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October 10, 2016

Mr. Nate Will, P.E./Ms. Amber Klein, P.E.
SRF Consulting Group, Inc.
One Carlson Parkway North
Plymouth MN 55447

GTE Project No. 95423-C

RE: Geotechnical Engineering Project Memo- Hennepin County CSAH 112 Phase 2 – Roadway Embankment Construction Over/Adjacent to Soft Ground Encroachment Areas in Long Lake, MN

Dear Mr. Will/Ms. Klein:

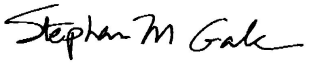
In our meeting on September 28, we discussed some additional considerations with respect to roadway embankment construction over/adjacent to the soft ground areas, located approximately between stations 1191+00 – 1193+50 and 1198+00 – 1201+00. This memo addresses the additional considerations, listed below, and should be considered complementary to our Geotechnical Report dated September 16, 2016.

- Foundation Recommendations for roadway embankment widening on South (RT) side of CSAH 112 approximately between stations 1191+00 – 1193+50
- Revised Surcharge Limits for roadway embankment widening on North (LT) side of CSAH 112 approximately between stations 1191+00 – 1193+50
- Limits of potential 1H:2.75V RSS for roadway embankment widening on North (LT) side of CSAH 112 approximately between stations 1191+00 – 1193+50

If you have any questions concerning this memo, please do not hesitate to contact us.

Respectfully,

GALE-TEC ENGINEERING, INC.



Nathan M. Lichty, P.E.
Project Engineer

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Principal Engineer

NML/SMG/pjk
REPORT/SRF, Blue Earth County CSAH 1

GEOTECHNICAL PROJECT MEMO FOR CSAH 112 – ADDITIONAL GEOTECHNICAL CONSIDERATIONS FOR SOFT GROUND AREAS

1.0 INTRODUCTION

After recent discussions SRF Consulting Group, Inc. we understand that the construction technique used in the soft ground areas, between approximately stations 1191+00 – 1193+50 and 1198+00 – 1201+00, is likely to be dependent on the maintenance of traffic plan and whether a bike trail is included in the typical pavement section on the north (LT) side of the CSAH 112. In our geotechnical report we discussed several potential construction techniques including: removal and replacement, stage loading and surcharge with/without wick drain inclusion and RSS construction to reduce/avoid wetland encroachment. Both wetlands contain approximately 13 – 15ft of unsuitable soils and are located on the north (LT) side of the existing roadway alignment. The technique that is chosen for roadway embankment widening in the soft ground areas will be largely dependent on the required roadway embankment crest width, which is determined by the MOT plan and/or bike trail inclusion.

We understand that SRF's current preliminary MOT plan includes construction of two temporary traffic lanes on the LT side of the existing CSAH 112 centerline to facilitate maintaining two lanes of traffic during CSAH 112 reconstruction. Near Station 1192+50 construction of the temporary traffic lanes requires the roadway embankments left shoulder PI to extend out to approximately 33ft LT approximately 12 – 15ft from the existing shoulder PI. This embankment geometry extends the new roadway embankment footprint out approximately 30ft out into the undisturbed wetland, assuming 3H:1V sideslopes.

We understand that the County is currently considering the inclusion of a bike trail, which would be located on the north (LT) of CSAH112 along the entire Phase 2 alignment. The approximately 8ft wide bike trail would require the roadway embankments left shoulder PI to extend approximately 25ft out past the existing roadway embankment shoulder PI.

2.0 SURCHARGE LIMITS ON ROADWAY EMBANKMENT CREST

One method for roadway embankment construction includes constructing over the soft, swamp deposited soils using a stage loading and surcharge technique. This method, discussed in our September 16, 2016 geotechnical report, would require a 5ft surcharge be placed over the widened roadway embankment wing for a period of 9 – 12 months. The surcharge would typically be placed at any location within the embankment footprint where a grade raise would be required. Based on the cross sections provided to us by SRF, we estimated that the full height surcharge would need to extend to approximately 20ft LT. A temporary grade separation structure, such as a Jersey barrier or vertical geosynthetic wrapped wall, could be placed to minimize the surcharge impact on the existing roadway embankment crest.

SRF has indicated that to facilitate temporary pavement placement for the MOT plan, the surcharge may need to end at 30ft LT, or 10ft left of the existing roadway embankment shoulder PI. Revision of the surcharge limits on the roadway embankment crest would change how the effective stress increase due to the surcharge is distributed into the underlying soft soils beneath/adjacent to the existing roadway embankment. If portions of the underlying soft soils are not appropriately "overstressed" by the surcharge, the roadway embankment could be subject to long term differential settlement. Long term settlement could result in poor pavement performance and cause distress to the proposed storm sewer system.

To investigate the revised surcharge limits and their impact on the underlying soft soils we performed a stress distribution analysis using the computer program Sigma-W by Geostudios, Inc. Sigma-W is a finite element program that can be used to calculate changes in stress in underlying soil strata due to embankment construction. In this case, the change in stress caused by surcharge placement on the widened roadway embankment was determined at several elevations and offsets within the underlying soft soil beneath the proposed widened embankment footprint. The limits of the surcharge were adjusted from 20ft to 30ft LT to determine the stress difference induced on the compressive soils, and if it would still be adequate to provide the required amount of over-stressing and thus settlement.

The analysis was performed on the cross section at station 1192+50, which was provided to us by SRF in a preliminary cross section dated 10/4/2016. The soil conditions used for the analysis were based on the results of the soil boring logs and the soft soil limits were the same as those discussed in our September 16th geotechnical report. The soil compressive properties, given in the Table below, were estimated based on the results of the subsurface exploration and our experience with similar soil conditions.

Table No. 1: Summary of Soil Compressibility Parameters used in Stress Distribution Analysis

Soil Layer	In-Situ Density (pcf)	Static Modulus (E) (psf)	Poisson's Ratio
Embankment/Surcharge Fill	120	850,000	0.49
Consolidated Peat	90	100,000	0.30
Undisturbed Peat	70	58,000	0.4
Consolidated Clay	110	125,000	0.30
Undisturbed Soft Clay	100	58,000	0.4

A sample analysis output is given in the figures below. The illustration indictes the stain induced in the underlying soft soils beneath the embankment footprint. The graphical output indicates the change in stress in the underlying soft soil caused by varying the surcharge limits.

Figure No. 1: Sample Analysis Output: Strain induced in underlying Soft Soils due to Embankment Widening/Surcharge Placement

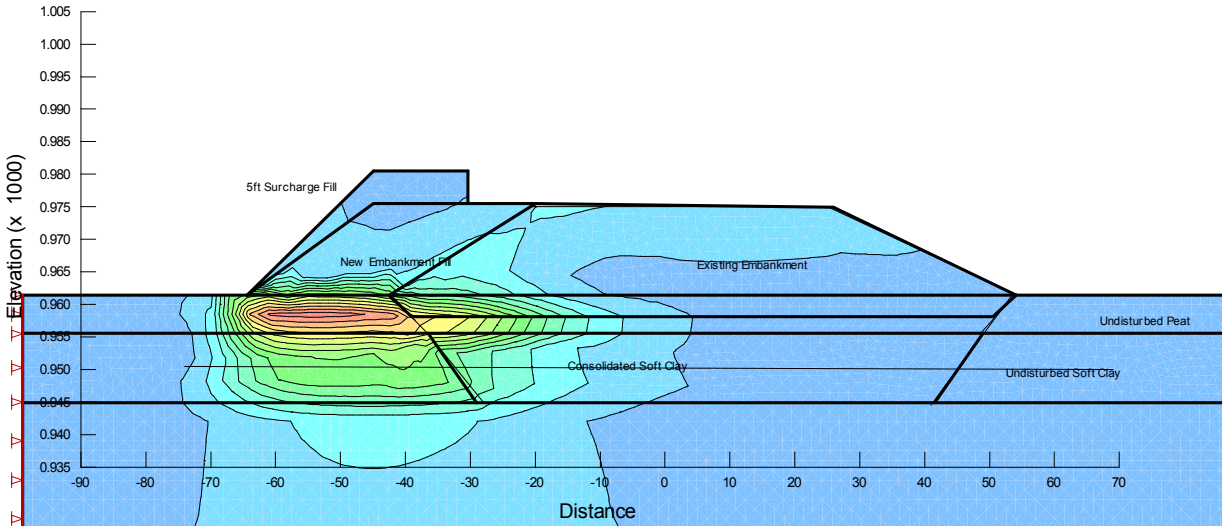


Figure No. 2: Graphical Results of Analysis, Stress Change caused by Varying Surcharge Limits at Midpoint of Soft Soil Layer

(INSERT EXCEL GRAPH USING FRONT COMPUTER)

The results of the analysis indicate that if the surcharge limits are revised from 20ft LT to 30ft LF then greater than 200- 250 psf will be induced on the underlying soft soil by the revised surcharge limits. We estimate that this stress increase is sufficient to provide adequate overstressing and settlement in the underlying soft soil layer during the surcharge period.

If this revised surcharge limit is implemented between stations 1191+00 – 1193+50, then it is recommended that geotechnical instrumentation, in the form of settlement plates and vibrating wire piezometers, be installed to monitor soft soil settlement and pore water pressure dissipation during the surcharge period. This observational approach during construction may indicate that additional surcharge will be required due to the reduced stress that will be applied to the underlying soft soils by the revised surcharge limits.

3.0 RSS CONSTRUCTION LIMITS ON ROADWAY EMBANKMENT CREST

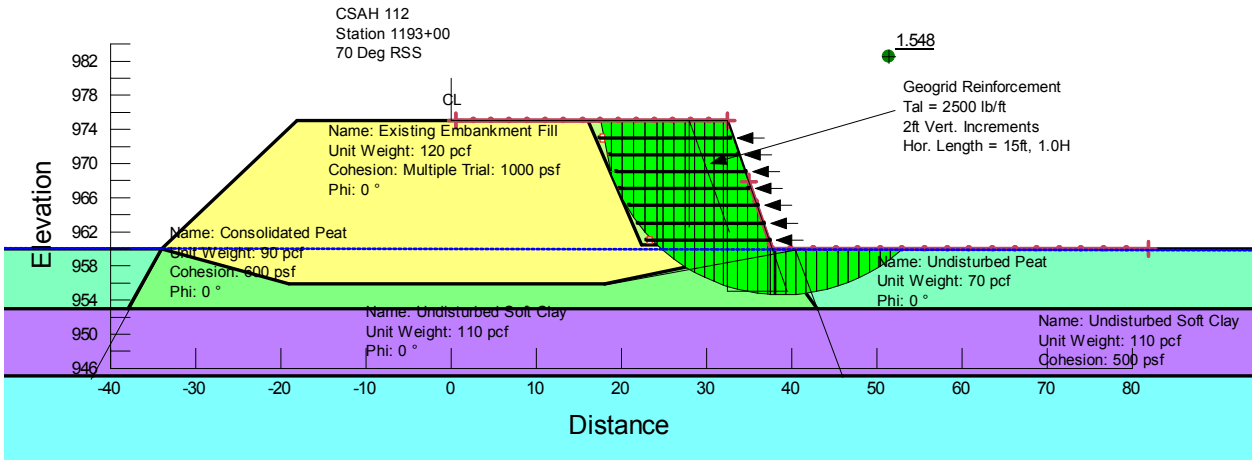
In our September 16, 2016 geotechnical report, we indicated that one method for roadway embankment widening could be to construct a 1H:2.75V RSS between stations 1190+00 – 1193+50 to create a widened roadway embankment crest without encroaching into the adjacent wetland. A 1H:2.75V RSS was recommended as a grade separation

structure because would to keep the widened embankment within the existing embankment footprint as well as be tolerable to some settlement that may occur due to potential soft soils located beneath the existing embankment. This settlement potential would likely require concrete face grade separation structures to be located on piles, which would not be a cost effective solution.

One RSS requirement is that it must be constructed over a stable foundation, or within the footprint of the existing roadway embankment. If the bike trail is included on the embankment crest, then the RSS option would not be feasible. If the bike trail is not included, then an RSS could be constructed up to a given Shoulder PI offset before an adequate factor of safety with respect to embankment stability could not be maintained. A slope stability evaluation was performed to determine the offset limit that could facilitate RSS construction.

The stabilility analysis was performed at station 1193+00 using the same soil stratigraphy and strength parameters discussed in our September 16, 2016 geotechnical report. The computer program Slope-W by Geostudios, Inc. was employed used the Spencer's method of limit eqiuilibrium to assess global embankment stability with respect to RSS construction. The shoulder PI, or RSS crest, we increased and extended out until the minimum recommended factor of safety (1.5) was obtained. The results of the stability analysis are illustrated in Figure No. 3 below.

Figure No. 3:



The results of the stability analysis indicate that an RSS, constructed with geogrid reinforcement with a Tal = 2500 lb/ft placed at horizontal lengths of 1.0H (15ft) in 2ft vertical increments, can be constructed out to a shoulder PI of approximately 33ft LT at station 1193+00. This corresponds to the toe of the RSS being approximately at the toe of the existing roadway embankment, near a 40ft offset.

5.0 EMBANKMENT WIDENING ON SOUTH SIDE OF ROADWAY – STATIONS 1191+00 – 1194+00

According to the SRF preliminary Phase 2 Layout, a small wetland area exists on the south side of the existing roadway embankment approximately between stations 1191+00 and 1194+00. This wetland area was visually inspected during the GTE subsurface exploration and no evidence of soft soils was observed. Previous soil borings, performed as part of the preliminary design in 2012, indicated the presence of 1-2ft of consolidated peat and organic clay beneath the existing roadway embankment. We estimate that the existing roadway embankment was originally constructed on the edge of the wetland in this area, thus the presence of consolidated swamp deposited soils beneath the embankment and not on the south side.

Current roadway reconstruction plans indicate the roadway embankment crest to be widened out 5ft or less on the south (RT) side of the embankment. As such, we recommend that a subcut be performed in the area beneath the proposed embankment footprint between stations 1191+00 – 1194+00 on the south (RT) side of the embankment. The subcut should be at least 2ft and extend to soils containing an organic content of less than 6%, a moisture content of less than 35% and an unconfined compsressive strength of at least 0.5 tsf.

5.0 GENERAL QUALIFICATIONS

This geotechnical project memo has been prepared in order to aid in the evaluation of the proposed roadway and to assist SRF Consulting Group, Inc. in the design of Hennepin County CSAH 112. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects relevant to soil and foundation characteristics. In the event that any changes in the design, as outlined in this report, are planned, we should be informed so that changes can be reviewed and the conclusion of this report modified or approved in writing. As a check, we recommend that we be authorized to review project plans and specifications to confirm that our report recommendations have been interpreted in accordance with our intent. Without this review, we will not be responsible for misinterpretations of our data, or analysis and/or our recommendations nor how these are incorporated into the final design.

The analysis and recommendations are based on the data obtained from soil borings performed at the locations indicated in this report. This report does not reflect any variations which may occur between these borings. In the performance of subsurface explorations, specific information is obtained at specific locations and at specific times. It is a well-known fact that variations in soil conditions occur in most sites between boring locations. The nature and extent of the variation may not become evident until the course of construction. If variations appear event during foundation installation, it will be necessary for a re-evaluation of the recommendations of this report after performing

on-site observations during the construction period and noting the characteristics of any variations.