Run-On and Run-Off Control Plan Update – OML Existing Landfill and Expansion Phase 1

Ottumwa-Midland Landfill
15300 130th Street
Ottumwa, Iowa 52501

Prepared for:

Interstate Power and Light Company
15300 130th Street
Ottumwa, Iowa 52501

SCS ENGINEERS

25221073.00 | September 15, 2021

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

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PE CERTIFICATION

9/15/21

I, Eric J. Nelson, hereby certify that this Run-On and Run-Off Control Plan Update meets the requirements of 40 CFR 257.81(c), was prepared by me or under my direct supervision, and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

9/15/2021

(signature) (date)

Eric J. Nelson

(printed or typed name)

License number 23136

My license renewal date is December 31, 2022.

Pages or sheets covered by this seal:

All pages of Run-On and Run-Off Control Plan Update,

OML Existing Landfill and Expansion Phase 1

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Interstate Power and Light Company (IPL), SCS Engineers (SCS) has prepared this Run-on and Run-off Control Plan Update for the Ottumwa-Midland Landfill (OML) in accordance with 40 CFR 257.81(c)(4) as follows.

40 CFR 257.81(c)(4). *"The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first subsequent plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph (c)(4), the owner or operator has completed a periodic run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by §257.105(g)(3).*"

The OML Landfill includes an active coal combustion residual (CCR) landfill, which currently consists of two existing CCR landfill units:

- OML Existing (Original) Landfill (currently covered with intermediate/final cover)
- OML Expansion Phase 1

The initial Run-on and Run-off Control Plan was completed in 2016, and there have been no previous updates,

The OML Existing Landfill has received CCR both before and after the effective date of the CCR Rule. Five future CCR units (OML Expansion Phases 2, 3, 4, 5, and 6) are permitted with the Iowa Department of Natural Resources (IDNR), but have not been developed. When developed, the future units will be new CCR landfills, as defined by 40 CFR 257.53. Future CCR units are not addressed by this plan update and are not discussed further herein.

Refer to Figure 1 for the site location. Figure 2 shows the run-on and run-off drainage areas.

1.1 5-YEAR PERIODIC PLAN UPDATES

The following items has been updated in this periodic plan update:

- Additional rain cover has been removed from the OML Expansion Phase 1, creating additional area contributing to run-off being managed as contact water. In addition to previous design calculations, run-off calculations supporting 2018 rain cover removal are provided with this update.

- IPL has obtained IDNR National Pollutant Discharge Elimination System (NPDES) General Permit Number 1 authorization to discharge contact water from the North Expansion Contact Water Basin. IDNR correspondence related to this change is provided with this update.

- IPL has installed evaporators to assist with managing contact water collected in the North Expansion Contact Water Basin. IDNR correspondence related to this change is provided with this update.

- Figure 2 has been updated to show topographic data for active landfill areas obtained during the most recent survey of the landfill in June 2021.

No other changes impacting the run-on and run-off controls have been identified with this update.

2.0 RUN-ON AND RUN-OFF CONTROL PLAN

40 CFR 257.81(a). *"The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:*

(1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm."

The entire facility has run-on and run-off control in place, as approved by the IDNR. Run-on is controlled by berms and swales around the perimeter of the landfill that divert storm water away from the landfill and to detention basins or natural drainage features.

(2) "A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm."

Run-off from the active portions of the OML Existing Landfill is handled as contact water and is collected by a leachate collection system, which routes the contact water to a sump, where the contact water is then pumped to a concrete-lined leachate lagoon. Run-off from the active portions of the OML Expansion Phase 1 is handled as contact water and drains to a lined contact water basin, or is collected by a leachate collection system and pumped to a concrete-lined leachate lagoon.

Water in the leachate lagoon and contact water basin is used for ash conditioning and other applications within the CCR unit. Water collected in the contact water basin not used in CCR unit operations is either discharged to the adjacent surface water in accordance with IDNR NPDES General Permit Number 1 or evaporated as described in correspondence between IPL and IDNR provided in Appendix B. If needed, excess water in the leachate lagoon is pumped into a tanker truck and taken to the Ottumwa Generating Station (OGS) Main Ash Pond. Wastewater from the OGS Main Ash Pond discharges through an outfall regulated by an NPDES permit. Per 257.81(b), this is consistent with the surface water requirements under 40 CFR 257.3-3.

Run-off from areas of the existing CCR units with intermediate or future final cover will be diverted into perimeter drainage swales, which drain to sedimentation basins. Intermediate swales/berms, downslope flumes, and energy dissipators on the proposed final cover help minimize erosion of the cover and divert water to the perimeter drainage system, and ultimately to the sedimentation basins. At the time of this update, no active disposal areas are present in the OML Existing Landfill, and intermediate cover is in place across the unit.

In addition to these controls, a rain cover has been installed to limit contact water production in Phase 1. Storm water collected on the rain cover is diverted to perimeter swales, and ultimately to a temporary sedimentation basin. The rain cover will be removed in sections to accommodate waste placement. As the rain cover is removed, new berms will be constructed to form the perimeter of a storm water containment area. The berms will prevent contact water from running onto the rain cover and will anchor or ballast the rain cover at the new limits.

Since the initial Run-on and Run-off Control Plan was prepared, additional rain cover was removed from Phase 1 in late-2018. Storm water calculations supporting the rain cover removal and new

diversion berms are provided in **Appendix A**. Additional rain cover removal completed in 2020/2021 has further increased the portion of Phase 1 that drains to the contact water basin, which is addressed in previously provided permit amendment calculations also provided in **Appendix A**.

2.1 DESIGN CRITERIA

The storm water features described above are designed to handle run-on and run-off from a 25-year, 24-hour storm event, as required by 40 CFR 257.81(a)(1) and (2). The precipitation depth of the 25-year, 24-hour storm event was assumed to be 5.67 inches, based on Technical Paper-40 (TP-40) precipitation data published in May 1961. The sedimentation basin outlet structures are designed to safely pass run-off from a 100-year, 24-hour storm event.

Rain cover diversion berms were similarly sized as required by 40 CFR 257.81(a)(1). The precipitation depth of the 25-year, 24-hour storm event was assumed to be 5.51 inches, using the location of the landfill and National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Point Precipitation Frequency Estimates Data Server, Volume 8, Version 2.

2.2 DESIGN WITH CALCULATIONS

Storm water management and contact water management design calculations (as described above) from the IDNR approved permit amendment and subsequent rain cover removal activities are contained in **Appendix A**. As described in **Section 2.1**, the calculations show that the run-on and run-off control systems will control the water volume resulting from a 25-year, 24-hour storm. The calculations were performed, or overseen by, a professional engineer licensed in the State of Iowa.

Currently available design storm event data from NOAA Atlas 14, Volume 8, Version 2 and the design calculations described above were reviewed at the time of this update. Current design storm event data does not substantially affect the results of design calculations provided in **Appendix A**.

2.3 CONSTRUCTION

Initial storm water management features for the OML Existing Landfill and OML Expansion Phase 1 were constructed to site specifications with construction oversight directed by a professional engineer licensed in the State of Iowa. Construction documentation reports for the storm water management features were prepared, submitted to the IDNR, and approved by the IDNR.

Rain cover removal and related temporary/intermediate storm water management features are constructed by IPL based on design and permit documents prepared for the facility. These activities do not require oversight or documentation.

3.0 CERTIFICATIONS

40 CFR 257.81(c)(5). "*The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.*"

Eric Nelson, PE, a licensed profession engineer in the State of Iowa, has overseen the preparation of this Run-on and Run-off Control Plan Update. A certification statement is provided on **page iii** of this plan.

4.0 RECORDKEEPING AND PERIOD UPDATES

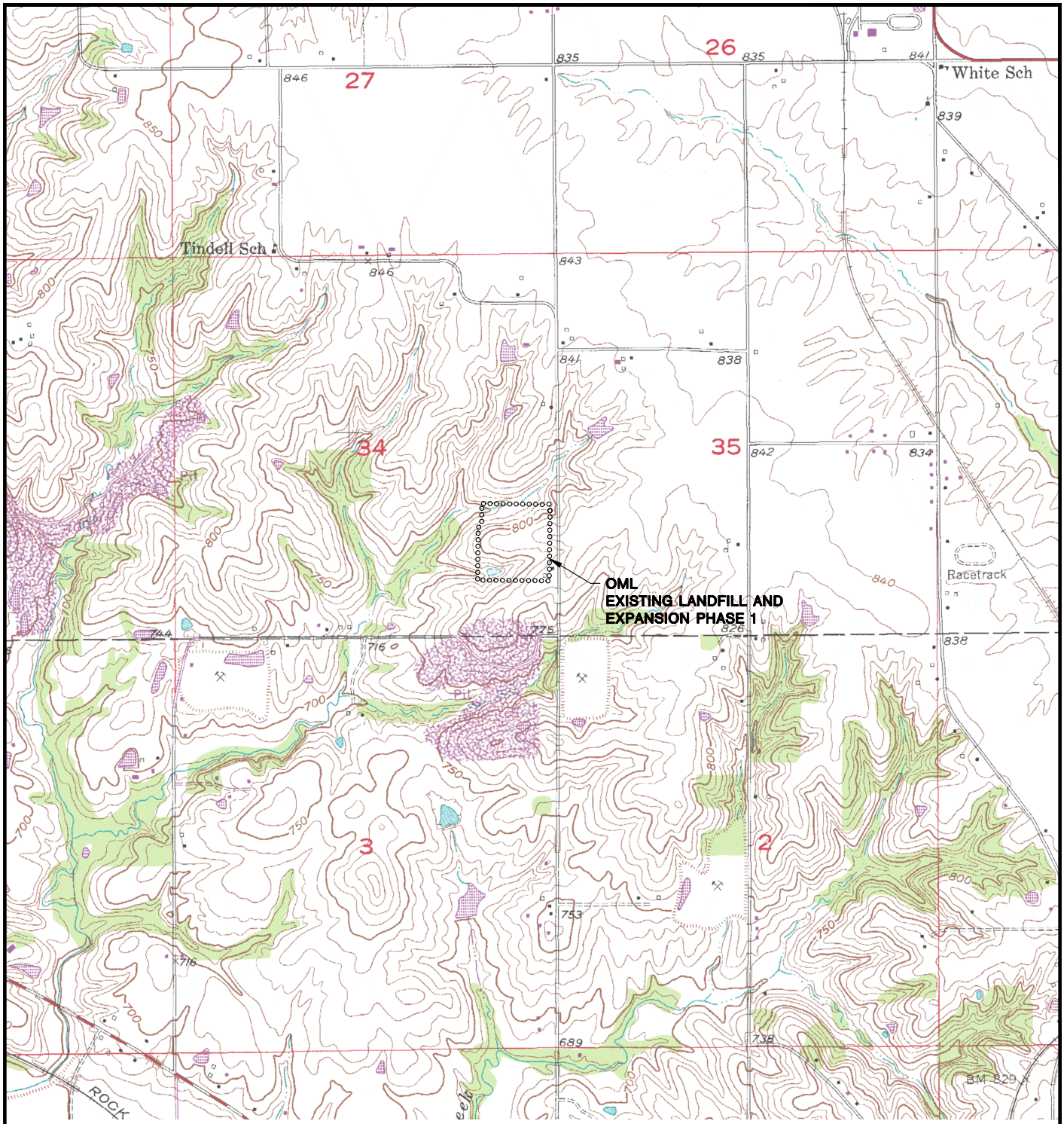
40 CFR 257.81(d). *"The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in section 257.105(g), the notification requirements specified in section 257.106(g), and the internet requirements specified in section 257.107(g)"*

This Run-On and Run-Off Control Plan Update, and all additional periodic plans, will be placed in the facility's operating record and on Alliant Energy's CCR Rule Compliance Data and Information website, as will all amendments. Periodic plans will be completed every 5 years per 40 CFR 257.81(c)(4).

Notification will be provided to the State Director (Iowa Department of Natural Resources Land Quality Bureau Environmental Program Supervisor) when this Run-On and Run-Off Control Plan Update, and all subsequent updates, are available in the facility's operating record and on the facility's website per 40 CFR 257.105(g), 257.106(g), and 257.107(g).

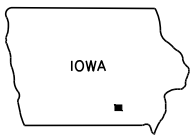
Figures

1 Site Location Map
2 Run-On and Run-Off Control Plan



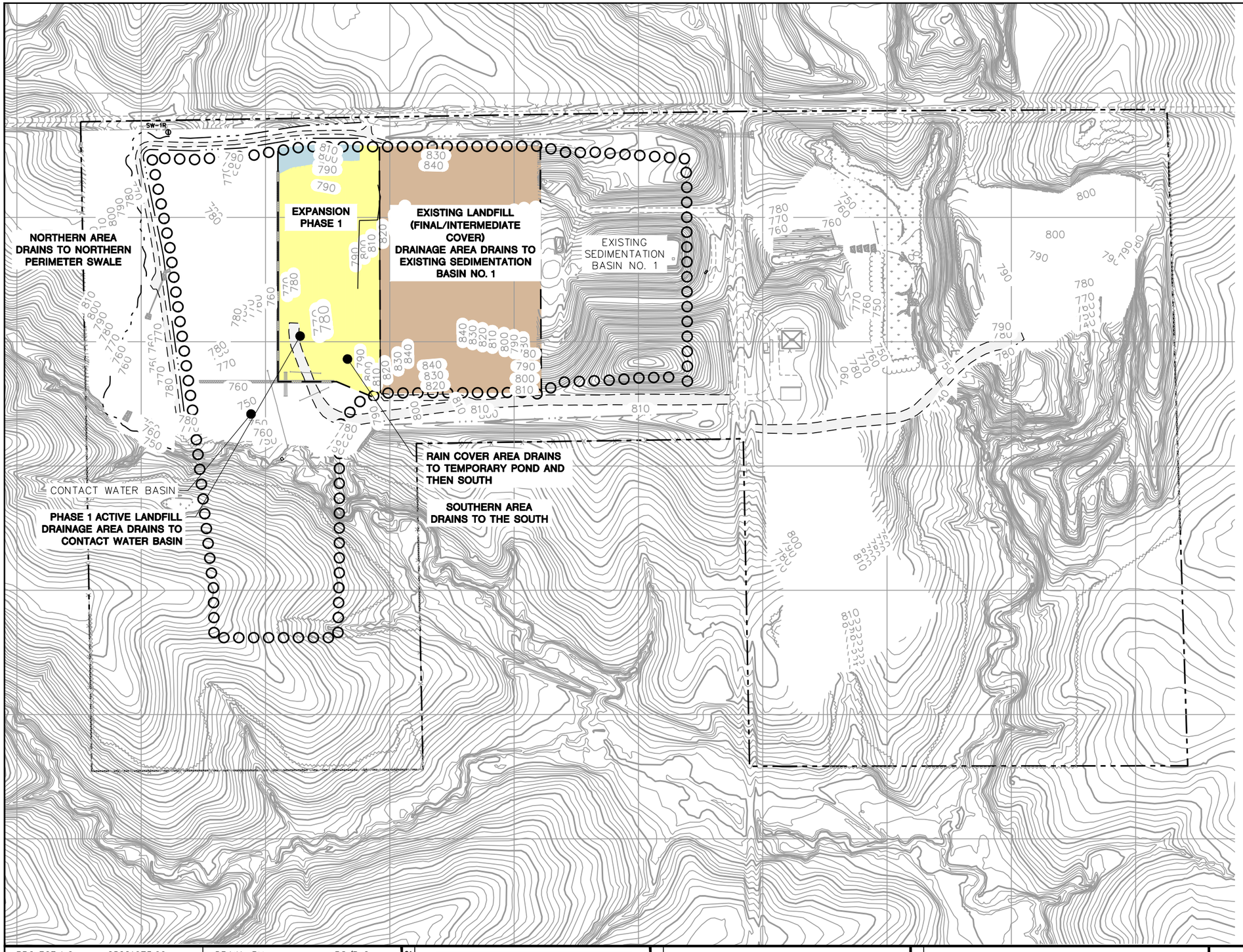
OTTUMWA NORTH QUADRANGLE
IOWA–WAPELLO CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
SW/4 OTTUMWA NORTH 15' QUADRANGLE
1976
SCALE: 1" = 2,000'

N



CLIENT	INTERSTATE POWER AND LIGHT CO. 15300 130th STREET OTTUMWA, IA 52501	SITE	RUN–ON AND RUN–OFF CONTROL PLAN OTTUMWA MIDLAND LANDFILL OTTUMWA, IOWA
			SITE LOCATION MAP

PROJECT NO.	25221073.00	DRAWN BY:	KP/RJG	ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830
DRAWN:	09/15/11	CHECKED BY:	BP/PG		FIGURE 1
REVISED:	07/16/21	APPROVED BY:	EJN 9/15/21		



LEGEND

- PROPERTY LINE
- LIMITS OF WASTE
- PHASE LIMITS
- TREE/SHRUB LINE
- 770 EXISTING GROUND SURFACE (10' CONTOUR)
- EXISTING GROUND SURFACE (2' CONTOUR)
- FENCE
- WETLAND
- STREAM FLOW LINE
- DITCH FLOW LINE
- GRAVEL LIMITS
- EXISTING CULVERT
- ACTIVE LANDFILL DRAINAGE AREA
- RAIN COVER DRAINAGE AREA
- INTERMEDIATE/FINAL COVER AREA

NOTES:

1. TOPOGRAPHIC BASE MAP WAS COMPILED FROM IOWA DEPARTMENT OF NATURAL RESOURCES GENERALIZED TWO FOOT CONTOURS OF WAPELLO COUNTY IOWA DERIVED FROM LIDAR DATA. THE LIDAR DATA WAS ACQUIRED IN THE SPRING OF 2008. THE CONTOUR DATA WAS FIELD VERIFIED BY GLOBAL POSITIONING SURVEY (GPS) IN THE SPRING OF 2012. LIDAR DATA SUPPLEMENTED WITH NOVEMBER 2015 CONSTRUCTION DOCUMENTATION SURVEY BY SCS ENGINEERS AND MAY 2017, DECEMBER 2019, AND JUNE 2021 SURVEY BY FRENCH-RENEKER ASSOCIATES, INC.

N

400 0 400

SCALE: 1" = 400'

PROJECT NO.	25221073.00	DRAWN BY:	BS/RJG
DRAWN:	12/09/13	CHECKED BY:	BP/PG
REVISED:	08/30/21	APPROVED BY:	EJN 9/15/21

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT: INTERSTATE POWER AND LIGHT COMPANY
OTTUMWA MIDLAND LANDFILL
15300 130TH STREET
OTTUMWA, IOWA 52501

SITE: RUN-ON AND RUN-OFF CONTROL PLAN
OTTUMWA MIDLAND LANDFILL
OTTUMWA, IOWA

RUN-ON AND RUN-OFF CONTROL PLAN

FIGURE 2

Appendix A

Drainage Design Calculations

Storm Water Management Calculations – Phase 1 Diversion Berm Sizing

Purpose:
The purpose of the Phase 1 diversion berm sizing calculation is to demonstrate that the proposed rain cover diversion berm is properly sized to accommodate peak discharge from a 25-year, 24-hour storm event. Also check performance of the berm during a 100-year, 24-hour storm event.

Approach:
Hydrograph Generation
To properly size the diversion berm, runoff hydrographs for the 25- and 100-year, 24-hour storm events were developed. HydroCAD was used to generate the hydrographs using TR-20 methodologies. The model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for the design storm event, contributing drainage areas, runoff curve numbers, time of concentration, and travel time.

The contributing drainage area is shown on **Figure 1**.

Diversion Berm Sizing
The diversion berm was sized to create a ditch for the 25-year, 24-hour storm event using the Manning's equation to determine the depth of flow and velocity in the ditch based on the ditch/berm geometry and peak flow rate in the ditch (as determined by the Hydrograph Generation calculations).

Key Assumptions/Information:
- The runoff curve number for the drainage area was assumed to be 98 for a geomembrane-lined area.
- An MSE-4 rainfall distribution was used. The following precipitation depths were used as determined from the NOAA Atlas 14 Point Precipitation Frequency Estimates Data Server:

Storm Event	Precipitation Depth (inches)
2-year, 24-hour	3.12
25-year, 24-hour	5.51
100-year, 24-hour	7.16

- Other assumptions are included with the calculations attached to this appendix.

Results:
The peak flow resulting from the storm events modeled are:
- 32.5 cfs for a 25-year, 24-hour storm
- 42.3 cfs for a 100-year, 24-hour storm

The following berm configurations can be considered:

Berm Slope	Depth of Flow Along Berm		Minimum Berm Height
	25-year	100-year	
1% slope	1.1 ft	1.2 ft	1.5 ft
2% slope	0.9 ft	1.0 ft	1.5 ft

FIGURE 1

PHASE 1 STORM WATER DIVERSION BERM SIZING

SITE

OTTUMWA, WAPELLO COUNTY, IOWA
OTTUMWA SANITARY LANDFILL

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE, MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT

INTERSTATE POWER AND LIGHT COMPANY
OTTUMWA SANITARY LANDFILL
15300 HWY 63
OTTUMWA, IOWA 52501

PROJECT NO.	25218413.00
DRAWN:	DMH
REVISED:	9/14/18
	9/17/18

DRAWN BY:	JMO
CHECKED BY:	
APPROVED BY:	

SCALE: 1" = 50'

N

EXISTING LANDFILL

KEB LANE

PHI AREA TO DIVERSION BERM
AREA = 4.084 ACRES

86T CHANNEL FLOW = 20%

LIMITS OF BOTTOM ASH PAD

PHASE 1

APPROXIMATE TEMPORARY RAIN COVER EXTENTS

1% SHALLOW CONC. FLOW = 33.3%

100' SHEET FLOW = 33.3%

TEMPORARY SEDIMENTATION BASIN NO. 6

TEMPORARY STORMWATER CULVERT
N. INV. ELEV. = 76690
S. INV. ELEV. = 76606

CAPPED

CULVERT NO. 6-1

TEMPORARY CONTACT WATER BASIN 1/2

PHASE 3

FUTURE PHASE 2

CULVERTS 1-1 AND 1-2

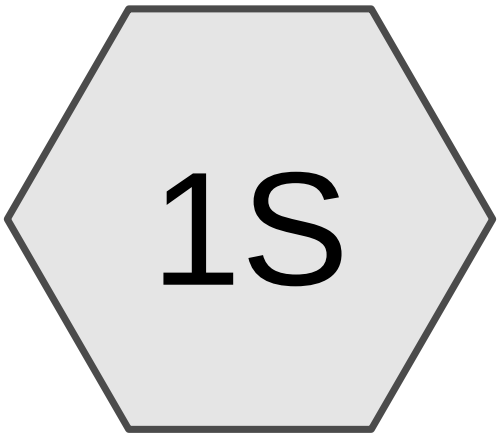
SEDIMENTATION BASIN NO. 2

LEGEND

- APPROXIMATE PROPERTY LINE
- LIMITS OF WASTE
- PHASE LIMITS
- EXISTING GROUND SURFACE (10' CONTOUR)
- EXISTING GROUND SURFACE (2' CONTOUR)
- DESIGN GRADE (10' CONTOUR)
- DESIGN GRADE (2' CONTOUR)
- AS-BUILT GRADE (10' CONTOUR)
- AS-BUILT GRADE (2' CONTOUR)
- LIMITS OF 2' CLAY LINER
- EXISTING DITCH
- EXISTING STREAM
- EXISTING CULVERT
- SLOPE AND DIRECTION
- PERIMETER DITCH
- REALIGNED STREAM
- ACCESS ROAD
- CONCRETE BARRIER
- CULVERT
- UNDERDRAIN GRAVITY TRANSFER PIPE
- PHASE DELINEATION BERM
- LIMITS OF CONTACT WATER BASIN LINER
- EXISTING LEACHATE CLEANOUT
- 6" DIA. PERFORATED LEACHATE COLLECTION PIPE
- 6" DIA. NON-PERFORATED LEACHATE RISER PIPE
- 6" DIA. LEACHATE FORCEMAIN
- 6" DIA. LEACHATE FORCEMAIN, ELECTRIC AND INSTRUMENT CONDUITS
- LEACHATE CLEANOUT RISER
- GRADE TABLE POINT
- LEACHATE HEADWELL
- LEACHATE VAULT
- ELECTRIC VAULT
- ELECTRIC AND INSTRUMENT CONDUITS
- STAFF GAUGE
- 6' HIGH CHAIN LINK FENCE
- RIPRAP
- FEATURE ABANDONED
- TEMPORARY RAIN COVER
- DRAINAGE AREA BOUNDARY
- TIME-OF-CONCENTRATION FLOWPATH

Hydrograph Generation

- 25-year, 24-hour Storm Event
- 100-year, 24-hour Storm Event



Ph1 Area to Diversion Berm

Subcat Reach Pond Link

Routing Diagram for OML Ph1 Diversion Berm Sizing_180914
Prepared by {enter your company name here}, Printed 9/21/2018

Summary for Subcatchment 1S: Ph1 Area to Diversion Berm

[49] Hint: Tc<2dt may require smaller dt

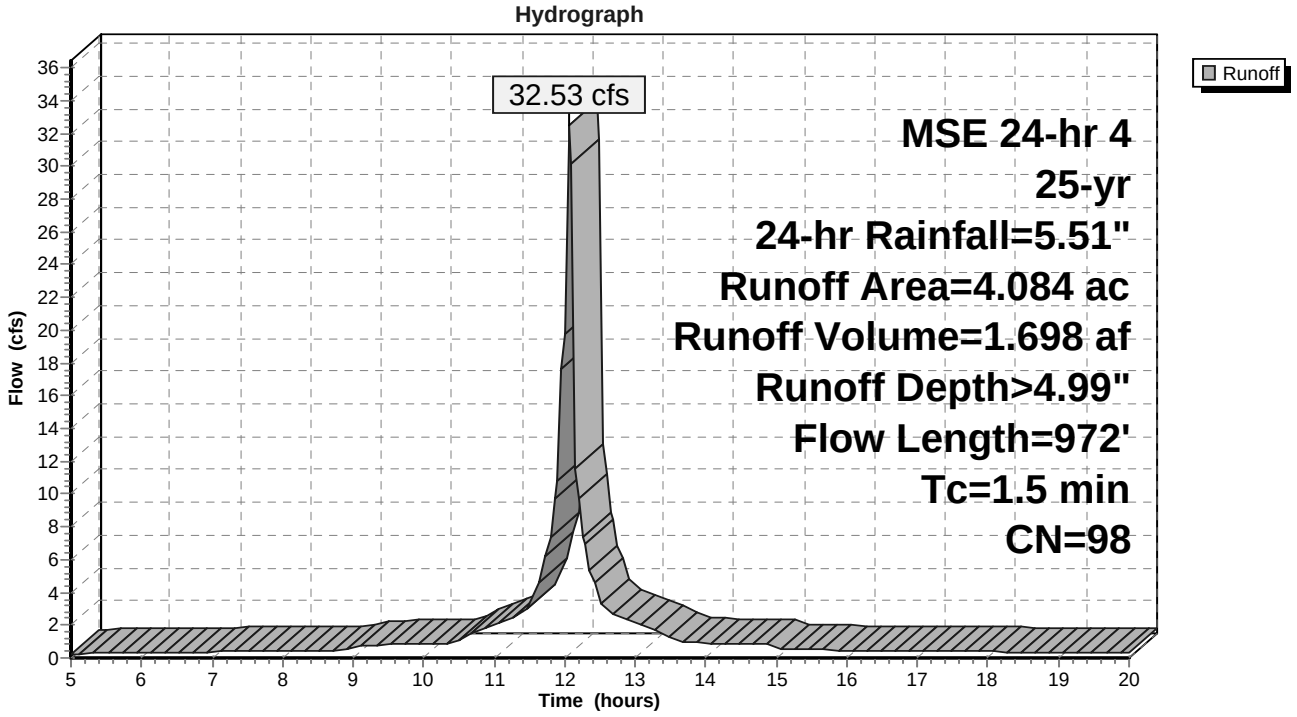
Runoff = 32.53 cfs @ 12.07 hrs, Volume= 1.698 af, Depth> 4.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 25-yr, 24-hr Rainfall=5.51"

	Area (ac)	CN	Description
*	4.084	98	
	4.084		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3333	4.19		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.12"
0.0	11	0.3333	11.72		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	861	0.0200	12.58	31.45	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 3.0 & 2.0 '/' Top.W=5.00' n= 0.010 PVC, smooth interior
1.5	972	Total			

Subcatchment 1S: Ph1 Area to Diversion Berm



Summary for Subcatchment 1S: Ph1 Area to Diversion Berm

[49] Hint: Tc<2dt may require smaller dt

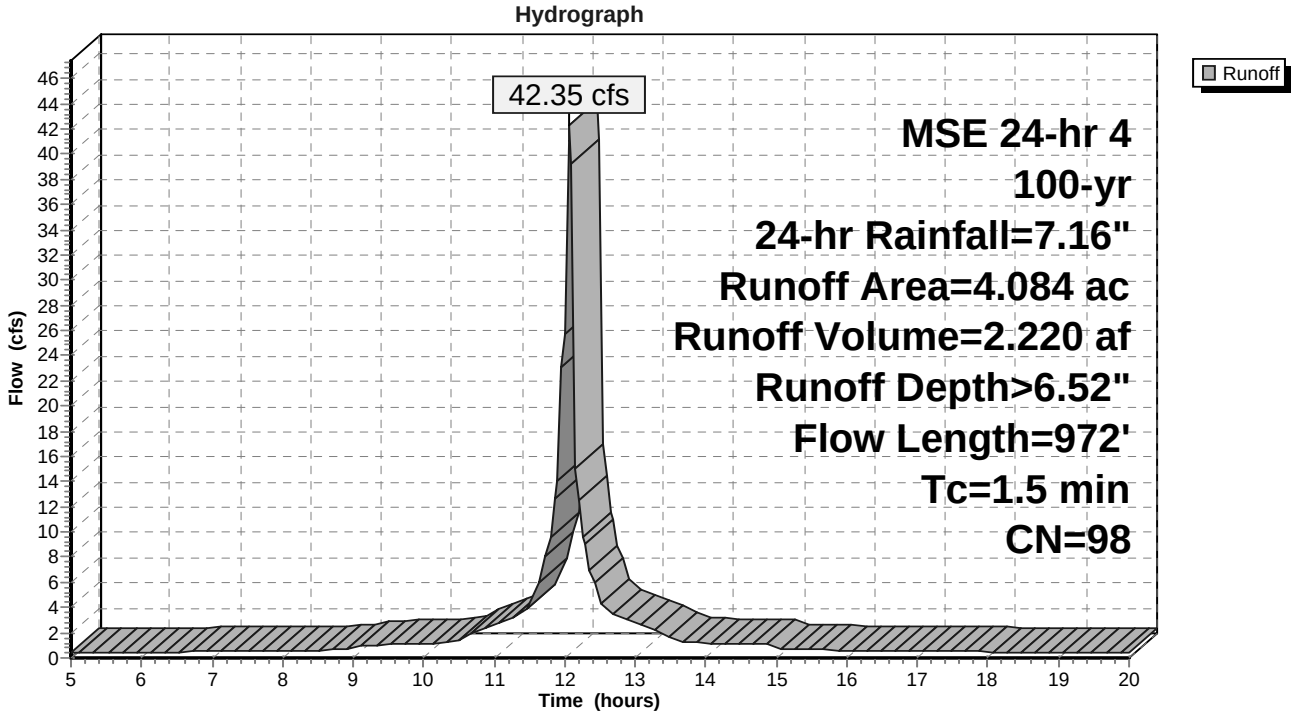
Runoff = 42.35 cfs @ 12.07 hrs, Volume= 2.220 af, Depth> 6.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
MSE 24-hr 4 100-yr, 24-hr Rainfall=7.16"

	Area (ac)	CN	Description
*	4.084	98	
	4.084		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.3333	4.19		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.12"
0.0	11	0.3333	11.72		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	861	0.0200	12.58	31.45	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 3.0 & 2.0 '/' Top.W=5.00' n= 0.010 PVC, smooth interior
1.5	972	Total			

Subcatchment 1S: Ph1 Area to Diversion Berm



Diversion Berm Sizing
(Manning's Calculation)

SCS ENGINEERS

		Sheet No.	
		Calc. No.	
		Rev. No.	
Job No. 25218143.00	Job: OML Rain Flap/Diversion Berm	By: JMO	Date: 9/21/18
Client: IPL	Subject: Diversion Berm Sizing	Chk'd BLP	Date 9/26/18

Phase 1 Diversion Berm Sizing

Use Manning's equation to determine flow depth in the perimeter ditch

Manning's Equation: $Q = (1.49/n) \times A \times R^{(2/3)} \times S^{(1/2)}$

where: Q = Flow rate, cfs (from HydroCAD model for 25-yr and 100-yr, 24-hour storms)

n = Manning's roughness coefficient (assumed 0.10 for smooth geomembrane)

A = Flow area, sf (based on v-noth ditch with 3:1 sideslopes)

R = Hydraulic radius, ft (= A/P, with A and P from ditch dimensions)

S = Channel slope, ft/ft (assumed at 2%)

Vary the flow depth input value below until the flow rate estimated by HydroCAD is achieved.

25-yr, 24-hr storm event, Q = 32.53 cfs, 2% berm slope

Inputs for Trapezoidal Channel		**Calculations/Output**	
Bottom width, b =	0 ft	Cross-sectional area, A =	2.7 sf
Depth of flow, y =	0.94 ft	Wetted perimeter, P =	5.9 ft
Channel side slope, H/V =	3 :1	Hydraulic radius, R =	0.4 ft
Manning's roughness, n =	0.01	Discharge, Q =	32.60 cfs
Channel bottom slope, s =	0.02 ft/ft	Average velocity, V =	12.30 ft/s

From above, depth of flow in ditch is approximately 0.94 ft < 2 ft, so okay

100-yr, 24-hr storm event, Q = 42.34 cfs, 2% berm slope

Inputs for Trapezoidal Channel		**Calculations/Output**	
Bottom width, b =	0 ft	Cross-sectional area, A =	3.2 sf
Depth of flow, y =	1.04 ft	Wetted perimeter, P =	6.6 ft
Channel side slope, H/V =	3 :1	Hydraulic radius, R =	0.5 ft
Manning's roughness, n =	0.01	Discharge, Q =	42.69 cfs
Channel bottom slope, s =	0.02 ft/ft	Average velocity, V =	13.16 ft/s

From above, depth of flow in ditch is approximately 1.04 ft < 2 ft, so okay

25-yr, 24-hr storm event, Q = 32.53 cfs, 1% berm slope

Inputs for Trapezoidal Channel		**Calculations/Output**	
Bottom width, b =	0 ft	Cross-sectional area, A =	3.4 sf
Depth of flow, y =	1.07 ft	Wetted perimeter, P =	6.8 ft
Channel side slope, H/V =	3 :1	Hydraulic radius, R =	0.5 ft
Manning's roughness, n =	0.01	Discharge, Q =	32.56 cfs
Channel bottom slope, s =	0.01 ft/ft	Average velocity, V =	9.48 ft/s

From above, depth of flow in ditch is approximately 1.07 ft < 2 ft, so okay

100-yr, 24-hr storm event, Q = 42.34 cfs, 1% berm slope

Inputs for Trapezoidal Channel		**Calculations/Output**	
Bottom width, b =	0 ft	Cross-sectional area, A =	4.2 sf
Depth of flow, y =	1.18 ft	Wetted perimeter, P =	7.5 ft
Channel side slope, H/V =	3 :1	Hydraulic radius, R =	0.6 ft
Manning's roughness, n =	0.01	Discharge, Q =	42.27 cfs
Channel bottom slope, s =	0.01 ft/ft	Average velocity, V =	10.12 ft/s

From above, depth of flow in ditch is approximately 1.18 ft < 2 ft, so okay

NOAA Atlas 14 Point Precipitation Frequency Estimates

NOAA Atlas 14, Volume 8, Version 2
Location name: Ottumwa, Iowa, USA*
Latitude: 41.0791°, Longitude: -92.4499°
Elevation: 792.79 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.384 (0.322-0.465)	0.445 (0.373-0.539)	0.551 (0.460-0.668)	0.645 (0.534-0.784)	0.782 (0.626-0.983)	0.895 (0.695-1.13)	1.01 (0.756-1.31)	1.14 (0.809-1.50)	1.31 (0.892-1.76)	1.45 (0.954-1.97)
10-min	0.563 (0.472-0.680)	0.652 (0.546-0.789)	0.807 (0.673-0.978)	0.944 (0.782-1.15)	1.15 (0.917-1.44)	1.31 (1.02-1.66)	1.48 (1.11-1.91)	1.67 (1.18-2.19)	1.93 (1.31-2.58)	2.13 (1.40-2.88)
15-min	0.686 (0.576-0.830)	0.795 (0.666-0.962)	0.984 (0.821-1.19)	1.15 (0.954-1.40)	1.40 (1.12-1.75)	1.60 (1.24-2.02)	1.81 (1.35-2.33)	2.03 (1.44-2.68)	2.35 (1.59-3.15)	2.60 (1.70-3.51)
30-min	0.955 (0.801-1.16)	1.11 (0.930-1.34)	1.38 (1.15-1.67)	1.62 (1.34-1.96)	1.96 (1.57-2.46)	2.24 (1.74-2.84)	2.54 (1.89-3.27)	2.86 (2.03-3.75)	3.29 (2.23-4.42)	3.64 (2.39-4.92)
60-min	1.22 (1.02-1.47)	1.44 (1.20-1.74)	1.81 (1.51-2.19)	2.13 (1.77-2.59)	2.61 (2.08-3.27)	2.99 (2.32-3.79)	3.40 (2.53-4.38)	3.82 (2.71-5.03)	4.42 (2.99-5.92)	4.89 (3.21-6.60)
2-hr	1.48 (1.25-1.78)	1.76 (1.49-2.11)	2.24 (1.88-2.69)	2.65 (2.21-3.19)	3.25 (2.62-4.05)	3.74 (2.93-4.69)	4.25 (3.20-5.43)	4.79 (3.44-6.24)	5.54 (3.80-7.36)	6.13 (4.08-8.20)
3-hr	1.65 (1.39-1.96)	1.96 (1.66-2.34)	2.51 (2.12-3.00)	2.99 (2.51-3.58)	3.68 (2.98-4.56)	4.25 (3.34-5.30)	4.83 (3.66-6.13)	5.45 (3.94-7.06)	6.31 (4.36-8.33)	6.99 (4.68-9.30)
6-hr	1.95 (1.66-2.30)	2.33 (1.98-2.75)	2.98 (2.53-3.52)	3.54 (2.99-4.21)	4.37 (3.57-5.36)	5.04 (4.01-6.24)	5.75 (4.40-7.23)	6.49 (4.75-8.33)	7.53 (5.28-9.85)	8.35 (5.67-11.0)
12-hr	2.31 (1.98-2.70)	2.71 (2.33-3.18)	3.42 (2.92-4.01)	4.04 (3.44-4.76)	4.96 (4.09-6.03)	5.71 (4.58-7.00)	6.50 (5.03-8.10)	7.34 (5.44-9.33)	8.52 (6.05-11.0)	9.46 (6.51-12.3)
24-hr	2.69 (2.33-3.12)	3.12 (2.70-3.63)	3.87 (3.34-4.51)	4.54 (3.89-5.29)	5.51 (4.59-6.64)	6.31 (5.12-7.66)	7.16 (5.60-8.84)	8.06 (6.04-10.1)	9.32 (6.70-11.9)	10.3 (7.21-13.3)
2-day	3.10 (2.70-3.57)	3.57 (3.11-4.11)	4.39 (3.81-5.06)	5.10 (4.40-5.89)	6.13 (5.14-7.29)	6.96 (5.69-8.35)	7.83 (6.19-9.56)	8.75 (6.63-10.9)	10.0 (7.31-12.7)	11.0 (7.82-14.1)
3-day	3.38 (2.96-3.87)	3.88 (3.39-4.44)	4.73 (4.13-5.43)	5.47 (4.74-6.29)	6.53 (5.50-7.72)	7.38 (6.07-8.79)	8.26 (6.57-10.0)	9.19 (7.01-11.3)	10.5 (7.68-13.2)	11.5 (8.19-14.5)
4-day	3.63 (3.19-4.13)	4.14 (3.64-4.72)	5.02 (4.39-5.73)	5.77 (5.02-6.61)	6.85 (5.78-8.05)	7.71 (6.36-9.14)	8.60 (6.87-10.4)	9.53 (7.31-11.7)	10.8 (7.98-13.5)	11.8 (8.49-14.9)
7-day	4.32 (3.82-4.89)	4.86 (4.29-5.51)	5.78 (5.08-6.55)	6.56 (5.74-7.46)	7.68 (6.53-8.94)	8.56 (7.12-10.1)	9.48 (7.63-11.3)	10.4 (8.07-12.7)	11.7 (8.75-14.5)	12.7 (9.26-15.9)
10-day	4.96 (4.40-5.58)	5.55 (4.92-6.25)	6.53 (5.77-7.37)	7.36 (6.47-8.34)	8.54 (7.29-9.89)	9.47 (7.91-11.1)	10.4 (8.43-12.4)	11.4 (8.88-13.8)	12.7 (9.57-15.7)	13.8 (10.1-17.1)
20-day	6.81 (6.09-7.60)	7.61 (6.79-8.49)	8.90 (7.92-9.95)	9.97 (8.83-11.2)	11.4 (9.82-13.0)	12.5 (10.6-14.5)	13.7 (11.2-16.0)	14.8 (11.6-17.6)	16.2 (12.4-19.8)	17.3 (12.9-21.4)
30-day	8.36 (7.51-9.28)	9.36 (8.39-10.4)	10.9 (9.79-12.2)	12.2 (10.9-13.6)	13.9 (12.0-15.8)	15.2 (12.9-17.4)	16.5 (13.5-19.1)	17.7 (14.0-20.9)	19.2 (14.7-23.2)	20.4 (15.3-24.9)
45-day	10.3 (9.32-11.4)	11.6 (10.4-12.8)	13.5 (12.2-15.0)	15.1 (13.5-16.7)	17.1 (14.8-19.2)	18.6 (15.8-21.0)	19.9 (16.4-23.0)	21.2 (16.9-24.9)	22.9 (17.6-27.3)	24.0 (18.2-29.2)
60-day	12.0 (10.9-13.2)	13.5 (12.2-14.8)	15.7 (14.2-17.3)	17.5 (15.7-19.3)	19.7 (17.1-22.0)	21.3 (18.2-24.1)	22.8 (18.9-26.1)	24.2 (19.4-28.2)	25.8 (20.0-30.7)	26.9 (20.5-32.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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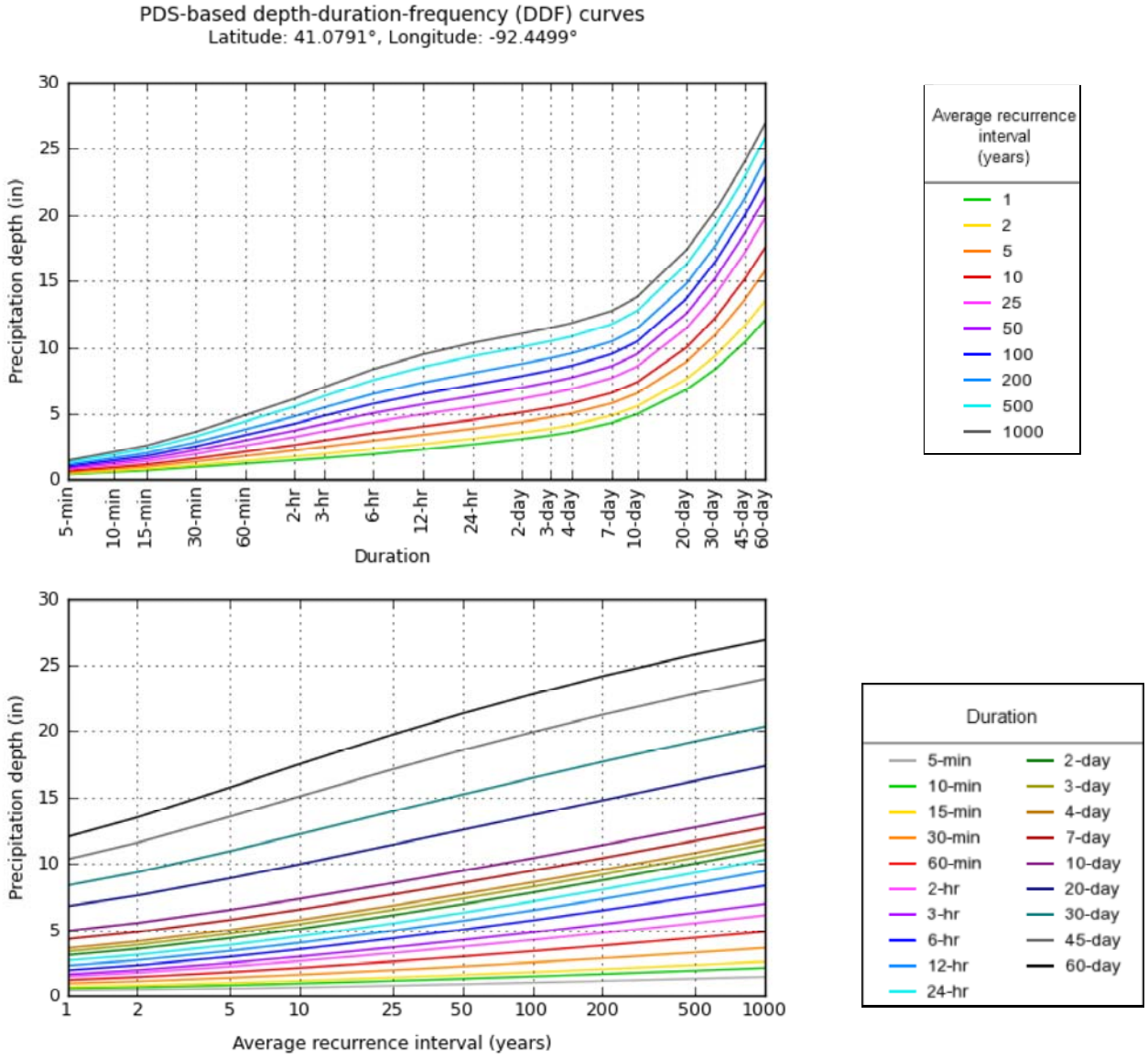
PF graphical



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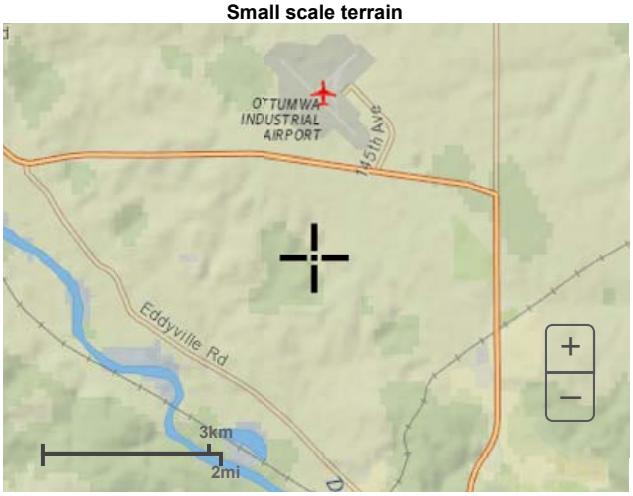
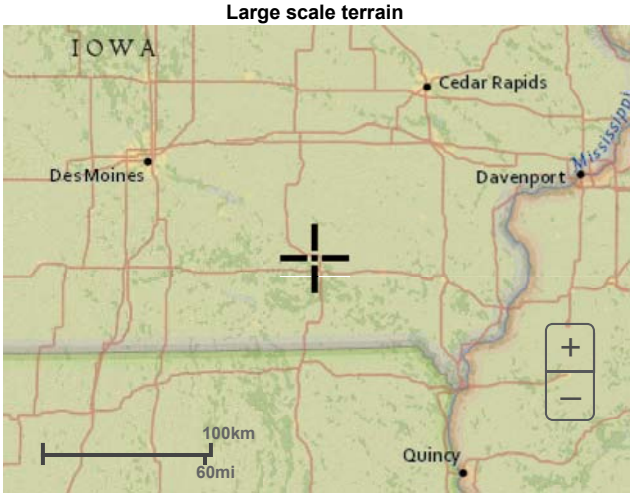
Maps & aerials

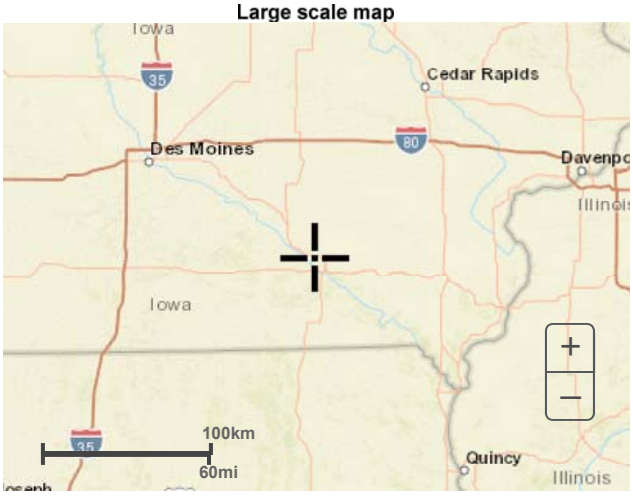
Small scale terrain



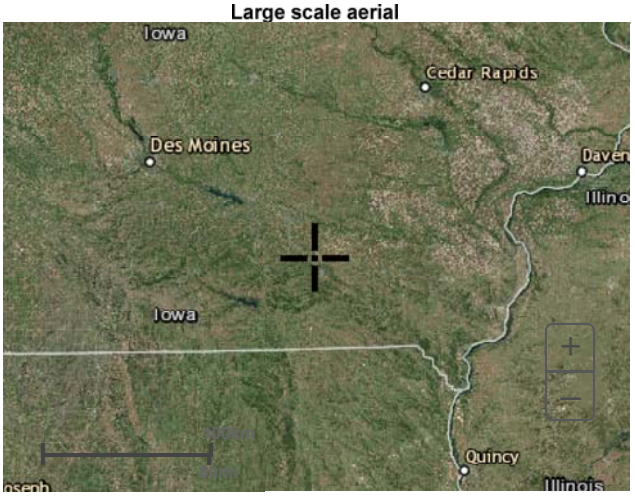
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Contact Water Management Calculations

Purpose:
To estimate the amount of contact water runoff during each phase of development and accordingly size the following contact water management features:

- Temporary contact water basins
- Temporary contact water basin culverts
- Perimeter contact water diversion berms to route the contact water runoff to the contact water basins

Approach:
Hydrograph Generation
To properly size the contact water management features, runoff hydrographs for the 25-year, 24-hour storm event were developed. HydroCAD was used to model the storm water management system and develop the hydrographs using TR-20 methodologies. The model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for the design storm event, contributing drainage areas, runoff curve numbers, time of concentration, and travel time.

Figures H-1 through H-6 show the drainage areas modeled for each phase of development.

Contact Water Basin Sizing
The contact water basins were sized for the 25-year, 24-hour storm event by routing the runoff hydrographs through the ponds using HydroCAD. HydroCAD utilizes the hydrographs (as determined by the Hydrograph Generation calculations) along with the input pond capacity to determine the peak water elevation in the pond.

Contact water will be stored in the ponds for CCR conditioning/dust suppression. To ensure that the contact water basins are operated properly, charts were developed to show the relationship between remaining capacities of the basins based on current water level and additional rainfall in inches. The charts are attached to this calculation and are also presented in the Operations Manual.

Contact Water Basin Culvert Sizing
The culverts routing contact water runoff from the active phase to the contact water basin were sized for the 25-year, 24-hour storm event using the HY-8 computer model developed by the US Department of Transportation, Federal Highway Administration.

Contact Water Perimeter and Interior Diversion Berm/Swale Sizing
The perimeter and interior swales were sized for the 25-year, 24-hour storm event using Manning's equation to determine the depth of flow and velocity in the swale based on the

swale geometry and peak flow in the swale (as determined by the Hydrograph Generation calculations).

Key Assumptions:

- The runoff curve number for in-place ash was assumed to be 98, which is representative of paved areas.
- The precipitation depth for a 25-year, 24-hour storm event was assumed to be 5.67 inches, based on Bulletin 71, Rainfall Frequency Atlas of the Midwest (1992).
- The contact water basin volumes were computed based on top of leachate drainage layer and contact basin stone (i.e., no storage volume provided within these layers).
- Other assumptions are included with the attached calculations.

Results:

The proposed contact water management features are adequately sized to manage the contact water runoff resulting from a 25-year, 24-hour storm event during each phase of development, as further described below. Refer to the calculations section of this attachment for the detailed input and output.

Contact Water Basin Sizing

The temporary contact water basins will be lined to the elevations shown on the Expansion Permit Amendment design drawings. The liner limits shown provide a minimum 0.5 foot of freeboard for the runoff from a 25-year, 24-hour storm event.

Contact Water Basin Culvert Sizing

The temporary contact water basin culverts are adequately sized to route contact water runoff from the active phase area to the temporary contact water basin for a 25-year, 24-hour storm event without overtopping the phase delineation berm. The culvert sizes, lengths and inverts are as shown on the Expansion Permit Amendment design drawings.

Contact Water Perimeter and Interior Diversion Berm/Swale Sizing

The perimeter and interior contact water diversion berms are adequately sized to route contact water runoff resulting from a 25-year, 24-hour storm event without overtopping the berms. The perimeter contact water diversion berm design is as shown on the Expansion Permit Amendment design drawings.

LEGEND

CONTACT WATER BASIN DRAINAGE AREA = 13.9 ACRES

N

200 0 200

SCALE: 1" = 200'

PROJECT NO.	25211509.03	DRAWN BY:	BJM
DRAWN:	10/25/13	CHECKED BY:	BP
REVISED:	10/25/13	APPROVED BY:	BP 11/27/13

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OTTUMWA, IOWA 52501

SITE

PERMIT AMAENDMENT PLANS
NORTH & SOUTH EXPANSION
OTTUMWA MIDLAND LANDFILL
OTTUMWA, IOWA

PHASE 1 CONTACT WATER BASIN DRAINAGE AREA

FIGURE
H-1

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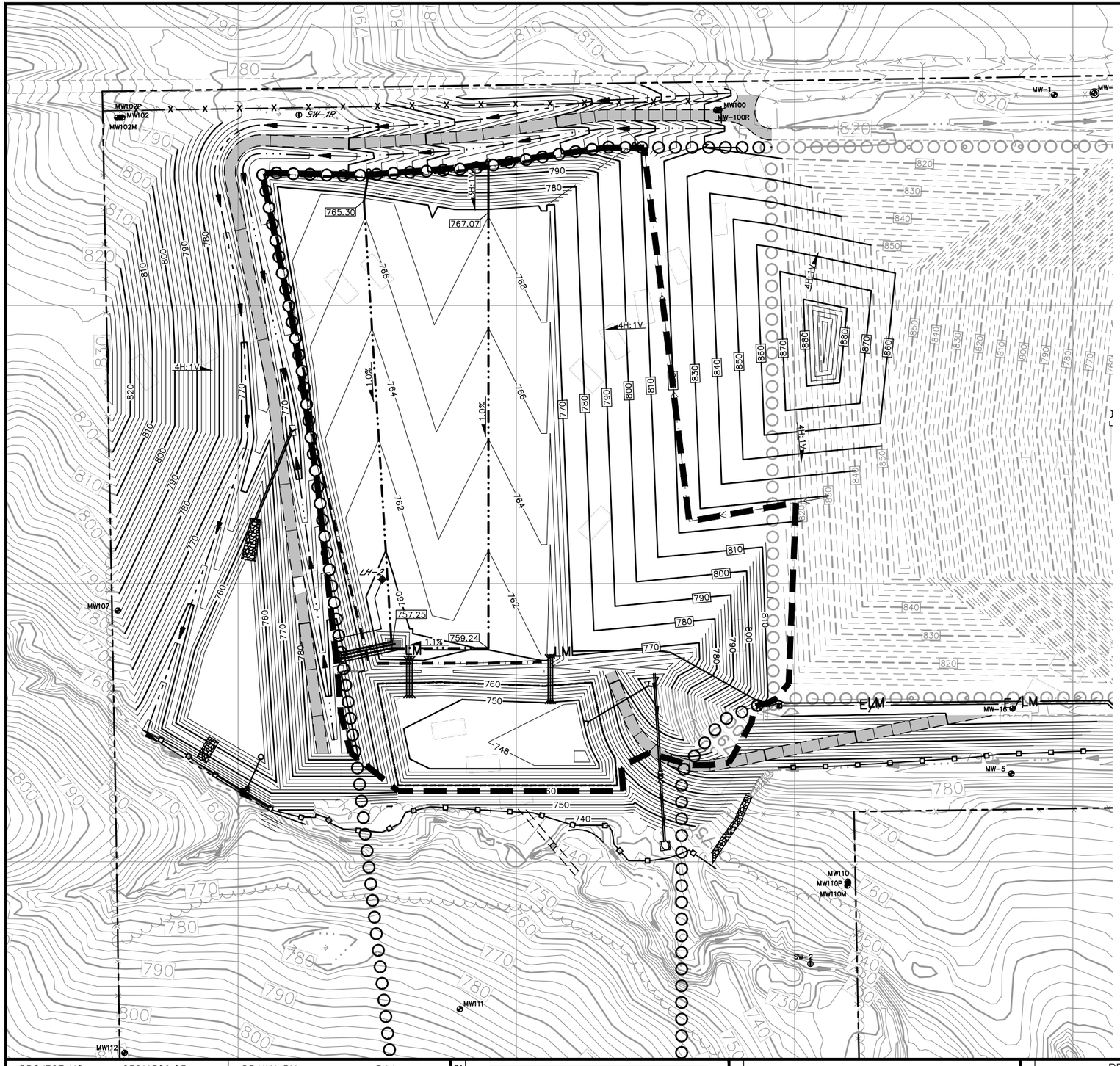

LEGEND

CONTACT WATER BASIN DRAINAGE AREA = 18.4 ACRES

N

200 0 200

SCALE: 1" = 200'

PROJECT NO.	25211509.03	DRAWN BY:	BJM
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REVISED:	10/25/13	APPROVED BY:	BP 11/27/13

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PHASE 2 CONTACT WATER BASIN DRAINAGE AREA

FIGURE
H-2

I:\25211509\Drawings-General\25211509.03\100%-Final\Phase 2 Prep.dwg, 11/27/2013 11:19:36 AM

LEGEND

CONTACT WATER BASIN DRAINAGE AREA = 12.2 ACRES

200 0 200

SCALE: 1" = 200'

PROJECT NO.	25211509.03	DRAWN BY:	BJM
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PHASE 3 CONTACT WATER BASIN DRAINAGE AREA

FIGURE H-3

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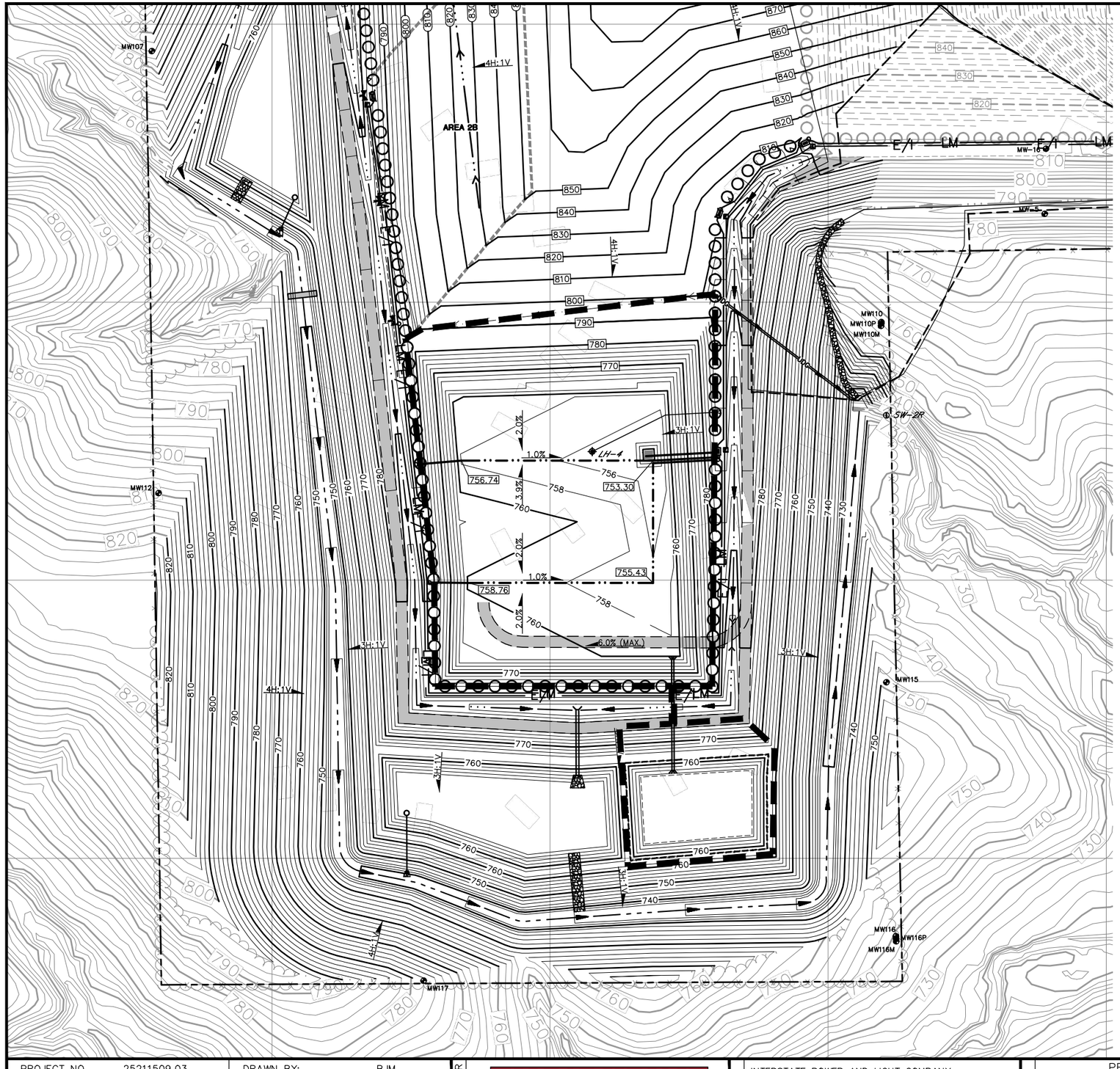

LEGEND

CONTACT WATER BASIN DRAINAGE AREA = 9.6 ACRES

N

200 0 200

SCALE: 1" = 200'

PROJECT NO.	25211509.03	DRAWN BY:	BJM
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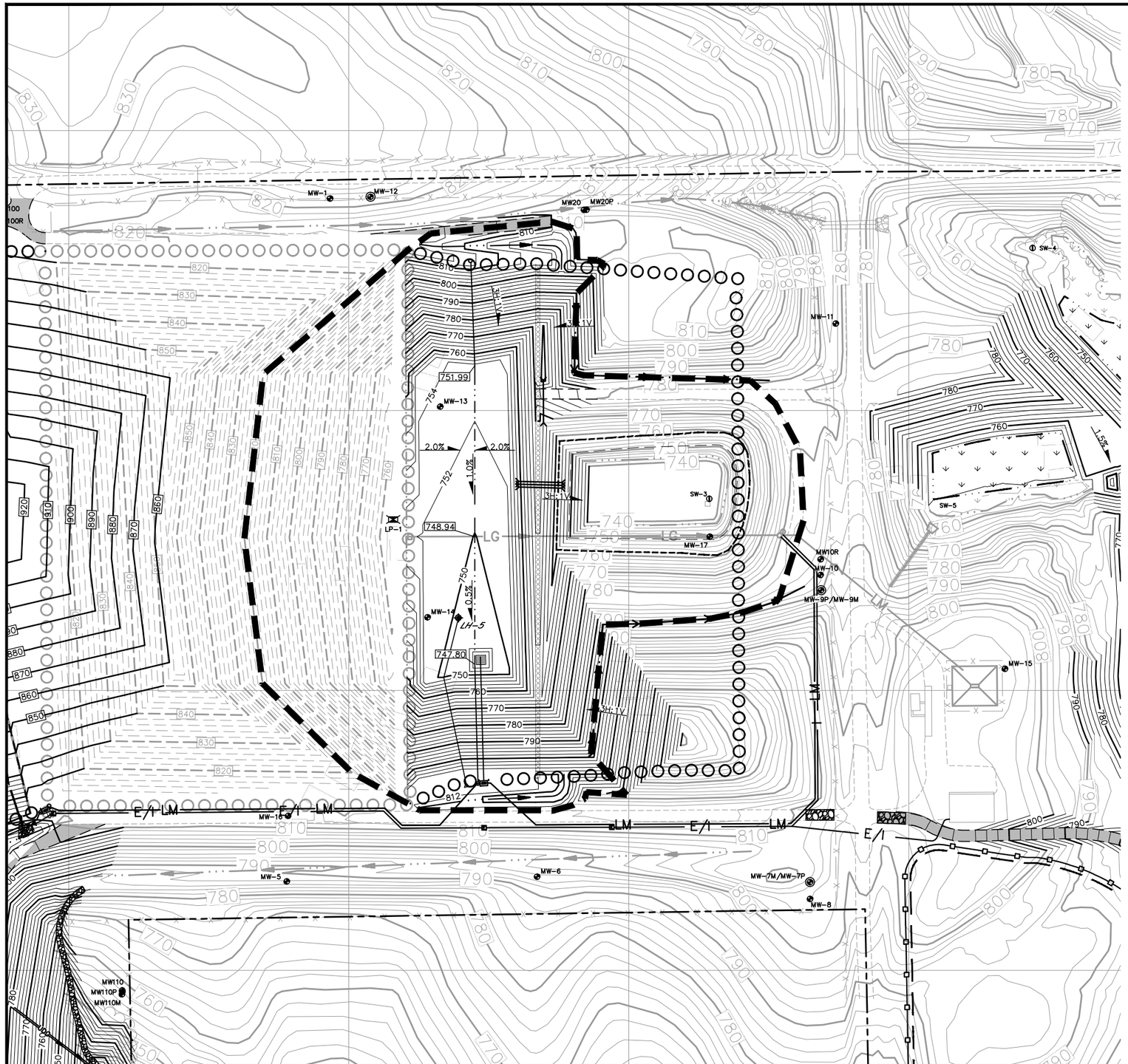
PHASE 4 CONTACT WATER BASIN DRAINAGE AREA

FIGURE H-4

I:\25211509\Drawings-General\25211509.03\100%-Final\Phase 4 Prep.dwg, 11/27/2013 11:15:47 AM

LEGEND

CONTACT WATER BASIN DRAINAGE AREA = 16.1 ACRES



N

200 0 200

SCALE: 1" = 200'

PROJECT NO.	25211509.03	DRAWN BY:	BJM
DRAWN:	10/25/13	CHECKED BY:	BP
REVISED:	11/21/13	APPROVED BY:	BP 11/27/13

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PHASE 5 CONTACT WATER BASIN DRAINAGE AREA

FIGURE H-5

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LEGEND

CONTACT WATER BASIN DRAINAGE AREA = 15.6 ACRES

200 0 200

SCALE: 1" = 200'

PROJECT NO.	25211509.03	DRAWN BY:	BJM
DRAWN:	10/25/13	CHECKED BY:	BP
REVISED:	11/21/13	APPROVED BY:	BP 11/27/13

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PHASE 6 CONTACT WATER BASIN DRAINAGE AREA

FIGURE H-6

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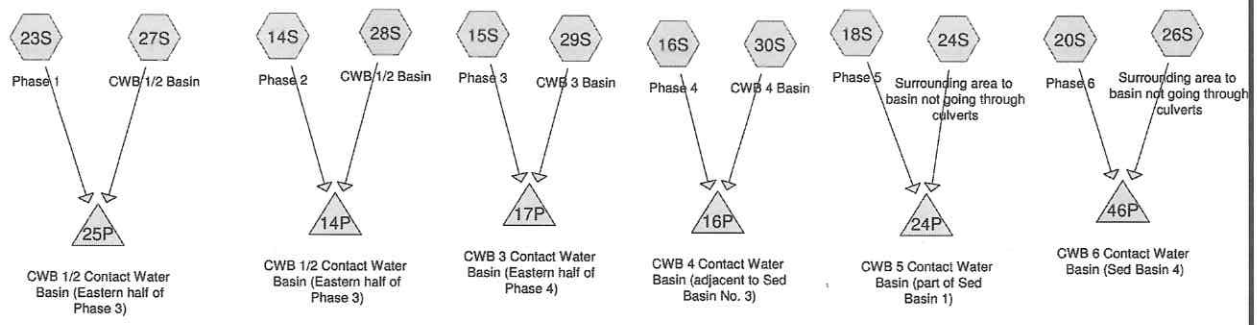
Contact Water Basin Sizing



Subcat Reach Pond Link

Drainage Diagram for Contact Water Runoff Calcs and Basin Sizing_131126
Prepared by SCS Engineers, Printed 11/26/2013
HydroCAD® 8.50 s/n 005804 © 2007 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.120	74	>75% Grass cover, Good, HSG C (24S,26S)
71.066	98	Ash (14S,15S,16S,18S,20S,23S)
5.900	98	Basin (27S,28S,29S,30S)
1.500	98	Basin area (26S)
1.200	98	basin area (24S)
85.786		**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Goup	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
6.120	HSG C	24S, 26S
0.000	HSG D	
79.666	Other	14S, 15S, 16S, 18S, 20S, 23S, 24S, 26S, 27S, 28S, 29S, 30S
85.786		**TOTAL AREA**

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 14S: Phase 2	Runoff Area=16.814 ac 100.00% Impervious Runoff Depth=5.43" Tc=3.0 min CN=98 Runoff=144.54 cfs 7.611 af
Subcatchment 15S: Phase 3	Runoff Area=10.452 ac 100.00% Impervious Runoff Depth=5.43" Tc=3.0 min CN=98 Runoff=89.85 cfs 4.731 af
Subcatchment 16S: Phase 4	Runoff Area=8.600 ac 100.00% Impervious Runoff Depth=5.43" Tc=3.0 min CN=98 Runoff=73.93 cfs 3.893 af
Subcatchment 18S: Phase 5	Runoff Area=10.400 ac 100.00% Impervious Runoff Depth=5.43" Tc=3.0 min CN=98 Runoff=89.40 cfs 4.708 af
Subcatchment 20S: Phase 6	Runoff Area=12.500 ac 100.00% Impervious Runoff Depth=5.43" Tc=3.0 min CN=98 Runoff=107.45 cfs 5.659 af
Subcatchment 23S: Phase 1	Runoff Area=12.300 ac 100.00% Impervious Runoff Depth=5.43" Tc=0.0 min CN=98 Runoff=111.67 cfs 5.568 af
Subcatchment 24S: Surrounding area to	Runoff Area=5.710 ac 21.02% Impervious Runoff Depth=3.39" Tc=3.0 min CN=79 Runoff=36.60 cfs 1.611 af
Subcatchment 26S: Surrounding area to	Runoff Area=3.110 ac 48.23% Impervious Runoff Depth=4.10" Tc=3.0 min CN=86 Runoff=23.17 cfs 1.062 af
Subcatchment 27S: CWB 1/2 Basin	Runoff Area=1.600 ac 100.00% Impervious Runoff Depth=5.43" Tc=0.0 min CN=98 Runoff=14.53 cfs 0.724 af
Subcatchment 28S: CWB 1/2 Basin	Runoff Area=1.600 ac 100.00% Impervious Runoff Depth=5.43" Tc=3.0 min CN=98 Runoff=13.75 cfs 0.724 af
Subcatchment 29S: CWB 3 Basin	Runoff Area=1.700 ac 100.00% Impervious Runoff Depth=5.43" Tc=3.0 min CN=98 Runoff=14.61 cfs 0.770 af
Subcatchment 30S: CWB 4 Basin	Runoff Area=1.000 ac 100.00% Impervious Runoff Depth=5.43" Tc=3.0 min CN=98 Runoff=8.60 cfs 0.453 af
Pond 14P: CWB 1/2 Contact Water Basin	Peak Elev=757.27' Storage=8.336 af Inflow=158.29 cfs 8.336 af Outflow=0.00 cfs 0.000 af
Pond 16P: CWB 4 Contact Water Basin	Peak Elev=760.34' Storage=4.346 af Inflow=82.52 cfs 4.346 af Outflow=0.00 cfs 0.000 af
Pond 17P: CWB 3 Contact Water Basin	Peak Elev=759.62' Storage=5.501 af Inflow=104.46 cfs 5.501 af Outflow=0.00 cfs 0.000 af
Pond 24P: CWB 5 Contact Water Basin	Peak Elev=756.27' Storage=6.319 af Inflow=125.94 cfs 6.319 af Outflow=0.00 cfs 0.000 af

Pond 25P: CWB 1/2 Contact Water Basin Peak Elev=755.69' Storage=6.292 af Inflow=126.19 cfs 6.292 af
Outflow=0.00 cfs 0.000 af

Pond 46P: CWB 6 Contact Water Basin Peak Elev=757.75' Storage=6.720 af Inflow=130.62 cfs 6.720 af
Outflow=0.00 cfs 0.000 af

Total Runoff Area = 85.786 ac Runoff Volume = 37.515 af Average Runoff Depth = 5.25"
7.13% Pervious = 6.120 ac 92.87% Impervious = 79.666 ac

Summary for Subcatchment 14S: Phase 2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 144.54 cfs @ 11.93 hrs, Volume= 7.611 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	16.814	98	Ash
	16.814		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment 15S: Phase 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 89.85 cfs @ 11.93 hrs, Volume= 4.731 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	10.452	98	Ash
	10.452		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment 16S: Phase 4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 73.93 cfs @ 11.93 hrs, Volume= 3.893 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	8.600	98	Ash
	8.600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment 18S: Phase 5

Area = 9.83 (phase areas to basin)

[49] Hint: Tc<2dt may require smaller dt

Runoff = 89.40 cfs @ 11.93 hrs, Volume= 4.708 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	10.400	98	Ash
	10.400		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment 20S: Phase 6

[49] Hint: Tc<2dt may require smaller dt

Runoff = 107.45 cfs @ 11.93 hrs, Volume= 5.659 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	12.500	98	Ash
	12.500		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment 23S: Phase 1

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 111.67 cfs @ 11.89 hrs, Volume= 5.568 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	12.300	98	Ash
	12.300		Impervious Area

Summary for Subcatchment 24S: Surrounding area to basin not going through culverts

Area = 9.83 (phase areas to basin)

[49] Hint: Tc<2dt may require smaller dt

Runoff = 36.60 cfs @ 11.94 hrs, Volume= 1.611 af, Depth= 3.39"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
	4.510	74	>75% Grass cover, Good, HSG C
*	1.200	98	basin area
	5.710	79	Weighted Average
	4.510		Pervious Area
	1.200		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment 26S: Surrounding area to basin not going through culverts

[49] Hint: Tc<2dt may require smaller dt

Runoff = 23.17 cfs @ 11.93 hrs, Volume= 1.062 af, Depth= 4.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
	1.610	74	>75% Grass cover, Good, HSG C
*	1.500	98	Basin area
	3.110	86	Weighted Average
	1.610		Pervious Area
	1.500		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment 27S: CWB 1/2 Basin

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.53 cfs @ 11.89 hrs, Volume= 0.724 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	1.600	98	Basin
	1.600		Impervious Area

Summary for Subcatchment 28S: CWB 1/2 Basin

[49] Hint: Tc<2dt may require smaller dt

Runoff = 13.75 cfs @ 11.93 hrs, Volume= 0.724 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	1.600	98	Basin
	1.600		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment 29S: CWB 3 Basin

[49] Hint: Tc<2dt may require smaller dt

Runoff = 14.61 cfs @ 11.93 hrs, Volume= 0.770 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	1.700	98	Basin
	1.700		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Subcatchment 30S: CWB 4 Basin

[49] Hint: Tc<2dt may require smaller dt

Runoff = 8.60 cfs @ 11.93 hrs, Volume= 0.453 af, Depth= 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year, 24-hour Rainfall=5.67"

	Area (ac)	CN	Description
*	1.000	98	Basin
	1.000		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.0					**Direct Entry,**

Summary for Pond 14P: CWB 1/2 Contact Water Basin (Eastern half of Phase 3)

Inflow Area = 18.414 ac,100.00% Impervious, Inflow Depth = 5.43" for 25-year, 24-hour event
Inflow = 158.29 cfs @ 11.93 hrs, Volume= 8.336 af < 10.83 af ✓
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 757.27' @ 24.20 hrs Surf.Area= 1.354 ac Storage= 8.336 af

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	748.00'	12.317 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
748.00	0.063	0.000	0.000
750.00	0.569	0.632	0.632
752.00	0.986	1.555	2.187
754.00	1.122	2.108	4.295
756.00	1.262	2.384	6.679
758.00	1.408	2.670	9.349
760.00	1.560	2.968	12.317

← Top of Pond = 759.0 = 10.83af w/ 1' freeboard

Summary for Pond 16P: CWB 4 Contact Water Basin (adjacent to Sed Basin No. 3)

Inflow Area = 9.600 ac,100.00% Impervious, Inflow Depth = 5.43" for 25-year, 24-hour event
Inflow = 82.52 cfs @ 11.93 hrs, Volume= 4.346 af < 4.95 af ✓
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Peak Elev= 760.34' @ 24.20 hrs Surf.Area= 0.849 ac Storage= 4.346 af

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	754.00'	5.830 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
754.00	0.540	0.000	0.000
755.00	0.580	0.560	0.560
756.00	0.630	0.605	1.165
757.00	0.670	0.650	1.815
758.00	0.720	0.695	2.510
760.00	0.830	1.550	4.060 ← Top of Basin w/ 1' Freeboard = 761.0 = 4.95 af
762.00	0.940	1.770	5.830

Summary for Pond 17P: CWB 3 Contact Water Basin (Eastern half of Phase 4)

Inflow Area = 12.152 ac,100.00% Impervious, Inflow Depth = 5.43" for 25-year, 24-hour event
Inflow = 104.46 cfs @ 11.93 hrs, Volume= 5.501 af < 6.13 af ✓
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 759.62' @ 24.20 hrs Surf.Area= 1.654 ac Storage= 5.501 af

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	754.00'	6.127 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
754.00	0.070	0.000	0.000
755.00	0.312	0.191	0.191
756.00	0.720	0.516	0.707
757.00	1.150	0.935	1.642
758.00	1.460	1.305	2.947
759.00	1.610	1.535	4.482
760.00	1.680	1.645	6.127 ← Top of Basin w/ 1' Freeboard

Summary for Pond 24P: CWB 5 Contact Water Basin (part of Sed Basin 1)

Inflow Area = 16.110 ac, 72.00% Impervious, Inflow Depth = 4.71" for 25-year, 24-hour event
Inflow = 125.94 cfs @ 11.93 hrs, Volume= 6.319 af < 7.38 af ✓
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Peak Elev= 756.27' @ 24.20 hrs Surf.Area= 1.381 ac Storage= 6.319 af

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	8.819 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
751.00	1.030	0.000	0.000
752.00	1.090	1.060	1.060
754.00	1.219	2.309	3.369
756.00	1.361	2.580	5.949
758.00	1.509	2.870	8.819

← Top of Basin w/ 1' Freeboard = 757.0 = 7.38af

Summary for Pond 25P: CWB 1/2 Contact Water Basin (Eastern half of Phase 3)

Inflow Area = 13.900 ac,100.00% Impervious, Inflow Depth = 5.43" for 25-year, 24-hour event
Inflow = 126.19 cfs @ 11.89 hrs, Volume= 6.292 af < 10.83af ✓
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 755.69' @ 24.05 hrs Surf.Area= 1.240 ac Storage= 6.292 af

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	748.00'	12.317 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
748.00	0.063	0.000	0.000
750.00	0.569	0.632	0.632
752.00	0.986	1.555	2.187
754.00	1.122	2.108	4.295
756.00	1.262	2.384	6.679
758.00	1.408	2.670	9.349
760.00	1.560	2.968	12.317

← Top of Basin w/ 1' Freeboard = 759.0 = 10.93

Summary for Pond 46P: CWB 6 Contact Water Basin (Sed Basin 4)

Sedimentation Basin No. 4 will be lined and serve as a temporary contact water basin.

Inflow Area = 15.610 ac, 89.69% Impervious, Inflow Depth = 5.17" for 25-year, 24-hour event
Inflow = 130.62 cfs @ 11.93 hrs, Volume= 6.720 af < 8.35af ✓
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs

Peak Elev= 757.75' @ 24.20 hrs Surf.Area= 1.227 ac Storage= 6.720 af

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

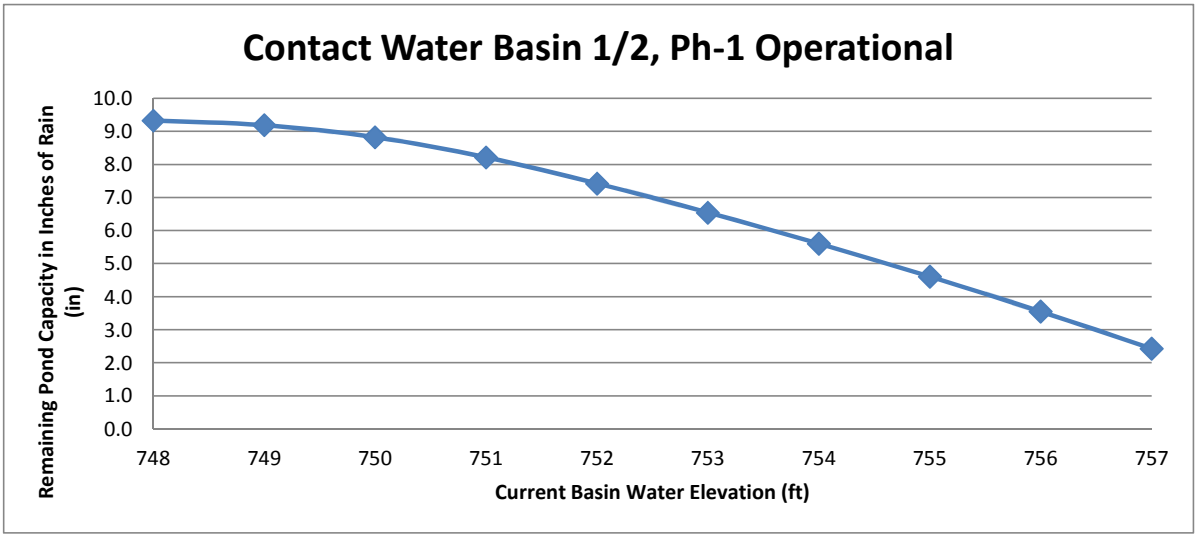
Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	9.673 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
751.00	0.779	0.000	0.000
752.00	0.840	0.810	0.810
754.00	0.967	1.807	2.617
756.00	1.102	2.069	4.686
758.00	1.245	2.347	7.033 ← Top of Basin w/ 1' Freeboard = 759.0 = 8.35 af
760.00	1.395	2.640	9.673

OML Expansion
Temporary Contact Water Basin 1/2, Phase 1 Operational

Starting Water Elevation in Basin	Starting Water Depth (ft)	Basin Storage Volume (cf)	Incremental Volume (cf)	Cumulative Rainfall to Reach Basin Water Elevation (in)	Remaining Pond Capacity in Inches of Rain (in)	Notes
748	0	0	N/A	0.00	9.33	Basin Bottom
749	1	7,084	7,084	0.14	9.19	
750	2	25,463	18,378	0.50	8.83	
751	3	56,131	30,668	1.11	8.22	
752	4	96,050	39,919	1.90	7.43	
753	5	140,507	44,457	2.78	6.55	
754	6	187,929	47,421	3.72	5.61	
755	7	238,317	50,388	4.72	4.61	
756	8	291,742	53,426	5.78	3.55	
757	9	348,277	56,535	6.90	2.43	
758	10	407,993	59,716	8.09	1.25	
759	11	470,963	62,970	9.33	0.00	Peak Elevation (1' Freeboard)
760	12	537,249	66,286	10.65	0.00	Top of Basin Liner

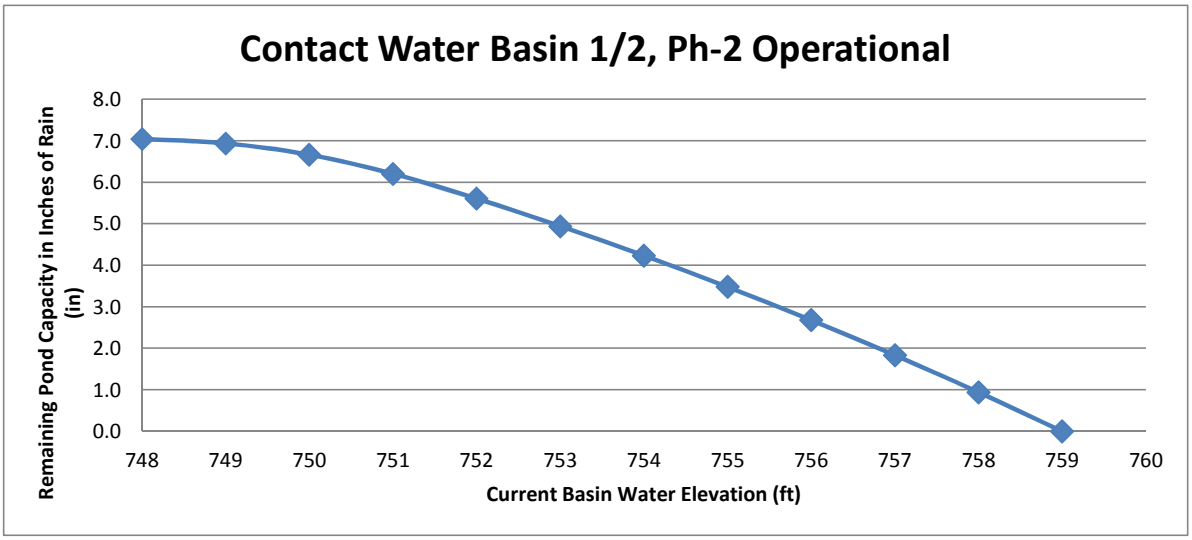
Notes:
1. Basin Volumes from AutoCAD Civil 3D surface.
2. Assumes drainage area to contact water basin = 605,524 sf, as shown on attached Figure H-1.



OML Expansion
Temporary Contact Water Basin 1/2, Phase 2 Operational

Starting Water Elevation in Basin	Starting Water Depth (ft)	Basin Storage Volume (cf)	Incremental Volume (cf)	Cumulative Rainfall to Reach Basin Water Elevation (in)	Remaining Pond Capacity in Inches of Rain (in)	Notes
748	0	0	N/A	0.00	7.05	Basin Bottom
749	1	7,084	7,084	0.11	6.94	
750	2	25,463	18,378	0.38	6.66	
751	3	56,131	30,668	0.84	6.21	
752	4	96,050	39,919	1.44	5.61	
753	5	140,507	44,457	2.10	4.94	
754	6	187,929	47,421	2.81	4.23	
755	7	238,317	50,388	3.57	3.48	
756	8	291,742	53,426	4.36	2.68	
757	9	348,277	56,535	5.21	1.84	
758	10	407,993	59,716	6.10	0.94	
759	11	470,963	62,970	7.05	0.00	Peak Elevation (1' Freeboard)
760	12	537,249	66,286	8.04	0.00	Top of Basin Liner

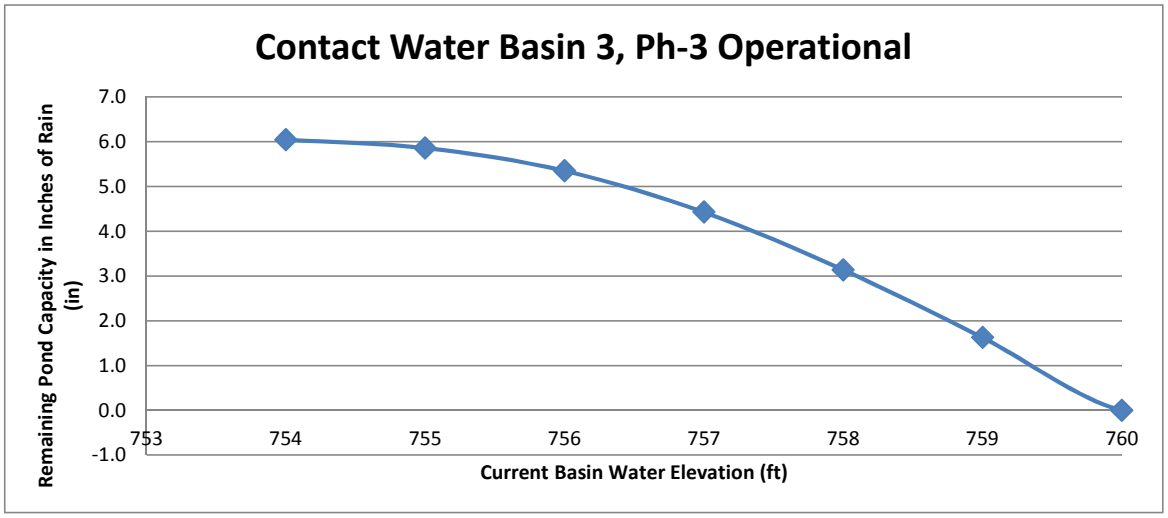
Notes:
1. Basin Volumes from AutoCAD Civil 3D surface.
2. Assumes drainage area to contact water basin = 802,117 sf, as shown on attached Figure H-2.



OML Expansion
Temporary Contact Water Basin 3, Phase 3 Operational

Starting Water Elevation in Basin	Starting Water Depth (ft)	Basin Storage Volume (cf)	Incremental Volume (cf)	Cumulative Rainfall to Reach Basin Water Elevation (in)	Remaining Pond Capacity in Inches of Rain (in)	Notes
754	0	0	N/A	0.00	6.05	Basin Bottom
755	1	8227.41	8227.41	0.19	5.86	
756	2	30703.75	22476.34	0.70	5.35	
757	3	71482.97	40779.22	1.62	4.43	
758	4	128279.82	56796.85	2.91	3.14	
759	5	194997.22	66717.4	4.42	1.63	
760	6	266705.27	71708.06	6.05	0.00	Peak Elevation (1' Freeboard)
761	7	341247.09	74541.81	7.74	0.00	Top of Basin Liner

Notes:
1. Basin Volumes from AutoCAD Civil 3D surface.
2. Assumes drainage area to contact water basin = 529,337 sf, as shown on attached Figure H-3.

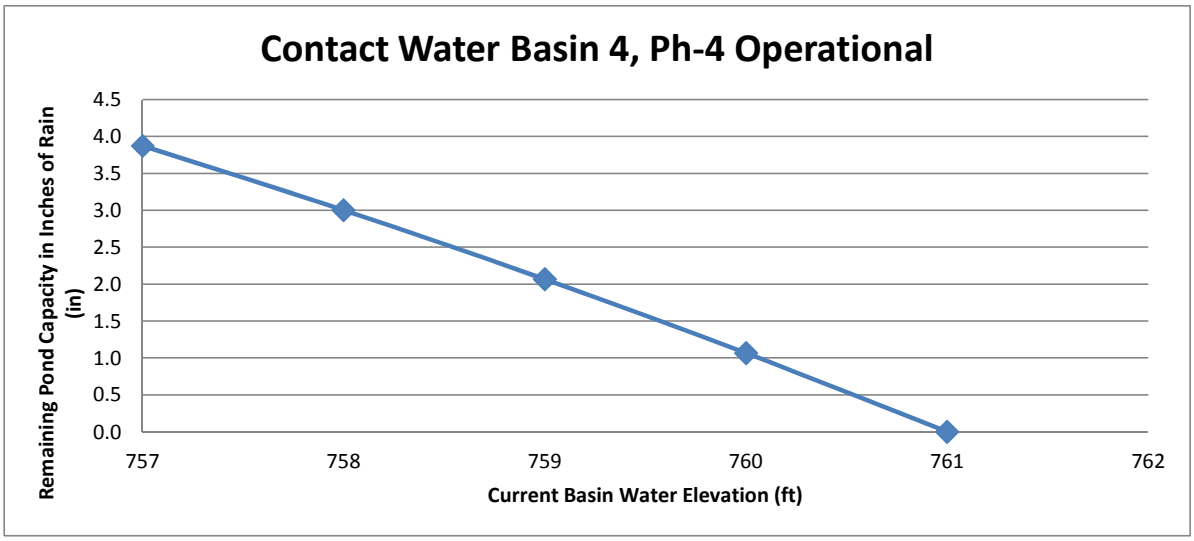


OML Expansion
Temporary Contact Water Basin 4, Phase 4 Operational

Starting Water Elevation in Basin	Starting Water Depth (ft)	Basin Storage Volume (cf)	Incremental Volume (cf)	Cumulative Rainfall to Reach Basin Water Elevation (in)	Remaining Pond Capacity in Inches of Rain (in)	Notes
754	0	-	N/A	0.00	6.14	Basin Bottom
755	1	24,281	24,281	0.70	5.44	
756	2	50,529	26,248	1.45	4.69	
757	3	78,818	28,289	2.26	3.88	
758	4	109,196	30,378	3.14	3.00	
759	5	141,760	32,564	4.07	2.07	
760	6	176,583	34,824	5.07	1.07	
761	7	213,739	37,156	6.14	0.00	Peak Elevation (1' Freeboard)
762	8	253,301	39,562	7.28	0.00	Top of Basin Liner

Notes:

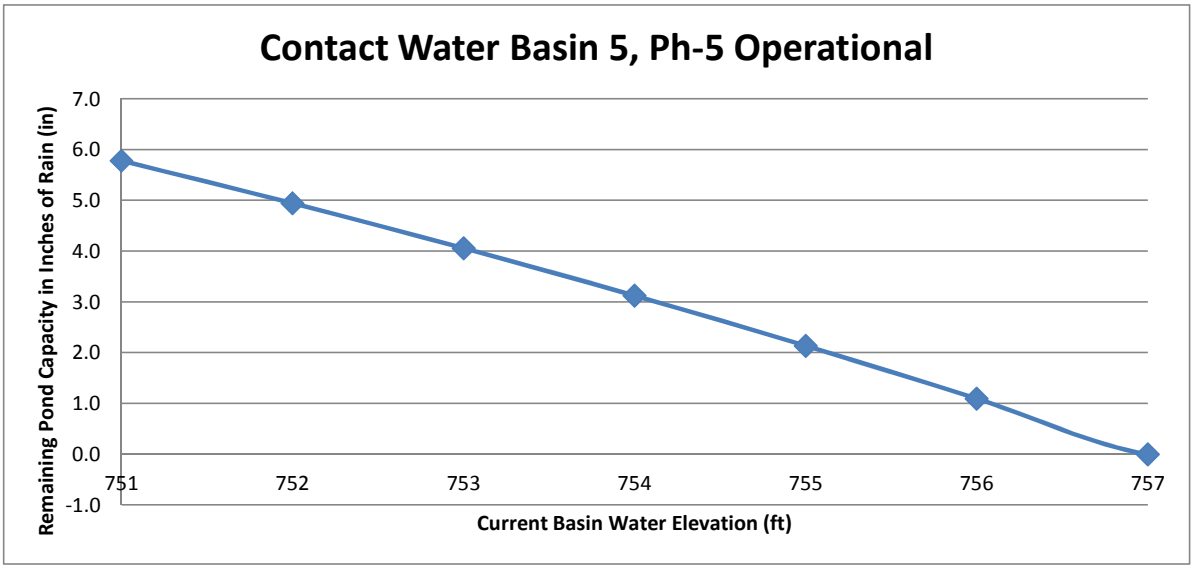
1. Basin Volumes from AutoCAD Civil 3D surface.
2. Assumes drainage area to contact water basin = 417,711 sf, as shown on attached Figure H-4.



OML Expansion
Temporary Contact Water Basin 5, Phase 5 Operational

Starting Water Elevation in Basin	Starting Water Depth (ft)	Basin Storage Volume (cf)	Incremental Volume (cf)	Cumulative Rainfall to Reach Basin Water Elevation (in)	Remaining Pond Capacity in Inches of Rain (in)	Notes
751	0	-	N/A	0.00	5.78	Basin Bottom
752	1	48,951	48,951	0.84	4.95	
753	2	100,775	51,824	1.72	4.06	
754	3	155,474	103,650	2.66	3.12	
755	4	213,192	109,542	3.65	2.14	
756	5	274,078	164,536	4.69	1.10	
757	6	338,203	173,667	5.78	0.00	Peak Elevation (1' Freeboard)
758	7	405,640	231,973	6.94	0.00	Top of Basin Liner

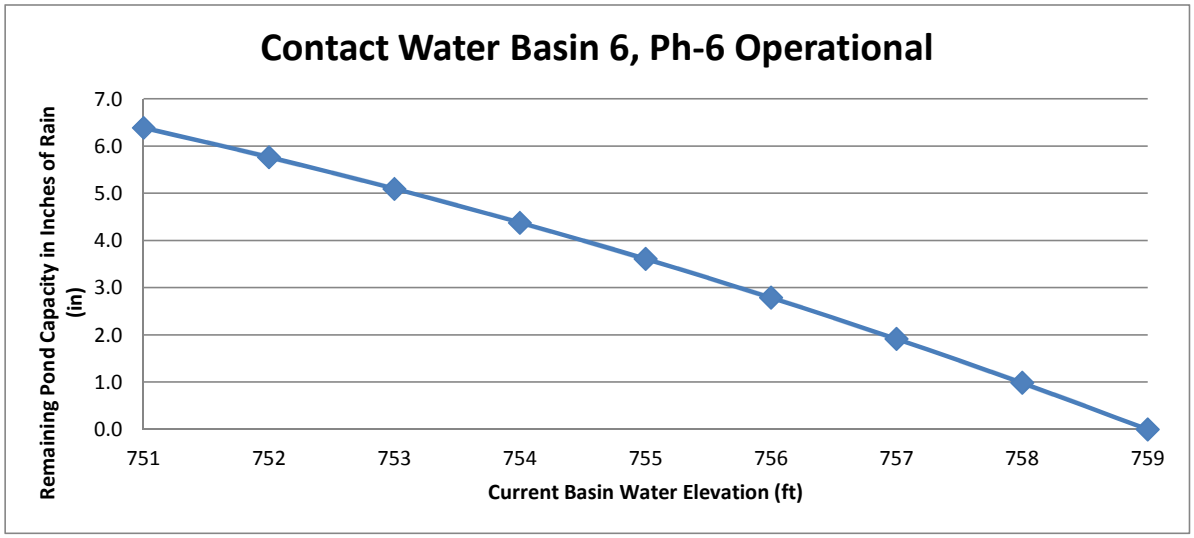
Notes:
1. Basin Volumes from AutoCAD Civil 3D surface.
2. Assumes drainage area to contact water basin = 701,822 sf, as shown on attached Figure H-5.



OML Expansion
Temporary Contact Water Basin 6, Phase 6 Operational

Starting Water Elevation in Basin	Starting Water Depth (ft)	Basin Storage Volume (cf)	Incremental Volume (cf)	Cumulative Rainfall to Reach Basin Water Elevation (in)	Remaining Pond Capacity in Inches of Rain (in)	Notes
751	0	-	N/A	0.00	6.39	Basin Bottom
752	1	35,250	35,250	0.62	5.77	
753	2	73,188	37,938	1.29	5.10	
754	3	113,900	40,712	2.01	4.38	
755	4	157,470	43,570	2.78	3.61	
756	5	203,982	46,513	3.60	2.79	
757	6	253,522	49,540	4.47	1.92	
758	7	306,224	52,654	5.40	0.99	
759	8	362,072	55,848	6.39	0.00	Peak Elevation (1' Freeboard)
760	9	421,196	59,124	7.43	0.00	Top of Basin Liner

Notes:
1. Basin Volumes from AutoCAD Civil 3D surface.
2. Assumes drainage area to contact water basin = 679,949 sf, as shown on attached Figure H-6.



Contact Water Basin Culvert Sizing

Phase 1 Contact Water Basin Culverts

Site Data - 3-3' dia. HDPE

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 760.00 ft

Outlet Station: 82.70 ft

Outlet Elevation: 751.00 ft

Number of Barrels: 3

Culvert Data Summary - 3-3' dia. HDPE

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Phase 1

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 755.69 ft

Roadway Data for Crossing: Phase 1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 ft

Crest Elevation: 766.00 ft

Roadway Surface: Gravel

Roadway Top Width: 8.00 ft

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 111.67 cfs

Maximum Flow: 111.67 cfs

Table 4 - Culvert Summary Table: 3-3' dia. HDPE

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)
	0.00	0.00	760.00	0.000	0.000	0-NF	0.000	0.000	3.000	-4.310	0.000
	11.17	11.17	760.80	0.801	0.0*	1-JS1f	0.249	0.597	3.000	-4.310	0.552
	22.33	22.33	761.16	1.158	0.0*	1-JS1f	0.342	0.854	3.000	-4.310	1.103
	33.50	33.50	761.43	1.433	0.040	1-JS1f	0.420	1.057	3.000	-4.310	1.655
	44.67	44.67	761.71	1.706	0.113	1-JS1f	0.497	1.226	3.000	-4.310	2.206
	55.84	55.84	761.97	1.971	0.206	1-JS1f	0.563	1.382	3.000	-4.310	2.758
	67.00	67.00	762.23	2.227	0.320	1-JS1f	0.610	1.520	3.000	-4.310	3.309
	78.17	78.17	762.48	2.483	0.455	1-JS1f	0.657	1.643	3.000	-4.310	3.861
	89.34	89.34	762.74	2.743	0.611	1-JS1f	0.704	1.763	3.000	-4.310	4.412
	100.50	100.50	763.01	3.014	0.787	5-JS1f	0.751	1.876	3.000	-4.310	4.964
	111.67	111.67	763.30	3.300	0.985	5-JS1f	0.798	1.980	3.000	-4.310	5.516

* Full Flow Headwater elevation is below inlet invert.

****

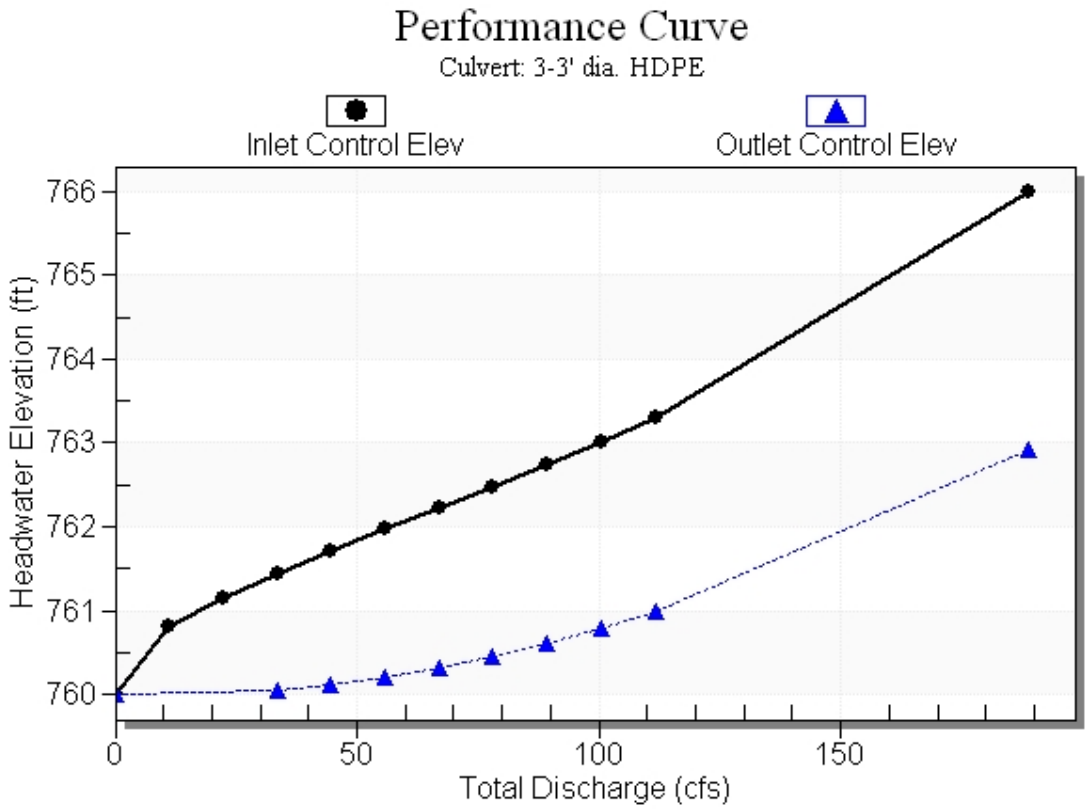
Straight Culvert

Inlet Elevation (invert): 760.00 ft, Outlet Elevation (invert): 751.00 ft

Culvert Length: 83.19 ft, Culvert Slope: 0.1088

****

Culvert Performance Curve Plot: 3-3' dia. HDPE



Water Surface Profile Plot for Culvert: 3-3' dia. HDPE

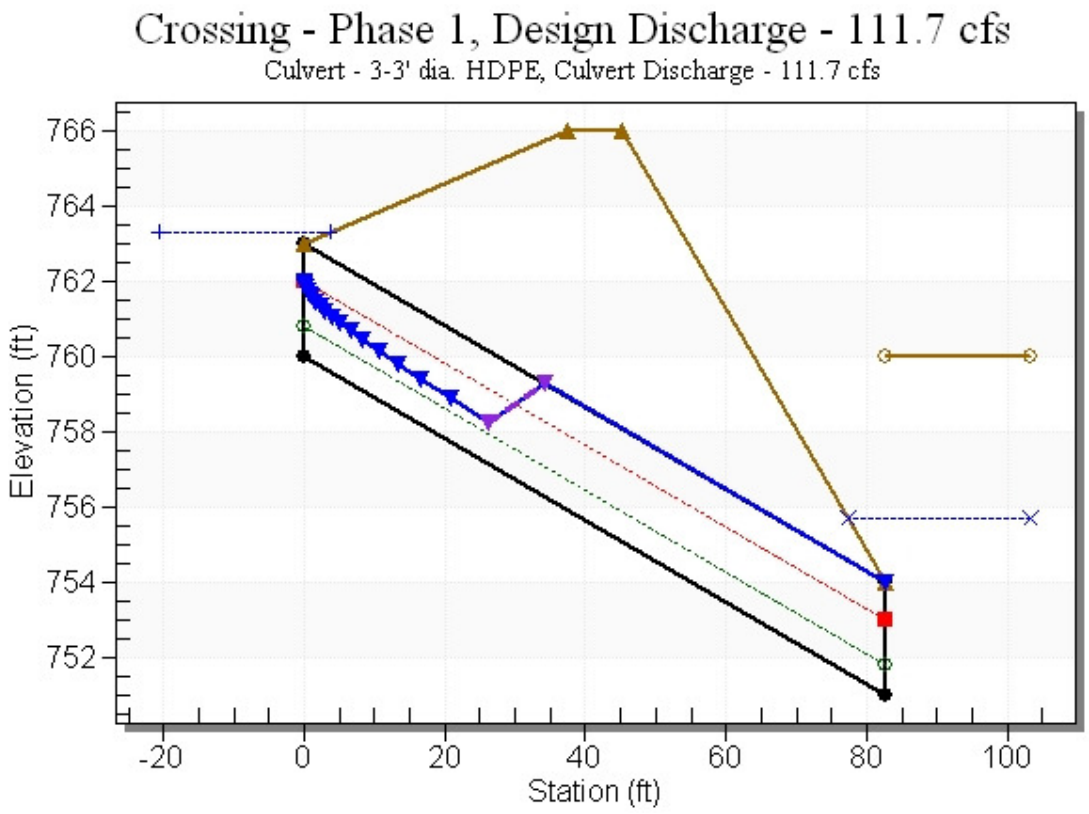


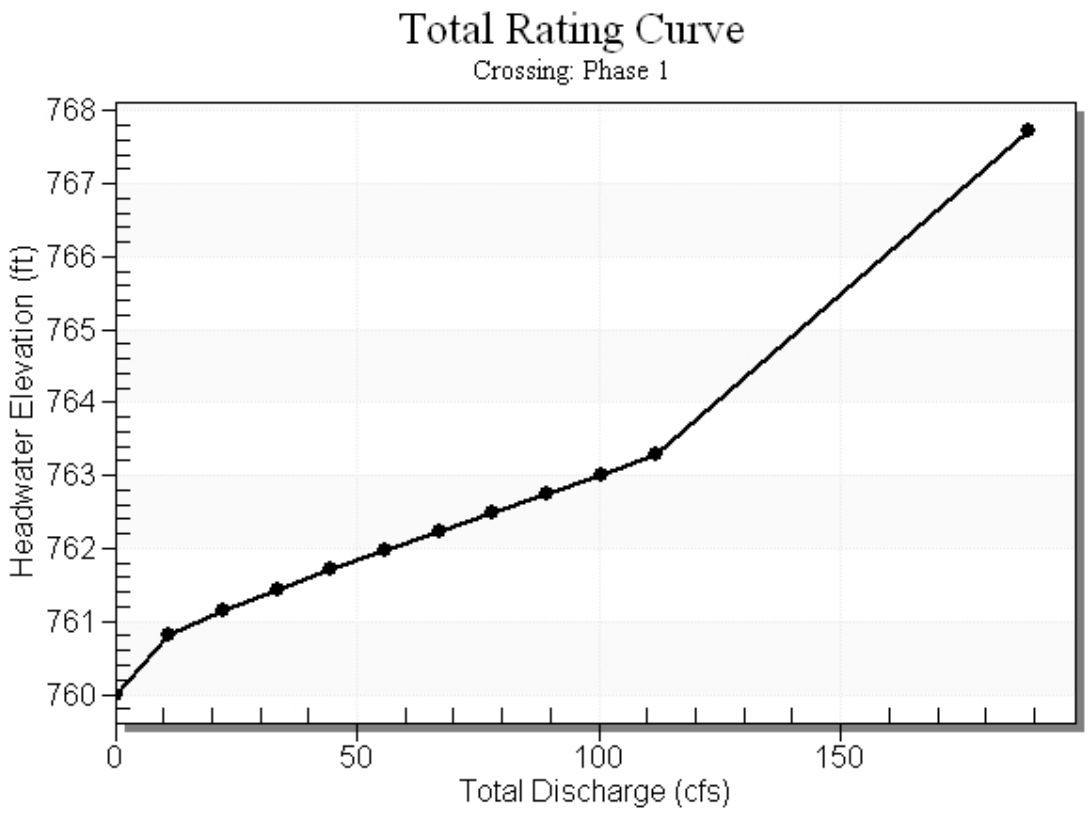
Table 5 - Downstream Channel Rating Curve (Crossing: Phase 1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	755.69	-4.31
11.17	755.69	-4.31
22.33	755.69	-4.31
33.50	755.69	-4.31
44.67	755.69	-4.31
55.84	755.69	-4.31
67.00	755.69	-4.31
78.17	755.69	-4.31
89.34	755.69	-4.31
100.50	755.69	-4.31
111.67	755.69	-4.31

Table 6 - Summary of Culvert Flows at Crossing: Phase 1

Headwater Elevation (ft)	Total Discharge (cfs)	3-3' dia. HDPE Discharge (cfs)	Roadway Discharge (cfs)	Iterations
760.00	0.00	0.00	0.00	1
760.80	11.17	11.17	0.00	1
761.16	22.33	22.33	0.00	1
761.43	33.50	33.50	0.00	1
761.71	44.67	44.67	0.00	1
761.97	55.84	55.84	0.00	1
762.23	67.00	67.00	0.00	1
762.48	78.17	78.17	0.00	1
762.74	89.34	89.34	0.00	1
763.01	100.50	100.50	0.00	1
763.30	111.67	111.67	0.00	1
766.00	188.90	188.90	0.00	Overtopping

Rating Curve Plot for Crossing: Phase 1



Phase 2 Contact Water Basin Culverts

Site Data - 3-3' dia. HDPE

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 760.50 ft

Outlet Station: 63.80 ft

Outlet Elevation: 754.00 ft

Number of Barrels: 3

Culvert Data Summary - 3-3' dia. HDPE

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Phase 2

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 757.27 ft

Roadway Data for Crossing: Phase 2

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 766.00 ft

Roadway Surface: Gravel

Roadway Top Width: 8.00 ft

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 144.54 cfs

Maximum Flow: 144.54 cfs

Table 1 - Culvert Summary Table: 3-3' dia. HDPE

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)
	0.00	0.00	760.50	0.000	0.000	0-NF	0.000	0.000	3.000	-3.230	0.000
	14.45	14.45	761.42	0.921	0.0*	1-JS1f	0.291	0.683	3.000	-3.230	0.714
	28.91	28.91	761.83	1.330	0.033	1-JS1f	0.395	0.978	3.000	-3.230	1.428
	43.36	43.36	762.18	1.684	0.115	1-JS1f	0.498	1.206	3.000	-3.230	2.142
	57.82	57.82	762.53	2.027	0.231	1-JS1f	0.579	1.408	3.000	-3.230	2.856
	72.27	72.27	762.86	2.358	0.380	1-JS1f	0.642	1.580	3.000	-3.230	3.570
	86.72	86.72	763.19	2.692	0.562	1-JS1f	0.705	1.736	3.000	-3.230	4.283
	101.18	101.18	763.54	3.041	0.777	5-JS1f	0.768	1.883	3.000	-3.230	4.997
	115.63	115.63	763.92	3.416	1.025	5-JS1f	0.828	2.015	3.000	-3.230	5.711
	130.09	130.09	764.33	3.827	1.306	5-JS1f	0.875	2.143	3.000	-3.230	6.425
	144.54	144.54	764.78	4.282	1.621	5-JS1f	0.923	2.257	3.000	-3.230	7.139

* Full Flow Headwater elevation is below inlet invert.

****

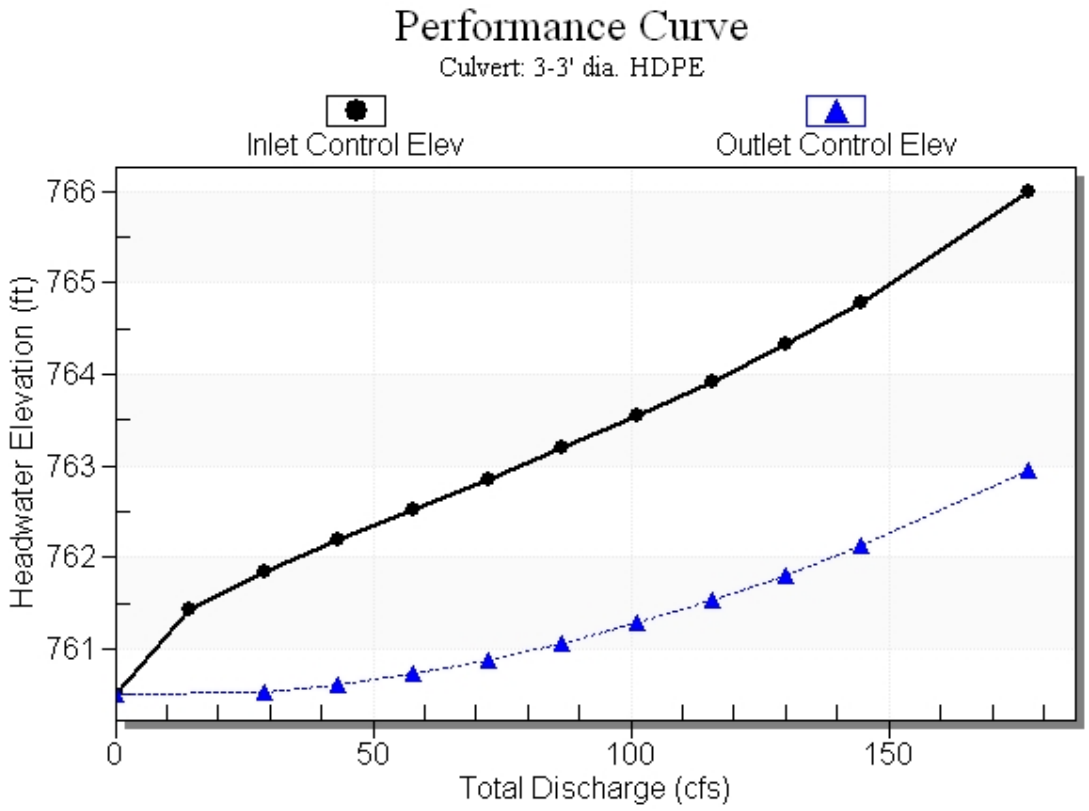
Straight Culvert

Inlet Elevation (invert): 760.50 ft, Outlet Elevation (invert): 754.00 ft

Culvert Length: 64.13 ft, Culvert Slope: 0.1019

****

Culvert Performance Curve Plot: 3-3' dia. HDPE



Water Surface Profile Plot for Culvert: 3-3' dia. HDPE

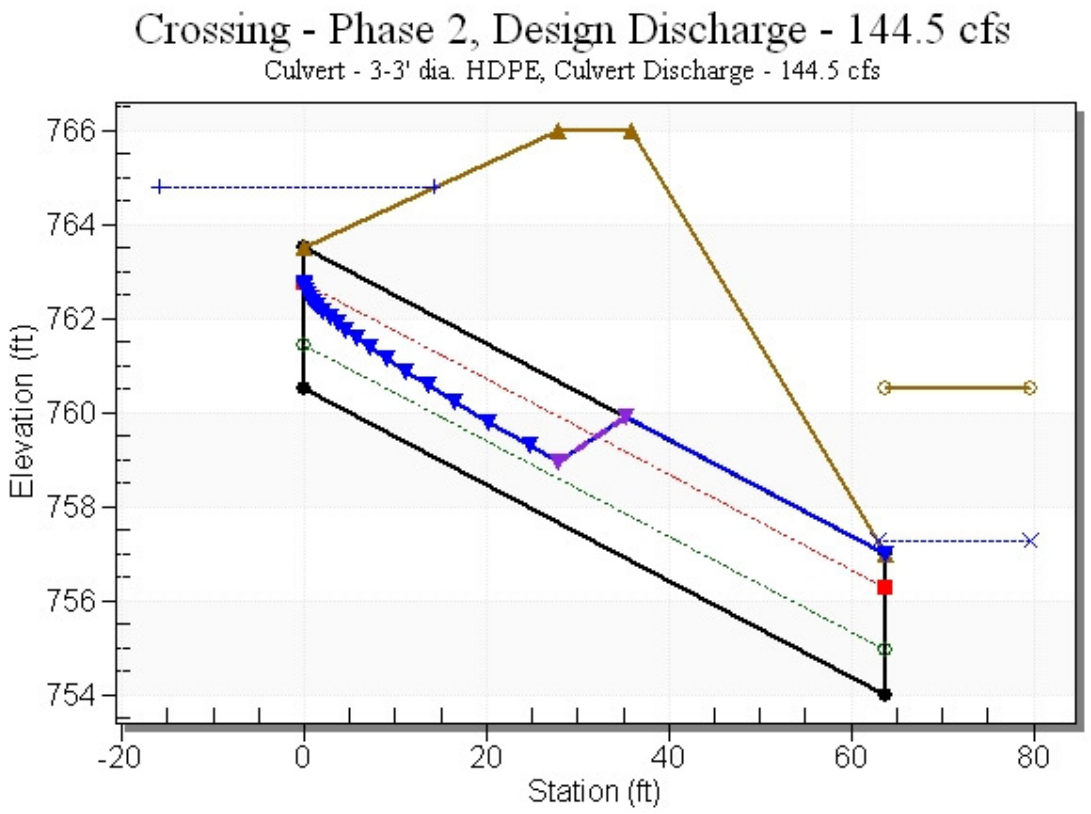


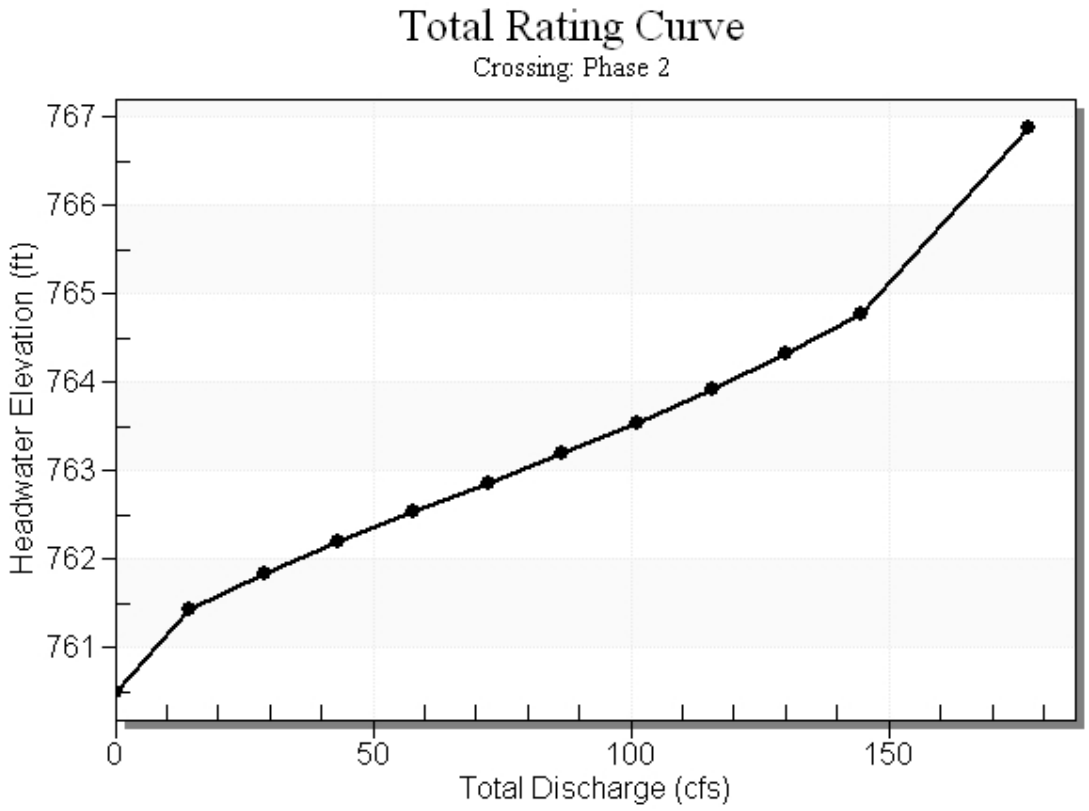
Table 2 - Downstream Channel Rating Curve (Crossing: Phase 2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	757.27	-3.23
14.45	757.27	-3.23
28.91	757.27	-3.23
43.36	757.27	-3.23
57.82	757.27	-3.23
72.27	757.27	-3.23
86.72	757.27	-3.23
101.18	757.27	-3.23
115.63	757.27	-3.23
130.09	757.27	-3.23
144.54	757.27	-3.23

Table 3 - Summary of Culvert Flows at Crossing: Phase 2

Headwater Elevation (ft)	Total Discharge (cfs)	3-3' dia. HDPE Discharge (cfs)	Roadway Discharge (cfs)	Iterations
760.50	0.00	0.00	0.00	1
761.42	14.45	14.45	0.00	1
761.83	28.91	28.91	0.00	1
762.18	43.36	43.36	0.00	1
762.53	57.82	57.82	0.00	1
762.86	72.27	72.27	0.00	1
763.19	86.72	86.72	0.00	1
763.54	101.18	101.18	0.00	1
763.92	115.63	115.63	0.00	1
764.33	130.09	130.09	0.00	1
764.78	144.54	144.54	0.00	1
766.00	177.16	177.16	0.00	Overtopping

Rating Curve Plot for Crossing: Phase 2



Phase 3 Contact Water Basin Culverts

Site Data - 3-3' dia. HDPE

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 757.50 ft

Outlet Station: 37.60 ft

Outlet Elevation: 757.00 ft

Number of Barrels: 3

Culvert Data Summary - 3-3' dia. HDPE

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Phase 3

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 758.83 ft

Roadway Data for Crossing: Phase 3

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 ft

Crest Elevation: 761.00 ft

Roadway Surface: Gravel

Roadway Top Width: 8.00 ft

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 89.85 cfs

Maximum Flow: 89.85 cfs

Table 7 - Culvert Summary Table: 3-3' dia. HDPE

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)
	0.00	0.00	758.83	0.000	1.330	0-NF	0.000	0.000	1.830	1.330	0.000
	8.98	8.98	758.85	0.783	1.353	1-S1t	0.366	0.537	1.830	1.330	0.664
	17.97	17.97	758.92	1.122	1.425	1-S1t	0.543	0.765	1.830	1.330	1.327
	26.95	26.95	759.06	1.392	1.558	1-S1t	0.652	0.943	1.830	1.330	1.991
	35.94	35.94	759.13	1.631	1.425	1-JS1t	0.760	1.094	1.830	1.330	2.654
	44.92	44.92	759.36	1.855	1.478	1-JS1t	0.856	1.230	1.830	1.330	3.318
	53.91	53.91	759.57	2.069	1.544	1-S2n	0.938	1.357	1.039	1.330	8.254
	62.89	62.89	759.78	2.277	1.621	1-S2n	1.019	1.471	1.134	1.330	8.580
	71.88	71.88	759.98	2.482	1.710	1-S2n	1.100	1.575	1.225	1.330	8.819
	80.86	80.86	760.19	2.688	1.811	1-S2n	1.169	1.675	1.311	1.330	9.071
	89.85	89.85	760.40	2.898	1.924	1-S2n	1.238	1.768	1.394	1.330	9.312

****

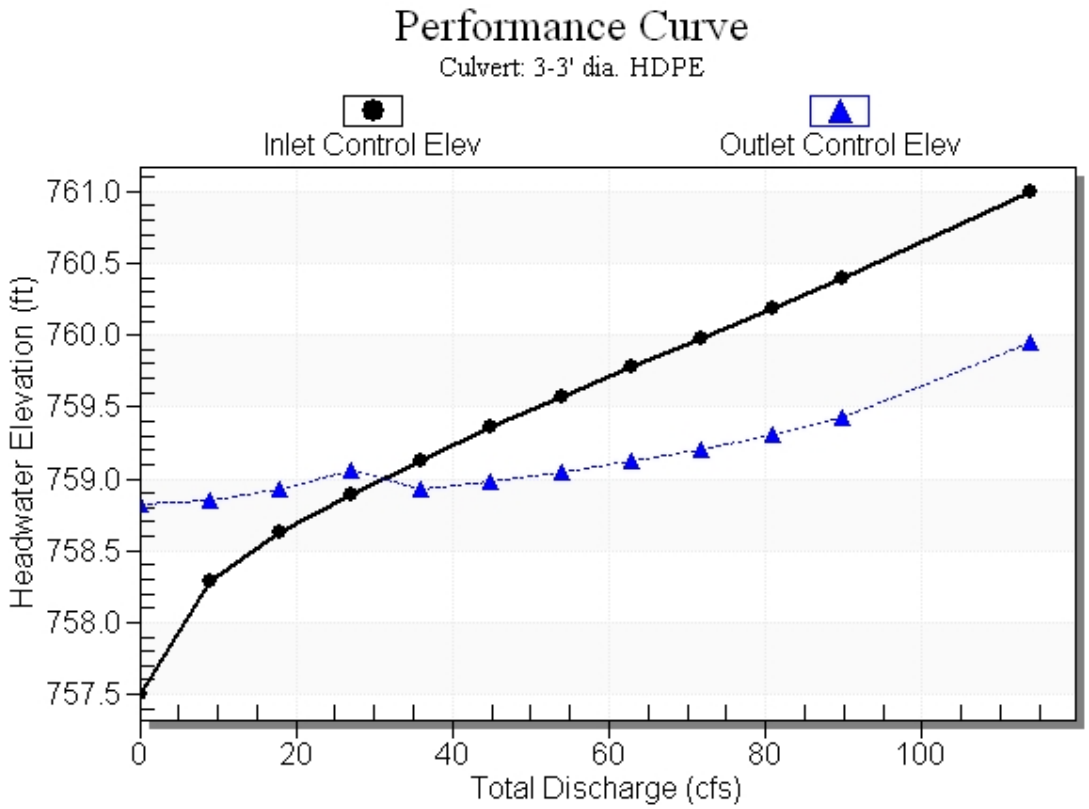
Straight Culvert

Inlet Elevation (invert): 757.50 ft, Outlet Elevation (invert): 757.00 ft

Culvert Length: 37.60 ft, Culvert Slope: 0.0133

****

Culvert Performance Curve Plot: 3-3' dia. HDPE



Water Surface Profile Plot for Culvert: 3-3' dia. HDPE

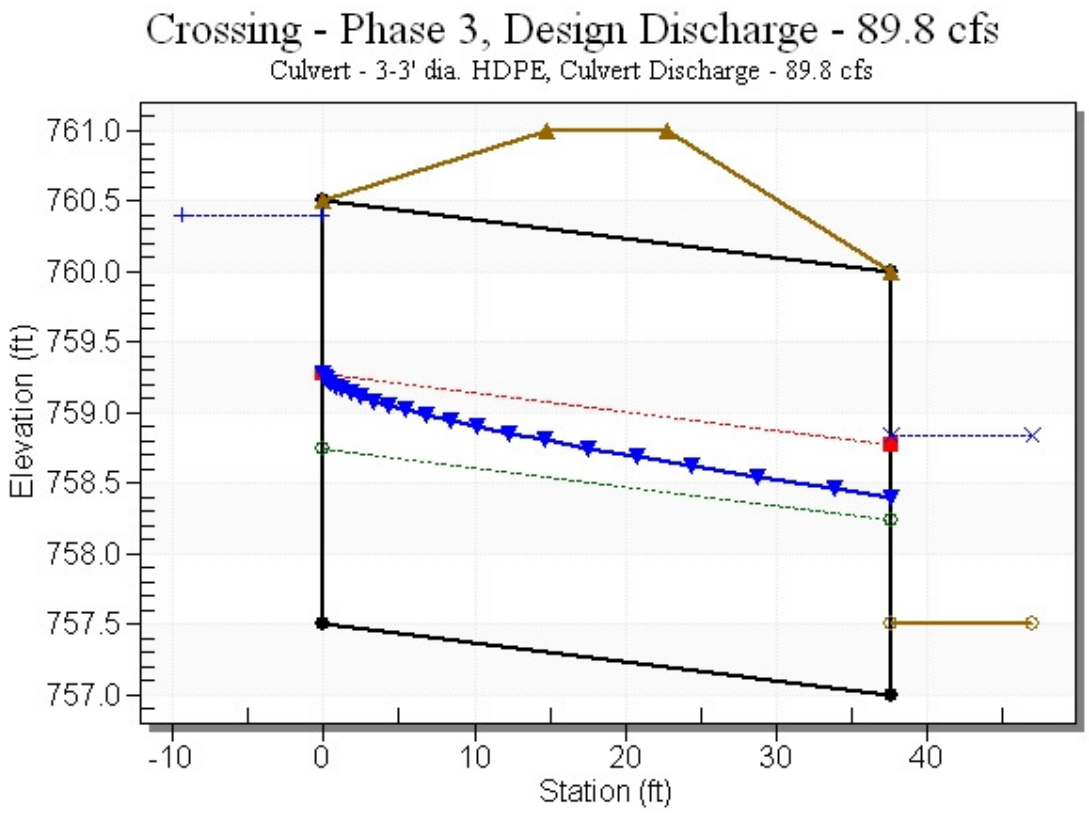


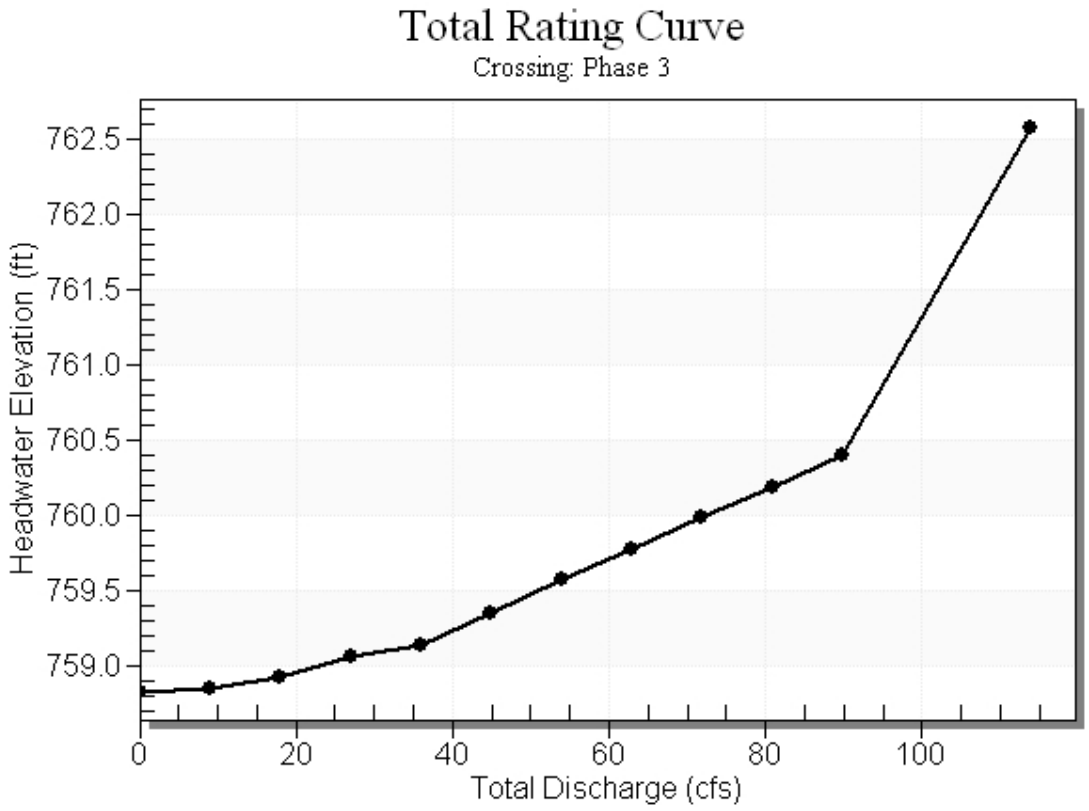
Table 8 - Downstream Channel Rating Curve (Crossing: Phase 3)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	758.83	1.33
8.98	758.83	1.33
17.97	758.83	1.33
26.95	758.83	1.33
35.94	758.83	1.33
44.92	758.83	1.33
53.91	758.83	1.33
62.89	758.83	1.33
71.88	758.83	1.33
80.86	758.83	1.33
89.85	758.83	1.33

Table 9 - Summary of Culvert Flows at Crossing: Phase 3

Headwater Elevation (ft)	Total Discharge (cfs)	3-3' dia. HDPE Discharge (cfs)	Roadway Discharge (cfs)	Iterations
758.83	0.00	0.00	0.00	1
758.85	8.98	8.98	0.00	1
758.92	17.97	17.97	0.00	1
759.06	26.95	26.95	0.00	1
759.13	35.94	35.94	0.00	1
759.36	44.92	44.92	0.00	1
759.57	53.91	53.91	0.00	1
759.78	62.89	62.89	0.00	1
759.98	71.88	71.88	0.00	1
760.19	80.86	80.86	0.00	1
760.40	89.85	89.85	0.00	1
761.00	113.80	113.80	0.00	Overtopping

Rating Curve Plot for Crossing: Phase 3



Phase 4 Contact Water Basin Culverts

Site Data - 2-3' dia. HDPE

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 763.00 ft

Outlet Station: 198.50 ft

Outlet Elevation: 757.00 ft

Number of Barrels: 2

Culvert Data Summary - 2-3' dia. HDPE

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Phase 4

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 762.35 ft

Roadway Data for Crossing: Phase 4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 20.00 ft

Crest Elevation: 780.00 ft

Roadway Surface: Gravel

Roadway Top Width: 16.00 ft

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 73.93 cfs

Maximum Flow: 73.93 cfs

Table 10 - Culvert Summary Table: 2-3' dia. HDPE

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)
	0.00	0.00	763.00	0.000	0.000	0-NF	0.000	0.000	3.000	-0.650	0.000
	7.39	7.39	763.87	0.869	0.010	1-JS1f	0.334	0.595	3.000	-0.650	0.548
	14.79	14.79	764.24	1.241	0.050	1-JS1f	0.479	0.850	3.000	-0.650	1.095
	22.18	22.18	764.54	1.536	0.116	1-JS1f	0.594	1.053	3.000	-0.650	1.643
	29.57	29.57	764.82	1.816	0.209	1-JS1f	0.682	1.221	3.000	-0.650	2.191
	36.97	36.97	765.08	2.080	0.328	1-JS1f	0.771	1.377	3.000	-0.650	2.739
	44.36	44.36	765.33	2.335	0.474	1-JS1f	0.849	1.514	3.000	-0.650	3.286
	51.75	51.75	765.59	2.588	0.646	1-JS1f	0.916	1.637	3.000	-0.650	3.834
	59.14	59.14	765.85	2.846	0.844	1-JS1f	0.983	1.756	3.000	-0.650	4.382
	66.54	66.54	766.11	3.114	1.069	5-JS1f	1.049	1.869	3.000	-0.650	4.930
	73.93	73.93	766.40	3.397	1.321	5-JS1f	1.112	1.973	3.000	-0.650	5.477

****

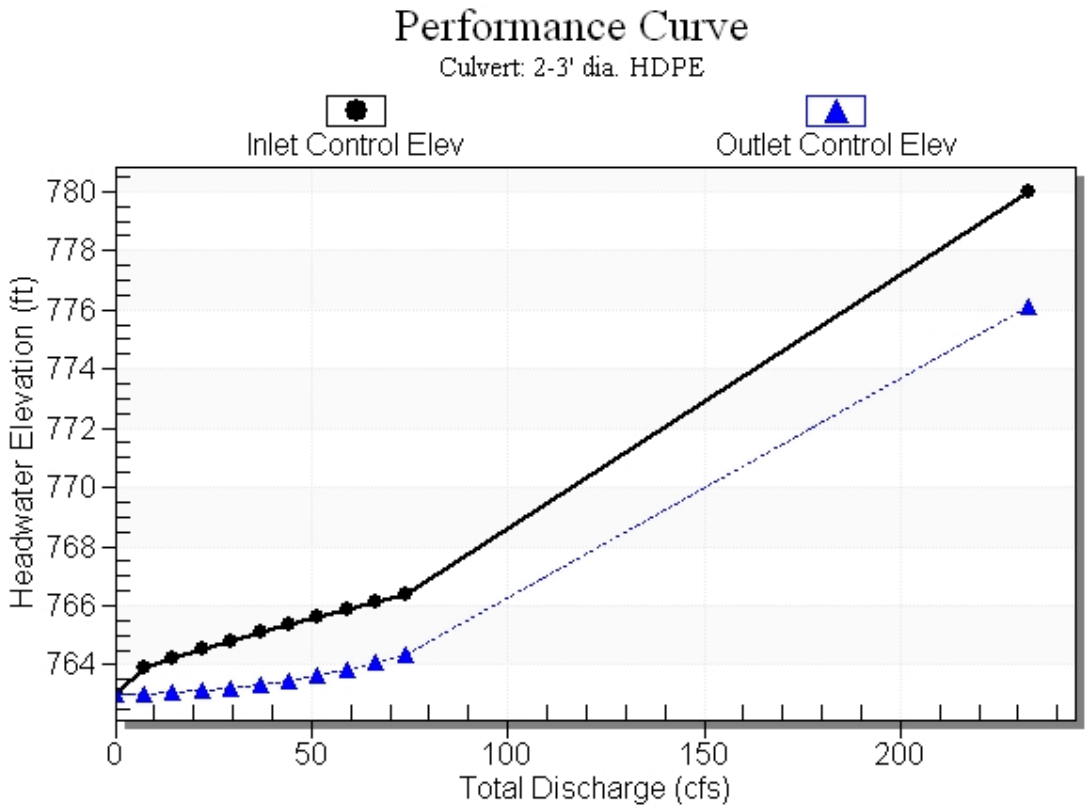
Straight Culvert

Inlet Elevation (invert): 763.00 ft, Outlet Elevation (invert): 757.00 ft

Culvert Length: 198.59 ft, Culvert Slope: 0.0302

****

Culvert Performance Curve Plot: 2-3' dia. HDPE



Water Surface Profile Plot for Culvert: 2-3' dia. HDPE

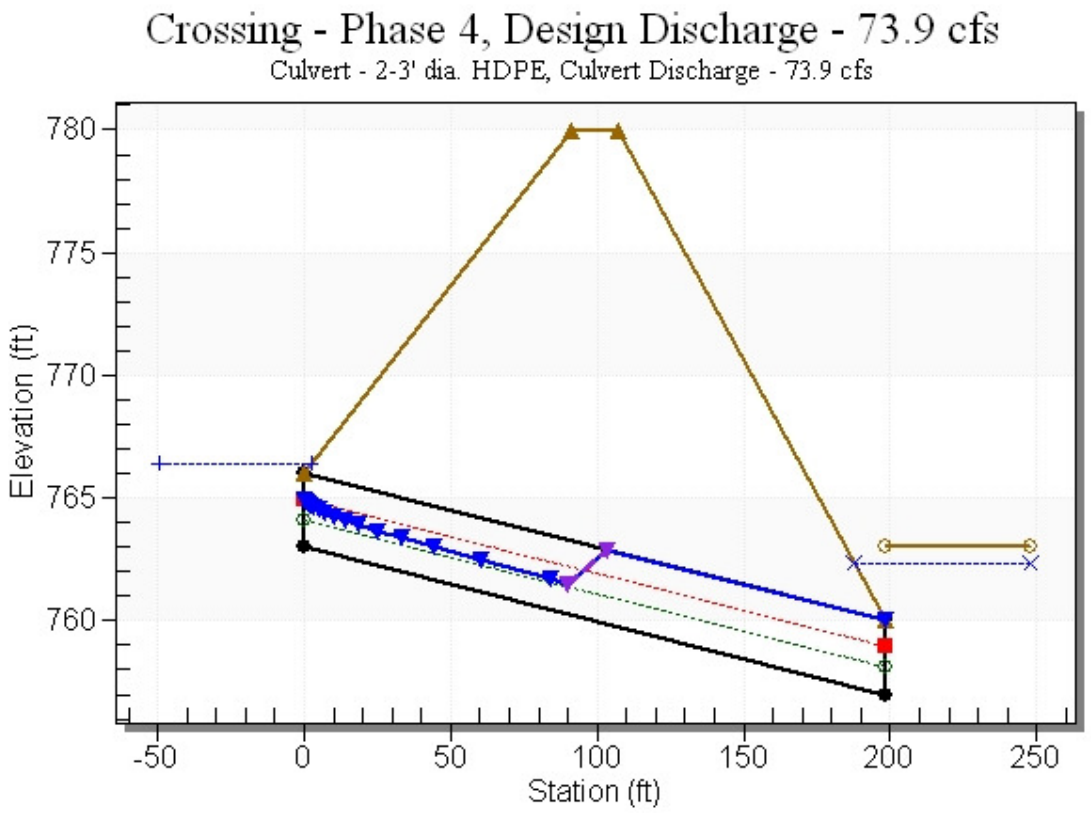


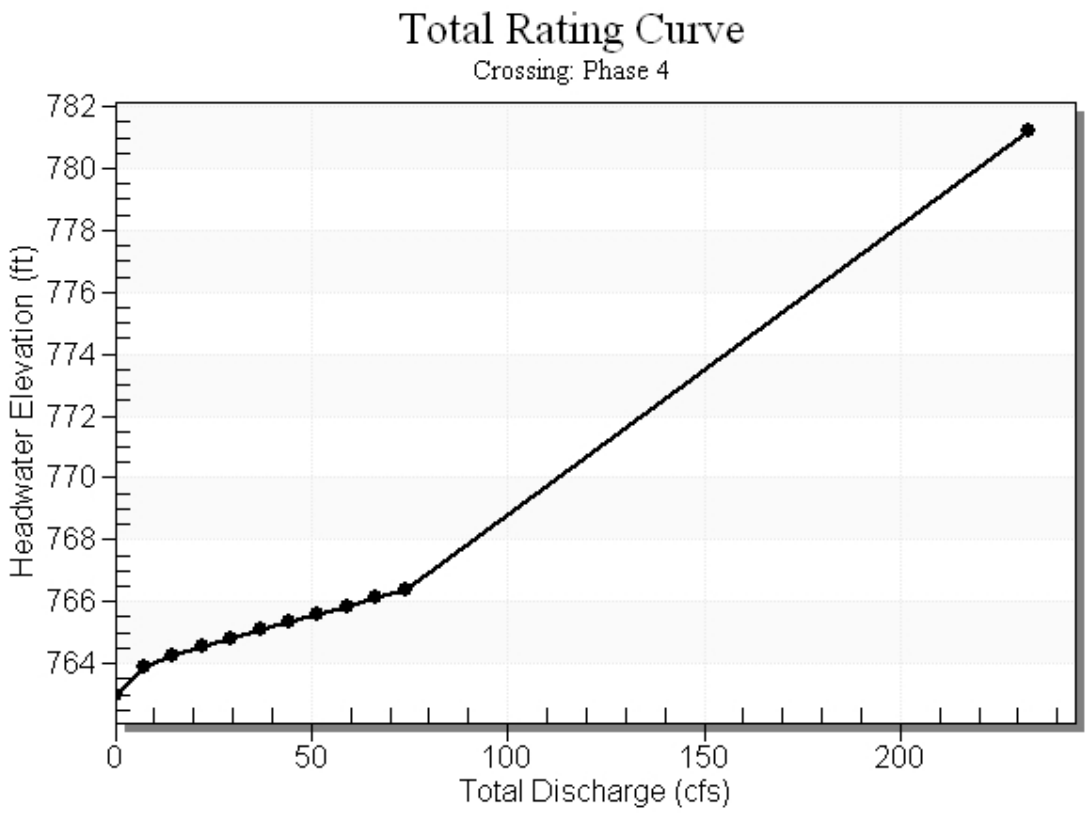
Table 11 - Downstream Channel Rating Curve (Crossing: Phase 4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	762.35	-0.65
7.39	762.35	-0.65
14.79	762.35	-0.65
22.18	762.35	-0.65
29.57	762.35	-0.65
36.97	762.35	-0.65
44.36	762.35	-0.65
51.75	762.35	-0.65
59.14	762.35	-0.65
66.54	762.35	-0.65
73.93	762.35	-0.65

Table 12 - Summary of Culvert Flows at Crossing: Phase 4

Headwater Elevation (ft)	Total Discharge (cfs)	2-3' dia. HDPE Discharge (cfs)	Roadway Discharge (cfs)	Iterations
763.00	0.00	0.00	0.00	1
763.87	7.39	7.39	0.00	1
764.24	14.79	14.79	0.00	1
764.54	22.18	22.18	0.00	1
764.82	29.57	29.57	0.00	1
765.08	36.97	36.97	0.00	1
765.33	44.36	44.36	0.00	1
765.59	51.75	51.75	0.00	1
765.85	59.14	59.14	0.00	1
766.11	66.54	66.54	0.00	1
766.40	73.93	73.93	0.00	1
780.00	232.76	232.76	0.00	Overtopping

Rating Curve Plot for Crossing: Phase 4



Phase 5 Contact Water Basin Culverts

Site Data - 3-3' dia. HDPE

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 760.00 ft

Outlet Station: 75.90 ft

Outlet Elevation: 757.00 ft

Number of Barrels: 3

Culvert Data Summary - 3-3' dia. HDPE

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Tailwater Channel Data - Phase 5

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 756.27 ft

Roadway Data for Crossing: Phase 5

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 110.00 ft

Crest Elevation: 764.00 ft

Roadway Surface: Gravel

Roadway Top Width: 8.00 ft

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 89.4 cfs

Maximum Flow: 89.4 cfs

Table 13 - Culvert Summary Table: 3-3' dia. HDPE

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)
	0.00	0.00	760.00	0.000	0.000	0-NF	0.000	0.000	3.000	-3.730	0.000
	8.94	8.94	760.76	0.761	0.004	1-JS1f	0.291	0.535	3.000	-3.730	0.442
	17.88	17.88	761.09	1.091	0.024	1-JS1f	0.393	0.763	3.000	-3.730	0.883
	26.82	26.82	761.35	1.353	0.056	1-JS1f	0.496	0.940	3.000	-3.730	1.325
	35.76	35.76	761.59	1.587	0.102	1-JS1f	0.578	1.091	3.000	-3.730	1.766
	44.70	44.70	761.81	1.810	0.161	1-JS1f	0.640	1.226	3.000	-3.730	2.208
	53.64	53.64	762.02	2.023	0.233	1-JS1f	0.702	1.353	3.000	-3.730	2.649
	62.58	62.58	762.23	2.230	0.318	1-JS1f	0.765	1.467	3.000	-3.730	3.091
	71.52	71.52	762.43	2.435	0.415	1-S2n	0.825	1.571	0.898	-3.730	13.352
	80.46	80.46	762.64	2.640	0.526	1-S2n	0.872	1.671	0.961	-3.730	13.690
	89.40	89.40	762.85	2.848	0.650	1-S2n	0.919	1.763	1.020	-3.730	14.033

****

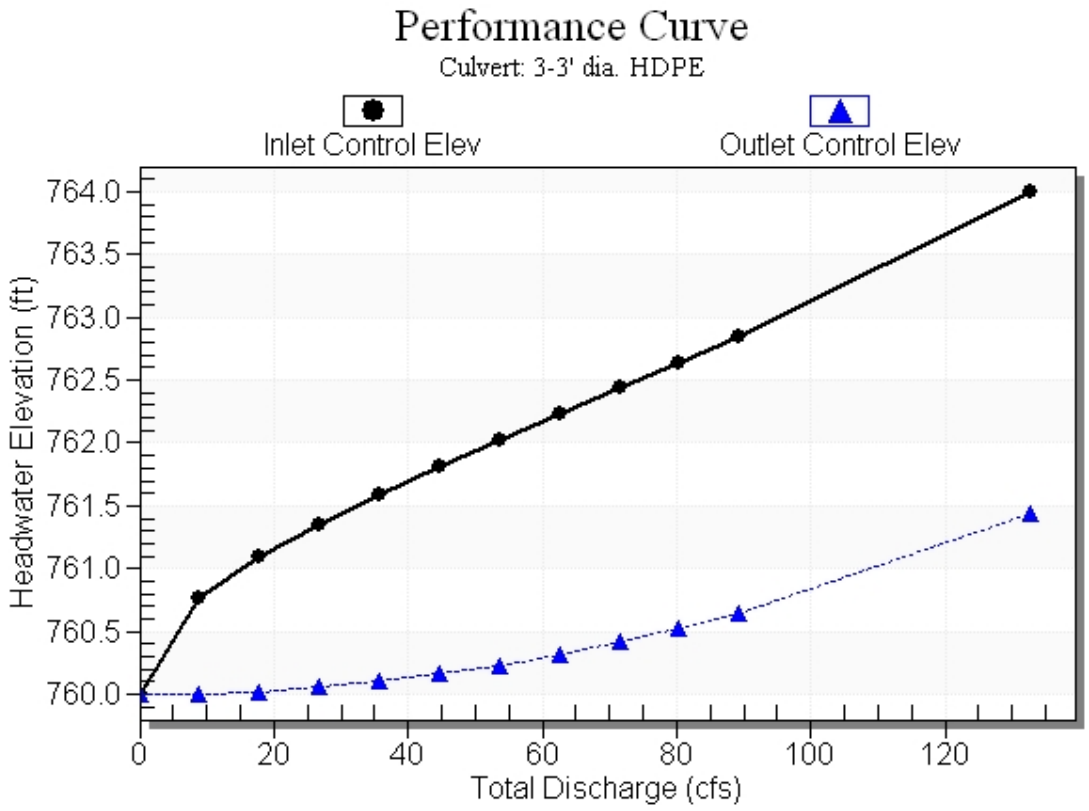
Straight Culvert

Inlet Elevation (invert): 760.00 ft, Outlet Elevation (invert): 757.00 ft

Culvert Length: 75.96 ft, Culvert Slope: 0.0395

****

Culvert Performance Curve Plot: 3-3' dia. HDPE



Water Surface Profile Plot for Culvert: 3-3' dia. HDPE

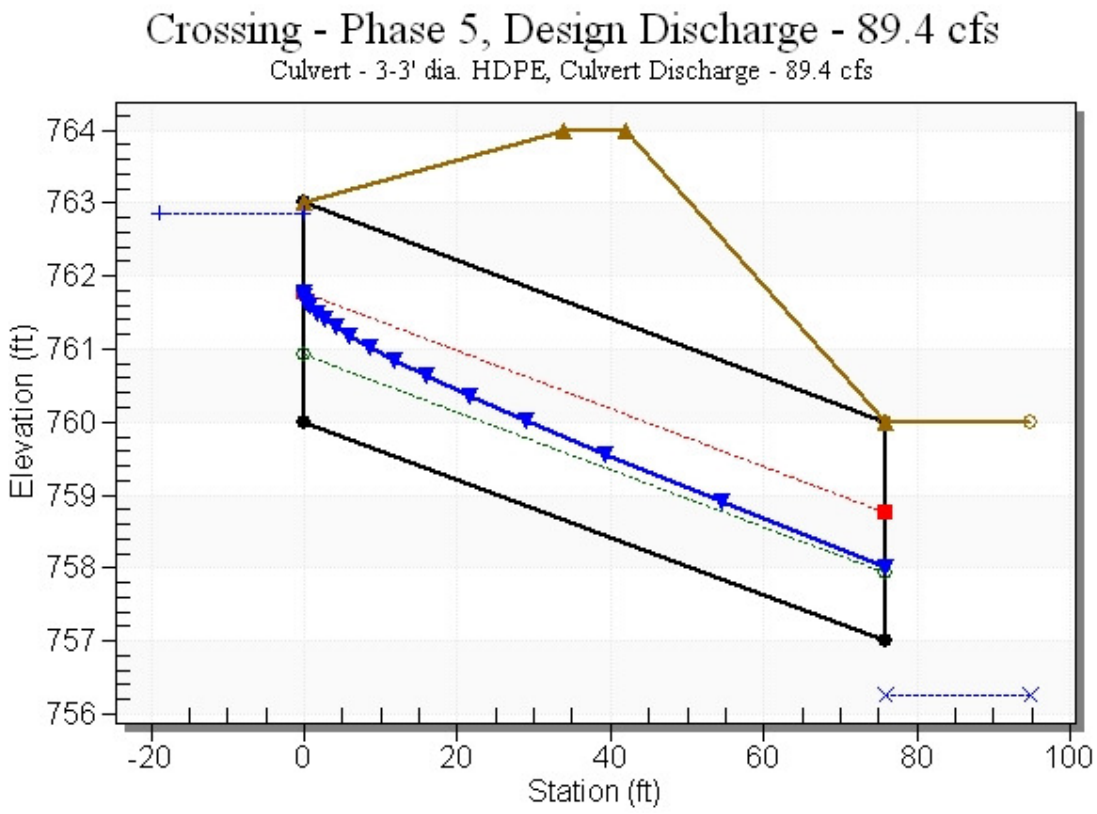


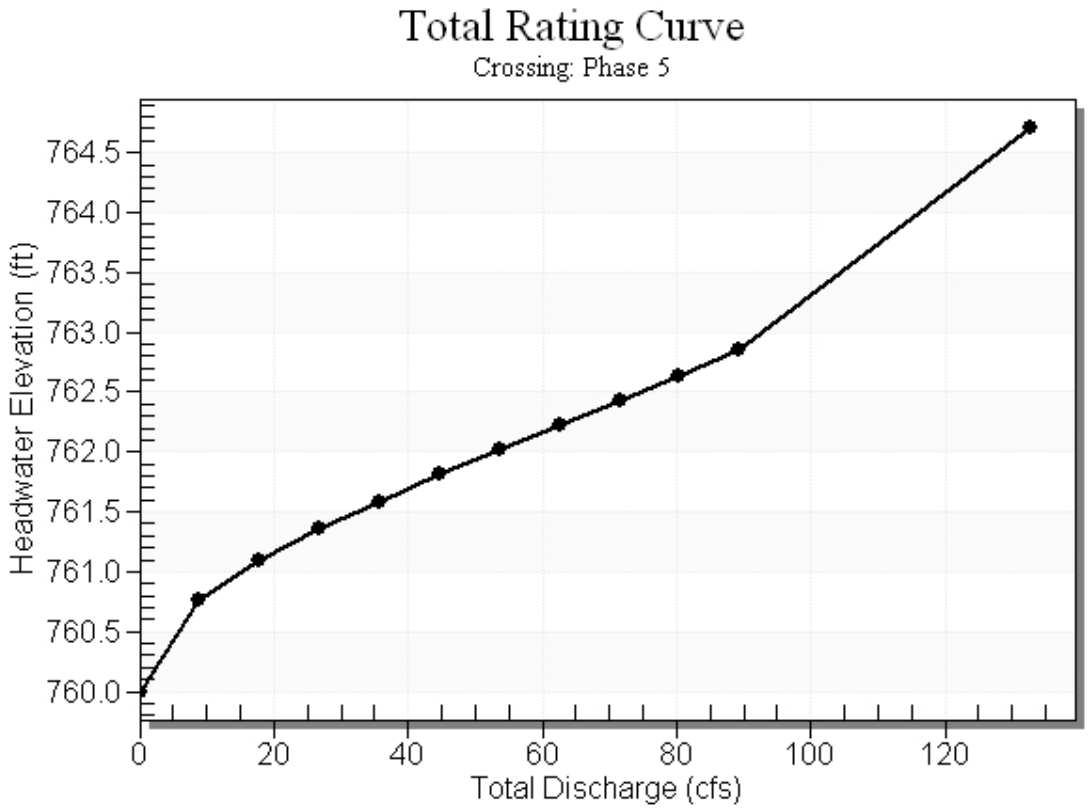
Table 14 - Downstream Channel Rating Curve (Crossing: Phase 5)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	756.27	-3.73
8.94	756.27	-3.73
17.88	756.27	-3.73
26.82	756.27	-3.73
35.76	756.27	-3.73
44.70	756.27	-3.73
53.64	756.27	-3.73
62.58	756.27	-3.73
71.52	756.27	-3.73
80.46	756.27	-3.73
89.40	756.27	-3.73

Table 15 - Summary of Culvert Flows at Crossing: Phase 5

Headwater Elevation (ft)	Total Discharge (cfs)	3-3' dia. HDPE Discharge (cfs)	Roadway Discharge (cfs)	Iterations
760.00	0.00	0.00	0.00	1
760.76	8.94	8.94	0.00	1
761.09	17.88	17.88	0.00	1
761.35	26.82	26.82	0.00	1
761.59	35.76	35.76	0.00	1
761.81	44.70	44.70	0.00	1
762.02	53.64	53.64	0.00	1
762.23	62.58	62.58	0.00	1
762.43	71.52	71.52	0.00	1
762.64	80.46	80.46	0.00	1
762.85	89.40	89.40	0.00	1
764.00	132.70	132.70	0.00	Overtopping

Rating Curve Plot for Crossing: Phase 5



Phase 6 Contact Water Basin Culverts

Site Data - 2-3' dia. HDPE

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 795.00 ft

Outlet Station: 311.00 ft

Outlet Elevation: 757.00 ft

Number of Barrels: 2

Culvert Data Summary - 2-3' dia. HDPE

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Tailwater Channel Data - Phase 6

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 758.00 ft

Roadway Data for Crossing: Phase 6

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 35.00 ft

Crest Elevation: 800.00 ft

Roadway Surface: Paved

Roadway Top Width: 20.00 ft

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 107 cfs

Maximum Flow: 107 cfs

Table 1 - Culvert Summary Table: 2-3' dia. HDPE

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)
	0.00	0.00	795.00	0.000	0.000	0-NF	0.000	0.000	1.000	5.000	0.000
	10.70	10.70	795.90	0.901	0.0*	1-S2n	0.293	0.722	0.293	5.000	16.820
	21.40	21.40	796.30	1.300	0.0*	1-S2n	0.398	1.034	0.398	5.000	18.605
	32.10	32.10	796.65	1.653	0.0*	1-S2n	0.502	1.277	0.502	5.000	20.333
	42.80	42.80	797.01	2.008	0.0*	1-S2n	0.583	1.487	0.583	5.000	22.424
	53.50	53.50	797.33	2.329	0.0*	1-S2n	0.647	1.669	0.647	5.000	23.644
	64.20	64.20	797.64	2.640	0.0*	1-S2n	0.710	1.835	0.710	5.000	24.862
	74.90	74.90	797.96	2.959	0.0*	1-S2n	0.774	1.986	0.774	5.000	25.812
	85.60	85.60	798.30	3.302	0.0*	5-S2n	0.833	2.129	0.833	5.000	26.773
	96.30	96.30	798.68	3.678	0.0*	5-S2n	0.881	2.257	0.881	5.000	27.721
	107.00	107.00	799.10	4.097	0.0*	5-S2n	0.929	2.374	0.953	5.000	27.617

* Full Flow Headwater elevation is below inlet invert.

****

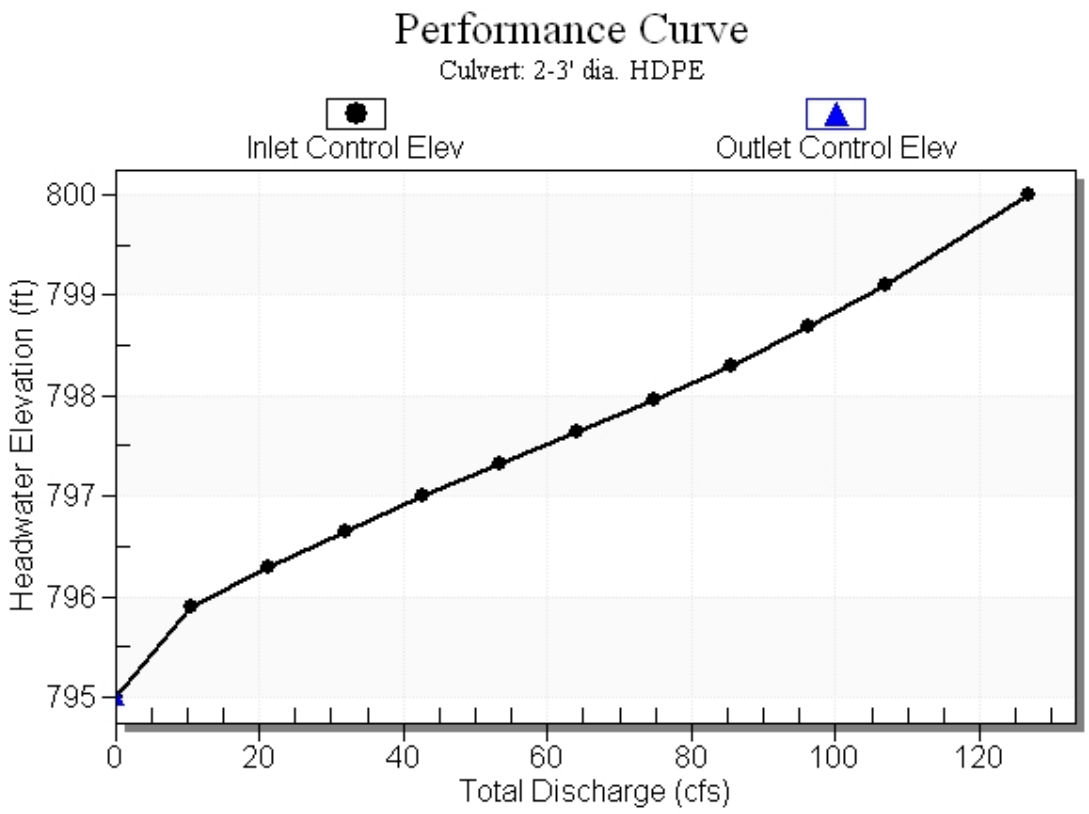
Straight Culvert

Inlet Elevation (invert): 795.00 ft, Outlet Elevation (invert): 757.00 ft

Culvert Length: 313.31 ft, Culvert Slope: 0.1222

****

Culvert Performance Curve Plot: 2-3' dia. HDPE



Water Surface Profile Plot for Culvert: 2-3' dia. HDPE

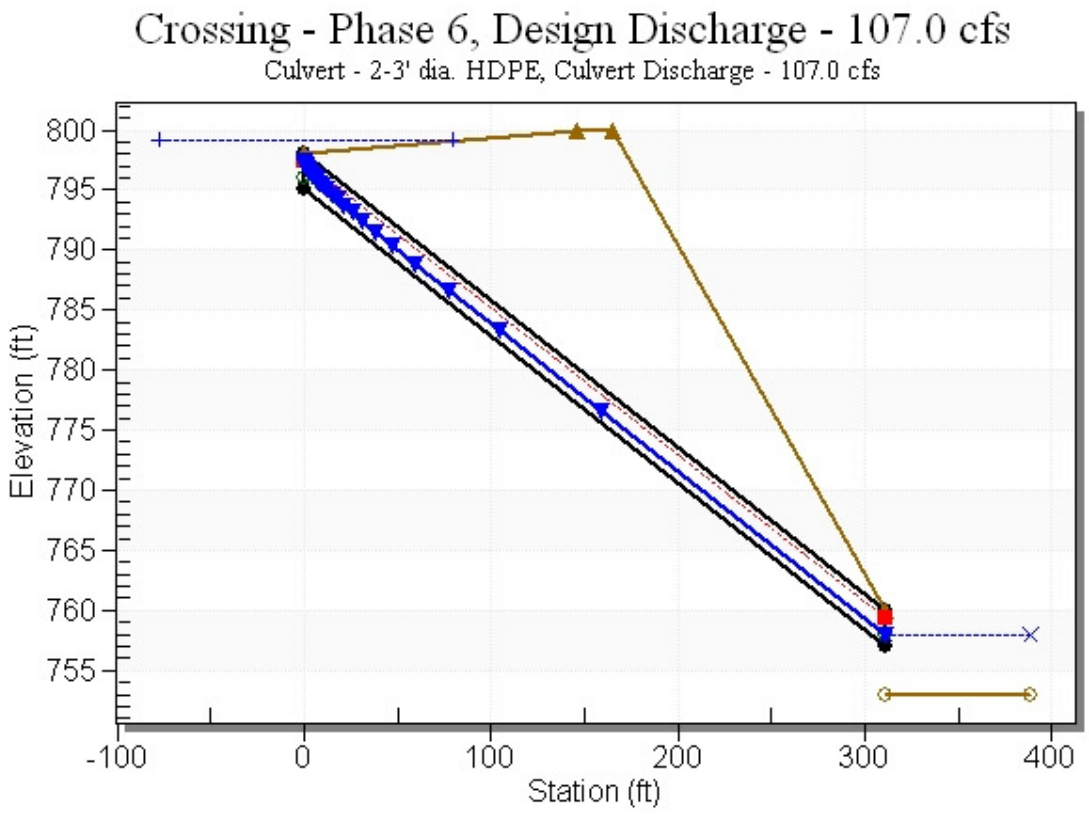


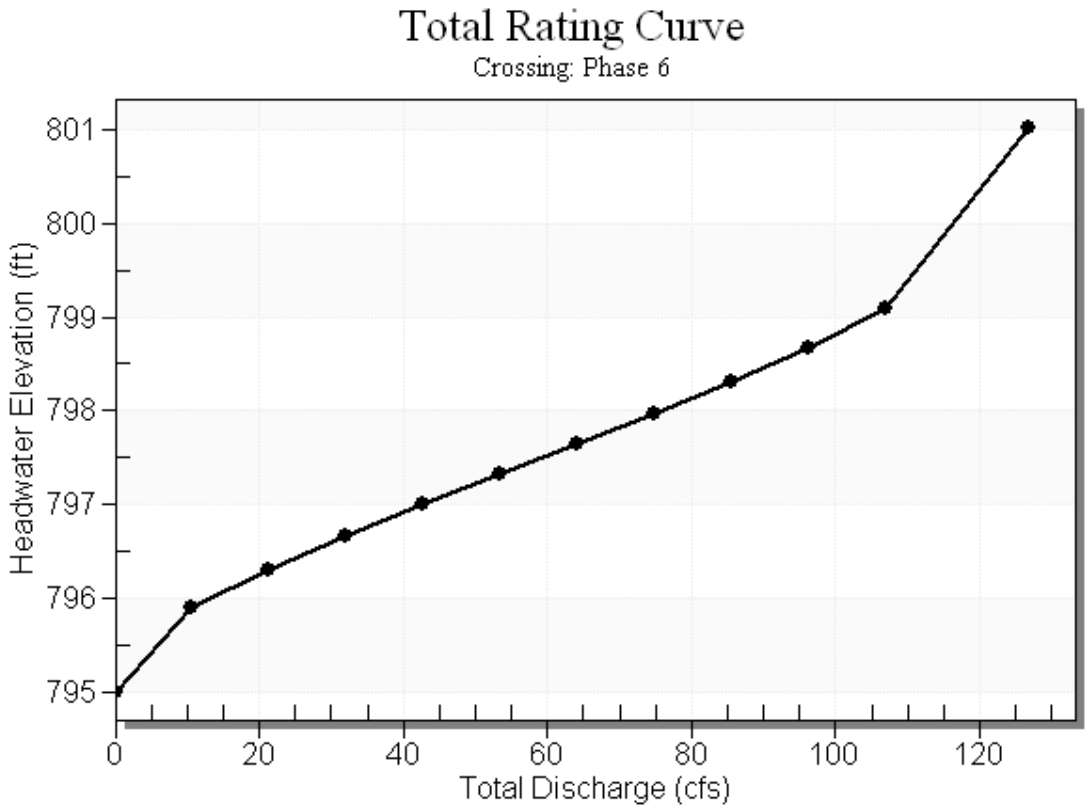
Table 2 - Downstream Channel Rating Curve (Crossing: Phase 6)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	758.00	5.00
10.70	758.00	5.00
21.40	758.00	5.00
32.10	758.00	5.00
42.80	758.00	5.00
53.50	758.00	5.00
64.20	758.00	5.00
74.90	758.00	5.00
85.60	758.00	5.00
96.30	758.00	5.00
107.00	758.00	5.00

Table 3 - Summary of Culvert Flows at Crossing: Phase 6

Headwater Elevation (ft)	Total Discharge (cfs)	2-3' dia. HDPE Discharge (cfs)	Roadway Discharge (cfs)	Iterations
795.00	0.00	0.00	0.00	1
795.90	10.70	10.70	0.00	1
796.30	21.40	21.40	0.00	1
796.65	32.10	32.10	0.00	1
797.01	42.80	42.80	0.00	1
797.33	53.50	53.50	0.00	1
797.64	64.20	64.20	0.00	1
797.96	74.90	74.90	0.00	1
798.30	85.60	85.60	0.00	1
798.68	96.30	96.30	0.00	1
799.10	107.00	107.00	0.00	1
800.00	126.83	126.83	0.00	Overtopping

Rating Curve Plot for Crossing: Phase 6



Contact Water Perimeter and Interior Diversion Berm/Swale Sizing

SCS ENGINEERS

		Sheet No.	
		Calc. No.	
		Rev. No.	
Job No. 25211509.3	Job: Proposed Expansion	By: BLP	Date: 11/26/13
Client: OML	Subject: Perimeter Contact Water Div Berm	Chk'd: MRH	Date: 11/27/13

Contact Water Perimeter and Interior Diversion Berm/Swale Sizing

Size the perimeter and interior swales to route the contact water runoff from the waste sideslopes to the culverts in the active phase that will then discharge to the temporary contact water basin for each phase. Sizing is based on a 25-year, 24-hour storm event

Use Manning's equation to determine flow depth in the perimeter ditch

Manning's Equation: $Q = (1.49/n) \times A \times R^{(2/3)} \times S^{(1/2)}$

where: Q = Flow rate, cfs (from HydroCAD model for 25-year, 24-hour storm)
n = Manning's roughness coefficient (assumed smooth surface, 0.013)
A = Flow area, sf
R = Hydraulic radius, ft
S = Channel slope, ft/ft

Vary the flow depth input value below until the flow rate estimated by HydroCAD is achieved.

From HydroCAD modeling for hydrograph generation, the peak runoff rate from the phase area to a temporary contact water basin is 144.5 cfs (Phase 2).

Phase 1 flow from phase area to perimeter diversion berm, Q = 112 cfs

Inputs for Trapezoidal Channel		**Calculations/Output**	
Depth of flow, y =	1.72 ft	Cross-sectional area, A =	4.4 sf
Channel side slope, H/V =	1 :1	Wetted perimeter, P =	6.3 ft
Channel side slope, H/V =	2 :1	Hydraulic radius, R =	0.7 ft
Manning's roughness, n =	0.013	Discharge, Q =	112 cfs
Channel bottom slope, s =	0.077 ft/ft	Average velocity, V =	25.24 ft/s

Phase 2 flow from phase area to perimeter diversion berm, Q = 145 cfs (Note: Minimimum perimeter berm slope modeled below; majority of Phase 2 perimeter berm slope is greater than 1%; results below are worst-case and in limited area)

Inputs for Trapezoidal Channel		**Calculations/Output**	
Depth of flow, y =	2.78 ft	Cross-sectional area, A =	11.6 sf
Channel side slope, H/V =	1 :1	Wetted perimeter, P =	10.1 ft
Channel side slope, H/V =	2 :1	Hydraulic radius, R =	1.1 ft
Manning's roughness, n =	0.013	Discharge, Q =	145 cfs
Channel bottom slope, s =	0.01 ft/ft	Average velocity, V =	12.53 ft/s

Phase 3 flow from phase area to perimeter diversion berm, Q = 90 cfs

Inputs for Trapezoidal Channel		**Calculations/Output**	
Depth of flow, y =	2.32 ft	Cross-sectional area, A =	8.1 sf
Channel side slope, H/V =	1 :1	Wetted perimeter, P =	8.5 ft
Channel side slope, H/V =	2 :1	Hydraulic radius, R =	1.0 ft
Manning's roughness, n =	0.013	Discharge, Q =	90 cfs
Channel bottom slope, s =	0.01 ft/ft	Average velocity, V =	11.10 ft/s

SCS ENGINEERS

		Sheet No.	
		Calc. No.	
		Rev. No.	
Job No. 25211509.3	Job: Proposed Expansion	By: BLP	Date: 11/26/13
Client: OML	Subject: Preliminary Contact Water Ditch	Chk'd: MRH	Date: 11/27/13

Contact Water Perimeter and Interior Diversion Berm/Swale Sizing

Phase 4 flow from phase area to perimeter diversion berm, Q = 74 cfs (Note: Minimimum 1% perimeter berm slope modeled below - worst-case)

Inputs for Trapezoidal Channel		**Calculations/Output**	
Depth of flow, y =	2.16 ft	Cross-sectional area, A =	7.0 sf
Channel side slope, H/V =	1 :1	Wetted perimeter, P =	7.9 ft
Channel side slope, H/V =	2 :1	Hydraulic radius, R =	0.9 ft
Manning's roughness, n =	0.013	Discharge, Q =	74 cfs
Channel bottom slope, s =	0.01 ft/ft	Average velocity, V =	10.59 ft/s

Phase 5 flow from phase area to perimeter diversion berm, Q = 89 cfs

Inputs for Trapezoidal Channel		**Calculations/Output**	
Depth of flow, y =	2.31 ft	Cross-sectional area, A =	8.0 sf
Channel side slope, H/V =	1 :1	Wetted perimeter, P =	8.4 ft
Channel side slope, H/V =	2 :1	Hydraulic radius, R =	0.9 ft
Manning's roughness, n =	0.013	Discharge, Q =	89 cfs
Channel bottom slope, s =	0.01 ft/ft	Average velocity, V =	11.07 ft/s

Phase 6 flow from phase area to perimeter diversion berm, Q = 107 cfs

Inputs for Trapezoidal Channel		**Calculations/Output**	
Depth of flow, y =	2.48 ft	Cross-sectional area, A =	9.2 sf
Channel side slope, H/V =	1 :1	Wetted perimeter, P =	9.1 ft
Channel side slope, H/V =	2 :1	Hydraulic radius, R =	1.0 ft
Manning's roughness, n =	0.013	Discharge, Q =	107 cfs
Channel bottom slope, s =	0.01 ft/ft	Average velocity, V =	11.61 ft/s

Phase 2 flow from phase area to interior diversion berm, Q = 145 cfs

Inputs for Trapezoidal Channel		**Calculations/Output**	
Depth of flow, y =	2.23 ft	Cross-sectional area, A =	12.4 sf
Channel side slope, H/V =	3 :1	Wetted perimeter, P =	12.0 ft
Channel side slope, H/V =	2 :1	Hydraulic radius, R =	1.0 ft
Manning's roughness, n =	0.013	Discharge, Q =	146 cfs
Channel bottom slope, s =	0.01 ft/ft	Average velocity, V =	11.71 ft/s

Manning's roughness coefficient reference table (source: Engineering Tool Box website):

Surface Material	Manning's Roughness Coefficient - n -
Asbestos cement	0.011
Asphalt	0.016
Brass	0.011
Brickwork	0.015
Cast-iron, new	0.012
Clay tile	0.014
Concrete - steel forms	0.011
Concrete - finished	0.012
Concrete - wooden forms	0.015
Concrete - centrifugally spun	0.013
Copper	0.011
Corrugated metal	0.022
Earth	0.025
Earth channel - clean	0.022
Earth channel - gravelly	0.025
Earth channel - weedy	0.030
Earth channel - stony, cobbles	0.035

Assume Manning's of 0.013 for hardened CCR

Assume Manning's of 0.013, which is between the various concrete roughness coefficients.

Storm Water Management Calculations

Purpose:
The purpose of the storm water runoff calculations is to demonstrate that the proposed landfill surface water management system design meets the requirements of the Iowa Administrative Code, Environmental Protection Commission [567], Chapter 113.7(8)*a*(2) for providing a runoff control system to collect and control peak discharge from a 25-year storm event.

Approach:
Final Cover Soil Loss
The Universal Soil Loss Equation (USLE) was used to estimate soil loss along the final cover slopes. The USLE estimates the final cover soil erosion based on the erodibility of the soil, the rainfall and runoff erosivity, the slope steepness, cover management, and soil practice factors. A maximum soil loss of 3 tons per acre is considered acceptable.

Hydrograph Generation
To properly size the storm water management features, runoff hydrographs for the 25-year, 24-hour, and 100-year, 24-hour, storm events were developed. HydroCAD was used to model the storm water management system and develop the hydrographs using TR-20 methodologies. The model is designed to simulate the surface runoff response of a watershed to a precipitation event. Input parameters for the model include precipitation depth for the design storm event, contributing drainage areas, runoff curve numbers, time of concentration, and travel time.

The final cover watersheds are shown on **Figure 1**.

Perimeter Ditch and Diversion Berm Sizing
Diversion berms and perimeter ditches outside the landfill limits were sized for the 25-year, 24-hour storm event using the Manning's equation to determine the depth of flow and velocity in the berm/ditch based on the berm/ditch geometry and peak flow in the berm/ditch (as determined by the Hydrograph Generation calculations). The Iowa NRCS Rock Chute Design spreadsheet was used for steep-slope locations.

Downslope Flume and Energy Dissipator Sizing
The downslope flume inlets were sized for the 25-year, 24-hour storm event using the orifice equation. The downslope flume pipes were sized based on the peak flow conditions in the pipe using Manning's equation. Energy dissipators were sized using tables from the reference book "Hydraulic Design of Energy Dissipators for Culvert and Channels," US Department of Transportation, Federal Highway Administration, July 2006.

Culvert Sizing
The culverts were sized for the 25-year, 24-hour storm event using the HY-8 computer model developed by the US Department of Transportation, Federal Highway Administration. Culvert outlet protection was sizing using guidance from the Iowa Statewide Urban Design and Specifications (SUDAS) Design Manual, Chapter 7E-10 – Riprap.

Haul Road Culvert Sizing
Culverts were sized for the 25-year, 24-hour storm event for placement under the haul road.

Sedimentation Basin Sizing
The permanent sedimentation basin sizing process involved determining an appropriate ratio of surface area to flow rate that would allow particles to settle out during a design storm event. The sedimentation

basins were sized for the 25-year, 24-hour storm event. The sedimentation basin emergency spillways were sized for the 100-year, 24-hour storm event.

A table presented in the "Erosion and Sediment Control Handbook" (Goldman, et. Al., 1986) provides the surface area-to-discharge ratio required to achieve settlement of the desired particle sizes.

The HydroCAD model was used in conjunction with accepted formulas and engineering calculations to size the sedimentation basins.

Key Assumptions:

- Runoff curve numbers were based on tables presented in Urban Hydrology for Small Watersheds, and were assumed as follows

Cover Type	CN
Landfill final cover	74 – Pasture/grassland/range in good condition, hydrologic soil group C
Gravel access road	96 – Compacted gravel surface
Sedimentation basins	98 – Water surface

- A Type II rainfall distribution was used, based on figures presented in Urban Hydrology for Small Watersheds. The following precipitation depths were assumed.

Storm Event	Precipitation Depth (inches)
2-year, 24-hour	3.14
25-year, 24-hour	5.67
100-year, 24-hour	7.59

- Other assumptions are included with the calculations attached to this appendix.

Results:

The proposed landfill surface water management system design meets the requirements of the Iowa Administrative Code, Environmental Protection Commission [567], Chapter 113.7(8)a(2). Further details are provided below.

Soil Loss

The USLE calculations indicate a minimal soil loss rate along the 20H:1V final cover sideslopes. Therefore, the 4H:1V final cover sideslopes were used to determine appropriate diversion berm spacing. The USLE calculations indicate that a 300 ft slope length will result in a soil loss rate of 3.0 tons/acre; therefore, diversion berms have been added at a maximum spacing of 300 ft to provide protection against rill formation along the final cover, to provide outlets for the final cover intermediate drains, and to provide soil loss reduction measures during vegetation establishment. Refer to the USLE Calculations section of this appendix for the detailed calculations.

Hydrograph Generation

The hydrograph modeling results for the 25-year and 100-year, 24-hour storm events are included the Hydrograph Generation section of this appendix.

Perimeter Ditch and Diversion Berm Sizing

The diversion berms will be constructed as shown on the plan set. The diversion berms will maintain a minimum 0.5 foot freeboard. Refer to the Diversion Berm and Ditch Sizing section of this appendix for the detailed calculations.

The perimeter ditches will be constructed as shown on the plan set. The perimeter ditches will contain the runoff from the 25-year, 24-hour storm event and maintain a minimum 0.5 foot of freeboard. Two rock-lined channels will be constructed as shown on the plan set. Refer to the Diversion Berm and Ditch Sizing section of this appendix for the detailed calculations.

Downslope Flume and Energy Dissipator Sizing

The downslope flumes will be constructed as shown on the plan set. The downslope flumes are designed to accommodate the surface water runoff from the final cover for a 25-year, 24-hour storm event. Energy dissipators at the bottom of the downslope flumes have been designed to handle the peak velocities, and additional riprap protection has been sized for the energy dissipator outlets. Refer to the Downslope Flume and Energy Dissipator Sizing section of this appendix for the detailed calculations.

Culvert Sizing

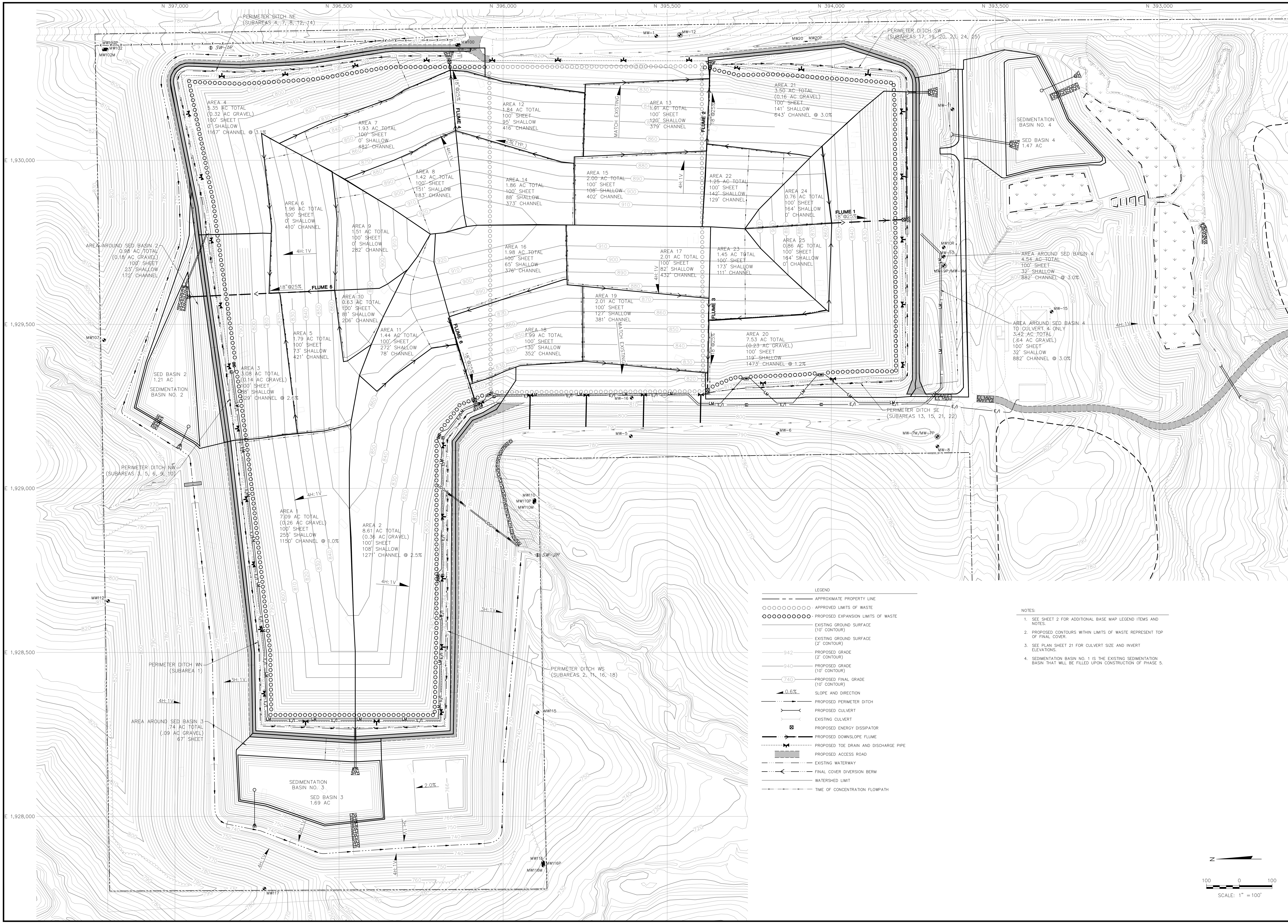
The culverts are designed to accommodate the flows from the perimeter ditches for the 25-year, 24-hour storm event. Riprap outlet protection has been sized based on the discharge rates and outlet velocities. Refer to the Culvert Sizing section of this appendix for the detailed calculations.

Haul Road Culvert Sizing

Culverts are designed to route flows from the stream for the 25-year, 24-hour storm event. Refer to the Haul Road Culvert Sizing section of this appendix for the detailed calculations. Refer to the Stream and Wetland Mitigation Plan for additional information on the stream crossing.

Sedimentation Basin Sizing

The principal outlet structures for the sedimentation basins are sized to control runoff from the 25-year, 24-hour storm event, assuming the starting water elevation is at the bottom of the lowest outlet structure opening. The sedimentation basins are designed to settle out particles 17 microns and larger in diameter. Refer to the Sedimentation Basin Sizing section of this appendix for the detailed calculations. The emergency spillways have been designed to pass the 100-year, 24-hour storm event.


N 397,000
N 396,500
N 396,000
N 395,500
N 394,000
N 393,500
N 393,000
E 1,930,000
E 1,929,500
E 1,929,000
E 1,928,500
E 1,928,000
PERIMETER DITCH NE
(SUBAREAS 4, 7, 8, 12, 14)
PERIMETER DITCH SW
(SUBAREAS 17, 19, 20, 23, 24, 25)
AREA 4
5.35 AC TOTAL
(0.32 AC GRAVEL)
100' SHEET
0' SHALLOW
1167' CHANNEL @ 3.1%
AREA 7
1.93 AC TOTAL
100' SHEET
0' SHALLOW
482' CHANNEL
AREA 12
1.84 AC TOTAL
100' SHEET
95' SHALLOW
416' CHANNEL
AREA 13
1.91 AC TOTAL
100' SHEET
120' SHALLOW
379' CHANNEL
AREA 21
3.50 AC TOTAL
(0.16 AC GRAVEL)
100' SHEET
141' SHALLOW
643' CHANNEL @ 3.0%
SEDIMENTATION BASIN NO. 4
SED BASIN 4
1.47 AC
AREA 8
1.42 AC TOTAL
100' SHEET
151' SHALLOW
183' CHANNEL
AREA 14
1.86 AC TOTAL
100' SHEET
88' SHALLOW
373' CHANNEL
AREA 15
2.00 AC TOTAL
100' SHEET
108' SHALLOW
402' CHANNEL
AREA 22
1.25 AC TOTAL
100' SHEET
142' SHALLOW
129' CHANNEL
AREA 24
0.76 AC TOTAL
100' SHEET
164' SHALLOW
0' CHANNEL
FLUME 1
18"@25%
FLUME 2
FLUME 3
FLUME 4
FLUME 5
FLUME 6
MATCH EXISTING
AREA 6
1.96 AC TOTAL
100' SHEET
0' SHALLOW
410' CHANNEL
AREA 9
1.51 AC TOTAL
100' SHEET
0' SHALLOW
282' CHANNEL
AREA 16
1.98 AC TOTAL
100' SHEET
65' SHALLOW
376' CHANNEL
AREA 17
2.01 AC TOTAL
100' SHEET
82' SHALLOW
432' CHANNEL
AREA 23
1.45 AC TOTAL
100' SHEET
173' SHALLOW
111' CHANNEL
AREA 25
0.86 AC TOTAL
100' SHEET
164' SHALLOW
0' CHANNEL
AREA AROUND SED BASIN 4
4.54 AC TOTAL
100' SHEET
32' SHALLOW
882' CHANNEL @ 3.0%
AREA AROUND SED BASIN 2
0.98 AC TOTAL
(0.18 AC GRAVEL)
100' SHEET
23' SHALLOW
172' CHANNEL
AREA 10
0.63 AC TOTAL
100' SHEET
81' SHALLOW
206' CHANNEL
AREA 19
2.01 AC TOTAL
100' SHEET
127' SHALLOW
381' CHANNEL
AREA AROUND SED BASIN 4
TO CULVERT 4 ONLY
3.42 AC TOTAL
(.64 AC GRAVEL)
100' SHEET
32' SHALLOW
882' CHANNEL @ 3.0%
AREA 5
1.79 AC TOTAL
100' SHEET
73' SHALLOW
421' CHANNEL
AREA 11
1.44 AC TOTAL
100' SHEET
272' SHALLOW
78' CHANNEL
AREA 18
1.99 AC TOTAL
100' SHEET
130' SHALLOW
352' CHANNEL
AREA 20
7.53 AC TOTAL
(0.23 AC GRAVEL)
100' SHEET
119' SHALLOW
1473' CHANNEL @ 1.2%
SED BASIN 2
1.21 AC
SEDIMENTATION BASIN NO. 2
AREA 3
3.08 AC TOTAL
(0.14 AC GRAVEL)
100' SHEET
38' SHALLOW
229' CHANNEL @ 2.6%
PERIMETER DITCH SE
(SUBAREAS 13, 15, 21, 22)
PERIMETER DITCH NW
(SUBAREAS 3, 5, 6, 9, 10)
AREA 1
7.09 AC TOTAL
(0.26 AC GRAVEL)
100' SHEET
255' SHALLOW
1150' CHANNEL @ 1.0%
AREA 2
8.61 AC TOTAL
(0.36 AC GRAVEL)
100' SHEET
108' SHALLOW
1271' CHANNEL @ 2.5%
PERIMETER DITCH WN
(SUBAREA 1)
PERIMETER DITCH WS
(SUBAREAS 2, 11, 16, 18)
AREA AROUND SED BASIN 3
.74 AC TOTAL
(.09 AC GRAVEL)
67' SHEET
SEDIMENTATION BASIN NO. 3
SED BASIN 3
1.69 AC
2.0%
4H:1V
3H:1V
SW-1R
SW-2R
LEGEND
APPROXIMATE PROPERTY LINE
APPROVED LIMITS OF WASTE
PROPOSED EXPANSION LIMITS OF WASTE
EXISTING GROUND SURFACE (10' CONTOUR)
EXISTING GROUND SURFACE (2' CONTOUR)
942 PROPOSED GRADE (2' CONTOUR)
940 PROPOSED GRADE (10' CONTOUR)
740 PROPOSED FINAL GRADE (10' CONTOUR)
0.6% SLOPE AND DIRECTION
PROPOSED PERIMETER DITCH
PROPOSED CULVERT
EXISTING CULVERT
PROPOSED ENERGY DISSIPATOR
PROPOSED DOWNSLOPE FLUME
PROPOSED TOE DRAIN AND DISCHARGE PIPE
PROPOSED ACCESS ROAD
EXISTING WATERWAY
FINAL COVER DIVERSION BERM
WATERSHED LIMIT
TIME OF CONCENTRATION FLOWPATH
N
100 0 100
SCALE: 1" = 100'

NOTES:

1. SEE SHEET 2 FOR ADDITIONAL BASE MAP LEGEND ITEMS AND NOTES.
2. PROPOSED CONTOURS WITHIN LIMITS OF WASTE REPRESENT TOP OF FINAL COVER.
3. SEE PLAN SHEET 21 FOR CULVERT SIZE AND INVERT ELEVATIONS.
4. SEDIMENTATION BASIN NO. 1 IS THE EXISTING SEDIMENTATION BASIN THAT WILL BE FILLED UPON CONSTRUCTION OF PHASE 5.

FIGURE 1

PROPOSED FINAL GRADES AND SURFACE WATER MANAGEMENT

PERMIT AMENDMENT PLANS
NORTH & SOUTH EXPANSION
OTTUMWA MIDLAND LANDFILL
OTTUMWA, IOWA

SITE

INTERSTATE POWER AND LIGHT COMPANY
OTTUMWA MIDLAND LANDFILL
15300 130TH STREET
OTTUMWA, IOWA 52501

CLIENT

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

ENGINEER

PROJECT NO.	25211509.03	DRAWN BY:	EN/KP
DRAWN:	11/26/12	CHECKED BY:	BP/EN
REVISED:	11/26/13	APPROVED BY:	BP 11/26/13

USLE Calculation

SCS ENGINEERS

		Sheet No.	1 of 6
		Calc. No.	
		Rev. No.	
Job No. 25211509.03	Job: Proposed Expansion	By: BLP	Date: 9/25/13
Client: IPL	Subject: Soil Loss Along Final Cover	Chk'd: JMO	Date: 10/14/2013

Universal Soil Loss Equation (USLE) Calculation

Use USLE to estimate soil loss along the 5% final cover slope, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

USLE Equation:

A = R * K * LS * C * P

where: A = Average annual soil loss, ton/acre
R = Rainfall and runoff erosivity index
K = Soil erodibility factor, tons/acre
LS = Slope length and steepness factor
C = Cover management factor
P = Practice factor

The LS factor is a function of the slope and flow length.

LS = L * S

where: L = Slope length factor = (l/72.6)^m

where: l = Slope length, feet
m = Slope-length exponent (m = 0.3 for slopes of 1% to 3%
m = 0.4 for slopes of 3.5% to 4.5%
m = 0.5 for slopes greater than 5%)

S = Slope steepness factor = (65.41s^2/(s^2 + 10,000)) + (4.56s/(SQRT(s^2 + 10,000))) + 0.065

where: s = Slope, in percent

The soil type chosen for selecting the appropriate K factor is based on surface soil descriptions included in Table 5 of the Expansion Soil and Hydrogeologic Investigation Report (SCS, September 2013). The top layer of surface soils consists of silt loam, silty clay loam, and loam, with the majority consisting of silt loam. Silt loam with an organic matter content of 2% was assumed.

Data Entered		**Data Computed**		
Slope (%), s =	5	S =	0.46	
l =	80	L =	1.0	(Note: 80 feet is the maximum slope length along the 5% slope)
m =	0.5	LS =	0.5	

Calculate Average Annual Soil Loss, A:

R =	175	*
K =	0.42	*
LS =	0.5	
C =	0.004	*
P =	1.0	*

A = R * K * LS * C * P = 0.1 tons/acre

* See attached references for R, K, C, and P factors

Soil loss along the 5% slope of the final cover results in minimal soil loss. Diversion berm spacing along the 25% final cover slope are more critical.

Universal Soil Loss Equation (USLE) Calculation

Use USLE to estimate soil loss along the 25% final cover slope, with the goal of maintaining ≤ 3 ton/acre of soil loss along the final cover.

USLE Equation:

A = R * K * LS * C * P

where: A = Average annual soil loss, ton/acre
R = Rainfall and runoff erosivity index
K = Soil erodibility factor, tons/acre
LS = Slope length and steepness factor
C = Cover management factor
P = Practice factor

The LS factor is a function of the slope and flow length.

LS = L * S

where: L = Slope length factor = (l/72.6)^m

where: l = Slope length, feet

m = Slope-length exponent (m = 0.3 for slopes of 1% to 3%
m = 0.4 for slopes of 3.5% to 4.5%
m = 0.5 for slopes greater than 5%)

S = Slope steepness factor = (65.41s^2/(s^2 + 10,000)) + (4.56s/(SQRT(s^2 + 10,000))) + 0.065

where: s = Slope, in percent

The soil type chosen for selecting the appropriate K factor is based on surface soil descriptions included in Table 5 of the Expansion Soil and Hydrogeologic Investigation Report (SCS, September 2013). The top layer of surface soils consists of silt loam, silty clay loam, and loam, with the majority consisting of silt loam. Silt loam with an organic matter content of 2% was assumed.

Data Entered		**Data Computed**	
Slope (%), s =	25	S =	5.02
l =	300	L =	2.0
m =	0.5	LS =	10.2

Calculate Average Annual Soil Loss, A:

R =	175	*
K =	0.42	*
LS =	10.2	
C =	0.004	*
P =	1.0	*

A = R * K * LS * C * P = 3.0 tons/acre

* See attached references for R, K, C, and P factors

A maximum length of 300 feet should be provided between diversion berms along the 25% slope to maintain ≤ 3 ton/acre of soil loss along the final cover; this equates to maximum diversion berm spacing of 75 feet vertically.

Not only is erosion objectionable in itself but erosion can degrade the cover and seriously reduce its effectiveness.

Evaluate Erosion Potential — Step 19

The USDA universal soil loss equation (USLE) is a convenient tool for use in evaluating erosion potential. The USLE predicts average annual soil loss as the product of six quantifiable factors. The equation is:

$$A = R\,K\,L\,S\,C\,P$$

where A = average annual soil loss, in tons/acre
R = rainfall and runoff erosivity index
K = soil erodibility factor, tons/acre
L = slope-length factor
S = slope-steepness factor
C = cover-management factor
P = practice factor

The data necessary as input to this equation are available to the evaluator in a figure and tables included below. Note that the evaluations in Step 8 on soil composition and Steps 25-32 on vegetation all impact on the evaluation of erosion also.

Factor R in the USLE can be calculated empirically from climatological data. For average annual soil loss determinations, however, R can be obtained directly from Figure 20. Factor K, the average soil loss for a given

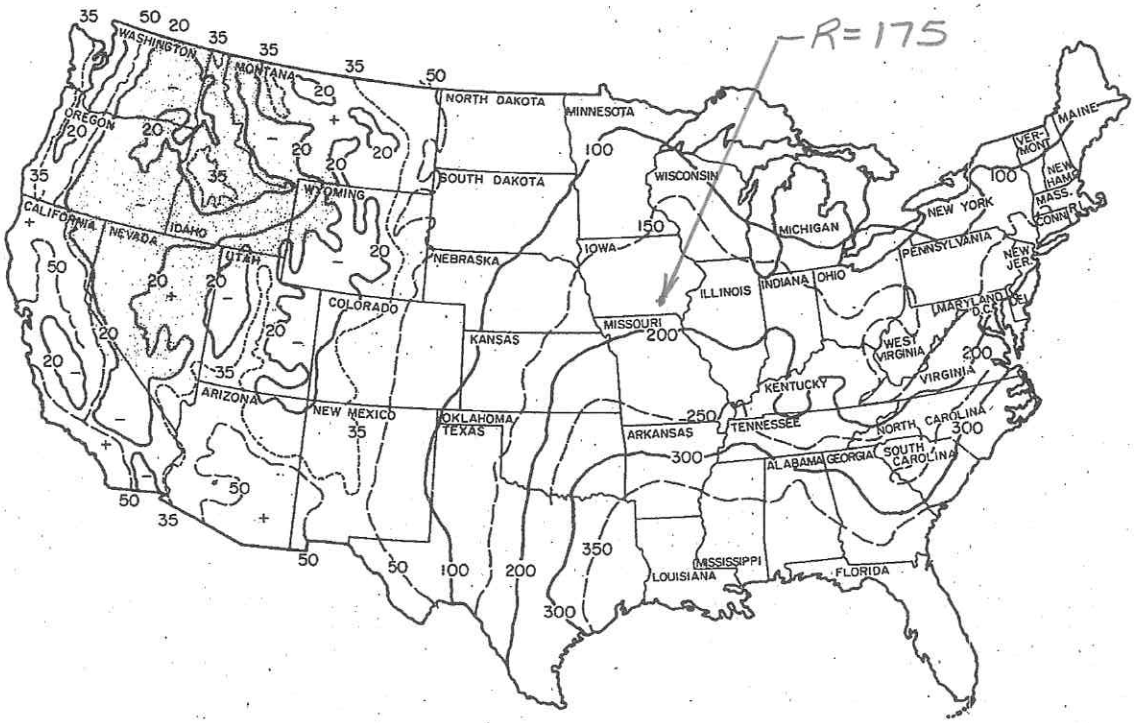


Figure 20. Average annual values of rainfall-erosivity factor R.[11]

soil in a unit plot, pinpoints differences in erosion according to differences in soil type. Long-term plot studies under natural rainfall have produced K values generalized in Table 5 for the USDA soil types.

TABLE 5. APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES[11]

Texture class	Organic matter content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

The evaluator must next consider the shape of the slope in terms of length and inclination. The appropriate LS factor is obtained from Table 6. A nonlinear slope may have to be evaluated as a series of segments, each with uniform gradient. Two or three segments should be sufficient for most engineered landfills, provided the segments are selected so that they are also of equal length (Table 6 can be used, with certain adjustments). Enter Table 6 with the total slope length and read LS values corresponding to the percent slope of each segment. For three segments, multiply the chart LS values for the upper, middle, and lower segments by 0.58, 1.06, and 1.37, respectively. The average of the three products is a good estimate of the

TABLE 7. GENERALIZED VALUES OF FACTOR C FOR STATES EAST OF THE ROCKY MOUNTAINS[11]

Crop, rotation, and management	Productivity level	
	High	Mod.
	C value	
Base value: continuous fallow, tilled up and down slope	1.00	1.00
CORN		
C, RdR, fall TP, conv	0.54	0.62
C, RdR, spring TP, conv	.50	.59
C, RdL, fall TP, conv	.42	.52
C, RdR, wc seeding, spring TP, conv	.40	.49
C, RdL, standing, spring TP, conv	.38	.48
C-W-M-M, RdL, TP for C, disk for W	.039	.074
C-W-M-M-M, RdL, TP for C, disk for W	.032	.061
C, no-till pl in c-k sod, 95-80% rc	.017	.053
COTTON		
Cot, conv (Western Plains)	0.42	0.49
Cot, conv (South)	.34	.40
MEADOW		
Grass & Legume mix	0.004	0.01
Alfalfa, lespedeza or Sericia	.020	
Sweet clover	.025	
SORGHUM, GRAIN (Western Plains)		
RdL, spring TP, conv	0.43	0.53
No-till pl in shredded 70-50% rc	.11	.18
SOYBEANS		
B, RdL, spring TP, conv	0.48	0.54
C-B, TP annually, conv	.43	.51
B, no-till pl	.22	.28
C-B, no-till pl, fall shred C stalks	.18	.22
WHEAT		
W-F, fall TP after W	0.38	
W-F, stubble mulch, 500 lbs rc	.32	
W-F, stubble mulch, 1000 lbs rc	.21	

Abbreviations defined:

B - soybeans
C - corn
c-k - chemically killed
conv - conventional
cot - cotton
F - fallow
M - grass & legume hay
pl - plant
W - wheat
wc - winter cover

lbs rc - pounds of crop residue per acre remaining on surface after new crop seeding
% rc - percentage of soil surface covered by residue mulch after new crop seeding
70-50% rc - 70% cover for C values in first column; 50% for second column
RdR - residues (corn stover, straw, etc.) removed or burned
RdL - all residues left on field (on surface or incorporated)
TP - turn plowed (upper 5 or more inches of soil inverted, covering residues)

are listed in Table 8. These values are based on rather limited field data, but P has a narrower range of possible values than the other five factors.

TABLE 8. VALUES OF FACTOR P[11]

Practice	Land slope (percent)				
	1.1-2	2.1-7	7.1-12	12.1-18	18.1-24
	(Factor P)				
Contouring (P_c)	0.60	0.50	0.60	0.80	0.90
Contour strip cropping (P_{sc})					
R-R-M-M[1]	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting (P_{c1})	0.30	0.25	0.30	0.40	0.45
Contour terracing (P_t)[2]	[3] $0.6/\sqrt{n}$	$0.5/\sqrt{n}$	$0.6/\sqrt{n}$	$0.8/\sqrt{n}$	$0.9/\sqrt{n}$
No support practice	1.0	1.0	1.0	1.0	1.0

[1] R = rowcrop, W = fall-seeded grain, O = spring-seeded grain, M = meadow. The crops are grown in rotation and so arranged on the field that rowcrop strips are always separated by a meadow or winter-grain strip.

[2] These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[3] n = number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

Example: An owner/operator proposes to close one section of his small landfill with a sandy clay subsoil cover having the surface configuration shown in Figure 21. The factor R has been established as 200 for this locality. The evaluator questions anticipated erosion along the steep side and assigns the following values to the other factors in the USLE after inspecting Tables 5 through 8:

K = 0.14 LS = 8.3 C = 1.00 P = 0.90

The rate of erosion for the steep slope of the landfill is calculated as follows:

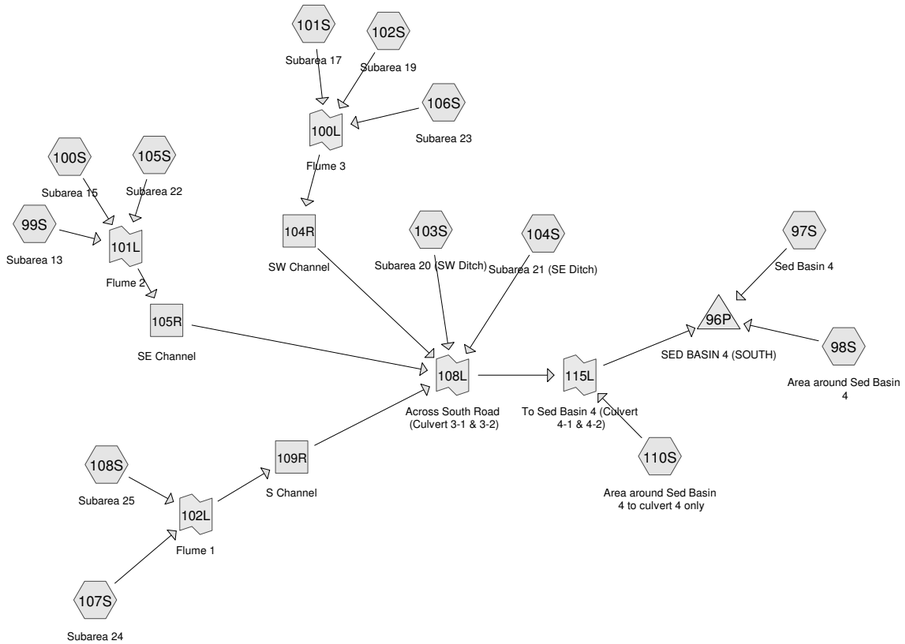
A = 200 (0.14 tons/acre) (8.3) (1.00) (0.90)
= 209 tons/acre

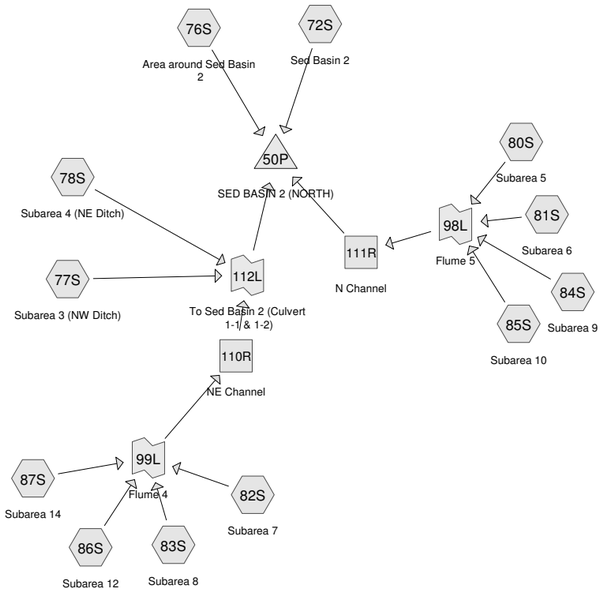
This erosion not only exceeds a limit recommended by the permitting authority but also indicates a potential

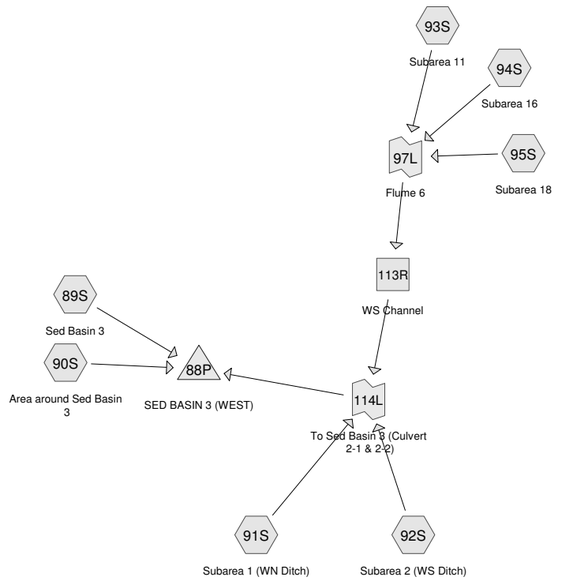
Hydrograph Generation

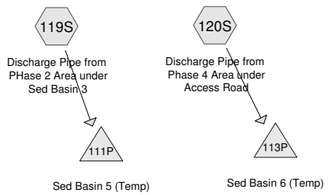
- 25-year, 24-hour Storm Event
- 100-year, 24-hour Storm Event

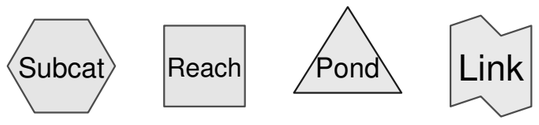
25-year, 24-hour Storm











Drainage Diagram for Post development sw calcs_131025

Prepared by SCS Engineers, Printed 10/25/2013

Summary for Subcatchment 72S: Sed Basin 2

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 10.99 cfs @ 11.89 hrs, Volume= 0.548 af, Depth> 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.210	98	Water
	1.210		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Water**

Summary for Subcatchment 76S: Area around Sed Basin 2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 6.94 cfs @ 11.92 hrs, Volume= 0.309 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	0.980	74	Grass
*	0.180	96	Gravel Road
	1.160	77	Weighted Average
	1.160		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0150	1.21		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.2	23	0.0150	1.97		**Shallow Concentrated Flow, flow across access road** Unpaved Kv= 16.1 fps
0.5	172	0.0800	5.37	9.55	**Trap/Vee/Rect Channel Flow, Channel down to basin** Bot.W=0.00' D=0.77' Z= 3.0 '/' Top.W=4.62' n= 0.040
2.1	295	Total			

Summary for Subcatchment 77S: Subarea 3 (NW Ditch)

Runoff = 15.50 cfs @ 11.99 hrs, Volume= 0.771 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	2.940	74	Final Cover
*	0.140	96	Gravel Access Road
	3.080	75	Weighted Average
	3.080		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	88	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
3.2	629	0.0260	3.28	17.18	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.46' Z= 3.0 '/' Top.W=12.76' n= 0.040
7.2	817	Total			

Summary for Subcatchment 78S: Subarea 4 (NE Ditch)

Runoff = 27.15 cfs @ 11.98 hrs, Volume= 1.339 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	5.030	74	Final Cover
*	0.320	96	Gravel Access Road
	5.350	75	Weighted Average
	5.350		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	64	0.2500	0.42		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
4.4	1,173	0.0310	4.39	34.12	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.65' Z= 3.0 '/' Top.W=13.90' n= 0.040
6.9	1,237	Total			

Summary for Subcatchment 80S: Subarea 5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 9.11 cfs @ 11.97 hrs, Volume= 0.434 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.790	74	Final Cover
	1.790		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.3	73	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.7	421	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.6	594	Total			

Summary for Subcatchment 81S: Subarea 6

[49] Hint: Tc<2dt may require smaller dt

Runoff = 10.15 cfs @ 11.96 hrs, Volume= 0.475 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.960	74	Final Cover
	1.960		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
1.6	410	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.2	510	Total			

Summary for Subcatchment 82S: Subarea 7

[49] Hint: Tc<2dt may require smaller dt

Runoff = 9.82 cfs @ 11.97 hrs, Volume= 0.468 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.930	74	Final Cover
	1.930		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	83	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.6	399	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.6	582	Total			

Summary for Subcatchment 83S: Subarea 8

[49] Hint: Tc<2dt may require smaller dt

Runoff = 7.42 cfs @ 11.96 hrs, Volume= 0.344 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.420	74	Final Cover
	1.420		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.7	151	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.7	183	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.0	434	Total			

Summary for Subcatchment 84S: Subarea 9

[49] Hint: Tc<2dt may require smaller dt

Runoff = 8.00 cfs @ 11.95 hrs, Volume= 0.366 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.510	74	Final Cover
	1.510		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
1.1	282	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
4.7	382	Total			

Summary for Subcatchment 85S: Subarea 10

[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.32 cfs @ 11.96 hrs, Volume= 0.153 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	0.630	74	Final Cover
	0.630		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	81	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.8	206	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
4.8	387	Total			

Summary for Subcatchment 86S: Subarea 12

[49] Hint: Tc<2dt may require smaller dt

Runoff = 9.32 cfs @ 11.97 hrs, Volume= 0.446 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.840	74	Final Cover
	1.840		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.5	95	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.6	416	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	611	Total			

Summary for Subcatchment 87S: Subarea 14

[49] Hint: Tc<2dt may require smaller dt

Runoff = 9.50 cfs @ 11.96 hrs, Volume= 0.451 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.860	74	Final Cover
	1.860		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	88	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.5	373	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.5	561	Total			

Summary for Subcatchment 89S: Sed Basin 3

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 15.34 cfs @ 11.89 hrs, Volume= 0.765 af, Depth> 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.690	98	Water
	1.690		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Water**

Summary for Subcatchment 90S: Area around Sed Basin 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 4.66 cfs @ 11.90 hrs, Volume= 0.197 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	0.650	74	Grass
*	0.090	96	Gravel Road
	0.740	77	Weighted Average
	0.740		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	67	0.0150	1.12		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"

Summary for Subcatchment 91S: Subarea 1 (WN Ditch)

[49] Hint: Tc<2dt may require smaller dt

Runoff = 37.50 cfs @ 11.96 hrs, Volume= 1.774 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	6.830	74	Final Cover
*	0.260	96	Gravel Access Road
	7.090	75	Weighted Average
	7.090		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
1.2	255	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.6	1,150	1.0000	31.01	378.54	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.95' Z= 3.0 '/' Top.W=15.70' n= 0.040
5.4	1,505	Total			

Summary for Subcatchment 92S: Subarea 2 (WS Ditch)

Runoff = 41.15 cfs @ 12.00 hrs, Volume= 2.155 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	8.250	74	Final Cover
*	0.360	96	Gravel Access Road
	8.610	75	Weighted Average
	8.610		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.5	108	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
4.6	1,271	0.0250	4.60	49.11	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.85' Z= 3.0 '/' Top.W=15.10' n= 0.040
8.7	1,479	Total			

Summary for Subcatchment 93S: Subarea 11

[49] Hint: Tc<2dt may require smaller dt

Runoff = 7.46 cfs @ 11.96 hrs, Volume= 0.349 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.440	74	Final Cover
	1.440		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
1.3	272	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.3	78	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.2	450	Total			

Summary for Subcatchment 94S: Subarea 16

[49] Hint: Tc<2dt may require smaller dt

Runoff = 10.16 cfs @ 11.96 hrs, Volume= 0.480 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.980	74	Final Cover
	1.980		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.3	65	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.5	376	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.4	541	Total			

Summary for Subcatchment 95S: Subarea 18

[49] Hint: Tc<2dt may require smaller dt

Runoff = 10.12 cfs @ 11.97 hrs, Volume= 0.482 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.990	74	Final Cover
	1.990		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.6	130	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.4	352	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.6	582	Total			

Summary for Subcatchment 97S: Sed Basin 4

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 13.35 cfs @ 11.89 hrs, Volume= 0.665 af, Depth> 5.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.470	98	Water
	1.470		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Water**

Summary for Subcatchment 98S: Area around Sed Basin 4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 6.10 cfs @ 11.96 hrs, Volume= 0.289 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.030	74	Grass
*	0.090	96	Gravel Access Road
	1.120	76	Weighted Average
	1.120		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0150	1.21		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.2	32	0.2500	3.50		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
3.8	882	0.0300	3.91	11.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 3.0 '/' Top.W=6.00' n= 0.040
5.4	1,014	Total			

Summary for Subcatchment 99S: Subarea 13

[49] Hint: Tc<2dt may require smaller dt

Runoff = 9.67 cfs @ 11.97 hrs, Volume= 0.463 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.910	74	Final Cover
	1.910		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.6	120	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.5	379	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	599	Total			

Summary for Subcatchment 100S: Subarea 15

[49] Hint: Tc<2dt may require smaller dt

Runoff = 10.13 cfs @ 11.97 hrs, Volume= 0.485 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	2.000	74	Final Cover
	2.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.5	108	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.6	402	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	610	Total			

Summary for Subcatchment 101S: Subarea 17

[49] Hint: Tc<2dt may require smaller dt

Runoff = 10.18 cfs @ 11.97 hrs, Volume= 0.487 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	2.010	74	Final Cover
	2.010		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	82	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.7	432	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	614	Total			

Summary for Subcatchment 102S: Subarea 19

[49] Hint: Tc<2dt may require smaller dt

Runoff = 10.18 cfs @ 11.97 hrs, Volume= 0.487 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	2.010	74	Final Cover
	2.010		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.6	127	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.5	381	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	608	Total			

Summary for Subcatchment 103S: Subarea 20 (SW Ditch)

Runoff = 32.49 cfs @ 12.04 hrs, Volume= 1.884 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	7.300	74	Final Cover
*	0.230	96	Access Road Gravel
	7.530	75	Weighted Average
	7.530		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.6	119	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
7.4	1,473	0.0116	3.34	40.77	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.95' Z= 3.0 '/' Top.W=15.70' n= 0.040
11.6	1,692	Total			

Summary for Subcatchment 104S: Subarea 21 (SE Ditch)

Runoff = 17.56 cfs @ 11.99 hrs, Volume= 0.876 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	3.340	74	Final Cover
*	0.160	96	Gravel Access Road
	3.500	75	Weighted Average
	3.500		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.7	141	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
3.0	643	0.0300	3.53	18.45	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.46' Z= 3.0 '/' Top.W=12.76' n= 0.040
7.3	884	Total			

Summary for Subcatchment 105S: Subarea 22

[49] Hint: Tc<2dt may require smaller dt

Runoff = 6.59 cfs @ 11.96 hrs, Volume= 0.303 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.250	74	Final Cover
	1.250		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.7	142	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.5	129	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
4.8	371	Total			

Summary for Subcatchment 106S: Subarea 23

[49] Hint: Tc<2dt may require smaller dt

Runoff = 7.65 cfs @ 11.96 hrs, Volume= 0.352 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.450	74	Final Cover
	1.450		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.8	173	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.4	111	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
4.8	384	Total			

Summary for Subcatchment 107S: Subarea 24

[49] Hint: Tc<2dt may require smaller dt

Runoff = 4.08 cfs @ 11.95 hrs, Volume= 0.184 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	0.760	74	Final Cover
	0.760		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.8	164	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
4.4	264	Total			

Summary for Subcatchment 108S: Subarea 25

[49] Hint: Tc<2dt may require smaller dt

Runoff = 4.61 cfs @ 11.95 hrs, Volume= 0.209 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	0.860	74	Final Cover
	0.860		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.8	164	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
4.4	264	Total			

Summary for Subcatchment 110S: Area around Sed Basin 4 to culvert 4 only

[49] Hint: Tc<2dt may require smaller dt

Runoff = 20.54 cfs @ 11.95 hrs, Volume= 0.937 af, Depth= 3.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	2.780	74	Grass
*	0.640	96	Gravel Access Road
	3.420	78	Weighted Average
	3.420		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0150	1.21		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.2	32	0.2500	3.50		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
2.8	882	0.0300	5.32	21.27	**Channel Flow, Channel flow** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.030 Earth, grassed & winding
4.4	1,014	Total			

Summary for Subcatchment 111S: West Rock-lined Channel (vegetation established)

Runoff = 51.10 cfs @ 11.99 hrs, Volume= 2.565 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
	9.570	74	>75% Grass cover, Good, HSG C
*	0.680	96	Gravel Access Road
	10.250	75	Weighted Average
	10.250		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.2500	3.74		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.6	78	0.1000	2.21		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
6.5	1,177	0.0200	3.01	13.99	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=0.88' Z= 6.0 '/' Top.W=10.56' n= 0.040
7.5	1,355	Total			

Summary for Subcatchment 112S: West Rock-lined Channel (worst case)

Runoff = 72.72 cfs @ 11.98 hrs, Volume= 3.959 af, Depth= 4.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
	9.570	91	Fallow, bare soil, HSG C
*	0.680	96	Gravel Access Road
	10.250	91	Weighted Average
	10.250		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.2500	3.74		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.6	78	0.1000	2.21		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
6.5	1,177	0.0200	3.01	13.99	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=0.88' Z= 6.0 '/' Top.W=10.56' n= 0.040
7.5	1,355	Total			

Summary for Subcatchment 113S: Culvert 5-1 (Ph 1 Access Road

Runoff = 3.05 cfs @ 11.98 hrs, Volume= 0.148 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	0.610	74	Grass
	0.610		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	100	0.2400	0.31		**Sheet Flow, Sheet flow** Grass: Dense n= 0.240 P2= 3.14"
1.0	182	0.1800	2.97		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
6.3	282	Total			

Summary for Subcatchment 116S: Culvert 12-1 (Across LF Perimeter Road

Runoff = 12.23 cfs @ 11.99 hrs, Volume= 0.625 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (sf)	CN	Description
*	88,968	74	Final Cover
*	13,311	96	Access Road Gravel
	102,279	77	Weighted Average
	102,279		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	11	0.3300	0.33		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
7.3	1,378	0.0102	3.13	38.23	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.95' Z= 3.0 '/' Top.W=15.70' n= 0.040
7.9	1,389	Total			

Summary for Subcatchment 117S: Culvert 11-1 (Ph 5 Access Road)

Runoff = 7.80 cfs @ 12.06 hrs, Volume= 0.491 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	2.025	74	Grass
	2.025		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0	100	0.0500	0.17		**Sheet Flow, Sheet flow** Grass: Dense n= 0.240 P2= 3.14"
4.1	505	0.0871	2.07		**Shallow Concentrated Flow, Shallow Flow to culvert** Short Grass Pasture Kv= 7.0 fps
14.1	605	Total			

Summary for Subcatchment 118S: Culvert 15-1 (Ph 3 Access Road)

[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.03 cfs @ 11.92 hrs, Volume= 0.136 af, Depth= 3.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (sf)	CN	Description
*	14,820	74	Grass
*	5,567	96	Access Road Gravel
	20,387	80	Weighted Average
	20,387		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	60	0.0330	1.50		**Sheet Flow, Sheet flow across final cover** Smooth surfaces n= 0.011 P2= 3.14"
1.3	293	0.0650	3.63	2.72	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=0.00' D=0.50' Z= 3.0 '/' Top.W=3.00' n= 0.040
2.0	353	Total			

Summary for Subcatchment 119S: Discharge Pipe from PHase 2 Area under Sed Basin 3

Runoff = 26.22 cfs @ 12.18 hrs, Volume= 2.242 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	9.248	74	Grass
	9.248		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	100	0.0600	0.26		**Sheet Flow, Sheet flow across access road** Grass: Short n= 0.150 P2= 3.14"
18.3	983	0.0163	0.89		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
24.7	1,083	Total			

Summary for Subcatchment 120S: Discharge Pipe from Phase 4 Area under Access Road

Runoff = 5.28 cfs @ 12.06 hrs, Volume= 0.334 af, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	1.379	74	Grass
	1.379		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	100	0.1900	0.41		**Sheet Flow, Sheet flow across access road** Grass: Short n= 0.150 P2= 3.14"
10.3	382	0.0078	0.62		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
14.3	482	Total			

Summary for Reach 104R: SW Channel

Inflow Area = 5.470 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 27.96 cfs @ 11.96 hrs, Volume= 1.326 af
Outflow = 19.86 cfs @ 12.19 hrs, Volume= 1.326 af, Atten= 29%, Lag= 13.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.64 fps, Min. Travel Time= 9.3 min
Avg. Velocity = 0.55 fps, Avg. Travel Time= 44.8 min

Peak Storage= 11,086 cf @ 12.03 hrs, Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 161.13 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 1,467.0' Slope= 0.0116 '/'
Inlet Invert= 812.00', Outlet Invert= 795.00'

‡

Summary for Reach 105R: SE Channel

Inflow Area = 5.160 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 26.35 cfs @ 11.96 hrs, Volume= 1.251 af
Outflow = 24.51 cfs @ 12.04 hrs, Volume= 1.251 af, Atten= 7%, Lag= 4.6 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.88 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.87 fps, Avg. Travel Time= 12.3 min

Peak Storage= 4,110 cf @ 11.99 hrs, Average Depth at Peak Storage= 0.55'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 257.30 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 643.0' Slope= 0.0295 '/'
Inlet Invert= 814.00', Outlet Invert= 795.00'

‡

Summary for Reach 109R: S Channel

[65] Warning: Inlet elevation not specified

Inflow Area = 1.620 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 8.69 cfs @ 11.95 hrs, Volume= 0.393 af
Outflow = 7.73 cfs @ 12.04 hrs, Volume= 0.393 af, Atten= 11%, Lag= 5.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.93 fps, Min. Travel Time= 3.4 min
Avg. Velocity = 0.45 fps, Avg. Travel Time= 14.5 min

Peak Storage= 1,575 cf @ 11.99 hrs, Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 164.01 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 389.0' Slope= 0.0120 '/'
Inlet Invert= 0.00', Outlet Invert= -4.67'

‡

Summary for Reach 110R: NE Channel

Inflow Area = 7.050 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 36.04 cfs @ 11.96 hrs, Volume= 1.709 af
Outflow = 30.05 cfs @ 12.09 hrs, Volume= 1.709 af, Atten= 17%, Lag= 7.6 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.54 fps, Min. Travel Time= 4.9 min
Avg. Velocity = 0.99 fps, Avg. Travel Time= 22.4 min

Peak Storage= 9,100 cf @ 12.01 hrs, Average Depth at Peak Storage= 0.58'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 290.44 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 1,328.0' Slope= 0.0377 '/'
Inlet Invert= 818.00', Outlet Invert= 768.00'

‡

Summary for Reach 111R: N Channel

[65] Warning: Inlet elevation not specified

Inflow Area = 5.890 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 30.53 cfs @ 11.96 hrs, Volume= 1.428 af
Outflow = 29.25 cfs @ 11.98 hrs, Volume= 1.428 af, Atten= 4%, Lag= 1.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.93 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 0.93 fps, Avg. Travel Time= 3.4 min

Peak Storage= 1,427 cf @ 11.97 hrs, Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 241.26 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 189.0' Slope= 0.0260 '/'
Inlet Invert= 0.00', Outlet Invert= -4.91'

‡

Summary for Reach 113R: WS Channel

Inflow Area = 5.410 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 27.73 cfs @ 11.96 hrs, Volume= 1.312 af
Outflow = 22.83 cfs @ 12.11 hrs, Volume= 1.312 af, Atten= 18%, Lag= 9.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.55 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 0.77 fps, Avg. Travel Time= 27.4 min

Peak Storage= 8,155 cf @ 12.01 hrs, Average Depth at Peak Storage= 0.55'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 235.64 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 1,271.0' Slope= 0.0248 '/'
Inlet Invert= 804.50', Outlet Invert= 773.00'

‡

Summary for Pond 50P: SED BASIN 2 (NORTH)

Inflow Area = 23.740 ac, 5.10% Impervious, Inflow Depth > 3.08" for 25-yr, 24-hr event
Inflow = 97.61 cfs @ 11.98 hrs, Volume= 6.103 af
Outflow = 9.89 cfs @ 12.65 hrs, Volume= 6.068 af, Atten= 90%, Lag= 40.0 min
Primary = 9.89 cfs @ 12.65 hrs, Volume= 6.068 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Starting Elev= 757.00' Surf.Area= 36,291 sf Storage= 95,928 cf
Peak Elev= 760.39' @ 12.65 hrs Surf.Area= 47,104 sf Storage= 237,002 cf (141,074 cf above start)

Plug-Flow detention time= 1,064.8 min calculated for 3.863 af (63% of inflow)
Center-of-Mass det. time= 609.2 min (1,433.4 - 824.2)

Volume	Invert	Avail.Storage	Storage Description
#1	754.00'	317,147 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
754.00	27,824	0	0
756.00	33,306	61,130	61,130
758.00	39,275	72,581	133,711
760.00	45,733	85,008	218,719
762.00	52,695	98,428	317,147

Device	Routing	Invert	Outlet Devices
#1	Primary	755.00'	**24.0" x 55.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 754.50' S= 0.0091 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	760.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Device 1	757.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#4	Secondary	761.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=9.88 cfs @ 12.65 hrs HW=760.39' (Free Discharge)
└**1=Culvert** (Passes 9.88 cfs of 25.03 cfs potential flow)
  ├**2=Orifice/Grate** (Weir Controls 7.62 cfs @ 2.05 fps)
  └**3=Orifice/Grate** (Orifice Controls 2.26 cfs @ 8.65 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=757.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 88P: SED BASIN 3 (WEST)

Inflow Area = 23.540 ac, 7.18% Impervious, Inflow Depth > 3.16" for 25-yr, 24-hr event
Inflow = 94.53 cfs @ 11.97 hrs, Volume= 6.202 af
Outflow = 4.79 cfs @ 13.79 hrs, Volume= 6.123 af, Atten= 95%, Lag= 109.1 min
Primary = 4.79 cfs @ 13.79 hrs, Volume= 6.123 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Starting Elev= 754.00' Surf.Area= 47,396 sf Storage= 128,978 cf
Peak Elev= 757.19' @ 13.79 hrs Surf.Area= 57,420 sf Storage= 295,954 cf (166,977 cf above start)

Plug-Flow detention time= 1,557.2 min calculated for 3.159 af (51% of inflow)
Center-of-Mass det. time= 847.1 min (1,667.3 - 820.1)

Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	611,006 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.00	38,660	0	0
752.00	41,501	40,081	40,081
754.00	47,396	88,897	128,978
756.00	53,576	100,972	229,950
758.00	60,040	113,616	343,566
760.00	66,789	126,829	470,395
762.00	73,822	140,611	611,006

Device	Routing	Invert	Outlet Devices
#1	Primary	751.00'	**24.0" x 100.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 742.00' S= 0.0900 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	757.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Device 1	754.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#4	Secondary	761.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=4.73 cfs @ 13.79 hrs HW=757.19' (Free Discharge)
└**1=Culvert** (Passes 4.73 cfs of 27.20 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 2.54 cfs @ 1.42 fps)
└**3=Orifice/Grate** (Orifice Controls 2.19 cfs @ 8.37 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=754.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 96P: SED BASIN 4 (SOUTH)

Inflow Area = 29.290 ac, 5.02% Impervious, Inflow Depth > 3.12" for 25-yr, 24-hr event
Inflow = 107.74 cfs @ 12.00 hrs, Volume= 7.622 af
Outflow = 15.90 cfs @ 12.57 hrs, Volume= 7.585 af, Atten= 85%, Lag= 34.2 min
Primary = 15.90 cfs @ 12.57 hrs, Volume= 7.585 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Starting Elev= 753.00' Surf.Area= 42,207 sf Storage= 114,100 cf
Peak Elev= 756.35' @ 12.57 hrs Surf.Area= 52,239 sf Storage= 272,043 cf (157,943 cf above start)

Plug-Flow detention time= 756.8 min calculated for 4.966 af (65% of inflow)
Center-of-Mass det. time= 404.2 min (1,231.0 - 826.8)

Volume	Invert	Avail.Storage	Storage Description
#1	750.00'	484,301 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
750.00	33,973	0	0
752.00	39,349	73,322	73,322
754.00	45,064	84,413	157,735
756.00	51,118	96,182	253,917
758.00	57,511	108,629	362,546
760.00	64,244	121,755	484,301

Device	Routing	Invert	Outlet Devices
#1	Primary	750.00'	**18.0" x 105.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 748.00' S= 0.0190 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	755.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Device 1	753.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#4	Secondary	759.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=15.90 cfs @ 12.57 hrs HW=756.35' (Free Discharge)
└**1=Culvert** (Inlet Controls 15.90 cfs @ 9.00 fps)
└**2=Orifice/Grate** (Passes < 39.55 cfs potential flow)
└**3=Orifice/Grate** (Passes < 2.25 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=753.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 111P: Sed Basin 5 (Temp)

Inflow Area = 9.248 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 26.22 cfs @ 12.18 hrs, Volume= 2.242 af
Outflow = 1.44 cfs @ 14.70 hrs, Volume= 1.815 af, Atten= 95%, Lag= 151.1 min
Primary = 1.44 cfs @ 14.70 hrs, Volume= 1.815 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 759.48' @ 14.70 hrs Surf.Area= 0.859 ac Storage= 1.365 af

Plug-Flow detention time= 500.1 min calculated for 1.813 af (81% of inflow)
Center-of-Mass det. time= 420.4 min (1,266.0 - 845.6)

Volume	Invert	Avail.Storage	Storage Description
#1	756.00'	1.857 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
756.00	0.009	0.000	0.000
758.00	0.416	0.425	0.425
760.00	1.016	1.432	1.857

Device	Routing	Invert	Outlet Devices
#1	Device 2	758.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#2	Primary	756.00'	**12.0" x 321.0' long Culvert** RCP, groove end projecting, Ke= 0.200 Outlet Invert= 739.95' S= 0.0500 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#3	Device 2	761.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=1.44 cfs @ 14.70 hrs HW=759.48' (Free Discharge)
└**2=Culvert** (Passes 1.44 cfs of 8.08 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 1.44 cfs @ 5.51 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Summary for Pond 113P: Sed Basin 6 (Temp)

Inflow Area = 1.379 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 5.28 cfs @ 12.06 hrs, Volume= 0.334 af
Outflow = 0.11 cfs @ 18.46 hrs, Volume= 0.093 af, Atten= 98%, Lag= 383.5 min
Primary = 0.11 cfs @ 18.46 hrs, Volume= 0.093 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 762.12' @ 18.46 hrs Surf.Area= 0.235 ac Storage= 0.270 af

Plug-Flow detention time= 644.9 min calculated for 0.093 af (28% of inflow)
Center-of-Mass det. time= 514.1 min (1,350.0 - 835.9)

Volume	Invert	Avail.Storage	Storage Description
#1	760.00'	1.620 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
760.00	0.013	0.000	0.000
762.00	0.228	0.241	0.241
764.00	0.343	0.571	0.812
766.00	0.465	0.808	1.620

Device	Routing	Invert	Outlet Devices
#1	Device 2	762.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#2	Primary	760.00'	**8.0" x 210.0' long Culvert** RCP, groove end projecting, Ke= 0.200 Outlet Invert= 757.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#3	Device 2	765.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=0.11 cfs @ 18.46 hrs HW=762.12' (Free Discharge)
└**2=Culvert** (Passes 0.11 cfs of 1.49 cfs potential flow)
  ├**1=Orifice/Grate** (Orifice Controls 0.11 cfs @ 1.20 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Summary for Link 97L: Flume 6

Inflow Area = 5.410 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 27.73 cfs @ 11.96 hrs, Volume= 1.312 af
Primary = 27.73 cfs @ 11.96 hrs, Volume= 1.312 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 98L: Flume 5

Inflow Area = 5.890 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 30.53 cfs @ 11.96 hrs, Volume= 1.428 af
Primary = 30.53 cfs @ 11.96 hrs, Volume= 1.428 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 99L: Flume 4

Inflow Area = 7.050 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 36.04 cfs @ 11.96 hrs, Volume= 1.709 af
Primary = 36.04 cfs @ 11.96 hrs, Volume= 1.709 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 100L: Flume 3

Inflow Area = 5.470 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 27.96 cfs @ 11.96 hrs, Volume= 1.326 af
Primary = 27.96 cfs @ 11.96 hrs, Volume= 1.326 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 101L: Flume 2

Inflow Area = 5.160 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 26.35 cfs @ 11.96 hrs, Volume= 1.251 af
Primary = 26.35 cfs @ 11.96 hrs, Volume= 1.251 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 102L: Flume 1

Inflow Area = 1.620 ac, 0.00% Impervious, Inflow Depth = 2.91" for 25-yr, 24-hr event
Inflow = 8.69 cfs @ 11.95 hrs, Volume= 0.393 af
Primary = 8.69 cfs @ 11.95 hrs, Volume= 0.393 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 108L: Across South Road (Culvert 3-1 & 3-2)

Inflow Area = 23.280 ac, 0.00% Impervious, Inflow Depth = 2.95" for 25-yr, 24-hr event
Inflow = 87.60 cfs @ 12.04 hrs, Volume= 5.730 af
Primary = 87.60 cfs @ 12.04 hrs, Volume= 5.730 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 112L: To Sed Basin 2 (Culvert 1-1 & 1-2)

Inflow Area = 15.480 ac, 0.00% Impervious, Inflow Depth = 2.96" for 25-yr, 24-hr event
Inflow = 62.71 cfs @ 12.01 hrs, Volume= 3.819 af
Primary = 62.71 cfs @ 12.01 hrs, Volume= 3.819 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 114L: To Sed Basin 3 (Culvert 2-1 & 2-2)

Inflow Area = 21.110 ac, 0.00% Impervious, Inflow Depth = 2.98" for 25-yr, 24-hr event
Inflow = 87.98 cfs @ 11.99 hrs, Volume= 5.240 af
Primary = 87.98 cfs @ 11.99 hrs, Volume= 5.240 af, Atten= 0%, Lag= 0.0 min

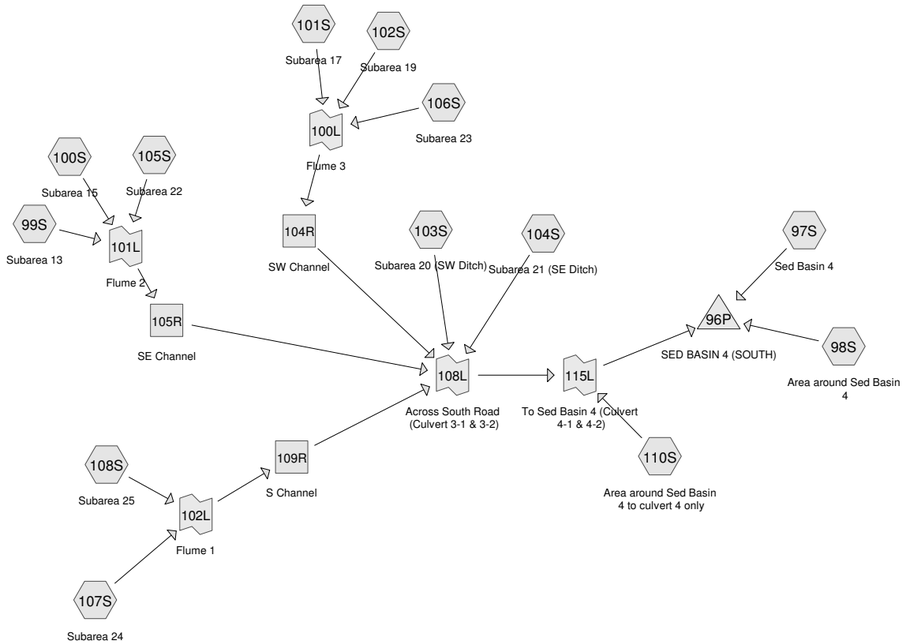
Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

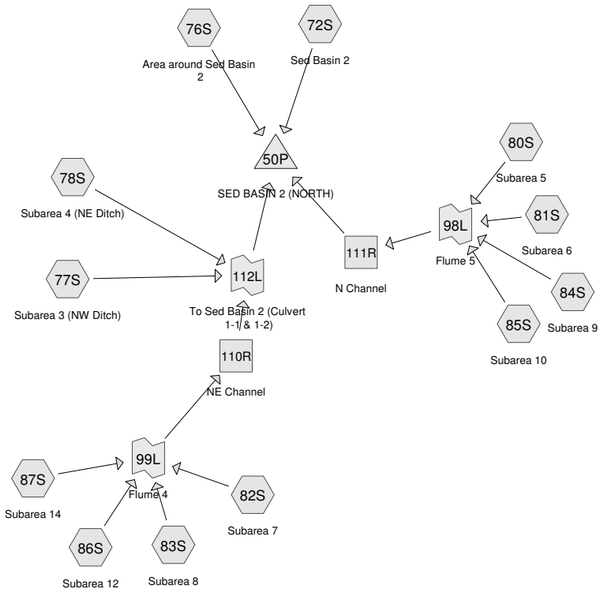
Summary for Link 115L: To Sed Basin 4 (Culvert 4-1 & 4-2)

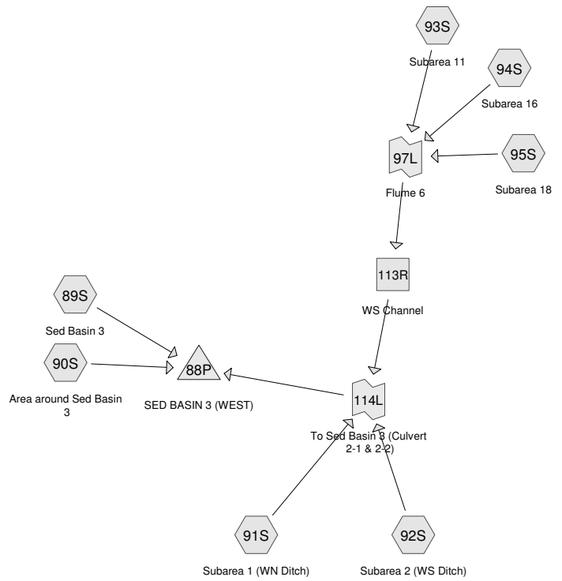
Inflow Area = 26.700 ac, 0.00% Impervious, Inflow Depth = 3.00" for 25-yr, 24-hr event
Inflow = 100.36 cfs @ 12.01 hrs, Volume= 6.667 af
Primary = 100.36 cfs @ 12.01 hrs, Volume= 6.667 af, Atten= 0%, Lag= 0.0 min

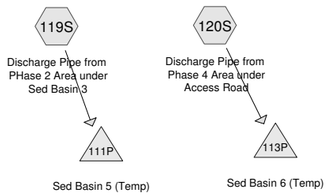
Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

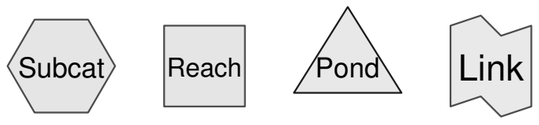
100-year, 24-hour Storm











Drainage Diagram for Post development sw calcs_131025

Prepared by SCS Engineers, Printed 10/25/2013

Summary for Subcatchment 72S: Sed Basin 2

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 14.73 cfs @ 11.89 hrs, Volume= 0.741 af, Depth> 7.34"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.210	98	Water
	1.210		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Water**

Summary for Subcatchment 76S: Area around Sed Basin 2

[49] Hint: Tc<2dt may require smaller dt

Runoff = 10.45 cfs @ 11.92 hrs, Volume= 0.474 af, Depth= 4.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	0.980	74	Grass
*	0.180	96	Gravel Road
	1.160	77	Weighted Average
	1.160		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0150	1.21		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.2	23	0.0150	1.97		**Shallow Concentrated Flow, flow across access road** Unpaved Kv= 16.1 fps
0.5	172	0.0800	5.37	9.55	**Trap/Vee/Rect Channel Flow, Channel down to basin** Bot.W=0.00' D=0.77' Z= 3.0 '/' Top.W=4.62' n= 0.040
2.1	295	Total			

Summary for Subcatchment 77S: Subarea 3 (NW Ditch)

Runoff = 23.78 cfs @ 11.98 hrs, Volume= 1.199 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	2.940	74	Final Cover
*	0.140	96	Gravel Access Road
	3.080	75	Weighted Average
	3.080		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	88	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
3.2	629	0.0260	3.28	17.18	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.46' Z= 3.0 '/' Top.W=12.76' n= 0.040
7.2	817	Total			

Summary for Subcatchment 78S: Subarea 4 (NE Ditch)

Runoff = 41.65 cfs @ 11.98 hrs, Volume= 2.084 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	5.030	74	Final Cover
*	0.320	96	Gravel Access Road
	5.350	75	Weighted Average
	5.350		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	64	0.2500	0.42		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
4.4	1,173	0.0310	4.39	34.12	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.65' Z= 3.0 '/' Top.W=13.90' n= 0.040
6.9	1,237	Total			

Summary for Subcatchment 80S: Subarea 5

[49] Hint: Tc<2dt may require smaller dt

Runoff = 14.10 cfs @ 11.96 hrs, Volume= 0.680 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.790	74	Final Cover
	1.790		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.3	73	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.7	421	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.6	594	Total			

Summary for Subcatchment 81S: Subarea 6

[49] Hint: Tc<2dt may require smaller dt

Runoff = 15.71 cfs @ 11.96 hrs, Volume= 0.745 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.960	74	Final Cover
	1.960		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
1.6	410	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.2	510	Total			

Summary for Subcatchment 82S: Subarea 7

[49] Hint: Tc<2dt may require smaller dt

Runoff = 15.20 cfs @ 11.96 hrs, Volume= 0.734 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.930	74	Final Cover
	1.930		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	83	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.6	399	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.6	582	Total			

Summary for Subcatchment 83S: Subarea 8

[49] Hint: Tc<2dt may require smaller dt

Runoff = 11.48 cfs @ 11.96 hrs, Volume= 0.540 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.420	74	Final Cover
	1.420		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.7	151	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.7	183	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.0	434	Total			

Summary for Subcatchment 84S: Subarea 9

[49] Hint: Tc<2dt may require smaller dt

Runoff = 12.37 cfs @ 11.95 hrs, Volume= 0.574 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.510	74	Final Cover
	1.510		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
1.1	282	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
4.7	382	Total			

Summary for Subcatchment 85S: Subarea 10

[49] Hint: Tc<2dt may require smaller dt

Runoff = 5.14 cfs @ 11.95 hrs, Volume= 0.239 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	0.630	74	Final Cover
	0.630		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	81	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.8	206	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
4.8	387	Total			

Summary for Subcatchment 86S: Subarea 12

[49] Hint: Tc<2dt may require smaller dt

Runoff = 14.43 cfs @ 11.96 hrs, Volume= 0.699 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.840	74	Final Cover
	1.840		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.5	95	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.6	416	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	611	Total			

Summary for Subcatchment 87S: Subarea 14

[49] Hint: Tc<2dt may require smaller dt

Runoff = 14.72 cfs @ 11.96 hrs, Volume= 0.707 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.860	74	Final Cover
	1.860		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	88	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.5	373	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.5	561	Total			

Summary for Subcatchment 89S: Sed Basin 3

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 20.57 cfs @ 11.89 hrs, Volume= 1.034 af, Depth> 7.34"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.690	98	Water
	1.690		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Water**

Summary for Subcatchment 90S: Area around Sed Basin 3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 7.02 cfs @ 11.90 hrs, Volume= 0.302 af, Depth= 4.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	0.650	74	Grass
*	0.090	96	Gravel Road
	0.740	77	Weighted Average
	0.740		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	67	0.0150	1.12		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"

Summary for Subcatchment 91S: Subarea 1 (WN Ditch)

[49] Hint: Tc<2dt may require smaller dt

Runoff = 57.56 cfs @ 11.96 hrs, Volume= 2.761 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	6.830	74	Final Cover
*	0.260	96	Gravel Access Road
	7.090	75	Weighted Average
	7.090		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
1.2	255	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.6	1,150	1.0000	31.01	378.54	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.95' Z= 3.0 '/' Top.W=15.70' n= 0.040
5.4	1,505	Total			

Summary for Subcatchment 92S: Subarea 2 (WS Ditch)

Runoff = 63.32 cfs @ 12.00 hrs, Volume= 3.353 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	8.250	74	Final Cover
*	0.360	96	Gravel Access Road
	8.610	75	Weighted Average
	8.610		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.5	108	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
4.6	1,271	0.0250	4.60	49.11	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.85' Z= 3.0 '/' Top.W=15.10' n= 0.040
8.7	1,479	Total			

Summary for Subcatchment 93S: Subarea 11

[49] Hint: Tc<2dt may require smaller dt

Runoff = 11.54 cfs @ 11.96 hrs, Volume= 0.547 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.440	74	Final Cover
	1.440		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
1.3	272	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.3	78	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.2	450	Total			

Summary for Subcatchment 94S: Subarea 16

[49] Hint: Tc<2dt may require smaller dt

Runoff = 15.73 cfs @ 11.96 hrs, Volume= 0.753 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.980	74	Final Cover
	1.980		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.3	65	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.5	376	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.4	541	Total			

Summary for Subcatchment 95S: Subarea 18

[49] Hint: Tc<2dt may require smaller dt

Runoff = 15.68 cfs @ 11.96 hrs, Volume= 0.756 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.990	74	Final Cover
	1.990		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.6	130	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.4	352	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.6	582	Total			

Summary for Subcatchment 97S: Sed Basin 4

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 17.89 cfs @ 11.89 hrs, Volume= 0.900 af, Depth> 7.34"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.470	98	Water
	1.470		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry, Water**

Summary for Subcatchment 98S: Area around Sed Basin 4

[49] Hint: Tc<2dt may require smaller dt

Runoff = 9.28 cfs @ 11.96 hrs, Volume= 0.447 af, Depth= 4.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.030	74	Grass
*	0.090	96	Gravel Access Road
	1.120	76	Weighted Average
	1.120		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0150	1.21		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.2	32	0.2500	3.50		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
3.8	882	0.0300	3.91	11.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 3.0 '/' Top.W=6.00' n= 0.040
5.4	1,014	Total			

Summary for Subcatchment 99S: Subarea 13

[49] Hint: Tc<2dt may require smaller dt

Runoff = 14.98 cfs @ 11.96 hrs, Volume= 0.726 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.910	74	Final Cover
	1.910		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.6	120	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.5	379	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	599	Total			

Summary for Subcatchment 100S: Subarea 15

[49] Hint: Tc<2dt may require smaller dt

Runoff = 15.69 cfs @ 11.96 hrs, Volume= 0.760 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	2.000	74	Final Cover
	2.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.5	108	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.6	402	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	610	Total			

Summary for Subcatchment 101S: Subarea 17

[49] Hint: Tc<2dt may require smaller dt

Runoff = 15.77 cfs @ 11.96 hrs, Volume= 0.764 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	2.010	74	Final Cover
	2.010		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.4	82	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.7	432	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	614	Total			

Summary for Subcatchment 102S: Subarea 19

[49] Hint: Tc<2dt may require smaller dt

Runoff = 15.77 cfs @ 11.96 hrs, Volume= 0.764 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	2.010	74	Final Cover
	2.010		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.6	127	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
1.5	381	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
5.7	608	Total			

Summary for Subcatchment 103S: Subarea 20 (SW Ditch)

Runoff = 50.12 cfs @ 12.03 hrs, Volume= 2.932 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	7.300	74	Final Cover
*	0.230	96	Access Road Gravel
	7.530	75	Weighted Average
	7.530		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.6	119	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
7.4	1,473	0.0116	3.34	40.77	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.95' Z= 3.0 '/' Top.W=15.70' n= 0.040
11.6	1,692	Total			

Summary for Subcatchment 104S: Subarea 21 (SE Ditch)

Runoff = 26.95 cfs @ 11.99 hrs, Volume= 1.363 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	3.340	74	Final Cover
*	0.160	96	Gravel Access Road
	3.500	75	Weighted Average
	3.500		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.7	141	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
3.0	643	0.0300	3.53	18.45	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.46' Z= 3.0 '/' Top.W=12.76' n= 0.040
7.3	884	Total			

Summary for Subcatchment 105S: Subarea 22

[49] Hint: Tc<2dt may require smaller dt

Runoff = 10.19 cfs @ 11.95 hrs, Volume= 0.475 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.250	74	Final Cover
	1.250		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.7	142	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.5	129	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
4.8	371	Total			

Summary for Subcatchment 106S: Subarea 23

[49] Hint: Tc<2dt may require smaller dt

Runoff = 11.83 cfs @ 11.95 hrs, Volume= 0.551 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.450	74	Final Cover
	1.450		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.8	173	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
0.4	111	0.0200	4.20	28.59	**Channel Flow, Flow in diversion berm** Area= 6.8 sf Perim= 9.5' r= 0.72' n= 0.040
4.8	384	Total			

Summary for Subcatchment 107S: Subarea 24

[49] Hint: Tc<2dt may require smaller dt

Runoff = 6.30 cfs @ 11.95 hrs, Volume= 0.289 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	0.760	74	Final Cover
	0.760		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.8	164	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
4.4	264	Total			

Summary for Subcatchment 108S: Subarea 25

[49] Hint: Tc<2dt may require smaller dt

Runoff = 7.13 cfs @ 11.95 hrs, Volume= 0.327 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	0.860	74	Final Cover
	0.860		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.6	100	0.2500	0.46		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
0.8	164	0.2500	3.50		**Shallow Concentrated Flow, Final Cover** Short Grass Pasture Kv= 7.0 fps
4.4	264	Total			

Summary for Subcatchment 110S: Area around Sed Basin 4 to culvert 4 only

[49] Hint: Tc<2dt may require smaller dt

Runoff = 30.72 cfs @ 11.95 hrs, Volume= 1.429 af, Depth= 5.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	2.780	74	Grass
*	0.640	96	Gravel Access Road
	3.420	78	Weighted Average
	3.420		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	100	0.0150	1.21		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.2	32	0.2500	3.50		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
2.8	882	0.0300	5.32	21.27	**Channel Flow, Channel flow** Area= 4.0 sf Perim= 8.2' r= 0.49' n= 0.030 Earth, grassed & winding
4.4	1,014	Total			

Summary for Subcatchment 111S: West Rock-lined Channel (vegetation established)

Runoff = 78.46 cfs @ 11.99 hrs, Volume= 3.992 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
	9.570	74	>75% Grass cover, Good, HSG C
*	0.680	96	Gravel Access Road
	10.250	75	Weighted Average
	10.250		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.2500	3.74		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.6	78	0.1000	2.21		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
6.5	1,177	0.0200	3.01	13.99	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=0.88' Z= 6.0 '/' Top.W=10.56' n= 0.040
7.5	1,355	Total			

Summary for Subcatchment 112S: West Rock-lined Channel (worst case)

Runoff = 100.07 cfs @ 11.98 hrs, Volume= 5.569 af, Depth= 6.52"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
	9.570	91	Fallow, bare soil, HSG C
*	0.680	96	Gravel Access Road
	10.250	91	Weighted Average
	10.250		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	100	0.2500	3.74		**Sheet Flow, Sheet flow across access road** Smooth surfaces n= 0.011 P2= 3.14"
0.6	78	0.1000	2.21		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
6.5	1,177	0.0200	3.01	13.99	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=0.88' Z= 6.0 '/' Top.W=10.56' n= 0.040
7.5	1,355	Total			

Summary for Subcatchment 113S: Culvert 5-1 (Ph 1 Access Road

Runoff = 4.67 cfs @ 11.97 hrs, Volume= 0.232 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	0.610	74	Grass
	0.610		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	100	0.2400	0.31		**Sheet Flow, Sheet flow** Grass: Dense n= 0.240 P2= 3.14"
1.0	182	0.1800	2.97		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
6.3	282	Total			

Summary for Subcatchment 116S: Culvert 12-1 (Across LF Perimeter Road

Runoff = 18.49 cfs @ 11.99 hrs, Volume= 0.959 af, Depth= 4.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (sf)	CN	Description
*	88,968	74	Final Cover
*	13,311	96	Access Road Gravel
	102,279	77	Weighted Average
	102,279		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	11	0.3300	0.33		**Sheet Flow, Sheet flow across final cover** Grass: Short n= 0.150 P2= 3.14"
7.3	1,378	0.0102	3.13	38.23	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=10.00' D=0.95' Z= 3.0 '/' Top.W=15.70' n= 0.040
7.9	1,389	Total			

Summary for Subcatchment 117S: Culvert 11-1 (Ph 5 Access Road)

Runoff = 12.18 cfs @ 12.06 hrs, Volume= 0.770 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	2.025	74	Grass
	2.025		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0	100	0.0500	0.17		**Sheet Flow, Sheet flow** Grass: Dense n= 0.240 P2= 3.14"
4.1	505	0.0871	2.07		**Shallow Concentrated Flow, Shallow Flow to culvert** Short Grass Pasture Kv= 7.0 fps
14.1	605	Total			

Summary for Subcatchment 118S: Culvert 15-1 (Ph 3 Access Road)

[49] Hint: Tc<2dt may require smaller dt

Runoff = 4.47 cfs @ 11.92 hrs, Volume= 0.204 af, Depth= 5.24"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (sf)	CN	Description
*	14,820	74	Grass
*	5,567	96	Access Road Gravel
	20,387	80	Weighted Average
	20,387		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	60	0.0330	1.50		**Sheet Flow, Sheet flow across final cover** Smooth surfaces n= 0.011 P2= 3.14"
1.3	293	0.0650	3.63	2.72	**Trap/Vee/Rect Channel Flow, Perimeter Ditch** Bot.W=0.00' D=0.50' Z= 3.0 '/' Top.W=3.00' n= 0.040
2.0	353	Total			

Summary for Subcatchment 119S: Discharge Pipe from PHase 2 Area under Sed Basin 3

Runoff = 41.21 cfs @ 12.18 hrs, Volume= 3.515 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	9.248	74	Grass
	9.248		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.4	100	0.0600	0.26		**Sheet Flow, Sheet flow across access road** Grass: Short n= 0.150 P2= 3.14"
18.3	983	0.0163	0.89		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
24.7	1,083	Total			

Summary for Subcatchment 120S: Discharge Pipe from Phase 4 Area under Access Road

Runoff = 8.24 cfs @ 12.06 hrs, Volume= 0.524 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr, 24-hr Rainfall=7.59"

	Area (ac)	CN	Description
*	1.379	74	Grass
	1.379		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	100	0.1900	0.41		**Sheet Flow, Sheet flow across access road** Grass: Short n= 0.150 P2= 3.14"
10.3	382	0.0078	0.62		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
14.3	482	Total			

Summary for Reach 104R: SW Channel

Inflow Area = 5.470 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 43.29 cfs @ 11.96 hrs, Volume= 2.079 af
Outflow = 32.31 cfs @ 12.15 hrs, Volume= 2.079 af, Atten= 25%, Lag= 11.6 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.11 fps, Min. Travel Time= 7.9 min
Avg. Velocity = 0.61 fps, Avg. Travel Time= 40.2 min

Peak Storage= 15,558 cf @ 12.02 hrs, Average Depth at Peak Storage= 0.85'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 161.13 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 1,467.0' Slope= 0.0116 '/'
Inlet Invert= 812.00', Outlet Invert= 795.00'

‡

Summary for Reach 105R: SE Channel

Inflow Area = 5.160 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 40.80 cfs @ 11.96 hrs, Volume= 1.961 af
Outflow = 37.70 cfs @ 12.03 hrs, Volume= 1.961 af, Atten= 8%, Lag= 4.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.50 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 10.9 min

Peak Storage= 5,544 cf @ 11.99 hrs, Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 257.30 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 643.0' Slope= 0.0295 '/'
Inlet Invert= 814.00', Outlet Invert= 795.00'

‡

Summary for Reach 109R: S Channel

[65] Warning: Inlet elevation not specified

Inflow Area = 1.620 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 13.43 cfs @ 11.95 hrs, Volume= 0.616 af
Outflow = 12.25 cfs @ 12.03 hrs, Volume= 0.616 af, Atten= 9%, Lag= 4.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.25 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.50 fps, Avg. Travel Time= 13.0 min

Peak Storage= 2,115 cf @ 11.98 hrs, Average Depth at Peak Storage= 0.48'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 164.01 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 389.0' Slope= 0.0120 '/'
Inlet Invert= 0.00', Outlet Invert= -4.67'

‡

Summary for Reach 110R: NE Channel

Inflow Area = 7.050 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 55.80 cfs @ 11.96 hrs, Volume= 2.679 af
Outflow = 47.72 cfs @ 12.07 hrs, Volume= 2.679 af, Atten= 14%, Lag= 6.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.31 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 20.0 min

Peak Storage= 12,442 cf @ 12.00 hrs, Average Depth at Peak Storage= 0.76'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 290.44 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 1,328.0' Slope= 0.0377 '/'
Inlet Invert= 818.00', Outlet Invert= 768.00'

‡

Summary for Reach 111R: N Channel

[65] Warning: Inlet elevation not specified

Inflow Area = 5.890 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 47.26 cfs @ 11.96 hrs, Volume= 2.239 af
Outflow = 45.42 cfs @ 11.98 hrs, Volume= 2.239 af, Atten= 4%, Lag= 1.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.56 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.05 fps, Avg. Travel Time= 3.0 min

Peak Storage= 1,916 cf @ 11.97 hrs, Average Depth at Peak Storage= 0.81'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 241.26 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 189.0' Slope= 0.0260 '/'
Inlet Invert= 0.00', Outlet Invert= -4.91'

‡

Summary for Reach 113R: WS Channel

Inflow Area = 5.410 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 42.94 cfs @ 11.96 hrs, Volume= 2.056 af
Outflow = 35.76 cfs @ 12.09 hrs, Volume= 2.056 af, Atten= 17%, Lag= 7.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.18 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 24.5 min

Peak Storage= 11,208 cf @ 12.01 hrs, Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 235.64 cfs

10.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 '/' Top Width= 22.00'
Length= 1,271.0' Slope= 0.0248 '/'
Inlet Invert= 804.50', Outlet Invert= 773.00'

‡

Summary for Pond 50P: SED BASIN 2 (NORTH)

Inflow Area = 23.740 ac, 5.10% Impervious, Inflow Depth > 4.76" for 100-yr, 24-hr event
Inflow = 155.71 cfs @ 11.98 hrs, Volume= 9.415 af
Outflow = 40.36 cfs @ 12.22 hrs, Volume= 9.378 af, Atten= 74%, Lag= 14.4 min
Primary = 27.73 cfs @ 12.22 hrs, Volume= 9.052 af
Secondary = 12.63 cfs @ 12.22 hrs, Volume= 0.326 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Starting Elev= 757.00' Surf.Area= 36,291 sf Storage= 95,928 cf
Peak Elev= 761.39' @ 12.22 hrs Surf.Area= 50,579 sf Storage= 285,761 cf (189,833 cf above start)

Plug-Flow detention time= 686.9 min calculated for 7.176 af (76% of inflow)
Center-of-Mass det. time= 436.7 min (1,249.2 - 812.5)

Volume	Invert	Avail.Storage	Storage Description
#1	754.00'	317,147 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
754.00	27,824	0	0
756.00	33,306	61,130	61,130
758.00	39,275	72,581	133,711
760.00	45,733	85,008	218,719
762.00	52,695	98,428	317,147

Device	Routing	Invert	Outlet Devices
#1	Primary	755.00'	**24.0" x 55.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 754.50' S= 0.0091 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	760.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Device 1	757.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#4	Secondary	761.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=27.71 cfs @ 12.22 hrs HW=761.39' (Free Discharge)
└**1=Culvert** (Inlet Controls 27.71 cfs @ 8.82 fps)
  └**2=Orifice/Grate** (Passes < 40.06 cfs potential flow)
  └**3=Orifice/Grate** (Passes < 2.59 cfs potential flow)

Secondary OutFlow Max=12.22 cfs @ 12.22 hrs HW=761.39' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Weir Controls 12.22 cfs @ 1.59 fps)

Summary for Pond 88P: SED BASIN 3 (WEST)

Inflow Area = 23.540 ac, 7.18% Impervious, Inflow Depth > 4.85" for 100-yr, 24-hr event
Inflow = 149.19 cfs @ 11.97 hrs, Volume= 9.507 af
Outflow = 28.18 cfs @ 12.32 hrs, Volume= 9.423 af, Atten= 81%, Lag= 20.8 min
Primary = 28.18 cfs @ 12.32 hrs, Volume= 9.423 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Starting Elev= 754.00' Surf.Area= 47,396 sf Storage= 128,978 cf
Peak Elev= 757.90' @ 12.32 hrs Surf.Area= 59,729 sf Storage= 337,808 cf (208,830 cf above start)

Plug-Flow detention time= 1,004.6 min calculated for 6.462 af (68% of inflow)
Center-of-Mass det. time= 602.4 min (1,411.6 - 809.2)

Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	611,006 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.00	38,660	0	0
752.00	41,501	40,081	40,081
754.00	47,396	88,897	128,978
756.00	53,576	100,972	229,950
758.00	60,040	113,616	343,566
760.00	66,789	126,829	470,395
762.00	73,822	140,611	611,006

Device	Routing	Invert	Outlet Devices
#1	Primary	751.00'	**24.0" x 100.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 742.00' S= 0.0900 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	757.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Device 1	754.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#4	Secondary	761.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=28.83 cfs @ 12.32 hrs HW=757.90' (Free Discharge)
└**1=Culvert** (Passes 28.83 cfs of 29.01 cfs potential flow)
  ├**2=Orifice/Grate** (Weir Controls 26.40 cfs @ 3.11 fps)
  └**3=Orifice/Grate** (Orifice Controls 2.44 cfs @ 9.31 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=754.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 96P: SED BASIN 4 (SOUTH)

Inflow Area = 29.290 ac, 5.02% Impervious, Inflow Depth > 4.80" for 100-yr, 24-hr event
Inflow = 172.35 cfs @ 12.00 hrs, Volume= 11.727 af
Outflow = 18.39 cfs @ 12.69 hrs, Volume= 11.689 af, Atten= 89%, Lag= 41.6 min
Primary = 18.39 cfs @ 12.69 hrs, Volume= 11.689 af
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Starting Elev= 753.00' Surf.Area= 42,207 sf Storage= 114,100 cf
Peak Elev= 758.24' @ 12.69 hrs Surf.Area= 58,334 sf Storage= 376,711 cf (262,611 cf above start)

Plug-Flow detention time= 527.9 min calculated for 9.070 af (77% of inflow)
Center-of-Mass det. time= 326.3 min (1,141.1 - 814.8)

Volume	Invert	Avail.Storage	Storage Description
#1	750.00'	484,301 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
750.00	33,973	0	0
752.00	39,349	73,322	73,322
754.00	45,064	84,413	157,735
756.00	51,118	96,182	253,917
758.00	57,511	108,629	362,546
760.00	64,244	121,755	484,301

Device	Routing	Invert	Outlet Devices
#1	Primary	750.00'	**18.0" x 105.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 748.00' S= 0.0190 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	755.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Device 1	753.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#4	Secondary	759.00'	**20.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=18.39 cfs @ 12.69 hrs HW=758.24' (Free Discharge)
└**1=Culvert** (Inlet Controls 18.39 cfs @ 10.41 fps)
└**2=Orifice/Grate** (Passes < 61.30 cfs potential flow)
└**3=Orifice/Grate** (Passes < 2.84 cfs potential flow)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=753.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 111P: Sed Basin 5 (Temp)

[93] Warning: Storage range exceeded by 53.90'
[85] Warning: Oscillations may require Finer Routing>1

Inflow Area = 9.248 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 41.21 cfs @ 12.18 hrs, Volume= 3.515 af
Outflow = 16.20 cfs @ 12.61 hrs, Volume= 3.090 af, Atten= 61%, Lag= 25.6 min
Primary = 16.20 cfs @ 12.61 hrs, Volume= 3.090 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 813.90' @ 12.60 hrs Surf.Area= 1.016 ac Storage= 1.857 af

Plug-Flow detention time= 495.8 min calculated for 3.090 af (88% of inflow)
Center-of-Mass det. time= 436.6 min (1,269.3 - 832.8)

Volume	Invert	Avail.Storage	Storage Description
#1	756.00'	1.857 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
756.00	0.009	0.000	0.000
758.00	0.416	0.425	0.425
760.00	1.016	1.432	1.857

Device	Routing	Invert	Outlet Devices
#1	Device 2	758.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#2	Primary	756.00'	**12.0" x 321.0' long Culvert** RCP, groove end projecting, Ke= 0.200 Outlet Invert= 739.95' S= 0.0500 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#3	Device 2	761.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=15.31 cfs @ 12.61 hrs HW=807.51' (Free Discharge)
└**2=Culvert** (Barrel Controls 15.31 cfs @ 19.49 fps)
  ├**1=Orifice/Grate** (Passes < 8.85 cfs potential flow)
  └**3=Orifice/Grate** (Passes < 232.11 cfs potential flow)

Summary for Pond 113P: Sed Basin 6 (Temp)

Inflow Area = 1.379 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 8.24 cfs @ 12.06 hrs, Volume= 0.524 af
Outflow = 0.51 cfs @ 13.36 hrs, Volume= 0.283 af, Atten= 94%, Lag= 77.7 min
Primary = 0.51 cfs @ 13.36 hrs, Volume= 0.283 af

Routing by Stor-Ind method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 762.33' @ 13.36 hrs Surf.Area= 0.247 ac Storage= 0.319 af

Plug-Flow detention time= 371.2 min calculated for 0.283 af (54% of inflow)
Center-of-Mass det. time= 257.0 min (1,080.2 - 823.1)

Volume	Invert	Avail.Storage	Storage Description
#1	760.00'	1.620 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
760.00	0.013	0.000	0.000
762.00	0.228	0.241	0.241
764.00	0.343	0.571	0.812
766.00	0.465	0.808	1.620

Device	Routing	Invert	Outlet Devices
#1	Device 2	762.00'	**4.0" Vert. Orifice/Grate X 3.00** C= 0.600
#2	Primary	760.00'	**8.0" x 210.0' long Culvert** RCP, groove end projecting, Ke= 0.200 Outlet Invert= 757.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#3	Device 2	765.00'	**36.0" Horiz. Orifice/Grate** Limited to weir flow C= 0.600

Primary OutFlow Max=0.51 cfs @ 13.36 hrs HW=762.33' (Free Discharge)
└─**2=Culvert** (Passes 0.51 cfs of 1.54 cfs potential flow)
  ├─**1=Orifice/Grate** (Orifice Controls 0.51 cfs @ 1.96 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Summary for Link 97L: Flume 6

Inflow Area = 5.410 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 42.94 cfs @ 11.96 hrs, Volume= 2.056 af
Primary = 42.94 cfs @ 11.96 hrs, Volume= 2.056 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 98L: Flume 5

Inflow Area = 5.890 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 47.26 cfs @ 11.96 hrs, Volume= 2.239 af
Primary = 47.26 cfs @ 11.96 hrs, Volume= 2.239 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 99L: Flume 4

Inflow Area = 7.050 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 55.80 cfs @ 11.96 hrs, Volume= 2.679 af
Primary = 55.80 cfs @ 11.96 hrs, Volume= 2.679 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 100L: Flume 3

Inflow Area = 5.470 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 43.29 cfs @ 11.96 hrs, Volume= 2.079 af
Primary = 43.29 cfs @ 11.96 hrs, Volume= 2.079 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 101L: Flume 2

Inflow Area = 5.160 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 40.80 cfs @ 11.96 hrs, Volume= 1.961 af
Primary = 40.80 cfs @ 11.96 hrs, Volume= 1.961 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 102L: Flume 1

Inflow Area = 1.620 ac, 0.00% Impervious, Inflow Depth = 4.56" for 100-yr, 24-hr event
Inflow = 13.43 cfs @ 11.95 hrs, Volume= 0.616 af
Primary = 13.43 cfs @ 11.95 hrs, Volume= 0.616 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 108L: Across South Road (Culvert 3-1 & 3-2)

Inflow Area = 23.280 ac, 0.00% Impervious, Inflow Depth = 4.61" for 100-yr, 24-hr event
Inflow = 141.13 cfs @ 12.03 hrs, Volume= 8.951 af
Primary = 141.13 cfs @ 12.03 hrs, Volume= 8.951 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 112L: To Sed Basin 2 (Culvert 1-1 & 1-2)

Inflow Area = 15.480 ac, 0.00% Impervious, Inflow Depth = 4.62" for 100-yr, 24-hr event
Inflow = 102.06 cfs @ 12.01 hrs, Volume= 5.962 af
Primary = 102.06 cfs @ 12.01 hrs, Volume= 5.962 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 114L: To Sed Basin 3 (Culvert 2-1 & 2-2)

Inflow Area = 21.110 ac, 0.00% Impervious, Inflow Depth = 4.64" for 100-yr, 24-hr event
Inflow = 140.27 cfs @ 11.99 hrs, Volume= 8.170 af
Primary = 140.27 cfs @ 11.99 hrs, Volume= 8.170 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 115L: To Sed Basin 4 (Culvert 4-1 & 4-2)

Inflow Area = 26.700 ac, 0.00% Impervious, Inflow Depth = 4.67" for 100-yr, 24-hr event
Inflow = 161.24 cfs @ 12.01 hrs, Volume= 10.380 af
Primary = 161.24 cfs @ 12.01 hrs, Volume= 10.380 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs

Perimeter Ditch and Diversion Berm Sizing

- Perimeter Ditch and Diversion Berm Sizing
- Rock-lined Channel Sizing

Perimeter Ditch and Diversion Berm Sizing

Perimeter Ditch and Diversion Berm Sizing Flow Summary

This calculation sums the flows from the contributing drainage subareas to each perimeter ditch for the 25-year, 24-hour storm event. By summing the flows, this approach is considered conservative. This calculation also considers the worst-case diversion berm flow for the 25-year, 24-hour storm event.

Perimeter Ditch Flows

Swale	Subarea	Flow Rate (cfs)
NE	4	27.15
	7	9.82
	8	7.42
	12	9.32
	14	9.50
		63.21

Swale	Subarea	Flow Rate (cfs)
NW	3	15.50
	5	9.11
	6	10.15
	9	8.00
	10	3.32
		46.08

Swale	Subarea	Flow Rate (cfs)
WN	1	37.50
		37.50

Swale	Subarea	Flow Rate (cfs)
WS	2	41.15
	11	7.46
	16	10.16
	18	10.12
		68.89

Notes:
1. Refer to Storm Water Management Plan Sheet for swale locations
2. Subarea flow rates from HydroCAD model output for 25-yr, 24-hr storm event

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Perimeter Ditch Flows (continued)

Swale	Subarea		Flow Rate (cfs)
SW	17		10.18
	19		10.18
	20		32.49
	23		7.65
	24		4.08
	25		4.61
		Total:	69.19

Swale	Subarea		Flow Rate (cfs)
SE	13		9.67
	15		10.13
	21		17.56
	22		6.59
		Total:	43.95

Worst-Case Diversion Berm Flow

Diversion Berm	Flow Rate (cfs)
Subareas 17, 19	10.18

Notes:
1. Refer to Storm Water Management Plan Sheet for swale locations
2. Subarea flow rates from HydroCAD model output for 25-yr, 24-hr storm event

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Lining Type: Vegetation

Project ID: 25211509.03
Location: Ottuma Iowa
Designer/Checker: JMO/
Date: 10/25/13

DITCH/DIVERSION BERM	NE	NW	WN	WS	SW	SE	Diversion Berm Subareas 17, 19
Channel/Ditch Geometry							
Channel Slope, S_o (ft/ft)	0.031	0.026	0.010	0.025	0.012	0.030	0.02
Channel Bottom Width, B (ft)	10	10	10	10	10	10	0
Channel Side Slope, z_1	3	3	3	3	3	3	4
Channel Side Slope, z_2	3	3	3	3	3	3	2
Flow Depth, d (ft) Solve iteratively	0.81	0.75	1.02	0.92	1.27	0.70	1.05
Safety Factor, SF	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Vegetation/Soil Parameters							
Vegetation Retardance Class	D	D	D	D	D	D	D
Vegetation Condition	good	good	good	good	good	good	good
Vegetation Growth Form	turf	turf	turf	turf	turf	turf	turf
Soil Type	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive	cohesive
D_{75} (in) (Set at 0.00 for cohesive soils)							
ASTM Soil Class	ML	ML	ML	ML	ML	ML	ML
Plasticity Index, PI	16	16	16	16	16	16	16
Results Summary							
Design Q (ft^3/s)	63.21	46.08	37.50	68.89	69.19	43.95	10.2
Calculated Q (ft^3/s)	63.3	46.1	37.6	69.1	69.4	44.1	10.2
Difference Between Design & Calc. Flow (%)	0.2%	0.1%	0.3%	0.3%	0.3%	0.4%	0.2%
Stable (Yes or No)	YES	YES	YES	YES	YES	YES	YES
Channel Parameters							
Vegetation Height, h (ft)	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Grass Roughness Coefficient, C_n	0.165	0.165	0.165	0.165	0.165	0.165	0.165
Cover Factor, C_f	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Noncohesive Soil							
Soil Grain Roughness, n_s	0.016	0.016	0.016	0.016	0.016	0.016	0.016
Permissible Soil Shear Stress, τ_p (lb/ft^2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cohesive Soil							
Porosity, e	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Soil Coefficient 1, c_1	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700	1.0700
Soil Coefficient 2, c_2	7.15	7.15	7.15	7.15	7.15	7.15	7.15
Soil Coefficient 3, c_3	11.900	11.900	11.900	11.900	11.900	11.900	11.900
Soil Coefficient 4, c_4	1.48	1.48	1.48	1.48	1.48	1.48	1.48
Soil Coefficient 5, c_5	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57	-0.57
Soil Coefficient 6, c_6	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
Permissible Soil Shear Stress, τ_p (lb/ft^2)	0.067	0.067	0.067	0.067	0.067	0.067	0.067
Total Permissible Shear Stress, τ_p (lb/ft^2)	0.067	0.067	0.067	0.067	0.067	0.067	0.067
Cross Sectional Area, A (ft^2)	10.113	9.202	13.353	11.786	17.592	8.399	3.320
Wetted Perimeter, P (ft)	15.14	14.75	16.46	15.84	18.05	14.40	6.69
Hydraulic Radius, R (ft)	0.668	0.624	0.811	0.744	0.975	0.583	0.496
Top Width, T (ft)	I:\25211509\Reports\Permit Amendment\Appendices\Storm Water Management\Calcs - final\[Perimeter Ditch and Di						
Hydraulic Depth, D (ft)	#VALUE!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Froude Number (Q design)	#VALUE!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Channel Shear Stress, τ_o (lb/ft^2)	1.29	1.01	0.51	1.16	0.71	1.07	0.62
Actual Sheer Stress, τ_d (lb/ft^2)	1.57	1.22	0.64	1.44	0.92	1.28	1.31
Mannings n	0.032	0.035	0.046	0.033	0.040	0.034	0.043
Average Velocity, V (ft/s)	6.25	5.01	2.81	5.85	3.93	5.23	3.07
Calculated Flow, Q (ft^3/s)	63.3	46.1	37.6	69.1	69.4	44.1	10.2
Difference Between Design & Calc. Flow (%)	0.2%	0.1%	0.3%	0.3%	0.3%	0.4%	0.2%
Effective Shear on Soil Surface, τ_e (lb/ft^2)	0.039	0.025	0.008	0.034	0.015	0.028	0.018
Total Permissible Shear on Veg., $\tau_{p,veg}$ (lb/ft^2)	2.67	3.20	5.52	2.84	4.17	3.02	4.82
Stable (Y or N)	YES	YES	YES	YES	YES	YES	YES

Rock-lined Channel Sizing

Rock Chute Design Data

(Version 4.01 - 04/23/03, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: OML Expansion | **County:** Wapello
Designer: JMO | **Checked by:** BP
Date: 11/27/2013 | **Date:** 11/27/13

Input Channel Geometry

→ Inlet Channel	→ Chute	→ Outlet Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 6.0 (m:1)	Factor of safety = 1.20 (F_s)	Side slopes = 3.0 (m:1)
n-value = 0.040	Side slopes = 3.0 (m:1) → **2.0:1 max.**	n-value = 0.040
Bed slope = 0.0200 ft./ft.	Bed slope (5.9:1) = 0.170 ft./ft. → **2.5:1 max.**	Bed slope = 0.0200 ft./ft.
Freeboard = 0.5 ft.	Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

Design Storm Data (Table 2, NHCP, NRCS Grade Stabilization Structure No. 410)

Drainage area = acres | Rainfall = ○ 0 - 3 in. ○ 3 - 5 in. ◉ 5+ in.

Apron elev. --- Inlet = 784.0 ft. --- Outlet = 726.0 ft. --- (H_{drop} = 57 ft.)

Chute capacity = Q25-year
Total capacity = Q100-year
Minimum capacity (based on a 5-year, 24-hour storm with a 5+ inch rainfall)

Q_{high} = 51.1 cfs — High flow storm through chute → Tw (ft.) = Program

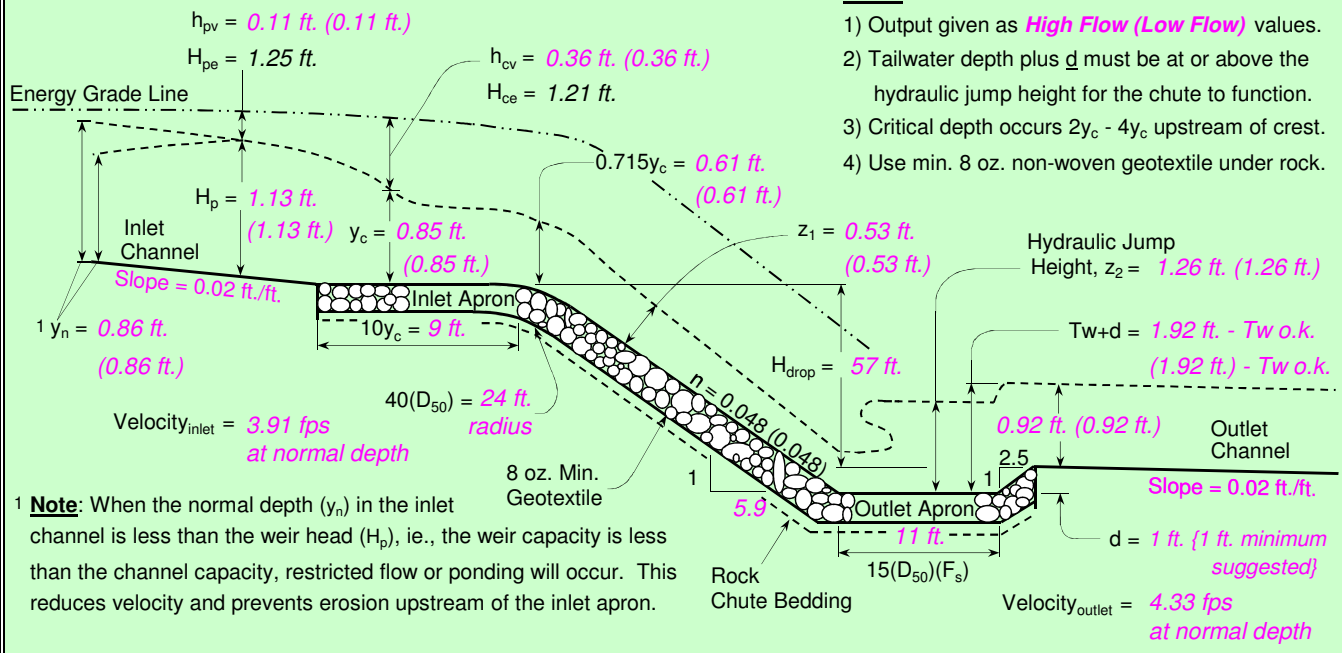
Q_{low} = 51.1 cfs — Low flow storm through chute → Tw (ft.) = Program

***Note**: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*

***Input tailwater (Tw)**:*

0.17

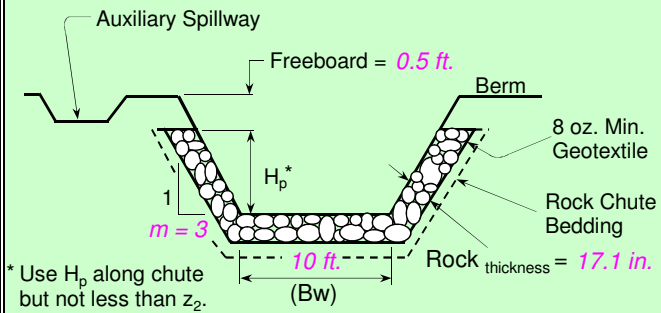
Profile and Cross Section (Output)



Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.
4) Use min. 8 oz. non-woven geotextile under rock.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute



* Use H_p along chute but not less than z_2.

Typical Cross Section

q_t =	4.46 cfs/ft.	Equivalent unit discharge
F_S =	1.20	Factor of safety (multiplier)
z_1 =	0.53 ft.	Normal depth in chute
n-value =	0.048	Manning's roughness coefficient
$D_{50}(F_s)$ =	8.5 in. (45 lbs. - 50% round / 50% angular)	
2(D_{50})(F_s) =	17.1 in.	Rock chute thickness
Tw + d =	1.92 ft.	Tailwater above outlet apron
z_2 =	1.26 ft.	Hydraulic jump height
*** **The outlet**	**will**	***function adequately***

High Flow Storm Information

LEGEND

- ROCK CHUTE DRAINAGE AREA = 10.25 ACRES
- SHEET FLOW = 100 FT
- SHALLOW FLOW = 78 FT
- CHANNEL FLOW = 1177 FT

AREA 2A

200 0 200

SCALE: 1" = 200'

PROJECT NO.	25211509.03	DRAWN BY:	BJM
DRAWN:	10/25/13	CHECKED BY:	BP
REVISED:	11/27/13	APPROVED BY:	BP 11/27/13

ENGINEER: SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT: INTERSTATE POWER AND LIGHT COMPANY
OTTUMWA MIDLAND LANDFILL
130TH STREET
OTTUMWA, IOWA 52501

SITE: PERMIT AMENDMENT PLANS
NORTH & SOUTH EXPANSION
OTTUMWA MIDLAND LANDFILL
OTTUMWA, IOWA

ROCK CHUTE
DRAINAGE AREA

FIGURE
2

10/07/2021 - Classification: Internal - ECRM12685223

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Downslope Flume and Energy Dissipator Sizing

SCS ENGINEERS

		Sheet No. 1/10	
		Calc. No.	
		Rev. No.	
Job No. 25211509.03	Job: OML Expansion	By: JMO	Date: 10/25/13
Client: IPL	Subject: Downslope Flume Sizing	Chk'd: BP	Date: 11/25/13

Purpose: To size the downslope flume pipes to accommodate the flows expected from a 25-year, 24-hour storm event.

Approach: Use the orifice equation to size the downslope pipe inlet and Manning's equation to size the downslope pipes.

Calculations:

For the diversion berm swales, the maximum flow from the 25-year, 24-hour storm is 10.18 cfs (see Subareas 17 and 19 in Hydrograph Generation section of appendix).

Flume inlet sizing:

Orifice Equation: $Q = C \times A \times (2 \times g \times h)^{0.5}$

Q = flow rate (cfs)

C = orifice coefficent = 0.63

A = area of orifice = 1.8 sf for 18" dia. pipe

g = acceleration due to gravity = 32.2 ft/sec^2

h = orifice head acting on centerline = 1.25 ft for 18" dia. pipe

$Q_{18" \text{ pipe}} = 0.63 \times 1.8 \times (2 \times 32.2 \times 1.25)^{0.5} = 10.2$ cfs ok

Downslope pipe sizing:

The downslope flume pipe diameter will be at least as big as the inlet pipe diameter. The capacity of an 18" dia. flume at the following slopes is as follows (see attached Sheets 2 and 3):

	Flow Capacity of Pipe
Flume Size	25% slope
18" dia.	68 cfs

The peak flows from a 25-year, 24-hour storm to each flume are as follows:

Flume Number	Subareas Contributing Flow	Flow Rate (cfs)
Flume 1	24, 25	9
Flume 2	13,15, 22	26
Flume 3	17, 19, 23	28
Flume 4	7, 8, 12, 14	36
Flume 5	5, 6, 9, 10	31
Flume 6	11, 16, 18	28

The 18" dia. Downslope flume pipes have sufficient capacity to accommodate the incoming flows.

Results:

18" dia. flume inlets will accommodate flows along diversion berms resulting from a 25-year, 24 hour storm.

18" dia. downslope flume pipes will accommodate flows resulting from a 25-year, 24-hour storm event.

I:\25211509\Reports\Permit Amendment\Appendices\Storm Water Management\Calcs - final\[Downslope Flume Sizing_131127.xls]Sizing Calc

Pipe Capacity - 18" dia.

Use the Manning Formula to determine max flow in a pipe flowing full

Manning's Equation: $Q = (1.49/n) \times A \times R^{(2/3)} \times S^{(1/2)}$

where: Q = Flow Rate, cfs
n = Manning's Roughness Coefficient
A = Flow Area, sf
R = Hydraulic Radius, ft (= A/P)
S = Pipe Slope, ft/ft

Design Criteria

Pipe Diameter (in) = D = 18
Pipe Slope (ft/ft) = S = 0.25
Manning's Roughness Coefficient = n = 0.010
Water Level (in) = 18

Cross Sectional Area Calculation

Pipe Radius (ft) = 0.75
Circle Segment Height (ft) = 0.0
Central Angle (rad) = 0.00
Wetted Perimeter (ft) = P = 4.71
Flow Area (sf) = A = 1.77
Hydraulic Raduis (ft) = A/P = R = 0.38

Flow Velocity Calculation

Flow Velocity (fps) = $V = (1.49/n) \times R^{2/3} \times S^{1/2}$ = 38.63

Flow Rate Calculation

Flow Rate (cfs) = Q = V x A = 68.27

I:\25211509\Reports\Permit Amendment\Appendices\Storm Water Management\Calcs - final\[Downslope Flume Sizing_131127.xls]18" capacity

Energy Dissipator Design

Pipe/Culvert: Flume 1

* Peak flow in this flume from 25-year, 24-hour event is 9 cfs.

Compute Flow Area:

$A = Q/V$ where: A = Flow Area
Q = Maximum flow rate = 9.0 cfs
V = Outlet velocity = 27 ft/sec (from Manning's equation, see Sheet 4)

A = 0.3 sf

Compute Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth
A = Area (from above)

Y_e = 0.4 ft

Compute Froude Number:

$Fr = V/[(g*Y_e)^{1/2}]$ where: Fr = Froude Number
V = Velocity (from above)
g = Gravity constant (32.2 ft/sec)
Y_e = Equivalent depth (from above)

Fr = 7.4

Compute Energy at End of Pipe:

$H_o = Y_e+V^2/2g$ where: H_o = Energy
Y_e = Equivalent depth (from above)
V = Velocity (from above)
g = Gravity constant (32.2 ft/sec)

Ho = 11.5 ft

Determine Width of Dissipator:

Use Froude Number computed above and Figure 9.14 from "Hydraulic Design of Energy Dissipators for Culverts and Channels" to obtain value for H_o/W. Given H_o above, compute W (width of dissipator).

From Figure 9.14, H_o/W_B = 3.1 (interpolated)

W_B = 3.7 ft

Determine Remaining Dimensions of the Dissipator:

Based on W determined above, use Table 9.2 (CU) to determine the remaining dissipator dimensions. Round the value of W_B to the nearest entry in the table (interpolation is not necessary).

Flume 1

Use the Manning Formula to determine flow in a pipe

Manning's Equation: Q = (1.49/n) x A x R^(2/3) x S^(1/2)

where: Q = Flow Rate, cfs
n = Manning's Roughness Coefficient
A = Flow Area, sf
R = Hydraulic Radius, ft (= A/P)
S = Pipe Slope, ft/ft

Design Criteria

Pipe Diameter (in) = D = 18
Pipe Slope (ft/ft) = S = 0.25
Manning's Roughness Coefficient = n = 0.010
Water Level (in) = 4.413

Cross Sectional Area Calculation

Pipe Radius (ft) = 0.75
Circle Segment Height (ft) = 0.4
Central Angle (rad) = 2.07
Wetted Perimeter (ft) = P = 1.55
Flow Area (sf) = A = 0.34
Hydraulic Raduis (ft) = A/P = R = 0.22

Flow Velocity Calculation

Flow Velocity (fps) = V = (1.49/n) x $R^{2/3}$ x $S^{1/2}$ = 26.77

Flow Rate Calculation

Flow Rate (cfs) = Q = V x A = 9.00

Energy Dissipator Design

Pipe/Culvert: Flumes 2, 3, 4, 5, 6

* Peak flow in these flumes from 25-year, 24-hour event ranges from 26-36 cfs. Design for 36 cfs.

Compute Flow Area:

$A = Q/V$ where: A = Flow Area
Q = Maximum flow rate = 36.0 cfs
V = Outlet velocity = 39 ft/sec (from Manning's equation, see Sheet 8)

A = 0.9 sf

Compute Equivalent Depth of Flow Entering Dissipator:

$Y_e = (A/2)^{1/2}$ where: Ye = Equivalent depth
A = Area (from above)

Y_e = 0.7 ft

Compute Froude Number:

$Fr = V/[(g*Y_e)^{1/2}]$ where: Fr = Froude Number
V = Velocity (from above)
g = Gravity constant (32.2 ft/sec)
Y_e = Equivalent depth (from above)

Fr = 8.4

Compute Energy at End of Pipe:

$H_o = Y_e+V^2/2g$ where: H_o = Energy
Y_e = Equivalent depth (from above)
V = Velocity (from above)
g = Gravity constant (32.2 ft/sec)

Ho = 24.5 ft

Determine Width of Dissipator:

Use Froude Number computed above and Figure 9.14 from "Hydraulic Design of Energy Dissipators for Culverts and Channels" to obtain value for H_o/W. Given H_o above, compute W (width of dissipator).

From Figure 9.14, H_o/W_B = 4.2 (interpolated)

W_B = 5.8 ft

Determine Remaining Dimensions of the Dissipator:

Based on W determined above, use Table 9.2 (CU) to determine the remaining dissipator dimensions. Round the value of W_B to the nearest entry in the table (interpolation is not necessary).

Flumes 2, 3, 4, 5, 6

Use the Manning Formula to determine flow in a pipe

Manning's Equation: $Q = (1.49/n) \times A \times R^{(2/3)} \times S^{(1/2)}$

where: Q = Flow Rate, cfs
n = Manning's Roughness Coefficient
A = Flow Area, sf
R = Hydraulic Radius, ft (= A/P)
S = Pipe Slope, ft/ft

Design Criteria

Pipe Diameter (in) = D = 18
Pipe Slope (ft/ft) = S = 0.25
Manning's Roughness Coefficient = n = 0.010
Water Level (in) = 9.288

Cross Sectional Area Calculation

Pipe Radius (ft) = 0.75
Circle Segment Height (ft) = 0.7
Central Angle (rad) = 3.08
Wetted Perimeter (ft) = P = 2.40
Flow Area (sf) = A = 0.92
Hydraulic Raduis (ft) = A/P = R = 0.38

Flow Velocity Calculation

Flow Velocity (fps) = $V = (1.49/n) \times R^{2/3} \times S^{1/2}$ = 39.15

Flow Rate Calculation

Flow Rate (cfs) = Q = V x A = 36.00

shows the relationship of the Froude number to the ratio of the energy entering the dissipator to the width of dissipator required. The Los Angeles tests indicate that limited extrapolation of this curve is permissible.

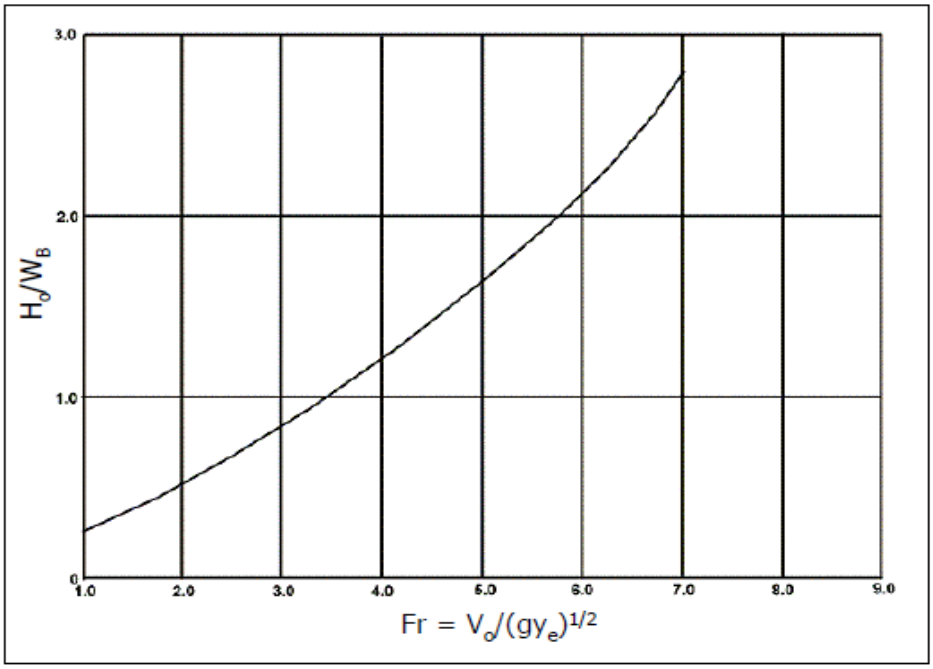

Figure 9.14. Design Curve for USBR Type VI Impact Basin

Once the basin width, W_B, has been determined, many of the other dimensions shown in Figure 9.13 follow according to Table 9.2. To use Table 9.2, round the value of W_B to the nearest entry in the table to determine the other dimensions. Interpolation is not necessary.

In calculating the energy and the Froude number, the equivalent depth of flow, $y_e = (A/2)^{1/2}$, entering the dissipator from a pipe or irregular-shaped conduit must be computed. In other words, the cross section flow area in the pipe is converted into an equivalent rectangular cross section in which the width is twice the depth of flow. The conduit preceding the dissipator can be open, closed, or of any cross section.

The effectiveness of the basin is best illustrated by comparing the energy losses within the structure to those in a natural hydraulic jump, Figure 9.15. The energy loss was computed based on depth and velocity measurements made in the approach pipe and also in the downstream channel with no tailwater. Compared with the natural hydraulic jump, the USBR Type VI impact basin shows a greater capacity for dissipating energy.

Purpose:

To size the riprap at the outfall of the energy dissipators.

Approach:

Determine the exit velocity from the dissipator as described in Section 9.4 (USBR Type VI Impact Basin) in the "Hydraulic Design of Energy Dissipators for Culverts and Channels", Hydraulic Engineering Circular Number 14, Third Edition, Federal Highway Administration (HEC 14, FHA). The method uses an energy balance between the culvert exit and basin exit using the following equation:

$$H_B = Q/(W_B V_B) + V_B^2/(2g) = H_o(1-H_L/H_o)$$

where: H_B = Energy at end of basin

Q = Flow rate

W_B = Width of basin

V_B = Exit velocity from basin

g = Gravitational acceleration constant

H_o = Energy at end of pipe

H_L = Total head loss

Using the equation, determine the exit velocity by trial and error. The equation yields 3 solutions, two positive and one negative. The negative solution is discarded, and the two positive results yield a subcritical and supercritical solution. Where low or no tailwater exists, the supercritical solution is used.

Once the exit velocity has been determined, use the method described in Section 10.3 (Riprap Aprons After Energy Dissipators) from the HEC 14 FHA reference to size the riprap downstream of the energy dissipator.

$$D_{50} = (0.692/S-1)(V^2/2g)$$

where: D_{50} = Median rock size

V = Exit velocity from dissipator

g = Gravitational acceleration constant

S = Riprap specific gravity

Assumptions:

The energy dissipator sizes and culvert discharge velocity into the dissipators is as presented in the Downslope Flume and Energy Dissipator Sizing section of this appendix.

The riprap specific gravity is 2.65, based on a typical value as presented in HEC 14, FHA.

Results:

Below is a summary of the D_{50} for riprap at the end of each dissipator. Refer to Sheet 9 for detailed calculations.

	Flume 1	Flumes 2, 3, 4, 5, 6
D50 (inches)	12	18

Calculations:

Value	Units	Flume 1	Flumes 2, 3, 4, 5, 6	Comment
Calculate Exit Velocity				
Q	cfs	9	36	direct input from Downslope Flume and Energy Dissipator Sizing
W_B	ft	4	6	direct input from Downslope Flume and Energy Dissipator Sizing
V_B (supercritical)	fps	12.30	15.07	vary this number to achieve H_B below; one positive solution to equation (supercritical)
V_B (subcritical)	fps	0.90	1.55	vary this number to achieve H_B below; second positive solution to equation (subcritical)
g	ft/sec^2	32.2	32.2	direct input
Fr	--	7.4	8.4	direct input from Downslope Flume and Energy Dissipator Sizing
H_L/H_O	ft/ft	0.78	0.84	direct input from Figure 9.15 from HEC 14, FHA (see Sheet 10)
H_O	ft	11.5	24.5	direct input from Downslope Flume and Energy Dissipator Sizing
$H_{B\ (supercritical)}$	ft	2.53	3.92	computed from $Q/(W_BV_B) + V_B^2/(2g)$ equation, varying V_B above to equal below computed H_B
$H_{B\ (subcritical)}$	ft	2.53	3.92	computed from $Q/(W_BV_B) + V_B^2/(2g)$ equation, varying V_B above to equal below computed H_B
H_B	ft	2.53	3.92	computed from Ho(1-HL/Ho) equation
V_o	fps	27	39	direct input from Downslope Flume and Energy Dissipator Sizing
V_B (supercritical)	fps	12.3	15.1	as determined above, assume supercritical, no tailwater
Reduction in velocity	percent	54%	61%	$(V_o-V_B)/V_o$ x 100%
Calculate Riprap Size				
S		2.65	2.65	direct input
V	fps	12.3	15.07	from above calculations, supercritical
g	ft/sec^2	32.2	32.2	direct input
D_{50}	ft	1.0	1.5	computed
D_{50}	in	12	18	computed
Calculate Riprap Apron Dimensions				
D	ft	0.18	0.40	depth of water exiting flume
L	ft	15	25	length of riprap apron, from SUDAS Design Manual Figure 7E-10.03
B_1	ft	6.2	9.3	width of apron at flume
B_2	ft	19	31	computed

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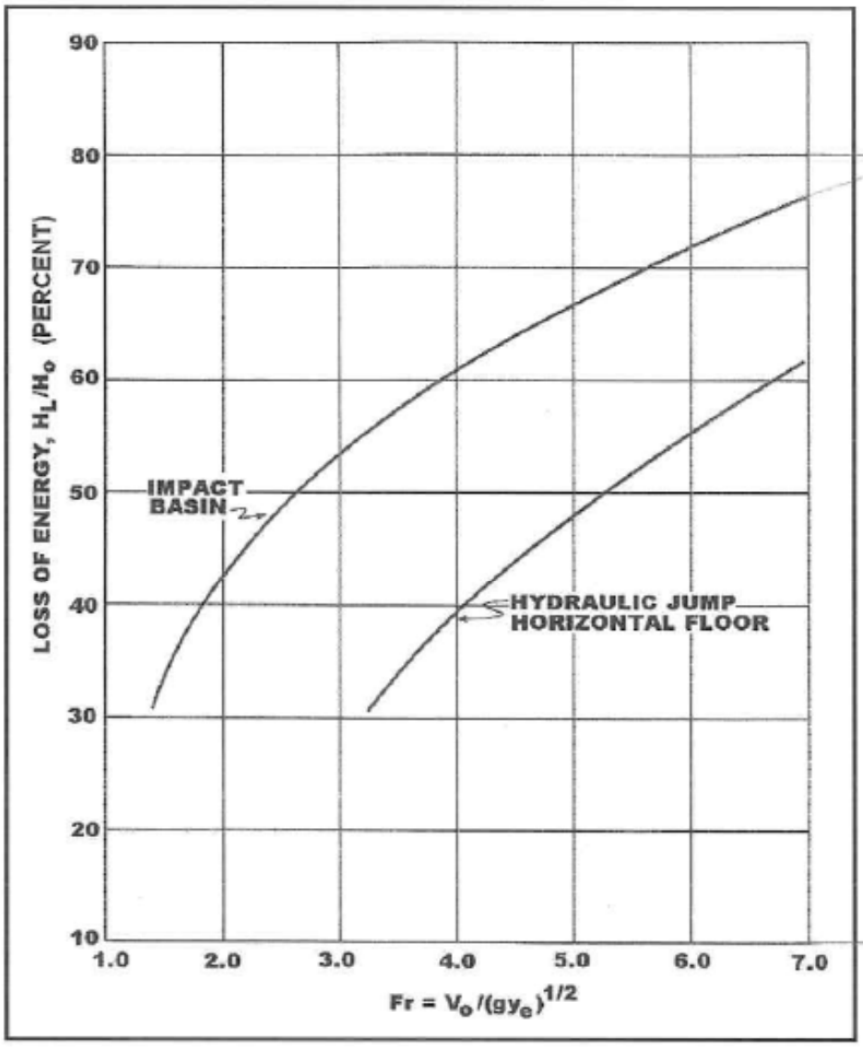

Figure 9.15. Energy Loss of USBR Type VI Impact Basin versus Hydraulic Jump

Source: HEC 14, FHA

Culvert Sizing

Culvert Sizing Flow Summary

This summary sheet provides design flows from the contributing drainage areas to each culvert for the 25-year, 24-hour storm event.

Culvert Flows

Culvert	HydroCAD Node	Flow Rate (cfs)	Culvert Diameter (ft)
1-1 & 1-2 (To Sed Basin 2)	112L	62.71	2 - 30" Barrels
2-1 & 2-2 (To Sed Basin 3)	114L	87.98	2 - 30" Barrels
3-1 & 3-2 (Across LF Perimeter Rd)	108L	87.60	2 - 36" Barrels
4-1 & 4-2 (To Sed Basin 4)	115L	100.36	2 - 36" Barrels
5-1 (Ph 1 Access Rd)	113S	3.05	1 - 12" Barrel
11-1 (Ph 5 Access Rd)	117S	7.80	1 - 18" Barrel
12-1 (Across LF Perimeter Rd)	116S	12.23	1 - 18" Barrel
14-1 & 14-2 (Across Haul Rd)	See Haul Road Culvert section of this appendix		2 - 48" Barrel
15-1 (Ph 3 Access Rd)	118S	3.03	1 - 12" Barrel

Purpose:

To size riprap aprons at the outlet of culverts.

Approach:

Size riprap D50 and size riprap apron dimensions using the Iowa Statewide Urban Design and Specifications (SUDAS) Design Manual, Chapter 7E-10 - Riprap.

Source: USDA NRCS, 2004

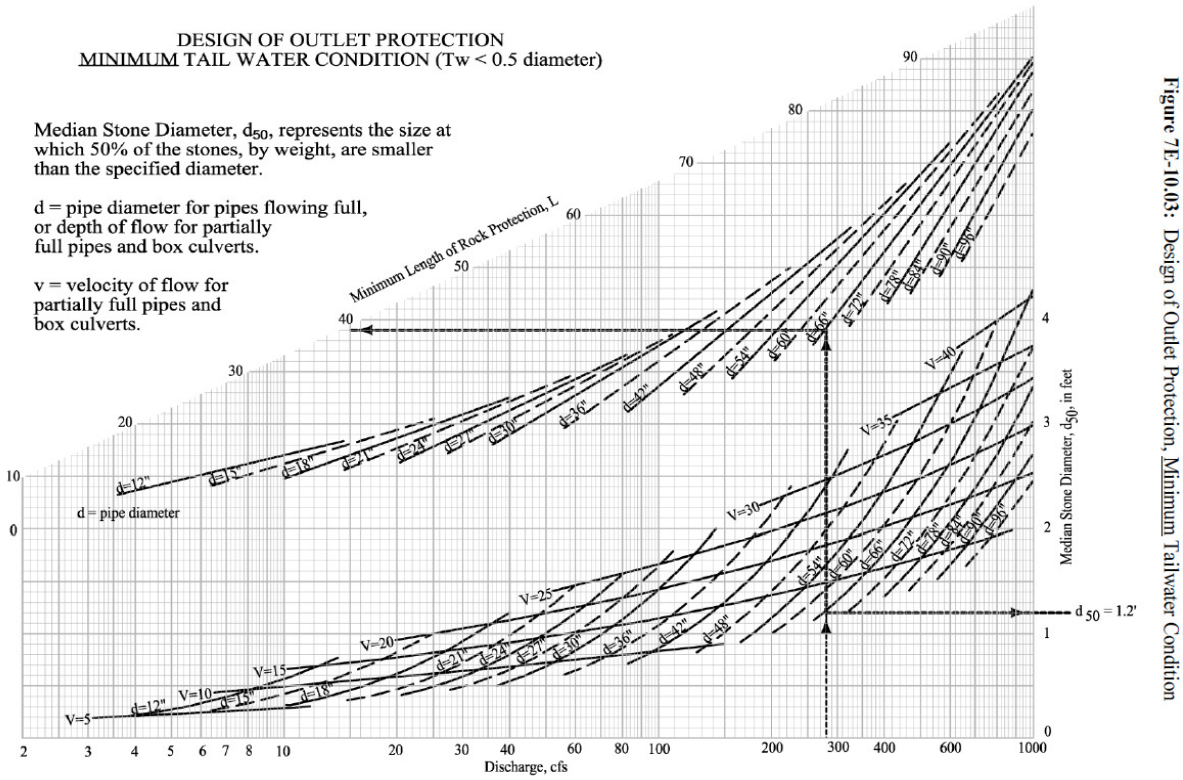

Figure 7E-10.03: Design of Outlet Protection, Minimum Tailwater Condition

Assumptions:

The riprap specific gravity is 2.65, based on a typical value as presented in SUDAS Chapter 7E-10.

Results:

The following sheets show the design D50 and apron dimensions for riprap at the end of each culvert outlet.

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Calculations:

Riprap D50 Sizing

Culvert Outlet	Design Q (cfs)	Culvert Diameter (ft)	Design D50 (ft)	Design Stone
1-1 & 1-2	31.36 ea.	2.5	1.0	Iowa DOT Section 4130.02 Class E Revetment
2-1 & 2-2	43.99 ea.	2.5	1.5	Iowa DOT Section 4130.02 Class B Revetment
3-1 & 3-2	43.80 ea.	3.0	1.0	Iowa DOT Section 4130.02 Class E Revetment
4-1 & 4-2	50.18 ea.	3.0	1.0	Iowa DOT Section 4130.02 Class E Revetment
Sed Basin 2 Outlet	9.88	2.0	0.5	Iowa DOT Section 4130.04 Erosion Stone
Sed Basin 3 Outlet	4.73	2.0	0.5	Iowa DOT Section 4130.04 Erosion Stone
Sed Basin 4 Outlet	12.72	1.5	1.0	Iowa DOT Section 4130.02 Class E Revetment

*No riprap anticipated at culverts 5, 11, 12, & 15.
**Refer to Wetland and Stream Mitigation Plan for Culvert 14-1 & 14-2 outlet protection.

I:\25211509\Reports\Permit Amendment\Appendices\Storm Water Management\Calcs - final\[Culvert Outlet Riprap Sizing Calc_131127.xls]D50 Calc

Calculations:

Riprap Apron Dimension Sizing

Culvert Outlet	Culvert Diameter (ft)	D50 (ft)	Apron Width @ Culvert (ft)	Apron Length (ft)	Apron Width @ End (ft)	Apron Depth (ft)
1-1 & 1-2	2.5	1.0	17.1	23.0	26.0	2.1
2-1 & 2-2	2.5	1.5	14.9	23.0	26.0	3.0
3-1 & 3-2	3.0	1.0	17.1	28.0	31.0	2.1
4-1 & 4-2	3.0	1.0	17.1	28.0	31.0	2.1
Sed Basin 2 Outlet	2.0	.5	6.0	15.0	17.0	1.2
Sed Basin 3 Outlet	2.0	.5	6.0	10.0	12.0	1.2
Sed Basin 4 Outlet	1.5	1.0	4.5	20.0	22.0	2.1

*No riprap anticipated at culverts 5, 11, 12, & 15.

**Refer to Wetland and Stream Mitigation Plan for Culvert 14-1 & 14-2 outlet protection.

I:\25211509\Reports\Permit Amendment\Appendices\Storm Water Management\Calcs - final\[Culvert Outlet Riprap Sizing Calc_131127.xls]Apron Sizing Calc

HY-8 Culvert Analysis Report
(Culverts 1-1 & 1-2)

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 62.71 cfs

Maximum Flow: 62.71 cfs

Table 1 - Summary of Culvert Flows at Crossing: To Sed Basin 2 (Culverts 1-1 & 1-2)

Headwater Elevation (ft)	Total Discharge (cfs)	Sed Basin 2 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
768.20	0.00	0.00	0.00	1
769.08	6.27	6.27	0.00	1
769.47	12.54	12.54	0.00	1
769.78	18.81	18.81	0.00	1
770.04	25.08	25.08	0.00	1
770.29	31.36	31.36	0.00	1
770.54	37.63	37.63	0.00	1
770.82	43.90	43.90	0.00	1
771.13	50.17	50.17	0.00	1
771.48	56.44	56.44	0.00	1
771.87	62.71	62.71	0.00	1
772.50	71.47	71.47	0.00	Overtopping

Tailwater Channel Data - To Sed Basin 2 (Culverts 1-1 & 1-2)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 757.00 ft

Roadway Data for Crossing: To Sed Basin 2 (Culverts 1-1 & 1-2)

Roadway Profile Shape: Constant Roadway Elevation

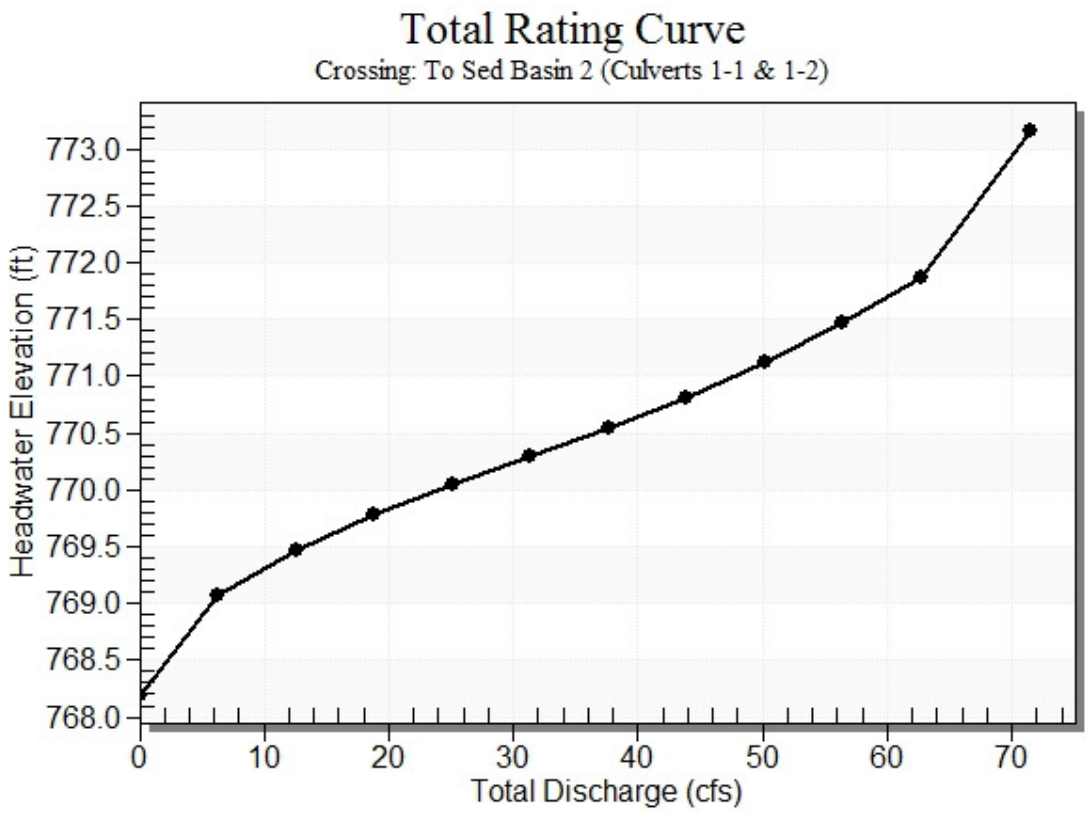
Crest Length: 100.00 ft

Crest Elevation: 772.50 ft

Roadway Surface: Gravel

Roadway Top Width: 18.00 ft

Rating Curve Plot for Crossing: To Sed Basin 2 (Culverts 1-1 & 1-2)



Site Data - Sed Basin 2

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 768.20 ft

Outlet Station: 156.00 ft

Outlet Elevation: 760.00 ft

Number of Barrels: 2

Culvert Data Summary - Sed Basin 2

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: NONE

Table 2 - Culvert Summary Table: Sed Basin 2

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)
0.00	0.00	768.20	0.000	0.000	0-NF	0.000	0.000	0.000	3.000	0.000	0.000
6.27	6.27	769.08	0.876	0.0*	1-S2n	0.284	0.577	0.284	3.000	9.860	0.000
12.54	12.54	769.47	1.271	0.0*	1-S2n	0.410	0.826	0.410	3.000	11.740	0.000
18.81	18.81	769.78	1.579	0.0*	1-S2n	0.505	1.020	0.505	3.000	13.164	0.000
25.08	25.08	770.04	1.841	0.0*	1-S2n	0.582	1.189	0.582	3.000	14.321	0.000
31.36	31.36	770.29	2.088	0.0*	1-S2n	0.659	1.334	0.659	3.000	15.119	0.000
37.63	37.63	770.54	2.340	0.0*	1-S2n	0.723	1.466	0.749	3.000	15.155	0.000
43.90	43.90	770.82	2.616	0.0*	5-S2n	0.781	1.590	0.805	3.000	16.022	0.000
50.17	50.17	771.13	2.926	0.0*	5-S2n	0.839	1.702	0.866	3.000	16.587	0.000
56.44	56.44	771.48	3.278	0.0*	5-S2n	0.898	1.809	0.926	3.000	17.077	0.000
62.71	62.71	771.87	3.674	0.0*	5-S2n	0.949	1.905	0.987	3.000	17.381	0.000

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 768.20 ft, Outlet Elevation (invert): 760.00 ft

Culvert Length: 156.22 ft, Culvert Slope: 0.0526

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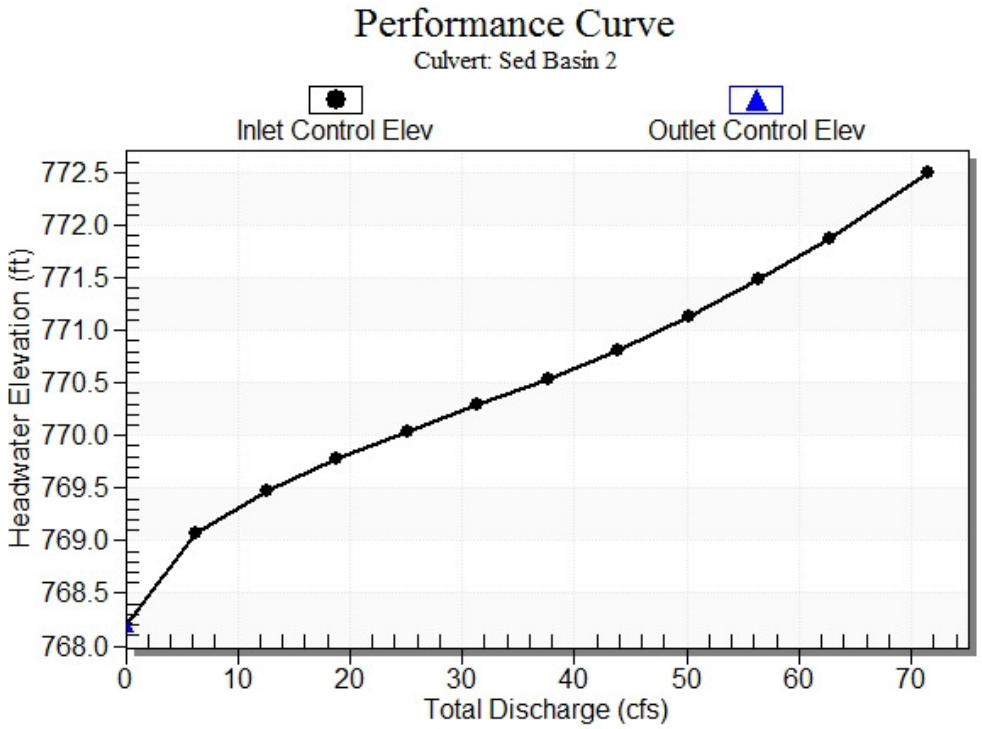
Culvert Performance Curve Plot: Sed Basin 2



Water Surface Profile Plot for Culvert: Sed Basin 2

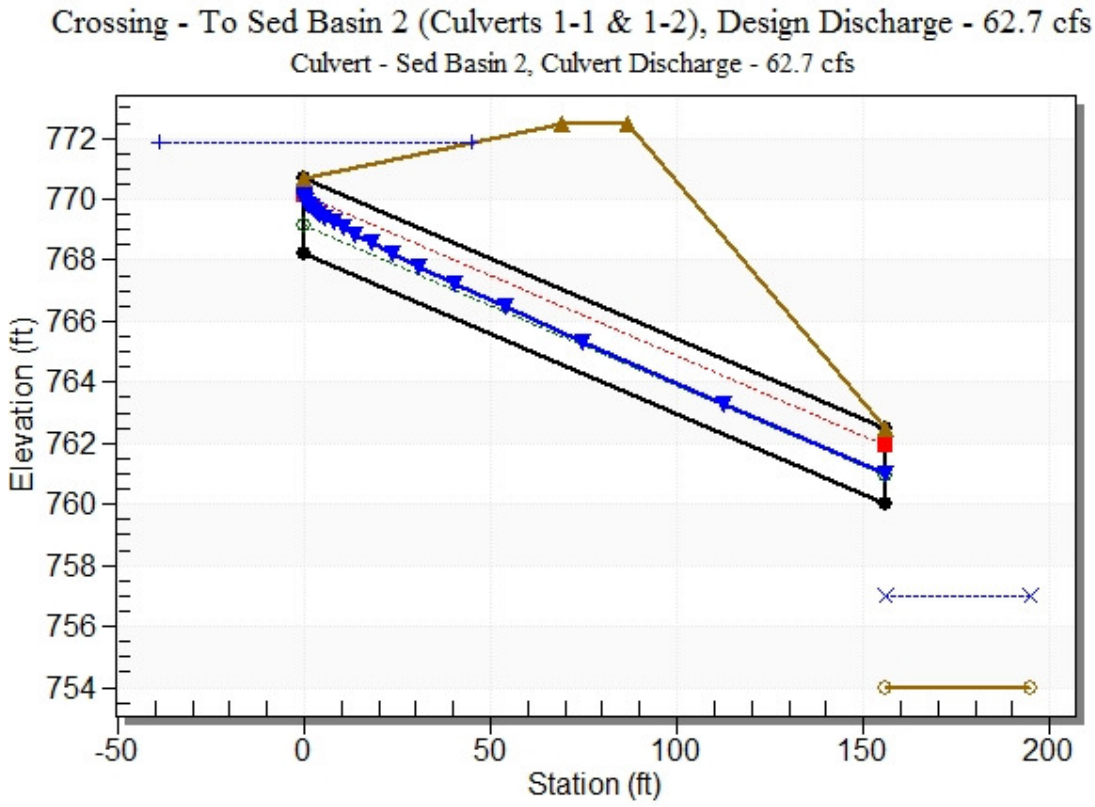


Table 3 - Downstream Channel Rating Curve (Crossing: To Sed Basin 2 (Culverts 1-1 & 1-2))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	757.00	3.00
6.27	757.00	3.00
12.54	757.00	3.00
18.81	757.00	3.00
25.08	757.00	3.00
31.36	757.00	3.00
37.63	757.00	3.00
43.90	757.00	3.00
50.17	757.00	3.00
56.44	757.00	3.00
62.71	757.00	3.00

HY-8 Culvert Analysis Report
(Culverts 2-1 & 2-2)

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 87.98 cfs

Maximum Flow: 87.98 cfs

Table 1 - Summary of Culvert Flows at Crossing: To Sed Basin 3 (Culverts 2-1 & 2-2)

Headwater Elevation (ft)	Total Discharge (cfs)	Sed Basin 3 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
772.20	0.00	0.00	0.00	1
773.06	8.80	8.80	0.00	1
773.44	17.60	17.60	0.00	1
773.84	26.39	26.39	0.00	1
774.19	35.19	35.19	0.00	1
774.52	43.99	43.99	0.00	1
774.88	52.79	52.79	0.00	1
775.29	61.59	61.59	0.00	1
775.75	70.38	70.38	0.00	1
776.28	79.18	79.18	0.00	1
776.89	87.98	87.98	0.00	1
778.00	102.09	102.09	0.00	Overtopping

Tailwater Channel Data - To Sed Basin 3 (Culverts 2-1 & 2-2)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 755.00 ft

Roadway Data for Crossing: To Sed Basin 3 (Culverts 2-1 & 2-2)

Roadway Profile Shape: Constant Roadway Elevation

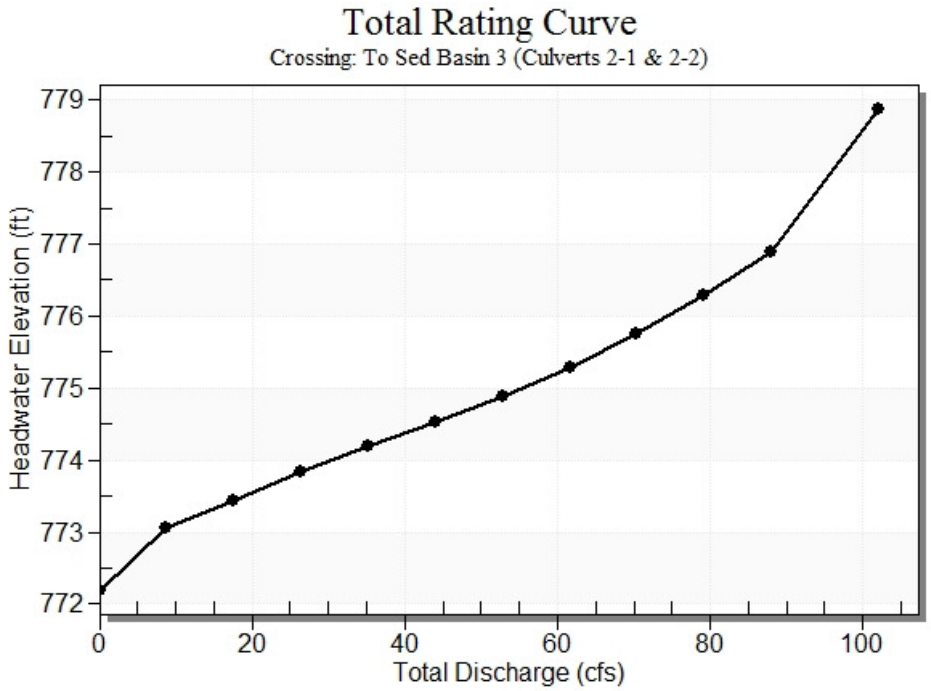
Crest Length: 100.00 ft

Crest Elevation: 778.00 ft

Roadway Surface: Gravel

Roadway Top Width: 18.00 ft

Rating Curve Plot for Crossing: To Sed Basin 3 (Culverts 2-1 & 2-2)



Site Data - Sed Basin 3

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 772.20 ft

Outlet Station: 113.00 ft

Outlet Elevation: 758.00 ft

Number of Barrels: 2

Culvert Data Summary - Sed Basin 3

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 2 - Culvert Summary Table: Sed Basin 3

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)
0.00	0.00	772.20	0.000	0.000	0-NF	0.000	0.000	0.000	3.000	0.000	0.000
8.80	8.80	773.06	0.860	0.0*	1-S2n	0.272	0.685	0.283	3.000	13.901	0.000
17.60	17.60	773.44	1.242	0.0*	1-S2n	0.387	0.983	0.425	3.000	15.747	0.000
26.39	26.39	773.84	1.638	0.0*	1-S2n	0.483	1.221	0.514	3.000	17.986	0.000
35.19	35.19	774.19	1.986	0.0*	1-S2n	0.553	1.417	0.575	3.000	20.406	0.000
43.99	43.99	774.52	2.323	0.0*	1-S2n	0.623	1.592	0.649	3.000	21.649	0.000
52.79	52.79	774.88	2.683	0.0*	5-S2n	0.691	1.746	0.726	3.000	22.445	0.000
61.59	61.59	775.29	3.087	0.0*	5-S2n	0.743	1.889	0.786	3.000	23.195	0.000
70.38	70.38	775.75	3.551	0.0*	5-S2n	0.796	2.012	0.851	3.000	23.796	0.000
79.18	79.18	776.28	4.083	0.0*	5-S2n	0.849	2.119	0.911	3.000	24.496	0.000
87.98	87.98	776.89	4.686	0.0*	5-S2n	0.902	2.208	0.967	3.000	25.069	0.000

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 772.20 ft, Outlet Elevation (invert): 758.00 ft

Culvert Length: 113.89 ft, Culvert Slope: 0.1257

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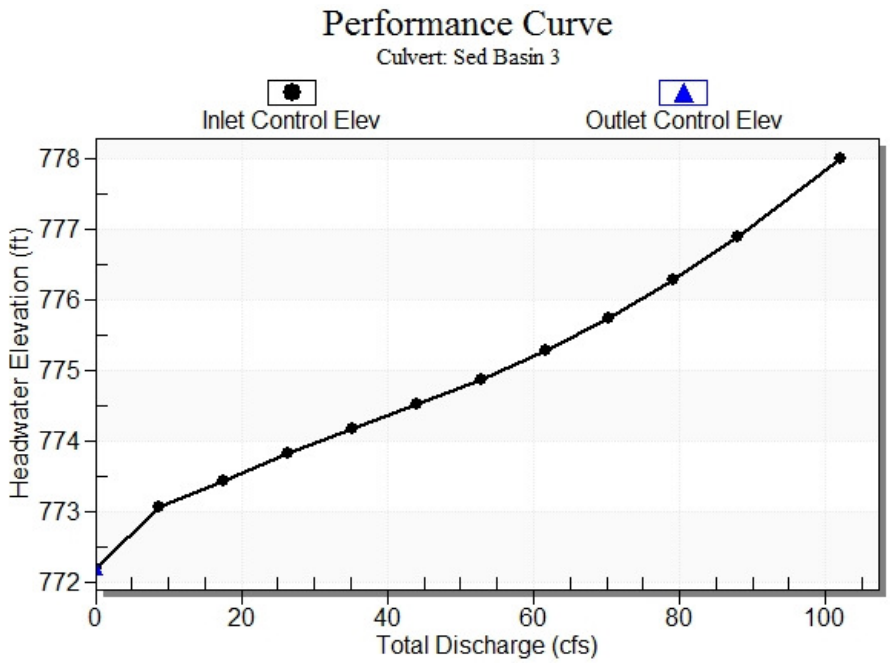
Culvert Performance Curve Plot: Sed Basin 3



Water Surface Profile Plot for Culvert: Sed Basin 3

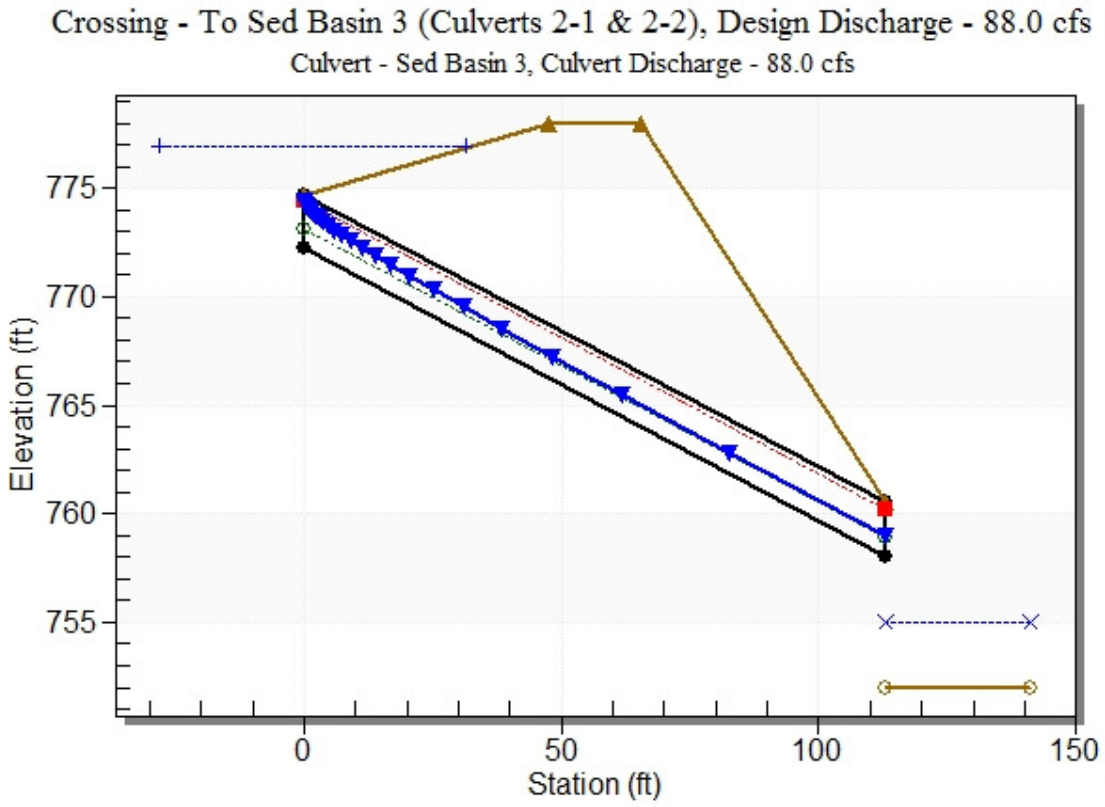


Table 3 - Downstream Channel Rating Curve (Crossing: To Sed Basin 3 (Culverts 2-1 & 2-2))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	755.00	3.00
8.80	755.00	3.00
17.60	755.00	3.00
26.39	755.00	3.00
35.19	755.00	3.00
43.99	755.00	3.00
52.79	755.00	3.00
61.59	755.00	3.00
70.38	755.00	3.00
79.18	755.00	3.00
87.98	755.00	3.00

HY-8 Culvert Analysis Report
(Culverts 3-1 & 3-2)

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 87.6 cfs

Maximum Flow: 87.6 cfs

Table 1 - Summary of Culvert Flows at Crossing: Across South Road (Culvert 3-1 & 3-2)

Headwater Elevation (ft)	Total Discharge (cfs)	Across South Road Discharge (cfs)	Roadway Discharge (cfs)	Iterations
795.70	0.00	0.00	0.00	1
796.57	8.76	8.76	0.00	1
796.96	17.52	17.52	0.00	1
797.28	26.28	26.28	0.00	1
797.60	35.04	35.04	0.00	1
797.88	43.80	43.80	0.00	1
798.14	52.56	52.56	0.00	1
798.40	61.32	61.32	0.00	1
798.65	70.08	70.08	0.00	1
798.92	78.84	78.84	0.00	1
799.21	87.60	87.60	0.00	1
800.00	108.50	108.50	0.00	Overtopping

Tailwater Channel Data - Across South Road (Culvert 3-1 & 3-2)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 779.00 ft

Roadway Data for Crossing: Across South Road (Culvert 3-1 & 3-2)

Roadway Profile Shape: Constant Roadway Elevation

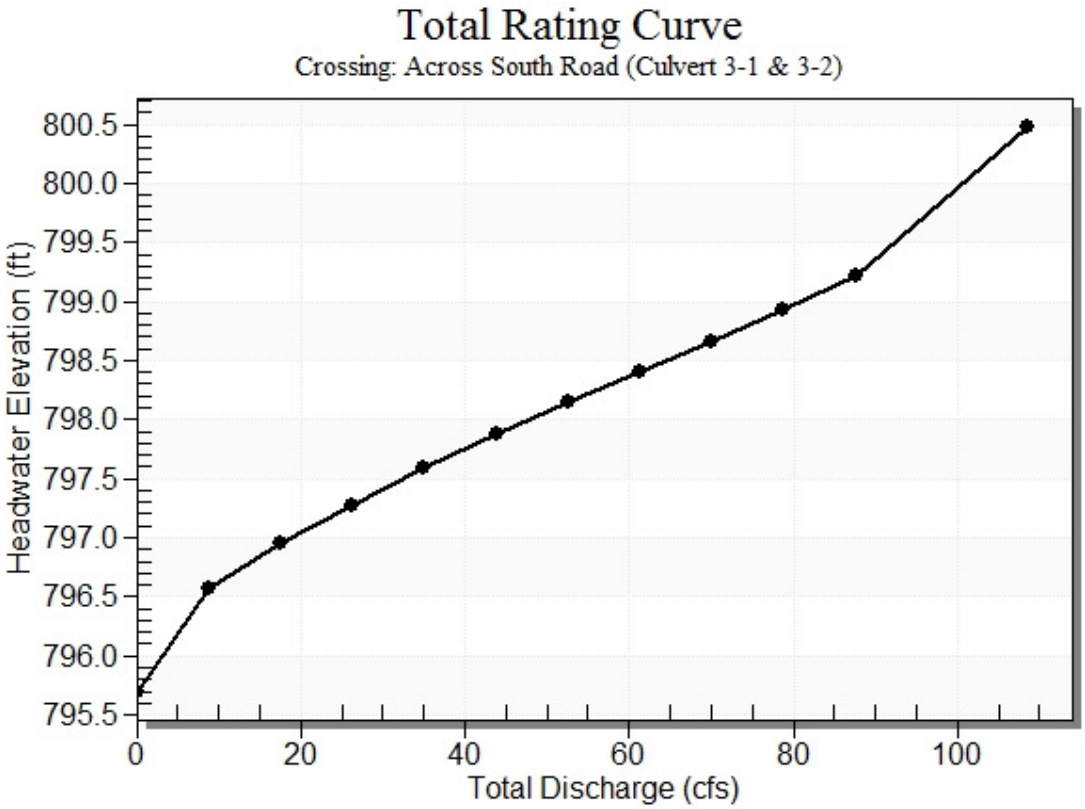
Crest Length: 333.00 ft

Crest Elevation: 800.00 ft

Roadway Surface: Gravel

Roadway Top Width: 18.00 ft

Rating Curve Plot for Crossing: Across South Road (Culvert 3-1 & 3-2)



Site Data - Across South Road

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 795.70 ft

Outlet Station: 60.00 ft

Outlet Elevation: 794.00 ft

Number of Barrels: 2

Culvert Data Summary - Across South Road

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 2 - Culvert Summary Table: Across South Road

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)
0.00	0.00	795.70	0.000	0.000	0-NF	0.000	0.000	0.000	3.000	0.000	0.000
8.76	8.76	796.57	0.870	0.0*	1-S2n	0.366	0.650	0.398	3.000	7.608	0.000
17.52	17.52	796.96	1.255	0.0*	1-S2n	0.544	0.930	0.568	3.000	9.490	0.000
26.28	26.28	797.28	1.577	0.0*	1-S2n	0.653	1.149	0.711	3.000	10.155	0.000
35.04	35.04	797.60	1.896	0.0*	1-S2n	0.761	1.339	0.835	3.000	10.923	0.000
43.80	43.80	797.88	2.180	0.083	1-S2n	0.857	1.505	0.949	3.000	11.361	0.000
52.56	52.56	798.14	2.443	0.351	1-S2n	0.939	1.650	1.055	3.000	11.827	0.000
61.32	61.32	798.40	2.697	0.635	1-S2n	1.021	1.789	1.158	3.000	12.173	0.000
70.08	70.08	798.65	2.954	0.933	1-S2n	1.101	1.920	1.254	3.000	12.506	0.000
78.84	78.84	798.92	3.223	1.240	5-S2n	1.170	2.038	1.345	3.000	12.843	0.000
87.60	87.60	799.21	3.510	1.567	5-S2n	1.239	2.153	1.435	3.000	13.116	0.000

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 795.70 ft, Outlet Elevation (invert): 794.00 ft

Culvert Length: 60.02 ft, Culvert Slope: 0.0283

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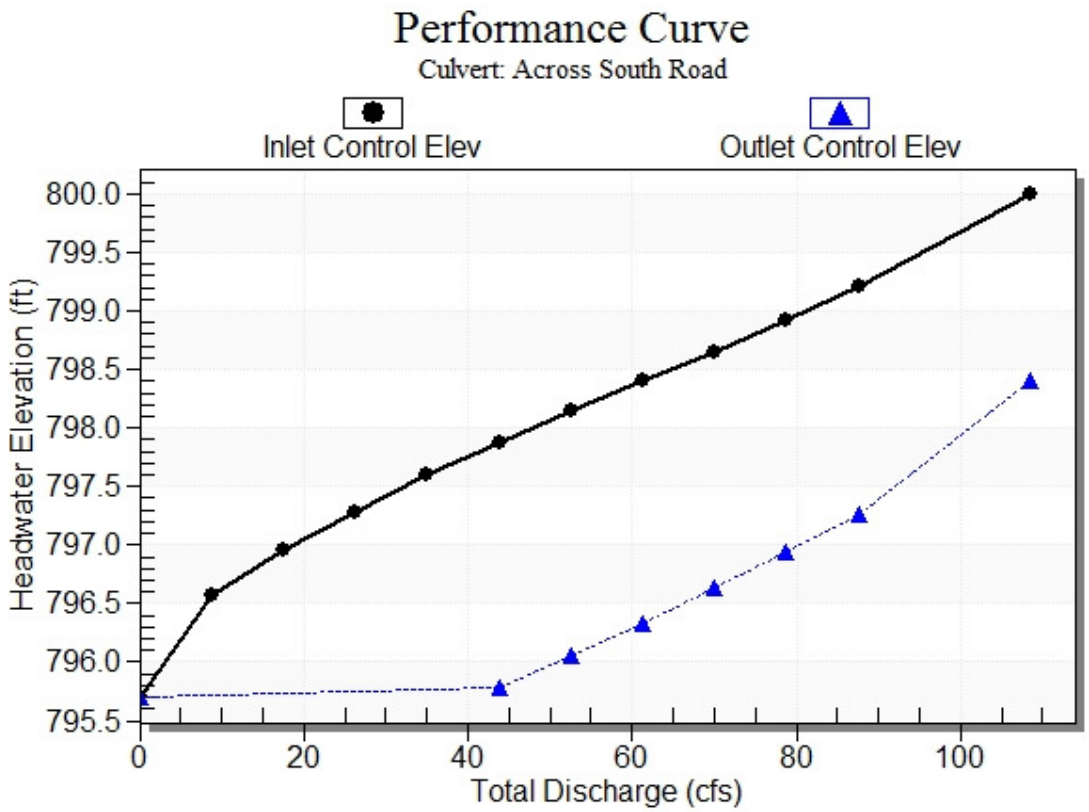
Culvert Performance Curve Plot: Across South Road



Water Surface Profile Plot for Culvert: Across South Road

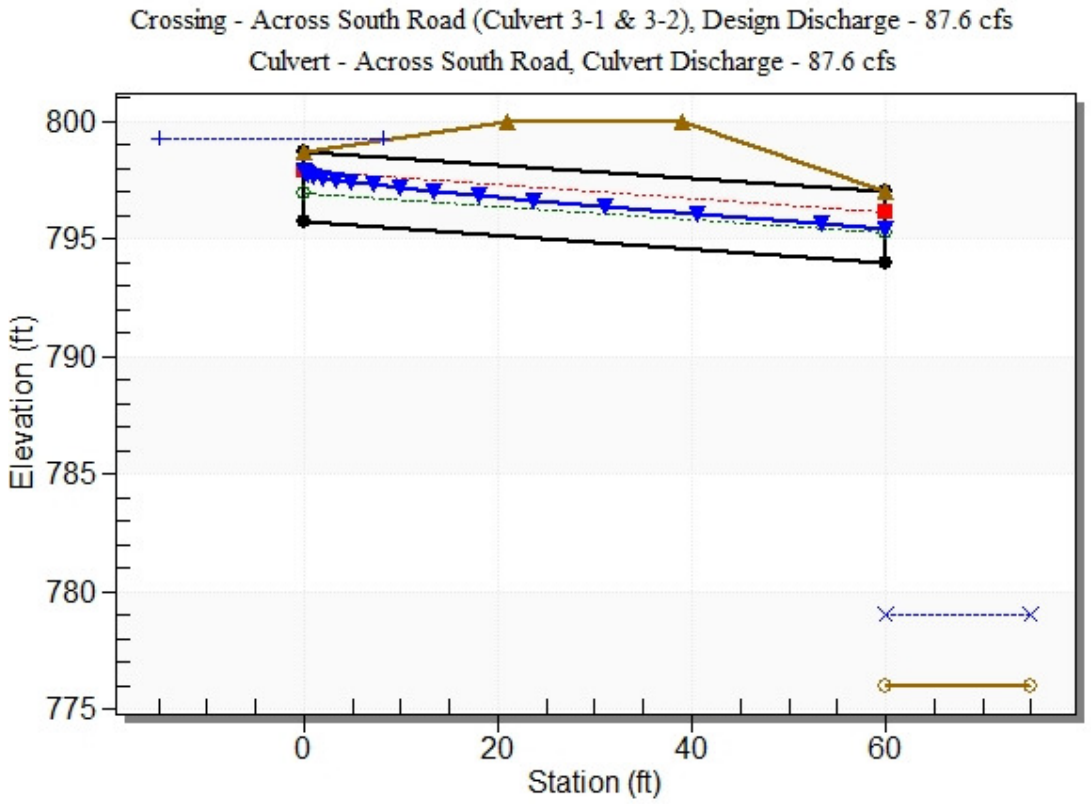


Table 3 - Downstream Channel Rating Curve (Crossing: Across South Road (Culvert 3-1 & 3-2))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	779.00	3.00
8.76	779.00	3.00
17.52	779.00	3.00
26.28	779.00	3.00
35.04	779.00	3.00
43.80	779.00	3.00
52.56	779.00	3.00
61.32	779.00	3.00
70.08	779.00	3.00
78.84	779.00	3.00
87.60	779.00	3.00

HY-8 Culvert Analysis Report
(Culverts 4-1 & 4-2)

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 100.36 cfs

Maximum Flow: 100.36 cfs

Table 1 - Summary of Culvert Flows at Crossing: To Sed Basin 4 (Culvert 4-1 & 4-2)

Headwater Elevation (ft)	Total Discharge (cfs)	To Sed Basin 4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
776.00	0.00	0.00	0.00	1
776.93	10.04	10.04	0.00	1
777.34	20.07	20.07	0.00	1
777.71	30.11	30.11	0.00	1
778.05	40.14	40.14	0.00	1
778.36	50.18	50.18	0.00	1
778.65	60.22	60.22	0.00	1
778.95	70.25	70.25	0.00	1
779.26	80.29	80.29	0.00	1
779.59	90.32	90.32	0.00	1
779.96	100.36	100.36	0.00	1
782.00	143.10	143.10	0.00	Overtopping

Tailwater Channel Data - To Sed Basin 4 (Culvert 4-1 & 4-2)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 753.00 ft

Roadway Data for Crossing: To Sed Basin 4 (Culvert 4-1 & 4-2)

Roadway Profile Shape: Constant Roadway Elevation

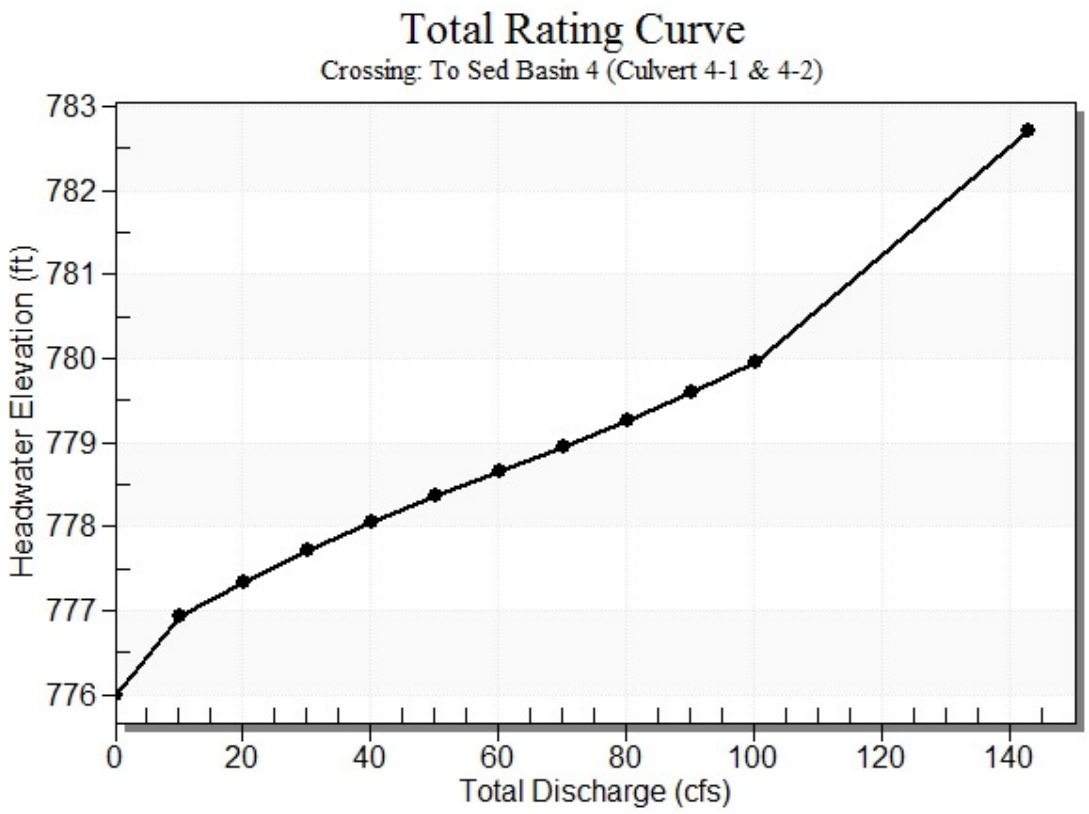
Crest Length: 333.00 ft

Crest Elevation: 782.00 ft

Roadway Surface: Gravel

Roadway Top Width: 18.00 ft

Rating Curve Plot for Crossing: To Sed Basin 4 (Culvert 4-1 & 4-2)



Site Data - To Sed Basin 4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 776.00 ft

Outlet Station: 110.00 ft

Outlet Elevation: 772.00 ft

Number of Barrels: 2

Culvert Data Summary - To Sed Basin 4

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 2 - Culvert Summary Table: To Sed Basin 4

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)
0.00	0.00	776.00	0.000	0.000	0-NF	0.000	0.000	0.000	3.000	0.000	0.000
10.04	10.04	776.93	0.928	0.0*	1-S2n	0.368	0.698	0.368	3.000	9.744	0.000
20.07	20.07	777.34	1.341	0.0*	1-S2n	0.547	0.999	0.547	3.000	11.390	0.000
30.11	30.11	777.71	1.710	0.0*	1-S2n	0.657	1.233	0.657	3.000	13.016	0.000
40.14	40.14	778.05	2.053	0.0*	1-S2n	0.766	1.438	0.805	3.000	13.139	0.000
50.18	50.18	778.36	2.360	0.0*	1-S2n	0.862	1.612	0.909	3.000	13.817	0.000
60.22	60.22	778.65	2.653	0.0*	1-S2n	0.944	1.773	1.010	3.000	14.353	0.000
70.25	70.25	778.95	2.947	0.0*	1-S2n	1.027	1.922	1.104	3.000	14.889	0.000
80.29	80.29	779.26	3.257	0.0*	5-S2n	1.107	2.061	1.194	3.000	15.290	0.000
90.32	90.32	779.59	3.592	0.0*	5-S2n	1.177	2.187	1.279	3.000	15.696	0.000
100.36	100.36	779.96	3.960	0.353	5-S2n	1.247	2.302	1.363	3.000	16.056	0.000

* Full Flow Headwater elevation is below inlet invert.

****

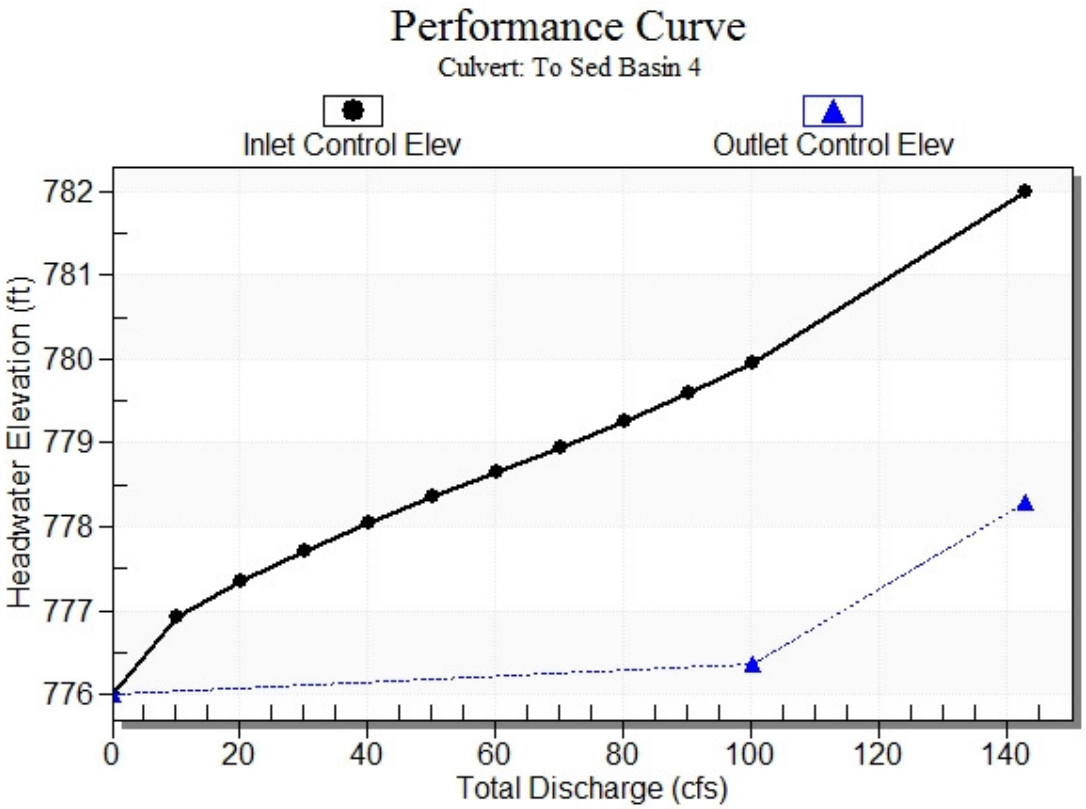
Straight Culvert

Inlet Elevation (invert): 776.00 ft, Outlet Elevation (invert): 772.00 ft

Culvert Length: 110.07 ft, Culvert Slope: 0.0364

****

Culvert Performance Curve Plot: To Sed Basin 4



Water Surface Profile Plot for Culvert: To Sed Basin 4

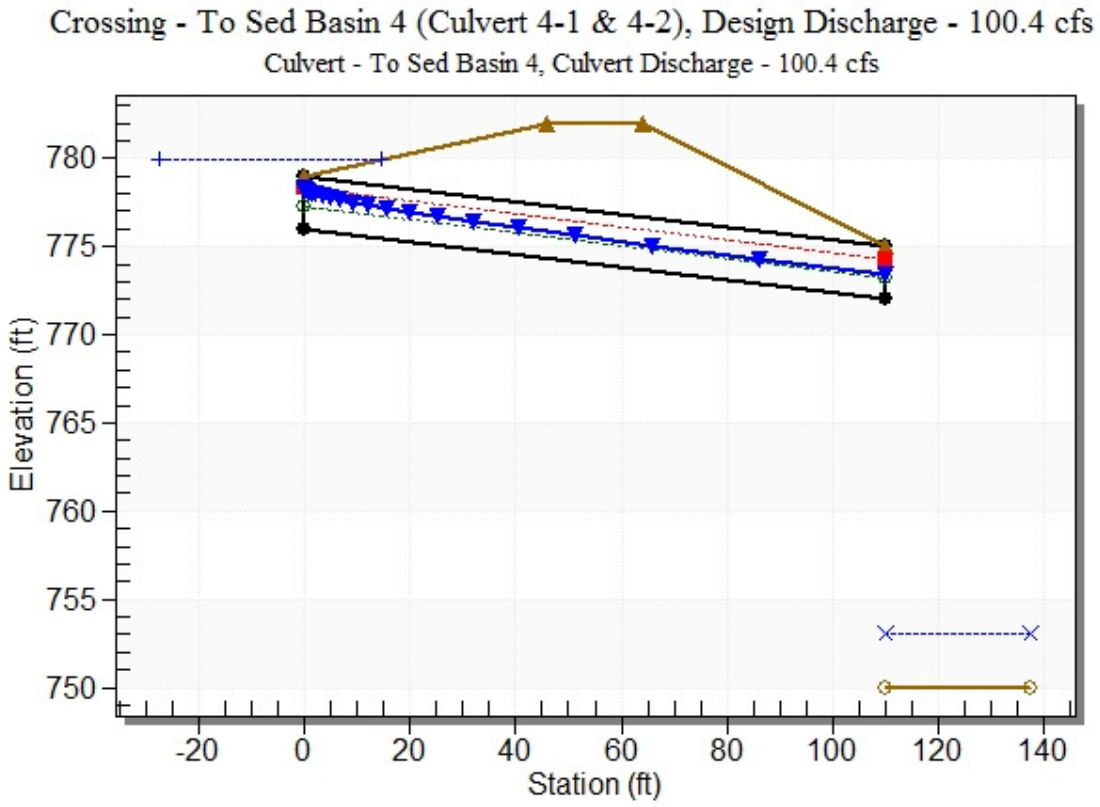


Table 3 - Downstream Channel Rating Curve (Crossing: To Sed Basin 4 (Culvert 4-1 & 4-2))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	753.00	3.00
10.04	753.00	3.00
20.07	753.00	3.00
30.11	753.00	3.00
40.14	753.00	3.00
50.18	753.00	3.00
60.22	753.00	3.00
70.25	753.00	3.00
80.29	753.00	3.00
90.32	753.00	3.00
100.36	753.00	3.00

HY-8 Culvert Analysis Report
(Culvert 5-1)

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 3.05 cfs

Maximum Flow: 3.05 cfs

Table 1 - Summary of Culvert Flows at Crossing: 5-1 (Ph 1 Access Rd)

Headwater Elevation (ft)	Total Discharge (cfs)	5-1 (Ph 1 Access Rd) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
758.00	0.00	0.00	0.00	1
758.31	0.30	0.30	0.00	1
758.44	0.61	0.61	0.00	1
758.55	0.92	0.92	0.00	1
758.66	1.22	1.22	0.00	1
758.76	1.52	1.52	0.00	1
758.85	1.83	1.83	0.00	1
758.95	2.13	2.13	0.00	1
759.04	2.44	2.44	0.00	1
759.14	2.75	2.75	0.00	1
759.25	3.05	3.05	0.00	1
772.50	12.18	12.18	0.00	Overtopping

Tailwater Channel Data - 5-1 (Ph 1 Access Rd)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 749.00 ft

Roadway Data for Crossing: 5-1 (Ph 1 Access Rd)

Roadway Profile Shape: Constant Roadway Elevation

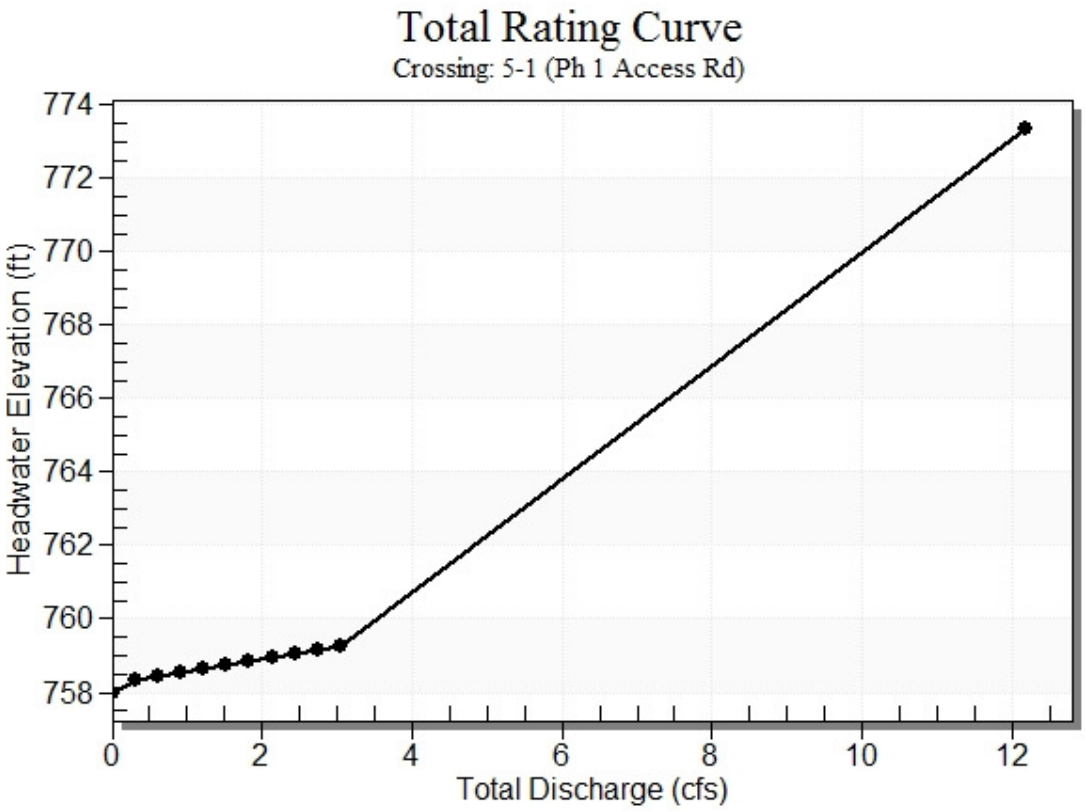
Crest Length: 100.00 ft

Crest Elevation: 772.50 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft

Rating Curve Plot for Crossing: 5-1 (Ph 1 Access Rd)



Site Data - 5-1 (Ph 1 Access Rd)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 758.00 ft

Outlet Station: 125.00 ft

Outlet Elevation: 753.50 ft

Number of Barrels: 1

Culvert Data Summary - 5-1 (Ph 1 Access Rd)

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 2 - Culvert Summary Table: 5-1 (Ph 1 Access Rd)

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)
0.00	0.00	758.00	0.000	0.000	0-NF	0.000	0.000	0.000	1.000	0.000	0.000
0.30	0.30	758.31	0.309	0.0*	1-S2n	0.131	0.224	0.131	1.000	10.698	0.000
0.61	0.61	758.44	0.439	0.0*	1-S2n	0.193	0.322	0.193	1.000	5.806	0.000
0.92	0.92	758.55	0.551	0.0*	1-S2n	0.235	0.399	0.235	1.000	6.459	0.000
1.22	1.22	758.66	0.662	0.0*	1-S2n	0.275	0.466	0.275	1.000	6.939	0.000
1.52	1.52	758.76	0.761	0.0*	1-S2n	0.307	0.523	0.307	1.000	7.544	0.000
1.83	1.83	758.85	0.854	0.0*	1-S2n	0.339	0.573	0.339	1.000	7.797	0.000
2.13	2.13	758.95	0.946	0.0*	1-S2n	0.369	0.622	0.369	1.000	8.115	0.000
2.44	2.44	759.04	1.042	0.0*	5-S2n	0.396	0.664	0.396	1.000	8.474	0.000
2.75	2.75	759.14	1.143	0.0*	5-S2n	0.422	0.708	0.422	1.000	8.692	0.000
3.05	3.05	759.25	1.254	0.0*	5-S2n	0.449	0.746	0.449	1.000	8.917	0.000

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 758.00 ft, Outlet Elevation (invert): 753.50 ft

Culvert Length: 125.08 ft, Culvert Slope: 0.0360

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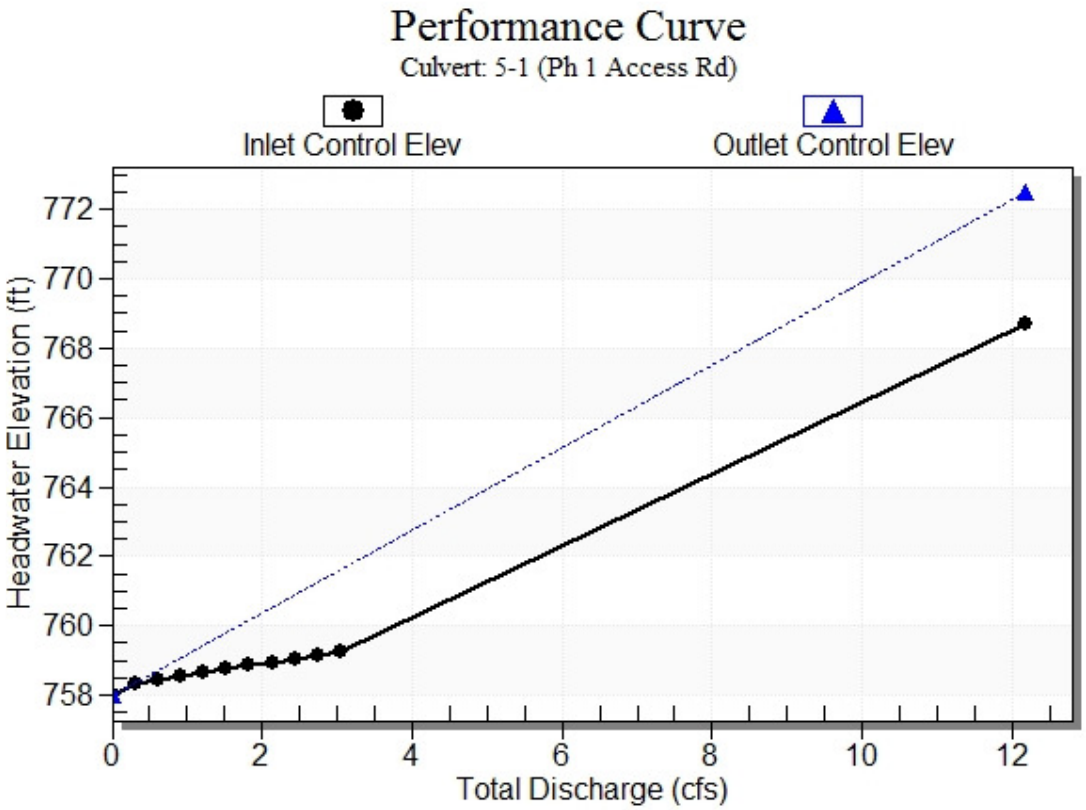
Culvert Performance Curve Plot: 5-1 (Ph 1 Access Rd)



Water Surface Profile Plot for Culvert: 5-1 (Ph 1 Access Rd)

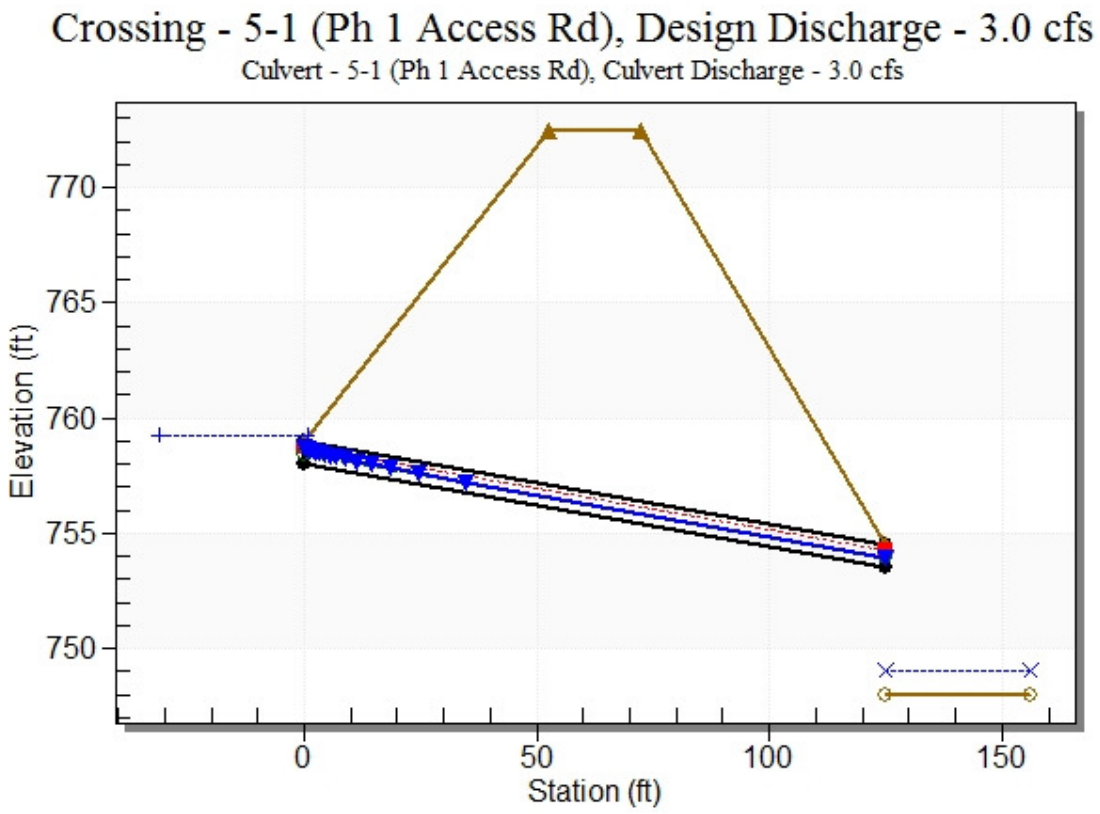


Table 3 - Downstream Channel Rating Curve (Crossing: 5-1 (Ph 1 Access Rd))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	749.00	1.00
0.30	749.00	1.00
0.61	749.00	1.00
0.92	749.00	1.00
1.22	749.00	1.00
1.52	749.00	1.00
1.83	749.00	1.00
2.13	749.00	1.00
2.44	749.00	1.00
2.75	749.00	1.00
3.05	749.00	1.00

HY-8 Culvert Analysis Report
(Culvert 11-1)

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 7.8 cfs

Maximum Flow: 7.8 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert 11-1 (Ph 5 Access Rd)

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 11-1 (Ph 5 Access Rd) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
770.00	0.00	0.00	0.00	1
770.44	0.78	0.78	0.00	1
770.63	1.56	1.56	0.00	1
770.79	2.34	2.34	0.00	1
770.95	3.12	3.12	0.00	1
771.10	3.90	3.90	0.00	1
771.23	4.68	4.68	0.00	1
771.36	5.46	5.46	0.00	1
771.49	6.24	6.24	0.00	1
771.62	7.02	7.02	0.00	1
771.77	7.80	7.80	0.00	1
774.00	15.40	15.40	0.00	Overtopping

Tailwater Channel Data - Culvert 11-1 (Ph 5 Access Rd)

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.3300

Channel Manning's n: 0.0200

Channel Invert Elevation: 768.00 ft

Roadway Data for Crossing: Culvert 11-1 (Ph 5 Access Rd)

Roadway Profile Shape: Constant Roadway Elevation

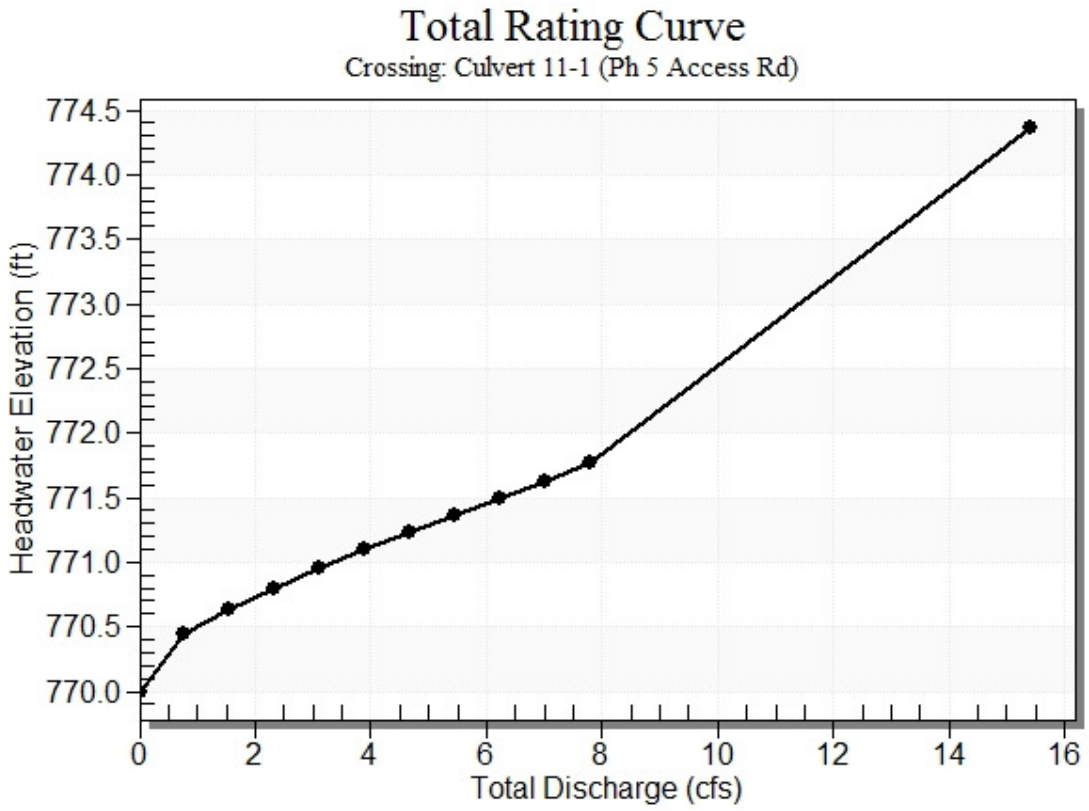
Crest Length: 100.00 ft

Crest Elevation: 774.00 ft

Roadway Surface: Gravel

Roadway Top Width: 18.00 ft

Rating Curve Plot for Crossing: Culvert 11-1 (Ph 5 Access Rd)



Site Data - Culvert 11-1 (Ph 5 Access Rd)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 770.00 ft

Outlet Station: 75.00 ft

Outlet Elevation: 768.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 11-1 (Ph 5 Access Rd)

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 2 - Culvert Summary Table: Culvert 11-1 (Ph 5 Access Rd)

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)
0.00	0.00	770.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.78	0.78	770.44	0.437	0.0*	1-S2n	0.198	0.323	0.211	0.178	4.977	8.212
1.56	1.56	770.63	0.631	0.0*	1-S2n	0.290	0.464	0.290	0.231	6.572	9.766
2.34	2.34	770.79	0.794	0.0*	1-S2n	0.353	0.574	0.359	0.269	7.131	10.808
3.12	3.12	770.95	0.954	0.0*	1-S2n	0.415	0.672	0.415	0.299	7.850	11.614
3.90	3.90	771.10	1.096	0.0*	1-S2n	0.462	0.755	0.474	0.325	8.113	12.280
4.68	4.68	771.23	1.228	0.0*	1-S2n	0.510	0.828	0.520	0.348	8.592	12.853
5.46	5.46	771.36	1.356	0.0*	1-S2n	0.556	0.898	0.568	0.369	8.915	13.358
6.24	6.24	771.49	1.486	0.0*	1-S2n	0.596	0.960	0.612	0.388	9.189	13.812
7.02	7.02	771.62	1.622	0.0*	5-S2n	0.637	1.023	0.655	0.406	9.453	14.224
7.80	7.80	771.77	1.767	0.0*	5-S2n	0.677	1.078	0.695	0.422	9.737	14.604

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 770.00 ft, Outlet Elevation (invert): 768.00 ft

Culvert Length: 75.03 ft, Culvert Slope: 0.0267

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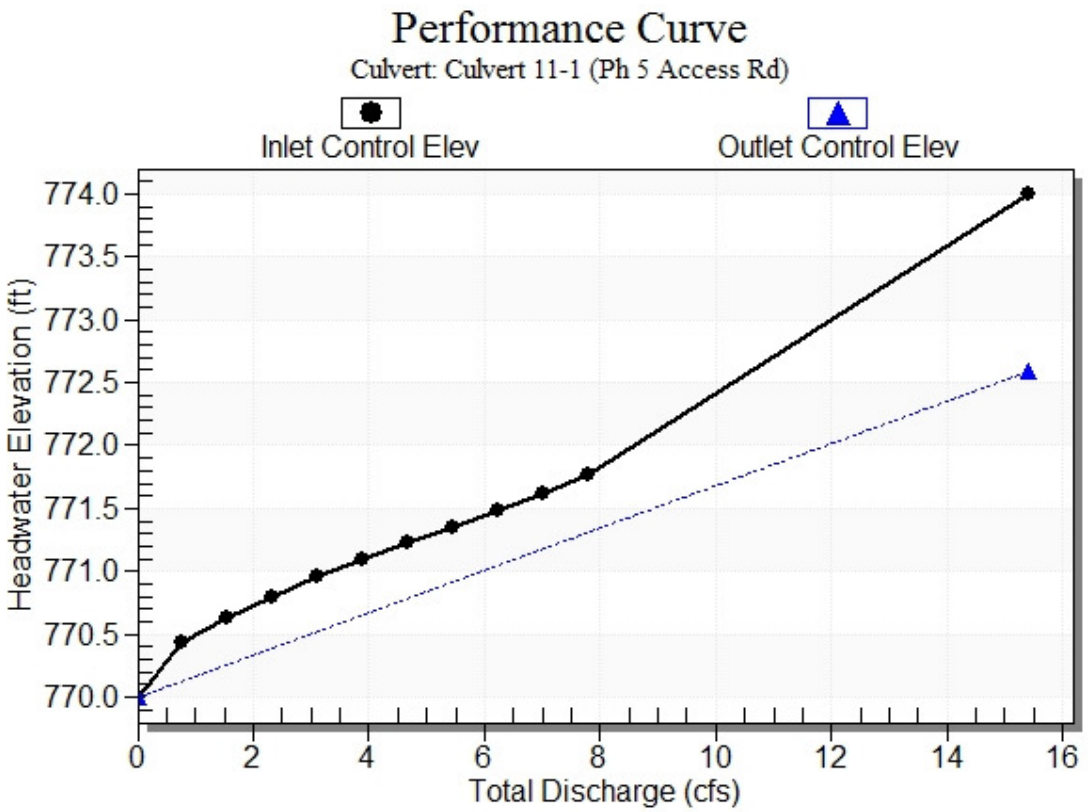
Culvert Performance Curve Plot: Culvert 11-1 (Ph 5 Access Rd)



Water Surface Profile Plot for Culvert: Culvert 11-1 (Ph 5 Access Rd)

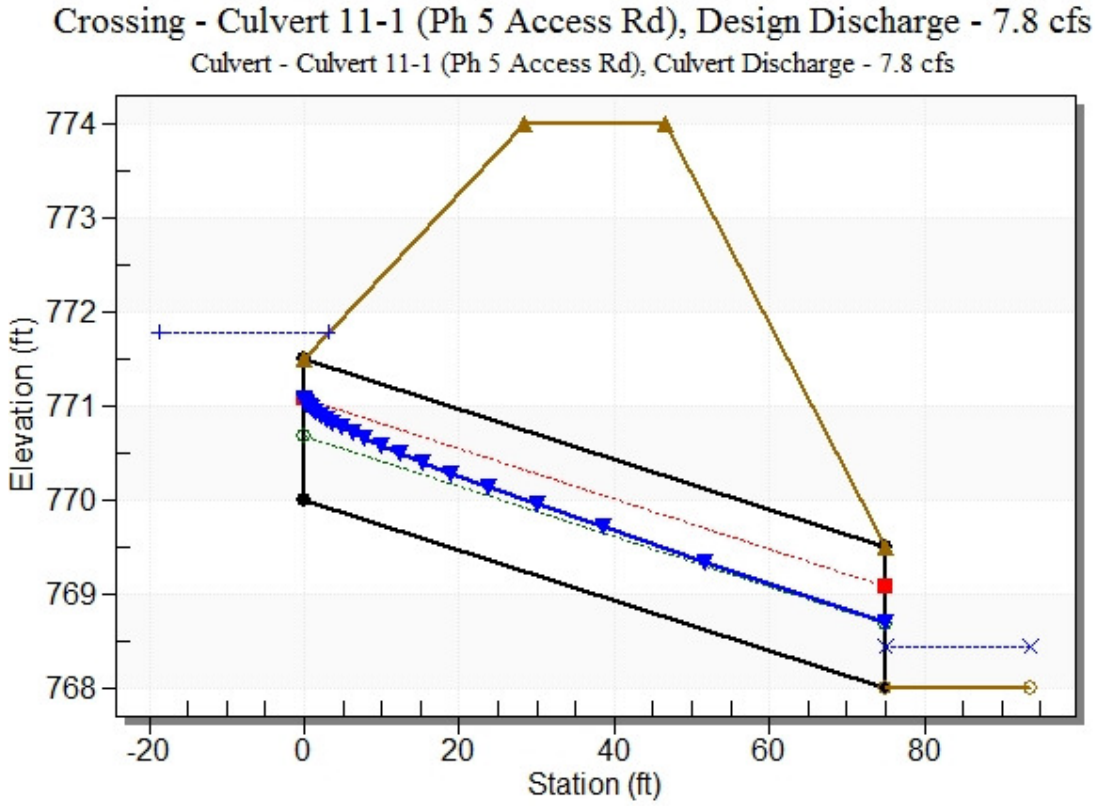


Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 11-1 (Ph 5 Access Rd))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	768.00	0.00	0.00	0.00	0.00
0.78	768.18	0.18	8.21	3.66	4.85
1.56	768.23	0.23	9.77	4.75	5.07
2.34	768.27	0.27	10.81	5.53	5.20
3.12	768.30	0.30	11.61	6.16	5.29
3.90	768.33	0.33	12.28	6.70	5.37
4.68	768.35	0.35	12.85	7.17	5.43
5.46	768.37	0.37	13.36	7.60	5.48
6.24	768.39	0.39	13.81	7.99	5.53
7.02	768.41	0.41	14.22	8.35	5.57
7.80	768.42	0.42	14.60	8.69	5.60

HY-8 Culvert Analysis Report
(Culvert 12-1)

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 12.23 cfs

Maximum Flow: 12.23 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert 12-1 (Across LF Perimeter Road)

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 12-1 (Across LF Perimeter Road) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
796.30	0.00	0.00	0.00	1
796.82	1.22	1.22	0.00	1
797.06	2.45	2.45	0.00	1
797.30	3.67	3.67	0.00	1
797.50	4.89	4.89	0.00	1
797.71	6.12	6.12	0.00	1
797.92	7.34	7.34	0.00	1
798.16	8.56	8.56	0.00	1
798.44	9.78	9.78	0.00	1
798.76	11.01	11.01	0.00	1
799.12	12.23	12.23	0.00	1
800.00	14.78	14.78	0.00	Overtopping

Tailwater Channel Data - Culvert 12-1 (Across LF Perimeter Road)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 777.00 ft

Roadway Data for Crossing: Culvert 12-1 (Across LF Perimeter Road)

Roadway Profile Shape: Constant Roadway Elevation

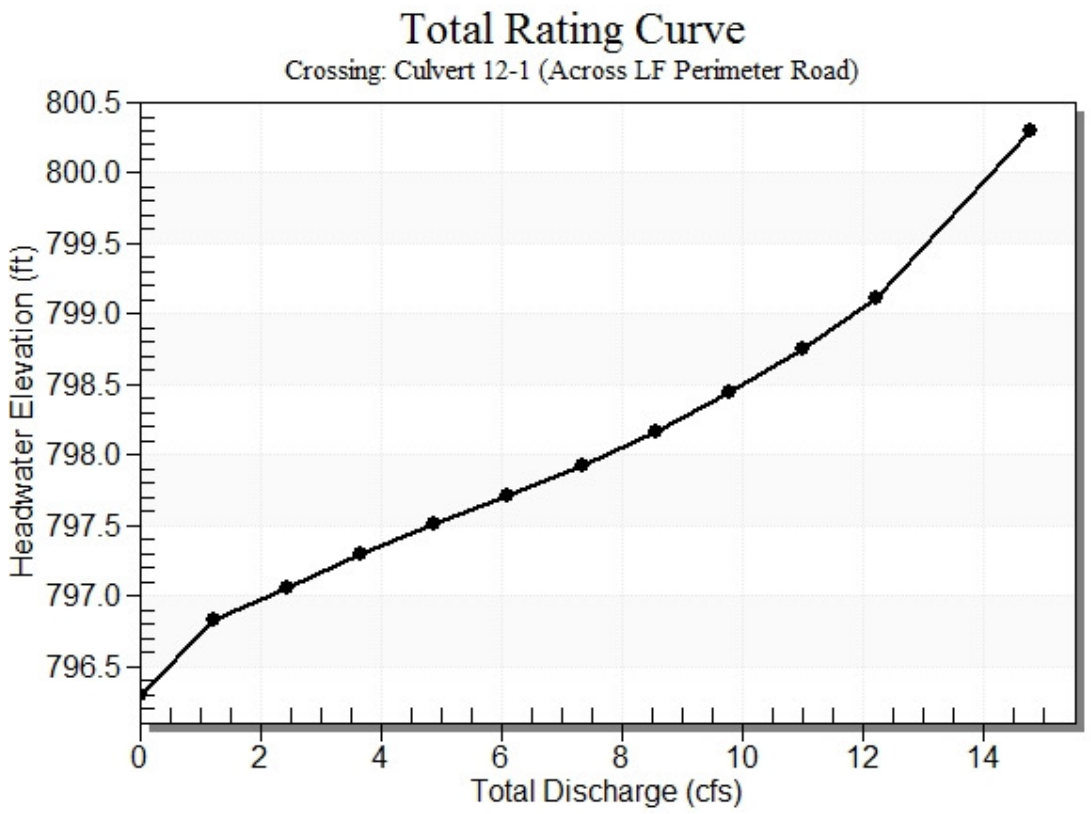
Crest Length: 100.00 ft

Crest Elevation: 800.00 ft

Roadway Surface: Gravel

Roadway Top Width: 18.00 ft

Rating Curve Plot for Crossing: Culvert 12-1 (Across LF Perimeter Road)



Site Data - Culvert 12-1 (Across LF Perimeter Road)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 796.30 ft

Outlet Station: 70.00 ft

Outlet Elevation: 789.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 12-1 (Across LF Perimeter Road)

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 2 - Culvert Summary Table: Culvert 12-1 (Across LF Perimeter Road)

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)
0.00	0.00	796.30	0.000	0.000	0-NF	0.000	0.000	0.000	3.000	0.000	0.000
1.22	1.22	796.82	0.523	0.0*	1-S2n	0.176	0.411	0.176	3.000	16.733	0.000
2.45	2.45	797.06	0.758	0.0*	1-S2n	0.259	0.589	0.259	3.000	11.934	0.000
3.67	3.67	797.30	0.997	0.0*	1-S2n	0.314	0.732	0.314	3.000	14.012	0.000
4.89	4.89	797.50	1.205	0.0*	1-S2n	0.364	0.846	0.364	3.000	14.640	0.000
6.12	6.12	797.71	1.407	0.0*	1-S2n	0.413	0.951	0.438	3.000	14.329	0.000
7.34	7.34	797.92	1.622	0.0*	5-S2n	0.451	1.046	0.479	3.000	15.035	0.000
8.56	8.56	798.16	1.863	0.0*	5-S2n	0.489	1.129	0.522	3.000	15.627	0.000
9.78	9.78	798.44	2.139	0.0*	5-S2n	0.526	1.206	0.526	3.000	17.662	0.000
11.01	11.01	798.76	2.456	0.0*	5-S2n	0.561	1.270	0.596	3.000	16.813	0.000
12.23	12.23	799.12	2.816	0.0*	5-S2n	0.593	1.322	0.626	3.000	17.492	0.000

* Full Flow Headwater elevation is below inlet invert.

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Straight Culvert

Inlet Elevation (invert): 796.30 ft, Outlet Elevation (invert): 789.00 ft

Culvert Length: 70.38 ft, Culvert Slope: 0.1043

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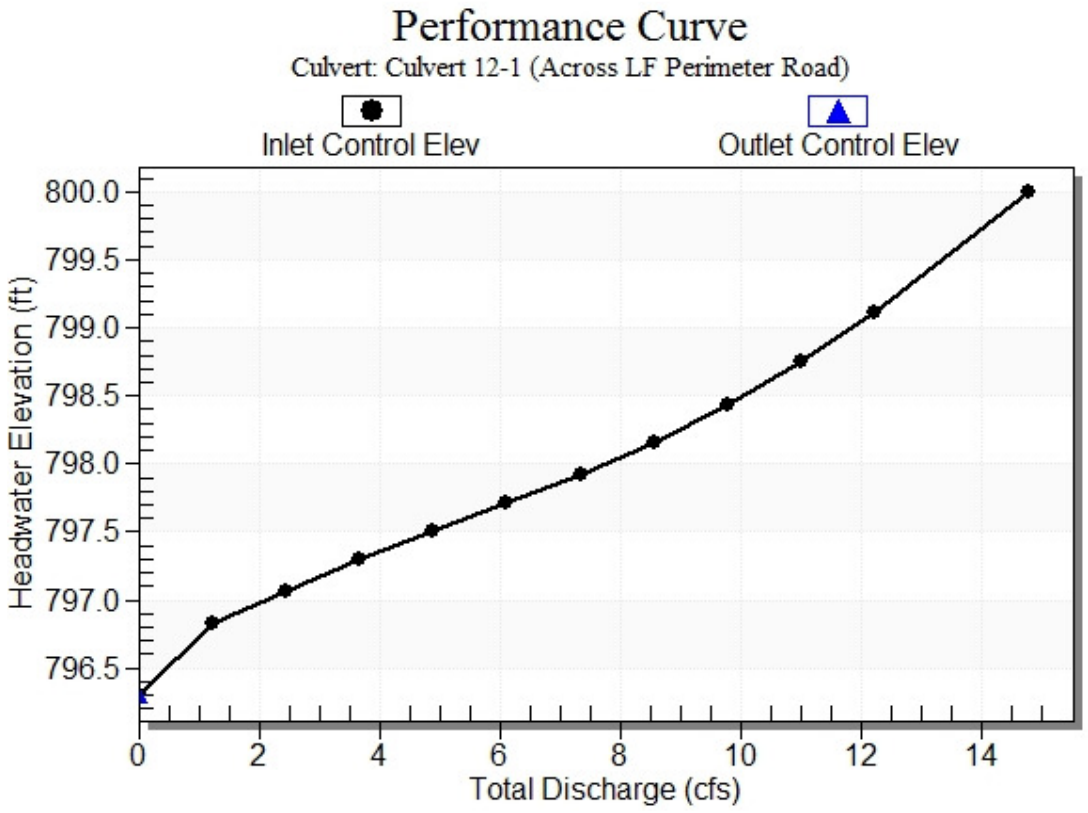
Culvert Performance Curve Plot: Culvert 12-1 (Across LF Perimeter Road)



Water Surface Profile Plot for Culvert: Culvert 12-1 (Across LF Perimeter Road)

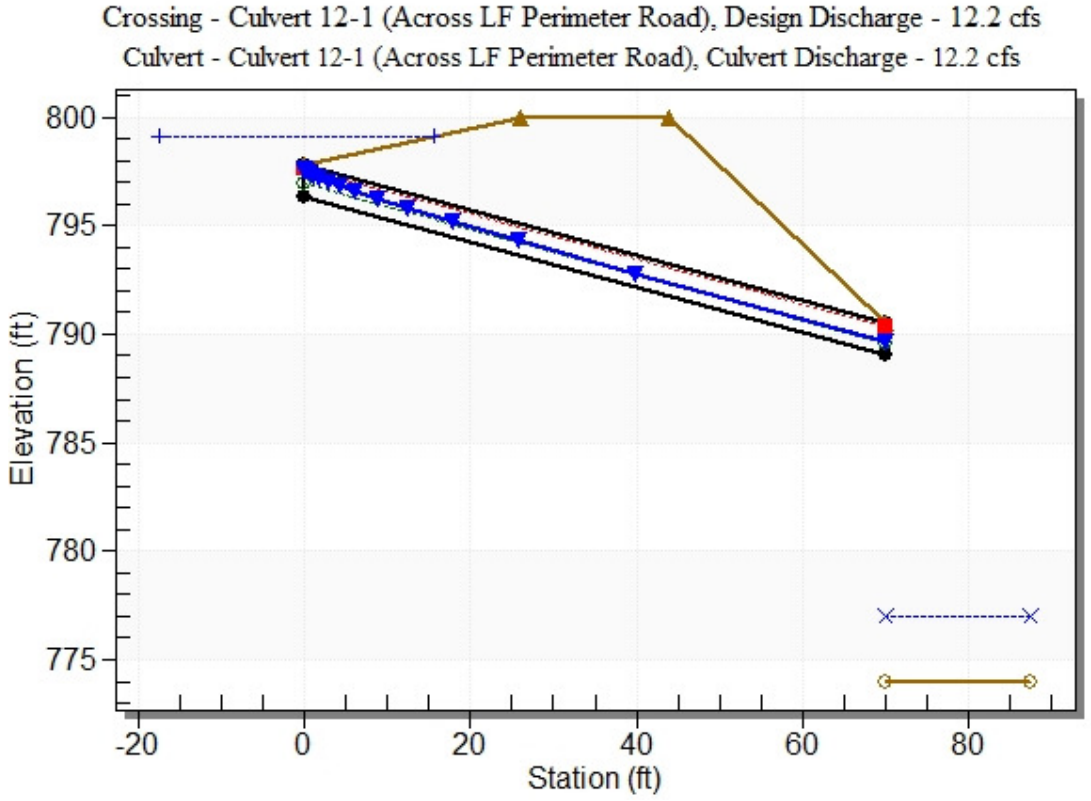


Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 12-1 (Across LF Perimeter Road))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	777.00	3.00
1.22	777.00	3.00
2.45	777.00	3.00
3.67	777.00	3.00
4.89	777.00	3.00
6.12	777.00	3.00
7.34	777.00	3.00
8.56	777.00	3.00
9.78	777.00	3.00
11.01	777.00	3.00
12.23	777.00	3.00

HY-8 Culvert Analysis Report
(Culvert 15-1)

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 3.03 cfs

Maximum Flow: 3.03 cfs

Table 1 - Summary of Culvert Flows at Crossing: Culvert 15-1 (Ph 3 Access Rd)

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 15-1 (Ph 3 Access Rd) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
764.00	0.00	0.00	0.00	1
764.30	0.30	0.30	0.00	1
764.43	0.61	0.61	0.00	1
764.54	0.91	0.91	0.00	1
764.65	1.21	1.21	0.00	1
764.75	1.51	1.51	0.00	1
764.84	1.82	1.82	0.00	1
764.93	2.12	2.12	0.00	1
765.03	2.42	2.42	0.00	1
765.13	2.73	2.73	0.00	1
765.24	3.03	3.03	0.00	1
769.00	8.12	8.12	0.00	Overtopping

Tailwater Channel Data - Culvert 15-1 (Ph 3 Access Rd)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 756.00 ft

Roadway Data for Crossing: Culvert 15-1 (Ph 3 Access Rd)

Roadway Profile Shape: Constant Roadway Elevation

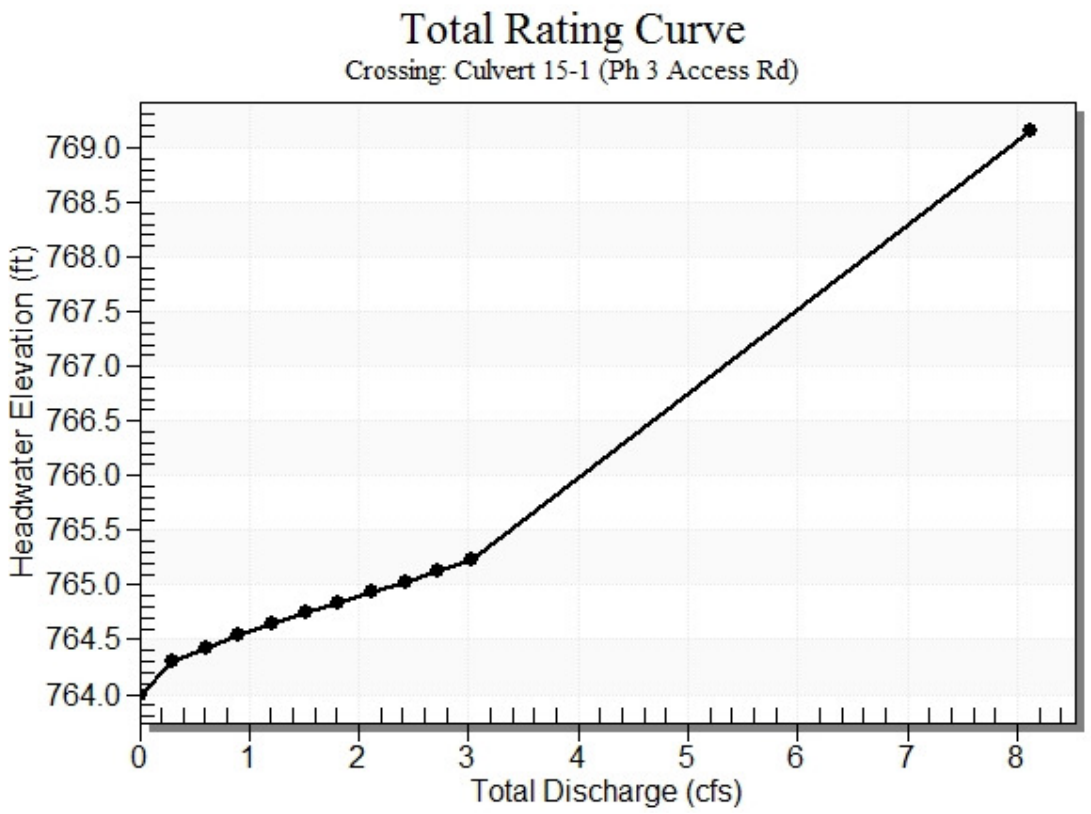
Crest Length: 100.00 ft

Crest Elevation: 769.00 ft

Roadway Surface: Gravel

Roadway Top Width: 18.00 ft

Rating Curve Plot for Crossing: Culvert 15-1 (Ph 3 Access Rd)



Site Data - Culvert 15-1 (Ph 3 Access Rd)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 764.00 ft

Outlet Station: 70.00 ft

Outlet Elevation: 760.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 15-1 (Ph 3 Access Rd)

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 2 - Culvert Summary Table: Culvert 15-1 (Ph 3 Access Rd)

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)
0.00	0.00	764.00	0.000	0.000	0-NF	0.000	0.000	0.000	2.000	0.000	0.000
0.30	0.30	764.30	0.302	0.0*	1-S2n	0.117	0.223	0.117	2.000	9.281	0.000
0.61	0.61	764.43	0.430	0.0*	1-S2n	0.171	0.321	0.171	2.000	6.726	0.000
0.91	0.91	764.54	0.538	0.0*	1-S2n	0.208	0.398	0.216	2.000	7.506	0.000
1.21	1.21	764.65	0.648	0.0*	1-S2n	0.241	0.464	0.241	2.000	8.243	0.000
1.51	1.51	764.75	0.747	0.0*	1-S2n	0.274	0.521	0.274	2.000	8.692	0.000
1.82	1.82	764.84	0.840	0.0*	1-S2n	0.299	0.571	0.299	2.000	9.319	0.000
2.12	2.12	764.93	0.931	0.0*	1-S2n	0.323	0.619	0.323	2.000	9.614	0.000
2.42	2.42	765.03	1.026	0.0*	5-S2n	0.348	0.662	0.348	2.000	9.946	0.000
2.73	2.73	765.13	1.127	0.0*	5-S2n	0.372	0.706	0.375	2.000	10.157	0.000
3.03	3.03	765.24	1.236	0.0*	5-S2n	0.393	0.743	0.393	2.000	10.629	0.000

* Full Flow Headwater elevation is below inlet invert.

****

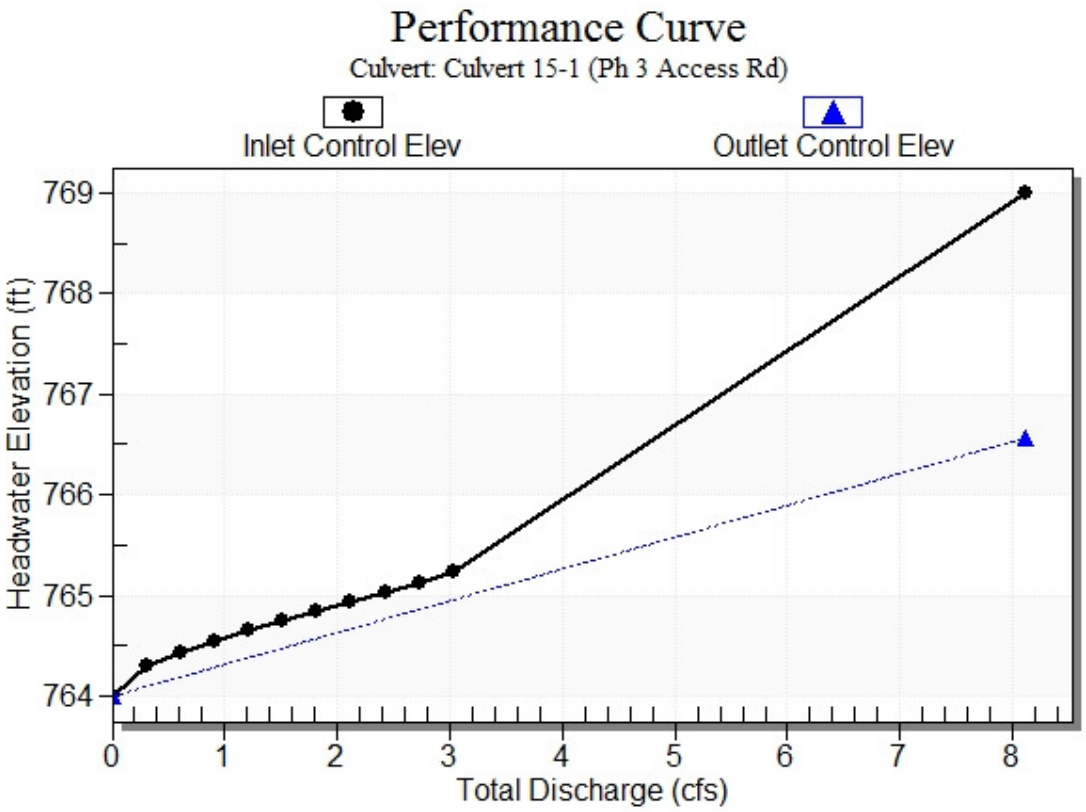
Straight Culvert

Inlet Elevation (invert): 764.00 ft, Outlet Elevation (invert): 760.00 ft

Culvert Length: 70.11 ft, Culvert Slope: 0.0571

****

Culvert Performance Curve Plot: Culvert 15-1 (Ph 3 Access Rd)



Water Surface Profile Plot for Culvert: Culvert 15-1 (Ph 3 Access Rd)

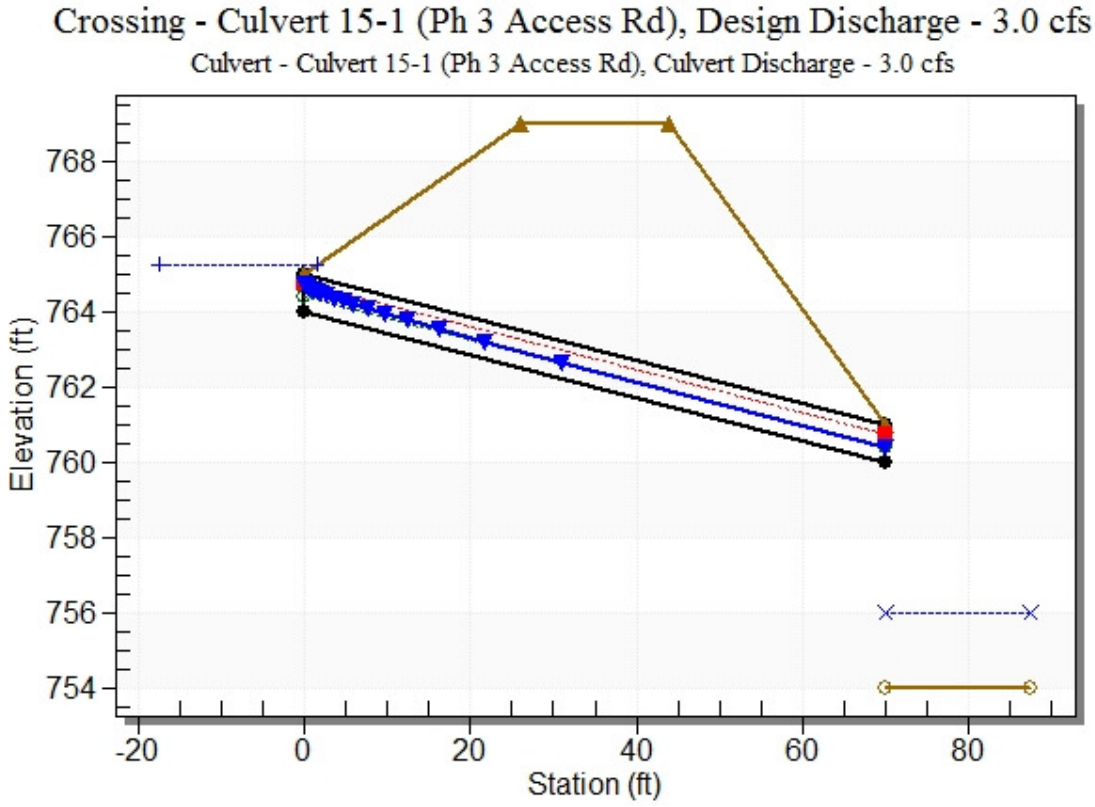


Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 15-1 (Ph 3 Access Rd))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	756.00	2.00
0.30	756.00	2.00
0.61	756.00	2.00
0.91	756.00	2.00
1.21	756.00	2.00
1.51	756.00	2.00
1.82	756.00	2.00
2.12	756.00	2.00
2.42	756.00	2.00
2.73	756.00	2.00
3.03	756.00	2.00

Haul Road Culvert Sizing

SCS ENGINEERS
2830 Dairy Drive
Madison, WI 53718
608-224-2830

JOB NO. 25211509.03
SHEET NO. 1 OF 9
CALCULATED BY KRG\BLP DATE 11/27/13
CHECKED BY _____ DATE _____
SCALE _____

Haul Road Culvert Sizing

Determine size of culvert required for haul road to stockpile area.

Use HydroCAD to estimate peak runoff to culvert for the 25-year, 24-hour storm event. See attached figure for drainage area and Tc flow paths. Use HY-8 to size culverts.

Drainage area to culvert = 189.5 ac

Tc Flow

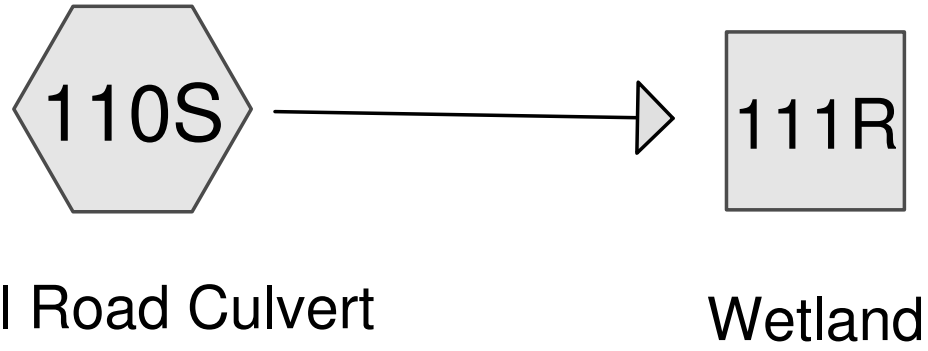
- Sheet flow = 100 ft at 0.5 % slope
- Shallow concentrated flow = 1373 ft at 2.3% slope, short grass
- Channel flow = 3225 ft at 2% slope in a trapazoidal channel, n = 0.035 earth, dense weeds.
- The wetland area is modeled as a reach of 734 ft in length and a slope of 0.14%

See sheets 2 - 8 for HydroCAD model of watershed and runoff calculations.

- 25-yr storm peak discharge rate to culverts = 304 cfs

The invert elevations, length of culverts, and height of access road over culvert are as shown on the Expansion Permit Amendment drawings.

Based on the results of the HY-8 analysis, 2-48" diameter culverts will accommodate the peak flows resulting from the 25-year, 24-hour storm event without overtopping the haul road.



Subcat Reach Pond Link

Drainage Diagram for Haul Road Culvert2
Prepared by SCS Engineers, Printed 11/27/2013

Summary for Subcatchment 110S: Haul Road Culvert

Runoff = 374.75 cfs @ 12.43 hrs, Volume= 47.419 af, Depth= 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr, 24-hr Rainfall=5.67"

	Area (ac)	CN	Description
*	189.500	75	Grass
	189.500		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.2	100	0.0050	0.10		**Sheet Flow, Sheet flow across access road** Grass: Short n= 0.150 P2= 3.14"
21.6	1,373	0.0230	1.06		**Shallow Concentrated Flow, Shallow slow across final cover** Short Grass Pasture Kv= 7.0 fps
5.8	3,225	0.0200	9.34	478.90	**Trap/Vee/Rect Channel Flow,** Bot.W=15.00' D=2.55' Z= 2.0 '/' Top.W=25.20' n= 0.035 Earth, dense weeds
44.6	4,698	Total			

Summary for Reach 111R: Wetland

[91] Warning: Storage range exceeded by 4.64'
[55] Hint: Peak inflow is 818% of Manning's capacity

Inflow Area = 189.500 ac, 0.00% Impervious, Inflow Depth = 3.00" for 25-yr, 24-hr event
Inflow = 374.75 cfs @ 12.43 hrs, Volume= 47.419 af
Outflow = 304.16 cfs @ 12.92 hrs, Volume= 47.419 af, Atten= 19%, Lag= 29.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.75 fps, Min. Travel Time= 16.3 min
Avg. Velocity = 0.13 fps, Avg. Travel Time= 92.0 min

Peak Storage= 298,452 cf @ 12.65 hrs, Average Depth at Peak Storage= 6.14'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 45.83 cfs

40.00' x 1.50' deep channel, n= 0.110
Side Slope Z-value= 10.0 '/' Top Width= 70.00'
Length= 734.0' Slope= 0.0014 '/'
Inlet Invert= 746.00', Outlet Invert= 745.00'

‡

Haul Road Culvert Sizing

Site Data - Box Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 772.20 ft

Outlet Station: 100.00 ft

Outlet Elevation: 770.20 ft

Number of Barrels: 1

Culvert Data Summary - Box Culvert

Barrel Shape: Concrete Box

Barrel Span: 20.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Tailwater Channel Data - Haul Road Box Culvert

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 15.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0200

Channel Manning's n: 0.0350

Channel Invert Elevation: 772.20 ft

Roadway Data for Crossing: Haul Road Box Culvert

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 780.00 ft

Roadway Surface: Gravel

Roadway Top Width: 18.00 ft

Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 685 cfs

Maximum Flow: 685 cfs

Table 1 - Culvert Summary Table: Box Culvert

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)
	0.00	0.00	772.20	0.000	0.000	0-NF	0.000	0.000	2.000	0.000	0.000
	68.50	68.50	773.40	1.202	0.843	1-JS1t	0.303	0.714	2.835	0.835	1.208
	137.00	137.00	774.11	1.908	1.284	1-JS1t	0.575	1.134	3.251	1.251	2.107
	205.50	205.50	774.70	2.500	1.656	1-JS1t	0.721	1.486	3.581	1.581	2.869
	274.00	274.00	775.23	3.029	1.996	1-JS1t	0.867	1.800	3.863	1.863	3.546
	342.50	342.50	775.70	3.505	2.321	1-JS1t	1.014	2.088	4.114	2.114	4.163
	411.00	411.00	776.15	3.950	2.640	1-JS1t	1.142	2.358	4.342	2.342	4.733
	479.50	479.50	776.57	4.372	2.958	1-JS1t	1.252	2.613	4.552	2.552	5.267
	548.00	548.00	776.98	4.776	3.277	1-S2n	1.361	2.857	1.732	2.747	15.817
	616.50	616.50	777.37	5.168	3.602	1-S2n	1.470	3.090	1.897	2.931	16.252
	685.00	685.00	777.75	5.553	3.933	1-S2n	1.579	3.315	2.058	3.105	16.642

****

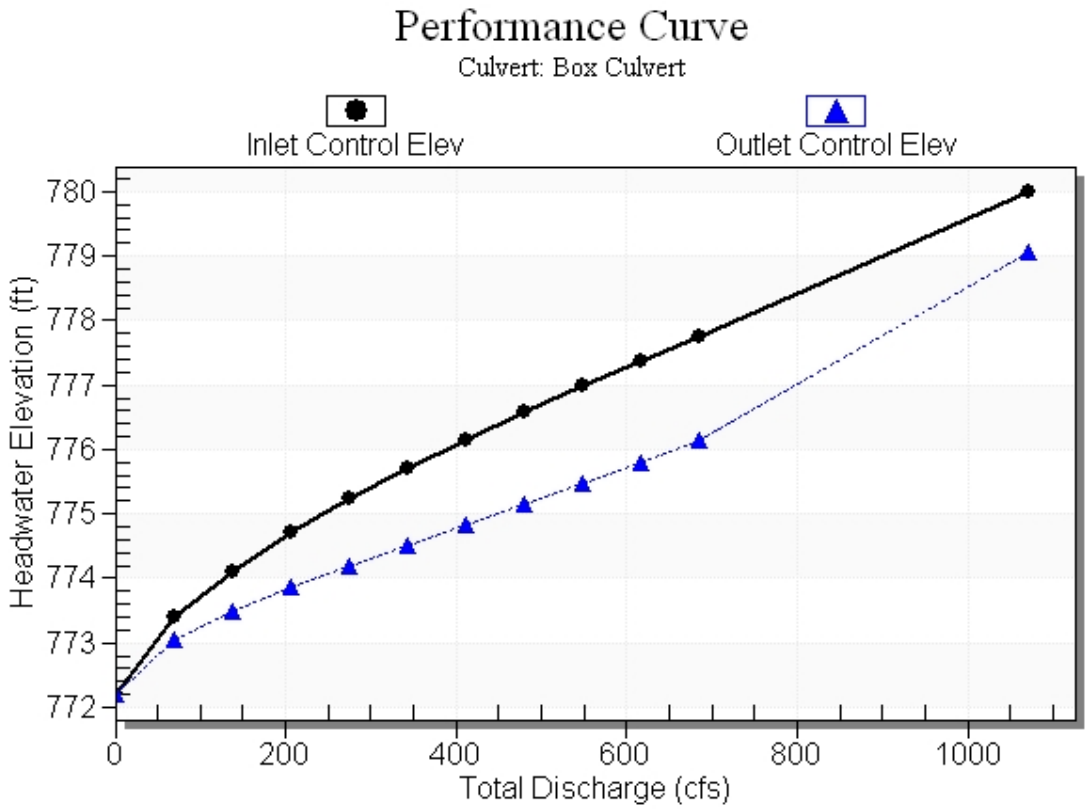
Straight Culvert

Inlet Elevation (invert): 772.20 ft, Outlet Elevation (invert): 770.20 ft

Culvert Length: 100.02 ft, Culvert Slope: 0.0200

****

Culvert Performance Curve Plot: Box Culvert



Water Surface Profile Plot for Culvert: Box Culvert

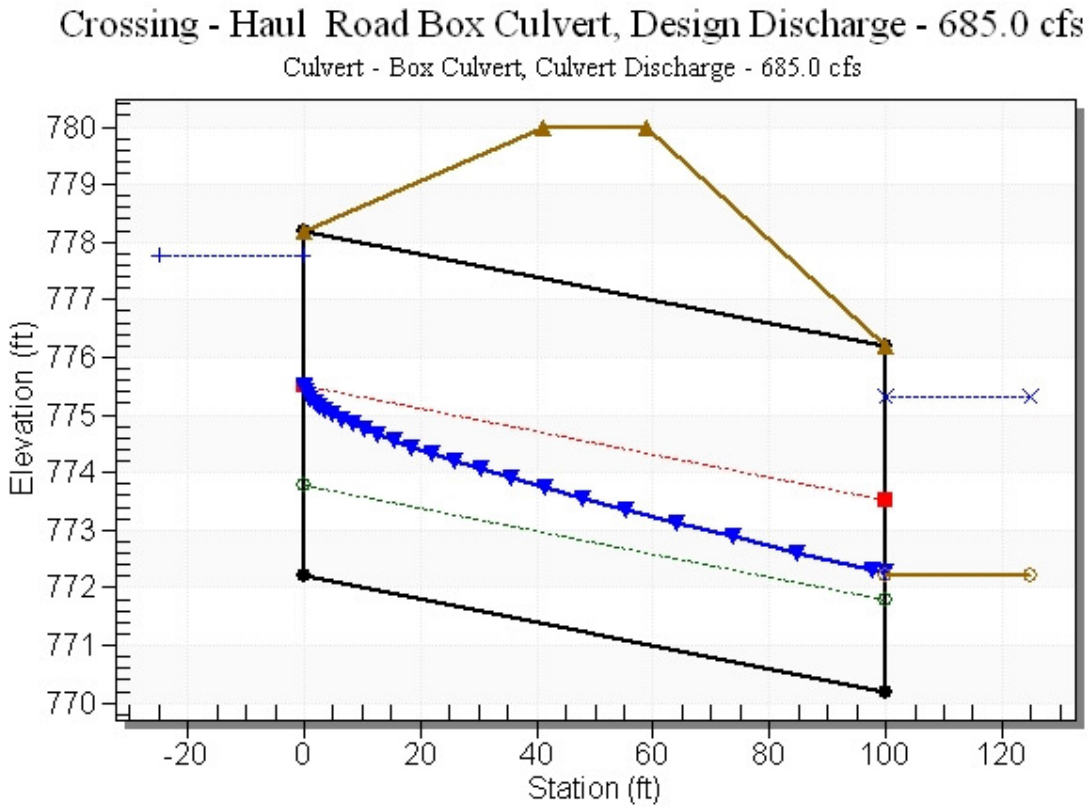


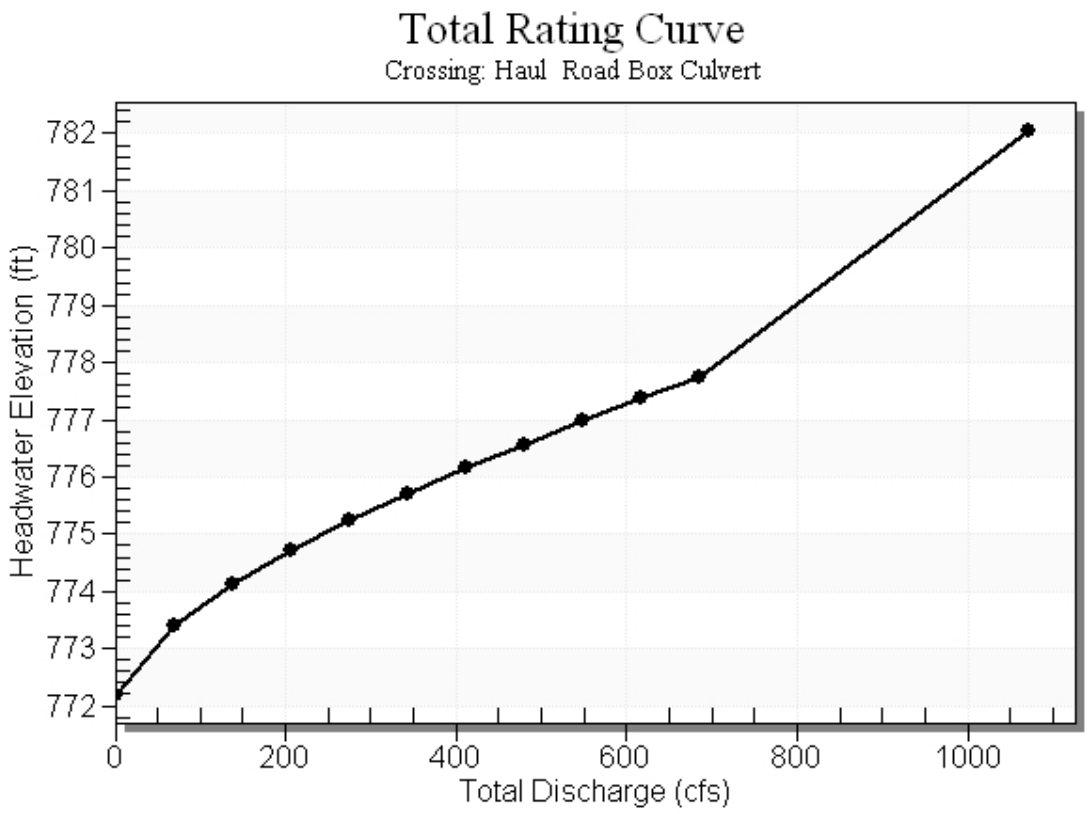
Table 2 - Downstream Channel Rating Curve (Crossing: Haul Road Box Culvert)

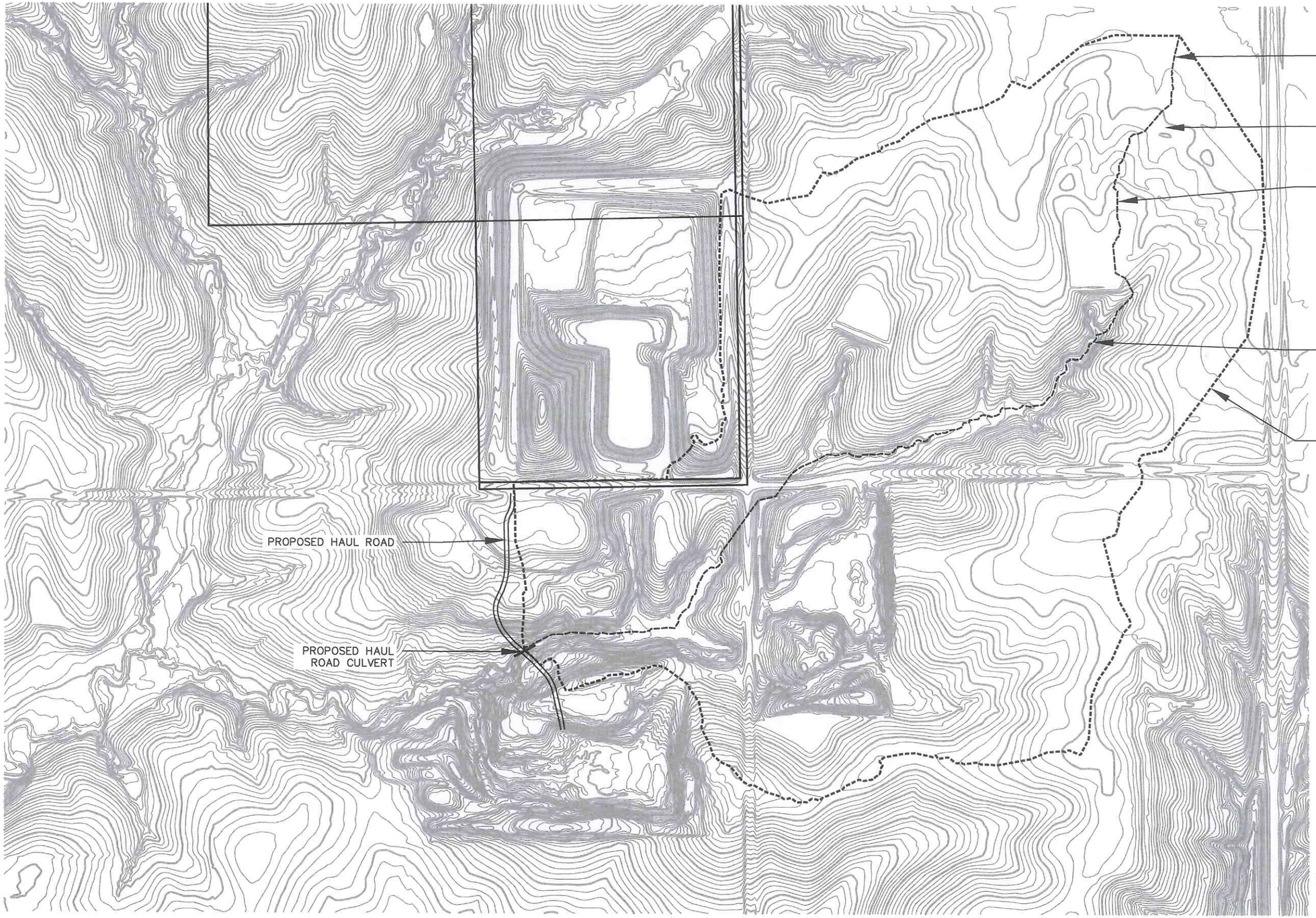
Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	772.20	0.00	0.00	0.00	0.00
68.50	773.03	0.83	4.92	1.04	1.00
137.00	773.45	1.25	6.26	1.56	1.05
205.50	773.78	1.58	7.16	1.97	1.09
274.00	774.06	1.86	7.85	2.33	1.11
342.50	774.31	2.11	8.43	2.64	1.13
411.00	774.54	2.34	8.92	2.92	1.14
479.50	774.75	2.55	9.35	3.18	1.15
548.00	774.95	2.75	9.73	3.43	1.17
616.50	775.13	2.93	10.08	3.66	1.17
685.00	775.31	3.11	10.40	3.88	1.18

Table 3 - Summary of Culvert Flows at Crossing: Haul Road Box Culvert

Headwater Elevation (ft)	Total Discharge (cfs)	Box Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
772.20	0.00	0.00	0.00	1
773.40	68.50	68.50	0.00	1
774.11	137.00	137.00	0.00	1
774.70	205.50	205.50	0.00	1
775.23	274.00	274.00	0.00	1
775.70	342.50	342.50	0.00	1
776.15	411.00	411.00	0.00	1
776.57	479.50	479.50	0.00	1
776.98	548.00	548.00	0.00	1
777.37	616.50	616.50	0.00	1
777.75	685.00	685.00	0.00	1
780.00	1072.05	1072.05	0.00	Overtopping

Rating Curve Plot for Crossing: Haul Road Box Culvert





PROJECT NO.	25211509.03	DRAWN BY:	BJM
DRAWN:	10/15/13	CHECKED BY:	BP
REVISED:	10/18/13	APPROVED BY:	

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT

INTERSTATE POWER AND LIGHT COMPANY
OTTUMWA MIDLAND LANDFILL
15300 130TH STREET
OTTUMWA, IOWA 52501

SITE

PERMIT AMENDMENT PLAN
NORTH & SOUTH EXPANSION
OTTUMWA MIDLAND LANDFILL
OTTUMWA, IOWA

HAUL ROAD CULVERT

FIGURE
X OF X

I:\25211509\Drawings-General\25211509.03\working\Temp-Pre-Watershed areas_131015.dwg, 10/23/2013 3:17:02 PM

Sedimentation Basin Sizing

Sedimentation Basin Sizing

Performance Criteria:

- Sedimentation basins have been designed to settle out particles 15 microns and greater for storms up to the 25-year, 24-hour storm event.
- Principle spillways have been designed to pass a 25-year, 24-hour storm event.
- Emergency spillways have been designed to pass a 100-year, 24-hour storm event.

Use the table presented in the Erosion and Sediment Control Handbook (Goldman, *et al.*, 1986) that provides the surface area-to-discharge ratios required to achieve settlement of the desired particle sizes. The table is included below. From the table, use the surface area to flow ratio for the sedimentation basins to determine the maximum particle size settled.

The table below summarizes the surface area to flow ratios for the sedimentation basins. It also summarizes the freeboard in the basins for a 100-year, 24-hour storm event. The information is based on the HydroCAD model output included with this appendix.

Spillway Sizing:

- Spillways will be sized with a 20' wide bottom width.

Use outputs from the HydroCAD Modeling to determine the water velocity over the spillway and provide appropriate riprap size.

TABLE 8.1 Surface Area Requirements of Sediment Traps and Basins

Particle size, mm	Settling velocity, ft/sec (m/sec)	Surface area requirements, ft^2 per ft^3/sec discharge	(m^2 per m^3/sec discharge)
0.5 (coarse sand)	0.19 (0.058)	6.3	(20.7)
0.2 (medium sand)	0.067 (0.020)	17.9	(58.7)
0.1 (fine sand)	0.023 (0.0070)	52.2	(171.0)
0.05 (coarse silt)	0.0062 (0.0019)	193.6	(635.0)
0.02 (medium silt)	0.00096 (0.00029)	1,250.0	(4,101.0)
0.01 (fine silt)	0.00024 (0.000073)	5,000.0	(16,404.0)
0.005 (clay)	0.00006 (0.000018)	20,000.0	(65,617.0)

Sedimentation Basin Performance Summary

Feature	25-yr, 24-hr Storm			Surface Area at Peak Water Surface Elevation, SA (sf)	SA/Q Ratio	Maximum Particle Size Settled (mm)	100-yr, 24-hr Storm Peak Water Surface Elevation	Top of Berm Elevation (Freeboard)	Basin Freeboard for 100-yr Storm (feet)
	Peak Inflow (cfs)	Peak Discharge, Q (cfs)	Peak Water Surface Elevation						
Sedimentation Basin No. 2	97.61	9.89	760.39	47,104	4,762	.010	761.40	762.0	0.60
Sedimentation Basin No. 3	94.53	4.79	757.19	57,420	11,987	.006	757.90	762.0	4.10
Sedimentation Basin No. 4	107.74	15.90	756.35	52,239	3,285	.015	758.24	760.0	1.76

Velocity Over Riprap Spillways
OML Expansion

100-year, 24-hour Storm

Basin	Width of Spillway, ft	Flow Rate, cfs	Depth of Flow, ft	Cross-sectional flow area, sq. ft.	Velocity, fps	Riprap D50, ft
Sed Basin 2	20	12.52	0.4	8.10	1.5	0.5
Sed Basin 3	20	0.0	--	--	--	0.5
Sed Basin 4	20	0.0	--	--	--	0.5

Notes:

1. The peak water levels from the 25-year, 24-hour storm events do not overtop the emergency spillways.

2. The peak water levels from the 100-year, 24-hour storm events do not overtop the emergency spillway at sed basin 3 and sed basin 4.

3. Flow rate and spillway configuration based on HydroCAD modeling.

Appendix B

Agency Correspondence

Alliant Energy
4902 North Biltmore Lane
P.O. Box 77007
Madison, WI 53707-1007

1-800-ALLIANT (800-255-4268)
alliantenergy.com

December 6, 2018

Ms. Nina M. Booker
Land Quality Bureau
Iowa Department of Natural Resources
502 East 9th St
Des Moines, IA 50319-0034

Subject: **Contact Water Management**
Interstate Power and Light Company
Ottumwa Midland CCR Landfill
Ottumwa, IA (Permit #90-SDP-05-01P)

Dear Ms. Booker,

On behalf of Interstate Power and Light Company (IPL), Alliant Energy is providing two updates regarding contact water management at the IPL Ottumwa Midland Landfill Facility (Permit #90-SDP-05-01P). First, IPL intends to discharge contact water from the North Expansion Contact Water Basin, in accordance with IDNR NPDES General Permit Number 1. Second, IPL is proposing to use evaporators in the North Expansion Contact Water Basin to assist with contact water management during favorable conditions. IPL is requesting IDNR concurrence that these activities are consistent with the Sanitary Disposal Permit issued on July 21, 2017 and subsequent amendments.

Discharge of Contact Water under IDNR NPDES General Permit 1

The eligibility of General Permit 1 authorizes the "discharge of all new and existing 'Storm water discharge associated with industrial activities' that are composed entirely of storm water or storm water mixed with non-storm water listed in Part III.A." This is applicable to Ottumwa Midland Landfill as our Contact Water Basin holds storm water that has come into contact with waste within the active filling areas. Land Disposal Units are required to monitor discharges authorized under General Permit 1, in compliance with Part V.B.3. Since the Ottumwa Midland Landfill has already obtained coverage under General Permit 1, the facility plans to start discharging in accordance with the permit. This management change would also be reflected in an update to the facility's Storm Water Pollution Prevention Plan.

Use of evaporators for North Expansion Contact Water Basin

IPL is proposing to use evaporators for the North Expansion Contact Water Basin. The evaporators would be used in conjunction with contact water discharge to provide efficient water

Use of evaporators for North Expansion Contact Water Basin

IPL is proposing to use evaporators for the North Expansion Contact Water Basin. The evaporators would be used in conjunction with contact water discharge to provide efficient water management. The two evaporators that would be installed are 420F Evaporator units, manufactured by SMI Evaporative Solutions. Each unit consists of a 25 hp fan, 2 hp pump, and an annual evaporation rate of up to 70%. Please refer to the attached manufacturer data sheet for further detail.

The evaporators would be operated with an automated system that would cycle based on weather conditions. This would maximize evaporation and minimize drift, allowing the system to run 24/7 if needed. The evaporators would start off running on a Monday-Friday schedule from the hours of 7 am-3:30 pm while personnel are on site. They are able to be operational during all weather conditions; the automatic controls factor in weather conditions to run during ideal evaporation conditions. The evaporators would be removed from service during winter months to prevent freezing on fan blades and pump components. Lastly, there is minimal noise associated with this model of evaporators, and disruptions to surrounding areas are not anticipated during run time.

Thank you for your consideration. If you have any questions or concerns, please call me at (641) 437-5262.

Sincerely,

Tasha Fowler

Tasha Fowler
Environmental Specialist II
Alliant Energy Corporate Services, Inc

Cc: Heather Hoskins, Rob Saunders, Steve Keck – IPL Ottumwa Midland Landfill
Jeff Maxted, Jenna Wischmeyer – Alliant Energy
Eric Nelson – SCS Engineers

SMI 420F EVAPORATOR

OVERVIEW

The SMI® 420F Evaporator is a floating unit, designed for effective operation in small areas, especially sites containing large particles or highly corrosive water. The 420F Evaporator is durable, simple to use and easy to maintain – a reliable way to manage excess water.

BENEFITS

Low Buildup: the SMI® 420F Evaporator is designed with a minimal amount of top surface area to control the build-up of residue or ice, helping to reduce clean up and maintenance!

High Performance: High-speed fan blade rotation creates an optimum water droplet distribution for evaporation. Annual evaporation rates up to 70% have been achieved with the 420F, and averages are typically between 25% and 60%. Evaporation rates depend on many factors, including ambient temperature, relative humidity, water make-up and wind conditions.

Easy Maintenance: The machine is designed for easy cleaning and maintenance. It requires no weekly bearing lubrication, as it is lubricated for the life of the motor.

Minimal Clogging: The SMI® 420F Evaporator can pass particles up to 3/16 inch (4.7 mm) in diameter, which reduces the need for pre-filtering, filter cleaning and the hassles of clogged nozzles.

Extreme Duty: This design has evolved from 10 years of experience in industrial and extreme outdoor applications. Polyethylene pontoons are filled with closed-cell polyurethane foam, ensuring buoyancy even after any accidental puncturing of the plastic outer shell. Critical components are manufactured from stainless steel for extended life in harsh environments.

FEATURES

Floating unit supported by plastic pontoons containing closed-cell PU foam

Low plume height for shorter drift distance, allowing longer operation in swirling or changing winds

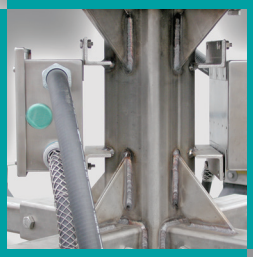
Heavy industrial construction, including stainless control panel, motor enclosure, manifold and fan blade, increasing durability and life span

Vibration sensor included to shut down motor before catastrophic failure due to residue or ice build-up

Stainless steel submersible pump attached to floating frame

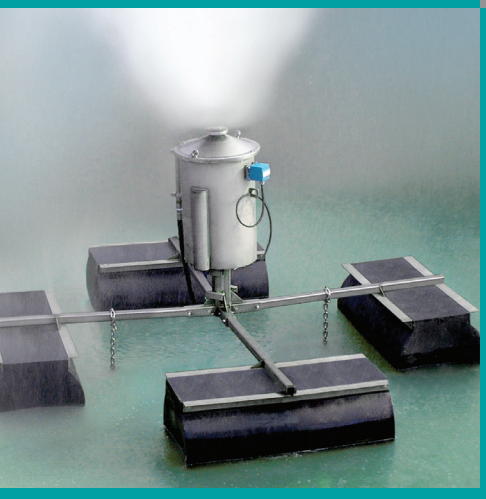
SMI 420F EVAPORATOR

Fan



Frame

Pontoon



SPECIFICATIONS

Fan and Head Assembly

- Stainless steel 20 inch diameter 12 blade patented fan
- Stainless steel enclosure protects fan motor and enhances cooling
- Vibration sensor for motor shut down due to fan imbalance

Floats and Platform

- Galvanized steel frame structure using stainless steel fasteners
- 4 polyethylene UV stabilized pontoons
- Pontoons filled with closed-cell polyurethane foam

Water System

- 2.0 HP stainless steel submersible pump
- Pump options: 460V / 60HZ, or 400V / 50HZ, or 575V /60HZ
- Stainless steel spray manifold, designed to provide up to 25GPM flow
- Ball Valve to regulate flow to spray manifold for changing weather conditions on manual units; VFD on automated equipment

Electrical

- 25 HP Premium efficiency fan motor
- Fan motor rotates at 3600 RPM at 480 or 575 volts, 3 phase, 60 cycle power or 2900 RPM at 400 volts 50 cycle power
- Stainless steel control panel with start and stop buttons
- 200 feet (61 M) electrical power cord

Warranty

- 6 month warranty on all parts and workmanship

Options

- For acidic or high alkaline water applications, stainless steel construction and acid-resistant coating
- Y-line manual flush filter for dirtier water
- Automation, to shut down and start-up evaporator due to wind speed and direction, temperature and humidity

SMI Evaporative Solutions

SMI Evaporative Solutions
1512 North Rockwell Dr.
Midland, MI 48642
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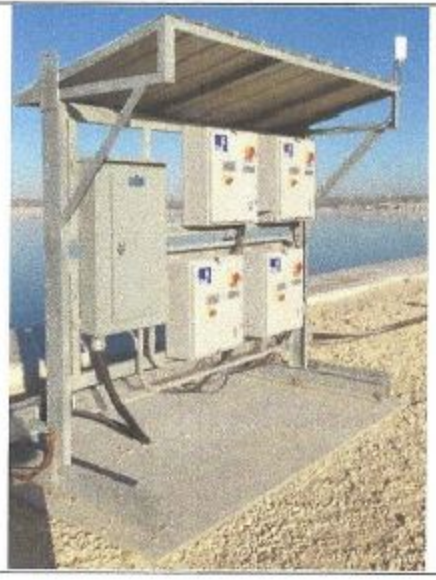
+1-800-248-6600
evapor.com


DANGER
HIGH VOLTAGE
SMI
Honeywell
POWER ON
Only personnel who have read the manual and received appropriate instruction should operate this equipment.
ELECTRICAL SHOCK CAN BE FATAL
CAUTION
Do Not service with the electrical power source connected.
FAN
PUMP
EMERGENCY
SAFETY PRECAUTIONS
SNOW MACHINES INC. MIDLAND, MI USA

	Description	Qty.
	SMI 420F standalone fully automatic Evaporator with 480V/60Hz 25 HP (18.7 kW) fan motor, vibration switch, stainless steel motor enclosure, water manifold and propeller, mounted on galvanized steel support and plastic pontoon float system with 480V/60Hz 2 HP (1.5 kW) stainless steel submersible pump, automatic control panel with PLC, and VFD controls, weather control panel, weather devices (includes wind speed, wind direction, humidity and temperature) and 300ft (91m)* of 18/7 & 10/7 custom and 10/4 SEOOW pump cords.	1
	SMI 420F standalone fully automatic Evaporator with 480V/60Hz 25 HP (18.7 kW) fan motor, vibraton switch, stainless steel motor enclosure, water manifold and propeller, mounted on galvanized steel support and plastic pontoon float system with 480V/60Hz 2 HP (1.5 kW) stainless steel submersible pump, automatic control panel with PLC, and VFD controls, no weather control panel, no weather devices, weather is supplied from weather panel supplied with unit above and 300ft (91m)* of 18/7 & 10/7 custom and 10/4 SEOOW pump cords.	3

	Description	Qty.
	Galvanized structural steel control panel and load center shelter with roof for 4 units, supplied with (1) load center containing (1) 480V 250A 3-pole main breaker rated for 18 kAIC and (4) 50A 3-pole breakers to supply power to the machine control panels and (1) 15A 2-pole breaker to supply power to the weather control panel. The power cable from the Evaporator unit(s) is routed to the machine control panesl on the shelter. The shelter comes ready for power to be supplied to the load center from customer power source. Supplied with hardware for mounting weather devices.	1

January 16, 2019

Tasha Campbell, Environmental Specialist II
Alliant Energy
PO Box 77007
4902 N. Biltmore Lane
Madison, WI 53718

Con 12-1-1
Doc # 94155

RE: Ottumwa-Midland CCR Landfill
Contact Water Management
Permit #90-SDP-08-92P

Dear Ms. Campbell:

We have received the *Contact Water Management* update as contained in your December 6, 2018 correspondence.

The Iowa Department of Natural Resources (IDNR) acknowledges the intent of the permit holder to obtain an NPDES General Permit #1 for the discharge of storm water associated with industrial activities at the site; and to utilize evaporators for the North Expansion Contact Water Basin.

The Solid Waste Section of the IDNR does not regulate storm water discharge; therefore, the permit holder is responsible for compliance with all applicable rules and laws regarding the same.

The permit holder shall also use best management practices during operation of the proposed evaporators. The use of the evaporators is prohibited unless there is appropriate personnel on site during their operation.

This information will be filed, accordingly.

If you have any questions, you may contact me at (515) 725-8309.

Sincerely,

Nina M. Booker

Nina M. Booker
Environmental Engineer Senior
Land Quality Bureau

cc: DNR Field Office #6

SCS Engineers
2830 Dairy Drive
Madison, Wisconsin 53718-6751

DEPARTMENT OF NATURAL RESOURCES
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
NOTICE OF GENERAL PERMIT COVERAGE UNDER
GENERAL PERMIT NO. 1

STORM WATER DISCHARGE ASSOCIATED WITH INDUSTRIAL ACTIVITY

This notice of general permit coverage for a storm water discharge associated with industrial activity is issued pursuant to the authority of section 402 (b) of the Clean Water Act (U.S.C. 1342(b)), Iowa Code 455B.174, and subrule 567--64.4(2), Iowa Administrative Code. A Notice of Intent has been filed with the Iowa Department of Natural Resources that this storm water discharge complies with the terms and conditions of NPDES General Permit No. 1. Authorization is hereby issued to discharge storm water associated with industrial activity as defined in Part VIII of the Iowa Department of Natural Resources NPDES General Permit No. 1 in accordance with the terms and conditions set forth in the permit.

Owner:

INTERSTATE POWER AND LIGHT COMPANY
20775 POWER PLANT ROAD
OTTUMWA IA 52501-8797
(319)786-2903

Contact:

ROB SAUNDERS
INTERSTATE POWER AND LIGHT COMPANY (ALLIANT ENERGY)
20775 POWER PLANT ROAD
OTTUMWA IA 52501-8797
(641)935-2971

Permit Coverage Issued To:

OTTUMWA-MIDLAND LANDFILL
15300 130TH ST.
in OTTUMWA, WAPELLO COUNTY
located at

1/4 Section	Section	Township	Range
SW	26	73N	15W

Coverage Provided Through: **9/30/2023**

Standard Industrial Classification Code: **4911**

NPDES Permit Discharge Authorization Number: **2681 - 2522**

Discharge Authorization Date: **7/10/1995**