AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Bruce Martin, P.E. Roadway Design Project Manager

SPM CEE

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

Date: May 11th, 2017

Subject: Mount Holly ER STP 0133(8) Culvert Wingwall Stability Analysis

1.0 INTRODUCTION

As requested, we have completed an additional geotechnical assessment for the Mount Holly ER STP 0133(8) project located on Vermont Route 155 near MM 5.57 in Mount Holly, Vermont. This is an addendum report to the geotechnical report dated February 23rd, 2017, which contains design parameters for use in the design and construction of the proposed box culverts at Stations 292+21.53 and 296+33.35. Provided herein are the results of the additional analysis for global stability at the outlet wingwalls for each culvert.

2.0 ANALYSIS

We have evaluated the overall stability of the outlet wingwalls using the SLIDE 6.0 limit equilibrium slope stability analysis program developed by Rocscience. The outlet wingwalls for each culvert were analyzed at a critical cross-section representing the full height of the wingwall. The wingwall geometries and cross sections used were based on the plans provided by Erik Atkins of Green International Affiliates, Inc. in an email dated March 6th, 2017. Per Section 11.6.2.3 of the *AASHTO LRFD Bridge Design Specification*, a maximum resistance factor of 0.65 is allowable for slopes containing or supporting a structural element and a resistance factor of 0.75 is allowable for slopes not containing or supporting structural elements. The resistance factor of the slope is the inverse of the factor of safety as determined from the stability analysis.

Computer models were generated using SLIDE for Stations 292+21.53 and 296+33.35 and were analyzed using the Spencer Method. According to the VTrans Geotechnical Engineering Instruction on Soil Slope Stability Investigation & Evaluation Manual (GEC 14-01), the Spencer Method is recommended to be used for the analysis of failure surfaces of any shape. Soil parameters used in the analysis were taken from the February 23, 2017 report and a conservative water table elevation was modeled.

The culvert at Sta. 292+21.53 did not display a sensitivity to the water table elevation when modeled in SLIDE. The water table was modeled at a depth of 11.7 feet below the ground surface, based on what was encountered during drilling of B-101.

Our initial analysis of the proposed culvert wingwalls and slope at Station 296+33.35, and associated factor of safety of the SLIDE model, indicated a sensitivity to the water table elevation chosen. A site visit was conducted on May 4th, 2017 to assess the condition of the existing soils on the slope following a prolonged period of heavy rainfall. During the site visit water was not observed to be seeping from the face of the slope and the surface materials were relatively dry to moist. Pooled water was visible towards the toe of the slope and directly adjacent to the river. Information from the borings and subsequent lab testing, and visual identification of the soils during the site visit, indicate that the soils are mostly granular in nature and appear relatively free draining of water.

A water table sensitivity analysis was conducted for the proposed conditions and it showed that as the depth to the water table was increased the stability of the slope increased sharply. When the water table was modeled between 2 feet above the bottom of footing and 4 feet below the bottom of footing, the slope was stable with a factor of safety between 1.0 and 1.3. When the water table was modeled at 4 feet below the proposed bottom of footing elevation or lower, the slope was stable with a factor of safety of 1.3 or higher. Based on the observations made during the site visit, information from the nearby boring, and our understanding of the performance of the current slope, it was determined that a water table modeled at a depth of 25 feet below the ground surface (approximately 8 feet below proposed bottom of footing elevation), was appropriate for modeling of the slope.

Due to the variable nature of the channel sections along the length of the wingwalls, it was assumed for the analysis that the wingwall footings would have an embedment of 4 feet. The maximum heights of the outlet wingwalls were used, corresponding to a height of 6.71 feet for the culvert at Station 292+21.53 and a height of 11.35 feet for the culvert at Station 296+33.35.

Based on the analysis it appears that no deep-seated global stability issues will exist given the proposed conditions for the slopes, and the overall stability of the wingwalls is acceptable. The resistance factors for slip surfaces beneath the wingwalls are less than AASHTO's maximum recommended value of 0.75. See Figures 2.1 and 2.2 below for outputs of the completed analysis at Stations 292+21.53 and 296+33.35, respectively.

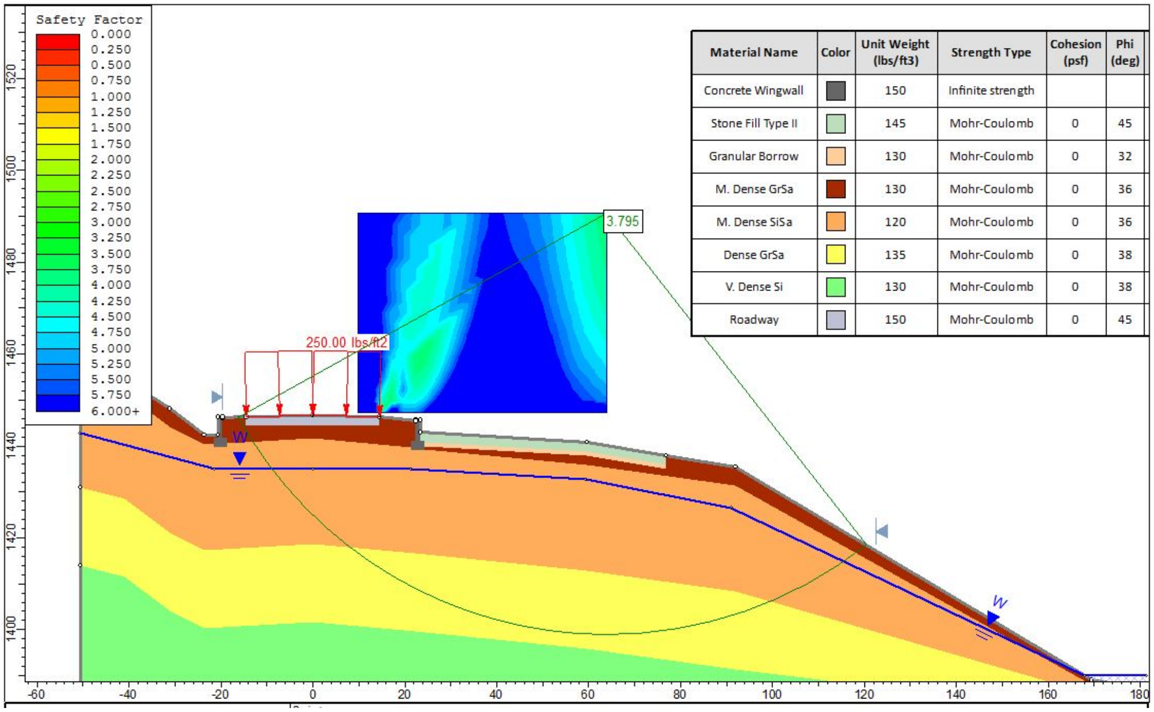

Figure 2.1. Proposed Cross-Section @ Sta 292+21.53

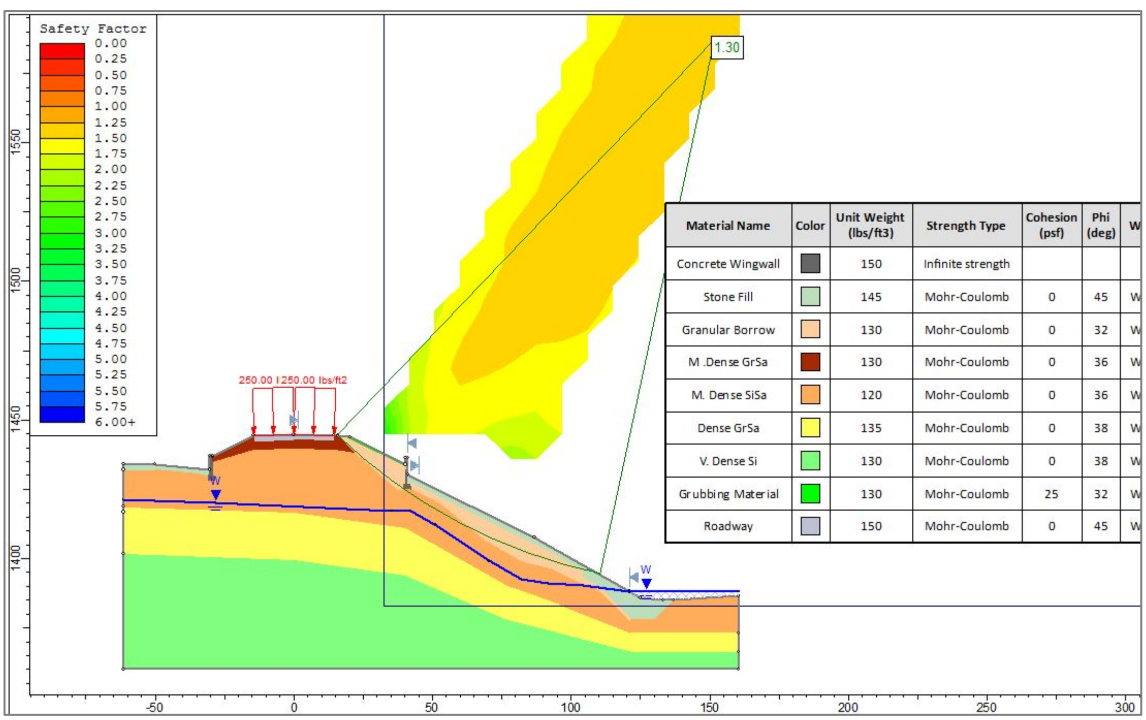

Figure 2.2. Proposed Cross-Section @ Sta 296+33.35

3.0 CONCLUSION

If you have any questions or would like to discuss this report, please contact us by phone at (802) 828-2561.

cc: Electronic Read File/DJH
Project File/CEE
SPM

Z:\Highways\CMB\GeotechEngineering\Projects\Mount_Holly_STP_013-3(8)\REPORTS\Culverts\Mt._Holly_STP_0133(8)_Geotechnical_Report (Culvert Recommendations).docx