Michigan EQIP Cost Estimator

Applicant Name:	Human Nature School
Application #:	
Ranking Pool:	

Is this a Historically Underserved applicant?
No

Calculator version
FY2022 v1.0

NRCS Natural Resources Conservation Service

Sub TOTAL ..... $ 48,138.00

Culvert... $60,052.30

$108,190.30

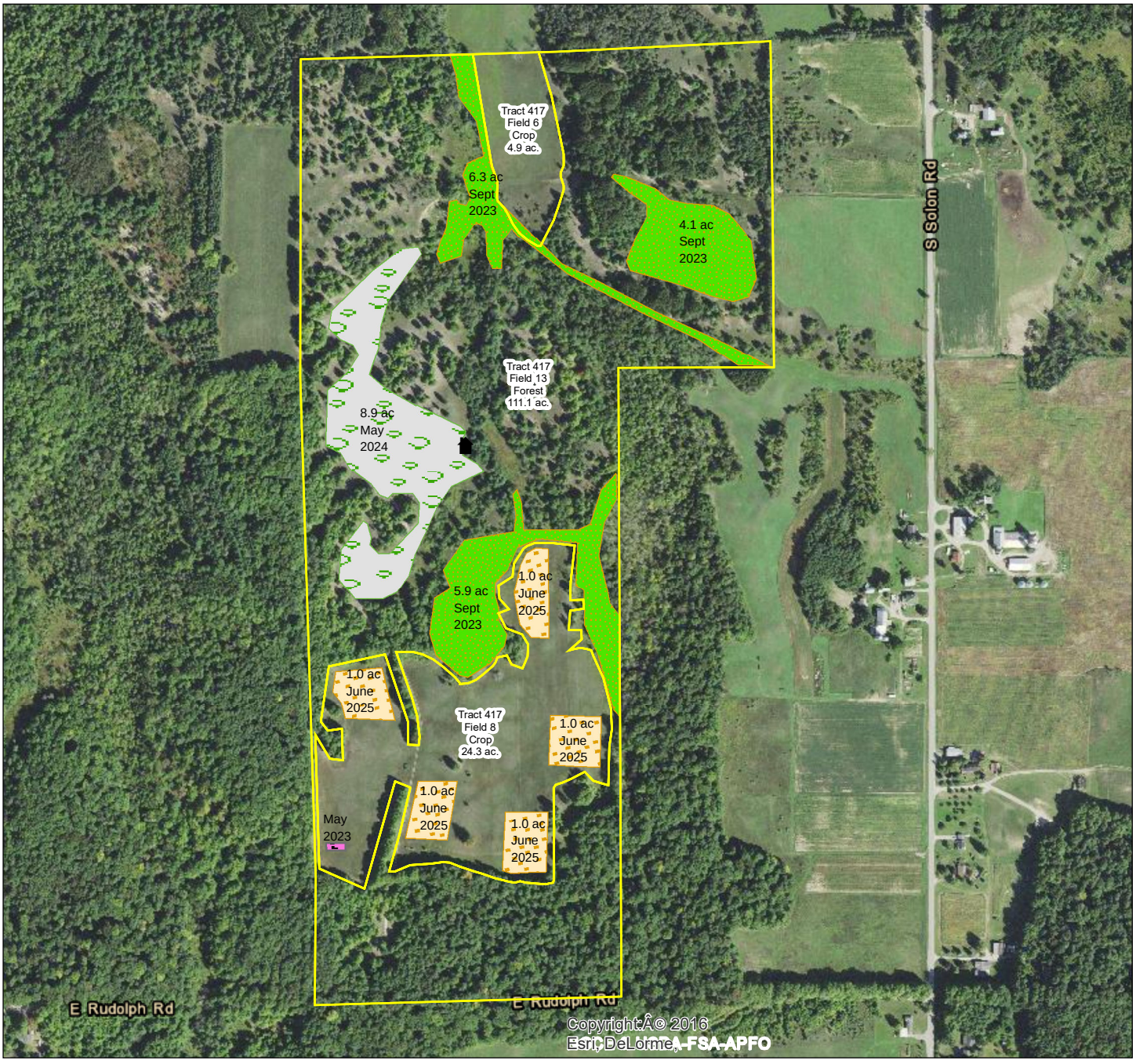
Practice Code	Practice Name	Scenario	Quantity	Unit Type	Unit Cost	# Years of Payment	Program Cost Estimate
612	Tree/Shrub Establishment	Individual Tree with Solid Protector	3880.4	Each	$ 8.68 per Each	1	$ 33,682.00
314	Brush Management	Mechanical and Chemical, Large Shrubs	16.3	Acres	$ 222.1 per Acres	1	$ 3,621.00
327	Conservation Cover	Pollinator Species	5	Acres	$ 507.1 per Acres	1	$ 2,536.00
325	High Tunnel System	Seasonal High Tunnel	2178	Square Fee	$ 3.81 per Square Feet	1	$ 8,299.00

Date: 2/10/2022

Conservation Plan Map

Client(s): HUMAN NATURE SCHOOL
Leelanau County, Michigan

Assisted By: JASON KIMBROUGH
USDA Natural Resources Conservation Service
TRAVERSE CITY SERVICE CENTER
LEELANAU CONSERVATION DISTRICT



Prepared with assistance from USDA-Natural Resources Conservation Service

0 625 Feet

Practice Schedule PLUs

Conservation Practice Points

Fish and Wildlife Habitat Plan - Written (142)

Conservation Practice Polygons

Brush Management (314)

Conservation Cover (327)

Tree/Shrub Establishment (612)

High Tunnel System (325)

N

USDA

INVENTORY & EVALUATION (I&E)
(JOB APPROVAL DOCUMENTATION)

Customer:	Human Nature School		
Location:	Leelanau Co. SolonTwp, T28N,R12W,Section 28	Date:	2-14-22

CPS Name and Number			
Practice	Controlling Factor	Amounts/Units	Job Class
Access Road (561)	Surface	Gravel	I ✓
	Length (mile)	0.04	I ✓
Stream Crossing (578)-Culvert	Traffic	vehicles	IV ✓
Structure for water control (587)	Drainage Area	512 acres	V ✓
	Effective Height	4.9 ft.	II ✓
	Pipe Nonpressure flow - inside diameter	48" equiv. diameter	V ✓

NOTE:
I&E engineering approval indicates that the selected practices and preliminary design work meets the applicable conservation practice standards. The preliminary design work is extensive enough to identify the location, size, extent, and complexity of the conservation practice(s). This I&E was used to develop preliminary quantities and cost estimates. See NRCS Conservation Plan for the resource concerns as identified by the Certified Conservation Planner.

I&E Preparer	ANDREA PALADINO Digitally signed by ANDREA PALADINO Date: 2022.02.15 13:48:16 -05'00'	DATE	
I&E Checker	[signature]	DATE	2/22
I&E Approver	Andrea Paladino	DATE	2-23-22

January 25, 2022

Attendance:
Andrea Paladino – NRCS
Jason Kimbrough - NRCS
Matt Miller - Human Nature School
Proposed practice standards- Stream Crossing (578), Access Road (560)

Prepared by: A. Paladino

Existing Conditions:

The Human Nature School (HNS) had a Wildlife Habitat Management Plan completed. The plan identified the need for a stream crossing improvement and improved Access Road. On the site visit conducted on January 25,2022 it was seen that the current stream crossing is currently not functioning to allow access by vehicles. (photo 1).

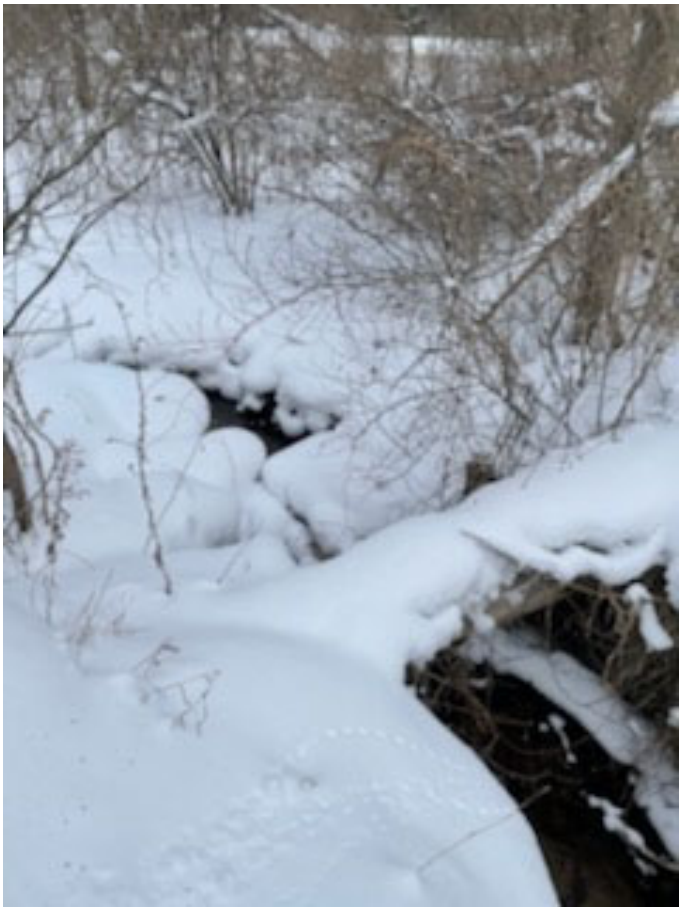


Photo 1 – 1-25-22

The access road adjacent was through a low wet area with a narrower width. A soil probe was used on soils on either side of the existing access road and it appears that there is between 2ft. and 3ft. of more organic loam soil over sandy soil. The web soil

survey shows this area as SP,SM,SC soils, which corresponds to field information. A soil boring will be completed prior to design completion and if any differing site conditions are found this could alter the cost estimate.There is currently metal sheeting spaced 5ft. apart at the tributary and a small width of timber spanning the width to allow foot traffic. The HNS identified that the proposed use of the crossing to access and maintain the rest of the property will be a crossing that could pass a pickup truck and trailer. The current crossing could be replaced to provide a stabilized vehicle access.

The limited streambed survey taken to date showed a relatively uniform slope with no offsets.

The cross-section measurements showed a bankfull width of 3ft. in the area adjacent to the crossing.

Proposed alternatives and evaluation:

Type of structure options:

Options for this location could be a full invert pipe, a bottomless structure or a bridge structure. Matt with HNS was interested in bottomless and bridge options. We all discussed that NRCS could provide a design for a full invert structure but a **bottomless structure or bridge would require a design from a private provider that they pay for**. I said I would look into prefab bridge structure costs for their purposes. I prepared cost estimates for all three options. The bottomless structure and bridge structure have a larger potential for change, since they would be designed by others. The bridge structure included in this cost estimate is prefabricated and has a greater span than needed because it is the narrowest standard span available as a prefabricated option, other designs could be different. It would be necessary for HNS to consult a bridge designer prior to an approved I&E if they wish to construct that option.

The structure selected for this site to complete this I&E is a pipe arch measuring 57” span by 38” rise. This structure size will allow the spanning of the bankfull width and when recessed will allow necessary soil cover. Therefore, the new proposed culvert would be recessed 1/6 its rise (6in.).

It is planned to surface the stream crossing and adjacent access road with gravel. Any poor soils will be over excavated to construct the minimum roadway width. The access road width will be the minimum 14ft. for one way traffic and the stream crossing will have the same width. The NRCS Access Road standard requires a minimum 14ft. width for one way traffic and the stream crossing standard allows the access road standard to apply when the stream crossing is part of the access road.

Client: Human Nature School
County: Leelanau MSE3 State: MI
Practice: Stream Crossing
Calculated By: A Paladino Date: 2/9/2022
Checked By: DMB Date: 2/22

Drainage Area:	512	Acres (provided from RCN Calculator)
Curve Number:	64	(provided from RCN Calculator)
Watershed Length:	7624	Feet
Watershed Slope:	4.4	Percent ✓
Time of Concentration:	2.00	Hours (calculated value)
Rainfall Type:	MSE3	

Storm Number	1	2	3	4	5	6	7
Frequency (yrs)	1	2	5	10	25	50	100
24-Hr rainfall (in)	2.02	2.28	2.77	3.24	3.98	4.62	5.32
Ia/P Ratio	0.56	0.49	0.41	0.35	0.28	0.24	0.21
Runoff (in)	.12	.20	.37	.58	.96	1.34	1.79
(ac-ft)	5.12	8.53	15.79	24.75	40.96	57.17	76.37
Peak Discharge (cfs)	12.32	21.96	46.83	77.68	138.31	199.34	273.95

Warning: - RCN data inconsistant or different from Basic data.

Curve number Computation

Client: Human Nature School
County: Leelanau MSE3 State: MI
Practice: Stream Crossing
Calculated By: A.Paladino Date: 2/9/2022
Checked By: DRBowler Date: 2/22

COVER DESCRIPTION		Avg % imperv	Acres (CN) Hydrologic Soil Group A	B	C	D
FULLY DEVELOPED URBAN AREAS (Veg Estab.)						
Streets and roads						
Paved; open ditches (w/right-of-way)			.3(83)	1.6(89)	-	-
Residential districts (by average lot size)						
2 acre		12	-	8.2(65)	-	-
CULTIVATED AGRICULTURAL LANDS						
Small grain	Straight row (SR)	good	125.2(63)	189(75)	8.9(83)	-
OTHER AGRICULTURAL LANDS						
Pasture, grassland or range		good	27.5(39)	17.9(61)	2.3(74)	-
Woods		good	33.7(30)	61.5(55)	10.1(70)	23.2(77)
Farmsteads		----	-	2.9(74)	-	-
Total Area (by Hydrologic Soil Group)			186.7	281.1	21.3	23.2
TOTAL DRAINAGE AREA: 512.3 Acres					WEIGHTED CURVE NUMBER: 64	

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project			
MI	HNS - Stream Crossing			
By: A. Paladino	Date: 2-8-22	Checked by: RLB	Date: 2/22	Job No.
Subject: Hydrology				Sheet 1 of

Watershed Site = 512 ac. = 0.8 sq. mi.

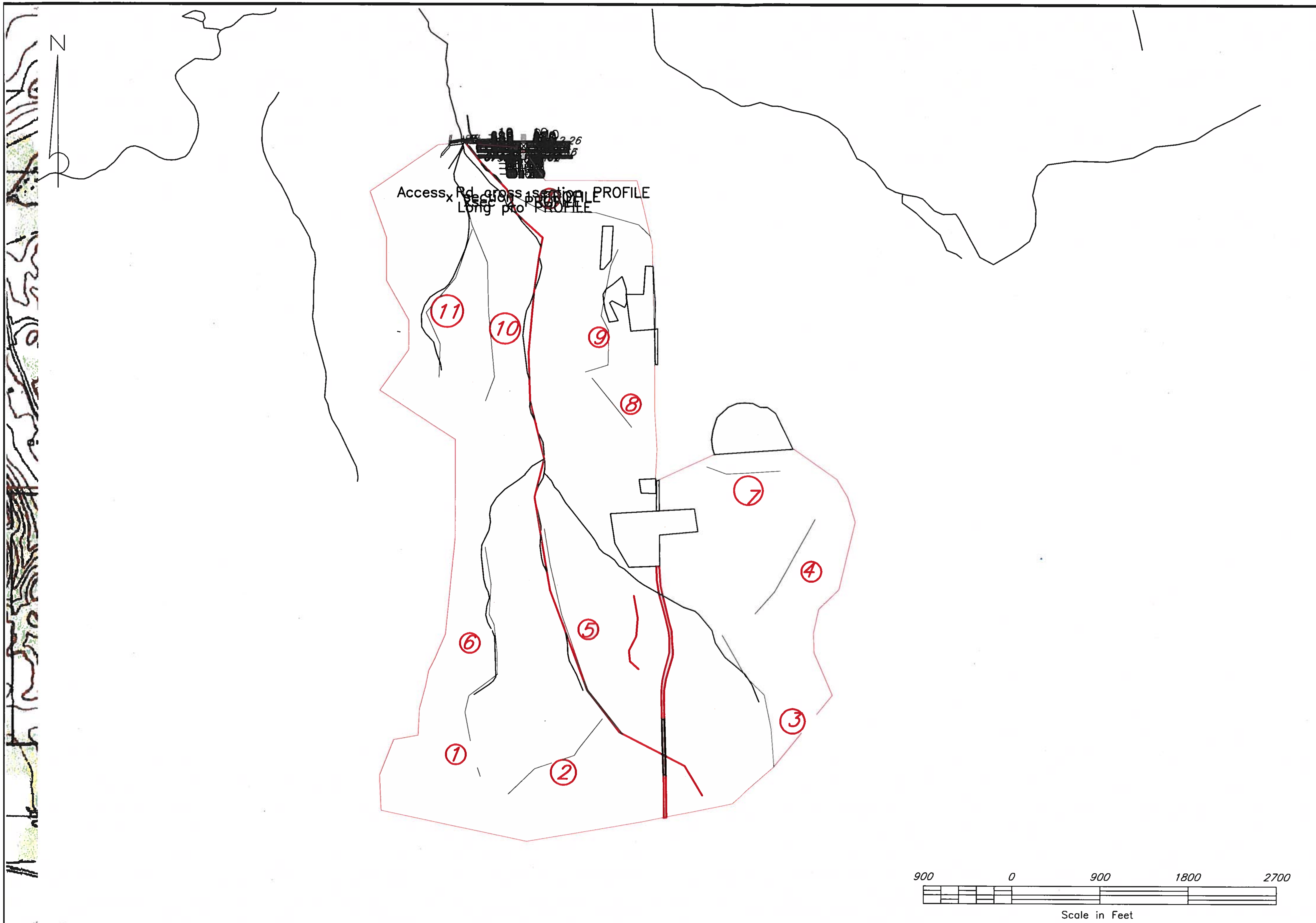
Soil hydrologic group	Land use	Area (ac.)
A	Forested	33.7
A	Open field	27.5
A	Agriculture	125.2
A	Rd	0.3
B	Forested	61.5
B	Open field	17.9
B	Agriculture	189
B	Rds	1.6
B	Farmstead	2.9
B	Residential	8.2
C	Forested	10.1
C	Open field	2.3
C	Agriculture	8.9
D	Forested	23.2
		512.3 ac.

GPO U.S. GOVERNMENT PRINTING OFFICE: 2009—353-490

By:	A.Paladino	Checked By:	DLBrink
Date:	2/9/2022	Date:	2/22

Watershed slopes
Contours are in 5m intervals
Watershed Length = 7624 ft.

Slope number	# of contours	Rise	Length	Slope (ft/ft)	weighted slope
1	2	32.8	1213	0.027	0.002
2	2	32.8	1271	0.026	0.002
3	5	82	1494	0.055	0.005
4	3	49.2	1145	0.043	0.003
5	6	98.4	2273	0.043	0.006
6	4	65.6	1314	0.050	0.004
7	5	82	764	0.107	0.005
8	3	49.2	1345	0.037	0.003
9	2	32.8	1506	0.022	0.002
10	5	82	2242	0.037	0.005
11	4	65.6	1679	0.039	0.004
12	5	82	808	0.101	0.005
		Total length	**17054**	**Weighted Average slope**	**0.044**



Designed
Drawn
Checked
Approved
Date

Site Layout

HNS Stream Crossing Drainage Area

---- Co., Michigan

Solon Township, T. 28N-R. 12W, Sec. 28

United States Department of Agriculture

USDA Natural Resources Conservation Service

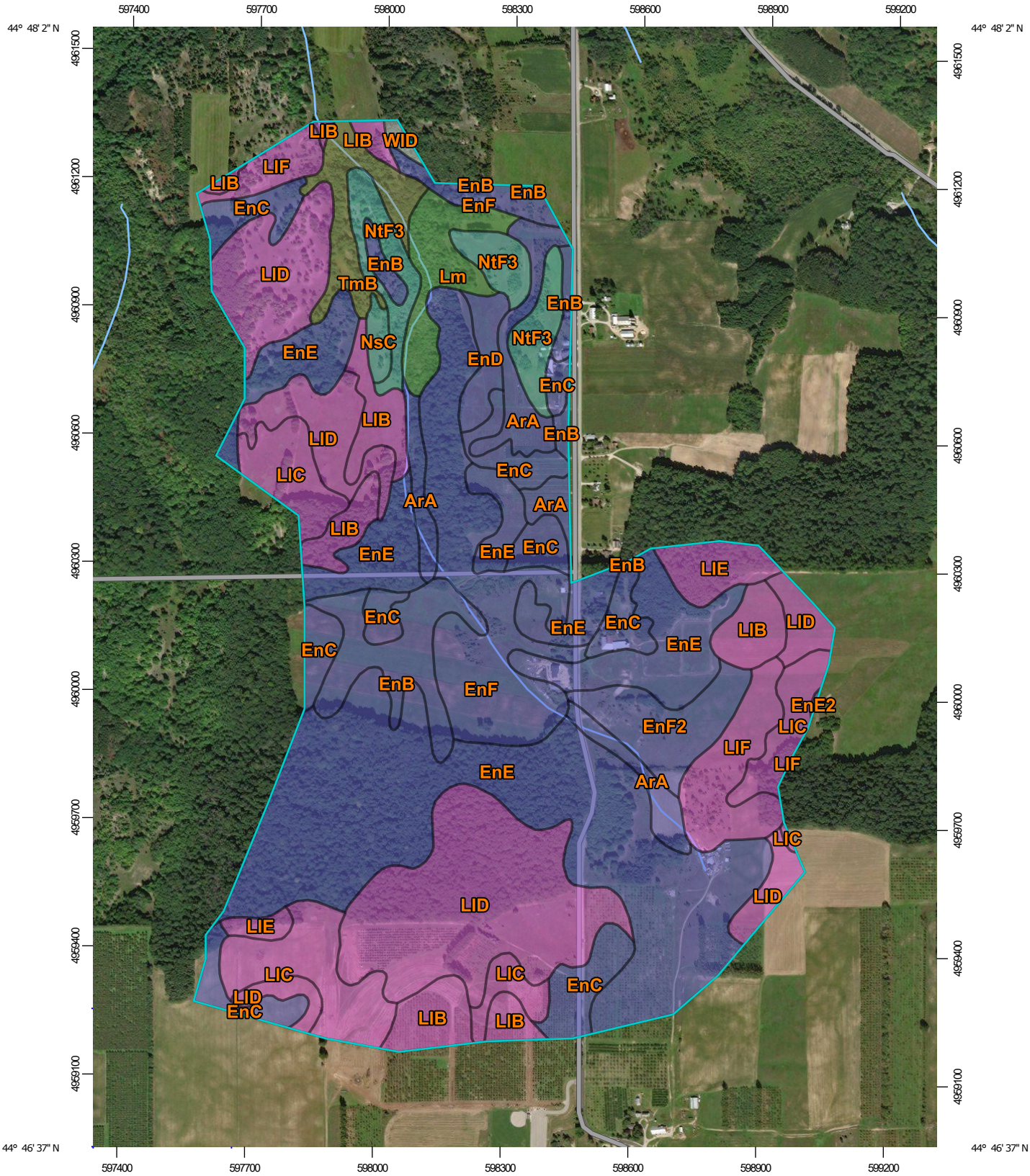
File Name: Human Nature School Stream Crossing

Drawing Name: Site Layout

2/14/2022 2:46 PM

Sheet 5 of ---

Hydrologic Soil Group—Leelanau County, Michigan
(HNS Stream crossing watershed Hydrologic Group)



Map Scale: 1:12,800 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Leelanau County, Michigan
Survey Area Data: Version 15, Sep 1, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Jun 19, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
ArA	Alcona-Richter sandy loams, 0 to 2 percent slopes	B	20.0	3.9%
EnB	Emmet-Leelanau complex, 2 to 6 percent slopes	B	21.3	4.1%
EnC	Emmet-Leelanau complex, 6 to 12 percent slopes	B	36.8	7.1%
EnD	Emmet-Leelanau complex, 12 to 18 percent slopes	B	5.3	1.0%
EnE	Emmet-Leelanau complex, 18 to 25 percent slopes	B	145.0	27.9%
EnE2	Emmet-Leelanau complex, 18 to 25 percent slopes, eroded	B	0.1	0.0%
EnF	Emmet-Leelanau complex, 25 to 50 percent slopes	B	45.8	8.8%
EnF2	Emmet-Leelanau complex, 25 to 50 percent slopes, eroded	B	13.7	2.6%
LlB	Leelanau-East Lake loamy sands, 0 to 6 percent slopes	A	28.8	5.6%
LlC	Leelanau-East Lake loamy sands, 6 to 12 percent slopes	A	36.9	7.1%
LlD	Leelanau-East Lake loamy sands, 12 to 18 percent slopes, lake moderated	A	90.6	17.5%
LlE	Leelanau-East Lake loamy sands, 18 to 25 percent slopes, lake moderated	A	9.1	1.7%
LlF	Leelanau-East Lake loamy sands, 25 to 45 percent slopes	A	19.8	3.8%
Lm	Lupton-Markey mucks	A/D	12.2	2.3%
NsC	Nester silt loam, 6 to 12 percent slopes	C	2.3	0.4%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
NtF3	Nester silty clay loam, 20 to 50 percent slopes, severely eroded	C	19.0	3.7%
TmB	Tonkey-Munuscong-Iosco sandy loams, 2 to 6 percent slopes	C/D	11.4	2.2%
WID	Wind eroded land, steep		1.0	0.2%
Totals for Area of Interest			**519.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

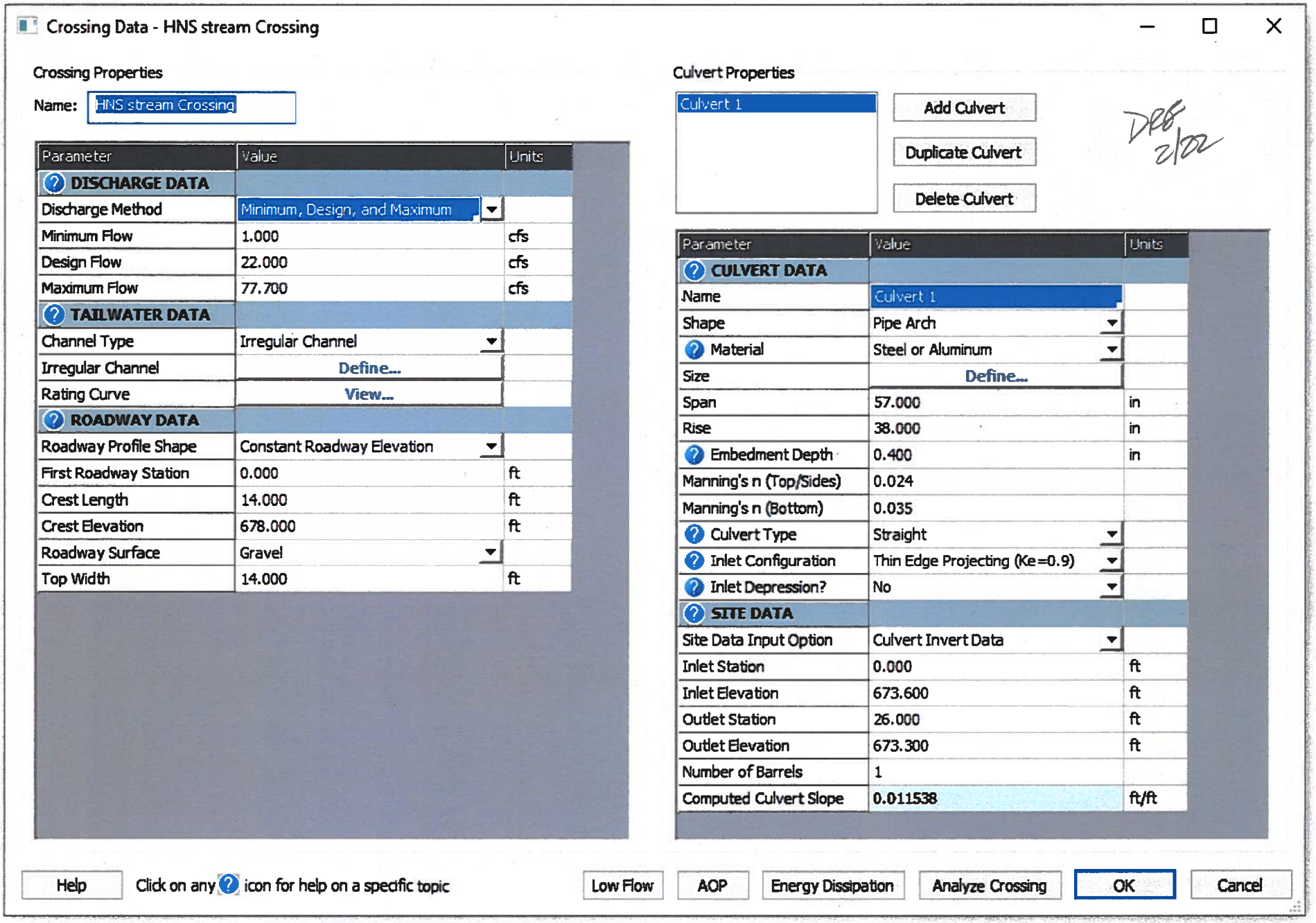
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher


Crossing Data - HNS stream Crossing
Crossing Properties
Name: HNS stream Crossing
Parameter | Value | Units
DISCHARGE DATA
Discharge Method | Minimum, Design, and Maximum
Minimum Flow | 1.000 | cfs
Design Flow | 22.000 | cfs
Maximum Flow | 77.700 | cfs
TAILWATER DATA
Channel Type | Irregular Channel
Irregular Channel | Define...
Rating Curve | View...
ROADWAY DATA
Roadway Profile Shape | Constant Roadway Elevation
First Roadway Station | 0.000 | ft
Crest Length | 14.000 | ft
Crest Elevation | 678.000 | ft
Roadway Surface | Gravel
Top Width | 14.000 | ft
Culvert Properties
Culvert 1
Add Culvert
Duplicate Culvert
Delete Culvert
DRB 2/22
Parameter | Value | Units
CULVERT DATA
Name | Culvert 1
Shape | Pipe Arch
Material | Steel or Aluminum
Size | Define...
Span | 57.000 | in
Rise | 38.000 | in
Embedment Depth | 0.400 | in
Manning's n (Top/Sides) | 0.024
Manning's n (Bottom) | 0.035
Culvert Type | Straight
Inlet Configuration | Thin Edge Projecting (Ke=0.9)
Inlet Depression? | No
SITE DATA
Site Data Input Option | Culvert Invert Data
Inlet Station | 0.000 | ft
Inlet Elevation | 673.600 | ft
Outlet Station | 26.000 | ft
Outlet Elevation | 673.300 | ft
Number of Barrels | 1
Computed Culvert Slope | 0.011538 | ft/ft
Help
Click on any icon for help on a specific topic
Low Flow
AOP
Energy Dissipation
Analyze Crossing
OK
Cancel

DLS 2/22

Culvert Crossing: Crossing 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)
1.00	1.00	673.98	0.27	0.35	3-M1t	0.24	0.18	0.60	0.63	0.45	1.70
8.67	8.67	674.93	0.89	1.30	3-M1t	0.73	0.59	1.49	1.52	1.36	1.37
16.34	16.34	675.26	1.29	1.63	3-M1t	1.06	0.85	1.66	1.69	2.29	0.98
22.00	22.00	675.49	1.54	1.85	3-M1t	1.25	1.01	1.72	1.75	2.97	0.98
31.68	31.68	675.88	2.02	2.25	3-M1t	1.57	1.25	1.80	1.84	4.08	0.96
39.35	39.35	676.20	2.40	2.57	3-M1t	1.82	1.41	1.86	1.89	4.93	0.96
47.02	47.02	676.52	2.75	2.89	3-M2t	2.08	1.57	1.90	1.93	5.75	0.96
54.69	54.69	676.84	3.10	3.20	3-M2t	2.37	1.72	1.94	1.97	6.56	0.97
62.36	62.36	677.15	3.44	3.52	3-M2t	2.76	1.85	1.98	2.01	7.34	0.97
70.03	70.03	677.48	3.80	3.84	3-M2t	3.13	1.99	2.01	2.04	8.12	0.98
77.70	77.70	677.81	4.16	4.18	7-M2c	3.13	2.11	2.11	2.07	8.63	0.98

DRG 2/22

Culvert Crossing: Crossing 1

Crossing Summary Table

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
673.98	1.00	1.00	0.00	1
674.93	8.67	8.67	0.00	1
675.26	16.34	16.34	0.00	1
675.49	22.00	22.00	0.00	1
675.88	31.68	31.68	0.00	1
676.20	39.35	39.35	0.00	1
676.52	47.02	47.02	0.00	1
676.84	54.69	54.69	0.00	1
677.15	62.36	62.36	0.00	1
677.48	70.03	70.03	0.00	1
677.81	77.70	77.70	0.00	1
678.00	81.71	81.71	0.00	Overtopping

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project			
MI	HNS Stream Crossing / Access Rd			
By: A. Paladino	Date: 2-14-22	Checked by: D. Bosch	Date: 2/22	Job No.
Subject: Gravel thickness				Sheet 4 of

Soil Survey

Mapped as TMB / LIB ⇒ SC, SM, SP

Soil probe used in field

There seemed to be 2'-3' of Softer/Mucky soil over Sand off the side of existing trail.

Need a few soil borings to confirm depth of soils encountered but est. 2.5' of mucky soil to remove

Full size Pickup truck (one ton)

Use 10,000 lb / 80 Psi ✓

Trailer w/ Trailer could pull 20000 lb ✓
50 psi

10,000 lb truck + 6000 lb Payload in tandem tires

2 axles $\frac{10000 lb}{2} + 6000 lb = 11,000 lb$ ✓

11,000 for rear tandem axle

Wheel load = $\frac{11,000}{4}(1.20) = 3300 lb$ / wheel ✓
(+20% for tandem)
= L

Typ. tire inflation pressure = 80 psi ✓
= P

$B^2 = \frac{L}{P} = \frac{3300 lb}{80 psi} = 41.25$ ✓ $B = 6.4$ ✓

Soils under organics to be removed SC-SM, SP

C = 750 Psf (Medium consistancy) - Table 3 ✓

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project			
MI	HNS Stream Crossing / Access Rd			
By: A. Paladino	Date: 2-14-22	Checked by: DRL Smith	Date: 2/22	Job No.
Subject: Gravel thickness			Sheet 5 of	

$C = \frac{750 \text{ psf}}{144} = 5.2 \text{ psi}$

$X_{geo} = \frac{C(5.0)}{4(P)} = \frac{5.2(5.0)}{4(80)} = 0.08$ ✓

From table 6: If $X = 0.08$ then $M = 0.48$ ✓

$.084 - .072 = 0.012$ $\quad \frac{.008}{.012} = .67$

$0.5 - 0.45 = .05$

$.67(.05) = .033$

$0.45 + 0.33 = 0.48$ ✓

Agg base thickness

$H_{geo} = \frac{B(in)}{2 M_{geo}} = \frac{6.4}{2(.48)} = 6.67$ ✓

✓ Use 8 in thickness

load exerted by a single wheel is applied at a surface contact pressure (P) equal to the tire inflation pressure. Dual wheel loads apply a P equal to 75 percent of the tire inflation pressure. Tandem axles exert 20 percent more than their actual weight to the subgrade soil due to overlapping stress from the adjacent axle in the tandem set.

Estimate the area being loaded (B^2):

$$B^2=L/P$$

Where B = Length of one side of the square contact area

Table 5: Vehicle Loading Parameters

Vehicle Type (Choose Category Nearest the Actual Design Vehicle)	Axles S - Single T - Tandem	Wheels S - Single D - Dual	Axle Loads (lb)	Wheel Loads[1] L (lb)	Typical[2] Tire Inflation Pressure (psi)	Contact Pressure[3] P (psi)	Wheel Contact Area B^2 (in^2)	One Side of Square Contact Area B (in)
Highway Legal Vehicles								
Haul trucks[4] - F Axle (stone, concrete)	S	S	18,000	9,000	110	110	82	9.0
R Axle	T	D	18,000	10,800	110	83	130	11.4
Tractor trailer - F Axle	S	S	18,000	9,000	120	120	75	8.7
(18 wheeler) - R Axle	T	D	18,000	10,800	120	90	120	11.0
Off Highway Legal Vehicles[5]								
35-ton trucks - F Axle	S	S	48,000	24,000	90	90	267	16.3
(CAT 769C) - R Axle	S	D	89,200	44,600	90	68	656	25.6
Wheel loader - F Axle	S	S	24,000	12,000	50	50	240	15.5
(CAT 910) - R Axle	S	S	10,000	5,000	50	50	100	10.0
Wheel loader - F Axle	S	S	37,000	18,500	60	60	308	17.6
(CAT 930) - R Axle	S	S	14,000	7,000	60	60	117	10.8
Wheel loader - F Axle	S	S	65,000	32,000	60	60	542	23.3
(CAT 966C) - R Axle	S	S	25,000	12,500	60	60	208	14.4
Wheel loader - F Axle	S	S	136,000	68,000	85	85	800	28.3
(CAT 988B) - R Axle	S	S	55,000	27,500	85	85	324	18.0
Wheel loader - F Axle	S	S	290,000	145,000	70	70	2071	45.5
(CAT 992) - R Axle	S	S	120,000	60,000	60	60	1000	31.6
Scraper - F Axle	S	S	88,600	44,300	80	80	554	23.5
(CAT 631D) - R Axle	S	S	75,400	37,700	75	75	503	22.4
Scraper - F Axle	S	S	120,000	60,000	85	85	706	26.6
(CAT 651B) - R Axle	S	S	110,800	55,400	80	80	692	26.3

NOTES:

1. Wheel load is one-half the axle load and increased by 20% if the wheel is on a tandem axle.
2. Maximum tire inflation pressure is given for each class of vehicle. Using tires with lower inflation pressures would lower the contact pressures and allow for less thickness of the aggregate structural section.
3. Same as tire inflation pressure except that a factor of 0.75 times the inflation pressure must be used for all dual wheels.
4. Trucks used on- and off-highway generally use lower inflation presure tires requiring only 75 to 90 psi.
5. Manufacturers' specifications should be consulted for off-highway vehicles. Wide ranges of different inflation pressure tires are available for these vehicles.

2. Determine Aggregate-Base Thickness

Assuming that wheel loads will be applied over a square area, we can use Boussinesq Theory of load distribution to determine the aggregate-section thickness required to support the design load. Boussinesq Theory coefficients are found in Table 6.

- The DCP produces a DCP Index (mm/blow or in./blow) which is correlated to a field CBR by the equations (ASTM D6951) in Table 2:

Table 2: DCP Index Relationship to CBR

All soils, except for CL soils below CBR 10 and CH soils	CBR = $292/DCP^{1.12}$ for DCP in mm/blow	CBR = $292/(DCP \times 25.4)^{1.12}$ for DCP in in./blow
CL soils with CBR < 10	CBR = $1/(0.017019 \times DCP)^2$ for DCP in mm/blow	CBR = $1/(0.432283 \times DCP)^2$ for DCP in in./blow
CH soils	CBR = (1/0.002871 X DCP) for DCP in mm/blow	CBR = (1/0.0729233 X DCP) in in./blow

  - The DCP measures a field CBR which is does not correlate to the laboratory CBR and is highly influence by the subgrade condition at the time of testing.
- The FVS measures c directly.
  - Applicable to soft to stiff clays, not applicable for sandy or gravelly soils.
  - The device is more precise and measures the in situ strength of the soils versus the miniature torvane.
- The Field CBR measured field CBR directly.
- The SPT measures n values, which then are correlated to friction angle for cohesionless soils and unconfined compressive strength (q_u) for cohesive soils.
  - Note that there is considerable scatter in the data of N_{60} and the corresponding values of q_u such that the average is very large (Terzaghi et al., 1996).
  - Table 3 provides estimates of undrained shear strengths corresponding to N_{60} values.

Table 3: Undrained Shear Strength Estimates

Consistency	Identification procedure	Undrained Shear Strength (C), Psf	N_{60} (SPT) Blows/Ft.
Very Soft	Thumb penetrates > 1 inch, extruded between Fingers	< 250	< 2
Soft	Thumb penetrates 1 inch, molded by light finger pressure	250-500	2-4
Medium	Thumb penetrates 1/4 inch, molded be strong finger pressure	500-1,000	4-8
Stiff	Indented by thumb but not penetrated	1,000-2,000	8-15
Very Stiff	Not Indented by thumb, but indented by thumbnail	2,000-4,000	15-30
Hard	Not Indented by thumbnail, Indented with knife	> 4,000	> 30

Table 6: Boussinesq Theory Coefficients

If X =	Then M =		If X =	Then M =
0.005	0.10		0.169	0.95
0.011	0.15		0.175	1.00
0.018	0.20		0.186	1.10
0.026	0.25		0.196	1.20
0.037	0.30		0.207	1.35
0.048	0.35		0.215	1.50
0.060	0.40		0.224	1.75
0.072	0.45		0.232	2.00
0.084	0.50		0.237	2.25
0.096	0.55		0.240	2.50
0.107	0.60		0.242	2.75
0.118	0.65		0.244	3.00
0.128	0.70		0.247	4.00
0.138	0.75		0.249	5.00
0.146	0.80		0.249+	7.50
0.155	0.85		0.250	10.00
0.162	0.90		0.250+	oo

a. First, solve for X
   Without a geotextile: X=C(2.8)/(4)P

   With a geotextile: $X_{geotextile}$ = C(5.0)/(4)P

b. Using the calculated values of X and Xgeotextile, find the corresponding value of M and Mgeotextile from Table 6.

c. Then solve for aggregate-based thickness (H) without geotextile and (H) with geotextile.

   Without a geotextile: H = B(inches)/(2)M

   With a geotextile: $H_{geotextile}$ = B(inches)/(2)$M_{geotextile}$

1993 AASHTO Low Volume Road Design

The AASHTO's 1993 *Design of Pavement Structures* provides two empirical methods for designing low-volume aggregate-surfaced roads. The first method (Appendix A - Section 4.1) utilizes the selection of design inputs and nomographs to determine aggregate thickness. The second method (Appendix A - Section 4.2) utilizes the AASHTO design catalogs to determine aggregate thickness, when more detailed project information is not available.

Note that these methods were developed for a maximum traffic level of 100,000 18-kip ESAL application, with a practical minimum level (during a single performance period) of 10,000. That is to say the AASHTO methods may be overly conservative for many applications within NRCS; however, unlike the preceding methods, the methods accounts for climate, as indicated by Appendix A, Figure 4.1. The 1993 AASHTO Low Volume Road design procedure is provided in its entirety as Appendix A, along with figures for relative roadbed quality and soil strength.

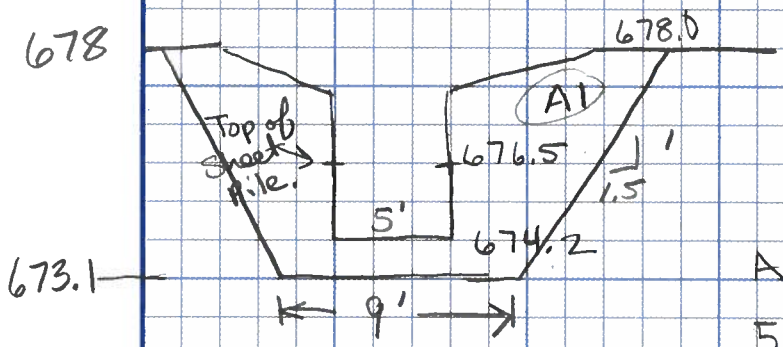
Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project			
MI	HNS Stream Crossing			
By: A. Paladino	Date: 2-10-22	Checked by: D. Bruch	Date: 2/22	Job No.
Subject: Quantities			Sheet 6 of	

Pipe size → Pipe arch 57" span x 38" rise.



Pipe Excavation: A1 (From CAD)

Length = 10 ft

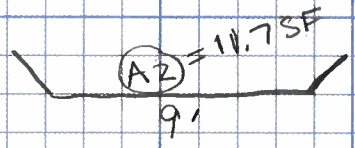
A1 = 53.6 ft² (in Roadway)

53.6 SF (10 ft) = 536 ft³ ✓

= 20 cy ✓

(outside existing Roadway)

Proposed Length of pipe = 26 ft ✓

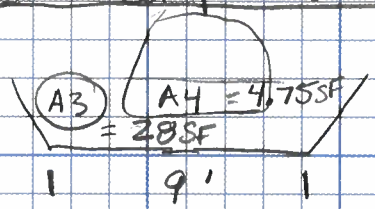


(26'-10')(11.7 SF) = 187.2 ft³ ✓

$= \frac{536\,ft^3 + 187.2\,ft^3}{27} = 26.8$ ✓

use 30 cy ✓

6AA compacted fill



Length = 26 ft

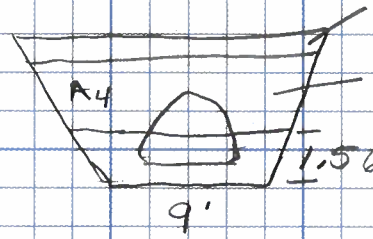
(28 SF - 4.75 SF)(26 ft) = $\frac{604.5\,ft^3}{27}$

= 22.4 ✓

Use 25 cy ✓

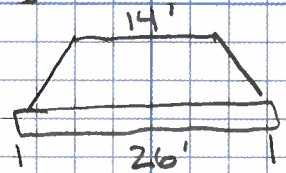
Class II earth fill

23A Gravel 8 in thickness over Class II non woven geotextile.



Area of Pipe = 11.6 SF ✓

$A_{\frac{4}{5}}$ = 48 SF - (11.6 - 4.75) = 41.2 SF ✓



41.2 SF $\left(14' + \left(\frac{26-14}{2}\right)\right)$ = $\frac{824\,ft^3}{27}$ ✓

= 30.5 cy ✓

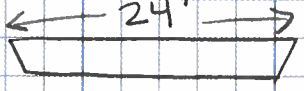
Computation Sheet

NRCS-ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project			
MI	HNS Stream Crossing / Access Rd			
By: A. Paladino	Date: 2-14-22	Checked by: DRBrink	Date: 2/22	Job No:
Subject: Quantities			Sheet 7 of	

23A Gravel - Stream Crossing



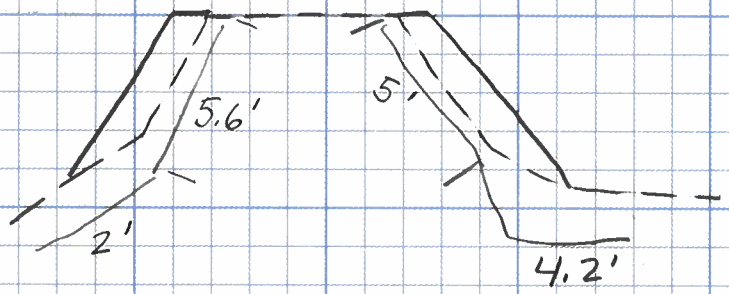
$29' \times 14' \times 0.67' = \frac{225\ ft^3}{27} = 8.3\ cy$ ✓

Access Rd

Total Length = 232 ft

Access Rd: Tot - Stream crossing length

232 ft - 24 ft = 208 ft ✓



Excavation:

$(5.6' + 5')(0.5') = 5.3\ ft^2 (208\ ft) = \frac{1102\ ft^3}{27}$ ✓

$= 40.8\ cy$ ✓

(over excavate organics) ✓

$(2' + 4.2')(2.5') = 15.5\ ft^2 (208\ ft) = \frac{3224\ ft^3}{27}$ ✓

$= 119\ cy$ ✓

$11.7\ ft\ (208\ ft)(0.67') = \frac{1630\ ft^3}{27} = 60\ cy$ ✓

$40.8\ cy + 119\ cy + 60\ cy = 219.8 = 220\ cy$ ✓

Earthfill: $(3.9\ SF + 5.3\ SF)\ 208\ ft = \frac{1913.6\ ft^3}{27} = 70.9$

$40.8\ cy + 119\ cy + 70.9\ cy = 230.7\ cy$ ✓

Use 230 cy ✓

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project			
MI	HNS Stream Crossing / Access Rd			
By: A. Paladino	Date: 2-14-22	Checked by:	Date: 2/22	Job No.
Subject: Quantities			Sheet 8 of	

23A Gravel: Access

$0.67\ ft\ (208\ ft)(14\ ft)$

$= \frac{1951\ ft^3}{27} = 72\ cy$ ✓

Use 75 cy ✓

Geotextile: Access Rd

Class ~~IV~~ non woven

Width = 15'
Length = 208'

$15' \times 208' = \frac{3120\ ft^2}{9}$ ✓

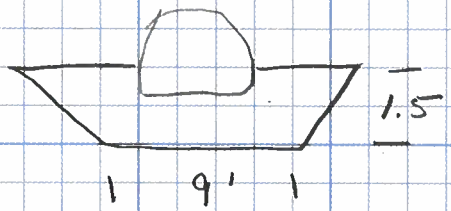
$= 346.7\ SY$ ✓

Use 350 SY ✓

Stream Crossing:

Width = 15'
Length = 24'

$15' \times 24' = \frac{360\ ft^2}{9} = 40\ SY$ ✓

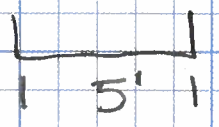


Width = 24'

Length = 26' + 3' = 29 ft ✓

$29\ ft\ (24\ ft) = \frac{696\ ft^2}{9} = 77.3\ SY$ ✓

Stream Crossing Inlet/Outlet Rock (Excavation/Rock)



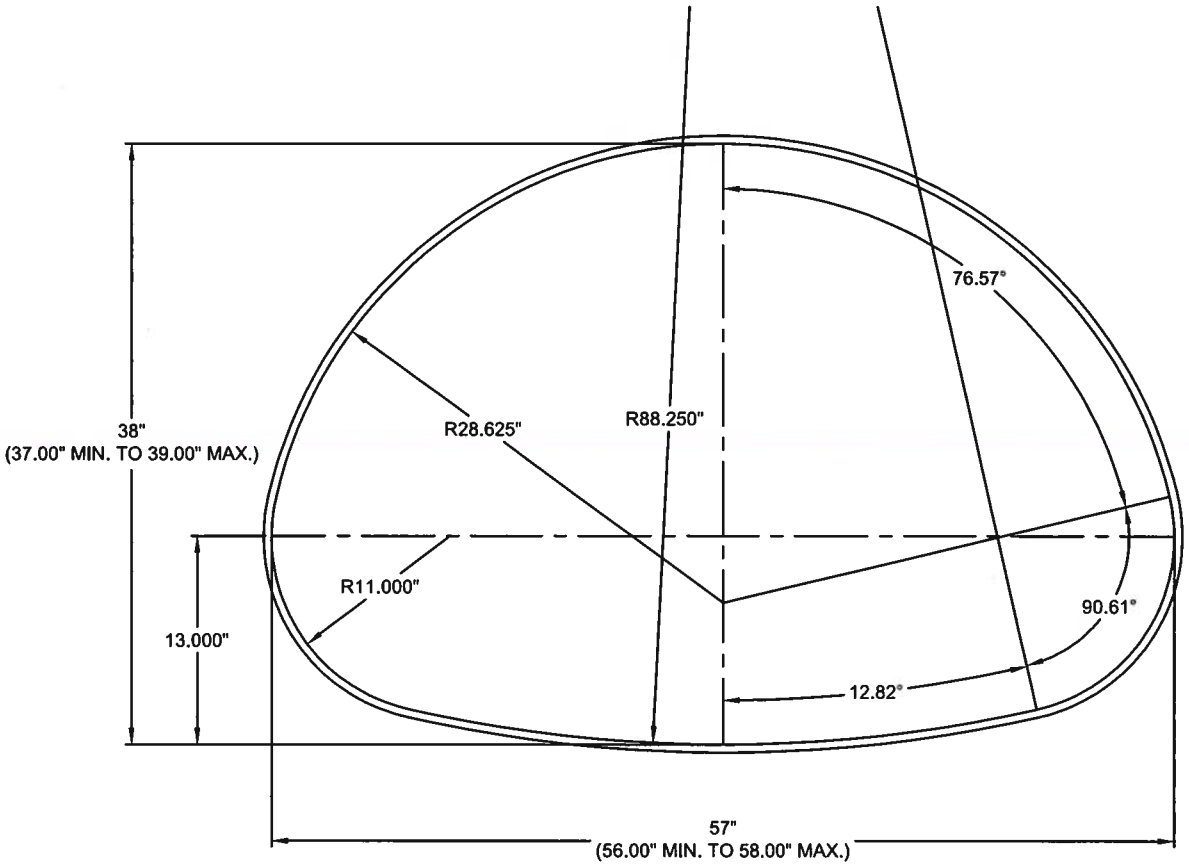
$[1'(5')(5')]\,2 = \frac{50\ ft^3}{27} = 1.9\ cy$

Use 2 cy ✓

geotextile: $[(1' + 5' + 1')(1' + 5' + 1')]\,2 = \frac{98\ ft^2}{9}$ ✓

$= 10.9$

Use 12 SY ✓



NOMINAL 57" X 38" (48" ROUND EQUIVALENT)

AREA= 11.6 SF

NOTES:
1. ALL DIMENSIONS ARE TO THE INSIDE CORRUGATION CREST UNLESS NOTED OTHERWISE.
2. ALL DIMENSIONS ARE SUBJECT TO MANUFACTURING TOLERANCES.
3. RISE AND SPAN DIMENSIONS ACCOUNT FOR SPECIFICATION TOLERANCES FROM NOMINAL DIMENSIONS. (AASHTO M 36 STEEL, M 196 ALUMINUM, ASTM A 760 STEEL, B 745 ALUMINUM).

CMP 2 2_3 48IN PA

CONTECH ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CONTECH PIPE SOLUTIONS

SHAPE DRAWING
2 2/3" x 1/2" CMP PIPE ARCH
48" EQ DIA 57"x38"

DATE DRAWN: 6/16/16	REV #:	REV DATE:	SCALE: N.T.S.	DRAWING TYPE:

JOB COST ESTIMATE

USDA United States Department of Agriculture
Natural Resources Conservation Service

Landowner: HNS
Practice: Access Road (560)
Location: Leelanau Co.
208' x 14'

Funding Source: I&E
Prepared By: A.Paladino Date: 2/14/2022
Checked By: DBrule Date: 2/22

No.	Description	Unit	Amount	Cost/Unit	Cost
1	Excavation	CY	220	$5.00	$1,100.00
2	MDOT 23A Gravel	CY	75	$35.00	$2,625.00
3	Class IV Non-Woven Geotextile	SY	350	$3.50	$1,225.00
4	Earthfill	CY	230	$10.00	$2,300.00
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19	Contingency 10%	CY		$725.00	$725.00
20	Mobilization	LS	1	$398.75	$398.75

Total Estimated Cost: $8,373.75

** This estimate is of total construction costs. This does not indicate the amount that may be in an NRCS contract.

** This estimate is based on measurements and computations of the amount of each item. The cost per unit is based on current price lists of materials from manufacturers and prevailing construction costs. The total cost could be affected by inexperienced contractors, adverse weather conditions, shipping costs, and/or other factors.

JOB COST ESTIMATE

USDA United States Department of Agriculture
Natural Resources Conservation Service

Landowner: HNS
Practice: Stream Crossing (578)(full invert pipe arch)
Location: Leelanau Co.

Funding Source: I&E
Prepared By: A.Paladino Date: 2/14/2022
Checked By: DRBrake Date: 2/22

No.	Description	Unit	Amount	Cost/Unit	Cost
1	Excavation	CY	52	$10.00	$520.00
2	MDOT 23A Gravel	CY	8.5	$60.00	$510.00
3	Class IV Non-Woven Geotextile	SY	130	$3.50	$455.00
4	Earthfill (Compacted class II)	CY	31	$15.00	$465.00
5	6AA crushed compacted fill	CY	25	$45.00	$1,125.00
6	Rock Riprap	CY	2	$100.00	$200.00
7	Removal of existing sheet piling	LS	1	$1,000.00	$1,000.00
8	Dewatering	LS	1	$8,000.00	$8,000.00
9	Corrugated galvanized Pipe Arch (57"x38")	LF	26	$150.00	$3,900.00
10	Seeding and Mulching	AC	0.1	$1,200.00	$120.00
11	silt fence	LF	50	$3.50	$175.00
12					
13					
14					
15					
16					
17					
18					
19	Contingency 10%	CY		$1,647.00	$1,647.00
20	Mobilization	LS	1	$1,811.70	$1,811.70

Total Estimated Cost: $19,928.70

** This estimate is of total construction costs. This does not indicate the amount that may be in an NRCS contract.

** This estimate is based on measurements and computations of the amount of each item. The cost per unit is based on current price lists of materials from manufacturers and prevailing construction costs. The total cost could be affected by inexperienced contractors, adverse weather conditions, shipping costs, and/or other factors.

JOB COST ESTIMATE

USDA United States Department of Agriculture
Natural Resources Conservation Service

Landowner: HNS
Funding Source: I&E
Practice: Stream Crossing (578) (Bottomless culvert)
Prepared By: A.Paladino
Date: 2/14/2022
Location: Leelanau Co.
Checked By: TJP
Date: 2/22

No.	Description	Unit	Amount	Cost/Unit	Cost
1	Excavation	CY	65	$10.00	$650.00
2	MDOT 23A Gravel	CY	10.5	$60.00	$630.00
3	Class IV Non-Woven Geotextile	SY	162	$3.50	$567.00
4	Earthfill (Compacted class II)	CY	40	$15.00	$600.00
5	6AA crushed compacted fill	CY	31	$45.00	$1,395.00
6	Rock Riprap	CY	2.5	$100.00	$250.00
7	Removal of existing sheet piling	LS	1	$1,000.00	$1,000.00
8	Dewatering	LS	1	$1,500.00	$1,500.00
9	Single Radius Arch (6'span - 3'-2" rise) with footing	LF	26	$500.00	$13,000.00
10	Seeding and Mulching	AC	0.1	$1,200.00	$120.00
11	Soil Boring	EA	1	$2,000.00	$2,000.00
12	Footing design	EA	1	$4,000.00	$4,000.00
13	silt fence	LF	60	$3.50	$210.00
14					
15					
16					
17					
18					
19	Contingency 10%	CY		$2,592.20	$2,592.20
20	Mobilization	LS	1	$2,851.42	$2,851.42

Total Estimated Cost: $31,365.62

** This estimate is of total construction costs. This does not indicate the amount that may be in an NRCS contract.

** This estimate is based on measurements and computations of the amount of each item. The cost per unit is based on current price lists of materials from manufacturers and prevailing construction costs. The total cost could be affected by inexperienced contractors, adverse weather conditions, shipping costs, and/or other factors. FOOTING DESIGNED BY OTHERS THEREFORE

JOB COST ESTIMATE

USDA United States Department of Agriculture
Natural Resources Conservation Service

Landowner: HNS
Practice: Stream Crossing (578)(prefabricated bridge)
Location: Leelanau Co.

Funding Source: I&E
Prepared By: A.Paladino Date: 2/14/2022
Checked By: DRB Date: 2/22

No.	Description	Unit	Amount	Cost/Unit	Cost
1	Prefabricated steel Bridge (14'x20') with design	SF	280	$150.00	$42,000.00
2	MDOT 23A Gravel	CY	8.5	$60.00	$510.00
3	Soil Boring	LS	1	$2,000.00	$2,000.00
4	Abutment design	LS	1	$4,000.00	$4,000.00
5	Removal of existing sheet piling	EA	1	$1,000.00	$1,000.00
6	Seeding and Mulching	AC	0.1	$1,200.00	$120.00
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19	Contingency 10%	CY		$4,963.00	$4,963.00
20	Mobilization	LS	1	$5,459.30	$5,459.30

Total Estimated Cost: $60,052.30

** This estimate is of total construction costs. This does not indicate the amount that may be in an NRCS contract.

** This estimate is based on measurements and computations of the amount of each item. The cost per unit is based on current price lists of materials from manufacturers and prevailing construction costs. The total cost could be affected by inexperienced contractors, adverse weather conditions, shipping costs, and/or other factors. FOOTING DESIGN IS UNKNOWN AND THEREFORE ESTIMATE WOULD VARY BASED ON THAT FINAL DESIGN, IF DIFFERENT FROM ESTIMATED FOOTING WITH PREFAB STRUCTURE.

Paladino, Andrea - NRCS, Traverse City, MI

From: Ryan Loeprich <Ryan.Loeprich@ContechES.com>
Sent: Friday, February 11, 2022 7:51 AM
To: Paladino, Andrea - NRCS, Traverse City, MI
Subject: RE: [EXTERNAL] Prefab bridge option questions.
Attachments: 50 ft Tem Bridge Approach and Finish Course.jpg

Andrea,

Gravel is an option for a finished surface. Based on the structure size, I would expect this to be in the $150 per sq ft range. We would probably want to have this as a galvanized finish due to the low clearance to the water course/wetland. I would expect this to be consistently wet, and a weathering steel structure needs wet & dry cycles. The design would be HL-93...we could possibly look to reduce the design to a H-10 (20K) or H-20 (40K) vehicle. Thoughts?

Material only, delivered. The system would be completely prefabricated.

Best Regards,

Ryan Loeprich
Senior State Bridge Consultant
Contech Engineered Solutions, LLC

Phone: 616-403-5525
Website: www.conteches.com

From: Paladino, Andrea - NRCS, Traverse City, MI <andrea.paladino@usda.gov>
Sent: Thursday, February 10, 2022 4:24 PM
To: Ryan Loeprich <Ryan.Loeprich@ContechES.com>
Subject: RE: [EXTERNAL] Prefab bridge option questions.

Hi Ryan,
That is great to know for this site and future projects! That might be an option here and depending on costs, the extra span could work to encompass more of the flood plain. From the information it looks like gravel is a finished surface option? That would probably be the preferred surfacing here. Would you be able to provide an estimate on the costs associated with the total package from Contech. I am just looking for an estimate to be used in the preliminary planning and decision making level. I assume you would need soil borings provided prior to a design, but I don't know if you would be able to give a preliminary estimate with only the basic soils information shared previously. I know costs currently are pretty hard to predict but a starting point at this time would be helpful.
Please let me know if you need any more information at this stage to be able to provide a preliminary estimate on the full package cost.

Thank you!
Andrea

Andrea Paladino
Civil Engineer, P.E.

USDA-NRCS
Cell: 989-698-6036
Phone: 231-486-2523
andrea.paladino@usda.gov

From: Ryan Loeprich <Ryan.Loeprich@ContechES.com>
Sent: Thursday, February 10, 2022 12:51 PM
To: Paladino, Andrea - NRCS, Traverse City, MI <andrea.paladino@usda.gov>
Subject: RE: [EXTERNAL] Prefab bridge option questions.

Thank you for reaching out! Do we have an option for you! About 2 years ago, Contech acquired a company out west that specializes in pre-fabricated steel truss bridges specifically for remote access sites – forestry, logging, mining, etc. Our goal is to bring the same concept to the county level crossings. Contech would include the design of bridge (similar to plate), but also include an abutment system/design with the package. See the attached information for reference.

You crossing span is a little short for standard designs. Perhaps we extend to 20 ft for better conditions.

Best Regards,

Ryan Loeprich
Senior State Bridge Consultant
Contech Engineered Solutions, LLC

Phone: 616-403-5525
Website: www.conteches.com

From: Paladino, Andrea - NRCS, Traverse City, MI <andrea.paladino@usda.gov>
Sent: Thursday, February 10, 2022 12:35 PM
To: Ryan Loeprich <Ryan.Loeprich@ContechES.com>; Ryan Loeprich <Ryan.Loeprich@ContechES.com>
Subject: [EXTERNAL] Prefab bridge option questions.

Hi Ryan,
I Hope all is well with you! It has been a while since I have reached out. I have a small access road in need of a small tributary crossing. There is interest in exploring a bridge option. NRCS MI does not design bridges in house so I am looking into prefab options and what Contech could provide in terms of design of the prefab structure and what if any prefab abutment options may be.
To give you some idea of the site, The site has approximately 3ft. of muck soil over sand soils (outside the access road). The span would be 11 ft. and the travel way total width (including shoulders) would be 14ft. The rise from streambed to top of access road elevation will be 4.5ft.

I would appreciate any information you could provide.

Thanks!

Andrea

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