Geotechnical Evaluation Report

MHSRC Precision Maneuver Pad Resurfacing
US Highway 10
St. Cloud, Minnesota

Prepared for

St. Cloud State University

Professional Certification:
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

Andrew J. Hillerud, PE
Project Engineer
License Number: 59434
November 22, 2021

Project B2109834
Braun Intertec Corporation
Mr. Larry Blaiser  
St. Cloud State University  
205 Administration Services Building  
720 4th Avenue South  
St. Cloud, MN 56301

Re: Geotechnical Evaluation  
MHSRC Precision Maneuver Pad Resurfacing  
US Highway 10  
St. Cloud, Minnesota

Dear Mr. Blaiser:

We are pleased to present this Geotechnical Evaluation Report for the pavement resurfacing project at the Minnesota Highway Safety and Research Center (MHSRC) in St. Cloud, Minnesota.

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please contact Steve Thayer at 320.980.3187 (sthayer@braunintertec.com) or Andrew Hillerud at 218.260.0930 (ahillerud@braunintertec.com).

Sincerely,

BRAUN INTERTEC CORPORATION

Andrew J. Hillerud, PE  
Project Engineer

Steven A. Thayer, PE  
Senior Engineer
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Appendix

Soil Boring Location Sketch
Log of Boring Sheets ST-1 through ST-6
Descriptive Terminology of Soil
A. Introduction

A.1. Project Description

This Geotechnical Evaluation Report addresses the proposed resurfacing of the existing bituminous pavement on the Precision Maneuver Pad, located at Minnesota Highway Safety and Research Center (MHSRC) in St. Cloud, Minnesota. The project will likely consist of one of three construction options – 1) partial depth mill and overlay, 2) full depth reclamtion and paving, or 3) complete removal and reconstruction. We assumed the area and grades will remain relatively near existing.

A.2. Site Conditions and History

Currently, the Precision Maneuver Pad is bituminous surfaced and is located in the north-central area of the MHSRC. The photograph below shows the existing site layout and approximate boring and bituminous core locations. This project area is outlined in red below.

Figure 1. Aerial Photograph of the Site and Approximate Boring and Bituminous Core Locations

Figure obtained from Google Earth®
A.3. Purpose

The purpose of our geotechnical evaluation is to characterize subsurface geologic conditions at selected boring locations, evaluate their impact on the project, and provide geotechnical recommendations for the design and construction of the pavement.

A.4. Background Information and Reference Documents

We reviewed the following information:

- A proposal request and communications with Mr. Larry Blaiser, St. Cloud State University.
- Aerial photographs of the project areas using Google Earth®.

We have described our understanding of the proposed construction and site to the extent others reported it to us. Depending on the extent of available information, we may have made assumptions based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, the project team should notify us. New or changed information could require additional evaluation, analyses and/or recommendations.

A.5. Scope of Services

We performed our scope of services for the project in accordance with our Proposal QTB145979 to Mr. Blaiser, dated September 15, 2021, and authorized on October 6, 2021 with Purchase Order U03893. The following list describes the geotechnical tasks completed in accordance with our authorized scope of services.

- Reviewing the background information and reference documents previously cited.

- Staking and clearing the boring and core locations of underground utilities. Braun Intertec selected and staked the boring and core locations. We acquired the surface elevations and locations with GPS technology using the State of Minnesota’s permanent GPS base station network. The Soil Boring Location Sketch included in the Appendix shows the approximate locations of the borings and bituminous cores.
Performing 6 standard penetration test (SPT) borings, denoted as ST-1 to ST-6, to nominal depths of 5 feet below grade.

Obtaining 6 bituminous core samples at the soil boring locations.

Performing laboratory testing on select samples to aid in soil classification and engineering analysis.

Preparing this report containing a boring location sketch, logs of soil borings, a summary of the soils encountered, results of laboratory tests, and recommendations for pavement subgrade preparation and the design of pavements.

Our scope of services did not include environmental services or testing and our geotechnical personnel performing this evaluation are not trained to provide environmental services or testing. We can provide environmental services or testing at your request.

B. Results

B.1. Geologic Overview

We based the geologic origins used in this report on the soil types, laboratory testing, and available common knowledge of the geological history of the site. Because of the complex depositional history, geologic origins can be difficult to ascertain. We did not perform a detailed investigation of the geologic history for the site.
B.2. Core Results

Table 1 provides a summary of the core thicknesses and observations of the core condition.

Table 1. Bituminous Core Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>Wear Thickness (in)</th>
<th>Base Thickness (in)</th>
<th>Total Thickness (in)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-1</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>Mild stripping in the base course</td>
</tr>
<tr>
<td>ST-2</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>Moderate stripping in the base course</td>
</tr>
<tr>
<td>ST-3</td>
<td>2 1/2</td>
<td>3</td>
<td>5 1/2</td>
<td>Mild stripping in the base course</td>
</tr>
<tr>
<td>ST-4</td>
<td>3</td>
<td>2 1/2</td>
<td>5 1/2</td>
<td>Substantial stripping in the base course, mild stripping in the wear course</td>
</tr>
<tr>
<td>ST-5</td>
<td>3</td>
<td>1 1/2</td>
<td>4 1/2</td>
<td>Moderate stripping in the base course</td>
</tr>
<tr>
<td>ST-6</td>
<td>2 1/2</td>
<td>3</td>
<td>5 1/2</td>
<td>Substantial stripping and cracking in the base course</td>
</tr>
</tbody>
</table>

Stripping indicates deterioration of the pavement through separation or loss of bond between the asphalt binder and the aggregate. Pictures of each core are provided below. The core locations are numbered left to right in the pictures below.
Photograph 1. Cores ST-1, ST-2, and ST-3

Photograph 2. Cores ST-4, ST-5, and ST-6
B.3. Boring Results

Table 2 provides a summary of the soil boring results, in the general order we encountered the strata. Please refer to the Log of Boring sheets in the Appendix for additional details. The Descriptive Terminology sheets in the Appendix include definitions of abbreviations used in Table 2.

Table 2. Subsurface Profile Summary*

<table>
<thead>
<tr>
<th>Strata</th>
<th>Soil Type - ASTM Classification</th>
<th>Range of Penetration Resistances</th>
<th>Commentary and Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement section</td>
<td>---</td>
<td>---</td>
<td>▪ Overall thickness ranges from 11 to 17 1/2 inches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Bituminous thickness ranges from 4 1/2 to 6 inches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Apparent aggregate base thickness ranges from 5 to 12 inches.</td>
</tr>
<tr>
<td>Fill</td>
<td>SM</td>
<td>---</td>
<td>▪ Only observed in Boring ST-5 to a depth of about 4 feet.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Penetration resistance of 26 BPF.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Moisture condition generally moist.</td>
</tr>
<tr>
<td>Glacial Outwash</td>
<td>SP-SM, SM</td>
<td>9 to Greater than 50 BPF</td>
<td>▪ General penetration resistance of 15 to 15 BPF.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Variable amounts of gravel; may contain cobbles and boulders.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>▪ Moisture condition generally moist.</td>
</tr>
</tbody>
</table>

*Abbreviations defined in the attached Descriptive Terminology sheets.

We did not perform gradation analysis on the apparent aggregate base material encountered as part of the pavement section, in accordance with our scope of work. Therefore, we cannot conclusively determine if the encountered material satisfies a particular specification.

For simplicity in this report, we define existing fill to mean existing, uncontrolled or undocumented fill.

B.4. Groundwater

We did not observe groundwater while advancing our borings. Therefore, it appears that groundwater is below the depths explored. Project planning should anticipate seasonal and annual fluctuations of groundwater.
B.5. Laboratory Test Results

The boring logs show the results of moisture content and percent passing a #200 sieve testing we performed, next to the tested sample depth. Table 3 also presents the results of our laboratory tests.

Table 3. Laboratory Classification Test Results

<table>
<thead>
<tr>
<th>Location</th>
<th>Sample Depth (ft)</th>
<th>Classification</th>
<th>Moisture Content (w, %)</th>
<th>Percent Passing a #200 Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-1</td>
<td>1 – 3</td>
<td>SP-SM</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>ST-3</td>
<td>Apparent aggregate base</td>
<td>SP-SM</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>ST-5</td>
<td>1 – 3</td>
<td>SM</td>
<td>11</td>
<td>19</td>
</tr>
</tbody>
</table>

C. Recommendations

C.1. Design and Reconstruction Discussion

C.1.a. Pavement Reconstruction

The cores and boring indicated the existing pavement section which consisted of 4 1/2 to 6 inches of bituminous over 5 to 12 inches of apparent aggregate base material. The soils encountered below the pavements were sands and silty sands.

Based on the condition of the bituminous cores, we do not recommend mill and overlay. Mild to severe stripping was observed in the base course of each core. After milling, these areas have a high probability of breaking up during construction, and they provide very little support to a new overlay. In addition, the existing surface appears to have a moderate amount of linear cracking. The linear cracks will likely reflect through a new pavement within the first year.

Based on the limitations above, we recommend reconstructing the pavements. Suitable reconstruction methods include complete reconstruction of the pavements with new aggregate base and bituminous surfacing, removing the existing bituminous and repaving, or full depth reclamation and repaving. Recommendations for each reconstruction method are provided below.
C.2. Reconstruction

C.2.a. Complete Reconstruction
We recommend the following steps for complete reconstruction, understanding the site will have a grade change of 1 foot or less.

1. Strip existing bituminous and apparent aggregate base section to a depth suitable for the new pavement section.
2. Strip any unsuitable soils consisting of organic soils, within 3 feet of the surface of the proposed pavement grade.
3. Have a geotechnical representative observe the excavated subgrade to evaluate if additional subgrade improvements are necessary.
4. Scarify, moisture condition and surface compact the subgrade with at least 5 passes of a large roller with a minimum drum diameter of 3 1/2 feet.
5. Place pavement engineered fill to grade and compact in accordance with Section C.2.d. to the bottom of the aggregate base layer.
6. Proofroll the pavement subgrade as described in Section C.2.e.
7. Place new pavement section as recommended in Section C.3.

C.2.b. Bituminous Removal and Repaving
We recommend the following steps for removal and replacement of the bituminous section, understanding the site will have a grade change of 1 foot or less.

1. Strip the existing bituminous from within the reconstruction area.
2. Conduct test pits throughout the pavement area to further evaluate the thickness of the existing aggregate base.
3. Have a geotechnical representative observe the subgrade to evaluate if additional improvements are necessary.
4. As needed, place additional aggregate base to grade then surface compact the entire reconstruction area with at least 5 passes of a large roller with a minimum drum diameter of 3 1/2 feet.
5. Proofroll the pavement subgrade as described in Section C.2.e.
6. Note areas that yield or deflect during proofroll and correct as described in Section C.2.e.
7. Place new bituminous surfacing as recommended in Section C.3.
C.2.c. Full-Depth Reclamation and Repaving

Based on the borings, the existing pavement section ranges from about 11 to 17 1/2 inches, which appears to be adequate thicknesses for completing FDR. Also, it appears the subgrade soils are suitable for the pavements.

Assuming an average bituminous thickness of 5 inches, based on the core measurements, a design reclamation depth of 10 inches would achieve the approximately 50-50 blend of recycled bituminous and underlying soils (typically aggregate base) that is desirable for reclaimed materials.

Regardless of the design reclaim depth chosen, adjustments will be necessary in the field by the reclamation contractor to account for variation in material depths and conditions. We recommend test pits during construction to confirm aggregate base thickness.

After the reclaimed material has been shaped and compacted, we recommend the surface be proof rolled as discussed in Section C.2.e. below. Any necessary subgrade corrections should be completed as discussed in Section C.2.e. After preparation of the subgrade, new bituminous surfacing can be placed as recommended in section C.3. below.

C.2.d. Engineered Fill Materials and Compaction

Onsite soils free of organics and debris, can be considered for reuse as backfill and fill materials. Imported materials should be similar to the onsite soils.

We recommend spreading engineered fill in loose lifts of approximately 8 inches thick. We recommend compacting engineered fill in accordance with the criteria presented below in Table 4.

Table 4. Compaction Recommendations Summary

<table>
<thead>
<tr>
<th>Reference</th>
<th>Relative Compaction, percent (ASTM D698 – Standard Proctor)</th>
<th>Moisture Content Variance from Optimum, percentage points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within 3 feet of pavement subgrade</td>
<td>100</td>
<td>±3</td>
</tr>
<tr>
<td>More than 3 feet below pavement subgrade</td>
<td>95</td>
<td>±3</td>
</tr>
</tbody>
</table>

*Increase compaction requirement to meet compaction required for structure supported by this engineered fill.

The project documents should not allow the contractor to use frozen material as engineered fill or to place engineered fill on frozen material.
We recommend performing density tests in engineered fill to evaluate if the contractors are effectively compacting the soil and meeting project requirements.

C.2.e. Pavement Subgrade Proofroll
After preparing the subgrade as described above, we recommend proofrolling the soils with a fully loaded tandem-axle truck. We also recommend having a geotechnical representative observe the proofroll. Areas that fail the proofroll likely indicate soft or weak areas that will require additional soil correction work to support pavements.

The contractor should correct areas that display excessive yielding or rutting during the proofroll, as determined by the geotechnical representative. Possible options for subgrade correction include moisture conditioning and recompaction, subcutting and replacement with soil or crushed aggregate, chemical stabilization and/or geotextiles. We recommend performing a second proofroll after any necessary corrections are made, and prior to placing bituminous pavement.

C.3. Pavements

C.3.a. Design Section
Our scope of services for this project did not include laboratory tests on subgrade soils to determine an R-value for pavement design. Based on our experience with similar silty sand soils anticipated at the pavement subgrade elevation, we recommend pavement design assume an R-value of 50.

Based on the aforementioned R-value, soils support, and traffic loads, we recommend the new pavement section consist of a minimum of 5 inches of bituminous over a minimum of 6 inches of aggregate base.

Table 5 provides recommended pavement material specifications, bituminous mix designs, and lift thicknesses for the pavement section.

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Wear: MnDOT Spec. 2360 SPWEA340F</td>
<td>1 1/2 Inches</td>
</tr>
<tr>
<td>First Wear: MnDOT Spec. 2360 SPWEA340F</td>
<td>1 1/2 Inches</td>
</tr>
<tr>
<td>Non-Wear: MnDOT Spec. 2360 SPNWB330B</td>
<td>2 Inches</td>
</tr>
<tr>
<td>Aggregate Base: MnDOT 3138 Spec. Class 5 Aggregate Base</td>
<td>6 Inches</td>
</tr>
</tbody>
</table>
C.3.b. Performance and Maintenance

We based the above pavement designs on a 20-year performance life for bituminous. This is the amount of time before we anticipate the pavement will require reconstruction. This performance life assumes routine maintenance, such as seal coating and crack sealing. The actual pavement life will vary depending on variations in weather, traffic conditions and maintenance.

Many conditions affect the overall performance of the pavements. Some of these conditions include the environment, loading conditions and the level of ongoing maintenance. With regard to bituminous pavements in particular, it is common to have thermal cracking develop within the first few years of placement, and continue throughout the life of the pavement. We recommend developing a regular maintenance plan for filling cracks in pavements to lessen the potential impacts for cold weather distress due to frost heave or warm weather distress due to wetting and softening of the subgrade.

D. Procedures

D.1. Penetration Test Borings

We drilled the penetration test borings with a truck-mounted core and auger drill equipped with hollow-stem auger. We performed the borings in general accordance with ASTM D6151 taking continuous penetration test samples in general accordance to ASTM D1586. The boring logs show the actual sample intervals and corresponding depths.

D.2. Exploration Logs

D.2.a. Log of Boring Sheets

The Appendix includes Log of Boring sheets for our penetration test borings. The logs identify and describe the penetrated geologic materials, and present the results of penetration resistance and other in-situ tests performed. The logs also present the results of laboratory tests performed on penetration test samples, and groundwater measurements.

We inferred strata boundaries from changes in the penetration test samples and the auger cuttings. The strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may occur as gradual rather than abrupt transitions.
D.2.b. Geologic Origins
We assigned geologic origins to the materials shown on the logs and referenced within this report, based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

D.3. Material Classification and Testing

D.3.a. Visual and Manual Classification
We visually and manually classified the geologic materials encountered based on ASTM D2488. When we performed laboratory classification tests, we used the results to classify the geologic materials in accordance with ASTM D2487. The Appendix includes a chart explaining the classification system we used.

D.3.b. Laboratory Testing
The exploration logs in the Appendix note most of the results of the laboratory tests performed on geologic material samples. The remaining laboratory test results follow the exploration logs. We performed the tests in general accordance with ASTM procedures.

D.4. Groundwater Measurements

The drillers checked for groundwater while advancing the penetration test borings, and again after auger withdrawal. We then filled the boreholes or allowed them to remain open for an extended period of observation, as noted on the boring logs.

E. Qualifications

E.1. Variations in Subsurface Conditions

E.1.a. Material Strata
We developed our evaluation, analyses and recommendations from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from
exploration locations continuously with depth. Therefore, we must infer strata boundaries and thicknesses to some extent. Strata boundaries may also be gradual transitions, and project planning should expect the strata to vary in depth, elevation and thickness, away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until performing additional exploration work, or starting construction. If future activity for this project reveals any such variations, you should notify us so that we may reevaluate our recommendations. Such variations could increase construction costs, and we recommend including a contingency to accommodate them.

E.1.b. Groundwater Levels
We made groundwater measurements under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. Note that the observation periods were relatively short, and project planning can expect groundwater levels to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

E.2. Continuity of Professional Responsibility

E.2.a. Plan Review
We based this report on a limited amount of information, and we made a number of assumptions to help us develop our recommendations. We should be retained to review the geotechnical aspects of the designs and specifications. This review will allow us to evaluate whether we anticipated the design correctly, if any design changes affect the validity of our recommendations, and if the design and specifications correctly interpret and implement our recommendations.

E.2.b. Construction Observations and Testing
We recommend retaining us to perform the required observations and testing during construction as part of the ongoing geotechnical evaluation. This will allow us to correlate the subsurface conditions exposed during construction with those encountered by the borings and provide professional continuity from the design phase to the construction phase. If we do not perform observations and testing during construction, it becomes the responsibility of others to validate the assumption made during the preparation of this report and to accept the construction-related geotechnical engineer-of-record responsibilities.
E.3.  Use of Report

This report is for the exclusive use of the addressed parties. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

E.4.  Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.
Appendix
DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING
**LOG OF BORING**

Project Number B2109834  
Geotechnical Evaluation  
MHSRC Precision Maneuver Pad Resurfacing  
U.S. Highway 10  
Saint Cloud, Minnesota

<table>
<thead>
<tr>
<th>Elev./Depth ft</th>
<th>Water Level</th>
<th>Description of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1018.8</td>
<td></td>
<td>BITUMINOUS, 5 inches</td>
</tr>
<tr>
<td>1018.3</td>
<td>0.4</td>
<td>APPARENT AGGREGATE BASE, 6 inches</td>
</tr>
<tr>
<td>1016.7</td>
<td>0.9</td>
<td>POORLY GRADED SAND with SILT (SP-SM), fine-grained, dark brown, moist, medium dense (GLACIAL OUTWASH)</td>
</tr>
<tr>
<td>1015.4</td>
<td>2.5</td>
<td>POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, little Gravel, brown, moist, very dense (GLACIAL OUTWASH)</td>
</tr>
<tr>
<td>1014.6</td>
<td>3.8</td>
<td>END OF BORING</td>
</tr>
</tbody>
</table>

Boring then backfilled with auger cuttings

<table>
<thead>
<tr>
<th>Blows (N-Value) Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU 4-6-14-16 14&quot;</td>
</tr>
<tr>
<td>10-50/3&quot; (REF) 6&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample</th>
<th>q承担责任</th>
<th>MC</th>
<th>Tests or Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU 4-6-14-16 (20) 14&quot;</td>
<td>8</td>
<td>P200=11%</td>
<td></td>
</tr>
</tbody>
</table>

Water not observed while drilling.

See Descriptive Terminology sheet for explanation of abbreviations.
### Description of Materials

- **Bituminous, 6 inches**
- **Apparent Aggregate Base, 5 inches**
- **Poorly Graded Sand with Silt (SP-SM)**
  - Fine-grained, brown, moist, medium dense
  - Glacial Outwash

### Tests or Remarks

- Water not observed while drilling.

<table>
<thead>
<tr>
<th>Elev./Depth ft</th>
<th>Water Level</th>
<th>Sample</th>
<th>Blows (N-Value)</th>
<th>Recovery</th>
<th>$q_p$ tsf</th>
<th>MC %</th>
<th>Tests or Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1018.6</td>
<td>0.5</td>
<td></td>
<td>AU</td>
<td>5-5-6-9</td>
<td>19&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1018.2</td>
<td>0.9</td>
<td></td>
<td>AU</td>
<td>5-8-11-9</td>
<td>10&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1014.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**LOG OF BORING**

**Project Number B2109834**
**Geotechnical Evaluation**
**MHSRC Precision Maneuver Pad Resurfacing**
**U.S. Highway 10**
**Saint Cloud, Minnesota**

**BORING:** ST-3

**LOCATION:** See attached sketch

**NORTHING:** 306960  **EASTING:** 443592

**START DATE:** 11/08/21  **END DATE:** 11/08/21

**RIG:** 7516B  **METHOD:** 3 1/4" HSA

**SURFACING:** Bituminous  **WEATHER:** Partly Cloudy, 37°

<table>
<thead>
<tr>
<th>Elev./Depth</th>
<th>Water Level</th>
<th>Description of Materials</th>
<th>Blows (N-Value)</th>
<th>qₜ</th>
<th>MC</th>
<th>Tests or Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1019.1</td>
<td></td>
<td>BITUMINOUS, 5 1/2 inches</td>
<td>AU</td>
<td>7 8-9-9 (17) 18&quot;</td>
<td>2</td>
<td>Apparent aggregate base P200=12%</td>
</tr>
<tr>
<td>1018.1</td>
<td></td>
<td>APPARENT AGGREGATE BASE, 12 inches</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1016.5</td>
<td></td>
<td>SILTY SAND (SM), fine-grained, dark brown, moist, medium dense (GLACIAL OUTWASH)</td>
<td>8-10-8-8 (18) 17&quot;</td>
<td></td>
<td></td>
<td>Water not observed while drilling.</td>
</tr>
<tr>
<td>1014.5</td>
<td></td>
<td>POORLY GRADED SAND with Silt (SP-SM), fine to medium-grained, little Gravel, brown, moist, medium dense (GLACIAL OUTWASH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**END OF BORING**

Boring then backfilled with auger cuttings
# Project Number B2109834
Geotechnical Evaluation
MHSRC Precision Maneuver Pad Resurfacing
U.S. Highway 10
Saint Cloud, Minnesota

**BORING:** ST-4

**LOCATION:** See attached sketch

**START DATE:** 11/08/21  
**END DATE:** 11/08/21

**NORTHING:** 306878  
**EASTING:** 443571

## Surface Elevations

<table>
<thead>
<tr>
<th>Elev./Depth ft</th>
<th>Water Level</th>
<th>Description of Materials</th>
<th>Blows (N-Value) Recovery</th>
<th>q₀</th>
<th>MC %</th>
<th>Tests or Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1019.0</td>
<td></td>
<td>BITUMINOUS, 5 1/2 inches</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1018.3</td>
<td></td>
<td>APPARENT AGGREGATE BASE, 8 inches</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1017.4</td>
<td></td>
<td>POORLY GRADED SAND with Silt (SP-SM), fine-grained, brown, moist, medium dense (GLACIAL OUTWASH)</td>
<td>7-11-11-18 (22)</td>
<td>8&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td></td>
<td>POORLY GRADED SAND with Silt (SP-SM), fine to medium-grained, with Gravel, with Cobbles, brown, moist, medium dense to dense (GLACIAL OUTWASH)</td>
<td>5-13-36-18 (49)</td>
<td>4&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1014.4</td>
<td></td>
<td>END OF BORING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boring then backfilled with auger cuttings

Water not observed while drilling.
<table>
<thead>
<tr>
<th>Elev./Depth ft</th>
<th>Water Level</th>
<th>Description of Materials</th>
<th>Blows (N-Value)</th>
<th>Sample</th>
<th>q&lt;sub&gt;u&lt;/sub&gt; tsf</th>
<th>MC %</th>
<th>Tests or Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1018.3</td>
<td></td>
<td>BITUMINOUS, 4 1/2 inches</td>
<td>AU</td>
<td>7-11-15-14</td>
<td>12&quot;</td>
<td>11</td>
<td>P200=19%</td>
</tr>
<tr>
<td>1017.6</td>
<td></td>
<td>APPARENT AGGREGATE BASE, 8 inches</td>
<td></td>
<td>4-11-20-12</td>
<td>15&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1014.6</td>
<td></td>
<td>FILL: SILTY SAND (SM), fine to medium-grained, little Gravel, dark brown and brown, moist</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1013.6</td>
<td></td>
<td>POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, with Gravel, brown, moist, medium dense (GLACIAL OUTWASH)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boring then backfilled with auger cuttings

Water not observed while drilling.
## Description of Materials

- **BITUMINOUS**, 5 1/2 inches
- **APPARENT AGGREGATE BASE**, 8 inches
- **SILTY SAND (SM)**, brown, moist, medium dense (GLACIAL OUTWASH)
- **SILTY SAND (SM)**, fine to medium-grained, little Gravel, brown, moist, loose (GLACIAL OUTWASH)

## Blows (N-Value) Recovery

<table>
<thead>
<tr>
<th>Blows</th>
<th>Recovery</th>
<th>qₚtsf</th>
<th>MC %</th>
<th>Tests or Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-6-6-5 (12)</td>
<td>20&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-4-5-5 (9)</td>
<td>10&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Tests or Remarks:** Water not observed while drilling.

---

**END OF BORING**

Boring then backfilled with auger cuttings
### Descriptive Terminology of Soil
Based on Standards ASTM D2487/2488 (Unified Soil Classification System)

<table>
<thead>
<tr>
<th>Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests</th>
<th>Soil Classification</th>
</tr>
</thead>
</table>
| Gravels (More than 50% of coarse fraction retained on No. 4 sieve) | Clean Gravels | W-GM Well-graded gravel
| (Less than 5% fines) | C_{4+} ≥ 1 and C_{6} ≤ 3 |
| Gravels with Fines (More than 12% fines) | Fines classify as ML or MH | Silty gravel
| (Fines classify as CL or CH) | | GC Clayey gravel
| Sands (50% or more coarse fraction passes No. 4 sieve) | Clean Sands | SW Well-graded sand
| (Less than 5% fines) | C_{4+} ≥ 1 and C_{6} ≤ 3 |
| Sands with Fines (More than 12% fines) | Fines classify as ML or MH | SM Silty sand
| (Fines classify as CL or CH) | | SC Clayey sand

| Silts and Clays (Liquid limit less than 50) | Organic | Inorganic
|---|---|---|
| PI plots on or above "A" line | PI > 7 and plots on or above "A" line | CL Lean clay
| PI < 4 or plots below "A" line | ML Silt
| | | LO Organic clay
| | | OC Organic silty clay
| Organic Liquid Limit – oven dried | Organic clay
| Liquid Limit – not dried | Organic silt

| Silts and Clays (Liquid limit 50 or more) | Organic | Inorganic
|---|---|---|
| PI plots on or above "A" line | PI > 7 and plots on or above "A" line | CL Lean clay
| PI plots below "A" line | ML Silt
| | | LO Organic clay
| | | OC Organic silty clay
| Organic Liquid Limit – oven dried | Organic clay
| Liquid Limit – not dried | Organic silt

| Highly Organic Soils | Primary organic matter, dark in color, and organic odor | PT Peat

### Particle Size Identification
- **Boulders**: over 12"
- **Cobbles**: 3" to 12"
- **Gravel**:
  - Coarse: 3/4" to 3" (19.00 mm to 75.00 mm)
  - Fine: No. 4 to 3/4" (4.75 mm to 19.00 mm)
- **Sand**:
  - Coarse: No. 10 to No. 4 (2.00 mm to 4.75 mm)
  - Medium: No. 40 to No. 10 (0.425 mm to 2.00 mm)
  - Fine: No. 200 to No. 40 (0.075 mm to 0.425 mm)
- **Silt**: No. 200 (0.075 mm) to .005 mm
- **Clay**: < .005 mm

### Relative Proportions
- **Sand**: trace to 30%
- **Silt**: 1/3 to 1/1
- **Clay**: 1/1 to 1/3
- **Organic**: < 1/3

#### Inclusion Thicknesses
- **Lenses**: 0 to 1/8" (2.00 mm)
- **Seam**: 1/8" to 1/1" (3.00 mm to 25.00 mm)
- **Layer**: over 1" (25.00 mm)

#### Apparent Relative Density of Cohesionless Soils
- **Very loose**: 0 to 1 BPF
- **Loose**: 1 to 5 BPF
- **Medium dense**: 6 to 15 BPF
- **Dense**: 16 to 25 BPF
- **Very dense**: over 25 BPF

#### Consistency of Cohesion Soils
- **Borings**:
  - **Soft**: 0 to 1 BPF
  - **Soft**: 2 to 4 BPF
  - **Medium**: 5 to 10 BPF
  - **Hard**: 11 to 30 BPF
  - **Very hard**: over 30 BPF
- **Approximate Unconfined Compressive Strength**
  - **Very soft**: 0 to 0.25 tsf
  - **Soft**: 0.25 to 0.5 tsf
  - **Medium**: 0.5 to 1 tsf
  - **Stiff**: 1 to 2 tsf
  - **Very stiff**: 2 to 4 tsf
  - **Hard**: over 4 tsf

#### Moisture Content
- **Dry**: Absence of moisture, dusty, dry to the touch.
- **Moist**: Damp but no visible water.
- **Wet**: Visible free water, usually soil is below water table.

#### Drilling Notes
- **Blows/N-value**: Blows indicate the driving resistance recorded for each 6-inch interval. The reported N-value is the blows per foot recorded by summing the second and third interval in accordance with the Standard Penetration Test, ASTM D1586.
- **Partial Penetration**: If the sampler could not be driven through a full 6-inch interval, the number of blows for that partial penetration is shown as #/x (i.e. 50/2”). The N-value is reported as “REF” indicating refusal.
- **Recovery**: Indicates the inches of sample recovered from the sampled interval. For a standard penetration test, full recovery is 18", and is 24” for a thinwall/shelby tube sample.
- **WOF**: Indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.
- **WOR**: Indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

#### Water Level:
Indicates the water level measured by the drillers either while drilling (\(\therefore\)), at the end of drilling (\(\triangleright\)), or at some time after drilling (\(\triangleright\)).

### Laboratory Tests
- **DD**: Dry density, pcf
- **WD**: Wet density, pcf
- **P200**: % Passing #200 sieve
- **MC**: Moisture content, %
- **OC**: Organic content, %
- **q_{e}**: Pocket penetrometer strength, tsf
- **q_{u}**: Unconfined compression test, tsf
- **LL**: Liquid limit
- **PI**: Plasticity index
- **ML**: Plastic limit
- **CL**: Liquid limit

#### Sample Symbols
- **Standard Penetration Test**: Rock Core
- **Modified California (MC)**: Thinwall (TW)/Shelby Tube (SH)
- **Auger**: Texas Cone Penetrometer
- **Grab Sample**: Dynamic Cone Penetrometer

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*[5/21]*