Office of Materials & Road Research
1400 Gervais Avenue
Maplewood, MN 55109-2044

Date: March 14, 2017

To: Richard Augustin
Preliminary Project Manager

From: Paul Martin, Asst. Foundations Engineer
Geotechnical Engineering Section

Paul Martin Digitally signed by Paul Martin DN: cn=Paul Martin Date: 2017.03.14 09:44:06 -05'00'

Concur: Rich Lamb, Foundations Engineer
Geotechnical Engineering Section

RAL

Subject: S.P. 8508-38, T.H. 74, Rehabilitation of Culverts 8592, 8593, 8594, 8595, 5836, 5835
Whitewater State Park
Foundation Investigation and Recommendations

Project Description

This report provides a foundation investigation and recommendations for the rehabilitation of Bridges 8592, 8593, 8594, 8595, 5836 and 5835. During a walk-through, all of the culverts appeared to be built using similar details. They are constructed of steel arches supported by mortared stone masonry foundation walls extending about 3 ½ feet above the culvert floor. The floor of the culvert is constructed of mortared rock slabs and the culvert end sections appear to be constructed of stone masonry. BR 5835 has been repaired previously, so its construction materials vary.

Bridge culverts 8592, 8593, 8594 and 8595 are located on the TH74 slope which drops into Whitewater State Park from the south. They transmit an intermittent stream diagonally back and forth under TH 74 as it flows toward the Whitewater River in the Park. Culverts 5836 and 5835 also transmit intermittent streams under TH 74 in the Park.

Existing Culvert 8592

Field Investigation and Foundation Conditions

A MnDOT drill crew conducted two Standard Penetration Test (SPT) borings (T01 and T02) to depths of 20.6 and 25.1 feet in October of 2016. Copies of the logs of these borings and a boring location drawing are attached for your use.

The borings were conducted off the edge of the pavement, near the culvert. The borings encountered boulders and cobbles in a variable matrix of Silty Clay Loam, Silt Loam or Sandy Loam containing stone chips and pieces. The "Possible Top of Bedrock" was encountered at depths of 10 feet (elevation 962.1) and 18 feet (elevation 957.1) in the two borings. It was not possible to confidently identify the top of bedrock because of the scattered cobbles and boulders and the broken and weathered condition of the upper part of the bedrock. The drilling became smoother at those depths, possibly indicating rock that was more solid below those depths.

Foundation Analysis

Based on the soil boring data, the soils and rock below the elevation of the bottom of the existing culvert are generally capable of bearing the weight of a proposed new, widened embankment and rehabilitated culvert with less than 1 inch of settlement.

Excavations for the rehabilitation work are likely to encounter gravel, cobbles and boulder-sized slabs of the sandstone, siltstone and dolostone native to the area. Dolostone bedrock may also be encountered. The unweathered dolostone in this area typically has an average compressive strength of about 10,000 psi and a peak strength of 35,000psi. It is likely the bedrock surface will be rough and irregular.

Existing Culvert 8593

Field Investigation and Foundation Conditions

A MnDOT drill crew conducted two Standard Penetration Test (SPT) borings (T03 and T04) to depths of 23.6 and 23.1 feet in November of 2016. Copies of the logs of these borings and a boring location drawing are attached for your use.

Boring T03 was conducted off the edge of the pavement and Boring T04 was drilled through the pavement, near the existing culvert. The borings encountered boulders and cobbles in a variable matrix of Loamy Sand and Gravel, Silt Loam or Sandy Loam containing stone chips and pieces. The "Possible Top of Bedrock" was encountered at depths of 18.5 feet (elevation 950.6) and 18 feet (elevation 943) in the two borings. It was not possible to confidently identify the top of bedrock because of the scattered cobbles and boulders and the broken and weathered condition of the upper part of the bedrock. The drilling generally became smoother at depth, possibly indicating fewer cracks in the rock.

Foundation Analysis

Based on the soil boring data, the soils and rock below the elevation of the bottom of the existing culvert are generally capable of bearing the weight of the new, widened embankment and rehabilitated culvert with less than 1 inch of settlement.

Excavations for the rehabilitation work are likely to encounter gravel, cobbles and boulder-sized slabs of the sandstone, siltstone and dolostone native to the area. Dolostone bedrock may also be encountered. The unweathered dolostone in this area typically has an average compressive strength of about 10,000 psi and a peak strength of 35,000 psi. It is likely the bedrock surface will be rough and irregular.

Existing Culvert 8594

Field Investigation and Foundation Conditions

A MnDOT drill crew conducted two Standard Penetration Test (SPT) borings (T05 and T06) to depths of 23.6 and 28.8 feet in November of 2016. Copies of the logs of these borings and a boring location drawing are attached for your use.

The borings were drilled through the pavement, near the existing culvert. The borings generally encountered boulders and cobbles in a variable matrix of Loamy Sand and Gravel, Silt Loam, Sandy Loam or Sand generally containing stone chips and pieces. The "Possible Top of Bedrock" was encountered at depths of 23.5 feet (elevation 929.3) and 28.5 feet (elevation 920.6) in the two borings. It was not possible to confidently identify the top of bedrock because of the scattered cobbles and boulders and the broken and weathered condition of the upper part of the bedrock. The drilling generally became smoother at depth, possibly indicating fewer cracks in the rock.

Foundation Analysis

Based on the soil boring data, the soils and rock below the elevation of the bottom of the existing culvert are generally capable of bearing the weight of the new, widened embankment and rehabilitated culvert with less than 1 inch of settlement.

Excavations for the rehabilitation work are likely to encounter gravel, cobbles and boulder-sized slabs of the sandstone, siltstone and dolostone native to the area. Dolostone bedrock may also be encountered. The unweathered dolostone in this area typically has an average compressive strength of about 10,000 psi and a peak strength of 35,000 psi. It is likely the bedrock surface will be rough and irregular.

Existing Culvert 8595

Field Investigation and Foundation Conditions

A MnDOT drill crew conducted two Standard Penetration Test (SPT) borings (T07 and T08) to depths of 33.9 and 33.6 feet in November of 2016. Copies of the logs of these borings and a boring location drawing are attached for your use.

The borings were drilled through the pavement, near the existing culvert. The borings generally encountered boulders and cobbles in a variable matrix of Sandy Loam, Loamy Sand Sand and Gravel, Silt Loam, Sandy Loam or Loamy Sand and Gravel generally containing stone chips and pieces. The "Possible Top of Bedrock" was encountered at depths of 32 feet (elevation 993.2) and 33.5 feet (elevation 889.5) in the two borings. It was not possible to confidently identify the top of bedrock because of the scattered cobbles and boulders and the broken and weathered condition of the upper part of the bedrock. The drilling generally became smoother at depth, possibly indicating fewer cracks in the rock.

Foundation Analysis

Based on the soil boring data, the soils and rock below the elevation of the bottom of the existing culvert are generally capable of bearing the weight of the new, widened embankment and rehabilitated culvert with less than 1 inch of settlement.

Excavations for the rehabilitation work are likely to encounter gravel, cobbles and boulder-sized slabs of the sandstone, siltstone and dolostone native to the area. Dolostone bedrock may also be encountered. The unweathered dolostone in this area typically has an average compressive strength of about 10,000 psi and a peak strength of 35,000 psi. It is likely the bedrock surface will be rough and irregular.

Existing Culvert 5836

Field Investigation and Foundation Conditions

A MnDOT drill crew conducted two Standard Penetration Test (SPT) borings (T09 and T10) to a depth of 30.5 feet in November of 2016. Copies of the logs of these borings and a boring location drawing are attached for your use.

The borings were drilled off the edges of the pavement, near the existing culvert. Below some grading material (T10) the borings generally encountered plastic Silt Loam, Silty Clay Loam, Loamy Sand, Sand and Gravel and Sand. The silty soils were generally firm to stiff and the sands were very loose to dense.

Foundation Analysis

Based on the soil boring data, the soils below the elevation of the bottom of the existing culvert are generally capable of bearing the weight of the new, widened embankment and rehabilitated culvert with less than 1 inch of settlement.

Since this area has been graded, excavations for the rehabilitation work could encounter some cobbles or boulders.

Existing Culvert 5835

Field Investigation and Foundation Conditions

A MnDOT drill crew conducted two Standard Penetration Test (SPT) borings (T11 and T12) to a depth of 35 feet in November of 2016. Copies of the logs of these borings and a boring location drawing are attached for your use.

The borings were drilled through the pavement, near the existing culvert. The borings generally encountered layers of Loamy Sand and Gravel, Silt Loam, Sandy Loam, Loamy Sand, Cobbles and Boulders with Loamy Sand and Silt Loam, and Sand. The silty soils were generally firm to stiff and the sands were medium dense to dense.

Foundation Analysis

Based on the soil boring data, the soils below the elevation of the bottom of the existing culvert are generally capable of bearing the weight of the new, widened embankment and rehabilitated culvert with less than 1 inch of settlement.

Recommendations

Based on the above discussions, we recommend:

1. Topsoil and other organic materials be removed from areas where fill is to be placed and the resulting subgrade shaped and surface-compacted.

2. Culverts be bedded on Coarse Aggregate Bedding, MnDOT Spec. 3149.2.G.2.

3. Culverts be backfilled with Select Granular material, using 1:20 Slope Tapers (Treatment # 2, Figure 360.3, MnDOT Pavement Design Manual).

4. If any the culverts are relocated, lengthened or realigned significantly, we recommend we be provided drawings and information so that slope stability can be re-evaluated.

If you have any questions regarding these recommendations, or require further assistance, please contact this office.
Attachments:

Overall Layout Drawing

BR 8592 Layout

Boring Logs T01 and T02, Unique Numbers 81406, 81407

BR 8593 Layout

Boring Logs T03 and T04, Unique Numbers 81419, 81420

BR 8594 Layout

Boring Logs T05 and T06, Unique Numbers 81421, 81422

BR 8595 Layout

Boring Logs T07 and T08, Unique Numbers 81423, 81424

BR 5836 Layout

Boring Logs T09 and T10, Unique Numbers 81425, 81426

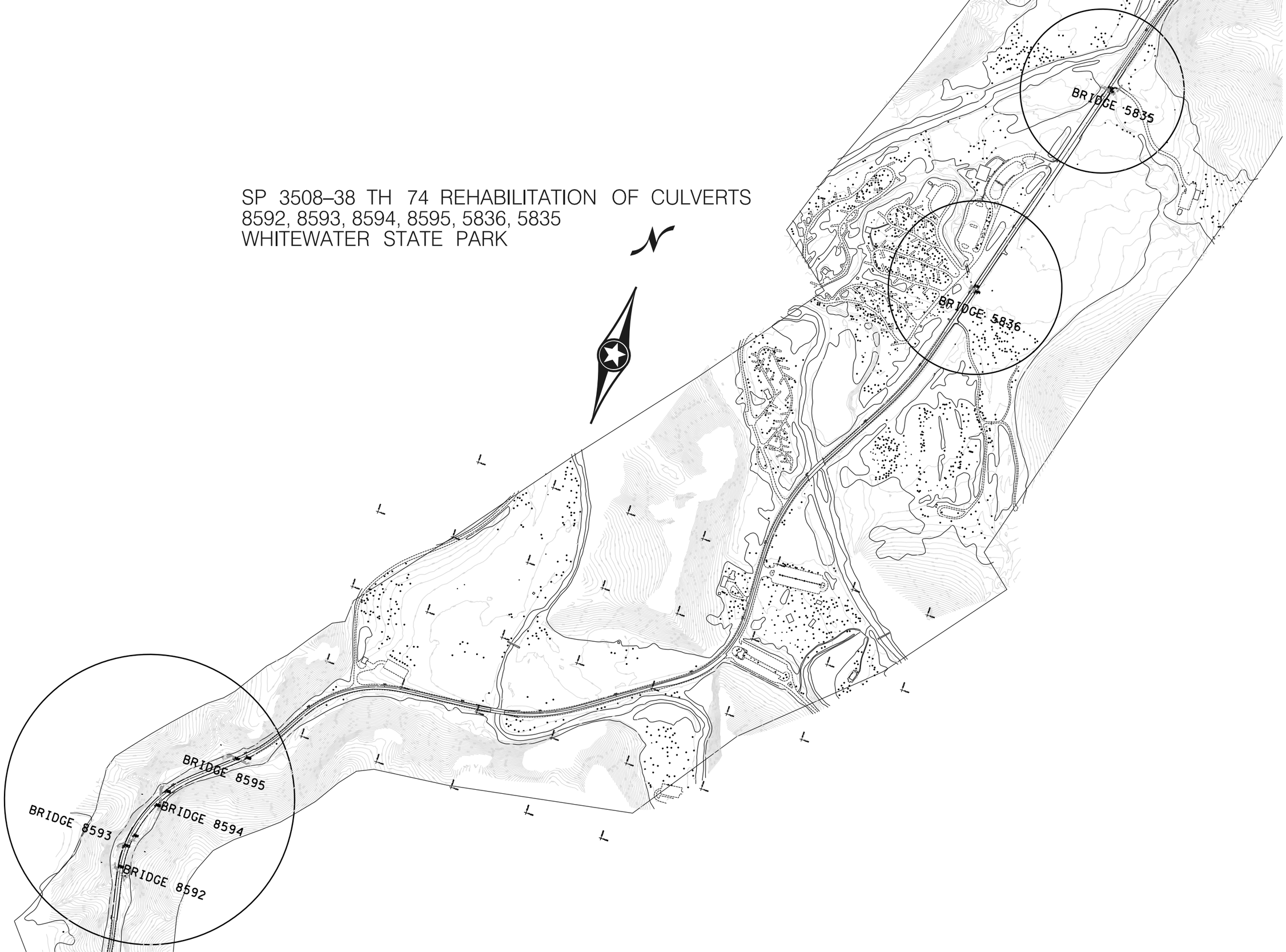
BR 5835 Layout

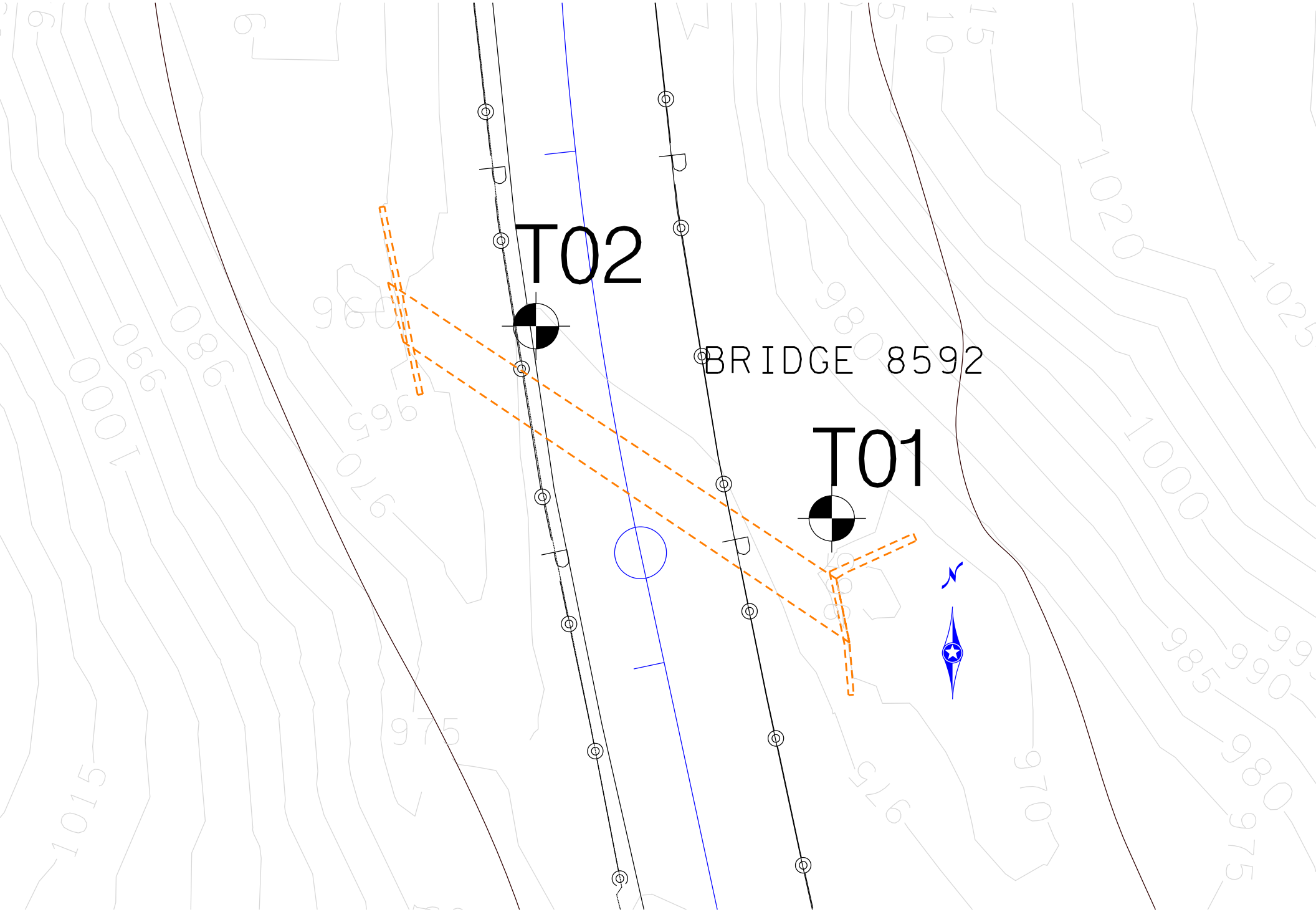
Boring Logs T11 and T12, Unique Numbers 81427, 81428

SPT Index Sheet

CC: Brad Skow, Chief Geotechnical Engineer
Karl Gronvall, South Region Bridge Construction Engineer
Angel Staples, Bridge Design Engineer

SP 3508–38 TH 74 REHABILITATION OF CULVERTS
8592, 8593, 8594, 8595, 5836, 5835
WHITEWATER STATE PARK




T02
BRIDGE 8592
T01
N

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81406

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 8592**	**MN Trunk Highway TH 74**	**T01**	**972.1** (DTM)

Location: Winona Coord:X=383729 Y=172805 (ft.)

Latitude (North)=44°02'45.87" Longitude (West)=92°03'31.84"

TH 74 363+20 37 ft. RT

Drill Machine: **205120 CME(LC55) Track**

Hammer: **CME Automatic Calibrated**

SHEET 1 of 1

Drilling Completed: **10/25/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			Silty Clay Loam with roots 2.0'-3.0', Cobbles and stone chips and pieces 3.5'-5.5', brown, moist		21	20				rough augering 4'
5					26	16				
	6.5 / 965.6		Cobbles with Loamy Sand and Gravel, mixed with dark-brown plastic Silt Loam seams weatherd Bedrock chips and pieces at 8.0' Possible Top of Bedrock		24	10				
10	10.0 / 962.1				3 / 50/.4	10				
					50/.2	3				PRAIRIE DU CHIEN GROUP-ONEOTA DOLOSTONE hard smooth augering 11' rougher augering 12'- 14.5'
					50/.1	9				
15			DOLOSTONE to SANDY DOLOSTONE; generally fresh with slight weathering; crystalline to sandy texture; tan to gray.	PD	50/.1	NSR				hard smooth rotary drilling 14.5'-20.6'
				WS	50/.1	NSR				
				WS						
20	20.6 / 951.5				50/.1	NSR				

Bottom of Hole -20.6

No water encountered or measured during drilling

Index Sheet Code 3.0

Soil Class:JAH Rock Class: JNH Edit: Date: 1/10/17

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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81407

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 8592**	**MN Trunk Highway TH 74**	**T02**	**975.1** (DTM)

Location: Winona Coord:X=383672 Y=172842 (ft.)

Latitude (North)=44°02'46.24" Longitude (West)=92°03'32.62"

TH 74 363+68 12 ft. LT

Drill Machine: **205120 CME(LC55) Track**

Hammer: **CME Automatic Calibrated**

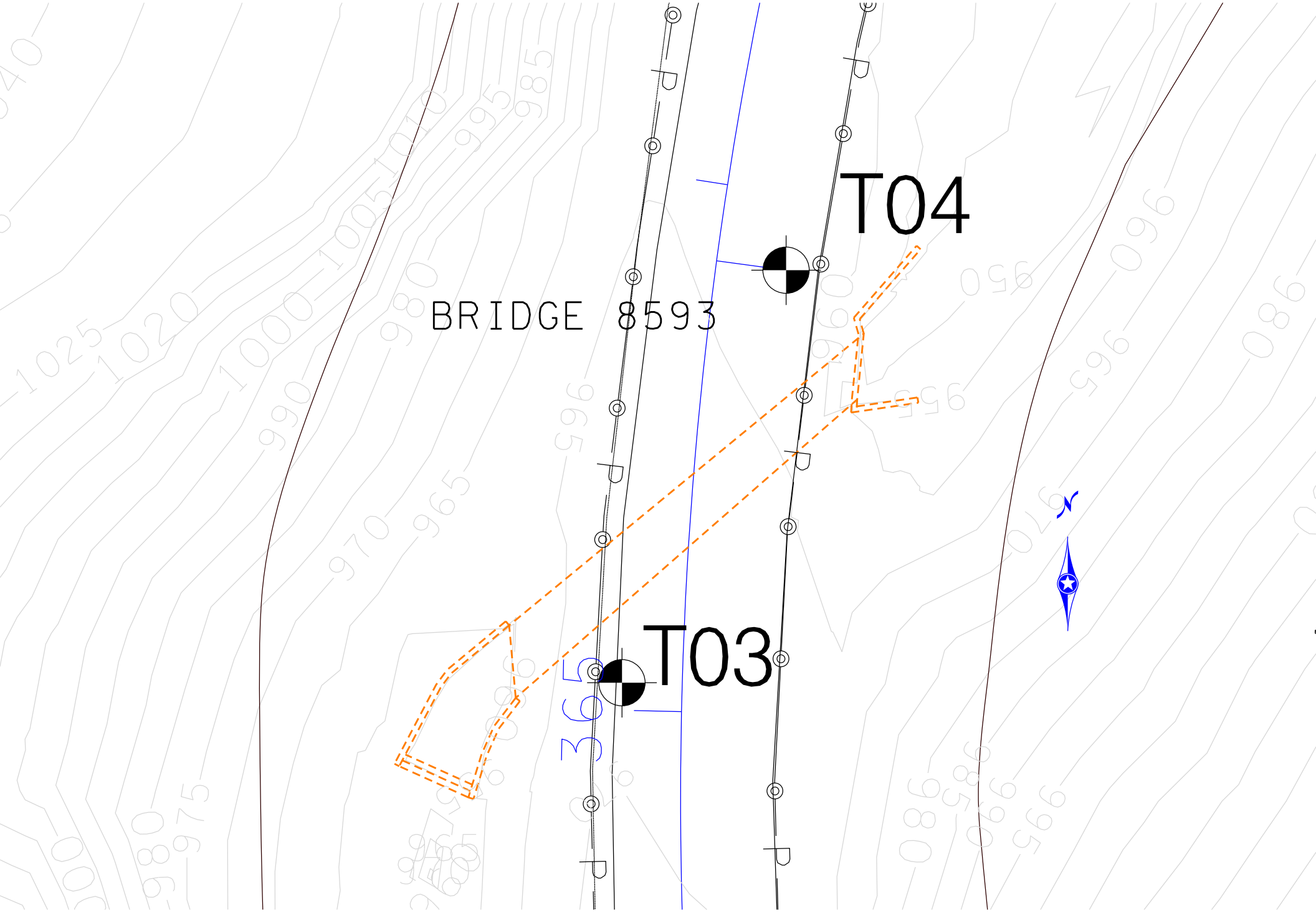
SHEET 1 of 1

Drilling Completed: **10/26/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
5			Boulders and Cobbles with slightly plastic Sandy Loam and plastic Silt Loam; weathered Bedrock chips and stone pieces; browns, moist		29	14				rock in shoe
					8	14				
					24	N/A				
10					6	16				
	12.5 / 962.6									
			Boulders and Cobbles with Loamy Sand and Gravel; Rock chips and pieces, browns, moist		18	8				
15					23	9				
			Possible Top of Bedrock							
	18.0 / 957.1				28 / 50/.2	11				
20			DOLOSTONE; generally fresh with slight weathering; crystalline with some sandy/silty texture; some calcite crystals; tan to gray.		50/.2					PRAIRIE DU CHIEN GROUP-ONEOTA DOLOSTONE rough augering 18.0'-25.0'
					50/.2					
25	25.1 / 950.0				50/.1	NSR				

Bottom of Hole -25.1'

No water encountered or measured during drilling


T04
BRIDGE 8593
T03
N

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81419

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 8593**	**MN Trunk Highway TH 74**	**T03**	**969.1** (DTM)

Location: Winona Coord:X=383664 Y=172981 (ft.)

Latitude (North)=44°02'47.61" Longitude (West)=92°03'32.75"

TH 74 365+05 11 ft. LT

Drill Machine: **205120 CME(LC55) Track**

Hammer: **CME Automatic Calibrated**

SHEET 1 of 1

Drilling Completed: **11/2/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			Loamy Sand and Gravel with Cobbles, browns, damp		22	4				
5					11	6				
	7.0 / 962.1									
			slightly plastic Sandy Loam with Gravel and a few Cobbles; and a dark-brown plastic Silt Loam seam at 8.5', dark-brown to brown, moist		12	19				
10					12	16				
					18	12				
15					35	4				
			Possible Top of Bedrock		50/.2	N/A				hard smooth augering at 17.3' rough drilling at 17.8' hard smooth drilling 18.5'- 23.1'
	18.5 / 950.6									
20			DOLOSTONE; crystalline; abundant calcite fragments in wash sample; tan to white.	PD	50/.1	NSR				PRAIRIE DU CHIEN GROUP-ONEOTA DOLOSTONE
				WS		N/A				
	23.6 / 945.5				50/.1	NSR				

Bottom of Hole -23.6'

No water encountered or measured during drilling

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81420

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 8593**	**MN Trunk Highway TH 74**	**T04**	**963.5** (DTM)

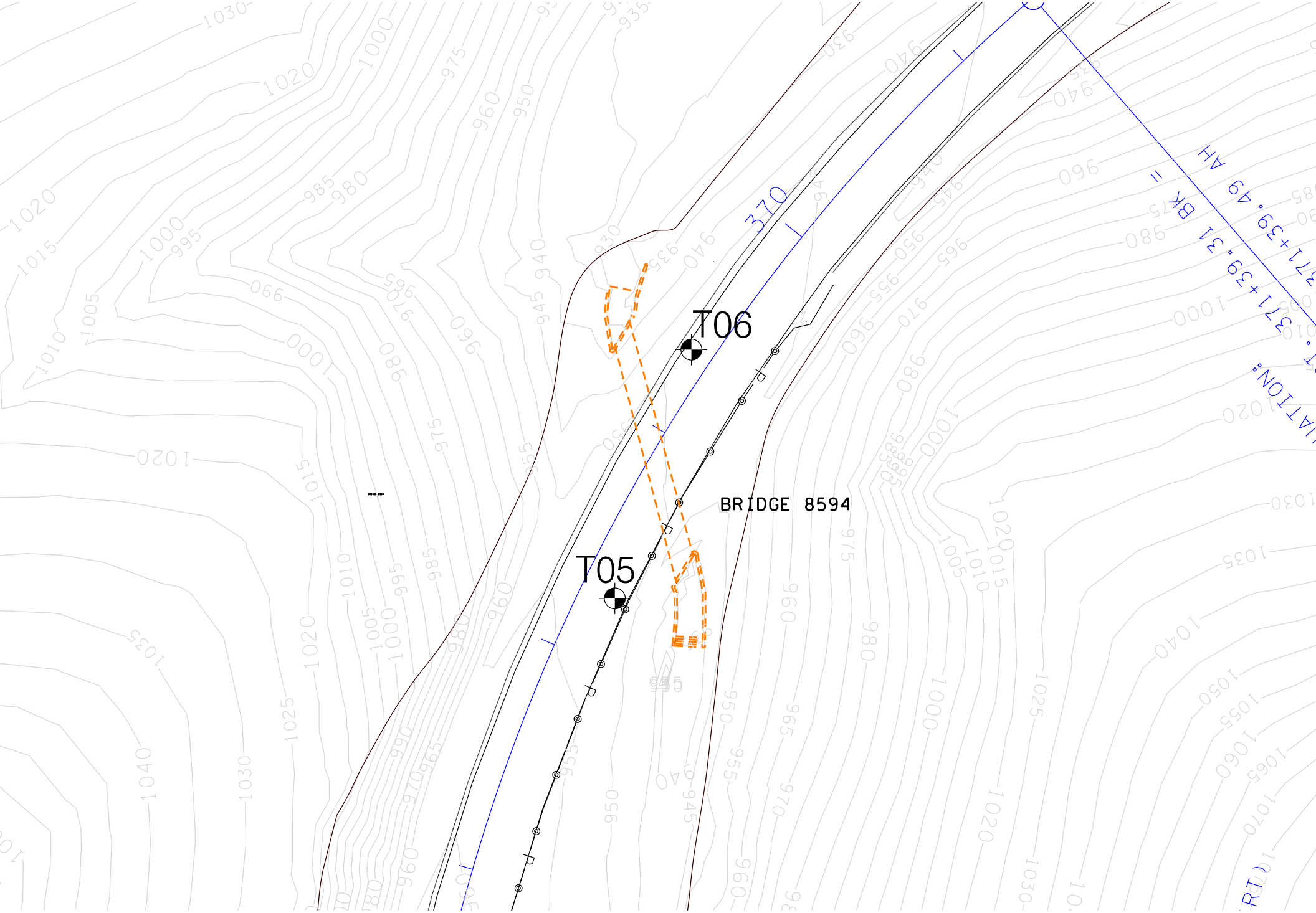
Location: Winona Coord:X=383695 Y=173059 (ft.)
Latitude (North)=44°02'48.38" Longitude (West)=92°03'32.32"
TH 74 365+86 13 ft. RT

Drill Machine: **205120 CME(LC55) Track**
Hammer: **CME Automatic Calibrated**

SHEET 1 of 1
Drilling Completed: **11/3/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.8 / 962.7		Asphalt, black							
			Cobbles with Loamy Sand and Gravel mixed with Sandy Loam, gray-brown, damp		39	7				
5					63	2				Cobbles
					12	5				
	9.0 / 954.5		slightly plastic Silt Loam, dark-brown, moist		17 14 50/.1	17				
10	10.5 / 953.0		Boulder, light gray-brown	PD						Boulder
	12.0 / 951.5		slightly organic slightly plastic Silt Loam, dark-brown, wet		4	35				
15	15.5 / 948.0			PD	50/.1	NSR				
			Boulders and Cobbles, tan-gray, damp	WS	50/.1	N/A NSR				
20	20.5 / 943.0		Possible Top of Bedrock	PD	50/.2	N/A				
	23.1 / 940.4		DOLOSTONE; crystalline; brown to gray	PD	50/1	NSR				PRAIRIE DU CHIEN GROUP-ONEOTA DOLOSTONE

Bottom of Hole -23.1'
No water encountered or measured during drilling


T06
T05
BRIDGE 8594
370
371+39.31 BK =
371+39.49 AH

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81421

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 8594**	**MN Trunk Highway TH 74**	**T05**	**952.8** (DTM)

Location: Winona Coord:X=383765 Y=173286 (ft.)

Latitude (North)=44°02'50.63" Longitude (West)=92°03'31.39"

TH 74 368+28 15 ft. RT

Drill Machine: **205120 CME(LC55) Track**

Hammer: **CME Automatic Calibrated**

SHEET 1 of 1

Drilling Completed: **11/8/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.7 / 952.1		Asphalt, black							
	3.0 / 949.8		Loamy Sand and Gravel, browns, damp			4				
5			Cobbles and Boulders with Loamy Sand and Gravel, browns, damp		26	N/A				
					21	6				
	9.0 / 943.8		plastic Silt Loam, dark-brown, moist							
10	10.0 / 942.8		Cobbles and Boulders with slightly plastic Sandy Loam layers at 13.0', 15.8' and 19.5', browns, moist		2 12 50/.2	16				rock in shoe of splitspoon
					66	13 2				
15					35	13				
					24 45 50.4	15				
				PD						
					4 14 50/.2					bottom of culvert measured at 18.0'
20	20.5 / 932.3			PD						
					50/.3					
			Fine Sand with stone chips and pieces, light-brown, wet	PD						
	23.5 / 929.3		Possible Top of Bedrock		50/.1					
			DOLOSTONE; crystalline; tan							PRAIRIE DU CHIEN GROUP-ONEOTA DOLOSTONE

23.6 / 929.2 Bottom of Hole -23.6'

No water encountered or measured during drilling

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81422

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 8594**	**MN Trunk Highway TH 74**	**T06**	**949.1** (DTM)

Location: Winona Coord:X=383797 Y=173390 (ft.)

Latitude (North)=44°02'51.65" Longitude (West)=92°03'30.95"

TH 74 369+35 9 ft. LT

Drill Machine: **207184 CME 850 Track**

Hammer: **CME Automatic Calibrated**

SHEET 1 of 1

Drilling Completed: **11/7/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.9 / 948.2		Asphalt							
			Loamy Sand and Gravel with Cobbles, browns, damp		9	4				
5	5.5 / 943.6				50/.1	6				rotary drill on boulder 5.5'-7.5'
	7.5 / 941.6		Boulder, light-brown, dry	PD						lost mud return switch back to augers
			Boulders and Cobbles, gray-brown, damp		18	7				
10	10.5 / 938.6				7	27				
15			plastic Silt Loam with Cobbles and Gravel mixed, dark-browns with light-browns, moist		31	26				
					2	27				
20	19.0 / 930.1				26	17				
			Boulders and Cobbles with Loamy Sand and Gravel, browns, moist to wet		25	25				
25					70	10				
					52	N/A				
	28.5 / 920.6		Possible Top of Bedrock							
			SANDY DOLOSTONE; fine grained to crystalline; tan to brown		50/.3	N/A				PRAIRIE DU CHIEN GROUP-ONEOTA DOLOSTONE
	28.8 / 920.3		Bottom of Hole -28.8' No water encountered or measured during drilling							

Index Sheet Code 3.0

Soil Class:JAH Rock Class: JNH Edit: Date: 3/14/17

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TH74 PC. 374+51.54
375
T08
BRIDGE 8595
T07

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81423

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 8595**	**MN Trunk Highway TH 74**	**T07**	**925.2** (DTM)

Location: Winona Coord:X=384144 Y=173725 (ft.)

Latitude (North)=44°02'54.98" Longitude (West)=92°03'26.23"

TH 74 374+17 9 ft. LT

Drill Machine: **207184 CME 850 Track**

Hammer: **CME Automatic Calibrated**

SHEET 1 of 1

Drilling Completed: **11/1/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.7 / 924.5		Asphalt							
			plastic Sandy Loam, brown, moist			18				
	3.5 / 921.7				28	5				
5			Cobbles and Boulders mixed with Sand and Gravel, light-brown, damp		10	4				hard rough drilling 4.5'-9.0'
	9.0 / 916.2				10	19				
10			plastic Silt Loam with Cobbles, stone chips and pieces, dark-brown, moist		8	24				rough drilling 9.5'- 10.5'
15					3	22				
	15.5 / 909.7		Boulders and Cobbles, light-brown, damp		16	3				
	18.0 / 907.2		plastic Silt Loam with Cobbles, stone chips and pieces, dark-brown, moist		17	18				
20	20.5 / 904.7				33	16				
					21	9				
25			Cobbles and Boulders with Loamy Sand and Gravel, browns, damp to wet		51	9				
					77	6				
30			Possible Top of Bedrock		16 35 50/.4	4				
	32.0 / 893.2		DOLOSTONE; crystalline; tan-gray							
	33.0 / 892.2		DOLOMITIC SANDSTONE; very fine grained friable sandstone; tan		50/.4	15				PRAIRIE DU CHIEN GROUP-ONEOTA DOLOSTONE
	33.9 / 891.3		Bottom of Hole -33.9' Water measured at 32.7' with auger							

Index Sheet Code 3.0

Soil Class:JAH Rock Class: JNH Edit: Date: 3/14/17

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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81424

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 8595**	**MN Trunk Highway TH 74**	**T08**	**923.0** (DTM)

Location: Winona Coord:X=384210 Y=173754 (ft.)

Latitude (North)=44°02'55.27" Longitude (West)=92°03'25.33"

TH 74 374+85 13 ft. RT

Drill Machine: **207184 CME 850 Track**

Hammer: **CME Automatic Calibrated**

SHEET 1 of 1

Drilling Completed: **11/2/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.9 / 922.1		Asphalt							
	3.0 / 920.0		Loamy Sand and Gravel, dark-brown, damp			5				
5			Cobbles and Boulders with dark-brown slightly plastic Sandy Loam, browns, damp to moist to damp		18	4				
					24	11				
10					55	5				
					62	7				
	13.0 / 910.0		slightly organic slightly plastic Silt Loam, dark-brown to black, moist		21	30				
15	15.5 / 907.5		Cobbles and Boulders with slightly plastic Sandy Loam, browns, damp to moist		38	3				
	19.5 / 903.5		slightly plastic Silt Loam, brown, moist		31	17				
20					7	25				
	23.0 / 900.0		Cobbles and Boulders with Loamy Sand and Gravel, browns, damp		50/.3	3				
25					13	8				
					49	8				
30					24 33 50/.4	10				
▼	33.5 / 889.5		Possible Top of Bedrock		50/.1	8				
			DOLOSTONE; crystalline; tan to gray							PRAIRIE DU CHIEN GROUP-ONEOTA DOLOSTONE

33.6 / 889.4 Bottom of Hole -33.6'

Water measured at 33.5' with auger

Index Sheet Code 3.0

Soil Class:JAH Rock Class: JNH Edit: Date: 3/14/17

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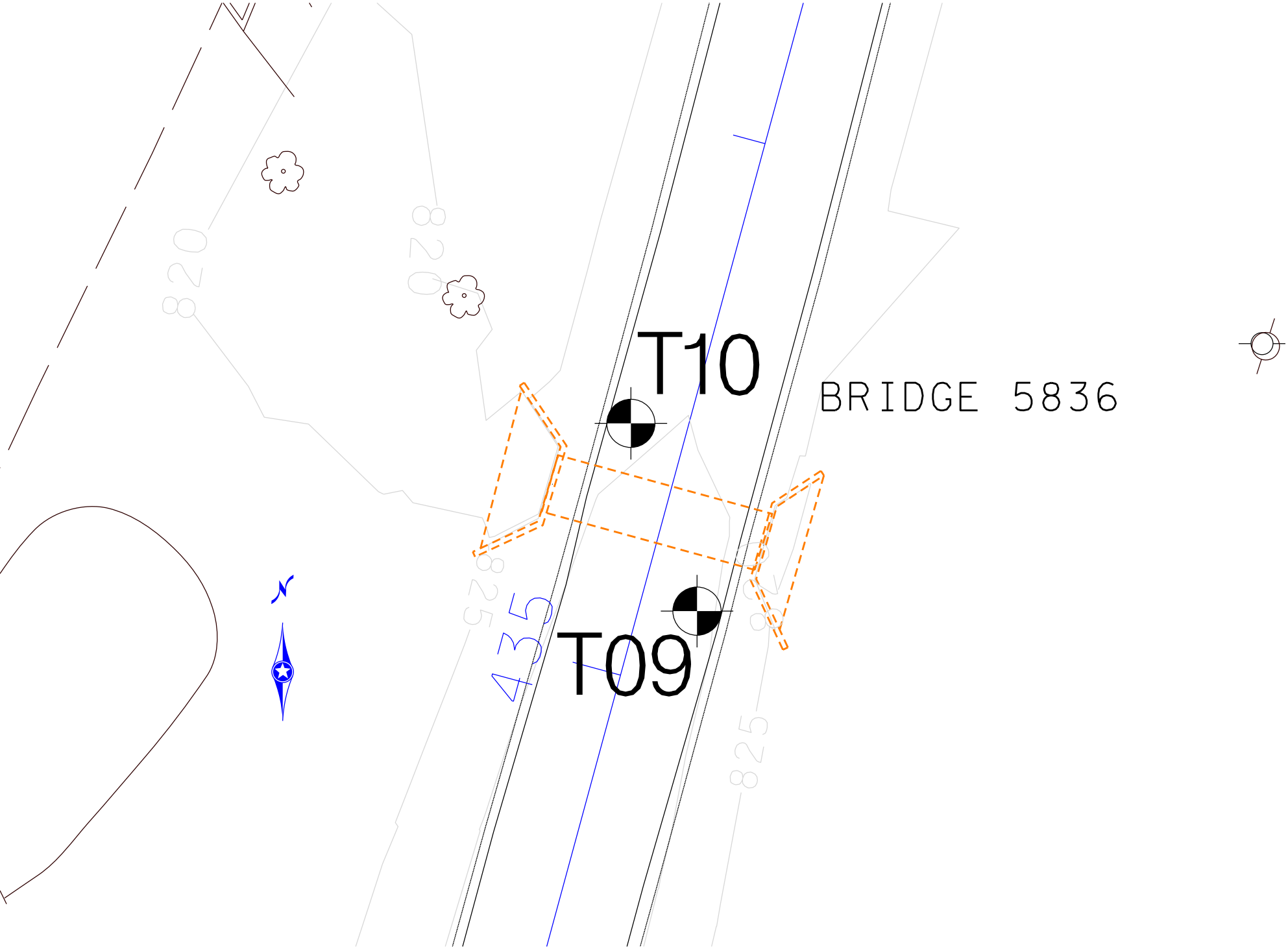
T10
BRIDGE 5836
T09
435
820
820
825
825
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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81425

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	CULVERT # 5836	MN Trunk Highway TH 74	T09	830.2 (DTM)

Location: Winona Coord:X=387624 Y=178026 (ft.)
Latitude (North)=44°03'37.63" Longitude (West)=92°02'38.89"
TH 74 435+15 10 ft. RT

Drill Machine: 207184 CME 850 Track
Hammer: CME Automatic Calibrated

SHEET 1 of 1
Drilling Completed: 11/8/16

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
						20				
5			plastic Silt Loam sightly organic at 7.5' with a thin seam of Loamy Sand at 5.0', dark-brown to brown, moist		6	21				
					6	27				
10					8	26				
					6	27				
	13.5 / 816.7									
15			Silty Clay Loam, brown with IOS, moist		6	26				
	16.0 / 814.2									
			slightly plastic Silt Loam, brown with a little IOS, moist		5	27				
	19.0 / 811.2									
20			Loamy Sand with varved thin seams of Silt Loam and IOS pockets, browns, very moist		3	17				
	21.0 / 809.2									
			Sand and Gravel, brown, damp		47	4				
	24.0 / 806.2									
25					36	5				
			Medium-Grained Sand with a little IOS at 30.0', brown, damp to wet		26	4				
30	30.5 / 799.7				31	12				

Bottom of Hole -30.5'
No water encountered or measured during drilling

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81426

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 5836**	**MN Trunk Highway TH 74**	**T10**	**829.9** (DTM)

Location: Winona Coord:X=387612 Y=178060 (ft.)

Latitude (North)=44°03'37.97" Longitude (West)=92°02'39.05"

TH 74 435+45 10 ft. LT

Drill Machine: **207184 CME 850 Track**

Hammer: **CME Automatic Calibrated**

SHEET 1 of 1

Drilling Completed: **11/10/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			Loamy Sand and Gravel, browns, damp			4				
	3.0 / 826.9									
5					5	24				
					5	24				
10			plastic Silt Loam, with IOS 14.0'-18.0', dark-brown to brown, moist to very moist		7	24				
					7	25				
15					11	21				
					6	26				
	18.5 / 811.4									
20			Loamy Sand with a little Gravel and IOS, browns, moist		25	4				
	21.0 / 808.9									
			Sand and Gravel, browns, damp		45	3				
	23.5 / 806.4									
25					26	2				
			Fine-Grained to Medium-Grained Sand, browns, damp to wet		25	6				
30					30	10				
	30.5 / 799.4									

Bottom of Hole -30.5'

No water encountered or measured during drilling

Index Sheet Code 3.0

Soil Class:JAH Rock Class: Edit: Date: 3/14/17

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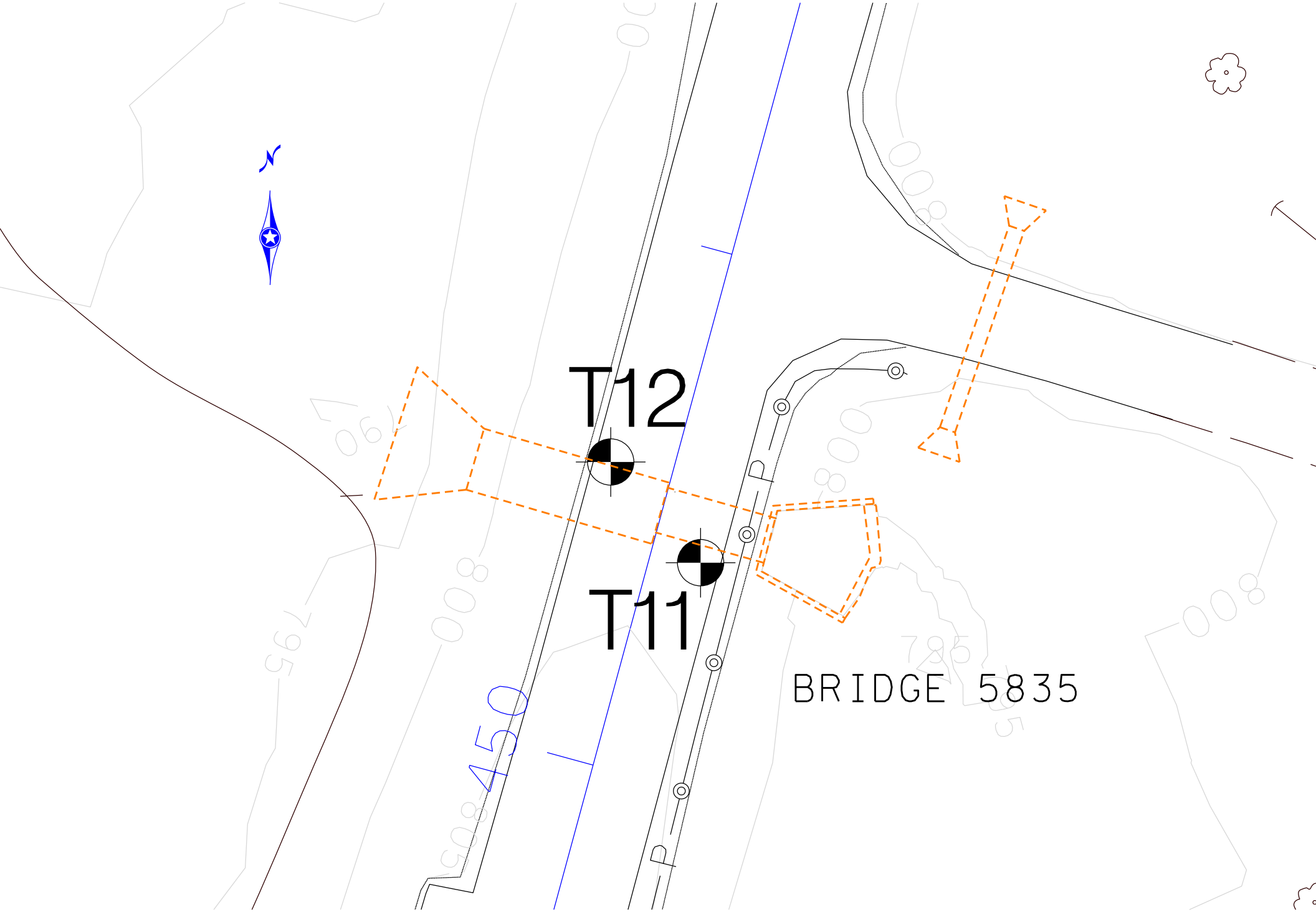
T12
T11
BRIDGE 5835
450
800
795
P

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81427

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 5835**	**MN Trunk Highway TH 74**	**T11**	**804.6** (DTM)

Location: Winona Coord:X=388024 Y=179500 (ft.)

Latitude (North)=44°03'52.21" Longitude (West)=92°02'33.51"

TH 74 450+42 10 ft. RT

Drill Machine: **205120 CME(LC55) Track**

Hammer: **CME Automatic Calibrated**

SHEET 1 of 1

Drilling Completed: **11/8/16**

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.7 / 803.9		Asphalt							
	3.5 / 801.1		Loamy Sand and Gravel, brown, moist			5				
5	6.5 / 798.1		slightly plastic Silt Loam with stone chips and pieces, dark-brown, moist		15	15				
	9.0 / 795.6		slightly plastic Sandy Loam with a few pebbles, dark-brown, moist		5	11				
10			Cobbles and Boulders with Loamy Sand and Gravel and a thin seam of Sandy Loam at 10.0', light-brown, damp		41 / 50/.4	5				
					50/.2	6				
15	16.0 / 788.6				50/.2	10				
▼			Sand with a little Gravel from 26.0'-32.5', brown, saturated		31	17				
20					16	17				
					26	22				12" heave after sampling to 21.0'
				PD	26	20				
25				PD	26	17				
				PD	20	17				
30				PD	34	16				
	32.5 / 772.1		Sand with a little Fine Gravel, brown, saturated	PD	34	17				
35	35.0 / 769.6		Bottom of Hole -35.0'							

Water measured at 18.0' with auger

Index Sheet Code 3.0

Soil Class:JAH Rock Class: Edit: Date: 3/14/17

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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

UNIQUE NUMBER 81428

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
8508-38	**CULVERT # 5835**	**MN Trunk Highway TH 74**	**T12**	**804.4** (DTM)

Location: Winona Coord:X=388007 Y=179519 (ft.)

Latitude (North)=44°03'52.4" Longitude (West)=92°02'33.75"

TH 74 450+56 12 ft. LT

Drill Machine: **205120 CME(LC55) Track**

Hammer: **CME Automatic Calibrated**

SHEET 1 of 1

Drilling Completed: **11/9/16**

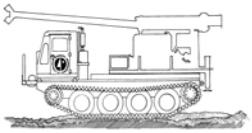
DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.7 / 803.7		Asphalt							
			Loamy Sand and Gravel with Cobbles at 6.0', browns to greenish-brown, moist			5				
5					18	6				
	6.5 / 797.9		Cobbles and Boulders with greenish slightly plastic Silt Loam and Loamy Sand; with stone chips and pieces, greenish-brown, moist		34	9				
10					22	14				hard drilling 10.9'-11.9'; 12.0'-12.5'; 14.8'-16.0'
	11.5 / 792.9		Cobbles and Boulders with brown Loamy Sand and Gravel; with stone chips and pieces, light-brown, damp to moist		50/.2	7				
15					50/.3	8				
					50/.3	11				
▼	19.0 / 785.4		Sand and Gravel, brown, saturated							
20					14	18				
					41	19				
25	25.0 / 779.4		Sand with a little Fine Gravel, brown, saturated	PD						
					25	19				
				PD						
30					23	16				
				PD						
					25	17				
	33.0 / 771.4		Sand with Fine Gravel, brown, saturated	PD						
35	35.0 / 769.4				29	15				

Bottom of Hole -35.0'

Water measured at 19.0' with auger

Minnesota Department of Transportation Geotechnical Section

Boring Log Descriptive Terminology (English Units)



USER NOTES, ABBREVIATIONS AND DEFINITIONS - Additional information available in Geotechnical Manual.

This boring was made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since this boring was not taken to gather information relating to the construction of the project, the data noted in the field and recorded may not necessarily be the same as that which a contractor would desire. While the Department believes that the information as to the conditions and materials reported is accurate, it does not warrant that the information is necessarily complete. This information has been edited or abridged and may not reveal all the information which might be useful or of interest to the contractor. Consequently, the Department will make available at its offices, the field logs relating to this boring.

Since subsurface conditions outside each borehole are unknown, and soil, rock and water conditions cannot be relied upon to be consistent or uniform, no warrant is made that conditions adjacent to this boring will necessarily be the same as or similar to those shown on this log. Furthermore, the Department will not be responsible for any interpretations, assumptions, projections or interpolations made by contractors, or other users of this log.

Water levels recorded on this log should be used with discretion since the use of drilling fluids in borings may seriously distort the true field conditions. Also, water levels in cohesive soils often take extended periods of time to reach equilibrium and thus reflect their true field level. Water levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that this boring was dry or that the contractor will not encounter subsurface water during the course of construction.

WH ..... Weight of Hammer
WR ..... Weight of Rod
Mud..... Drilling Fluids in Sample
CS ..... Continuous Sample

SOIL/CORE TESTS

SPT N_{60} ..... ASTM D1586 Modified Blows per foot with 140 lb. hammer and a standard energy of 210 ft-lbs. This energy represents 60% of the potential energy of the system and is the average energy provided by a Rope & Cathead system.
MC..... Moisture Content
COH ..... Cohesion
γ ..... Sample Density
LL..... Liquid Limit
PI..... Plasticity Index
Φ ..... Phi Angle
REC..... Percent Core Recovered
RQD ..... Rock Quality Description (Percent of total core interval consisting of unbroken pieces 4 inches or longer)
ACL..... Average Core Length (Average length of core that is greater than 4 inches long)
Core Breaks .... Number of natural core breaks per 2-foot interval.

DISCONTINUITY SPACING

Fractures	Distance	Bedding
Very Close	<2 inches	Very Thin
Close	2-12 inches	Thin
Mod. Close	12-36 inches	Medium
Wide	>36 inches	Thick

very loose	0-4
loose	5-10
medium dense	11-24
dense	25-50
very dense	>50

Consistency - Cohesive Soils	BPF
very soft	0-1
soft	2-4
firm	5-8
stiff	9-15
very stiff	16-30
hard	31-60
very hard	> 60

COLOR

blk..... Black **wht** .....White
grn ..... Green **brn**.....Brown
orng ..... Orange **yel**.....Yellow
dk..... Dark **lt** .....Light
IOS..... Iron Oxide Stained

GRAIN SIZE /PLASTICITY

VF..... Very Fine **pl** .....Plastic
F ..... Fine **slpl** .....Slightly Plastic
Cr ..... Coarse

SOIL/ROCK TERMS

C..... Clay **Lmst**.....Limestone
L..... Loam **Sst**.....Sandstone
S..... Sand **Dolo**.....Dolostone
Si..... Silt **wx**.....weathered
G ..... Gravel (No. 10 Sieve to 3 inches)
Bldr..... Boulder (over 3 inches)
T..... till (unsorted, nonstratified glacial deposits)

WATER MEASUREMENT

AB ..... After Bailing
AC ..... After Completion
AF..... After Flushing
w/C..... with Casing
w/M ..... with Mud
WSD..... While Sampling/Drilling
w/AUG..... with Hollow Stem Auger

MISCELLANEOUS

NA ..... Not Applicable
w/ ..... with
w/o ..... with out
sat ..... saturated

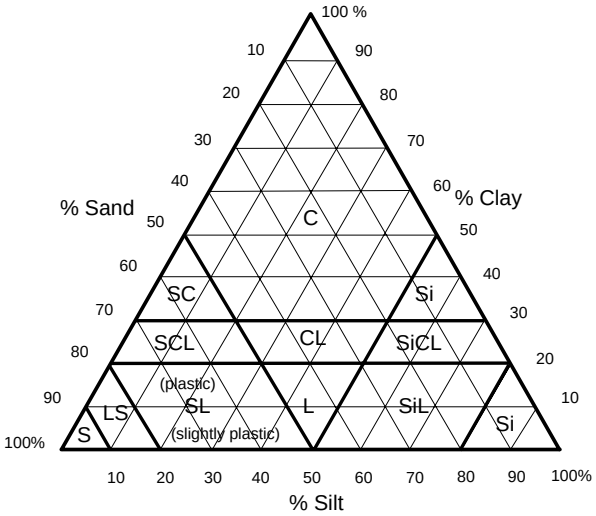
DRILLING OPERATIONS

AUG ..... Augered
CD ..... Core Drilled
DBD..... Disturbed by Drilling
DBJ ..... Disturbed by Jetting
PD ..... Plug Drilled
ST..... Split Tube (SPT test)
TW..... Thinwall (Shelby Tube)
WS..... Wash Sample
NSR..... No Sample Retrieved

DRILLING SYMBOLS

- Vane Shear Test
- WS — Washed Sample (Collected during plug drilling)
- Augered
- PD — Plug Drilled
- Split Tube Sample (SPT N_{60} 2 in. spilt tube with liners)
- Thin Wall Sample (3 in. Shelby Tube)
- Core Drilled (NV Core Barrel unless otherwise noted)
- CS — Continuous Soil Sample
- A/J — Augered & Jetted
- Jet — Jetted
- A/P — Augered & Plug Drilled

Mn/DOT Triangular Textural Soil Classification System



RELATIVE DENSITY

Compactness - Granular Soils	BPF