CULVERT REPLACEMENT PRELIMINARY ENGINEERING REPORT

3/18/2015

Prepared for: Cleveland Township

Prepared by: Gosling Czubak Engineering Sciences, Inc
1280 Business Park Dr.
Traverse City, MI 49686
231-946-9191

TABLE OF CONTENTS

INTRODUCTION

This phase of the investigation follows the "Water Level Investigation" that was conducted in 2014 for the Little Traverse Lake Property Owners Association. That report identified culvert replacement as one facet of a combination of several items that could possibly lower Little Traverse Lake water levels. The goal of this phase of the investigation is to provide preliminary engineering information and opinions of probable costs to Cleveland Township on options for replacing the culverts at Traverse Lake Road and County Road 669 (CR 669).

The first part of the investigation involves gathering data on the soils. Two soil borings were completed at each culvert location in order to identify the soils present and determine their suitability for supporting a culvert or bridge structure foundation. Replacement options for the culverts were then evaluated hydraulically to determine the size and type for developing the preliminary opinions of cost.

METHODS

Soil borings were completed for this investigation using a rotary drill rig. Standard Penetration Tests were completed during drilling to determine engineering properties of the soils encountered.

Hydraulic analysis of the proposed culverts was completed utilizing the HY-8 culvert analysis program developed by the Federal Highway Administration. Inputs were gathered from the limited survey information available that was previously completed for the "Water Level Investigation". Consultation with Jeff Silagy of the MDEQ regarding permitting requirements was also sought during this phase.

DISCUSSION

TYPE, SIZE, & LOCATION

There are several factors which affect the type, size, and location of a bridge or culvert structure that is ultimately chosen for any stream crossing. These typically include site topography, hydraulics, environmental factors, and soil conditions as the major factors. All of these were considered in evaluating possible culvert replacement structures for Traverse Lake Road and CR 669 over Shalda Creek.

The topography of the two sites is fairly low and flat. The difference between the road surface and the water surface that was measured in April 2014 is about 1.7 feet at both locations. Utilizing typical concrete beam and deck structures, as well as timber structures, would typically require maintaining at least two feet of clearance between the water surface and beams. This would keep the beams out of water and ice flow as well as allow for routine inspections. Unless the road grade is raised at the culverts, these types of bridges do not fit with the current site topography. Raising the road grade at either location would be more costly than the estimates show as the amount of additional road work would increase. Replacing the existing culverts with larger culvert structures appears to be achievable within the topographic constraints of each site.

The hydraulic capacity and the ability of any replacement culverts to handle higher flows than the existing culverts is a major criteria for sizing the replacement culverts. The Michigan Department of Environmental Quality (MDEQ) has indicated that a replacement culvert will need to have an equal or greater capacity than the existing culvert for all flows up to the 100 year flow. The MDEQ Hydrological Unit has provided estimated peak runoff flow rates for various rainfall events at each culvert location. Table 1 below shows these values.

Table 1.

	Total Drainage Area (Sq. Miles)	Cont. Drainage Area (Sq. Miles)	Flow (cfs) at Frequency			
			50% (2yr)	10% (10yr)	2% (50yr)	1%(100yr)
Traverse Lake Road	18.7	15.8	20	120	350	500
CR 669	19.2	16.3	20	120	350	500
Rainfall Depth by Frequency (in)			2.4	3.25	4.2	4.67

Two types of culverts in three different sizes were analyzed hydraulically at each location. Note that the dimensions of culverts noted are width by height. The culverts analyzed include a 22.75'x5.33' aluminum arch culvert at Traverse Lake Road and a 21.83'x5.66' aluminum arch at CR 669. Three sided precast concrete culverts measuring 20'x5' and 30'x5' at Traverse Lake Road were analyzed while 20'x6' and 30'x6' three sided precast concrete culverts were analyzed at CR 669. Example photos of these types of structures are included in Appendix 1. Table 2 below summarizes the estimated lake level increase above "naturally occurring conditions" due to the culverts at 669 and Traverse Lake Rd for various flow conditions.

Table 2. Total Water Level Increase Due to Culverts at Traverse Lake Rd. & CR 669

Flow Condition	Existing Culverts	Aluminum Arches	Concrete, 20' spans	Concrete, 30' spans
20 cfs	.40 ft (4.8 in)	0.0	0.0	0.0
60 cfs	.70 ft (8.4 in)	0.0	0.0	0.0
120 cfs	2.5 ft	.3 ft (3.6 in)	.3 ft (3.6 in)	.2 ft (2.4 in)
350 cfs	5.2 ft	1.9 ft	1.2 ft	.6 ft (7.2 in)
500 cfs	5.4 ft	3.2 ft	2.4 ft	1.15 ft

We can look at recently recorded lake water level and flow measurements to help explain these analysis results. For example, in October 2014, lake levels were recorded at 596.1. (A lake level of 595.65 has been reported to cause structure flooding) Flow was estimated to be about 70 cfs, and the actual combined water level difference that was measured through both of the existing culverts was 0.7 feet (8.4"). So, if both the existing culverts are replaced with a 20' concrete span, the data shows at a flow of 70 cfs, there is 0.0 feet of increase in the lake level expected due to the culverts. So, the expected lake level would be 0.7' lower, or elevation 595.4 under similar downstream conditions. Under less severe conditions experienced prior to the snow melt in March, 2014, the recorded water level difference through the existing culverts was only 0.3'. So, the benefit of the new culverts would only reduce lake levels by 0.3' under similar conditions.

At the lower flow conditions (< 70 cfs), the lake level will be based on downstream conditions and will be unaffected by the replacement culverts that were analyzed.

During the 2014 study, typical flow rates out of Little Traverse Lake were estimated to range from 20 cfs to 80 cfs. However, MDEQ requires analysis of new culverts under extreme “100 year” flow conditions (500 cfs). The analysis of the aluminum arch culvert at Traverse Lake Road showed that the 100 year flow of 500 cfs would result in overtopping of the road. Overtopping is not expected to occur for the three sided precast concrete structures at either location or the aluminum culvert at CR 669.

Both the 20’ and 30’ concrete structures are able to pass all the flows including the 100 year flow. Although, the headwater elevations estimated for the 100 year flows do back up above the bottom of the concrete elevation of the culvert tops.

The supplied costs of the aluminum arch structure and the 20’ concrete structure are nearly the same. Given the benefit of greater flow capacity for nearly the same costs, the complete estimates were prepared only for the concrete structures.

It is noted the difference in performance between the 20’ and 30’ spans is only significant at very high flows. The difference in cost for the 30’ structure over the 20’ structure shown in the estimates is fairly significant.

The precast concrete culvert structures will be required to carry a paved road cross section slightly wider than existing. The overall culvert lengths are 36 feet. Headwalls one foot wide are anticipated at each end resulting in a pavement width of 34 feet over the culvert. This equates to two 12’ traffic lanes with 5’ paved shoulders. Guardrail is anticipated to be attached to the headwalls and extended approximately 30 feet past each end of the headwall. The 34 foot pavement width will be carried through the guardrail section and then tapered back to the existing pavement width. Drawings showing the general plan and section at each crossing are included in Appendix 4.

The design traffic loading on the culvert is anticipated to be HS-20 loading. This is equivalent to a truck with a 8,000 lb front axle and a 32,000 lb rear axles. Two lanes of this loading will be used to determine the loads required to be supported by the foundation. Weights of the structure itself will also be included in the loads required to be supported by the foundation.

The main environmental factor related to these crossings include designing the structure to have an equal or greater capacity than the existing culvert for all flows up to the 100 year flow as already mentioned. The MDEQ also typically requires structures to span the bankfull width of a stream. The MDEQ has estimated the bankfull widths at these sites at approximately 20 to 25 feet. They have indicated the 20 foot span could work provided the flow criteria are met and the stream bottom is natural. The culverts will be supported on pile foundations and natural stream bottoms will be provided with these designs. The MDEQ will not approve a specific structure until the permitting process is begun and an official review process can be completed.

Soil erosion and sedimentation control measures are other environmental related items. Details for these items are related to protecting the stream during construction and would be included on

construction drawings and the permit applications. These items are accounted for in the estimates.

SOILS & FOUNDATIONS

Soil boring logs that were completed for each culvert location are included in Appendix 3. Poor soils were generally encountered in the upper strata at each location. Peat and marl were present from depths of 6 ½ feet to 24 feet below grade at the CR 669 culvert while peat and marl were present from depths of 4 feet to 19 ½ feet below grade at the Traverse Lake Road culvert. Peat and marl are soft, compressible soils with varying amounts of organics and are not suitable for supporting foundations. With these types of soils present, the foundations for the culverts will have to be supported with pile foundations.

Below the peat and marl layers, the soils encountered are typically fine to medium sands with some trace gravel. The blow counts indicate the soils are dense in the range of 30 feet to 40 feet below grade. It is estimated that an ultimate pile capacity of 60 tons per pile will be attainable at depths of approximately 45 feet below grade at Traverse Lake Road and 35 to 40 feet below grade at CR 669.

CONSTRUCTION ISSUES

It is estimated that construction of these structures will require temporary cofferdams in order to divert the stream. This temporary stream diversion will allow the area for the proposed foundations to be dewatered and foundation work to be completed. Once the foundations are completed, the precast units and wing wall can be placed. Riprap will then be placed and the cofferdam and stream diversion will be removed.

It is assumed that all construction would occur with a road closure in place. Coordinating this with the County Road Commission and the National Park Service will be necessary.

OPINIONS OF COST

The preliminary opinions of cost were completed by figuring quantities of the major work items and estimating the unit costs of those items. Estimates of the unit costs are based on MDOT average unit prices, preliminary estimates from manufacturers and contractors, and experience. The opinions of cost also include a 10% contingency and a 15% amount to cover final engineering, permitting, construction observation, and testing. The complete opinion of cost for each structure is in Appendix 2. A summary of those costs is as follows:

Traverse Lake Road 20'x5' Precast three sided culvert option -	$375,938
Traverse Lake Road 30'x5' Precast three sided culvert option -	$413,063
County Road 669 20'x6' Precast three sided culvert option -	$382,813
County Road 669 30'x6' Precast three sided culvert option -	$418,813

APPENDIX 1 – Example Photos

Subject	Example photo of typical three sided precast concrete culvert construction	Gosling Czubak Project No. 2014590.01	#1

Subject	Example Photo typical three sided precast concrete culvert	Gosling Czubak Project No. 2014590.01	#2

Subject	Example photo of typical aluminum arch culvert	Gosling Czubak Project No. 2014590.01	#3

APPENDIX 2 – Estimates

Gosling Czubak
engineering sciences, inc.

Project: Traverse Lake Road over Shalda Creek
Cleveland Township

Date: Feb 25, 2015
Project No.: 2014590.01
By: RMV

Preliminary Opinion of Probable Cost

20'x5' Precast Three Sided Structure

Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$14,000.00	$14,000
2	Traffic Control	1	LS	$5,000.00	$5,000
3	Excavation, Earth	525	Cyd	$10.00	$5,250
4	Backfill, Structure, CIP	300	Cyd	$20.00	$6,000
5	Erosion Control, Silt Fence	400	Ft	$2.00	$800
6	Erosion Control, Filter Bag	4	Ea	$500.00	$2,000
7	Aggregate Base	165	Ton	$15.00	$2,475
8	HMA Base Crushing and Shaping	800	Syd	$2.00	$1,600
9	Shoulder, Cl II, 3 inch	150	Syd	$6.00	$900
10	HMA, 13A	165	Ton	$75.00	$12,375
11	Cofferdams/Stream Diversion	1	LS	$50,000.00	$50,000
12	Dewatering	1	LS	$8,000.00	$8,000
13	Culv, Precast Three-Sided or Arch, 20 foot by 5 foot, Furnish	36	Ft	$1,375.00	$49,500
14	Culv, Precast Three-Sided or Arch, Erect	1	LS	$12,000.00	$12,000
15	Pile Driving Equipment, Furn	1	LS	$15,000.00	$15,000
16	Pile, Steel, Furn and Driven, 12 inch	810	Ft	$50.00	$40,500
17	Test Pile, Steel, 12 inch	2	Ea	$5,000.00	$10,000
18	Conc, Grade S2	50	Cyd	$650.00	$32,500
19	Reinforcement, Steel	3500	Lb	$2.00	$7,000
20	Guardrail Anch, Bridge, Det T2	4	Ea	$1,500.00	$6,000
21	Guardrail Approach Terminal, Type 1B	4	Ea	$2,000.00	$8,000
22	Pavt Mrkg, Regular Dry, 4 inch, White	600	Ft	$0.50	$300
23	Pavt Mrkg, Regular Dry, 4 inch, Yellow	600	Ft	$0.50	$300
24	Riprap, Heavy	75	Syd	$150.00	$11,250
25	Slope Restoration	300	Syd	$5.00	$1,500
				Subtotal	$300,750
				Contingency (10%)	$30,075
				Final Engineering, Permitting, Construction Obs. & Testing (15%)	$45,113
				Project Total	**$375,938**

Gosling Czubak
engineering sciences, inc.

Project: Traverse Lake Road over Shalda Creek
Cleveland Township

Date: Feb 25, 2015
Project No.: 2014590.01
By: RMV

Preliminary Opinion of Probable Cost

30'x5' Precast Three Sided Structure

Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$14,000.00	$14,000
2	Traffic Control	1	LS	$5,000.00	$5,000
3	Excavation, Earth	525	Cyd	$10.00	$5,250
4	Backfill, Structure, CIP	300	Cyd	$20.00	$6,000
5	Erosion Control, Silt Fence	400	Ft	$2.00	$800
6	Erosion Control, Filter Bag	4	Ea	$500.00	$2,000
7	Aggregate Base	165	Ton	$15.00	$2,475
8	HMA Base Crushing and Shaping	800	Syd	$2.00	$1,600
9	Shoulder, Cl II, 3 inch	150	Syd	$6.00	$900
10	HMA, 13A	165	Ton	$75.00	$12,375
11	Cofferdams/Stream Diversion	1	LS	$50,000.00	$50,000
12	Dewatering	1	LS	$8,000.00	$8,000
13	Culv, Precast Three-Sided or Arch, 30 foot by 5 foot, Furnish	36	Ft	$1,950.00	$70,200
14	Culv, Precast Three-Sided or Arch, Erect	1	LS	$12,000.00	$12,000
15	Pile Driving Equipment, Furn	1	LS	$15,000.00	$15,000
16	Pile, Steel, Furn and Driven, 12 inch	990	Ft	$50.00	$49,500
17	Test Pile, Steel, 12 inch	2	Ea	$5,000.00	$10,000
18	Conc, Grade S2	50	Cyd	$650.00	$32,500
19	Reinforcement, Steel	3500	Lb	$2.00	$7,000
20	Guardrail Anch, Bridge, Det T2	4	Ea	$1,500.00	$6,000
21	Guardrail Approach Terminal, Type 1B	4	Ea	$2,000.00	$8,000
22	Pavt Mrkg, Regular Dry, 4 inch, White	600	Ft	$0.50	$300
23	Pavt Mrkg, Regular Dry, 4 inch, Yellow	600	Ft	$0.50	$300
24	Riprap, Heavy	75	Syd	$150.00	$11,250
25	Slope Restoration	300	Syd	$5.00	$1,500
				Subtotal	$330,450
				Contingency (10%)	$33,045
				Final Engineering, Permitting, Construction Obs. & Testing (15%)	$49,568
				Project Total	**$413,063**

Gosling Czubak
engineering sciences, inc.

Project: County Road 669 over Shalda Creek
Cleveland Township

Date: Feb 25, 2015
Project No.: 2014590.01
By: RMV

Preliminary Opinion of Probable Cost

20'x6' Precast Three Sided Structure

Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$14,000.00	$14,000
2	Traffic Control	1	LS	$5,000.00	$5,000
3	Excavation, Earth	655	Cyd	$10.00	$6,550
4	Backfill, Structure, CIP	375	Cyd	$20.00	$7,500
5	Erosion Control, Silt Fence	400	Ft	$2.00	$800
6	Erosion Control, Filter Bag	4	Ea	$500.00	$2,000
7	Aggregate Base	165	Ton	$15.00	$2,475
8	HMA Base Crushing and Shaping	800	Syd	$2.00	$1,600
9	Shoulder, Cl II, 3 inch	150	Syd	$6.00	$900
10	HMA, 13A	165	Ton	$75.00	$12,375
11	Cofferdams/Stream Diversion	1	LS	$50,000.00	$50,000
12	Dewatering	1	LS	$8,000.00	$8,000
13	Culv, Precast Three-Sided or Arch, 20 foot by 6 foot, Furnish	36	Ft	$1,450.00	$52,200
14	Culv, Precast Three-Sided or Arch, Erect	1	LS	$12,000.00	$12,000
15	Pile Driving Equipment, Furn	1	LS	$15,000.00	$15,000
16	Pile, Steel, Furn and Driven, 12 inch	810	Ft	$50.00	$40,500
17	Test Pile, Steel, 12 inch	2	Ea	$5,000.00	$10,000
18	Conc, Grade S2	50	Cyd	$650.00	$32,500
19	Reinforcement, Steel	3500	Lb	$2.00	$7,000
20	Guardrail Anch, Bridge, Det T2	4	Ea	$1,500.00	$6,000
21	Guardrail Approach Terminal, Type 1B	4	Ea	$2,000.00	$8,000
22	Pavt Mrkg, Regular Dry, 4 inch, White	600	Ft	$0.50	$300
23	Pavt Mrkg, Regular Dry, 4 inch, Yellow	600	Ft	$0.50	$300
24	Riprap, Heavy	75	Syd	$150.00	$11,250
25	Slope Restoration	300	Syd	$5.00	$1,500
				Subtotal	$306,250
				Contingency (10%)	$30,625
				Final Engineering, Permitting, Construction Obs. & Testing (15%)	$45,938
				Project Total	**$382,813**

Gosling Czubak
engineering sciences, inc.

Project: County Road 669 over Shalda Creek
Cleveland Township

Date: Feb 25, 2015
Project No.: 2014590.01
By: RMV

Preliminary Opinion of Probable Cost

30'x6' Precast Three Sided Structure

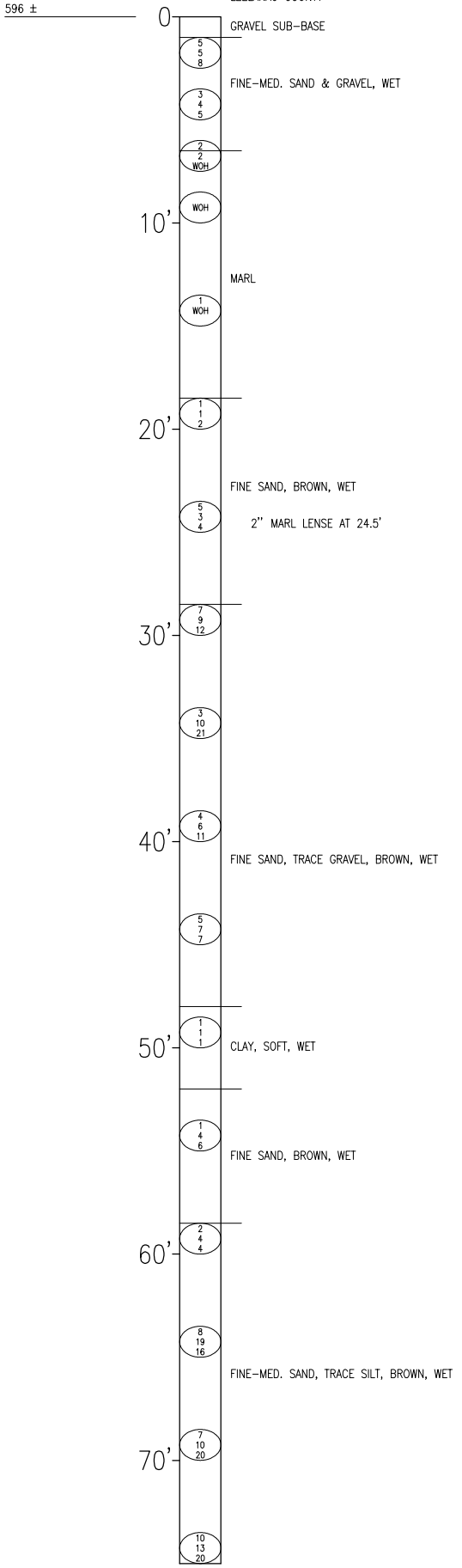
Item No.	Item Description	Estimated Quantity	Unit	Unit Price	Amount
1	Mobilization	1	LS	$14,000.00	$14,000
2	Traffic Control	1	LS	$5,000.00	$5,000
3	Excavation, Earth	655	Cyd	$10.00	$6,550
4	Backfill, Structure, CIP	375	Cyd	$20.00	$7,500
5	Erosion Control, Silt Fence	400	Ft	$2.00	$800
6	Erosion Control, Filter Bag	4	Ea	$500.00	$2,000
7	Aggregate Base	165	Ton	$15.00	$2,475
8	HMA Base Crushing and Shaping	800	Syd	$2.00	$1,600
9	Shoulder, Cl II, 3 inch	150	Syd	$6.00	$900
10	HMA, 13A	165	Ton	$75.00	$12,375
11	Cofferdams/Stream Diversion	1	LS	$50,000.00	$50,000
12	Dewatering	1	LS	$8,000.00	$8,000
13	Culv, Precast Three-Sided or Arch, 30 foot by 6 foot, Furnish	36	Ft	$2,000.00	$72,000
14	Culv, Precast Three-Sided or Arch, Erect	1	LS	$12,000.00	$12,000
15	Pile Driving Equipment, Furn	1	LS	$15,000.00	$15,000
16	Pile, Steel, Furn and Driven, 12 inch	990	Ft	$50.00	$49,500
17	Test Pile, Steel, 12 inch	2	Ea	$5,000.00	$10,000
18	Conc, Grade S2	50	Cyd	$650.00	$32,500
19	Reinforcement, Steel	3500	Lb	$2.00	$7,000
20	Guardrail Anch, Bridge, Det T2	4	Ea	$1,500.00	$6,000
21	Guardrail Approach Terminal, Type 1B	4	Ea	$2,000.00	$8,000
22	Pavt Mrkg, Regular Dry, 4 inch, White	600	Ft	$0.50	$300
23	Pavt Mrkg, Regular Dry, 4 inch, Yellow	600	Ft	$0.50	$300
24	Riprap, Heavy	75	Syd	$150.00	$11,250
25	Slope Restoration	300	Syd	$5.00	$1,500
				Subtotal	$335,050
				Contingency (10%)	$33,505
				Final Engineering, Permitting, Construction Obs. & Testing (15%)	$50,258
				Project Total	**$418,813**

APPENDIX 3 – Soil Boring Logs

TEST HOLE SB-1

596 ±

LOCATION: 25' NORTH OF EXISTING CULVERT, E. SIDE OF ROAD
CR 669
SECTION 9 & 10 CLEVELAND TOWNSHIP
LEELANAU COUNTY



END OF BORING: 75'

BORING DATE: 11-19-2014

BORING PERFORMED BY GOSLING CZUBAK ENGINEERING SCIENCES, INC.

NOTES:

NUMBERS IN CIRCLES DENOTE NUMBER OF BLOWS REQUIRED TO DRIVE A 2" O.D. (1 3/8" I.D.) SPLIT SPOON SAMPLER 3 SUCCESSIVE 6" INCREMENTS USING A 140# HAMMER FALLING 30".

WOH INDICATES THE WEIGHT OF HAMMER DROVE THE SPLIT SPOON SAMPLER THROUGH THE LAYER.

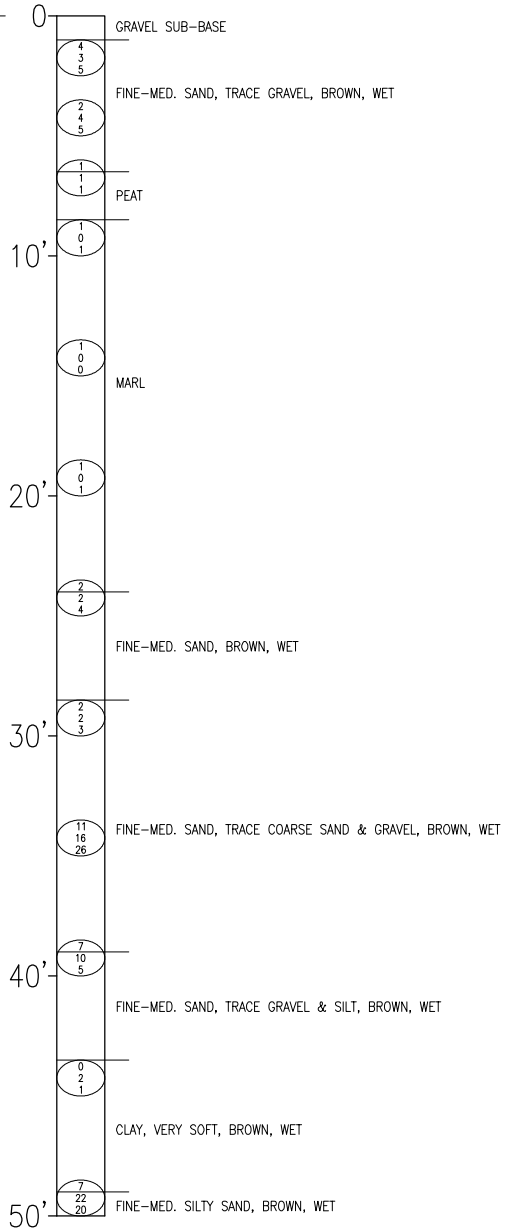
Gosling Czubak
engineering sciences, inc.
1280 Business Park Drive
Traverse City, MI 49686-8607
231-946-9191 800-968-1062
Fax: 231-941-4603

- *Engineers*
- *Surveyors*
- *Environmental Services*
- *Landscape Architecture*

TEST HOLE SB-2

596 ±

LOCATION: 25' SOUTH OF EXISTING CULVERT, E. SIDE OF ROAD
CR 669
SECTION 9 & 10 CLEVELAND TOWNSHIP
LEELANAU COUNTY



END OF BORING: 50'

BORING DATE: 11-19-2014

BORING PERFORMED BY GOSLING CZUBAK ENGINEERING SCIENCES, INC.

NOTES:

NUMBERS IN CIRCLES DENOTE NUMBER OF BLOWS REQUIRED TO DRIVE A 2" O.D. (1 3/8" I.D.) SPLIT SPOON SAMPLER 3 SUCCESSIVE 6" INCREMENTS USING A 140# HAMMER FALLING 30".

WOH INDICATES THE WEIGHT OF HAMMER DROVE THE SPLIT SPOON SAMPLER THROUGH THE LAYER.

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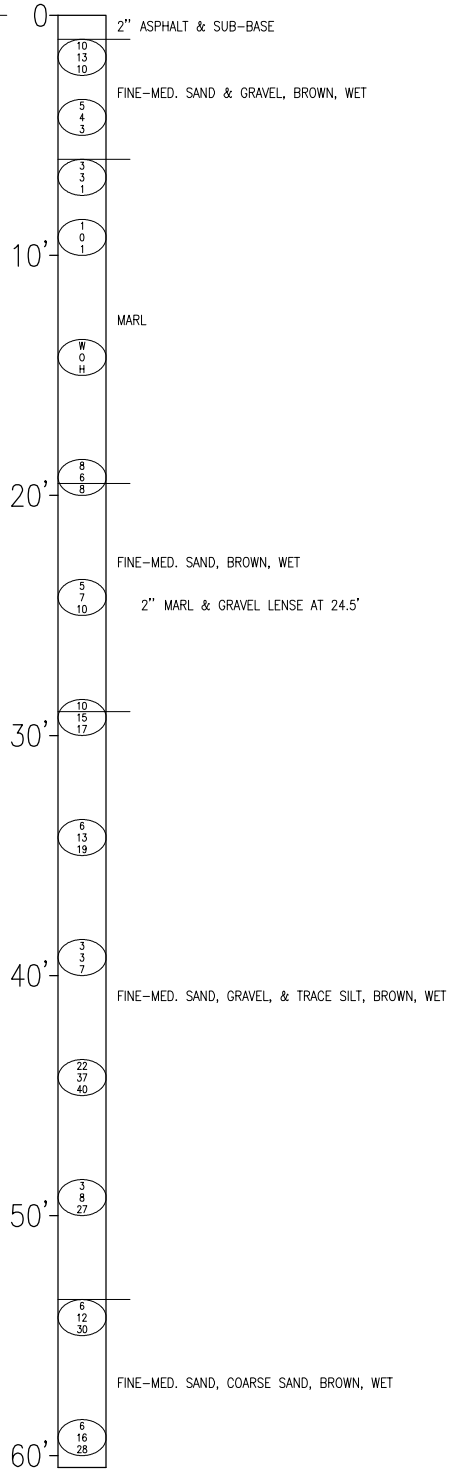
- *Engineers*
- *Surveyors*
- *Environmental Services*
- *Landscape Architecture*

TEST HOLE SB-3

LOCATION: 25' NORTH OF EXISTING CULVERT, E. SIDE OF ROAD
TRAVERSE LAKE ROAD
SECTION 10 CLEVELAND TOWNSHIP
LEELANAU COUNTY

597 ±



END OF BORING: 60'

BORING DATE: 11-19-2014

BORING PERFORMED BY GOSLING CZUBAK ENGINEERING SCIENCES, INC.

NOTES:

NUMBERS IN CIRCLES DENOTE NUMBER OF BLOWS REQUIRED TO DRIVE A 2" O.D. (1 3/8" I.D.) SPLIT SPOON SAMPLER 3 SUCCESSIVE 6" INCREMENTS USING A 140# HAMMER FALLING 30".

WOH INDICATES THE WEIGHT OF HAMMER DROVE THE SPLIT SPOON SAMPLER THROUGH THE LAYER.

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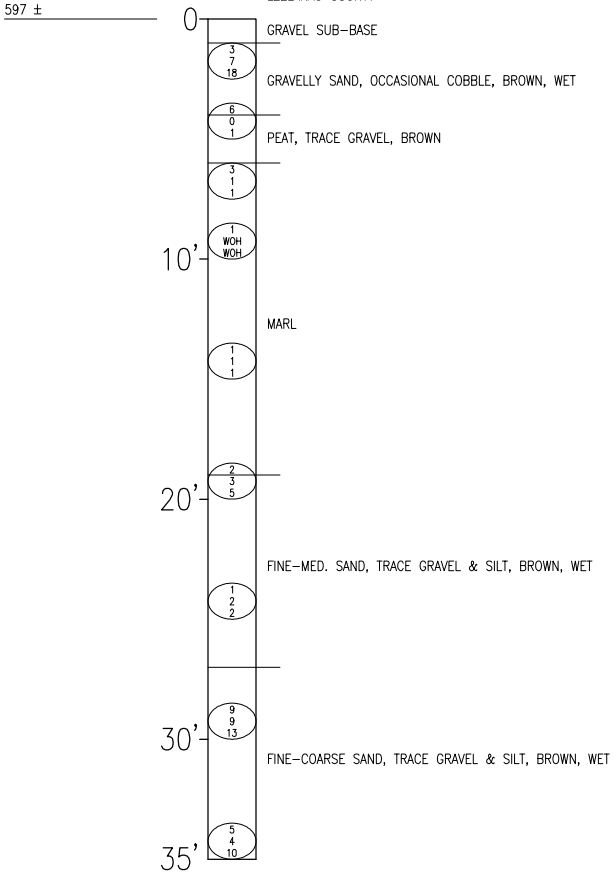
- *Engineers*
- *Surveyors*
- *Environmental Services*
- *Landscape Architecture*

TEST HOLE SB-4

LOCATION: 25' SOUTH OF EXISTING CULVERT, E. SIDE OF ROAD
TRAVERSE LAKE ROAD
SECTION 10 CLEVELAND TOWNSHIP
LEELANAU COUNTY



END OF BORING: 35'

BORING DATE: 11-20-2014

BORING PERFORMED BY GOSLING CZUBAK ENGINEERING SCIENCES, INC.

NOTES:

NUMBERS IN CIRCLES DENOTE NUMBER OF BLOWS REQUIRED TO DRIVE A 2" O.D. (1 3/8" I.D.) SPLIT SPOON SAMPLER 3 SUCCESSIVE 6" INCREMENTS USING A 140# HAMMER FALLING 30".

WOH INDICATES THE WEIGHT OF HAMMER DROVE THE SPLIT SPOON SAMPLER THROUGH THE LAYER.

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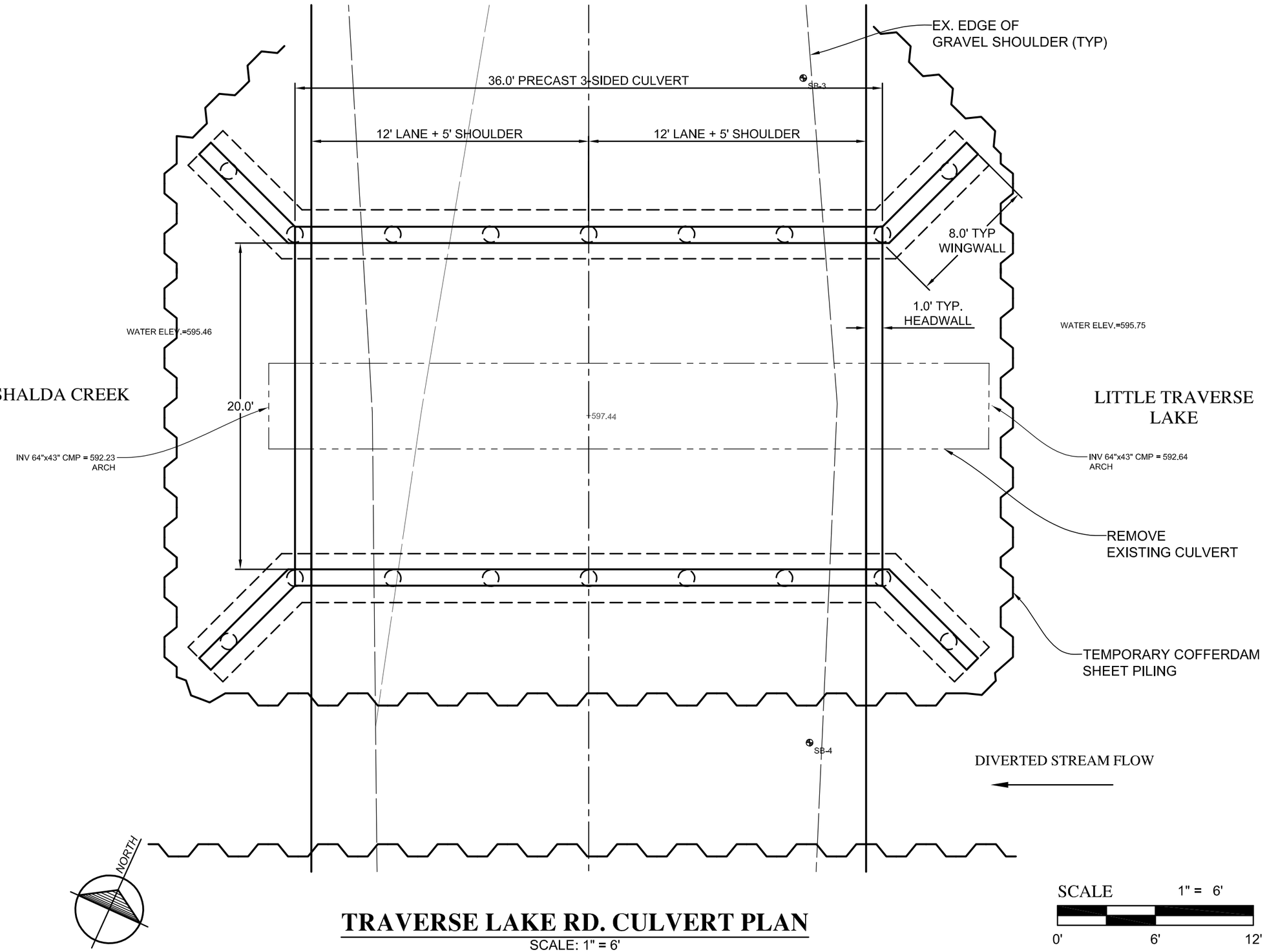
APPENDIX 4 – Drawings



TRAVERSE LAKE RD. CULVERT PLAN

SCALE: 1" = 6'

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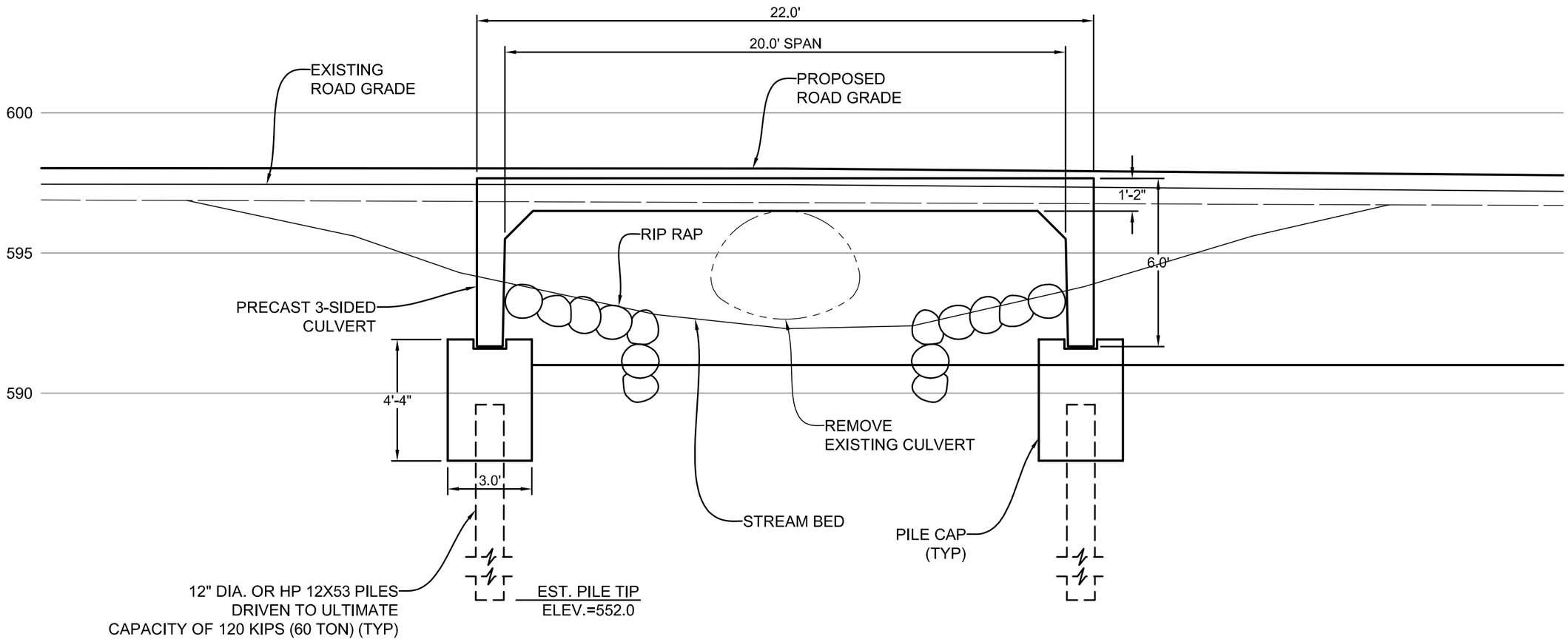
• Engineers
• Surveyors
• Environmental Services
• Landscape Architecture
1280 Business Park Drive
Traverse City, MI 49686-8607
231-946-9191 800-968-1062
Fax: 231-941-4603

Job #:	2014590.01
Date:	01-23-2015
Scale:	AS NOTED
Drawn:	RMV
Chk'd.:	-
Rev.:	-

PROP. CULVERT PLAN
TRAVERSE LAKE ROAD
CULVERT REPLACEMENT

Location:
SECTION 10, T29N, R13W
CLEVELAND TOWNSHIP
LEELANAU COUNTY, MICHIGAN



TRAVERSE LAKE RD. CULVERT SECTION

SCALE: 1" = 4'

SCALE 1" = 4'

0' 4' 8'

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1280 Business Park Drive
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Job #: 20145590.01
Date: 01-23-2015
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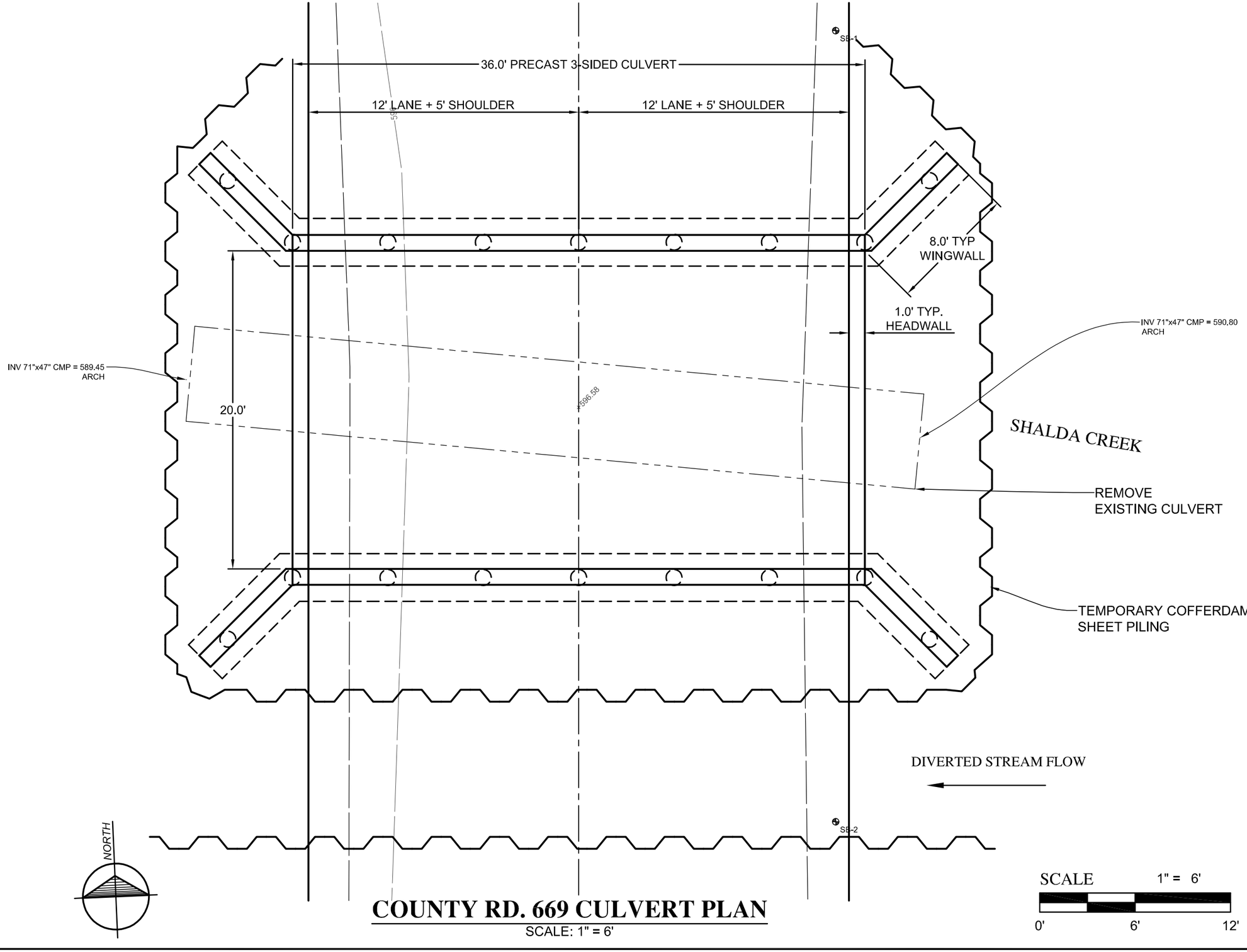
Chk'd.: -
Rev.: -

PROP. CULVERT SECTION TRAVERSE LAKE ROAD CULVERT REPLACEMENT

Location:
SECTION 10, T29N, R13W
CLEVELAND TOWNSHIP
LEELANAU COUNTY, MICHIGAN



COUNTY RD. 669 CULVERT PLAN

SCALE: 1" = 6'

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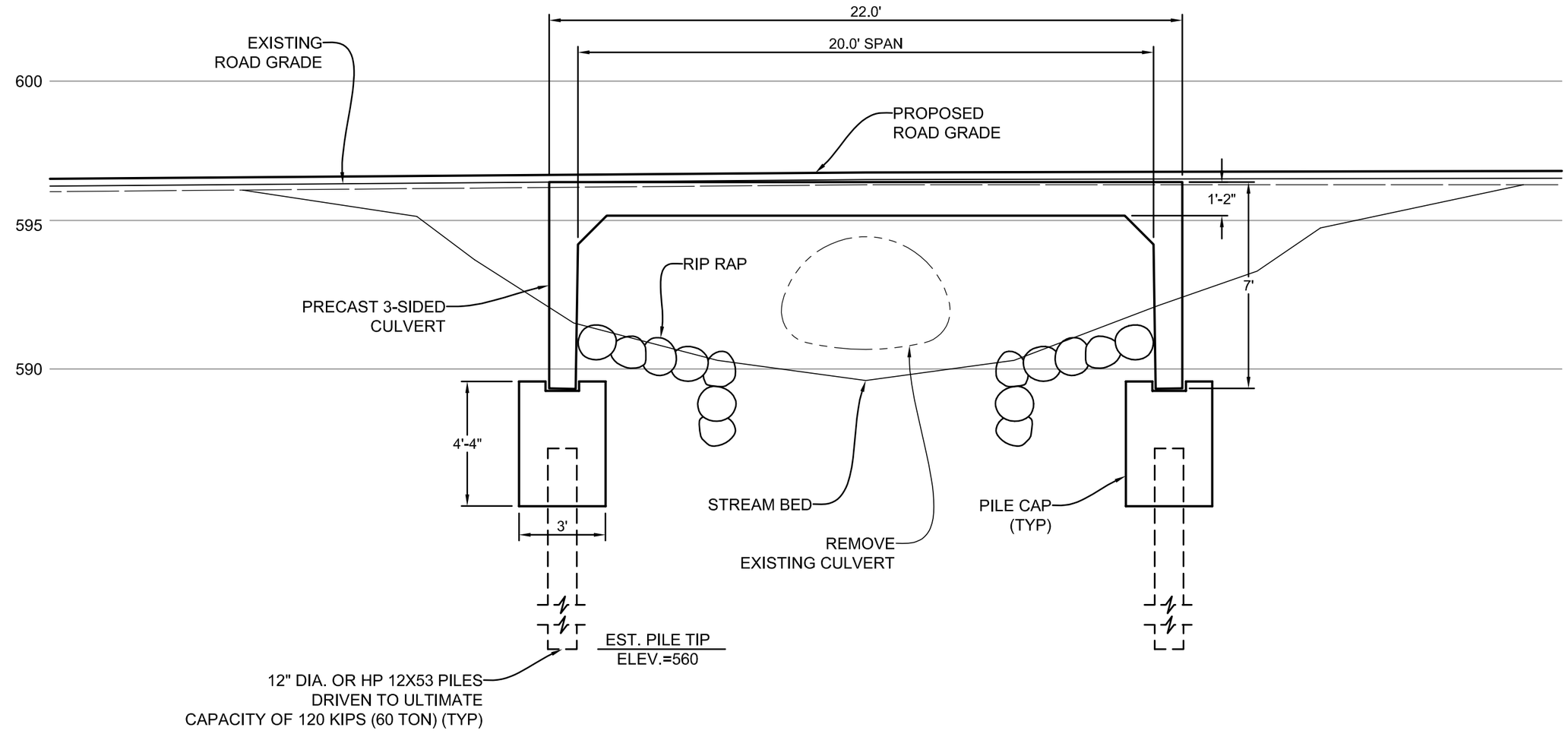
Rev.: -

PROP. CULVERT PLAN
COUNTY ROAD 669
CULVERT REPLACEMENT

Location:
SECTION 10, T29N, R13W
CLEVELAND TOWNSHIP
LEELANAU COUNTY, MICHIGAN



COUNTY RD. 669 CULVERT SECTION

SCALE: 1" = 4'

SCALE 1" = 4'

0' 4' 8'

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PROP. CULVERT SECTION
COUNTY ROAD 669
CULVERT REPLACEMENT

Location:
SECTION 10, T29N, R13W
CLEVELAND TOWNSHIP
LEELANAU COUNTY, MICHIGAN

Sheet 4 of 4