Table No. 1: Boring Locations/Elevations by Segment

Soil Boring	Segment	Ground Surface Elevation (ft)	Northing	Easting
B-1	Segment 1	984.6	172544.8	440877.4
B-2	Segment 1	983.3	172429	441711.9
B-3	Segment 1	990.4	172432.8	441969.7
B-4	Segment 1	997.7	172389	442470.6
B-5	Segment 1	996	172428.6	442673.9
B-6	Segment 1	985.9	172409.1	443147.5
B-7	Segment 1	984.8	172380.2	443511.8
B-8	Segment 1	1005.2	172406.8	444169.4
B-9	Segment 1	1026.1	172347.4	444833.9
B-10	Segment 1	1028	172372.9	445071.8
B-11	Segment 1	1026.6	172328.4	445325.7
B-12	Segment 2	1026.4	172330.8	445662.1
B-13	Segment 2	1025.2	172389.2	446157.8
B-14	Segment 2	1023.2	172353.6	446486.1
B-15	Segment 2	1015.8	172306.4	447002
B-16	Segment 2	1016.2	172370.2	447442.1
B-17	Segment 2	1019.1	172292.7	447771.3
B-18	Segment 2	1025.1	172339.3	448762.9
B-19	Segment 2	1013.6	172108	449365
B-20	Segment 2	999.8	172018.6	449969.6
B-21	Segment 2	988.1	171969.7	450337.2
B-22	Segment 2	979.7	172002.3	450537.9
B-23	Segment 3	959.2	171589.1	451053.5
B-24	Segment 3	962.1	171249.1	451306.4
B-25	Segment 3	962.7	171145.4	451423.7
B-26	Segment 3	967.9	170771.7	451846.1
B-27	Segment 3	957.7	170692.8	452331.3
B-28	Segment 3	952.2	170580.9	452838.5
B-29	Segment 3	954.7	170531.8	453169.8
B-30	Segment 3	955.8	170622.8	453849.8
B-31	Segment 4	959	170673.6	454630.2
B-32	Segment 4	979.6	170655.1	455077.3
B-33	Segment 4	992.1	170744.6	455847.2
B-34	Segment 4	993.3	170773.1	456714.6
B-35	Segment 4	989.3	170563.6	457061.4
B-36	Segment 4	974.9	170152.4	457419
B-37	Segment 4	971.4	169815.8	457576.1
B-38	Segment 4	968.9	169485	457822.4
B-39	Segment 4	969	168884.2	458165.6
B-40	Segment 4	966.5	168154.8	458842.2

The borings were advanced with hollow stem auger.

Soil samples were collected at 2 ½ to 5 ft intervals using the split-spoon (SS) sampling procedures. In the SS method, the number of blows required to drive the split-spoon sampler into the ground in 6-inch increments is recorded. The sampling spoon is driven into the ground with a 140-pound hammer falling a distance of 30 inches. SS soil samples were placed in glass jars and returned to us for classification. The depths at which water was encountered was recorded during drilling operations and the borings were then immediately backfilled. The boreholes were backfilled with soil or grout according Minnesota Department of Health standards.

Calibrated penetrometer (Q_p) tests were performed on clay/peat samples. The calibrated penetrometer is a spring calibrated probe that is used to estimate the unconfined compressive strength of clay-type soil and is reported in tons per square foot (tsf). The percent passing the No. 200 sieve (P200) as well as moisture content, and organic content were performed on select soil samples. Standard Proctor density testing and R-value testing was also performed on select samples taken from the roadway subgrade at the boring locations. All laboratory test results are shown on the boring logs.

4.0 GEOLOGIC CONDITIONS

The Minnesota Soil Atlas, St. Paul Sheet and the Minnesota Geological Survey, Geologic Atlas for Hennepin County, identify that the Long Lake and Orono area is generally deposited with well drained loam to clayey loam soils which comprise lower levels of the Lonsdale-Lerdal till deposit. The lower level of this till deposit is typically interspersed with lakes, such as Long Lake, and peat bogs. These soils were deposited during the last glacial retreat from south central Minnesota approximately 10,000 years ago.

Mapping identifies that the nearest bedrock surface consists of a marine sedimentary rock of the early Paleozoic age from approximately 500 million years ago. Mapping identifies the bedrock surface to be approximately 150 – 200 ft below the surface and to be the Prairie du Chien limestone deposit. This deposit dips slightly toward the downtown Minneapolis area.

5.0 SITE, SOIL AND GROUNDWATER CONDITIONS

5.1 Site Conditions

Segment 1 – CSAH 6 to Old Crystal Bay Road - This portion of CSAH 112 is located directly west of the City of Long Lake. This segment of roadway runs through two (2) swamp areas and has significant elevation change along its length. Soil borings were performed through both of the low areas where potential soft soils may be present as well as some typical locations along the roadway alignment.

Segment 2 - Old Crystal Bay Road to Brown Road (Urban Section) - This segment of CSAH 112 is located within the City of Long Lake and at-grade with the adjacent properties. The majority of the roadway in this area does not contain curb and gutter. There are also several existing retention ponds located along this portion of roadway. Soil borings were performed adjacent to the retention ponds where potential soft soils may be present as well at typical locations along the roadway alignment.

Segment 3 – Brown Road to Cemetery Road (Urban Section) – This segment of CSAH 112 is located along the eastern portion of the City of Long Lake as well as adjacent to Long Lake. The portion of the roadway that runs through the eastern portion of the City of Long Lake is at-grade with adjacent properties. Adjacent to Long Lake and to the east of the lake, the roadway is supported on an elevated embankment. Soil borings were performed along the roadway alignment through the City and adjacent to Long Lake.

Segment 4 – Cemetery Road to TH 12 (Rural Section) – This segment consists of the eastern portion of CSAH 112 ending at the overpass with T.H. 12. The roadway alignment in this area runs adjacent to several wooded hills as well as low lying swamp areas. Soil borings were performed adjacent to the swamp areas along the alignment as well as areas where roadway expansion may involve grade separation structures.

5.2 Segment 1 – CSAH 6 to Old Crystal Bay Road - Soil Conditions

Existing Pavement Section- Soil borings B-2, B-3, B-4, B-6, B-7 and B-10 were drilled through the existing pavement within Segment 1. The wearing course consisted of bituminous pavement at all soil boring locations. The bituminous pavement was underlain by a concrete pavement section at some locations and aggregate base course at other locations. At B-2 and B-10, a section of concrete pavement was located beneath the bituminous. At B-3, a potential Class 7 crushed bituminous material was encountered beneath the bituminous wearing course. The granular base course material generally consisted of a fine to medium coarse sand with a trace of gravel and silt. This material seems to meet a Mn/DOT Class 3 or 4 material. The pavement section at each soil boring location is detailed in Table No. 2.

Table No. 2: Segment 1 Pavement Section Details

Soil Boring	Wearing Course & Thickness	Base Course & Thickness	Subbase & Thickness
B-2	11 inches Bituminous	9 inches Concrete	-
B-3	6 inches Bituminous	6 inches Crushed Bituminous	6 inches Granular
B-4	4 inches Bituminous	15 inches Granular	-
B-6	13 inches Bituminous	6 inches Granular	-
B-7	14 inches Bituminous	8 inches Granular	-
B-10	7 inches Bituminous	10 inches Concrete	-

Roadway Embankment Fill – Soil borings B-1, B-5, B-8, B-9 and B-11 were drilled through the existing roadway embankment on the shoulders of CSAH 112. Based on the results of these borings as well as those drilled through the pavement, the CSAH 112 roadway embankment fill generally consists of a medium stiff to very stiff silty clay. The embankment fill material is similar to the native material encountered beneath the roadway embankment and the fill thickness was generally encountered to range between 0 ft and 8 ft at the soil boring locations. However, at B-2 and B-6, where the roadway had been built up over a swamp area, the roadway embankment fill depths were 23 ft and 15 ½ ft respectively. Laboratory testing on samples of this clay fill indicated a water content ranging from 15.1% to 23.6%.

Standard Proctor compaction testing was performed on a sample of the roadway embankment fill taken from soil boring B-2 at depths ranging from 2ft to 5ft. The testing on the silty clay material indicated a maximum dry density ($\gamma_{dry/max}$) of 109.2 pounds per cubic foot (pcf) and an optimum moisture content (OMC) of 16.4%. The standard Proctor curve, as well as the soil laboratory testing results, are given in the Appendix.

Swamp Soils - Two (2) low areas are present along this segment of the CSAH 112 roadway alignment. Soil boring B-2 was drilled at the location of the western most low area at Classon Creek. At soil boring B-2, a layer of very stiff fibrous peat was encountered from depths of approximately 23 to 28 ft. This peat layer had a penetrometer strength of 3.0 tsf, contained many plant and root fibers and appeared to have been consolidated by the 23 ft thick roadway embankment. Below the very stiff fibrous peat layer, a layer of soft amorphous peat was encountered from depths of approximately 28-38 ft. This decomposed peat had a water content of 50.7% and a penetrometer strength of 0.3 tsf., This layer appeared to have been somewhat consolidated by the weight of the embankment fill, but was of much lower strength than the fibrous peat as it did not contain the intertwined roots and fibers that serve as a source of reinforcement.

Soil boring B-7 was drilled through the roadway embankment in the Classon Lake area within Segment 1. At this location, an approximately ½ ft thick layer of very soft amorphous peat was encountered at a depth of 8 to 8 ½ ft beneath the roadway embankment. This very soft peat layer had a penetrometer strength of 0.1 tsf. Beneath the very soft peat layer, an approximately 3ft thick layer of soft silty clay with trace organics was encountered. This layer had a penetrometer strength of 0.3 tsf, a moisture content of 23.1% and an organic content of 3.1%.

Native Silty Clay - B-1, B-3, B-4, B-6 and B-10, a medium stiff to very stiff silty clay (CL) was encountered beneath the roadway embankment fill. This medium stiff to very stiff layer was present to the termination depth of the borings. This soil layer had a penetrometer strength ranging from 0.5 to 2.0 tsf and a moisture content varying from 16.1 to 17.6%.

Native Silt – At soil boring locations B-8, B-9 and B-11, a layer of very soft to medium stiff silt (ML) was encountered beneath the roadway embankment fill. This soil layer was present to the termination depth of borings B-8 and B-11. At soil boring B-9, the soft to medium stiff silt layer terminated at a depth of approximately 12 ft. This silt layer had a penetrometer strength ranging from 0.1 to 1.0 tsf and a moisture content ranging from 29.6 to 33.1%

5.3 Segment 2 Old Crystal Bay Road to Brown Road Soil Conditions

Existing Pavement Section- Soil borings B-14, B-16, B-18, B-19, B-20, B-21 and B-22 were drilled through the existing pavement within Segment 2. The wearing course consisted of bituminous pavement at all soil boring locations. At soil boring locations, B-14 and B-21, the bituminous pavement was underlain concrete pavement. At B-19, a potential Class 7 crushed bituminous aggregate base course was encountered beneath the bituminous wearing coarse. A granular base course was encountered beneath the bituminous wearing coarse section at the remaining boring locations. The granular base course generally consisted of a fine to medium coarse sand with a trace of gravel and silt. At B-18, the granular base coarse material contained a 11.1% passing the U.S. No. 200 sieve (P200), which is just above the 10% maximum requirement specified by Mn/DOT Spec 3138.2 for Class 3 to Class 5 base course material. The pavement section at each soil boring location is detailed in Table No. 3.

Table No. 3: Segment 2 Pavement Section Details

Soil Boring	Wearing Course & Thickness	Base Course & Thickness
B-14	11 inches Bituminous	8 inches Concrete
B-16	6 inches Bituminous	10 inches Granular
B-18	10 inches Bituminous	30 inches Granular
B-19	10 inches Bituminous	6 inches Crushed Bituminous
B-20	10 inches Bituminous	16 inches Granular
B-21	9 inches Bituminous	10 inches Concrete
B-22	9 inches Bituminous	13 inches Granular

Roadway Subgrade –Base on the results of the borings drilled through the pavement, the CSAH 112 roadway subgrade material in Segment 2 generally consists of a stiff to very stiff silty clay to sandy clay which appears to be a fill. The stiff to very stiff nature of this material indicates that this material had probably been compacted. The compacted fill material varied in thickness between approximately 2 ft to 3½ ft directly beneath the pavement section. This material had a penetrometer strength ranging from 2.0 to 2.5 tsf and a moisture content of 23.3% at B-21.

Near Surface Soils –B-12, B-13, B-15 and B-17 were drilled adjacent to the roadway. Within Segment 2, the CSAH 12 pavement grade was similar to the surrounding properties.

B-13 and B-17 each encountered a layer of silty organic clay extending from the surface to a depth of 4 ft. At B-13 this material was stiff, with a penetrometer strength of 1.0 to 1.8 tsf, and was likely previously compacted as fill. Unlike the material at B-13, the soft silty organic clay at B-17 had not been previously compacted. The soft organic clay had a penetrometer strength of 0.3 tsf and moisture content of 22.1%.

Soil boring B-15 was drilled at a location adjacent to a culvert underlying the roadway. At B-15, the upper 6 ft consisted of a very soft to soft silty clay material, which is likely fill material from placement of the culvert. This fill material did not appear to be compacted as it had a penetrometer strength ranging from 0.1 to 0.3 tsf and a moisture content of 22.1%. Beneath the 6ft of uncompacted trench fill, an approximately 2 ft thick layer of soft organic clay was encountered. This material had a penetrometer strength of 0.3 tsf and a moisture content of 31.0%.

Native Silt Soils – The soil borings on the western portion of Segment 2 (B-12 to B-15) contained very soft to medium stiff silt and sandy silt beneath the roadway fill material. This layer began at approximate depths ranging from 3½ ft to 8½ ft and had a thickness ranging from 4½ ft at B-14 to 8 ½ ft at B-15. This very soft to medium stiff layer had a penetrometer strength ranging from 0.1 to 0.8 tsf and a moisture content ranging from 16.7% to 22.6%.

Native Silty Clay Soils – The soil borings on the eastern portion of Segment 2 (B-16 to B-22), contained a layer of stiff clay beneath the roadway fill material. This stiff clay layer had a penetrometer strength ranging from 1.0 to 2.5 tsf and had a moisture content of 9.7% at B-20. This soil layer was present to the termination depth of all of these borings with the exception of B-19.

At B-19, a soft to medium stiff silty clay with trace organics was present beneath the roadway pavement section to a depth of approximately 6 ½ ft. This soil layer had a moisture content of 21.4% and an organic content of 2.0%. Beneath this layer a soft to medium stiff silty clay was present to the termination depth of the boring.

The soil borings on the western portion of Segment 2 also contained a medium stiff to stiff silty clay layer beneath the soft to medium stiff silt layer. At these boring locations, this soil layer began at approximate depths ranging from 8 ½ to 17 ft and extended to the termination depth of the borings.

5.4 Segment 3 Brown Road to Cemetery Road - Soil Conditions

Existing Pavement Section- B-25, B-27, B-28 and B-29 were drilled through the existing pavement within Segment 3. Like the previous two (2) roadway segments, the wearing course consisted of bituminous pavement at all soil boring locations. At B-25 and B-27, a section of concrete pavement was located beneath the bituminous. Granular base course material was encountered beneath the bituminous section at B-29. At B-28, no base coarse material was present beneath the bituminous pavement. The pavement section at each soil boring location is detailed in Table No. 4.

Table No. 4: Segment 3 Pavement Section Details

Soil Boring	Wearing Course & Thickness	Base Course & Thickness
B-25	5 inches Bituminous	10 inches Concrete
B-27	3 inches Bituminous	8 inches Concrete
B-28	6 inches Bituminous	-
B-29	9 inches Bituminous	4 inches Granular

Roadway Embankment Fill – Based on the results of the borings drilled through the pavement as well as through the shoulder, the portion of CSAH 112 along Long Lake contains an elevated roadway embankment consisting of clay fill. At B-27 to B-30, the roadway embankment fill generally consists of a medium stiff to very stiff sandy clay to clayey sand. The depth of the embankment fill varied between 3 ½ ft at B-30 to 7 ft at B-29. The fill material had a moisture content of 14.5% and a P200 of 39.5% at B-28.

Standard Proctor compaction testing was performed on a sample of the roadway embankment fill taken from soil boring B-27 at depths ranging from 1ft to 4ft. The testing on the sandy clay material indicated a maximum dry density ($\gamma_{dry/max}$) of 110.9 pcf and an optimum moisture content (OMC) of 15.9%. The standard Proctor curve, as well as the soil laboratory testing results, are given in the Appendix.

Hveem Stabilometer (R-value) testing was also performed on a sample of the roadway embankment fill taken from soil boring B-29 at depths ranging from 1 ft to 4 ft. The testing of the silty clay, compacted to 95% Standard Proctor dry density, identified a R-Value of five (5).

Roadway Subgrade Material –The subgrade material for the portion of CSAH 112 located in the eastern portion of the City of Long Lake generally consists of a stiff to very stiff silty clay with trace organics that appears to be a fill, according to B-25. The stiff to very stiff nature of this clay fill indicates that this material had been previously compacted and was likely placed after a subcut for the existing roadway. The compacted fill material extended to a depth of 4½ ft beneath the pavement section. This material had a penetrometer strength ranging from 2.5 to 3.5 tsf.

Native Silty Clay Soils – The soil borings on the western portion of Segment 3 (B-23 to B-26) contained a layer of medium stiff to stiff clay beneath the roadway fill. This medium stiff to stiff layer had a penetrometer strength ranging from 0.5 to 2.5 tsf and had a moisture content from 34.6% to 37.8%. Our visual observation indicates this soil may exhibit moderate to high plasticity.

A low plasticity silty clay soils was encountered at B-27 and B-29. At B-27, a soft silty clay with trace organics was encountered beneath the roadway embankment fill a depth of 6 ft and extended to a depth of 12ft. This soil layer had a penetrometer strength of 0.3 tsf. At soil boring B-29, a very soft silty clay layer was encountered at a depth of 11ft below the ground surface and extended to a depth of approximately 14 ½ ft. This very soft silty clay layer had a penetrometer strength of 0.1 tsf

Native Clayey Sand to Clayey Silt – The native soils on the eastern portion of Segment 3 (B-27 to B-30) tended to be either a stiff sandy clay or a soft sandy silt. At B-28 and B-30, a sandy clay to clayey sand was encountered beneath the roadway embankment fill at a depths of 8 ½ ft and 3 ½ ft, respectively. This soil layer had a P200 of 28.2 % and a moisture content of 12.1% at B-30.

Buried Peat/Muck Soils – A layer of very soft amorphous peat was encountered at a depth of approximately 12½ to 18½ ft at B-28. This buried peat layer had a penetrometer strength of 0.1 tsf and a moisture content of 125%.

Beneath the layer of very soft peat, an approximately 6 ½ ft thick layer of very soft muck/peat was encountered. This buried layer was gray in color and contained decomposed shells. This very soft layer had a moisture content of 94%.

At B-29, ad approximately 1 ½ ft thick layer of very soft organic clay was encountered beneath the roadway embankment fill at a depth of approximately 8 ft. This very soft layer had a penetrometer strength of 0.1 tsf.

Potential Contaminated Soils – Potentially contaminated soils may be present at B-25, B-26 and B-28. Silty clay soil samples obtained between a depth of 5–13 ft, 3-13 ft and 9–13 ft contained a gasoline like odor at B-25, B-26 and B-28, respectively.

5.5 Segment 4 Cemetery Road to TH 12 - Soil Conditions

Existing Pavement Section - B-31, B-32, B-36, B-38 and B-39 were drilled through the existing pavement within Segment 4. Unlike the previous three (3) roadway segments, the wearing course at the Segment 4 borings consisted of bituminous pavement underlain by either aggregate base or crushed bituminous base material, i.e. no buried concrete. The aggregate base course material generally consisted of a fine sand with gravel, typical of a Mn/DOT Spec 3138 Class 5 material. At B-32, the base course material consisted of 8 inches of crushed bituminous material, potentially a Class 7 material. The pavement section at each soil boring location is detailed in Table No. 5.

Table No. 5: Segment 4 Pavement Section Details

Soil Boring	Wearing Course & Thickness	Base Course & Thickness
B-31	6 inches Bituminous	15 inches Crushed Bituminous
B-32	3 inches Bituminous	8 inches Crushed Bituminous
B-36	6 inches Bituminous	10 inches Granular
B-38	7 inches Bituminous	6 inches Granular
B-39	12 inches Bituminous	6 inches Granular

<u>Roadway Embankment Fill</u> – Based on the results of the borings drilled through the pavement as well as the shoulder, the portion of CSAH 112 along Segment 4 consists of an elevated roadway embankment over native soils. The borings indicate that the roadway embankment fill generally consists of a medium stiff to stiff sandy clay to clayey sand. The thickness of the embankment fill depth varied between 1 ft at boring B-32 to 3 ½ ft at B-39. The fill material had a moisture content ranging from 15.9% to 18.7% and a P200 of 41.5% to 40.1%.

B-31, B-36 and B-38 were drilled at locations where the roadway embankment appeared to have been constructed over a swamp area. The roadway embankment fill at B-31 extended to a depth of approximately 17 ft. The fill material consisted of a medium stiff to very stiff sandy silty clay that had a moisture content of 23.3%. The roadway embankment fill at B-36 extended to a depth of approximately 14 ½ ft. This fill material consisted of a very stiff silty clay material. This clay fill had a penetrometer strength of 2.0 to 2.5 tsf. At B-38, the roadway embankment fill extended to a depth of approximately 6 ft and consisted of a stiff to very stiff sandy clay.

<u>Native Silty Clay Soils –</u> The soil borings in Segment 4 generally encountered a soft to medium stiff silty clay layer beneath the roadway embankment fill material. This material was generally encountered beneath the roadway embankment or existed at the natural ground surface and extended to a depth ranging from 3 ½ ft at B-32 to the termination depth at B-37 at 15 ½ ft.

A stiff to very stiff layer of brown silty clay was encountered beneath a layer of fine sand or sandy clay at B-33 and B-35 at a depth ranging from 6 ½ ft to 13 ½ ft. This very stiff layer had a penetrometer strength of 2.0 to 2.5 tsf.

Native Fine Sand to Clayey Sand Soils - At the majority of the borings within Segment 4, a medium dense fine sand or medium dense clayey sand soil was encountered. At B-32, a layer of medium dense fine sand was encountered beginning at a depth of 3 ½ ft and extending to the termination depth of the boring at 25 ½ ft. Similar sand layers were encountered at soil borings B-34, B-35, B-39 and B-40 although these layers varied in thickness from 1 ½ ft to 6ft and were present to the termination depth of the borings.

A medium dense clayey sand to sandy clay layer was encountered at B-34 and B-40. In both instances these layers were encountered beneath a silty clay soil layer located at or near the ground surface. At B-34, the clayey sand layer was located at a depth of about 8 ft and had a thickness of approximately 5 ft. At B-40, the medium dense sandy clay layer was located at a depth of about 4 ½ ft and had a thickness of about 4 ft.

Buried Peat/Organic Soils –B-31, B-36 and B-38 encountered buried very soft organic soils beneath the roadway embankment fill. At B-31, a layer of soft organic clay was encountered between a depth of approximately 17 ft and 23 ½ ft. The organic clay soil had a penetrometer strength of 0.3 tsf, a moisture content of 97.7% and an organic content of 17.1%.

At B-36, buried soft peat/organic clay was encountered between a depth of approximately 10 ft and 24 ½ ft. The organic clay layer had a penetrometer strength of 0.3 tsf and a moisture content of 45.0%.

At B-38, a buried fibrous peat was encountered between a depth of approximately 6 ft and 8 ½ ft. This peat layer had a penetrometer strength of 3.0 tsf, contained many plant and root fibers and had a moisture content of 328%.

5.6 Groundwater Conditions

Segment 1 CSAH 6 to Old Crystal Bay Road - Groundwater was encountered at B-5, B-8 and B-9 at depths ranging from 5 to 9 ft while drilling, but the boreholes were dry upon completion of drilling. This water condition likely represents a perched ground water condition where groundwater is present in sand seams present within a clay soil matrix. In the cohesive soils that exist along this portion of the roadway, a relatively long period of time is required for groundwater to reach an equilibrium position within a borehole.

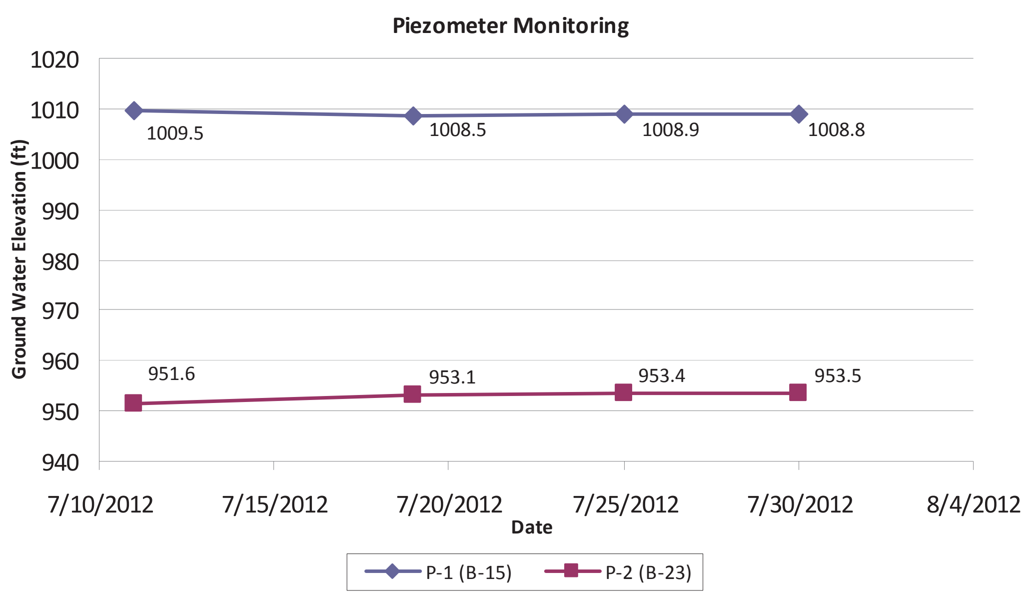
Segment 2 Old Crystal Bay Road to Brown Road – Groundwater was not encountered at any of the boring locations along Segment 2 neither while drilling nor after drilling operations. As previously stated, a relatively long period of time is required for the groundwater table to obtain a equilibrium position in cohesive soils.

An open pipe piezometer (P-1) was installed at soil boring B-15, which was located adjacent to a culvert and retention pond near Kelley Parkway within the City of Long Lake, to determine the location of the long term groundwater table in the area. The water levels measured in the piezometer are given in Figure No. 1.

Segment 3 Brown Road to Cemetery Road – Groundwater was encountered at soil borings B-23 and B-26 through B-30. At soil borings B-23, B-26 and B-27 groundwater was encountered while drilling at depth of 12ft, 3ft and 14ft, respectively, however upon completion of the borings groundwater was not observed. An open pipe piezometer (P-2) was installed at soil boring B-23 near Lake St., to determine the long term groundwater elevation in the area of a culvert crossing beneath CSAH 112, and observe its' fluctuations over time. Figure No. 1 indicates the elevation of the groundwater table during the monitoring period. This likely represents perched water within sand layers within the clay soil.

At soil boring B-28 groundwater was observed at a depth of 7 ft while drilling and at a depth of 22 ft at the completion of drilling. At soil borings B-29 and B-30, also adjacent to Long Lake, groundwater was encountered at a depth of 14 ft while drilling and at a depth of 12 ft after the completion of drilling operations. These water levels are likely related to the elevation of Long Lake and are likely an indicator of the long term groundwater table in this area.

Figure No. 1: Groundwater Table Elevation v. Time for Piezometers P-1 and P-2



Segment 4 Cemetery Road to TH 12 - Groundwater was encountered at soil borings B-37 and B-38 during drilling operations. At soil boring B-37, groundwater was encountered at a depth of 7ft while drilling, however at the completion of drilling the borehole was dry. At soil boring B-38, groundwater was encountered at a depth of 14ft while drilling and at

a depth of 12ft at the completion of drilling operations. These water levels likely represent perched water within sand layers within the silty clay.

In cohesive soils, a relatively long period of time is required for groundwater to reach an equilibrium position within a borehole.

6.0 GEOTECHNICAL PROJECT EVALUATION

6.1 General Subgrade Preparation

6.1.a Existing Pavement Recommendations
Buried concrete pavement was encountered beneath the bituminous pavement throughout Segments 1, 2 and 3 of the project. Further probing is recommended to determine the lateral extent of the buried concrete sections.

If roadway widening or roadway grade changes are proposed, we recommend removing the existing pavement and recycling the bituminous and buried concrete pavements and the existing aggregate base. If the road is widened, and the existing section remains, differential frost heave can result in uneven pavements. If a trail addition is planned and it is separated from the CSAH 112 pavement, it can be designed as a separate pavement. In this case, modifications to the existing pavement do not need to be made.

6.1.b Subgrade Improvement
The borings beneath the CSAH 112 pavement and within the embankment constructed when the road was built encountered mostly silty clay soils. The clay was generally soft to stiff in place. At numerous locations, buried black silty clay with trace organics was encountered. According to MnDOT Materials and Road Research frost depth testing, frost penetration depths are generally in the range of 4ft in Southern Minnesota and silty clay soils, and especially organic silty clay soils within this zone, are frost susceptible and susceptible to thaw settlement. Soft clay, peat and/or black silty clay with trace organics was encountered at B-1, B-2, B-3, B-7 – Segment 1; B-15, B-16, B-17, B-18, B-19, B-21 and B-22 – Segment 2; B-23, B-24, B-25, B-27, B-28 and B-29 – Segment 3; and B-31, B-32, B-36, B-37 and B-38 – Segment 4. According to Holtz & Krizek, 1970 and Franklin, et al, 1973, clay soils with an organic content less than 6% do not experience a significant reduction in strength or an increase in compressibility. Organic content tests were performed on seven (7) different samples of clayey sands and silty clays throughout the project; the test results identified an organic content of between 2 and 6%. Thus, where these soil layers exist below the depth of frost penetration, existing or new pavement performance should not be significantly compromised by the existence of these layers.

The organic clay and underlying silty clay soils are both susceptible to loss of strength with the introduction of water and/or traffic from construction equipment. Disturbance of the clays from either of these two (2) events or other influences could cause them to loose strength and offer poor support for associated backfill. Care should be exercised by the Contractor to reduce disturbance of the clays.

In low areas and where the roadway embankment is adjacent to wetlands, buried organic clay and peat layers were encountered beneath the pavement. It appears that these wetland soils were not excavated from beneath the roadway embankment when it was originally constructed. Deeply buried peat soils are susceptible to settlement if new construction will involve a raise in grade. If road widening or trail additions occur into wetlands adjacent to the roadway, failure of the embankment into the wetlands can occur unless these soils are excavated or reinforced.

In general, we recommend subcutting pavement areas a minimum of 2 ft to 3ft where soft clay and black silty clay with organics less the 6% by dry weight occur, placing a Mn/DOT Specification 3733 – Type VI geotextile and backfilling with a Mn/DOT 3149 Select Granular material before preparing the pavement foundation. Based on the silty clay soils encountered, we recommend that the pavement be designed on a Hveem Stabilometer Value (R-Value) of 5-10. An R-Value of 40 can be used where a thickened granular layer is placed.

A Select Granular Borrow section beneath the pavement should be provided with a means of subsurface drainage to prevent water buildup in the pavement section and subgrade. This can be in the form of drain tile lines which dispose into storm water systems, or outlets into ditches. Where sand basecourse layers include sufficient sloping, and water can migrate to lower areas, drain tile lines can be limited to finger drains at the catch basins. Perimeter edge drains can also aid in intercepting water which may infiltrate below the pavement.

We recommend using a Mn/DOT Specification 3733 Type VI geotextile to help provide separation between the Select Granular Borrow and the subgrade. The Type VI, as opposed to a Type V, is recommended for it's higher strength and so that drainage through the geotextile (or permittivity) can occur. The Type VI geotextile should have the following properties:

Test Description (units)	Test Method	Minimum Test Value[1]
Wide-Width Tensile Strength (pounds/inch) Machine direction	ASTM D-4595	100 minimum at 5% elongation
Wide-width Tensile Strength (pounds/inch) Machine Direction	ASTM D-4595	300 minimum at ultimate
Wide-Width Tensile Strength (pounds/inch) Cross direction	ASTM D-4595	300 minimum at ultimate
Permittivity (gallons/minutes/foot^2)	ASTM D-4491 8 CM TO 2 CM Falling Head Test Method	40 minimum

[1]Minimum Average Roll Value

The geotextile should be installed full-width beneath the new pavement section. Although Mn/DOT Specification 3733 requires that geotextile panels be sewn together, adjacent panels could be overlapped a minimum of 1 foot to provide full coverage or attached with a MnDOT approved adhesive such as 3M Holdfast 70.

6.2 Segment 1 – CSAH 6 to Old Crystal Bay Road (Rural Section) Recommendations

6.2.a Existing Pavement Recommendations

The soil borings drilled in this segment identify a pavement section of 11 inches of bituminous over a 9 inch thick concrete pavement at the Classon Creek crossing and a pavement section consisting of 13-14 inches of bituminous over 6 to 8 inches of granular base course at the Classon Lake area. Near the CSAH 112 intersection with Old Crystal Bay Road, a pavement section consisting of 7 inches of bituminous over 10 inches of concrete was encountered.

If the road is to be reconstructed or widened, we recommend removing the existing pavement and recycling the bituminous and buried concrete pavements and the existing aggregate base. If the road is widened, and the existing section remains, differential frost heave can result in uneven pavements over time.

6.2.b Subgrade Recommendations

This segment of rural roadway crosses over two wetland areas; the first area at Classon Creek was represented by borings B-1, B-2 and B-3 and the area adjacent to Classon Lake which is represented by borings B-6 and B-7. These borings indicated that original construction through these areas involved placement of fill over at least a portion of the existing swamp deposited soil. At the Classon Creek crossing, a fill section ranging from 4 ft to as much as 23 ft was encountered overlying organic soils which appear to be the original surface soils in the area. These buried organic clay and peat deposits ranged from 1 ½ ft to 15 ft thick.

In the areas between these wetland encroachments and in the high ground areas close to Old Crystal Bay Road, the subgrade consisted of natural silty clays ranging in stiffness from soft to stiff.

Subgrade preparation in new pavement areas, in widened pavement areas and for trail additions should include the excavation of the in-place soils in order to provide a section consisting of a Type VI geotextile, a minimum of 2 ft of Select Granular Borrow, drains and then the pavement structure as included in Report Section 6.1.

6.2.c Construction Concepts Over Peat for Classon Creek and Classon Lake Area Embankment Widening

If widening of the embankment is to be considered for the addition of a trail, the new embankment will extend out over undisturbed peat soils. When fill is placed over peat soils, failure of those soils could occur during construction. Generally, unconsolidated peat does not have the strength to support even shallow lifts of fill. The ability to support a lift of fill would be dependent on the conditions of the vegetated crust and the shear strength and depth of the peat soils. In the event of failure, a rotational shear failure plane extending through the new fill into the underlying soft soils could occur resulting in the formation of a mud wave outside the embankment. This shear movement could also be exhibited more slowly in the formation of a longitudinal crack within the embankment.

Peat soils are also highly compressible, a 10 ft high roadway embankment constructed over peat has the potential to settle up to several feet. A portion of the settlement would likely occur shortly after embankment construction, however long term “secondary” settlement is likely to occur for up to several years after construction completion. Long term differential settlement of the roadway embankment could also occur as the thickness of the peat deposit varies at this site.

Options for the roadway embankment widening through the Classon Creek area and the Classon Lake area includes:

<u>Option 1 - Removal/Replacement</u> – This option bears a higher degree of reliability and a lower amount of risk with respect to both embankment stability and long-term settlement than other options if constructed properly. The peat/organic soils could be excavated from beneath the proposed expansion extending out from the future toe 1 ft for each 1 ft of excavation depth and replaced with compacted Select Granular fill. The excavation should remove the peat to the clay base; based on the borings drilled this depth may range between 5 ft and 20 ft, however, more borings and additional testing should be performed. We recommend the use of a granular material for backfill, such as Mn/DOT Select Granular Borrow. The excavation should occur in the dry. Prior to backfilling, the base of the excavation should be checked by a geotechnical engineer. With this approach, the “consolidated” peat beneath the present embankment would remain. This peat under the existing road would compress under the weight of any new fill, and thus time should be allowed for this settlement to occur prior to paving or if possible the grade should not be raised.

<u>Option 2 - Reinforcement Geosynthetic Placement, Staged Fill Placement with Final Surcharge</u> – Peat soils that are filled over in a controlled and stable manner can be expected to gain strength over time as they consolidate. We suspect the peat and soft clay on this project might take longer to settle and consolidate than fibrous peat due to its low permeability and slow drainage properties. A surcharge would need to be placed to decrease long-term settlements on this widened embankment section. This surcharge, of about 3 to 5 ft above final grade, would need to be in-place for an estimated period of 12 months. We recommend consolidation testing to evaluate a surcharge height and predict the time of surcharge.

A high-strength reinforcement geosynthetic can be used to help maintain a desired factor of safety with regard to side slope stability of the embankment during staged construction, and afterward as the peat consolidates. A reinforcement geosynthetic used in embankment construction over soft ground typically has a high tensile modulus and strength in the roll direction. It is deployed in panels with its high strength direction placed perpendicular to the centerline of the roadway embankment. Adjacent geotextile panels are sewn together to help maintain a stable separation of the embankment fill and the underlying soils. The geotextile would extend from future embankment toe, over the present embankment, to future embankment toe. The high tensile strength within the geosynthetic acts to resist the forces that can cause a rotational shear failure of the peat. As the embankment settles and the peat consolidates, the geosynthetic stretches, mobilizing its resisting tensile force. The geosynthetic must also be permeable in order to allow the transfer of water from the underlying soft soils as the excess pore pressure dissipates with consolidation. A geosynthetic/slope stability design would be required.

Option 3 - Lightweight Fill – The roadway embankment widening could be constructed using lightweight fill materials, such as: shredded tires, extruded polystyrene blocks (e.g. geofoam), wood chips and/or lightweight aggregates. Typically lightweight fill materials are employed to result in no new net loading or minor net loading of the underlying soft soil material. Minor loading would reduce the amount of consolidation settlement. Shredded tires, wood chips and geofoam require a certain amount of soil cover to act as ballast and counterweight uplift forces. The use of shredded tires is restricted in that the tire material cannot encounter the water table where undesirable metals will leach out from the tires into the groundwater and a beneficial use must be proved to the regulatory agencies. Geofoam products are not as useful when near the water table or submerged due to hydrostatic uplift forces. Wood chips would decompose if placed above the water table. As 3 to 4 feet of soil cover is typically required for shredded tires, wood chips and geofoam and the proposed new embankment may only be 10 ft in height and with the water table potentially near the surface, the benefit of these products for this project may be small.

The general intent of lightweight aggregate is usually as an alternative to normal fill placement. We believe that the preconsolidation pressure of the peat is such that even with lightweight aggregate used as embankment fill, some form of surcharge would be required anyway. This offsets the main benefit of using relatively expensive lightweight aggregate.

Summary – Our experience indicates a cost effective construction approach for potential embankment widening into wetland soil conditions, if time and the ability to place a surcharge exists, will be geosynthetic reinforcement, staging fill placement with a final surcharge.

6.2.d Recommended R-Value

We recommend that a Hveen Stabilometer (R-Value) of 5-10 be used to represent silty clay subgrade soils in the design of the pavement for CSAH 112 – Segment 1. An R-Value of 40 can be used where a thickened granular layer is placed.

6.3 Segment 2 - Old Crystal Bay Road to Brown Road (Urban Section) Recommendations

6.3.a Pavement Recommendations

The soil borings drilled in this segment identify a pavement section of 9 to 11 inches of bituminous over a 8-10 inch thick concrete pavement beneath the median at B-14 across from the retention pond separating Kelley Parkway with CSAH 112 and in the east bound turn lane of CSAH 112 at Brown Road. Other pavement areas identified 6-10 inches of bituminous over 6 to 16 inches of granular base course.

If the road is to be reconstructed or widened, we recommend removing the existing pavement and recycling the bituminous and buried concrete pavements and the existing aggregate base. If the road is widened, and the existing section remains, differential frost heave can result in uneven pavements over time.

6.3.b Subgrade Recommendations

This segment of urban roadway crosses over low areas adjacent to a stormwater retention pond west of Willow Drive and through a retail area between Willow Drive and Brown Road. There is a small retention pond in the northwest corner of CSAH 112 and Brown Road. Generally, borings in this segment identified a silty clay fill beneath the pavement which extended to a depth of 3 to 6 ft below the surface. At the borings drilled adjacent to the stormwater retention ponds, including B-16, B-17 and B-22, the silty clay fill was encountered overlying a black silty clay with trace organics.

Subgrade preparation in new pavement areas, in widened pavement areas and for trail additions should include the excavation of the in-place soils in order to provide a section consisting of a Type VI geotextile, a minimum of 3 ft of Select Granular Borrow, drains and then the pavement structure as included in Report Section 6.1

6.3.c Stormwater Retention Ponds between Kelley Parkway & CSAH 112 and at NW Corner of Brown Road

The borings identify that the stormwater retention ponds were cut into clay soils and thus probably do not infiltrate a significant amount of storm water. Modifications to the ponds would likely require outlets to reduce potential overtopping. Piezometer P-1 was installed near the large pond between Kelley Parkway and CSAH 112. The piezometer water level appears to be consistent with the pond level, indicating the pond level is a reflection of the long term groundwater table.

6.3.d R-Value Recommendation

We recommend that a Hveen Stabilometer (R-Value) of 5-10 be used to represent silty clay subgrade soils in the design of the pavement for CSAH 112 – Segment 2. An R-Value of 40 can be used where a thickened granular layer is placed.

6.4 Segment 3 – Brown Road to Cemetery Road (Urban Section) Recommendations

6.4.a Existing Pavement Conditions

The soil borings drilled in this segment identify a pavement section of 3 to 5 inches of bituminous over 8 to 10 inch thick concrete pavement extending from Lake Street east to Long Lake. The one boring drilled through the pavement section adjacent to Long Lake indicates a pavement section consisting of 9 inches of bituminous over 4 inches of granular base coarse.

If the road is to be reconstructed or widened, we recommend removing the existing pavement and recycling the bituminous and buried concrete pavements and the existing aggregate base. If the road is widened, and the existing section remains, differential frost heave can result in uneven pavements over time.

6.4.b Subgrade Recommendations

Subgrade preparation in new pavement areas, in widened pavement areas and for trail additions should include the excavation of the in-place soils in order to provide a section consisting of a Type VI geotextile, 2 ft of Select Granular Borrow, drains and then the pavement structure as included in Report Section 6.1

6.4.c Potential Construction Concepts Adjacent to Long Lake

Pavement distress was noted on the Long Lake side of the CSAH 112 pavement. The lake is in close proximity to CSAH 112. A retaining wall may be required at the CSAH 112/Long Lake shoreline interface. A segmental wet cast "big block" or a cast-in-place wall could be an acceptable solution. Additional soil borings along the proposed wall alignment are recommended. Boring B-29 indicated buried organic clay that could be a foundation issue.

6.4.d Culvert West of Lake Street Recommendations

The culvert crossing of CSAH 112 just west of Lake Street may need to be replaced. B-23 encountered soft clay fill that will need to be removed from the site. Culvert support in the stiff to very stiff silty clay at depth will be required. The anticipated clay foundation soil is classified as a "high plasticity" CH clay. This clay will be sensitive to moisture and construction. We recommend that this high plasticity material be over excavated at least 2 ft below a new culvert and a structural fill pad placed.

6.4.e Environmental Impacts

Gasoline-type odors were encountered when classifying the soil samples for B-25, B-26 and B-28. Gasoline-type odors were detected in samples from 3 to 15 ft at these boring locations. B-25 is located just east of Lake Street in the City of Long Lake and B-26 and B-28 are located adjacent to Long Lake.

6.4.f R-Value Recommendations

We recommend that a Hveen Stabilometer (R-Value) of 5-10 be used to represent silty clay subgrade soils in the design of the pavement for CSAH 112 – Segment 3. An R-Value of 40 can be used where a thickened granular layer is placed.

6.5 Segment 4 – Cemetery Road to TH 12 (Rural Section) Recommendations

6.5.a Existing Pavement Recommendations

The soil borings drilled in this segment identify a pavement section of 3 to 12 inches of bituminous over 6 to 15 inches of granular base course.

If the road is to be reconstructed or widened, we recommend removing the existing pavement and recycling the bituminous and buried concrete pavements and the existing aggregate base. If the road is widened, and the existing section remains, differential frost heave can result in uneven pavements over time.

6.5.b Subgrade Recommendations

Subgrade preparation and new pavement areas, widened pavement areas and for trail additions should include the excavation of the in-place soils in order to provide a section consisting of a Type VI geotextile, 2 ft of Select Granular Borrow, drains and then the pavement structure as included in Report Section 6.1

6.5.c Construction Concepts over Peat for B-36 and B-38

Wetlands encroach on CSAH 112 at two (2) locations within Segment 4, both just west of the Luce Line Trail. B-36 encountered peat beneath the existing roadway embankment to a depth of 18ft and then soft clay to at least a depth of 25 ft. B-38 encountered peat beneath the roadway embankment to a depth of 9ft and then soft clay to a depth of 15ft. The existing CSAH 112 embankment was constructed over these original swamp deposits.

If widening of the embankment is to be considered for the addition of a trail or widening of the roadway, the new embankment will extend out over undisturbed peat soils. When fill is placed over peat soils, failure of those soils could occur during construction. Generally, unconsolidated peat does not have the strength to support even shallow lifts of fill. The ability to support a lift of fill would be dependent on the conditions of the vegetated crust and the shear strength and depth of the peat soils. In the event of failure, a rotational shear failure plane extending through the new fill into the underlying soft soils could occur resulting in the formation of a mud wave outside the embankment. This shear movement could also be exhibited more slowly in the formation of a longitudinal crack within the embankment.

Peat soils are also highly compressible, a 10 to 20 ft high roadway embankment constructed over peat has the potential to settle up to several feet. A portion of the settlement would likely occur shortly after embankment construction, however long term “secondary” settlement is likely to occur for up to several years after construction completion. Long term differential settlement of the roadway embankment could also occur as the thickness of the peat deposit varies at this site.

Options for construction of road embankment widening into these virgin wetland areas includes:

Option 1 - Removal/Replacement – This option bears a higher degree of reliability and a lower amount of risk with respect to both embankment stability and long-term settlement than other options if constructed properly. The peat/organic soils could be excavated from beneath the proposed expansion extending out from the future toe 1 ft for each 1 ft of excavation depth and replaced with compacted Select Granular fill. The excavation should remove the peat to the clay base; based on the borings drilled this depth may range between 5 ft and 20 ft, however, more borings and additional testing should be performed. We recommend the use of a granular material for backfill, such as Mn/DOT Select Granular Borrow. The excavation should occur in the dry. Prior to backfilling, the base of the excavation should be checked by a geotechnical engineer. With this approach, the “consolidated” peat beneath the present embankment would remain. This peat under the existing road would compress under the weight of any new fill, and thus time should be allowed for this settlement to occur prior to paving or if possible the grade should not be raised.

Option 2 - Reinforcement Geosynthetic Placement, Staged Fill Placement with Final Surcharge – Peat soils that are filled over in a controlled and stable manner can be expected to gain strength over time as they consolidate. We suspect the peat and soft clay on this project might take longer to settle and consolidate than fibrous peat due to its low permeability and slow drainage properties. A surcharge would need to be placed to decrease long-term settlements on this widened embankment section. This surcharge, of about 3 to 5 ft above final grade, would need to be in-place for an estimated period of 12 months. We recommend consolidation testing to evaluate a surcharge height and predict the time of surcharge.

A high-strength reinforcement geosynthetic can be used to help maintain a desired factor of safety with regard to side slope stability of the embankment during staged construction, and afterward as the peat consolidates. A reinforcement geosynthetic used in embankment construction over soft ground typically has a high tensile modulus and strength in the roll direction. It is deployed in panels with its high strength direction placed perpendicular to the centerline of the roadway embankment. Adjacent geotextile panels are sewn together to help maintain a stable separation of the embankment fill and the underlying soils. The geotextile would extend from future embankment toe, over the present embankment, to future embankment toe. The high tensile strength within the geosynthetic acts to resist the forces that can cause a rotational shear failure of the peat. As the embankment settles and the peat consolidates, the geosynthetic stretches, mobilizing its resisting tensile force. The geosynthetic must also be permeable in order to allow the transfer of water from the underlying soft soils as the excess pore pressure dissipates with consolidation. A geosynthetic/slope stability design would be required.

Option 3 - Lightweight Fill – The roadway embankment widening could be constructed using lightweight fill materials, such as: shredded tires, extruded polystyrene blocks (e.g. geofoam), wood chips and/or lightweight aggregates. Typically lightweight fill materials are employed to result in no new net loading or minor net loading of the underlying soft soil material. Minor loading would reduce the amount of consolidation settlement. Shredded tires, wood chips and geofoam require a certain amount of soil cover to act as ballast and counterweight uplift forces. The use of shredded tires is restricted in that the tire material cannot encounter the water table where undesirable metals will leach out from the tires into the groundwater and a beneficial use must be proved to the regulatory agencies. Geofoam products are not as useful when near the water table or submerged due to hydrostatic uplift forces. Wood chips would decompose if placed above the water table. As 3 to 4 feet of soil cover is typically required for shredded tires, wood chips and geofoam and the proposed new embankment may only be 10 ft in height and with the water table potentially near the surface, the benefit of these products for this project may be small.

The general intent of lightweight aggregate is usually as an alternative to normal fill placement. We believe that the preconsolidation pressure of the peat is such that even with lightweight aggregate used as embankment fill, some form of surcharge would be required anyway. This offsets the main benefit of using relatively expensive lightweight aggregate.

Summary – Our experience indicates a cost effective construction approach for potential embankment widening into wetland soil conditions, if time and the ability to place a surcharge exists, will be geosynthetic reinforcement, staging fill placement with a final surcharge.

6.5.d Culvert Crossing at Cemetery Road Recommendations

The culvert crossing of CSAH 112 at Cemetery Road may need to be replaced. B-31 encountered medium stiff to stiff silty clay fill to a depth of 17ft below the ground surface underlain by a black organic clay (organic content = 17% by dry weight) with a moisture content of 98% at a depth of 23 ft. Culvert support in the stiff to very stiff silty clay at depth will be required. If supported over the 6ft thick (17ft to 23ft) layer of organic clay, culvert settlement could occur. Additional borings and testing are required in order to assess foundation support conditions.

6.5.e Grade Separation Structure Recommendations

Between the Cemetery Road and the Wayzata Blvd connections with CSAH 112 (Segment 4) grade separation structures may be required if the roadway alignment is changed or if a trail is to be added. The soil borings indicate a native silty clay with sand layers in the higher ground areas where grade separation structures are likely. Once the structure locations are identified, soil borings and/or CPT soundings should be performed on the alignment.

Overall, the site is suited for the construction of a reinforced soil slope or a retaining wall system to support the surrounding hillsides. In lower areas, soft soils could exist that would need to be removed and replaced for support of the grade separation structures. Additional soil borings at these specific locations would identify these needs. The reinforced soil slope or retaining wall system can be either designed in advance by the design professional or can be identified as a vendor design by the Contractor. If the vendor design is chosen, baseline plans and a specification would need to be prepared which identified input requirements. The reinforced soil slope special (RSS) can be designed with a slope face ranging from 1H:1V to a 70° slope face utilizing a geosynthetic wrap in combination with a wire basket system or with a cellular confinement system face.

6.5.f R-Value Recommendations

We recommend that a Hveen Stabilometer (R-Value) of 5-10 be used to represent silty clay subgrade soils in the design of the pavement for CSAH 112 – Segment 4. An R-Value of 40 can be used where a thickened granular layer is placed.

7.0 GENERAL QUALIFICATIONS

This report has been prepared in order to aid in the preliminary design of 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 preliminary 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 final preliminary design concepts and reports 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 during construction, 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.

APPENDIX

1. Soil Boring Location Diagram
2. Soil Boring Logs
3. General Notes
   Classification of Soils for Engineering Purposes
4. Standard Proctor and R-Value Laboratory Test Results
5. R-Value Correlation Chart

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

For

SRF CONSULTING GROUP, INC.

CSAH 112

BETWEEN

CASH 6 AND TH 12 IN LONG LAKE AND ORONO, MN

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AUGUST, 2012

GTE Project No. 95423
Hennepin County Project No. 0911
SRF Project No. 7738

SRF CONSULTING GROUP, INC.

CSAH 112 BETWEEN CSAH 6 AND TH 12 –
LONG LAKE AND ORONO, MN

1. Soil Boring Location Diagram