Client:	*General Electric/United Nuclear Corporation*	**Sheet:**	*1* **of** *6*
Project:	*NECR 95% Design*	**Date:**	*09/13/2017*
Description:	*Design of Haul Road Stormwater Controls*	**Job No:**	*10508639*

ATTACHMENT D.1: TEMPORARY STORMWATER CONTROLS FOR MINE WASTE HAUL ROAD AND CONSTRUCTION SUPPORT FACILITIES

Revisioning

Rev.	Date	Description	By	Checked	Date
0	*5/13/2016*	*Preliminary (30%) Design*	*T. Steen*	*N. Haws*	*6/6/2016*
1	*9/29/2017*	*95% Design*	*S. Murphy*	*N. Haws*	*9/7/2017*
2	*4/9/2018*	*95% Design (minor revisions)*	*S. Murphy*	*N. Haws*	*4/9/2018*
3	*3/4/2020*	*Response to NRC comments*	*S. Murphy*	*N. Haws*	*3/20/2020*

Revisions

Issue Date	Description
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Location and Format

Electronic copies of these calculations are located on the project team site.

Calculations were generated using the following software:

- HEC-HMS – Hydrologic Modeling System. Version 4.1 July 2015. U.S. Army Corps of Engineers Hydraulic Engineering Center
- Microsoft Excel 2013

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Objective

The objective of these calculations is to evaluate the 95% design for stormwater controls for the mine waste haul road that would be constructed for the Northeast Church Rock (NECR) Removal Action (RA).

Background

The proposed Mine Waste Haul Road for the NECR RA runs from the Mine Site to the proposed repository area at the Mill Site. The design includes temporary roadside ditches, stormwater ponds, and culverts to limit co-mingling of contact and non-contact stormwater as described in Appendix E of the NECR Design Report and as shown in the Design Drawings (Section 2 and 4).

Applicable Codes and Standards

Stantec used the following criteria for the design of the temporary haul road stormwater controls.

Design Storm Event

Stantec selected the 10-year event for the design of the temporary haul road stormwater controls. Potential risks associated with large storm events where the road may be overtopped are considered acceptable as performing repairs is likely more economic than designing large structures. Hauling operations may be temporarily affected in the event of road failure.

Road Side Ditches and Diversion Ditches

- The road side ditches must have capacity to convey the peak design discharge from surface runoff from the haul roads and any contributing native catchments that cannot be reasonably diverted away from the ditches.
- Where practical, the design must prevent co-mingling of stormwater runoff from the haul road and stormwater runoff from upgradient, non-contact catchments through the use of culvert crossings. Where separation of runoff waters would not be practical, the design must include capacity in the haul road ditches to convey runoff from upgradient catchments.
- Diversion ditches with earthen berms shall be used where appropriate to divert non-contact stormwater runoff.
- The side slopes of the channels should be 1.5:1 (Horizontal:Vertical) or flatter.
- The ditches can be sized without freeboard considerations.

Stormwater Ponds

- Stormwater ponds should be sized to retain the total volume of runoff delivery by the upstream roadside ditch during the 10-year, 24-hour storm event.
- Stormwater ponds may require maintenance and pumping after storm events to maintain capacity to retain additional runoff from subsequent storm events.

Culvert Crossings

- Culverts must be sized to convey the stormwater runoff from upgradient catchments.
- The minimum cover for each culvert should be 3 ft to provide protection from haul road traffic.

Methods

Stormwater Runoff

Stantec estimated peak stormwater flow rates and runoff volumes for the 10-year, 24-hour storm event using the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's – Hydrologic Modeling System (HEC-HMS) version 4.1, build 1542. Catchment delineations for the model are shown in **Attachment I.1 Figure I.1-1S** and catchment areas are listed in **Attachment I.1 Table A5**. Stantec developed the 10-year storm hyetograph using the center-peaking alternative block technique with the depth-duration frequency curve built from the National Oceanic and Atmospheric Association (NOAA) Precipitation Data Frequency Server (PDFS) (Bonnin et al., 2011) using the methods described in Attachment I-1 of Appendix I. The estimated total depth for the 10-year, 24-hour storm is 1.91 inches and the calculated cumulated hyetograph ordinates are listed in **Attachment I.1 Table B2** and shown in **Attachment I.1 Figure 5.** Because the hyetograph for the 10-year, 24-hour storm was developed with using the alternative block method, the simulated hydrograph for the 10-year 24-hour event includes the maximum peak flow for storms of lesser durations.

Stantec used the Green Ampt method to simulate rainfall losses and the Clark Unit Hydrograph method to simulate hydrograph transforms at the catchment outlets. The Green-Ampt and Clark Unit Hydrograph parameters for each catchment are listed in **Attachment I.1 Table C.5**. Attachment I-1 of Appendix I described the methods for estimating these parameters.

Ditch Sizing

Stantec computed the hydraulics in the roadside ditches and diversion ditches using the Manning's Equations with the assumption of steady, normal flow at the peak 10-year flow:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

Where:

Q = peak design discharge (cubic feet per second [cfs])
A = channel cross-sectional area (square feet [ft^2]
R = channel hydraulic radius = A/P, where P is the wetted perimeter
n = Manning roughness

Stantec then computed the maximum flow depths using the geometric relationships for the area and wetted perimeter of the channel. Stantec approximated Manning's roughness for the ditches to be 0.03, which assumes the ditches are relatively straight and are maintained to be clean and free of debris or accumulated sediment.

Stormwater Retention Pond Sizing

Stantec sized the stormwater ponds to contain the estimated runoff volume from the 10-year, 24-hour storm. This assumes the Construction Contractor (CC) will evacuate the ponds within 48 hours after large storm events. The two stormwater ponds in the Exclusion Area were sized for the full storm depth, without accounting for rainfall losses in the catchment.

Culvert Sizing

Stantec computed culvert capacities for both inlet and outlet control conditions. For inlet control, Stantec used the submerged inlet control equation (Schall et al. 2012):

$$\frac{HW_i}{D} = c\left[\frac{K_u Q}{AD^{0.5}}\right]^2 + Y + K_S S$$

Where:

HW_i = headwater above invert of culvert (ft)
D = culvert diameter (ft)
c = inlet control constant = 0.0553 for submerged circular corrugated metal pipe (CMP) with projecting inlet
K_u = unit conversion coefficient = 1.0 for US customary units
Q = flow rate (ft^3/s)
A = culvert inlet area (ft^2)
Y = inlet control constant = 0.54 for circular CM pipe with projecting inlet
K_S = slope correction coefficient = -0.5 for non-mitered outlets
S = culvert slope

For outlet control, Stantec calculated the flow for a given headwater condition (HW) using entrance, friction, and exit loss relationships:

$$HW = h_o + H - S_o L \quad \text{and} \quad H = \left[1 + k_e + \left(\frac{29n^2 L}{R^{1.33}}\right)\right]\left[\frac{V^2}{2g}\right]$$

Where:

k_e = entrance loss coefficient = 0.9 for corrugated metal pipe projecting out of backfill
n = manning's roughness coefficient
L = length of culvert (ft)
R = full-flowing hydraulic radius of culvert (ft)
V = full-flowing velocity in culvert
h_o = tailwater depth = normal depth, y_n (assumed) or D

For outlet control of a culvert in outlet control flowing partially flow, Stantec used the following approximation for Headwater Elevation (Schall et al. 2012):

$$HW_{approx} = max\left\{\frac{d_c+D}{2},\ h_0\right\} + H - S_0 L$$

Where:

d_c = critical depth
D = pipe diameter
h_o = tailwater depth above outlet invert = normal depth, y_n (assumed)
H = hydraulic head required at inlet (ft)
L = length of culvert (ft)

Stantec determined critical depth (d_c) from an iterative method using the two following equations derived from knowing that critical depth occurs when the specific energy is at a minimum:

$$16Q\left[\frac{2}{g}\sin\left(\frac{\theta_c}{2}\right)\right]^{\frac{1}{2}} = D^{5/2}[\theta_c - \sin(\theta_c)]^{3/2}$$

$$d_c = \frac{D}{2}\left[1 - \cos\left(\frac{\theta_c}{2}\right)\right]$$

Where:

d_c = critical depth (ft)
D = pipe diameter (ft)
θ_c = water surface angle (radians)

For design, Stantec used the maximum inlet headwater elevation to evaluate whether the culvert is inlet or outlet controlled.

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Assumptions

Statntec used the following criteria for these calculations:

- The slope of the road side ditches would coincide with the slope of the haul road.
- Culverts are CMP with a Manning's roughness value of 0.027.
- The culverts would be installed with the inlet projecting out of backfill materials.
- The culverts would be straight with no bends and a constant slope.
- The maximum allowable headwater above culverts adjacent to the roadside ditch is 2 feet above the culvert inlet, leaving approximately 1-ft of freeboard between the road surface and the surface of the headwater.
- Stormwater ponds would be evacuated within 48 hours following large storm events.

Results

Roadside Ditches

The minimum depth required for roadside ditches would be generally less than 1 foot (with 1.5:1 side slopes) to pass, and Stantec selected a standard depth of 2 feet. The roadside ditch geometric design parameters are listed in **Table 1** and calculation worksheets are provided in Attachment A.

Diversion Ditches

The peak flow depth for the 10-yr storm ranges from 0.8 feet to 2.7 feet deep with 1.5:1 channel side slopes. Stantec selected a standard depth of 2 feet, however, two drainage ditches must be deeper than 2 feet deep. The two largest drainage basins, 1b and 28, require a 3 foot depth and 2.5 foot depth, respectively. Diversion Ditch 1A has also been adjusted to 3 feet to match Diversion Ditch 1B. The diversion ditch depths can be found in **Table 2**.

Stormwater Ponds

The required stormwater pond volumes generally range from 3,943 cubic feet (cf) to 13,420 cf along the haul road. The average size is about 6,173 cf. The two stormwater ponds in the Exclusion Area are 18,952 cf and 24,763 cf. Two stormwater ponds that will be combined with culverts are 7,919 cf and 4,200 cf. Minimum sizing for stormwater ponds is shown in **Table 3**.

Culverts

Stantec selected standard culvert diameter of 2 feet, but culverts C13 and C14 were given a diameter of 1 foot due to restrictions imposed by the size of the branch swale channels. The standard sizing and design freeboard is shown in **Table 4**. The culvert calculation worksheet is provided in Attachment A. Culverts shall have a standard minimum slope of 1.75 percent with the exception of culverts C11, C12, and C14, which are designed to have a slope matching the natural drainage slope which may be less than 1 percent.

References

Bonnin, G.M., D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley, 2011. Precipitation-Frequency Atlas of the United States. NOAA Atlas 14, Volume 1, Version 5.0: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah). Accessed online February 2016 at: http://www.nws.noaa.gov/oh/hdsc/PF_documents/Atlas14_Volume1.pdf

Schall, James D., Philip L. Thompson, Steve M. Zerges, Roger T. Kilgore, and Johnny L. Morris, 2012. Hydraulic Design of Highway Culverts, 3rd Edition. Ayres Associates. Office of Bridge Technology, Federal Highway Administration (FHWA). Report No FHWA-HIF-12-026 HDS 5. April.

TABLES

Table 1: Roadside Ditch Design Summary

Approximate Station		Drainage Basin(s)	Length of Channel	Total Q (10-Year Runoff)	Terminal Stormwater Pond ID	Side Slope Angle	10-yr Peak Flow Depth	Selected Channel Height
From	To		ft	cfs			ft	ft
0	450	0	450	2.1	S01	1.5	0.5	**2.0**
1040	450	2	590	13.2	S01	1.5	0.9	**2.0**
1040	1410	4	370	6.5	S02	1.5	0.9	**2.0**
1590	1410	6	180	4.1	S02	1.5	0.5	**2.0**
1590	1900	7	310	5.3	S03	1.5	0.6	**2.0**
1900	2320	8	420	1.1	S04	1.5	0.5	**2.0**
2320	2580	10	260	2.4	S05	1.5	0.6	**2.0**
2580	2960	11, 12	380	2.8	S06	1.5	1.0	**2.0**
2980	1000(Spur)	14, 15	320	7.6	S07	1.5	1.4	**2.0**
1000(Spur)	500(Spur)	17, 18	500	3.3	S08	1.5	0.8	**2.0**
500(Spur)	100(Spur)	19	280	1.1	S09	1.5	0.4	**2.0**
0(Spur)	100(Spur)	23	220	3.1	S09	1.5	0.9	**2.0**
3100	3610	25	510	2.0	S10	1.5	0.5	**2.0**
3610	4640	27	1030	3.6	S11	1.5	1.1	**2.0**

Table 2: Diversion Ditch Design Summary

Diversion Ditch ID	10-yr Maximum Flow Depth ft	Selected Channel Depth ft	Side Slope Angle ft/ft
1a	1.6	**3.0**	1.5
1b	2.7	**3.0**	1.5
2	1.5	**2.0**	1.5
3a	1.3	**2.0**	1.5
3b	1.4	**2.0**	1.5
4	2.4	**2.5**	1.5

Table 3: Stormwater Pond Design Summary

Stormwater Pond ID	Approximate Station	Drainage Basin(s)	Volume (cf)	Notes
S-01	4+50	0,2	13,420	Adjacent to Culvert C02
S-02	14+10	4, 6	7,919	Adjacent to Culvert C03
S-03	19+00	7	3,943	Adjacent to Road
S-04	23+00	8	4,035	Adjacent to Road
S-05	25+80	10	3,395	Adjacent to Road
S-06	29+80	11, 12	4,200	Adjacent to Culvert C05
S-07	10+00 (Spur)	14, 15	8,705	Adjacent to Road
S-08	5+00 (Spur)	17, 18	4,413	Adjacent to Road
S-09	0+90 (Spur)	19, 23	5,268	Adjacent to Road
S-10	36+00	25	4,075	Drainage from Road
S-11	46+40	27	8,532	Drainage from Road
S-12	N/A	West of Decon Zone	24,763	West of Exclusion Zone
S-13	N/A	East of Decon Zone	18,952	East of Exclusion Zone

Table 4: Culvert Design Summary

Culvert ID	Approximate Station ft	Watershed Model ID	Drainage Basin(s)	Design Diameter inch	Number of Pipe(s)	Design Slope ft/ft	10-yr Peak Flow cfs	10-yr Peak Freeboard ft
C-01	2+20	Haul Road-update	1a	24	1	2%	13.2	2.97
C-02	5+50	Haul Road-update	1b	24	3	3%	52.4	2.24
C-03	10+90	Haul Road-update	3	24	1	5%	2.9	3.92
C-04	14+50	Haul Road-update	5	24	1	5%	5.3	5.81
C-05	23+80	Haul Road-update	9	24	1	5%	8.2	3.59
C-06	30+20	Haul Road-update	13	24	1	5%	8.0	5.61
C-07	9+40 (Spur)	Haul Road-update	16	24	1	5%	8.9	3.52
C-08	2+50 (Spur)	Haul Road-update	20, 21	24	1	5%	19.5	1.84
C-09	0+30 (Spur)	Haul Road-update	22, 28	24	3	5%	72.8	0.67
C-10	36+50	Haul Road-update	13, 26	24	1	3%	16.3	2.47
C-11	44+80	Pipeline Design	J-R12ds*	24	4	0.37%	281 (5-yr)	87 cfs capacity
C-12	48+40	Mill Design	J-RC01ds*	24	3	0.1%	37.8	1.67
C-13	5+38 (East Borrow Road)	Mill Design	J-SCds*	12	4	5%	14.3	1.34
C-14	4+30 (East Borrow Road)	Mill Design	J-RC05ds*	12	3	1%	8.1	0.97
C-15	0+50 (East Borrow Road)	Mill Design	J-ND04us*	24	2	4%	45.5	0.06
C-16	24+50 (North Borrow Road)	Mill Design	J-RC03ds*	24	2	2%	26.2	2.98

*Note that Culverts C-11 to C-15 use the peak flow from elements of different hydrologic models

ATTACHMENT A

CALCULATION WORKSHEETS

Calculation Worksheet for Roadside Ditches and Diversion Ditches

Drainage Basin(s)	Total Q (10-Year Runoff)	Approximate Station		Length of Channel	Terminal Sediment Pond ID	Manning n	Average Slope	Side Slope Angle	Minimum Channel Depth	Selected Channel Depth	Flow Area	Wetted Perimeter	Hydraulic Radius	Top Width	Velocity	Froude #
	cfs	From	To	ft			ft/ft		ft	ft	ft²	ft	ft	ft	ft/s	
0	2.1	0	450	450	S01	0.03	0.074	1.5	**0.5**	**2.0**	0.4	1.9	0.2	6.0	5.0	1.71
2	6.5	450	1040	590	S01	0.03	0.046	1.5	**0.9**	**2.0**	1.2	3.2	0.4	6.0	5.5	1.45
4	4.1	1040	1410	370	S02	0.03	0.023	1.5	**0.9**	**2.0**	1.1	3.1	0.4	6.0	3.8	1.02
6	1.1	1410	1590	180	S02	0.03	0.023	1.5	**0.5**	**2.0**	0.4	1.9	0.2	6.0	2.7	0.94
7	2.8	1590	1900	310	S03	0.03	0.074	1.5	**0.6**	**2.0**	0.5	2.1	0.2	6.0	5.3	1.72
8	1.9	1900	2320	420	S04	0.03	0.074	1.5	**0.5**	**2.0**	0.4	1.9	0.2	6.0	4.8	1.68
10	2.4	2320	2580	260	S05	0.03	0.041	1.5	**0.6**	**2.0**	0.6	2.3	0.3	6.0	4.1	1.29
11, 12	2.8	2580	2960	380	S06	0.03	0.004	1.5	**1.0**	**2.0**	1.6	3.7	0.4	6.0	1.8	1.29
14, 15	7.6	2980	1000(Spur)	320	S07	0.03	0.005	1.5	**1.4**	**2.0**	3.0	5.1	0.6	6.0	2.5	0.92
17, 18	3.3	1000(Spur)	500(Spur)	500	S08	0.03	0.025	1.5	**0.8**	**2.0**	0.9	2.8	0.3	6.0	3.7	1.05
19	1.1	500(Spur)	100(Spur)	400	S09	0.03	0.057	1.5	**0.4**	**2.0**	0.3	1.6	0.2	6.0	3.8	1.43
23	3.1	0(Spur)	100(Spur)	100	S09	0.03	0.008	1.5	**0.9**	**2.0**	1.3	3.4	0.4	6.0	2.4	0.61
25	2.0	3100	3610	510	S10	0.03	0.078	1.5	**0.5**	**2.0**	0.4	1.9	0.2	6.0	5.0	1.73
27	3.6	3700	4889	1189	S11	0.03	0.004	1.5	**1.1**	**2.0**	1.9	4.0	0.5	6.0	1.9	1.28
28	72.8	-	-	-	Div Berm 4	0.03	0.032	1.5	**2.4**	**2.5**	8.3	8.5	1.0	7.5	8.7	1.42
21	8.7	-	-	-	Div Berm 3a	0.03	0.011	1.5	**1.3**	**2.0**	2.5	4.7	0.5	6.0	3.5	0.76
20	10.7	-	-	-	Div Berm 3b	0.03	0.011	1.5	**1.4**	**2.0**	3.0	5.1	0.6	6.0	3.6	0.77
1a	13.2	-	-	-	Div Berm 1a	0.03	0.0094	1.5	**0.8**	**2.0**	1.0	3.0	0.3	6.0	2.4	0.72
1b	52.4	-	-	-	Div Berm 1b	0.03	0.00865	1.5	**2.7**	**3.0**	10.6	9.6	1.1	9.0	4.9	0.76
16, 24	17.6	-	-	-	Div Berm 2	0.03	0.008	1.5	**1.8**	**2.0**	4.8	6.5	0.7	6.0	3.7	0.68

Notes

10 Year, 24 Hour peak discharge used to estimate design flow

Minimum channel sizing based on Manning's equation to contain 10 year peak flow (no freeboard)

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

Side slopes are assumed to be 1.5:1 (H:V)

Normal Manning's n = 0.030 for channels that are clean, straight, full stage, no rifts or deep pools (Chow, 1959)

Approximate station and average channel slope based on NORTHEAST CHURCH ROCK PROJECT 95% DESIGN DRAWINGS (10/30/2017)

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

Calculation Worksheet for Culverts

Culvert ID	Q (cfs)	Approximate Length of Culvert	Approximate Slope of Culvert (S)	Elevation Change	Number of Pipes	Q per pipe	Submerged Y	Submerged c	Ku	Ks	Design Diameter	Submerged HW for inlet
	cfs	ft	ft/ft	ft		cfs					in	ft
C01	13.16499	200	0.02	4	1	13.16499	0.54	0.0553	1	-0.5	**24**	2.03
C02	52.377	200	0.03	6	3	17.459	0.54	0.0553	1	-0.5	**24**	2.76
C03	2.9433	70	0.05	3.5	1	2.9433	0.54	0.0553	1	-0.5	**24**	1.08
C04	5.33286	55	0.05	2.75	1	5.33286	0.54	0.0553	1	-0.5	**24**	1.19
C05	8.232	40	0.05	2	1	8.232	0.54	0.0553	1	-0.5	**24**	1.41
C06	8.04455	50	0.05	2.5	1	8.04455	0.54	0.0553	1	-0.5	**24**	1.39
C07	8.94948	40	0.05	2	1	8.94948	0.54	0.0553	1	-0.5	**24**	1.48
C08	19.48018	40	0.05	2	1	19.48018	0.54	0.0553	1	-0.5	**24**	3.16
C09	72.8	40	0.05	2	3	24.26667	0.54	0.0553	1	-0.5	**24**	4.33
C10	16.26736	40	0.033	1.32	1	16.26736	0.54	0.0553	1	-0.5	**24**	2.53
C11	281.539	100	0.004	0.37	4	70.38475	0.54	0.0553	1	-0.5	**24**	28.83
C13	14.324	47.5	0.05	2.375	4	3.581	0.54	0.0553	1	-0.5	**12**	1.66
C14	8.064	47.5	0.01	0.475	3	2.688	0.54	0.0553	1	-0.5	**12**	1.18
C15	45.506	85	0.04	3.4	2	22.753	0.54	0.0553	1	-0.5	**24**	3.94
C12	37.765	70	0.001	0.07	3	12.58833	0.54	0.0553	1	-0.5	**24**	1.97
C16	26.221	70	0.02	1.4	2	13.1105	0.54	0.0553	1	-0.5	**24**	2.02

Culvert ID	Q (cfs)	Length of Culvert	Slope of Culvert (S)	Elevation Change	Number of Pipes	Q per pipe	Ku	Ks	Pipe Size	Normal Depth y_n	Critical theta	Critical Depth y_c	Barrel Velocity (V)	Hydraulic Radius, R	Full Perimeter	Full Velocity	Full Hydraulic Radius	ke	Roughness, n	Headloss, H	Exit Depth	$(y_c+D)/2$	HWo normal depth	HWo Approx
	cfs	ft	ft/ft	ft		cfs			in	ft	rad	ft	ft/s	ft	ft	ft/s	ft			ft	ft		ft	ft
C01	13.2	200	0.02	4	1	13.2	1	-0.5	**24**	**1.42**	3.76	1.31	5.52	0.60	6.28	4.19	0.50	0.9	0.027	3.42	1.42	1.65	0.8	1.1
C02	52.4	200	0.03	6	3	17.5	1	-0.5	**24**	**1.54**	4.24	1.52	6.71	0.61	6.28	5.56	0.50	0.9	0.027	6.01	1.54	1.76	1.6	1.8
C03	2.9	70	0.05	3.5	1	2.9	1	-0.5	**24**	**0.47**	2.32	0.60	5.25	0.28	6.28	0.94	0.50	0.9	0.027	0.08	0.47	1.30	-3.0	-2.1
C04	5.3	55	0.05	2.75	1	5.3	1	-0.5	**24**	**0.63**	2.77	0.81	6.22	0.36	6.28	1.70	0.50	0.9	0.027	0.22	0.63	1.41	-1.9	-1.1
C05	8.2	40	0.05	2	1	8.2	1	-0.5	**24**	**0.80**	3.19	1.02	7.02	0.43	6.28	2.62	0.50	0.9	0.027	0.43	0.80	1.51	-0.8	-0.1
C06	8.0	50	0.05	2.5	1	8.0	1	-0.5	**24**	**0.79**	3.16	1.01	6.97	0.42	6.28	2.56	0.50	0.9	0.027	0.46	0.79	1.50	-1.2	-0.5
C07	8.9	40	0.05	2	1	8.9	1	-0.5	**24**	**0.84**	3.28	1.07	7.17	0.44	6.28	2.85	0.50	0.9	0.027	0.51	0.84	1.53	-0.7	0.0
C08	19.5	40	0.05	2	1	19.5	1	-0.5	**24**	**1.35**	4.40	1.59	8.63	0.59	6.28	6.20	0.50	0.9	0.027	2.41	1.35	1.79	1.8	2.2
C09	72.8	40	0.05	2	3	24.26	1	-0.5	**24**	**1.63**	4.82	1.74	8.86	0.61	6.28	7.72	0.50	0.9	0.027	3.73	1.63	1.87	3.4	3.6
C10	16.3	40	0.033	1.32	1	16.3	1	-0.5	**24**	**1.38**	4.08	1.45	7.05	0.59	6.28	5.18	0.50	0.9	0.027	1.68	1.38	1.73	1.7	2.1
C11	281.5	100	0.004	0.37	4	70.4	1	-0.5	**24**	**2.00**	6.09	2.00	22.40	0.50	6.28	22.40	0.50	0.9	0.027	56.29	2.00	2.00	57.9	57.9
C13	14.3	47.5	0.05	2.375	4	3.6	1	-0.5	**12**	**0.76**	4.47	0.81	5.56	0.30	3.14	4.56	0.25	0.9	0.027	2.66	0.76	0.90	1.1	1.2
C14	8.1	47.5	0.01	0.475	3	2.7	1	-0.5	**12**	**1.00**	3.98	0.70	3.42	0.25	3.14	3.42	0.25	0.9	0.027	1.50	1.00	0.85	2.0	1.9
C15	45.5	85	0.04	3.4	2	22.8	1	-0.5	**24**	**1.73**	4.69	1.70	7.89	0.60	6.28	7.24	0.50	0.9	0.027	5.23	1.73	1.85	3.6	3.7
C12	37.8	70	0.001	0.07	3	12.6	1	-0.5	**24**	**2.00**	3.70	1.28	4.01	0.50	6.28	4.01	0.50	0.9	0.027	1.40	2.00	1.64	3.3	3.0
C16	26.2	70	0.02	1.4	2	13.11	1	-0.5	**24**	**1.41**	3.76	1.30	5.52	0.59	6.28	4.17	0.5	0.9	0.027	1.52	1.41	1.65	1.5	1.8

Culvert ID	Headwater ELo	Control	Max headwater EL	Allowable HW above crown	ELa	Design Clearance	Freeboard
	ft		ft	ft	ft	ft	ft
C01	1.1	**INLET**	**2.03**	2.00	4.00	1.97	2.97
C02	1.8	**INLET**	**2.76**	2.00	4.00	1.24	2.24
C03	-2.1	**INLET**	**1.08**	2.00	4.00	2.92	3.92
C04	-1.1	**INLET**	**1.19**	5.00	7.00	5.81	5.81
C05	-0.1	**INLET**	**1.41**	2.00	4.00	2.59	3.59
C06	-0.5	**INLET**	**1.39**	5.00	7.00	5.61	5.61
C07	0.0	**INLET**	**1.48**	2.00	4.00	2.52	3.52
C08	2.2	**INLET**	**3.16**	2.00	4.00	0.84	1.84
C09	3.6	**INLET**	**4.33**	2.00	4.00	-0.33	0.67
C10	2.1	**INLET**	**2.53**	2.00	4.00	1.47	2.47
C11	57.9	**OUTLET**	**57.89**	2.00	4.00	-53.89	-52.89
C13	1.2	**INLET**	**1.66**	2.00	3.00	1.34	2.34
C14	2.0	**OUTLET**	**1.18**	2.00	3.00	1.82	2.82
C15	3.7	**INLET**	**3.94**	2.00	4.00	0.06	1.06
C12	3.3	**OUTLET**	**1.97**	2.00	4.00	2.03	3.03
C16	1.8	**INLET**	**2.02**	2.00	4.00	1.98	2.98