{0.147}$$ Equation 2

The channel hydraulic conditions were computed twice for each channel; once using the minimum channel slope (see Table 2) to determine the maximum flow depth (used to evaluate channel freeboard) and another using the maximum channel slope (see Table 2) to evaluate riprap stability.

Stantec evaluated the channel flow velocity (V) by continuity of the incompressible fluid (Equation 3).

$$V = \frac{Q}{A}$$ Equation 3

To evaluate the design riprap (D_{50d}), the median riprap gradation stone diameter that is on the verge of failure/mobilization during the design discharge event (D_{50f}) was computed for each channel. For channel slopes greater than 0.02 the National Engineering Handbook – Technical Supplement 14c (NRCS, 2007) suggests the method developed by Robinson et. al (1998) (Equation 4a and 4b).

$$for\ 0.02 < S \leq 0.1;\ D_{50f} = 12 * (1.923 * q * S)^{0.529}$$ Equation 4a

$$for\ 0.1 < S;\ D_{50f} = 12 * (0.233 * q * S^{0.58})^{0.529}$$ Equation 4b

Where:

D_{50f} = median riprap gradation stone diameter at the brink of failure, inches
q = unit discharge, cubic feet per second per foot where $q = V * Y$

If the channel slope is less than 0.02, the manual suggests the Maynord Method presented by the U.S. Army Corps of Engineers (USACE, 1994) (Equation 5).

$$D_{50f} = 12 * K_1 * C_s * C_v * C_t * Y * \left[\left(\frac{1}{SG-1}\right)^{0.5} * \frac{V}{\sqrt{K_1 * 32.2 * Y}}\right]^{2.5} \qquad \text{Equation 5}$$

Where:

K = gradation coefficient, 1.15 assumed as suggested in NEH TS14c (NRCS, 2007b)
C_s = stability coefficient, 0.3 as suggested in USACE (1994) angular riprap
C_v = velocity distribution coefficient, 1 as suggested in USACE (1994) for straight channel reach
C_t = thickness coefficient, 1 as suggested in USACE (1994) for riprap thickness > $1.5*D_{50d}$
K_1 = side slope correction factor, $k_1 = \sqrt{1 - \frac{\sin^2 \theta}{\sin^2 \Phi}}$
θ = side slope angle, degrees where $\theta = \tan^{-1}\left(\frac{1}{Z}\right)$

Φ = riprap angle of repose, 40 degrees assumed

Stantec evaluated the design riprap by computing a riprap stability factor using Equation 6.

$$SF = \frac{D_{50d}}{D_{50f}} \qquad \text{Equation 6}$$

Channel Scour

The design for Sections 8+00 to 14+00 and 14+00 to 27+50 of the Pit 1 Diversion Channel and Section 4+50 to 10+25 of the Pit 2 Diversion Channel includes a riprap armored berm to form one bank of the channel. The rest of the channel will be unarmored (see Details 6 and 8 on Sheet 17 of the design drawings). To evaluate the potential for channel scour to occur during the design discharge event in the unarmored channel Stantec used the Lacey Equation (Pemberton and Lara, 1984) (Equation 7) and Zeller Equation (Zeller, 1981) (Equation 8). These equations were chosen because they relate specifically to silt/sand bedded streams. The maximum scour depth predicted by the two methods was used for design.

$$Y_s = Z_l * 0.47 * \left(\frac{Q}{f}\right)^{\frac{1}{3}} \qquad \text{Equation 7}$$

Where:

Y_s = predicted scour depth, feet
Z_l = Lacey's multiplying factor
f = Lacey's silt factor computed as $f = 1.76 * D_{50n}^{\frac{1}{2}}$
D_{50n}= native sediment median particle diameter, millimeters

Pemberton and Lara (1984) recommends a multiplying factor (Z) equal to 0.25. The native sediment median particle diameter (D_{50n}) was assumed to be equal to 0.06 mm. This value approximately equals the median particle size from samples measured in the lab by Daniel B. Stevens and Associates (2018) at the borehole sample locations shown on Sheet 4 of the design drawings.

$$Y_s = Y * \left(\frac{0.0685 * V^{0.8}}{Y_h^{0.4} * S^{0.3}} - 1\right) \qquad \text{Equation 8}$$

Where:

Y_h = hydraulic depth of flow where $Y_h = \frac{A}{B + Y * Z}$.

Channel Evaluation Results and Discussion

Table 3 presents the channel evaluation results.

Table 3: Channel Evaluation Results

	Diversion Channel 1				Diversion Channel 2				
Channel Station	5+00 to 8+00	8+00 to 14+00	14+00 to 27+50	27+50 to 41+00 (End)	4+50 to 10+25	10+25 to 17+50	17+50 to 22+50	22+50 to 25+85	25+85 to 28+50 (End)
Channel Roughness, $n^{1/2}$	0.048/ 0.048	0.033/ 0.033	0.033/ 0.033	0.043/ 0.049	0.033/ 0.033	0.038/ 0.043	0.039/ 0.042	0.039/ 0.040	0.043/ 0.057
Channel Flow Depth, Y^1	0.86 ft	1.48 ft	2.68 ft	2.42 ft	1.26 ft	1.32 ft	1.27 ft	1.66 ft	1.50 ft
Channel Freeboard	1.1 ft	2.5 ft	1.3 ft	1.6 ft	1.2 ft	1.2 ft	1.2 ft	1.3 ft	1.5 ft
Channel Flow Velocity, V^2	7.66 fps	4.56 fps	4.83 fps	11.15 fps	2.79 fps	8.14 fps	7.80 fps	8.27 fps	11.06 fps
Riprap Computation Method^2	Equation 4a	Equation 5	Equation 5	Equation 4a	Equation 5	Equation 4a	Equation 4a	Equation 4a	Equation 4b
Median Riprap at Brink of Failure, D_{50f}^2	7.3 in	1.5 in	1.5 in	12.1 in	0.63 in	6.1 in	5.3 in	5.1 in	12.6 in
Riprap Stability Factor, SF	1.65	2.0	2.0	1.5	6.9	1.5	1.7	1.8	1.4

Notes: ft = feet; in = inch; fps = feet per second

1. Minimum Reach Channel Slope Assumed
2. Maximum Reach Channel Slope Assumed

From Table 3, flow depths range between 0.86 and 2.68 feet during the 100-year event in Diversion Channel 1, and between 1.26 and 1.50 in Diversion Channel 2. Diversion Channel 1 and 2 will maintain a minimum channel freeboard of 1.1 feet and 1.2 feet, respectively which meets the design criteria outlined in Table 1.

The high variability in slope along both diversion channels results in a wide range of predicted riprap sizes necessary for channel stability. As outlined in Table 2, the design uses riprap with median stone diameters ranging between 3 inches and 18 inches for each channel. These design riprap sizes result in predicted stability factors ranging between 1.4 and 6.9.

Table 4 shows the results of the channel scour evaluation from Equations 7 and 8.

Table 4: Scour Depth Evaluation Results

Parameter	Diversion Channel 1 Sta. 08+00 to 14+00	Diversion Channel 1 Sta. 14+00 to 27+50	Diversion Channel 2 Sta. 0+00 to 10+25
Lacey Scour Depth	0.7 feet	1.1 feet	0.6 feet
Zeller Scour Depth	0.2 feet	0.4 feet	0.1 feet
Design Scour Depth	0.7 feet	1.1 feet	0.6 feet

From Table 4, the scour depth predicted by the Lacey Equation was consistently deeper than that predicted by the Zeller Equation. The scour depth predicted by Lacey will be adopted for design.
The information presented here reflects a preliminary design. Future design iterations will address:

- Design of soil filter systems beneath the riprap revetments. Properly designed soil filters will be particularly important due to the highly erosive soils. The channel filter system may utilize granular filters (as depicted in the preliminary St. Anthony Mine Closeout Plan design drawings) or manufactured geotextiles specifically designed for surface water drainage applications.
- Cost optimization of the channel alignments and lining systems. Particularly, in the lower sloping segments of the diversion channels where vegetative lining systems may be protective.
- Potential issues that could arise due to aggradation of sediments in reaches of the diversion channels were shear stresses decrease.
- Detailed designs of the area where the diversion channels transition into the Meyer Draw channel.

References

Chow, V.T. 1959, Open-Channel Hydraulics. McGraw-Hill Civil Engineering Series.

Daniel B. Stephens and Associates, 2018. Laboratory Report for Stantec – St. Anthony Geotech Investigation. PO#233001076-DBS. June 20.

Lacey, G. 1931. Regime diagrams for the design of canals and distributaries. Tech. paper no. 1. United Provinces: Public Work Dept., Irrigation Branch.

Natural Resources Conservation Service, 2007. National Engineering Handbook Part 654 – Technical Supplement 14c – Stone Sizing Criteria. NEH-TS14c. August.

Pemberton, E.L., and J.M. Lara. 1984. Computing degradation and local scour: technical guideline for Bureau of Reclamation. U.S. Dept. of Interior, Bureau of Reclamation Engineering and Research Center. Denver, CO.

Rice, C.E., Kadavy, K.C., Robinson, K.M., 1998. Roughness of Loose Rock Riprap on Steep Slopes. Journal of Hydraulic Engineering. February.

Robinson, K.M., Rice, C.E., Kadavy, K.C., 1998. Design of Rock Chutes. American Society of Agricultural Engineers. Vol. 41(3):621-626.

U.S. Army Corps of Engineers. 1994. Hydraulic design of flood control channels. EM 1110-2-1601.

Zeller, M.E. 1981. Scour depth formula for estimation of toe protection against general scour. Pima County Department of Transportation and Flood Control District, Tucson, Arizona.

ATTACHMENT A

Calculation Worksheets

Diversion Channel 1 Freeboard Calculations

	Sta 500 to 800	Sta 800 to 1400	Sta 1400 to 2750	Sta 2750 to 4300	
Hydrologic Element :	J-P1_Div-01	J-P1_Div-01	J-P1_Div-02	J-P1_Div-03	
Discharge, Q (cfs) :	83.2	83.2	320.7	424.3	Appendix E.1
Slope, S (ft/ft) :	0.098	0.008	0.005	0.043	Design Drawings
Bottom Width, B (ft) :	10	0	0	10	Design Drawings
Side Slope, Z:1 :	3	11.5	11.5	3	Design Drawings
Median Riprap, D50 (in) :	12	3	3	12	Design Drawings
Median Riprap, D50 (ft) :	1	0.25	0.25	1	
RR SG :	2.6	2.6	2.6	2.6	
Roughness, n :	0.048	0.033	0.033	0.043	if S>2% (Rice et al., 1998) Else, n = 0.03
Flow Depth, Y (ft) :	0.86	1.48	2.68	2.42	
Iterate to Zero --->	0.0	0.0	0.0	0.0	Use Solver
Flow Area, A (ft2) :	10.86	25.23	82.79	41.86	
Wetted Per., P (ft) :	15.5	34.2	61.9	25.3	
Top Width, TW (ft) :	15.2	34.1	61.7	24.5	
Channel Velocity, V (fps) :	7.66	3.30	3.87	10.14	V = Q/A
Channel Shear, T (lbs/ft2) :	4.3	0.4	0.4	4.4	T = 62.4*(A/P)*S
Unit Discharge, q (cfs/ft) :	6.6	4.9	10.4	24.6	q = V*Y
Froude Number :	1.6	0.68	0.6	1.4	Fr = V/(32.2*A/T)^0.5
	4.00	3.23	3.27	4.48	
Design Channel Depth, ft :	2	4	4	4	Design Drawings
Channel Freeboard, ft :	1.1	2.5	1.3	1.6	

Diversion Channel 1 Riprap Calculations

	Sta 500 to 800	Sta 800 to 1400	Sta 1400 to 2750	Sta 2750 to 4300	
Hydrologic Element :	J-P1_Div-01	J-P1_Div-01	J-P1_Div-02	J-P1_Div-03	
Discharge, Q (cfs) :	83.2	83.2	320.7	424.3	Appendix E.1
Slope, S (ft/ft) :	0.098	0.019	0.009	0.074	Design Drawings
Bottom Width, B (ft) :	10	0	0	10	Design Drawings
Side Slope, Z:1 :	3	11.5	11.5	3	Design Drawings
Median Riprap, D50 (in) :	12	3	3	18	Design Drawings
Median Riprap, D50 (ft) :	1	0.25	0.25	1.5	
RR SG :	2.6	2.6	2.6	2.6	
Roughness, n :	0.048	0.033	0.033	0.049	if S>2% (Rice et al., 1998) Else, n = 0.03
Flow Depth, Y (ft) :	0.86	1.26	2.40	2.27	
Iterate to Zero --->	0.0	0.0	0.0	0.0	Use Solver
Flow Area, A (ft2) :	10.86	18.24	66.41	38.06	
Wetted Per., P (ft) :	15.5	29.1	55.5	24.3	
Top Width, TW (ft) :	15.2	29.0	55.3	23.6	
Channel Velocity, V (fps) :	7.66	4.56	4.83	11.15	V = Q/A
Channel Shear, T (lbs/ft2) :	4.3	0.7	0.7	7.2	T = 62.4*(A/P)*S
Unit Discharge, q (cfs/ft) :	6.6	5.7	11.6	25.3	q = V*Y
Froude Number :	1.6	1.01	0.8	1.5	Fr = V/(32.2*A/T)^0.5
Robinson					
Min RR Diameter, D50f (in) :	7.28	#VALUE!	#VALUE!	11.84	Robinson, 1998
FS Riprap :	1.65	#VALUE!	#VALUE!	1.52	FS = D50f/D50
Applicability :	Applicable	N/A	N/A	Applicable	Applicable is S>0.02
Maynord					
Stability Coeff, Cs :	0.3	0.3	0.3	0.3	
Vert Vel Coeff, Cv :	1	1	1	1	
Thickness Coeff, Ct :	1	1	1	1	
Side Slope Correction, K1 :	0.87	0.87	0.87	0.87	
Min Stable RR, D30 (in) :	5.23	1.30	1.28	10.49	
Min Stable RR, D50 (in) :	6.01	1.50	1.47	12.06	
FS Riprap :	2.00	2.01	2.04	1.49	

Diversion Channel 2 Freeboard Calculations

	Sta 4+50 - 10+25	**Sta 10+25 - 17+50**	**Sta 17+50 - 22+50**	**Sta 22+50+25+85**	**Sta 25+85 - 28+25**	
Hydrologic Element :	J-P2_Div-01	J-P2_Div-02	J-P2_Ch-01	J-P2_Ch-02	J-P2_Ch-03	
Discharge, Q (cfs) :	48.3	134.9	135.9	203	214.4	Appendix E.1
Slope, S (ft/ft) :	0.004	0.039	0.048	0.037	0.037	Design Drawings
Bottom Width, B (ft) :	10	10	10	10	15	Design Drawings
Side Slope, Z:1 :	3	3	3	3	3	Design Drawings
Median Riprap, D50 (in) :	3	9	9	9	18	Design Drawings
Median Riprap, D50 (ft) :	0.25	0.75	0.75	0.75	1.5	
RR SG :	2.6	2.6	2.6	2.6	2.6	
Roughness, n :	0.033	0.040	0.042	0.040	0.044	Rice et al., 1998
Flow Depth, Y (ft) :	1.26	1.32	1.27	1.66	1.50	
Iterate to Zero --->	0.0	0.0	0.0	0.0	0.0	Use Solver
Flow Area, A (ft2) :	17.32	18.42	17.59	24.88	29.36	
Wetted Per., P (ft) :	18.0	18.3	18.1	20.5	24.5	
Top Width, TW (ft) :	17.5	17.9	17.6	20.0	24.0	
	0	0	0	1	0	
Channel Velocity, V (fps) :	2.79	7.32	7.73	8.16	7.30	V = Q/A
Channel Shear, T (lbs/ft2) :	0.2	2.4	2.9	2.8	2.8	T = 62.4*(A/P)*S
Unit Discharge, q (cfs/ft) :	3.5	9.7	9.8	13.5	11.0	q = V*Y
Froude Number :	0.5	1.3	1.4	1.3	1.2	
		3.05	2.81	2.63	2.68	
Design Channel Depth, ft :	2.5	2.5	2.5	3	3	
Channel Freeboard, ft :	1.2	1.2	1.2	1.3	1.5	

Diversion Channel 2 Riprap Calculations

	Sta 4+50 - 10+25	**Sta 10+25 - 17+50**	**Sta 17+50 - 22+50**	**Sta 22+50+25+85**	**Sta 25+85 - 28+25**	
Hydrologic Element :	J-P2_Div-01	J-P2_Div-02	J-P2_Ch-01	J-P2_Ch-02	J-P2_Ch-03	
Discharge, Q (cfs) :	48.3	134.9	135.9	203	214.4	Appendix E.1
Slope, S (ft/ft) :	0.004	0.06	0.05	0.039	0.209	Design Drawings
Bottom Width, B (ft) :	10	10	10	10	15	Design Drawings
Side Slope, Z:1 :	3	3	3	3	3	Design Drawings
Median Riprap, D50 (in) :	3	9	9	9	18	Design Drawings
Median Riprap, D50 (ft) :	0.25	0.75	0.75	0.75	1.5	
RR SG :	2.6	2.6	2.6	2.6	2.6	
Roughness, n :	0.033	0.043	0.042	0.040	0.057	Rice et al., 1998
Flow Depth, Y (ft) :	1.26	1.21	1.26	1.64	1.07	
Iterate to Zero --->	0.0	0.0	0.0	0.0	0.0	Use Solver
Flow Area, A (ft2) :	17.33	16.56	17.41	24.55	19.39	
Wetted Per., P (ft) :	18.0	17.7	18.0	20.4	21.7	
Top Width, TW (ft) :	17.5	17.3	17.6	19.9	21.4	
	0	0	0	1	0	
Channel Velocity, V (fps) :	2.79	8.14	7.80	8.27	11.06	V = Q/A
Channel Shear, T (lbs/ft2) :	0.2	3.5	3.0	2.9	11.6	T = 62.4*(A/P)*S
Unit Discharge, q (cfs/ft) :	3.5	9.9	9.9	13.6	11.8	q = V*Y
Froude Number :	0.5	1.5	1.4	1.3	2.0	
Robinson						
Min RR Diameter, D50f (in) :	#VALUE!	6.11	5.27	5.13	12.59	Robinson, 1998
FS Riprap :	#VALUE!	1.47	1.71	1.75	1.43	FS = D50f/D50
Applicability :	N/A	Applicable	Applicable	Applicable	Applicable	Applicable if S>0.02
Maynord						
Stability Coeff, Cs :	0.3	0.3	0.3	0.3	0.3	
Vert Vel Coeff, Cv :	1	1	1	1	1	
Thickness Coeff, Ct :	1	1	1	1	1	
Side Slope Correction, K1 :	0.87	0.87	0.87	0.87	0.87	
Min Stable RR, D30 (in) :	0.38	5.59	4.98	5.38	12.41	
Min Stable RR, D50 (in) :	0.44	6.43	5.73	6.19	14.27	
FS Riprap :	6.86	1.40	1.57	1.45	1.26	

Diversion Channel Scour Depths

	Pit 1		**Pit 2**	**Notes**
		Design Parameters		
Channel Reach :	Sta 800 to 1400	Sta 1400 to 2750	0+00 to 10+25	
Hydrologic Element :	J-P1_Div-01	J-P1_Div-02	J-P2_Div-01	
Dseign Discharge, Qd (cfs/ft) :	83.2	320.7	48.3	100-Year Discharge (Appendix E.1)
Flow Depth, Y (ft) :	1.26	2.40	1.26	
Flow Velocity, V (fps) :	4.56	4.83	2.79	
Flow Area, A (ft) :	18.24	66.41	17.33	
Unit Discharge, q (cfs/ft) :	5.74	11.60	3.51	
Channel Top Width, Wf (ft) :	29.0	55.3	17.5	See Arroyo Riprap spreadsheet Cell C18 and E18
Hydrauilc Depth, Yh (ft) :	0.6	1.2	1.0	
Channel Slope , S :	0.019	0.009	0.004	
Median Bed Particle Size, D50b (mm) :	0.06	0.06	0.06	Approximate average of all borehole PSD data
	Predicted Scour Depth - Pemberton and Lara and Zeller			
Lacey's Silt Factor, f :	0.43	0.43	0.43	Pemberton and Lara, 1984
Lacey Multiplying Factor, Z :	0.25	0.25	0.25	Pemberton and Lara, 1984
Lacey Scour Depth, Zl (ft) :	0.7	1.1	0.6	Pemberton and Lara, 1984
Zeller Scour Depth, Zz (ft) :	0.18	0.38	0.04	Zeller, M.E. 1981.