



Drainage Design Calculations

Stage 3

LOG-CR-FY27
PID 116483

Ohio Department of Transportation
District 7
Culvert Replacements
LOG-117-5.78
LOG-287-7.27
LOG-287-10.03
Logan County, Ohio

GAI Project Number: R231259.00, Task 002
January 2026



Prepared by: GAI Consultants, Inc.
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Prepared for: Ohio Department of Transportation
District 7
1001 Saint Marys Avenue
Sidney, Ohio 45365

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Section 1 – Project Drainage Narrative

The project consists of replacing three (3) culverts in Logan County, Ohio. LOG-117-5.78 is under a rural 2-lane tangent section of S.R. 117 approximately 250 feet north of the intersection with S.R. 274. LOG-287-7.27 is under a rural 2-lane tangent section of S.R. 287 approximately 1.1 miles southwest of the intersection with S.R. 559. LOG-287-10.03 is under a suburban 2-lane tangent section of S.R. 287 near the unincorporated community of Middleburg, Ohio, approximately 0.95 miles southwest of the intersection of S.R. 347.

The surrounding area consists of agricultural and commercial land uses with some nearby residential properties.

LOG-117-5.78 – GAI Consultants

Existing Drainage

This project is in level terrain. S.R. 117 runs north-south, with the existing culvert crossing nearly perpendicular to the centerline. The surrounding area consists of agricultural and commercial land uses. East of S.R. 117 is a gas station with large parking lot. The culvert inlet is below the south edge of the parking lot. The culvert receives runoff from a drainage area of 0.29 square miles. The existing culvert is a 36-inch diameter cast steel pipe about 37' long. The culvert is an unknown age and has been extended to the east and west at unknown times. It was extended to the upstream side, to the east, with a 12' long section of 36" corrugated metal pipe. This pipe is now heavily damaged. Upstream of this pipe is a private 48" corrugated plastic pipe under the gas station parking lot. There is a buildup of debris at the pipe size reduction from 48" under the parking lot to 36" under the road. The downstream end of the culvert, to the west, was extended with a 5'-3" section of 3'x3' concrete box. The culvert outlets into a hole in the field to the west. The hole is drained by a private 24" reinforced concrete pipe which goes southwest under the field.

The existing system was modeled to determine the adequacy of conveying the required flows. The design year for this culvert is the 4% AEP (25-year) storm. Check storms will be the 2% AEP (50-year) and 1% AEP (100-year) storm. ODOT CDSS program was used to model the existing culvert materials as culverts in series, using the headwater of each pipe as the tailwater of the upstream section of culvert. Four sections of the culvert were used in the model. From upstream to downstream they are: 48" CPP 162', 36" CMP 12', 36" cast iron pipe 37', and 3'x3' concrete box 5.25'. The tailwater was calculated by calculating the water elevation from an open ditch downstream and from calculating the 24" downstream storm sewer as a culvert and comparing the headwater to find the highest. The 25-year tailwater is 1063.26. The resulting headwater at the beginning of the 36" CMP, just upstream of the road is surcharging over the road at the design year storm. The headwater elevation calculated in CDSS is 1095.63, with roadway elevation of 1065.86, and ground elevation at a nearby structure at elevation 1064.23. The water will flow over the road and not reach this elevation, but it will flood. These calculations are not included in the report as they only show the extent of the flooding problem in the area.

The existing system was also modeled as a storm sewer. This includes the downstream storm sewer and the culverts under S.R. 117 and under the gas station parking lot. This treats the sump with the outlet of the culvert and the inlet of the 24" storm sewer to the southwest as a junction in the storm sewer. The result of this model is that the hydraulic grade line will surcharge even more than the culvert model. This indicates that the area will often have water flowing over ground and flooding the road and surrounding area. The results of this calculation are also not included as the information provided is not useful beyond knowing that the system does not work.

The existing culvert was again modeled using HY-8 as if it were a single 36" cast metal pipe without the pipe under the gas station parking lot included, and with no impact of downstream storm sewers. This was done to compare with proposed culverts that were modeled with these same conditions. The design year 4% AEP headwater is 1066.20. This will overtop the roadway and be above ground level adjacent to the nearby structure. At this storm event, 68.70 cfs will pass through the pipe, and 112.26 cfs will flow over the road. The 1% AEP only increases to 1066.37 due to water freely passing over the road. At that storm event, 68.60 cfs will pass through the pipe, and 209.35 cfs will overflow the road. This calculation is included in Section 2 of the report.

The 24" storm sewer through the field on the downstream side of the culvert is a cause of additional tailwater and flooding at the S.R. 117 culvert. A letter by the Logan County Engineer, Scott C. Coleman to AJR Farms LLC, dated May 20, 2013, to address flooding at Plant World, a now closed business on the east side of the road, discusses this pipe. The county performed a hydraulic analysis at that time. The result of that study was that a 60" diameter pipe or an open ditch was needed. The 24" pipe was called "completely inadequate for this watershed". They recommended an open ditch due to lack of cover for a 60" pipe. The letter offered to construct the ditch at a fee using Logan County ditch crews. Plant World closed and nothing was ever done. A copy of the letter is attached.

Proposed Drainage

Several different culverts were analyzed to replace the existing culvert. The initial calculation assumed that there were no restrictions to flow upstream and downstream. The proposed culverts needed to be nearly the same flow elevation and slope due to the flat slope of the channel. The existing culvert invert at the outfall is 0.24' over the invert of the existing downstream 24" storm sewer. The existing culvert has a slope of 0.58%. The 24" storm sewer is 393 feet long and has a slope of 0.62%. These restrictions keep the outlet invert from being lowered. The road surface will also be replaced in essentially the same elevation as the existing. This will restrict the maximum diameter or rise of the proposed culvert. The minimum distance from the pipe invert to the pavement surface was 6.42 feet. There is also a low area off the roadway with a distance from invert to final grade of 5.00 feet. The ODOT Location & Design Manual, Volume 2 (LD2) was used to determine the largest pipe size for each material type based on minimum cover requirements. A table of maximum pipe size and material for cover can be found with the calculations in Section 2. The table includes calculations to determine the maximum rise of each conduit type. The following conduits were analyzed in the initial calculations.

1. 42" Corrugated Metal Pipe x2
2. 42" Concrete Pipe x2
3. 42" Thermoplastic Pipe x2
4. 64"x43" Corrugated Pipe Arch x2
5. 43"x68" Elliptical Concrete x2
6. 6'x4' Concrete Box Culvert
7. 7'x4' Concrete Box Culvert

Conduits number 1 through 5 require double pipes and a junction structure on the upstream end to separate the flow. None of the analyzed culverts meet all of the Design Storm Controls and Check Storm Controls from LD2. A table in Section 2 lists the headwater values for each conduit analyzed, the allowable headwater for each control, and an indication of whether it passes or not. These pipes were not used in the final design, and the results table is provided for information only. Here is a summary of some of the results:

- None of the conduits analyzed meet Check Storm Control Section A, two feet below the lowest ground elevation adjacent to an occupied building for a 2% AEP storm. The required headwater level is $1064.23 - 2' = 1062.23$. Additionally, none of them are below the ground

adjacent to the building, but they improve on the existing condition by as little as 0.17' (#1) to 2.04' (#5).

- Each of the conduits analyzed meet Check Storm Control Section D, size replacement structure so that flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure.
- #1 - #3 do not meet Design Storm Control Section A or B, or Check Storm Control Section A or B.
- #4, #5, and #7 meet all of the controls except for Check Storm Control Section A as noted above.

After the initial analysis of the culvert, a meeting was held between District 7 and GAI personnel to discuss the findings and to find a solution to best meet the current area. The meeting minutes can be found in the Section 2 of the report. After additional rounds of calculations, it was decided to use a single 48" concrete pipe to replace the existing culvert. This solves the critical problem of the failing culvert under SR 117, and improves the flow under the road. The concrete pipe will provide the largest diameter due to cover restrictions. It does not completely solve the flooding issues since they would require a regional approach which is beyond the scope of the project. Increasing the size of the culvert and improving the downstream ditch could result in more flooding at the homes downstream, so a detailed analysis of the region would be needed before any changes are made.

The 48" culvert will have a Catch Basin No. 2-5 upstream to tie into the existing 48" CPP under the gas station parking lot. Downstream will be a modified Catch Basin No. 2-6 that will connect to the existing 24" through the field. Additional openings have been included in the CB 2-6 to allow an equal amount of water to leave through the 24" and openings as will enter through the 48" at the design storm flow and headwater elevation. This way the catch basin is not an additional restriction to flow after the 48" culvert. Water will back up through the catch basin and flow overland through the field, as it appears to be currently doing. Calculations of the proposed 48" concrete pipe and an estimation of the flow leaving the CB No. 2-6 are included in Section 2.

Clear Zone

The existing culvert outfall is not outside of the clear zone distance of 30 feet on the west side of the road for the design speed and average daily traffic of the road. The proposed catch basin is raised above the ground level and is a hazard that requires guardrail. The culvert cannot be extended out of the existing right of way due to a utility easement and 4" and 8" gas lines in that easement.

Rock Channel Protection at Catch Basin Outlet

The maximum velocity of water surcharging through the side inlets in the CB No. 2-6 has been estimated as 6.91 ft/s. From ODOT LD2 Figure 1002-4 this velocity and span will require 13'x8'x30" of 12" Type B Rock. Since the side inlets are only 6" high, the values from the table using a 60" pipe are an over-estimation of the required rock needed. A length of 8' from the CB No. 2-6 in the three directions of the side inlets has been provided with Type B rock at 30" deep.

Durability Design

A durability design has been done for this culvert using the ODOT Conduit Durability Design spreadsheet dated July 2021. The following pipe material will be used in the plans for cover: 706.02.

LOG-287-7.27 – GAI Consultants

Existing Drainage

This project is S.R. 287 over an unnamed tributary to Little Darby Creek. The existing road is oriented from southwest to northeast, and the stream crosses with almost no skew. The project is in rolling terrain. The surrounding area is agricultural to the right side of the road and wooded to the left, downstream side. The culvert receives runoff from a drainage area of 0.22 square miles. The existing culvert is a 60-inch diameter corrugated metal pipe about 62' long with a 0.15% slope. The culvert is an unknown age and has corrosion through much of its length.

The existing system has been modeled to determine the adequacy of conveying the required flows. The design year for this culvert is the 10% AEP (10-year) storm. Check storms will be the 2% AEP (50-year) and 1% AEP (100-year) storm. The HY-8 program was used to model the existing culvert. The tailwater was calculated by inputting the downstream channel information into HY-8. The headwater elevation calculated is 1262.80, with roadway elevation of 1266.12. The existing culvert appears to adequately convey the design year flows.

Proposed Drainage

Several different culverts were analyzed to replace the existing culvert. The existing culvert is skewed at about 3°21'51" R.F., but placing the proposed at zero skew will improve the orientation when the culvert is extended to be out of the clear zone. Since the existing 60-inch diameter pipe was acceptable, that was used as the starting point for the proposed design. The existing culvert outlet invert was about one foot above channel elevation, allowing the proposed culverts to be slightly steeper. The road surface will be replaced in essentially the same elevation as the existing. This will restrict the maximum diameter or rise of the proposed culvert, but the 60-inch conduit will fit with the required cover for all pipe materials per the ODOT LD2. The proposed culverts analyzed will have a length of 82 feet, slope of 1.04% with invert elevations of 1258.15 to 1257.30. The following conduits were analyzed:

1. 60" Corrugated metal pipe
2. 60" Diameter smooth pipe (concrete or plastic)
3. 6'x4' Concrete box

Each of the analyzed culverts meet all of the Design Storm Controls and Check Storm Controls from LD2. Calculations in Section 3 lists the required elevation for each Control and the calculated headwater values for each conduit analyzed. The 60-inch corrugated metal pipe culvert is borderline on two of the Controls due to extending the pipe length out of the clear zone. For this pipe, the existing 1% AEP overtops the roadway by 0.02', and the proposed nearly overtops the roadway with 0.03' freeboard. Also, the upstream land will flood to 1266.17 for the proposed culvert, while it floods to 1266.20 for the existing. This is considered an insignificant change, and the proposed 60-inch corrugated metal pipe is still seen as an acceptable option.

The other two culverts analyzed adequately meet all of the Controls. The box culvert appears to be oversized but was included as an extra option. It is the smallest common size box culvert in the ODOT Item Master. It is recommended that the 60-inch Conduit, Type A be used in the plans.

Clear Zone

The existing culvert ends are not outside of the clear zone distance of 29 feet for the design speed, average daily traffic of the road, and foreslopes of 6:1 to 4:1. The proposed culvert, whichever is

chosen, would require guardrail if it is not outside of the clear zone. The culvert has been extended to be out of the clear zone.

Rock Channel Protection at Culvert Outlet

The maximum velocity at the outlet of the three options analyzed is 12.58 ft/s for the smooth lined pipe. From ODOT LD2 Figure 1002-4 this velocity and pipe size will require 17'x10.5'x30" of 12" Type B Rock.

Durability Design

A durability design has been done for this culvert using the ODOT Conduit Durability Design spreadsheet dated July 2021. The following pipe sizes and materials will be used in the plans: 60" Conduit, Type A 707.02 (0.109) With CFP, 707.02 (0.064) Aluminized, 707.04 (0.064) Polymeric, 706.02, 707.34, 707.75.

LOG-287-10.03 – Halle's Engineering & Design

Existing Drainage

This project is S.R. 287 over an unnamed tributary to Little Darby Creek. The existing road is oriented from southwest to northeast, and the culvert crosses with almost no skew. The project is in level terrain and the surrounding area is residential with small farms. The culvert receives runoff from a drainage area of 17.21 acres. The existing culvert is a 50"x31" pipe arch corrugated metal pipe about 41' long with a 0.53% slope. The culvert is of an unknown age and has extensive heavy rust.

The existing system has been modeled to determine the adequacy of conveying the required flows. The design year for this culvert is the 10% AEP (10-year) storm. Check storms will be the 2% AEP (50-year) and 1% AEP (100-year) storm. The HY-8 program was used to model the existing culvert. The tailwater was calculated by inputting the downstream channel information into HY-8. The existing headwater elevation calculated is 1141.28 (10% AEP). The existing culvert appears to adequately convey the design year flows.

Proposed Drainage

Several culvert options were analyzed to replace the existing structure. The current culvert is skewed at approximately 1°9'17" L.F.; however, aligning the proposed culvert with zero skew will improve its orientation when extended out of the clear zone. The existing 50"x31" pipe arch is roughly equivalent to a 39.2" diameter pipe, so a 42-inch diameter pipe was used as the starting point for the proposed design. The road surface will be replaced at a similar elevation to the existing one, which will limit the maximum diameter or rise of the proposed culvert. Although the 42-inch diameter conduit satisfies all Design Storm Controls and Check Storm Controls per ODOT LD2, it does not meet the required cover for any pipe materials according to ODOT LD2 standards. Three additional options were analyzed:

1. 36" Reinforced Concrete Pipe (RCP)
2. 34"x53" Elliptical Concrete Pipe
3. 49"x33" Corrugated Metal Pipe Arch

Calculations in Section 4 provide the required elevations for each control and the calculated headwater values for each analyzed conduit. 36" RCP does not meet all Check Storm Controls from ODOT LD2. The upstream land will flood to an elevation of 1142.84 feet with the proposed culvert, compared to 1141.95 feet (1% AEP) with the existing structure. Additionally, the proposed headwater elevation for

the 2% AEP event is 1142.62 feet, which is higher than 2 feet below the lowest adjacent house elevation of 1142.23 feet. Furthermore, the use of a 36" culvert would reduce the hydraulic opening compared to the existing culvert.

Both of remaining options meet all Design Storm Controls and Check Storm Controls from ODOT LD2. Except the pipe arch, the upstream land will flood to an elevation of 1142.09 feet with the proposed culvert, compared to 1141.95 feet (1% AEP) with the existing structure. This is considered an insignificant change, and the proposed 49"x33" Corrugated Metal Pipe Arch is still deemed an acceptable option. Additionally, it is more economical than the 34"x53" Elliptical Concrete Pipe. The proposed culverts will have a length of 59 feet, a slope of 1.49%, and invert elevations ranging from 1139.45 feet to 1138.57 feet.

Clear Zone

The existing culvert ends are not outside of the clear zone distance of 13 feet for the design speed, average daily traffic of the road, and foreslopes of 6:1 to 4:1. The proposed culvert, whichever is chosen, would require guardrail if it is not outside of the clear zone. The culvert has been extended to be out of the clear zone.

Hydrology Calculation

Since the drainage area is less than 100 acres, the Rational Method is used to estimate the discharge. Detailed calculations, land use map, and time of concentration map are provided in Section 4

SECTION 2
LOG-117-5.78
GAI Consultants

Section 2 Contents

LOG-117-5.78

- Drainage Design Criteria
- Roadway Design Criteria
- Photos
- Hydrology Calculation (USGS StreamStats)
- Hydraulic Analysis (Results Summary, HY-8)
- RCP at outlet
- Logan County Engineer's letter on ditch downstream of culvert
- CB 2-6 Modified Top Slab Structure Analysis
- Durability Design
- Guardrail Length of Need Calculations
- ODOT District 7/GAI Consultants Meeting Minutes, November 26,2024
- Maximum pipe size and material for cover
- Preliminary Culvert Calculation Results – For Information Only
- FEMA Map
- Wetland Information (NWI Mapping)
- Location map and Aerial
- Culvert Detail Sheet

PROJECT INFORMATION:

COUNTY	ROUTE	SECTION	PID
LOGAN	117	5.78	116483

PIPE POLICY:

The Pipe Policy of ODOT will be used for this project.

(Attach a copy of the written pipe policy or furnish a link to the policy. In lieu of a written policy, documentation of locally funded construction practices may be provided)

POST CONSTRUCTION BMP POLICY:

The Post Construction BMP Policy of ODOT will be used for this project.

If a policy other than ODOT's is being used, the following BMP's are permitted:

DRAINAGE WATERSHED(S):

HUC8: Upper Great Miami 05080001

HUC12: Cherokee Mans Run 050800010301

PROJECT SPECIFIC INFORMATION AFFECTING DRAINAGE:

Project will replace a culvert and adjust roadside ditches and catch basins as needed to
accommodate the new culvert.

Drainage Design Criteria

Traffic:	2026 ADT: 8,500	From ODOT TFMS - segment Forecast Report
	2046 ADT: 8,600	
Drainage area = 0.29 sq. mi. = 185.6 ac.		

1002-1	Minimum Culvert Sizes: 15" for Fill <8'	
1004	Flood Clearance	
1004.2	Other Highways over 3000 ADT 4% AEP (25-yr)	
1006	Allowable Headwater	
	A. 1ft below near low edge of pavement (area less than 1000ac)	1064.47
	B. 2ft above inlet crown	1065.82
	C. 4ft above inlet crown in a deep ravine	N/A
1006.2.2	Check Storm Controls	
	A. 2ft below lowest ground elevation adjacent to an occupied building for a 2% AEP storm	1062.23
	B. Limit max. 1%AEP storm headwater to 2x the diameter or rise of culvert	1068.82
	C. size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with existing culvert	N/A
	D. Size replacement structure so flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure.	1116.60

1101-2	RDF Curve: B
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1102.3	Ditch Design Criteria
	>= 3000 ADT
	Depth of Flow 10% AEP
	Shear Stress 20% AEP
	Tc = 15 minutes, min.
	Depth limited to 1' below edge of pavement or overtop ditch bank in toe of slope ditches

1103	Pavement Drainage - N/A no curbed pavement
	Highways over 6000 ADT -
	Allowable Pavement Spread
	High volume (over 6000 ADT) >= mph = ft
	(plus gutter width)

Drainage Design Criteria

1104 Storm Sewers		
1104.2	Cover	
	Rigid Pipe	15" min. to pavement surface 9" min. to top of subgrade 18" min. not under pavement
	Flexible pipe	24" min. to top of pavement 12" min. to top of subgrade 24" min. not under pavement
1104.3	Just Full Capacity	10% AEP (10-yr)
	Hydraulic Grade Line (HGL)	4% AEP (25-yr)
	12" below near edge of pavement for sections without curb	
	Elev. Of a curb opening grate elevation of pavement catch basin	
	Sag HGL	2% AEP (50-yr)
	Min. size	12"
1105.5.6	Entrance coefficient	
	Concrete	ke=0.2

Max. surface to flowline: 6.42' at edge of pavement
5.00' at low point

1008.1	Corrugated and Spiral Rib Steel and Aluminum Pipes, Corrugated Steel and Aluminum Pipe Arches		
1008-1	Min. cover		
	707.01, 707.04, 707.05, 707.13 2 2/3"x1/2" Corrugations	60" dia.	12"
	707.02, 707.04, 707.07, 707.14 5"x1" Corrugations	60" dia.	12"
1008-3	707.03 Structural Plate Corrugated Steel Pipe		
		60" dia.	12"
1008-6	Corrugated Steel Spiral Rib Pipe		
	707.12 and 707.11 3/4"x7 1/2" Corrugations	60" dia.	15"
1008-7	Corrugated Aluminum Pipe		
	707.21 2 2/3"x1/2" Corrugations	60" dia.	18"
	707.22 3"x1" Corrugations	60" dia.	18"
1008-9	Structural Plate Corrugated Aluminum Pipe		
	707.23	60" dia.	15"
1008-11	Corrugated Aluminum Spiral Rib Pipe		
	707.24 2 2/3"x1/2" Corrugations	60" dia.	18"
1008.2	Rigid Pipes		

Drainage Design Criteria

1008.2.2	Min. height of cover	15" to pavement surface, including 9" min to top of subgrade
		9" min. to finished grade if not under pavement
1008.3	Thermoplastic Pipe	
1008.3.1	Min. height of cover	18" to the pavement surface, including 12" min. to top of subgrade
		18" min. to finished grade if not under pavement
1008.4	Corrugated Steel and Aluminum Box Culverts, Corrugated Steel Long Span Culverts	
1008.4.2	Min. height of cover	18" min. from trough of the corr. to pvmnt surface
1008.5	Precast Reinforced Concrete Box Culverts	
1008.5.2	Max. height of cover	10 feet
1008.6	Precast Reinforced Concrete Three-Sided Flat-Topped Culverts	
1008.6.2	Max. height of cover	5 feet
1008.7	Precast Reinforced Concrete Arch Sections	
1008.7.2	Max. height of cover	12 feet
	Min. height of cover	12" to top of the pavement surface
1008.8	Precast Reinforced Concrete Round Sections	
1008.8.2	Max. height of cover	12 feet
	Min. height of cover	12" to top of the pavement surface

1105.5.5	Culvert Manning's n	n = 0.012 all smooth flow pipe	
1105-2	Corrugated Metal Pipe Type A Conduit		
	1/2" Corrugations	5.0' Dia	n=0.0229
	1" Corrugations	5.0' Dia	n=0.0271
	2" Corrugations	5.0' Dia	n=0.0332
	2 1/2" Corrugations	5.0' Dia	n=0.035



gai consultants

Subject: LOG-CR-FY27 - LOG-117-5.78

Roadway Design Criteria

Calc. by: CMK Date: 11/16/24 Check by:

PID.: 116483

Sheet 1 of 1

Date:

Culvert LOG-117-5.78 CFN: 1847868

Design Designation		Source			Remarks
Opening Year ADT	8,500				
Design Year ADT (2046)	8,600				
Design Hourly Volume	900				
Directional Distribution, D	56.4%				
Trucks, T24	17%				
Design Speed, DS (mph)	60				
Legal Speed (mph)	55				
Functional Classification, FC	Rural Major Collector				
Curbed?	No				
NHS Project					
	Criterion	Value	Source (L&D Vol 1)	Control Parameter	Remarks
Horizontal Alignment					
	Stopping Sight Distance, SSD (ft)	570	Fig 201-1	DS	
	Passing Sight Distance, PSD (ft)	1000	Fig 201-3	DS	Requires K-Crest = 357’ min
	Intersection Sight Distance, ISD (ft) (left)		Fig 201-5	DS	No intersection present
	Intersection Sight Distance, ISD (ft) (right)		Fig 201-5	DS	No intersection present
	Decision Sight Distance, DSD, stop (ft)	610	Fig 201-6	DS	Urban Stop
	Decision Sight Distance, DSD, change (ft)	990	Fig 201-6	DS	Urban Speed/Path/Direction Change
	Max. C.L. deflection w/out Horz. Curve	0° 55'	Fig 202-1	DS	
	Dist. Between Horz. Deflections (ft)	200’	Fig 202-1	DS	Recommended minimum
	Maximum Degree of Curvature, DC	4°45'	Fig 202-2	DS	Minimum radius = 1206’; Dc = 5729.58/R
	Maximum Dc w/out Superelevation	0°32'	Fig 202-3	DS	Minimum radius = 10,743’; Dc = 5729.58/R
Maximum Dc w/out a Spiral	NA	Fig 202-11	DS		
Vertical Alignment					
	Maximum Vertical Grade	5	Fig 203-1	FC&DS	Level Terrain
	Minimum Vertical Grade	0.00%	Sec 203.2.2		For non-curbed pavement
		0.50%	Sec 203.2.2		For curbed pavement
	Maximum Vertical Grade Break	0.30%	Fig 203-2	DS	
	Min. Dist. Between VC's and Breaks (ft)	100	Fig 203-2	DS	Recommended minimum
	Minimum K value - Crest VC	151	Fig 203-3	DS	SSD = 570’
	Minimum K value - Sag VC	136	Fig 203-6	DS	SSD = 570’
	Minimum VC length (ft)	180	Sec 203.3.3 & 4	DS	Length = 3 x (DS in feet)
Typical Section					
	Number of Lanes	2		Scope	Same as existing
	Minimum Design Level of Service (LOS)	C	Fig 301-1	FC, Locale	Urban & Urbanized
	Minimum Lane Width (ft)	11	Fig 301-2	FC	Same as existing per Scope (10 ft. lanes may be used in constrained environments to help accommodate bicycle and pedestrian traffic)
	Pavement Width Transition	60:1	Sec 301.1.4	DS	L=WS²/60
	Treated Shoulder Width (ft)	4’, Varies	Fig 301-3,4	FC&ADT	Use same as existing
	Graded Shoulder Width (ft) with Barrier	11’, Varies	Fig 301-3,4	FC&ADT	Use same as existing
	" w/out Barrier, Foreslope Steeper than 6:1	10’, Varies	Fig 301-3,4	FC&ADT	Use same as existing
	" w/out Barrier, Foreslope 6:1 or Flatter	8’, Varies	Fig 301-3,4	FC&ADT	Use same as existing
	Minimum Curbed Shoulder Width (Parking)	NA	Fig 301-4		Not a curbed roadway
	Minimum Curbed Shoulder Width (No Parking)	NA	Fig 301-4		Not a curbed roadway
	Shoulder Width Taper	25:1	Sec 301.2.3.2		For decreasing shoulder width
		5:1	Sec 301.2.3.2		For increasing shoulder width
	Guardrail Offset (ft)	8’ Min	Fig 301-3	FC&ADT	8’ min. from traveled lane
	Curve Widening	N/A	Fig 301-5c	FC&DS	Depends on Dc or curve radius
	Clear Zone (ft), foreslope 6:1 or flatter	30	Fig 600-1	DS&ADT	ADT>6,000
	Clear Zone (ft), foreslope 6:1 to 4:1	30	Fig 600-1	DS&ADT	ADT>6,000
	Clear Zone (ft), backslope 6:1 or flatter	27	Fig 600-1	DS&ADT	ADT>6,000
	Clear Zone (ft), backslope 6:1 to 4:1	25	Fig 600-1	DS&ADT	ADT>6,000
Clear Zone (ft), backslope steeper than 4:1	21	Fig 600-1	DS&ADT	ADT>6,000	



LOG-117-5.78 Outlet end. Looking west.



LOG-117-5.78 Outlet end. Looking east.



LOG-117-5.78 Outlet end. Looking south.



LOG-117-5.78 Inlet end. Looking east.



LOG-117-5.78 Inlet end. Looking west.



LOG-117-5.78 Path of culvert under gas station parking lot. Looking west.



LOG-117-5.78 Catch basin at inlet. Looking west.



LOG-117-5.78 Path of 24" storm sewer downstream from outlet end. Looking southwest.



LOG-117-5.78 Catch basin at the S.R. 274 end of the 24" storm sewer. Looking north.



LOG-117-5.78 Path of storm sewer downstream of S.R. 274. Looking south.



LOG-117-5.78 48" CPP under gas station parking. Looking west, 2017 inspection.



LOG-117-5.78 36" cast iron pipe/36" CMP transition. Looking east, 2017 inspection.



LOG-117-5.78 36" CMP damage from 2017 inspection.



LOG-117-5.78 3'x3' concrete box to 36" cast iron. Looking east, from 2017 inspection.



LOG-117-5.78 36" CMP/48" CPP transition with debris and damage. Looking east from 2021 inspection.



LOG-117-5.78 Culvert materials from 2021 inspection report.



Google Earth, 5/2018 with Plant World with red roof.



Google Earth, 9/2021 with Plant World removed.

Google Street view of outlet



November 2021



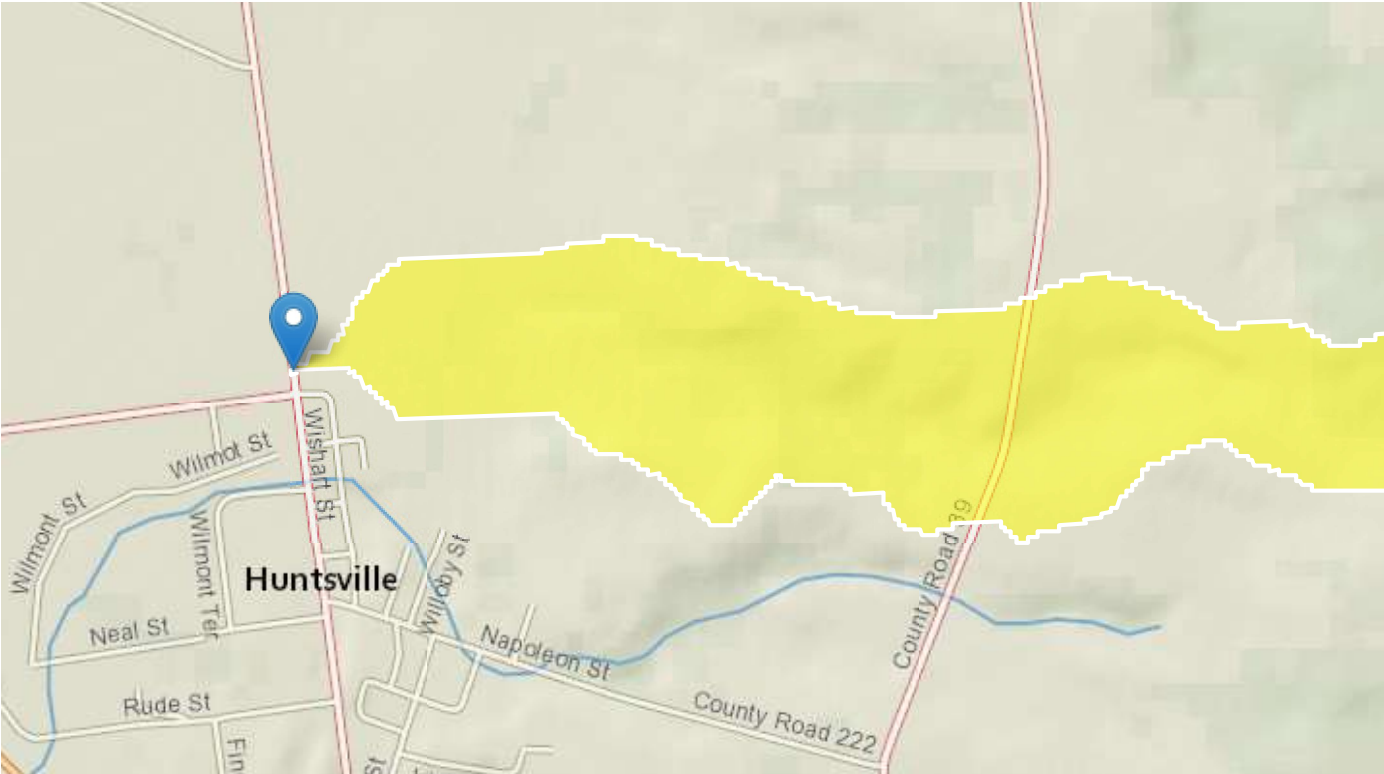
August 2014



October 2008

LOG-117-5.78 StreamStats Report

Region ID: OH
Workspace ID: OH20240709135443363000
Clicked Point (Latitude, Longitude): 40.44750, -83.80663
Time: 2024-07-09 09:55:05 -0400



 Collapse All

➤ Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CSL1085LFP	Change in elevation divided by length between points 10 and 85 percent of distance along the longest flow path to the basin divide, LFP from 2D grid	74.4	feet per mi
DRNAREA	Area that drains to a point on a stream	0.29	square miles
FOREST	Percentage of area covered by forest	12	percent
LAT_CENT	Latitude of Basin Centroid	40.4472	decimal degrees

Parameter Code	Parameter Description	Value	Unit
LC92STOR	Percentage of water bodies and wetlands determined from the NLCD	0	percent
LONG_CENT	Longitude Basin Centroid	83.7929	decimal degrees
OHREGA	Ohio Region A Indicator	1	dimensionless
OHREGC	Ohio Region C Indicator	0	dimensionless
PRECIPCENT	Mean Annual Precip at Basin Centroid	35.5	inches
STREAM_VARG	Streamflow variability index as defined in WRIR 02-4068, computed from regional grid	0.45	dimensionless

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Flow Full Model Reg A SIR2019 5018]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	0.04	5989
OHREGC	Ohio Region C Indicator 1 if in C else 0	0	dimensionless	0	1
OHREGA	Ohio Region A Indicator 1 if in A else 0	1	dimensionless	0	1
CSL1085LFP	Stream Slope 10 and 85 Longest Flow Path	74.4	feet per mi	1.53	516
LC92STOR	Percent Storage from NLCD1992	0	percent	0	25.35

Peak-Flow Statistics Flow Report [Peak Flow Full Model Reg A SIR2019 5018]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	PIL	PIU	ASEp
50-percent AEP flood	47.7	ft ³ /s	25.1	90.5	40.1
20-percent AEP flood	90.4	ft ³ /s	49.8	164	37.2
10-percent AEP flood	126	ft ³ /s	68.9	230	37.6
4-percent AEP flood	181	ft ³ /s	98.2	333	38.1

Statistic	Value	Unit	PIL	PIU	ASEp
2-percent AEP flood	227	ft ³ /s	122	423	37.8
1-percent AEP flood	278	ft ³ /s	147	524	39.6
0.2-percent AEP flood	415	ft ³ /s	218	791	40.3

Peak-Flow Statistics Citations

Koltun, G.F.,2019, Flood-frequency estimates for Ohio streamgages based on data through water year 2015 and techniques for estimating flood-frequency characteristics of rural, unregulated Ohio streams: U.S. Geological Survey Scientific Investigations Report 2019–5018, 25 p. (<https://dx.doi.org/10.3133/sir20195018>)

➤ Low-Flow Statistics

Low-Flow Statistics Parameters [Low Flow Region A 2012 5138]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.45	dimensionless	0.24	1.12

Low-Flow Statistics Disclaimers [Low Flow Region A 2012 5138]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Low-Flow Statistics Flow Report [Low Flow Region A 2012 5138]

Statistic	Value	Unit
1 Day 10 Year Low Flow	0.012	ft ³ /s
7 Day 10 Year Low Flow	0.014	ft ³ /s
30 Day 10 Year Low Flow	0.0191	ft ³ /s
90 Day 10 Year Low Flow	0.0251	ft ³ /s

Low-Flow Statistics Citations

Koltun, G.F., and Kula, S.P.,2013, Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5138, 195 p. (<http://pubs.usgs.gov/sir/2012/5138/>)

➤ Flow-Duration Statistics

Flow-Duration Statistics Parameters [Low Flow Region A 2012 5138]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.45	dimensionless	0.24	1.12

Flow-Duration Statistics Disclaimers [Low Flow Region A 2012 5138]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Flow-Duration Statistics Flow Report [Low Flow Region A 2012 5138]

Statistic	Value	Unit
80 Percent Duration	0.0433	ft ³ /s

Flow-Duration Statistics Citations

Koltun, G.F., and Kula, S.P., 2013, Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5138, 195 p. (<http://pubs.usgs.gov/sir/2012/5138/>)

➤ Annual Flow Statistics

Annual Flow Statistics Parameters [Low Flow LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	0.12	7422
LAT_CENT	Latitude of Basin Centroid	40.4472	decimal degrees	38.68	41.2
PRECIPCENT	Mean Annual Precip at Basin Centroid	35.5	inches	34	43.2

Annual Flow Statistics Flow Report [Low Flow LatLE 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	SE	ASEp
Mean Annual Flow	0.253	ft ³ /s	11.4	11.4

Annual Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p
(<https://pubs.er.usgs.gov/publication/wri024068>)

➤ Monthly Flow Statistics

Monthly Flow Statistics Parameters [Low Flow LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	0	percent	0	19
PRECIPCENT	Mean Annual Precip at Basin Centroid	35.5	inches	34	43.2
FOREST	Percent Forest	12	percent	0	99.1
LAT_CENT	Latitude of Basin Centroid	40.4472	decimal degrees	38.68	41.2
STREAM_VARG	Streamflow Variability Index from Grid	0.45	dimensionless	0.25	1.13

Monthly Flow Statistics Flow Report [Low Flow LatLE 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	SE	ASEp
January Mean Flow	0.335	ft ³ /s	16.6	16.6
February Mean Flow	0.471	ft ³ /s	11.9	11.9
March Mean Flow	0.512	ft ³ /s	14	14
April Mean Flow	0.492	ft ³ /s	11.2	11.2

Statistic	Value	Unit	SE	ASEp
May Mean Flow	0.318	ft^3/s	19.5	19.5
June Mean Flow	0.228	ft^3/s	27	27
July Mean Flow	0.15	ft^3/s	28.2	28.2
August Mean Flow	0.0858	ft^3/s	36.8	36.8
September Mean Flow	0.0506	ft^3/s	43.6	43.6
October Mean Flow	0.0643	ft^3/s	50.8	50.8
November Mean Flow	0.116	ft^3/s	37.5	37.5
December Mean Flow	0.254	ft^3/s	21.8	21.8

Monthly Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p
(<https://pubs.er.usgs.gov/publication/wri024068>)

➤ General Flow Statistics

General Flow Statistics Parameters [Low Flow LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	0	percent	0	19
STREAM_VARG	Streamflow Variability Index from Grid	0.45	dimensionless	0.25	1.13
LAT_CENT	Latitude of Basin Centroid	40.4472	decimal degrees	38.68	41.2

General Flow Statistics Flow Report [Low Flow LatLE 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	SE	ASEp
Harmonic Mean Streamflow	0.0441	ft^3/s	65.9	65.9

General Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p
(<https://pubs.er.usgs.gov/publication/wri024068>)

➤ Flow Percentile Statistics

Flow Percentile Statistics Parameters [Low Flow LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	0	percent	0	19
STREAM_VARG	Streamflow Variability Index from Grid	0.45	dimensionless	0.25	1.13
LAT_CENT	Latitude of Basin Centroid	40.4472	decimal degrees	38.68	41.2
LONG_CENT	Longitude of Basin Centroid	83.7929	decimal degrees	80.53	84.6

Flow Percentile Statistics Flow Report [Low Flow LatLE 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	SE	ASEp
25th Percentile Flow	0.09	ft ³ /s	29.2	29.2
50th Percentile Flow Median	0.147	ft ³ /s	40.3	40.3
75th Percentile Flow	0.264	ft ³ /s	47.9	47.9

Flow Percentile Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p
(<https://pubs.er.usgs.gov/publication/wri024068>)

➤ Bankfull Statistics

Bankfull Statistics Parameters [Interior Plains D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	0.19305	59927.7393

Bankfull Statistics Parameters [Central Lowland P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	0.200772	59927.66594

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Interior Plains D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	7.6	ft
Bieger_D_channel_depth	1.18	ft
Bieger_D_channel_cross_sectional_area	12	ft^2

Bankfull Statistics Flow Report [Central Lowland P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	8.87	ft
Bieger_P_channel_depth	1.5	ft
Bieger_P_channel_cross_sectional_area	11.8	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	8.01	ft
Bieger_USA_channel_depth	0.926	ft
Bieger_USA_channel_cross_sectional_area	8.76	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	7.6	ft
Bieger_D_channel_depth	1.18	ft
Bieger_D_channel_cross_sectional_area	12	ft^2
Bieger_P_channel_width	8.87	ft
Bieger_P_channel_depth	1.5	ft
Bieger_P_channel_cross_sectional_area	11.8	ft^2
Bieger_USA_channel_width	8.01	ft
Bieger_USA_channel_depth	0.926	ft
Bieger_USA_channel_cross_sectional_area	8.76	ft^2

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=

➤ Probability Statistics

Probability Statistics Parameters [P zero Flow 2012 5138]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.45	dimensionless	0.24	1.12

Probability Statistics Disclaimers [P zero Flow 2012 5138]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Probability Statistics Flow Report [P zero Flow 2012 5138]

Statistic	Value	Unit
Probability zero flow 1Day	0.0125	dim
Probability zero flow 7Day	0.00488	dim
Probability zero flow 30Day	0.000166	dim

Probability Statistics Citations

Koltun, G.F., and Kula, S.P.,2013, Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5138, 195 p. (<http://pubs.usgs.gov/sir/2012/5138/>)

➤ Maximum Probable Flood Statistics

Maximum Probable Flood Statistics Parameters [Crippen Bue Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.29	square miles	0.1	10000

Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 6]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	2400	ft ³ /s

Maximum Probable Flood Statistics Citations

Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (<https://pubs.usgs.gov/wsp/1887/report.pdf>)

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Application Version: 4.21.0

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

Pipe options			Headwater values from culvert calculations				1006.2.1 Design Storm Controls				1006.2.2 Check Storm Controls							
							Overtop Q		A		B		A		B		C	
Allowable sizes for cover	No. Culverts	Rise	HW(25)	HW(50)	HW(100)	(cfs)	Max.	OK?	Max.	OK?	Max.	OK?	Max.	OK?	Max.	OK?	Max.	OK?
48" Concrete Pipe	1	4	1066.06	1066.17	1066.26	127.38	1064.47	NG	1065.14	NG	1062.2	NG	1067.14	OK	N/A	N/A	1066.37	OK
Existing 36" Cast Roadway Alone	1	3	1066.20	1066.29	1066.37	65.98												
Q(cfs)			181	227(232.4)	278													

1006.1 Design AEP Storm

Use the design AEP storm as shown in Section 1004.2.

1006.2 Culvert Headwater Controls**1006.2.1 Design Storm Controls**

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the design storm:

- A. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.
- B. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat terrain.

A. 1065.47 - 1' = 1064.47

B. 1059.14 + Rise + 2'

1006.2.2 Check Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the applicable check storm.

- A. 2 feet below the lowest ground elevation adjacent to an occupied building for a 2% AEP storm. This is not intended to lower existing high-water elevations around buildings.
- B. Limit the maximum 1% AEP storm headwater depth to twice the diameter or rise of the culvert.
- C. Size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with the existing structure.
- D. Size a replacement structure so that flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure. Before implementing this criteria consider the type of upstream property and land use.

A. 1064.23 - 2' = 1062.23

B. 1059.14 + Rise*2

C. Ex. Structure overtops at 1% storm (1066.37)

D. Ex. Structure 1% AEP HW = 1066.37

HY-8 Culvert Analysis Report – LOG-117-5.78 – Prop. 48” Concrete

Crossing Discharge Data

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

Minimum Flow: 126.00 cfs

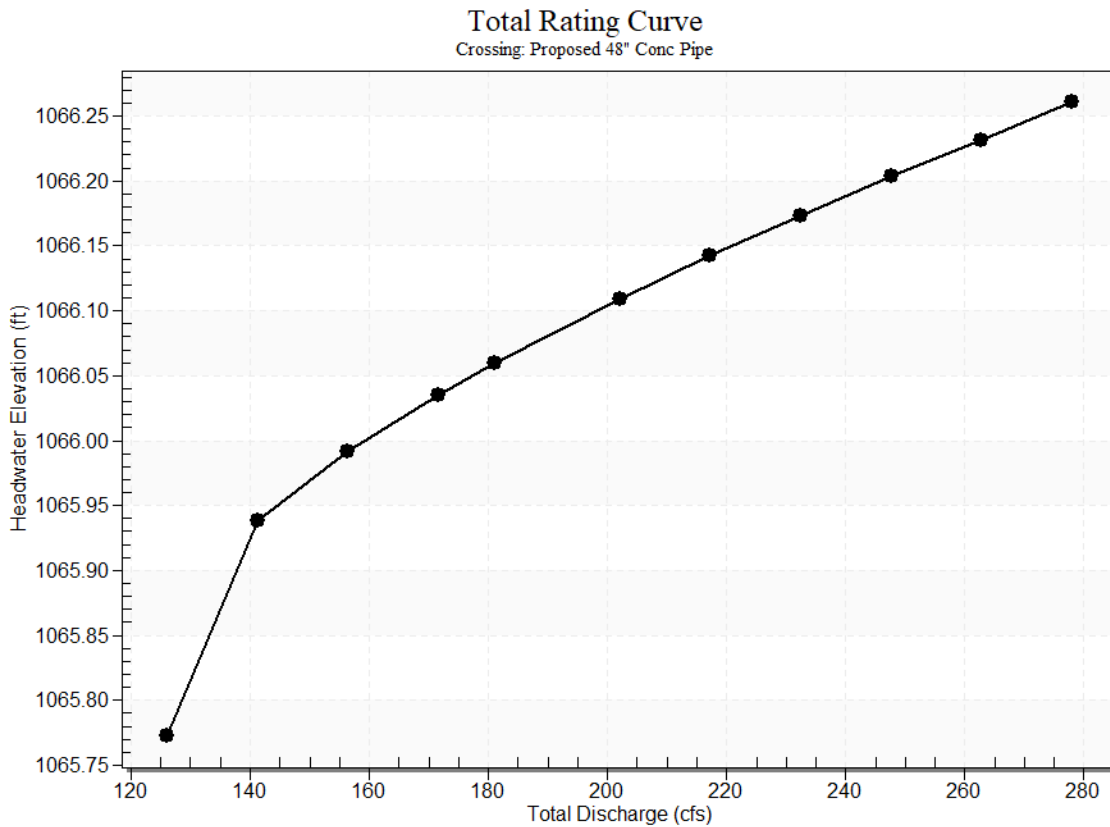
Design Flow: 181.00 cfs

Maximum Flow: 278.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Proposed 48" Conc Pipe

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1065.77	126.00	126.00	0.00	1
1065.94	141.20	128.63	12.38	11
1065.99	156.40	129.44	26.77	6
1066.04	171.60	130.12	41.41	6
1066.06	181.00	130.50	50.42	5
1066.11	202.00	131.26	70.66	5
1066.14	217.20	131.77	85.41	5
1066.17	232.40	132.24	100.08	4
1066.20	247.60	132.69	114.86	4
1066.23	262.80	133.12	129.65	4
1066.26	278.00	133.11	144.87	4
1065.86	127.38	127.38	0.00	Overtopping

Rating Curve Plot for Crossing: Proposed 48" Conc Pipe



Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
126.00 cfs	126.00 cfs	1065.77	6.63	6.227	7-M2c	3.51	3.37	3.37	3.36	11.16	4.32
141.20 cfs	128.63 cfs	1065.94	6.80	6.325	7-M2c	4.00	3.40	3.40	3.51	11.31	4.43
156.40 cfs	129.44 cfs	1065.99	6.85	6.356	3-M2t	4.00	3.41	3.43	3.66	11.28	4.54
171.60 cfs	130.12 cfs	1066.04	6.90	6.378	3-M2t	4.00	3.41	3.59	3.82	10.95	4.65

181.0 0 cfs	130.5 0 cfs	1066.0 6	6.92	6.39 5	3- M2 t	4.00	3.42	3.6 8	3.91	10.7 9	4.72
202.0 0 cfs	131.2 6 cfs	1066.1 1	6.97	6.47 6	3- M2 t	4.00	3.42	3.8 6	4.09	10.5 6	4.85
217.2 0 cfs	131.7 7 cfs	1066.1 4	7.00	6.61 5	7- M2 t	4.00	3.43	4.0 0	4.22	10.4 9	4.94
232.4 0 cfs	132.2 4 cfs	1066.1 7	7.03	6.75 9	4- FFf	4.00	3.43	4.0 0	4.34	10.5 2	5.02
247.6 0 cfs	132.6 9 cfs	1066.2 0	7.06	6.88 9	4- FFf	4.00	3.44	4.0 0	4.45	10.5 6	5.10
262.8 0 cfs	133.1 2 cfs	1066.2 3	7.09	7.01 8	4- FFf	4.00	3.44	4.0 0	4.56	10.5 9	5.18
278.0 0 cfs	133.1 1 cfs	1066.2 6	7.09	7.12 1	4- FFf	4.00	3.44	4.0 0	4.66	10.5 9	5.25

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

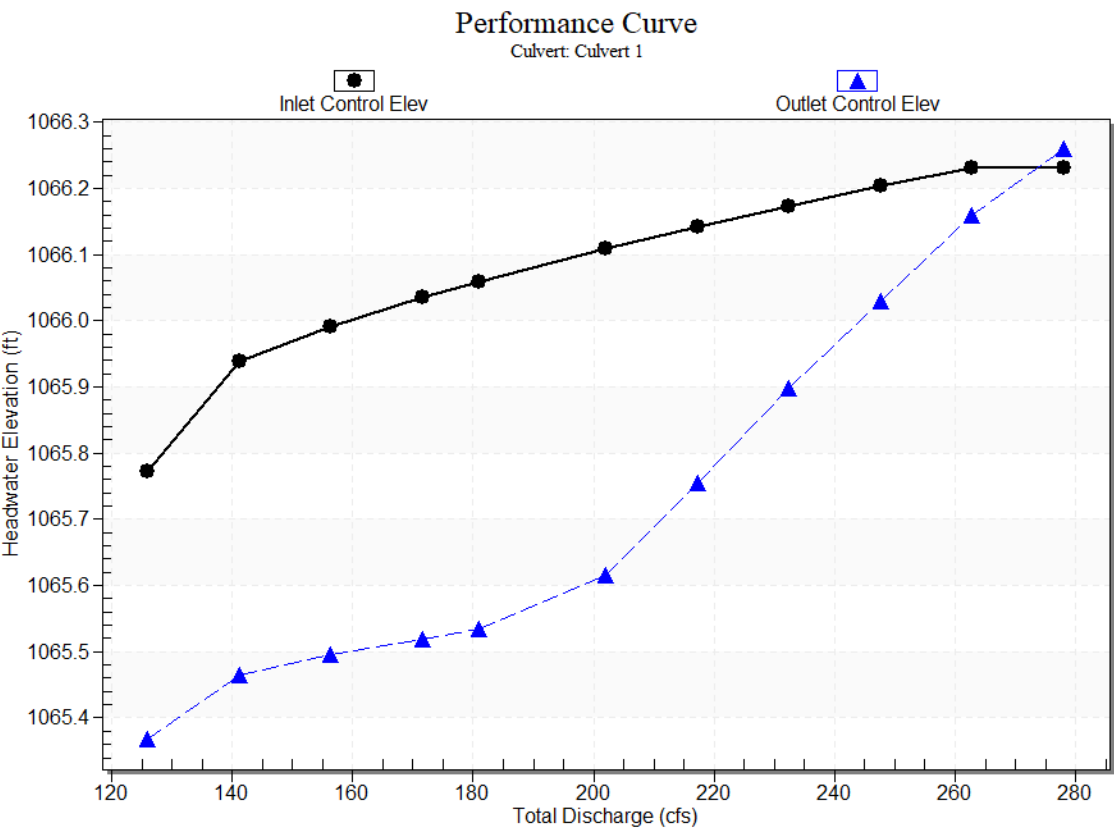
Inlet Elevation (invert): 1059.14 ft,

Outlet Elevation (invert): 1058.81 ft

Culvert Length: 56.00 ft,

Culvert Slope: 0.0059

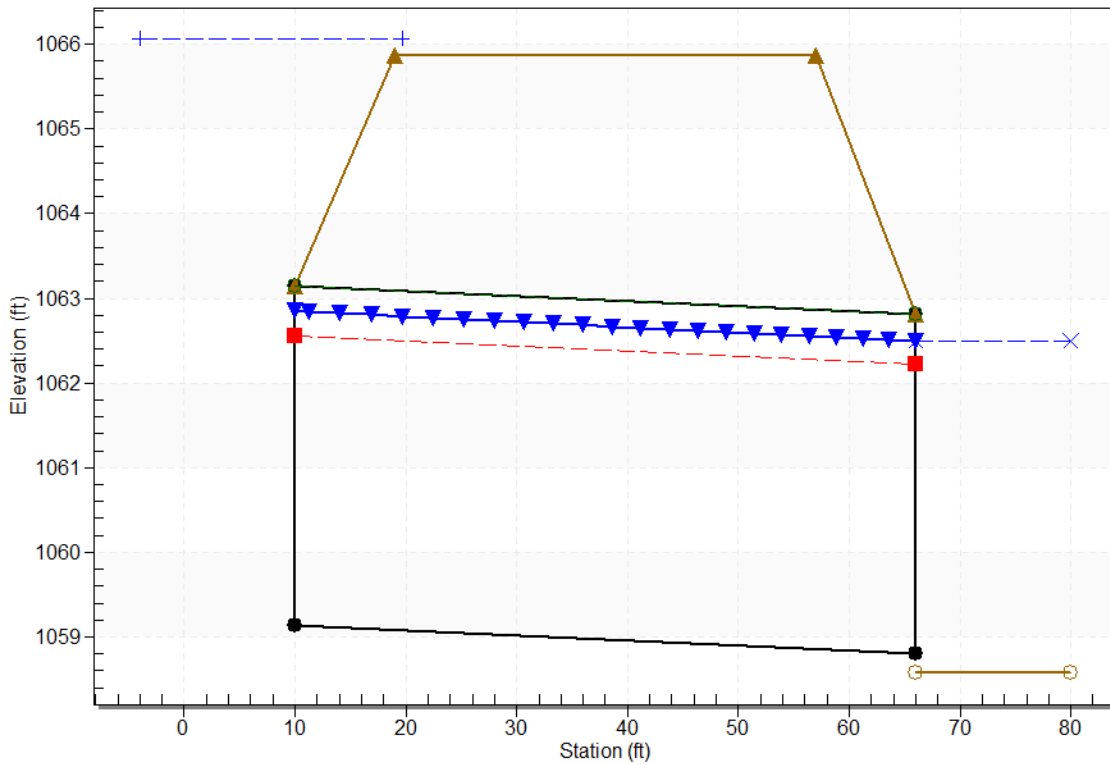
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Proposed 48" Conc Pipe, Design Discharge - 181.0 cfs

Culvert - Culvert 1, Culvert Discharge - 130.5 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 10.00 ft

Inlet Elevation: 1059.14 ft

Outlet Station: 66.00 ft

Outlet Elevation: 1058.81 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall ($K_e=0.5$)

Inlet Depression: None

Tailwater Data for Crossing: Proposed 48" Conc Pipe

Table 2 - Downstream Channel Rating Curve (Crossing: Proposed 48" Conc Pipe)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)
125.00	1061.93	1061.93	4.31
188.00	1062.56	1062.56	4.77
230.00	1062.90	1062.90	5.01
277.00	1063.24	1063.24	5.25

Tailwater Channel Data - Proposed 48" Conc Pipe

Tailwater Channel Option: Enter Rating Curve

Channel Invert Elevation: Enter Rating Curve

Roadway Data for Crossing: Proposed 48" Conc Pipe

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 1065.86 ft

Roadway Surface: Paved

Roadway Top Width: 38.00 ft

HY-8 Culvert Analysis Report – LOG-117-5.78 – Ex. 36” Cast Metal

Crossing Discharge Data

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

Minimum Flow: 126.00 cfs

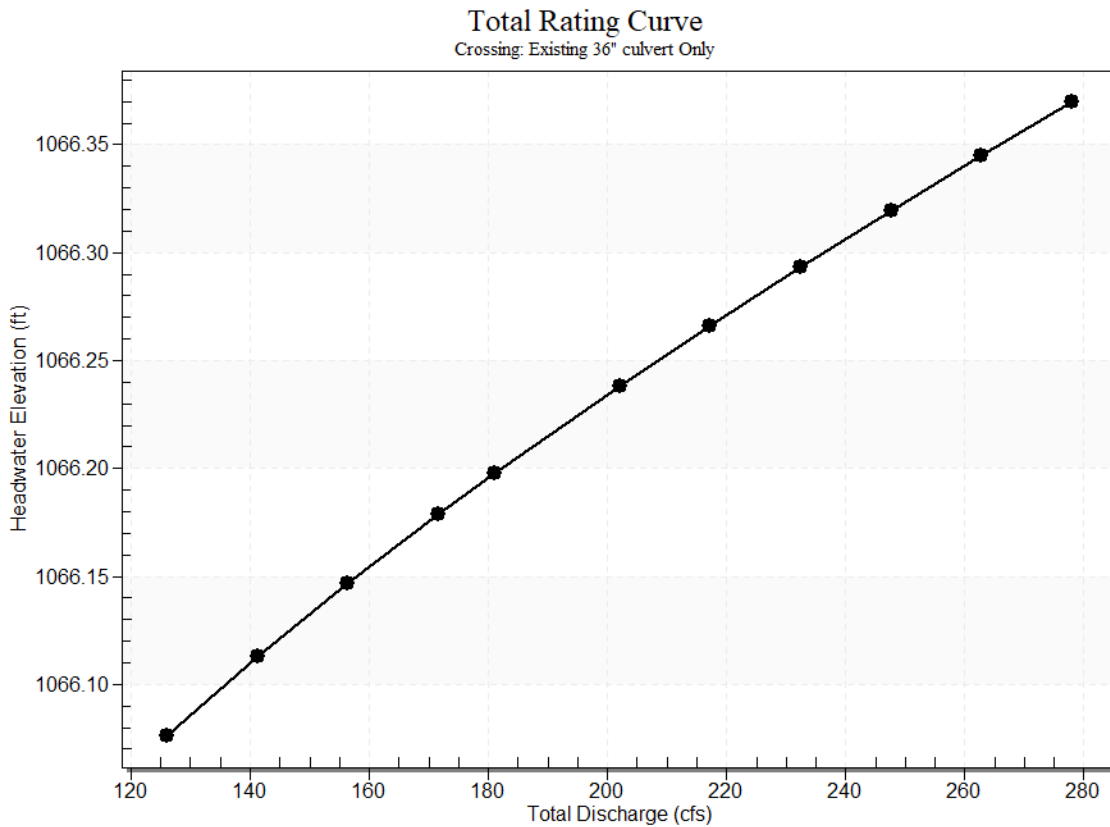
Design Flow: 181.00 cfs

Maximum Flow: 278.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Existing 36" culvert Only

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1066.08	126.00	68.81	57.10	10
1066.11	141.20	68.82	72.33	5
1066.15	156.40	68.79	87.58	5
1066.18	171.60	68.74	102.77	4
1066.20	181.00	68.70	112.26	4
1066.24	202.00	68.70	133.26	4
1066.27	217.20	68.67	148.51	4
1066.29	232.40	68.64	163.75	4
1066.32	247.60	68.63	178.96	4
1066.34	262.80	68.62	194.18	4
1066.37	278.00	68.60	209.35	3
1065.86	65.98	65.98	0.00	Overtopping

Rating Curve Plot for Crossing: Existing 36" culvert Only



Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
126.00 cfs	68.81 cfs	1066.08	5.74	6.936	4-FFf	3.00	2.64	3.00	7.85	9.73	4.31
141.20 cfs	68.82 cfs	1066.11	5.74	6.973	4-FFf	3.00	2.64	3.00	7.89	9.74	4.44
156.40 cfs	68.79 cfs	1066.15	5.74	7.007	4-FFf	3.00	2.64	3.00	7.92	9.73	4.56
171.60 cfs	68.74 cfs	1066.18	5.73	7.039	4-FFf	3.00	2.64	3.00	7.96	9.73	4.69
181.00 cfs	68.70 cfs	1066.20	5.73	7.058	4-FFf	3.00	2.64	3.00	7.98	9.72	4.77
202.00 cfs	68.70 cfs	1066.24	5.73	7.098	4-FFf	3.00	2.64	3.00	8.02	9.72	4.87

217.2 0 cfs	68.67 cfs	1066.2 7	5.72	7.12 6	4- FFf	3.00	2.64	3.0 0	8.05	9.72	4.94
232.4 0 cfs	68.64 cfs	1066.2 9	5.72	7.15 3	4- FFf	3.00	2.64	3.0 0	8.08	9.71	5.01
247.6 0 cfs	68.63 cfs	1066.3 2	5.72	7.17 9	4- FFf	3.00	2.64	3.0 0	8.11	9.71	5.09
262.8 0 cfs	68.62 cfs	1066.3 4	5.72	7.20 5	4- FFf	3.00	2.64	3.0 0	8.13	9.71	5.17
278.0 0 cfs	68.60 cfs	1066.3 7	5.72	7.23 0	4- FFf	3.00	2.64	3.0 0	8.16	9.70	5.25

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

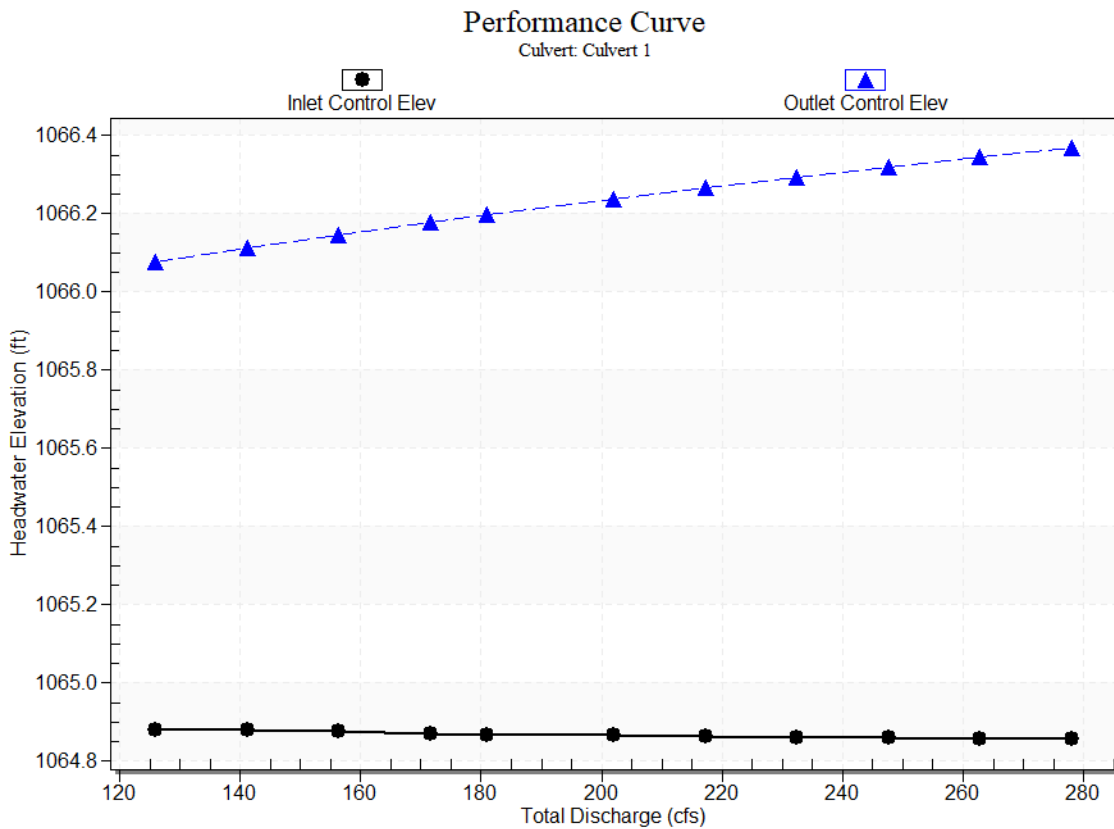
Inlet Elevation (invert): 1059.14 ft,

Outlet Elevation (invert): 1058.82 ft

Culvert Length: 54.25 ft,

Culvert Slope: 0.0059

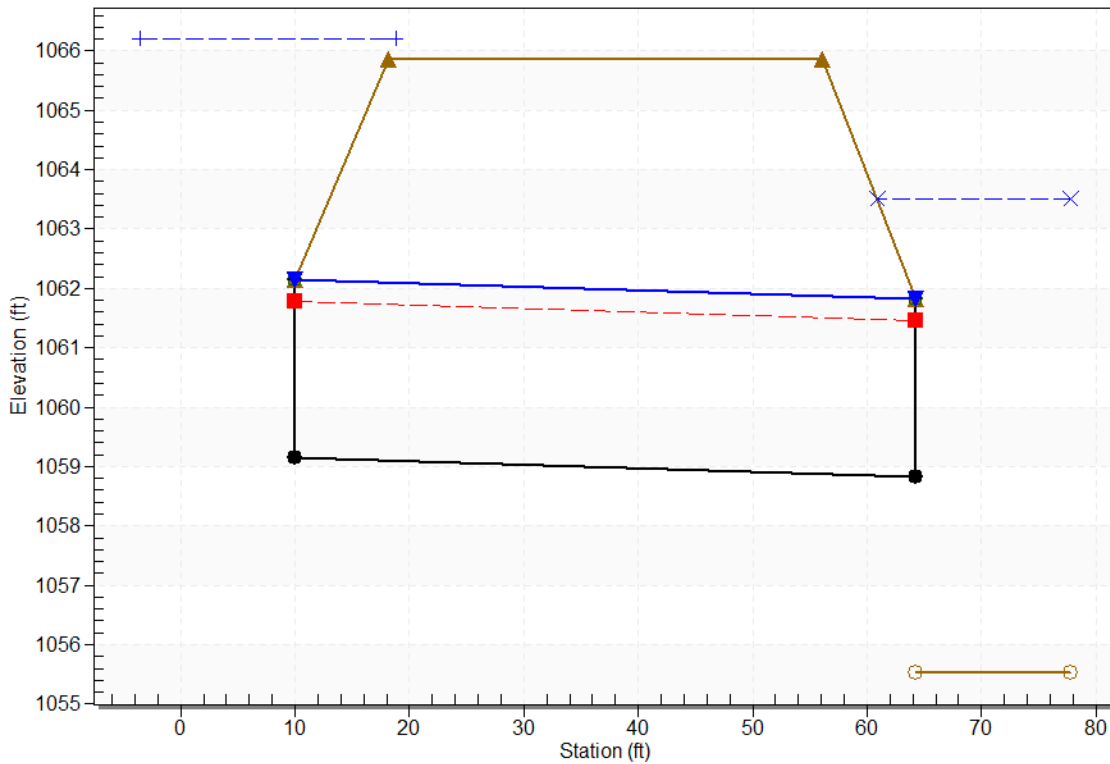
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Existing 36" culvert Only, Design Discharge - 181.0 cfs

Culvert - Culvert 1, Culvert Discharge - 68.7 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 10.00 ft

Inlet Elevation: 1059.14 ft

Outlet Station: 64.25 ft

Outlet Elevation: 1058.82 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall ($K_e=0.5$)

Inlet Depression: None

Tailwater Data for Crossing: Existing 36" culvert Only

Table 2 - Downstream Channel Rating Curve (Crossing: Existing 36" culvert Only)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)
126.00	1063.38	1063.38	4.31
181.00	1063.51	1063.51	4.77
232.40	1063.61	1063.61	5.01
278.00	1063.69	1063.69	5.25

Tailwater Channel Data - Existing 36" culvert Only

Tailwater Channel Option: Enter Rating Curve

Channel Invert Elevation: Enter Rating Curve

Roadway Data for Crossing: Existing 36" culvert Only

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 1065.86 ft

Roadway Surface: Paved

Roadway Top Width: 38.00 ft

HY-8 Culvert Analysis Report – LOG-117-5.78 – Ex. 24” pipe in field as a culvert

Crossing Discharge Data

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

Minimum Flow: 126.00 cfs

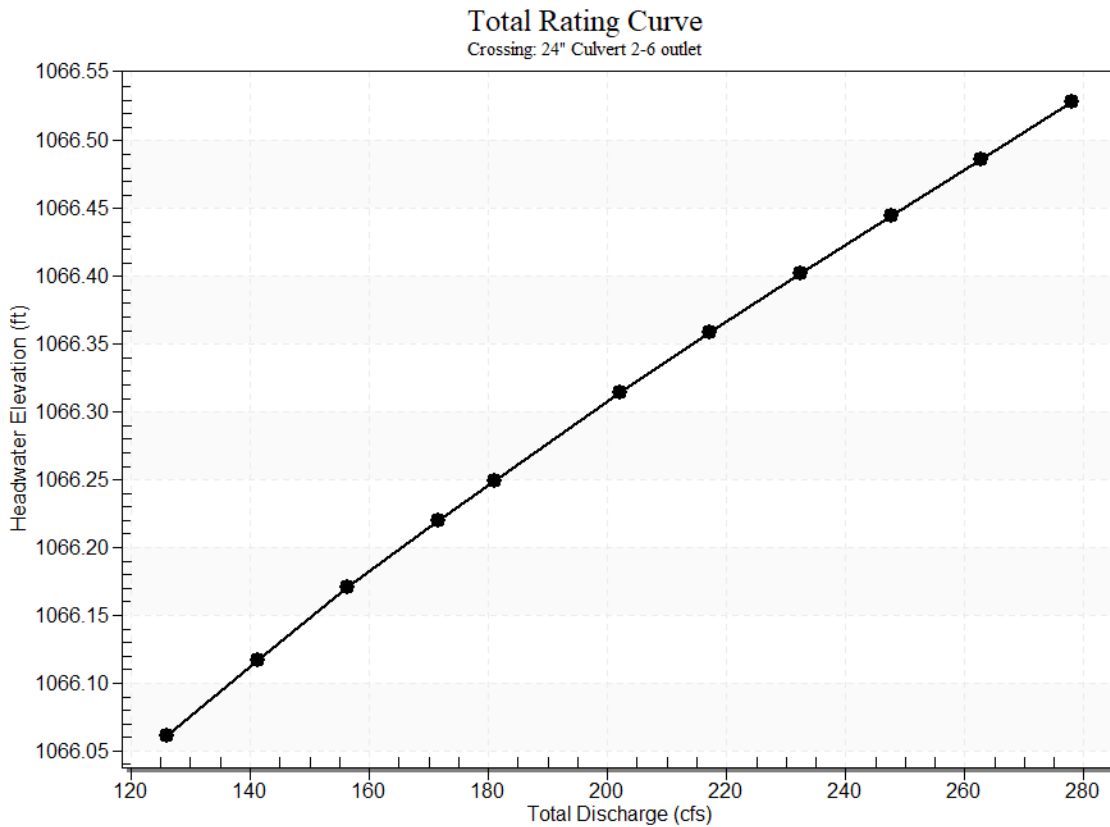
Design Flow: 181.00 cfs

Maximum Flow: 278.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: 24" Culvert 2-6 outlet

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1066.06	126.00	30.02	95.93	13
1066.12	141.20	30.12	111.06	5
1066.17	156.40	30.21	126.18	5
1066.22	171.60	30.31	141.26	4
1066.25	181.00	30.36	150.62	4
1066.31	202.00	30.48	171.51	4
1066.36	217.20	30.56	186.63	4
1066.40	232.40	30.64	201.76	4
1066.45	247.60	30.72	216.88	4
1066.49	262.80	30.79	231.99	3
1066.53	278.00	30.87	247.13	3
1065.50	28.96	28.96	0.00	Overtopping

Rating Curve Plot for Crossing: 24" Culvert 2-6 outlet



Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
126.00 cfs	30.02 cfs	1066.06	4.95	7.481	7-M2c	2.00	1.86	1.86	0.85	9.85	73.84
141.20 cfs	30.12 cfs	1066.12	4.98	7.537	7-M2c	2.00	1.86	1.86	0.93	9.88	76.06
156.40 cfs	30.21 cfs	1066.17	5.00	7.591	7-M2c	2.00	1.87	1.87	1.00	9.90	78.05
171.60 cfs	30.31 cfs	1066.22	5.02	7.640	7-M2c	2.00	1.87	1.87	1.07	9.93	79.87

181.0 0 cfs	30.36 cfs	1066.2 5	5.04	7.67 0	7- M2 c	2.00	1.87	1.8 7	1.12	9.95	80.89
202.0 0 cfs	30.48 cfs	1066.3 1	5.07	7.73 4	7- M2 c	2.00	1.87	1.8 7	1.22	9.98	83.01
217.2 0 cfs	30.56 cfs	1066.3 6	5.09	7.77 8	7- M2 c	2.00	1.87	1.8 7	1.29	10.0 0	84.40
232.4 0 cfs	30.64 cfs	1066.4 0	5.11	7.82 2	7- M2 c	2.00	1.87	1.8 7	1.36	10.0 2	85.68
247.6 0 cfs	30.72 cfs	1066.4 5	5.13	7.86 5	7- M2 c	2.00	1.87	1.8 7	1.43	10.0 5	86.87
262.8 0 cfs	30.79 cfs	1066.4 9	5.14	7.90 7	7- M2 c	2.00	1.87	1.8 7	1.49	10.0 7	87.99
278.0 0 cfs	30.87 cfs	1066.5 3	5.16	7.94 8	7- M2 c	2.00	1.88	1.8 8	1.56	10.0 9	89.02

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

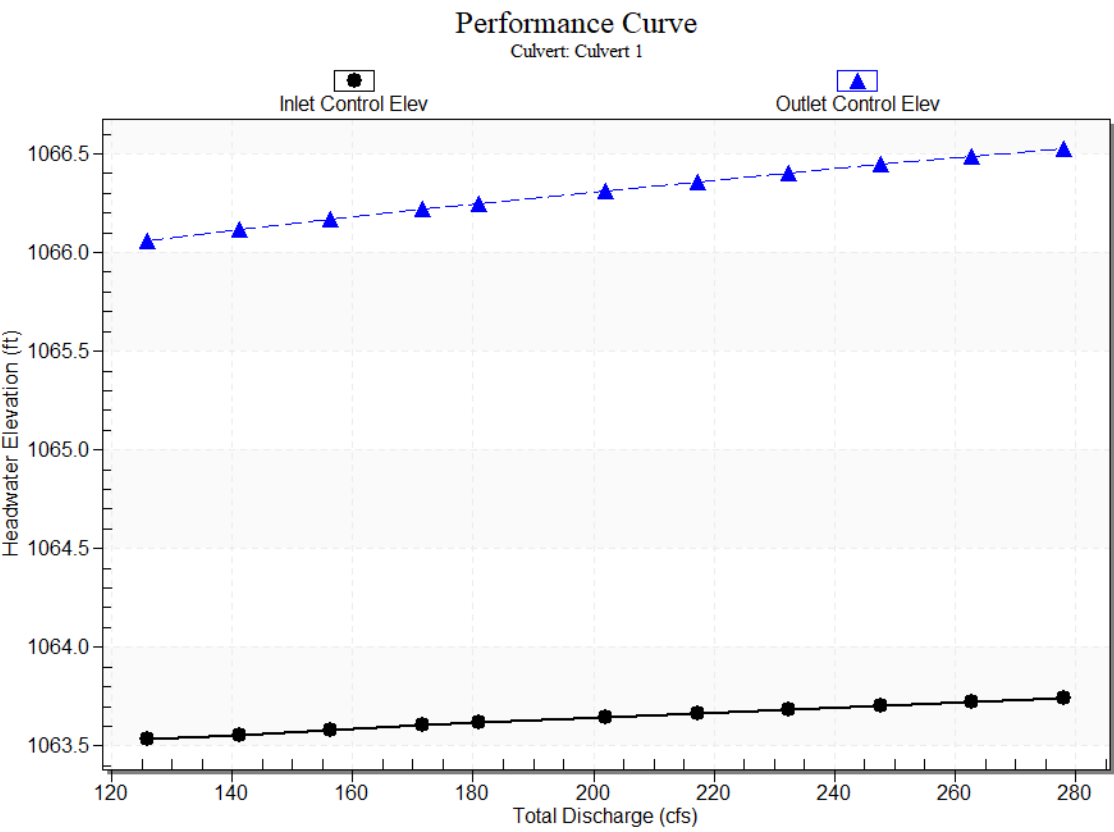
Inlet Elevation (invert): 1058.58 ft,

Outlet Elevation (invert): 1056.13 ft

Culvert Length: 393.01 ft,

Culvert Slope: 0.0062

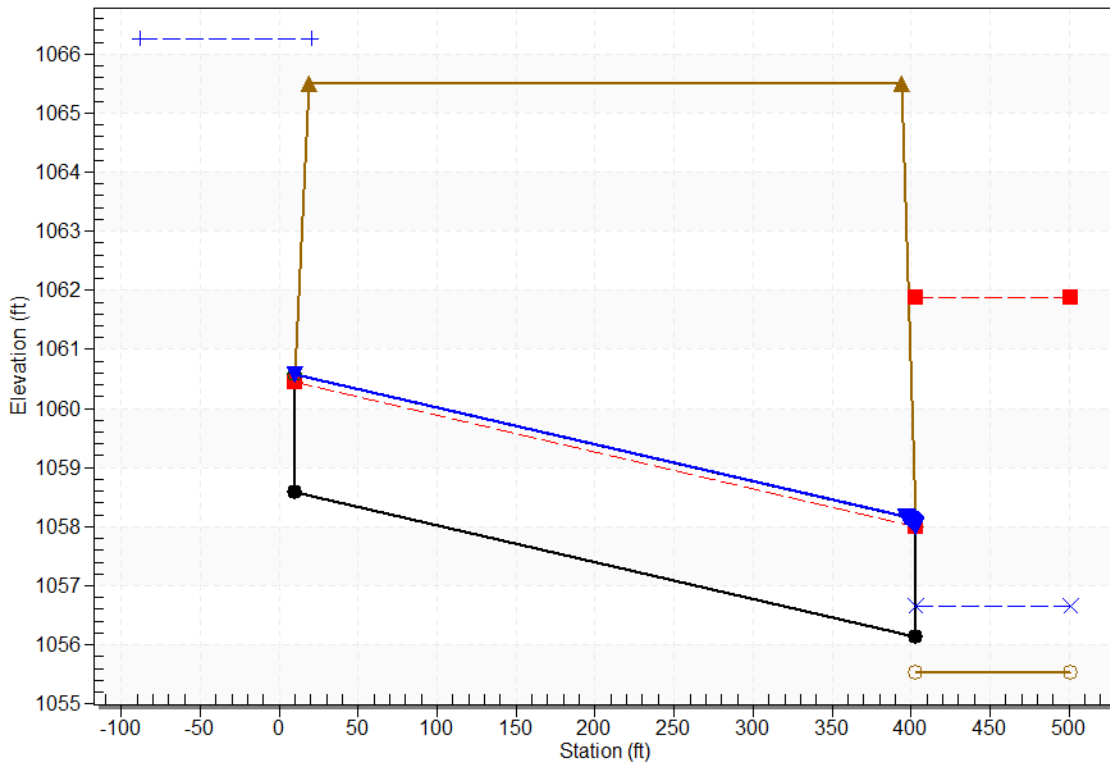
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - 24" Culvert 2-6 outlet, Design Discharge - 181.0 cfs

Culvert - Culvert 1, Culvert Discharge - 30.4 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 10.00 ft

Inlet Elevation: 1058.58 ft

Outlet Station: 403.00 ft

Outlet Elevation: 1056.13 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall ($K_e=0.5$)

Inlet Depression: None

Tailwater Data for Crossing: 24" Culvert 2-6 outlet

Table 2 - Downstream Channel Rating Curve (Crossing: 24" Culvert 2-6 outlet)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
126.00	1056.38	0.85	73.84	53.24	14.09
141.20	1056.46	0.93	76.06	57.92	13.91
156.40	1056.53	1.00	78.05	62.52	13.74
171.60	1056.60	1.07	79.87	67.04	13.58
181.00	1056.65	1.12	80.89	69.81	13.48
202.00	1056.75	1.22	83.01	75.92	13.26
217.20	1056.82	1.29	84.40	80.29	13.11
232.40	1056.89	1.36	85.68	84.62	12.97
247.60	1056.96	1.43	86.87	88.92	12.82
262.80	1057.02	1.49	87.99	93.19	12.69
278.00	1057.09	1.56	89.02	97.43	12.56

Tailwater Channel Data - 24" Culvert 2-6 outlet

Tailwater Channel Option: Rectangular Channel

Bottom Width: 2.00 ft

Channel Slope: 1.0000

Channel Manning's n: 0.0120

Channel Invert Elevation: 1055.53 ft

Roadway Data for Crossing: 24" Culvert 2-6 outlet

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 16.00 ft

Crest Elevation: 1065.50 ft

Roadway Surface: Gravel

Roadway Top Width: 375.00 ft

Check outlet capacity of modified 2-6 catch basin at design year flows

4% AEP $Q_{25} = 181 \text{ cfs}$

From HY-8 design of 48" concrete culvert:

$Q = 130.50 \text{ cfs}$ culvert discharge

$Q = 50.42 \text{ cfs}$ roadway discharge

HW = 1066.06

check that flow out of CB 2-6 is greater or equal to 130.50 cfs at 1066.06 water elevation

Flow thru 24" culvert

will be inlet or outlet control, like a culvert - analyze in HY-8

$n = 0.012$ $K_e = 0.5$ square edge $L = 393'$

Inlet Inv. 1058.58 Outlet Inv. 1056.13 $S = 0.62\%$

Crest elev. 1065.5 dummy value to find HW = 1066.06

$Q_1 = 30.02 \text{ cfs}$ thru culvert @ HW = 1066.06

Flow thru side inlets

60" x 6" @ Inv. 1063.75

HW = 1066.06

orifice equation

$$Q = C_o A \sqrt{\frac{2gh}{1 + K_L}} N_6$$

$$A = 5' \times 0.5' = 2.5 \text{ ft}^2$$

$$C_o = 0.60$$

$$g = 32.2 \text{ ft/s}^2$$

$$h = 1066.06 - 1063.75 - 0.25 = 2.06'$$

$$K_L = 1 = 1.5 + [(29n2L)/(R1.33)]$$

$$N_6 = 3 \text{ barrels}$$

$$\underline{Q_2 = 51.83 \text{ cfs}}$$

Flow thru top Grates - as orifice

$$A = 2' \times 2' = 4 \text{ ft}^2$$

$$h = 1066.06 - 1064.75 + 0.5 = 1.81' \quad \text{at surface plate at orifice opening}$$

$$N_6 = 2$$

$$\underline{Q_3 = 51.82 \text{ cfs}}$$

$$\text{Total Flow} = \Sigma Q = 30.02 \text{ cfs} + 51.83 + 51.82 = \underline{133.67 \text{ cfs}} > 130.50 \text{ ok}$$

Velocities out of CB 2-6side inlets $Q = 51.83 \text{ cfs}$ 4% AEP

$$A = 2.5 \text{ ft}^2 \times 3 = 7.5 \text{ ft}^2$$

$$V = Q/A = 6.91 \text{ ft/s}$$

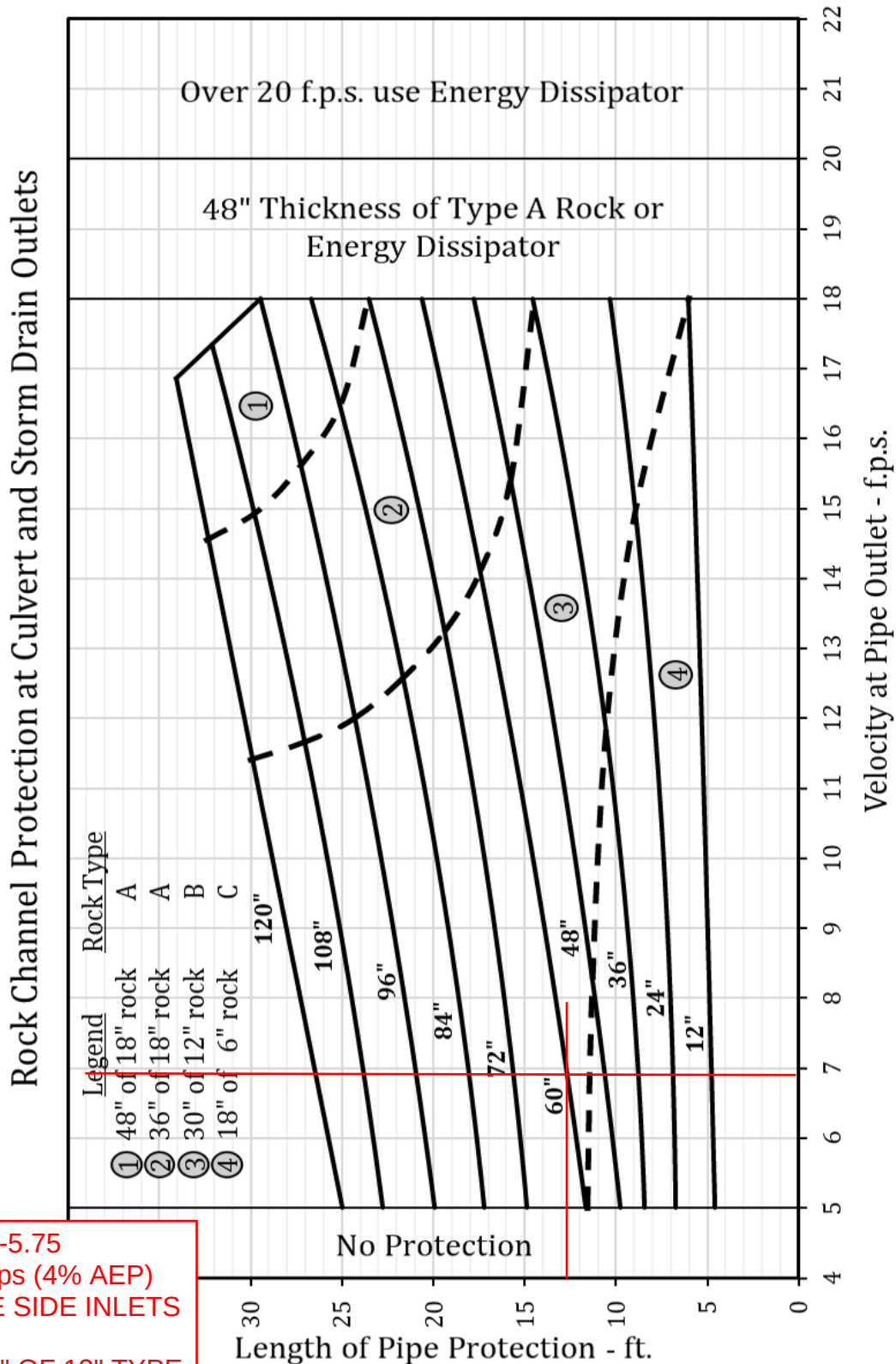
L+D Figure 1002-4 $D = 60''$ wide side inlets $\rightarrow 13' \text{ long} \times 8' \text{ wide} \times 30'' \text{ deep } 12'' \text{ rock, TYPE B}$

19.26 CY RCP, TYPE B w/ Filter

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS

1002-4

REFERENCE SECTION
1002.2.3



LOG-117-5.75
V = 6.91fps (4% AEP)
60" WIDE SIDE INLETS
13'x8'x30" OF 12" TYPE
B ROCK

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS	1002-4
	REFERENCE SECTION 1002.2.3

Notes:

Rock size (6", 12", 18") indicates the square opening on which 85% of the material by weight is retained.

Provide rock channel protection the width of the headwall with a minimum of 4'.

No rock channel protection is required where the natural stream bed will withstand the calculated velocity without erosion.

Equations for length of protection:

Rise	Length
120"	$L = 0.764996 * V + 21.17502$
108"	$L = 0.0203 * V^2 + 0.3004 * V + 20.765$
96"	$L = 0.0184 * V^2 + 0.3121 * V + 17.892$
84"	$L = 0.0261 * V^2 + 0.1234 * V + 15.970$
72"	$L = 0.0251 * V^2 + 0.0897 * V + 13.798$
60"	$L = 0.0139 * V^2 + 0.3683 * V + 9.4671$
48"	$L = 0.0151 * V^2 + 0.2661 * V + 8.0899$
36"	$L = 0.0262 * V^2 + 0.1341 * V + 8.4794$
24"	$L = 0.0182 * V^2 + 0.1404 * V + 6.983$
12"	$L = 0.0014 * V^2 + 0.0816 * V + 4.1255$

V=Velocity (f.p.s.)

L=Length of minimum Rock Channel Protection (ft.)

OFFICE OF THE
LOGAN COUNTY ENGINEER
P.O. BOX 427
1991 COUNTY ROAD 13
BELLEFONTAINE, OH 43311
www.co.logan.oh.us

FILE COPY

SCOTT C. COLEMAN, P.E., P.S.
LOGAN COUNTY ENGINEER

TELEPHONE: (937) 592-2791
FAX: (937) 599-2658

May 20, 2013

AJR Farms LLC
9264 Hickory Lane
Huntsville, OH 43324

RE: Plant World and AJR Farms Drainage

Dear Mr. Reed,

As per our previous conversations, the Logan County Engineer's Office has completed a hydraulic analysis of the drainage across the AJR Farms property at the northwest corner of SR 274 and SR 117. The system begins with a 48" diameter pipe at the east end of the Beard Oil Company property. This enters a 38" wide by 36" tall box structure under SR 117. The waterway across the AJR Farms property was filled with a 24" diameter concrete pipe at some time. This enters a 36" diameter concrete pipe under SR 274 and a 36" diameter plastic pipe going south through the residential subdivision and to the creek.

The drainage area east of the tile system is 198 acres. The ten year frequency storm flow for this area is calculated at 183 cubic feet per second (cfs). The existing 24" pipe across the AJR Farms property can only carry about 16 cfs, which is completely inadequate for this watershed. The two year frequency storm generates about 78 cfs. Our calculations indicate that the system should be upgraded to a 60" diameter pipe or open ditch in order to carry the ten year frequency storm event.

Our recommendation is that the 24" pipe across the AJR Farms property should be removed and replaced with an open waterway because it is the most restrictive section of the tiled system. The open waterway makes sense because there is not enough depth to cover an adequately sized pipe. The open waterway has been designed with a 2 feet bottom width and 3:1 (3 horizontal units to 1 vertical unit) sloped bank. The top width of the open ditch would be 26 feet. The banks should be easily mowable at this slope. Another advantage of the open ditch is that it provides some temporary storage volume for large storm events.

We have estimated the cost for Logan County ditch crews to perform this construction. We have two options. Option one is to excavate the described open ditch and hauling away only the excavated 24" pipe, spreading the excavated material on site, seeding and mulching. Option one is estimated at \$16,583. Option two is to excavate the described open ditch, haul all material away, seed and mulch. Option two is estimated at \$21,811.

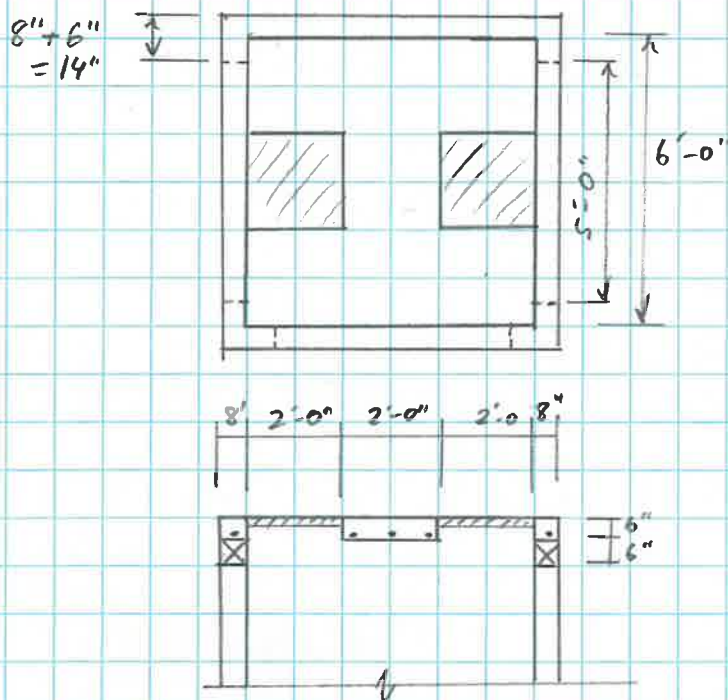
Please let us know how you wish to proceed by June 20, 2013. If you have any questions, please contact me at 937-592-2791.

Sincerely,



Scott C. Coleman, P.E., P.S.
Logan County Engineer

Cc: Cindy Meese; Ohio Department of Transportation

CB 2-6 modified top slabLoads - From ASCE 7-16

Dead Load Concrete slab $150 \text{ pcf} (8''/12) = 100 \text{ psf}$

Live Load 75 psf pedestrians, mowers

Snow Load $p_g = 20 \text{ psf}$
 $S = 20 \text{ psf}$

Factored Combined Loads

- 1) $1.4D = 140 \text{ psf}$
- 2) $1.2D + 1.6L + 0.5S = 250 \text{ psf} \leftarrow \text{max.}$
- 3) $1.2D + 1.6S + L = 227 \text{ psf}$

Deck between grates

$$w = 250 \text{ psf} (6') = 1500 \text{ plf}$$

$$l = 6'$$

$$b = 24" \quad h = 6" \quad d = 4"$$

Simple Span:

$$R = V_u = w l / 2 = 4500 \text{ lb}$$

$$M_u = w l^2 / 8 = 6750 \text{ lb}\cdot\text{ft}$$

Shear

$$\phi = 0.75$$

$$\phi V_c = \phi 2 \sqrt{f_c'} d b$$

$$= 9107 \text{ lb} > V_u \text{ ok}$$

$$f_c' = 4000 \text{ psi}$$

Flexure

$$A_s = \frac{M_u l^2}{\phi F_y (d - a/2)}$$

$$= 0.39 \text{ in}^2$$

$$\text{check } a = \frac{A_s F_y}{0.85 f_c' b} = 0.29" \checkmark$$

$$F_y = 60,000 \text{ psi}$$

$$\phi = 0.90$$

$$\text{assume } a = 0.29"$$

$$0.39 \text{ in}^2 \div 3 \text{ bars} = 0.13 \text{ in}^2 \quad \# 4 \text{ bars } 0.20 \text{ in}^2 \text{ ok}$$

Temp. and shrinkage steel

$$A_b = 0.0018 h b = 0.26 \text{ in}^2$$

$$3 \# 4 \text{ bars } A_s = 0.60 \text{ in}^2 > 0.26 \text{ ok}$$

Span over side inlet

$$b = 14" \quad h = 6" \quad d = 4"$$

$$l = 6.5'$$

$$w = 250 \text{ psf} (6 + 8" \times 2) / 2 = 917 \text{ plf}$$

$$R = V_u = 2980 \text{ lb}$$

$$M_u = 4843 \text{ lb}\cdot\text{ft}$$

Shear

$$\phi V_c = 5313 \text{ lb} > V_u \text{ ok}$$

Flexure

$$A_s = 0.28 \text{ in}^2 \quad a = 0.35"$$

$$2 \# 4 \text{ bars } A_s = 0.40 \text{ in}^2 \text{ ok}$$

Temp. and shrinkage steel

$$A_b = 0.0018 h b = 0.15 \text{ in}^2 < 0.40 \text{ in}^2 \text{ ok}$$

County	Logan	Route	117	Section	5.78	PID	116483	Shape	Circular
Station	10+00	Station	10+00					Span x Rise	48

User Input	
pH _a	Abrasion Level
7.9	2.0

Constants and Calculated Values			
pH _s	Sediment/Rise	End of Service Life GA	Service Life Required
7.6	0	4	75

Metal Conduit Durability Results																							
Material		707.01, 707.02, or 707.03 Metallic coated (galvanized)	707.01 or 707.02 or 707.03 Metallic coated (galvanized) with Concrete Field Paving	707.01 or 707.02 Metallic coated (Aluminized)	***707.01 or 707.02 Metallic coated (aluminized) with Concrete Field Paving	707.04 Polymeric Coated over galvanized steel	**707.04 Polymeric Coated with Concrete Field Paving	707.05 or 707.07 (707.01 or 707.02 galvanized) 1/2 Bituminous coated with Bituminous paved invert	***707.05 or 707.07 (707.01 or 707.02 aluminized) 1/2 Bituminous coated with Bituminous paved invert	**707.11 Polymer Precoated spiral rib steel	**707.12 or 707.17 Aluminum coated spiral rib steel	707.13 or 707.14 (707.01 or 707.02 galvanized) Bituminous lined galvanized steel	707.13 or 707.14 (707.01 or 707.02 aluminized) Bituminous lined aluminized steel	707.15 Galvanized steel box	**707.18 Polymer Precoated, Galvanized Steel Conduits with precoated galvanized smooth steel interior liner	**707.19 Aluminum coated Steel Conduits with precoated galvanized smooth steel interior liner	**707.20 Galvanized Coated Steel Conduits with precoated galvanized smooth steel interior liner	**748.06 Steel Casing Pipe non-galvanized	707.21 or 707.22 Aluminum	707.23 Aluminum Structural Plate	707.24 Aluminum Spiral Rib	707.25 Aluminum Box	707.21, 707.22, or 707.23 Aluminum Alloy or Aluminum Alloy Structural Plate with Concrete Invert Paving
Conduit Use and Shape		Culvert or Liner Pipe - Round or Pipe Arch	Culvert-Round, Pipe Arch, and Arch	Culvert or Liner Pipe -Round or Pipe Arch	Culvert -Round or Pipe Arch	Culvert or Liner Pipe - Round or Pipe Arch	Culvert-Round or Pipe Arch	Culvert -Round or Pipe Arch	Culvert -Round or Pipe Arch	Storm Sewer or Liner Pipe -Round	Liner Pipe -Round or Pipe Arch	Storm Sewer - Round or Pipe Arch	Storm Sewer -Round or Pipe Arch	Culvert -Box	Liner Pipe -Round	Liner Pipe -Round	Liner Pipe - Round	Culvert or Liner Pipe- Round, Pipe Arch, or Box	Culvert or Liner Pipe- Round or Pipe Arch	Culvert or Liner Pipe - Round, Pipe Arch, and Arch	Storm Sewer or Liner Pipe -Round	Culvert -Box	Culvert - Round or Pipe Arch
min gauge or thickness	Corr. Depth (inches)																						
	1/4 or 1/2	16	16	16	16	16	16	16	16	N/A	N/A	16	16	N/A	16	16	16	0.5	12	N/A	N/A	N/A	12
	1	16	16	16	16	16	16	16	16	N/A	N/A	16	16	N/A	N/A	N/A	N/A		16	N/A	N/A	N/A	16
	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A
3/4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	
max gauge or thickness	1/4 or 1/2	8	8	10	10	10	10	8	10	N/A	N/A	8	10	N/A	12	12	12	0.5	8	N/A	10	N/A	8
	1	8	8	10	10	10	10	8	10	N/A	N/A	8	10	N/A	N/A	N/A	N/A		10	N/A	N/A	N/A	10
	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A
	3/4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A
Gauge	Thickness (Inches)																						
16	0.064																						
14	0.079																						
12	0.109																						
10	0.138																						
8	0.168																						
7	0.188																						
5	0.218																						
3	0.249																						
1	0.28																						
Casing	0.5																						

Concrete Conduit Durability Results						
Material	**706.01 Non-reinforced Concrete Pipe	**706.02 Reinforced Concrete Circular Pipe	**706.03 Reinforced Concrete Pipe, Epoxy Coated	**706.04 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe	**706.05 Precast Reinforced Concrete Box Sections	706.08 Clay Drain Tile
Conduit Use and Shape	Culvert or Storm Sewer - Round	Culvert or Storm Sewer -Round	Culvert or Storm Sewer - Round or Elliptical	Culvert or Storm Sewer -Elliptical	Culvert or Storm Sewer - Box	Culvert or Storm Sewer - Round

Plastic Conduit Durability Results													
Material	707.33 Corrugated Polyethylene Smooth Lined Pipe	707.34 Polyethylene Plastic Pipe Based on Outside Diameter (OD)	707.35 Polyethylene Profile Wall Pipe	707.42 Polyvinyl Chloride Corrugated Smooth Interior Pipe	707.43 Polyvinyl Chloride Profile Wall Pipe	707.45 Polyvinyl Chloride Solid Wall Pipe	707.46 Polyvinyl Chloride Drain Waste and Vent Pipe	707.47 ABS and Polyvinyl Chloride Composite Pipe	707.48 Polyvinyl Chloride Large-Diameter Solid Wall Pipe	707.65 Corrugated Polypropylene Smooth Lined Pipe	707.75 Glass-Fiber-Reinforced Polymer Mortar Pipe	707.85 Steel Reinforced Thermoplastic Ribbed Pipe	748.02 Polyvinyl Chloride (PVC) Pipe, Joints, and Fittings
Conduit Use and Shape	Culvert, Storm Sewer, or Liner Pipe - Round	Culvert, Storm Sewer, or Liner Pipe - Round	Culvert, Storm Sewer, or Liner Pipe - Round	Storm Sewer or Liner Pipe - Round	Storm Sewer or Liner Pipe - Round	Storm Sewer - Round	Storm Sewer - Round	Storm Sewer - Round	Storm Sewer - Round	Culvert or Storm Sewer - Round	Culvert, Storm Sewer, or Liner Pipe - Round	Culvert or Liner Pipe - Round	Storm Sewer - Round

Notes:

Many metal options are eliminated when abrasion level equals 4 or greater

Aluminum is only available between pH levels ranging from 5.0 to less than 9.0

Aluminized protective coating is 0 years when pH levels are outside of allowable for Aluminum

Polymeric coated is only available for pH ranges greater than 5.0 and less than 9.0

Options were eliminated when the NCSPA online Service Life Calculator did not recommend option; typically due to abrasive conditions or pH limitations

Epoxy is required on all concrete surfaces when pH<5

** Smooth lined conduit

***Minimum gauges set per industry comments; see Reference Data

Provide concrete field paving on corrugated metal conduits 60" or larger where the invert is always submerged due to tail water conditions from a body of water

Constants	
Protective Coating Constants-Initial Service Life (years)	
Concrete Invert Paving=	20
Aluminized=	35
Aluminized Spiral Rib=	35
Polymeric=	50
Bituminous coated w/ bitum. paved invert=	10
Bituminous lined =	25
Galvanized=	0

48" TYPE A CONDUIT, 706.02

LOG-117-5.78 Guardrail for catch Basin

2-lane Rural major Collector ADT=8,600

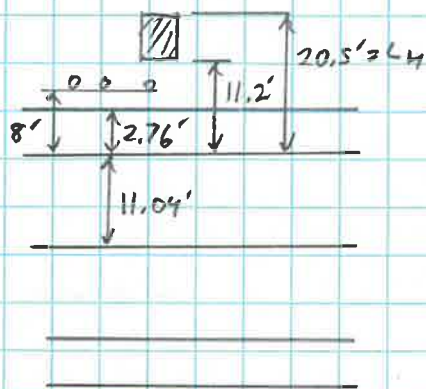
4:1 Foreslope

Design Speed = 60 mph

Graded Shoulder with barrier 11'

Guardrail Offset 8' min

Distance to object 11.2' (from adjacent traveled lane) Available clear zone
Back of object 20.5' (")



Barrier clearance $11.2' - 8' = 3.2'$
min. for type MGS guardrail
is 5.0 ft

Figure 603-2 - need MGS
guardrail with quarter post
spacing for 3' min.

$L_R = 250'$

7:1 MGS guardrail - use no flare for grading restraints

$L_H < L_C$

$20.5' < 30'$

$$X = \frac{L_H + (b/a)L_1 - L_2}{(b/a) + L_H/L_R}$$

$$= \frac{20.5' - 8'}{20.5'/250'} = 152.4'$$

$b/a = 0$

Opposing traffic

$L_C = 30'$

$11.2 + 11.04 = 22.24'$ inside clear zone

$L_H = 20.5 + 11.04 = 31.54'$

$L_H > L_C$

$L_2 = 8 + 11.04 = 19.04'$

$$X_{\text{opposing}} = \frac{L_C - L_2}{L_C/L_R} = \frac{30 - 19.04}{30/250} = 91.3'$$

Length of guardrail required

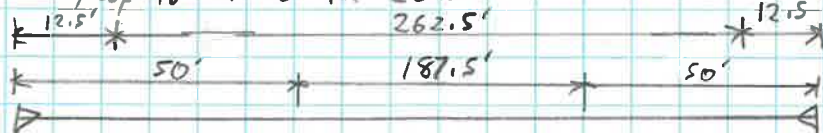
$$152.4' + 6.35' + 91.3' = 250.1'$$

$$250.1 / 12.5 = 20.01 \text{ panels} \rightarrow 21 \text{ panels}$$

$$262.5' \text{ LON}$$

Type E Anchors on both sides of run

50' up to 37'-6" in LON



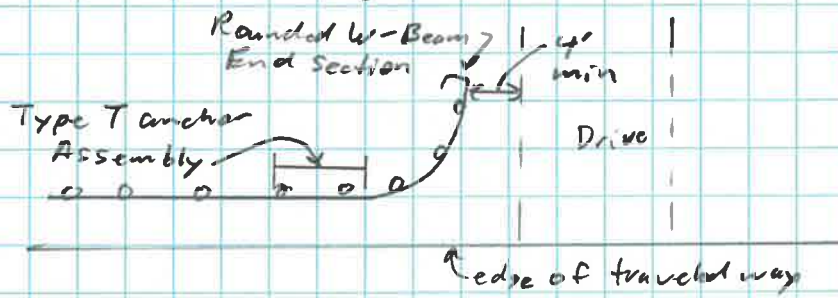
287.5' total

8' min offset

19.25' LT of G

Guardrail At Drive

603-3



Attendees:**ODOT – Amy Havenar, Tony Bensman, Robin Sebring, Dan Grilliot, Ben Ankrom****GAI Consultants – Art Rometo, Craig Klein**

MEETING MINUTES

SR 117 Culvert

- Current calculations are calling for a 4'X7' box. This would require Geotech work.
- Culvert is bound by constraints on both sides.
 - Existing 48" plastic pipe running underneath the asphalt driveway on the east side.
 - Existing 24" running underneath the grass field on the west side to the catch basin along SR 274.
- Property on the east side of SR 117 floods. The County Engineer proposed to construct either an open ditch or enclose a 60" pipe on the west side of SR 117 back in 2013 to help alleviate the flooding to the property on the east side, however, the property that flooded went out of business and the building has since been torn down.
- The team decided that the culvert should not be any larger than either a 36" or a 48" so as not to flood out the downstream properties.
 - Robin and Craig are going to have a call next week to run some calcs to determine the best size pipe to install.
- There was discussions about installing a junction chamber on the west side to connect our proposed pipe with the existing 24" pipe. This would allow for the water to come up out of the chamber and flood the area on the west side of SR 117.
 - There is a triangle-shaped property on the west side of SR 117 that is not being used as anything now most likely due to the constant flooding.
- There are a lot of utilities on the west side of the road. There was discussion about there being a large gas main on the west side of the road, however, this was not showing up on the survey. GAI will reach back out to the gas company to confirm the locations. DP&L has major electric lines on the west side of the road in an easement. There is also a sanitary sewer force main on the west side of SR 117.
- Try to achieve clear zone grading. Will need to acquire R/W regardless, so let's not install guardrail.
- It was decided that the scope of the project is to replace the structurally deficient culvert under SR 117 to improve the flooding, but any sized pipe would be unable to



completely fix it because it is a regional issue and would require multiple properties and additional study to determine if downstream properties would be flooded by the improvements.

Maximum pipe size and material for cover

Culvert inlet to pavement surface	6.42 ft.	Min. at E/P
Culvert inlet to final grade	5.00 ft.	Min. at low point
Pavement depth	1.58 ft.	(19" proposed pavement)

POSSIBLE PIPE MATERIALS AND SIZES**1008.1 Corrugated Metal**

	12 in	Min Cover
6.42'-1'-1.58'-.08' wall =	45.08 in	Min Cover
1008-1 Round pipe		
2-2/3" X1/2" Corr.	42" With 12" cover	
5"x1" Corr.	42" With 12" cover	
1008-2 Pipe Arches		
2-2/3" X1/2" Corr.	64"x43" with 12" cover	
5"x1" Corr.	53"x41" with 15" cover	
1008-3 707.03 Structural plate corr. Steel		
60" min	N.G.	
1008-4 707.03 Structural plate corr. Steel pipe arches		
4'7" min rise	N.G.	
1008-5 707.03 Structural plate corr. Steel pipe arches		
9'4" min rise	N.G.	
1008-6 Corrugated Steel Spiral Rib Pipe		
3/4" x 7 1/2" Corr.	42" with 15" cover	
1008-7 Corrugated Aluminum Pipe		
707.21 (2 2/3"x1/2" corrugations)	42" With 12" cover	
707.22 (3"x1" corrugations)	42" With 12" cover	
1008-8 Corrugated Aluminum Pipe Arches		
707.21 (2 2/3"x1/2" corrugations)	64"x43" with 12" cover	
707.22 (3"x1" corrugations)	53"x41" with 15" cover	
1008-9 707.23 Structural plate corrugated aluminum pipe		
60" min	N.G.	
1008-10 707.23 structural plate corrugated aluminum pipe arches		
5'8" min rise	N.G.	
1008-11 Corrugated Aluminum spiral rib pipe		
707.24 (2 2/3"x1/2" Corr.)	42" with 15" cover	

1008.2 Rigid Pipes

15" min. to Pavement surface		
	6.42-15"	62.04 in.
9" min. to top of subgrade		
	6.42-1.58-9"	49.08 in.
9" to final grade		
	5.00'-9" =	51 in.

Maximum pipe size and material for cover

1008-12 Reinforced concrete circular pipe

Max. size $42" + 4.5" \text{ wall} = 46.5" < 49.08"$ OK

1008-13 Elliptical pipe

$43 \times 68, 6" \text{ wall} = 43" + 6" = 49" < 49.08"$ OK

1008.3 Thermoplastic Pipe

18" min. to Pavement surface

6.42-18" 59.04 in.

12" min. to top of subgrade

6.42-1.58-12" 46.08 in.

18" to final grade

5.00'-18" = 42 in.

Max Size: 42" + wall should be acceptable for most length

1008.4 Corrugated steel and aluminum box culverts

18" trough of corr. To pavement surface

Rib of stiffeners within subgrade

$6.42' - 18" = 59"$

$5.00' - 18" = 42"$

1008.5 Concrete Box Culverts

No minimum fill

$6.42' - 6" \text{ asphalt min.} - 1' \text{ wall} = 59.04" \text{ max rise}$

For low spot in profile, need 4'xspan

TRIED THESE CULVERTS:

42" Corrugated Metal Pipe

42" Concrete Pipe

42" Thermoplastic Pipe (Same calculation as concrete)

64x43 Corrugated Pipe Arch

43x68 Elliptical Concrete

4x6 Concrete Box Culvert

4x7 Concrete Box Culvert

Existing 36" Cast Roadway Alone

PRELIMINARY Culvert Calculation Results and Comparison - **NOT USED FOR FINAL DESIGN, INCLUDED FOR INFORMATION ONLY**

Pipe options			Headwater values from culvert calculations			1006.2.1 Design Storm Controls				1006.2.2 Check Storm Controls								PRICE PER FOOT OF CONDUIT	LENGTH OF CONDUIT	CONDUIT COST
						A		B		A		B		C		D				
Allowable sizes for cover	No. Culverts	Rise	HW(25)	HW(50)	HW(100)	Max.	OK?	Max.	OK?	Max.	OK?	Max.	OK?	Max.	OK?	Max.	OK?	\$/FT.	FT.	\$
42" Corrugated Metal Pipe	2	3.5	1065.95	1066.12	1066.22	1064.47	NG	1064.64	NG	1062.23	NG	1066.14	NG	N/A	N/A	1066.37	OK	\$ 610.00	110	\$ 67,100.00
42" Concrete Pipe	2	3.5	1064.96	1066.00	1066.13	1064.47	NG	1064.64	NG	1062.23	NG	1066.14	NG	N/A	N/A	1066.37	OK	\$ 610.00	110	\$ 67,100.00
42" Thermoplastic Pipe	2	3.5	1064.96	1066.00	1066.13	1064.47	NG	1064.64	NG	1062.23	NG	1066.14	NG	N/A	N/A	1066.37	OK	\$ 610.00	110	\$ 67,100.00
64x43 Corrugated Pipe Arch	2	3.58	1064.03	1065.45	1066.02	1064.47	OK	1064.72	OK	1062.23	NG	1066.31	OK	N/A	N/A	1066.37	OK	\$ 1,120.00	110	\$ 123,200.00
43x68 Elliptical Concrete	2	3.58	1063.30	1064.25	1065.15	1064.47	OK	1064.72	OK	1062.23	NG	1066.31	OK	N/A	N/A	1066.37	OK	\$ 975.00	110	\$ 107,250.00
4x6 Concrete Box Culvert	1	4	1064.52	1065.90	1066.04	1064.47	NG	1065.14	OK	1062.23	NG	1067.14	OK	N/A	N/A	1066.37	OK	\$ 1,230.00	55	\$ 67,650.00
4x7 Concrete Box Culvert	1	4	1063.87	1065.02	1065.93	1064.47	OK	1065.14	OK	1062.23	NG	1067.14	OK	N/A	N/A	1066.37	OK	\$ 1,495.00	55	\$ 82,225.00
Existing 36" Cast Roadway Alone	1	3	1066.20	1066.29	1066.37															
Q(cfs)			181	227(232.4)	278															
																		Double pipe culverts will need additional		

Double pipe culverts will need additional cost of large junction chamber

1006.1 Design AEP Storm

Use the design AEP storm as shown in Section 1004.2.

1006.2 Culvert Headwater Controls**1006.2.1 Design Storm Controls**

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the design storm:

- A. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.
- B. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat terrain.

A. 1065.47 - 1' = 1064.47

B. 1059.14 + Rise + 2'

1006.2.2 Check Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the applicable check storm.

- A. 2 feet below the lowest ground elevation adjacent to an occupied building for a 2% AEP storm. This is not intended to lower existing high-water elevations around buildings.
- B. Limit the maximum 1% AEP storm headwater depth to twice the diameter or rise of the culvert.
- C. Size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with the existing structure.
- D. Size a replacement structure so that flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure. Before implementing this criteria consider the type of upstream property and land use.

A. 1064.23 - 2' = 1062.23

B. 1059.14 + Rise*2

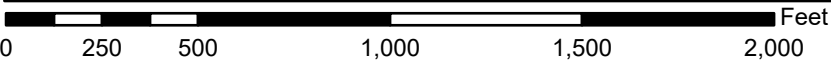
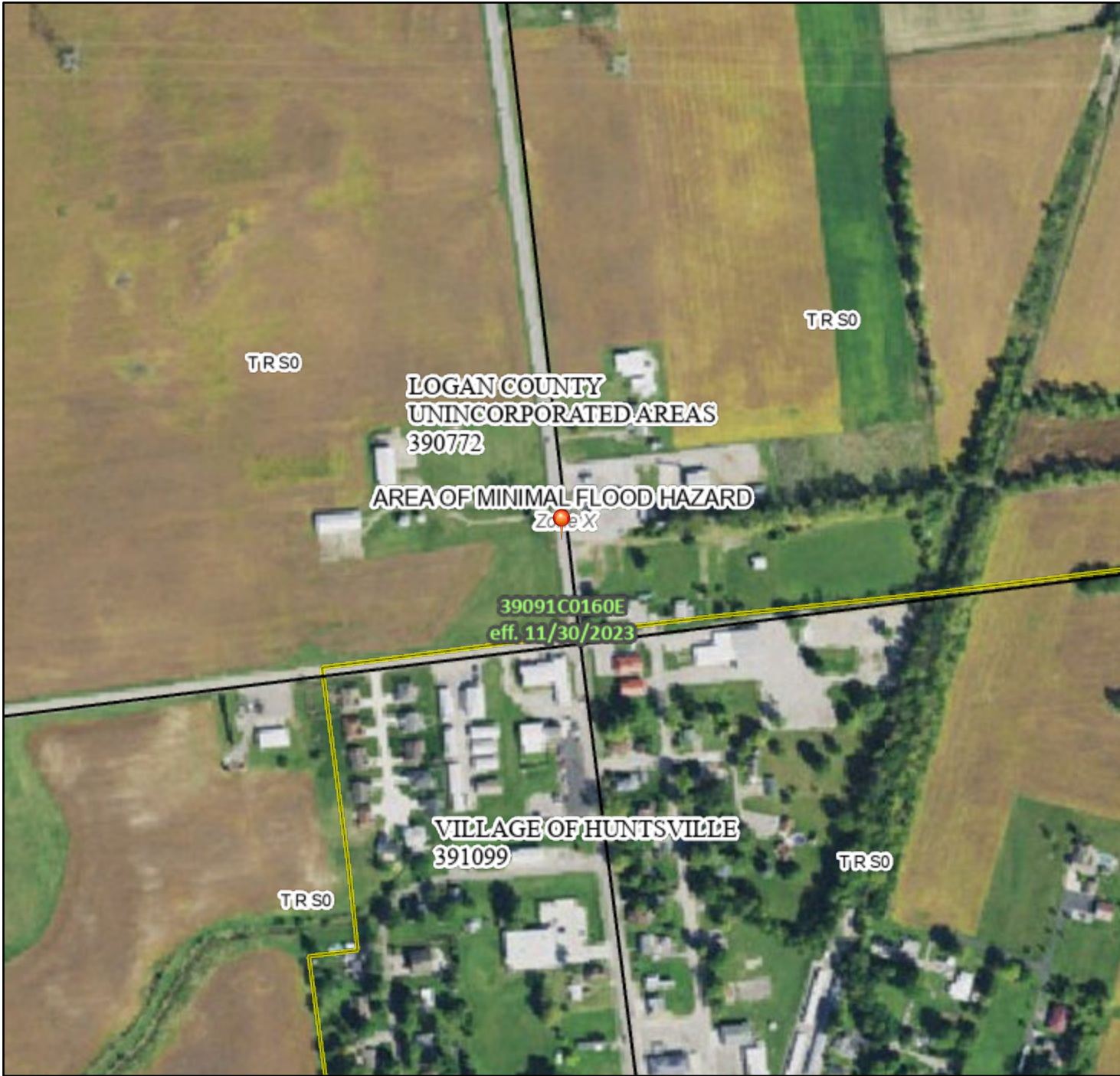
C. Ex. Structure overtops at 1% storm (1066.37)

D. Ex. Structure 1% AEP HW = 1066.37

National Flood Hazard Layer FIRMette



83°48'43"W 40°27'6"N



1:6,000

83°48'5"W 40°26'39"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **10/28/2024 at 5:51 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



U.S. Fish and Wildlife Service

National Wetlands Inventory

LOG-117-5.78



U.S. Fish and Wildlife Service, National Standards and Support Team,
wetlands_team@fws.gov

October 28, 2024

Wetlands

	Estuarine and Marine Deepwater		Freshwater Emergent Wetland		Lake
	Estuarine and Marine Wetland		Freshwater Forested/Shrub Wetland		Other
			Freshwater Pond		Riverine

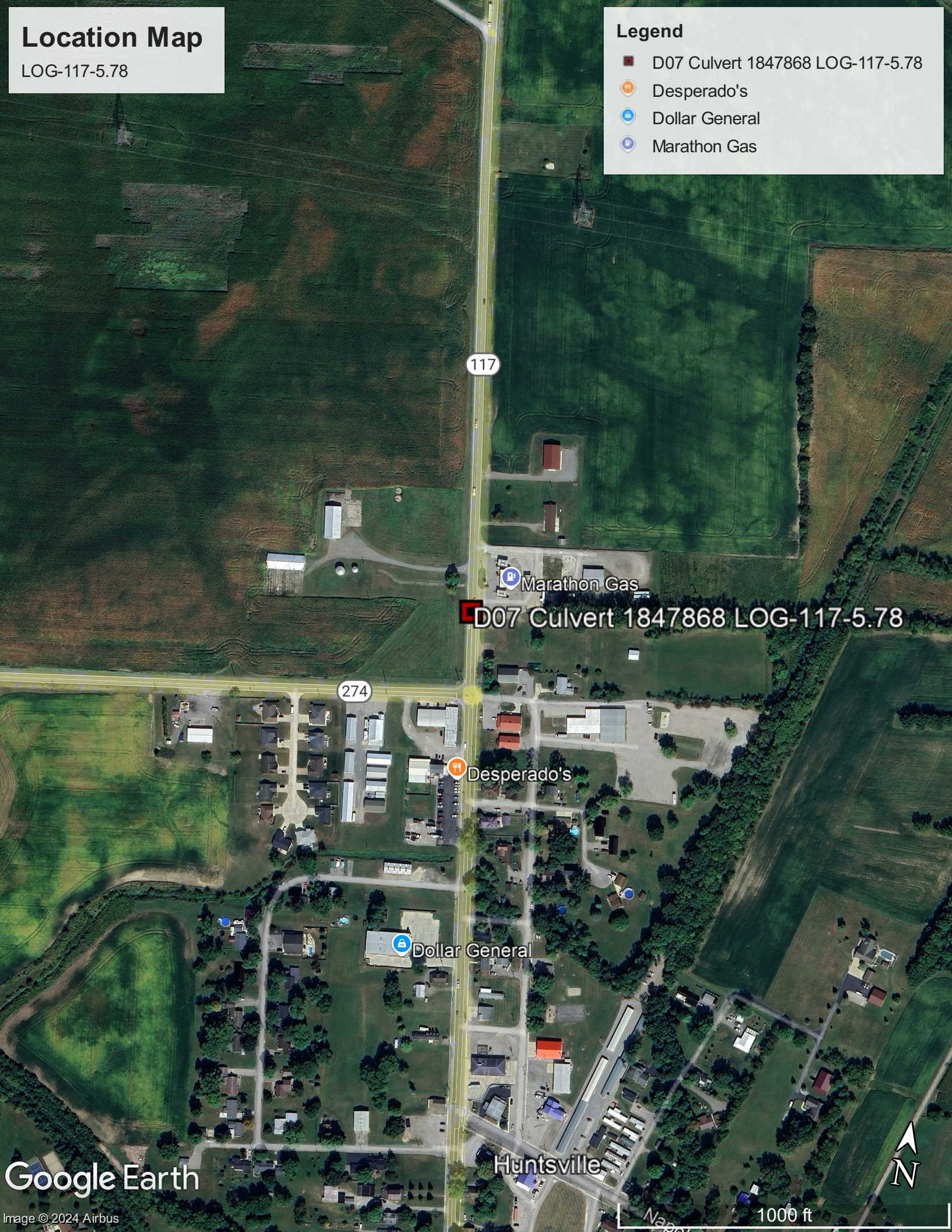
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

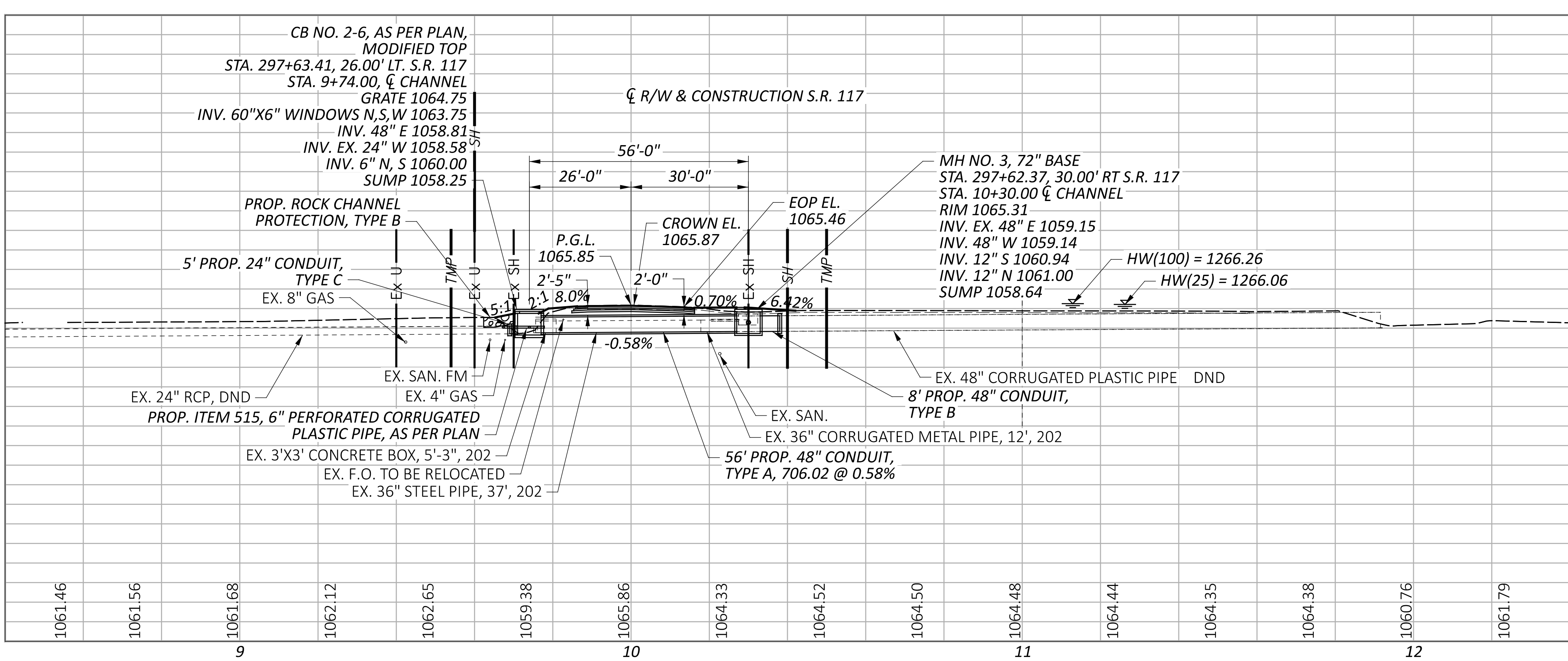
Location Map

LOG-117-5.78

Legend

- D07 Culvert 1847868 LOG-117-5.78
- Desperado's
- Dollar General
- Marathon Gas





PROPOSED STRUCTURE

TYPE: 48" CONDUIT, TYPE A

DIMENSIONS: 48"

LENGTH: 58'

SKEW: 1°03'21" R.F.

ALIGNMENT: TANGENT

ROADWAY: 30'-1" +- TREATED SH. TO TREATED SH.

CFN: 1997599

COORDINATES: LATITUDE 40° 26' 52" N
LONGITUDE 83° 48' 24" W

DESIGN SERVICE LIFE: 75 YEARS

	
HORIZONTAL SCALE IN FEET	
CULVERT DETAILS LOG-117-5.78	
DESIGN AGENCY  gai consultants CANTON OFFICE 5399 LAUBY ROAD SUITE 120 NORTH CANTON, OH 44720	
DESIGNER CMK	
REVIEWER ACR 06-13-25	
PROJECT ID 116483	
SHEET P.18	TOTAL 0

SECTION 3
LOG-287-7.27
GAI Consultants

Section 3 Contents

LOG-287-7.27

- Drainage Design Criteria
- Roadway Design Criteria
- Photos
- Hydrology Calculation (USGS StreamStats)
- Hydraulic Analysis (Results Summary, HY-8 Calculations)
- RCP at outlet
- Durability Design
- FEMA Map
- Wetland Information (NWI Mapping)
- Location map and Aerial
- Culvert Detail Sheet

PROJECT INFORMATION:

COUNTY	ROUTE	SECTION	PID
LOGAN	287	7.27	116483

PIPE POLICY:

The Pipe Policy of ODOT will be used for this project.

(Attach a copy of the written pipe policy or furnish a link to the policy. In lieu of a written policy, documentation of locally funded construction practices may be provided)

POST CONSTRUCTION BMP POLICY:

The Post Construction BMP Policy of ODOT will be used for this project.

If a policy other than ODOT's is being used, the following BMP's are permitted:

DRAINAGE WATERSHED(S):

HUC8: Upper Scioto 05060001

HUC12: Spain Creek - Big Darby Creek 050600011902

PROJECT SPECIFIC INFORMATION AFFECTING DRAINAGE:

Project will replace a culvert and adjust roadside ditches as needed to
accommodate the new culvert.

Drainage Design Criteria

Traffic:	2026 ADT: 1,500	From ODOT TFMS - segment Forecast Report
	2046 ADT: 1,700	
Drainage area = 0.22 sq. mi. = 140.8 ac.		

1002-1	Minimum Culvert Sizes: 15" for Fill <8'	
1004	Flood Clearance	
1004.2	Other Highways under 3000 ADT 10% AEP (10-yr)	
1006	Allowable Headwater	
	A. 1ft below near low edge of pavement (area less than 1000ac)	1265.11
	B. 2ft above inlet crown	1265.15
	C. 4ft above inlet crown in a deep ravine	N/A
1006.2.2	Check Storm Controls	
	A. 2ft below lowest ground elevation adjacent to an occupied building for a 2% AEP storm	1290
	B. Limit max. 1%AEP storm headwater to 2x the diameter or rise of culvert	1268.15
	C. size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with existing culvert	N/A
	D. Size replacement structure so flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure.	1266.64

1101-2	RDF Curve: B
--------	--------------

1102.3	Ditch Design Criteria		
	< 3000 ADT		
	Depth of Flow 20% AEP		
	Shear Stress 50% AEP		
	Tc = 15 minutes, min.		
	Depth limited to 1' below edge of pavement or overtop ditch bank in toe of slope ditches		

1103	Pavement Drainage - N/A no curbed pavement
------	--

1104	Storm Sewers - N/A no storm sewers
------	------------------------------------

1008.1	Corrugated and Spiral Rib Steel and Aluminum Pipes, Corrugated Steel and Aluminum Pipe Arches		
1008-1	Min. cover		
	707.01, 707.04, 707.05, 707.13 2 2/3"x1/2" Corrugations	60" dia.	12"
	707.02, 707.04, 707.07, 707.14 5"x1" Corrugations	60" dia.	12"

Drainage Design Criteria

1008-3	707.03 Structural Plate Corrugated Steel Pipe		
		60" dia.	12"
1008-6	Corrugated Steel Spiral Rib Pipe		
	707.12 and 707.11 3/4"x7 1/2" Corrugations	60" dia.	15"
1008-7	Corrugated Aluminum Pipe		
	707.21 2 2/3"x1 1/2" Corrugations	60" dia.	18"
	707.22 3"x1" Corrugations	60" dia.	18"
1008-9	Structural Plate Corrugated Aluminum Pipe		
	707.23	60" dia.	15"
1008-11	Corrugated Aluminum Spiral Rib Pipe		
	707.24 2 2/3"x1 1/2" Corrugations	60" dia.	18"

1008.2	Rigid Pipes	
1008.2.2	Min. height of cover	15" to pavement surface, including 9" min to top of subgrade
		9" min. to finished grade if not under pavement
1008.3	Thermoplastic Pipe	
1008.3.1	Min. height of cover	18" to the pavement surface, including 12" min. to top of subgrade
		18" min. to finished grade if not under pavement
1008.4	Corrugated Steel and Aluminum Box Culverts, Corrugated Steel Long Span Culverts	
1008.4.2	Min. height of cover	18" min. from trough of the corr. to pvmnt surface
1008.5	Precast Reinforced Concrete Box Culverts	
1008.5.2	Max. height of cover	10 feet
1008.6	Precast Reifored Concrete Three-Sided Flat-Topped Culverts	
1008.6.2	Max. height of cover	5 feet
1008.7	Precast Reinforced Concrete Arch Sections	
1008.7.2	Max. height of cover	12 feet
	Min. height of cover	12" to top of the pavement surface
1008.8	Precast Reinforced Concrete Round Sections	
1008.8.2	Max. height of cover	12 feet
	Min. height of cover	12" to top of the pavement surface

1105.5.5	Culvert Manning's n	n = 0.012 all smooth flow pipe	
1105-2	Corrugated Metal Pipe Type A Conduit		
	1/2" Corrugations	5.0' Dia	n=0.0229
	1" Corrugations	5.0' Dia	n=0.0271
	2" Corrugations	5.0' Dia	n=0.0332
	2 1/2" Corrugations	5.0' Dia	n=0.035



gai consultants

Subject: LOG-CR-FY27 - LOG-287-7.27

Roadway Design Criteria

Calc. by: CMK

Date: 11/16/24

Check by:

PID.: 116483

Sheet 1 of 1

Date:

Culvert LOG-287-7.27 CFN: 1848010

Design Designation		Source			Remarks
Opening Year ADT	1,500				
Design Year ADT (2046)	1,700				
Design Hourly Volume	300				
Directional Distribution, D	70.0%				
Trucks, T24	6%				
Design Speed, DS (mph)	60				
Legal Speed (mph)	55				
Functional Classification, FC	Rural Minor Collector				
Curbed?	No				
NHS Project					
	Criterion	Value	Source (L&D Vol 1)	Control Parameter	Remarks
Horizontal Alignment					
	Stopping Sight Distance, SSD (ft)	570	Fig 201-1	DS	
	Passing Sight Distance, PSD (ft)	1000	Fig 201-3	DS	Requires K-Crest = 357' min
	Intersection Sight Distance, ISD (ft) (left)		Fig 201-5	DS	No intersection present
	Intersection Sight Distance, ISD (ft) (right)		Fig 201-5	DS	No intersection present
	Decision Sight Distance, DSD, stop (ft)	610	Fig 201-6	DS	Urban Stop
	Decision Sight Distance, DSD, change (ft)	990	Fig 201-6	DS	Urban Speed/Path/Direction Change
	Max. C.L. deflection w/out Horz. Curve	0° 55'	Fig 202-1	DS	
	Dist. Between Horz. Deflections (ft)	200'	Fig 202-1	DS	Recommended minimum
	Maximum Degree of Curvature, DC	4°45'	Fig 202-2	DS	Minimum radius = 1206'; Dc = 5729.58/R
	Maximum Dc w/out Superelevation	0°32'	Fig 202-3	DS	Minimum radius = 10,743'; Dc = 5729.58/R
	Maximum Dc w/out a Spiral	NA	Fig 202-11	DS	
Vertical Alignment					
	Maximum Vertical Grade	6	Fig 203-1	FC&DS	Rolling Terrain
	Minimum Vertical Grade	0.00%	Sec 203.2.2		For non-curbed pavement
		0.50%	Sec 203.2.2		For curbed pavement
	Maximum Vertical Grade Break	0.30%	Fig 203-2	DS	
	Min. Dist. Between VC's and Breaks (ft)	100	Fig 203-2	DS	Recommended minimum
	Minimum K value - Crest VC	151	Fig 203-3	DS	SSD = 570'
	Minimum K value - Sag VC	136	Fig 203-6	DS	SSD = 570'
	Minimum VC length (ft)	180	Sec 203.3.3 & 4	DS	Length = 3 x (DS in feet)
Typical Section					
	Number of Lanes	2		Scope	Same as existing
	Minimum Design Level of Service (LOS)	C	Fig 301-1	FC, Locale	Urban & Urbanized
	Minimum Lane Width (ft)	11	Fig 301-2	FC	Same as existing per Scope (10 ft. lanes may be used in constrained environments to help accommodate bicycle and pedestrian traffic)
	Pavement Width Transition	60:1	Sec 301.1.4	DS	L=WS²/60
	Treated Shoulder Width (ft)	4', Varies	Fig 301-3,4	FC&ADT	Use same as existing
	Graded Shoulder Width (ft) with Barrier	9', Varies	Fig 301-3,4	FC&ADT	Use same as existing
	" w/out Barrier, Foreslope Steeper than 6:1	8', Varies	Fig 301-3,4	FC&ADT	Use same as existing
	" w/out Barrier, Foreslope 6:1 or Flatter	6', Varies	Fig 301-3,4	FC&ADT	Use same as existing
	Minimum Curbed Shoulder Width (Parking)	NA	Fig 301-4		Not a curbed roadway
	Minimum Curbed Shoulder Width (No Parking)	NA	Fig 301-4		Not a curbed roadway
	Shoulder Width Taper	25:1	Sec 301.2.3.2		For decreasing shoulder width
		5:1	Sec 301.2.3.2		For increasing shoulder width
	Guardrail Offset (ft)	6' Min	Fig 301-3	FC&ADT	No guardrail
	Curve Widening	N/A	Fig 301-5c	FC&DS	Depends on Dc or curve radius
	Clear Zone (ft), foreslope 6:1 or flatter	22	Fig 600-1	DS&ADT	1,501<ADT<6,000
	Clear Zone (ft), foreslope 6:1 to 4:1	29	Fig 600-1	DS&ADT	1,501<ADT<6,000
	Clear Zone (ft), backslope 6:1 or flatter	21	Fig 600-1	DS&ADT	1,501<ADT<6,000
	Clear Zone (ft), backslope 6:1 to 4:1	17	Fig 600-1	DS&ADT	1,501<ADT<6,000
	Clear Zone (ft), backslope steeper than 4:1	13	Fig 600-1	DS&ADT	1,501<ADT<6,000



LOG-287-7.27 Outlet end. Looking southwest.



LOG-287-7.27 Outlet end. Looking south.



LOG-287-7.27 Outlet end. Looking southeast.



LOG-287-7.27 Inlet end. Looking east.



LOG-287-7.27 Inlet end. Looking north.



LOG-287-7.27 Inlet end. Looking northwest.



LOG-287-7.27 Inlet end. Looking southwest.



LOG-287-7.27 Inlet end. Looking northeast.



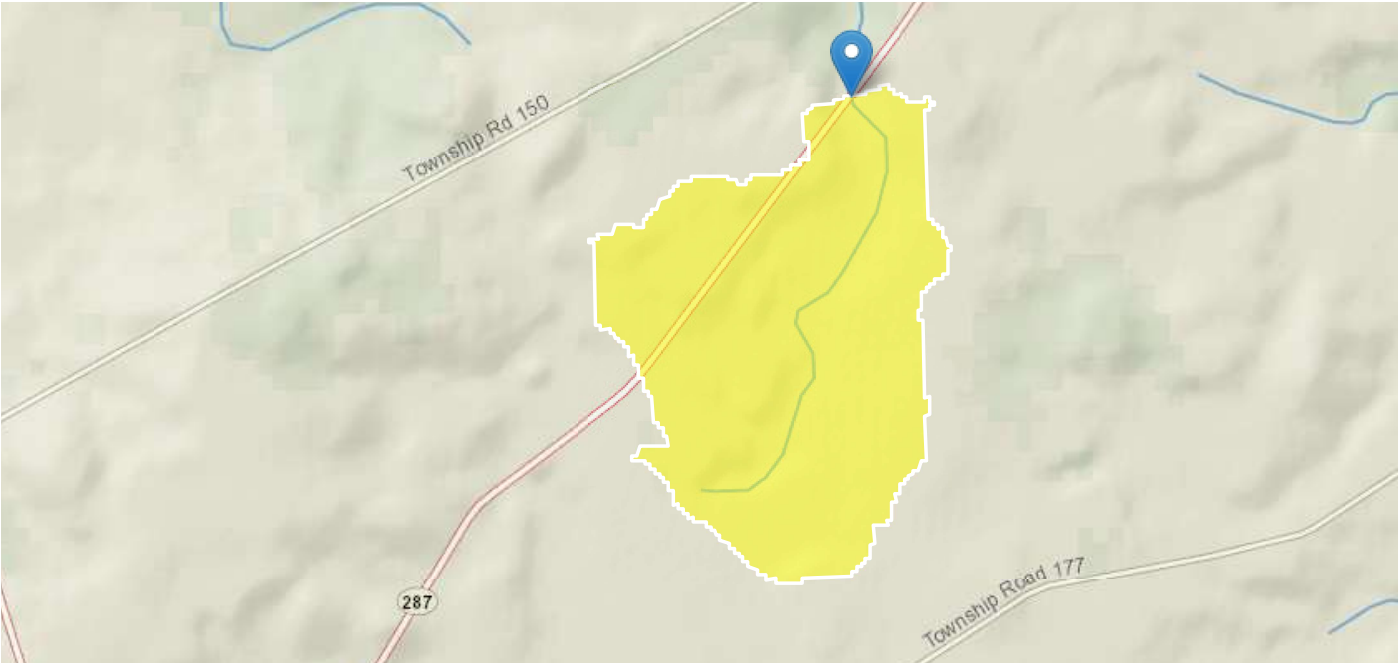
LOG-287-7.27 Damage in culvert from 2018 inspection.



LOG-287-7.27 Damage in culvert from 2018 inspection.

LOG- 287-7.27 StreamStats Report

Region ID: OH
Workspace ID: OH20240709141226590000
Clicked Point (Latitude, Longitude): 40.26396, -83.60986
Time: 2024-07-09 10:12:45 -0400



 Collapse All

➤ Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CSL1085LFP	Change in elevation divided by length between points 10 and 85 percent of distance along the longest flow path to the basin divide, LFP from 2D grid	45	feet per mi
DRNAREA	Area that drains to a point on a stream	0.22	square miles
FOREST	Percentage of area covered by forest	0.58	percent
LAT_CENT	Latitude of Basin Centroid	40.2592	decimal degrees
LC92STOR	Percentage of water bodies and wetlands determined from the NLCD	0.16	percent
LONG_CENT	Longitude Basin Centroid	83.6115	decimal degrees
OHREGA	Ohio Region A Indicator	1	dimensionless
OHREGC	Ohio Region C Indicator	0	dimensionless
PRECIPCENT	Mean Annual Precip at Basin Centroid	36.5	inches

Parameter Code	Parameter Description	Value	Unit
STREAM_VARG	Streamflow variability index as defined in WRIR 02-4068, computed from regional grid	0.47	dimensionless

➤ Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Flow Full Model Reg A SIR2019 5018]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	0.04	5989
OHREGC	Ohio Region C Indicator 1 if in C else 0	0	dimensionless	0	1
OHREGA	Ohio Region A Indicator 1 if in A else 0	1	dimensionless	0	1
CSL1085LFP	Stream Slope 10 and 85 Longest Flow Path	45	feet per mi	1.53	516
LC92STOR	Percent Storage from NLCD1992	0.16	percent	0	25.35

Peak-Flow Statistics Flow Report [Peak Flow Full Model Reg A SIR2019 5018]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	PIL	PIU	ASEp
50-percent AEP flood	34.8	ft ³ /s	18.3	66.1	40.1
20-percent AEP flood	64.3	ft ³ /s	35.4	117	37.2
10-percent AEP flood	89.1	ft ³ /s	48.7	163	37.6
4-percent AEP flood	126	ft ³ /s	68.3	232	38.1
2-percent AEP flood	157	ft ³ /s	84.2	293	37.8
1-percent AEP flood	191	ft ³ /s	101	360	39.6
0.2-percent AEP flood	284	ft ³ /s	149	542	40.3

Peak-Flow Statistics Citations

Koltun, G.F.,2019, Flood-frequency estimates for Ohio streamgages based on data through water year 2015 and techniques for estimating flood-frequency characteristics of rural, unregulated Ohio streams: U.S. Geological Survey Scientific Investigations Report 2019–5018, 25 p.
(<https://dx.doi.org/10.3133/sir20195018>)

➤ Low-Flow Statistics

Low-Flow Statistics Parameters [Low Flow Region A 2012 5138]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.47	dimensionless	0.24	1.12

Low-Flow Statistics Disclaimers [Low Flow Region A 2012 5138]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Low-Flow Statistics Flow Report [Low Flow Region A 2012 5138]

Statistic	Value	Unit
1 Day 10 Year Low Flow	0.00755	ft ³ /s
7 Day 10 Year Low Flow	0.00893	ft ³ /s
30 Day 10 Year Low Flow	0.0124	ft ³ /s
90 Day 10 Year Low Flow	0.0168	ft ³ /s

Low-Flow Statistics Citations

Koltun, G.F., and Kula, S.P.,2013, Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5138, 195 p. (<http://pubs.usgs.gov/sir/2012/5138/>)

➤ Flow-Duration Statistics

Flow-Duration Statistics Parameters [Low Flow Region A 2012 5138]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.47	dimensionless	0.24	1.12

Flow-Duration Statistics Disclaimers [Low Flow Region A 2012 5138]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Flow-Duration Statistics Flow Report [Low Flow Region A 2012 5138]

Statistic	Value	Unit
80 Percent Duration	0.0299	ft ³ /s

Flow-Duration Statistics Citations

Koltun, G.F., and Kula, S.P.,2013, Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5138, 195 p. (<http://pubs.usgs.gov/sir/2012/5138/>)

➤ Annual Flow Statistics

Annual Flow Statistics Parameters [Low Flow LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	0.12	7422
LAT_CENT	Latitude of Basin Centroid	40.2592	decimal degrees	38.68	41.2
PRECIPCENT	Mean Annual Precip at Basin Centroid	36.5	inches	34	43.2

Annual Flow Statistics Flow Report [Low Flow LatLE 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	SE	ASEp
Mean Annual Flow	0.202	ft ³ /s	11.4	11.4

Annual Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p (<https://pubs.er.usgs.gov/publication/wri024068>)

➤ Monthly Flow Statistics

Monthly Flow Statistics Parameters [Low Flow LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	0.16	percent	0	19
PRECIPCENT	Mean Annual Precip at Basin Centroid	36.5	inches	34	43.2
FOREST	Percent Forest	0.58	percent	0	99.1
LAT_CENT	Latitude of Basin Centroid	40.2592	decimal degrees	38.68	41.2
STREAM_VARG	Streamflow Variability Index from Grid	0.47	dimensionless	0.25	1.13

Monthly Flow Statistics Flow Report [Low Flow LatLE 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	SE	ASEp
January Mean Flow	0.273	ft ³ /s	16.6	16.6
February Mean Flow	0.349	ft ³ /s	11.9	11.9
March Mean Flow	0.366	ft ³ /s	14	14
April Mean Flow	0.363	ft ³ /s	11.2	11.2
May Mean Flow	0.22	ft ³ /s	19.5	19.5

Statistic	Value	Unit	SE	ASEp
June Mean Flow	0.172	ft ³ /s	27	27
July Mean Flow	0.108	ft ³ /s	28.2	28.2
August Mean Flow	0.0694	ft ³ /s	36.8	36.8
September Mean Flow	0.0327	ft ³ /s	43.6	43.6
October Mean Flow	0.0465	ft ³ /s	50.8	50.8
November Mean Flow	0.0905	ft ³ /s	37.5	37.5
December Mean Flow	0.177	ft ³ /s	21.8	21.8

Monthly Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p (<https://pubs.er.usgs.gov/publication/wri024068>)

➤ General Flow Statistics

General Flow Statistics Parameters [Low Flow LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	0.16	percent	0	19
STREAM_VARG	Streamflow Variability Index from Grid	0.47	dimensionless	0.25	1.13
LAT_CENT	Latitude of Basin Centroid	40.2592	decimal degrees	38.68	41.2

General Flow Statistics Flow Report [Low Flow LatLE 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	SE	ASEp
Harmonic Mean Streamflow	0.0332	ft ³ /s	65.9	65.9

General Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p (<https://pubs.er.usgs.gov/publication/wri024068>)

➤ Flow Percentile Statistics

Flow Percentile Statistics Parameters [Low Flow LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	0.16	percent	0	19

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
STREAM_VARG	Streamflow Variability Index from Grid	0.47	dimensionless	0.25	1.13
LAT_CENT	Latitude of Basin Centroid	40.2592	decimal degrees	38.68	41.2
LONG_CENT	Longitude of Basin Centroid	83.6115	decimal degrees	80.53	84.6

Flow Percentile Statistics Flow Report [Low Flow LatLE 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct (other -- see report)

Statistic	Value	Unit	SE	ASEp
25th Percentile Flow	0.072	ft^3/s	29.2	29.2
50th Percentile Flow Median	0.12	ft^3/s	40.3	40.3
75th Percentile Flow	0.218	ft^3/s	47.9	47.9

Flow Percentile Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p (<https://pubs.er.usgs.gov/publication/wri024068>)

➤ Bankfull Statistics

Bankfull Statistics Parameters [Interior Plains D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	0.19305	59927.7393

Bankfull Statistics Parameters [Central Lowland P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	0.200772	59927.66594

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Interior Plains D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	6.89	ft
Bieger_D_channel_depth	1.12	ft
Bieger_D_channel_cross_sectional_area	10.6	ft^2

Bankfull Statistics Flow Report [Central Lowland P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	8.08	ft
Bieger_P_channel_depth	1.43	ft
Bieger_P_channel_cross_sectional_area	10.4	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	7.27	ft
Bieger_USA_channel_depth	0.873	ft
Bieger_USA_channel_cross_sectional_area	7.54	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	6.89	ft
Bieger_D_channel_depth	1.12	ft
Bieger_D_channel_cross_sectional_area	10.6	ft^2
Bieger_P_channel_width	8.08	ft
Bieger_P_channel_depth	1.43	ft
Bieger_P_channel_cross_sectional_area	10.4	ft^2
Bieger_USA_channel_width	7.27	ft
Bieger_USA_channel_depth	0.873	ft
Bieger_USA_channel_cross_sectional_area	7.54	ft^2

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverf)

> Probability Statistics

Probability Statistics Parameters [P zero Flow 2012 5138]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.47	dimensionless	0.24	1.12

Probability Statistics Disclaimers [P zero Flow 2012 5138]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors.

Probability Statistics Flow Report [P zero Flow 2012 5138]

Statistic	Value	Unit
Probability zero flow 1Day	0.0151	dim
Probability zero flow 7Day	0.006	dim
Probability zero flow 30Day	0.000213	dim

Probability Statistics Citations

Koltun, G.F., and Kula, S.P.,2013, Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5138, 195 p. (<http://pubs.usgs.gov/sir/2012/5138/>)

➤ Maximum Probable Flood Statistics

Maximum Probable Flood Statistics Parameters [Crippen Bue Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.22	square miles	0.1	10000

Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 6]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	1880	ft ³ /s

Maximum Probable Flood Statistics Citations

Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (<https://pubs.usgs.gov/wsp/1887/report.pdf>)

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Application Version: 4.21.0

StreamStats Services Version: 1.2.22

NSS Services Version: 2.2.1

LOG-287-7.27

HEADWATER RESULTS

HEADWATER RESULTS				HEADWATER			
YEAR	AER	DESCRIPTION	FLOW (cfs)	EX. 60" CORR. ROUND	PROP. 60" CORR. ROUND	60" SMOOTH ROUND	6'x4' CONC. BOX
5	20%	MINIMUM	64.3	1261.99	1261.92	1261.40	1260.73
10	10%	DESIGN	89.1	1262.80	1262.69	1262.12	1261.34
50	2%	FLOOD	157 (165)	1265.54	1265.19	1264.32	1263.13
100	1%	FLOOD	191	1266.20	1266.17	1265.22	1263.79

Culvert Check

10/30/2024

5' Diameter Corrugated Metal Pipe

n=0.0270

1006.1 Design AEP Storm

Use the design AEP storm as shown in Section 1004.2.

1006.2 Culvert Headwater Controls

1006.2.1 Design Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the design storm:

- A. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.
- B. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat terrain.

1006.2.1

A.

EOP Elev. - 2' 1264.11 ft

EOP Elev. - 1' 1265.11 ft

Design Elev. 1262.69 ft

B.

Inlet Crown Elev. + 2' 1265.154 ft

Design Elev. 1262.69 ft

1006.2.2 Check Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the applicable check storm.

- A. 2 feet below the lowest ground elevation adjacent to an occupied building for a 2% AEP storm. This is not intended to lower existing high-water elevations around buildings.
- B. Limit the maximum 1% AEP storm headwater depth to twice the diameter or rise of the culvert.
- C. Size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with the existing structure.
- D. Size a replacement structure so that flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure. Before implementing this criteria consider the type of upstream property and land use.

1006.2.2

A.

Min. Build. Elev. - 2' 1290 ft

Design Elev. 1265.19 ft

B.

Elev. Culvert Rise x 2 1268.154 ft

Design Elev. 1266.17 ft

C.

Ex. 1% HW 1266.20 ft

Overtops by 1266.20-1266.18 = 0.02'

Prop. 1% HW 1266.17 ft

Does not overtop

D.

Ex. 1% HW 1266.20 ft

Prop. 1% HW 1266.17 ft

No increase in upstream flood

Culvert Check

10/30/2024

5' Diameter Smooth Pipe (Concrete and Plastic, $n=0.012$)

1006.1 Design AEP Storm

Use the design AEP storm as shown in Section 1004.2.

1006.2 Culvert Headwater Controls

1006.2.1 Design Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the design storm:

- A. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.
- B. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat terrain.

1006.2.1

A.

EOP Elev. - 2' 1264.11 ft

EOP Elev. - 1' 1265.11 ft

Design Elev. 1262.12 ft

B.

Inlet Crown Elev. + 2' 1265.154 ft

Design Elev. 1262.12 ft

1006.2.2 Check Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the applicable check storm.

- A. 2 feet below the lowest ground elevation adjacent to an occupied building for a 2% AEP storm. This is not intended to lower existing high-water elevations around buildings.
- B. Limit the maximum 1% AEP storm headwater depth to twice the diameter or rise of the culvert.
- C. Size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with the existing structure.
- D. Size a replacement structure so that flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure. Before implementing this criteria consider the type of upstream property and land use.

1006.2.2

A.

Min. Build. Elev. - 2' 1290 ft

Design Elev. 1264.32 ft

B.

Elev. Culvert Rise x 2 1268.154 ft

Design Elev. 1265.22 ft

C.

Ex. 1% HW 1266.20 ft

Overtops by $1266.20 - 1266.18 = 0.02'$

Prop. 1% HW 1265.22 ft

Does not overtop

D.

Ex. 1% HW 1266.20 ft

Prop. 1% HW 1265.22 ft

No increase in upstream flood

Culvert Check

10/30/2024

6' x 4' Concrete Box $n=0.012$

1006.1 Design AEP Storm

Use the design AEP storm as shown in Section 1004.2.

1006.2 Culvert Headwater Controls

1006.2.1 Design Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the design storm:

- A. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.
- B. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat terrain.

1006.2.1

A.

EOP Elev. - 2' 1264.11 ft
EOP Elev. - 1' 1265.11 ft
Design Elev. 1261.34 ft

B.

Inlet Crown Elev. + 2' 1265.154 ft
Design Elev. 1261.34 ft

1006.2.2 Check Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the applicable check storm.

- A. 2 feet below the lowest ground elevation adjacent to an occupied building for a 2% AEP storm. This is not intended to lower existing high-water elevations around buildings.
- B. Limit the maximum 1% AEP storm headwater depth to twice the diameter or rise of the culvert.
- C. Size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with the existing structure.
- D. Size a replacement structure so that flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure. Before implementing this criteria consider the type of upstream property and land use.

1006.2.2

A.

Min. Build. Elev. - 2' 1290 ft
Design Elev. 1263.13 ft

B.

Elev. Culvert Rise x 2 1268.154 ft
Design Elev. 1263.79 ft

C.

Ex. 1% HW 1266.20 ft
Overtops by 1266.20-1266.18 = 0.02'
Prop. 1% HW 1263.79 ft

D.

Ex. 1% HW 1266.20 ft
Prop. 1% HW 1263.79 ft
No increase in upstream flood

Does not overtop

HY-8 Culvert Analysis Report – Existing Corrugated Metal Circular, 60”

Crossing Discharge Data

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

Minimum Flow: 64.30 cfs

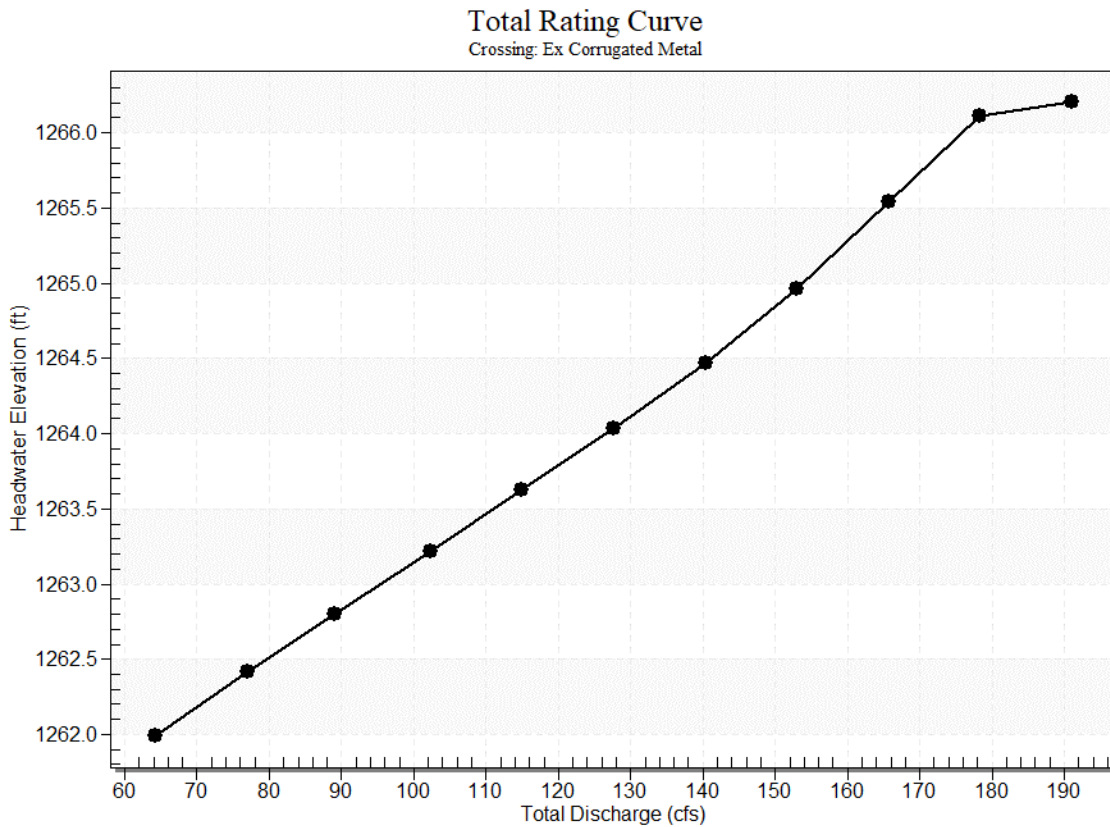
Design Flow: 89.10 cfs

Maximum Flow: 191.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Ex Corrugated Metal

Headwater Elevation (ft)	Total Discharge (cfs)	Existing Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1261.99	64.30	64.30	0.00	1
1262.41	76.97	76.97	0.00	1
1262.80	89.10	89.10	0.00	1
1263.22	102.31	102.31	0.00	1
1263.62	114.98	114.98	0.00	1
1264.03	127.65	127.65	0.00	1
1264.47	140.32	140.32	0.00	1
1264.96	152.99	152.99	0.00	1
1265.54	165.66	165.66	0.00	1
1266.12	178.33	178.03	0.00	46
1266.20	191.00	179.61	11.27	8
1266.12	178.11	178.11	0.00	Overtopping

Rating Curve Plot for Crossing: Ex Corrugated Metal



Culvert Data: Existing

Table 1 - Culvert Summary Table: Existing

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
64.30 cfs	64.30 cfs	1261.99	3.47	3.839	2-M2c	5.00	2.26	2.26	0.82	7.47	7.51
76.97 cfs	76.97 cfs	1262.41	3.88	4.259	2-M2c	5.00	2.48	2.48	0.91	7.91	8.00
89.10 cfs	89.10 cfs	1262.80	4.27	4.648	2-M2c	5.00	2.68	2.68	0.99	8.32	8.41
102.31 cfs	102.31 cfs	1263.22	4.69	5.066	7-M2c	5.00	2.88	2.88	1.08	8.74	8.82

114.9 8 cfs	114.9 8 cfs	1263.6 2	5.11	5.46 8	7- M2 c	5.00	3.06	3.0 6	1.16	9.13	9.18
127.6 5 cfs	127.6 5 cfs	1264.0 3	5.56	5.88 0	7- M2 c	5.00	3.23	3.2 3	1.23	9.51	9.51
140.3 2 cfs	140.3 2 cfs	1264.4 7	6.02	6.31 4	7- M2 c	5.00	3.39	3.3 9	1.30	9.89	9.82
152.9 9 cfs	152.9 9 cfs	1264.9 6	6.53	6.80 6	7- M2 c	5.00	3.55	3.5 5	1.37	10.2 7	10.11
165.6 6 cfs	165.6 6 cfs	1265.5 4	7.07	7.38 5	7- M2 c	5.00	3.69	3.6 9	1.44	10.6 6	10.38
178.3 3 cfs	178.0 3 cfs	1266.1 2	7.63	7.96 1	7- M2 c	5.00	3.82	3.8 2	1.50	11.0 5	10.63
191.0 0 cfs	179.6 1 cfs	1266.2 0	7.71	8.04 9	7- M2 c	5.00	3.84	3.8 4	1.57	11.1 0	10.87

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

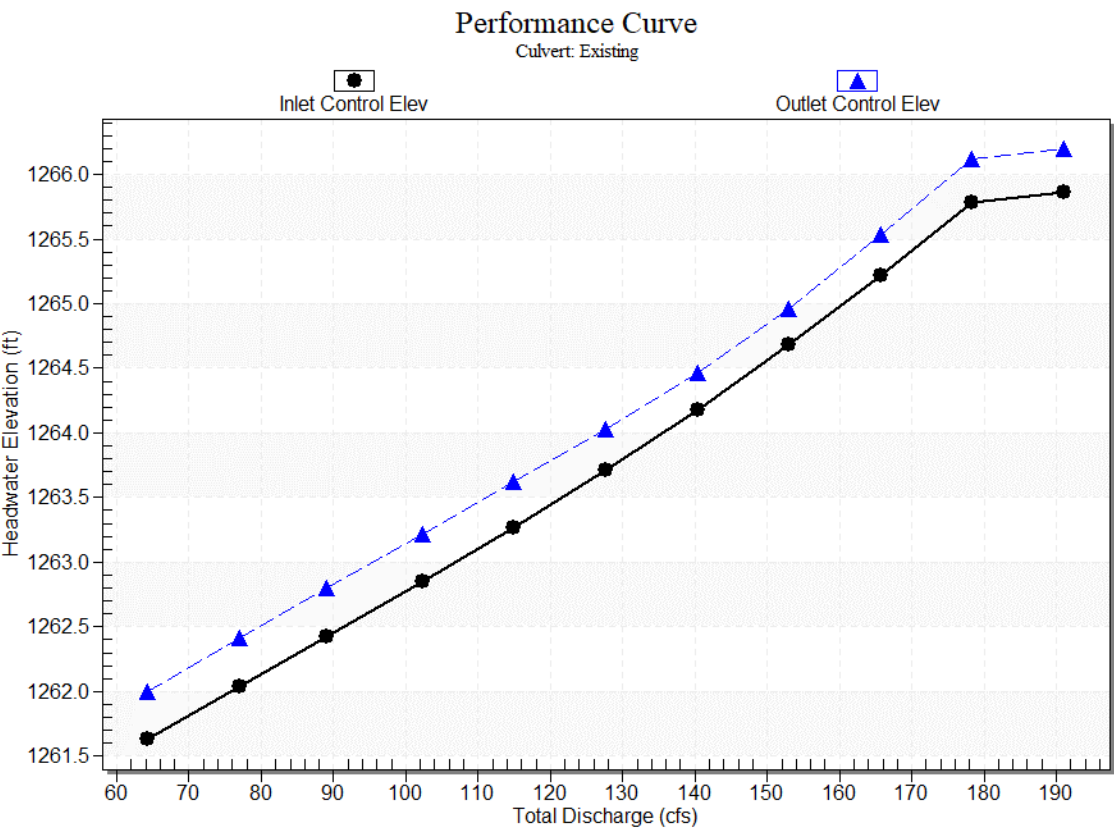
Inlet Elevation (invert): 1258.15 ft,

Outlet Elevation (invert): 1258.06 ft

Culvert Length: 62.04 ft,

Culvert Slope: 0.0015

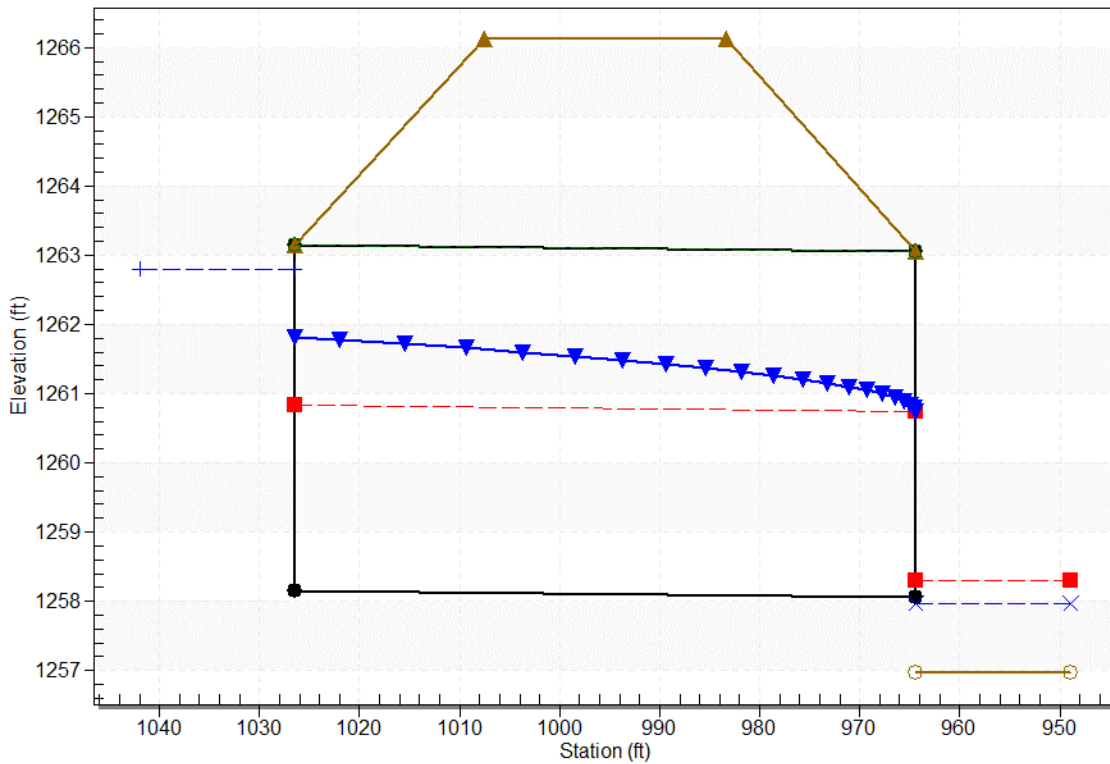
Culvert Performance Curve Plot: Existing



Water Surface Profile Plot for Culvert: Existing

Crossing - Ex Corrugated Metal, Design Discharge - 89.1 cfs

Culvert - Existing, Culvert Discharge - 89.1 cfs



Site Data - Existing

Site Data Option: Culvert Invert Data

Inlet Station: 1026.45 ft

Inlet Elevation: 1258.15 ft

Outlet Station: 964.41 ft

Outlet Elevation: 1258.06 ft

Number of Barrels: 1

Culvert Data Summary - Existing

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0270

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting ($K_e=0.9$)

Inlet Depression: None

Tailwater Data for Crossing: Ex Corrugated Metal

Table 2 - Downstream Channel Rating Curve (Crossing: Ex Corrugated Metal)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
64.30	1257.79	0.82	7.51	2.49	1.52
76.97	1257.88	0.91	8.00	2.77	1.54
89.10	1257.97	0.99	8.41	3.03	1.55
102.31	1258.05	1.08	8.82	3.29	1.57
114.98	1258.13	1.16	9.18	3.53	1.58
127.65	1258.20	1.23	9.51	3.75	1.59
140.32	1258.28	1.30	9.82	3.97	1.60
152.99	1258.34	1.37	10.11	4.18	1.61
165.66	1258.41	1.44	10.38	4.38	1.62
178.33	1258.47	1.50	10.63	4.58	1.63
191.00	1258.54	1.57	10.87	4.77	1.63

Tailwater Channel Data - Ex Corrugated Metal

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 9.65 ft

Side Slope (H:V): 1.00 (.:1)

Channel Slope: 0.0488

Channel Manning's n: 0.0350

Channel Invert Elevation: 1256.97 ft

Roadway Data for Crossing: Ex Corrugated Metal

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 160.00 ft

Crest Elevation: 1266.12 ft

Roadway Surface: Paved

Roadway Top Width: 24.07 ft

HY-8 Culvert Analysis Report – Prop. Corrugated Metal, 60”

Crossing Discharge Data

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

Minimum Flow: 64.30 cfs

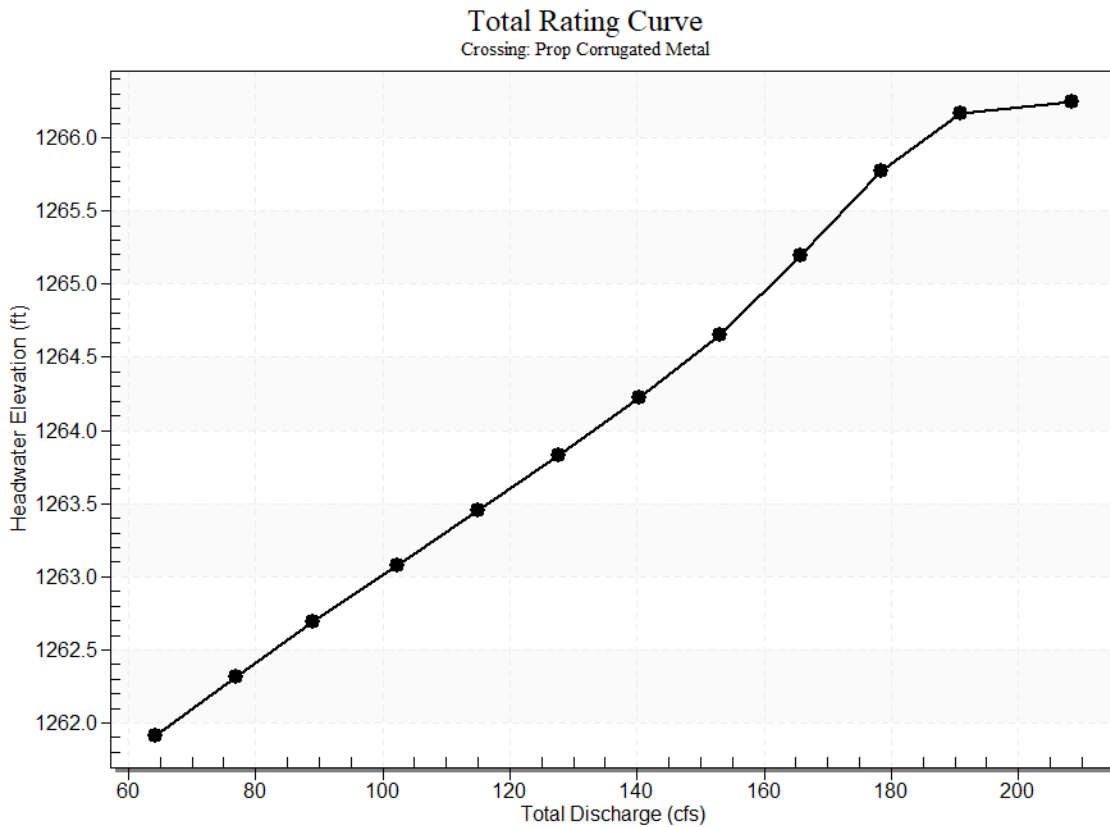
Design Flow: 89.10 cfs

Maximum Flow: 191.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Prop Corrugated Metal

Headwater Elevation (ft)	Total Discharge (cfs)	Proposed Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1261.92	64.30	64.30	0.00	1
1262.32	76.97	76.97	0.00	1
1262.69	89.10	89.10	0.00	1
1263.08	102.31	102.31	0.00	1
1263.45	114.98	114.98	0.00	1
1263.83	127.65	127.65	0.00	1
1264.22	140.32	140.32	0.00	1
1264.65	152.99	152.99	0.00	1
1265.19	165.66	165.66	0.00	1
1265.78	178.33	178.33	0.00	1
1266.17	191.00	186.29	4.54	20
1266.12	185.37	185.37	0.00	Overtopping

Rating Curve Plot for Crossing: Prop Corrugated Metal



Culvert Data: Proposed

Table 1 - Culvert Summary Table: Proposed

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
64.30 cfs	64.30 cfs	1261.92	3.45	3.765	2-M2c	2.51	2.26	2.26	0.78	7.47	7.33
76.97 cfs	76.97 cfs	1262.32	3.86	4.167	2-M2c	2.80	2.48	2.48	0.87	7.91	7.82
89.10 cfs	89.10 cfs	1262.69	4.25	4.538	2-M2c	3.07	2.68	2.68	0.95	8.32	8.23
102.31 cfs	102.31 cfs	1263.08	4.67	4.931	2-M2c	3.38	2.88	2.88	1.03	8.74	8.64

114.9 8 cfs	114.9 8 cfs	1263.4 5	5.09	5.30 4	7- M2 c	3.70	3.06	3.0 6	1.10	9.13	8.99
127.6 5 cfs	127.6 5 cfs	1263.8 3	5.53	5.68 1	7- M2 c	4.09	3.23	3.2 3	1.17	9.51	9.32
140.3 2 cfs	140.3 2 cfs	1264.2 2	6.00	6.07 0	7- M2 c	5.00	3.39	3.3 9	1.24	9.89	9.63
152.9 9 cfs	152.9 9 cfs	1264.6 5	6.50	6.48 3	7- M2 c	5.00	3.55	3.5 5	1.31	10.2 7	9.92
165.6 6 cfs	165.6 6 cfs	1265.1 9	7.04	6.94 4	7- M2 c	5.00	3.69	3.6 9	1.37	10.6 6	10.19
178.3 3 cfs	178.3 3 cfs	1265.7 8	7.63	7.57 3	7- M2 c	5.00	3.83	3.8 3	1.43	11.0 6	10.44
191.0 0 cfs	186.2 9 cfs	1266.1 7	8.02	7.99 3	7- M2 c	5.00	3.91	3.9 1	1.49	11.3 2	10.68

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

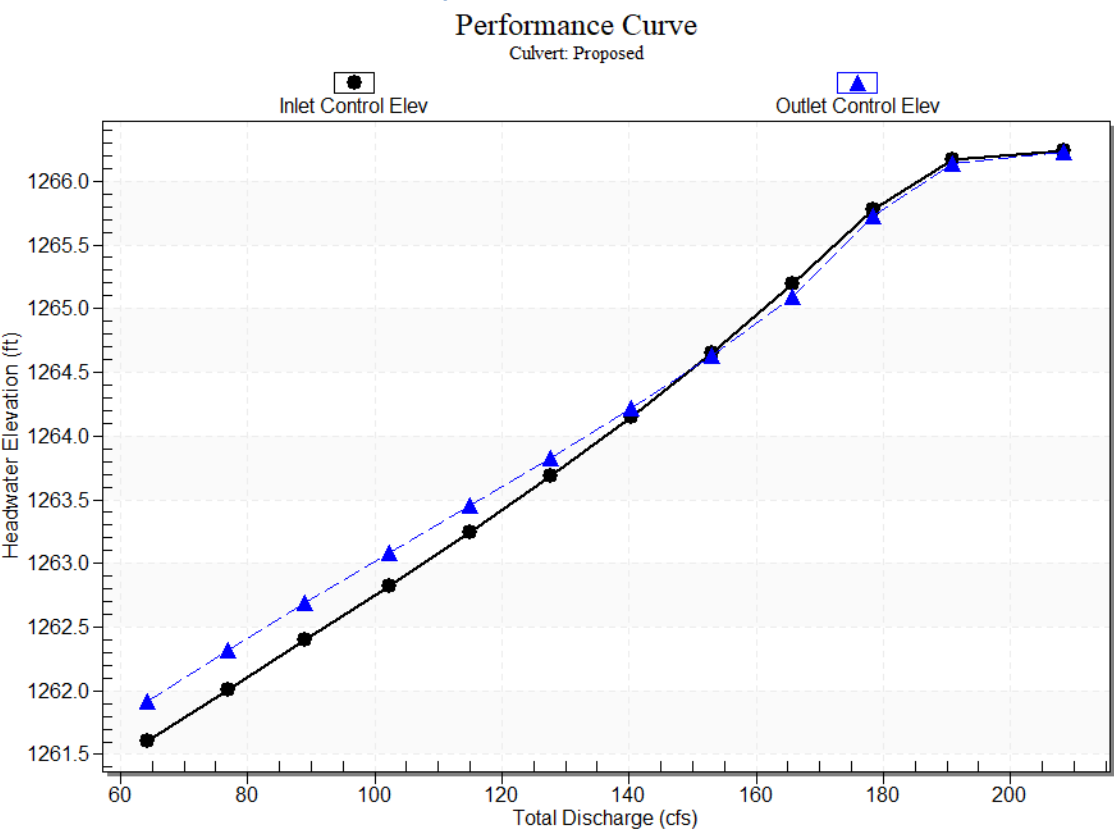
Inlet Elevation (invert): 1258.15 ft,

Outlet Elevation (invert): 1257.30 ft

Culvert Length: 82.00 ft,

Culvert Slope: 0.0104

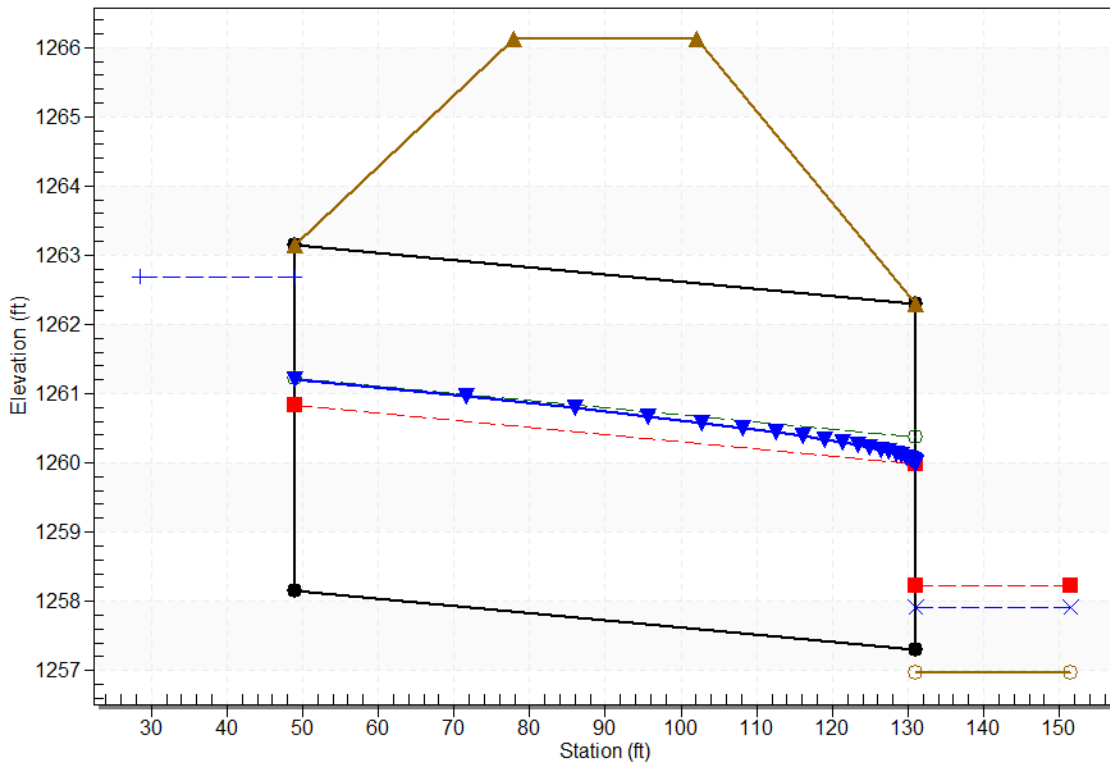
Culvert Performance Curve Plot: Proposed



Water Surface Profile Plot for Culvert: Proposed

Crossing - Prop Corrugated Metal, Design Discharge - 89.1 cfs

Culvert - Proposed, Culvert Discharge - 89.1 cfs



Site Data - Proposed

Site Data Option: Culvert Invert Data

Inlet Station: 49.00 ft

Inlet Elevation: 1258.15 ft

Outlet Station: 131.00 ft

Outlet Elevation: 1257.30 ft

Number of Barrels: 1

Culvert Data Summary - Proposed

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0270

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting ($K_e=0.9$)

Inlet Depression: None

Tailwater Data for Crossing: Prop Corrugated Metal

Table 2 - Downstream Channel Rating Curve (Crossing: Prop Corrugated Metal)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
64.30	1257.75	0.78	7.33	2.37	1.51
76.97	1257.84	0.87	7.82	2.64	1.53
89.10	1257.92	0.95	8.23	2.88	1.55
102.31	1258.00	1.03	8.64	3.13	1.57
114.98	1258.07	1.10	8.99	3.36	1.58
127.65	1258.14	1.17	9.32	3.57	1.59
140.32	1258.21	1.24	9.63	3.78	1.60
152.99	1258.28	1.31	9.92	3.98	1.61
165.66	1258.34	1.37	10.19	4.17	1.62
178.33	1258.40	1.43	10.44	4.36	1.63
191.00	1258.46	1.49	10.68	4.54	1.63

Tailwater Channel Data - Prop Corrugated Metal

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.50 ft

Side Slope (H:V): 1.00 (:1)

Channel Slope: 0.0488

Channel Manning's n: 0.0350

Channel Invert Elevation: 1256.97 ft

Roadway Data for Crossing: Prop Corrugated Metal

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 160.00 ft

Crest Elevation: 1266.12 ft

Roadway Surface: Paved

Roadway Top Width: 24.07 ft

HY-8 Culvert Analysis Report – Circular Smooth (Conc./Plastic)

Crossing Discharge Data

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

Minimum Flow: 64.30 cfs

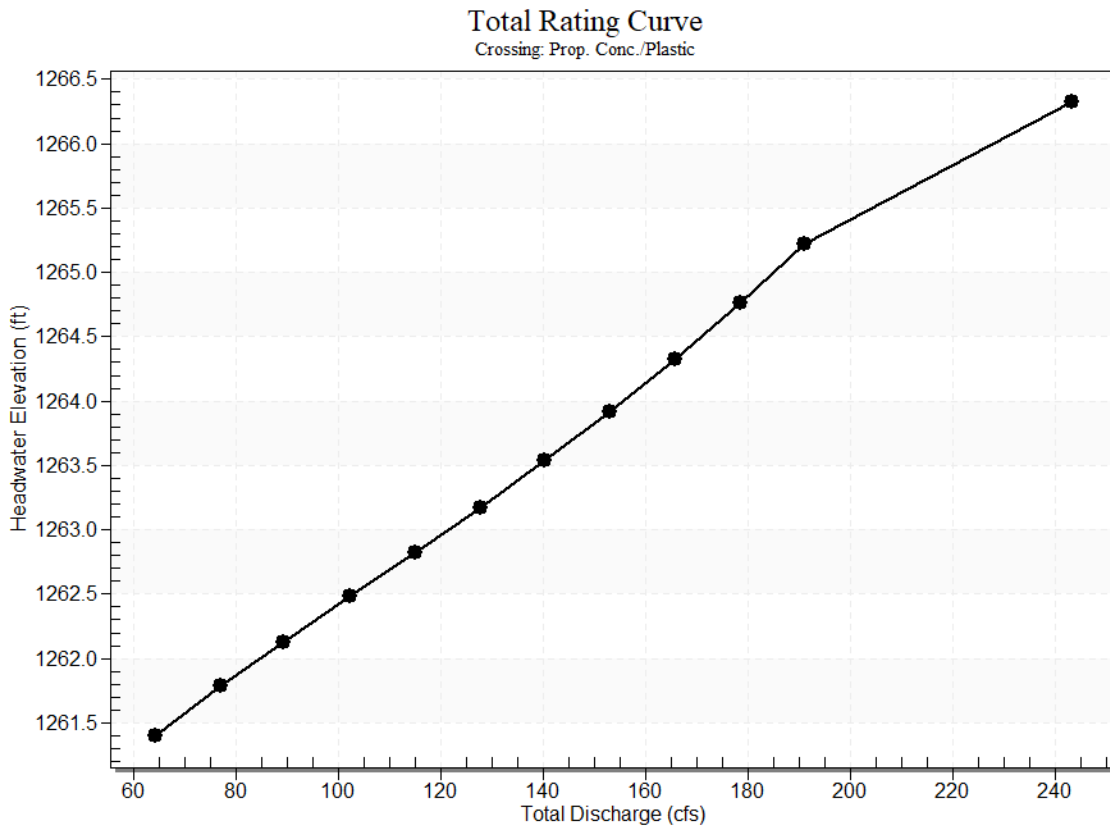
Design Flow: 89.10 cfs

Maximum Flow: 191.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Prop. Conc./Plastic

Headwater Elevation (ft)	Total Discharge (cfs)	Circular Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1261.40	64.30	64.30	0.00	1
1261.78	76.97	76.97	0.00	1
1262.12	89.10	89.10	0.00	1
1262.48	102.31	102.31	0.00	1
1262.83	114.98	114.98	0.00	1
1263.17	127.65	127.65	0.00	1
1263.54	140.32	140.32	0.00	1
1263.92	152.99	152.99	0.00	1
1264.32	165.66	165.66	0.00	1
1264.76	178.33	178.33	0.00	1
1265.22	191.00	191.00	0.00	1
1266.18	214.44	214.44	0.00	Overtopping

Rating Curve Plot for Crossing: Prop. Conc./Plastic



Culvert Data: Circular

Table 1 - Culvert Summary Table: Circular

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
64.30 cfs	64.30 cfs	1261.40	3.25	1.701	1-S2n	1.61	2.26	1.74	0.78	10.55	7.33
76.97 cfs	76.97 cfs	1261.78	3.63	2.050	1-S2n	1.77	2.48	1.93	0.87	11.01	7.82
89.10 cfs	89.10 cfs	1262.12	3.97	2.390	1-S2n	1.91	2.68	2.10	0.95	11.38	8.23
102.31 cfs	102.31 cfs	1262.48	4.33	2.770	1-S2n	2.06	2.88	2.27	1.03	11.77	8.64

114.9 8 cfs	114.9 8 cfs	1262.8 3	4.68	3.14 5	1- S2 n	2.20	3.06	2.4 4	1.10	12.1 1	8.99
127.6 5 cfs	127.6 5 cfs	1263.1 7	5.02	3.53 3	5- S2 n	2.33	3.23	2.5 9	1.17	12.4 3	9.32
140.3 2 cfs	140.3 2 cfs	1263.5 4	5.39	3.93 5	5- S2 n	2.46	3.39	2.7 4	1.24	12.7 4	9.63
152.9 9 cfs	152.9 9 cfs	1263.9 2	5.77	4.35 0	5- S2 n	2.59	3.55	2.8 9	1.31	13.0 3	9.92
165.6 6 cfs	165.6 6 cfs	1264.3 2	6.17	4.77 9	5- S2 n	2.72	3.69	3.0 3	1.37	13.3 2	10.19
178.3 3 cfs	178.3 3 cfs	1264.7 6	6.61	5.81 0	5- S2 n	2.85	3.83	3.1 7	1.43	13.6 0	10.44
191.0 0 cfs	191.0 0 cfs	1265.2 2	7.07	6.20 4	5- S2 n	2.98	3.95	3.3 0	1.49	13.8 9	10.68

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

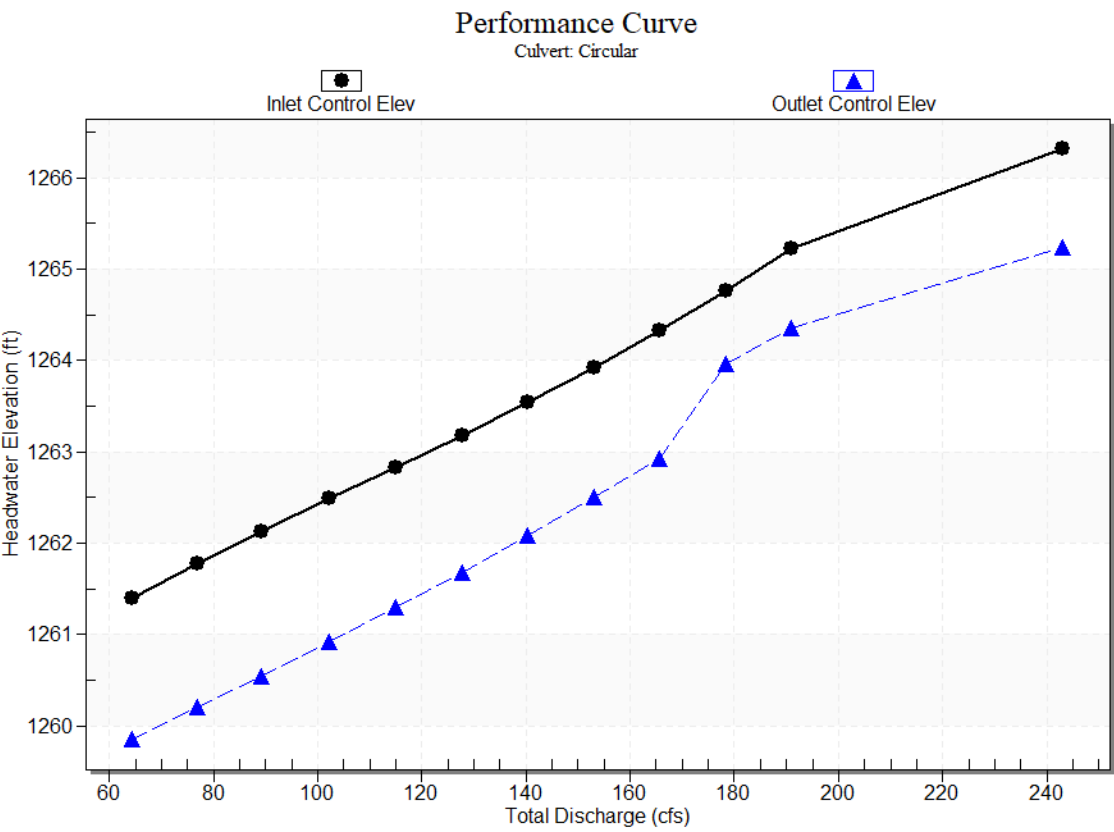
Inlet Elevation (invert): 1258.15 ft,

Outlet Elevation (invert): 1257.30 ft

Culvert Length: 82.00 ft,

Culvert Slope: 0.0104

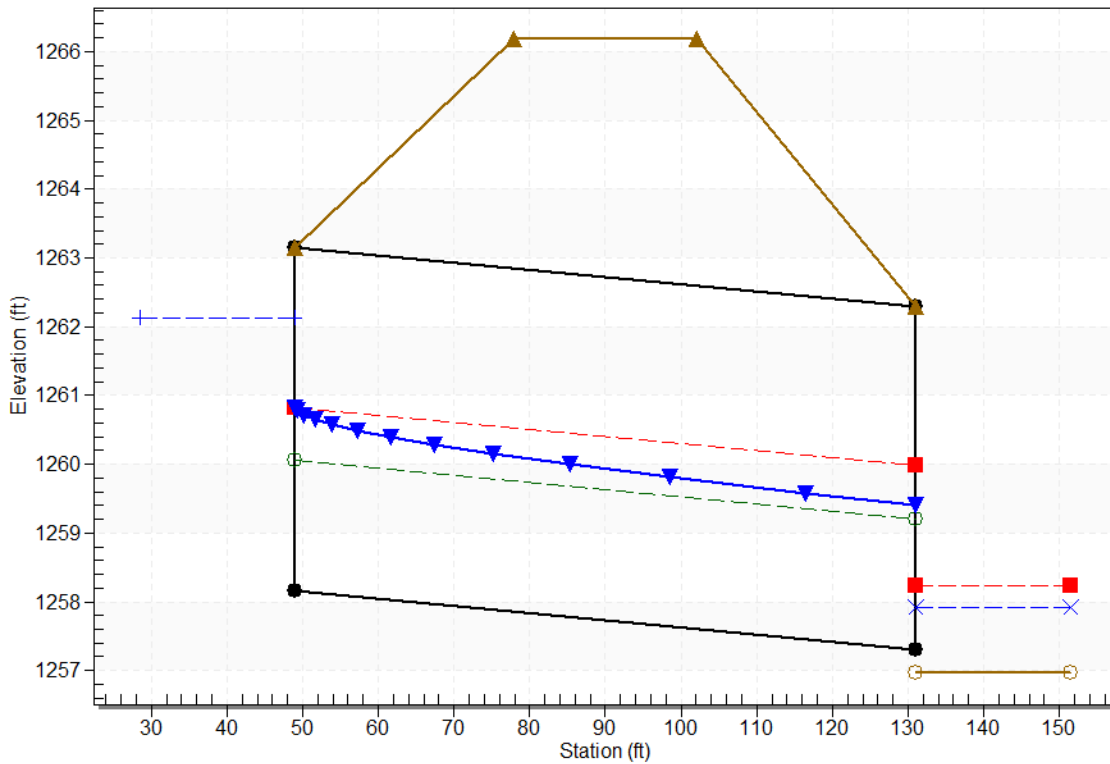
Culvert Performance Curve Plot: Circular



Water Surface Profile Plot for Culvert: Circular

Crossing - Prop. Conc./Plastic, Design Discharge - 89.1 cfs

Culvert - Circular, Culvert Discharge - 89.1 cfs



Site Data - Circular

Site Data Option: Culvert Invert Data

Inlet Station: 49.00 ft

Inlet Elevation: 1258.15 ft

Outlet Station: 131.00 ft

Outlet Elevation: 1257.30 ft

Number of Barrels: 1

Culvert Data Summary - Circular

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall ($K_e=0.5$)

Inlet Depression: None

Tailwater Data for Crossing: Prop. Conc./Plastic

Table 2 - Downstream Channel Rating Curve (Crossing: Prop. Conc./Plastic)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
64.30	1257.75	0.78	7.33	2.37	1.51
76.97	1257.84	0.87	7.82	2.64	1.53
89.10	1257.92	0.95	8.23	2.88	1.55
102.31	1258.00	1.03	8.64	3.13	1.57
114.98	1258.07	1.10	8.99	3.36	1.58
127.65	1258.14	1.17	9.32	3.57	1.59
140.32	1258.21	1.24	9.63	3.78	1.60
152.99	1258.28	1.31	9.92	3.98	1.61
165.66	1258.34	1.37	10.19	4.17	1.62
178.33	1258.40	1.43	10.44	4.36	1.63
191.00	1258.46	1.49	10.68	4.54	1.63

Tailwater Channel Data - Prop. Conc./Plastic

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.50 ft

Side Slope (H:V): 1.00 (:1)

Channel Slope: 0.0488

Channel Manning's n: 0.0350

Channel Invert Elevation: 1256.97 ft

Roadway Data for Crossing: Prop. Conc./Plastic

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 160.00 ft

Crest Elevation: 1266.18 ft

Roadway Surface: Paved

Roadway Top Width: 24.07 ft

HY-8 Culvert Analysis Report – Concrete Box, 6'x4'

Crossing Discharge Data

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

Minimum Flow: 64.30 cfs

Design Flow: 89.10 cfs

Maximum Flow: 191.00 cfs

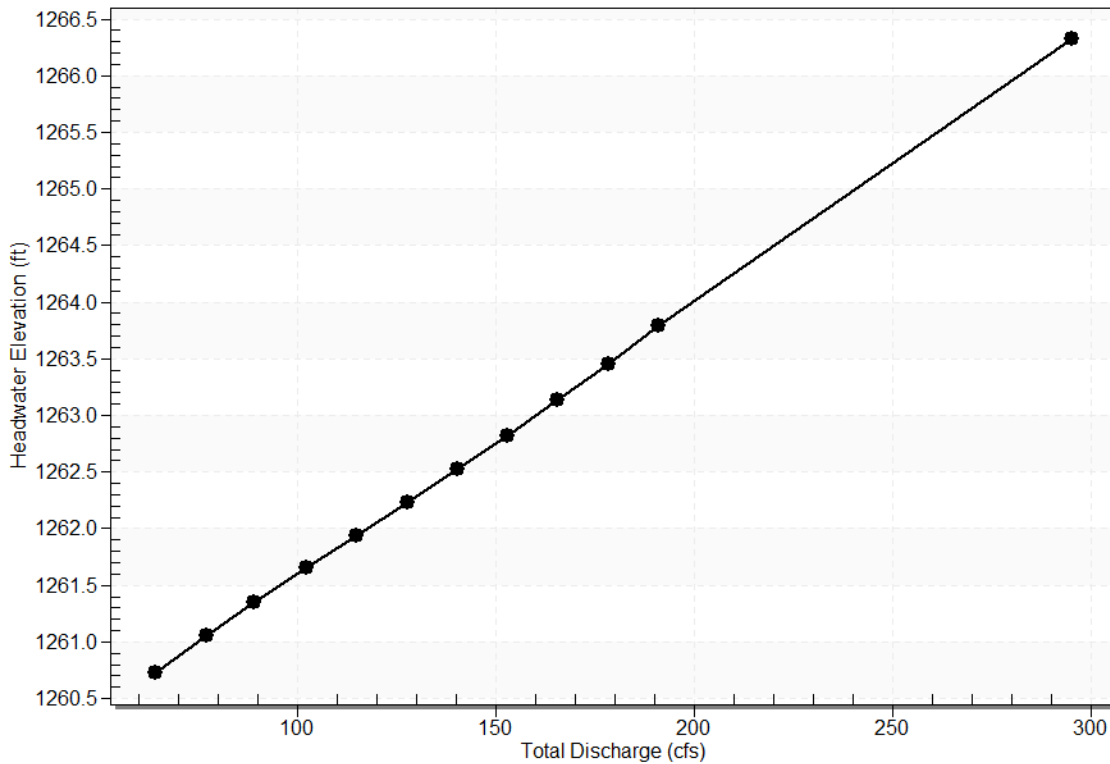
Table 1 - Summary of Culvert Flows at Crossing: Prop. Conc. Box

Headwater Elevation (ft)	Total Discharge (cfs)	Box Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1260.73	64.30	64.30	0.00	1
1261.05	76.97	76.97	0.00	1
1261.34	89.10	89.10	0.00	1
1261.65	102.31	102.31	0.00	1
1261.94	114.98	114.98	0.00	1
1262.23	127.65	127.65	0.00	1
1262.52	140.32	140.32	0.00	1
1262.82	152.99	152.99	0.00	1
1263.13	165.66	165.66	0.00	1
1263.45	178.33	178.33	0.00	1
1263.79	191.00	191.00	0.00	1
1266.18	265.60	265.60	0.00	Overtopping

Rating Curve Plot for Crossing: Prop. Conc. Box

Total Rating Curve

Crossing: Prop. Conc. Box



Culvert Data: Box

Table 1 - Culvert Summary Table: Box

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
64.30 cfs	64.30 cfs	1260.73	2.58	0.875	1-S2n	1.02	1.53	1.09	0.78	9.79	7.33
76.97 cfs	76.97 cfs	1261.05	2.90	1.155	1-S2n	1.15	1.72	1.25	0.87	10.28	7.82
89.10 cfs	89.10 cfs	1261.34	3.19	1.428	1-S2n	1.27	1.90	1.39	0.95	10.70	8.23
102.31 cfs	102.31 cfs	1261.65	3.50	1.731	1-S2n	1.39	2.08	1.54	1.03	11.10	8.64

114.9 8 cfs	114.9 8 cfs	1261.9 4	3.79	2.03 1	1- S2 n	1.51	2.25	1.6 8	1.10	11.4 3	8.99
127.6 5 cfs	127.6 5 cfs	1262.2 3	4.08	2.34 0	5- S2 n	1.63	2.41	1.8 1	1.17	11.7 5	9.32
140.3 2 cfs	140.3 2 cfs	1262.5 2	4.37	2.65 9	5- S2 n	1.74	2.57	1.9 4	1.24	12.0 3	9.63
152.9 9 cfs	152.9 9 cfs	1262.8 2	4.67	2.98 9	5- S2 n	1.85	2.72	2.0 7	1.31	12.3 1	9.92
165.6 6 cfs	165.6 6 cfs	1263.1 3	4.98	3.33 0	5- S2 n	1.95	2.87	2.2 0	1.37	12.5 5	10.19
178.3 3 cfs	178.3 3 cfs	1263.4 5	5.30	4.17 4	5- S2 n	2.06	3.02	2.3 2	1.43	12.7 9	10.44
191.0 0 cfs	191.0 0 cfs	1263.7 9	5.64	4.46 8	5- S2 n	2.16	3.16	2.4 5	1.49	13.0 1	10.68

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

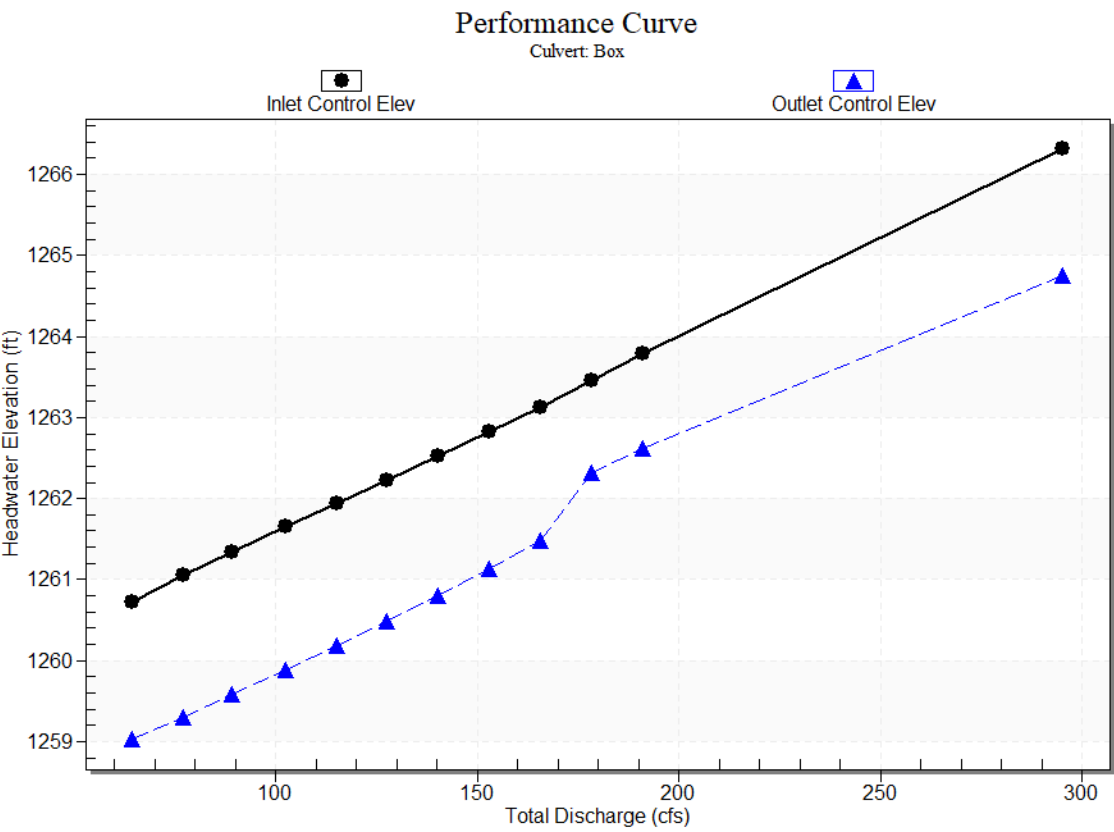
Inlet Elevation (invert): 1258.15 ft,

Outlet Elevation (invert): 1257.30 ft

Culvert Length: 82.00 ft,

Culvert Slope: 0.0104

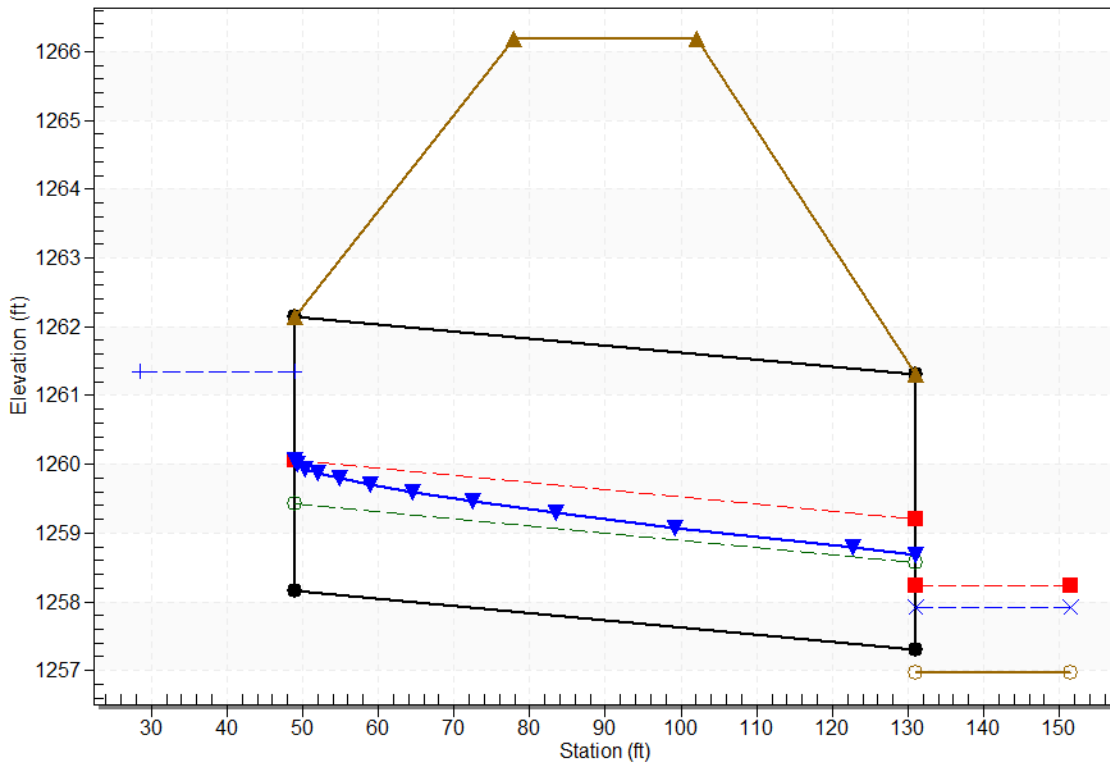
Culvert Performance Curve Plot: Box



Water Surface Profile Plot for Culvert: Box

Crossing - Prop. Conc. Box, Design Discharge - 89.1 cfs

Culvert - Box, Culvert Discharge - 89.1 cfs



Site Data - Box

Site Data Option: Culvert Invert Data

Inlet Station: 49.00 ft

Inlet Elevation: 1258.15 ft

Outlet Station: 131.00 ft

Outlet Elevation: 1257.30 ft

Number of Barrels: 1

Culvert Data Summary - Box

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Prop. Conc. Box

Table 2 - Downstream Channel Rating Curve (Crossing: Prop. Conc. Box)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
64.30	1257.75	0.78	7.33	2.37	1.51
76.97	1257.84	0.87	7.82	2.64	1.53
89.10	1257.92	0.95	8.23	2.88	1.55
102.31	1258.00	1.03	8.64	3.13	1.57
114.98	1258.07	1.10	8.99	3.36	1.58
127.65	1258.14	1.17	9.32	3.57	1.59
140.32	1258.21	1.24	9.63	3.78	1.60
152.99	1258.28	1.31	9.92	3.98	1.61
165.66	1258.34	1.37	10.19	4.17	1.62
178.33	1258.40	1.43	10.44	4.36	1.63
191.00	1258.46	1.49	10.68	4.54	1.63

Tailwater Channel Data - Prop. Conc. Box

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.50 ft

Side Slope (H:V): 1.00 (:1)

Channel Slope: 0.0488

Channel Manning's n: 0.0350

Channel Invert Elevation: 1256.97 ft

Roadway Data for Crossing: Prop. Conc. Box

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 160.00 ft

Crest Elevation: 1266.18 ft

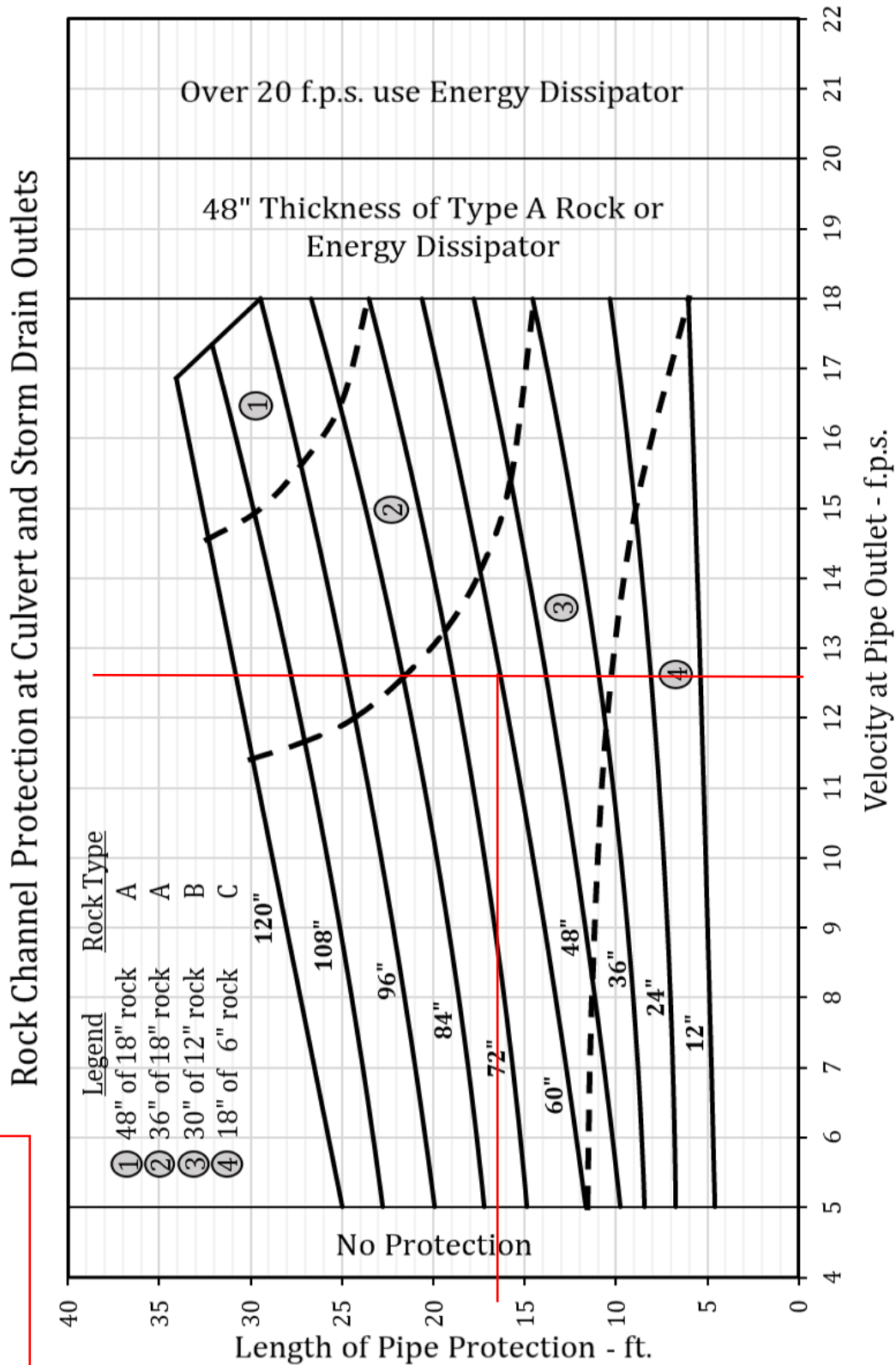
Roadway Surface: Paved

Roadway Top Width: 24.07 ft

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS

1002-4

REFERENCE SECTION
1002.2.3



LOG-287-7.27
V = 12.58fps
D = 60"
17'x10.5'
30" OF 12"
TYPE B ROCK

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS	1002-4
	REFERENCE SECTION 1002.2.3

Notes:

Rock size (6", 12", 18") indicates the square opening on which 85% of the material by weight is retained.

Provide rock channel protection the width of the headwall with a minimum of 4'.

No rock channel protection is required where the natural stream bed will withstand the calculated velocity without erosion.

Equations for length of protection:

Rise	Length
120"	$L = 0.764996 * V + 21.17502$
108"	$L = 0.0203 * V^2 + 0.3004 * V + 20.765$
96"	$L = 0.0184 * V^2 + 0.3121 * V + 17.892$
84"	$L = 0.0261 * V^2 + 0.1234 * V + 15.970$
72"	$L = 0.0251 * V^2 + 0.0897 * V + 13.798$
60"	$L = 0.0139 * V^2 + 0.3683 * V + 9.4671$
48"	$L = 0.0151 * V^2 + 0.2661 * V + 8.0899$
36"	$L = 0.0262 * V^2 + 0.1341 * V + 8.4794$
24"	$L = 0.0182 * V^2 + 0.1404 * V + 6.983$
12"	$L = 0.0014 * V^2 + 0.0816 * V + 4.1255$

V=Velocity (f.p.s.)

L=Length of minimum Rock Channel Protection (ft.)

County	Sevier	Route	387	Section	7.22	RDP	114483	Name	Charles
Station	20-06	Station					Scan #	06	

User Input	
pH _a	Abatement Level
7.0	2.0

Constants and Calculated Values			
pH _a	Sediment/Rate	End of Service Life GA	Service Life Required
7.6	0	4	75

[illegible]

Concrete Conduit Durability Results						
Material	**706.01 Non-reinforced Concrete Pipe	**706.02 Reinforced Concrete Corrugated Pipe	**706.03 Reinforced Concrete Pipe, Heavy Corrugated	**706.04 Reinforced Concrete Elliptical Conduit, Storm Drains, and Sewer Pipes	**706.05 Prestressed Reinforced Concrete Box Sections	706.06 Clay Drain Tile
Conduit Use and Shape	Conduit or Storm Sewer - Round	Conduit or Storm Sewer - Round	Conduit or Storm Sewer - Round or Elliptical	Conduit or Storm Sewer - Elliptical	Conduit or Storm Sewer - Box	Conduit or Storm Sewer - Round

Plastic Conduit Durability Results												
Material	707.35 Corrugated Polyethylene Smooth Liner Pipe	707.34 Polyethylene Plastic Pipe Based on Oxidize Diamer (OD)	707.36 Polyethylene Profile	707.42 Polyvinyl Chloride Corrugated Smooth Interior Pipe	707.43 Polyvinyl Chloride Profile Wall Pipe	707.45 Polyvinyl Chloride Solid Wall Pipe	707.46 Polyvinyl Chloride Corrugated Corrug Waste and Vent Pipe	707.47 ABS and Polyethylene Chloride Composite Pipe	707.48 Polyvinyl Chloride Large Diameter Solid Wall Pipe	707.65 Corrugated Polypropylene Smooth Liner Pipe	707.75 Glass-Fiber-Reinforced Polyester	748.02 Polyvinyl Chloride (PVC) Joints, Joints, and Fittings
Conduit Use and Shape	Culvert, Storm Sewer, or Under-Pipe - Round	Culvert, Storm Sewer, or Under-Pipe - Round	Culvert, Storm Sewer, or Under-Pipe - Round	Storm Sewer or Under-Pipe - Round	Storm Sewer or Under-Pipe - Round	Storm Sewer or Under-Pipe - Round	Storm Sewer - Round	Storm Sewer - Round	Storm Sewer - Round	Culvert or Storm Sewer - Round	Culvert, Storm Sewer, or Under-Pipe - Round	Storm Sewer - Round

Notes:

- Many metal options are eliminated when abrasion level equals 4 or greater
- Aluminum is only available between pH levels ranging from 5.0 to less than 9.0
- Aluminum protective coating is 1 year when pH levels are outside of allowable for Aluminum
- Polymers coated is only available for pH ranges greater than 5.0 and less than 9.0
- Options were eliminated when the NCSHA online Service Life Calculator did not recommend option; typically due to abrasive conditions or pH limitations
- Expense is required on all concrete surfaces when pH=5
- ** Smooth finish
- ** Minimum average cost per industry consensus; see Reference Data
- ** Provide concrete floor panning on corrugated metal conduits 60" or larger where the invert is always submerged due to tail water conditions from a body of water

Constants	
Protective Coating Constants-Initial Service Life (years)	
Concrete Invert Paving	20
Aluminasols	35
Aluminized Steel Ribs	35
Polymeric	50
Bituminous coated w/ bitum, paved invert	30
Bituminous lined	25
Galvanized	0

60" TYPE A CONDUIT, 707.01 (0.109) WITH CFP, 707.02 (0.064) ALUMINIZED, 707.04 (0.064) POLYMERIC, 706.02, 707.33

National Flood Hazard Layer FIRMMette



83°36'54"W 40°16'4"N



0 250 500 1,000 1,500 2,000 Feet

1:6,000

83°36'17"W 40°15'36"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **10/28/2024 at 5:54 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

[illegible]

 Estuarine and Marine Deepwater
 Estuarine and Marine Wetland

 Freshwater Emergent Wetland
 Freshwater Forested/Shrub Wetland
 Freshwater Pond

 Lake
 Other
 Riverine

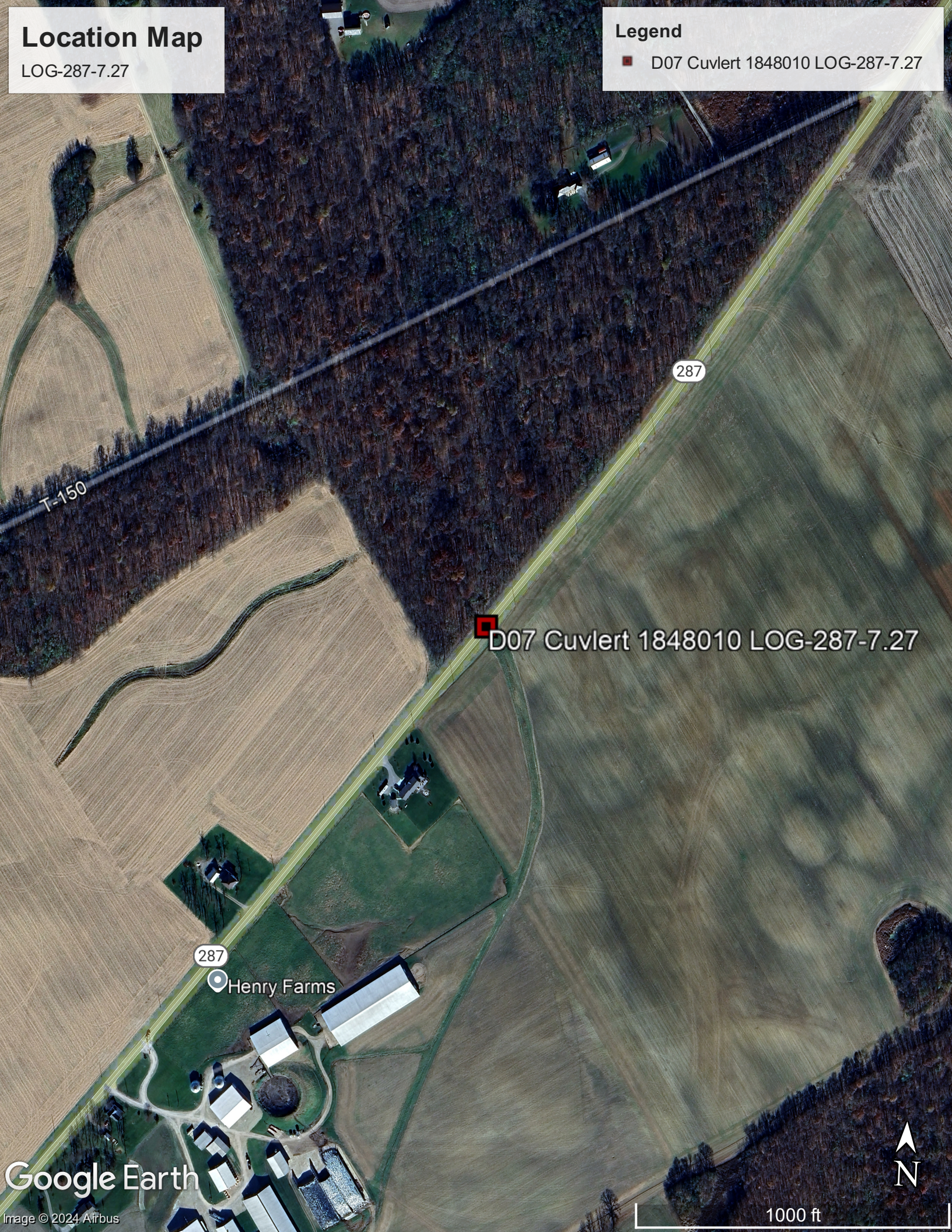
National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

Location Map

LOG-287-7.27

Legend

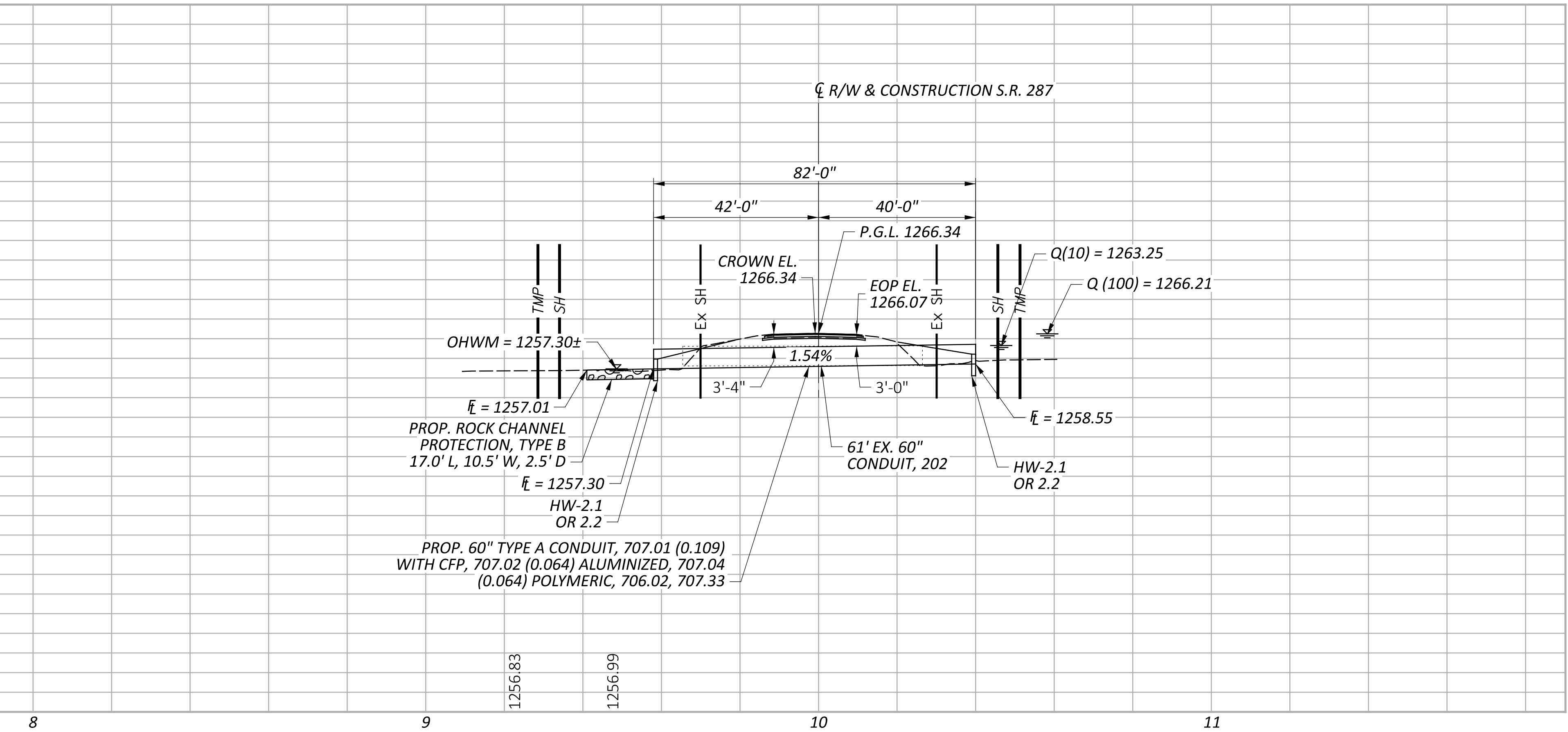
■ D07 Cuvlert 1848010 LOG-287-7.27



Google Earth

Image © 2024 Airbus

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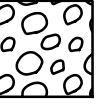
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ESTIMATED QUANTITIES			
ITEM	QUANTITY	UNIT	DESCRIPTION

HYDRAULIC DATA			
DRAINAGE AREA = 0.22 SQ. MILES			
Q (10) =	89.1 CFS	V (10) =	12.58 FT/S
Q (100) =	191 CFS	V (100) =	15.10 FT/S
ABRASION LEVEL: 2			
pH: 7.9			

EXISTING STRUCTURE	
TYPE: CORRUGATED METAL PIPE	
DIMENSIONS: 60" DIAMETER	
LENGTH: 61'	
SKEW: 3° 51' 51" RF	
ALIGNMENT: TANGENT	
DATE BUILT: UNKNOWN	
DISPOSITION: POOR (TO BE REPLACED)	
CFN: 1855245	

PROPOSED STRUCTURE	
TYPE: 60" CONDUIT, TYPE A, 707.02 (0.109) WITH CFP, 707.02 (0.064) ALUMINIZED, 707.04 (0.064) POLYMERIC, 706.02, 707.34, 707.75	
DIMENSIONS: 60" DIAMETER	
LENGTH: 82'	
SKEW: 0°	
ALIGNMENT: TANGENT	
ROADWAY: 24'-0" ± TREATED SH. TO TREATED SH.	
CFN: 1997600	
COORDINATES: LATITUDE 40° 15' 50" N LONGITUDE 83° 36' 36" W	
DESIGN SERVICE LIFE : 75 YEARS	

LEGEND	
202 - TO BE REMOVED	
DND - DO NOT DISTURB	
 - ROCK CHANNEL PROTECTION, TYPE B W/ FILTER	
NOTES	
EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.	
EXISTING STRUCTURE TO BE REMOVED. ROAD TO BE CLOSED DURING CONSTRUCTION AND TRAFFIC TO BE DETOURED. MAINTENANCE OF TRAFFIC DETAILS ARE SHOWN ON THE DETOUR PLAN SHEETS.	
ROADWAY, PAVEMENT, AND DRAINAGE QUANTITIES ARE SHOWN ON THE ROADWAY SUB-SUMMARY SHEET.	

HORIZONTAL SCALE IN FEET
0 10 20 40

CULVERT DETAILS
LOG-287-7.27

DESIGN AGENCY

CANTON OFFICE
5399 LAUBY ROAD
SUITE 120
NORTH CANTON, OH 44720

DESIGNER
CMK

REVIEWER
ACR 06-13-25

PROJECT ID
116483

SHEET
P.25

TOTAL
0

SECTION 4
LOG-287-10.03
Halle's Engineering & Design

Section 4 Contents

LOG-287-10.03

- Drainage Design Criteria
- Roadway Design Criteria
- Photos
- Hydrology Calculation (Rational Method)
- Hydraulic Analysis (Results Summary, HY-8 Calculations)
- RCP at outlet
- Durability Design
- FEMA Map
- Wetland Information (NWI Mapping)
- Location map and Aerial
- Culvert Detail Sheet

PROJECT INFORMATION:

COUNTY	ROUTE	SECTION	PID
LOGAN	287	10.03	116483

PIPE POLICY:

The Pipe Policy of _____ ODOT _____ will be used for this project.

(Attach a copy of the written pipe policy or furnish a link to the policy. In lieu of a written policy, documentation of locally funded construction practices may be provided)

POST CONSTRUCTION BMP POLICY:

The Post Construction BMP Policy of _____ ODOT _____ will be used for this project.

If a policy other than ODOT's is being used, the following BMP's are permitted:

DRAINAGE WATERSHED(S):

HUC8: Upper Scioto 05060001

HUC12: Headwaters Big Darby Creek 050600011901

PROJECT SPECIFIC INFORMATION AFFECTING DRAINAGE:

Project will replace a culvert and adjust roadside ditches as needed to
accommodate the new culvert.

Traffic:	2026 ADT: 1,400 2046 ADT: 1,400	From ODOT TFMS - segment Forecast Report
Drainage area = 0.0269 sq. mi. = 17.21 ac.		

1002-1	Minimum Culvert Sizes: 15" for Fill <8'	
1004	Flood Clearance	
1004.2	Other Highways under 3000 ADT 10% AEP (10-yr)	
1006	Allowable Headwater	
	A. 1ft below near low edge of pavement (area less than 1000ac)	1142.78
	B. 2ft above inlet crown	1144.20
	C. 4ft above inlet crown in a deep ravine	N/A
1006.2.2	Check Storm Controls	
	A. 2ft below lowest ground elevation adjacent to an occupied building for a 2% AEP storm	1142.23
	B. Limit max. 1%AEP storm headwater to 2x the diameter or rise of culvert	1146.95
	C. size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with existing culvert	N/A
	D. Size replacement structure so flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure.	1141.95

1101-2	RDF Curve: B
--------	--------------

1102.3	Ditch Design Criteria
	< 3000 ADT
	Depth of Flow 20% AEP
	Shear Stress 50% AEP
	Tc = 15 minutes, min.
	Depth limited to 1' below edge of pavement or overtop ditch bank in toe of slope ditches

1103	Pavement Drainage - N/A no curbed pavement
------	--

1104	Storm Sewers - N/A no storm sewers
------	------------------------------------

1008.1	Corrugated and Spiral Rib Steel and Aluminum Pipes, Corrugated Steel and Aluminum Pipe Arches		
1008-2	Corrugated Steel Pipe Min. cover		
	707.01, 707.04, 707.05, 707.13		
	2 2/3"x1/2" Corrugations	49"x33"	12"
1008-8	Corrugated Aluminum Pipe Min. cover		
	707.21 2 2/3"x1/2" Corrugations	49"x33"	12"

1008.2	Rigid Pipes	
1008.2.2	Min. height of cover	15" to pavement surface, including 9" min to top of subgrade
		9" min. to finished grade if not under pavement

1105.5.5	Culvert Manning's n	n = 0.012 all smooth flow pipe	
	Corrugated Metal Pipe Type A Conduit		
	1/2" Corrugations	49"x33"	n=0.024



gai consultants

Subject: LOG-CR-FY27 - LOG-287-10.03

Roadway Design Criteria

Calc. by: HE Date: 11/26/24 Check by:

PID.: 116483

Sheet 1 of 1

Date:

Culvert LOG-287-10.03

Design Designation		Source			Remarks
Opening Year ADT	1,400				
Design Year ADT (2046)	1,400				
Design Hourly Volume	250				
Directional Distribution, D	67.2%				
Trucks, T24	8%				
Design Speed, DS (mph)	40				
Legal Speed (mph)	35				
Functional Classification, FC	Rural Minor Collector				
Curbed?	No				
NHS Project					
	Criterion	Value	Source (L&D Vol 1)	Control Parameter	Remarks
Horizontal Alignment					
	Stopping Sight Distance, SSD (ft)	305	Fig 201-1	DS	
	Passing Sight Distance, PSD (ft)	600	Fig 201-3	DS	Requires K-Crest = 129' min
	Intersection Sight Distance, ISD (ft) (left)		Fig 201-5	DS	No intersection present
	Intersection Sight Distance, ISD (ft) (right)		Fig 201-5	DS	No intersection present
	Decision Sight Distance, DSD, stop (ft)	330	Fig 201-6	DS	Rural Stop
	Decision Sight Distance, DSD, change (ft)	600	Fig 201-6	DS	Rural Speed/Path/Direction Change
	Max. C.L. deflection w/out Horz. Curve	2° 05'	Fig 202-1	DS	
	Dist. Between Horz. Deflections (ft)	100'	Fig 202-1	DS	Recommended minimum
	Maximum Degree of Curvature, DC	12°45'	Fig 202-2	DS	Minimum radius = 449'; Dc = 5729.58/R
	Maximum Dc w/out Superelevation	1°08'	Fig 202-3	DS	Minimum radius = 5,055'; Dc = 5729.58/R
Maximum Dc w/out a Spiral	NA	Fig 202-11	DS		
Vertical Alignment					
	Maximum Vertical Grade	7	Fig 203-1	FC&DS	Level Terrain
	Minimum Vertical Grade	0.00%	Sec 203.2.2		For non-curbed pavement
		0.50%	Sec 203.2.2		For curbed pavement
	Maximum Vertical Grade Break	0.75%	Fig 203-2	DS	
	Min. Dist. Between VC's and Breaks (ft)	50	Fig 203-2	DS	Recommended minimum
	Minimum K value - Crest VC	44	Fig 203-3	DS	SSD = 305'
	Minimum K value - Sag VC	64	Fig 203-6	DS	SSD = 305'
Minimum VC length (ft)	120	Sec 203.3.3 & 4	DS	Length = 3 x (DS in feet)	
Typical Section					
	Number of Lanes	2		Scope	Same as existing
	Minimum Design Level of Service (LOS)	C	Fig 301-1	FC, Locale	Rural & Level
	Minimum Lane Width (ft)	11	Fig 301-2	FC&DS	Same as existing per Scope
	Pavement Width Transition	40:1	Sec 301.1.4	DS	L=WS
	Treated Shoulder Width (ft)	4'	Fig 301-3,4	FC&ADT	Use same as existing
	Graded Shoulder Width (ft) with Barrier	7'	Fig 301-3,4	FC&ADT	Use same as existing
	" w/out Barrier, Foreslope Steeper than 6:1	6'	Fig 301-3,4	FC&ADT	Use same as existing
	" w/out Barrier, Foreslope 6:1 or flatter	5'	Fig 301-3,4	FC&ADT	Use same as existing
	Minimum Curbed Shoulder Width (Parking)	NA	Fig 301-4		Not a curbed roadway
	Minimum Curbed Shoulder Width (No Parking)	NA	Fig 301-4		Not a curbed roadway
	Shoulder Width Taper	25:1	Sec 301.2.3.2		For decreasing shoulder width
		5:1	Sec 301.2.3.2		For increasing shoulder width
	Guardrail Offset (ft)	4' Min	Fig 301-3	FC&ADT	No guardrail
	Curve Widening	N/A	Fig 301-5c	FC&DS	Depends on Dc or curve radius
	Clear Zone (ft), foreslope 6:1 or flatter	11	Fig 600-1	DS&ADT	750<ADT<1,500
	Clear Zone (ft), foreslope 6:1 to 4:1	13	Fig 600-1	DS&ADT	750<ADT<1,500
	Clear Zone (ft), backslope 6:1 or flatter	11	Fig 600-1	DS&ADT	750<ADT<1,500
	Clear Zone (ft), backslope 6:1 to 4:1	11	Fig 600-1	DS&ADT	750<ADT<1,500
	Clear Zone (ft), backslope steeper than 4:1	11	Fig 600-1	DS&ADT	750<ADT<1,500



LOG-287-10.03: Outlet End. Field measurement of pH.



LOG-287-10.03: Outlet End. Looking East.



LOG-287-10.03: Outlet End. Inside view.



LOG-287-10.03: Outlet End. Looking northwest.



LOG-287-10.03: Outlet End. Looking west.



LOG-287-10.03: Inlet End. Looking southeast.



LOG-287-10.03: Inlet End – Looking southwest.



LOG-287-10.03: Inlet End – Looking southwest.

Hydrology Calculation (Rational Method)

LAND USE

	SQ.FT	ACRE		
Total Drainage Area	749,594	17.208		
			AREA	RUNOFF COEFFICIENT (C)
			SQ.FT	Table 1101-2
Impervious (Pvmt,walk,bldg)			79,935	1.835
Residential (single family)			183,361	4.209
Berms and slopes 4:1 or flatter			486,298	11.164
Weighted Curve Number =	0.52	749,594	17.208	8.92

TIME OF CONCENTRATION

OVERLAND FLOW

Runoff coefficient, C (Table 1101-2)	0.5
Flow length, L (total L < 300 ft) [ft]	300
Overland slope, S [%]	2.50
Time of overland flow [mins]	13.78

$$t_o = 1.811 \cdot C \cdot L^{1/2} \cdot S^{-1/4}$$

Where:

t_o = Time of overland flow in minutes

C = Runoff coefficient

L = Distance to most remote location in drainage area in feet

S = Overland slope (percent)

SHALLOW CONCENTRATED FLOW

Flow length, L [ft]	581
Intercept coefficient, k (Table 1101-1)	0.213
Overland slope, S [%]	3.70
Velocity, V [ft/sec]	1.35
Time of shallow concentrated flow [mins]	7.16

$$V = 3.3kS^{1/2}$$

Where:

V = Velocity in fps

k = Intercept coefficient (see Table 1101-1)

S = Overland slope (percent)

$$t_s \text{ or } t_c = \frac{L}{60V}$$

Where:

t_s = Travel time for shallow concentrated flow in minutes

t_c = Travel time for open channel or pipe flow in minutes

L = Flow length in feet

V = Velocity in fps

OPEN CHANNEL FLOW

Flow length, L [ft]	561
Manning's coefficient, n (Table 1102-2)	0.03
Slope, S [ft/ft]	0.0232
Area, A [sf]	2
Wetted perimeter, P [ft]	5.23
Hydraulic radius, R [ft]	0.38
Velocity, V [ft/sec]	3.99
Time of open channel flow [mins]	2.35

$$R = A/P$$

$$V = (1.49/n) \cdot (R^{2/3}) \cdot (S^{0.5})$$

Total time of concentration [mins]	23.29
------------------------------------	-------

RAINFALL INTENSITY

	10% AEP	2% AEP	1% AEP
Time of concentration [mins]	23.29	23.29	23.29
Constant a	73.126	65.621	85.047
Constant b	12.000	10.000	13.250
Constant c	0.863	0.781	0.806
Rainfall intensity, i [inches/hour]	3.38	4.25	4.68

DISCHARGE RESULTS

	10% AEP	2% AEP	1% AEP
Runoff coefficient, C	0.52	0.52	0.52
Rainfall intensity, i [inches/hour]	3.38	4.25	4.68
Drainage area, A [acres]	17.208	17.208	17.208
Discharge, Q [cf/sec]	30.11	37.87	41.71

$$Q = C \cdot i \cdot A$$

Where:

Q = Discharge in cubic feet per second

C = Coefficient of runoff

i = Average rainfall intensity in inches per hour, for a given AEP storm and for a duration equal to the time of concentration.

A = Drainage area in acres

Rainfall Intensity-Frequency-Duration Curves

1101-2

REFERENCE SECTION

1101.2.3

The Rainfall Intensity-Duration-Frequency (IDF) curves are based upon precipitation data obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14. The precipitation data was collected between 4/1863 to 12/2000.

Rainfall depth varies across the State with more rainfall depth present in the Southwest portion of the state and gradually decreasing towards the Northeast. IDF curves were developed for 4 regions across the State to simplify hydraulic design. The regions were determined by normalizing contours created from NOAA precipitation GIS data from the 10% AEP, 60 minute duration.

Federal Highway Administration Hydraulic Engineering Circular No. 12 Appendix A offers a methodology for converting IDF data points to an equation of the general form:

$$i = a/(t+b)^c$$

Where: i = rainfall intensity (inches/hour)
 t = time of concentration (minutes)
 a = constant
 b = constant
 c = constant

The IDF Curves can be expressed using the above general equation utilizing the constants shown below.

Intensity Zone	AEP %	Constant a	Constant b	Constant c
A	50	46.184	9.000	0.859
	20	56.985	10.250	0.851
	10	64.167	11.000	0.842
	4	66.528	11.000	0.811
	2	65.702	10.750	0.782
	1	64.489	10.500	0.754
B	50	47.987	9.000	0.859
	20	60.684	10.500	0.858
	10	73.126	12.000	0.863
	4	75.841	12.000	0.833
	2	65.621	10.000	0.781
	1	85.047	13.250	0.806
C	50	56.299	10.000	0.876
	20	67.933	11.000	0.869
	10	84.550	13.000	0.882
	4	95.736	14.000	0.871
	2	96.783	14.000	0.850
	1	80.436	11.500	0.794
D	50	57.448	10.000	0.876
	20	67.933	11.000	0.869
	10	79.192	12.000	0.864
	4	87.886	12.750	0.849
	2	95.169	13.500	0.839
	1	91.982	13.000	0.810

LAND USE



Culvert Check

12/9/2024

49"x33" Corrugated Metal Pipe Arch

n=0.0240

1006.1 Design AEP Storm

Use the design AEP storm as shown in Section 1004.2.

1006.2 Culvert Headwater Controls

1006.2.1 Design Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the design storm:

- A. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.
- B. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat terrain.

1006.2.2 Check Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the applicable check storm.

- A. 2 feet below the lowest ground elevation adjacent to an occupied building for a 2% AEP storm. This is not intended to lower existing high-water elevations around buildings.
- B. Limit the maximum 1% AEP storm headwater depth to twice the diameter or rise of the culvert.
- C. Size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with the existing structure.
- D. Size a replacement structure so that flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure. Before implementing this criteria consider the type of upstream property and land use.

1006.2.1

A.

EOP Elev. - 2' 1141.78 ft

EOP Elev. - 1' 1142.78 ft

Design Elev. 1141.56 ft

B.

Inlet Crown Elev. + 2' 1144.20 ft

Design Elev. 1141.56 ft

1006.2.2

A.

Min. Build. Elev. - 2' 1142.23 ft

Design Elev. 1141.93 ft

B.

Elev. Culvert Rise x 2 1146.95 ft

Design Elev. 1142.09 ft

C.

No overtopping

D.

Ex. 1% HW 1141.95 ft

Prop. 1% HW 1142.09 ft

Insignificant increase in upstream flood

Culvert Check

12/9/2024

34"x53" Concrete Elliptical Pipe

n=0.012

1006.1 Design AEP Storm

Use the design AEP storm as shown in Section 1004.2.

1006.2 Culvert Headwater Controls

1006.2.1 Design Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the design storm:

- A. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.
- B. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat terrain.

1006.2.2 Check Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the applicable check storm.

- A. 2 feet below the lowest ground elevation adjacent to an occupied building for a 2% AEP storm. This is not intended to lower existing high-water elevations around buildings.
- B. Limit the maximum 1% AEP storm headwater depth to twice the diameter or rise of the culvert.
- C. Size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with the existing structure.
- D. Size a replacement structure so that flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure. Before implementing this criteria consider the type of upstream property and land use.

1006.2.1

A.

EOP Elev. - 2' 1141.78 ft

EOP Elev. - 1' 1142.78 ft

Design Elev. 1141.33 ft

B.

Inlet Crown Elev. + 2' 1144.20 ft

Design Elev. 1141.33 ft

1006.2.2

A.

Min. Build. Elev. - 2' 1142.23 ft

Design Elev. 1141.67 ft

B.

Elev. Culvert Rise x 2 1146.95 ft

Design Elev. 1141.81 ft

C.

No overtopping

D.

Ex. 1% HW 1141.95 ft

Prop. 1% HW 1141.81 ft

Culvert Check

5/28/2025

36" Reinforced concrete pipe (RCP)

n=0.012

1006.1 Design AEP Storm

Use the design AEP storm as shown in Section 1004.2.

1006.2 Culvert Headwater Controls

1006.2.1 Design Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the design storm:

- A. 2 feet below the near, low edge of the pavement for drainage areas 1000 acres or greater and 1 foot below for culverts draining less than 1000 acres.
- B. 2 feet above the inlet crown of the culvert or above a tailwater elevation that submerges the inlet crown in flat terrain.

1006.2.2 Check Storm Controls

Headwater depth for all culverts (Type A Conduits) must not exceed any of the following controls for the applicable check storm.

- A. 2 feet below the lowest ground elevation adjacent to an occupied building for a 2% AEP storm. This is not intended to lower existing high-water elevations around buildings.
- B. Limit the maximum 1% AEP storm headwater depth to twice the diameter or rise of the culvert.
- C. Size a replacement structure to prevent overtopping by the 1% AEP storm where overtopping would not occur with the existing structure.
- D. Size a replacement structure so that flooding of upstream land is not increased for the 1% AEP storm when compared to the existing structure. Before implementing this criteria consider the type of upstream property and land use.

1006.2.1

A.

EOP Elev. - 2'

1141.78 ft

EOP Elev. - 1'

1142.78 ft

Design Elev.

1142.14 ft

B.

Inlet Crown Elev. + 2'

1144.20 ft

Design Elev.

1142.14 ft

1006.2.2

A.

Min. Build. Elev. - 2'

1142.23 ft

Design Elev.

1142.62 ft

B.

Elev. Culvert Rise x 2

1146.95 ft

Design Elev.

1142.84 ft

C.

No overtopping

D.

Ex. 1% HW

1141.95 ft

Prop. 1% HW

1142.84 ft

HY-8 Culvert Analysis Report – Existing Pipe Arch.

Crossing Discharge Data

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

Minimum Flow: 30.11 cfs

Design Flow: 30.11 cfs

Maximum Flow: 41.71 cfs

Table 1 - Summary of Culvert Flows at crossing: Ex. Culvert

Headwater Elevation (ft)	Total Discharge (cfs)	Ex. Pipe Arch Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1141.28	30.11	30.11	0.00	1
1141.34	31.27	31.27	0.00	1
1141.40	32.43	32.43	0.00	1
1141.47	33.59	33.59	0.00	1
1141.53	34.75	34.75	0.00	1
1141.60	35.91	35.91	0.00	1
1141.67	37.07	37.07	0.00	1
1141.73	38.23	38.23	0.00	1
1141.80	39.39	39.39	0.00	1
1141.88	40.55	40.55	0.00	1
1141.95	41.71	41.71	0.00	1
1144.30	67.64	67.64	0.00	Overtopping

Rating Curve Plot for crossing: Ex. Culvert

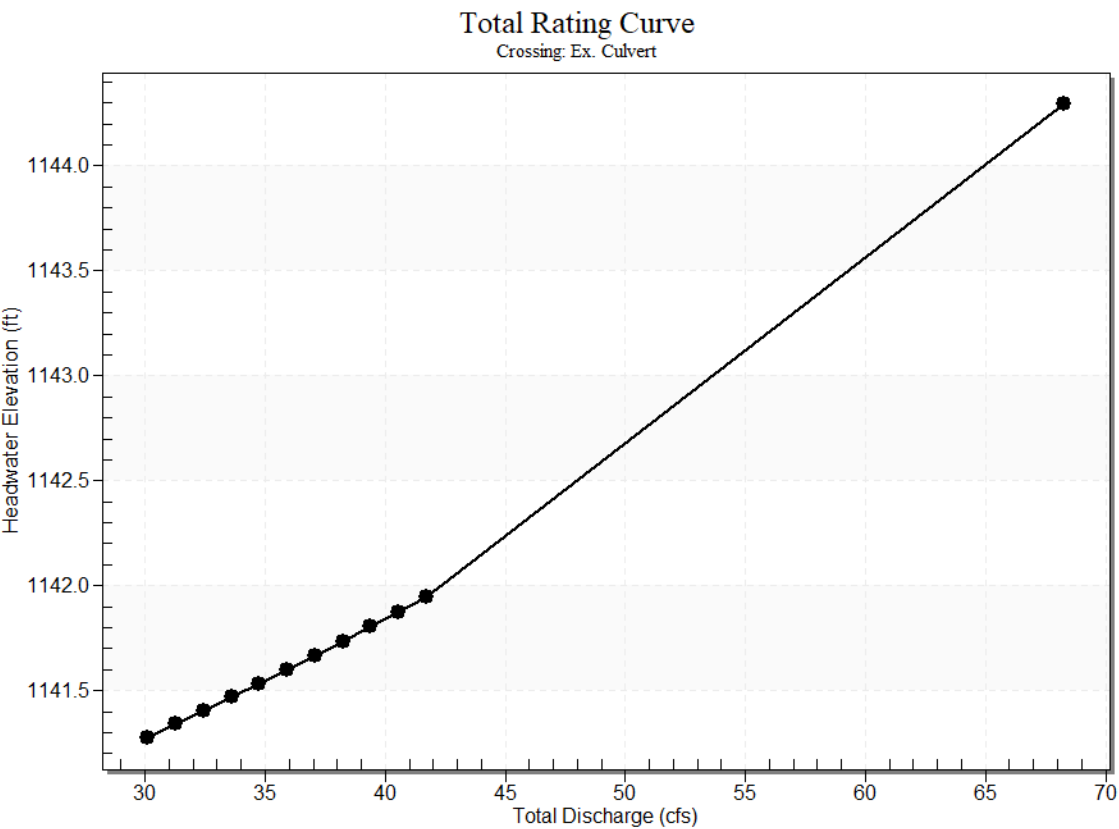


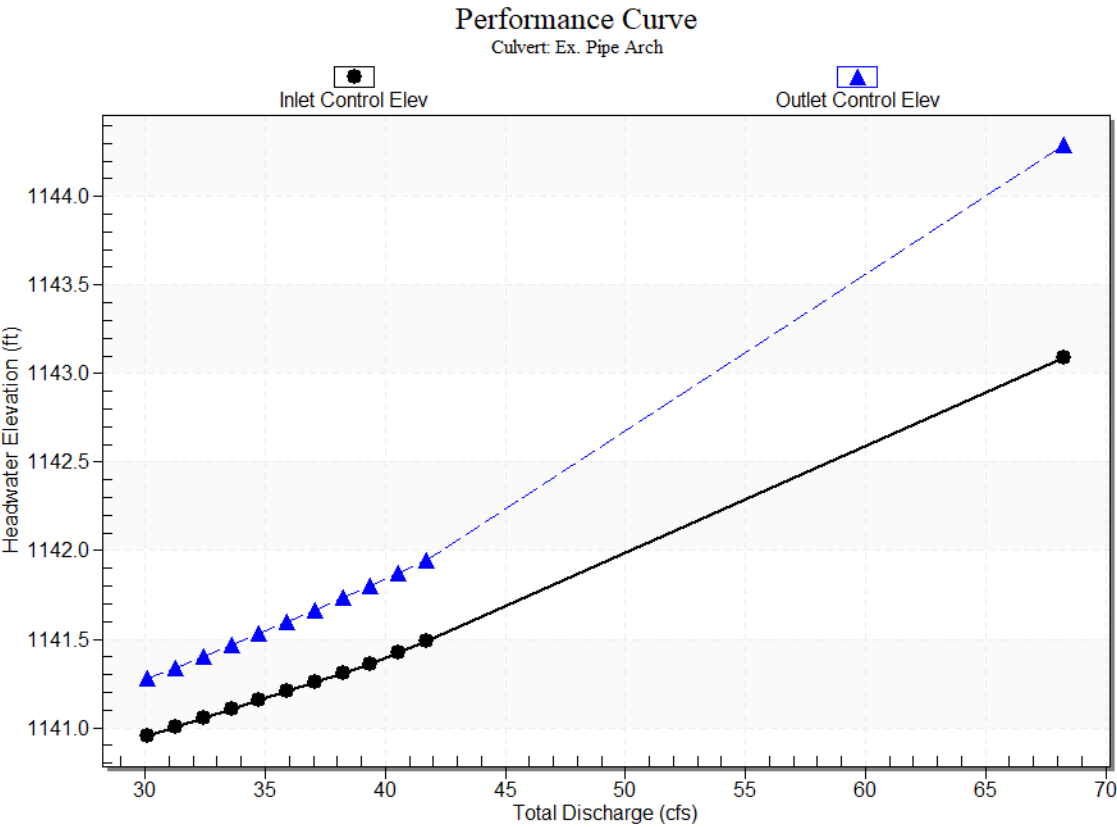
Table 2 - Culvert Summary Table: Ex. Pipe Arch

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	HW / D (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
30.11	30.11	1141.28	1.99	2.314	0.93	2-M2c	2.50	1.26	1.26	0.82	6.27	4.45
31.27	31.27	1141.34	2.04	2.378	0.95	2-M2c	2.50	1.28	1.28	0.83	6.36	4.49
32.43	32.43	1141.40	2.09	2.441	0.98	2-M2c	2.50	1.31	1.31	0.85	6.46	4.54
33.59	33.59	1141.47	2.14	2.506	1.00	7-M2c	2.50	1.34	1.34	0.87	6.55	4.58
34.75	34.75	1141.53	2.19	2.571	1.03	7-M2c	2.50	1.37	1.37	0.88	6.64	4.63
35.91	35.91	1141.60	2.24	2.637	1.05	7-M2c	2.50	1.39	1.39	0.90	6.73	4.67
37.07	37.07	1141.67	2.29	2.704	1.08	7-M2c	2.50	1.42	1.42	0.91	6.82	4.71
38.23	38.23	1141.73	2.34	2.771	1.11	7-M2c	2.50	1.45	1.45	0.92	6.91	4.75
39.39	39.39	1141.80	2.39	2.841	1.14	7-M2c	2.50	1.47	1.47	0.94	7.00	4.79
40.55	40.55	1141.88	2.46	2.912	1.16	7-M2c	2.50	1.50	1.50	0.95	7.09	4.83
41.71	41.71	1141.95	2.53	2.986	1.19	7-M2c	2.50	1.52	1.52	0.97	7.18	4.87
68.25	67.57	1144.29	4.13	5.330	2.13	7-M2c	2.50	1.99	1.99	1.23	9.20	5.57

Culvert Barrel Data

Culvert Barrel Type: Straight Culvert
Inlet Elevation(invert): 1138.96 ft
Outlet Elevation (invert): 1138.74 ft
Culvert Length: 41.22 ft
Culvert Slope: 0.01 ft/ft

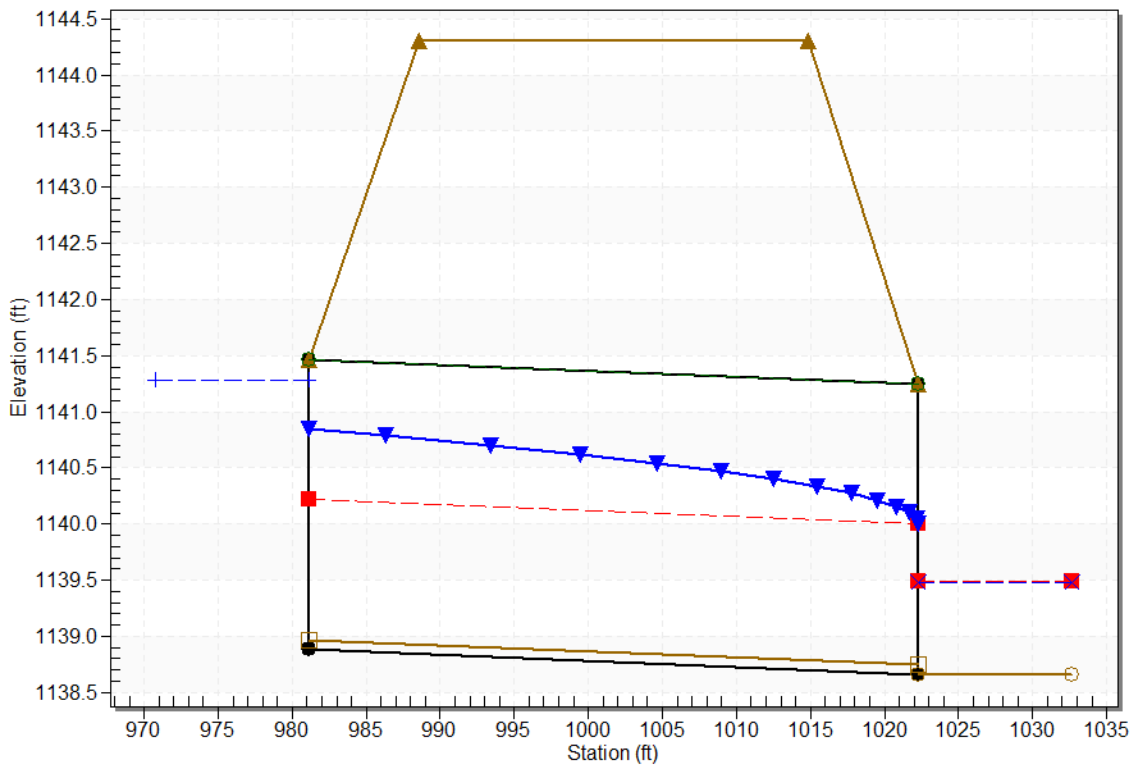
Culvert Performance Curve Plot: Ex. Pipe Arch



Water Surface Profile Plot for Culvert: Ex. Pipe Arch

Crossing - Ex. Culvert, Design Discharge - 30.1 cfs

Culvert - Ex. Pipe Arch, Culvert Discharge - 30.1 cfs



Site Data - Ex. Pipe Arch

Site Data Option: Culvert Invert Data

Inlet Station: 981.10 ft

Inlet Elevation: 1138.88 ft

Outlet Station: 1022.32 ft

Outlet Elevation: 1138.66 ft

Number of Barrels: 1

Culvert Data Summary - Ex. Pipe Arch

Barrel Shape: Pipe Arch

Barrel Span: 50.00 in

Barrel Rise: 31.00 in

Barrel Material: Steel or Aluminum

Embedment: 1.00 in

Barrel Manning's n: 0.0280 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall ($K_e=0.5$)

Inlet Depression: None

Tailwater Channel Data for Crossing: Ex. Culvert

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

a_side Slope (H:V): 4.00 (1:1)
Channel Slope: 0.02 ft/ft
Channel Manning's n: 0.0300
Channel Invert Elevation: 1138.66 ft

Table 3 - Downstream Channel Rating Curve (crossing: Ex. Culvert)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
30.11	1139.48	0.82	4.45	0.86	1.02
31.27	1139.49	0.83	4.49	0.87	1.03
32.43	1139.51	0.85	4.54	0.89	1.03
33.59	1139.53	0.87	4.58	0.91	1.03
34.75	1139.54	0.88	4.63	0.92	1.03
35.91	1139.56	0.90	4.67	0.94	1.04
37.07	1139.57	0.91	4.71	0.95	1.04
38.23	1139.58	0.92	4.75	0.97	1.04
39.39	1139.60	0.94	4.79	0.98	1.04
40.55	1139.61	0.95	4.83	1.00	1.04
41.71	1139.63	0.97	4.87	1.01	1.05

Roadway Data for crossing: Ex. Culvert

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 113.00 ft
Crest Elevation: 1144.30 ft
Roadway Surface: Paved
Roadway Top Width: 26.30 ft

HY-8 Culvert Analysis Report – Proposed 49”x33” Pipe Arch

Crossing Discharge Data

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

Minimum Flow: 30.11 cfs

Design Flow: 30.11 cfs

Maximum Flow: 41.71 cfs

Table 1 - Summary of Culvert Flows at crossing: 49"33" Pipe Arch

Headwater Elevation (ft)	Total Discharge (cfs)	Pipe Arch Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1141.56	30.11	30.11	0.00	1
1141.61	31.27	31.27	0.00	1
1141.66	32.43	32.43	0.00	1
1141.72	33.59	33.59	0.00	1
1141.77	34.75	34.75	0.00	1
1141.82	35.91	35.91	0.00	1
1141.87	37.07	37.07	0.00	1
1141.93	38.23	38.23	0.00	1
1141.98	39.39	39.39	0.00	1
1142.03	40.55	40.55	0.00	1
1142.09	41.71	41.71	0.00	1
1144.30	77.18	77.18	0.00	Overtopping

Rating Curve Plot for crossing: 49"33" Pipe Arch

Total Rating Curve
Crossing: 49"33" Pipe Arch

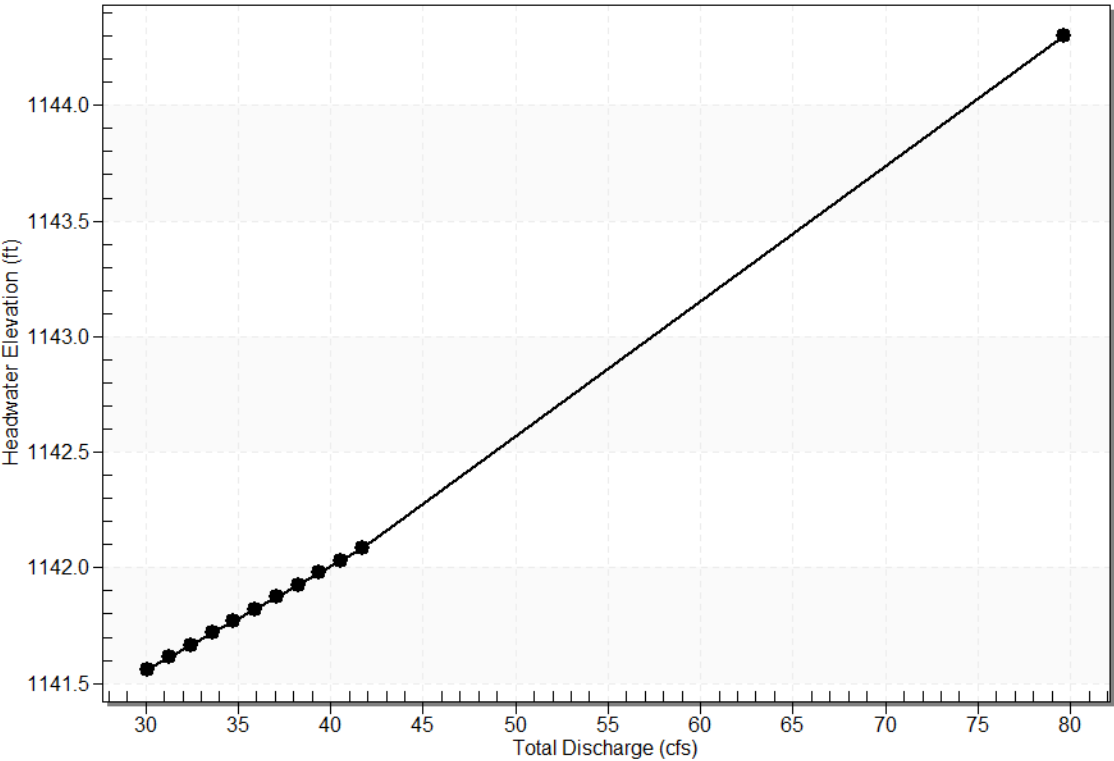


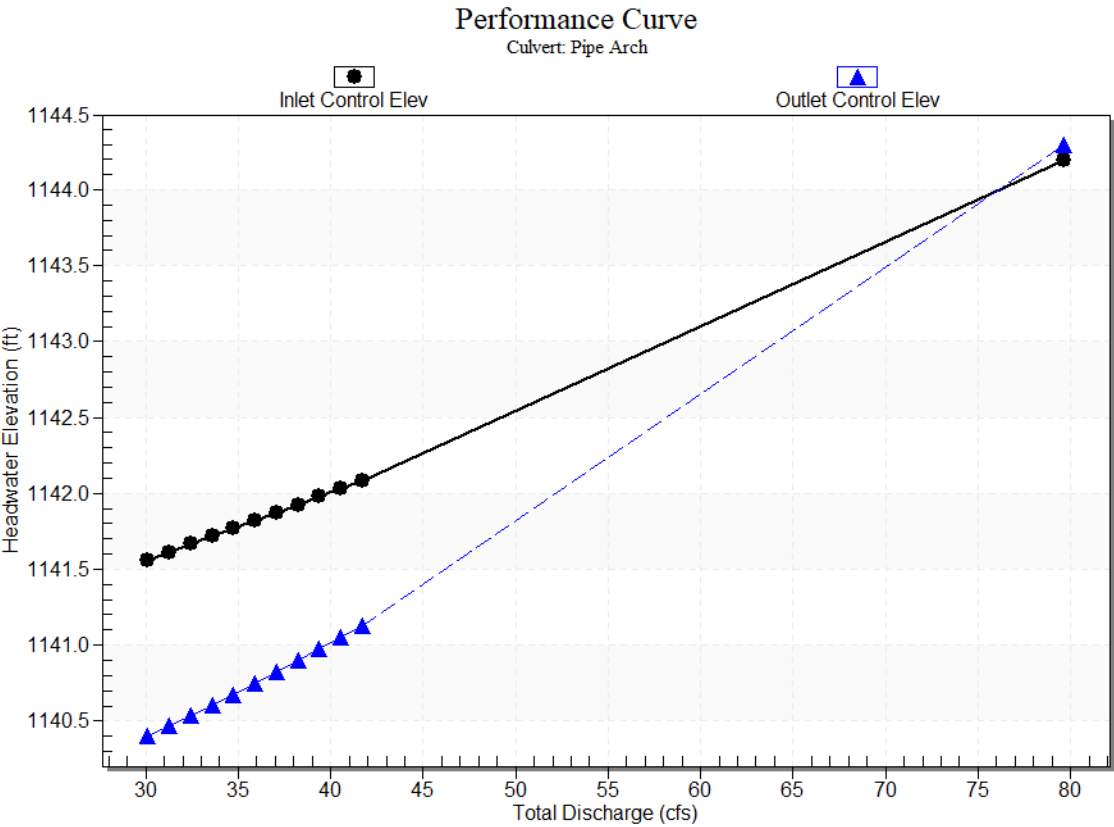
Table 2 - Culvert Summary Table: Pipe Arch

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	HW / D (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
30.11	30.11	1141.56	2.11	0.948	0.77	1-S2n	1.28	1.33	1.28	0.82	6.56	4.45
31.27	31.27	1141.61	2.16	1.016	0.79	1-S2n	1.31	1.36	1.31	0.83	6.63	4.49
32.43	32.43	1141.66	2.21	1.085	0.81	1-S2n	1.34	1.39	1.34	0.85	6.69	4.54
33.59	33.59	1141.72	2.27	1.155	0.82	1-S2n	1.37	1.42	1.37	0.87	6.76	4.58
34.75	34.75	1141.77	2.32	1.226	0.84	1-S2n	1.40	1.45	1.40	0.88	6.81	4.63
35.91	35.91	1141.82	2.37	1.298	0.86	1-S2n	1.44	1.47	1.44	0.90	6.88	4.67
37.07	37.07	1141.87	2.42	1.372	0.88	1-S2n	1.47	1.50	1.47	0.91	6.93	4.71
38.23	38.23	1141.93	2.48	1.446	0.90	1-S2n	1.50	1.53	1.50	0.92	6.99	4.75
39.39	39.39	1141.98	2.53	1.522	0.92	1-S2n	1.53	1.55	1.53	0.94	7.04	4.79
40.55	40.55	1142.03	2.58	1.599	0.94	1-S2n	1.57	1.58	1.57	0.95	7.09	4.83
41.71	41.71	1142.09	2.64	1.677	0.96	1-S2n	1.60	1.60	1.60	0.97	7.13	4.87
79.63	77.18	1144.30	4.75	4.850	1.76	7- M2c	2.75	2.24	2.24	1.33	9.68	5.80

Culvert Barrel Data

Culvert Barrel Type: Straight Culvert
Inlet Elevation(invert): 1139.45 ft
Outlet Elevation (invert): 1138.57 ft
Culvert Length: 59.20 ft
Culvert Slope: 0.01 ft/ft

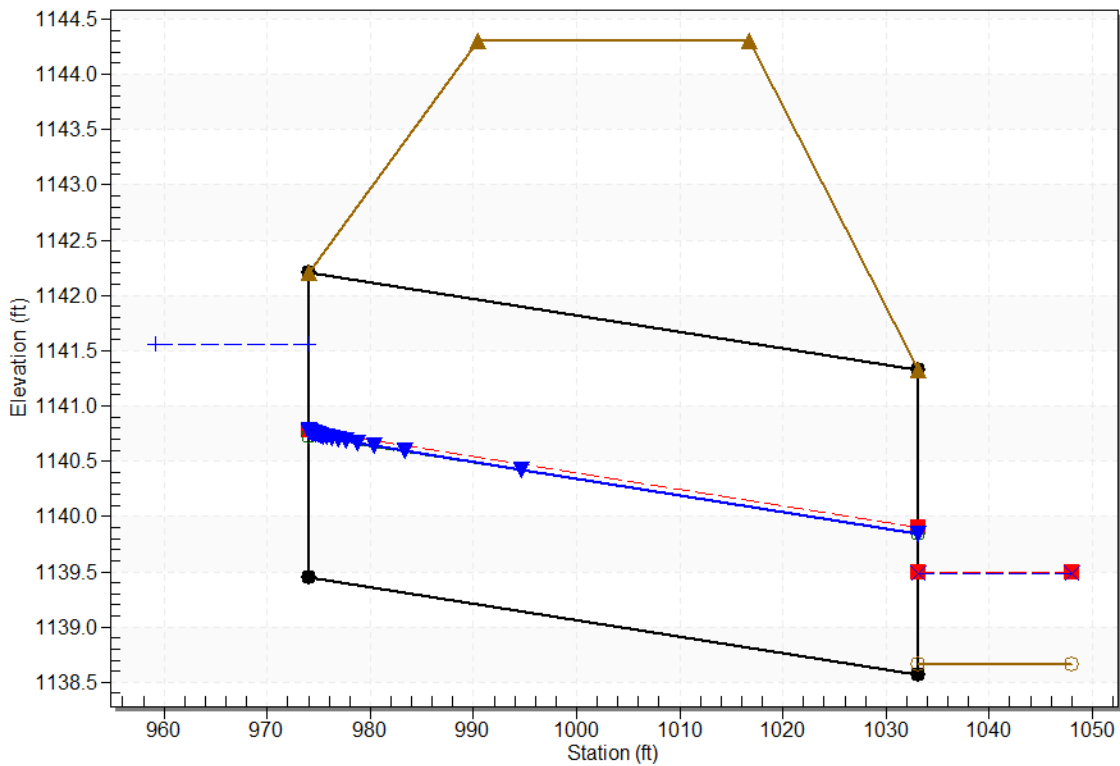
Culvert Performance Curve Plot: Pipe Arch



Water Surface Profile Plot for Culvert: Pipe Arch

Crossing - 49"33" Pipe Arch, Design Discharge - 30.1 cfs

Culvert - Pipe Arch, Culvert Discharge - 30.1 cfs



Site Data - Pipe Arch

Site Data Option: Culvert Invert Data

Inlet Station: 974.00 ft

Inlet Elevation: 1139.45 ft

Outlet Station: 1033.19 ft

Outlet Elevation: 1138.57 ft

Number of Barrels: 1

Culvert Data Summary - Pipe Arch

Barrel Shape: Pipe Arch

Barrel Span: 49.00 in

Barrel Rise: 33.00 in

Barrel Material: Steel or Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Channel Data for Crossing: 49"33" Pipe Arch

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

a_side Slope (H:V): 4.00 (1:4)

Channel Slope: 0.02 ft/ft
Channel Manning's n: 0.0300
Channel Invert Elevation: 1138.66 ft

Table 3 - Downstream Channel Rating Curve (crossing: 49"33" Pipe Arch)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
30.11	1139.48	0.82	4.45	0.86	1.02
31.27	1139.49	0.83	4.49	0.87	1.03
32.43	1139.51	0.85	4.54	0.89	1.03
33.59	1139.53	0.87	4.58	0.91	1.03
34.75	1139.54	0.88	4.63	0.92	1.03
35.91	1139.56	0.90	4.67	0.94	1.04
37.07	1139.57	0.91	4.71	0.95	1.04
38.23	1139.58	0.92	4.75	0.97	1.04
39.39	1139.60	0.94	4.79	0.98	1.04
40.55	1139.61	0.95	4.83	1.00	1.04
41.71	1139.63	0.97	4.87	1.01	1.05

Roadway Data for crossing: 49"33" Pipe Arch

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 113.00 ft
Crest Elevation: 1144.30 ft
Roadway Surface: Paved
Roadway Top Width: 26.30 ft

HY-8 Culvert Analysis Report – 34"x53" Elliptical Concrete

Crossing Discharge Data

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

Minimum Flow: 30.11 cfs

Design Flow: 30.11 cfs

Maximum Flow: 41.71 cfs

Table 1 - Summary of Culvert Flows at crossing: 34"x53" Concrete

Headwater Elevation (ft)	Total Discharge (cfs)	Elliptical Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1141.33	30.11	30.11	0.00	1
1141.38	31.27	31.27	0.00	1
1141.43	32.43	32.43	0.00	1
1141.48	33.59	33.59	0.00	1
1141.52	34.75	34.75	0.00	1
1141.57	35.91	35.91	0.00	1
1141.62	37.07	37.07	0.00	1
1141.67	38.23	38.23	0.00	1
1141.71	39.39	39.39	0.00	1
1141.76	40.55	40.55	0.00	1
1141.81	41.71	41.71	0.00	1
1144.30	89.99	89.99	0.00	Overtopping

Rating Curve Plot for crossing: 34"x53" Concrete

Total Rating Curve
Crossing: 34"x53" Concrete

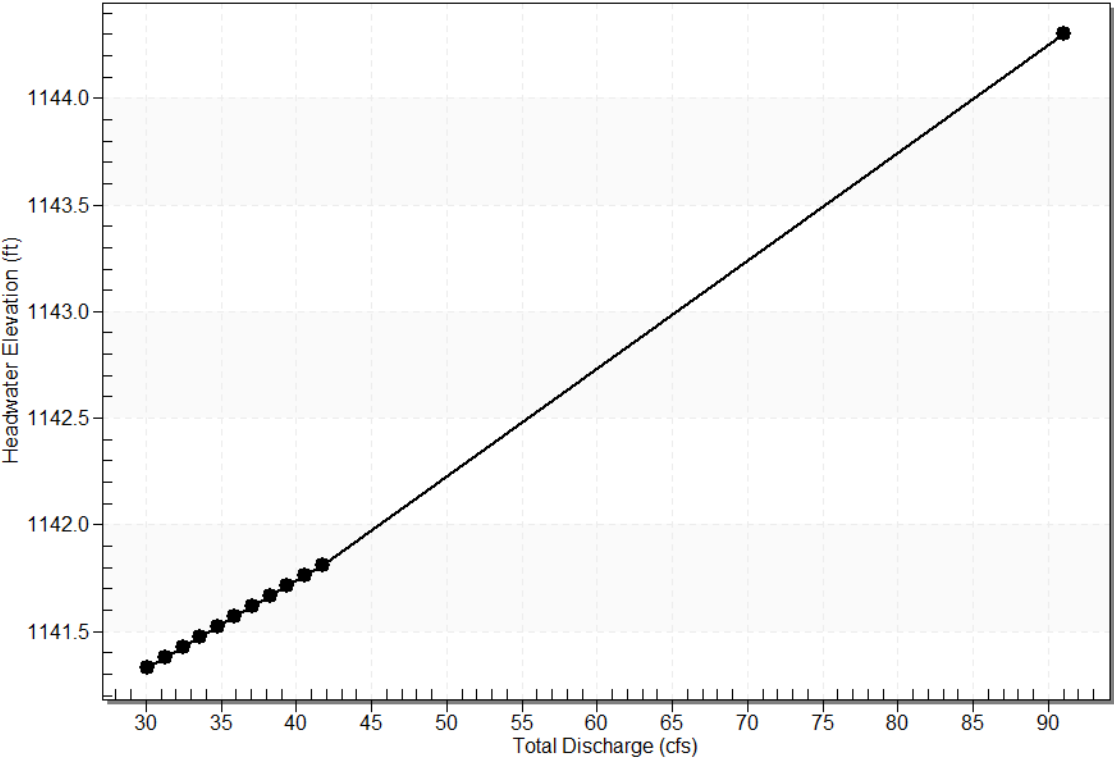


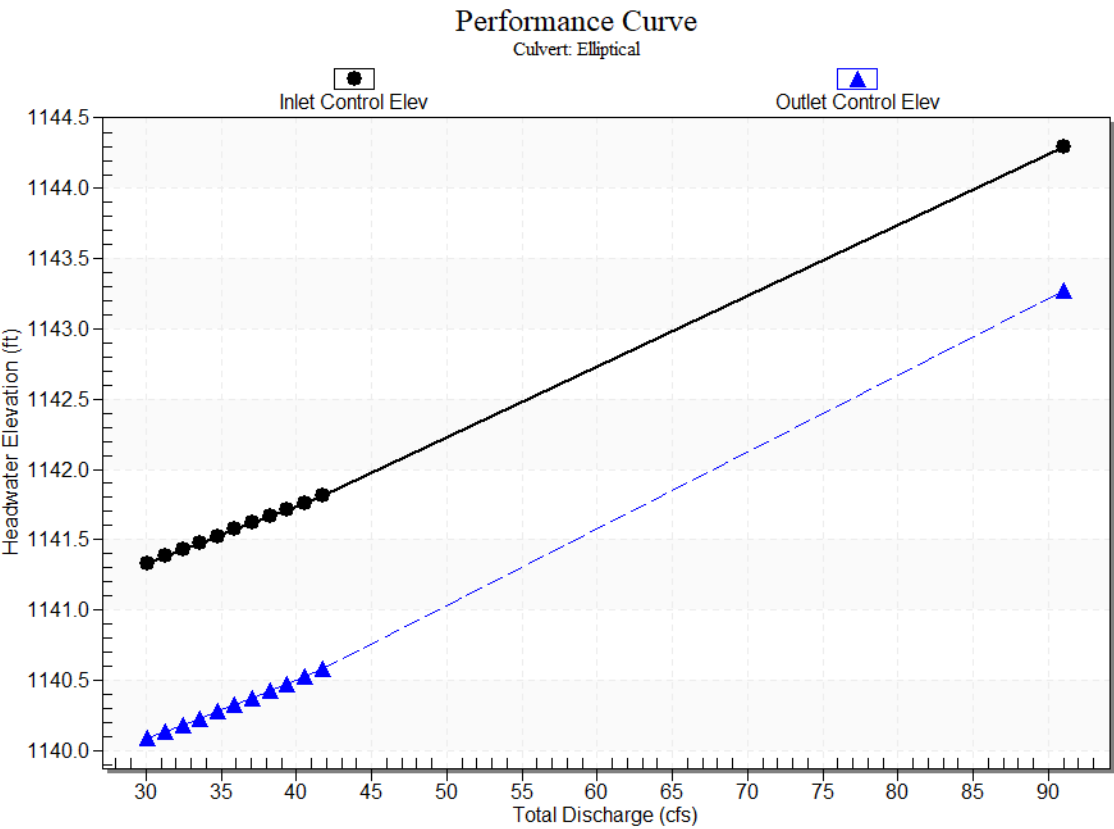
Table 2 - Culvert Summary Table: Elliptical

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	HW / D (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
30.11	30.11	1141.33	2.00	0.754	0.71	1-S2n	0.90	1.40	0.98	0.82	9.45	4.45
31.27	31.27	1141.38	2.05	0.800	0.72	1-S2n	0.92	1.43	1.01	0.83	9.53	4.49
32.43	32.43	1141.43	2.10	0.849	0.74	1-S2n	0.93	1.45	1.03	0.85	9.61	4.54
33.59	33.59	1141.48	2.15	0.897	0.76	1-S2n	0.95	1.48	1.05	0.87	9.70	4.58
34.75	34.75	1141.52	2.19	0.946	0.77	1-S2n	0.97	1.51	1.07	0.88	9.80	4.63
35.91	35.91	1141.57	2.24	0.995	0.79	1-S2n	0.98	1.54	1.09	0.90	9.89	4.67
37.07	37.07	1141.62	2.29	1.045	0.81	1-S2n	1.00	1.56	1.11	0.91	9.95	4.71
38.23	38.23	1141.67	2.34	1.095	0.82	1-S2n	1.02	1.59	1.13	0.92	10.01	4.75
39.39	39.39	1141.71	2.38	1.145	0.84	1-S2n	1.03	1.62	1.15	0.94	10.07	4.79
40.55	40.55	1141.76	2.43	1.196	0.86	1-S2n	1.05	1.64	1.17	0.95	10.14	4.83
41.71	41.71	1141.81	2.48	1.247	0.88	1-S2n	1.07	1.67	1.19	0.97	10.21	4.87
91.00	89.98	1144.30	4.97	3.945	1.75	5-S2n	1.64	2.46	1.91	1.42	12.47	6.01

Culvert Barrel Data

Culvert Barrel Type: Straight Culvert
Inlet Elevation(invert): 1139.33 ft
Outlet Elevation (invert): 1138.44 ft
Culvert Length: 59.54 ft
Culvert Slope: 0.01 ft/ft

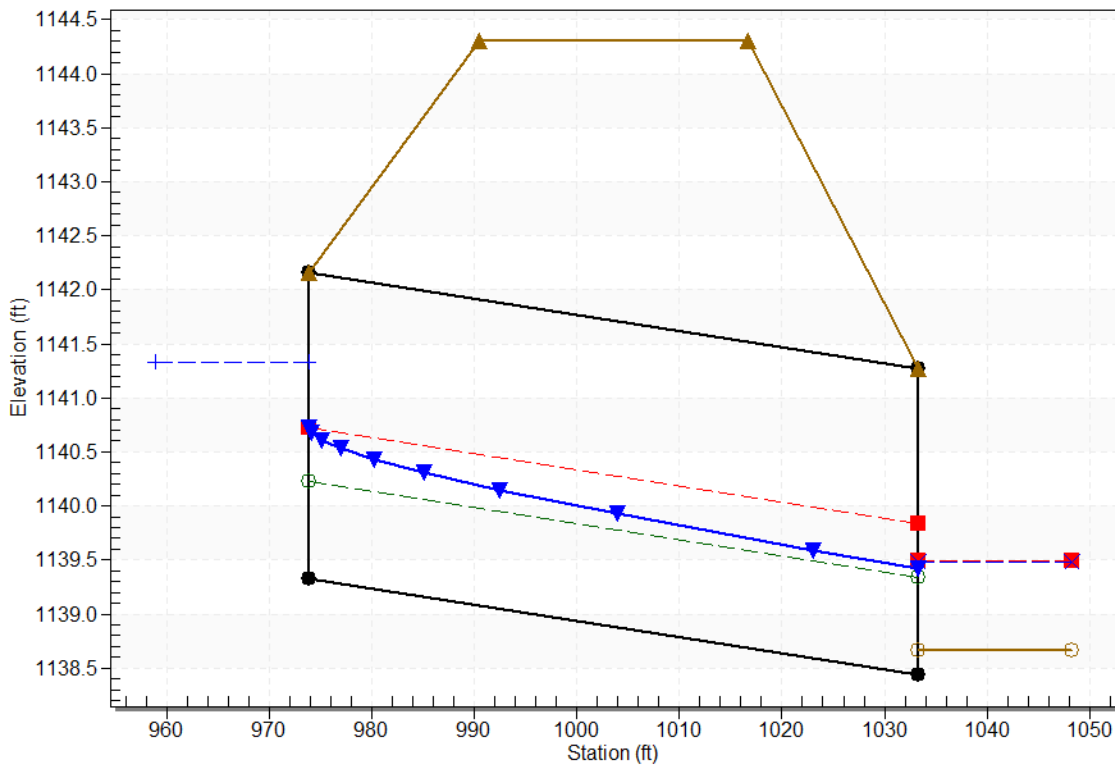
Culvert Performance Curve Plot: Elliptical



Water Surface Profile Plot for Culvert: Elliptical

Crossing - 34"x53" Concrete, Design Discharge - 30.1 cfs

Culvert - Elliptical, Culvert Discharge - 30.1 cfs



Site Data - Elliptical

Site Data Option: Culvert Invert Data

Inlet Station: 973.83 ft

Inlet Elevation: 1139.33 ft

Outlet Station: 1033.36 ft

Outlet Elevation: 1138.44 ft

Number of Barrels: 1

Culvert Data Summary - Elliptical

Barrel Shape: Elliptical

Barrel Span: 53.00 in

Barrel Rise: 34.00 in

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall ($K_e=0.5$)

Inlet Depression: None

Tailwater Channel Data for Crossing: 34"x53" Concrete

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

a_side Slope (H:V): 4.00 (1:1)

Channel Slope: 0.02 ft/ft
Channel Manning's n: 0.0300
Channel Invert Elevation: 1138.66 ft

Table 3 - Downstream Channel Rating Curve (crossing: 34"x53" Concrete)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
30.11	1139.48	0.82	4.45	0.86	1.02
31.27	1139.49	0.83	4.49	0.87	1.03
32.43	1139.51	0.85	4.54	0.89	1.03
33.59	1139.53	0.87	4.58	0.91	1.03
34.75	1139.54	0.88	4.63	0.92	1.03
35.91	1139.56	0.90	4.67	0.94	1.04
37.07	1139.57	0.91	4.71	0.95	1.04
38.23	1139.58	0.92	4.75	0.97	1.04
39.39	1139.60	0.94	4.79	0.98	1.04
40.55	1139.61	0.95	4.83	1.00	1.04
41.71	1139.63	0.97	4.87	1.01	1.05

Roadway Data for crossing: 34"x53" Concrete

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 113.00 ft
Crest Elevation: 1144.30 ft
Roadway Surface: Paved
Roadway Top Width: 26.30 ft

HY-8 Culvert Analysis Report – 36” RCP

Crossing Discharge Data

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

Minimum Flow: 30.11 cfs

Design Flow: 30.11 cfs

Maximum Flow: 41.71 cfs

Table 1 - Summary of Culvert Flows at crossing: 36" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	36" RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1142.14	30.11	30.11	0.00	1
1142.20	31.27	31.27	0.00	1
1142.27	32.43	32.43	0.00	1
1142.34	33.59	33.59	0.00	1
1142.41	34.75	34.75	0.00	1
1142.48	35.91	35.91	0.00	1
1142.55	37.07	37.07	0.00	1
1142.62	38.23	38.23	0.00	1
1142.69	39.39	39.39	0.00	1
1142.77	40.55	40.55	0.00	1
1142.84	41.71	41.71	0.00	1
1144.30	60.22	60.22	0.00	Overtopping

Rating Curve Plot for crossing: 36" RCP

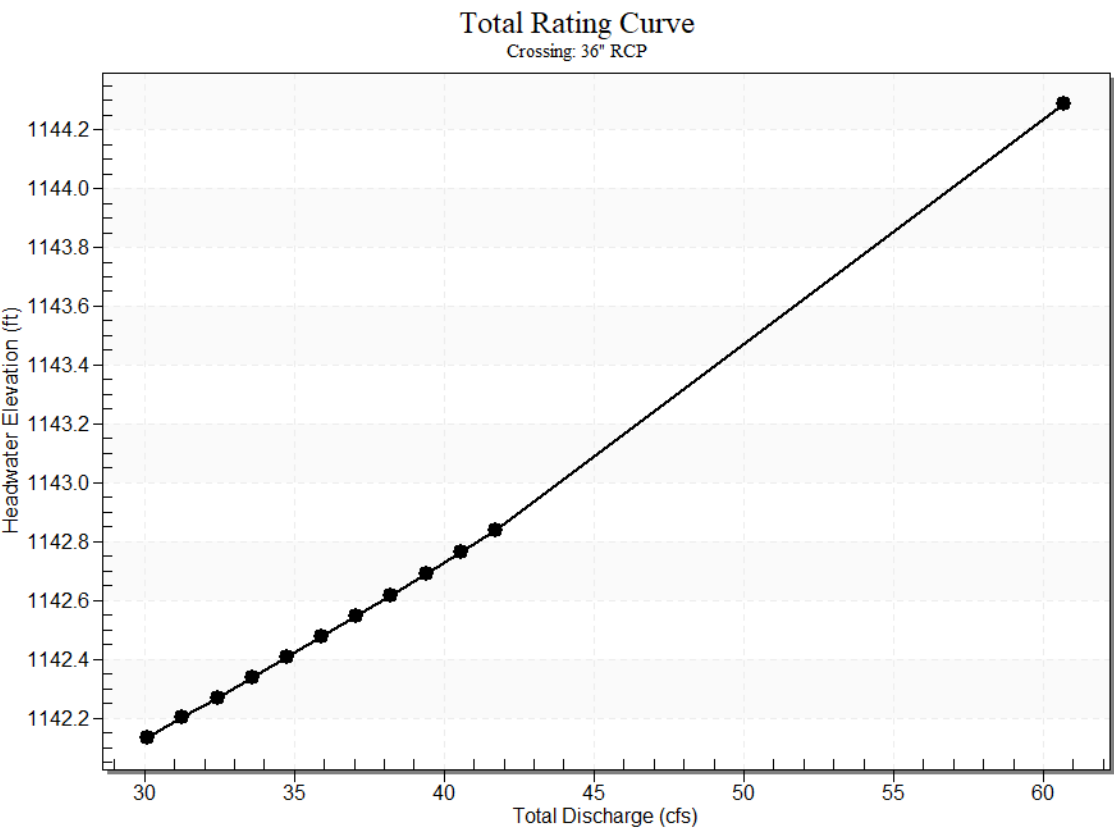


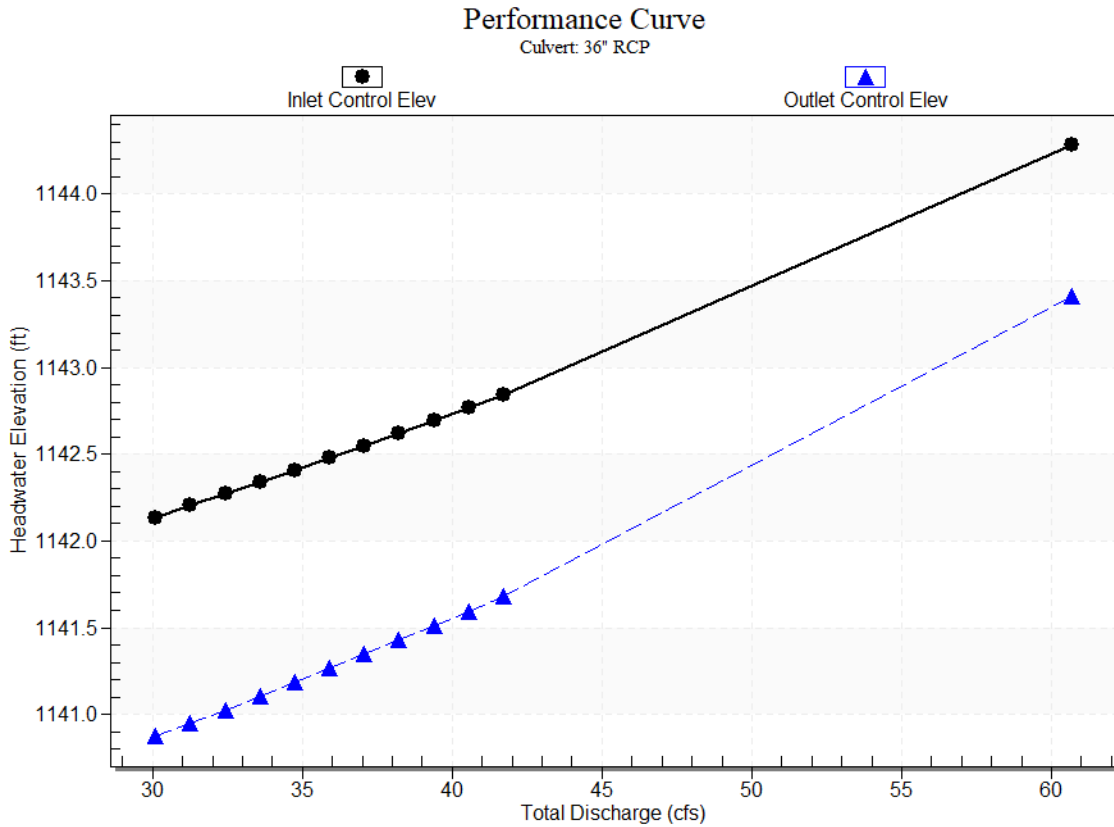
Table 2 - Culvert Summary Table: 36" RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	HW / D (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
30.11	30.11	1142.14	2.69	1.422	0.90	1-S2n	1.21	1.78	1.32	0.82	10.05	4.45
31.27	31.27	1142.20	2.75	1.499	0.92	1-S2n	1.23	1.81	1.35	0.83	10.13	4.49
32.43	32.43	1142.27	2.82	1.576	0.94	1-S2n	1.26	1.85	1.38	0.85	10.21	4.54
33.59	33.59	1142.34	2.89	1.655	0.96	1-S2n	1.28	1.88	1.41	0.87	10.30	4.58
34.75	34.75	1142.41	2.96	1.734	0.99	1-S2n	1.31	1.92	1.44	0.88	10.38	4.63
35.91	35.91	1142.48	3.03	1.815	1.01	5-S2n	1.33	1.95	1.47	0.90	10.47	4.67
37.07	37.07	1142.55	3.10	1.896	1.03	5-S2n	1.36	1.98	1.49	0.91	10.55	4.71
38.23	38.23	1142.62	3.17	1.978	1.06	5-S2n	1.38	2.01	1.52	0.92	10.63	4.75
39.39	39.39	1142.69	3.24	2.061	1.08	5-S2n	1.40	2.04	1.55	0.94	10.71	4.79
40.55	40.55	1142.77	3.32	2.145	1.11	5-S2n	1.43	2.07	1.57	0.95	10.80	4.83
41.71	41.71	1142.84	3.39	2.230	1.13	5-S2n	1.45	2.10	1.60	0.97	10.87	4.87
60.67	60.06	1144.29	4.84	3.960	1.61	5-S2n	1.82	2.50	2.01	1.16	11.96	5.39

Culvert Barrel Data

Culvert Barrel Type: Straight Culvert
Inlet Elevation(invert): 1139.45 ft
Outlet Elevation (invert): 1138.57 ft
Culvert Length: 59.20 ft
Culvert Slope: 0.01 ft/ft

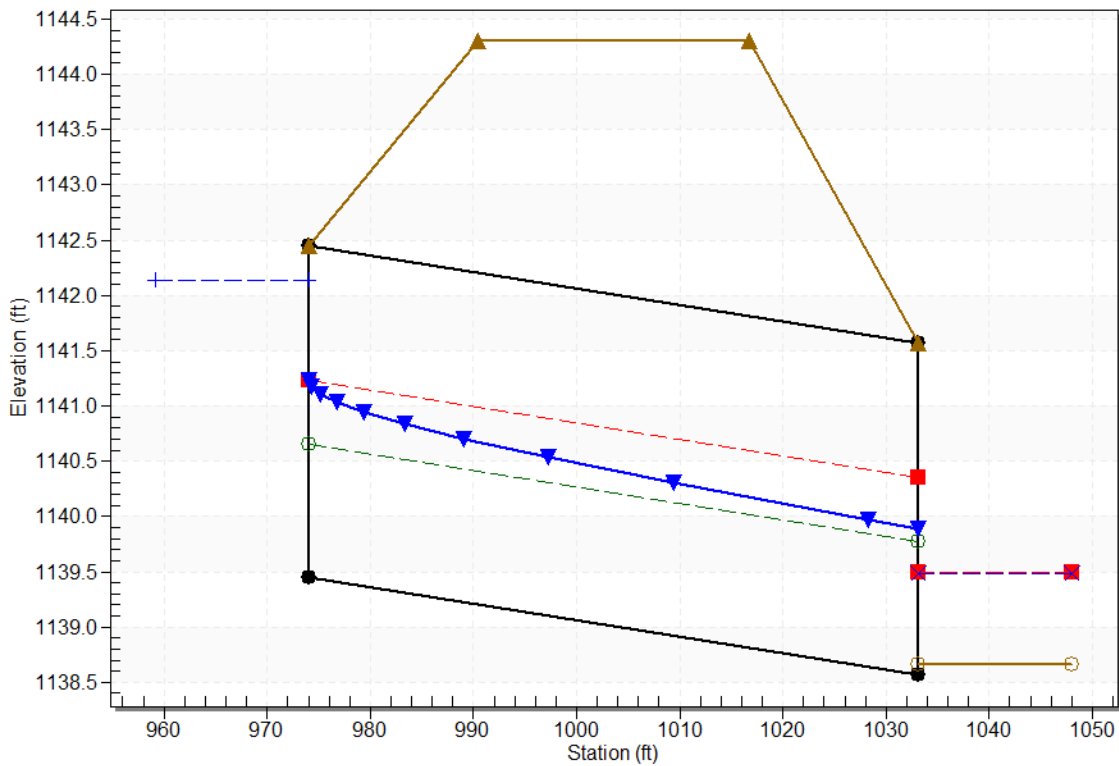
Culvert Performance Curve Plot: 36" RCP



Water Surface Profile Plot for Culvert: 36" RCP

Crossing - 36" RCP, Design Discharge - 30.1 cfs

Culvert - 36" RCP, Culvert Discharge - 30.1 cfs



Site Data - 36" RCP

Site Data Option: Culvert Invert Data

Inlet Station: 974.00 ft

Inlet Elevation: 1139.45 ft

Outlet Station: 1033.19 ft

Outlet Elevation: 1138.57 ft

Number of Barrels: 1

Culvert Data Summary - 36" RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall ($K_e=0.5$)

Inlet Depression: None

Tailwater Channel Data for Crossing: 36" RCP

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 5.00 ft

a_side Slope (H:V): 4.00 (.:1)

Channel Slope: 0.02 ft/ft

Channel Manning's n: 0.0300
Channel Invert Elevation: 1138.66 ft

Table 3 - Downstream Channel Rating Curve (crossing: 36" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
30.11	1139.48	0.82	4.45	0.86	1.02
31.27	1139.49	0.83	4.49	0.87	1.03
32.43	1139.51	0.85	4.54	0.89	1.03
33.59	1139.53	0.87	4.58	0.91	1.03
34.75	1139.54	0.88	4.63	0.92	1.03
35.91	1139.56	0.90	4.67	0.94	1.04
37.07	1139.57	0.91	4.71	0.95	1.04
38.23	1139.58	0.92	4.75	0.97	1.04
39.39	1139.60	0.94	4.79	0.98	1.04
40.55	1139.61	0.95	4.83	1.00	1.04
41.71	1139.63	0.97	4.87	1.01	1.05

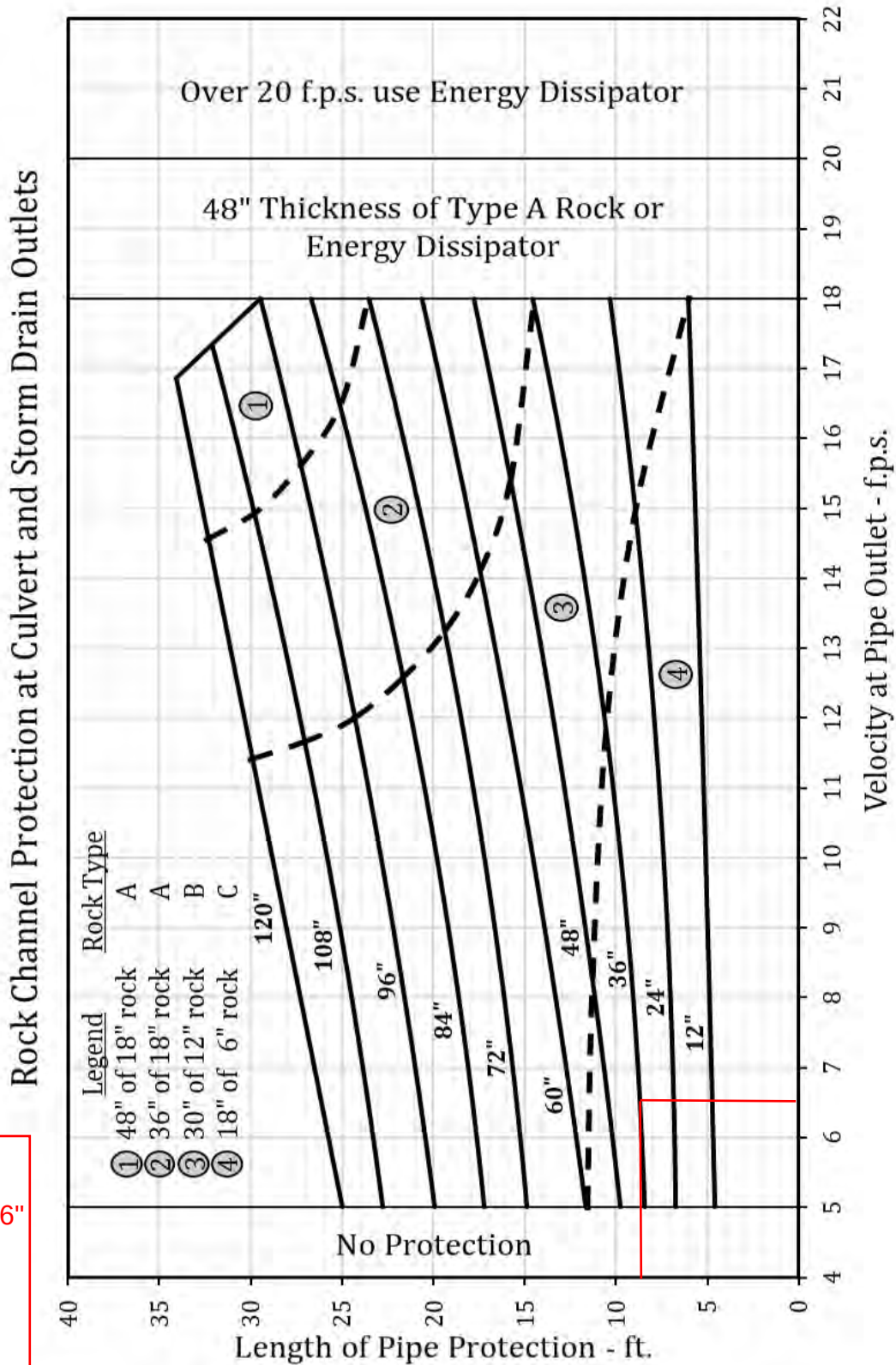
Roadway Data for crossing: 36" RCP

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 113.00 ft
Crest Elevation: 1144.30 ft
Roadway Surface: Paved
Roadway Top Width: 26.30 ft

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS

1002-4

REFERENCE SECTION
1002.2.3



LOG-287-10.03
V = 6.56 fps
Rise = 33" --> 36"
9"x8"x18" OF 6"
TYPE C ROCK

ROCK CHANNEL PROTECTION AT CULVERT AND STORM SEWER OUTLETS	1002-4
	REFERENCE SECTION 1002.2.3

Notes:

Rock size (6", 12", 18") indicates the square opening on which 85% of the material by weight is retained.

Provide rock channel protection the width of the headwall with a minimum of 4'.

No rock channel protection is required where the natural stream bed will withstand the calculated velocity without erosion.

Equations for length of protection:

Rise	Length
120"	$L = 0.764996 * V + 21.17502$
108"	$L = 0.0203 * V^2 + 0.3004 * V + 20.765$
96"	$L = 0.0184 * V^2 + 0.3121 * V + 17.892$
84"	$L = 0.0261 * V^2 + 0.1234 * V + 15.970$
72"	$L = 0.0251 * V^2 + 0.0897 * V + 13.798$
60"	$L = 0.0139 * V^2 + 0.3683 * V + 9.4671$
48"	$L = 0.0151 * V^2 + 0.2661 * V + 8.0899$
36"	$L = 0.0262 * V^2 + 0.1341 * V + 8.4794$
24"	$L = 0.0182 * V^2 + 0.1404 * V + 6.983$
12"	$L = 0.0014 * V^2 + 0.0816 * V + 4.1255$

V=Velocity (f.p.s.)

L=Length of minimum Rock Channel Protection (ft.)

County	Logan	Route	287	Section	10.03	PID	116483	Shape	Pipe Arch
Station	10+00	Station						Span x Rise	49 x 33

User Input	
pH _a	Abrasion Level
7.9	2.0

Constants and Calculated Values			
pH _s	Sediment/Rise	End of Service Life GA	Service Life Required
7.6	0	4	75

Zinc or Aluminum Coated Corrugated Steel Pipe Conduit Durability Results										
Material	707.01, or 707.02 Metallic Coated (galvanized)	707.01 or 707.02 Metallic Coated (galvanized) with Concrete Field Paving	707.01 or 707.02 Metallic coated (Aluminized)	***707.01 or 707.02 Metallic coated (aluminized) with Concrete Field Paving	707.04 Polymeric Precoated Galvanized Steel	***707.04 Polymeric Precoated with Concrete Field Paving	**707.11 Polymeric Precoated Spiral Rib Steel	**707.12 or 707.17 Aluminum Coated Spiral Rib Steel	**707.18 Polymer Precoated, Galvanized Steel Conduits with Polymer Precoated Galvanized Smooth Steel Interior Liner	
Conduit Use and Shape	Culvert or Liner Pipe - Round or Pipe Arch	Culvert-Round, Pipe Arch, and Arch	Culvert or Liner Pipe - Round or Pipe Arch	Culvert -Round or Pipe Arch	Culvert or Liner Pipe - Round or Pipe Arch	Culvert-Round or Pipe Arch	Storm Sewer or Liner Pipe- Round	Liner Pipe- Round or Pipe Arch	Culvert, Storm Sewer, or Liner Pipe -Round	
min gauge or thickness	Corr. Depth (inches)									
	1/4 or 1/2	14	N/A	14	N/A	14	N/A	N/A	N/A	N/A
	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3/4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
max gauge or thickness	1/4 or 1/2	8	N/A	10	N/A	10	N/A	N/A	N/A	N/A
	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	3/4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gauge	Thickness (inches)									
16	0.064									
14	0.079									
12	0.109									
10	0.138									
8	0.168									

Corrugated Aluminum Pipe Durability Results				
Material		707.21 or 707.22 Aluminum	707.21 or 707.22 Aluminum Alloy with Concrete Invert Paving	707.24 Aluminum Spiral Rib
Conduit Use and Shape		Culvert or Liner Pipe- Round or Pipe Arch	Culvert - Round or Pipe Arch	Storm Sewer or Liner Pipe -Round
min gauge or thickness	Corr. Depth (Inches)			
	1/4 or 1/2	12	N/A	N/A
	1	N/A	N/A	N/A
	3/4	N/A	N/A	N/A
max gauge or thickness	1/4 or 1/2	8	N/A	N/A
	1	N/A	N/A	N/A
	3/4	N/A	N/A	N/A
Gauge	Thickness (inches)			
16	0.06			
14	0.075			
12	0.105			
10	0.135			
8	0.164			

Steel Casing Pipe	
**748.06 Steel Casing Pipe non-galvanized	
Culvert or Liner Pipe- Round, Pipe Arch, or Box	
0.5	
0.5	
0.5	

49"x33" PIPE ARCH CONDUIT, TYPE A, 707.01 (0.079)
ALUMINIZED, 707.04 (0.079) POLYMERIC, 707.21 (0.075)
ALUMINUM

Corrugated Aluminum Structural Plate Conduit Durability Results				
Material		707.23 Aluminum Structural Plate	707.23 Aluminum Alloy Structural Plate with Concrete Invert Paving	707.25 Aluminum Box
Conduit Use and Shape		Culvert or Liner Pipe - Round or Pipe Arch	Culvert - Round or Pipe Arch	Culvert or Liner Pipe - Box Shape
min gauge or thickness	Corr. Depth (inches)			
	3	N/A	N/A	N/A
max gauge or thickness	3	N/A	N/A	N/A
Gauge	Thickness (inches)			
12	0.1			
10	0.125			
8	0.15			
7	0.175			
5	0.2			
3	0.225			
	0.25			

Corrugated Steel Structural Plate Conduit Durability Results				
Material		707.03 Metallic coated (galvanized)	707.03 Metallic coated (galvanized) with Concrete Field Paving	707.15 Galvanized steel box
Conduit Use and Shape		Culvert or Liner Pipe -Round or Pipe Arch	Culvert-Round, Pipe Arch, and Arch	Culvert or Liner Pipe -Box Shape
min gauge or thickness	Corr. Depth (inches) 2	N/A	N/A	N/A
max gauge or thickness	2	N/A	N/A	N/A
Gauge	Thickness (inches)			
12	0.109			
10	0.138			
8	0.168			
7	0.188			
5	0.218			
3	0.249			
1	0.28			

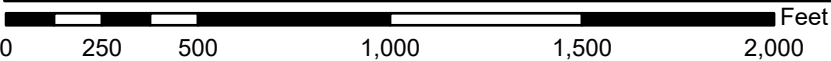
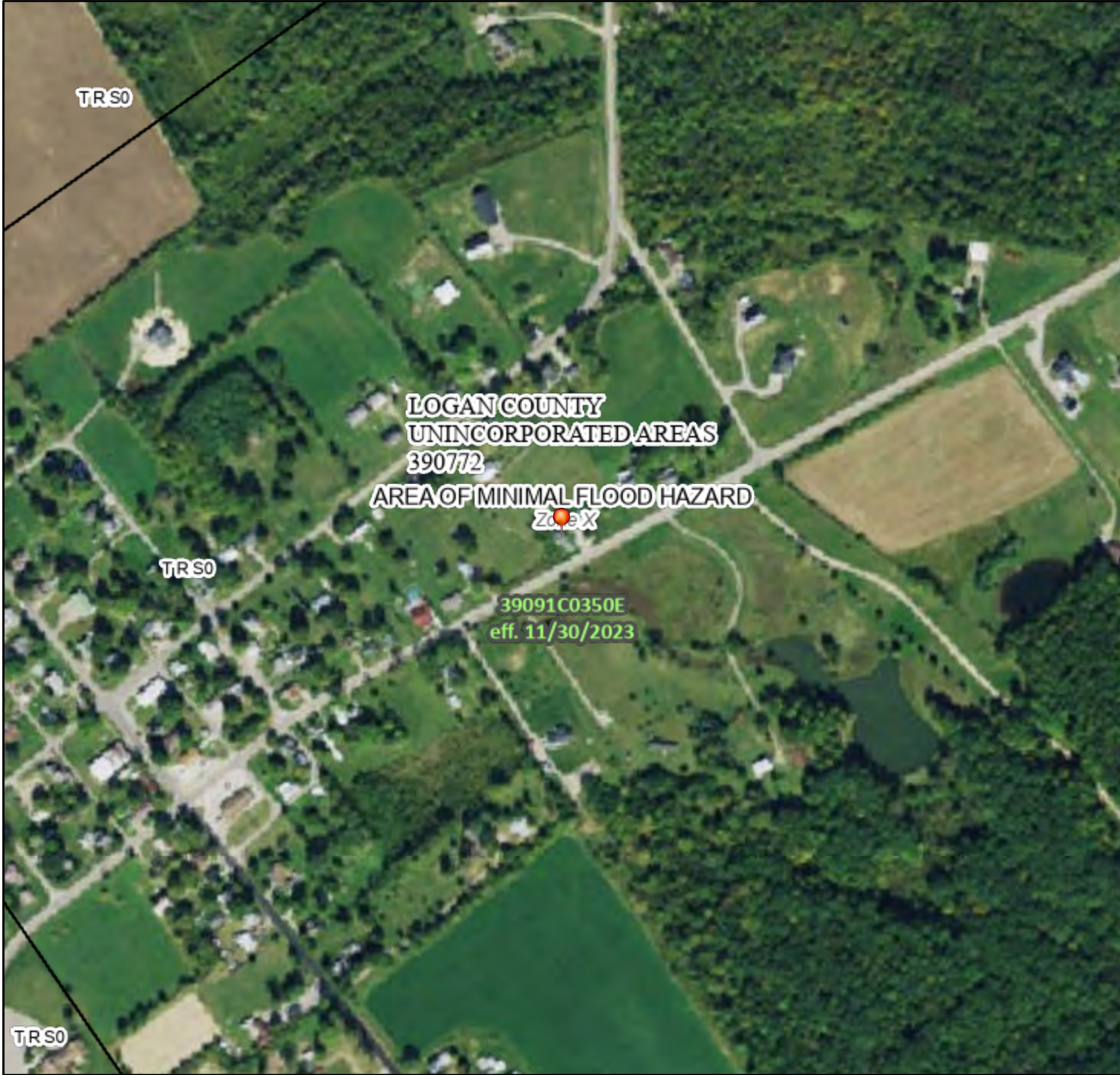
Concrete Conduit Durability Results						
Material	**706.01 Non-reinforced Concrete Pipe	**706.02 Reinforced Concrete Circular Pipe	**706.03 Reinforced Concrete Pipe, Epoxy Coated	**706.04 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe	**706.05 Precast Reinforced Concrete Box Sections	706.08 Clay Drain Tile
Conduit Use and Shape	Culvert or Storm Sewer - Round	Culvert or Storm Sewer - Round	Culvert or Storm Sewer - Round or Elliptical	Culvert or Storm Sewer - Elliptical	Culvert or Storm Sewer - Box	Culvert or Storm Sewer - Round

Plastic Conduit Durability Results													
Material	707.33 Corrugated Polyethylene Smooth Lined Pipe	707.34 Polyethylene Plastic Pipe Based on Outside Diameter (OD)	707.35 Polyethylene Profile Wall Pipe	707.42 Polyvinyl Chloride Corrugated Smooth Interior Pipe	707.43 Polyvinyl Chloride Profile Wall Pipe	707.45 Polyvinyl Chloride Solid Wall Pipe	707.46 Polyvinyl Chloride Drain Waste and Vent Pipe	707.47 ABS and Polyvinyl Chloride Composite Pipe	707.48 Polyvinyl Chloride Large-Diameter Solid Wall Pipe	707.65 Corrugated Polypropylene Smooth Lined Pipe	707.75 Glass-Fiber-Reinforced Polymer Mortar Pipe	707.85 Steel Reinforced Thermoplastic Ribbed Pipe	748.02 Polyvinyl Chloride (PVC) Pipe, Joints, and Fittings
Conduit Use and Shape	Culvert, Storm Sewer, or Liner Pipe - Round	Culvert, Storm Sewer, or Liner Pipe - Round	Culvert, Storm Sewer, or Liner Pipe - Round	Storm Sewer or Liner Pipe - Round	Storm Sewer or Liner Pipe - Round	Storm Sewer - Round	Storm Sewer - Round	Storm Sewer - Round	Storm Sewer - Round	Culvert or Storm Sewer - Round	Culvert, Storm Sewer, or Liner Pipe - Round	Culvert, Storm Sewer, or Liner Pipe - Round	Storm Sewer - Round

National Flood Hazard Layer FIRMMette



83°35'1"W 40°17'53"N



1:6,000

83°34'24"W 40°17'26"N

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance
		17.5 Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped

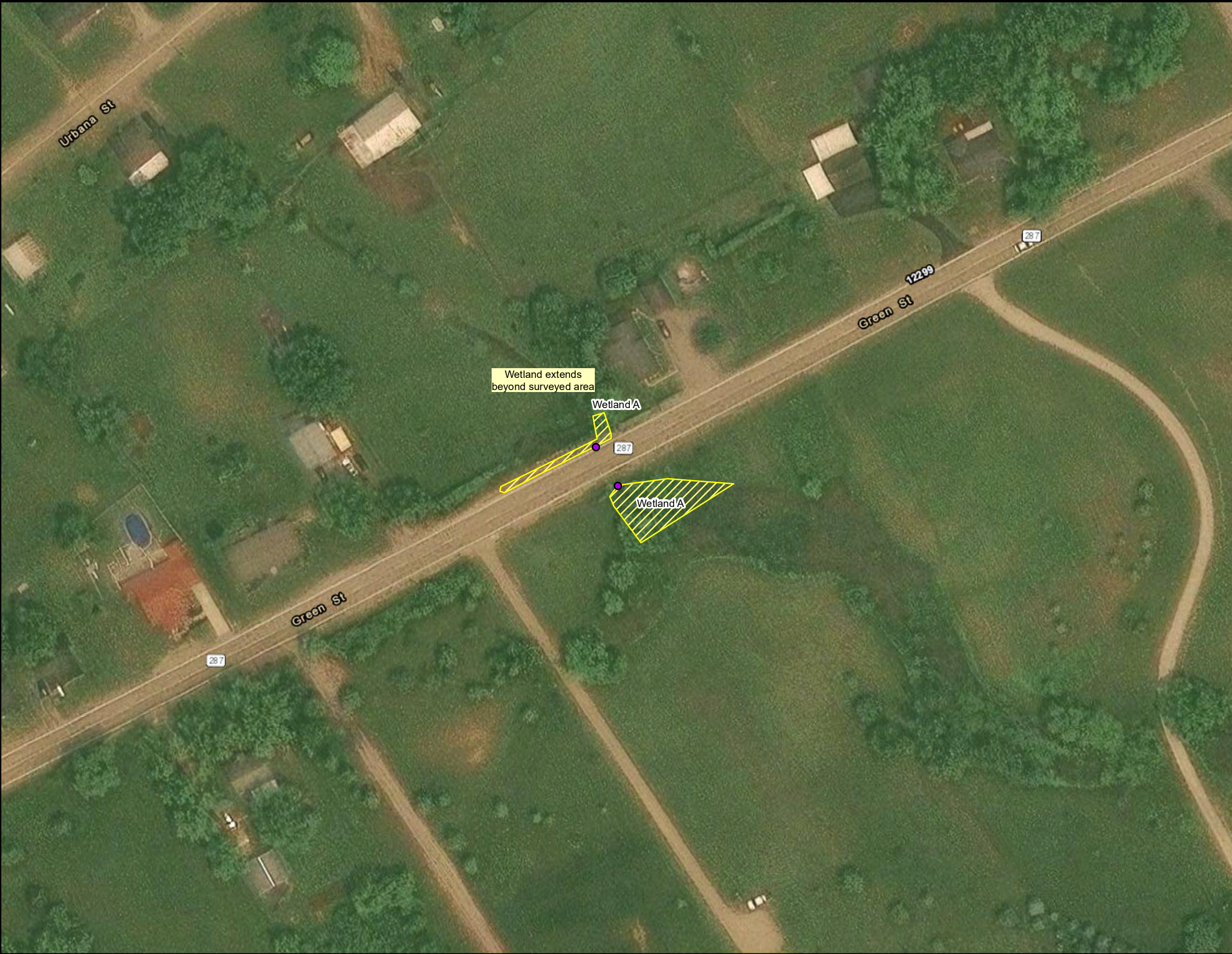


The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **12/9/2024 at 3:01 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



Site Location Map

Legend

-  Culvert
-  Wetland



N



0 25 50 100 150 Feet

LOG-287-1003
PID: 116483

Ecological Resources
Draft Map



Lawhon & Associates, Inc.

Date: Mar 2024	Approved by: CA	L&A No. 22-0008	Figure —
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Location Map

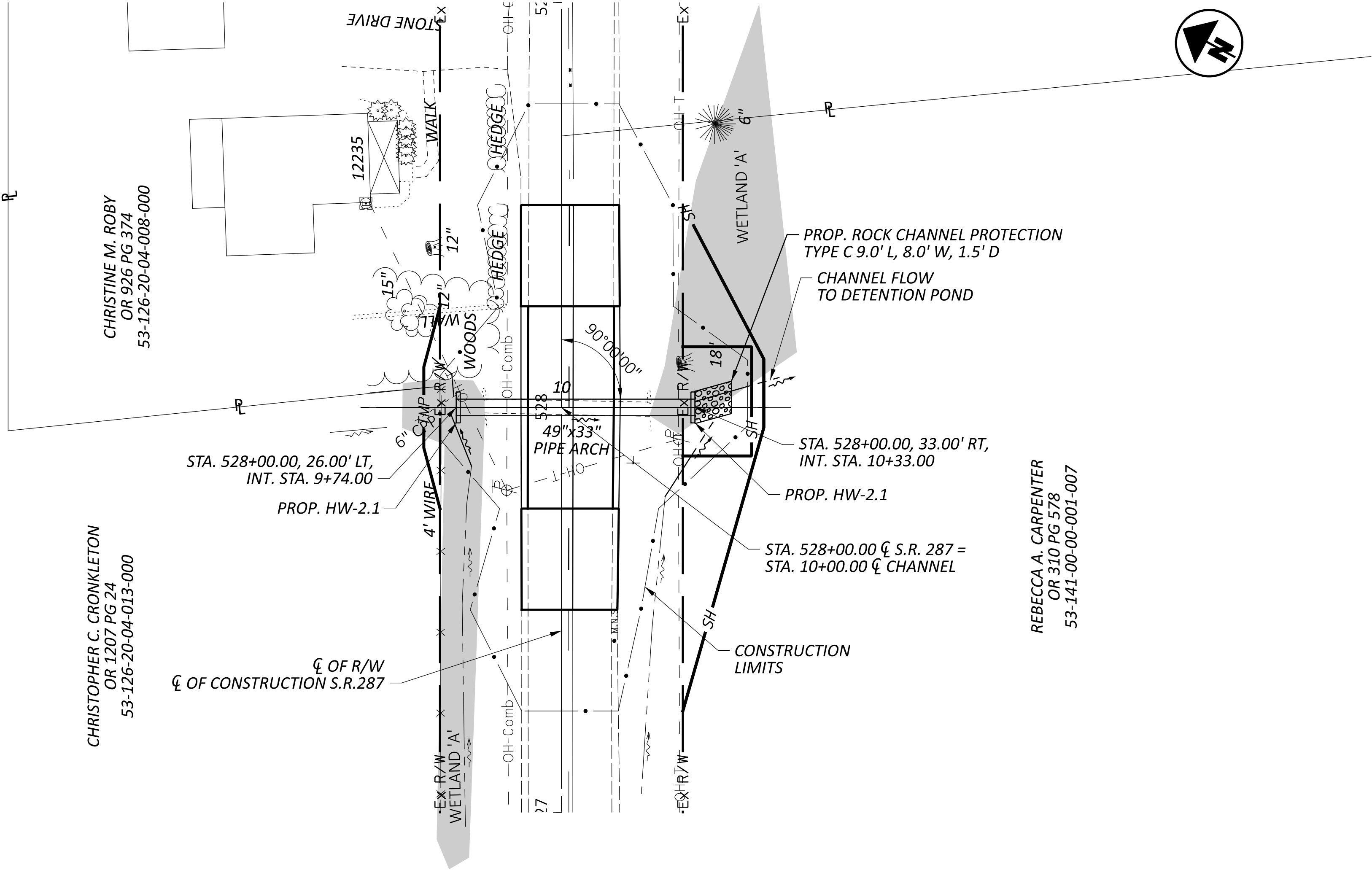
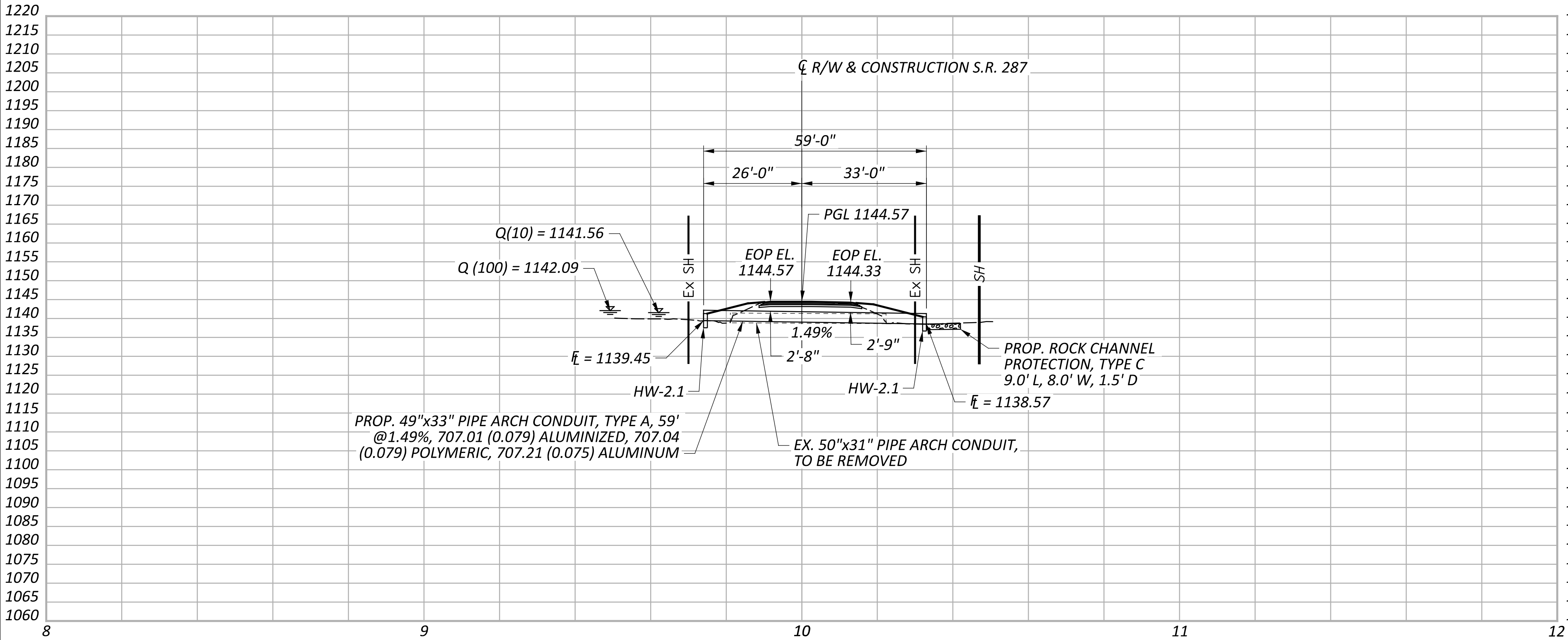
LOG-287-10.03

Legend

 LOG-287-10.03

 Big Darby Headwaters Nature Preserve





ESTIMATED QUANTITIES			
ITEM	QUANTITY	UNIT	DESCRIPTION

HYDRAULIC DATA			
DRAINAGE AREA = 17.21 ACRES			
Q (10) =	30.11 CFS	V (10) =	6.56 FT/S
Q (100) =	41.71 CFS	V (100) =	7.13 FT/S
DESIGN SERVICE LIFE: 75 YEARS			
ABRASION LEVEL: 2			
pH: 7.9			

EXISTING STRUCTURE	
TYPE:	CORRUGATED METAL PIPE ARCH
SIZE:	50"x31"
LENGTH:	41'
SKEW:	1°9'17" L.F.
ALIGNMENT:	TANGENT
DATE BUILT:	UNKNOWN
DISPOSITION:	TO BE REPLACED
CFN:	1855247

PROPOSED STRUCTURE	
TYPE:	49"x33" PIPE ARCH CONDUIT, 707.01 (0.079) ALUMINIZED, 707.04 (0.079) POLYMERIC, 707.21 (0.075) ALUMINIUM
DIMENSIONS:	49"x33"
LENGTH:	59'
SKEW:	0°
ALIGNMENT:	TANGENT
ROADWAY:	24'-0" ± TREATED SH. TO TREATED SH.
CFN:	1997602
COORDINATES:	LATITUDE 40°17'39" LONGITUDE 83°34'43"

LEGEND	
	- ROCK CHANNEL PROTECTION, TYPE C
	- WETLAND 'A'

NOTES	
EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.	
EXISTING STRUCTURE TO BE REMOVED. ROAD TO BE CLOSED DURING CONSTRUCTION AND TRAFFIC TO BE DETOURED. MAINTENANCE OF TRAFFIC DETAILS ARE SHOWN ON THE DETOUR PLAN SHEETS.	

HORIZONTAL SCALE IN FEET
0 10 20 40

CULVERT DETAILS
LOG-287-10.03

DESIGN AGENCY
HALLES
ENGINEERING & DESIGN
520 SOUTH MAIN STREET
SUITE 2531
AKRON, OH 44311

DESIGNER
HE

REVIEWER
CMK 06-06-25

PROJECT ID
116483

SUBSET
0

TOTAL
0

SHEET
P.30

TOTAL
0

SECTION 5

ODOT Culvert Inventory Reports

CFN 1847868 LOG-117-5.78

OBJECTID	34359348
NLFID	SLOGSR00117**C
CRS	LOG-117-5.579
ODOT District	07
County	LOGAN
County CD	LOG
Route Type	SR
Route Number	00117
Route Suffix	Null
CTL Begin Number	5.579
STL Begin Number	57.982
Latitude DD Begin	40.450745
Longitude DD Begin	-83.807268
Perp Date	12/31/2023
Status	A
Installation Date	Null
Let Plans URL	Null
Special Designation (Formerly Road ID)	Mainline
Conduit File Number	1826401
Replacing Conduit	N
Replaced CFN	Null
Old Culvert File Number	461170556
Conduit Owner	S
Maintenance Responsibility	S
Entry Class	A
Features Intersected	

Number of Cells	1
Broken Back	N
Conduit Shape	Circular
Conduit Material	Cast or Ductile Iron
Span (Inches)	15
Rise (Inches)	15
Length (Feet)	50
Metal Gage Thickness	Null
Type of Pipe Protection	Null
Slope of Pipe (Percent)	1
Skew (Degrees)	0
Centerline Span	15
Inlet End Treatment	None
Outlet End Treatment	Full Height Concrete Headwall
Closed System	N
Maximum Height of Cover (Feet)	4
Scour Critical	N
Height of Inlet Headwall (Feet)	3
Inlet Headwall to Edge Pavement Distance (Feet)	Null
Height of Outlet Headwall (Feet)	3
Outlet Headwall to Edge Pavement Distance (Feet)	6
Headwall Critical	N
Atmospheric Physical Hazard	N
Drainage Area (Acres)	Null
Drainage Discharge (CFS)	Null
Abrasion Level	1
pH	Null

Conduit Media	\\filestore.dot.state.oh.us\Conduits_Inspection\D07\LOGAN\SR\117\1826401
Inventory Comments	CMP EXTENSION AT INLET LEFT.
Modification Type	Section Repair
Year Modified	Null
Modification Comments	Null
PID	Null
Capital Fiscal Year	Null
Latest General Appraisal	6
Latest Inspection Date	7/9/2018 3:36:45 PM
Last Inspection Year	2018
Frequency (Years)	12
Latest Level of Inspection	Inspection from ends of conduit
Partial Inspection Indicator	Null
Inspection Due	Null
Inventory Photos	https://collectornew.dot.state.oh.us/arcgis/rest/services/CULVERTS/Culvert_Inventory_Viewer/MapServer/0/65688/attachments
InvPASS_GA_QC	Null
Invcreated_user	COLLECTOR@D31_AG
Invcreated_date	8/2/2016 10:40:10 AM
Invlast_edited_user	gwise1
Invlast_edited_date	7/9/2018 3:27:56 PM
Invsys_updated_date	8/6/2024 10:15:46 PM
Level of Inspection	Inspection from ends of conduit
Conduit Material Condition	7
Conduit Alignment	7
Conduit Shape Rating	8
Seams or Joints	6
Slab	Null

Abutments	Null
Headwalls	5
End Structure	Null
Channel Alignment	7
Channel Protection	7
Waterway Blockage	7
Scour	7
Pavement	7
Guardrail	Null
Embankment	7
General Appraisal	6
Operational Status	Open - no restriction
Inspection Comments	MINOR MISALIGNMENT OR SETTLEMENT AT ISOLATED LOCATIONS. MISALIGNMENT OF JOINTS WITH NO INFILTRATION. CMP AT INLET LEFT HAS HEAVY DAMAGE AND PERFORATIONS IN THE BOTTOM AT END OF PIPE. HEADWALL DETERIORATION AND SPALLS WITH EXPOSED STEEL.
Inspection Date	7/9/2018 3:36:45 PM
Recommend Preventive Maintenance	Null
Recommend Inspection Frequency (Months)	Null
Inspection Photos	https://collectornew.dot.state.oh.us/arcgis/rest/services/CULVERTS/Culvert_Inventory_Viewer/MapServer/8/125149/attachments
InpPASS_GA_QC	Null
Inspcreated_user	gwise1
Inspcreated_date	7/9/2018 3:36:56 PM
Insplast_edited_user	gwise1
Insplast_edited_date	5/28/2021 5:21:03 PM
Inspsys_updated_date	2/13/2024 1:22:49 AM

P2 General Appraisal	6
Image_Attach_Inv	Null
Image_Attach_Insp	Null
JURISDICTION	S
DIVIDED_HWY	N
ACCESS_CONTROL	N
URBAN_AREA_CODE	99999
BASE_TYPE	L
FUNCTIONAL_CLASS	5
HPMS_SAMPLE_ID	Null
LANES	2
MAINTENANCE_AUTHORITY	Null
NHS	Null
PRIORITY_SYSTEM	G
SURFACE_TYPE	G
SURFACE_WIDTH	24
ESAL_TOTAL	Null
AADT_PASSENGER	7455
AADT_TOTAL	8409
AADT_BC_TRUCK	954
PAVE_TYPE	FLEX
PCR_YEAR	Null
ROADWAY_WIDTH_NBR	38
created_user	TIMS@P31_TIMS_CLASSIC
created_date	11/16/2024 8:09:19 AM
last_edited_user	TIMS@P31_TIMS_CLASSIC
last_edited_date	11/16/2024 8:09:19 AM
SHAPE	Point

CFN 1848010 LOG-287-7.27

OBJECTID	34263417
NLFID	SLOGSR00287**C
CRS	LOG-287-7.273
ODOT District	07
County	LOGAN
County CD	LOG
Route Type	SR
Route Number	00287
Route Suffix	Null
CTL Begin Number	7.273
STL Begin Number	7.273
Latitude DD Begin	40.264032
Longitude DD Begin	-83.61004
Perp Date	12/31/2023
Status	A
Installation Date	Null
Let Plans URL	http://contracts.dot.state.oh.us/common/searchAPI.do?cabinetId=1002&PID_NUM=116483
Special Designation (Formerly Road ID)	Mainline
Conduit File Number	1855245
Replacing Conduit	N
Replaced CFN	Null
Old Culvert File Number	462870727
Conduit Owner	S
Maintenance Responsibility	S
Entry Class	A
Features Intersected	

Number of Cells	1
Broken Back	N
Conduit Shape	Circular
Conduit Material	Corrugated Metal - Pipe
Span (Inches)	60
Rise (Inches)	Null
Length (Feet)	72
Metal Gage Thickness	Null
Type of Pipe Protection	Fully Bituminous Coated
Slope of Pipe (Percent)	0.1
Skew (Degrees)	0
Centerline Span	60
Inlet End Treatment	None
Outlet End Treatment	None
Closed System	N
Maximum Height of Cover (Feet)	3
Scour Critical	N
Height of Inlet Headwall (Feet)	Null
Inlet Headwall to Edge Pavement Distance (Feet)	Null
Height of Outlet Headwall (Feet)	Null
Outlet Headwall to Edge Pavement Distance (Feet)	Null
Headwall Critical	N
Atmospheric Physical Hazard	N
Drainage Area (Acres)	Null
Drainage Discharge (CFS)	Null
Abrasion Level	1
pH	Null

Conduit Media	\\filestore.dot.state.oh.us\Conduits_Inspection\D07\LOGAN\SR\287\1855245
Inventory Comments	10' SPIRAL RIB EXTENSIONS ON BOTH ENDS.
Modification Type	Null
Year Modified	Null
Modification Comments	Null
PID	116483
Capital Fiscal Year	2027
Latest General Appraisal	3
Latest Inspection Date	7/19/2023 1:46:12 PM
Last Inspection Year	2023
Frequency (Years)	1
Latest Level of Inspection	Manned entry inspection
Partial Inspection Indicator	Null
Inspection Due	Needs Inspected this CY
Inventory Photos	https://collectornew.dot.state.oh.us/arcgis/rest/services/CULVERTS/Culvert_Inventory_Viewer/MapServer/0/67160/attachments
InvPASS_GA_QC	Null
Invcreated_user	COLLECTOR@D31_AG
Invcreated_date	8/2/2016 10:40:10 AM
Invlast_edited_user	gwise1@Editor
Invlast_edited_date	8/30/2021 1:15:22 PM
Invsys_updated_date	8/6/2024 11:56:43 PM
Level of Inspection	Manned entry inspection
Conduit Material Condition	3
Conduit Alignment	6
Conduit Shape Rating	5
Seams or Joints	6
Slab	Null

Abutments	Null
Headwalls	Null
End Structure	Null
Channel Alignment	7
Channel Protection	6
Waterway Blockage	7
Scour	5
Pavement	8
Guardrail	Null
Embankment	6
General Appraisal	3
Operational Status	Open - no restriction
Inspection Comments	DAMAGE IN TOP OF EXTENSION AT INLET. EXTENSIVE HEAVY RUST AND SCALE THROUGHOUT. PERFORATIONS THROUGHOUT INVERT UNDER ROADWAY. REVERSE CURVATURE ALONG REAR SIDE OF INVERT AT 2 LOCATIONS. 1-1/2" SEAM AT INLET EXTENSION. EROSION AROUND END OF PIPE AT INLET AND OUTLET. SCOUR HOLE AT OUTLET UNDERMINING END OF PIPE .
Inspection Date	7/19/2023 1:46:12 PM
Recommend Preventive Maintenance	Drainage Structure Repair
Recommend Inspection Frequency (Months)	Null
Inspection Photos	https://collectornew.dot.state.oh.us/arcgis/rest/services/CULVERTS/Culvert_Inventory_Viewer/MapServer/8/1499547/attachments
InpPASS_GA_QC	Null
Inspcreated_user	gwise1
Inspcreated_date	7/19/2023 1:46:12 PM
Insplast_edited_user	gwise1
Insplast_edited_date	7/19/2023 1:46:12 PM
Inspsys_updated_date	2/13/2024 1:22:49 AM

P2 General Appraisal	Null
Image_Attach_Inv	Null
Image_Attach_Insp	Null
JURISDICTION	S
DIVIDED_HWY	N
ACCESS_CONTROL	N
URBAN_AREA_CODE	99999
BASE_TYPE	I
FUNCTIONAL_CLASS	6
HPMS_SAMPLE_ID	Null
LANES	2
MAINTENANCE_AUTHORITY	Null
NHS	Null
PRIORITY_SYSTEM	G
SURFACE_TYPE	G
SURFACE_WIDTH	19
ESAL_TOTAL	Null
AADT_PASSENGER	1684
AADT_TOTAL	1828
AADT_BC_TRUCK	144
PAVE_TYPE	FLEX
PCR_YEAR	Null
ROADWAY_WIDTH_NBR	24
created_user	TIMS@P31_TIMS_CLASSIC
created_date	11/16/2024 8:09:19 AM
last_edited_user	TIMS@P31_TIMS_CLASSIC
last_edited_date	11/16/2024 8:09:19 AM
SHAPE	Point

CFN 1848013 LOG-287-10.03

OBJECTID	34316797
NLFID	SLOGSR00287**C
CRS	LOG-287-10.034
ODOT District	07
County	LOGAN
County CD	LOG
Route Type	SR
Route Number	00287
Route Suffix	Null
CTL Begin Number	10.034
STL Begin Number	10.034
Latitude DD Begin	40.29412
Longitude DD Begin	-83.57854
Perp Date	12/31/2023
Status	A
Installation Date	Null
Let Plans URL	http://contracts.dot.state.oh.us/common/searchAPI.do?cabinetId=1002&PID_NUM=116483
Special Designation (Formerly Road ID)	Mainline
Conduit File Number	1855247
Replacing Conduit	N
Replaced CFN	Null
Old Culvert File Number	462871005
Conduit Owner	S
Maintenance Responsibility	S
Entry Class	A
Features Intersected	

Number of Cells	1
Broken Back	N
Conduit Shape	Pipe Arch
Conduit Material	Corrugated Metal - Non-Sectional Plate
Span (Inches)	50
Rise (Inches)	31
Length (Feet)	40
Metal Gage Thickness	Null
Type of Pipe Protection	Fully Bituminous Coated
Slope of Pipe (Percent)	0.8
Skew (Degrees)	0
Centerline Span	50
Inlet End Treatment	Stone
Outlet End Treatment	Stone
Closed System	N
Maximum Height of Cover (Feet)	3
Scour Critical	N
Height of Inlet Headwall (Feet)	Null
Inlet Headwall to Edge Pavement Distance (Feet)	Null
Height of Outlet Headwall (Feet)	Null
Outlet Headwall to Edge Pavement Distance (Feet)	Null
Headwall Critical	N
Atmospheric Physical Hazard	N
Drainage Area (Acres)	Null
Drainage Discharge (CFS)	Null
Abrasion Level	1
pH	Null

Conduit Media	\\filestore.dot.state.oh.us\Conduits_Inspection\D07\LOGAN\SR \287\1855247
Inventory Comments	
Modification Type	Null
Year Modified	Null
Modification Comments	Null
PID	116483
Capital Fiscal Year	2027
Latest General Appraisal	4
Latest Inspection Date	7/19/2023 1:11:19 PM
Last Inspection Year	2023
Frequency (Years)	1
Latest Level of Inspection	Inspection from ends of conduit
Partial Inspection Indicator	Null
Inspection Due	Needs Inspected this CY
Inventory Photos	https://collectornew.dot.state.oh.us/arcgis/rest/services/CULVERTS/Culvert_Inventory_Viewer/MapServer/0/101740/attachments
InvPASS_GA_QC	Null
Invcreated_user	COLLECTOR@D31_AG
Invcreated_date	8/2/2016 10:40:10 AM
Invlast_edited_user	gwise1
Invlast_edited_date	10/30/2020 4:19:12 PM
Invsys_updated_date	8/7/2024 1:43:21 AM
Level of Inspection	Inspection from ends of conduit
Conduit Material Condition	4
Conduit Alignment	5
Conduit Shape Rating	4
Seams or Joints	6

Slab	Null
Abutments	Null
Headwalls	4
End Structure	Null
Channel Alignment	7
Channel Protection	7
Waterway Blockage	5
Scour	7
Pavement	6
Guardrail	Null
Embankment	7
General Appraisal	4
Operational Status	Open - no restriction
Inspection Comments	EXTENSIVE HEAVY RUST AND SCALE THROUGHOUT. PERFORATIONS THROUGHOUT INVERT. MISALIGNMENT OR SETTLEMENT THROUGHOUT. BULGES IN SIDE REAR. SAG IN TOP LEFT. DETERIORATION OF MASONRY END STRUCTURES WITH WALLS LEANING OUT AND REAR LEFT TOP MISSING. SEDIMENT BUILDUP THROUGH CULVERT. SETTLEMENT IN ASPHALT PAVEMENT IN RIGHT WHEEL TRACK EASTBOUND.
Inspection Date	7/19/2023 1:11:19 PM
Recommend Preventive Maintenance	Drainage Structure Repair
Recommend Inspection Frequency (Months)	Null
Inspection Photos	https://collectornew.dot.state.oh.us/arcgis/rest/services/CULVERTS/Culvert_Inventory_Viewer/MapServer/8/1499545/attachments
InpPASS_GA_QC	Null
Inspcreated_user	gwise1
Inspcreated_date	7/19/2023 1:11:19 PM
Insplast_edited_user	gwise1

Insplast_edited_date	7/19/2023 1:11:44 PM
Inspsys_updated_date	2/13/2024 1:22:49 AM
P2 General Appraisal	Null
Image_Attach_Inv	Null
Image_Attach_Insp	Null
JURISDICTION	S
DIVIDED_HWY	N
ACCESS_CONTROL	N
URBAN_AREA_CODE	99999
BASE_TYPE	I
FUNCTIONAL_CLASS	6
HPMS_SAMPLE_ID	Null
LANES	2
MAINTENANCE_AUTHORITY	Null
NHS	Null
PRIORITY_SYSTEM	G
SURFACE_TYPE	G
SURFACE_WIDTH	19
ESAL_TOTAL	Null
AADT_PASSENGER	1684
AADT_TOTAL	1828
AADT_BC_TRUCK	144
PAVE_TYPE	FLEX
PCR_YEAR	Null
ROADWAY_WIDTH_NBR	24
created_user	TIMS@P31_TIMS_CLASSIC
created_date	11/16/2024 8:09:19 AM
last_edited_user	TIMS@P31_TIMS_CLASSIC

last_edited_date	11/16/2024 8:09:19 AM
SHAPE	Point

SECTION 6

Pavement Design

Simplified Pavement Designs for Short* Projects															
Pavement Composition	Pavement Course Thicknesses														
	Number of Trucks in Opening Day ADT														
	B (ADT x T24)														
	<=10		11-25		26-50		51-100		101-200		201-400		401-800		>800
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	
Flexible Design															
441 AC Surface, Type 1, (449), PG64-22**	1.25	32	3	75	3	75	3	75	3	75	3	75	3	75	n/a
301 Asphalt Concrete Base, (449), PG64-22	4	100	4	100	5	125	6	150	7	180	8	200	9	230	n/a
304 Aggregate Base	6	150	6	150	6	150	6	150	6	150	6	150	6	150	n/a
Alternate Flexible Design															
441 AC Surface, Type 1, (449), PG64-22**	3	75	-	-	-	-	-	-	-	-	-	-	-	-	n/a
304 Aggregate Base	12	300	-	-	-	-	-	-	-	-	-	-	-	-	n/a
Rigid Design															
452 Non-Reinforced Concrete Pavement, Class QC 1P	7***	180	7***	180	7***	180	7***	180	8	210	9	230	10	260	n/a
304 Aggregate Base	6	150	6	150	6	150	6	150	6	150	6	150	6	150	n/a

* Less than 300 linear feet (100 m) of total pavement replacement.

** Include a plan note restricting the 441 to 2-inch (50 mm) maximum lift thickness.

*** 7-inch (180 mm) concrete is allowed for short projects only. All other projects require 8-inch (200 mm) minimum in accordance with Section 302.

A - CSN 1847868, LOG-117-5.78 $8,500 \times 0.17 = 1445$ trucks Use pavement design methods
 B - CSN 1848010, LOG-287-7.27 $1,500 \times 0.06 = 90$ trucks

GAI Consultants
LOG-117-5.78
PID 116483

DESIGNED CHECKED
CMK
10/28/2024

FLEXIBLE PAVEMENT DESIGN*

S.R. 117 DESIGN DESIGNATIONS:

	YEAR	
FUNCTIONAL CLASSIFICATION:		RURAL MAJOR COLLECTOR
NO. of LANES (CENTER TWO WAY TURNLANES DISREGARDE		2
CURRENT ADT	2023	8500
DESIGN YEAR ADT	2043	8600
DESIGN HOURLY VOLUME	2043	774
DIRECTIONAL DISTRIBUTION (D)		56%
TRUCKS		17%
DESIGN SPEED		60 MPH
LEGAL SPEED		55 MPH

PAVEMENT DESIGN PARAMETERS

CBR from SOIL REPORT	3	(ASSUMED)
SOIL SUPPORT VALUE (SSV) from SOIL REPORT	3	
B:C RATIO from fig 202-1 for URBAN PRINCIPAL ARTERIAL	2	1
B FACTOR from fig 202-1		0.79
C FACTOR from fig 202-1		0.48
LANE FACTOR from fig 202-1		95%
MID YEAR TRAFFIC (ADTMY) 2033		8550
RELIABILITY from fig 202-1 for URBAN MINOR ARTERIAL		85%
OVERALL STANDARD DEVIATION from fig 202-1 FLEXIBLE PAV		0.49
DESIGN SEVICEABILITY from fig 201-1		2.0
RESILIENT MODULUS (MR)		3600

18 Kip EQUIVALENT SINGLE AXLE LOAD (ESAL)

ESAL'S FOR B TRUCKS

$$\text{ADTMY} \times \text{Trucks} \times \text{D} \times \text{LANE FACTOR} \times \text{B} \times \text{B:C} \\ 8550 \times 0.17 \times 0.56 \times 0.95 \times 0.79 \times 0.6667 = 410 \text{ ESAL} \\ 8550 \times 0.17 \times 0.56 \times 1.0 \times 0.79 \times 0.67 =$$

ESAL'S FOR C TRUCKS

$$\text{ADTMY} \times \text{Trucks} \times \text{D} \times \text{LANE FACTOR} \times \text{C} \times \text{B:C} \\ 8550 \times 0.17 \times 0.56 \times 0.95 \times 0.48 \times 0.3333 = 125 \text{ ESAL}$$

total ESAL'S 535 / day

DESIGN PERIOD ESAL 2043

TOTAL ESAL'Sd X 365.25d/y X 20y

$$535 \times 365.25 \times 20 = 3.91\text{E}+06 \text{ ESAL}$$

STRUCTURAL NUMBER REQUIRED (SN) from fig 402-3 **5.1**

ADTT (2007)

$$8500 \times 0.17 = 1445 < 1500^{**}, \quad 50^{***} < 1445 < 1500^{***}$$

* ODOT DIST. 4 PREFERENCE IS NOT TO USE CONCRETE COMPOSITE FOR WIDENING PROJECTS

** SECTION 404.4 ITEM 446 & 448 A.C. TYPE 1 H IS NOT NEEDED

*** APPENDIX B TRAFFIC IS CONSIDERED MEDIUM

LOG-117-5.78

DESIGNED	CHECKED
CMK	
10/28/2024	10/28/2024

FLEXIBLE PAVEMENT DESIGN

PROPOSED PAVEMENT

ITEM	DESCRIPTION	THICKNESS (inch)		COEFFICIENT	SN
441	A.C. SURFACE COURSE, TYPE 1, (449), PG64-22	3	x	0.35	= 1.0500
441	A.C. INTERMEDIATE COURSE, TYPE 2, (449)	0	x	0.35	= 0.0000
301	A.C. BASE, (449), PG64-28	10	x	0.35	= 3.5000
304	AGGREGATE BASE	6	x	0.14	= 0.8400
SN =					5.3900

PROPOSED PAVEMENT SN 5.4 > 5.1 SN REQ'D

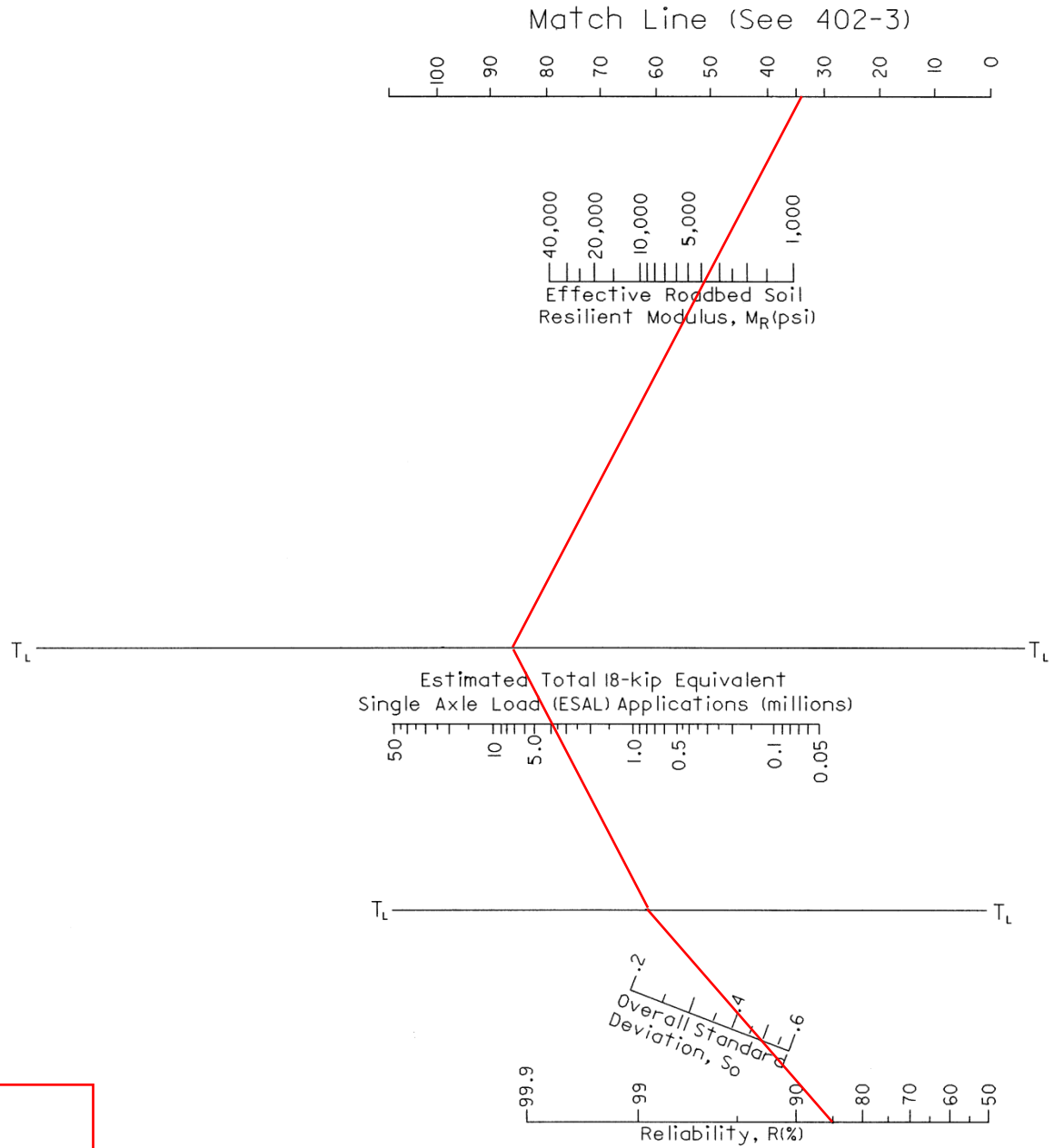
OK

Flexible Pavement Design Chart Segment 1

402-2

July 2008

Reference Section & Figure
402, 402-1(step 3)



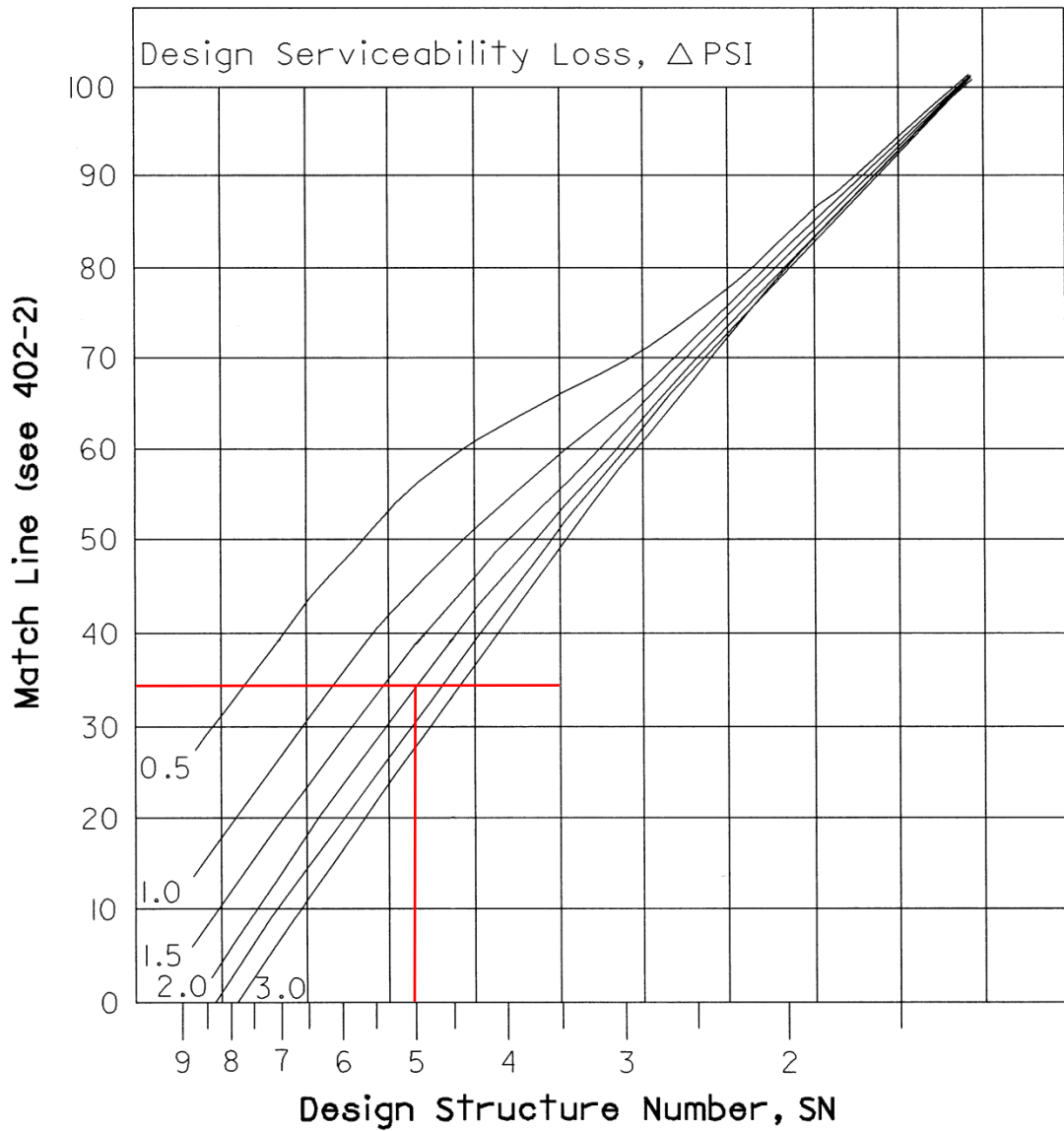
$R=85\%$
 $S_o = 0.49$
 $ESAL = 3.91 \times 10^6$
 $M_r = 3600 \text{ psi}$

Flexible Pavement Design Chart Segment 2

402-3

July 2008

Reference Section & Figure
402, 402-1(step 3)



Match line = 34
Dpsi = 2.0
SN = 5.1

Serviceability & Reliability	201-1 July 2016
	Reference Section 201 & 204

SERVICEABILITY FACTORS		
	Rigid	Flexible
Initial Serviceability	4.2	4.5
Terminal Serviceability	2.5	2.5
Design Serviceability Loss	1.7	2.0

RELIABILITY LEVELS (%)		
Functional Classification	Urban*	Rural*
Interstate and Freeway (01, 02)	95	90
Principle Arterial, Minor Arterial (03, 04)	90	85
Collectors (05, 06)	90	85
Local (07)	80	80

* The designer must determine if the location is urban or rural in character. The ODOT Highway Functional Classification System Concepts, Procedures and Instructions document available from the Office of Program Management should be used as a guide.

OVERALL STANDARD DEVIATION	
Flexible Pavement	0.49
Rigid Pavement	0.39

Traffic Factors	202-1 July 2016
	Reference Section 202

RATIO OF B:C COMMERCIAL VEHICLES		
Functional Classification	B:C Ratio	
	Urban*	Rural*
Interstate (01)	4:1	7:1
Other Freeway or Expressway (02)	3:1	
Principal Arterial (03)	2:1	5:1
All Other (04, 05, 06, 07)	1:1	2:1

ESAL CONVERSION FACTORS				
Functional Classification	Rigid		Flexible	
	B	C	B	C
Interstate (01), rural*	1.53	0.37	0.98	0.29
Principal Arterial (03), rural*	1.67	0.44	1.06	0.33
All Other (04, 05, 06, 07), rural*	1.26	0.76	0.79	0.48
Interstate (01), urban*	1.46	0.46	0.93	0.34
Expressway & Freeway (02), urban*	1.38	0.72	0.90	0.47
All Other (03, 04, 05, 06, 07), urban*	1.64	0.53	1.04	0.41

* The designer must determine if the location is urban or rural in character. The ODOT Highway Functional Classification System Concepts, Procedures and Instructions document available from the Office of Program Management should be used as a guide.

DESIGN LANE FACTORS		
Number of Lanes per Direction	Lane Factor (LF) (%)	Directional Distribution (D) for two-way traffic (%)
1 - Lane	100	50
2 - Lanes	95	50
3 - Lanes	80	50
4 (or more) - Lanes	70	50

Group Index Charts

203-1

July 2008

Reference Section

203

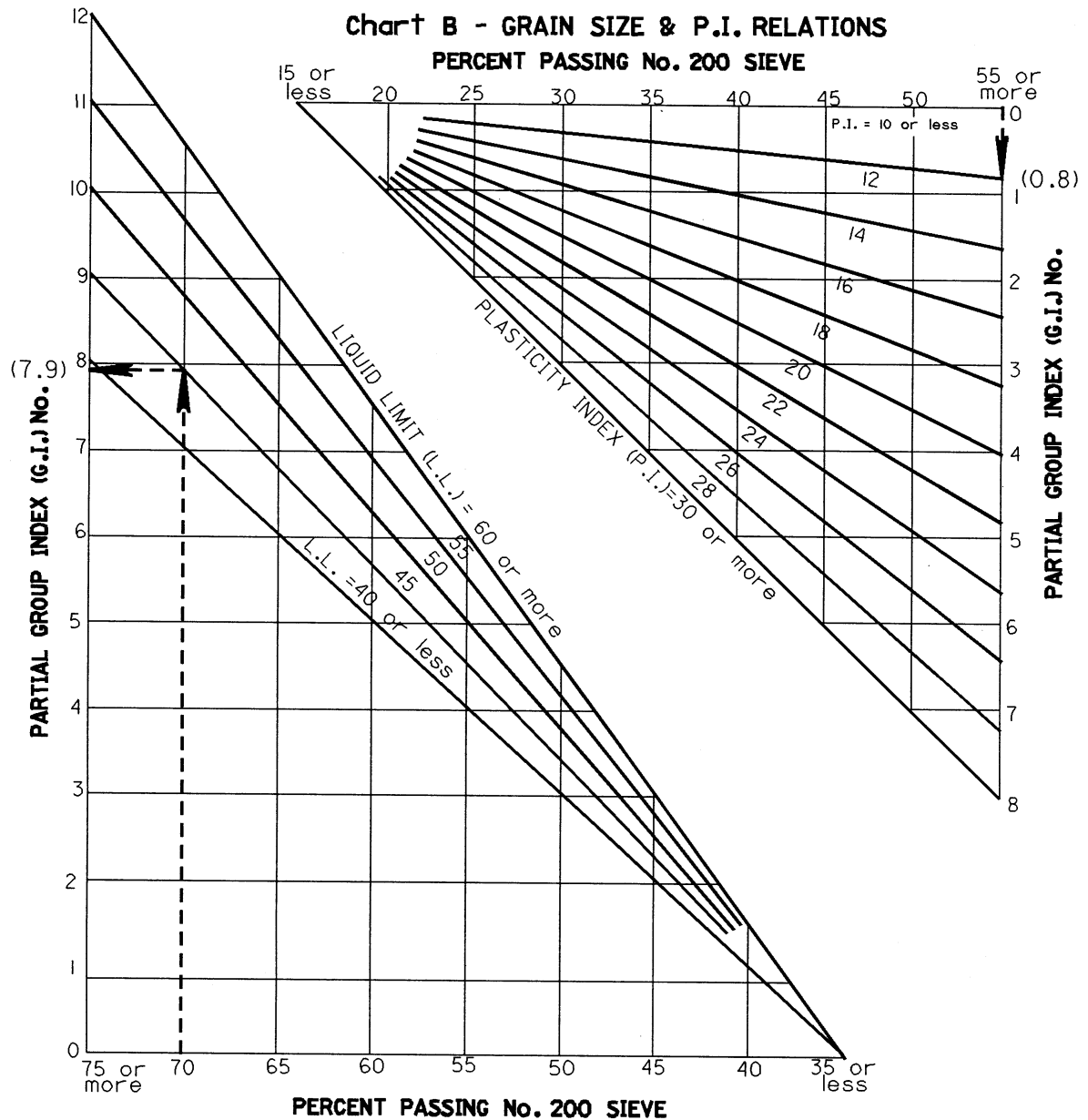


Chart A - GRAIN SIZE & L.L. RELATIONS

GROUP INDEX EQUALS SUM OF READINGS ON BOTH VERTICAL SCALES

Example: The G.I. of soil having 70% of its particles passing a No.200 sieve, with a L.L.=45 and a P.I.=12.

Chart A=7.9; Chart B=0.8

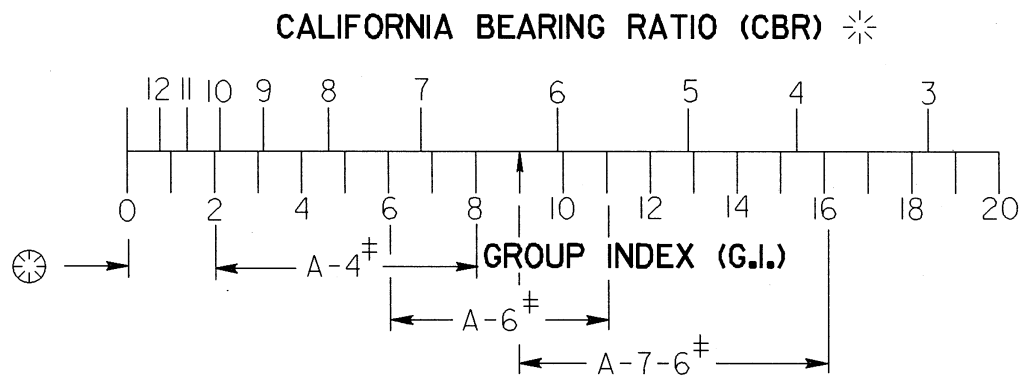
G.I. = 7.9+0.8 = 8.7 (rounded off to 9).

Subgrade Resilient Modulus

203-2

July 2015

**Reference Section
203**



⊗ AASHTO Classes A-1, A-2 & A-3. K=200+.

‡ Usual range of AASHTO Classes.

* 5-1/2 LB. hammer, 12" drop, 4 layers, 45 blows per layer, compacted at optimum moisture as determined by AASHTO T-99.

Example: G.I.=9 (Figure 203-2) CBR=6 (Rounded, from above)

$$\text{RESILIENT MODULUS } (M_R) = 1200 \times \text{CBR}$$

$$M_R = 1200 \times 6 = 7200 \text{ psi}$$

Simplified Pavement Designs for Short* Projects															
Pavement Composition	Pavement Course Thicknesses														
	Number of Trucks in Opening Day ADT (ADT x T24)														
	<=10		11-25		26-50		51-100		101-200		201-400		401-800		>800
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	
Flexible Design															
441 AC Surface, Type 1, (449), PG64-22**	1.25	32	3	75	3	75	3	75	3	75	3	75	3	75	n/a
301 Asphalt Concrete Base, (449), PG64-22	4	100	4	100	5	125	6	150	7	180	8	200	9	230	n/a
304 Aggregate Base	6	150	6	150	6	150	6	150	6	150	6	150	6	150	n/a
Alternate Flexible Design															
441 AC Surface, Type 1, (449), PG64-22**	3	75	-	-	-	-	-	-	-	-	-	-	-	-	n/a
304 Aggregate Base	12	300	-	-	-	-	-	-	-	-	-	-	-	-	n/a
Rigid Design															
452 Non-Reinforced Concrete Pavement, Class QC 1P	7***	180	7***	180	7***	180	7***	180	8	210	9	230	10	260	n/a
304 Aggregate Base	6	150	6	150	6	150	6	150	6	150	6	150	6	150	n/a

* Less than 300 linear feet (100 m) of total pavement replacement.

** Include a plan note restricting the 441 to 2-inch (50 mm) maximum lift thickness.

*** 7-inch (180 mm) concrete is allowed for short projects only. All other projects require 8-inch (200 mm) minimum in accordance with Section 302.

NUMBER OF TRUCKS IN OPENING DAY = ADT x T24 = 1,400 x 0.08 = 112 TRUCKS