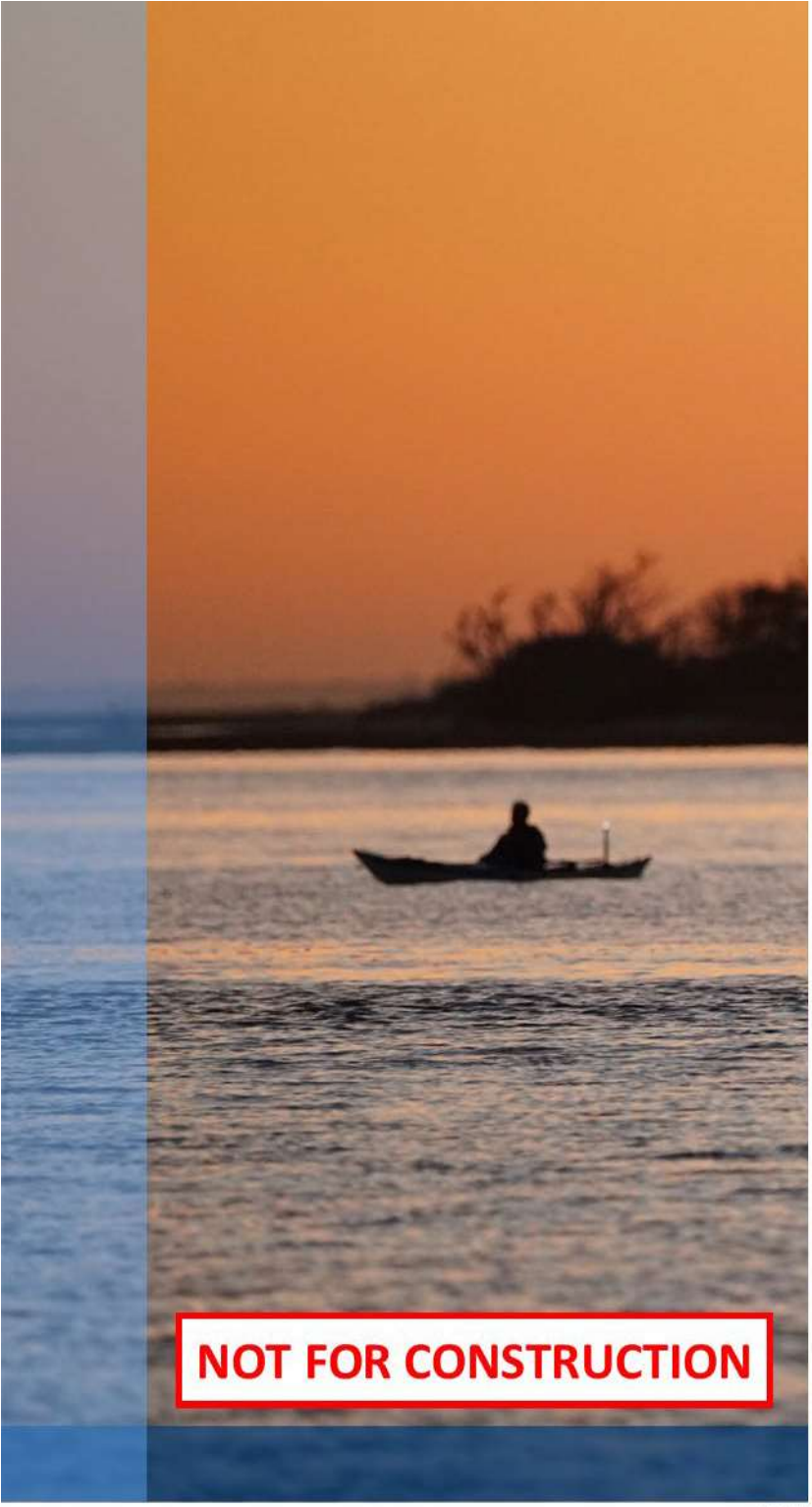


MANY TALENTS, ONE FIRM

Feasibility Study for Pump and Drainage Improvements for Swanquarter Town Ditch Canal

Engineering Assistance

December 2021

Prepared by:

GPI

Jonathan Hinkle, PE
Greenman-Pederson, Inc. | Kinston, NC
1308 HWY 258 N
Kinston NC 28504
Phone: 910-663-4123
jhinkle@gpinet.com

NORTH CAROLINA PROFESSIONAL SEAL 038624 ENGINEER JONATHAN D. HINKLE

Jonathan Hinkle

2021/12/30

Prepared for:

THE COUNTY OF HYDE AGRICULTURE SEAFOOD WILDLIFE RECREATION 1712

Daniel Brinn, Water & Flood Control Manager
Hyde County
30 Oyster Creek Road,
Swan Quarter, NC 27885
dbrinn@hydecountync.com

"This report was prepared by the County of Hyde under grant award# NA17NOS4190066 to the Department of Environmental Quality, Division of Coastal Management from the Office for Coastal Management, National Oceanic and Atmospheric Administration. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of DEQ, OCM or NOAA."

December 30, 2021

Hyde County
Mr. Daniel Brinn
Flood Control Manager
30 Oyster Creek Road
Swan Quarter, NC 27885

Subject: Feasibility Study for Pump and Drainage Improvements for Swanquarter Town Ditch Canal

Dear Mr. Brinn,

Greenman-Pedersen, Inc. (GPI) is pleased to present a summary of findings for the Town Ditch Canal Feasibility Study. GPI completed survey, H&H modeling, active water management design, and provided these findings within the following report. GPI has deemed the drainage improvements feasible and recommends the County proceed forward with additional stages of engineering to develop contract and permit drawings to then proceed to the construction phase.

The staff at GPI and our project partners want to thank the County for allowing us to participate with this project and look forward to future phases. Our project partners are from the County, while our project manager has spent a significant portion of his life in the County and is passionate about improving the drainage conditions and resiliency of its stakeholders. After your review if you have any questions please feel free to contact our project manager, Mr. Jonathan Hinkle, PE.

Sincerely,

Jonathan Hinkle

Jonathan D. Hinkle, PE
Lead Environmental Engineer / North Carolina Engineering Manager
Assistant Vice President
jhinkle@gpinet.com
910.663.4123

2021/12/30

BACKGROUND

The Town of Swanquarter has experienced significant flooding from recent tropical events and other precipitation events that has caused damage to the Town's population along Town Ditch Canal. Hyde County was awarded a grant to study the feasibility of drainage improvements and active water management for the Canal. GPI (formerly LDSI) was selected as the engineering firm for this project. GPI performed:

- limited topographic survey on the existing drainage infrastructure
- first order H&H modeling
- pump configuration analysis
- assessment of future conditions
- first order drainage network improvement modeling

Assumptions

The following assumptions were utilized in the development of this feasibility study:

- The County will be responsible for all grant/contract administration and processing of documents with FEMA and other applicable grant agencies.
- The project includes the feasibility assessment of an active water management (pumped) drainage system and recommendations for drainage improvement to the Town Ditch Canal; neither the complete design of the active water management nor the design of recommended drainage improvements are part of this contract.
- First order H&H modeling,
    - Steady state
    - Hydraulic Grade-line, modeling only
    - Culvert analysis for the culverts along Town Ditch Canal
    - No channel/attenuation modeling will be conducted
- No major changes in land-use for future conditions analysis
- Opinion of Cost will be based on best professional judgement, the current economic climate is extremely volatile, therefore costs are difficult to accurately project

SURVEY EFFORTS

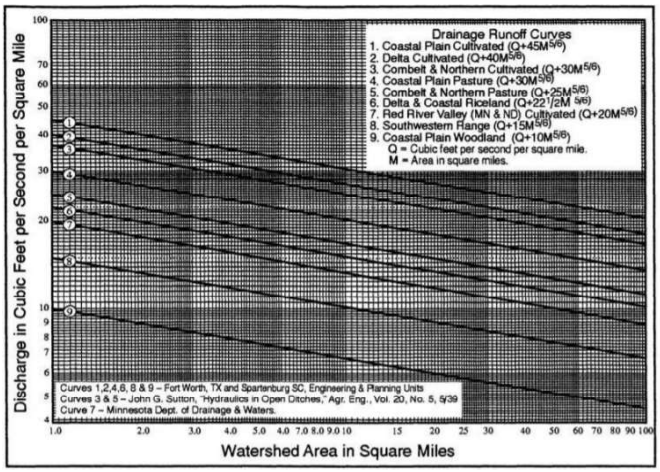
GPI completed the surveying phase of the project by locating pipes and drainage infrastructure along Main Street. The information gathered includes coordinates, elevations, ground cover, photos, and dimensions of structures, as well as coordinates, dimensions, and material. Cross sections for the canal near the gazabo were collected and used to determine adequacy of the pump operation and its feasibility.

HYDROLOGY

Historic rainfall data for this project was determined via NOAA's Atlas 14 tool. Watersheds were individually delineated for each catchment leading into the stormwater system so that a comprehensive analysis could be conducted of each section of the network. As a part of the analysis, rainfall area, percent impervious surface, time of concentration, and type of surface flow experienced during a storm event were determined for model inputs. These values were used when calibrating the stormwater model to determine at which points during a storm event any given section of the pipe network would be under maximum load. Determining the maximum load that the network might experience during a storm allows deficiencies in the network to be predicted and analyzed. This also allows for any tailwater effects that might be caused upstream of that section to be determined.

When analyzing the hydrologic conditions of the Town Ditch Canal Watershed, it was necessary to account for the organic and sandy, rapidly draining soils that are present near Swanquarter. These soils allow for very high stormwater infiltration rates which prevent a significant portion of the stormwater from ever entering the drainage infrastructure. Organic and sandy soils act as a sponge when the organic material is dry, the soil absorbs a majority of the precipitation events. On the other hand, when they are saturated, they will contribute to runoff as they have reached the maximum absorption. While runoff still occurs during large storm events, it is important to realize that surface flow does not mean that infiltration is not occurring. This means that any stormwater that passes over local soils prior to entering the drainage network will have a portion infiltrated into the soils, thus reducing the amount of water that must be routed through the drainage network. The runoff from the catchments during a storm event was simulated for each individual catchment using the rational method. This would simulate the peak flow experienced by the drainage network for the design events.

Additionally, we have modeled the watersheds through the Cypress Creek Drainage equations which are discussed in the NRCS Hydrology Handbook. "*The Cypress Creek formula is used by engineers as a means of determining the design capacity of drainage canals. It is an average removal rate for a 24-hour period and is not an instantaneous peak flow rate. Data were developed for this approach on flatland areas of the coastal plain and adjacent flatland resource areas.*" Work that we have previously done in Hyde County and with NRCS has shown that these curves are good estimates for drainage removal rates.



The following table is a summary of flow rates from both Rational Method and Cypress Creek Equations.

Model and Recurrence Interval	Flow Rates
Rational 005-year	13.3
Rational 010-year	16.6
Rational 025-year	20.1
Rational 050-year	24
Rational 100-year	27.7
Cypress Creek	11.6

HYDRAULICS

The rainfall runoff data generated by the simulated storms and watershed parameters was input to the model so the existing network's hydraulic properties could be analyzed. These properties included Hydraulic Grade Line (HGL), Water Surface Elevation (WSE), and maximum flow. It was found that there are multiple choke points or restrictions within the existing drainage network. This means that there are multiple locations where downstream pipes are smaller than their upstream pipes, tailwater limited pipes, undersized pipes, or other network restrictions. Transitioning from a pipe of a larger diameter to one of a smaller diameter severely restricts the quantity of water that can pass through and results in increased tailwater upstream of that pipe. Additionally, there are junction choke points where multiple pipes all lead into a single pipe that is not capable of adequately handling the volume of water that is provided. These have the same effect of reducing the quantity of water that can pass through and increasing the upstream tailwater. Several sedimentation restrictions have also been identified within the existing network including multiple clogs and blockages. There were multiple severe blockages due to sedimentation, including several surface exposed pipes that became partially or completely filled with soil. Sedimentation reduces the flow capacity within the pipe network by limiting the available area for water to flow through. Additionally, sedimentation will also reduce storage capacity and stormwater attenuation capability of the ponds within the drainage network.

FINDINGS

After analyzing the H&H model, GPI found that multiple pipes operate under surcharged conditions during storm events. The more intense, higher recurrence interval storms caused more pipes to operate under surcharged conditions. A surcharged pipe condition is a sign that the pipes in place are likely undersized or are inhibited in some way. This could include pipes being installed at a reverse grade, choke/throttle points within the pipe network, or an excess of pipes being drained through a single outlet. The following table summarizes the pipe network as modeled in the existing conditions.

Existing Conditions

For existing conditions, we performed a steady state hydraulic grade line analysis, neglecting the storage of canals or spread. This is a conservative and first order method for determining drainage network capacity. Given the feasibility study level and limited survey information this allowed for determination of potential drainage network restrictions.

Existing Conditions Summary				
Pipe ID	Flow	HW	TW	Notes
Pipe - 01	9.5	5.56	5.56	
Pipe - 02	9.5	5.86	5.56	BRANCH AT START OF SYSTEM
Pipe - 03	9.5	5.56	5.53	overtopping driveway/freeboard elev.
Pipe - 04	9.5	5.53	5.50	overtopping driveway/freeboard elev.
Pipe - 05	9.5	5.5	5.47	overtopping driveway/freeboard elev.
Pipe - 06	9.5	5.47	5.47	overtopping driveway/freeboard elev.
Pipe - 07	9.5	5.47	5.32	overtopping driveway/freeboard elev.
Pipe - 08	9.5	5.32	5.31	overtopping driveway/freeboard elev.
Pipe - 09	9.5	5.31	5.27	overtopping driveway/freeboard elev.

Pipe - 10	9.5	5.27	5.23	overtopping driveway/freeboard elev.
Pipe - 11	15.4	5.23	5.04	overtopping driveway/freeboard elev.
Pipe - 12	15.4	5.04	4.93	overtopping driveway/freeboard elev.
Pipe - 13	15.4	4.93	4.84	overtopping driveway/freeboard elev.
Pipe - 14	15.4	4.84	4.65	overtopping driveway/freeboard elev.
Pipe - 15	15.4	4.65	4.46	overtopping driveway/freeboard elev.
Pipe - 16	15.4	4.46	4.27	overtopping driveway/freeboard elev.
Pipe - 17	20	4.27	3.98	overtopping driveway/freeboard elev.
Pipe - 18	20	3.98	3.84	overtopping driveway/freeboard elev.
Pipe - 19	20	3.84	3.71	overtopping driveway/freeboard elev.
Pipe - 20	20	3.71	3.60	overtopping driveway/freeboard elev.
Pipe - 21	20	3.60	3.47	overtopping driveway/freeboard elev.
Pipe - 22	20	3.47	3.33	
Pipe - 23	20	3.33	3.11	overtopping driveway/freeboard elev.
Pipe - 24	20	3.11	3.04	overtopping driveway/freeboard elev.
Pipe - 25	20	3.04	2.96	overtopping driveway/freeboard elev.
Pipe - 26	20	2.96	2.89	
Pipe - 27	20	2.89	2.78	overtopping driveway/freeboard elev.
Pipe - 28	24	2.78	2.53	overtopping driveway/freeboard elev.
Pipe - 29	24	2.53	2.31	overtopping driveway/freeboard elev.
Pipe - 30	24	2.31	1.86	overtopping driveway/freeboard elev.
Pipe - 31	24	1.86	1.47	overtopping driveway/freeboard elev.
Pipe - 32	24	1.47	0.49	
Pipe - 33	24	0.49	0.02	
Pipe - 34	24	0.02	0.00	

Proposed Improvements

Keeping the same assumptions for development of drainage network improvement, the proposed improvements of the drainage network are summarized in the table below. The HGL/steady state analysis shows a significant improvement of the computed water-surface-elevations.

Proposed Improvement Summary

Pipe ID	Flow	HW	TW	Notes
Pipe - 01	9.5	2.41	2.41	
Pipe - 02	9.5	5.86	2.41	
Pipe - 03	9.5	2.41	2.38	
Pipe - 04	9.5	2.38	2.35	
Pipe - 05	9.5	2.35	2.32	
Pipe - 06	9.5	2.32	2.32	
Pipe - 07	9.5	2.32	2.28	Replace with (2) 36
Pipe - 08	9.5	2.28	2.27	
Pipe - 09	9.5	2.27	2.26	Replace with (2) 36
Pipe - 10	9.5	2.26	2.25	Replace with (2) 36
Pipe - 11	15.4	2.25	2.20	Replace with (2) 36
Pipe - 12	15.4	2.20	2.15	Replace with (2) 36
Pipe - 13	15.4	2.15	2.11	Replace with (2) 36
Pipe - 14	15.4	2.11	2.06	Replace with (2) 36

Pipe - 15	15.4	2.06	2.01	Replace with (2) 36
Pipe - 16	15.4	2.01	1.96	Replace with (2) 36
Pipe - 17	20	1.96	1.89	Replace with (2) 36
Pipe - 18	20	1.89	1.85	Replace with (2) 42
Pipe - 19	20	1.85	1.82	Replace with (2) 42
Pipe - 20	20	1.82	1.79	Replace with (2) 42
Pipe - 21	20	1.79	1.76	Replace with (2) 42
Pipe - 22	20	1.76	1.72	Replace with (2) 42
Pipe - 23	20	1.72	1.70	Replace with (2) 42
Pipe - 24	20	1.70	1.68	Replace with (2) 48
Pipe - 25	20	1.68	1.66	Replace with (2) 48
Pipe - 26	20	1.66	1.64	Replace with (2) 48
Pipe - 27	20	1.64	1.61	Replace with (2) 48
Pipe - 28	24	1.61	1.59	Replace with (2) 48
Pipe - 29	24	1.59	1.53	Replace with (2) 48
Pipe - 30	24	1.53	1.50	Replace with (2) 48
Pipe - 31	24	1.50	1.47	Replace with (2) 48
Pipe - 32	24	1.47	0.49	
Pipe - 33	24	0.49	0.02	
Pipe - 34	24	0.02	0.00	

Culvert summary sheets are attached to this report in Appendix A. Again, it should be noted that this is a first order model and has significant assumptions in order to estimate the need of drainage improvements and suitability of the installation of a pump near Landing Road.

Pump Recommendations

Based upon the H&H investigation and modeling, it appears we have three probable scenarios we should plan for in the selection and design of the proposed pump.

1. The conditions that exist currently with the identified choke points and canal sediment presence which gives us the lowest expected flow.
2. An improved condition scenario that assumes undersized culverts are replaced with recommended sizes, and flow restricting sediment is removed to connect a series of adequately sized culverts to the pump basin.
3. Lastly, under either of the previous noted flows, tropical events or events which yield, “out of bank flooding, (i.e. flooding in the streets event),” requiring the need for higher pumping rates in order to manage the out of bank flooding.

With these three different flowrates required, the pump needs to have a variable flowrate, after review a 24” axial flow pump with an electric drive motor, would be the recommended pump. This pump design would allow a flow rate of approximately 10,000 gpm to 17,000 gpm depending on operational speed. Additionally, this pump could be controlled using a Variable Frequency Drive (VFD) controller allowing the reduction of the drive motor speed in times of average to below average flows, while providing the ability to increase the drive motor speeds in a heavy flow or flood event to gain the maximum pump output. This operational flexibility is like powering the pump with a diesel engine where throttle control would achieve the same results but without the noise and environmental concerns associated with diesel powered equipment. For times of power outage, a switchgear would be provided for functional use as a backup.

Due to the close proximity of salt water and the salt air environment, we recommend the pump be outfitted with a full anti-corrosion package including stainless steel impeller, wear band, and bolt fasteners in all flange connections. The

pump, discharge pipe, and flapgate should be coated with 2-part coal tar epoxy coating and have zinc anodes attached in below water line locations. Additionally, all electrical equipment beyond the meter base should have stainless outdoor enclosures to ensure long life in the elements.

OPINION OF COSTS

The following table is a summary of potential costs to implement all the recommendations. Given high market fluctuations following the COVID pandemic and this is currently at a planning level study, significant changes to costs can happen as the design moves forward or with product cost/availability.

Opinion of Probable Costs	
Item	Estimate of Probable Cost
840 Linear feet of AASHTO M 294 Type 'S' 36 DIA Pipe	$ 114,000
460 Linear feet of AASHTO M 294 Type 'S' 42 DIA Pipe	$ 83,000
660 Linear feet of AASHTO M 294 Type 'S' 48 DIA Pipe	$ 138,000
Pump	$ 140,000
Design Fee for Construction Implementation & Permitting	$ 95,000
Contingency (35% Given COVID supply-chain disruptions)	$ 165,000
Total Planning Level Opinion of Costs	**$ 735,000**

RECOMMENDATIONS

The feasibility analysis of the Town Ditch Canal shows significant improvement with major modifications to the existing infrastructure. Again, it should be noted that this is a planning level study and additional engineering needs to be performed to analyze key portions of the drainage network and coordination with project stake holders on implementation. Our team recommends proceeding with an additional engineering project to develop construction documents for implementing the entire proposed conditions as we have modeled. A refined engineering study will be needed to determine if cost-savings can be gleaned from using existing pipes with a higher order drainage network analysis, as well as if project stakeholders want to include/exclude portions of the proposed recommendations.

FUNDING OPPORTUNITIES

There are several potential funding options for implementing the Town's stormwater outfall infiltration projects. Some of these are included in the table below.

Name	Funding Cycle	Application Deadline(s)
FEMA BRIC	1 – per year	Late Fall (November LOIs)
Water Resource Development Grant	2 – per year	Late June, Late December
Clean Water State Revolving Fund (CWSRF) Loan	NA	NA
Stormwater Utility Fee	NA	NA

The following sources were utilized for this list of funding opportunities: The Environmental Finance Center at the University of North Carolina, Chapel Hill Methods and Strategies for Financing Green Infrastructure, and Individual web sites from funding sources.

FEMA – Building Resilient Communities and Infrastructure (BRIC)

Overview: Building Resilient Infrastructure and Communities (BRIC) will support states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards.

The BRIC program guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency. (FEMA website)

Information: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities

Water Resource Development Grant

Overview: This grant program provides cost-share grants and technical assistance to local governments. Applications for grants are accepted for seven eligible project types: general navigation, recreational navigation, water management, stream restoration, water-based recreation, Natural Resources Conservation Service Environmental Quality Incentives Program (EQIP) stream restoration projects and feasibility/engineering studies. The non-navigation projects are collectively referred to as state and local projects.
Award Decision: Range $10,000 ~ $200,000
Cycles: There are two grant application cycles per fiscal year for state and local projects. The current spring 2019 grant cycle began Jan.1 and applications are due by June 30. The second cycle is from July 1 – December 31.
Contact: Amin Davis amin.davis@ncdenr.gov
Information:
https://files.nc.gov/ncdeq/Water%20Resources/documents/WRDG%20WSN%20New%20Bern%20102317_A%20Davis.pdf

Clean Water State Revolving Fund (CWSRF) Loan

The North Carolina State Water Infrastructure Authority (SWIA) overseas a number of water and wastewater loan and grant programs including the joint state/federal (EPA) funded Clean Water State Revolving Fund (CWSRF). According to the UNC Environmental Finance Center report entitled Methods and Strategies for Financing Green Infrastructure, local governments can obtain loans at rates as low as 0% for 20 years to fund eligible projects including stormwater projects.

Stormwater Utility Fee

Under North Carolina law, stormwater fees can be used to cover a wide range of stormwater quality and quantity programs.

Existing Conditions Model

Culvert Calculator Report
001 - CULVERT

Comments: OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.35	ft	Headwater Depth/Height	1.33	
Computed Headwater Elevation	5.56	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.56	ft	Tailwater Elevation	5.56	ft
Outlet Control HW Elev.	5.56	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.40	ft	Downstream Invert	-2.26	ft
Length	87.21	ft	Constructed Slope	-0.001605	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.82	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.35	ft
Velocity Downstream	0.20	ft/s	Critical Slope	0.003902	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 6 ft		Rise	6.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.56	ft	Upstream Velocity Head	0.00	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.56	ft	Flow Control	N/A	
Inlet Type	90° headwall w 3/4 inch chamfers		Area Full	48.0	ft²
K	0.51500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	1	
C	0.03750		Equation Form	2	
Y	0.79000				

Culvert Calculator Report
002 - CULVERT

Comments: OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.06	ft	Headwater Depth/Height	2.90	
Computed Headwater Elevation	5.86	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.56	ft	Tailwater Elevation	5.56	ft
Outlet Control HW Elev.	5.86	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	0.06	ft	Downstream Invert	-0.10	ft
Length	72.12	ft	Constructed Slope	0.002219	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.66	ft
Slope Type	N/A		Normal Depth	1.47	ft
Flow Regime	N/A		Critical Depth	1.10	ft
Velocity Downstream	3.02	ft/s	Critical Slope	0.005117	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.86	ft	Upstream Velocity Head	0.14	ft
Ke	0.20		Entrance Loss	0.03	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.56	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	3.1	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
003 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.78	ft	Headwater Depth/Height	2.24	
Computed Headwater Elevation	5.56	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.53	ft	Tailwater Elevation	5.53	ft
Outlet Control HW Elev.	5.56	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.29	ft	Downstream Invert	-2.32	ft
Length	19.71	ft	Constructed Slope	0.001522	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.85	ft
Slope Type	N/A		Normal Depth	1.64	ft
Flow Regime	N/A		Critical Depth	0.93	ft
Velocity Downstream	0.99	ft/s	Critical Slope	0.012642	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.56	ft	Upstream Velocity Head	0.02	ft
Ke	0.50		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.53	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	9.6	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
004 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.92	ft	Headwater Depth/Height	2.20	
Computed Headwater Elevation	5.53	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.50	ft	Tailwater Elevation	5.50	ft
Outlet Control HW Elev.	5.53	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.17	ft	Downstream Invert	-1.89	ft
Length	19.67	ft	Constructed Slope	-0.014235	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.39	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.93	ft
Velocity Downstream	0.99	ft/s	Critical Slope	0.012642	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.53	ft	Upstream Velocity Head	0.02	ft
Ke	0.90		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.50	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
005 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.34	ft	Headwater Depth/Height	2.17	
Computed Headwater Elevation	5.50	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.47	ft	Tailwater Elevation	5.47	ft
Outlet Control HW Elev.	5.50	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.09	ft	Downstream Invert	-2.17	ft
Length	19.81	ft	Constructed Slope	0.004038	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.64	ft
Slope Type	N/A		Normal Depth	1.25	ft
Flow Regime	N/A		Critical Depth	0.93	ft
Velocity Downstream	0.99	ft/s	Critical Slope	0.012642	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.50	ft	Upstream Velocity Head	0.02	ft
Ke	0.90		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.47	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
006 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.80	ft	Headwater Depth/Height	2.27	
Computed Headwater Elevation	5.47	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.47	ft	Tailwater Elevation	5.47	ft
Outlet Control HW Elev.	5.22	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	-2.49	ft	Downstream Invert	-2.20	ft
Length	49.81	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.67	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	0.93	ft
Velocity Downstream	0.99	ft/s	Critical Slope	0.012642	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.22	ft	Upstream Velocity Head	0.02	ft
Ke	0.90		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.47	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
007 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.62	ft	Headwater Depth/Height	2.44	
Computed Headwater Elevation	5.47	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.32	ft	Tailwater Elevation	5.32	ft
Outlet Control HW Elev.	5.47	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.85	ft	Downstream Invert	-1.30	ft
Length	133.32	ft	Constructed Slope	-0.004125	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.62	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.97	ft
Velocity Downstream	1.34	ft/s	Critical Slope	0.013291	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.47	ft	Upstream Velocity Head	0.03	ft
Ke	0.90		Entrance Loss	0.03	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.32	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
008 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.40	ft	Headwater Depth/Height	2.02	
Computed Headwater Elevation	5.32	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.31	ft	Tailwater Elevation	5.31	ft
Outlet Control HW Elev.	5.32	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.75	ft	Downstream Invert	-2.22	ft
Length	48.20	ft	Constructed Slope	0.009751	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.53	ft
Slope Type	N/A		Normal Depth	0.70	ft
Flow Regime	N/A		Critical Depth	0.65	ft
Velocity Downstream	0.49	ft/s	Critical Slope	0.013076	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	5.32	ft	Upstream Velocity Head	0.00	ft
Ke	0.90		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.31	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	19.2	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
009 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.89	ft	Headwater Depth/Height	2.55	
Computed Headwater Elevation	5.31	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.27	ft	Tailwater Elevation	5.27	ft
Outlet Control HW Elev.	5.31	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.34	ft	Downstream Invert	-1.67	ft
Length	38.58	ft	Constructed Slope	-0.017367	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.94	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.97	ft
Velocity Downstream	1.34	ft/s	Critical Slope	0.003323	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.31	ft	Upstream Velocity Head	0.03	ft
Ke	0.20		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.27	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	7.1	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
010 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4.20	ft	Headwater Depth/Height	2.04	
Computed Headwater Elevation	5.27	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	5.23	ft	Tailwater Elevation	5.23	ft
Outlet Control HW Elev.	5.27	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-0.86	ft	Downstream Invert	-1.05	ft
Length	38.73	ft	Constructed Slope	0.004906	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.28	ft
Slope Type	N/A		Normal Depth	0.88	ft
Flow Regime	N/A		Critical Depth	0.97	ft
Velocity Downstream	1.34	ft/s	Critical Slope	0.003323	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.27	ft	Upstream Velocity Head	0.03	ft
Ke	0.20		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.23	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	7.1	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
011 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.88	ft	Headwater Depth/Height	2.24	
Computed Headwater Elevation	5.23	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	5.04	ft	Tailwater Elevation	5.04	ft
Outlet Control HW Elev.	5.23	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.49	ft	Downstream Invert	-1.62	ft
Length	29.44	ft	Constructed Slope	0.004416	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.66	ft
Slope Type	N/A		Normal Depth	1.75	ft
Flow Regime	N/A		Critical Depth	1.25	ft
Velocity Downstream	2.18	ft/s	Critical Slope	0.013711	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.23	ft	Upstream Velocity Head	0.07	ft
Ke	0.90		Entrance Loss	0.07	ft

Inlet Control Properties					
Inlet Control HW Elev.	5.04	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
012 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.08	ft	Headwater Depth/Height	1.90	
Computed Headwater Elevation	5.04	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	4.93	ft	Tailwater Elevation	4.93	ft
Outlet Control HW Elev.	5.04	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.60	ft	Downstream Invert	-1.64	ft
Length	40.38	ft	Constructed Slope	0.000991	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.57	ft
Slope Type	N/A		Normal Depth	2.59	ft
Flow Regime	N/A		Critical Depth	1.20	ft
Velocity Downstream	1.60	ft/s	Critical Slope	0.012662	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5.04	ft	Upstream Velocity Head	0.04	ft
Ke	0.90		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev.	4.93	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
013 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.08	ft	Headwater Depth/Height	2.08	
Computed Headwater Elevation	4.93	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	4.84	ft	Tailwater Elevation	4.84	ft
Outlet Control HW Elev.	4.93	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.36	ft	Downstream Invert	-2.40	ft
Length	19.47	ft	Constructed Slope	0.002054	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.24	ft
Slope Type	N/A		Normal Depth	2.00	ft
Flow Regime	N/A		Critical Depth	1.20	ft
Velocity Downstream	1.60	ft/s	Critical Slope	0.012662	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	4.93	ft	Upstream Velocity Head	0.04	ft
Ke	0.90		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev.	4.84	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
014 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.90	ft	Headwater Depth/Height	2.46	
Computed Headwater Elevation	4.84	ft	Discharge	15.44	cfs
Inlet Control HW Elev.	4.65	ft	Tailwater Elevation	4.65	ft
Outlet Control HW Elev.	4.84	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.54	ft	Downstream Invert	-2.22	ft
Length	29.40	ft	Constructed Slope	-0.010884	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.87	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.25	ft
Velocity Downstream	2.18	ft/s	Critical Slope	0.013715	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	4.84	ft	Upstream Velocity Head	0.07	ft
Ke	0.90		Entrance Loss	0.07	ft

Inlet Control Properties					
Inlet Control HW Elev.	4.65	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
015 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.64	ft	Headwater Depth/Height	2.49	
Computed Headwater Elevation	4.65	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	4.46	ft	Tailwater Elevation	4.46	ft
Outlet Control HW Elev.	4.65	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.81	ft	Downstream Invert	-2.71	ft
Length	24.79	ft	Constructed Slope	-0.004034	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.17	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.25	ft
Velocity Downstream	2.18	ft/s	Critical Slope	0.013711	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	4.65	ft	Upstream Velocity Head	0.07	ft
Ke	0.90		Entrance Loss	0.07	ft

Inlet Control Properties					
Inlet Control HW Elev.	4.46	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
016 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.97	ft	Headwater Depth/Height	2.49	
Computed Headwater Elevation	4.46	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	4.27	ft	Tailwater Elevation	4.27	ft
Outlet Control HW Elev.	4.46	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.00	ft	Downstream Invert	-2.92	ft
Length	28.03	ft	Constructed Slope	-0.002854	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	7.19	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.25	ft
Velocity Downstream	2.18	ft/s	Critical Slope	0.013711	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	4.46	ft	Upstream Velocity Head	0.07	ft
Ke	0.90		Entrance Loss	0.07	ft

Inlet Control Properties					
Inlet Control HW Elev.	4.27	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
017 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.55	ft	Headwater Depth/Height	2.37	
Computed Headwater Elevation	4.27	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	3.98	ft	Tailwater Elevation	3.98	ft
Outlet Control HW Elev.	4.27	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.85	ft	Downstream Invert	-1.87	ft
Length	18.57	ft	Constructed Slope	-0.052773	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.85	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.44	ft
Velocity Downstream	2.83	ft/s	Critical Slope	0.014260	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	4.27	ft	Upstream Velocity Head	0.12	ft
Ke	0.90		Entrance Loss	0.11	ft

Inlet Control Properties					
Inlet Control HW Elev.	3.98	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
018 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.98	ft	Headwater Depth/Height	1.71	
Computed Headwater Elevation	3.93	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	3.84	ft	Tailwater Elevation	3.84	ft
Outlet Control HW Elev.	3.93	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.90	ft	Downstream Invert	-2.88	ft
Length	28.10	ft	Constructed Slope	-0.000712	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.72	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.32	ft
Velocity Downstream	1.59	ft/s	Critical Slope	0.012083	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	3.93	ft	Upstream Velocity Head	0.04	ft
Ke	0.90		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev.	3.84	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	12.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
019 - CULVERT

Comments: DRIVEWAY OVERTOPPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.92	ft	Headwater Depth/Height	1.97	
Computed Headwater Elevation	3.84	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	3.71	ft	Tailwater Elevation	3.71	ft
Outlet Control HW Elev.	3.84	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.05	ft	Downstream Invert	-2.79	ft
Length	20.22	ft	Constructed Slope	-0.012859	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.50	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.37	ft
Velocity Downstream	2.08	ft/s	Critical Slope	0.012864	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	3.84	ft	Upstream Velocity Head	0.07	ft
Ke	0.50		Entrance Loss	0.03	ft

Inlet Control Properties					
Inlet Control HW Elev.	3.71	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	9.6	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
020 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.60	ft	Headwater Depth/Height	1.70	
Computed Headwater Elevation	3.71	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	3.60	ft	Tailwater Elevation	3.60	ft
Outlet Control HW Elev.	3.71	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.23	ft	Downstream Invert	-2.33	ft
Length	88.36	ft	Constructed Slope	0.001132	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.93	ft
Slope Type	N/A		Normal Depth	1.84	ft
Flow Regime	N/A		Critical Depth	1.37	ft
Velocity Downstream	2.08	ft/s	Critical Slope	0.003216	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	3.71	ft	Upstream Velocity Head	0.07	ft
Ke	0.20		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	3.60	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	9.6	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
021 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.29	ft	Headwater Depth/Height	1.97	
Computed Headwater Elevation	3.60	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	3.47	ft	Tailwater Elevation	3.47	ft
Outlet Control HW Elev.	3.60	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.31	ft	Downstream Invert	-3.46	ft
Length	19.65	ft	Constructed Slope	0.007634	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.93	ft
Slope Type	N/A		Normal Depth	1.58	ft
Flow Regime	N/A		Critical Depth	1.37	ft
Velocity Downstream	2.08	ft/s	Critical Slope	0.012864	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	3.60	ft	Upstream Velocity Head	0.07	ft
Ke	0.50		Entrance Loss	0.03	ft

Inlet Control Properties					
Inlet Control HW Elev.	3.47	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	9.6	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
022 - CULVERT

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.91	ft	Headwater Depth/Height	1.51	
Computed Headwater Elevation	3.47	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	3.33	ft	Tailwater Elevation	3.33	ft
Outlet Control HW Elev.	3.47	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.82	ft	Downstream Invert	-2.06	ft
Length	30.13	ft	Constructed Slope	0.007965	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.39	ft
Slope Type	N/A		Normal Depth	1.56	ft
Flow Regime	N/A		Critical Depth	1.37	ft
Velocity Downstream	2.08	ft/s	Critical Slope	0.012864	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	3.47	ft	Upstream Velocity Head	0.07	ft
Ke	0.50		Entrance Loss	0.03	ft

Inlet Control Properties					
Inlet Control HW Elev.	3.33	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	9.6	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
023 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.64	ft	Headwater Depth/Height	1.50	
Computed Headwater Elevation	3.33	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	3.24	ft	Tailwater Elevation	3.24	ft
Outlet Control HW Elev.	3.33	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.90	ft	Downstream Invert	-1.65	ft
Length	40.93	ft	Constructed Slope	-0.006108	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.89	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.37	ft
Velocity Downstream	2.08	ft/s	Critical Slope	0.003216	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	3.33	ft	Upstream Velocity Head	0.07	ft
Ke	0.20		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	3.24	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	9.6	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
024 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.98	ft	Headwater Depth/Height	1.43	
Computed Headwater Elevation	3.11	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	3.04	ft	Tailwater Elevation	3.04	ft
Outlet Control HW Elev.	3.11	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.61	ft	Downstream Invert	-2.61	ft
Length	20.34	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.65	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.32	ft
Velocity Downstream	1.59	ft/s	Critical Slope	0.012083	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	3.11	ft	Upstream Velocity Head	0.04	ft
Ke	0.50		Entrance Loss	0.02	ft

Inlet Control Properties					
Inlet Control HW Elev.	3.04	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	12.6	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
025 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.96	ft	Headwater Depth/Height	1.59	
Computed Headwater Elevation	3.04	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	2.96	ft	Tailwater Elevation	2.96	ft
Outlet Control HW Elev.	3.04	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.32	ft	Downstream Invert	-3.25	ft
Length	30.18	ft	Constructed Slope	-0.002319	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.21	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.32	ft
Velocity Downstream	1.59	ft/s	Critical Slope	0.012083	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	3.04	ft	Upstream Velocity Head	0.04	ft
Ke	0.50		Entrance Loss	0.02	ft

Inlet Control Properties					
Inlet Control HW Elev.	2.96	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	12.6	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
026 - CULVERT

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.18	ft	Headwater Depth/Height	1.54	
Computed Headwater Elevation	2.96	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	2.89	ft	Tailwater Elevation	2.89	ft
Outlet Control HW Elev.	2.96	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.19	ft	Downstream Invert	-3.47	ft
Length	20.02	ft	Constructed Slope	0.013986	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.36	ft
Slope Type	N/A		Normal Depth	1.27	ft
Flow Regime	N/A		Critical Depth	1.32	ft
Velocity Downstream	1.59	ft/s	Critical Slope	0.012083	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2.96	ft	Upstream Velocity Head	0.04	ft
Ke	0.50		Entrance Loss	0.02	ft

Inlet Control Properties					
Inlet Control HW Elev.	2.89	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	12.6	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
027 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.58	ft	Headwater Depth/Height	1.56	
Computed Headwater Elevation	2.89	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	2.78	ft	Tailwater Elevation	2.78	ft
Outlet Control HW Elev.	2.89	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.34	ft	Downstream Invert	-3.41	ft
Length	50.24	ft	Constructed Slope	0.001393	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	6.19	ft
Slope Type	N/A		Normal Depth	2.44	ft
Flow Regime	N/A		Critical Depth	1.32	ft
Velocity Downstream	1.59	ft/s	Critical Slope	0.012083	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2.89	ft	Upstream Velocity Head	0.04	ft
Ke	0.90		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev.	2.78	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	12.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
028 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.34	ft	Headwater Depth/Height	1.51	
Computed Headwater Elevation	2.78	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	2.53	ft	Tailwater Elevation	2.53	ft
Outlet Control HW Elev.	2.78	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.75	ft	Downstream Invert	-2.19	ft
Length	30.68	ft	Constructed Slope	0.014342	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.72	ft
Slope Type	N/A		Normal Depth	1.08	ft
Flow Regime	N/A		Critical Depth	1.58	ft
Velocity Downstream	3.40	ft/s	Critical Slope	0.003715	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2.78	ft	Upstream Velocity Head	0.18	ft
Ke	0.20		Entrance Loss	0.04	ft

Inlet Control Properties					
Inlet Control HW Elev.	2.53	ft	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	7.1	ft²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Calculator Report
029 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.01	ft	Headwater Depth/Height	1.56	
Computed Headwater Elevation	2.53	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	2.31	ft	Tailwater Elevation	2.31	ft
Outlet Control HW Elev.	2.53	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.69	ft	Downstream Invert	-3.40	ft
Length	122.08	ft	Constructed Slope	-0.002375	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.71	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.45	ft
Velocity Downstream	1.91	ft/s	Critical Slope	0.012173	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2.53	ft	Upstream Velocity Head	0.06	ft
Ke	0.90		Entrance Loss	0.05	ft

Inlet Control Properties					
Inlet Control HW Elev.	2.31	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	12.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
030 - CULVERT

Comments: ASSUMED INV OUT
DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.59	ft	Headwater Depth/Height	1.76	
Computed Headwater Elevation	2.31	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	1.84	ft	Tailwater Elevation	1.84	ft
Outlet Control HW Elev.	2.31	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.96	ft	Downstream Invert	-2.97	ft
Length	29.42	ft	Constructed Slope	0.000340	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.81	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.58	ft
Velocity Downstream	3.40	ft/s	Critical Slope	0.014862	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2.31	ft	Upstream Velocity Head	0.18	ft
Ke	0.90		Entrance Loss	0.16	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.84	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
031 - CULVERT

Comments: ASSUMED INV OUT
DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.84	ft	Headwater Depth/Height	1.44	
Computed Headwater Elevation	1.86	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	1.47	ft	Tailwater Elevation	1.47	ft
Outlet Control HW Elev.	1.86	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.45	ft	Downstream Invert	-2.45	ft
Length	27.40	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.92	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.58	ft
Velocity Downstream	3.40	ft/s	Critical Slope	0.014862	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1.86	ft	Upstream Velocity Head	0.18	ft
Ke	0.50		Entrance Loss	0.09	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.47	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	7.1	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
032 - CULVERT

Comments: ASSUMED INV IN

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.15	ft	Headwater Depth/Height	1.45	
Computed Headwater Elevation	1.47	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	0.49	ft	Tailwater Elevation	0.49	ft
Outlet Control HW Elev.	1.47	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.89	ft	Downstream Invert	-2.89	ft
Length	145.72	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.38	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.58	ft
Velocity Downstream	3.40	ft/s	Critical Slope	0.014862	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1.47	ft	Upstream Velocity Head	0.18	ft
Ke	0.90		Entrance Loss	0.16	ft

Inlet Control Properties					
Inlet Control HW Elev.	0.49	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
033 - CULVERT

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.74	ft	Headwater Depth/Height	1.19	
Computed Headwater Elevation	0.49	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	0.02	ft	Tailwater Elevation	0.02	ft
Outlet Control HW Elev.	0.49	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.08	ft	Downstream Invert	-3.09	ft
Length	29.63	ft	Constructed Slope	0.000337	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.11	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.58	ft
Velocity Downstream	3.40	ft/s	Critical Slope	0.014862	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	0.49	ft	Upstream Velocity Head	0.18	ft
Ke	0.90		Entrance Loss	0.16	ft

Inlet Control Properties					
Inlet Control HW Elev.	0.02	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
034-CULVERT

Comments: INV OUT AND LENGTH ASSUMED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.51	ft	Headwater Depth/Height	0.72	
Computed Headwater Elevation	0.02	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	0.00	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	0.02	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.22	ft	Downstream Invert	-3.22	ft
Length	50.00	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	H2		Depth, Downstream	3.22	ft
Slope Type	Horizontal		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	0.80	ft
Velocity Downstream	0.66	ft/s	Critical Slope	0.012156	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	4.50	ft
Section Size	54 inch		Rise	4.50	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	0.02	ft	Upstream Velocity Head	0.01	ft
Ke	0.90		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	0.00	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	47.7	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Proposed Conditions Model

Culvert Calculator Report
001 - CULVERT

Comments: OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.35	ft	Headwater Depth/Height	0.74	
Computed Headwater Elevation	2.05	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	2.05	ft	Tailwater Elevation	2.05	ft
Outlet Control HW Elev.	2.05	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.40	ft	Downstream Invert	-2.26	ft
Length	87.21	ft	Constructed Slope	-0.001605	ft/ft

Hydraulic Profile					
Profile	A2		Depth, Downstream	4.31	ft
Slope Type	Adverse		Normal Depth	0.00	ft
Flow Regime	Subcritical		Critical Depth	0.35	ft
Velocity Downstream	0.28	ft/s	Critical Slope	0.003902	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 6 ft		Rise	6.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2.05	ft	Upstream Velocity Head	0.00	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	2.05	ft	Flow Control	N/A	
Inlet Type	90° headwall w 3/4 inch chamfers		Area Full	48.0	ft²
K	0.51500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	1	
C	0.03750		Equation Form	2	
Y	0.79000				

Culvert Calculator Report
002 - CULVERT

Comments: OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.06	ft	Headwater Depth/Height	1.14	
Computed Headwater Elevation	2.35	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	2.05	ft	Tailwater Elevation	2.05	ft
Outlet Control HW Elev.	2.35	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	0.06	ft	Downstream Invert	-0.10	ft
Length	72.12	ft	Constructed Slope	0.002219	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	2.15	ft
Slope Type	N/A		Normal Depth	1.47	ft
Flow Regime	N/A		Critical Depth	1.10	ft
Velocity Downstream	3.02	ft/s	Critical Slope	0.005117	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2.35	ft	Upstream Velocity Head	0.14	ft
Ke	0.20		Entrance Loss	0.03	ft

Inlet Control Properties					
Inlet Control HW Elev.	2.05	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	3.1	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
003 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.78	ft	Headwater Depth/Height	1.24	
Computed Headwater Elevation	2.05	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	2.02	ft	Tailwater Elevation	2.02	ft
Outlet Control HW Elev.	2.05	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.29	ft	Downstream Invert	-2.32	ft
Length	19.71	ft	Constructed Slope	0.001522	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.34	ft
Slope Type	N/A		Normal Depth	1.64	ft
Flow Regime	N/A		Critical Depth	0.93	ft
Velocity Downstream	0.99	ft/s	Critical Slope	0.012642	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2.05	ft	Upstream Velocity Head	0.02	ft
Ke	0.50		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	2.02	ft	Flow Control	N/A	
Inlet Type	Headwall		Area Full	9.6	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
004 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.92	ft	Headwater Depth/Height	1.20	
Computed Headwater Elevation	2.02	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	1.99	ft	Tailwater Elevation	1.99	ft
Outlet Control HW Elev.	2.02	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.17	ft	Downstream Invert	-1.89	ft
Length	19.67	ft	Constructed Slope	-0.014235	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.88	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.93	ft
Velocity Downstream	0.99	ft/s	Critical Slope	0.012642	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2.02	ft	Upstream Velocity Head	0.02	ft
Ke	0.90		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.99	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
005 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.34	ft	Headwater Depth/Height	1.17	
Computed Headwater Elevation	1.99	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	1.96	ft	Tailwater Elevation	1.96	ft
Outlet Control HW Elev.	1.99	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.09	ft	Downstream Invert	-2.17	ft
Length	19.81	ft	Constructed Slope	0.004038	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.13	ft
Slope Type	N/A		Normal Depth	1.25	ft
Flow Regime	N/A		Critical Depth	0.93	ft
Velocity Downstream	0.99	ft/s	Critical Slope	0.012642	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1.99	ft	Upstream Velocity Head	0.02	ft
Ke	0.90		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.96	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
006 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.80	ft	Headwater Depth/Height	1.27	
Computed Headwater Elevation	1.96	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	1.96	ft	Tailwater Elevation	1.96	ft
Outlet Control HW Elev.	1.71	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	-2.49	ft	Downstream Invert	-2.20	ft
Length	49.81	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.16	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	0.93	ft
Velocity Downstream	0.99	ft/s	Critical Slope	0.012642	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1.71	ft	Upstream Velocity Head	0.02	ft
Ke	0.90		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.96	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	9.6	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
007 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.62	ft	Headwater Depth/Height	1.27	
Computed Headwater Elevation	1.96	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	1.95	ft	Tailwater Elevation	1.95	ft
Outlet Control HW Elev.	1.96	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.85	ft	Downstream Invert	-1.30	ft
Length	133.32	ft	Constructed Slope	-0.004125	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.25	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.68	ft
Velocity Downstream	0.67	ft/s	Critical Slope	0.003361	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.96	ft	Upstream Velocity Head	0.01	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.95	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
008 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.40	ft	Headwater Depth/Height	1.06	
Computed Headwater Elevation	1.95	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	1.94	ft	Tailwater Elevation	1.94	ft
Outlet Control HW Elev.	1.95	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.75	ft	Downstream Invert	-2.22	ft
Length	48.20	ft	Constructed Slope	0.009751	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.16	ft
Slope Type	N/A		Normal Depth	0.70	ft
Flow Regime	N/A		Critical Depth	0.65	ft
Velocity Downstream	0.49	ft/s	Critical Slope	0.013076	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.95	ft	Upstream Velocity Head	0.00	ft
Ke	0.90		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.94	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	19.2	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
009 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.89	ft	Headwater Depth/Height	1.43	
Computed Headwater Elevation	1.94	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	1.93	ft	Tailwater Elevation	1.93	ft
Outlet Control HW Elev.	1.94	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.34	ft	Downstream Invert	-1.67	ft
Length	38.58	ft	Constructed Slope	-0.017367	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.60	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.68	ft
Velocity Downstream	0.67	ft/s	Critical Slope	0.003361	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.94	ft	Upstream Velocity Head	0.01	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.93	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	14.1	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
010 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	4.20	ft	Headwater Depth/Height	0.93	
Computed Headwater Elevation	1.93	ft	Discharge	9.50	cfs
Inlet Control HW Elev.	1.92	ft	Tailwater Elevation	1.92	ft
Outlet Control HW Elev.	1.93	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-0.86	ft	Downstream Invert	-1.05	ft
Length	38.73	ft	Constructed Slope	0.004906	ft/ft

Hydraulic Profile					
Profile	S1		Depth, Downstream	2.97	ft
Slope Type	Steep		Normal Depth	0.62	ft
Flow Regime	Subcritical		Critical Depth	0.68	ft
Velocity Downstream	0.67	ft/s	Critical Slope	0.003361	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.93	ft	Upstream Velocity Head	0.01	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.92	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	14.1	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
011 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.88	ft	Headwater Depth/Height	1.14	
Computed Headwater Elevation	1.92	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	1.89	ft	Tailwater Elevation	1.89	ft
Outlet Control HW Elev.	1.92	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.49	ft	Downstream Invert	-1.62	ft
Length	29.44	ft	Constructed Slope	0.004416	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.51	ft
Slope Type	N/A		Normal Depth	0.81	ft
Flow Regime	N/A		Critical Depth	0.87	ft
Velocity Downstream	1.09	ft/s	Critical Slope	0.003316	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.92	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.89	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
012 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.08	ft	Headwater Depth/Height	1.16	
Computed Headwater Elevation	1.89	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	1.86	ft	Tailwater Elevation	1.86	ft
Outlet Control HW Elev.	1.89	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.60	ft	Downstream Invert	-1.64	ft
Length	40.38	ft	Constructed Slope	0.000991	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.50	ft
Slope Type	N/A		Normal Depth	1.20	ft
Flow Regime	N/A		Critical Depth	0.87	ft
Velocity Downstream	1.09	ft/s	Critical Slope	0.003316	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.89	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.86	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
013 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.08	ft	Headwater Depth/Height	1.41	
Computed Headwater Elevation	1.86	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	1.84	ft	Tailwater Elevation	1.84	ft
Outlet Control HW Elev.	1.86	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.36	ft	Downstream Invert	-2.40	ft
Length	19.47	ft	Constructed Slope	0.002054	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.24	ft
Slope Type	N/A		Normal Depth	0.99	ft
Flow Regime	N/A		Critical Depth	0.87	ft
Velocity Downstream	1.09	ft/s	Critical Slope	0.003316	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.86	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.84	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
014 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.90	ft	Headwater Depth/Height	1.46	
Computed Headwater Elevation	1.84	ft	Discharge	15.44	cfs
Inlet Control HW Elev.	1.81	ft	Tailwater Elevation	1.81	ft
Outlet Control HW Elev.	1.84	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.54	ft	Downstream Invert	-2.22	ft
Length	29.40	ft	Constructed Slope	-0.010884	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.03	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.88	ft
Velocity Downstream	1.09	ft/s	Critical Slope	0.003316	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.84	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.81	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
015 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.64	ft	Headwater Depth/Height	1.54	
Computed Headwater Elevation	1.81	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	1.79	ft	Tailwater Elevation	1.79	ft
Outlet Control HW Elev.	1.81	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.81	ft	Downstream Invert	-2.71	ft
Length	24.79	ft	Constructed Slope	-0.004034	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.50	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.87	ft
Velocity Downstream	1.09	ft/s	Critical Slope	0.003316	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.81	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.79	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
016 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.97	ft	Headwater Depth/Height	1.60	
Computed Headwater Elevation	1.79	ft	Discharge	15.40	cfs
Inlet Control HW Elev.	1.76	ft	Tailwater Elevation	1.76	ft
Outlet Control HW Elev.	1.79	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.00	ft	Downstream Invert	-2.92	ft
Length	28.03	ft	Constructed Slope	-0.002854	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.68	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.87	ft
Velocity Downstream	1.09	ft/s	Critical Slope	0.003316	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.79	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.76	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
017 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.55	ft	Headwater Depth/Height	1.54	
Computed Headwater Elevation	1.76	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.72	ft	Tailwater Elevation	1.72	ft
Outlet Control HW Elev.	1.76	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.85	ft	Downstream Invert	-1.87	ft
Length	18.57	ft	Constructed Slope	-0.052773	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.59	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.00	ft
Velocity Downstream	1.41	ft/s	Critical Slope	0.003326	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.76	ft	Upstream Velocity Head	0.03	ft
Ke	0.20		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.72	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	14.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
018 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.98	ft	Headwater Depth/Height	1.32	
Computed Headwater Elevation	1.72	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.70	ft	Tailwater Elevation	1.70	ft
Outlet Control HW Elev.	1.72	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.90	ft	Downstream Invert	-2.88	ft
Length	28.10	ft	Constructed Slope	-0.000712	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.58	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.96	ft
Velocity Downstream	1.04	ft/s	Critical Slope	0.003154	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.72	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.70	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	19.2	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
019 - CULVERT

Comments: DRIVEWAY OVERTOPPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.92	ft	Headwater Depth/Height	1.36	
Computed Headwater Elevation	1.70	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.68	ft	Tailwater Elevation	1.68	ft
Outlet Control HW Elev.	1.70	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.05	ft	Downstream Invert	-2.79	ft
Length	20.22	ft	Constructed Slope	-0.012859	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.47	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.96	ft
Velocity Downstream	1.04	ft/s	Critical Slope	0.003154	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.70	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.68	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	19.2	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
020 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.60	ft	Headwater Depth/Height	1.12	
Computed Headwater Elevation	1.68	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.65	ft	Tailwater Elevation	1.65	ft
Outlet Control HW Elev.	1.68	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.23	ft	Downstream Invert	-2.33	ft
Length	88.36	ft	Constructed Slope	0.001132	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.98	ft
Slope Type	N/A		Normal Depth	1.25	ft
Flow Regime	N/A		Critical Depth	0.96	ft
Velocity Downstream	1.04	ft/s	Critical Slope	0.003154	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.68	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.65	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	19.2	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
021 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.29	ft	Headwater Depth/Height	1.42	
Computed Headwater Elevation	1.65	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.63	ft	Tailwater Elevation	1.63	ft
Outlet Control HW Elev.	1.65	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.31	ft	Downstream Invert	-3.46	ft
Length	19.65	ft	Constructed Slope	0.007634	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.09	ft
Slope Type	N/A		Normal Depth	0.77	ft
Flow Regime	N/A		Critical Depth	0.96	ft
Velocity Downstream	1.04	ft/s	Critical Slope	0.003154	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.65	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.63	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	19.2	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
022 - CULVERT

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.91	ft	Headwater Depth/Height	0.99	
Computed Headwater Elevation	1.63	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.61	ft	Tailwater Elevation	1.61	ft
Outlet Control HW Elev.	1.63	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.82	ft	Downstream Invert	-2.06	ft
Length	30.13	ft	Constructed Slope	0.007965	ft/ft

Hydraulic Profile					
Profile	CompositePressureProfileS1		Depth, Downstream	3.67	ft
Slope Type	N/A		Normal Depth	0.76	ft
Flow Regime	Subcritical		Critical Depth	0.96	ft
Velocity Downstream	1.04	ft/s	Critical Slope	0.003154	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.63	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.61	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	19.2	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
023 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.64	ft	Headwater Depth/Height	1.00	
Computed Headwater Elevation	1.61	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.59	ft	Tailwater Elevation	1.59	ft
Outlet Control HW Elev.	1.61	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.90	ft	Downstream Invert	-1.65	ft
Length	40.93	ft	Constructed Slope	-0.006108	ft/ft

Hydraulic Profile					
Profile	A2		Depth, Downstream	3.24	ft
Slope Type	Adverse		Normal Depth	0.00	ft
Flow Regime	Subcritical		Critical Depth	0.96	ft
Velocity Downstream	1.08	ft/s	Critical Slope	0.003154	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.61	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.59	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	19.2	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
024 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.98	ft	Headwater Depth/Height	1.05	
Computed Headwater Elevation	1.59	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.58	ft	Tailwater Elevation	1.58	ft
Outlet Control HW Elev.	1.59	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.61	ft	Downstream Invert	-2.61	ft
Length	20.34	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.19	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	0.92	ft
Velocity Downstream	0.80	ft/s	Critical Slope	0.003051	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.59	ft	Upstream Velocity Head	0.01	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.58	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	25.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
025 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.96	ft	Headwater Depth/Height	1.23	
Computed Headwater Elevation	1.58	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.57	ft	Tailwater Elevation	1.57	ft
Outlet Control HW Elev.	1.58	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.32	ft	Downstream Invert	-3.25	ft
Length	30.18	ft	Constructed Slope	-0.002319	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.82	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	0.92	ft
Velocity Downstream	0.80	ft/s	Critical Slope	0.003051	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.58	ft	Upstream Velocity Head	0.01	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.57	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	25.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
026 - CULVERT

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	3.18	ft	Headwater Depth/Height	1.19	
Computed Headwater Elevation	1.57	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.56	ft	Tailwater Elevation	1.56	ft
Outlet Control HW Elev.	1.57	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.19	ft	Downstream Invert	-3.47	ft
Length	20.02	ft	Constructed Slope	0.013986	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.03	ft
Slope Type	N/A		Normal Depth	0.63	ft
Flow Regime	N/A		Critical Depth	0.92	ft
Velocity Downstream	0.80	ft/s	Critical Slope	0.003051	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.57	ft	Upstream Velocity Head	0.01	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.56	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	25.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
027 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.58	ft	Headwater Depth/Height	1.23	
Computed Headwater Elevation	1.56	ft	Discharge	20.00	cfs
Inlet Control HW Elev.	1.55	ft	Tailwater Elevation	1.55	ft
Outlet Control HW Elev.	1.56	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.34	ft	Downstream Invert	-3.41	ft
Length	50.24	ft	Constructed Slope	0.001393	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.96	ft
Slope Type	N/A		Normal Depth	1.12	ft
Flow Regime	N/A		Critical Depth	0.92	ft
Velocity Downstream	0.80	ft/s	Critical Slope	0.003051	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.56	ft	Upstream Velocity Head	0.01	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.55	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	25.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
028 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.34	ft	Headwater Depth/Height	0.83	
Computed Headwater Elevation	1.55	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	1.53	ft	Tailwater Elevation	1.53	ft
Outlet Control HW Elev.	1.55	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-1.75	ft	Downstream Invert	-2.19	ft
Length	30.68	ft	Constructed Slope	0.014342	ft/ft

Hydraulic Profile					
Profile	S1		Depth, Downstream	3.72	ft
Slope Type	Steep		Normal Depth	0.69	ft
Flow Regime	Subcritical		Critical Depth	1.01	ft
Velocity Downstream	0.99	ft/s	Critical Slope	0.003031	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.55	ft	Upstream Velocity Head	0.02	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.53	ft	Flow Control	N/A	
Inlet Type	Groove end w/headwall		Area Full	25.1	ft²
K	0.00180		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	2	
C	0.02920		Equation Form	1	
Y	0.74000				

Culvert Calculator Report
029 - CULVERT

Comments: DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.01	ft	Headwater Depth/Height	1.31	
Computed Headwater Elevation	1.53	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	1.51	ft	Tailwater Elevation	1.51	ft
Outlet Control HW Elev.	1.53	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.69	ft	Downstream Invert	-3.40	ft
Length	122.08	ft	Constructed Slope	-0.002375	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.91	ft
Slope Type	N/A		Normal Depth	0.00	ft
Flow Regime	N/A		Critical Depth	1.01	ft
Velocity Downstream	0.95	ft/s	Critical Slope	0.003031	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.53	ft	Upstream Velocity Head	0.01	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.51	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	25.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
030 - CULVERT

Comments: ASSUMED INV OUT
DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.59	ft	Headwater Depth/Height	1.12	
Computed Headwater Elevation	1.51	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	1.49	ft	Tailwater Elevation	1.49	ft
Outlet Control HW Elev.	1.51	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.96	ft	Downstream Invert	-2.97	ft
Length	29.42	ft	Constructed Slope	0.000340	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	4.46	ft
Slope Type	N/A		Normal Depth	1.80	ft
Flow Regime	N/A		Critical Depth	1.01	ft
Velocity Downstream	0.95	ft/s	Critical Slope	0.003031	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.51	ft	Upstream Velocity Head	0.01	ft
Ke	0.20		Entrance Loss	0.00	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.49	ft	Flow Control	N/A	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	25.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

Culvert Calculator Report
031 - CULVERT

Comments: ASSUMED INV OUT
DRIVEWAY OVERTOPPED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.84	ft	Headwater Depth/Height	0.99	
Computed Headwater Elevation	1.49	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	1.47	ft	Tailwater Elevation	1.47	ft
Outlet Control HW Elev.	1.49	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.45	ft	Downstream Invert	-2.45	ft
Length	27.40	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	H2		Depth, Downstream	3.92	ft
Slope Type	Horizontal		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.01	ft
Velocity Downstream	0.96	ft/s	Critical Slope	0.003031	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1.49	ft	Upstream Velocity Head	0.01	ft
Ke	0.50		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	1.47	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	25.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
032 - CULVERT

Comments: ASSUMED INV IN

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	2.15	ft	Headwater Depth/Height	1.45	
Computed Headwater Elevation	1.47	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	0.49	ft	Tailwater Elevation	0.49	ft
Outlet Control HW Elev.	1.47	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-2.89	ft	Downstream Invert	-2.89	ft
Length	145.72	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.38	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.58	ft
Velocity Downstream	3.40	ft/s	Critical Slope	0.014862	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	1.47	ft	Upstream Velocity Head	0.18	ft
Ke	0.90		Entrance Loss	0.16	ft

Inlet Control Properties					
Inlet Control HW Elev.	0.49	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
033 - CULVERT

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.74	ft	Headwater Depth/Height	1.19	
Computed Headwater Elevation	0.49	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	0.02	ft	Tailwater Elevation	0.02	ft
Outlet Control HW Elev.	0.49	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.08	ft	Downstream Invert	-3.09	ft
Length	29.63	ft	Constructed Slope	0.000337	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	3.11	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	1.58	ft
Velocity Downstream	3.40	ft/s	Critical Slope	0.014862	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	0.49	ft	Upstream Velocity Head	0.18	ft
Ke	0.90		Entrance Loss	0.16	ft

Inlet Control Properties					
Inlet Control HW Elev.	0.02	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	7.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Culvert Calculator Report
034-CULVERT

Comments: INV OUT AND LENGTH ASSUMED

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	1.51	ft	Headwater Depth/Height	0.72	
Computed Headwater Elevation	0.02	ft	Discharge	24.00	cfs
Inlet Control HW Elev.	0.00	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	0.02	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	-3.22	ft	Downstream Invert	-3.22	ft
Length	50.00	ft	Constructed Slope	0.000000	ft/ft

Hydraulic Profile					
Profile	H2		Depth, Downstream	3.22	ft
Slope Type	Horizontal		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	0.80	ft
Velocity Downstream	0.66	ft/s	Critical Slope	0.012156	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	4.50	ft
Section Size	54 inch		Rise	4.50	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	0.02	ft	Upstream Velocity Head	0.01	ft
Ke	0.90		Entrance Loss	0.01	ft

Inlet Control Properties					
Inlet Control HW Elev.	0.00	ft	Flow Control	N/A	
Inlet Type	Projecting		Area Full	47.7	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

Study Area Map

OVERALL VIEW

(NTS..)

– 25	20	3.04	2.96	overtopping driveway/freeboard elev.
– 26	20	2.96	2.89	
– 27	20	2.89	2.78	overtopping driveway/freeboard elev.
– 28	24	2.78	2.53	overtopping driveway/freeboard elev.
– 29	24	2.53	2.31	overtopping driveway/freeboard elev.
– 30	24	2.31	1.86	overtopping driveway/freeboard elev.
– 31	24	1.86	1.47	overtopping driveway/freeboard elev.
– 32	24	1.47	0.49	
– 33	24	0.49	0.02	
– 34	24	0.02	0	

PROPOSED PIPES					
Pipe #	Flow	HW Elev	TW Elev	Notes/Proposed Culvert	LENGTH (Single stick)
Pipe – 01	9.5	2.05	2.05		*ALL REPLACEMENT CULVERTS ARE HDPE (SMOOTH INT)
Pipe – 02	9.5	2.35	2.05		
Pipe – 03	9.5	2.05	2.02		
Pipe – 04	9.5	2.02	1.99		
Pipe – 05	9.5	1.99	1.96		
Pipe – 06	9.5	1.96	1.96		
Pipe – 07	9.5	1.96	1.95	Replace with (2) 36	140.00
Pipe – 08	9.5	1.95	1.94		
Pipe – 09	9.5	1.94	1.93	Replace with (2) 36	40.00
Pipe – 10	9.5	1.93	1.92	Replace with (2) 36	40.00
Pipe – 11	15.4	1.92	1.89	Replace with (2) 36	30.00
Pipe – 12	15.4	1.89	1.86	Replace with (2) 36	40.00
Pipe – 13	15.4	1.86	1.84	Replace with (2) 36	20.00
Pipe – 14	15.4	1.84	1.81	Replace with (2) 36	30.00
Pipe – 15	15.4	1.81	1.79	Replace with (2) 36	30.00
Pipe – 16	15.4	1.79	1.76	Replace with (2) 36	30.00
Pipe – 17	20	1.76	1.72	Replace with (2) 36	20.00
Pipe – 18	20	1.72	1.7	Replace with (2) 42	30.00

Pump Schematic

POWER POLE AND
SUPPLY BY OTHER

1028
DI–
RIM: 2.62

PLAN VIEW
(NTS..)

PUMP UNIT
MESH COVER
PRECAST MANHOLE
STEPS
EXISTING GRADE
FLAP GATE
OUTFLOW
AUTOMATIC FLOAT
FLOW DIRECTION