

Written by: Sowmya Bulusu / Alexander Maestre Date: 12/07/06 Reviewed by: Ganesh Gopalakrishnan Date: 12/13/06

Client: TVA Project: Kingston Fossil Plant Gypsum Disposal Facility Project/Proposal No.: GR3731 Task No.: 06

**Attachment 11**

**Design of Downdrains**

Written by: Sowmya Bulusu / Alexander Maestre Date: 12/07/06 Reviewed by: Ganesh Gopalakrishnan Date: 12/13/06

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**DESIGN OF DOWNDRAINS**

**METHODOLOGY**

For the design of the downdrains, the critical condition was identified as the downdrain with the mildest slope (4 percent at drainage bench), receiving the highest discharge from a subarea (Subarea 202) to a downdrain.

The highest flow from a subarea to a downdrain is obtained from HydroCAD post-development analysis for the 25-year, 24-hour storm event. The highest flow (58.20 cfs) to a downdrain is anticipated from Subarea 202 (Attachment 2). The capacity of a 24-inch downdrain with a longitudinal slope of 4 percent is 70.47 cfs.

$$Q_{\text{anticipated}} = 58.20,$$

$$Q_{\text{max}} = 70.47 \text{ cfs}$$

$$Q_{\text{anticipated}} < Q_{\text{max}} \implies \text{OK}$$

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## Flow Through Circular Pipe

Diameter of pipe, D= 24 inches  
 Longitudinal Slope, So= 0.04 ft/ft  
 Manning's n= 0.009  
 Density of flowing liquid, rho= 1.94 slugs/ft<sup>3</sup>

Theta radians	Theta degrees	Depth of Flow y inches	Area of Flow A ft <sup>2</sup>	Wetted Perimeter P ft	Hydraulic Radius R ft	Average Velocity V ft/s	Discharge Q=A*V cfs	Force* F lbf
0.00	0	0.0	0.000	0.00		0.0	0.00	0.0
0.25	14	0.1	0.001	0.25	0.01	1.0	0.00	0.0
0.50	29	0.4	0.010	0.50	0.02	2.5	0.03	0.1
0.75	43	0.8	0.034	0.75	0.05	4.2	0.14	1.2
1.00	57	1.5	0.079	1.00	0.08	6.1	0.48	5.7
1.25	72	2.3	0.151	1.25	0.12	8.1	1.21	19.0
1.50	86	3.2	0.251	1.50	0.17	10.1	2.53	49.3
1.75	100	4.3	0.383	1.75	0.22	12.0	4.60	107.3
2.00	115	5.5	0.545	2.00	0.27	13.9	7.59	204.9
2.25	129	6.8	0.736	2.25	0.33	15.7	11.56	352.5
2.50	143	8.2	0.951	2.50	0.38	17.4	16.52	556.8
2.75	158	9.7	1.184	2.75	0.43	18.9	22.35	818.5
3.00	172	11.2	1.429	3.00	0.48	20.2	28.87	1130.9
3.25	186	12.7	1.679	3.25	0.52	21.3	35.79	1479.9
3.50	201	14.1	1.925	3.50	0.55	22.2	42.79	1845.1
3.75	215	15.6	2.161	3.75	0.58	22.9	49.53	2202.8
4.00	229	17.0	2.378	4.00	0.59	23.4	55.68	2528.4
4.25	244	18.3	2.572	4.25	0.61	23.7	60.94	2800.6
4.50	258	19.5	2.739	4.50	0.61	23.8	65.12	3003.4
4.75	272	20.6	2.875	4.75	0.61	23.7	68.09	3128.8
5.00	286	21.6	2.979	5.00	0.60	23.4	69.85	3176.6
5.25	301	22.4	3.054	5.25	0.58	23.1	70.47	3154.3
5.50	315	23.1	3.103	5.50	0.56	22.6	70.13	3075.0
5.75	329	23.6	3.129	5.75	0.54	22.1	69.05	2955.8
6.00	344	23.9	3.140	6.00	0.52	21.5	67.49	2814.7
6.25	358	24.0	3.142	6.25	0.50	20.9	65.75	2669.3

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## **Attachment 12**

### **Design of Drainage Channels**

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Reviewed by: Ganesh Gopalakrishnan

Date: 12/13/06

Client: TVA

Project: Kingston Fossil Plant Gypsum Disposal Facility Project/Proposal No.: GR3731

Task No.: 06

**TVA KINGSTON FOSSIL PLANT LANDFILL, ROANE COUNTY, TENNESSEE  
SURFACE WATER MANAGEMENT SYSTEM CALCULATIONS  
PERIMETER DRAINAGE CHANNELS**

Reach No <sup>(1)</sup>	Length (ft)	Starting Elevation (ft)	Ending Elevation (ft)	Slope, S <sub>o</sub> (ft/ft)	Width, B (ft)	Depth of channel, D (ft)	Left side slope H:1V	Right side slope H:1V	Post-Development Analysis results <sup>(3)</sup>			Average Traction Stress (psf)	Free Overboard (in)	Lining Type	Riprap d50 (inch)
									25-year, 24-hour Discharge (cfs)	Depth of flow (ft)	Maximum Velocity (ft/s)				
R1	617.6	786.58	759.39	0.0440	5.5	3.00	2.0	3.0	143.35	1.48	10.5	2.77	18.2	Riprap	12.41
R2	822.6	773.1	759.39	0.0167	5.5	3.00	3.0	2.0	216.31	2.32	8.2	1.52	8.2	Riprap	7.1
R3	870.4	781.2	773.1	0.0093	5.5	3.00	3.0	2.0	200.54	2.49	6.4	0.90	6.1	Grass	-
R4	828.1	789.05	781.2	0.0095	5.5	3.00	3.0	2.0	153.80	2.23	6	0.83	9.2	Grass	-
R5	869.2	800	789.05	0.0126	5.5	3.00	3.0	2.0	104.36	1.71	6	0.89	15.5	Grass	-
R6	777.2	805.92	797.85	0.0104	5.5	3.00	3.0	2.0	79.37	1.56	5.2	0.68	17.3	Grass	-
R7	908.9	815.32	805.92	0.0103	5.5	3.00	3.0	2.0	56.26	1.27	4.7	0.58	20.8	Grass	-
R8	767.1	823.23	815.32	0.0103	5.5	3.00	3.0	2.0	12.05	0.53	2.9	0.28	29.6	Grass	-
R9	611.2	823.23	816.31	0.0113	5.5	3.00	2.0	3.0	9.92	0.47	2.8	0.28	30.4	Grass	-
R10	578.9	816.31	809.39	0.0120	5.5	3.00	2.0	3.0	57.43	1.27	5	0.67	20.8	Grass	-
R11	655.3	809.39	786.59	0.0348	5.5	3.00	2.0	3.0	96.78	1.28	8.6	1.95	20.6	Riprap	9.59

**Notes:**

- (1) Reach numbers as shown in the Schematic Surface Water Management Plan
- (2) Maximum Allowable discharge computed using Manning's equation
- (3) Summary of post-development analysis was obtained from HydroCAD output presented in Attachment 8



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**TVA KINGSTON FOSSIL PLANT LANDFILL, ROANE COUNTY, TENNESSEE  
SURFACE WATER MANAGEMENT SYSTEM CALCULATIONS  
RUN-ON DRAINAGE CHANNELS**

Reach No <sup>(1)</sup>	Length (ft)	Starting Elevation (ft)	Ending Elevation (ft)	Slope, S <sub>o</sub> (ft/ft)	Width, B (ft)	Depth of channel, D (ft)	Left side slope H:1V	Right side slope H:1V	Post-Development Analysis results <sup>(3)</sup>			Average Traction Stress (psf)	Free Overboard (in)	Lining Type	Riprap d50 (inch)
									25-year 24 hour Discharge (cfs)	Depth of flow (ft)	Maximum Velocity (ft/s)				
RN1	528.7	828	768.08	0.1133	3.0	2.00	2.0	2.0	26.07	0.62	9.8	3.22	16.6	Riprap	17.23
RN2	432.3	828	818	0.0231	3.0	2.00	2.0	2.0	16.53	0.74	4.9	0.76	15.1	Grass	-
RN3	371.4	818	810	0.0215	3.0	2.00	2.0	2.0	43.91	1.26	6.3	1.08	8.9	Riprap	5.14
RN4	731.1	861.9	808.75	0.0727	3.0	2.00	2.0	2.0	25.33	0.69	8.4	2.25	15.7	Riprap	11.15
RN5	591.7	808.12	791.5	0.0281	3.0	3.00	2.0	2.0	76.24	1.55	8.0	1.67	17.4	Riprap	7.60
RN6	947.6	861.9	829.92	0.0337	3.0	2.00	2.0	2.0	44.02	1.11	7.3	1.53	10.7	Riprap	7.48
RN7	490.9	848	829.92	0.0368	3.0	2.00	2.0	2.0	45.85	1.12	7.7	1.68	10.6	Riprap	8.21
RN8	69	829.12	817.64	0.1664	3.0	2.00	2.0	2.0	86.3	1.37	10.9	8.95	7.56	Riprap	36.11
RN9	855.7	848	834.16	0.0162	3.0	2.00	2.0	2.0	21.99	0.92	4.6	0.63	13.0	Grass	-
RN10	627.6	834.16	794.93	0.0625	3.0	2.00	2.0	2.0	37.64	0.88	8.8	2.36	13.4	Riprap	11.77
RN11	378.5	794.93	766.18	0.0760	3.0	2.00	2.0	2.0	44.06	0.91	9.9	2.94	13.1	Riprap	14.89
RN12	430	765.33	755.50	0.0229	4.0	5.00	2.0	2.0	123.66	1.89	8.4	1.69	53.5	Riprap	7.13
RN13	246.6	770.60	766.18	0.0179	4.0	5.00	2.0	2.0	93.86	1.75	7.1	1.24	39.0	Riprap	5.16
RN14	712.3	781.64	770.60	0.0155	4.0	5.00	2.0	2.0	95.09	1.82	6.7	1.11	38.2	Riprap	5.25
RN15	1158.2	814.27	781.64	0.0282	6.0	3.00	2.0	2.0	93.79	1.32	8.0	1.69	44.2	Riprap	8.61
RN16	311.5	817.5	814.27	0.0104	6.0	3.00	2.0	2.0	92.65	1.72	5.6	2.09	15.4	Riprap	8.44
RN17	416.6	822.36	817.5	0.0117	0.0	3.00	2.0	2.0	7.43	1.05	3.2	0.34	23.4	Grass	-
RN18	392.0	822.36	816.53	0.0149	3.0	5.00	2.0	2.0	7.73	0.54	3.3	0.38	53.5	Grass	-
RN19	391.7	816.53	791.5	0.0639	3.0	6.00	2.0	2.0	13.30	0.50	6.6	1.52	66.0	Riprap	7.46
RN20	229.0	791.5	790.12	0.0060	3.0	29.00	2.0	2.0	86.61	2.37	4.7	0.51	319.6	Grass	-
RN21	872.8	790.12	770	0.0231	3.0	8.00	2.0	2.0	101.66	1.86	8.0	1.59	73.7	Riprap	7.78
RN22	465.1	770	764	0.0129	18.0	3.00	2.0	2.0	120.56	1.09	5.5	0.77	22.9	Grass	-
RN23	154.8	767.38	764	0.0289	1.0	2.00	2.0	2.0	25.31	1.02	6.2	1.01	11.8	Riprap	5.46
RN24	91.5	751.64	749.59	0.0224	4.0	5.00	2.0	2.0	140.94	2.03	8.6	1.75	35.6	Riprap	8.47

**NOTES:**

- (1) Reach numbers as shown in the Schematic Surface Water Management Plan
- (2) Maximum Allowable discharge computed using Manning's equation
- (3) Summary of post-development run-on analysis was obtained from HydroCAD output presented in Attachment 8



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**Attachment 13**

**Design of Culverts**



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**DESIGN OF CULVERTS**

**TABLE 1. SURFACE WATER MANAGEMENT SYSTEM CALCULATIONS - CULVERTS**

Pipe Designation in HydroCAD		Diameter (in)	Length (ft)	Starting Elevation (ft)	Ending Elevation (ft)	Slope (ft/ft)	Manning n	Maximum Flow Capacity (cfs)	25-year 24-hour Discharge (cfs)
ID	Type								
C1	Concrete	(3) x 48"	54.2	759.39	758.31	0.020	0.013	608.3	335.25
C2	Concrete	(1) x 36"	69.8	768.08	767.38	0.010	0.013	66.79	19.59
C3	Concrete	(1) x 36"	69.8	810.00	808.37	0.023	0.013	101.93	43.26
C4	Concrete	(1) x 36"	63.5	808.75	808.12	0.010	0.013	66.44	24.57
C5	Concrete	(1) x 48"	80	829.92	829.12	0.010	0.013	143.64	86.59
C6	Concrete	(2) x 48"	80.4	766.18	765.33	0.011	0.013	295.39	123.53
C7	Concrete	(3) x 48"	160	755.50	751.64	0.025	0.013	669.33	141.12
C8	Concrete	(3) x 48"	60	749.59	748.05	0.025	0.013	690.38	140.77





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**METHODOLOGY**

The design of culverts is analyzed for the governing hydraulic condition (i.e., inlet control versus outlet control) using the computer program CulvertMaster, and the headwater depth ( $H_w$ ) to diameter ( $D$ ) ratio for the pipe under consideration is obtained from the output report generated by CulvertMaster, based on the 100-year, 24-hour peak discharge from culvert and culvert diameter (input parameters). Based on the headwater depth to diameter ratio the headwater depth at the culvert inlet is estimated. The headwater depths for culverts C1 to C8 are listed in table below. The CulvertMaster outputs for the culvert C1 through C8 are presented in this attachment.

**TABLE 2. SUMMARY OF RESULTS FROM CulvertMaster® OUTPUTS.**

Pipe Designation in HydroCAD ID	Diameter (in)	100-year, 24-hour Discharge (cfs)	Inlet Type	Ke	Control Type	$H_w/D$	$H_w$ (ft)
C1	(3) x 48"	431.12	Square edge w/headwall	0.5	Outlet	2.10	8.40
C2	(1) x 36"	25.38	Square edge w/headwall	0.5	Entrance	0.87	2.61
C3	(1) x 36"	56.11	Square edge w/headwall	0.5	Inlet	1.49	4.47
C4	(1) x 36"	31.90	Square edge w/headwall	0.5	Entrance	1.00	3.00
C5	(1) x 48"	112.3	Square edge w/headwall	0.5	Inlet	1.46	5.84
C6	(2) x 48"	165.45	Square edge w/headwall	0.5	Inlet	1.16	4.64
C7	(3) x 48"	189.69	Square edge w/headwall	0.5	Inlet	0.98	3.90
C8	(3) x 48"	189.25	Square edge w/headwall	0.5	Inlet	0.98	3.88



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**CULVERTMASTER - CULVERT CALCULATOR RESULTS**



## Culvert Calculator Report

### TVA Kinston Fossil Plant - 100-yr 24-hr storm P=6.7 C1

Solve For: Headwater Elevation

**Culvert Summary**

Allowable HW Elevation	0.00 ft	Headwater Depth/Height	2.10
Computed Headwater Elev:	767.80 ft	Discharge	431.12 cfs
Inlet Control HW Elev.	767.24 ft	Tailwater Elevation	764.21 ft
Outlet Control HW Elev.	767.80 ft	Control Type	Outlet Control

**Grades**

Upstream Invert	759.39 ft	Downstream Invert	758.31 ft
Length	54.20 ft	Constructed Slope	0.019926 ft/ft

**Hydraulic Profile**

Profile	Pressure Profile	Depth, Downstream	5.90 ft
Slope Type	N/A	Normal Depth	2.49 ft
Flow Regime	N/A	Critical Depth	3.54 ft
Velocity Downstream	11.44 ft/s	Critical Slope	0.008942 ft/ft

**Section**

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	3		

**Outlet Control Properties**

Outlet Control HW Elev.	767.80 ft	Upstream Velocity Head	2.03 ft
Ke	0.50	Entrance Loss	1.02 ft

**Inlet Control Properties**

Inlet Control HW Elev.	767.24 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	37.7 ft <sup>2</sup>
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

143/149

### Culvert Calculator Report TVA Kinston Fossil Plant - 100-yr 24-hr storm P=6.7 C2

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	0.00 ft	Headwater Depth/Height	0.87
Computed Headwater Elev.	770.69 ft	Discharge	25.38 cfs
Inlet Control HW Elev.	770.47 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	770.69 ft	Control Type	Entrance Control

Grades			
Upstream Invert	768.08 ft	Downstream Invert	767.38 ft
Length	69.80 ft	Constructed Slope	0.010029 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.32 ft
Slope Type	Steep	Normal Depth	1.28 ft
Flow Regime	Supercritical	Critical Depth	1.63 ft
Velocity Downstream	8.50 ft/s	Critical Slope	0.004429 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	770.69 ft	Upstream Velocity Head	0.65 ft
Ke	0.50	Entrance Loss	0.33 ft

Inlet Control Properties			
Inlet Control HW Elev.	770.47 ft	Flow Control	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	7.1 ft <sup>2</sup>
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

144/149

## Culvert Calculator Report

### TVA Kinston Fossil Plant - 100-yr 24-hr storm P=6.7 C3

Solve For: Headwater Elevation

#### Culvert Summary

Allowable HW Elevation	0.00 ft	Headwater Depth/Height	1.49
Computed Headwater Elev.	814.48 ft	Discharge	56.11 cfs
Inlet Control HW Elev.	814.48 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	814.38 ft	Control Type	Inlet Control

#### Grades

Upstream Invert	810.00 ft	Downstream Invert	808.37 ft
Length	69.80 ft	Constructed Slope	0.023352 ft/ft

#### Hydraulic Profile

Profile	S2	Depth, Downstream	1.75 ft
Slope Type	Steep	Normal Depth	1.59 ft
Flow Regime	Supercritical	Critical Depth	2.43 ft
Velocity Downstream	13.12 ft/s	Critical Slope	0.007238 ft/ft

#### Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

#### Outlet Control Properties

Outlet Control HW Elev.	814.38 ft	Upstream Velocity Head	1.30 ft
Ke	0.50	Entrance Loss	0.65 ft

#### Inlet Control Properties

Inlet Control HW Elev.	814.48 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	7.1 ft <sup>2</sup>
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

145/149

### Culvert Calculator Report TVA Kinston Fossil Plant - 100-yr 24-hr storm P=6.7 C4

Solve For: Headwater Elevation

#### Culvert Summary

Allowable HW Elevation	0.00 ft	Headwater Depth/Height	1.00
Computed Headwater Elev.	811.74 ft	Discharge	31.90 cfs
Inlet Control HW Elev.	811.54 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	811.74 ft	Control Type	Entrance Control

#### Grades

Upstream Invert	808.75 ft	Downstream Invert	808.12 ft
Length	63.50 ft	Constructed Slope	0.009921 ft/ft

#### Hydraulic Profile

Profile	S2	Depth, Downstream	1.51 ft
Slope Type	Steep	Normal Depth	1.46 ft
Flow Regime	Supercritical	Critical Depth	1.83 ft
Velocity Downstream	8.92 ft/s	Critical Slope	0.004800 ft/ft

#### Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

#### Outlet Control Properties

Outlet Control HW Elev.	811.74 ft	Upstream Velocity Head	0.77 ft
Ke	0.50	Entrance Loss	0.39 ft

#### Inlet Control Properties

Inlet Control HW Elev.	811.54 ft	Flow Control	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	7.1 ft <sup>2</sup>
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

## Culvert Calculator Report

### TVA Kinston Fossil Plant - 100-yr 24-hr storm P=6.7 C5

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	0.00 ft	Headwater Depth/Height	1.46
Computed Headwater Elev.	835.76 ft	Discharge	112.30 cfs
Inlet Control HW Elev.	835.76 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	835.65 ft	Control Type	Inlet Control

Grades			
Upstream Invert	829.92 ft	Downstream Invert	829.12 ft
Length	80.00 ft	Constructed Slope	0.010000 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	2.78 ft
Slope Type	Steep	Normal Depth	2.66 ft
Flow Regime	Supercritical	Critical Depth	3.20 ft
Velocity Downstream	12.07 ft/s	Critical Slope	0.006392 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	835.65 ft	Upstream Velocity Head	1.69 ft
Ke	0.50	Entrance Loss	0.84 ft

Inlet Control Properties			
Inlet Control HW Elev.	835.76 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	12.6 ft <sup>2</sup>
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

147/149

### Culvert Calculator Report TVA Kinston Fossil Plant - 100-yr 24-hr storm P=6.7 C6

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	0.00 ft	Headwater Depth/Height	1.16
Computed Headwater Elev.	770.81 ft	Discharge	165.45 cfs
Inlet Control HW Elev.	770.59 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	770.81 ft	Control Type	Entrance Control

Grades			
Upstream Invert	766.18 ft	Downstream Invert	765.33 ft
Length	80.40 ft	Constructed Slope	0.010572 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	2.26 ft
Slope Type	Steep	Normal Depth	2.14 ft
Flow Regime	Supercritical	Critical Depth	2.76 ft
Velocity Downstream	11.30 ft/s	Critical Slope	0.004933 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	770.81 ft	Upstream Velocity Head	1.25 ft
Ke	0.50	Entrance Loss	0.62 ft

Inlet Control Properties			
Inlet Control HW Elev.	770.59 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	25.1 ft <sup>2</sup>
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		



148/149

## Culvert Calculator Report

### TVA Kinston Fossil Plant - 100-yr 24-hr storm P=6.7 C7

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	0.00 ft	Headwater Depth/Height	0.98
Computed Headwater Elev:	759.40 ft	Discharge	189.69 cfs
Inlet Control HW Elev.	759.10 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	759.40 ft	Control Type	Entrance Control

Grades			
Upstream Invert	755.50 ft	Downstream Invert	751.64 ft
Length	160.00 ft	Constructed Slope	0.024125 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.51 ft
Slope Type	Steep	Normal Depth	1.46 ft
Flow Regime	Supercritical	Critical Depth	2.40 ft
Velocity Downstream	14.58 ft/s	Critical Slope	0.004300 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	3		

Outlet Control Properties			
Outlet Control HW Elev.	759.40 ft	Upstream Velocity Head	1.00 ft
Ke	0.50	Entrance Loss	0.50 ft

Inlet Control Properties			
Inlet Control HW Elev.	759.10 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	37.7 ft <sup>2</sup>
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

149/149

# Culvert Calculator Report

## TVA Kinston Fossil Plant - 100-yr 24-hr storm P=6.7 C8

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	0.00 ft	Headwater Depth/Height	0.97
Computed Headwater Elev.	753.49 ft	Discharge	189.25 cfs
Inlet Control HW Elev.	753.18 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	753.49 ft	Control Type	Entrance Control

Grades			
Upstream Invert	749.59 ft	Downstream Invert	748.05 ft
Length	60.00 ft	Constructed Slope	0.025667 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.64 ft
Slope Type	Steep	Normal Depth	1.43 ft
Flow Regime	Supercritical	Critical Depth	2.40 ft
Velocity Downstream	13.01 ft/s	Critical Slope	0.004296 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	3		

Outlet Control Properties			
Outlet Control HW Elev.	753.49 ft	Upstream Velocity Head	1.00 ft
Ke	0.50	Entrance Loss	0.50 ft

Inlet Control Properties			
Inlet Control HW Elev.	753.18 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	37.7 ft <sup>2</sup>
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		