

COPY

HYDRAULIC STUDY
For
Culvert Recommendation
Montpelier Township
In NE 1/4 of NW 1/4 of Section 29, T 137 N, R 63 W.
Stutsman County, ND
July, 2019



7/18/19
Date

Benjamin B. Aaseth
License No. 10085

Interstate Engineering, Inc.
Jamestown, North Dakota
J19-04-090

I. GENERAL

This hydraulic study has been prepared to investigate the size of structure that would be required to convey the water at a crossing located in the NE 1/4 of NW 1/4 of Section 29, T 137 N, R 63 W, Montpelier Township in Stutsman County, North Dakota. There are no upstream structures that impact this site at the analyzed event year. This site will be designed for a 10-year event, based upon North Dakota Administrative Code 89 for township roads.

The existing pipe onsite has damaged end sections. The upstream end section has a damaged top as well as some rust. The downstream end section is split at the seams.

The existing site has the following characteristics:

- Top of Road = 1489'
- Existing Road Width = 22'
- Tailwater = 10 foot bottom with 10:1 side slopes
- Invert North end = 1484.19'
- Channel elevation near north end = 1484.07'
- Invert South end = 1484.13'
- Channel elevation near south end = 1484.13'
- Lat: 46° 39' 35.23" N Long: 98° 39' 42.12" W

II. HYDROLOGY

Originally when the quad maps were developed it appeared that this culvert drained a much larger area, since that time there has been some change in flow patterns. The water approximately one-mile south of the culvert located just south of the Section Line, flows primarily easterly thru an existing drainage channel. Originally it appeared that this water flowed north to the culvert in quad maps originally developed. Considering that this crossing is only to be sized for a 10-year event only 5% of the larger drainage flows were considered to flow north based upon aerial drone video and photo graphs that were taken in the spring of 2019. See Appendix B. If all of the area to the south would be considered when sizing the culvert, the size would need to be significantly larger. See sheet 3 for the original drainage area identified with the original quad maps, compared to the drainage used for sizing the culvert on Sheets 1 & 2.

The drainage area for this site was determined, using the USGS Quad Maps, to be approximately 0.95 square miles (approximately 608 acres). This area is shown on Sheets 1 & 2. The drainage basin flows through mainly farmland and wetland areas. The main use of the drainage area is agriculture land.

The discharges at the site were determined utilizing the USGS "Techniques for Estimating Peak-Flow Frequency Relations for North Dakota Streams 1992", which takes into consideration different soil types, vegetation, storage,

slope of the basin, and terrain. The area being studied is in Region C, with slopes of approximately 4 feet per mile.

III. HYDRAULIC ANALYSIS

The FHWA HY-8 program was used in the analysis. The following data has been compiled and utilized to determine a sufficient and appropriate structure at this location.

Channel: Area identified on quad maps

Total Drainage Area: 0.95 square miles

Existing Structure at Site:
18" Corrugated Steel Pipe

Existing Upstream Structure:
None or Unknown

Existing downstream Structure:
24" Corrugated Steel Pipe

Site Characteristics: (Small Drainage + 5% of the larger drainage)

Design (2):	9 cfs
Design (10):	43 cfs
Design (15):	56 cfs
Design (25):	74 cfs
Design (50):	103 cfs
Design (100):	136 cfs
Greatest Flood (500 year):	225 cfs

The structure was sized for 10-year event, restricting the headwater to be the pipe diameter + 2 feet which is based on the North Dakota Stream and Crossing Standards.

IV. STRUCTURE COMPARISON

The following chart analyzes the proposed structure for the crossing of the roadway:

<u>Number of Lines</u>	<u>Structure Type</u>	<u>Total Waterway Opening (sq. ft.)</u>	<u>Allowable Headwater Dia. + 2 feet</u>
1	* 30" CSP	4.90	

*24" CSP should be installed at this time due to downstream culvert sizes.

Headwater Comparison

Flood Event	Flow (cfs)	Headwater Existing (ft) 18" CSP	Headwater Proposed (ft) 30" CSP
2 Year	7	1486.06	1485.76
10 Year	32	1489.05	1488.50
25 Year	55	1489.10	1489.08
<i>Overtops road (cfs)</i>		15.01	46.79

V.

CONCLUSION & RECOMMENDATION

The recommendation pipe is a 30" Corrugated Steel Pipe, but considering that the downstream culvert is only 24", this culvert should be installed at only a 24" at this time. This pipe should be installed at the existing inverts. The pipe should be installed with end sections as there is evidence that the existing pipe has been damaged from machinery likely mowing the ditches. If further reports are done with a larger study, all the pipes on this drainage should be analyzed to the James River to create a system that would meet state laws.

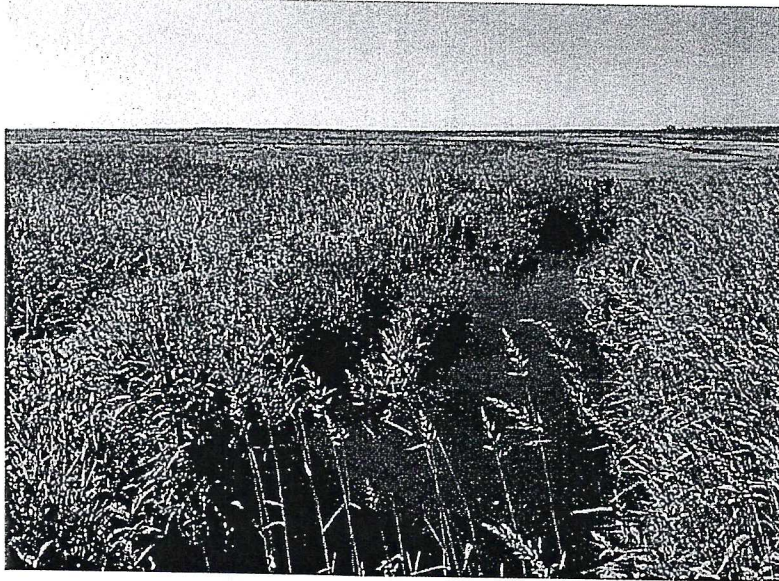
As per the North Dakota permit from the USACE, counter sinking is only required when there is a stable stream bed. This stream bed is not stable and therefor no need for counter sinking.

Please call at any time if you have any questions or need any further information.

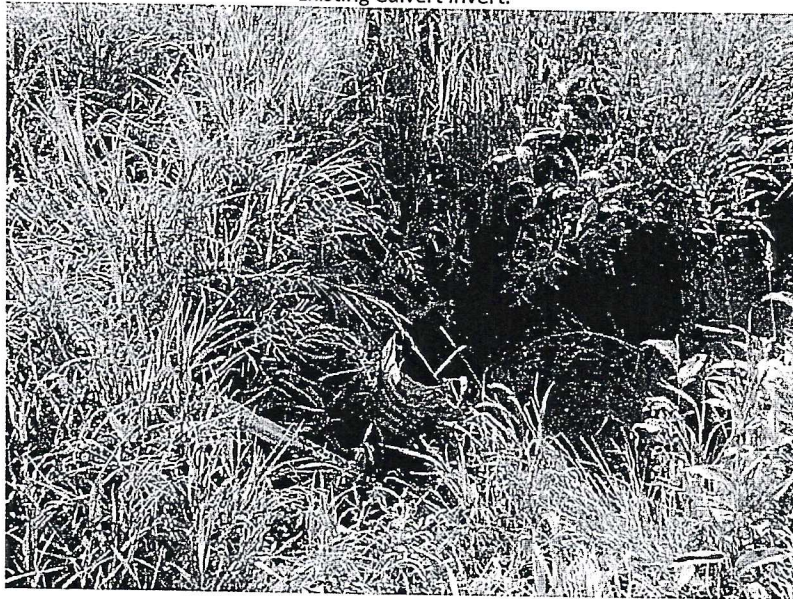
Ben Aaseth

Existing Site Photos

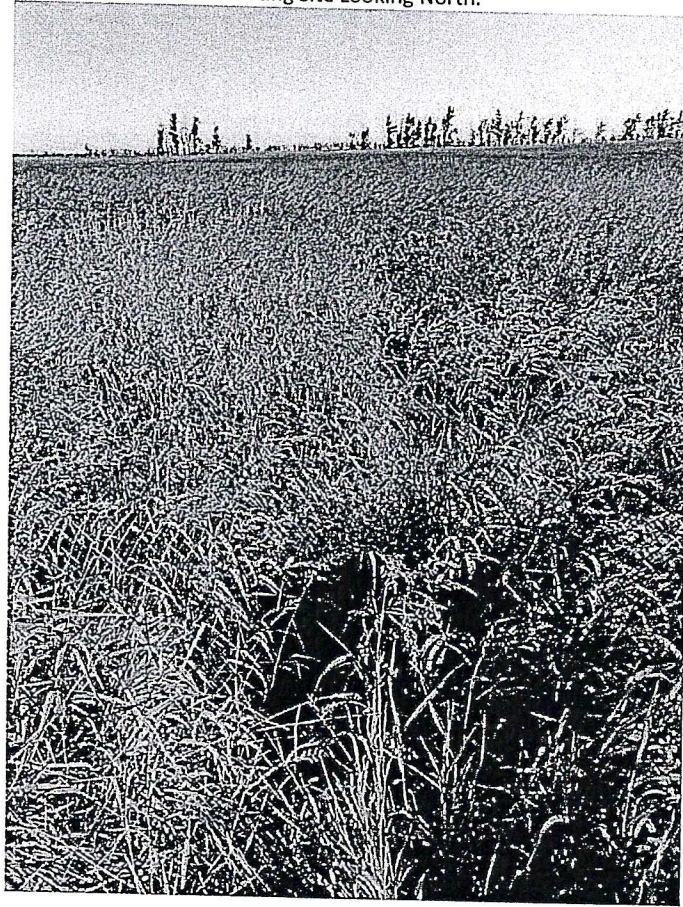
Existing site looking south.



Existing Culvert Invert.



Existing Site Looking North.



Existing Culvert Outlet



APPENDIX A

PROJECT MAPS

Rev No	Date	By	Description

Hydraulic Study
 545 23 1137N R83W
 Municipal Council
 Sherman County ND

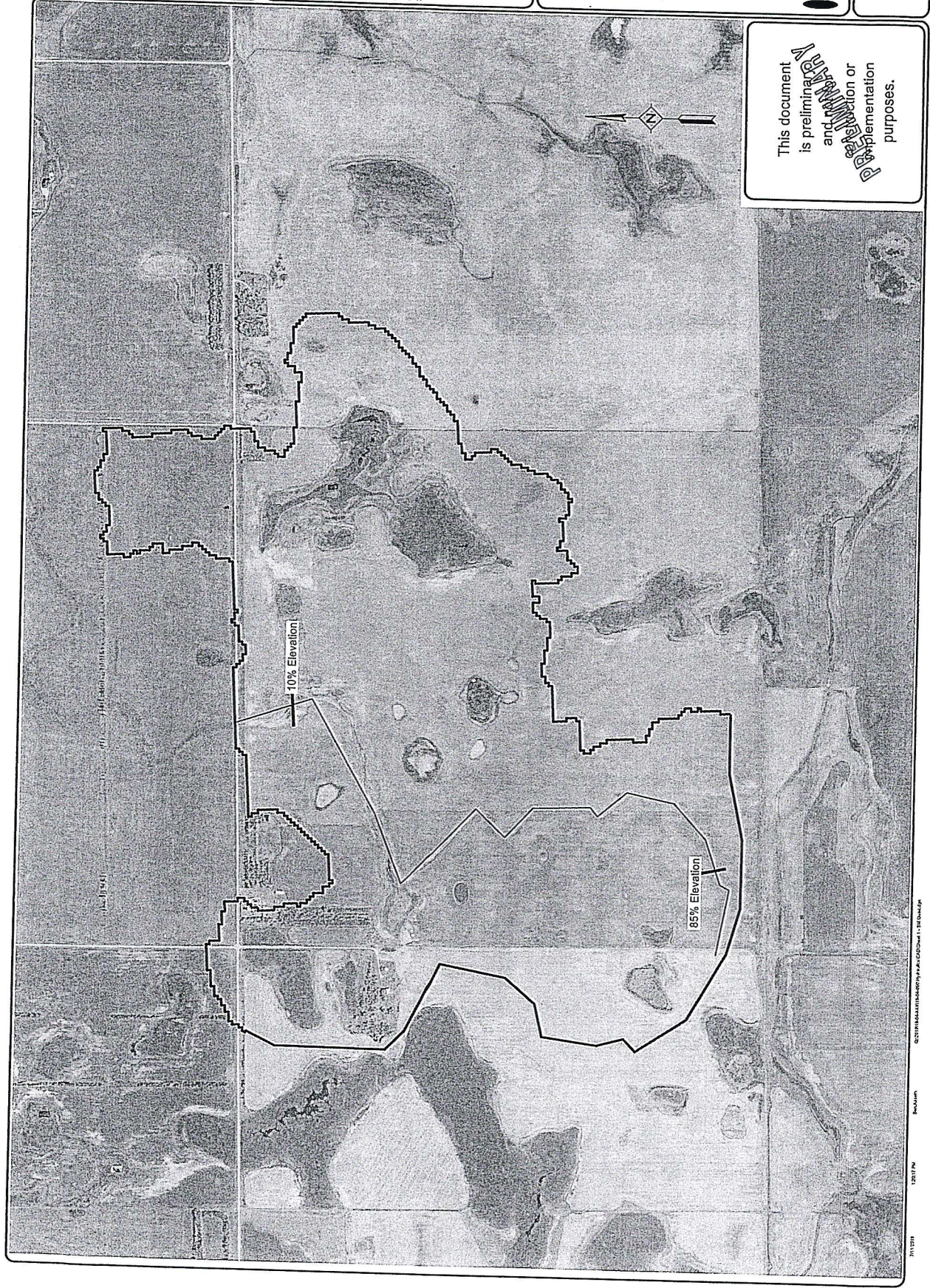
Drawn By: RA
 Surveyed By: RA
 Checked By: RA
 Project No: J1504-040
 Date: 07/11/19

Drainage Area - Aerial

Interstate Engineering, Inc.
 1503 12th Avenue SW
 P.O. Box 2035
 Jamestown, ND 58402-2035
 Ph (701) 252-0234
 Fax (701) 252-0203
 www.interstateeng.com

Professionals you need, people you trust.

INTERSTATE ENGINEERING



This document is preliminary and may be revised or supplemented for implementation purposes.

Sheet Number

1



Professionals you need, people you trust.

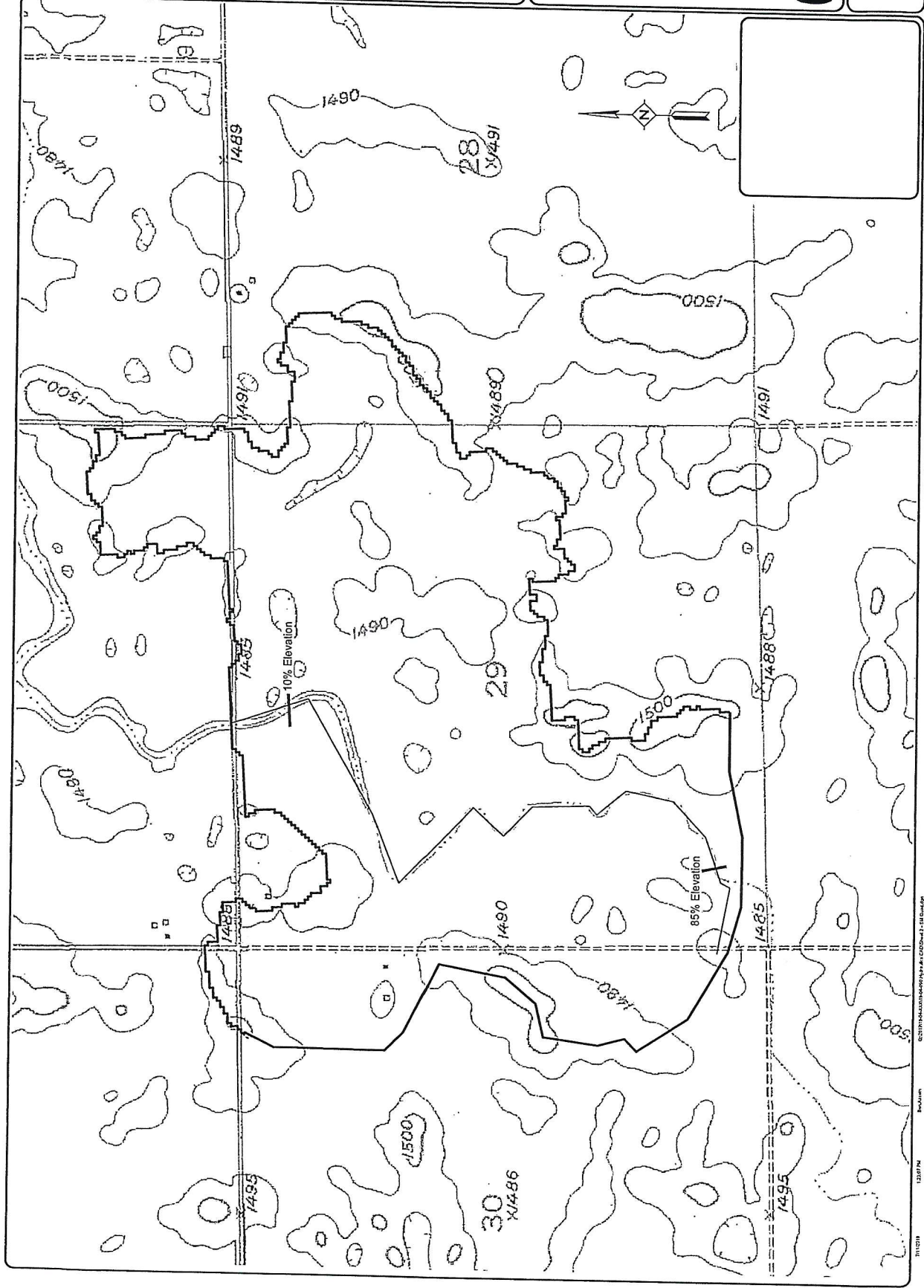
Interstate Engineering, Inc.
1903 12th Avenue SW
P.O. Box 2035
Jacksonville, NC 28602-2035
Ph (701) 252-0224
Fax (701) 252-0203
www.interstateeng.com

Checked By: BA
Drawn By: LR
Surveyed By: BA
Designed By: BA
Project No: J1904040
Date: 07/11/19

Drainage Area - Quad

Hydrus Study
Sec. 29, T13N, R33W
Northwest Township
Stuteman County, ND

Rev	Date	By	Description



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Rev No	Date	By	Description

Hydraulic Study
 Sec 59, T13N, R63W
 Stutsman County ND
 Kenyon, ND

Drainage Area - Original

Project No: J1504-010
 Date: 07/11/19

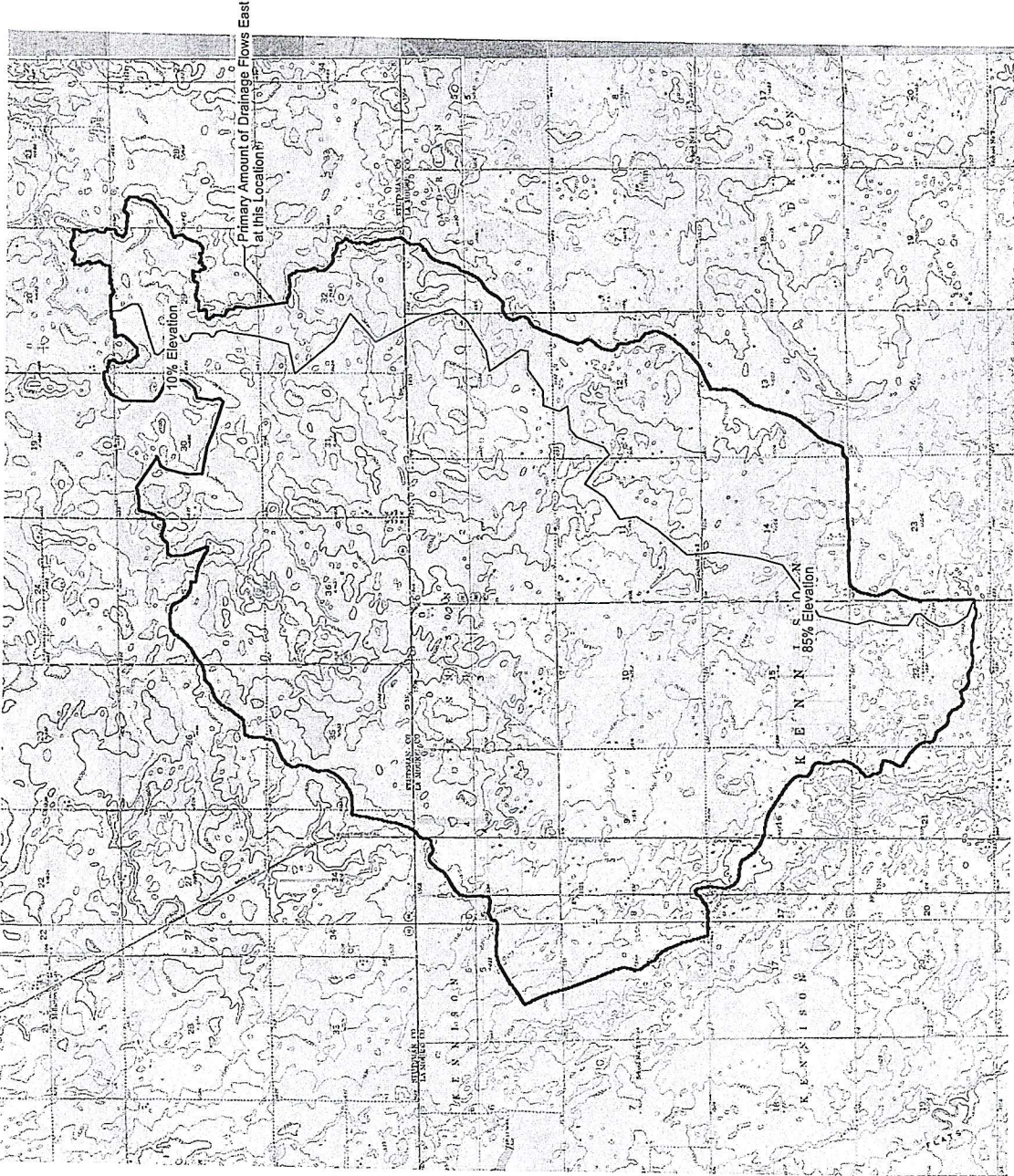
Checked By: RA
 Drawn By: IR
 Design By: RA

Interstate Engineering, Inc.
 1903 12th Avenue SW
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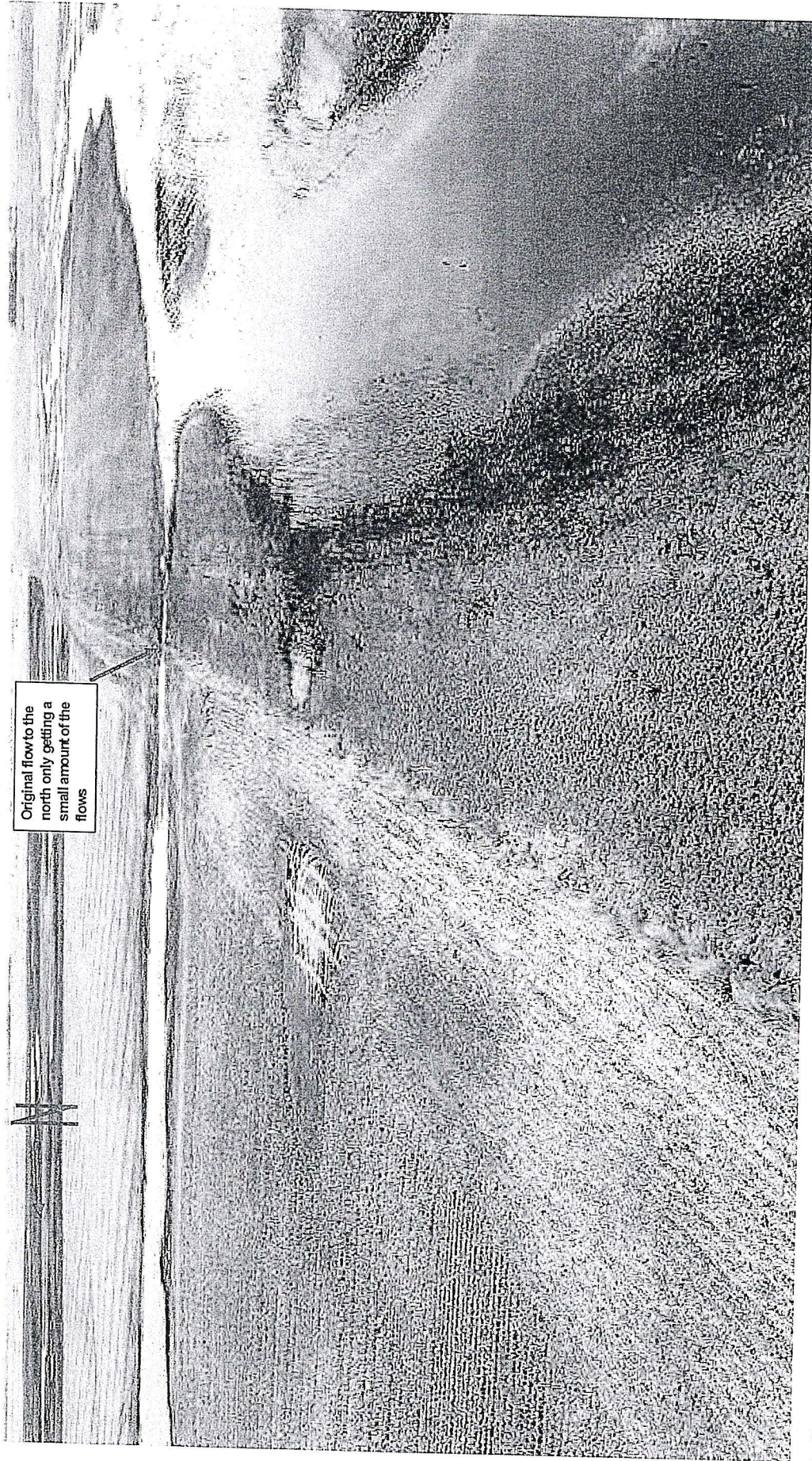
Original Drainage Area - 5% of this flow considered in this report due to overlapping at Section Line



Primary Amount of Drainage Flows East at this Location

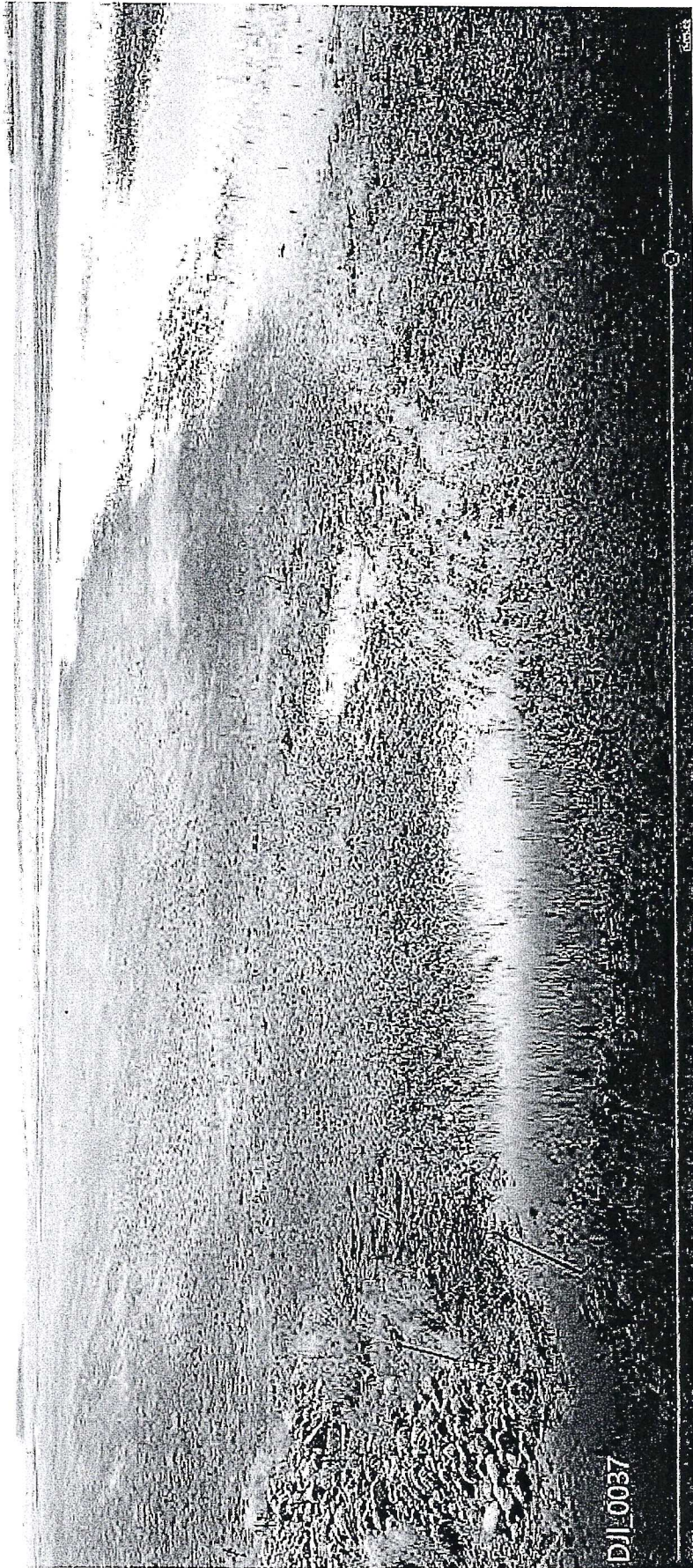
APPENDIX B

DRONE PHOTOS



Original flow to the north only getting a small amount of the flows

Looking East



Looking Southeast



Overtops road
here before
going north

Looking Southeast

APPENDIX C

CALCULATIONS

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 9 cfs

Design Flow: 43 cfs

Maximum Flow: 74 cfs

Table 1 - Summary of Culvert Flows at Crossing: Small Area - Existing

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1486.46	9.00	9.00	0.00	1
1488.94	15.50	14.90	0.00	100
1489.03	22.00	15.06	6.79	10
1489.05	28.50	15.09	13.16	4
1489.06	35.00	15.12	19.77	4
1489.08	41.50	15.14	26.09	3
1489.08	43.00	15.15	27.76	3
1489.10	54.50	15.18	39.14	3
1489.11	61.00	15.20	45.73	3
1489.12	67.50	15.22	51.81	2
1489.13	74.00	15.24	58.14	2
1489.00	15.01	15.01	0.00	Overtopping

Rating Curve Plot for Crossing: Small Area - Existing

Table 2 - 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)
9.00	9.00	1486.46	2.357	2.266	7-JH2c	-1.000	1.156	1.156	0.360	5.994	1.836
15.50	14.90	1488.94	4.837	3.598	7-JH2c	-1.000	1.405	1.405	0.483	8.527	2.163
22.00	15.06	1489.03	4.931	3.646	7-JH2c	-1.000	1.409	1.409	0.581	8.608	2.395
28.50	15.09	1489.05	4.947	3.654	7-JH2c	-1.000	1.410	1.410	0.664	8.622	2.579
35.00	15.12	1489.06	4.962	3.662	7-JH2c	-1.000	1.410	1.410	0.737	8.634	2.732
41.50	15.14	1489.08	4.974	3.668	7-H2c	-1.000	1.411	1.411	0.803	8.645	2.864
43.00	15.15	1489.08	4.978	3.670	7-H2c	-1.000	1.411	1.411	0.818	8.648	2.892
54.50	15.18	1489.10	4.998	3.680	7-H2t	-1.000	1.412	1.412	0.920	8.665	3.087
61.00	15.20	1489.11	5.008	3.686	7-JH2c	-1.000	1.413	1.413	0.972	8.674	3.182
67.50	15.22	1489.12	5.017	3.690	7-JH2c	-1.000	1.413	1.413	1.021	8.682	3.271
74.00	15.24	1489.13	5.027	3.695	7-H2c	-1.000	1.413	1.413	1.068	8.689	3.352

Straight Culvert

Inlet Elevation (invert): 1484.10 ft, Outlet Elevation (invert): 1484.10 ft

Culvert Length: 48.00 ft, Culvert Slope: 0.0000

Table 3 - Downstream Channel Rating Curve (Crossing: Small Area - Existing)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
9.00	1484.46	0.36	1.84	0.22	0.61
15.50	1484.58	0.48	2.16	0.30	0.63
22.00	1484.68	0.58	2.39	0.36	0.65
28.50	1484.76	0.66	2.58	0.41	0.66
35.00	1484.84	0.74	2.73	0.46	0.67
41.50	1484.90	0.80	2.86	0.50	0.68
43.00	1484.92	0.82	2.89	0.51	0.68
54.50	1485.02	0.92	3.09	0.57	0.69
61.00	1485.07	0.97	3.18	0.61	0.70
67.50	1485.12	1.02	3.27	0.64	0.70
74.00	1485.17	1.07	3.35	0.67	0.70

Tailwater Channel Data - Small Area - Existing

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 10.00 (1:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0350

Channel Invert Elevation: 1484.10 ft

Roadway Data for Crossing: Small Area - Existing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 500.00 ft

Crest Elevation: 1489.00 ft

Roadway Surface: Gravel

Roadway Top Width: 22.00 ft

Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1484.10 ft

Outlet Station: 48.00 ft

Outlet Elevation: 1484.10 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 9 cfs

Design Flow: 43 cfs

Maximum Flow: 74 cfs

Table 1 - Summary of Culvert Flows at Crossing: Small Area - Proposed

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1485.76	9.00	9.00	0.00	1
1486.34	15.50	15.50	0.00	1
1486.91	22.00	22.00	0.00	1
1487.23	28.50	28.50	0.00	1
1487.58	35.00	35.00	0.00	1
1488.31	41.50	41.50	0.00	1
1488.50	43.00	43.00	0.00	1
1489.03	54.50	47.02	7.19	17
1489.05	61.00	47.15	13.62	4
1489.06	67.50	47.25	19.80	3
1489.08	74.00	47.34	26.34	3
1489.00	46.79	46.79	0.00	Overtopping

Rating Curve Plot for Crossing: Small Area - Proposed

Table 2 - Culvert Summary Table: Culvert 1

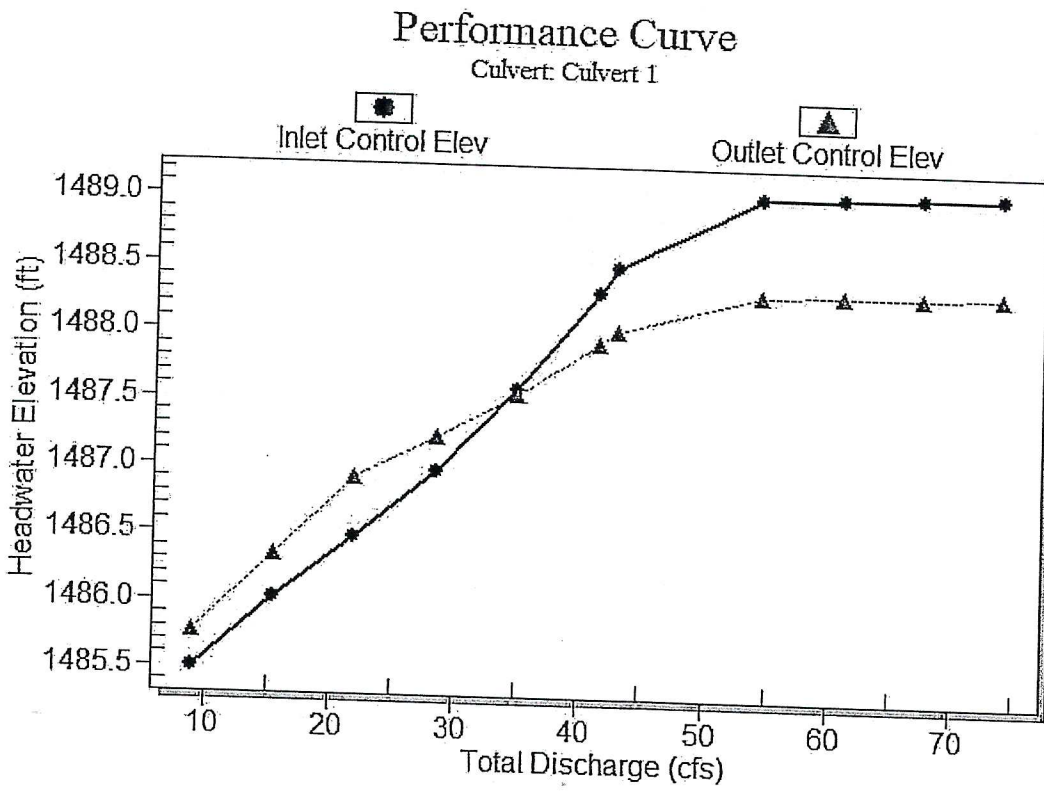
Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.00	9.00	1485.76	1.397	1.663	7-H2c	-1.000	0.995	0.995	0.360	4.941	1.836
15.50	15.50	1486.34	1.927	2.242	7-H2c	-1.000	1.326	1.326	0.483	5.860	2.163
22.00	22.00	1486.91	2.379	2.812	7-H2c	-1.000	1.592	1.592	0.581	6.670	2.395
28.50	28.50	1487.23	2.876	3.129	7-H2c	-1.000	1.818	1.818	0.664	7.453	2.579
35.00	35.00	1487.58	3.481	3.448	7-JH2c	-1.000	2.007	2.007	0.737	8.087	2.732
41.50	41.50	1488.31	4.214	3.833	7-JH2c	-1.000	2.160	2.160	0.803	9.008	2.864
43.00	43.00	1488.50	4.401	3.931	7-JH2c	-1.000	2.189	2.189	0.818	9.248	2.892
54.50	47.02	1489.03	4.932	4.211	7-JH2c	-1.000	2.258	2.258	0.920	9.900	3.087
61.00	47.15	1489.05	4.949	4.220	7-JH2c	-1.000	2.260	2.260	0.972	9.919	3.182
67.50	47.25	1489.06	4.962	4.228	7-JH2c	-1.000	2.262	2.262	1.021	9.935	3.271
74.00	47.34	1489.08	4.975	4.234	7-JH2c	-1.000	2.263	2.263	1.068	9.951	3.352

Straight Culvert

Inlet Elevation (invert): 1484.10 ft, Outlet Elevation (invert): 1484.10 ft

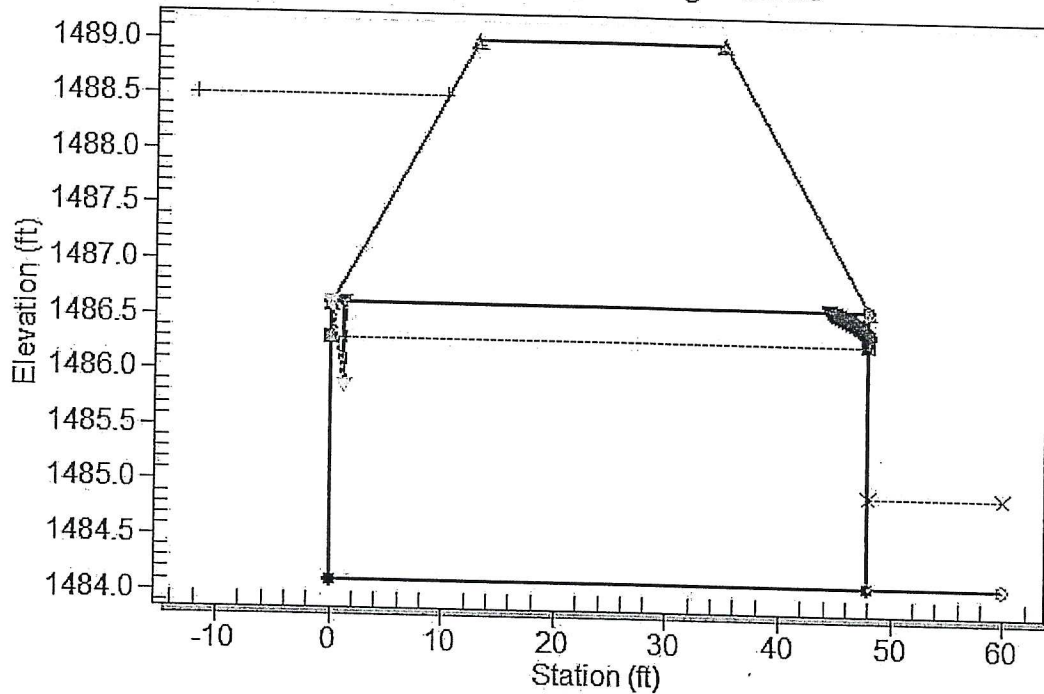
Culvert Length: 48.00 ft, Culvert Slope: 0.0000

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Small Area - Proposed, Design Discharge - 43.0 cfs
Culvert - Culvert 1, Culvert Discharge - 43.0 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1484.10 ft

Outlet Station: 48.00 ft

Outlet Elevation: 1484.10 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Beveled Edge (1:1)

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Small Area - Proposed)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
9.00	1484.46	0.36	1.84	0.22	0.61
15.50	1484.58	0.48	2.16	0.30	0.63
22.00	1484.68	0.58	2.39	0.36	0.65
28.50	1484.76	0.66	2.58	0.41	0.66
35.00	1484.84	0.74	2.73	0.46	0.67
41.50	1484.90	0.80	2.86	0.50	0.68
43.00	1484.92	0.82	2.89	0.51	0.68
54.50	1485.02	0.92	3.09	0.57	0.69
61.00	1485.07	0.97	3.18	0.61	0.70
67.50	1485.12	1.02	3.27	0.64	0.70
74.00	1485.17	1.07	3.35	0.67	0.70

Tailwater Channel Data - Small Area - Proposed

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 10.00 (1:1)

Channel Slope: 0.0100

Channel Manning's n: 0.0350

Channel Invert Elevation: 1484.10 ft

Roadway Data for Crossing: Small Area - Proposed

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 500.00 ft

Crest Elevation: 1489.00 ft

Roadway Surface: Gravel

Roadway Top Width: 22.00 ft

Project No.: 1904090

Date: 6/20/2019

Location: Montpelier

Existing Conditions: 18" CMP

Contributing Drainage Area (CA):

Contributing Area (SQ. FT.): 2.65E+07 (Fill In)

Contributing Area (Acres): 608.1088384

Contributing Area (SQ. MI.): 0.95

Main-channel Slope (S):

Elevation located 85% of longest water course: 1485

Elevation located 10% of longest water course: 1480

Distance Between Elevations: 6033

Main-channel Slope (FT/MI): 4.3759324

Peak Flow:

Region: c

Q(2) = 7

Q(10) = 32

Q(15) = 42

Q(25) = 55

Q(50) = 77

Q(100) = 101

Q(500) = 166

Project No.: 1904090

Date: 7/15/2019

Location: Montpelier

Existing Conditions: 18" CMP

Contributing Drainage Area (CA):

Contributing Area (SQ. FT.): 5.05E+08 (Fill In)

Contributing Area (Acres): 11590.11816

Contributing Area (SQ. MI.): 18.11

Main-channel Slope (S):

Elevation located 85% of longest water course: 1504

Elevation located 10% of longest water course: 1481

Distance Between Elevations: 34253

Main-channel Slope (FT/MI): 3.5453829

Peak Flow:

Region: c

Q(2) = 40

Q(10) = 217

Q(15) = 284

Q(25) = 379

Q(50) = 527

Q(100) = 699

Q(500) = 1171

NORTH
Dakota | State Engineer
Be Legendary.™

September 1, 2020

Mr. Joel Lees, Chairman
Stutsman County Water Resource District
PO Box 1727
Jamestown, ND 58402-1727,

RE: Stream Crossing Determination - Montpelier Township - Sections 20 and 29

Dear Mr. Lees:

On February 10, 2020, the Office of the State Engineer received a request from the Stutsman County Water Resource District to perform a stream crossing determination for a stream crossing (Crossing) located between Sections 20 and 29, Township 137 North, Range 63 West, Montpelier Township, Stutsman County. The Crossing is located through what is locally known as 52nd Street SE, which is classified as an off-system township road.

Our office analyzed the Crossing according to the minimum stream crossing standards outlined in North Dakota Administrative Code (N.D.A.C.) article 89-14, and determined the required design discharge at the Crossing is **46 cfs** (10-year event for a township road). While this is the minimum design standard required for the Crossing, N.D.A.C. section 89-14-01-03 states that there is no restriction on a road authority to provide even greater capacity.

According to N.D.A.C. section 89-14-01-01, anyone who fails to comply with these standards is not entitled to the immunity provided in North Dakota Century Code sections 24-03-06, 24-03-08, or 24-06-26.1.

Please contact me at 701-328-4958 or hsobrigewitch@nd.gov if you have any questions concerning this correspondence.

Sincerely,



Hunter Obrigewitch
Water Resource Engineer

HO/1348

Cc: Montpelier Township
Sue Backerman
John Fiebeger

TECHNICAL MEMORANDUM

DATE: **August 13, 2020**

TO: **JP** John Paczkowski, P.E., State Engineer (Interim)

FROM: **AC** Aaron Carranza, P.E., Director, Regulatory Division
ML Matt Lindsay, P.E., Manager, Engineering and Permitting Section
HO Hunter Obrigewitch, Water Resource Engineer

SUBJECT: **Stream Crossing Determination, Montpelier Township Road**

On February 10, 2020, the Office of the State Engineer (OSE) received a request to perform a stream crossing determination from the Stutsman County Water Resource District. The stream crossing (Crossing) is located between Sections 20 and 29, Township 137 North, Range 63 West, Montpelier Township, Stutsman County. The Crossing is located on an off-system township road locally known as 52nd Street SE, between 85th and 86th Avenue SE. (See Exhibit 1).

Contained within North Dakota Administrative Code § 89-14-01-03, flood frequency requirements are presented for varying stream crossings. The Crossing is located on an off-system township road, thus requiring the passage of a 10-year recurrence interval flow event within allowable headwater limitations.

USGS Scientific Investigations Report 2015-5096 (Report) was used to determine the peak runoff at the Crossing, see Figure 1. The input parameters, required for the Report's hydrologic zone C regression equation, include the drainage area (0.997 square miles), stream length (1.51 miles), and corresponding maximum and minimum basin elevations (1509 feet and 1483 feet, respectively).