# Geotechnical Evaluation Report

Proposed Highway Realignment and Slope Stability Analysis
County Highway N
Town of Eastman, Crawford County, Wisconsin

*Prepared for*

# Jewell Associates Engineers, Inc


Brandon K. Wright, PE
Project Engineer
License Number: 40141
May 6, 2015


WISCONSIN
BRANDON K.
WRIGHT
40141-006
LA CROSSE
WI
PROFESSIONAL ENGINEER

Project B1500554


Braun Intertec Corporation

**Braun Intertec Corporation**
2309 Palace Street
La Crosse, WI 54603

Phone: 608.781.7277
Fax: 608.781.7279
Web: braunintertec.com

May 6, 2015

Project B1500554

Mr. Ellery Schaffer, PE
Jewell Associates Engineers, Inc.
560 Sunrise Drive
Spring Green, Wisconsin 53588

Re: Geotechnical Evaluation
Proposed Highway Realignment and Slope Stability Analysis
County Highway N
Town of Eastman, Crawford County, Wisconsin

Dear Mr. Shaffer:

We are pleased to present this Geotechnical Evaluation Report for the proposed Highway Realignment and Slope Stability Analysis of County Highway N. Our results and recommendations influencing design and construction are presented in our report.

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 call Nicole Carlson or Brandon Wright at 608.781.7277.

Sincerely,

BRAUN INTERTEC CORPORATION

Nicole A. Carlson, EIT
Staff Engineer

Brandon K. Wright, PE
Project Engineer

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# A. Introduction

## A.1. Project Description

This Geotechnical Evaluation Report addresses Country Highway N located in the Town of Eastman, Crawford County, Wisconsin. The construction will include the realignment of the county highway and slope stability analysis of the proposed cut slopes and proposed retaining wall. Proposed slopes range in height from a few feet to as much as 10 to 30 feet in height and have slopes ranging from 0.5:1 (horizontal: vertical) to 2.5:1. The general location of the site with adjacent streets is shown in the Soil Boring Location Sketch in the Appendix.

## A.2. Purpose

The purpose of our geotechnical evaluation will be to characterize subsurface geologic conditions at selected exploration locations and evaluate their impact on the design and construction of the proposed cut and fill slopes, earthwork recommendations, re-use of on-site materials, pavement subgrade preparation and to provide recommendations for pavement thickness design.

## A.3. Background Information and Reference Documents

To facilitate our evaluation, we were provided with or reviewed the following information or documents:

- Geologic atlas and topographic maps within the area of the proposed highway realignment.
- Aerial photographs of the site.
- Preliminary site design drawings provided by Jewell Engineer Associates, Inc., dated August 7, 2014.
- WisDOT Traffic Forecast Report provided by Jewell Engineer Associates, Inc., completed October 8, 2014.

Our referenced documents and past project experience in the general area, indicate that the site is underlain with alluvial soils and shallow bedrock. The site currently exists as a county highway with sharp and potentially dangerous curves and steep hills.

## A.4. Scope of Services

Our scope of services for this project was originally submitted as a Proposal to Mr. Fred Gruber of Jewell Associates Engineers, Inc, dated March 15, 2013 (Proposal No. LC-13-01425). We received a notice to proceed from Jewell Associates on November 5, 2014. The Notice to Proceed indicated the scope of work had changed from our previously issued proposal, LC-13-01425. Our previously issued proposal included a scope of work to drill 35 borings extending to depths of 10 to 20 feet and to provide recommendations to reconstruct County Highway N. The Notice to Proceed indicated the scope of work now includes 27 borings extended to depths of 10 to 20 feet, but shall also include slope stability analysis along with reconstruction recommendations for County Highway N. Our scope of services was later modified through the submittal of a revised proposal to Mr. Ellery Schaffer of Jewell Associates Engineers who provided authorization to proceed. Our scope of services was performed under the terms of our September 1, 2009, General Conditions. Tasks performed in accordance with our authorized scope of services included:

- Performing a reconnaissance of the site to evaluate equipment access to exploration locations.
- Staking of exploration locations and clearing of underground utilities.
- Performing thirteen (13) penetration test borings; two borings to a depth of 5 feet, two borings to a depth of 10 feet, two borings to a depth of 15 feet, two borings to a depth of 20 feet, four borings to a depth of 30 feet, and one boring to a depth of 40 feet.
- Performing laboratory moisture content, organic content, mechanical sieve analysis through a number 200- sieve and unit weight tests on selected penetration test samples.
- Preparing this report containing a CAD sketch, exploration logs, a summary of the geologic materials encountered, results of laboratory tests, and recommendations for structure subgrade preparation, slope stability and the design of pavement sections.

We deviated from our proposed scope of services in the number of borings. This deviation was the result of limited access to the boring location at STA 37+50, offset 20 feet.

Exploration locations and surface elevations were staked and surveyed by Jewell Associates Engineers, Inc.

# B. Results

## B.1. Exploration Logs

### B.1.a. Log of Boring Sheets

Log of Boring sheets for our penetration test borings are included in the Appendix. The logs identify and describe the geologic materials that were penetrated, and present the results of penetration resistance tests performed within them, organic vapor screening, laboratory tests performed on penetration test samples retrieved from them, and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

### B.1.b. Geologic Origins

Geologic origins assigned to the materials shown on the logs and referenced within this report were 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.

## B.2. Geologic Profile

Our borings indicate that the site is underlain with pavement, topsoil and undocumented fill over alluvium and bedrock.

### B.2.a. Topsoil and Undocumented Fill

Borings ST-1 to ST-4, ST-8 and ST-12 initially encountered approximately ½ foot of topsoil. All of the borings, except Borings ST-4, ST-8, ST-10 and ST-12 encountered undocumented fill that extended to a depth of 2 to 5 feet. The undocumented fill consisted of silty sand (SM), clayey sand (SC), lean clay with sand (CL) and sandy lean clay (CL) that was tan to dark brown and frozen to 4 feet then wet.

The undocumented fill in Boring ST-6 was underlain with buried topsoil that extended to a depth of 5 ½ feet. The buried topsoil consisted of silty sand (SM) with a trace of roots and was dark brown and wet.

### B.2.b. Alluvial Soils

Below the topsoil and undocumented fill, the borings encountered alluvium that extended to 2 to 15 feet or the termination depth of the borings. The alluvium consisted of silty sand (SM), clayey sand (CL), silt (ML), sandy lean clay (CL), lean clay with sand (CL), lean clay (CL), organic clay (OL) and poorly graded gravel with sand (GP) that was light tan to tan, brown to dark brown and black and damp to wet.

### B.2.c. Residuum and Bedrock

In borings ST-2, ST-4 and ST-9 the alluvial soils were underlain with residuum that extended to depth of 4 feet or the termination depth of the borings. The residuum consisted of poorly graded sand (SP), clayey sand (SC) and lean clay (CL) that was tan to dark brown and damp to wet.

Borings ST-8, ST-9, ST-10 and ST-13 encountered sandstone and limestone bedrock from the Prairie du Chien Group that extended to the termination depth of the boring. The sandstone was tan to white and damp and the limestone was tan and damp.

### B.2.d. Penetration Resistance Testing

The results of our penetration resistance testing are summarized below in Table 1. Comments are provided to qualify the significance of the results.

**Table 1. Penetration Resistance Data**

| Geologic Material | Classification | Range of Penetration Resistances | Comments |
|---|---|---|---|
| Sandy alluvial soils | Silty sand (SM), Silt (ML), & gravel w/ sand (GP) | 5 to 17 BPF | Loose to medium dense |
| Clayey alluvial soils | Clayey sand (CL), sandy clay (CL), clay w/ sand (CL), clay (CL) & organic clay (OL) | 2 to 19 BPF | Rather soft to very stiff |
| Sandy Residuum | Sand (SP) | 30 BPF | Medium dense |
| Clayey Residuum | Clayey sand (SC) & clay (CL) | 45 to 49 BPF | Hard |
| Prairie du Chien Group | Sandstone and limestone | 52 to 59 BPF and 50 blows for 0 to 4 inches | Hard |

### B.2.e. Groundwater

Groundwater was not observed as our borings were advanced. Given the cohesive nature of the geologic materials encountered, however, it is likely that insufficient time was available for groundwater to seep into the borings and rise to its hydrostatic level. Piezometers or monitoring wells would be required to confirm if groundwater was present within the depths explored. Seasonal and annual fluctuations of groundwater should also be anticipated.

## B.3. Laboratory Test Results

Results of our laboratory tests are presented below in Table 2.

**Table 2. Laboratory Classification Test Results**

| Location | Sample Depth (ft) | Classification | Moisture Content (%) | Percent Passing a #200 Sieve | Organic Content (%) | Dry Density (pcf) |
|---|---|---|---|---|---|---|
| ST-1 | 2 ½ | Clayey Sand (SC) | 17 | 48 | -- | -- |
| ST-6 | 7 ½ | Sandy Silt (ML) | 16 | 51 | -- | -- |
| ST-7 | 10 | Organic Clay (OL) | 27 | -- | 9 | -- |
| ST-9 | 2 ½ | Lean Clay (CL) | 16 | -- | -- | 106 |
| ST-10 | 7 ½ | Lean Clay (CL) | 21 | -- | -- | 98 |
| ST-11 | 2 ½ | Lean Clay (CL) | 20 | 85 | -- | -- |
| ST-12 | 2 ½ | Lean Clay (CL) | 25 | -- | -- | 97 |
| ST-13 | 5 | Lean Clay with Sand (CL) | 24 | 98 | -- | -- |

# C. Basis for Recommendations

## C.1. Design Details

Based on preliminary site design drawings provided by Jewell Engineer Associates, Inc., dated August 7, 2014, we understand the project includes various components including; (1) realignment of an approximate 1.47-mile section of County Highway N from its intersection with State Highway 35 extending to the east, (2) construction of a 200-foot long soldier pile and lagging retaining wall from Station 11+00 to Station 13+00, and (3) reconstructing the intersection of County Highway N and Slama Lane (currently north of County Highway N, at approximate Station 77+00) and Demanes Lane (currently south of County Road N, at approximate Station 74+50). Specific discussion about each of the project scope components are outlined below.

### C.1.a. Pavements and Traffic Loads

Mr. Ellery Schaffer, PE, of Jewell Associates Engineers, Inc. proved us with a WisDOT Traffic Forecast Report for County Road N from State Highway 35 to Teter Lane. According to this report, the current Average Annual Daily Traffic (AADT) is 210 vehicles per day (vpd) and the forecasted AADT for 2026 is 230 vpd and for 2036 is 250 vpd. This traffic forecast also reports that CTH N is subjected to 13.1% truck traffic with the following designations, as defined by Table 5.1 in Chapter 14 Section 1 of the Wisconsin Department of Transportation (WisDOT) Facilities Design Manual (FDM 14-1):

**Table 3: Truck Class Percents**

| Truck Class (as classified by WisDOT) | Percent of AADT (%) |
|---|---|
| 2D | 7.2 |
| 3AX | 1.4 |
| 2S1+2S2 | 2.3 |
| 3-S2 | 2.2 |
| DBL-BTM | 0.0 |

### C.1.b. Proposed Cross-Sections/Realignment

The proved plan and profile sheets included existing and proposed cross sections at 100-foot intervals along the alignment. Side slopes along the alignment were variable, depending on the proposed grade change and right-of-way constraint. For our analysis, we analyzed the large cuts proposed along the north side of the alignment, specifically, from Station 31+00 to 32+00, side slope gradients are proposed to be at 1:1 (horizontal: vertical). From Station 36+00 to 39+00, side slope gradients are proposed to be at ½:1. From Station 58+00 to 63+00, side slope gradients are proposed to be at 1 ½:1.

### C.1.c. Anticipated Grade Changes

Existing ground surface elevations are within approximately 2 to 12 feet of the proposed finished grade of the highway. From STA 10+25 to 13+00, plans indicate cuts and fills on the order of 4 to 8 feet. From STA 13+00 to 74+50, the plans indicate cuts and fills on the order of 4 to 6 feet. From STA 74+50 to 78+00, the plans indicate cuts of up to 12 feet.

### C.1.d. Soldier Pile and Lagging Retaining Wall

A retaining wall is planned from Station 11+00 to 13+00. The wall is expected to be soldier pile with pre-cast concrete lagging between the piles. Pile size, spacing and installation depth is unknown at this time. For purposes of evaluation, we assumed steel H-piles would be installed to depths of 20 to 30 feet below the ground surface and the exposed wall heights would range from 10 to 15 feet.

### C.1.e. Precautions Regarding Changed Information

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

## C.2. Design and Construction Considerations

From a design and construction perspective, the project team should be aware that:

- The bedrock will be hard to excavate. Use of appropriate earthwork equipment and backhoes with toothed buckets will be required to cut the slopes.

- On-site soils free of organic soil and debris can be considered for reuse as backfill and fill in green areas and at depths of 3 feet or greater below the pavement surface.

- The soldier pile wall should be backfilled with medium- to coarse-grained sand or gravel to limit buildup of hydrostatic pressure on the walls and to promote drainage of subsurface water to a drain tile.

- Fill should be benched into existing slopes steeper than 5:1 (horizontal:vertical) to allow the fill to be spread and compacted on level surfaces and reduce the risk of fill instability.

# D. Recommendations

## D.1. Earthwork

### D.1.a. Fill Selection

On-site soils free of organic soil and debris can be considered for reuse as backfill and fill in green areas and at depths of 3 feet or greater below the pavement surface. Imported material needed to replace excavation spoils or balance cut and fill quantities, may consist of sand, silty sand, clayey sand, sandy lean clay or lean clay. We recommend, however, that the plastic index of these materials not exceed 15.

For the pavement subgrade, however, we recommend specifying crushed aggregate base meeting the requirements of Wisconsin Department of Transportation (WisDOT) Specification Section 305.2.2.1 1 ¼ inch Dense Graded Base. We recommend utilizing an E-1 mixture for the hot mix asphalt meeting the specifications of Wisconsin DOT Section 460. We recommend utilizing a nominal 12.5 mm gradation for the base courses and a nominal 9.5 mm gradation for the surface courses as defined in Table 460-1 in Section 460.2.2.3. We recommend the Performance Graded Asphalt cement be a PG 64-28.

### D.1.b. Filing over Slopes

We recommend benches be excavated into the natural soils of existing slopes that are steeper than 5:1 (horizontal: vertical) prior to placement of fill. The “stair step”-shaped benches are recommended to key the fill into existing slopes, allow fill to be spread and compacted on level surfaces and reduce the risk of fill instability.

### D.1.c. Compaction Requirements

We recommend compacting excavation backfill (including utility backfill) and additional required fill placed within 3 feet of pavement subgrade elevations to at least 100 percent of their maximum standard Proctor dry densities (ASTM D 698). Backfill and fill placed more than 3 feet below pavement subgrade elevations should be compacted to at least 95 percent.

## D.2. Slope Stability

### D.2.a. Selection of Analytical Sections and Method

We indentified cross sections that were judged to be representative of the most critical portions of the alignment. The three cross sections indentified for evaluation included those at Stations 12+00, 37+00 and 61+00. At each of these cross sections, we performed analyses of the following slope conditions using GeoStudio 2012 version 8.14.1.

- Existing conditions.
- From Stations 11+00 to 13+00: Soldier Pile and Lagging Wall (based on assumptions stated in Section C.1.d above).
- From Stations 36+00 to 39+00: 0.5:1 cut slope (as provided).
- From Stations 60+00 to 63+00: 1.5:1 cut slope (as provided).

### D.2.b. Geologic Profiles

The cut slopes are expected to expose residuum and bedrock materials. Zones of gravel, cobbles, boulders or limestone fragments within these strata may also be present. These materials were assigned the parameters shown below in Table 4 for analysis.

**Table 4. Summary of Analytical Parameters**

| Station 12+00 | | | |
|---|---|---|---|
| **Material** | **Unit Weight (pcf)** | **Friction Angle (degrees)** | **Cohesion (psf)** |
| Wall | 150 | 35 | 10,000 |
| Silty Sand | 120 | 32 | 0 |
| Silty | 100 | 30 | 0 |
| Fill | 125 | 34 | 0 |
| Bedrock | 130 | 45 | 5000 |
| Clayey sand | 120 | 30 | 100 |
| Station 37+00 | | | |
| **Material** | **Unit Weight (pcf)** | **Friction Angle (degrees)** | **Cohesion (psf)** |
| Silty Sand | 120 | 32 | 0 |
| Silt | 100 | 27 | 0 |
| Limestone Bedrock | 140 | 45 | 5000 |
| Gravel | 125 | 34 | 0 |
| Fill | 120 | 30 | 0 |
| Station 61+00 | | | |
| **Material** | **Unit Weight (pcf)** | **Friction Angle (degrees)** | **Cohesion (psf)** |
| Sandstone bedrock | 110 | 40 | 2000 |
| Limestone bedrock | 130 | 45 | 5000 |
| Lean Clay | 110 | 25 | 0 |
| Fill | 120 | 30 | 0 |

### D.2.c. Additional Assumptions

Additional assumptions were made to help us extend the cross sections beyond the limits of the available information. These assumptions should be considered when reviewing our analytical results, and should be confirmed in the field prior to finalizing the design of the cut slopes.

- **Profile Limits.** In general, the cross sections provided extended an adequate upstream/downstream distance for modeling purposes. In the cases where the cross sections provided did not extend significantly beyond the upslope limits of the maximum planned 1:1 (horizontal: vertical) cut slopes, we assumed the profiles beyond the extent of the provided cross sections continued at the same gradient for a minimum of 50 feet horizontally beyond the provided profile.

- **Subsurface Geology.** Due the site conditions and steep nature of the slopes, sets of borings were typically not performed at the evaluation locations to indentify the inclination of the subsurface profile. With the exception of the bedrock, we assumed the inclination of the strata generally was sloped, similar to the surface topography.

### D.2.d. Analytical Results

The results of our stability analyses for each cross section, including the existing and proposed slopes, are summarized below in Table 5. Companion graphics, showing the location and configuration of the critical failure surfaces associated with the various cross sections and slope configurations, are included in the Appendix.

**Table 5. Factor of Safety Summary**

| Road Station | Slope | |
|---|---|---|
| | Existing Slope | Proposed Cut |
| 12+00 | 1.4 | 1.5 |
| 37+00 | 3.8 | 4.1 |
| 61+00 | 5.9 | 5.4 |

The factor of safety associated with the existing slopes was 1.5 or greater at all locations. This conforms to the Wisconsin Department of Transportation (WisDot) minimum Factor of Safety for permanent slopes of 1.5.

In order to maintain the minimum required Factor of Safety at Station 12+00, we included a steel and concrete vertical wall. The vertical wall is expected to be embedded down to approximately Elevation 638 to 640. Local and global stability of the wall should be reevaluated once final plans for the wall have been completed.

It should be noted, however, that slope stability analysis to assess the factor of safety was not completed at Station 34+00. We cannot make any judgments as to the slopes stability regarding the factor of safety at this time. If the same geological conditions are the same those encountered Station 37+00 and 61+00, where slope stability analysis was completed, then slopes could be designed at 1:1 (horizontal: vertical) or 1.5:1, with the flatter slope angles having a higher factor of safety against slope failure. If, at the time of construction, bedrock is not present at Station 34+00, we should be notified to evaluate what slope angle is needed to maintain a safety factor above 1.5.

## D.3. Soldier Pile and Lagging Wall

A retaining wall is planned from Station 11+00 to 13+00. The wall is expected to be soldier pile with pre-cast concrete lagging between the piles. Pile size, spacing and installation depth is unknown at this time. For purposes of evaluation, we assumed steel H-piles would be installed to depths of 20 to 30 feet below the ground surface and the exposed wall heights would range from 10 to 15 feet.

### D.3.a. Drainage Control

We recommend installing subdrains behind the soldier pile wall. Preferably the subdrains should consist of perforated pipes embedded in washed gravel, which in turn is wrapped in filter fabric. Perforated pipes encased in a filter “sock” and embedded in washed gravel, however, may also be considered.

### D.3.b. Selection, Placement and Compaction of Backfill

Unless a drainage composite is placed against the backs of the exterior perimeter soldier pile wall, we recommend that backfill placed within 2 horizontal feet of those walls consist of sand having less than 50 percent of the particles by weight passing a #40 sieve and less than 5 percent of the particles by weight passing a #200 sieve. Sand meeting this gradation will need to be imported. We recommend that the balance of the backfill placed against exterior perimeter wall also consist of sand, though it is our opinion that the sand may contain up to 20 percent of the particles by weight passing a #200 sieve.

We recommend a walk behind compactor be used to compact the backfill placed within about 5 feet of the soldier pile wall. Further away than that, a self-propelled compactor can be used. Compaction criteria for below-grade walls should be determined based on the compaction recommendations provided above in Section D.1.

Exterior backfill should be capped with a low-permeability soil to limit the infiltration of surface drainage into the backfill. The finished surface should also be sloped to divert water away from the walls.

### D.3.c. Configuring and Resisting Lateral Loads

We recommend designing the wall based on the parameters presented below in Table 6. The parameters shown have not been reduced by safety factors. Saturated unit weights are recommended to account for the potential build up of hydrostatic pressure behind undrained support structures.

**Table 6. Soldier Pile Wall Design Parameters**

| Geologic Material | Depth (Ft) | Moist Unit Weight (pcf) | Saturated Unit Weight (γ, pcf) | Friction Angle (Ø, deg) | Cohesion (C, psf) | $K_A$ | $K_O$ | $K_P$ |
|---|---|---|---|---|---|---|---|---|
| FILL: Silty Sand & Alluvial Clayey Sand | 0 – 7 | 115 | 125 | 28 | 500 | 0.36 | 0.53 | 2.77 |
| Alluvial Silt/Silty Sand | 7 – 14 | 120 | 130 | 28 | 0 | 0.36 | 0.53 | 2.77 |
| Alluvial Clayey Sand | 14 – 20 | 120 | 130 | 28 | 500 | 0.36 | 0.53 | 2.77 |
| Residual Clayey Sand | 20 – 24 | 125 | 135 | 30 | 1,000 | 0.33 | 0.5 | 3.00 |

## D.4. Pavements

### D.4.a. Pavement Subgrade Preparations

We recommend stripping the existing pavement materials, and enough subgrade materials to provide placement of the recommended aggregate subbase. Following this removal, we recommend proofrolling the subgrade to look for soft spots.

### D.4.b. Pavement Subgrade Compaction

We recommend compacting excavation backfill (including utility backfill) and additional required fill placed within 3 feet of pavement subgrade elevations to at least 98 percent of their maximum standard Proctor dry densities (ASTM International D 698). Backfill and fill placed more than 3 feet below pavement subgrade elevations should be compacted to at least 95 percent.

### D.4.c. Subgrade Proof-Roll

Prior to placing aggregate base material, we recommend proof-rolling pavement subgrades to determine if the subgrade materials are loose, soft or weak, and in need of further stabilization, compaction or subexcavation and recompaction or replacement. A second proof-roll should be performed after the aggregate base material is in place, and prior to placing bituminous or concrete pavement.

### D.4.d. Soil Parameters for Pavement Design

Laboratory tests to determine the subgrade California Bearing Ratio (CBR) was not included in the scope of this project. Based on our experience with similar projects in the area and the clayey materials observed in the borings, however, it is our opinion that the following soil parameters should be used for pavement design:

**Table 7: Soil Parameters for Pavement Design**

| USGS Classification | Lean Clay (CL) |
|---|---|
| AASHTO Soil Classification | A-4/A-6 |
| Soil Support Value (SSV) | 3.8 |
| Wisconsin Design Group Index | 15 |
| Subgrade Modulus (K) | 125 |
| Frost Index | F-3 |

### D.4.e. Pavement Materials and Compaction

We recommend specifying crushed aggregate base meeting the requirements of Wisconsin Department of Transportation (WisDOT) Specification Section 305.2.2.1 for 1 ¼ inch Dense Graded Base. We recommend utilizing an E-1 mixture for the hot mix asphalt meeting the specifications of WisDOT Section 460. We recommend utilizing a nominal 12.5 mm gradation for the base courses and a nominal 9.5 mm gradation for the surface courses as defined in Table 460-1 in Section 460.2.2.3. We recommend the Performance Graded Asphalt cement be a PG 64-28.

We recommend that the aggregate base be compacted to a minimum of 95 percent of its maximum standard Proctor dry density. We recommend that the bituminous pavement be compacted to at least 92 percent of the maximum theoretical density.

## D.5. Construction Quality Control

### D.5.a. Excavation Observations

We recommend having a geotechnical engineer observe all excavations related to subgrade preparation and spread footing, slab-on-grade and pavement construction. The purpose of the observations is to evaluate the competence of the geologic materials exposed in the excavations, and the adequacy of required excavation oversizing.

### D.5.b. Materials Testing

We recommend density tests be taken in excavation backfill and additional required fill placed below spread footings, slab-on-grade construction, beside foundation walls behind basement walls, and below pavements.

### D.5.c. Pavement Subgrade Proof-Roll

We recommend that proof-rolling of the pavement subgrades be observed by a geotechnical engineer to determine if the results of the procedure meet project specifications, or delineate the extent of additional pavement subgrade preparation work.

### D.5.d. Cold Weather Precautions

If site grading and construction is anticipated during cold weather, all snow and ice should be removed from cut and fill areas prior to additional grading. No fill should be placed on frozen subgrades. No frozen soils should be used as fill.

Concrete delivered to the site should meet the temperature requirements of ASTM C 94. Concrete should not be placed on frozen subgrades. Concrete should be protected from freezing until the necessary strength is attained. Frost should not be permitted to penetrate below footings.

# E. Procedures

## E.1. Penetration Test Borings

The penetration test borings were drilled with an all-terrain and truck-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 ½- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

## E.2. Material Classification and Testing

### E.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

### E.2.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM or AASHTO procedures.

## E.3. Groundwater Measurements

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

# F. Qualifications

## F.1. Variations in Subsurface Conditions

### F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed 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, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected 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 additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

### F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

## F.2. Continuity of Professional Responsibility

### F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

### F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

## F.3. Use of Report

This report is for the exclusive use of Jewell Associate Engineers, Inc, Crawford County Highway Department, and their design and construction teams. 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.

## F.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.

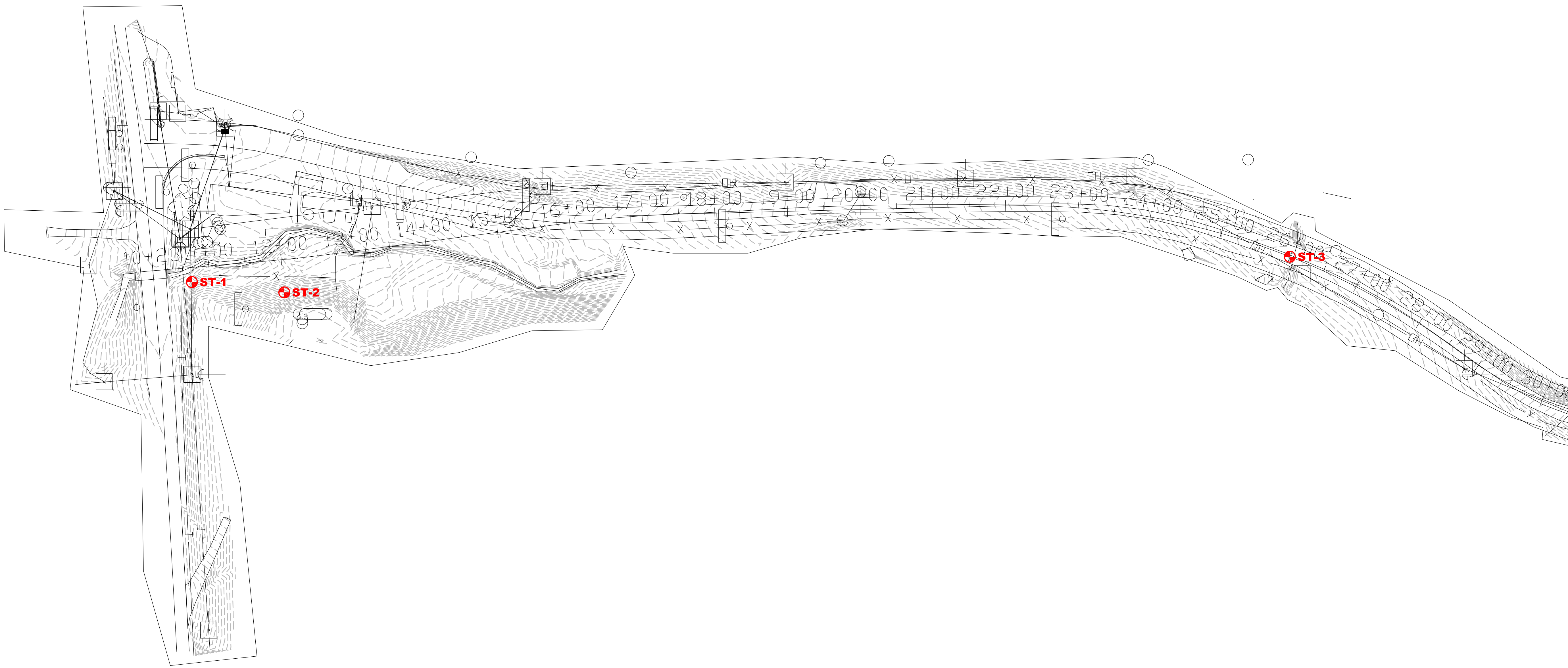
**Appendix**

BRAUN INTERTEC

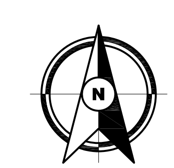
**BRAUN INTERTEC**
The Science You Build On.

2309 Palace Street
La Crosse, WI 54603
PH. (608) 781-7277
FAX (608) 781-7279

# SOIL BORING LOCATION SKETCH
GEOTECHNICAL EVALUATION
COUNTY HIGHWAY N
COUNTY HIGHWAY 35 TO SLAMA LANE
EASTMAN, WISCONSIN




**DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING**




75' 0 150'

SCALE: 1" = 150'

| | |
|---|---|
| Project No: | B1500554 |
| Drawing No: | B1500554 |
| Scale: | 1" = 150' |
| Drawn By: | BJB |
| Date Drawn: | 4/9/15 |
| Checked By: | NC |
| Last Modified: | 4/9/15 |
| Sheet: 1 of 4 | Fig: |

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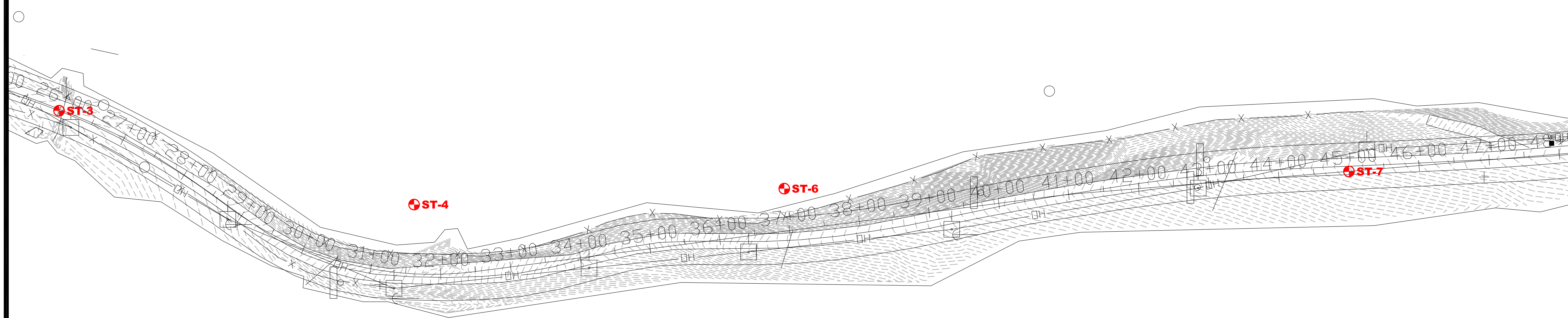


**DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING**

75'  0  150'

SCALE: 1" = 150'

**BRAUN INTERTEC**

The Science You Build On.

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La Crosse, WI 54603
PH. (608) 781-7277
FAX (608) 781-7279

# SOIL BORING LOCATION SKETCH

GEOTECHNICAL EVALUATION
COUNTY HIGHWAY N
COUNTY HIGHWAY 35 TO SLAMA LANE
EASTMAN, WISCONSIN

| | |
|---|---|
| Project No: | B1500554 |
| Drawing No: | B1500554 |
| Scale: | 1" = 150' |
| Drawn By: | BJB |
| Date Drawn: | 4/9/15 |
| Checked By: | NC |
| Last Modified: | 4/9/15 |
| Sheet: 2 of 4 | Fig: |

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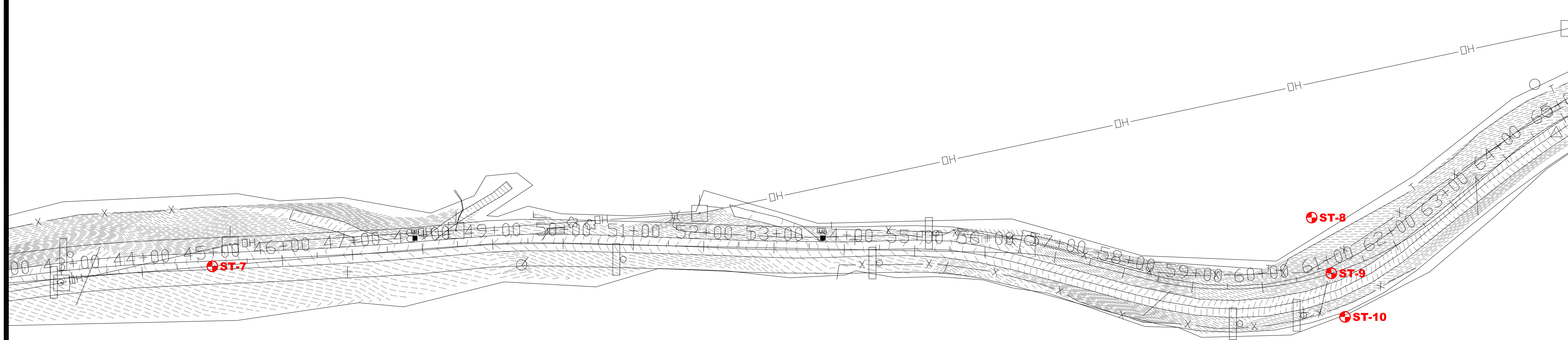
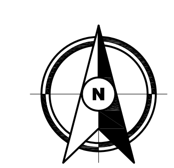



DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING




75' 0 150'

SCALE: 1" = 150'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SOIL BORING LOCATION SKETCH
GEOTECHNICAL EVALUATION
COUNTY HIGHWAY N
COUNTY HIGHWAY 35 TO SLAMA LANE
EASTMAN, WISCONSIN

| | |
|---|---|
| Project No: | B1500554 |
| Drawing No: | B1500554 |
| Scale: | 1" = 150' |
| Drawn By: | BJB |
| Date Drawn: | 4/9/15 |
| Checked By: | NC |
| Last Modified: | 4/9/15 |
| Sheet: 3 of 4 | Fig: |

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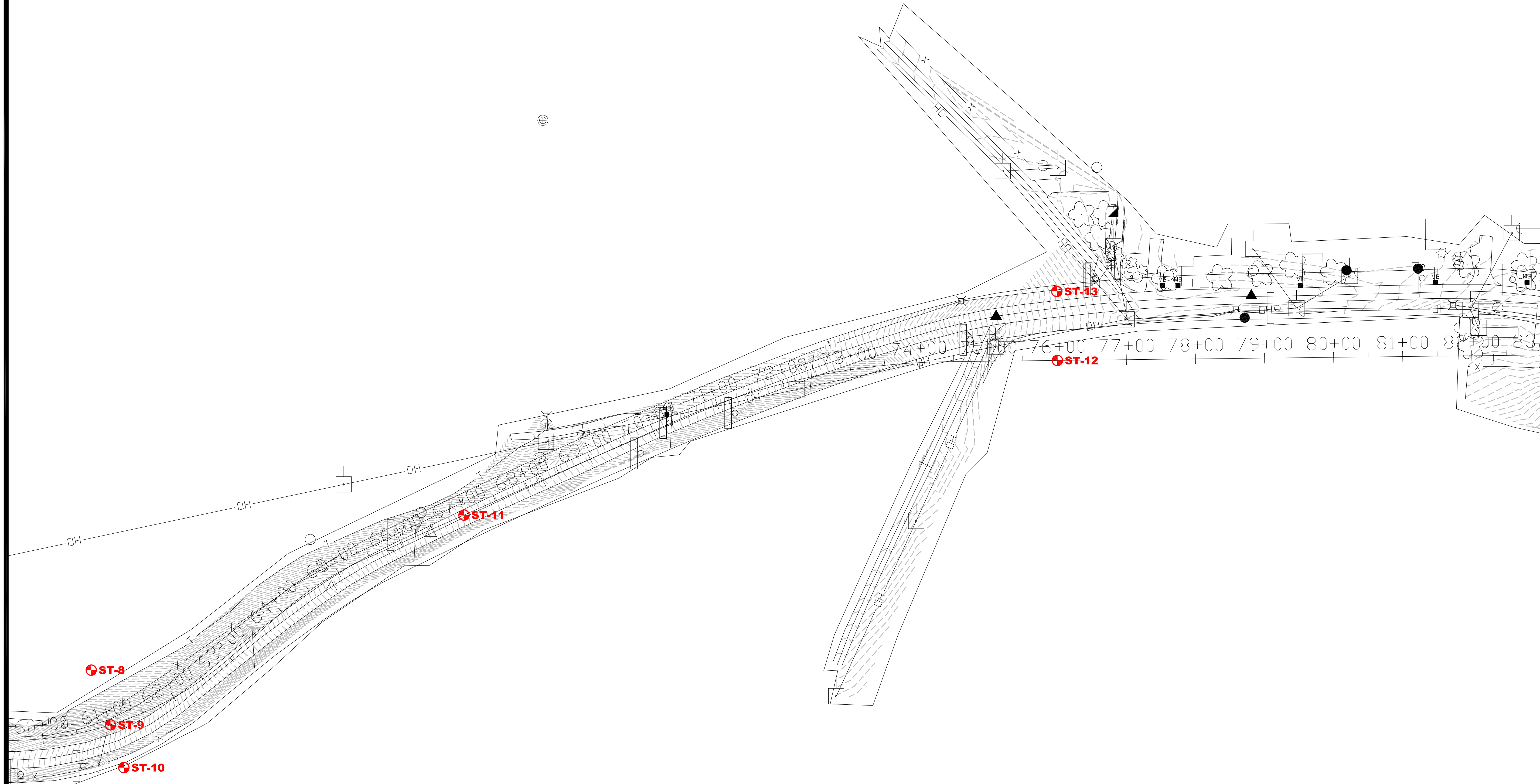


DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

75' 0 150'

SCALE: 1" = 150'

**BRAUN INTERTEC**

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SOIL BORING LOCATION SKETCH
GEOTECHNICAL EVALUATION
COUNTY HIGHWAY N
COUNTY HIGHWAY 35 TO SLAMA LANE
EASTMAN, WISCONSIN

| | |
|---|---|
| Project No: | B1500554 |
| Drawing No: | B1500554 |
| Scale: | 1" = 150' |
| Drawn By: | BJB |
| Date Drawn: | 4/9/15 |
| Checked By: | NC |
| Last Modified: | 4/9/15 |
| Sheet: 4 of 4 | Fig: |

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# LOG OF BORING

**Braun Project B15-00554**
**GEOTECHNICAL EVALUATION**
**County Highway N**
**State Highway 35 to Slama Lane**
**Eastman, Wisconsin**

BORING: **ST- 1**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: **2/17/15** | SCALE: **1" = 5'**

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| 0.7 | TS | 8-inches of Topsoil. | | | |
| 2.0 | FILL | FILL: Silty Sand, fine-grained, brown, frozen. | | | |
| 7.0 | SC | CLAYEY SAND, with Gravel, fine-grained, brown, moist, rather stiff to stiff. (Alluvium) | 12<br>13 | | MC=17%<br>P200=48% |
| 11.0 | SM | SILTY SAND, fine- to medium-dense, trace of gravel, brown, moist, loose. (Alluvium) | 10<br>9 | | |
| | | END OF BORING.<br>Water not observed while drilling.<br>Boring then backfilled. | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\LACROSSE\2015\B15-00554.GPJ BRAUN_V8_CURRENT.GDT 4/15/15 11:04

![BRAUN INTERTEC]

# LOG OF BORING

**Braun Project B15-00554**
**GEOTECHNICAL EVALUATION**
**County Highway N**
**State Highway 35 to Slama Lane**
**Eastman, Wisconsin**

BORING: **ST- 2**
LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: **2/17/15** | SCALE: **1" = 5'**

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| 0.5 | TS | 6-inches of Topsoil. | | | |
| 2.0 | FILL | FILL: Silty Sand, fine-grained, brown, frozen. | | | |
| 7.0 | SC | CLAYEY SAND, fine-grained, trace of gravel, brown, frozen to 3 feet then wet, medium. (Alluvium) | 11<br>6 | | |
| 9.0 | ML | SILT, brown, wet, loose. (Alluvium) | 8 | | |
| 14.0 | SM | SILTY SAND, with Gravel, fine-grained, brown, moist, loose to medium dense. (Alluvium) | 9<br>12 | | |
| 20.0 | SC | CLAYEY SAND, fine-grained, trace of gravel, brown, moist, stiff. (Alluvium) | 15 | | |
| 24.0 | SC | CLAYEY SAND, fine-grained, brown, moist, hard. (Residuum) | 49 | ▬ | |

END OF BORING.

Water not observed while drilling.

Water not observed to cave-in depth of 20 feet immediately after withdrawal of auger.

Auger met refusal at 24 feet.

Boring then backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\LACROSSE\2015\B15-00554.GPJ BRAUN_V8_CURRENT.GDT 4/15/15 11:04

BRAUN INTERTEC

# LOG OF BORING

| Braun Project B15-00554<br>GEOTECHNICAL EVALUATION<br>County Highway N<br>State Highway 35 to Slama Lane<br>Eastman, Wisconsin | BORING: ST- 3<br>LOCATION: See attached Boring Location Sketch. |
|---|---|

| DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/17/15 | SCALE: 1" = 5' |
|---|---|---|---|

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| 0.7 | TS | 8-inches of Topsoil. | | | |
| 4.5 | FILL | FILL: Clayey Sand, fine- to medium-grained, trace of gravel, brown, frozen. | | | |
| | | END OF BORING.<br>Water not observed while drilling.<br>Auger met refusal at 4 1/2 feet.<br>Boring then backfilled. | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\LACROSSE\2015\B15-00554.GPJ BRAUN_V8_CURRENT.GDT 4/15/15 11:04

BRAUN INTERTEC

# LOG OF BORING

**Braun Project B15-00554**
**GEOTECHNICAL EVALUATION**
**County Highway N**
**State Highway 35 to Slama Lane**
**Eastman, Wisconsin**

BORING: **ST- 4**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: **2/17/15** | SCALE: **1" = 5'**

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| 0.5 | TS | 6-inches of Topsoil. | | | |
| | SP | POORLY GRADED SAND, with Gravel, fine-grained, tan, damp, medium dense. (Residuum) | 11 | | |
| | | | 20 | | |
| | | | 19 | | |
| 10.0 | | | 30 | | |
| | | END OF BORING. Water not observed while drilling. Boring then backfilled. | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

# LOG OF BORING

**Braun Project B15-00554**
**GEOTECHNICAL EVALUATION**
**County Highway N**
**State Highway 35 to Slama Lane**
**Eastman, Wisconsin**

BORING: **ST- 6**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: **2/11/15** | SCALE: **1" = 5'**

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| 1.5 | FILL | FILL: Silty Sand, fine-grained, dark brown, frozen. | | | |
| 3.0 | FILL | FILL: Lean Clay, with Sand, tan, frozen. | 5 | | |
| 5.5 | SM | SILTY SAND, trace of roots, dark brown, wet, loose. (Buried Topsoil) | 12 | | |
| 7.0 | GP | POORLY GRADED GRAVEL, with Sand, coarse-grained, light tan, damp, medium dense. (Alluvium) | | | |
| 10.0 | ML | SANDY SILT, fine-grained, brown, moist, loose. (Alluvium) | 5 | | MC=16%<br>P200=51% |
| 15.5 | GP | POORLY GRADED GRAVEL, with Sand, coarse-grained, with layers of brown silty sand, light tan, damp, loose to medium dense. (Alluvium) | 10<br>14<br>17 | | |
| 21.0 | SM | SILTY SAND, with Gravel, brown, moist, medium dense. (Alluvium) | 15 | | |
| | | END OF BORING.<br>Water not observed while drilling.<br>Boring then grouted. | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

# LOG OF BORING

| Braun Project B15-00554<br>GEOTECHNICAL EVALUATION<br>County Highway N<br>State Highway 35 to Slama Lane<br>Eastman, Wisconsin | BORING: ST- 7<br>LOCATION: See attached Boring Location Sketch. |
|---|---|

| DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/9/15 | SCALE: 1" = 5' |
|---|---|---|---|

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| 2.0 | FILL | FILL: Sandy Lean Clay, with Gravel, brown, frozen. | | | |
| 5.0 | FILL | FILL: Silty Sand, with Gravel, brown, frozen to 4-feet then wet. | 17 | | |
| 7.0 | CL | LEAN CLAY, trace of gravel, dark brown, wet, rather soft. (Alluvium) | 5 | | |
| 8.0 | CL | SANDY LEAN CLAY, trace of gravel, brown, wet, medium. (Alluvium) | 6 | ▬ | |
| 11.0 | CL | SANDY LEAN CLAY, trace of gravel, dark brown, wet, medium. (Alluvium) | 4 | | MC=27%<br>OC=9% |
| 12.0 | OL | ORGANIC CLAY, with Sand, black, wet, rather soft. (Alluvium) | | | |
| 14.0 | CL | SANDY LEAN CLAY, with Gravel, dark brown, wet, soft. (Alluvium) | 3 | | |
| 16.0 | CL | SANDY LEAN CLAY, with thin layers of tan sand, brown mix, wet, rather soft. (Alluvium) | 5 | | |
| | | END OF BORING.<br><br>Water not observed while drilling.<br><br>Water not observed to cave-in depth of 8 feet immediately after withdrawal of auger.<br><br>Boring then grouted. | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

# LOG OF BORING

| | |
|---|---|
| **Braun Project B15-00554**<br>**GEOTECHNICAL EVALUATION**<br>**County Highway N**<br>**State Highway 35 to Slama Lane**<br>**Eastman, Wisconsin** | BORING: **ST- 8**<br>LOCATION: See attached Boring Location Sketch. |

| DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: **2/17/15** | SCALE: **1" = 5'** |
|---|---|---|---|

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| 0.5 | TS | 6-inches of Topsoil. | | | |
| 2.0 | SM | SILTY SAND, with Gravel, fine-grained, brown, frozen. (Alluvium) | | | |
| | SS | PRAIRIE DU CHIEN GROUP, SANDSTONE, tan to white, damp, texturally classified as "Poorly Graded Sand (SP)". | * | | *50 blows for 4-inches. |
| | | | * | | *50 blows for 3-inches. |
| | | | * | | *50 blows for 3-inches. |
| | | | * | | *50 blows for 2-inches. |
| | | | * | | *50 blows for 2-inches. |
| | | | * | | *50 blows for 2-inches. |
| 20.0 | | | * | | *50 blows for 1-inch. |
| | | END OF BORING.<br>Water not observed while drilling.<br>Auger met refusal at 20 feet.<br>Boring then backfilled. | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\LACROSSE\2015\B15-00554.GPJ BRAUN_V8_CURRENT.GDT 4/15/15 11:05

BRAUN[SM]
INTERTEC

# LOG OF BORING

| Braun Project B15-00554<br>GEOTECHNICAL EVALUATION<br>County Highway N<br>State Highway 35 to Slama Lane<br>Eastman, Wisconsin | | BORING: ST- 9<br>LOCATION: See attached Boring Location Sketch. | |
|---|---|---|---|
| DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/9/15 | SCALE: 1" = 5' |

| Depth feet 0.0 | Symbol | | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|---|
| 2.0 | FILL | | FILL: Silty Sand, with Gravel, fine-grained, dark brown, frozen. | | | |
| 4.0 | CL | | LEAN CLAY, dark brown, wet, hard. (Residuum) | 45 | | MC=16%<br>DD=106 pcf |
| 5.0 | SS | | PRAIRIE DU CHIEN GROUP, SANDSTONE, tan, damp, texurally classified as "Poorly Graded Sand (SP)". | * | | *50 blows for 0-inches. |
| | | | END OF BORING.<br><br>Water not observed while drilling.<br><br>Boring then grouted. | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\LACROSSE\2015\B15-00554.GPJ BRAUN_V8_CURRENT.GDT 4/15/15 11:05

BRAUN INTERTEC

# LOG OF BORING

| | |
|---|---|
| **Braun Project B15-00554**<br>**GEOTECHNICAL EVALUATION**<br>**County Highway N**<br>**State Highway 35 to Slama Lane**<br>**Eastman, Wisconsin** | BORING: **ST-10**<br>LOCATION: See attached Boring Location Sketch. |
| DRILLER: GDC — METHOD: 3 1/4" HSA, Autohammer | DATE: **2/9/15** — SCALE: **1" = 5'** |

(See Descriptive Terminology sheet for explanation of abbreviations)

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| | CL | LEAN CLAY, brown, wet, frozen to 4-feet then soft. (Alluvium) | 32 | | |
| | | | 3 | | |
| 7.0 | CL | LEAN CLAY, brown, wet, medium to rather stiff. (Alluvium) | 7 | | MC=21%<br>DD=98 pcf |
| | | | 10 | | |
| | | | 11 | | |
| 15.5 | LS | PRAIRIE DU CHIEN, FORMATION, LIMESTONE, tan, damp, texturally classified as "Poorly Graded Gravel with Sand (GP)". | 52 | | |
| 18.0 | | END OF BORING.<br><br>Water not observed while drilling.<br><br>Water not observed to cave-in depth of 11 feet immediately after withdrawal of auger.<br><br>Auger met refusal at 18 feet.<br><br>Boring then grouted. | | | |

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BRAUN INTERTEC

# LOG OF BORING

**Braun Project B15-00554**
**GEOTECHNICAL EVALUATION**
**County Highway N**
**State Highway 35 to Slama Lane**
**Eastman, Wisconsin**

BORING: **ST-11**

LOCATION: See attached Boring Location Sketch.

| DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/9/15 | SCALE: 1" = 5' |
|---|---|---|---|

| Depth feet 0.0 | Symbol | | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|---|
| 2.0 | FILL | | FILL: Silty Sand, with Gravel, fine-grained, dark brown, frozen. | | | |
| 4.0 | CL | | LEAN CLAY, with Sand, dark brown, frozen to wet, medium. (Alluvium) | 7 | | MC=20%<br>P200=85% |
| 6.0 | CL | | LEAN CLAY, trace of gravel, green-brown, wet, very stiff. (Alluvium) | 16 | | |
| | | | END OF BORING.<br>Water not observed while drilling.<br>Boring then grouted. | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\LACROSSE\2015\B15-00554.GPJ BRAUN_V8_CURRENT.GDT 4/15/15 11:05

BRAUN INTERTEC

# LOG OF BORING

| Braun Project B15-00554<br>GEOTECHNICAL EVALUATION<br>County Highway N<br>State Highway 35 to Slama Lane<br>Eastman, Wisconsin | BORING: ST-12<br>LOCATION: See attached Boring Location Sketch. |
|---|---|
| DRILLER: GDC   METHOD: 3 1/4" HSA, Autohammer | DATE: 2/11/15   SCALE: 1" = 5' |

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| 0.5 | TS | 6-inches of Topsoil. | | | |
| 2.0 | CL | LEAN CLAY, brown, frozen. (Alluvium) | | | |
| 12.0 | CL | LEAN CLAY, brown, frozen to 4 feet then wet, rather soft to soft. (Alluvium) | 7<br>5<br>2<br>3 | | MC=25%<br>DD=97 pcf |
| 31.0 | CL | SANDY LEAN CLAY, trace of gravel, red-brown, wet, stiff to very stiff. (Alluvium) | 16<br>14<br>19<br>15<br>19 | | |
| | | END OF BORING.<br><br>Water not observed while drilling.<br><br>Water not observed to cave-in depth of 12 feet immediately after withdrawal of auger.<br><br>Boring then grouted. | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

# LOG OF BORING

| Braun Project B15-00554<br>GEOTECHNICAL EVALUATION<br>County Highway N<br>State Highway 35 to Slama Lane<br>Eastman, Wisconsin | BORING: ST-13<br>LOCATION: See attached Boring Location Sketch. |
|---|---|

| DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/9/15 | SCALE: 1" = 5' |
|---|---|---|---|

| Depth feet 0.0 | Symbol | Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908) | BPF | WL | Tests or Notes |
|---|---|---|---|---|---|
| 2.0 | FILL | FILL: Silty Sand, fine-grained, trace of gravel, brown, frozen. | | | |
| 10.5 | CL | LEAN CLAY, brown, frozen to 4 feet then wet, rather soft to medium. (Alluvium) | 6<br>5<br>7 | | MC=24%<br>P200=98% |
| 13.0 | CL | LEAN CLAY, with Sand, trace of gravel, red-brown, wet, rather stiff. (Alluvium) | 10 | | |
| 14.0 | CL | LEAN CLAY, brown, wet, rather stiff. (Alluvium) | 10 | | |
| 15.5 | CL | LEAN CLAY, red-brown, wet, rather stiff. (Alluvium) | | | |
| 16.0 | SP | PRAIRIE DU CHIEN GROUP, SANDSTONE, tan, moist, texturally classified as "Poorly Graded Sand (SP). (Residuum) | 59 | | |

END OF BORING.

Water not observed while drilling.

Water not observed to cave-in depth of 7 feet immediately after withdrawal of auger.

Boring then grouted.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\LACROSSE\2015\B15-00554.GPJ BRAUN_V8_CURRENT.GDT 4/15/15 11:05

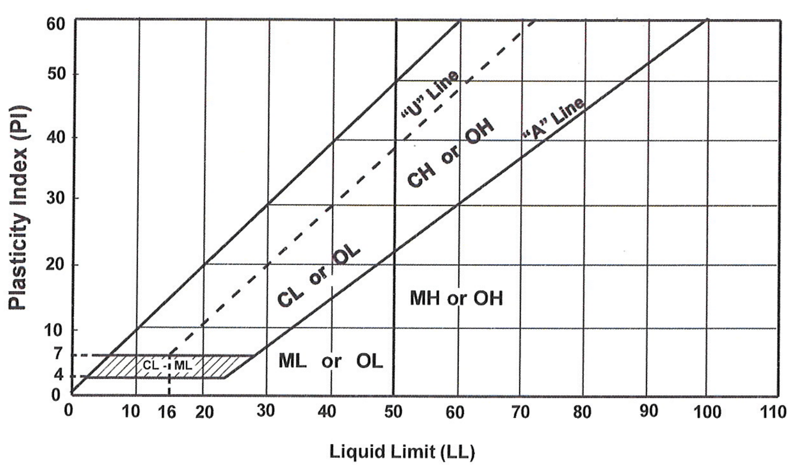
**BRAUN INTERTEC**

# Descriptive Terminology of Soil

**Standard D 2487 - 00**
**Classification of Soils for Engineering Purposes**
**(Unified Soil Classification System)**

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a] | | | | Soils Classification: Group Symbol | Soils Classification: Group Name [b] |
|---|---|---|---|---|---|
| Coarse-grained Soils more than 50% retained on No. 200 sieve | Gravels More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels 5% or less fines [e] | $C_u \geq 4$ and $1 \leq C_c \leq 3$ [c] | GW | Well-graded gravel [d] |
| | | | $C_u < 4$ and/or $1 > C_c > 3$ [c] | GP | Poorly graded gravel [d] |
| | | Gravels with Fines More than 12% fines [e] | Fines classify as ML or MH | GM | Silty gravel [d f g] |
| | | | Fines classify as CL or CH | GC | Clayey gravel [d f g] |
| | Sands 50% or more of coarse fraction passes No. 4 sieve | Clean Sands 5% or less fines [i] | $C_u \geq 6$ and $1 \leq C_c \leq 3$ [c] | SW | Well-graded sand [h] |
| | | | $C_u < 6$ and/or $1 > C_c > 3$ [c] | SP | Poorly graded sand [h] |
| | | Sands with Fines More than 12% [i] | Fines classify as ML or MH | SM | Silty sand [f g h] |
| | | | Fines classify as CL or CH | SC | Clayey sand [f g h] |
| Fine-grained Soils 50% or more passed the No. 200 sieve | Silts and Clays Liquid limit less than 50 | Inorganic | PI > 7 and plots on or above "A" line [j] | CL | Lean clay [k l m] |
| | | | PI < 4 or plots below "A" line [j] | ML | Silt [k l m] |
| | | Organic | Liquid limit - oven dried / Liquid limit - not dried < 0.75 | OL | Organic clay [k l m n] |
| | | | | OL | Organic silt [k l m o] |
| | Silts and clays Liquid limit 50 or more | Inorganic | PI plots on or above "A" line | CH | Fat clay [k l m] |
| | | | PI plots below "A" line | MH | Elastic silt [k l m] |
| | | Organic | Liquid limit - oven dried / Liquid limit - not dried < 0.75 | OH | Organic clay [k l m p] |
| | | | | OH | Organic silt [k l m q] |
| Highly Organic Soils | Primarily organic matter, dark in color and organic odor | | | PT | Peat |

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.




## Laboratory Tests

| | | | |
|---|---|---|---|
| DD | Dry density, pcf | OC | Organic content, % |
| WD | Wet density, pcf | S | Percent of saturation, % |
| MC | Natural moisture content, % | SG | Specific gravity |
| LL | Liquid limit, % | C | Cohesion, psf |
| PL | Plastic limit, % | ∅ | Angle of internal friction |
| PI | Plasticity index, % | qu | Unconfined compressive strength, psf |
| P200 | % passing 200 sieve | qp | Pocket penetrometer strength, tsf |

## Particle Size Identification

Boulders .............................. over 12"
Cobbles .............................. 3" to 12"
Gravel
  Coarse ........................... 3/4" to 3"
  Fine ................................ No. 4 to 3/4"
Sand
  Coarse ........................... No. 4 to No. 10
  Medium .......................... No. 10 to No. 40
  Fine ................................ No. 40 to No. 200
Silt ....................................... < No. 200, PI < 4 or below "A" line
Clay ..................................... < No. 200, PI ≥ 4 and on or above "A" line

## Relative Density of Cohesionless Soils

Very loose ............................... 0 to 4 BPF
Loose ...................................... 5 to 10 BPF
Medium dense ......................... 11 to 30 BPF
Dense ...................................... 31 to 50 BPF
Very dense .............................. over 50 BPF

## Consistency of Cohesive Soils

Very soft .................................. 0 to 1 BPF
Soft ........................................ 2 to 3 BPF
Rather soft .............................. 4 to 5 BPF
Medium ................................... 6 to 8 BPF
Rather stiff .............................. 9 to 12 BPF
Stiff ........................................ 13 to 16 BPF
Very stiff .................................. 17 to 30 BPF
Hard ....................................... over 30 BPF

## Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

**BPF:** Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

**WH:** WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

**WR:** WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

**TW** indicates thin-walled (undisturbed) tube sample.

**Note:** All tests were run in general accordance with applicable ASTM standards.

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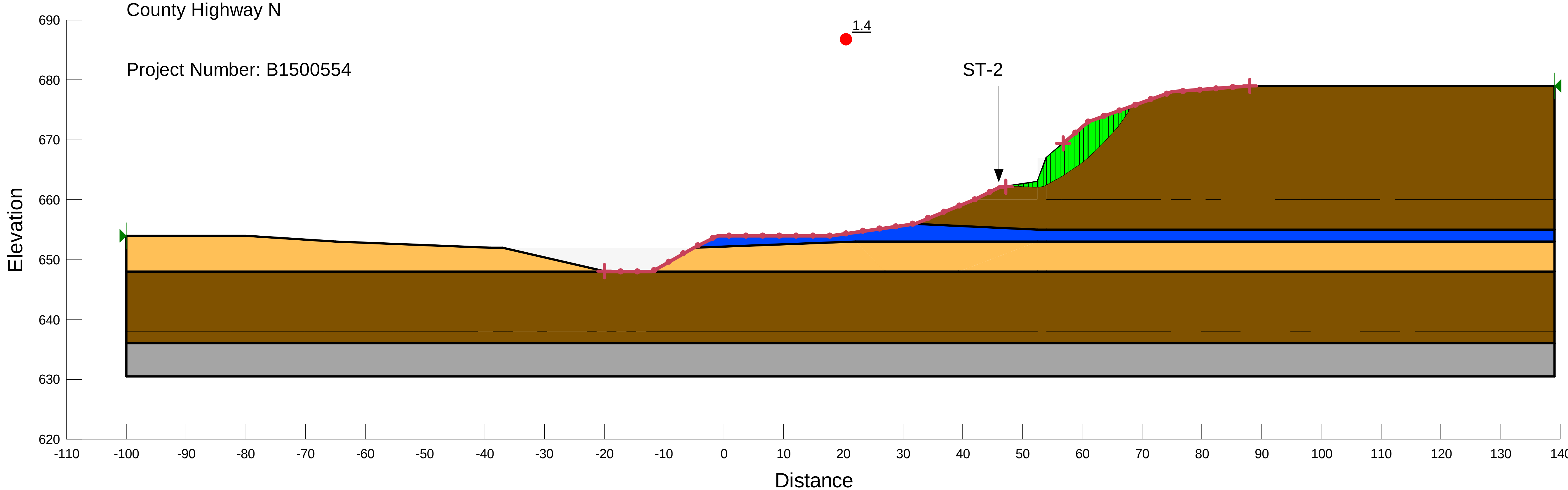
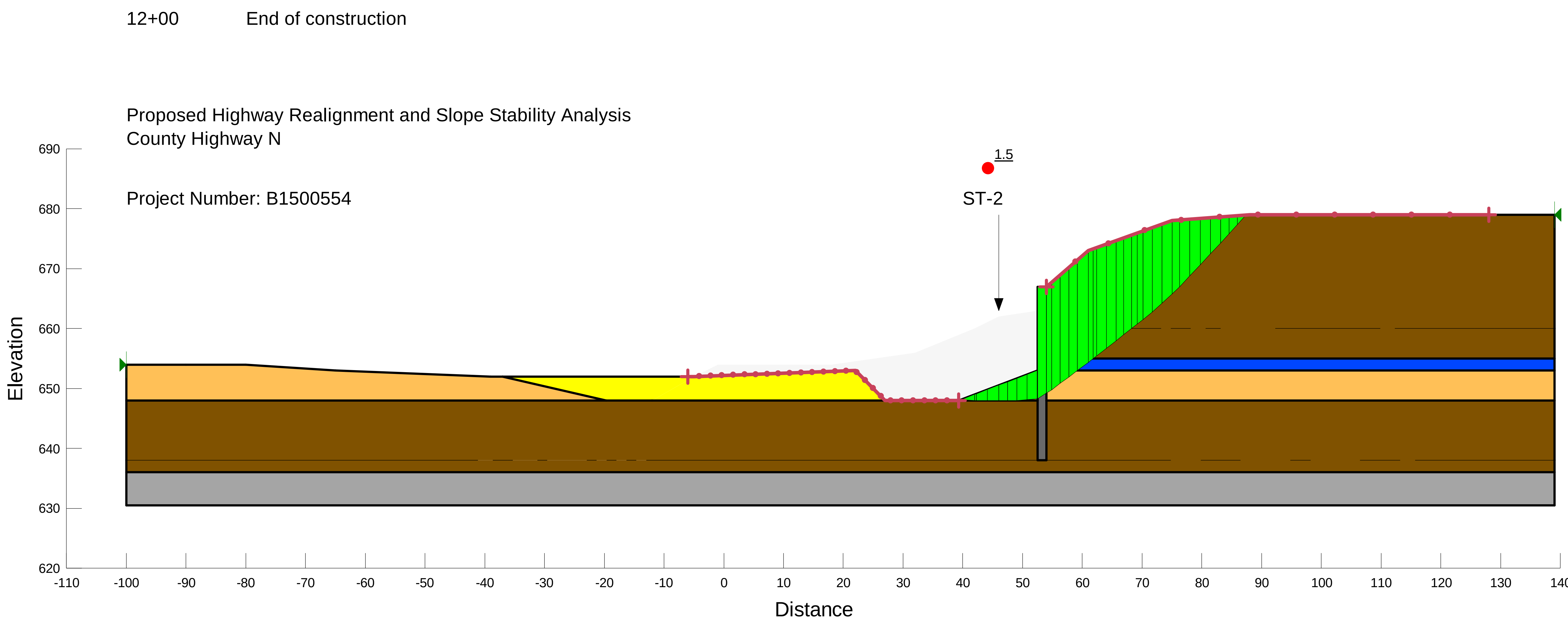
Proposed Highway Realignment and Slope Stability Analysis
County Highway N

Project Number: B1500554

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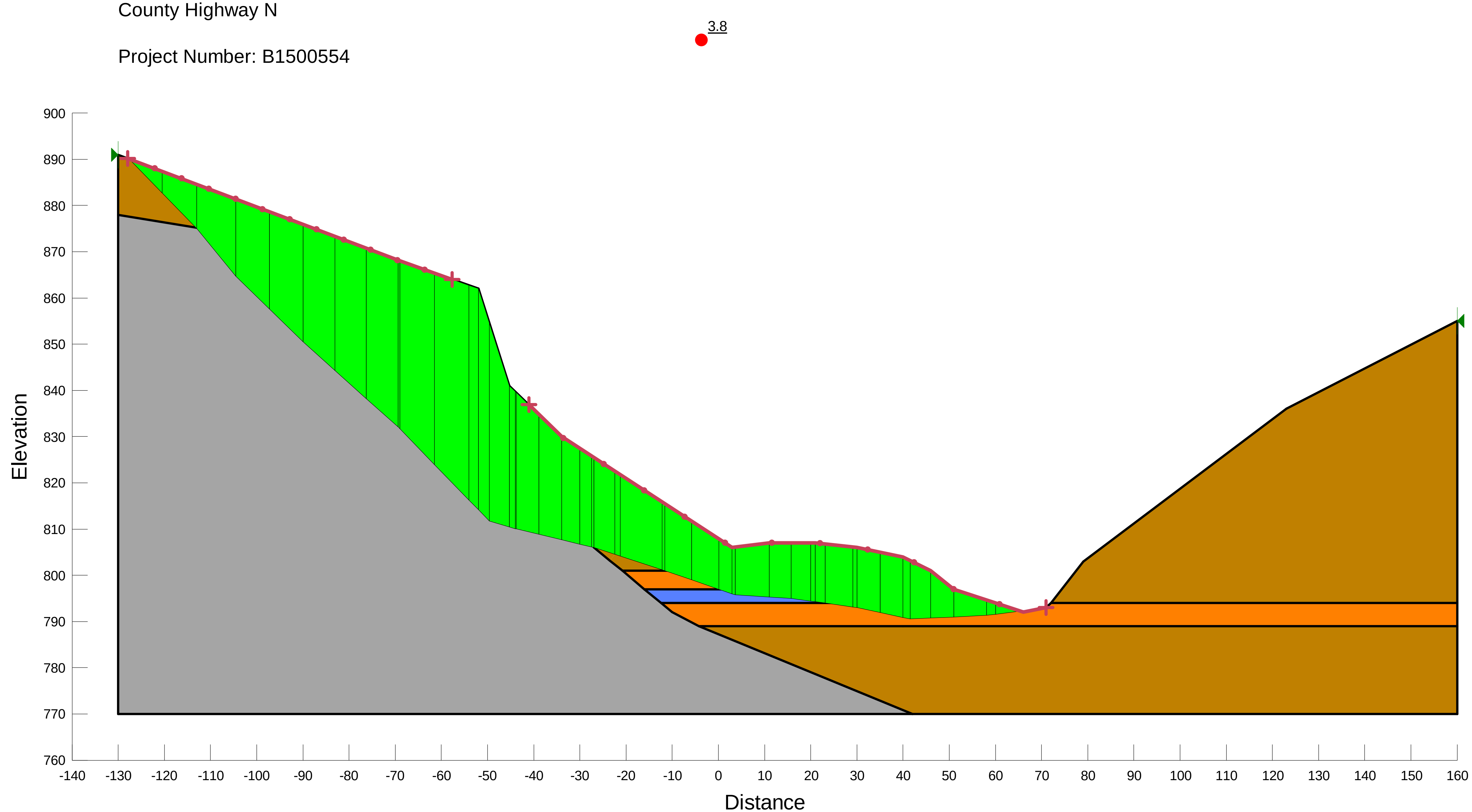
End of construction
Proposed Highway Realignment and Slope Stability Analysis
County Highway N
Project Number: B1500554
1.5
ST-2
Elevation
690
680
670
660
650
640
630
620
-110
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Distance

37+00 In-situ

Proposed Highway Realignment and Slope Stability Analysis
County Highway N

Project Number: B1500554



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Proposed Highway Realignment and Slope Stability Analysis
County Highway N

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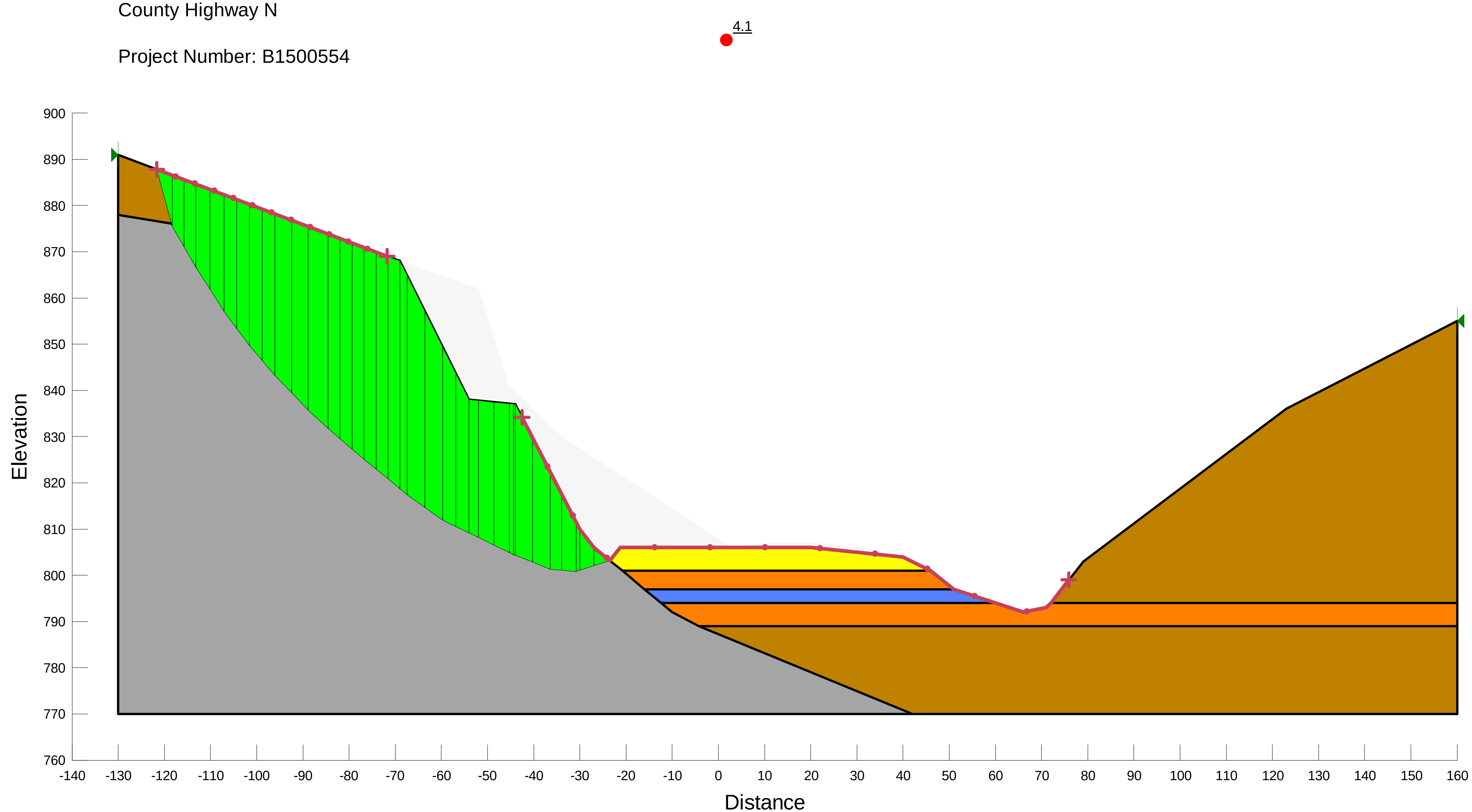
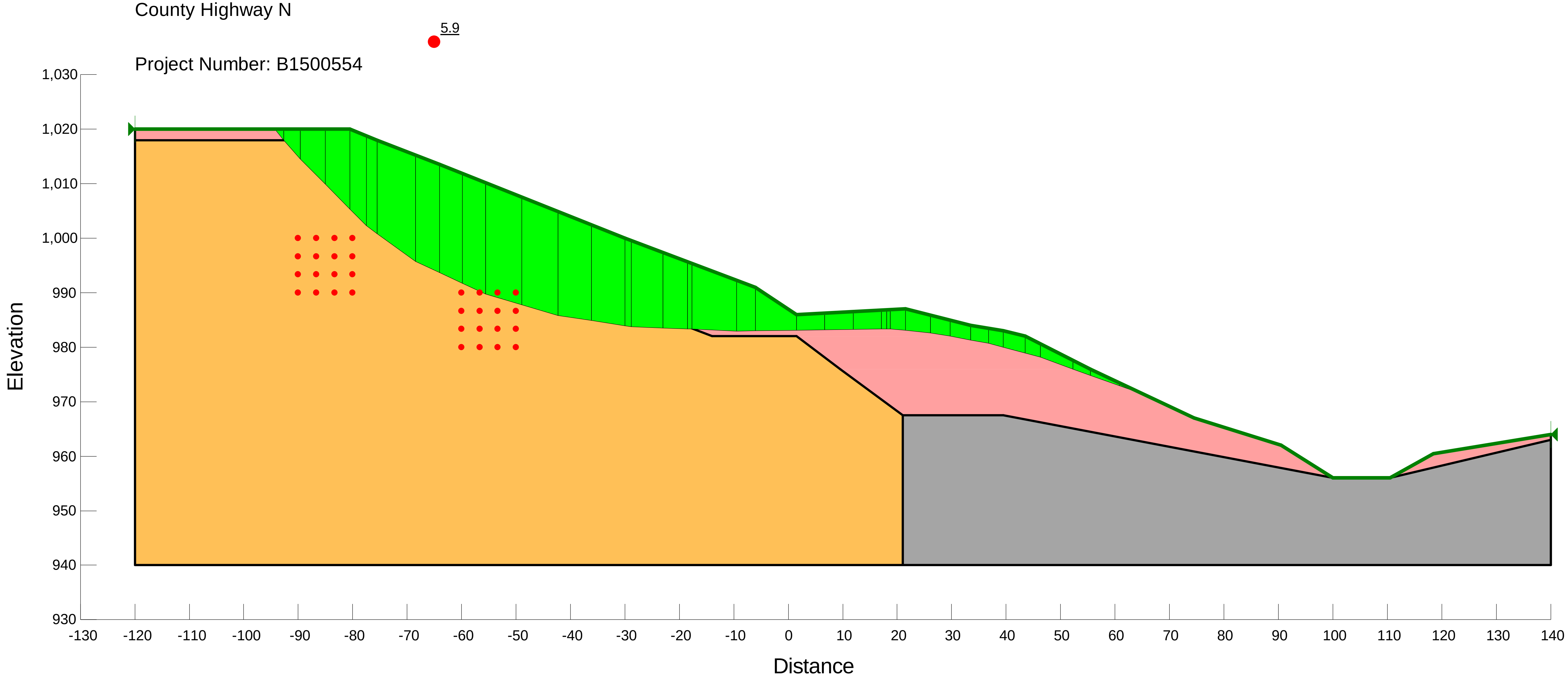


61+00 In-situ

Proposed Highway Realignment and Slope Stability Analysis
County Highway N

Project Number: B1500554



61+00 End of construction

Proposed Highway Realignment and Slope Stability Analysis
County Highway N

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