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February 15, 2017

Mr. Nathan Will, P.E.
Ms. Amber Klein, P.E.
SRF Consulting Group, Inc.
One Carlson Parkway North, Suite 150
Plymouth, MN 55447

GTE Project No. 95423-C

RE: Geotechnical Project Memo – Hennepin County CSAH 112, Phase 2 – Slope Stabilization between Stations 1186+00 – 1189+00

Dear Mr. Will/Ms. Klein:

CSAH 112, Phase 2 between Wolf Point Trail and Wayzata Blvd is proposed to include a bike trail located on the north side of the proposed roadway section. An approximate 5-12ft tall, approximately 1H-1.5H:1V slope currently exists between the roadway shoulder and the adjacent private property approximately between stations 1186+00 – 1189+00. The existing County right-of-way extends approximately 75% up the height of the slope, but does not extend to the slope crest. The existing slope currently contains some shrubs and trees with a trunk diameters of up to 6-8 inches.

According to SRF preliminary plans, bike trail inclusion will require some modification to this slope. A grade separation structure consisting of a prefabricated modular block (big block) wall or a concrete cantilever wall have been investigated as potential options, (see GTE January 25, 2017 Memo) however, due to right-of-way limitations and excavation requirements, these types of structures may not be feasible at this location. We understand that SRF is now considering keeping the existing slope and potentially increasing the slope angle up to 1H:1.5V near the slope toe at some locations to provide space for a bike trail and a curb section.

This memo discusses potential slope facing and slope reinforcement options for this area.

Soil Conditions at Wall D

As discussed in our January 25, 2017 memo discussing potential grade separation structures at this location, we estimate the soil conditions along the slope to consist of a medium stiff to stiff silty clay. This is based on the results of the soil borings performed on the opposite side of the road at the same station for a separate proposed retaining wall.

Slope Facing and Reinforcement Options

One option for maintaining slope stability and erosion resistance for an over steepened slope could be to provide a slope facing system combined with shallow earth anchors. The slope facing system could consist of geocells (a cellular confinement system) infilled with topsoil and a seed/fertilizer mix. The geocells would be held on the steep slope by shallow percussion driven anchors (PDAs), installed with lengths of 4-6ft into the slope in a 4-6ft triangular pattern.

Geocell Facing System

Six (6) inch high geocells, deployed as expandable 8ft by 12ft sheets on the slope face, would hold the topsoil for the slope in the short term and provide erosion protection on the slope face until vegetation is established on the reconstructed slope face. Given the geometry of the existing and proposed sideslope, it is recommended that a 6 inch tall geocell, with a maximum individual cell area of 72 square inches (in^2) be used. The geocells should consist of perforated textured HDPE with a minimum 50 mil thickness. The sheets should be ultrasonically bonded to form the expandable cell pattern and contain a peel strength of at least 450 lb. The individual expanded cells should be perforated and contain an appropriate stabilization package to avoid UV degradation. Adjacent geocell sheets, or panels, should be connected by a mechanical means such as ties or staples. A photo showing the typical expanded geocells is shown in the figure below.

Figure: Geocells deployed for Slope Face protection application

Since the geocells are not likely to be installed on the entire height of the slope, due to right-of-way constraints, a small anchor trench will be required to "key in" the geocells to the existing slope face. The anchor trench should be at least 8 inches deep and constructed as a triangular or wedge shape to allow for at least one cell to be buried. A series of PDAs, spaced at 4-6ft horizontal, would need to be installed within the anchor trench to support the geocells and topsoil during construction.

It is recommended that the shrubbery/brush be removed but the small existing trees could remain on the slope face with the geocells extended around the tree trunks. The smaller shrubs should be cut off at the ground surface and covered over with the geocell/topsoil without removing the root system. The geocells can be deployed around the trees by cutting individual cells and wrapping them around the existing tree trunks. The cut cells can be "reconnected" using the staples or clips after deployment.

Percussion Driven Anchors

Percussion driven anchors could be installed perpendicular to the slope face using hand held equipment. The anchors should consist of a minimum 6 inch long anchor head, or lead, that connects to a 1/8 inch diameter flexible steel cable (tendon) which connects to a 6 inch diameter bearing plate. The anchor head size and tendon length can be adjusted based on the slope reinforcement requirements. An individual anchor capacity of several kips can be obtained, depending on soil conditions. There are several popular manufacturers of these anchor systems, including Gripple®, Duckbill (Foresight®) and Platipus®.

For this application we recommend a minimum 6 inch long anchor head as well as a minimum 4ft long cable length. Based on the results of a stability evaluation, we recommend the anchors be installed at a 4-6ft horizontal within the anchor trench and in a triangular pattern at a 4-6ft vertical spacing along the slope face. Anchor spacing is primarily a function of the anchor geotechnical pullout capacity, which is dependent on soil conditions. For our evaluation, we assumed a factored anchor pullout capacity of 600-700 lbs. Final anchor capacities should be determined based on the results of at least three (3) anchor load tests performed prior to construction. The PDA installed within the anchor trench near the right-of-way limits would need to be installed prior to geocell deployment to hold the geocells/topsoil in place during placement. The PDAs installed along the slope face would be installed after geocell placement on the slope face.

After geocell deployment on the slope face, the geocells should be backfilled with a topsoil and seed fertilizer mix. The topsoil used should meet the requirements of a MnDOT Sandy Clay Loam Topsoil Borrow (Spec. 3877.2C), a topsoil that is typically used in steep slope applications where vegetation establishment is important. The fertilizer shall meet the requirements of a MnDOT 3881.2.B.3 – Slow Release Fertilizer and should be used in conjunction with an appropriate seed mix. The seed and fertilizer application rate should be at least 60lbs/acre along the slope face. It is recommended that the seed and fertilizer be pre-mixed with the topsoil prior to infilling, this will allow for better vegetation development along the slope face. A higher application rate will be

required for premixing. A MnDOT Category 4 (Spec. 3885.2) straw-coconut erosion control blanket (ECB) should be placed on the finished slope face to allow for short term erosion protection prior to vegetation establishment. The ECB shall be staked to the slope face as per the manufacturer's recommendations.

Summary

The proposed system geocells and driven anchors could be used to provide erosion protection at the slope face and to provide reinforcement against potential slope instability. This system is likely to be more cost effective and less invasive then the previously proposed grade separation structures.

We would be pleased to assist in SRF in plan and special provision development for this system. If you have any questions, please do not hesitate to contact us.

Respectfully,

GALE-TEC ENGINEERING, INC.

Nathan M. Lichty, P.E.
Project Engineer

Stephan M. Gale, P.E.
Principal Engineer

I hereby certify that this plan, specification, calculation, or report was prepared by me or under my direct supervision and that I am a Registered Professional Engineer under Minnesota Statute, Sections 326.02 to 326.15.

Nathan M. Lichty

Date: 2/15/2017 Reg. No. 51331

NML/SMG
REPORT/SRF, Hennepin County CSAH 112, Phase 2, Slope Anchors Long Lake, MN