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A Geotechnical Evaluation Report for Mr. Jamie Jensen

St. Clair Farms Residential Development
NE of Old Towne Road and 276th Street
Chisago City, Minnesota

Project BBXX-02-088A
May 21, 2002

Braun Intertec Corporation

Engineers and Scientists Serving the Built and Natural Environments

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651-487-3245 Fax: 487-1812

Engineers and Scientists Serving the Built and Natural Environments®

May 21, 2002

Project BBXX-02-088A

Mr. Jamie Jensen
2483 15th Street NW
New Brighton, MN 55112

Dear Mr. Jensen:

Re: Geotechnical Evaluation, Proposed St. Clair Farms Residential Development, NE of Old Towne Road and 276th Street, Chisago City, Minnesota.

The geotechnical evaluation for the above referenced project has been completed. This letter summarizes our results and recommendations.

Summary of Results

Beneath approximately ½- to 1-foot of topsoil, the borings encountered and terminated in glacial soils comprised mostly of glacial till, but also containing deposits of glaciofluvial and glacial outwash within the higher northern portion of the site.

The glaciofluvium consisted of wet silty clay, clayey sand and silty sand. The glacial outwash consisted of moist poorly graded sand with silt. The glacial till consisted of wet sandy lean clay and lean clay with sand.

Groundwater was encountered at elevations ranging from about 924 to 928. These observed water levels were, however, taken over a short time period and the groundwater may not have had sufficient time to stabilize.

Summary of Recommendations

The underlying glacial soils, in general, are considered suitable for building support. Some localized corrections, however, will likely be needed to remove soft or disturbed clays exposed at the time of grading or construction. Although generally suitable, the clayey soils are moisture sensitive and presently wet. An important part of site grading, therefore, will be to minimize disturbance to these soils and the ability to dry and reuse these materials.

For reasons discussed herein, we recommend that the developer consider, and have a contingency plan, for incorporating a two-foot sand cushion below the pavements.

Remarks
We refer you to the attached report for more details. If you have questions about the information provided in the attached report, call Phil Peterson at (651) 487-7020.

Sincerely,
Braun Intertec Corporation

Phillip J. Peterson, PG
Associate Principal

Keith S. Rosvold, PE, PG
Principal / Engineer-Geologist

c: Mr. Chuck Plowe (Plowe Engineering)

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Description

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Engineers and Scientists Serving the Built and Natural Environments®

A. Introduction

A.1. Project

Silvanesti Incorporated plans to develop an approximate 10-acre site for residential construction. The proposed St. Clair Farms development will likely consist of multi-family townhome type buildings along with construction of utilities, residential streets, and driveways. The project site is located along the east side of Old Towne Road between 276th and 278th Streets in Chisago City, Minnesota.

A.2. Purpose

The purpose of this geotechnical evaluation was to assess the site's soil and groundwater conditions relative to the proposed construction and provide recommendations for site grading and the design of residential foundations and pavements.

A.3. Scope of Services

Our scope of services was provided in general accordance with our April 9, 2002, Proposal to Mr. Jamie Jensen with Silvanesti Inc., which he subsequently authorized. Our services were provided under the terms of our General Conditions dated January 1, 1996 and were limited to:

- Notifying Gopher State One Call and meeting on-site with public utility locators to locate underground utilities within the work area.
- Drilling six (6) penetration test borings to a depth of 15 feet.
- Returning material samples to our laboratory for visual classification, testing and evaluation by a geotechnical engineer.
- Preparing this Geotechnical Evaluation Report containing Log of Boring sheets, a boring location sketch, a summary of soil and groundwater conditions encountered, and recommendations for site grading and the design of foundations and pavements.

A.4. Documents Provided

To assist in our evaluation, we received a faxed copy of an undated site plan from Plowe Engineering. This plan showed the conceptual layout of the proposed development along with the desired soil boring locations as selected by Plowe Engineering.

A.5. Site Conditions

The site is an approximate L-shaped property bordered to the west by Old Towne Road (CSAH 24), to the south by 276th Street, and to the north by 278th Street. There is an existing farmstead located in the northeast corner of the property. Overall, the northern portion of the site is topographically high relative to the remainder and used primarily as pasture. The middle (elbow) portion of the site is low and wet (wetland), while the east leg of the site is open and grassy.

A.6. Boring Locations and Elevations

The soil boring locations were selected and surveyed, including the ground surface elevations, by Plowe Engineering. Figure 1 in the Appendix shows the approximate boring locations. The attached logs indicate the ground surface elevations at the various boring locations.

B. Results

B.1. Logs

Log of Boring sheets indicating the depths and identifications of the various soil strata, penetration resistances, laboratory test data, ground surface elevations and groundwater observations are attached. Where shown, strata changes were inferred from changes in the penetration test samples. It should be noted that the depths shown as changes between the strata are only approximate. The changes are likely transitions and the depths of the changes will vary away from the borings. Geologic origins presented for each stratum on the Log of Boring sheets are based on the soil types, blows per foot, and available common knowledge of the depositional history of the area.

B.2. Soils Encountered

B.2.a. Topsoil. The borings encountered about ½ to 1 foot of topsoil at the surface. The topsoil consisted of sandy lean clay (CL), clayey sand (SC), silty sand (SM), and silty clay (CL-ML). These soils were dark brown, gray and black, wet, and contained roots and plant fibers.

B.2.b. Glacial Soils. Beneath the topsoil, the borings encountered and terminated in glacial soils comprised mostly of glacial till, but also containing deposits of glaciofluvial and glacial outwash within the topographic higher northern portion of the site. Borings ST-5 and ST-6 encountered about 11 to 14 feet of glacialfluvial and glacial outwash deposits over the glacial till. Elsewhere, glacial till was encountered immediately below the topsoil.

The glaciofluvium consisted of silty clay, clayey sand and silty sand. The glacial outwash consisted of poorly graded sand with silt (SP-SM). The clays were wet with moisture contents around 26 percent, while the sands were moist.

The glacial till consisted of sandy lean clay and lean clay with sand. These clays were brown near the surface, gray at depth, and wet throughout (where tested moisture contents ranged from 17 to 28 percent).

B.2.c Wetland Soils. This site has a designated wetland. Although not directly investigated, wetlands typically have organic deposits such as peat and muck associated with them (muck is a term used to describe swamp-deposited materials). If these areas are to be mitigated for roadway or building construction, we anticipate that some muck excavations will be required.

B.3. Penetration Resistances

Penetration resistance tests were performed at regular intervals in the borings and the results of these tests are shown on the Log of Boring sheets in the column marked "BPF" (blows per foot). Table 1, below, summarizes the results of these tests along with interpretive comments to help illustrate the engineering implications of the test results.

Table 1. Penetration Resistance Data Summary

Material	Range of Penetration Resistances	Comments
Glaciofluvium	5 to 16 BPF.	Rather soft to medium silty clay, medium to rather stiff clayey sand and medium dense silty sand.
Glacial Outwash	15 to 28 BPF.	Medium dense sand.
Glacial Till	4 to 15 BPF.	Rather soft to stiff clay.

B.4. Groundwater

During or immediately after drilling, groundwater was observed in Borings ST-1 through ST-4 at depths of about 4 to 6½ feet. Borings ST-1 and ST-2 were left open and rechecked for water about 2 hours later. Upon recheck, water was observed at depths of 4- to 4 ½-feet. These depths correspond to approximately elevations 925 and 928 for Borings ST-1 and ST-2, respectively. It is not known whether or not water levels would have continued to rise given additional time.

Borings ST-5 and ST-6 drilled within the higher northern portion of the site did not encounter groundwater while drilling nor when checking the borings immediately after drilling. Soils encountered within the upper portions of these borings were, however, wet. Possibly, with a longer monitoring period, these boreholes may have accumulated some water as well.

A summary of our groundwater observations is shown in Table 2 below.

B.4.a. Table 2. Summary of Observed Groundwater Levels

	Surface	Depths to Water			Highest Observed
Boring	Elevation	While Drilling	Immediately After	2-Hour Level	Water Elevation[A]
ST-1	928.9	4 feet	4 feet	4½ feet	924½
ST-2	932.0	6 feet	5 feet	4 feet	928
ST-3	930.6	6½ feet	6 feet	---	924½
ST-4	930.7	6½ feet	5 feet	---	925½
ST-5	934.2	NE	NE to 11½ feet	---	NE to 923
ST-6	937.7	NE	NE to 12½ feet	---	NE to 925

NE = Not Encountered

A - The highest observed water elevation rounded to nearest ½-foot.

C. Evaluation

C.1. Proposed Construction

C.1.a. Grade Changes. A grading plan showing proposed grade changes was not available for preparation of this report. We have assumed that the site will essentially be designed to balance earthwork quantities with a combination of cutting and filling. Grade changes overall are expected to be less than 10-feet.

C.1.b. Proposed Buildings. Multi-unit townhome type buildings will likely be constructed for this development. We anticipate that these homes will be one or two stories in height, possibly with a basement, and comprised of concrete block walls below ground and wood-frame construction above. Correspondingly, foundation loads for these structures are expected to be rather light, with maximum wall loads of 1 to 3 kips per lineal foot.

C.1.c. Proposed Pavements. Site development will include the construction of residential streets. These streets will be bituminous paved and subject to mainly automobile traffic with occasional trucks and buses. Although specific traffic loading conditions were not provided, Section D.5 of this report provides a typical pavement design section based on the assumed stated conditions.

C.1.d. Proposed Utilities. City water and sanitary sewer will be installed for service to the townhome buildings.

C.1.e. Precautions Regarding Changed Information. We have attempted to describe our understanding of the proposed construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experiences with similar projects. If we have not correctly recorded or interpreted the project details, we should be notified. Additional analyses and revised recommendations may be necessary.

C.2. Suitability of Existing Soils

C.2.a. Building Support. Beneath the topsoil, this site is generally characterized by clayey glacial soils (mostly sandy lean clay (CL) with some sandier soils within the northern portion of the development).

The topsoil is considered compressible and unsuitable for building support. These materials will need to be removed from beneath the proposed building areas.

The underlying glacial soils, in general, are considered suitable for building support. Some localized corrections, however, will likely be needed to remove soft or disturbed clays exposed at the time of grading or construction. Although generally suitable, these clayey soils are moisture sensitive and presently wet. An important part of site grading, therefore, will be to minimize disturbance to these soils and the ability to dry and reuse these materials. Recommendations for general building pad and footing subgrade preparations are provided in Sections D.1 and D.2, respectively.

C.2.b. Pavement Support. The clayey glacial soils which predominate this site are considered rather poor materials for direct support of pavements. These soils are moisture sensitive, difficult to compact when wet and susceptible to disturbance. Likewise, these soils are frost susceptible and poorly draining. The effects of these characteristics are that these soils, where wet, will likely be unstable or become unstable during construction. To correct unstable areas, wet soils will need to be properly aerated (disked and dried) and re-compacted. The ability to adequately dry these materials will, therefore, be weather dependent and may delay construction. Once adequately dried and compacted, these soils will still be susceptible to disturbance upon becoming wet. If these soils cannot be adequately dried and stabilized, they will need to be replaced with drier materials or stabilized by other methods such as fly ash or lime additives.

Although it is conceivable, and likely desirable, to construct pavements directly on the existing glacial soils, for reasons discussed above, we recommend that the developer consider, and have a contingency plan, for incorporating a two-foot sand cushion below the pavements. Use of a sand cushion would provide better subgrade support, a more frost-resistant subgrade, enable use of a thinner aggregate base and/or bituminous section, and reduce the potential for weather-related delays during construction. Based on the soil borings, it does not appear that a significant source of clean sand is available on-site for this purpose. Thus, if a sand cushion is employed, the sand would need to be imported. If a sand cushion is used below the pavements, a drainage system will also need to be installed to collect and drain water that may accumulate in the sand cushion.

C.2.c. Reuse of On-site Soils as Fill and Backfill. Excavated topsoil should be placed in landscaped areas or exported from the site. The underlying glacial soils are suitable for reuse as structural backfill and fill provided that they can be dried within a range of moisture suitable for compaction, typically within 1 percentage point below, to 2 to 3 percentage points above their optimum moisture contents. Presently, these soils are wet and would require drying.

C.3. Weather Affects on Grading

Because of the predominantly clayey soils on this site, site grading activities will be particularly impacted by weather. In general, the months of June, July and August are most favored for grading operations when silty and/or clayey soils require drying for stabilization. Cooler temperatures and rainy or snowy weather conditions in the spring, winter and fall tend to slow or delay grading and construction. Silt and clay soils which become saturated during those times of the year, will not likely become adequately dry and will provide limited support to heavy construction equipment. These soil conditions can cause heavy tracked dozers and rubber-tire equipment to disturb building and pavement subgrades, requiring additional excavation earthwork.

C.4. Groundwater

Table 2 of Section B.4., summarizes our water level observations made during and shortly after drilling. Based on these short-term water level readings, it appears that water is present at elevations ranging from about 924 to 928. For comparison, the centrally located wetland appears to have a surface elevation of about 928. We recommend that building and street design account for these water level conditions.

Due to the rather impermeable nature of the site's glacial soils, groundwater infiltration will be slow and the clays will have a tendency to trap or hold water. Thus, the on-site soils will likely be wet, especially in localized low spots and may be prone to seepage when excavating into them. Where groundwater or perched water is encountered during excavations, we anticipate that seepage rates will be rather slow and excavation dewatering, if necessary, can likely be handled with sumps and pumps.

D. Recommendations

D.1. Building Pad Preparation

D.1.a. Excavations. We recommend stripping topsoil from beneath the proposed building areas. Where soft clayey soils are exposed, we recommend that they be further excavated to stable or firm soils. Where existing wetlands are to be mitigated, we recommend that all organic soils be completely excavated to expose competent mineral soils.

Based on the soil borings, excavations to remove existing topsoil will extend about 1 foot or less. Areas immediately adjacent to the existing wetland, however, may encounter deeper topsoil and/or organic deposited materials.

Where excavations extend below proposed footings, we recommend that they be oversized to provide lateral stability for the backfill. The *bottoms* of the subexcavations should be oversized 1 foot beyond the edges of the footings for each foot subexcavation below the bottoms of the footing (1:1 oversizing). Loosened soil in the bottoms of the excavation should be compacted prior to backfilling.

It is important that stripped surfaces be stable prior to placing additional fill, foundations or pavements. To help reduce disturbance to the underlying wet and clayey soils, we recommend that site grading be performed with lighter weight tracked equipment as opposed to heavy scrapers.

D.1.b. Backfill/Fill and Compaction. We recommend that fill and backfill placed within the proposed building area consist of sandy gravel, sand, silt or clay with a plastic index less than 15. Clay with a plastic index between 15 and 25 may be used if it is placed at moisture contents over optimum. As indicated in Section C.2.c, the existing glacial soils are considered suitable for reuse as backfill and fill, but will likely require drying in order to attain adequate compaction. We recommend that the on-site soils reused as fill be placed at moisture contents within 1 percentage point below and 3 percentage points above their optimum moisture content.

We recommend backfill and fill be placed in lifts not exceeding 8 to 10 inches and compacted to a minimum of 95 percent of it's standard Proctor maximum dry density (ASTM D 698).

D.2. Footings

D.2.a. Depth. We recommend that perimeter footings for heated buildings bear a minimum of 3 1/2 feet below exterior grade for frost protection. Interior footings may be placed immediately beneath the slab. Exterior footings and unheated footings, such as those for stoops, should be extended at least 5 feet below exterior grade.

D.2.b. Subexcavations. After performing the recommended site grading, soils encountered at probable footing depths will likely consist of clayey glacial soils, compacted fill, or possibly some sandy soils towards the north end of the site. Locally, some of the glacial soils may be soft or become disturbed and require partial excavations (subexcavations) at the time of construction to stabilize the footing bottoms. Subexcavations on the order of one to two feet below footing bottoms are typically adequate for this purpose.

D.2.c. Allowable Bearing Pressure. In our opinion, footings placed on competent glacial soils or adequately compacted fill can be sized to exert a net allowable soil bearing pressure of 2,500 pounds per square foot (psf). We recommend that strip footings have a minimum width of 18 inches and column pads have a minimum size of 2 ½ by 2 ½ feet.

D.2.d. Settlement. We anticipate that total and differential settlement of footings will be less than 1 and ½ inch, respectively, under the assumed loads. Residential buildings of the types described can generally tolerate settlement of this magnitude.

D.3. Foundation/Basement Walls

D.3.a. Lateral Earth Pressure. We recommend that backfill placed on the exterior sides of the foundation/basement walls be compacted to a minimum of 90 percent of the standard Proctor maximum dry density. Beneath steps, slabs and pavements, it should be compacted to a minimum of 95 percent.

If imported sandy gravel or sand is used as backfill against the wall, a lateral earth pressure of 50 psf per foot of depth should be used to design the basement wall. If on-site clay is used as backfill against a synthetic wall drainage system, we recommend using a lateral earth pressure of 60 psf per foot of depth for designing the wall. These values are based on at-rest earth pressure conditions.

D.3.b. Seepage Control. The basement will likely be surrounded by clay soils. If water percolates down alongside the walls, it may become perched on a clay layer and then enter the basement through shrinkage cracks in the concrete. Collecting run-off and discharging it well away from the foundations and sloping the ground surface down and away from the basement walls are two common methods of reducing infiltration and percolation.

As an added precaution against basement seepage, we recommend installing a perimeter foundation drain system. The system should include a perforated pipe with an invert within 2 inches of bottom-of-footing elevation. Collected seepage should be routed to a sump and then drained by a pump or gravity to a storm sewer or low area on the site.

The seepage control system should include permeable material against the basement wall, such as a synthetic wall drainage system or at least 2 feet (horizontal) of permeable sandy gravel or sand backfill. The sandy gravel or sand backfill should have less than 5 percent of the particles by weight passing a 200 sieve. Where the sandy gravel or sand backfill extends outside the footprint of the building, it should be capped by a slab, pavement or at least 1 foot of topsoil and clay.

D.4. Floor Slabs

We recommend that floor slab elevations be designed to provide at least a 4-foot separation from static groundwater. Based on the boring data, it appears that groundwater levels presently range from about 924 to 928. Groundwater levels will fluctuate with seasonal conditions. If desired, piezometers could be installed for better evaluating potential groundwater levels. We recommend that you check with city or township personnel for their requirements for establishing lowest floor elevations.

If floor coverings less permeable than the concrete slab will be used, we recommend that a vapor barrier be placed beneath the slab. Some contractors prefer to bury the vapor barrier beneath a layer of sand to reduce curling of the floor slabs.

D.5. Pavements

D.5.a. Subgrade Preparations. We recommend removing topsoil, organic, soft or otherwise unsuitable soils from beneath the proposed pavement areas. We recommend that the upper 6 inches of the resulting subgrade be scarified, moistened or dried to a moisture content near optimum, and compacted to a minimum of 100 percent of the standard Proctor maximum dry density.

Where fill is required, we recommend that it be similarly moistened and compacted. If there are areas which cannot be compacted, we recommend that the unstable materials be subexcavated to a depth of 2 feet and be replaced by materials which can be compacted. To help limit disturbance to the underlying clayey soils, we recommend that roadway excavations be performed using light-weight tracked dozers or a backhoe. If the subgrade is wet during construction, we recommend establishing haul routes away from the proposed roadways.

If a sand sub-base is incorporated into the street section, additional subexcavations will be required to facilitate placement of the sand. The sand should consist of Select Granular Borrow (see Section D.5.f.) and should be placed over a stabilized subgrade as discussed above. If the subgrade soils cannot be stabilized as described, a thicker sand cushion may need to be employed and/or a geotextile fabric may be warranted. Subdrains should also be installed (see Section D.5.e.).

D.5.b. Test-Roll. Prior to placing the aggregate base, we recommend test rolling the pavement areas with a loaded dump truck or other heavy vehicle. The purpose of the test roll is to check for areas of loose or soft subgrade material that may require additional compaction or removal and replacement with more stable material. We recommend having the test roll procedure observed by a geotechnical engineer or engineering technician.

D.5.c. Soil R-Value. For the anticipated clayey subgrade, we estimate that soil R-values will range from 10 to 25. We assumed a soil R-value of 10 for the following design.

D.5.d. Design Sections. Table 3. on the following page, provides two possible pavement design sections for a typical street section. Option 1 assumes that the pavements are placed directly over a clayey subgrade. Option 2 incorporates an approximate 2-foot sand cushion (sub-base) within the pavement design section.

Table 3. Typical Street Pavement Sections*.

Course	Option 1	Option 2
Bituminous Wear	1 ½"	1 ½"
Bituminous Base	1 ½"	1 ½"
Gravel Base	14"	6"
Sand Sub-base	---	24"

*Assumptions: (1) Subgrade Soil R-value = 10.
(2) 18-kip Equivalent Traffic = 75,000.
(3) Pavement Design Life = 20 years.

Other pavement sections of equivalent structural strength could also be considered.

D.5.e. Pavement Area Subdrains. If the pavements are constructed on a 2-foot sand cushion placed over the existing subgrade, we recommend installing subdrains throughout low spots in the pavement areas to remove water that accumulates through seepage into the sand cushion placed over the less permeable clays. We recommend placing the subdrains at or below the bottom of the sand cushion, either by setting the subdrains in shallow trenches, or by sloping the bottom of the sand cushion toward them.

We recommend using perforated pipes wrapped in a filter fabric and embedded in gravel. The subdrains should be routed to catch basins or storm sewers.

D.5.f. Materials and Compaction. If a sand cushion is used in the pavement design section, we recommend using sand meeting the requirements of Mn/DOT Specification 3149 for Select Granular Borrow. We recommend specifying crushed gravel base meeting the requirements of Mn/DOT Specification 3138 for Class 5. We recommend that the bituminous surface and base courses meet the requirements of Mn/DOT Specification 2350, Type LV.

We recommend that the crushed gravel base be compacted to a minimum of 100 percent of the standard Proctor maximum dry density. We recommend that the bituminous courses be compacted to a minimum of 95 percent of their Marshall density.

D.6. Utilities

D.6.a. Pipe Support. The on-site glacial soils are considered suitable for support of utility pipes bedded in sand material. If the soils at invert grades become disturbed during excavation, they can lose strength. Disturbed soils should be re-compacted, if possible, or subcut and replaced.

D.6.b. Dewatering. Excavations for utilities will likely encounter groundwater or perched groundwater. Because of the rather impermeable soils, we anticipate that water infiltration will be relatively slow and can likely be controlled with sumps and pumps within the trenches. In the case of sandier soils, sumps may need to be located along side the trench. In waterbearing sands, a sand point dewatering system or wells may be required. With the present data, we do not anticipate the need for such extensive dewatering.

D.6.c. Backfill. We recommend that backfill placed over the utilities be placed in lifts not exceeding 12-inches and compacted to the specifications previously reported. Materials excavated from the utility trenches can be reused as trench backfill, however, most of these materials will be wet and require drying in order to attain adequate compaction. If these soils cannot be dried, we recommend that they be replaced with drier soils adequately compacted. If it is not practical to dry or replace these soils, a zero air voids criteria could be used as a means of controlling settlement over the trenches.

D.7. Additional Recommendations for Construction

D.7.a. Excavations. Site grading can be completed with typical construction equipment. However, where subgrade soils are overly wet, we recommend using light-weight tracked equipment to help limit disturbance to the underlying soils and reduce excavation quantities.

D.7.b. Observations. We recommend that all excavation, footing, slab and pavement subgrades be observed by a geotechnical engineer to evaluate if the subgrade soils are similar to those encountered by the borings, adequate to support the proposed construction and adequately oversized. These observations should be conducted prior to placing backfills, fills, or forms for footings.

D.7.c. Testing. We recommend density tests of backfills and fills placed beneath footings, slabs and pavements. We also recommend density testing of the compacted pavement subgrade and gravel base course. Samples of proposed backfill and fill materials should be submitted to our testing laboratory at least three days prior to placement for evaluation of their suitability and determination of the optimum moisture content and maximum dry density.

We recommend at least one density test for every 100 cubic yards of fill placed beneath building areas with at least one test for every 2 feet of fill placed. At least one compaction test should be taken for every 100 feet of trench at vertical intervals not exceeding 2 feet.

D.7.d. Cold Weather Considerations. If site grading and construction is anticipated during cold weather, we recommend that good winter construction practices be observed. All snow and ice should be removed from cut and fill areas prior to additional grading. No fill, footings or slabs should be placed on frozen soils or frozen materials. No frozen soils should be used as fill.

E. Field Procedures

E.1. Drilling and Sampling

The penetration test borings were performed on April 29, 2002, using a truck-mounted drill rig equipped with 3 1/4-inch inside diameter hollow-stem auger. Sampling for the borings was conducted in general accordance with ASTM D 1586, "Penetration Test and Split-Barrel Sampling of Soils." Using this method, we advanced the bore hole with the hollow-stem auger to the desired test depth. A 140-pound manual or automatic hammer falling 30 inches was then used to drive the standard 2-inch split-barrel sampler a total penetration of 1 1/2 feet below the tip of the hollow-stem auger. The blows for the last foot of penetration were recorded and are an index of soil strength characteristics. Samples were taken at 2 ½-foot vertical intervals to the 15-foot depth and at 5-foot intervals thereafter. A representative portion of each sample was then sealed in a glass jar.

E.2. Soil Classification

Soils encountered in the borings were visually and manually classified in the field by the crew chief in accordance with ASTM D 2488, "Description and Identification of Soils (Visual-Manual Procedures)." A summary of the ASTM classification system is attached. A soils engineer reviewed all samples and field classifications. Representative samples will remain in our St. Paul, Minnesota office for a period of 60 days to be available for your examination.

E.3. Groundwater Observations

Immediately after taking the final samples in the bottoms of the borings, the holes were probed through the hollow-stem auger to check for the presence of groundwater. Immediately or within about 2 hours after withdrawal of the auger, the holes were again probed and the depths to groundwater or cave-in were noted. The borings were then backfilled with auger cuttings.

F. General Recommendations

F.1. Basis of Recommendations

The evaluation and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated on the attached sketch. Variations may occur between these borings, the nature and extent of which may not become evident until construction or further explorations. If variations are encountered, it will be necessary to make a reevaluation of the recommendations in this report. Such variations may result in additional construction costs and it is suggested that a contingency be provided for this purpose.

F.2. Plan Review

This report is based on a limited amount of information. As such, a number of assumptions were necessary to permit us to make recommendations. For this reason it is recommended that we be retained to review the final design and specifications to determine whether those assumptions were correct and whether any change in concept may have had any effect on the validity of our recommendations, and whether our recommendations have been implemented in the design and specifications. If we are not permitted an opportunity to make this recommended review, we will not be liable for any losses arising out of incorrect assumptions, design changes, or misinterpretation or misapplication of the recommendations.

F.3. Groundwater Fluctuations

Water level readings have been made in the borings at the times and under conditions stated on the boring logs. This data has been reviewed and interpretations made in the text of this report. However, it must be noted that the period of observation was relatively short. Fluctuations in groundwater level can occur due to variations in rainfall, aquifer response and other factors not evident at the time measurements were made and reported herein. Design drawings, specifications and construction planning should recognize the possibility of fluctuations.

F.4. Use of Report

This report is for the exclusive use of the addressee and copied parties for purposes described in Section A of this report. The data, analyses and recommendations may not be appropriate for other purposes. We recommend that parties contemplating other purposes contact us. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report.

F.5. Level of Care

Services performed by the geotechnical engineers for this project have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is made.

Professional Certification

I hereby certify that this report
was prepared by me or under my direct
supervision and that I am a duly
Registered Professional Engineer
under the laws of the State of
Minnesota.

Keith S. Rosvold, PE
Registration Number: 20416
Date: May 21, 2002

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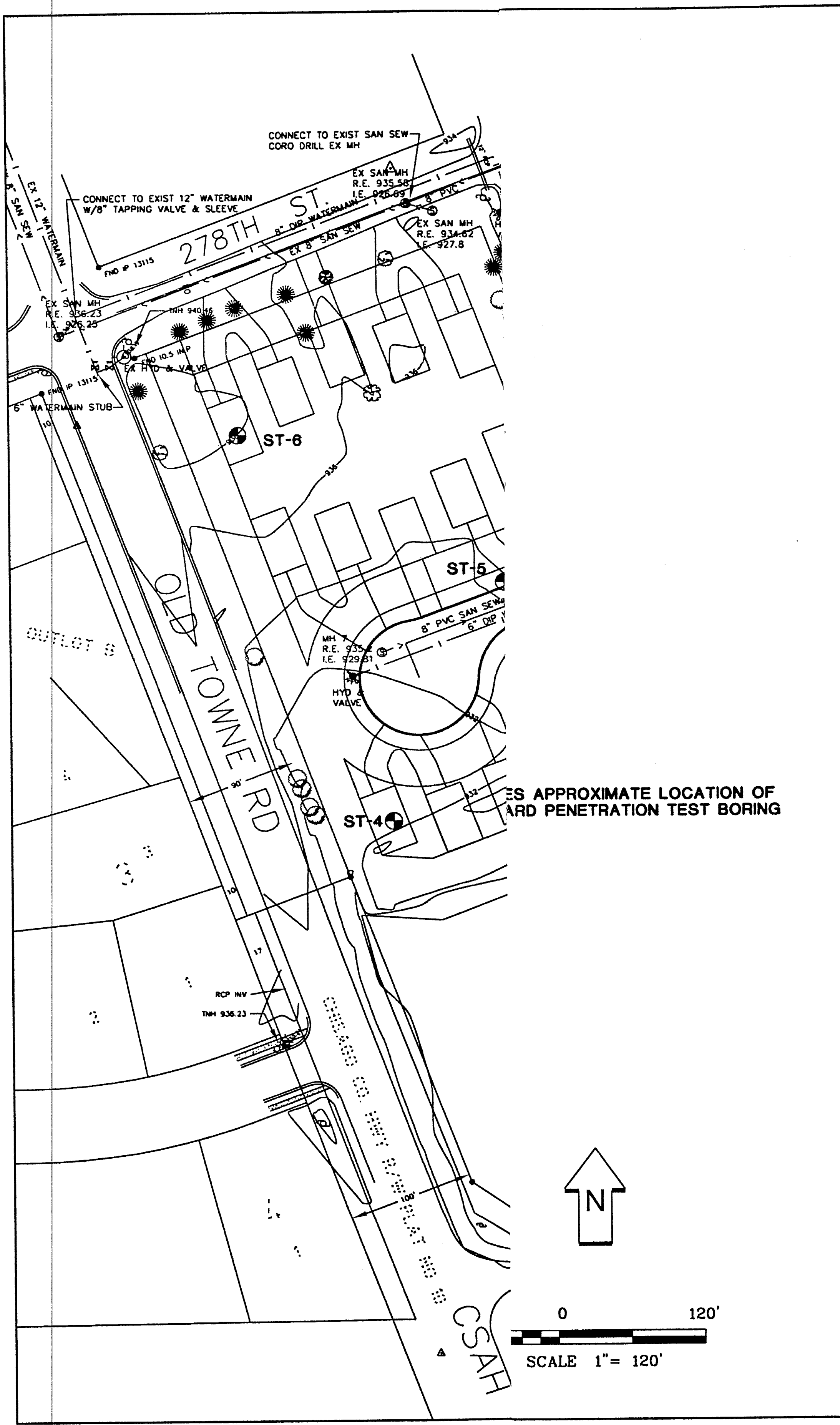
Appendix



BRAUN INTERTEC

SOIL BORING LOCATION SKETCH
GEOTECHNICAL EVALUATION
PROPOSED ST. CLAIR DEVELOPMENT
CHISAGO CITY, MINNESOTA

INT		DATE
DRAWN BY:	JAG	5-13-02
APP'D BY:	PJP	5-13-02
JOB NO.	BBXX-02-088A	
DWG. NO.	BX2088A	SHEET OF
SCALE	1" = 120'	

FIGURE NO.

LOG OF BORING

BRAUN℠ INTERTEC

Braun Project BBXX-02-088A **Geotechnical Evaluation Services** **Proposed St. Clair Farms** **NE of 276th Street N. and CSAH 24** **Chisago City, Minnesota**	BORING: **ST-1** LOCATION: See attached sketch.
DRILLER: C. Powers / METHOD: 3 1/4" HSA, Autohmr	DATE: **4/29/02** / SCALE: **1" = 4'**

Elev. feet 928.9	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
927.9	1.0	CL	SANDY LEAN CLAY, with Roots, dark brown, black, wet. (Topsoil)			Benchmark: The surface elevations were provided by Plowe Engineering.
924.9	4.0	CL	SANDY LEAN CLAY, trace of Gravel and Roots, olive, wet, medium. (Glacial Till)	7*		* MC = 19%
920.9	8.0	CL	SANDY LEAN CLAY, trace of Gravel, brown, wet, rather soft to medium. (Glacial Till)	4*	▽	* MC = 27%
				7		An open triangle in the water level (WL) column indicates the highest depth at which groundwater was observed while drilling.
913.4	15.5	CL	SANDY LEAN CLAY, trace of Gravel, gray, wet, medium. (Glacial Till)	7		
				6		
				7		
			END OF BORING. Water down 4 feet with 14 feet of hollow-stem auger in the ground. Water down 4 1/2 feet 2 hours after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project BBXX-02-088A Geotechnical Evaluation Services Proposed St. Clair Farms NE of 276th Street N. and CSAH 24 Chisago City, Minnesota	BORING: ST-2 LOCATION: See attached sketch.
DRILLER: C. Powers — METHOD: 3 1/4" HSA, Autohmr	DATE: 4/29/02 — SCALE: 1" = 4'

Elev. feet 932.0	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
931.3	0.7	CL	SANDY LEAN CLAY, with Roots, black to brown, wet. (Topsoil)			
		CL	SANDY LEAN CLAY, trace of Gravel and Roots, brown and light gray, wet, rather soft. (Glacial Till)	5*		* MC = 20%
					▽	
				6*		* MC = 23%
				5		
				7		
920.0	12.0					
		CL	SANDY LEAN CLAY, trace of Roots, gray, wet, rather stiff. (Glacial Till)	9		
				10		
916.5	15.5					
			END OF BORING. Water down 6 feet with 14 feet of hollow-stem auger in the ground. Water down 4 feet 2 hours after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project BBXX-02-088A Geotechnical Evaluation Services Proposed St. Clair Farms NE of 276th Street N. and CSAH 24 Chisago City, Minnesota	BORING: ST-3 LOCATION: See attached sketch.
DRILLER: C. Powers / METHOD: 3 1/4" HSA, Autohmr	DATE: 4/29/02 / SCALE: 1" = 4'

Elev. feet 930.6	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
929.5	1.1	CL	SANDY LEAN CLAY, with Roots, black and dark brown, wet. (Topsoil)			
		CL	SANDY LEAN CLAY, trace of Roots, light gray and brown, wet, rather soft to medium. (Glacial Till)	7		
				4	▽	
921.6	9.0			5		
		CL	SANDY LEAN CLAY, trace of Gravel, gray, wet, medium to rather stiff. (Glacial Till)	7		
				6		
915.1	15.5			9		
			END OF BORING. Water down 6 1/2 feet with 14 feet of hollow-stem auger in the ground. Water observed at 6-foot depth immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN℠ INTERTEC

LOG OF BORING

Braun Project BBXX-02-088A Geotechnical Evaluation Services Proposed St. Clair Farms NE of 276th Street N. and CSAH 24 Chisago City, Minnesota		BORING: ST-4 LOCATION: See attached sketch.	
DRILLER: C. Powers	METHOD: 3 1/4" HSA, Autohmr	DATE: 4/29/02	SCALE: 1" = 4'

Elev. feet 930.7	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
930.2	0.5	CL-ML	SILTY CLAY, with Roots, dark gray, wet. (Topsoil)			
		CL	LEAN CLAY with SAND, trace of Gravel and Roots, light gray, wet, medium to rather soft. (Glacial Till)	7*		* MC = 28%
				4*	▽	* MC = 25%
923.7	7.0	CL	SANDY LEAN CLAY, trace of Gravel, brown, and gray, wet, medium to rather stiff. (Glacial Till)	8*		* MC = 17%
				12		
				9		
915.2	15.5			8		
			END OF BORING. Water down 6 1/2 feet with 14 feet of hollow-stem auger in the ground. Water observed at 5-foot depth immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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INTERTEC

LOG OF BORING

Braun Project BBXX-02-088A **Geotechnical Evaluation Services** **Proposed St. Clair Farms** **NE of 276th Street N. and CSAH 24** **Chisago City, Minnesota**	BORING: **ST-5** LOCATION: See attached sketch.
DRILLER: C. Powers — METHOD: 3 1/4" HSA, Autohmr	DATE: **4/29/02** — SCALE: **1" = 4'**

Elev. feet 934.2	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
933.1	1.1	SM	SILTY SAND, fine-grained, trace of Roots, dark brown, wet. (Topsoil)			
930.2	4.0	SC	CLAYEY SAND, fine- to medium-grained, trace of Gravel, brown, wet, rather stiff. (Glaciofluvium)	9		
927.2	7.0	SM	SILTY SAND, fine- to medium-grained, mixed with Clay, trace of Roots, brown, moist, medium. (Glaciofluvium)	16		
923.2	11.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, layer of Clay, brown, moist, medium dense. (Glacial Outwash)	18 15		
918.7	15.5	CL	SANDY LEAN CLAY, trace of Gravel, brown, wet, rather stiff. (Glacial Till)	11 12		
			END OF BORING. Water not observed with 14 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 11 1/2 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project BBXX-02-088A Geotechnical Evaluation Services Proposed St. Clair Farms NE of 276th Street N. and CSAH 24 Chisago City, Minnesota	BORING: ST-6 LOCATION: See attached sketch.

DRILLER: C. Powers	METHOD: 3 1/4" HSA, Autohmr	DATE: 4/29/02	SCALE: 1" = 4'

Elev. feet 937.7	Depth feet 0.0	ASTM Symbol	Description of Materials (ASTM D2488 or D2487)	BPF	WL	Tests or Notes
936.7	1.0	SC	CLAYEY SAND, fine-grained, trace of Roots, dark brown, wet. (Topsoil)			
931.7	6.0	CL-ML	SILTY CLAY, trace of Gravel and Roots, brown, wet, medium to rather soft. (Glaciofluvium)	7* 5*		* MC = 26% * MC = 26%
928.7	9.0	SC	CLAYEY SAND, fine- to medium-grained, brown, moist, medium. (Glaciofluvium)	7		
923.7	14.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace of Gravel, brown, moist, medium dense. (Glacial Outwash)	28 20		
922.2	15.5	CL	SANDY LEAN CLAY, trace of Gravel, brown, moist, stiff. (Glacial Till)	15		
			END OF BORING. Water not observed with 14 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 12 1/2 feet immediately after withdrawal of auger. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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