AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Ken Upmal, P.E., Roadway Design Project Manager
SPM

From: Stephen Madden, Geotechnical Engineer via Callie Ewald, P.E., Geotechnical Engineering Manager
CEE

Date: December 15th, 2017

Subject: Poultney STP 015-2(9) – Geotechnical Memo

1.0 INTRODUCTION

As requested, we have completed our geotechnical assessment for a section of the Poultney STP 015-2(9) project, located along VT Route 30 in the town of Poultney, Vermont. We were notified in an email from Susan Zwick, dated December 6th, 2017, that the latest design involves installation of a typical roadway section that includes a 1 foot wide RT shoulder, two 11 foot wide travel lanes, a 4 foot wide LT shoulder, and a guardrail with 8-foot posts. The length of the guard-railed section where slopes are to be over-steepened is approximately 500 feet. This typical would result in side slopes of 1:1.2 due to right of way and construction limitations. It was requested that we assess the stability of the proposed 1:1.2 side slope using 1 foot of stone reinforcement for this 500 foot section.

A previous Geotechnical Report submitted by Marcy Meyers on April, 5th 2013 details the subsurface investigations performed at the site and the subsequent slope stability analyses, and the parameters and soil profiles developed as part of this initial report were used as the basis for this updated analysis. Please refer to this report for details of the boring operations, lab testing, and slope stability analyses conducted. Contained herein are the results of our updated slope stability analyses and geotechnical recommendations.

2.0 ANALYSIS

2.1 Proposed Typical Section

A series of computer models were developed for the proposed conditions using a software program called Slide, version 6.0, developed by Rocscience. This program considers both rotational and translational failure mechanisms. Cross sections at 50 foot intervals between Stations 279+50 and 281+00 were provided in the December 6th, 2017 email. The typical roadway dimensions, as described above, were incorporated into the Slide models that were previously developed for the project and the soil properties established for the prior analyses were used. Based on the cross sections provided, a 12 inch layer of Type II stone fill covered with 6 inches of grubbing material is to be applied to the face of the slope. Based on the information obtained from the borings, and given the proposed replacement of existing subbase materials as part of this project, a groundwater depth of 5 feet below the pavement surface was assumed for the analyses.

According to the VTrans Slope Stability Investigation and Evaluation Manual, GEI 14-01, the Spencer method is recommended to be used for slope stability analyses for failure surfaces of

any shape and a minimum factor of safety of 1.3 shall be used for slopes adjacent to but not directly supporting structures. Below, in Figure 2.1, is the model output using the Spencer method showing the minimum factor or safety of 1.01 under the proposed typical section conditions. The proposed slope steepening and stone fill does not meet design requirements.

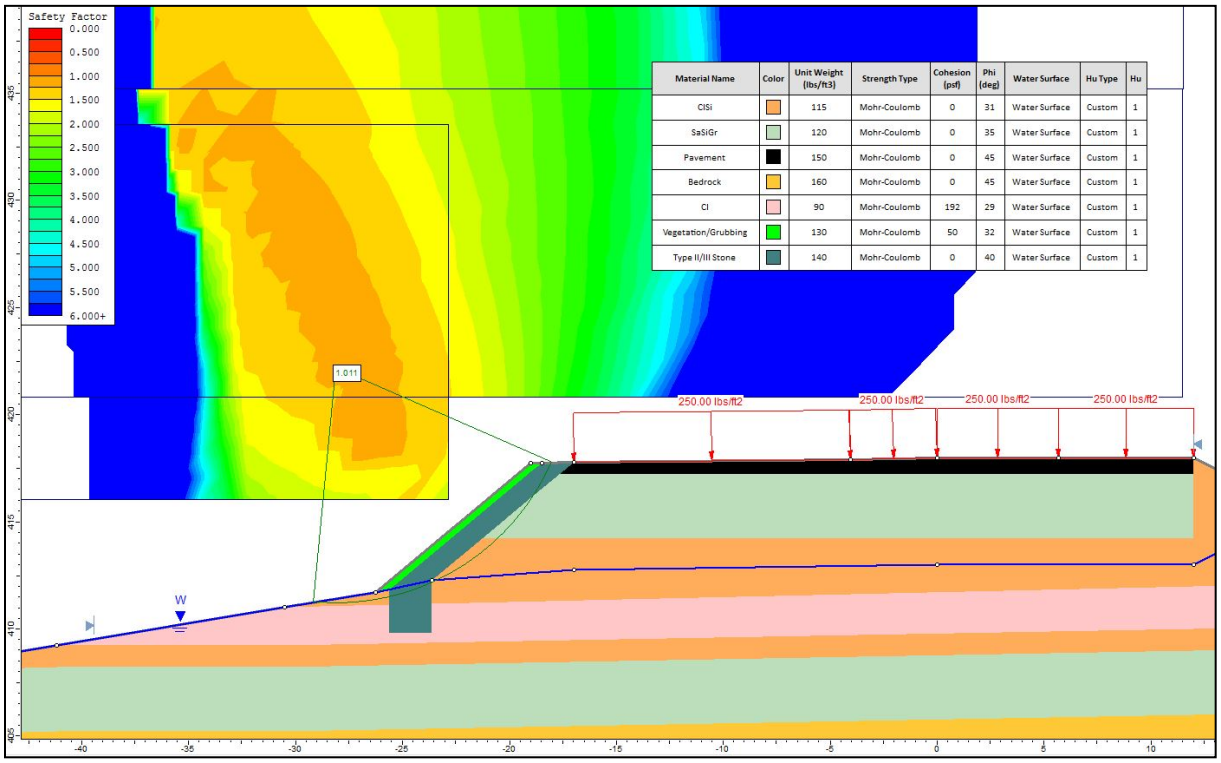

Figure 2.1: *Proposed Typical Section with FOS = 1.01*

2.2 Mitigation Design

In order to maintain stability along the proposed 1:1.2 slope and prevent both shoulder instability and a larger slope stability issue, we recommend installing a series of geogrid reinforcement layers along the over-steepened slope for the 500 foot length of guard-railed section. From the analyses, it was determined that a minimum tensile strength of 1000 lb/ft is required in order to raise the global factor of safety to 1.3. Figure 2.2 shows the typical section with the acceptable factor of safety = 1.31, utilizing three layers of 7 foot long geogrid with 1.0 foot vertical spacing.

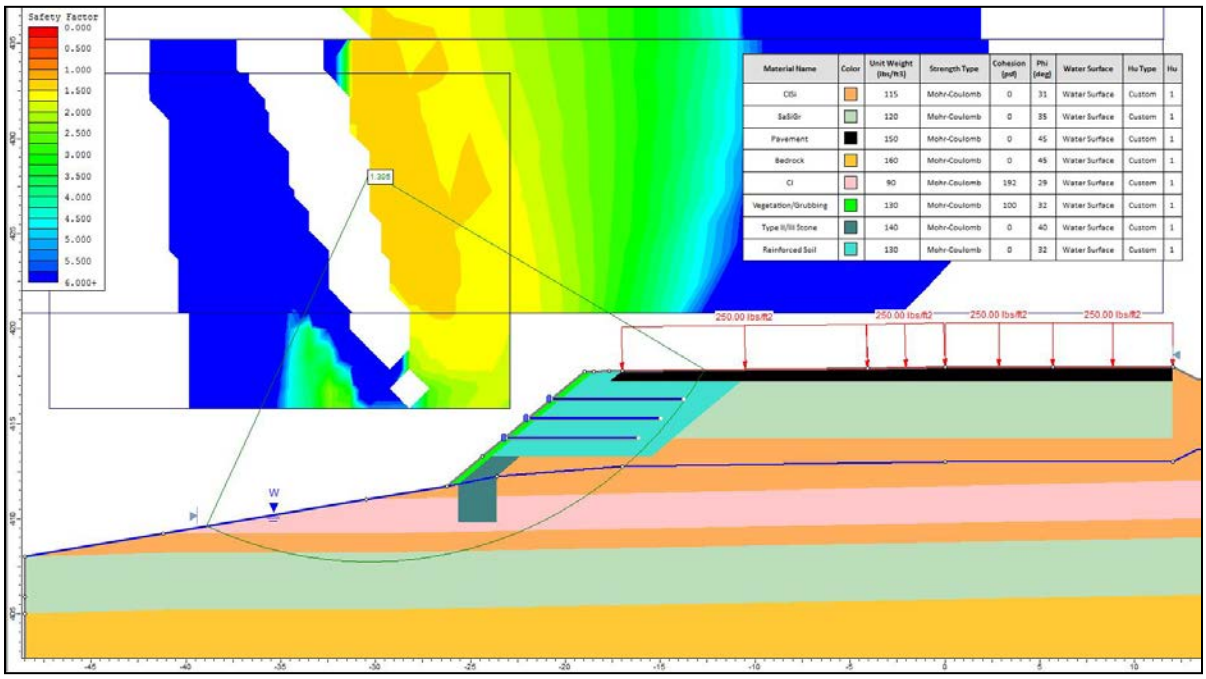

Figure 2.2: *Proposed Geogrid Typical Section, FOS = 1.31*

3.0 RECOMMENDATIONS

In order to achieve a minimum factor of safety of 1.3, we recommend implementing the recommendations stated along the 500 foot length of guard-railed section where slopes are not at a minimum slope of 1:1.5. The minimum design recommendations are highlighted in Table 3.1 below.

Table 3.1: Geogrid Design Recommendations

Min. Geogrid Ultimate Tensile Strength	1000 lb/ft
No. of Reinforcement Layers	3
Reinforcement Length	7 feet
Reinforcement Vertical Spacing	1.0 feet
Top Reinforcement Layer Location	1.5 feet below pavement surface

The geogrid reinforcement is required to be constructed with a wrapped face to maintain the stability of the slope. The geogrid re-embedment length should be at least 3 feet. A detail is shown below in Figure 3.1.

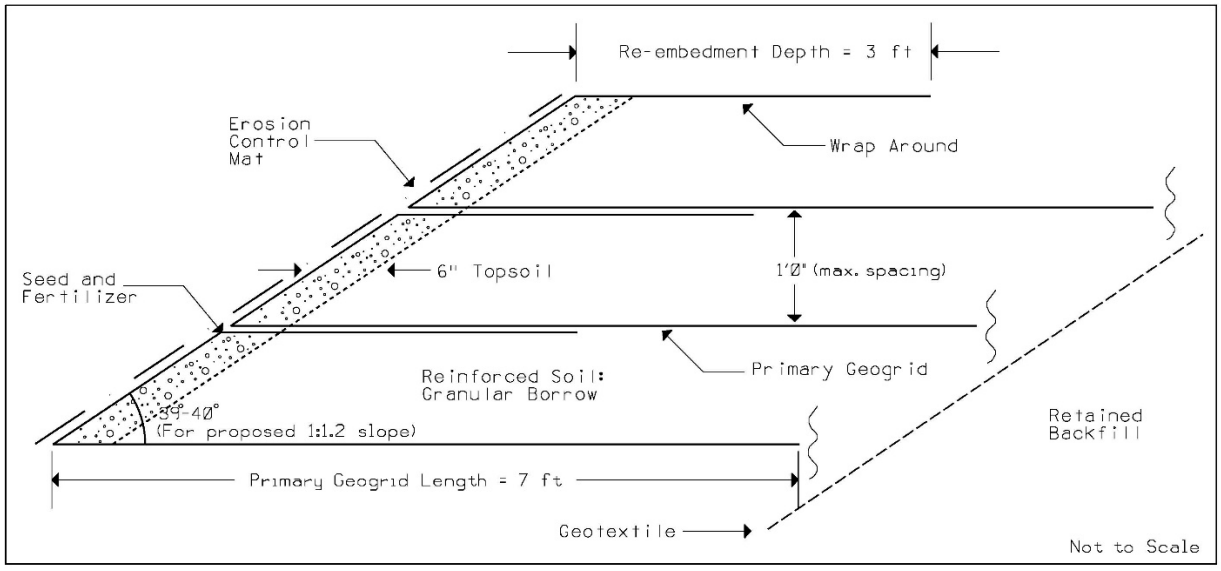

Figure 3.1: *Geogrid Wrapped Face Typical*

Treatment of the outward face needs to be taken care of to prevent ultraviolet light exposure from deteriorating the geosynthetic over time as well as to minimize erosion due to rainfall and run-off. We recommend a temporary synthetic erosion control mat meeting the requirements of VTrans *2011 Standard Specifications for Construction*, Item 755.11(a) for Temporary Erosion Matting to protect the reinforced slope and provide suitable growing conditions for vegetation. We also recommend a minimum of 6 inches of topsoil be placed on the face and properly seeded according to Item 755.04 Seed to ensure vegetation is established within a short period of time.

We recommend the reinforced soil material meet the requirements of Granular Borrow, Item 703.04 with a slight modification indicating a maximum of 80% passing the 4.75mm (No. 4) sieve in order to better facilitate drainage. Below the areas where geogrid is installed, stone fill should be installed to the toe of the slope as shown in the proposed cross sections provided.

4.0 CONCLUSION

Based on our analyses, we recommend reinforcing the shoulder and upper slope to stabilize the proposed over-steepened slope. These recommendations are preliminary in nature and prior to construction, proper design and construction details should be developed. If any further analysis is needed or you would like to discuss this report, please contact us at (802) 828-2561.

cc: Susan Zwick, Highway Safety and Design Section Technician
Electronic Read File/MG
Project File/CEE