# A Geotechnical Evaluation Report

Proposed Keystone of Medina Residential Development
North of Medina Road and Hunter Drive
Medina, Minnesota

*Prepared for*

## Pernsteiner & Associates

**Professional Certification**
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Staff Engineer
License Number: 45005
March 30, 2007

JOSHUA L. KIRK
LICENSED PROFESSIONAL ENGINEER
45005
STATE OF MINNESOTA

Project BL-07-01086

Braun Intertec Corporation

BRAUN INTERTEC

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March 30, 2007

Project BL-07-01086

Mr. Terry Pernsteiner
Pernsteiner & Associates
11022 Tanglewood Lane North
Champlin, MN 55316

Re: Geotechnical Evaluation
Proposed Keystone of Medina Residential Development
North of Medina Road and Hunter Drive
Medina, Minnesota

Dear Mr. Pernsteiner:

We have completed the geotechnical evaluation for the proposed Keystone of Medina residential development in Medina, Minnesota. The purpose of the geotechnical evaluation was to assist you and your design team in evaluating the soil and groundwater conditions for design of the proposed development. The evaluation was completed in general accordance with our Proposal for Geotechnical Evaluation, dated March 14, 2007.

Please refer to the attached report for a detailed summary of our analyses and recommendations. If we can provide additional assistance or observation and testing services during construction, please contact Josh Kirk at 952.995.2222 or Greg Bialon at 952.995.2380.

Sincerely,

BRAUN INTERTEC CORPORATION

Joshua L. Kirk, PE
Staff Engineer

Gregory J. Bialon, PE
Associate-Senior Engineer

Attachment:
Geotechnical Evaluation Report

GeoRpt-Keystone of Medina

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**Appendices**

# A. Introduction

## A.1. Project

Pernsteiner & Associates is proposing to construct a residential development in Medina, Minnesota. The property is located just north of the intersection of Medina Road and Hunter Drive. The proposed development includes single-family and multi-family homes with associated roadways and utilities.

As part of the proposed project, Pernsteiner & Associates has contracted Braun Intertec to perform soil borings and a geotechnical evaluation for the proposed residential development.

## A.2. Purpose

The purpose of the geotechnical evaluation is to assist Pernsteiner & Associates, and their design team, in evaluating the subsurface soil and groundwater conditions with regard to site grading and construction of the residential development.

## A.3. Scope

The following scope of geotechnical services was established in our Proposal for Geotechnical Evaluation, dated March 14, 2007.

- Coordinating the locating of underground utilities near the boring locations
- Selecting and staking the boring locations
- Conducting 14 penetration test borings to a nominal depth of 15 to 20 feet below grade
- Returning the samples to our laboratory for visual classification and logging by a geotechnical engineer
- Conducting limited laboratory tests on selected soil samples
- Submitting a geotechnical evaluation report containing logs of the borings, our analysis of the field and laboratory tests, and recommendations for site grading, compaction specifications, allowable soil-bearing capacity for foundation design, and pavement design parameters

As part of our original scope, 14 borings were proposed. Due to site constraints, we were only able to complete 13 of the borings (Boring ST-7 was not performed).

## A.4. Documents Provided

Sathre-Bergquist, Inc. (Sathre) provided us with a preliminary plan of the proposed development. The plan showed the proposed locations for house pads, ponds, and roadways.

### A.5. Site Conditions

The proposed project site is currently in use as a farmstead. A house and several barn structures are present in the central portion of the site. Numerous wetlands, varying in size are also present throughout the site. A large wetland is present on the south end of the site, with approximately 12 smaller wetlands present throughout the remainder of the site. A heavily wooded area is present in the east-central portion of the site, with the remaining land primarily being open.

### A.6. Locations and Elevations

For the project, we completed 13 soil borings denoted as ST-1 to ST-14. As part of our original scope, we proposed to conduct 14 borings. However, site constraints did not allow us to drill Boring ST-7. Braun Intertec selected and staked the boring locations. Braun Intertec also obtained the ground surface elevations at the boring locations through the use of GPS technology through the use of the state of Minnesota's permanent GPS base station network. The elevations and locations should be considered approximate, especially for Borings ST-9 and ST-10, which were performed in or near wooded areas. The attached Soil Boring Location Sketch shows the approximate boring locations.

## B. Results

### B.1. Soil Boring Logs

Log of Boring sheets indicating the depths and identifications of the various soil strata, penetration resistances, laboratory test results, and groundwater observations are attached. The strata changes were inferred from the changes in the penetration test samples and auger cuttings. The depths shown as changes between the strata are only approximate. The changes are likely transitions and the depths of the changes vary between 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 site. Because of the complex glacial and post-glacial depositional environments, geologic origins can be difficult to ascertain. A detailed investigation of the geologic history of the site was not performed.

### B.2. Soils

The soils encountered by the soil borings generally encountered about 1 1/2 to 4 feet of clayey topsoil at the surface. Below the topsoil, the borings generally encountered glacial till soils consisting of silty sand, clayey sand, sandy lean clay, and lean clay to the termination depths of the borings. Boring ST-1 encountered a fat clay layer from about 1 1/2 to 7 feet. The silty sand was encountered in thin, shallow layers in Borings ST-2, ST-4, and ST-5, and a larger, deeper layer at Boring ST-12. A soft layer of clayey sand was encountered at Boring ST-3 at a depth of 4 feet below the surface.

The penetration resistances in the silty sand soils ranged from 5 to 13 blows per foot (BPF), indicating loose to medium dense consistencies. The penetration resistances in the clayey sand, sandy lean clay, lean clay, and fat clay soils ranged from 2 to 23 BPF, indicating soft to very stiff consistencies. The majority of the clayey soils were in a medium to rather stiff condition.

## B.3. Groundwater

Groundwater was observed in Borings ST-1, ST-3, ST-4, ST-5, ST-8, and ST-12 while drilling at depths ranging from 5 to 12 1/2 feet, which corresponds to elevations ranging from 996 1/2 to 1004. After the auger was withdrawn from the boreholes, water was observed at depths ranging from about 4 to 12 1/2 feet. The groundwater encountered appears to be associated with perched groundwater, or water trapped in seams of granular soils. Annual and seasonal variations in water levels should be anticipated.

## B.4. Laboratory Tests

Laboratory tests were completed on selected soil samples in accordance with ASTM procedures. The test results can be found on the Log of Boring sheets opposite the soil sample tested. The laboratory tests performed during this evaluation included hand penetrometer, moisture content, percent passing the number 200 sieve, and Atterberg Limit tests.

Moisture content tests were completed on 19 selected samples. The results of the tests showed that the moisture content of the clays tested generally ranged from 13 to 40 percent, and the silty sand ranged from 22 to 25 percent, indicating these soils are generally at or above their optimum moisture content. These soils will likely need to be dried if they are used as engineered fill.

A number of selected samples were washed through a 200 sieve. The results indicated 24 to 29 percent fine by weight passing a 200 sieve, classifying the soils as silty sand.

An Atterberg Limits test was performed on a selected clay sample. The test found the soils to have a liquid limit of 50, and a plasticity index of 26, classifying the soil as a fat clay.

Hand pentrometer tests were completed on selected soil samples to estimate the soils unconfined compressive strength. The estimated unconfined compressive strength ranged from one-quarter to three ton per square foot (tsf).

# C. Analyses and Recommendations

## C.1. Construction

We understand the proposed construction will likely include wood-framed single-family and multi-family homes with associated streets and underground utilities. We anticipate wall and column loads will be relatively light. For this report, we have assumed wall loads will be less than 3 kips (3,000 pounds) per linear foot and column loads will be less than 75 kips.

## C.2. Discussion

Based on the results of the borings, the site is generally suitable for the proposed construction. However, some fat clays, soft clays, and wet soils were encountered. The wet soils will need to be dried if they are to be used as engineered fill. We recommend the site grading take place in the summer months (May through September) where conditions are more conducive to drying of these soils.

It is our opinion the proposed houses can be supported on spread footing foundations bearing in medium to stiff, naturally deposited clayey soils, or properly compacted structural fill. Care should be taken to avoid disturbance of the soils in the bottom of the excavations. If the clays become disturbed, they could potentially lose strength. We recommend using a backhoe with a smooth-edged bucket. The condition of the soils in the bottom of the excavations should be evaluated by a geotechnical engineer or engineering assistant.

It appears that shallow groundwater is present in some areas of the site. We recommend the site plan be constructed to allow a three-foot separation between any basement slabs and a static groundwater table. Piezometers or temporary water level indicators can be used to investigate the static groundwater elevations. Typically, groundwater levels are generally indicated by a gray color in the soils.

When designing the site layout, it is possible that underground utilities such as storm sewer pipe are designed to be constructed along a lot line between the buildings. In these cases, the buildings and attached structures should not be built on or over any part of the trench backfill or near to the trench where footing stresses will be carried by the backfill. The footing stresses generally extend down and away from the edge of the footings at a 45-degree angle (1H:1V slope). If it is necessary to construct utilities between lots, additional analysis and recommendations should be completed.

## C.3. Building Pad Preparation

### C.3.a. Excavation

The proposed house pad areas should be stripped and cleared of vegetation, topsoil, fat clay, and soft clay. The foundations can then be supported directly on the natural soils or properly compacted structural fill. Table 1 lists the recommended excavation depths at the boring locations. Excavation depths between borings will vary and could be deeper. It is typical to excavate about one foot deeper than the recommended depths to clean out the bottom of the excavation.

**Table 1. Recommended Excavation Depths**

| Boring | Approximate Surface Elevation | Recommended Depth of Excavation | Approximate Bottom Elevation | Approximate Groundwater Elevation |
|---|---|---|---|---|
| ST-1 | 1009.4 | 7 | 1002 1/2 | 997 |
| ST-2 | 998.0 | 4 | 994 | N/A |
| ST-3 | 1005.6 | 7 | 998 1/2 | 1000 1/2 |
| ST-4 | 1009.9 | 4 | 1005 1/2 | 1004 |
| ST-5 | 1005.5 | 2 | 1003 1/2 | 996 1/2 |
| ST-6 | 1009.3 | 2 | 1007 | N/A |
| ST-8 | 1008.8 | 7 | 1001 1/2 | 999 |
| ST-9 | 1010 | 1 1/2 | 1008 1/2 | N/A |
| ST-10 | 1007 | 1 1/2 to 6* | 1001 to 1005 1/2* | N/A |
| ST-11 | 1008.3 | 2 | 1006 | N/A |
| ST-12 | 1008.2 | 1 1/2 | 1007 | 997 |
| ST-13 | 1002.3 | 6 | 996 | N/A |
| ST-14 | 1003.2 | 1 1/2 | 1001 1/2 | N/A |

*We recommend this area be further evaluated with Test Pits

If the excavations to remove unsuitable soils within the building pad areas extends below design footing elevation, we recommend the excavation bottoms be extended laterally beyond the edges of the proposed footings a minimum of 1 foot for each vertical foot below the footing at that location (i.e., 1:1 lateral oversizing). This oversizing is necessary for the lateral distribution of the footing loads through the fill sequence.

### C.3.b. Fill

Fill and backfill required to bring the site to grade should be placed in thin lifts not exceeding 6 to 12 inches and be compacted to a minimum of 95 percent of the maximum dry density based on the standard Proctor test (ASTM D 698). The clayey fill should be placed at a moisture content no more than 3 percentage points above and one percentage point below the soil's optimum moisture content. If fill depths exceed 10 feet, the minimum compaction should be increased to 98 percent. If fill depths exceed 10 feet, a construction delay may also be needed. This should be evaluated on a case-by-case basis.

The on-site topsoil and fat clay is not suitable for use as fill or backfill within the building footprints and oversize areas. The naturally deposited on-site soils below the topsoil and fill are generally acceptable for use as fill. If the soils are significantly above their optimum moisture content, they may need to be dried prior to use. Conversely, if dry clayey soils are encountered, they may not be useable as engineered fill unless they are moisture conditioned. Dry soils may be encountered in the wooded areas.

If groundwater is present in the bottom of the excavations, we recommend controlling the groundwater through the use of sump pumps or other measures. Granular fill can then be placed and compacted to a height of 2 to 3 feet above controlled water levels. The fill should consist of a clean sand with less than 50 percent passing the number 40 sieve and less than 10 percent passing the number 200 sieve. After the sand fill has been placed, a less select mineral soil may be used to establish subgrade elevations.

Care should be taken when filling over existing slopes that are steeper than 5H:1V (horizontal to vertical). We recommend benches be excavated into the natural soils of existing slopes that are steeper than 5H:1V prior to placement. The "stair step"-shaped benches are recommended to key the fill into existing slopes and reduce the risk of fill instability. Benches should be a minimum of 10 feet wide. Once the benches are cut, the near-surface soils should have sufficiently disrupted any sand lenses, which could weep moisture out onto the slope face.

## C.4. Foundation Design

### C.4.a. Bearing Capacity

Based on the soil boring results and performance of the above-described soil correction procedures, it is our opinion the natural soils or engineered fill should be suitable for support of the proposed houses using a typical spread footing foundation sized for an allowable soil bearing pressure of up to 2,000 pounds per square foot. We recommend that strip footings be at least 16 inches wide and that column pads be at least 2 1/2 by 2 1/2 feet. This loading should provide a theoretical factor of safety of greater than 3 against localized shearing or base failure of the spread footings.

### C.4.b. Footing Depths

Perimeter footings in heated building areas should be founded a minimum of 42 inches below the nearest exterior grade for frost protection. Footings in unheated building or detached garage areas should be founded a minimum of 60 inches below the nearest exterior grade for frost protection. (Attached and tuck-under garages are generally considered heated structures.)

### C.4.c. Settlement

It is our opinion that total and differential settlements based on these loadings should not exceed 1 inch and 1/2 inch, respectively. In deep fill areas, settlements over 1 inch can occur. These deep fill areas may require a construction delay.

## C.5. Floor Slabs

### C.5.a. Subgrade

After the building pad preparation has been completed, we anticipate the floor subgrade will be natural clayey soils or compacted fill. Backfill in footing and mechanical trenches should be compacted to a minimum of 95 percent of the standard Proctor maximum dry density.

### C.5.b. Vapor Barrier

Excess transmission of water vapor could cause floor dampness, certain types of floor bonding agents to separate, or mold to form under floor coverings. We recommend placing a vapor retarder or barrier below the floor if coverings or coatings less permeable than concrete will be used, or if moisture is a concern.

Current industry recommendations are to place the vapor retarder or barrier directly below the concrete. It is then desirable to take precautions against shrinkage and curling of the floor slab. Industry practice has been to allow burying the vapor retarder or barrier below a layer of sand to reduce curling and shrinkage of the concrete, but this practice often traps water between the slabs and the vapor retarder or barrier, causing problems after a period of months. In any case, we recommend consulting with floor covering manufacturers regarding the appropriate type, use and installation of a vapor retarder or barrier to preserve warranty assurances.

To reduce shrinkage and curling processes associated with placing concrete directly on the vapor retarder or barrier, we recommend:

- using the largest possible maximum aggregate size and/or coarse aggregate,
- using the lowest practical slump,
- using the lowest necessary cement content to reduce top-to-bottom moisture differentials,
- carefully curing the concrete,
- optimizing the spacing of control joints, and
- cutting control joints as soon as practical.

We recommend that the vapor barrier be inspected immediately before the concrete is placed to identify and patch holes or other potential paths for moisture vapor migration.

## C.6. Drainage Considerations and Below Grade Walls

### C.6.a. Seepage Control

The basements will be surrounded by mostly clayey soils. If water percolates down alongside the walls, it may become perched and then enter the basement through shrinkage cracks in the concrete or masonry block. Collecting runoff 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.

As a precaution against basement seepage, we recommend installing a perimeter foundation drain system. One possible system could 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 50 percent passing the number 40 sieve and less than 5 percent passing the number 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 clay or clayey topsoil.

We also recommend that a drainage collection system be installed below the lowest floor grade. The system could include drainage pipe and coarse gravel or clean sand. Collected water could then be routed to a sump where it can be removed from the structure.

### C.6.b. Lateral Earth Pressure

Backfill against the basement walls should 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. The basement walls should be waterproofed and braced prior to backfilling.

If imported sandy gravel or sand is used as backfill against the wall, a lateral earth pressure of 45 psf per foot of depth should be used to design the basement wall. To use this design, the sand backfill must extend upward and outward from the bottom of the footing at a 30-degree angle from vertical. For an 8-foot wall, the horizontal thickness of sand fill must be a minimum of 4 feet at the top of the wall. If on-site clayey soil is used as backfill against a synthetic wall drainage system or granular chimney drainage layer, we recommend using a lateral earth pressure of 65 psf per foot of depth for designing the wall.

## C.7. Pavement Areas

### C.7.a. Subgrade Preparation

We recommend the vegetation, topsoil and soft clays be excavated from the pavement areas. In areas requiring engineered fill to establish pavement grades, the excavation should be oversized at least 1 foot beyond the outside edge of the curb and gutter for each foot of fill placed below the curb and gutter.

The engineered fill placed in paved areas should be compacted to at least 95 percent of the standard Proctor density to within 3 feet of subgrade and 100 percent within the upper 3 feet. We recommend the moisture contents of the engineered fill soils be within 3 percentage points of the optimum moisture content to within 3 feet of subgrade and no greater than 1 percentage point over the soils' optimum moisture content in the upper 3 feet.

### C.7.b. Proofroll

Prior to placement of the pavement section, we recommend the pavement subgrade be proofrolled with a loaded tandem truck to detect unstable areas. Unstable areas should be subcut and replaced with a drier, compactible soil or dried and recompacted.

### C.7.c. R-Value

Based on the borings, it appears the subgrade soils will consist mainly of clayey soils. These soils generally have Hveem stabilometer R-values ranging from 6 to 20. For pavement design, we recommend an assumed R-value of 10.

## C.8. Utilities

The soils at typical utility invert elevations appear generally suitable for pipe support. In most areas of the site, we do not anticipate that groundwater will adversely affect utility line excavation and installation. Due to the impermeable nature of the soils and since groundwater levels fluctuate with seasonal precipitation rates, on-site observations should be made during construction. If waterbearing lenses or layers of sand are encountered, provisions should be made to remove the water with sump pumps. If soft soils are encountered at the utility invert elevations, the soils may be subcut and additional two feet and replaced with rock to provide a stable subgrade for the utility pipes and structures.

Clayey soils are usually moderately corrosive to metal pipe. We recommend using non-corrosive pipe or provide a corrosion protection system for the underground utilities.

The utility trenches should be backfilled in thin, compacted lifts to the specifications described in Section C.7.

## C.9. Additional Investigation and Testing During Construction

Prior to starting grading, we recommend a series of test pits be excavated to further evaluate the subsurface soil and groundwater conditions.

We recommend a geotechnical engineer or representative be on site during the site grading. At that time, the suitability of the subsurface soils for support of fill and foundation loads can be further evaluated. Excavation depths and provided oversizing can also be documented.

Compaction tests should be taken during the site-grading operation, utility trench backfilling within the roadway areas, utility trench backfilling near house pad areas and house foundation wall backfill operations. In general, compaction tests should be taken after about 2 feet of fill has been placed in the excavations and then at about 2-foot vertical intervals thereafter.

In roadway subcut areas, we recommend a proofroll be performed before placement of the aggregate base. The proofroll should be performed by observing the behavior of the subgrade soils when subjected to the wheel loads of a fully loaded, tandem-axle end dump. The proofroll should be observed by a geotechnical engineer.

### C.10. Cold Weather

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 should be placed on soils which have frozen or contain frozen material. No frozen soils should be used as fill.

Concrete delivered to the site should meet the temperature requirements of ASTM C 94. Concrete should not be placed upon frozen soils or soils which contain frozen material. Concrete should be protected from freezing until the necessary strength is attained. Frost should not be permitted to penetrate below footings bearing on frost-susceptible soil since such freezing could heave and crack the footings and/or foundation walls.

## D. Procedures

### D.1. Drilling and Sampling

We performed the penetration test borings on March 19 and 20, 2007, with an auger drill equipped with a 3 1/4-inch inside-diameter hollow-stem auger mounted on an off road drill rig. Sampling for the borings was conducted in general accordance with ASTM D 1586, "Penetration Test and Split-Barrel Sampling of Soils." Using this method, the borehole was advanced with the hollow-stem auger to the desired test depth. A 140-pound 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. A representative portion of each sample was then sealed in a glass jar capped with a lid.

### D.2. Soil Classification

Our drill crew chief visually and manually classified soils encountered in the borings in general accordance with ASTM D 2488, "Description and Identification of Soils (Visual-Manual Procedure)."

A summary of the ASTM classification system is attached. All samples were then returned to our laboratory for review of the field classifications by a geotechnical engineer. Representative samples will remain in our office for a period of 30 days to be available for your examination.

### D.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. After the auger had been withdrawn from the boreholes, the depth to water or soil cave-in was recorded. The boreholes were then immediately backfilled.

## E. General Conditions

### E.1. Basis of Recommendations

The analyses 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. Often, variations occur between these borings, the nature and extent of which do not become evident until additional exploration or construction is conducted. A reevaluation of the recommendations in this report should be made after performing on-site observations during construction to note the characteristics of any variations. The variations may result in additional grading costs, and it is suggested that a contingency be provided for this purpose.

It is recommended that we be retained to perform the observation and testing program for the site preparation, utility installation, and street construction phases of this project. This will allow correlation of the soil conditions encountered during construction to the soil borings, and will provide continuity of professional responsibility.

### E.2. Review of Design

This report is based on the preliminary design of the proposed residential development as related to us for preparation of this report. It is recommended that we be retained to review the geotechnical aspects of the designs and specifications. With the review, we will evaluate whether any changes in design have affected the validity of the recommendations, and whether our recommendations have been correctly interpreted and implemented in the design and specifications.

### E.3. Groundwater Fluctuations

We made water-level observations in the borings at the times and under the conditions stated on the boring logs. These data were interpreted in the text of this report. The period of observation was relatively short, and fluctuations in the groundwater level may occur due to rainfall, flooding, irrigation, spring thaw, drainage, and other seasonal and annual factors not evident at the time the observations were made. Design drawings and specifications, and construction planning should recognize the possibility of fluctuations.

### E.4. Use of Report

This report is for the exclusive use of Pernsteiner & Associates and their design team to use to design the proposed residential development and prepare construction documents. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

### E.5. Level of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

# Appendix

**BRAUN**[SM]
INTERTEC

# LOG OF BORING

**Braun Project BL-07-01086**
**GEOTECHNICAL EVALUATION**
**Keystone of Medina**
**Hunter Drive and Medina Road**
**Medina, Minnesota**

BORING: **ST-1**

LOCATION: See attached sketch.

DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/19/07 | SCALE: 1" = 4'

| Elev. feet 1009.4 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1007.9 | 1.5 | CL | LEAN CLAY with SAND, black, wet. (Topsoil) | | | | | Benchmark: Surface elevations were obtained by a GPS. |
| | | CH | FAT CLAY, light brown, wet, rather soft. (Glacial Till) | 4 | | | 1/4 | |
| | | | | 5 | | 39 | 1 | PI = 26 LL = 50 |
| 1002.4 | 7.0 | | | | | | | |
| | | CL | SANDY LEAN CLAY, with a trace of Gravel, brown and gray to 15 feet then gray, wet, rather soft to rather stiff. (Glacial Till) | 9 | | | 1 3/4 | |
| | | | | 12 | | | 2 | |
| | | | | 11 | ∇ | | | |
| | | | | 4 | | 20 | 1 | An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. Groundwater levels fluctuate. |
| 988.9 | 20.5 | | | 7 | | | 1 | |
| | | | END OF BORING. Water observed at 12 1/2 feet with 12 1/2 feet of hollow-stem auger in the ground. Water observed at 12 feet with a cave-in depth of 17 feet immediately after withdrawing the auger. Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:04

# BRAUN INTERTEC

# LOG OF BORING

| Braun Project BL-07-01086<br>GEOTECHNICAL EVALUATION<br>Keystone of Medina<br>Hunter Drive and Medina Road<br>Medina, Minnesota | BORING: ST-2<br>LOCATION: See attached sketch. |
|---|---|
| DRILLER: Matthew Takada / METHOD: 3 1/4" HSA Autohammer | DATE: 3/19/07 / SCALE: 1" = 4' |

| Elev. feet 998.0 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | CL | LEAN CLAY with SAND, dark brown, wet. (Topsoil) | | | | | |
| | | | With a trace of Roots at 2 feet. | 10 | | | | |
| 994.0 | 4.0 | | | | | | | |
| | | SM | SILTY SAND, fine- to medium-grained, with a trace of Gravel, gray, wet, loose. (Glacial Till) | 6 | | | | |
| 992.0 | 6.0 | | | | | | | |
| | | CL | SANDY LEAN CLAY, with a trace of Gravel, brown to 12 feet then gray, wet, medium to rather stiff. (Glacial Till) | 9 | | 21 | 1 | |
| | | | | 11 | | | 1 3/4 | |
| | | | | 8 | | | 1 1/4 | |
| | | | | 8 | | | 1 1/2 | |
| | | | | 9 | | | 1 1/2 | |
| 977.5 | 20.5 | | | | | | | |
| | | | END OF BORING.<br>Water not observed with 19 feet of hollow-stem auger in the ground.<br>Water not observed to cave-in depth of 3 1/2 feet immediately after withdrawing the auger.<br>Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:06

# BRAUN INTERTEC

# LOG OF BORING

**Braun Project BL-07-01086**
**GEOTECHNICAL EVALUATION**
**Keystone of Medina**
**Hunter Drive and Medina Road**
**Medina, Minnesota**

BORING: **ST-3**

LOCATION: See attached sketch.

DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/20/07 | SCALE: 1" = 4'

| Elev. feet 1005.6 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1004.0 | 1.6 | CL | LEAN CLAY, black, moist. (Topsoil) | | | | | |
| 1001.6 | 4.0 | CL | SANDY LEAN CLAY, with Silty Sand lenses, gray, wet, medium. (Glacial Till) | 6 | | | 3/4 | |
| 998.6 | 7.0 | SC | CLAYEY SAND, fine- to medium-grained, gray, wet, soft. (Glacial Till) | 2 | ∇ | 31 | | |
| 990.1 | 15.5 | CL | SANDY LEAN CLAY, with a trace of Gravel, brown and gray to 12 feet then gray, wet, medium to rather stiff. (Glacial Till) | 8 | | | 1 | |
| | | | | 8 | | | 1 /2 | |
| | | | | 12 | | | 1 3/4 | |
| | | | | 9 | | | 1 1/2 | |

END OF BORING.

Water observed at 5 feet with 5 feet of hollow-stem auger in the ground.

Water observed at 4 feet with cave-in depth at 8 feet immediately after withdrawing the auger.

Boring immediately backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:06

**BRAUN**[SM]
INTERTEC

# LOG OF BORING

**Braun Project BL-07-01086**
**GEOTECHNICAL EVALUATION**
**Keystone of Medina**
**Hunter Drive and Medina Road**
**Medina, Minnesota**

BORING: **ST-4**

LOCATION: See attached sketch.

DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/20/07 | SCALE: 1" = 4'

| Elev. feet 1009.9 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1008.4 | 1.5 | CL | LEAN CLAY, black, wet. (Topsoil) | | | | | |
| 1005.9 | 4.0 | CL | SANDY LEAN CLAY, with Silty Sand lenses, brown and gray, wet, rather soft. (Glacial Till) | 4 | | 26 | | |
| 1002.9 | 7.0 | SM | SILTY SAND, fine- to medium-grained, brown, wet, loose. (Glacial Till) | 5 | ▽ | | | |
| 989.4 | 20.5 | CL | SANDY LEAN CLAY, with a trace of Gravel, with occasional Silty Sand lenses, brown and gray to 12 feet then gray, wet, medium to rather stiff. (Glacial Till) | 7 | | | 1 1/2 | |
| | | | | 10 | | | 1 3/4 | |
| | | | | 8 | | | 1 1/4 | |
| | | | | 7 | | | 1 1/4 | |
| | | | | 8 | | | 1 1/4 | |

END OF BORING.

Water observed at 6 feet with 5 feet of hollow-stem auger in the ground.

Water observed at 7 1/2 feet with a cave-in depth of 15 feet immediately after withdrawing the auger.

Boring immediately backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:06

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INTERTEC

# LOG OF BORING

**Braun Project BL-07-01086**
**GEOTECHNICAL EVALUATION**
**Keystone of Medina**
**Hunter Drive and Medina Road**
**Medina, Minnesota**

BORING: **ST-5**

LOCATION: See attached sketch.

DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/19/07 | SCALE: 1" = 4'

| Elev. feet 1005.5 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1003.7 | 1.8 | CL | SANDY LEAN CLAY, with a trace of Gravel, black, wet. (Topsoil) | | | | | |
| 1001.5 | 4.0 | CL | SANDY LEAN CLAY, with a trace of Gravel, gray, wet, medium. (Glacial Till) | 6 | | 31 | 3/4 | |
| 998.5 | 7.0 | SM | SILTY SAND, fine- to medium-grained, with a trace of Gravel, with Lean Clay lenses, brown and gray, wet, loose. (Glacial Till) | 7 | | 25 | | p200 = 30% |
| 993.5 | 12.0 | CL | LEAN CLAY, with frequent Silt lenses, brown and gray, wet, medium to rather stiff. (Glacial Till) | 7 | ▽ | | 1 1/2 | |
| | | | With waterbearing Poorly Graded Sand with Silt layer at 9 feet. | 11 | | | 1 1/2 | |
| 990.0 | 15.5 | CL | SANDY LEAN CLAY, with a trace of Gravel, brown to 14 feet then gray, wet, rather stiff to stiff. (Glacial Till) | 15 | | | 2 1/2 | |
| | | | | 9 | | | | |

END OF BORING.

Water observed at 9 feet with 9 feet of hollow-stem auger in the ground.

Water observed at 8 feet with a cave-in depth of 8 feet immediately after withdrawing the auger.

Boring immediately backfilled.

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:06

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# LOG OF BORING

| | |
|---|---|
| **Braun Project BL-07-01086**<br>**GEOTECHNICAL EVALUATION**<br>**Keystone of Medina**<br>**Hunter Drive and Medina Road**<br>**Medina, Minnesota** | BORING: **ST-6**<br>LOCATION: See attached sketch. |

| DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/19/07 | SCALE: 1" = 4' |
|---|---|---|---|

| Elev. feet 1009.3 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1007.7 | 1.6 | CL | LEAN CLAY, black, wet. (Topsoil) | | | | | |
| 1005.3 | 4.0 | CL | SANDY LEAN CLAY, brown, wet, stiff. (Glacial Till) | 13 | | | 2 1/2 | |
| 993.8 | 15.5 | CL | SANDY LEAN CLAY, with a trace of Gravel, brown and gray to 12 feet then gray, wet, rather soft to rather stiff. (Glacial Till) Poorly Graded Sand lense at 6 feet. | 5 | | 24 | 1 1/2 | |
| | | | | 7 | | | 1 3/4 | |
| | | | | 12 | | | 1 3/4 | |
| | | | | 10 | | | | |
| | | | | 7 | | | | |
| | | | END OF BORING.<br>Water not observed with 14 feet of hollow-stem auger in the ground.<br>Water not observed to cave-in depth of 9 feet immediately after withdrawing the auger.<br>Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:07

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# LOG OF BORING

| Braun Project BL-07-01086<br>GEOTECHNICAL EVALUATION<br>Keystone of Medina<br>Hunter Drive and Medina Road<br>Medina, Minnesota | BORING: ST-8<br>LOCATION: See attached sketch. |
|---|---|

| DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/19/07 | SCALE: 1" = 4' |
|---|---|---|---|

| Elev. feet 1008.8 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1007.3 | 1.5 | CL | SANDY LEAN CLAY, black, wet. (Topsoil) | | | | | |
| 1001.8 | 7.0 | CL | LEAN CLAY, with a trace of Gravel, brown and gray, wet, soft to rather soft. (Glacial Till) | 5 | | | | |
| | | | | 3 | | 29 | 1/4 | |
| 988.3 | 20.5 | CL | SANDY LEAN CLAY, with a trace of Gravel, brown to 12 feet then gray, wet, rather soft to rather stiff. (Glacial Till) | 10 | | | 1 3/4 | |
| | | | | 11 | ∇ | | 1 3/4 | |
| | | | | 5 | | | 1 | |
| | | | | 7 | | | | |
| | | | | 7 | | | 1 | |
| | | | END OF BORING.<br><br>Water observed at 10 feet with 10 feet of hollow-stem auger in the ground.<br><br>Water observed at 12 1/2 feet with a cave-in depth of 16 1/2 feet immediately after withdrawing the auger.<br><br>Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:07

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# LOG OF BORING

| Braun Project BL-07-01086<br>GEOTECHNICAL EVALUATION<br>Keystone of Medina<br>Hunter Drive and Medina Road<br>Medina, Minnesota | BORING: ST-9<br>LOCATION: See attached sketch. |
|---|---|

| DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/20/07 | SCALE: 1" = 4' |
|---|---|---|---|

| Elev. feet 1010.6 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1009.4 | 1.3 | CL | LEAN CLAY, black, wet. (Topsoil) | | | | | |
| | | CL | SANDY LEAN CLAY, with a trace of Gravel, with a trace of Roots, light brown to brown, moist to wet, rather stiff to very stiff. (Glacial Till) | 11 | | | 2 | |
| | | | | 23 | | 13 | | |
| 1003.6 | 7.0 | | | | | | | |
| | | CL | SANDY LEAN CLAY, with a trace of Gravel, brown, wet, rather stiff to very stiff. (Glacial Till) | 12 | | 17 | 3 | |
| | | | | 19 | | | | |
| | | | | 16 | | | | |
| | | | | 19 | | | | |
| 995.1 | 15.5 | | | | | | | |
| | | | END OF BORING.<br>Water not observed with 14 feet of hollow-stem auger in the ground.<br>Water not observed to cave-in depth of 12 feet immediately after withdrawing the auger.<br>Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:07

BRAUN[SM]
INTERTEC

# LOG OF BORING

**Braun Project BL-07-01086**
**GEOTECHNICAL EVALUATION**
**Keystone of Medina**
**Hunter Drive and Medina Road**
**Medina, Minnesota**

BORING: **ST-10**

LOCATION: See attached sketch.

DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/20/07 | SCALE: 1" = 4'

| Elev. feet 1007.4 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1006.0 | 1.4 | CL | LEAN CLAY, black, wet. (Topsoil) | | | | | |
| | | CL | SANDY LEAN CLAY, with a trace of Gravel, with a trace of Roots, brown, wet, rather soft to medium. (Glacial Till) | 7 | | | 1 1/2 | |
| | | | | 5 | | 23 | 3/4 | |
| 1000.4 | 7.0 | | | | | | | |
| | | CL | SANDY LEAN CLAY, with a trace of Gravel, with occasional Silty Sand lenses, brown to 15 feet then gray, wet, medium to stiff. (Glacial Till) | 15 | | | 2 1/2 | |
| | | | | 15 | | | 2 1/2 | |
| | | | | 16 | | | | |
| | | | | 11 | | 18 | | |
| 986.9 | 20.5 | | | 7 | | | | |
| | | | END OF BORING. | | | | | |
| | | | Water not observed with 19 feet of hollow-stem auger in the ground. | | | | | |
| | | | Water not observed to cave-in depth of 18 1/2 feet immediately after withdrawing the auger. | | | | | |
| | | | Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:04

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# LOG OF BORING

| Braun Project BL-07-01086<br>GEOTECHNICAL EVALUATION<br>Keystone of Medina<br>Hunter Drive and Medina Road<br>Medina, Minnesota | BORING: ST-11<br>LOCATION: See attached sketch. |
|---|---|

| DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/19/07 | SCALE: 1" = 4' |
|---|---|---|---|

| Elev. feet 1008.3 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | CL | LEAN CLAY, black, wet. (Topsoil) | | | | | |
| 1006.6 | 1.7 | CL | SANDY LEAN CLAY, with a trace of Gravel, brown and gray to 12 feet then gray, wet, medium to stiff. (Glacial Till) | 7 | | 23 | 1 3/4 | |
| | | | | 8 | | | 1 1/4 | |
| | | | | 7 | | | 1 1/4 | |
| | | | | 11 | | | 2 | |
| | | | | 11 | | | | |
| | | | | 9 | | | | |
| | | | | 13 | | | | |
| 987.8 | 20.5 | | END OF BORING.<br><br>Water not observed with 19 feet of hollow-stem auger in the ground.<br><br>Water not observed to cave-in depth of 13 feet immediately after withdrawing the auger.<br><br>Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:05

**BRAUN** INTERTEC

# LOG OF BORING

**Braun Project BL-07-01086**
GEOTECHNICAL EVALUATION
Keystone of Medina
Hunter Drive and Medina Road
Medina, Minnesota

BORING: **ST-12**
LOCATION: See attached sketch.

DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/19/07 | SCALE: 1" = 4'

| Elev. feet 1008.2 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1007.0 | 1.2 | CL | LEAN CLAY, dark brown, wet. (Topsoil) | | | | | |
| 1004.2 | 4.0 | CL | LEAN CLAY, with occasional Silt lenses, light brown, wet, medium. (Glacial Till) | 7 | | | 1 1/2 | |
| 1001.2 | 7.0 | CL | SANDY LEAN CLAY, with a trace of Gravel, brown, wet, medium. (Glacial Till) | 8 | | | | |
| 992.7 | 15.5 | SM | SILTY SAND, fine- to medium-grained, brown, wet to waterbearing at 10 feet, loose to medium dense. (Glacial Till) | 9 | ▽ | 22 | | p200 = 24% |
| | | | | 13 | | | | |
| | | | | 13 | | | | |
| | | | With Lean Clay lenses at 14 feet. | 10 | | | | |
| | | | END OF BORING. | | | | | |
| | | | Water observed at 11 feet with 11 feet of hollow-stem auger in the ground. | | | | | |
| | | | Water observed at 8 feet with a cave-in depth of 8 feet immediately after withdrawing the auger. | | | | | |
| | | | Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:05

**BRAUN**[SM]
INTERTEC

# LOG OF BORING

| | |
|---|---|
| **Braun Project BL-07-01086**<br>**GEOTECHNICAL EVALUATION**<br>**Keystone of Medina**<br>**Hunter Drive and Medina Road**<br>**Medina, Minnesota** | BORING: **ST-13**<br>LOCATION: See attached sketch. |

| DRILLER: Matthew Takada | METHOD: 3 1/4" HSA Autohammer | DATE: 3/19/07 | SCALE: 1" = 4' |
|---|---|---|---|

| Elev. feet 1002.3 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| | | CL | LEAN CLAY, black, wet. (Topsoil) | | | | | |
| 999.8 | 2.5 | CL | SANDY LEAN CLAY, with a trace of Gravel, brown and gray to 10 feet then gray, wet, rather soft to rather stiff. (Glacial Till) | 5 | | | | |
| | | | | 4 | | 40 | | |
| | | | | 8 | | | 1 3/4 | |
| | | | | 6 | | | 1 | |
| | | | | 7 | | 26 | | |
| | | | | 8 | | | | |
| 981.8 | 20.5 | | | 11 | | | | |
| | | | END OF BORING.<br>Water not observed with 19 feet of hollow-stem auger in the ground.<br>Water not observed to cave-in depth of 12 feet immediately after withdrawing the auger.<br>Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:05

**BRAUN** INTERTEC

# LOG OF BORING

| Braun Project BL-07-01086<br>GEOTECHNICAL EVALUATION<br>Keystone of Medina<br>Hunter Drive and Medina Road<br>Medina, Minnesota | BORING: ST-14<br>LOCATION: See attached sketch. |
|---|---|
| DRILLER: Matthew Takada — METHOD: 3 1/4" HSA Autohammer | DATE: 3/19/07 — SCALE: 1" = 4' |

| Elev. feet 1003.2 | Depth feet 0.0 | ASTM Symbol | Description of Materials (ASTM D2488 or D2487) | BPF | WL | MC % | qp tsf | Tests or Notes |
|---|---|---|---|---|---|---|---|---|
| 1001.8 | 1.4 | CL | LEAN CLAY, black, wet. (Topsoil) | | | | | |
| | | CL | SANDY LEAN CLAY, with a trace of Gravel, brown and gray to 10 feet then gray, wet, rather soft to stiff. (Glacial Till) | 7 | | 22 | 1 1/2 | |
| | | | | 5 | | | 1 1/4 | |
| | | | | 9 | | | 2 | |
| | | | | 15 | | 20 | | |
| | | | | 14 | | | | |
| | | | | 9 | | | 2 | |
| 982.7 | 20.5 | | | 9 | | | 2 | |
| | | | END OF BORING.<br>Water not observed with 19 feet of hollow-stem auger in the ground.<br>Water not observed to cave-in depth of 12 feet immediately after withdrawing the auger.<br>Boring immediately backfilled. | | | | | |

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN BASIC LOG 01086.GPJ BRAUN.GDT 3/30/07 13:05

# Descriptive Terminology

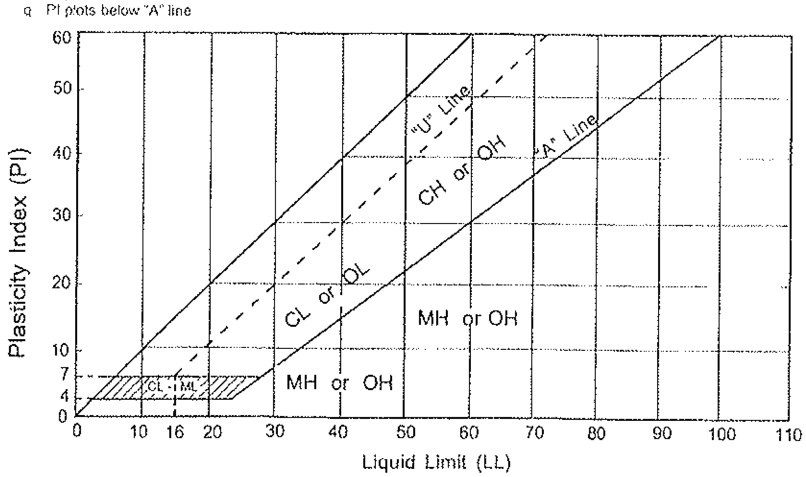
Rev 10/04

ASTM INTERNATIONAL

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a] | | | | Soils Classification: Group Symbol | Soils Classification: Group Name [b] |
|---|---|---|---|---|---|
| Coarse-grained Soils more than 50% retained on No. 200 sieve | Gravels More than 50% of coarse fraction retained on No. 4 sieve | Clean Gravels Less than 5% fines [e] | $C_u \geq 4$ and $1 \leq C_c \leq 3$ [c] | GW | Well-graded gravel [d] |
| | | | $C_u < 4$ and/or $1 > C_c > 3$ [c] | GP | Poorly graded gravel [d] |
| | | Gravels with Fines More than 12% fines [e] | Fines classify as ML or MH | GM | Silty gravel [d f g] |
| | | | Fines classify as CL or CH | GC | Clayey gravel [d f g] |
| | Sands 50% or more of coarse fraction passes No. 4 sieve | Clean Sands Less than 5% fines [i] | $C_u \geq 6$ and $1 \leq C_c \leq 3$ [c] | SW | Well-graded sand [h] |
| | | | $C_u < 6$ and/or $1 > C_c > 3$ [c] | SP | Poorly graded sand [h] |
| | | Sands with Fines More than 12% [i] | Fines classify as ML or MH | SM | Silty sand [f g h] |
| | | | Fines classify as CL or CH | SC | Clayey sand [f g h] |
| Fine-grained Soils 50% or more passed the No. 200 sieve | Silts and Clays Liquid limit less than 50 | Inorganic | PI > 7 and plots on or above "A" line [j] | CL | Lean clay [k l m] |
| | | | PI < 4 or plots below "A" line [j] | ML | Silt [k l m] |
| | | Organic | Liquid limit - oven dried / Liquid limit - not dried < 0.75 | OL | Organic clay [k l m n] |
| | | | | OL | Organic silt [k l m o] |
| | Silts and clays Liquid limit 50 or more | Inorganic | PI plots on or above "A" line | CH | Fat clay [k l m] |
| | | | PI plots below "A" line | MH | Elastic silt [k l m] |
| | | Organic | Liquid limit - oven dried / Liquid limit - not dried < 0.75 | OH | Organic clay [k l m p] |
| | | | | OH | Organic silt [k l m q] |
| Highly Organic Soils | | Primarily organic matter, dark in color and organic odor | | PT | Peat |

a Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥ 15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
  GW-GM well-graded gravel with silt
  GW-GC well-graded gravel with clay
  GP-GM poorly graded gravel with silt
  GP-GC poorly graded gravel with clay
f If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g If fines are organic, add "with organic fines" to group name
h If soil contains ≥ 15% gravel, add "with gravel" to group name.
i Sands with 5 to 12% fines require dual symbols:
  SW-SM well-graded sand with silt
  SW-SC well-graded sand with clay
  SP-SM poorly graded sand with silt
  SP-SC poorly graded sand with clay
j If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay
k If soil contains 15 to 29% plus No 200, add "with sand" or "with gravel" whichever is predominant
l If soil contains ≥ 30% plus No 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No 200 predominantly gravel, add "gravelly" to group name
n. PI ≥ 4 and plots on or above "A" line
o PI < 4 or plots below "A" line
p PI plots on or above "A" line
q PI plots below "A" line




## Laboratory Tests

| | | | |
|---|---|---|---|
| DD | Dry density, pcf | OC | Organic content, % |
| WD | Wet density, pcf | S | Percent of saturation, % |
| MC | Natural moisture content, % | SG | Specific gravity |
| LL | Liquid limit, % | C | Cohesion, psf |
| PL | Plastic limit, % | ∅ | Angle of internal friction |
| PI | Plasticity index, % | qu | Unconfined compressive strength, psf |
| P2000 | % passing 200 sieve | qp | Pocket penetrometer strength, tsf |

## Particle Size Identification

| | |
|---|---|
| Boulders | over 12" |
| Cobbles | 3" to 12" |
| Gravel | |
| Coarse | 3/4" to 3" |
| Fine | No 4 to 3/4" |
| Sand | |
| Coarse | No. 4 to No. 10 |
| Medium | No. 10 to No. 40 |
| Fine | No. 40 to No. 200 |
| Silt | < No. 200, PI < 4 or below "A" line |
| Clay | < No. 200, PI ≥ 4 and on or above "A" line |

## Relative Density of Cohesionless Soils

| | |
|---|---|
| Very loose | 0 to 4 BPF |
| Loose | 5 to 10 BPF |
| Medium dense | 11 to 30 BPF |
| Dense | 31 to 50 BPF |
| Very dense | over 50 BPF |

## Consistency of Cohesive Soils

| | |
|---|---|
| Very soft | 0 to 1 BPF |
| Soft | 2 to 3 BPF |
| Rather soft | 4 to 5 BPF |
| Medium | 6 to 8 BPF |
| Rather stiff | 9 to 12 BPF |
| Stiff | 13 to 16 BPF |
| Very stiff | 17 to 30 BPF |
| Hard | over 30 BPF |

## Drilling Notes

Standard penetration test borings were advanced by 3[illegible]" or 6[illegible]" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube) All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous flight, solid-stem augers Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1[illegible]" or 3[illegible]" diameter auger and were limited to the depth from which the auger could be manually withdrawn Hand auger borings are indicated by the prefix "H "

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required

TW indicates thin-walled (undisturbed) tube sample

Note: All tests were run in general accordance with applicable ASTM standards.

BRAUN INTERTEC