Geotechnical Report
Mountain Air Drive Extension
Anchorage, Alaska

June 2010

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Project Number: 32-1-02055-002

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MOUNTAIN AIR DRIVE EXTENSION
ANCHORAGE, ALASKA

1.0 INTRODUCTION

This report presents the results of subsurface explorations, laboratory testing and geotechnical engineering studies conducted by Shannon & Wilson, Inc. for the proposed Mountain Air Drive extension in Anchorage, Alaska. The purpose of this geotechnical study was to evaluate subsurface conditions along Mountain Air Drive for road improvements. Presented in this report are descriptions of the site and project, subsurface exploration and laboratory test procedures, an interpretation of subsurface conditions, and our geotechnical engineering recommendations for design of the proposed road improvements.

Authorization to proceed with this work was received in the form of a signed contract from Mr. Steve Kari of USKH on February 17, 2010. Our work was conducted in general accordance with our April 21, 2010 proposal and our revised cost estimate dated February 2010.

2.0 SITE AND PROJECT DESCRIPTION

The project is located in Anchorage, Alaska and includes a portion of the Mountain Air Drive Right-of-Way (ROW) from Rabbit Creek Road south, across Little Rabbit Creek to the East 155th Avenue ROW. A vicinity map indicating the general project location is presented in Figure 1. A site map is included as Figure 2 that provides a more detailed view of the project area including prominent site features, topography, and boring locations.

The developed portion of Mountain Air Drive extends east off Rabbit Creek Road as a two lane, paved road and is approximately 450 feet in length. The undeveloped portion of the project alignment follows the designated Mountain Air Drive ROW for approximately 650 feet and then continues south across Little Rabbit Creek to the undeveloped East 155th Avenue designated ROW as shown in Figure 2. The east side of the project alignment is occupied by the Rabbit Creek Fire Station 10, Bear Valley Elementary School entrance and playground, and undeveloped land. The west side of the project alignment is undeveloped. In general, topography on the northern portion of the proposed alignment slopes south toward Little Rabbit Creek and on the southern portion of the alignment, slopes north toward the creek. We understand the project includes improvements to the existing road and developing the new road with an approximately 130-foot long bridge across Little Rabbit Creek.

3.0 SUBSURFACE EXPLORATIONS

Explorations consisted of advancing and sampling eleven borings, designated Boring B-01 through B-11, from February 24 to March 3, 2010. Approximate boring locations are included as Figure 2. The focus of the field exploration program was to evaluate subsurface conditions along the proposed alignment. Our exploration program included four borings near the approximate proposed bridge abutment locations and seven borings along the proposed alignment. Borings B-01 and B-02 were advanced through the existing pavement section in the developed portion of Mountain Air Drive, the remainder were advanced in the undeveloped area. Drilling services for this project were provided by Discovery Drilling, of Anchorage, Alaska, using a track-mounted CME 75 drill rig.

Borings were advanced with $3^1/_4$-inch inner diameter (ID), continuous flight, hollow-stem augers to approximately 21.5 feet below ground surface (bgs) for the road alignment explorations and to approximately 51.5 feet bgs for the bridge abutment borings. An experienced geologist from our firm was present continuously during drilling to locate the borings, observe drill action, collect samples, log subsurface conditions, and observe groundwater if encountered.

As the borings were advanced, samples were recovered with a 2-inch outside diameter (OD) split spoon sampler using Standard Penetration Test (SPT) procedures. These samples were recovered by driving the sampler into the bottom of the advancing hole with blows of a 140-lb auto-hammer free falling 30 inches onto the drilling rod. The number of blows required to advance the sampler the final 12 inches of an 18-inch penetration is termed the penetration resistance, which was recorded for each sample. Penetration resistance values that were collected in the field are shown graphically on the boring logs adjacent to the sample depth and give a measure of the relative density (compactness) or consistency (stiffness) of cohesionless or cohesive soils, respectively. In addition to penetration samples, grab samples were taken in the upper 2 feet of each boring and samples of the cuttings were taken from the fill material in Borings B-01, B-02, and B-03 for bulk gradation laboratory testing.

Sampled soils were visually classified in the field using the Unified Soil Classification System (USCS) system presented in Appendix A as Figure A-1. The field classifications were then verified through selective laboratory analysis. USCS group symbols are provided for those soils confirmed by laboratory testing on the grain size classification sheets. Frost classifications were also estimated for select samples based on visual and laboratory evaluations. The frost classification system is presented in Appendix A as Figure A-2. Summary logs of the borings with material descriptions and frost classifications are presented in Appendix A as Figures A-3 through A-13.

Upon completion of drilling in Borings B-03, B-05, B-06, B-08, B-10, and B-11, 1-inch PVC casings were installed. These borings were then backfilled with auger cuttings that were hand tamped. The casings were allowed to stick up above the ground surface, and were installed to provide static water level measurements after drilling. The remaining borings were backfilled with auger cuttings. Asphalt penetrated by the borings on the surface was repaired with asphalt cold patch in Borings B-01 and B-02.

Boring locations shown on Figure 2 were established with a hand held differential global positioning system (GPS) with a horizontal accuracy of approximately 3 feet. The elevations shown on the boring logs were estimated from the topographic data provided by USKH. These locations and the elevations should be considered approximate.

4.0 LABORATORY TESTING

Laboratory tests were performed on selected samples recovered from the borings to confirm our field classifications and to approximate the index properties of the typical materials encountered at the site.

Water content tests were performed on samples collected from the borings. Water content tests were generally conducted according to procedures described in ASTM International (ASTM) D-2216. The results of the water content measurements are presented graphically on the boring logs in Appendix A.

Grain size classification tests were conducted to estimate the particle size distribution of selected samples from the borings. The gradation testing generally followed the procedures described in ASTM C-136 and D-422. Grain size testing results are presented in Appendix A as Figure A-14, and summarized on the boring logs as percent gravel, percent sand, and percent fines. Percent fines on the boring logs are equal to the sum of the silt and clay fractions indicated by the percent passing the Number 200 sieve or as estimated through hydrometer testing. Note that hydrometer testing indicates particle size only and visual classification under USCS designate the entire fraction of soil finer than the Number 200 sieve as silt unless Atterberg limit data shows plasticity properties consistent with clay.

In addition, tests were conducted to estimate the amount of material passing the Number 200 sieve (P-200) in the subgrade material. This test was performed in general accordance with ASTM C-117. The P-200 test provides an estimate of the fines (silt and clay) content. The results of this test are presented on the boring logs, indicated as percent fines.

To aid in classifying and correlating the properties of the cohesive soils, Atterberg limit tests (liquid and plastic limits) were conducted on two fine grained samples. Atterberg limit tests were performed in accordance with ASTM D-438. The results of these tests are presented on the appropriate boring logs and on Figure A-15.

5.0 SUBSURFACE CONDITIONS

Subsurface conditions are presented graphically in the boring logs in Appendix A, Figures A-3 through A-13. In general, our borings encountered medium dense to very dense granular material with occasional zones of fine-grained material. Material encountered was frozen from the ground surface to between 2 and 7 feet bgs.

Borings B-01 and B-02 were advanced through 1 ½ to 2 inches of asphalt and then 4 to 6 feet of fill material. The fill material encountered consisted of slightly silty to silty, sandy gravel. Native material that was found beneath the fill consisted of silty, gravelly sand and sandy silt.

The remaining borings were advanced in undeveloped areas. In Borings B-03, B-04, B-07, and B-08, material encountered in the upper 1 to 2 feet bgs may have been fill; however, it was difficult to discern a difference between this material and the native soil. This possible fill material consisted of slightly silty to silty sand and gravel. Native granular material, found beneath the possible fill typically ranged from slightly silty to silty, gravelly sand to slightly silty to silty, sandy gravel with occasional zones of sandy silt. Soils had penetration resistance values of between 8 and over 50 blows per foot. Boring B-04 encountered soft to stiff, organic silt and silty peat from approximately 1 foot bgs to approximately 13 feet bgs.

Moisture contents in the granular material ranged from 2 to 25 percent with the higher percentages present in the more silty material. The average moisture content for the granular material was approximately 8 percent. Moisture contents in the silt ranged from 13 to 37 percent, averaging approximately 24 percent and moisture contents of the peaty soils ranged from 110 to 149 percent by weight.

Groundwater was encountered during drilling in Boring B-07 at approximately 20 feet bgs, and in Borings B-08, B-09, and B-10 at approximately 35 feet bgs. Water level measurements were made on March 18, 2010 in the PVC casings in Borings B-03, B-05, B-06, B-08, B-10, and B-11. Water was not present in Borings B-03, B-05, B-06, or B-11. Static groundwater levels were measured at 37.7 feet bgs and 39.1 feet bgs in Borings B-08 and B-10, respectively. It is important to note that groundwater levels are subject to seasonal variations and may change by several feet.

6.0 SEISMIC ANALYSIS AND DESIGN

The soils beneath the proposed bridge abutments are largely granular with a moderate to high relative density. Liquefaction and seismically-induced compaction of loose, saturated, cohesionless soils due to seismic loading has been studied over the past 35 years, resulting in methods based on both laboratory and field procedures to evaluate liquefaction potential. The most widely used methods are empirical, and based on correlations between Standard Penetration Test (SPT) resistance (N-value), peak ground acceleration (PGA), and earthquake magnitude. We used three methods to evaluate liquefaction potential at this site:

- Youd et al. (2001)
- Seed et al. (2003)
- Idriss and Boulanger (2004)

An important factor in evaluating liquefaction potential is the fines content (percent of soil by weight smaller than 0.075 millimeter [mm] or a No. 200 sieve) of the soil deposit. We used the results of grain size analyses and fines content tests to characterize the fines content of the subsurface soils at the site. Where no laboratory data were available for individual samples, we estimated the fines content based on the soil classification.

We performed our liquefactions analyses for an earthquake of magnitude 9.2 and a soil PGA of 0.52g. We obtained the magnitude and PGA from regional probabilistic ground motion studies conducted by the U.S. Geological Survey (USGS) and Frankel et al. (2002). These seismic parameters are approximately representative of a 1,000 year return period ground motion and are consistent with the guidelines for seismic design according to American Association of State Highway and Transportation Officials, Load and Resistance Factor Design, Bridge Design Specifications, fifth edition, 2010 (AASHTO). Our analyses did not predict a credible risk of liquefaction during the design earthquake.

Densification of granular soils above and below the water table may occur when subject to earthquake shaking, resulting in potential ground settlement at the site. We used the relationship by Tokimatsu and Seed (1987) and Ishihara and Yosimine (1992), relating earthquake ground motion and penetration resistance with volumetric strain, to estimate the magnitude of ground settlement that may occur at the site. The relationships estimate negligible total ground settlements for the ground motions assumed in our liquefaction analyses. Our analysis was conducted assuming that the bridge abutment site is prepared by excavating and replacing loose and/or organic surface soils to develop a firm, unyielding subgrade that is not subject to compaction during a seismic event. Site preparation is addressed in greater detail in Section 7.1 below.

In our opinion, based on the blow count (N) method and the subsurface conditions described above, and assuming that any surface organic material is removed, the site class according to AASHTO should be D for a profile containing generally stiff soils. Therefore, we recommend that Site Class D be selected as consistent with the concept design and most representative of the overall properties of the site. Based on Section 3.10, Earthquake Effects from the AASHTO design manual, S_s and S_1 were estimated at 1.2 and 0.46, respectively. Consequently, the site specific modifying coefficients for the spectral response accelerations for the Maximum Considered Earthquake are $F_A = 1.1$, and $F_v = 1.5$ for the short and long periods, respectively.

7.0 ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

Geotechnical considerations associated with this project consist of developing appropriate structural support for the pavement section, bridge foundations and utility trench installation. We assume that the pavement design for this project will be consistent with the Municipality of Anchorage (MOA) January 2007 Design Criteria Manual (DCM) and AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, fifth edition, 2010 will be used for bridge foundations.

7.1 Road Subgrade Preparation

According to our borings along the alignment, surface soils containing occasional to numerous organic material were encountered over the length of the road extension are largely composed of organic silt or silt and sand containing roots and decayed plant matter. Where present, these soils extended to depths of up to 3 feet bgs, with the exception of Boring B-04, in which organic silt and silty peat was encountered to approximately 10.5 feet bgs. This soil is frost susceptible and compressible and will generally not provide adequate support of a roadway structural section. Therefore, we recommend that this material be removed and disposed of from beneath the new embankments.

In sub-cutting to remove organic soils and local areas of loose or compressible soils, the excavation should be extended laterally from the toe of the embankment to allow development of fill slopes at slopes not steeper than 1.5 horizontal (H) to 1 vertical (V). The material should be removed so that firm, native, mineral soils are exposed over the entire excavation bottom. The exposed soils at the bottom of the excavation may be moisture sensitive and flat-nosed excavator buckets should be used. Additionally, equipment should not be operated on the exposed subgrade prior to fill placement if the area is wet and moisture sensitive. After organic soils are removed and firm, mineral soils are exposed, embankment development may proceed as recommended below. Due to the compactness of the native soil, separation fabric will not be needed. If the subgrade is left open to the elements, or heavy equipment is driven on the area so that the surface becomes soft and begins to rut, the softened material should be over excavated and replaced with classified structural fill.

7.2 Embankment Development

Once the area to receive embankment fills have been stripped of organics and other unsuitable soils and a firm, uniform grade is achieved, embankment fill soils can be placed and compacted in controlled lifts as recommended in Section 7.9. For embankment thicknesses greater than the recommended pavement section, the embankment fill material beneath the structural section can be frost-susceptible but must be mineral soils, not containing organics or other unsuitable materials. We recommend limiting the fines content of the embankment fill soils to not more than 20 percent based on the minus 3-inch fraction. These higher silt content materials should only be used if the contractor demonstrates the ability to achieve the density requirements outlined in Section 7.9. Side slopes on embankments should be at least 2H to 1V.

7.3 Asphalt Pavement Section

We assume that the road will primarily be used for relatively light residential traffic with occasional truck traffic for maintenance and other services. The relatively dense native soils (with a frost classification of F-3 to F-4, in general) can provide a suitable subgrade support for roadway pavements if the section is designed to accommodate the frost susceptibility. Pavement design parameters given in the MOA DCM were followed to develop the recommended structural sections below. According to the manual, a structural section over subgrades classified as F2, F3, or F4 must be designed using the "Complete Protection" method which requires excavation of all frost susceptible soils within the active freezing zone and replacement with non-frost susceptible soils. Alternatively, the "Limited Subgrade Frost Penetration" method may be used. In this method, the maximum allowable depth of freeze into the subgrade soil is 10 percent of the structural section thickness. This method may also incorporate insulation into the structural section to reduce the depth of the active freezing zone, and thus the fill thickness.

Because of the relatively deep seasonal frost depth in the Anchorage area (approximately 8 to 10 feet below cleared roadways on average), we have developed recommendations for an insulated section along with an un-insulated section. In comparing the two section options, it is clear that an insulated section will require less excavation and backfill. While the insulated section likely represents the less expensive construction option, buried insulation in the roadway may be problematic during future utility work or road repair.

We evaluated frost penetration using BERG2 to arrive at the following recommended insulated and non-insulated sections. In our analysis, we assumed a generalized soil profile beneath the structural section consisting of silty sand and sandy silt native soils. We assumed a groundwater table approximately 35 feet below the existing ground surface. These sections are provided assuming that the site improvements will be designed to direct surface waters away from the pavement, since the moisture content of soils plays a significant part in determining the frost penetration depth. Based on these considerations and a "Limited Subgrade Frost Penetration" design, the following are recommended for insulated and non-insulated pavement sections. The structural sections for concrete sidewalks and asphalt pathways should also adhere to the recommendations outlined below.

Insulated Section

Thickness (inches)	Material
3	Asphalt
4	Leveling Course
12	Type II/II-A Base
2	Insulation
28	Type II/II-A Subbase

Non-Insulated Section

Thickness (inches)	Material
3	Asphalt
6	Leveling Course
114	Type II/II-A Subbase

The materials should conform to the gradation requirements presented in the Municipality of Anchorage Standard Specifications (MASS). In general, it does not appear that the on-site material meets the gradation requirements for leveling course, Type II-A base, or Type II subbase. The performance of pavement is controlled by the details of construction and by the quality (gradation characteristics) of the materials to develop the needed structural section. MOA Gradation Requirements are presented in Figure 3.

7.4 Insulation Installation

We recommend using 2 inches of extruded polystyrene "blueboard" or equivalent for the project. The MOA DCM provides further guidelines on the application of insulation in pavement structural sections. Insulation should be installed smoothly on the ground surface so that it covers the entire area to be paved. Fill lifts on top of insulation should be placed and compacted as described in Section 7.9. Traffic on top of the initial lift over the insulation should travel in straight lines to prevent damaging the insulation.

Insulation should extend a minimum of 2 feet past the outer edge of the curb and gutter and sidewalks or pathways that are attached to the curb and gutter. Sidewalks or pathways that are detached from the curb/gutter do not require the incorporation of insulation into the structural section as long as some vertical displacement during winter months can be tolerated. A smooth transition should also be provided between the insulated section and approaching roads and driveways. The new structural section should be tapered up at a slope no steeper than 4 H to 1 V.

If utilities are to be repaired or replaced in this project, that work should be done first, before the insulation is installed. Once the insulation has been installed, the remaining structural section for the roadway may be developed by placing (as described in Section 7.9) 12 inches of compacted Type II/II-A Base, 4 inches of leveling course, and 3 inches of asphalt pavement.

7.5 Construction Drainage

Groundwater was encountered in our explorations in March 2010, and could be expected between 20 and 35 feet below the grade of the existing ground surface. We anticipate that excavation for construction of the roadway will not encounter water. The project should be designed such that excavations below groundwater levels in our explorations are limited as much as practicable.

In general, excavation and backfilling work should be closely coordinated such that seepage and surface runoff is not allowed to collect and stand in open trenches for long time periods. The ground surface around excavations should be contoured to drain away from the excavation and the excavation bottoms should be graded to drain to a sump or topographic low. We believe that drainage at the site should work with the existing topography and it will likely be achieved by allowing water to drain downhill to the south.

7.6 Bridge Foundation

We understand that the structural bridge design team is planning to use the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications methodology for the bridge design. We understand that the structural designer will select size and depths of the footings required to the support the bridge.

7.6.1 Bearing Capacity

We calculated bearing resistance versus effective footing width for the service limit state for total settlements of 1.0 and 2.0 inches, the strength limit, and extreme limit states, assuming a rectangular footing (approximately 48 feet by variable widths) and burial of 5, 8 and 10 feet bgs. The results of our calculations are presented graphically in Figure 4.

7.6.2 Static Settlements

The magnitudes of the static settlements that will develop at the bridge site are dependent upon the applied loads, the density of the support material, and the care with which structural fills are placed and compacted. Compaction recommendations and procedures are described in Section 7.9; these recommendations should be strictly adhered to for best results. We estimated allowable bearing capacities for the service state using the elastic half-space method for calculating settlements and assuming total settlements of 1 inch and 2 inches. These capacity values are presented in Figure 4.

7.6.3 Lateral Earth Pressures

Design of buried shallow footings, stem walls or earth retaining walls should consider the lateral earth pressures that may be imposed or resisted by the soil. We have calculated the following lateral pressures (expressed as equivalent fluid pressures) which, in our opinion, are suitable for design of these structures. The magnitude of the pressure is dependent on the method of backfill placement, the type of backfill material, drainage provisions, and whether the wall is permitted to deflect after or during placement of backfill. For the earth pressures provided herein, we assume that footing trenches will be backfilled with a free-draining structural fill (such as Type II/II-A classified material) and groundwater levels will naturally remain below the footing level.

If the walls are allowed to deflect laterally or rotate an amount equal to about 0.001 times the height of the wall, an active earth pressure condition under static loading would prevail and an equivalent fluid weight of 40 pounds per cubic foot (pcf) is recommended for design of the walls. To simulate seismic loading, at-rest and active earth pressures should be increased with a uniformly distributed, rectangular pressure prism of 10 pounds per square foot per foot of wall length. For rigid walls that are restrained from deflecting at the top, an at-rest earth pressure condition would prevail and an equivalent fluid weight of 61 pcf is recommended.

Lateral forces from wind or seismic loading may be resisted by passive earth pressures against the sides of footings. These resisting pressures can be estimated using an equivalent fluid weight of 250 pcf. This value includes a factor of safety of at least 1.5 on the full passive earth pressure to limit deflections. The ultimate passive earth pressure is reduced during earthquake conditions but will still exceed the 250 pcf allowable pressure so there will be no loss of lateral resistance.

Lateral resistance may also be developed in friction against sliding along the base of foundations. These forces may be computed using a coefficient of 0.4 between concrete and soil.

7.7 <u>Bridge Approach Retaining Wall Design</u>

According to conceptual drawings, both ends of the bridge approach will include retaining wall structures. We understand the planned walls will be modular block MSE retaining walls. We anticipate that the retaining wall structure will likely be a proprietary product and therefore will likely be designed by the product manufacturer. The manufacturer's design should be followed; however, we offer the following additional general recommendations for the new wall.

Additional excavation (compared to that described in Section 7.1) will be needed under MSE supported embankments, at the bridge approaches. We recommend that the less compact, fine grained surface soils (encountered in the upper about 7 feet in our borings in that area) be excavated so that the base of the embankment fill and retaining walls are founded on the dense to very dense granular soil found in our borings in the vicinity of the bridge abutments. The ground surface around the base of the walls should be contoured to discourage surface water from flowing along the base of the wall.

Backfill beneath and behind the retaining walls should consist of clean, well-graded, granular soil (Type II/IIA structural fill) to provide drainage and frost protection and should be placed and compacted as outlined in Section 7.9. We recommend that the base of the retaining wall be established a minimum of 5 feet below the natural ground surface, or as needed to provide lateral resistance at the base of the wall, whichever is greater. As long as the compaction criteria are adhered to, an allowable bearing pressure for the soil below the base of the walls of 4,500 psf is recommended. Lateral earth pressures for the wall may be taken from Section 7.6.3 above. The internal design of the wall should also compensate for seismic loading resulting in horizontal ground acceleration and increased lateral earth pressures.

The existing ground surface slopes on either side of the creek channel are relatively shallow and have a factor of safety against sliding failure of greater than three, based on an idealized stability analyses. In our opinion, the stability of the MSE supported embankments at the bridge approaches will be controlled by the internal design of the walls, since the native soils are very dense and non-liquefiable. Additionally, the orientation of the walls is roughly parallel to the fall line of the natural slopes in the area and therefore, there should not be significant loading of the slope crest that would result in slope destabilization.

7.8 Utility Trench Design

Utility lines below the road surface will likely need to be installed when the road is constructed. We believe open-trench methods are favored for construction; therefore, we recommend that the trenches generally be designed as shown in Figure 6. Based on the generally moderate SPT values and moderate silt content, soils above the water table should have short-term cohesion will likely tend stand steeply initially. However, the typical soil encountered in our borings will likely behave as a cohesionless material over the long term (i.e., as they dry the soils will ravel to their natural angle of repose, which for planning purposes is estimated at about 1.5 horizontal to 1 vertical). Soils excavated below the water table may also slough into the open excavation if dewatering is not conducted. The trench side slopes and bottom conditions should be made the responsibility of the contractor as he or she is present on a day to day basis and can adjust his or her efforts to obtain the needed stability, and meet the applicable Alaska and Federal (OSHA) safety regulations.

Below areas that are receiving pavement sections, trench backfill should be placed in maximum 12-inch loose lifts and compacted to at least 95 percent of the Modified Proctor maximum dry density, as discussed in Section 7.9. The bedding and fill material around the pipe should be compacted to at least 95 percent of the Modified Proctor maximum dry density or per manufacturer recommendations to support and hold the pipe firmly in place. Utility trenches should be backfilled with existing inorganic native soils as much as practical between the top of the pipe bedding and the bottom of the road subgrade, or to original ground surface in areas where no pavement is needed. This procedure limits the contrast between trench backfill and the surrounding soil conditions that can lead to adverse settlement or frost heave behavior. Bulking of backfill into trenches should be discouraged as this can cause variable subgrade support or voids and lead to large future surface settlements with associated pavement distress.

7.9 Structural Fill and Compaction

Structural fill will be needed to support the footing excavation, behind stem walls, to bed and support buried utilities, to replace unsuitable excavated materials, and for support of pavements. Classified structural fill placed in these areas should be clean, granular soil to provide drainage and frost protection. In general, the existing fill and native soils encountered in our borings and tested in our laboratory contain 13 to 76 percent fines and do not meet the requirements for Type II or Type IIA subbase. Therefore, existing soils should not be used as structural fill in pavement sections for this project. However, we believe existing soils that do not contain intermixed organic material are suitable for reuse as unclassified fill above the pipe bedding materials and beneath the new pavement section.

Where imported fill is needed we recommend that it consist of a reasonably well graded, free-draining sand and gravel. Generally, Type II or Type II-A material as specified in MASS works well for this application and as the subbase layer since it can be placed under both wet and dry weather conditions. Its gradation properties are shown in Figure 3. Pipe bedding should also conform to the requirements of the manufacturer for the type of pipe selected in the project design studies. For deep embankments, the material beneath the pavement structural section may include more fines, but should be able to conform to the MASS Type IV classification.

Classified structural fills should be placed in lifts not to exceed 10 to 12 inches loose thickness and compacted to 95 percent of the maximum density as determined by the Modified Proctor compaction procedure (ASTM D-1557). During fill placement, we recommend that cobbles or boulders with dimensions in excess of 2/3 of the layer thickness be removed from structural fills. We recommend that our services be retained to inspect the quality of fill compaction during construction.

When backfilling within 18 inches of the stem walls where the wall is not supported on both sides, material should be placed in layers not to exceed six inches loose thickness and densely compacted with hand operated equipment. Heavy equipment should not be used as it could cause increased lateral pressures and damage walls.

8.0 CLOSURE AND LIMITATIONS

This report was prepared for the exclusive use of our client and their representatives for evaluating the site as it relates to the geotechnical aspects discussed herein. The analyses, conclusions and recommendations contained in this report are based on site conditions as they presently exist. It is assumed that the exploratory borings are representative of the subsurface conditions throughout the site, i.e., the subsurface conditions everywhere are not significantly different from those disclosed by the explorations.

If, during construction, subsurface conditions different from those encountered in these and prior explorations are observed or appear to be present, Shannon & Wilson, Inc. should be advised at once so that these conditions can be reviewed and recommendations can be reconsidered where necessary. If there is a substantial lapse of time between the submittal of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, it is recommended that this report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

We recommend that we be retained to review those portions of the plans and specifications pertaining to earthwork and foundations to determine if they are consistent with our recommendations. In addition, we should be retained to observe construction, particularly the compaction of structural fill, installation of shoring and site excavations, and also to make field measurements of ground displacements and such other field observations as may be necessary.

Unanticipated soil conditions are commonly encountered and cannot fully be determined by merely taking soil samples or advancing borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs. Shannon & Wilson has prepared the attachments in Appendix B *Important Information About Your Geotechnical/Environmental Report* to assist you and others in understanding the use and limitations of the reports.

Copies of documents that may be relied upon by our client are limited to the printed copies (also known as hard copies) that are signed or sealed by Shannon & Wilson with a wet, blue ink signature. Files provided in electronic media format are furnished solely for the convenience of the client. Any conclusion or information obtained or derived from such electronic files shall be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, or you question the authenticity of the report please contact the undersigned.

We appreciate this opportunity to be of service. Please contact the undersigned at (907) 561-2120 with questions or comments concerning the contents of this report.

Sincerely,

SHANNON & WILSON, INC.

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Katra Wedeking
Geologist III

Reviewed by:

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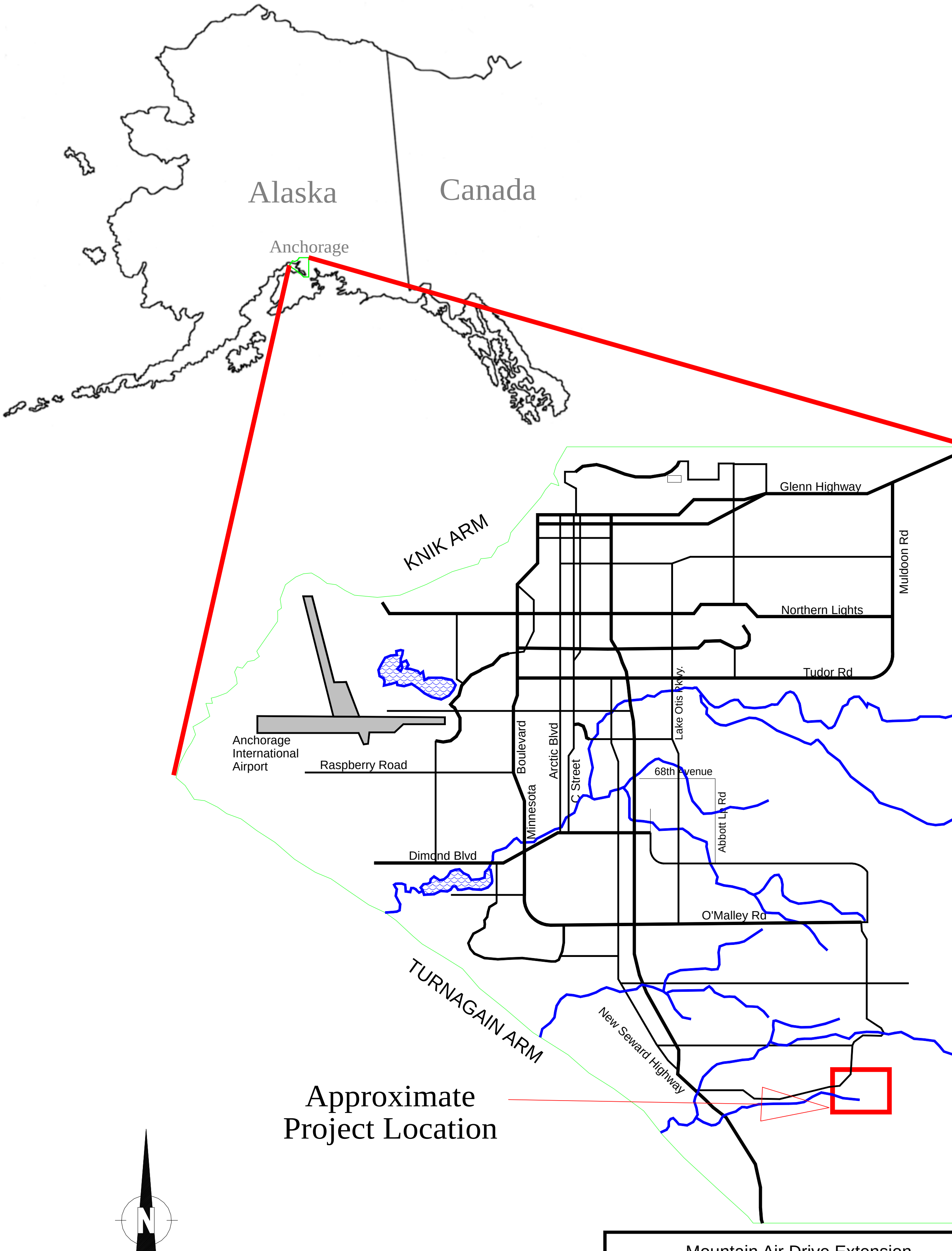


DRAWING NOT TO SCALE

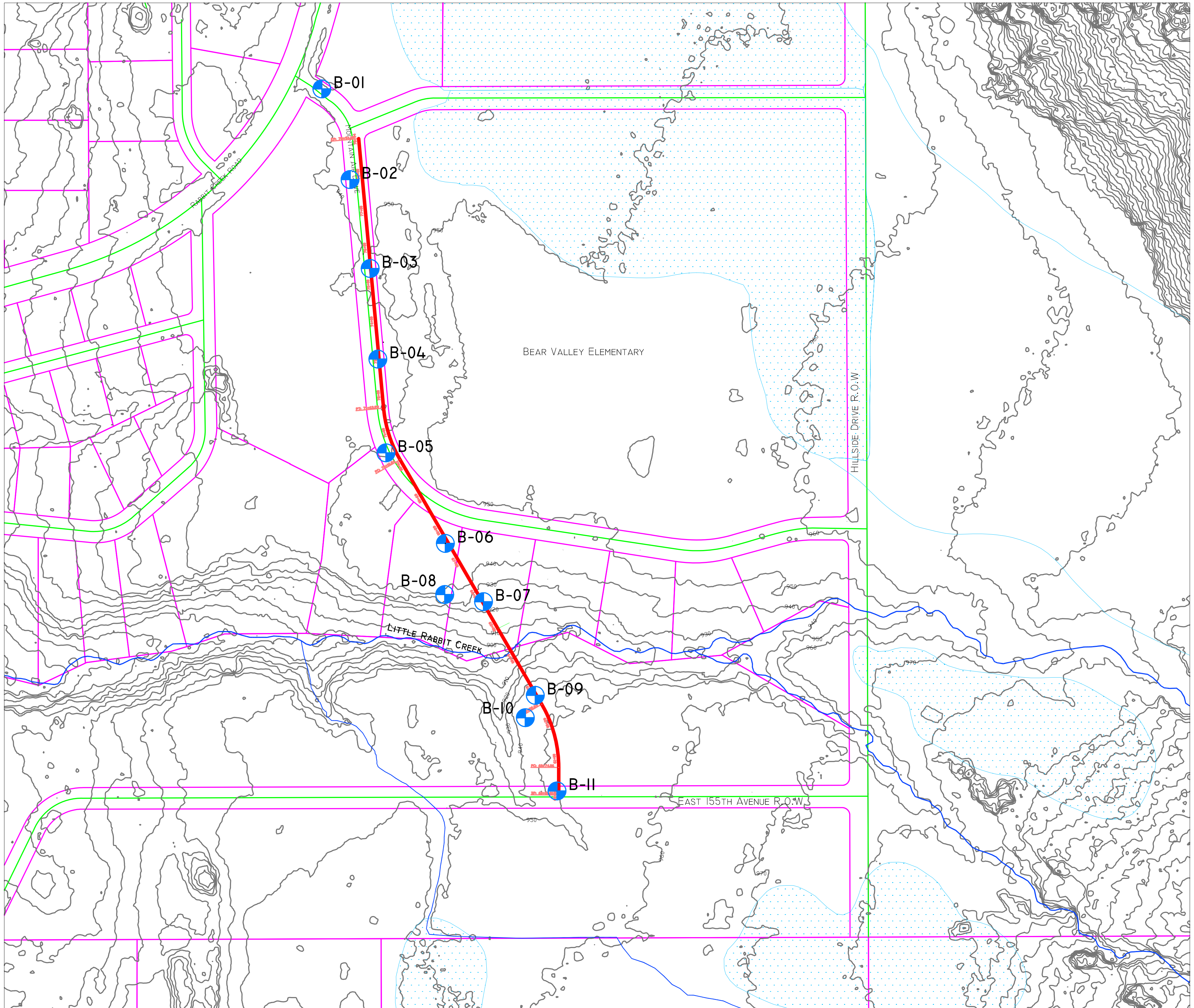
Mountain Air Drive Extension
Anchorage, Alaska

VICINITY MAP

June 2010 | 32-1-02055-002

SHANNON & WILSON, INC.
Geotechnical & Environmental Consultants

Fig. 1



LEGEND

B-09 Approximate Location of Boring B-09, advanced by Shannon & Wilson, 2010

Approximate Location of wetlands as designated by the Municipality of Anchorage GIS Database

Notes:
1) Topographic contours and MOA Rights of Way (ROW) provided by USKH, Inc.
2) Proposed alignment provided by USKH, Inc. and is approximate.
3) Contours represent approximate ground surface elevation in feet.

N

0 150 300 600

APPROXIMATE SCALE IN FEET

Mountain Air Drive Extension
Anchorage, Alaska

SITE PLAN

March 2010

32-1-02055-002

SHANNON & WILSON, INC.
Geotechnical & Environmental Consultants

FIG. 2

GRADATION REQUIREMENTS

(Adapted from Municipality of Anchorage Standard Specifications, 1994)

LEVELING COURSE

U.S. STANDARD SIEVE SIZE English	Metric	PERCENT PASSING BY WEIGHT
1 in.	25.0 mm	100
3/4 in.	19.0 mm	70 - 100
3/8 in.	9.5 mm	50 - 80
No. 4	4.75 mm	35 - 65
No. 8	2.36 mm	20 - 50
No. 50	0.30 mm	10 - 30
No. 200	0.075 mm	3 - 8*

TYPE II BASE

U.S. STANDARD SIEVE SIZE		PERCENT PASSING BY WEIGHT
8 in.	-	100
3 in.	75 mm	70 - 100
1-1/2 in.	37.5 mm	55 - 100
3/4 in.	19.0 mm	45 - 85
No. 4	4.75 mm	20 - 60
No. 10	2.00 mm	12 - 50
No. 40	0.425 mm	4 - 30
No. 200	0.075 mm	2 - 6**

TYPE II-A BASE

U.S. STANDARD SIEVE SIZE		PERCENT PASSING BY WEIGHT
3 in.	75 mm	100
3/4 in.	19.0 mm	50 - 100
No. 4	4.75 mm	25 - 60
No. 10	2.00 mm	15 - 50
No. 40	0.425 mm	4 - 30
No. 200	0.075 mm	2 - 6**

* The fraction passing the No. 200 sieve shall not exceed 75 percent of the fraction passing the No. 50 sieve.

** The fraction passing the No. 200 sieve shall not exceed 20 percent of the fraction passing the No. 4 sieve.

Mountain Air Drive Extension
Anchorage, Alaska

GRADATION REQUIREMENTS

June 2010 — 32-1-02055-002

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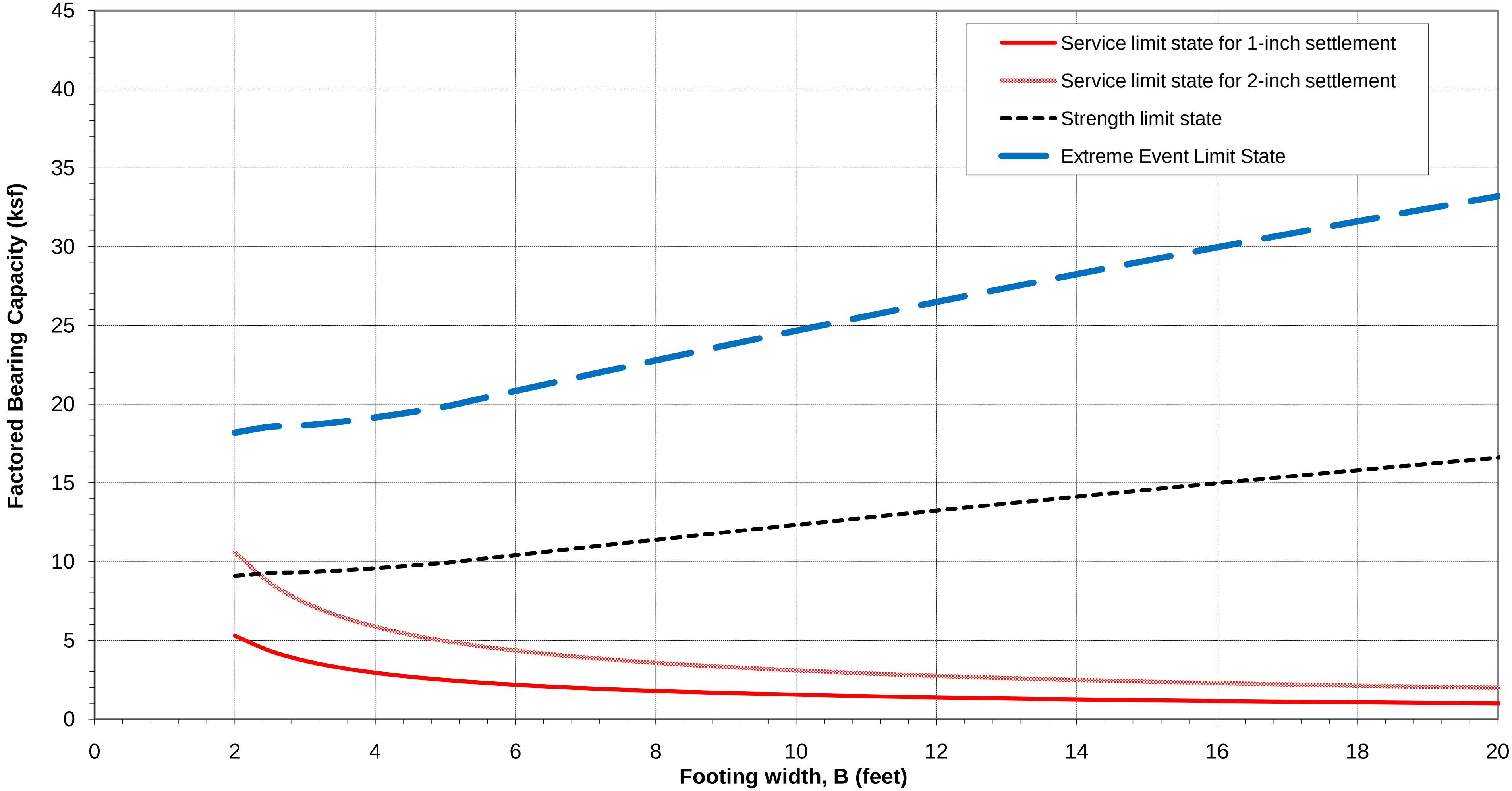
Fig. 3



NOTES

1. We recommend using the following resistance factors for footing LRFD design; the plotted bearing capacities use the bearing capacity resistance factors.

Limit State	Sliding Shear	Passive Press.	Bearing Capacity
Service	N/A	N/A	1.0
Strength	0.8	0.5	0.45
Extreme Event	1.0	1.0	0.9

2. The factored bearing capacities are based on a soil friction angle of 32 degrees, a soil cohesion of 0 psf, a total unit weight of 130 pcf, a Poisson's ratio of 0.3, and a soil elastic modulus of 300 ksf. We assumed that the bottom of the footing was 5 feet below the ground surface.

3. **psf** - pounds per square foot; **pcf** - pounds per cubic foot; **ksf** - kips per square foot (1 kip = 1000 pounds)

Mountain Air Drive Extension
Anchorage, Alaska

FACTORED BEARING CAPACITY VERSUS FOOTING WIDTH, DEPTH = 5 FT RECTANGULAR FOOTING, LENGTH = 48

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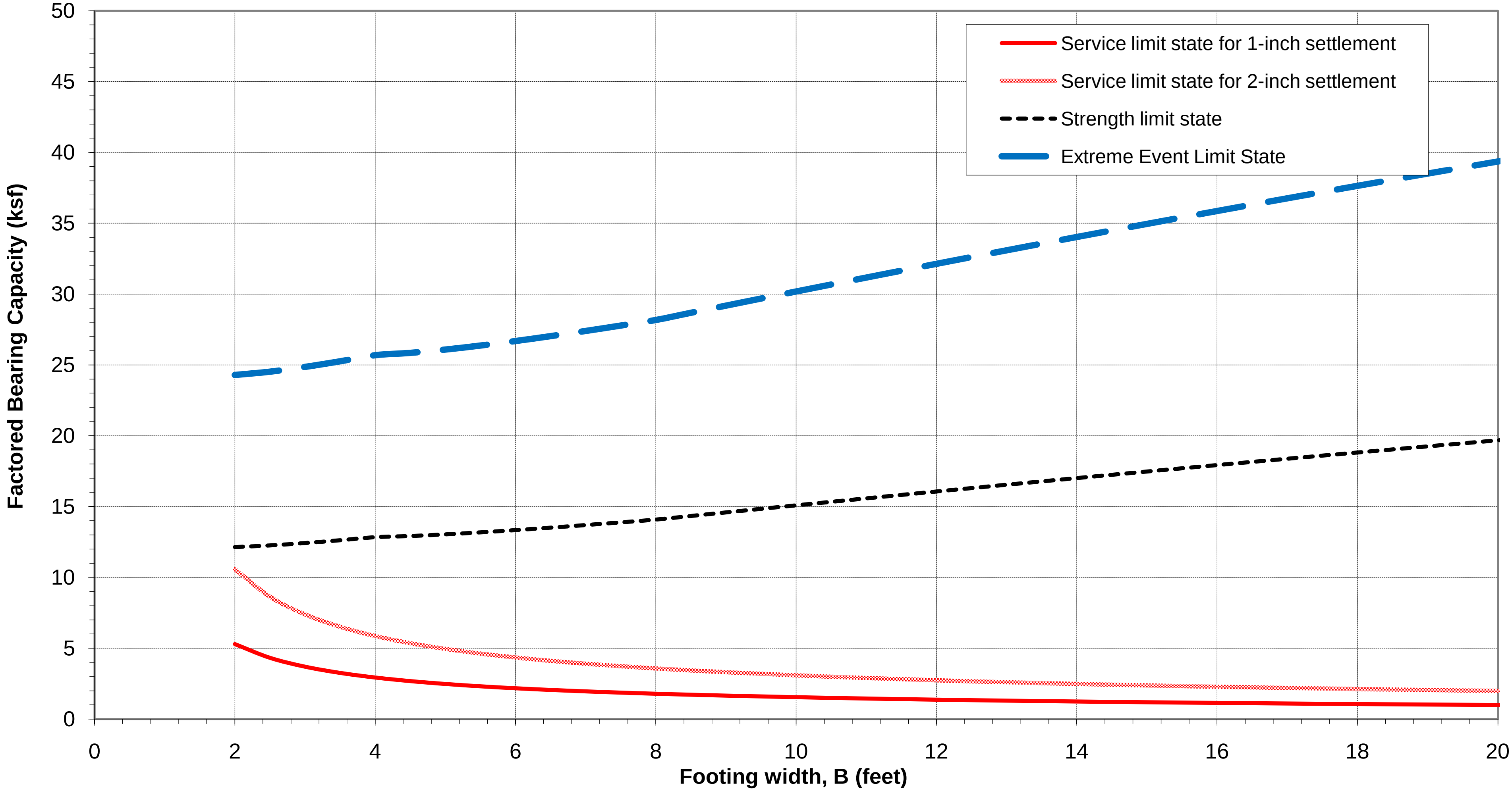
FIG. 4
Sheet 1 of 3

FIG. 4



NOTES

1. We recommend using the following resistance factors for footing LRFD design; the plotted bearing capacities use the bearing capacity resistance factors.

Limit State	Sliding Shear	Passive Press.	Bearing Capacity
Service	N/A	N/A	1.0
Strength	0.8	0.5	0.45
Extreme Event	1.0	1.0	0.9

2. The factored bearing capacities are based on a soil friction angle of 32 degrees, a soil cohesion of 0 psf, a total unit weight of 130 pcf, a Poisson's ratio of 0.3, and a soil elastic modulus of 300 ksf. We assumed that the bottom of the footing was 8 feet below the ground surface.

3. **psf** - pounds per square foot; **pcf** - pounds per cubic foot; **ksf** - kips per square foot (1 kip = 1000 pounds)

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FACTORED BEARING CAPACITY VERSUS FOOTING WIDTH, DEPTH = 8 FT RECTANGULAR FOOTING, LENGTH = 48

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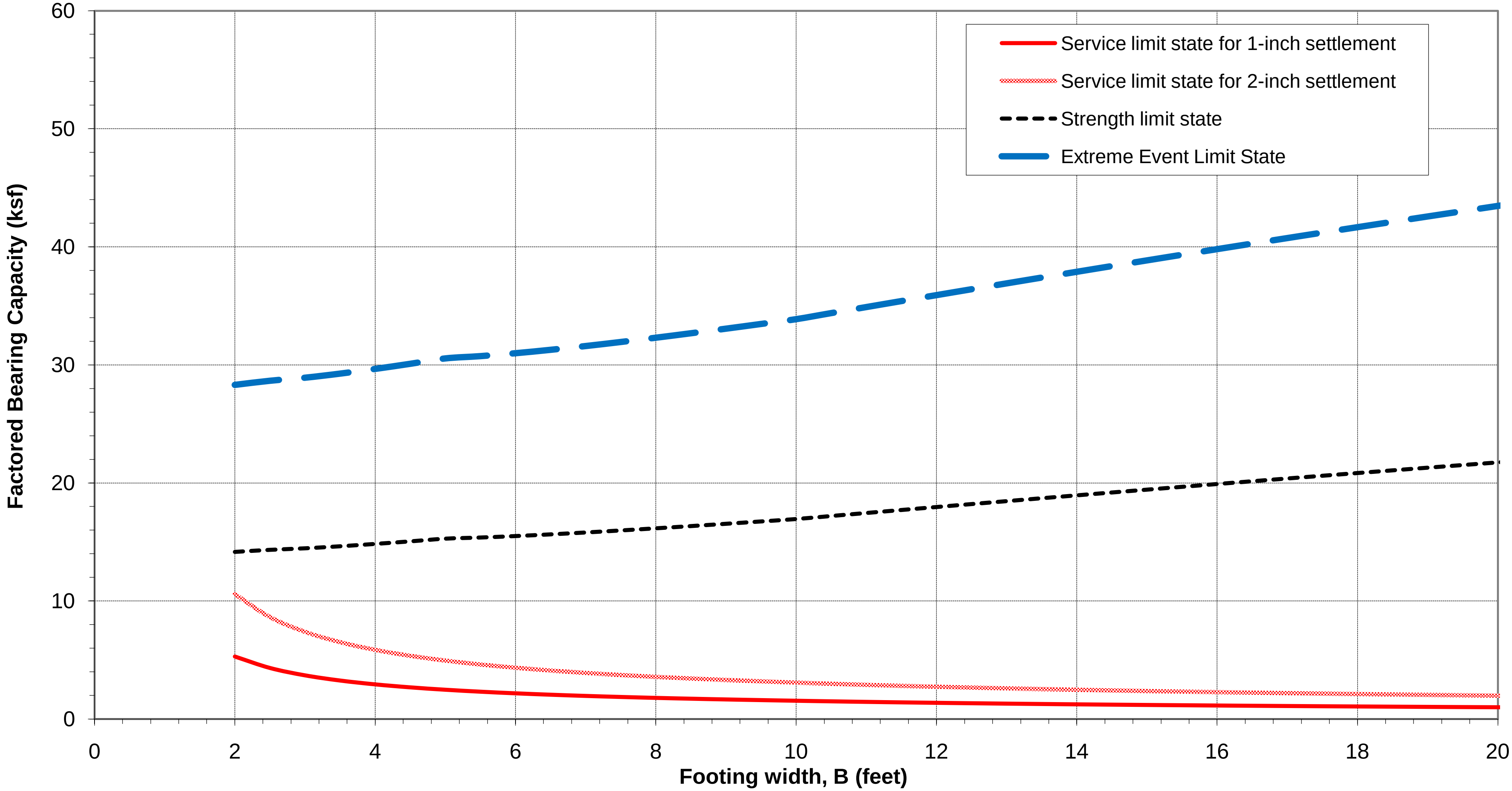
FIG. 4
Sheet 2 of 3

FIG. 4



NOTES

1. We recommend using the following resistance factors for footing LRFD design; the plotted bearing capacities use the bearing capacity resistance factors.

Limit State	Sliding Shear	Passive Press.	Bearing Capacity
Service	N/A	N/A	1.0
Strength	0.8	0.5	0.45
Extreme Event	1.0	1.0	0.9

2. The factored bearing capacities are based on a soil friction angle of 32 degrees, a soil cohesion of 0 psf, a total unit weight of 130 pcf, a Poisson's ratio of 0.3, and a soil elastic modulus of 300 ksf. We assumed that the bottom of the footing was 10 feet below the ground surface.

3. **psf** - pounds per square foot; **pcf** - pounds per cubic foot; **ksf** - kips per square foot (1 kip = 1000 pounds)

Mountain Air Drive Extension
Anchorage, Alaska

FACTORED BEARING CAPACITY VERSUS FOOTING WIDTH, DEPTH = 10 FT RECTANGULAR FOOTING, LENGTH = 48

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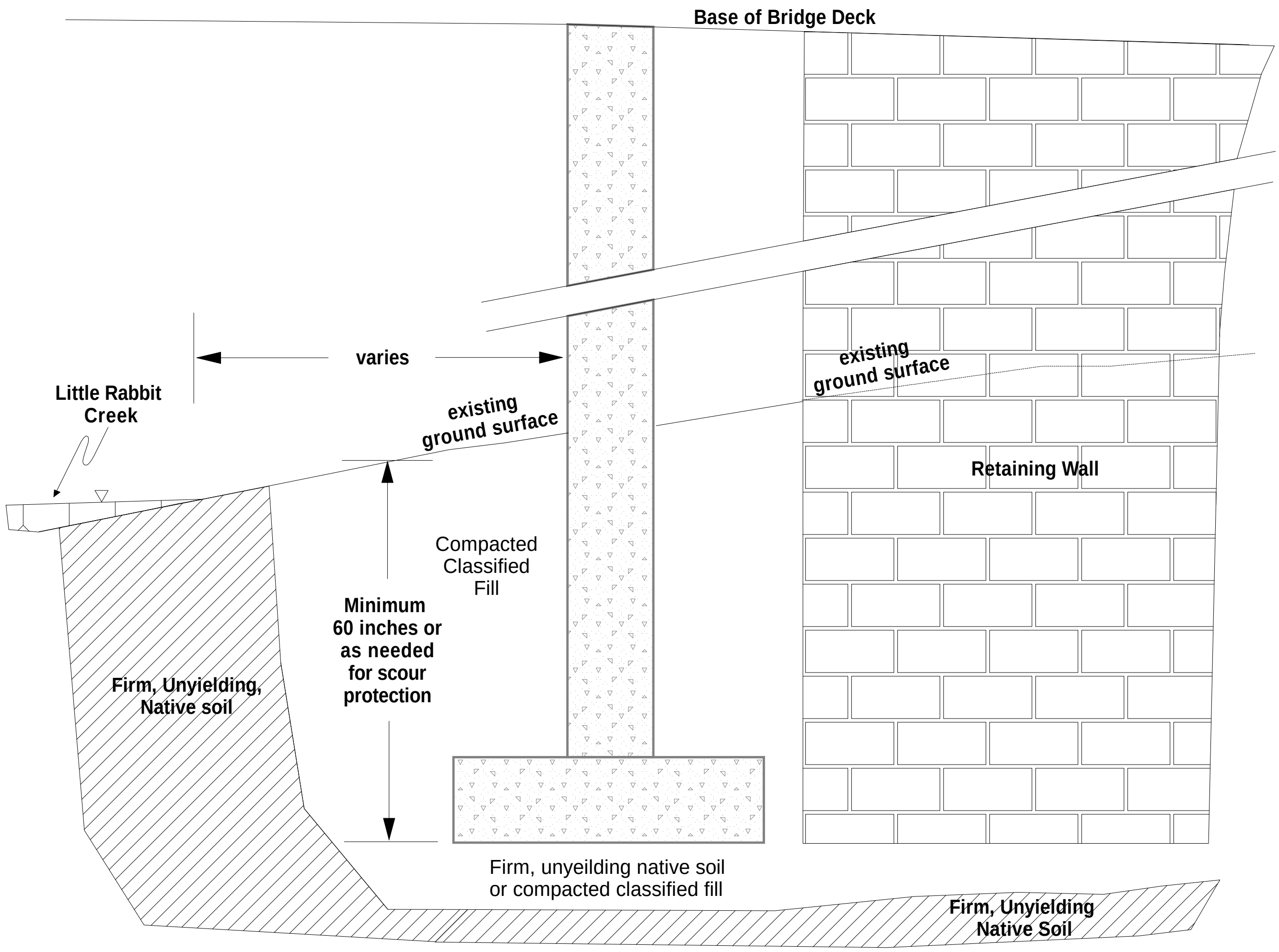
FIG. 4
Sheet 3 of 3

FIG. 4



NOTES:

1. If conditions render on-site soil unsuitable for compaction and drainage, backfill the zone shown above with free-draining granular soil with not more than 6% (by weight based on minus 3/4" portion) passing No. 200 sieve (by wet sieving) with no plastic fines.
2. All backfill should be placed in layers not exceeding 10 to 12 inches loose thickness and densely compacted. Structural fill should be compacted to 95% minimum, non-structural fill compacted to 90%, of ASTM D-1557.
3. Backfill within 18 inches of vertical foundation components should be placed in layers not exceeding 6 inches and densely compacted with hand-operated equipment. Heavy equipment should not be used for backfill, as such equipment operated near the wall could increase lateral earth pressures and possibly damage the wall.
4. If material beneath footing is soft and/or unsuitable, it should be overexcavated a minimum of 2 feet below footing grade and replaced with classified structural fill.

DRAWING NOT TO SCALE

Mountain Air Drive Extension
Anchorage, Alaska

TYPICAL FOOTING DETAIL

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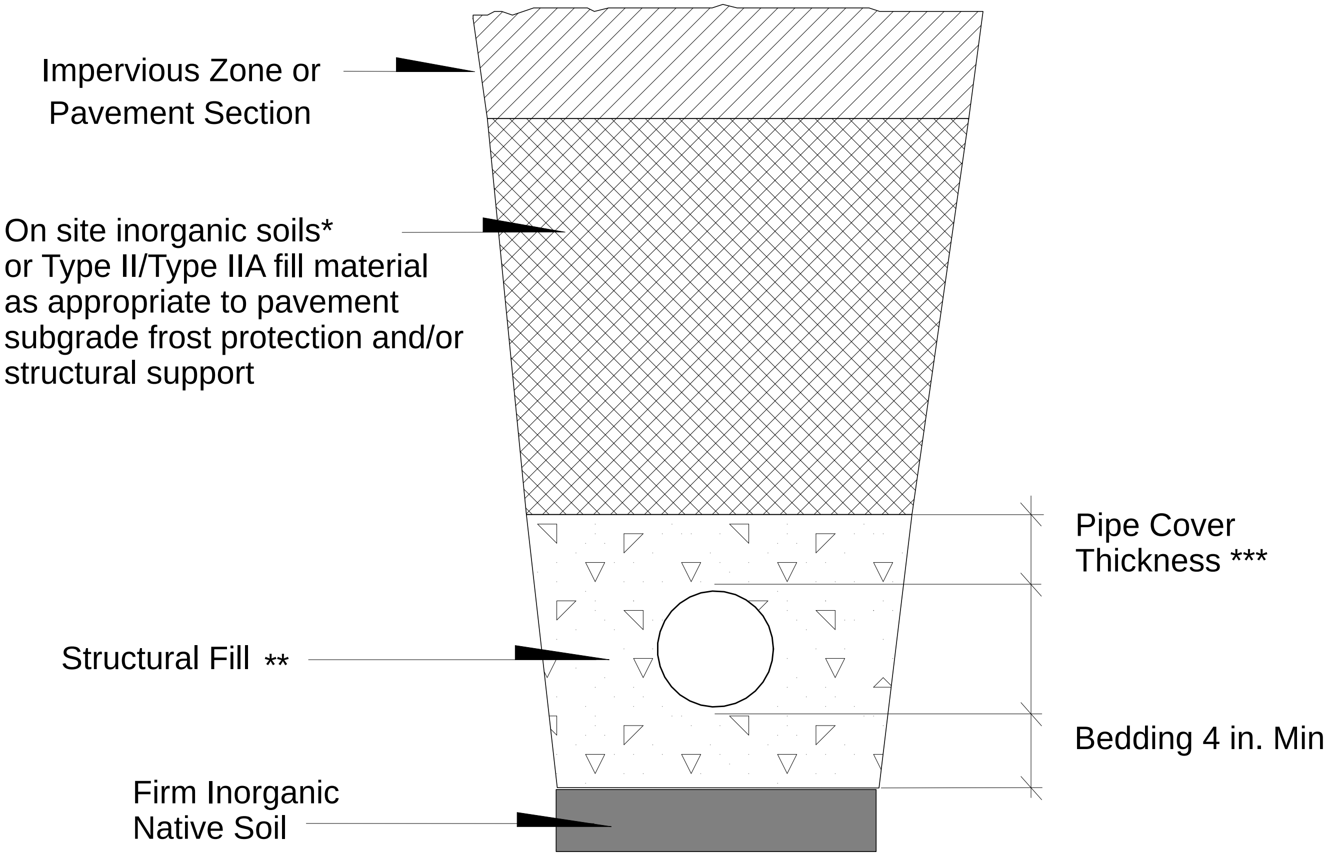
Fig. 5



* Inorganic soils, 95% compaction below structural fill supporting footings, streets, etc., 90% compaction in non structural support areas.

** Inorganic clean sand or well-graded sand and gravel (max. particle size 2-inch diameter) with less than 6 percent fines. Fill to be compacted to 95% Modified Proctor maximum dry density (ASTM D 1557) or as recommended by pipe manufacturer for specific application.

*** Pipe cover thickness as specified by pipe manufacturer for specific application. Absent manufacturer specifications, pipe cover thickness depends on corrosion and structural support properties. In non-structural support and non-corrosive environment, minimum bedding fill thickness should be at or above springline of pipe. In non-structural support area with corrosive environment, pipe cover should extend at least 6-inches above top of pipe. In structural support area, minimum pipe cover should be 6-inches or one pipe diameter above top of pipe, whichever is greater.

NOTE:

OSHA requires slope protection and support for all trenches greater than 4 feet deep. Side slope requirements are variable depending upon soil type and the duration of time in which the trench remains open. The contractor should be made responsible for compliance to these regulations as he/she is at the project on a day to day basis and is aware of changing conditions.

DRAWING NOT TO SCALE

Mountain Air Drive Extension Anchorage, Alaska	
UTILITY TRENCH DETAIL	
June 2010	32-1-02055-002
SHANNON & WILSON, INC. Geotechnical & Environmental Consultants	**Fig. 6**

APPENDIX A

BORING LOGS AND LABORATORY RESULTS

Figures

Unified Soil Classification System

GROUP NAME Criteria for Assigning Group Names and Group Symbols			Soil Classification Group Symbol with Generalized Group Descriptions	
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	Clean GRAVELS Less than 5% fines	GW	Well-graded Gravels
			GP	Poorly-graded Gravels
		GRAVELS with fines More than 12% fines	GM	Gravel & Silt Mixtures
			GC	Gravel & Clay Mixtures
	SANDS More than 50% of coarse fraction passes No. 4 sieve	Clean SANDS Less than 5% fines	SW	Well-graded Sands
			SP	Poorly-graded Sands
		SANDS with fines More than 12% fines	SM	Sand & Silt Mixtures
			SC	Sand & Clay Mixtures
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	SILTS AND CLAYS Liquid limit 50% or less	INORGANIC	ML	Non-plastic & Low-plasticity Silts
			CL	Low-plasticity Clays
		ORGANIC	OL	Non-plastic and Low-plasticity Organic Clays Non-plastic and Low-plasticity Organic Silts
	SILTS AND CLAYS Liquid limit greater than 50%	INORGANIC	CH	High-plasticity Clays
			MH	High-plasticity Silts
		ORGANIC	OH	High-plasticity Organic Clays High-plasticity Organic Silts
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat

Organic Content

Adjective	Percent by Volume
Occasional	0-1
Scattered	1-10
Numerous	10-30
Organic	30-50, minor constituent
Peat	50-100, MAJOR constituent

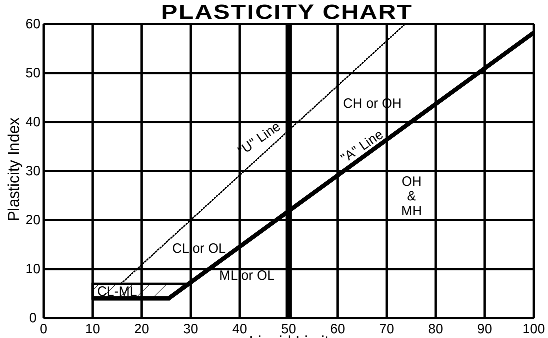
Descriptive Terminology Denoting Component Proportions

Description	Range of Proportion
Add the adjective "slightly"	5 - 12%
Add soil adjective[(a)]	12 - 50%
Major proportion in upper case, (e.g., SAND)	>50%

(a) Use gravelly, sandy, or silty as appropriate

NOTE: The soil descriptions used in the boring logs lists constituents from smallest percentage to largest percentage.

PLASTICITY CHART



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SOIL CLASSIFICATION LEGEND

June 2010 32-1-02055-002

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Fig. A-1

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FROST CLASSIFICATION

(after Municipality of Anchorage)

GROUP		0.02 Mil.	P-200	USC SYSTEM (based on P-200 results)
NFS	Sandy Soils		0 to 3	SW, SP
	Gravelly Soils	0 to 3	0 to 6	GW, GP, GW-GM, GP-GM
F1	Sandy Soils	0 to 3	3 to 6	SW, SP, SW-SM, SP-SM
	Gravelly Soils	3 to 10	6 to 13	GM, GW-GM, GP-GM
F2	Sandy Soils	3 to 15	6 to 19	SP-SM, SW-SM, SM
	Gravelly Soils	10 to 20	13 to 25	GM
F3	Sands, except very fine silty sands**	Over 15	Over 19	SM, SC
	Gravelly Soils	Over 20	Over 25	GM, GC
	Clays, PI>12			CL, CH
F4	All Silts			ML, MH
	Very fine silty sands**	Over 15	Over 19	SM, SC
	Clays, PI<12			CL, CL-ML
	Varved clays and other fined grained, banded sediments			CL and ML CL, ML, and SM; SL, SH, and ML; CL, CH, ML, and SM

P-200 = Percent passing the number 200 sieve
0.02 Mil. = Percent material below 0.02 millimeter grain size

*Approximate P-200 value equivalent for frost classification. Value range based on typical, well-graded soil curves. P-200 criteria in absence of hydrometer data.

** Very fine sand : greater than 50% of sand fraction passing the number 100 sieve

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Anchorage, Alaska

FROST CLASSIFICATION LEGEND

June 2010 32-1-02055-002

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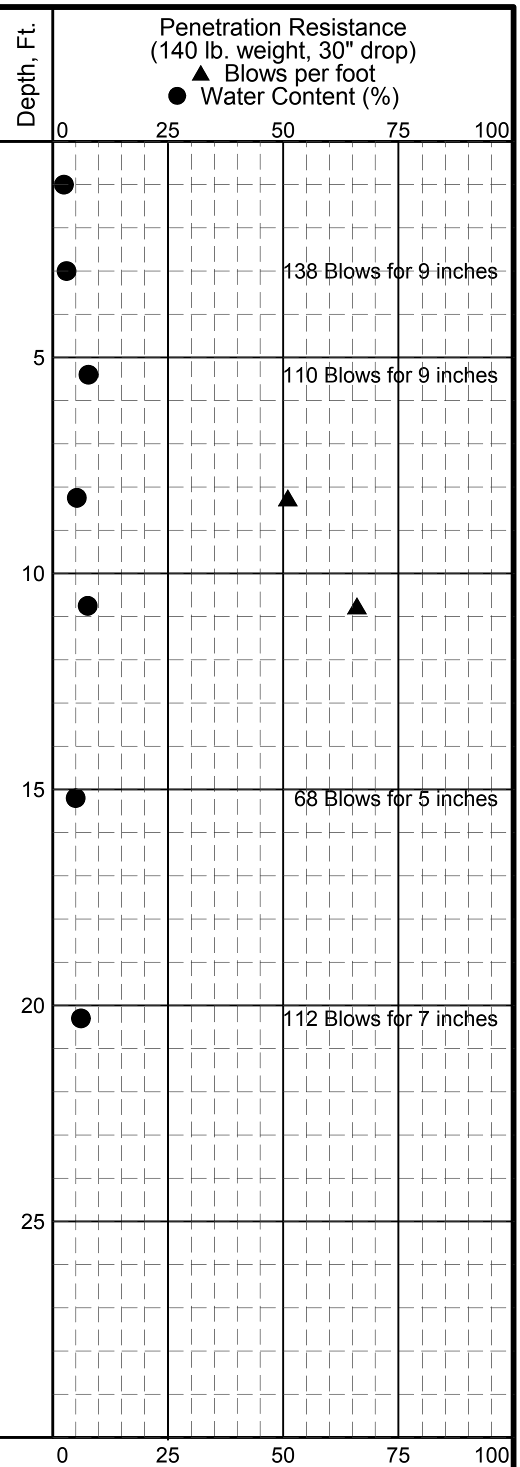
Fig. A-2

MATERIAL DESCRIPTION Approx. Elevation: 940 Ft.	Depth, Ft.	Symbol	Samples	Ground Water
1 1/2 inches of asphalt on surface Frozen, brown, slightly silty to silty, sandy GRAVEL; moist [FILL] SBulk 0-5 ft bgs: 46% Gravel, 42% Sand, 12% Fines (F1 (P200))	0.1		S1 S2 SBulk 0-5 ft bgs S3	
Very dense, brown, gravelly, silty SAND; moist S4: 23% Gravel, 51% Sand, 26% Fines (F3 (P200))	6.0		S4 S5 S6 S7	Groundwater not encountered during drilling on 3/1/10
Bottom of Boring Boring Completed 3/1/10	20.6			



● Water Content (%)
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-01

June 2010 32-1-02055-002

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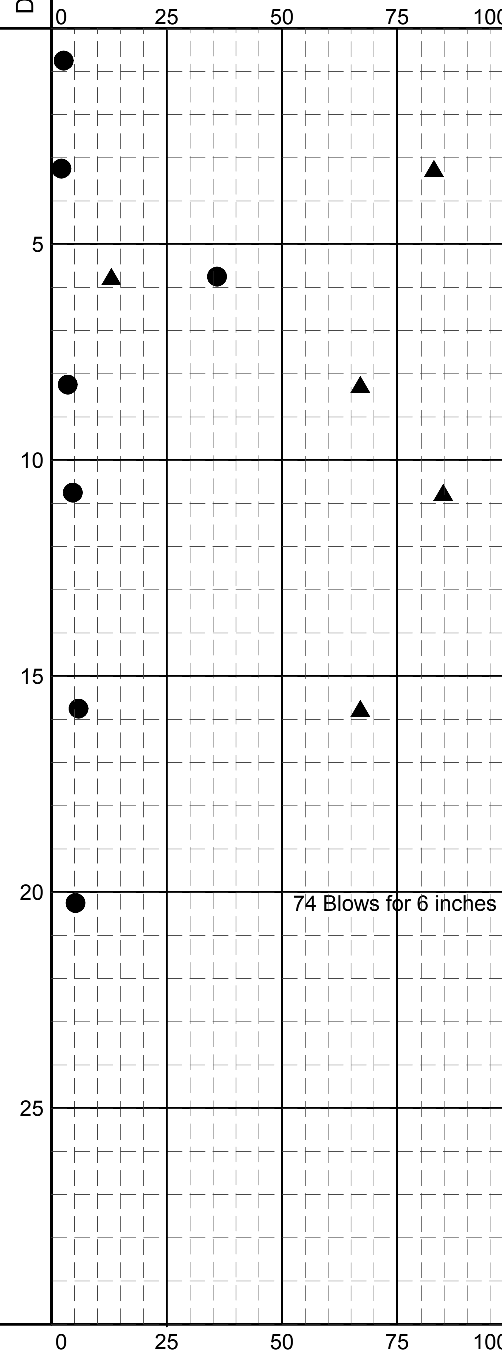
Fig. A-3

GEOTECHNICAL LOG 02055-002 GINT.GPJ S&W GEO1.GDT 6/21/10

MATERIAL DESCRIPTION Approx. Elevation: 944 Ft.	Depth, Ft.	Samples
2 inches asphalt on surface Frozen, brown, slightly silty to silty, sandy GRAVEL; moist [FILL] SBulk 0-4 ft bgs: 45% Gravel, 40% Sand, 15% Fines (F1 (0.02mm))	0.2	S1, SBulk 0-4 ft bgs, S2
Frozen, brown, gravelly, sandy SILT; moist S3: 51% Fines (F4 (P200))	4.0	S3
Very dense, brown, silty, gravelly SAND; moist S5: 28% Gravel, 52% Sand, 20% Fines (F3 (P200))	7.0	S4, S5, S6, S7
Bottom of Boring Boring Completed 3/1/10	20.5	

Ground Water: Groundwater not encountered during drilling on 3/1/10

Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



● Water Content (%)
Plastic Limit |—●—| Liquid Limit
Natural Water Content

LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- ▮ Frozen

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-02

June 2010 32-1-02055-002

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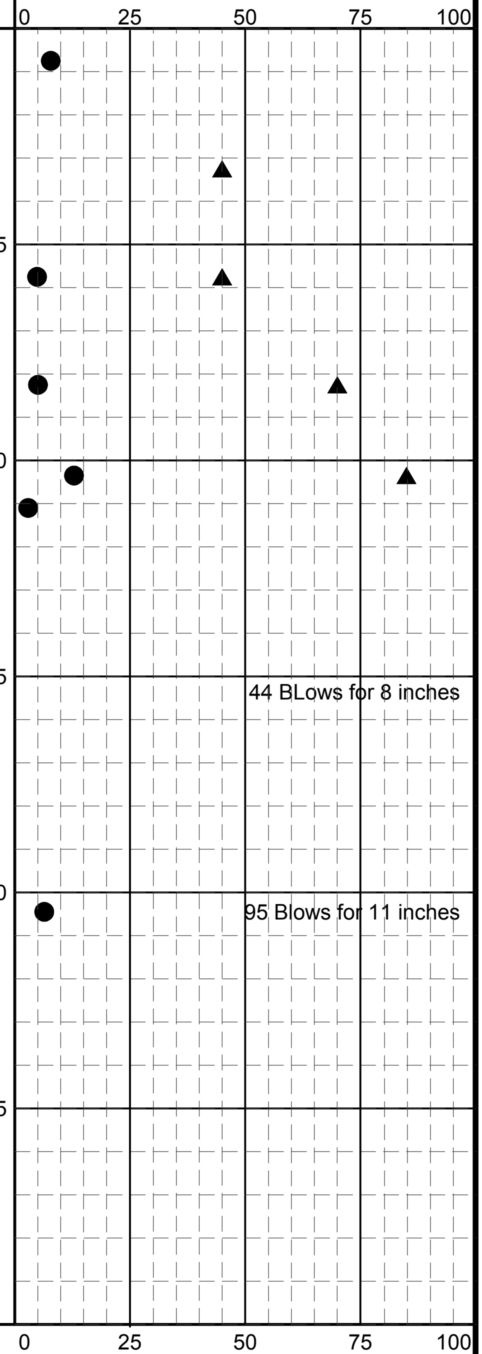
Fig. A-4

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Approx. Elevation: 942 Ft.					
Frozen, tan, slightly silty, gravelly SAND; moist [FILL?]			S1		
Frozen to very dense, tan, silty, gravelly SAND; moist	2.0		S2 *		
SBulk 0-7 ft bgs: 31% Gravel, 47% Sand, 22% Fines (F3 (P200))			SBulk 0-7 ft bgs		5
			S3		
S4: 33% Gravel, 43% Sand, 25% Fines (F3 (P200))			S4		
Hard, tan SILT; moist	9.5		S5a		10
Very dense, tan, slightly silty, gravelly SAND; moist	10.7		S5b		
Very dense, tan, silty, sandy GRAVEL; moist	13.0		S6 *		15
			S7		20
Bottom of Boring Boring Completed 2/26/10	20.9				25

Groundwater not encountered during drilling on 2/26/10

Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

* Sample Not Recovered
2" O.D. Split Spoon Sample
Bulk Sample
Frozen

Blank Section, Cuttings Backfill
Slotted Section, Cuttings Backfill
Well Casing and Filter Sand
Bentonite Seal

● Water Content (%)
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-03

June 2010 32-1-02055-002

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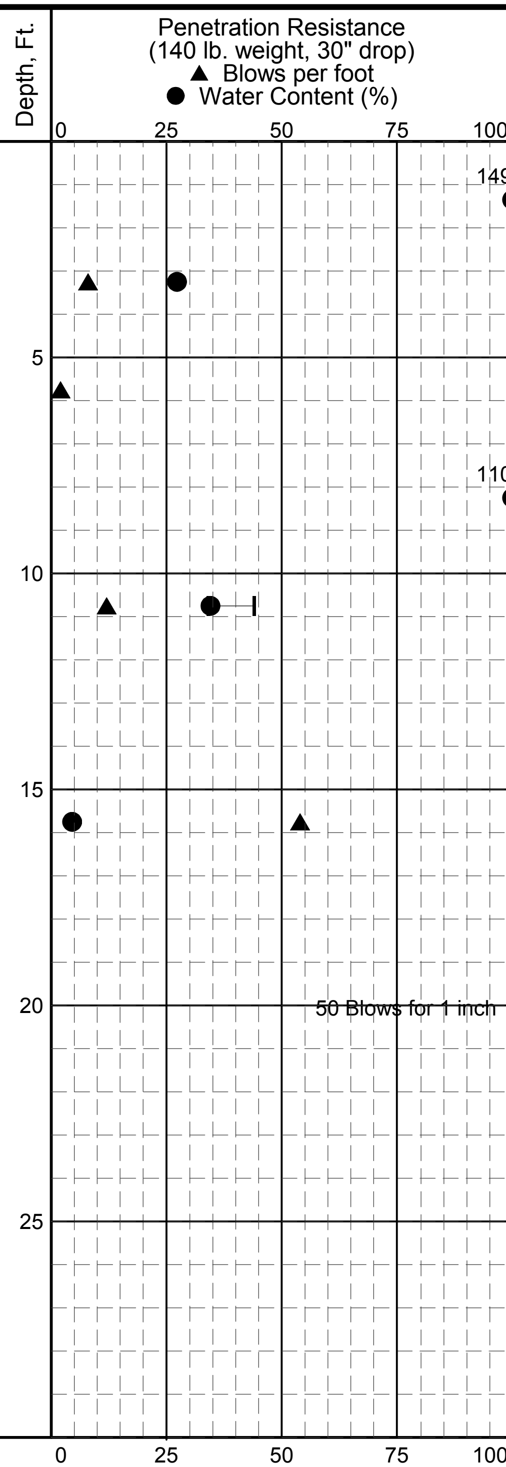
Fig. A-5

Approx. Elevation: 938 Ft.

MATERIAL DESCRIPTION	Depth, Ft.	Samples
Frozen, tan, silty, sandy GRAVEL; moist [FILL]	0.7	
Frozen, dark brown, organic SILT; moist	2.5	S1
Frozen to stiff, mottled light gray/red-orange SILT; moist to wet	3.8	S2
Loose, red-orange SAND; wet	4.5	
Soft, tan, silty PEAT; moist Sample S4: Sampler penetrates 1.5 feet with weight of hammer	10.5	S3 *, S4
Very stiff, gray, sandy SILT; moist to wet	13.0	S5
Very dense, tan, silty, gravelly SAND; moist S6: 42% Gravel, 46% Sand, 13% Fines (F2 (P200))	20.1	S6, S7 *
Bottom of Boring Boring Completed 2/26/10		

Ground Water: Groundwater not encountered during drilling on 2/26/10



LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen

● Water Content (%)
Plastic Limit |—●—| Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Mountain Air Drive Extension
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LOG OF BORING B-04

June 2010 | 32-1-02055-002

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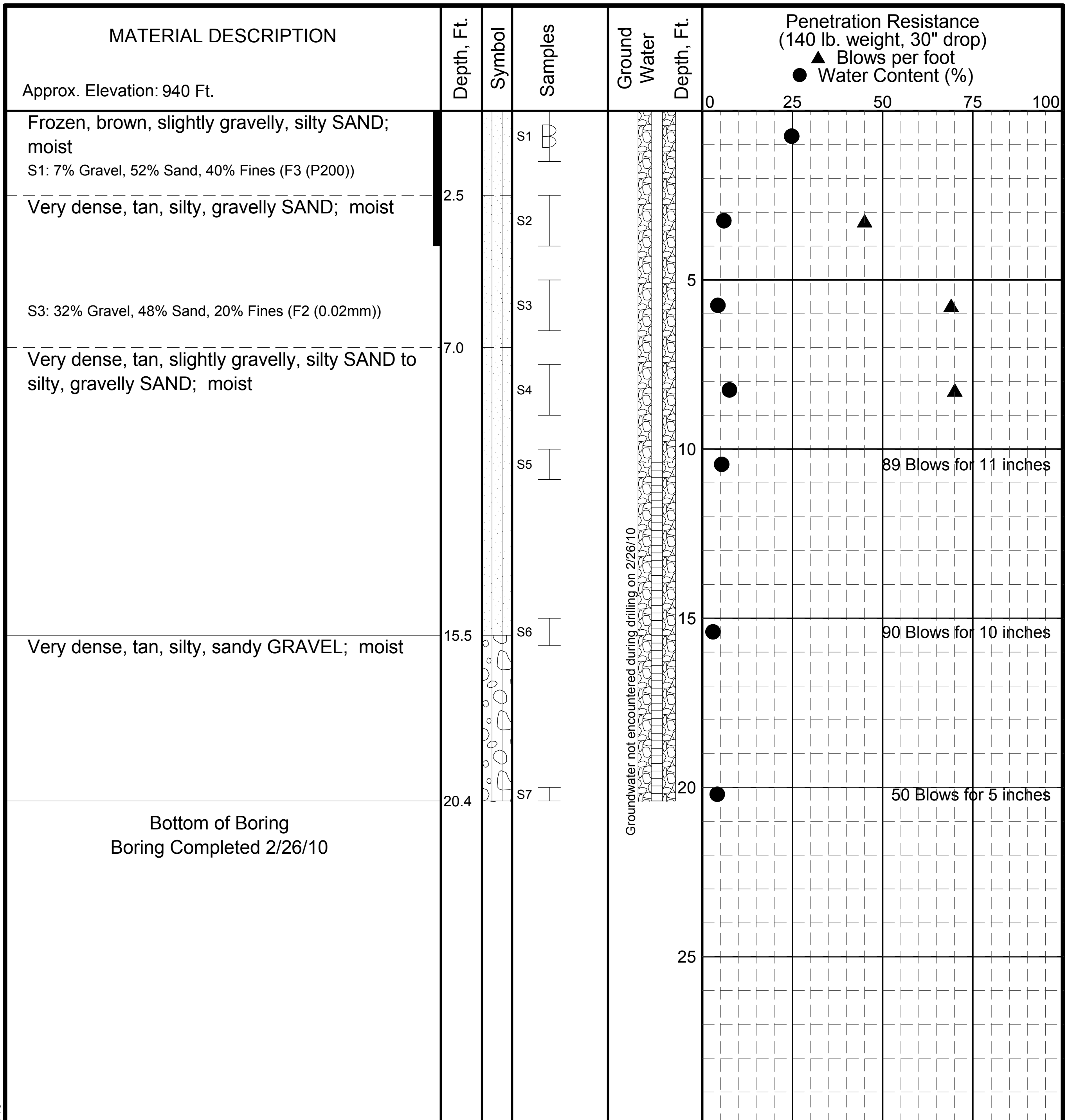
Fig. A-6



LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill
- Well Casing and Filter Sand
- Bentonite Seal

● Water Content (%)

Plastic Limit ——●—— Liquid Limit

Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-05

June 2010 32-1-02055-002

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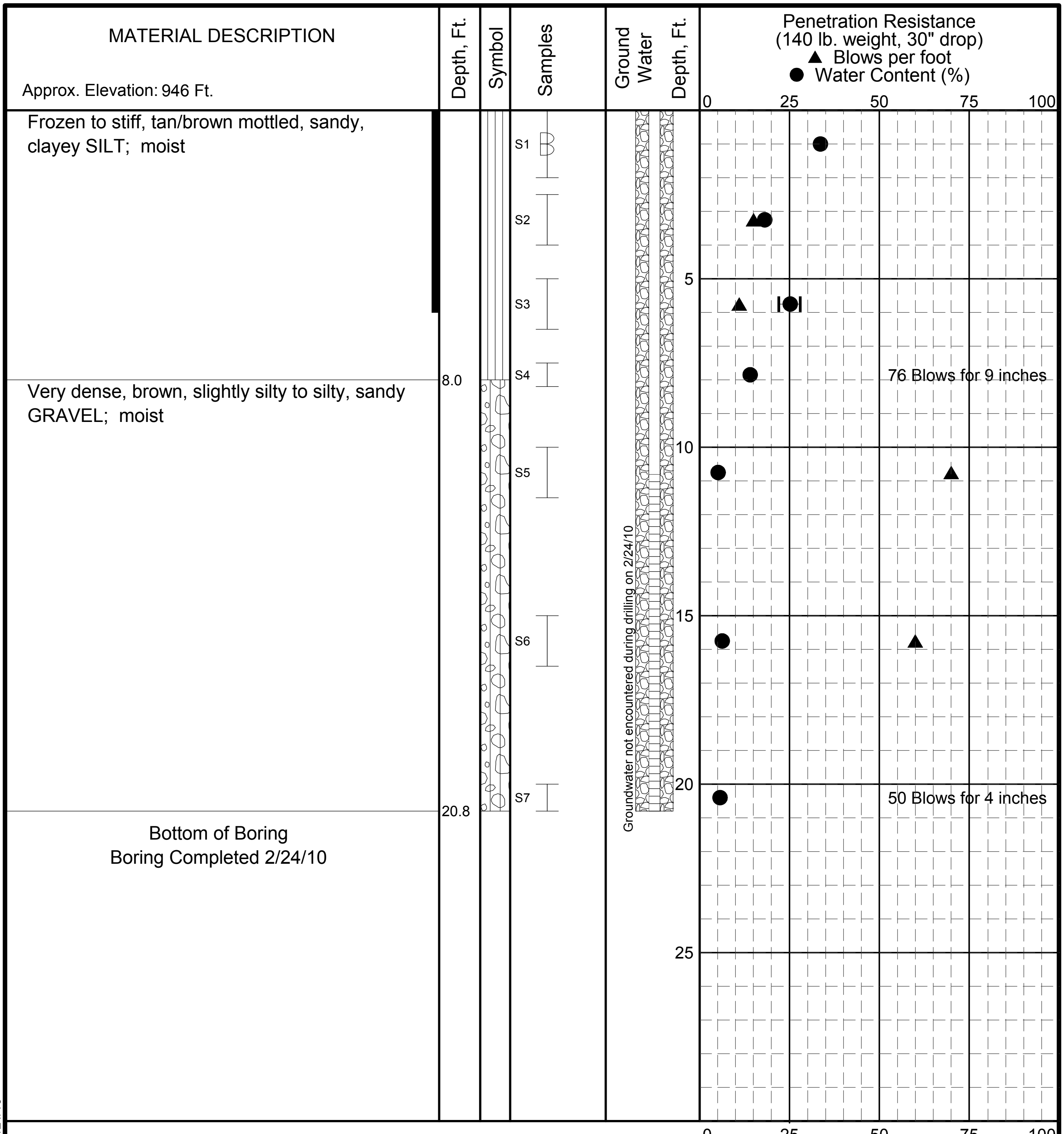
Fig. A-7



LEGEND

* Sample Not Recovered
2" O.D. Split Spoon Sample
Bulk Sample
Frozen

Blank Section, Cuttings Backfill
Slotted Section, Cuttings Backfill
Well Casing and Filter Sand
Bentonite Seal

● Water Content (%)
Plastic Limit ├──●──┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-06

June 2010 32-1-02055-002

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Fig. A-8

MATERIAL DESCRIPTION Approx. Elevation: 924 Ft.	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Medium dense, brown, silty, gravelly SAND; moist [FILL?] S1: 39% Gravel, 41% Sand, 20% Fines (F3 (P200))	2.0		S1		
Frozen to stiff, brown, sandy SILT; moist S2: 58% Fines (F4 (P200))	7.0		S2 S3		5
Dense to very dense, brown and gray, silty, gravelly SAND; moist S4: 42% Gravel, 42% Sand, 16% Fines (F3 (P200))			S4 S5 S6 S7 S8	2/25/10	10 15 20 25

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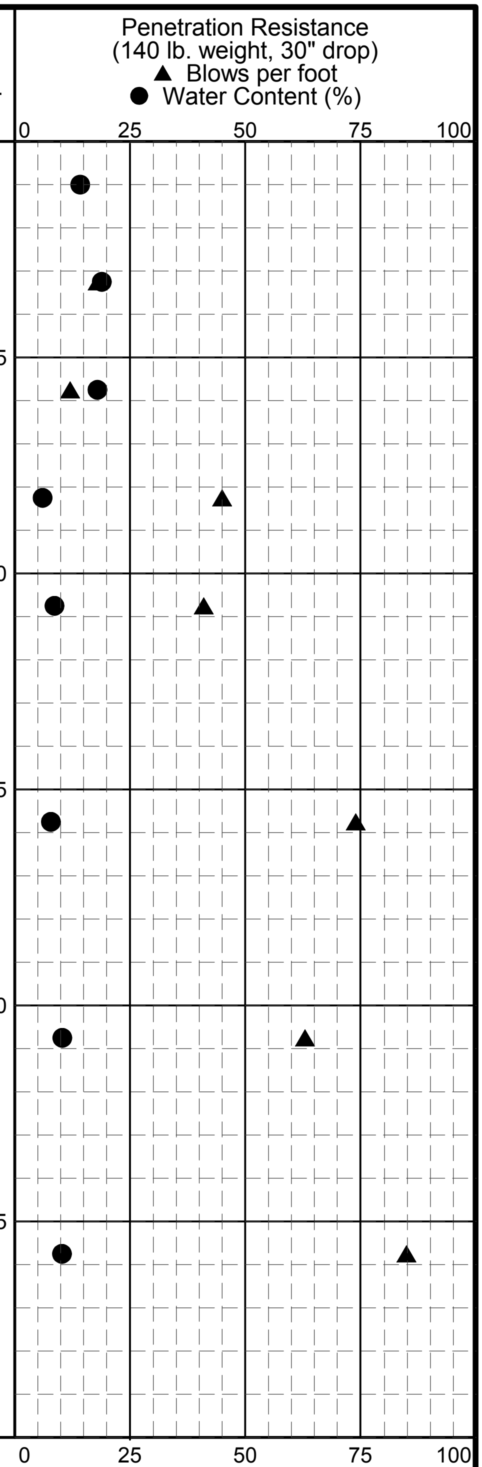

LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen
- Ground Water Level At Time Of Drilling

● Water Content (%)

Plastic Limit ├──●──┤ Liquid Limit

Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-07

June 2010 32-1-02055-002

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Fig. A-9
Sheet 1 of 2

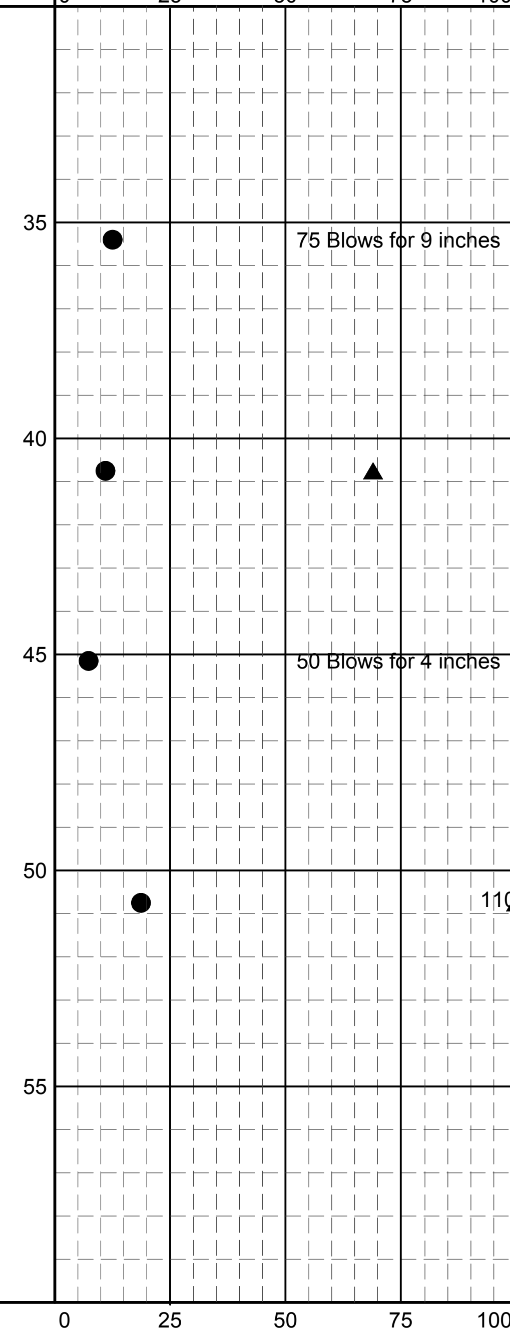
GEOTECHNICAL LOG 02055-002 GINT.GPJ S&W GEO1.GDT 6/21/10

MATERIAL DESCRIPTION

Approx. Elevation: 924 Ft.

MATERIAL DESCRIPTION	Depth, Ft.	Samples
Dense to very dense, brown and gray, silty, gravelly SAND; moist		
Very dense, gray, sandy, silty GRAVEL to hard, gray, gravelly, sandy SILT; moist to wet	32.0	S9, S10, S11, S12
Bottom of Boring Boring Completed 2/25/10	51.5	

Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

* Sample Not Recovered
2" O.D. Split Spoon Sample
Bulk Sample
Frozen
Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit —●— Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-07

June 2010 32-1-02055-002

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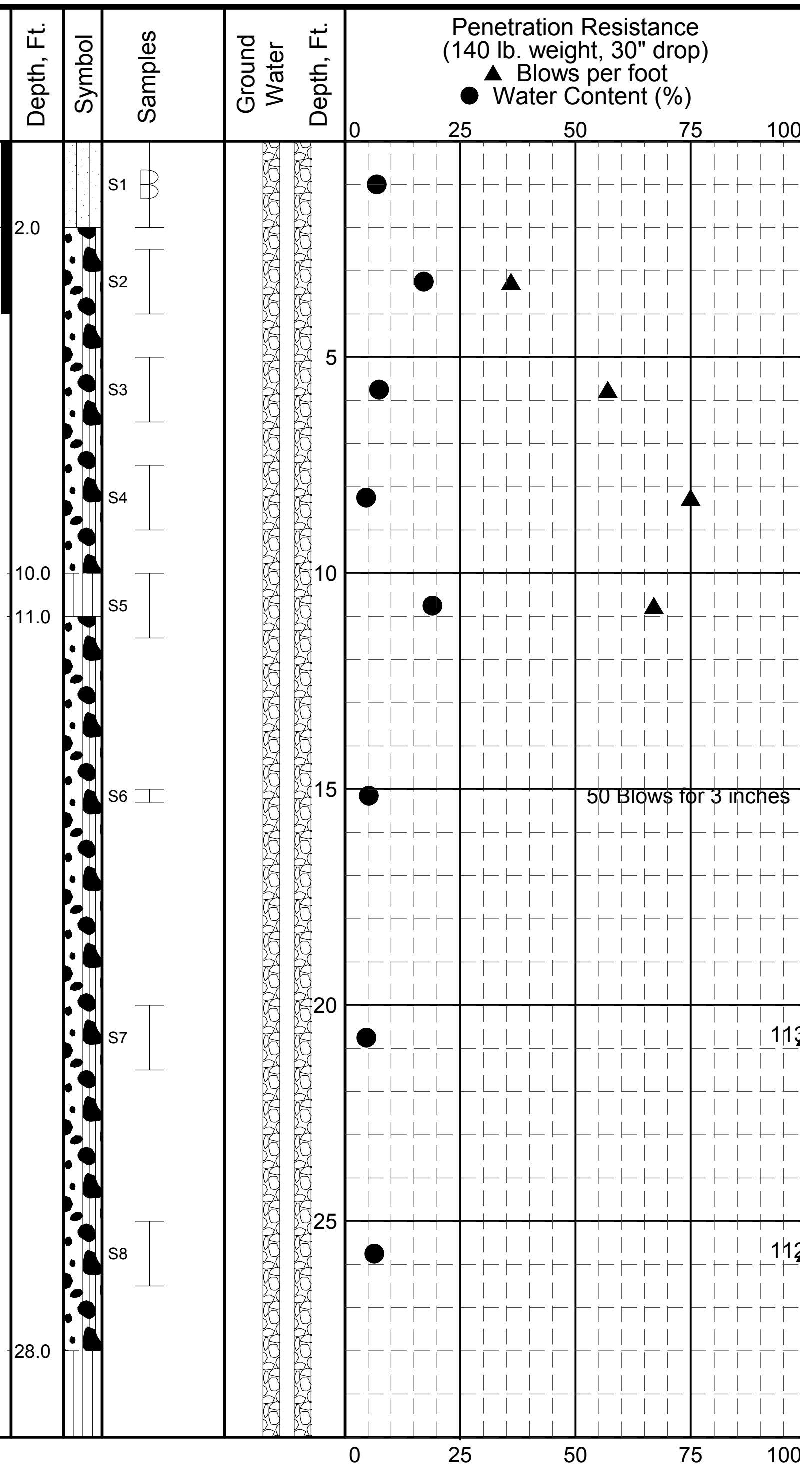
Fig. A-9
Sheet 2 of 2

MATERIAL DESCRIPTION

Approx. Elevation: 937 Ft.

Depth, Ft.	Material Description
0.0–2.0	Frozen, brown, silty, gravelly SAND; moist [FILL?] S1: 31% Gravel, 45% Sand, 25% Fines (F3 (P200))
2.0–10.0	Frozen to very dense, brown, slightly silty, sandy GRAVEL; moist
10.0–11.0	Hard, brown SILT; moist
11.0–28.0	Very dense, brown, slightly silty, sandy GRAVEL; moist
28.0–	Hard, brown and gray, sandy SILT; moist



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LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill
- Well Casing and Filter Sand
- Bentonite Seal
- Ground Water Level At Time Of Drilling
- Static Water Level

● Water Content (%)

Plastic Limit —●— Liquid Limit

Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-08

June 2010 | 32-1-02055-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

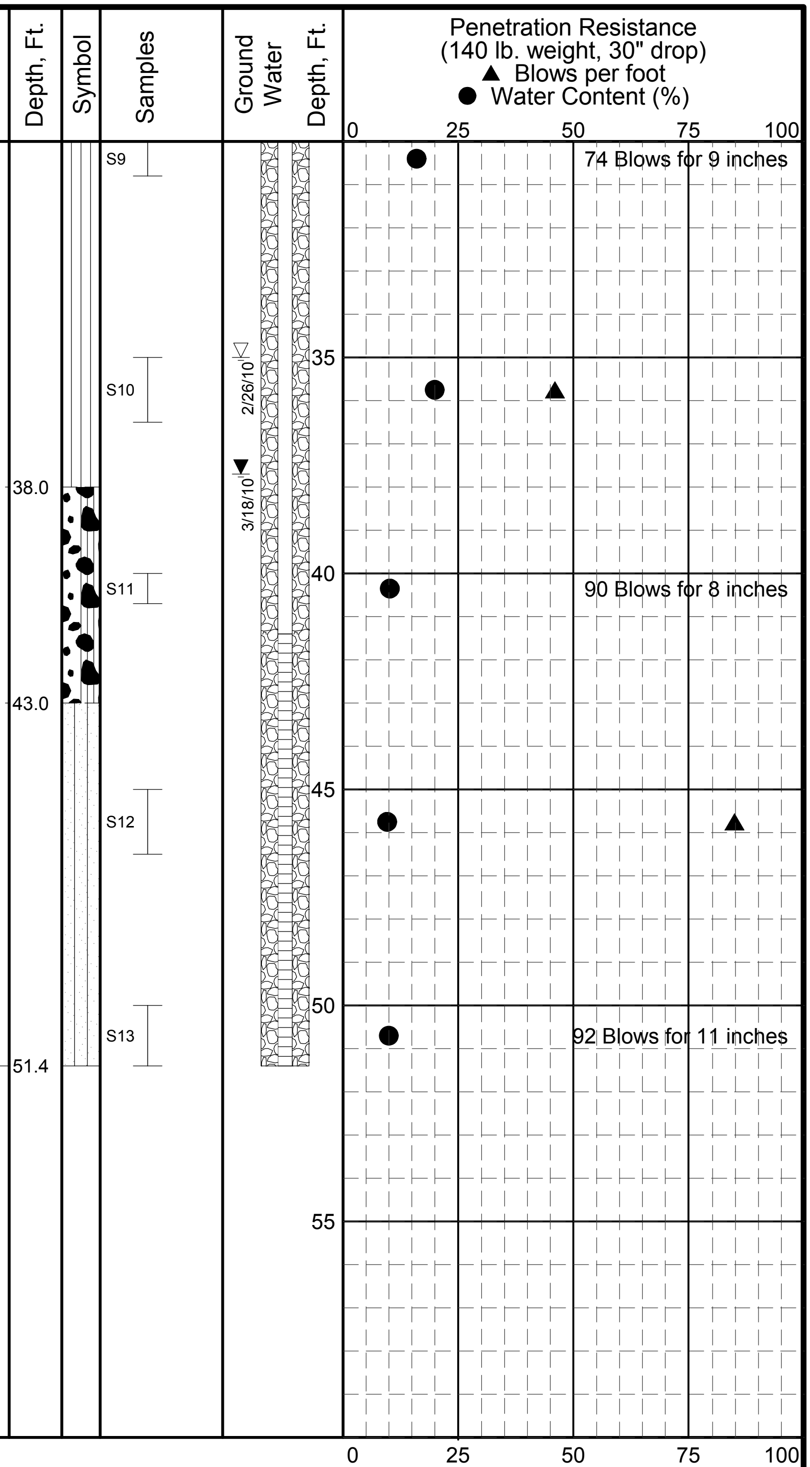
Fig. A-10
Sheet 1 of 2

MATERIAL DESCRIPTION

Approx. Elevation: 937 Ft.

Material Description	Depth, Ft.
Hard, brown and gray, sandy SILT; moist 6 inches of slightly silty SAND from approximately 35.5 to 36 feet bgs.	38.0
Very dense, dark brown, slightly silty, sandy GRAVEL; wet	43.0
Very dense, dark gray, slightly silty to silty, gravelly SAND; wet	51.4

Bottom of Boring
Boring Completed 2/25-26/10



LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill
- Well Casing and Filter Sand
- Bentonite Seal
- Ground Water Level At Time Of Drilling
- Static Water Level

● Water Content (%)

Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

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Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-08

June 2010 32-1-02055-002

SHANNON & WILSON, INC.
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Fig. A-10
Sheet 2 of 2

MATERIAL DESCRIPTION	Depth, Ft.	Symbol	Samples	Ground Water
Approx. Elevation: 946 Ft.				
Frozen, light brown, slightly sandy to sandy SILT with occasional organics; moist	2.0		S1	
Medium dense to dense, brown, gravelly, silty SAND; moist S2: 19% Gravel, 42% Sand, 40% Fines (F3 (P200))	7.0		S2 S3	
S4: 26% Gravel, 48% Sand, 26% Fines (F3 (P200)) Very dense, brown, slightly silty to silty, gravelly SAND and slightly silty, sandy GRAVEL; moist to wet			S4 S5 S6 S7 S8	

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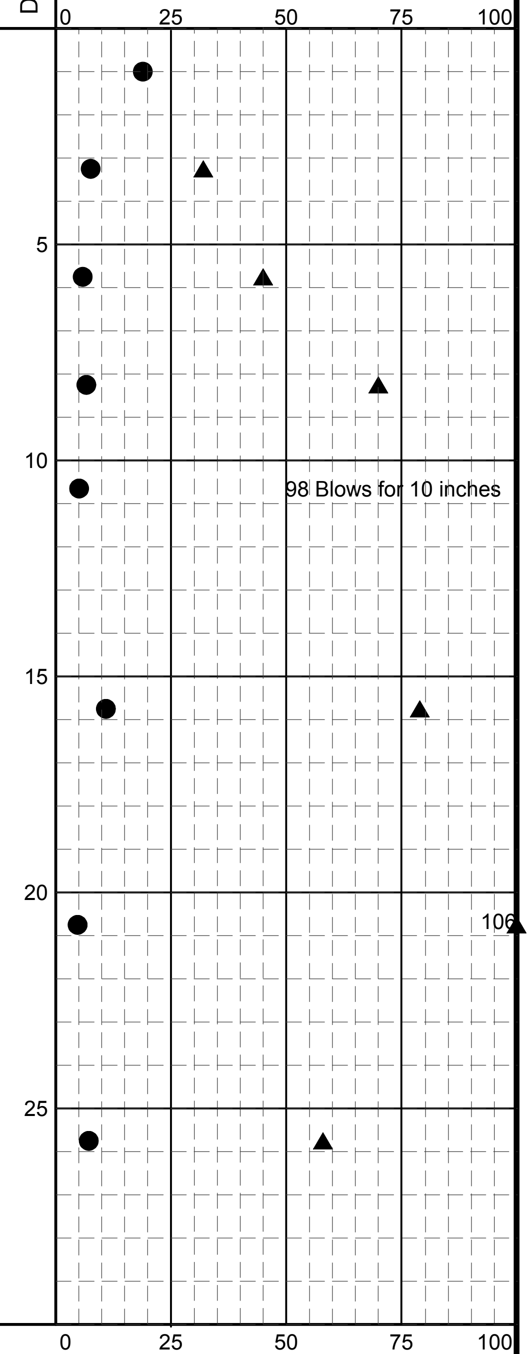
Penetration Resistance
(140 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen
- Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

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LOG OF BORING B-09

June 2010 — 32-1-02055-002

SHANNON & WILSON, INC.
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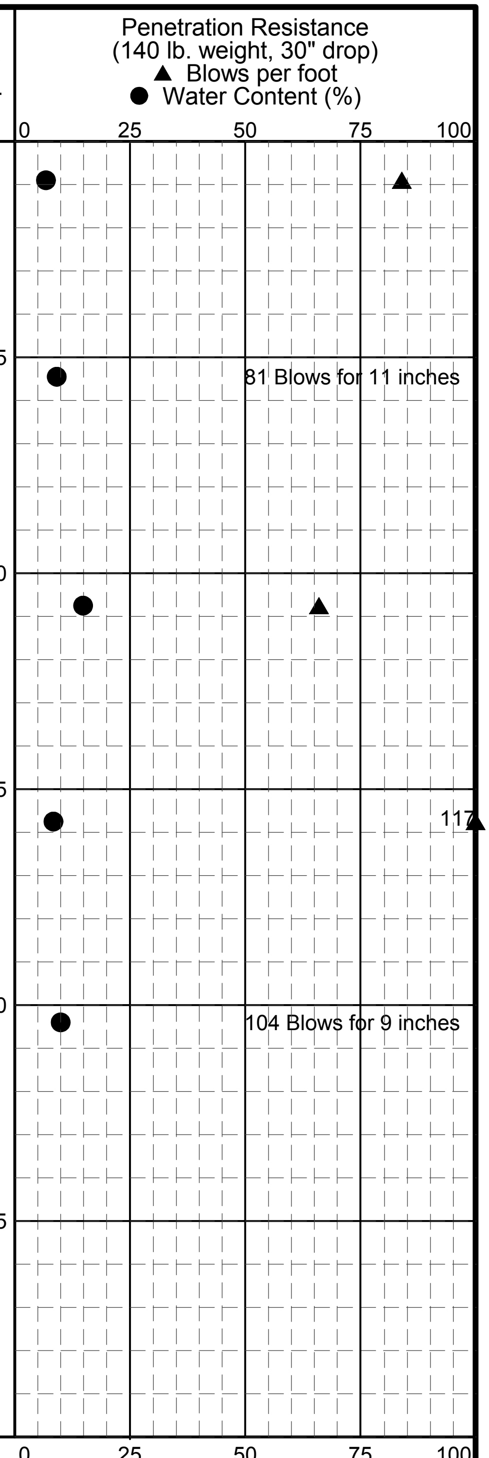
Fig. A-11
Sheet 1 of 2

MATERIAL DESCRIPTION Approx. Elevation: 946 Ft.	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Very dense, brown, slightly silty to silty, gravelly SAND and slightly silty, sandy GRAVEL; moist to wet			S9 S10 S11	3/3/10	35 40
Very dense, gray, slightly silty, gravelly SAND; wet	42.0		S12 S13		45 50
Bottom of Boring Boring Completed 3/2-3/10	50.8				55



LEGEND

* Sample Not Recovered
2" O.D. Split Spoon Sample
Bulk Sample
Frozen
Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit ⊢●⊣ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-09

June 2010 32-1-02055-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. A-11
Sheet 2 of 2

GEOTECHNICAL LOG 02055-002 GINT.GPJ S&W GEO1.GDT 6/21/10

MATERIAL DESCRIPTION

Approx. Elevation: 947 Ft.

Frozen to very stiff, brown, sandy SILT; moist

S1: 89% Fines (F4 (P200))

S2: 2% Gravel, 22% Sand, 76% Fines (F4 (0.02mm))

4.5 — Dense to very dense, brown, silty, gravelly SAND; moist

S5: 33% Gravel, 51% Sand, 16% Fines (F3 (P200))

13.0 — Hard, brown, slightly sandy to sandy SILT; moist

17.0 — Very dense, brown, slightly silty, sandy GRAVEL; moist

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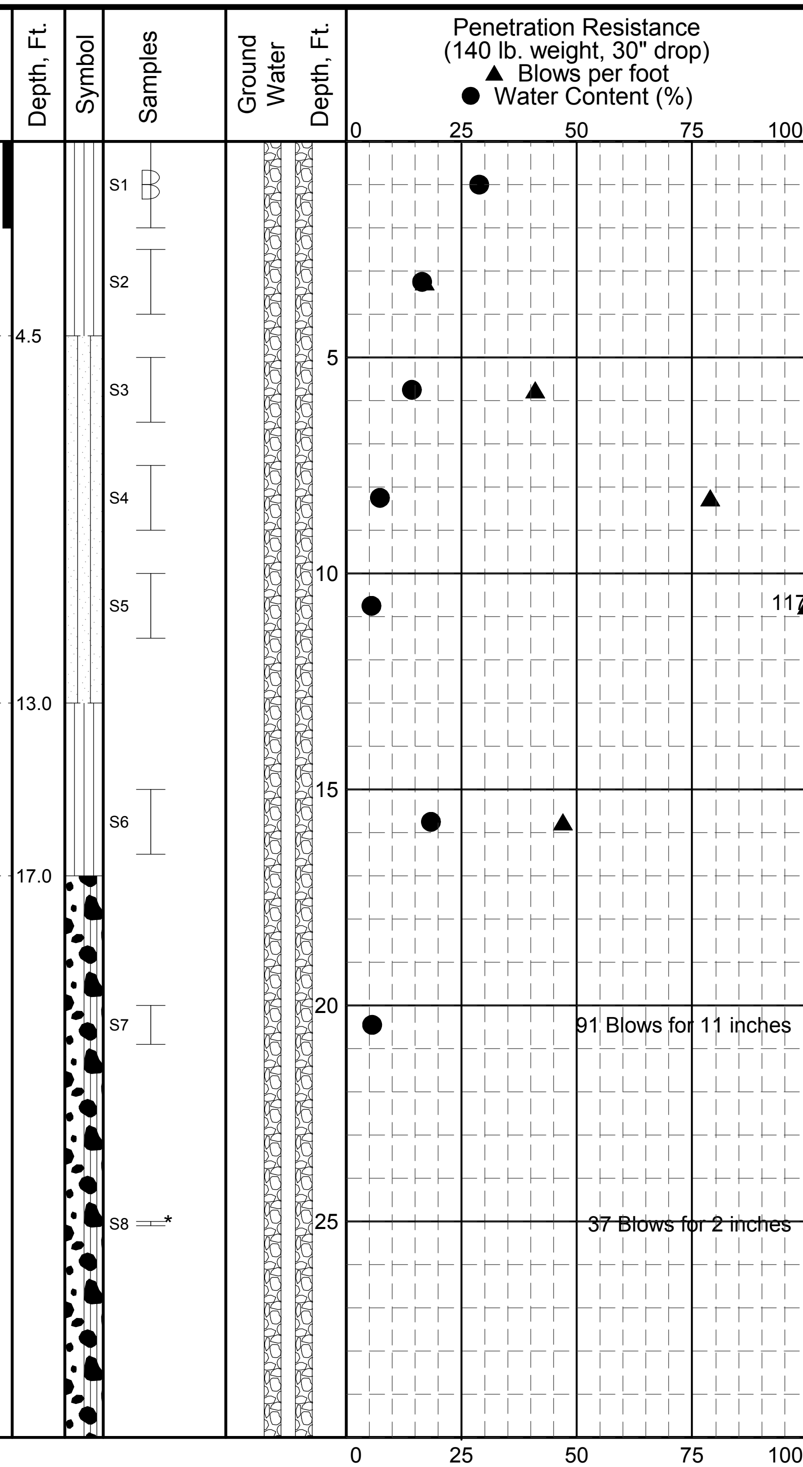

LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill
- Well Casing and Filter Sand
- Bentonite Seal
- ▽ Ground Water Level At Time Of Drilling
- ▼ Static Water Level

● Water Content (%)

Plastic Limit |—●—| Liquid Limit

Natural Water Content

NOTES

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Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-10

June 2010 — 32-1-02055-002

SHANNON & WILSON, INC.
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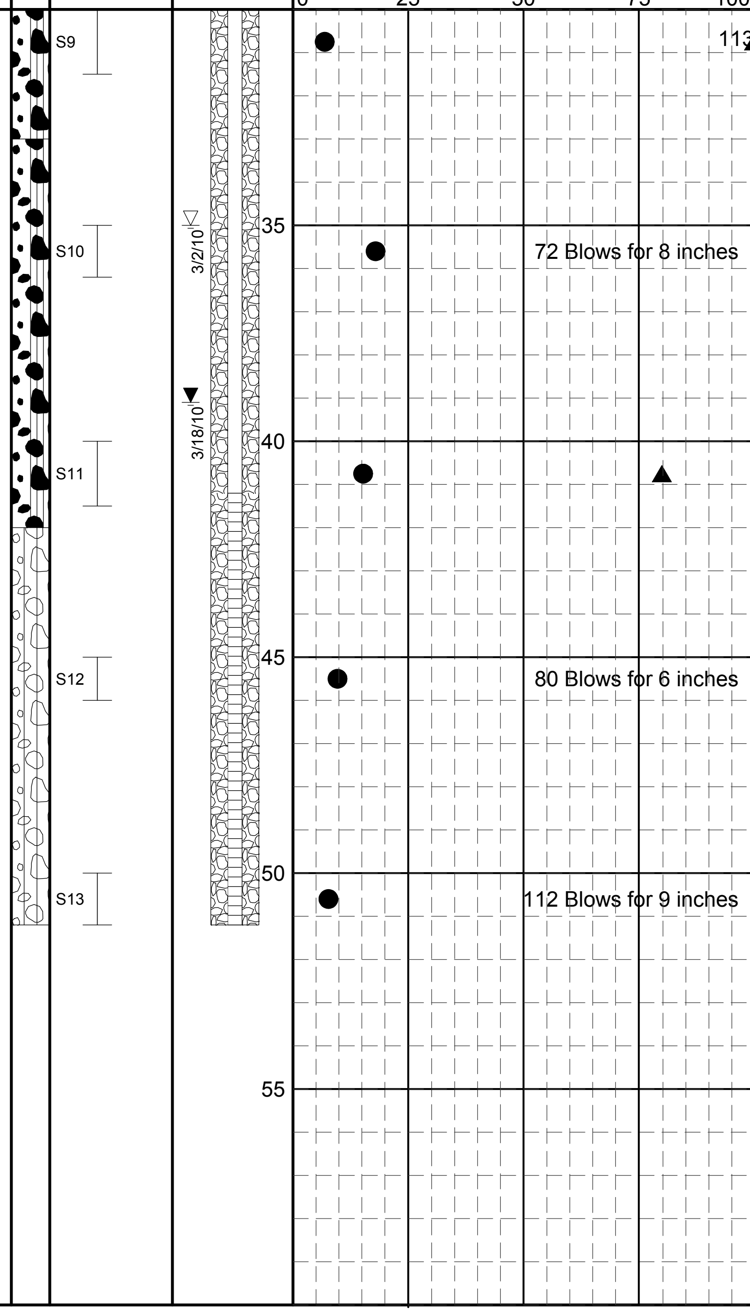
Fig. A-12
Sheet 1 of 2

MATERIAL DESCRIPTION Approx. Elevation: 947 Ft.	Depth, Ft.
Very dense, brown, slightly silty, sandy GRAVEL; moist	
Very dense, brown, slightly silty, sandy GRAVEL interbedded with very dense, brown, silty SAND; wet	33.0
Very dense, brown and gray, slightly silty to silty, sandy GRAVEL; wet	42.0
Bottom of Boring Boring Completed 3/2/10	51.2

Symbol | Samples | Ground Water | Depth, Ft. | Penetration Resistance (140 lb. weight, 30" drop) ▲ Blows per foot ● Water Content (%)



LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill
- Well Casing and Filter Sand
- Bentonite Seal
- Ground Water Level At Time Of Drilling
- Static Water Level

● Water Content (%)

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

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2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-10

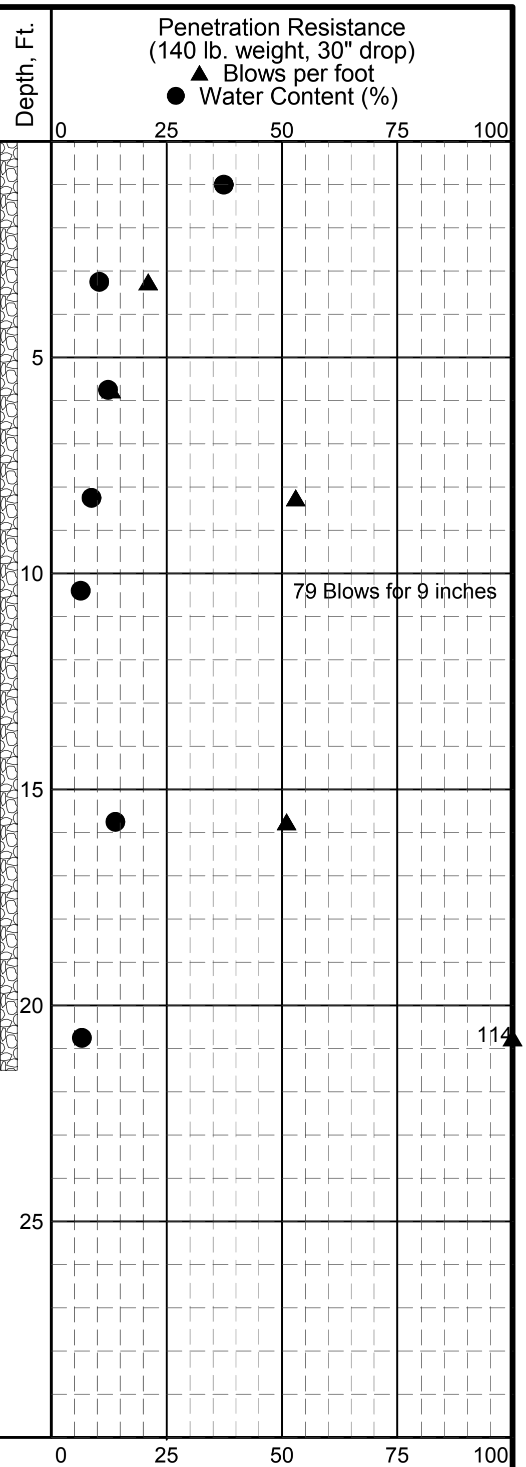
June 2010 32-1-02055-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Fig. A-12
Sheet 2 of 2

MATERIAL DESCRIPTION Approx. Elevation: 950 Ft.	Depth, Ft.	Samples
Frozen, brown, slightly sandy SILT with numerous organics; moist		S1
Medium dense, brown, silty, sandy GRAVEL; moist	3.0	S2
Medium dense to very dense, brown, gravelly, silty SAND; moist S3: 17% Gravel, 46% Sand, 37% Fines (F3 (0.02mm)) S4: 25% Gravel, 46% Sand, 29% Fines (F3 (P200)) 5 inch layer of laminated sandy SILT at approximately 15.5 feet bgs.	4.5	S3 S4 S5 S6 S7
Bottom of Boring Boring Completed 3/3/10	21.5	

Ground Water: Groundwater not encountered during drilling on 3/3/10



LEGEND

- * Sample Not Recovered
- 2" O.D. Split Spoon Sample
- Bulk Sample
- Frozen
- Blank Section, Cuttings Backfill
- Slotted Section, Cuttings Backfill
- Well Casing and Filter Sand
- Bentonite Seal

● Water Content (%)

Plastic Limit |—●—| Liquid Limit

Natural Water Content

NOTES

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Mountain Air Drive Extension
Anchorage, Alaska

LOG OF BORING B-11

June 2010 32-1-02055-002

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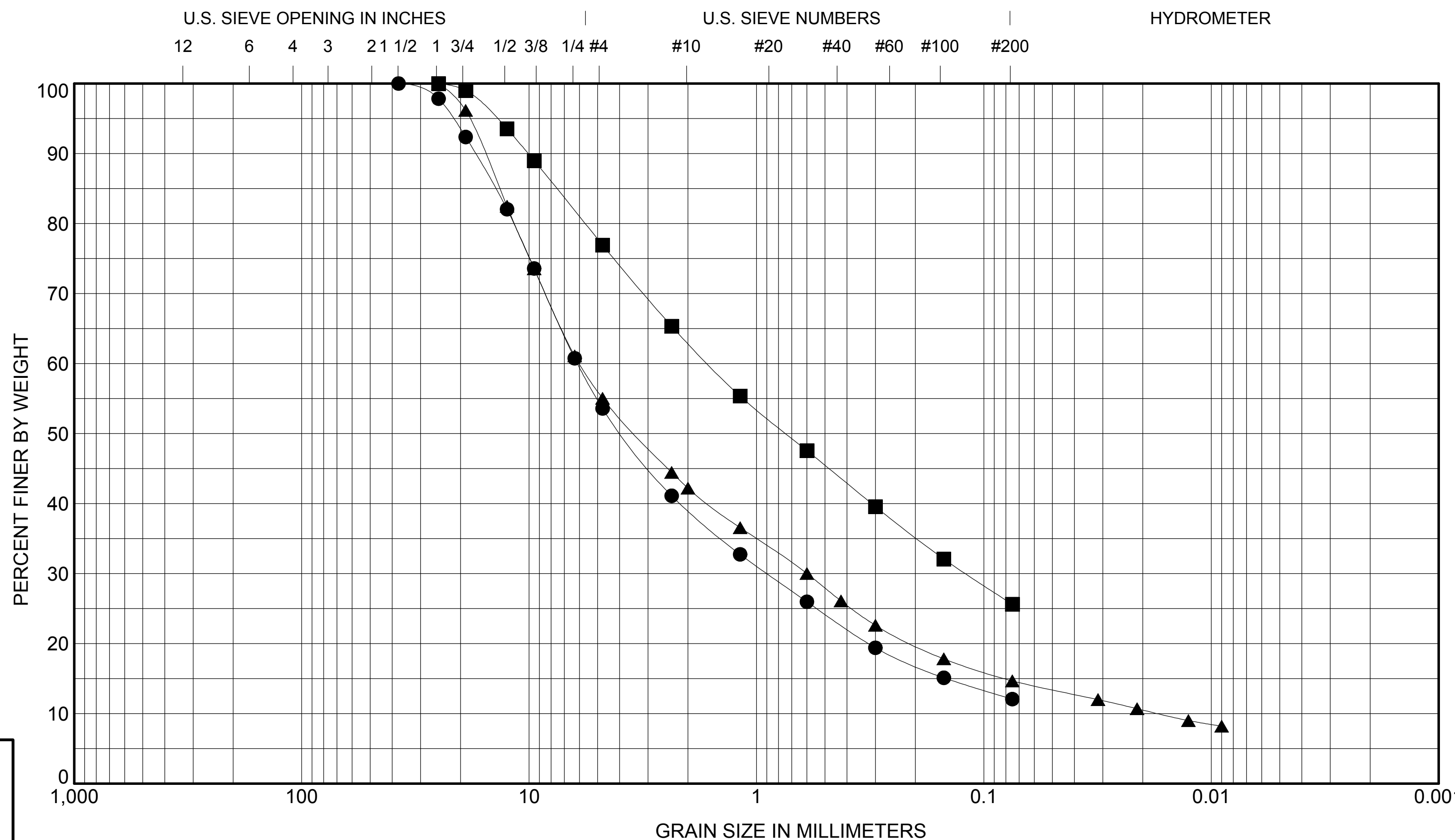
Geotechnical and Environmental Consultants

Fig. A-13



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-01 SBulk**	**0.0 - 5.0**	**Slightly silty, sandy GRAVEL (GW-GM)**				**2.8**	**130.6**
■	**B-01 S4**	**7.5 - 9.0**	**Gravelly, silty SAND (SM)**					
▲	**B-02 SBulk**	**0.0 - 5.0**	**Silty, sandy GRAVEL (GM)**				**3.5**	**349.9**

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-01 SBulk**	**0.0 - 5.0**	**37.5**	**6.12**	**0.9**		**46**	**42**	**12**	
■	**B-01 S4**	**7.5 - 9.0**	**25**	**1.63**	**0.12**		**23**	**51**	**26**	
▲	**B-02 SBulk**	**0.0 - 5.0**	**25**	**5.99**	**0.6**	**0.02**	**45**	**40**	**15**	

Mountain Air Drive Extension
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GRAIN SIZE CLASSIFICATION

June 2010

32-1-02055-002

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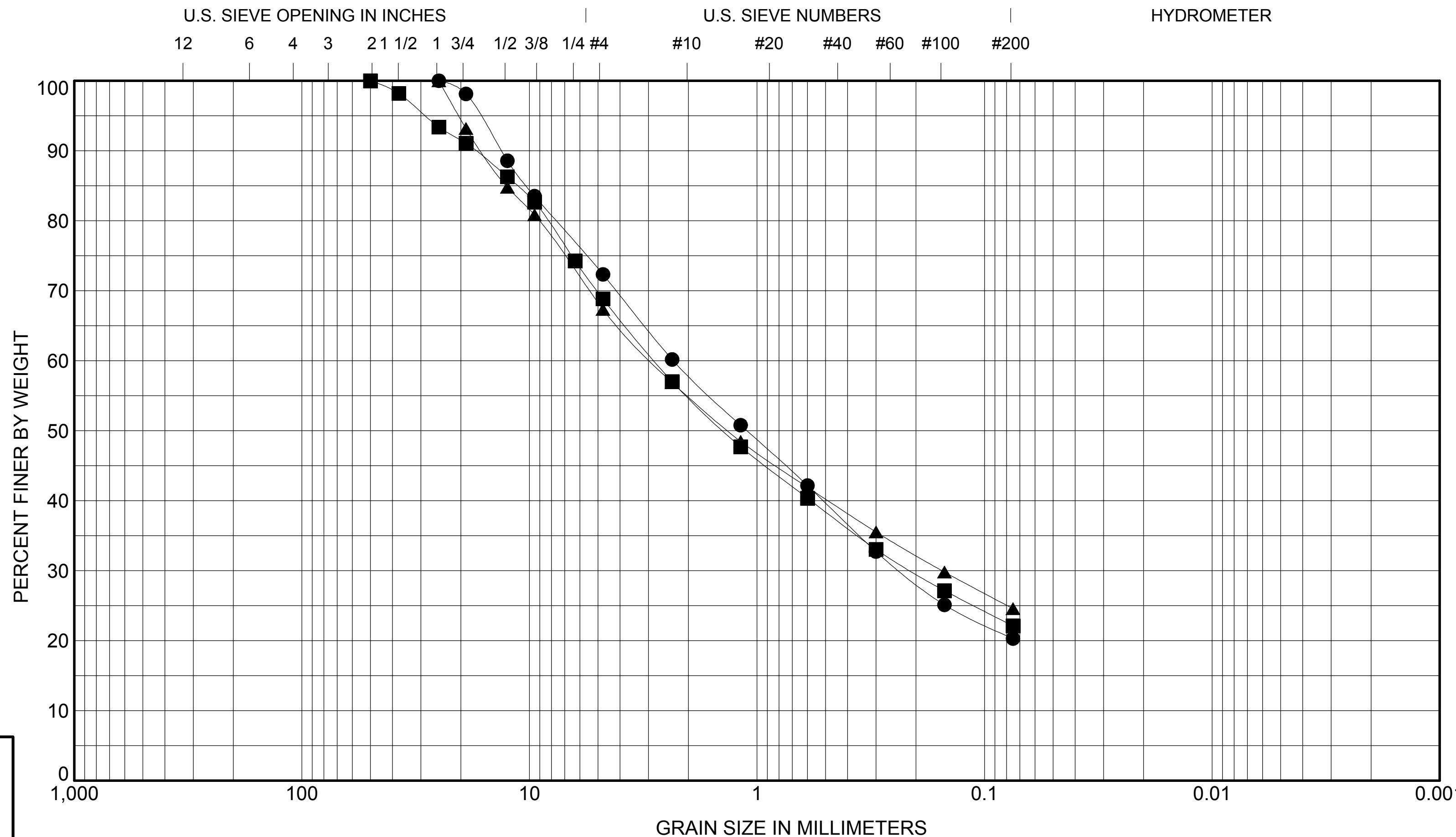
Fig. A-14
Sheet 1 of 6



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-02 S5**	**10.0 - 11.5**	**Silty, gravelly SAND (SM)**					
■	**B-03 SBulk**	**0.0 - 7.5**	**Silty, gravelly SAND (SM)**					
▲	**B-03 S4**	**7.5 - 9.0**	**Silty, gravelly SAND (SM)**					

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-02 S5**	**10.0 - 11.5**	**25**	**2.33**	**0.23**		**28**	**52**	**20**	
■	**B-03 SBulk**	**0.0 - 7.5**	**50**	**2.82**	**0.21**		**31**	**47**	**22**	
▲	**B-03 S4**	**7.5 - 9.0**	**25**	**2.91**	**0.15**		**33**	**43**	**25**	

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GRAIN SIZE CLASSIFICATION

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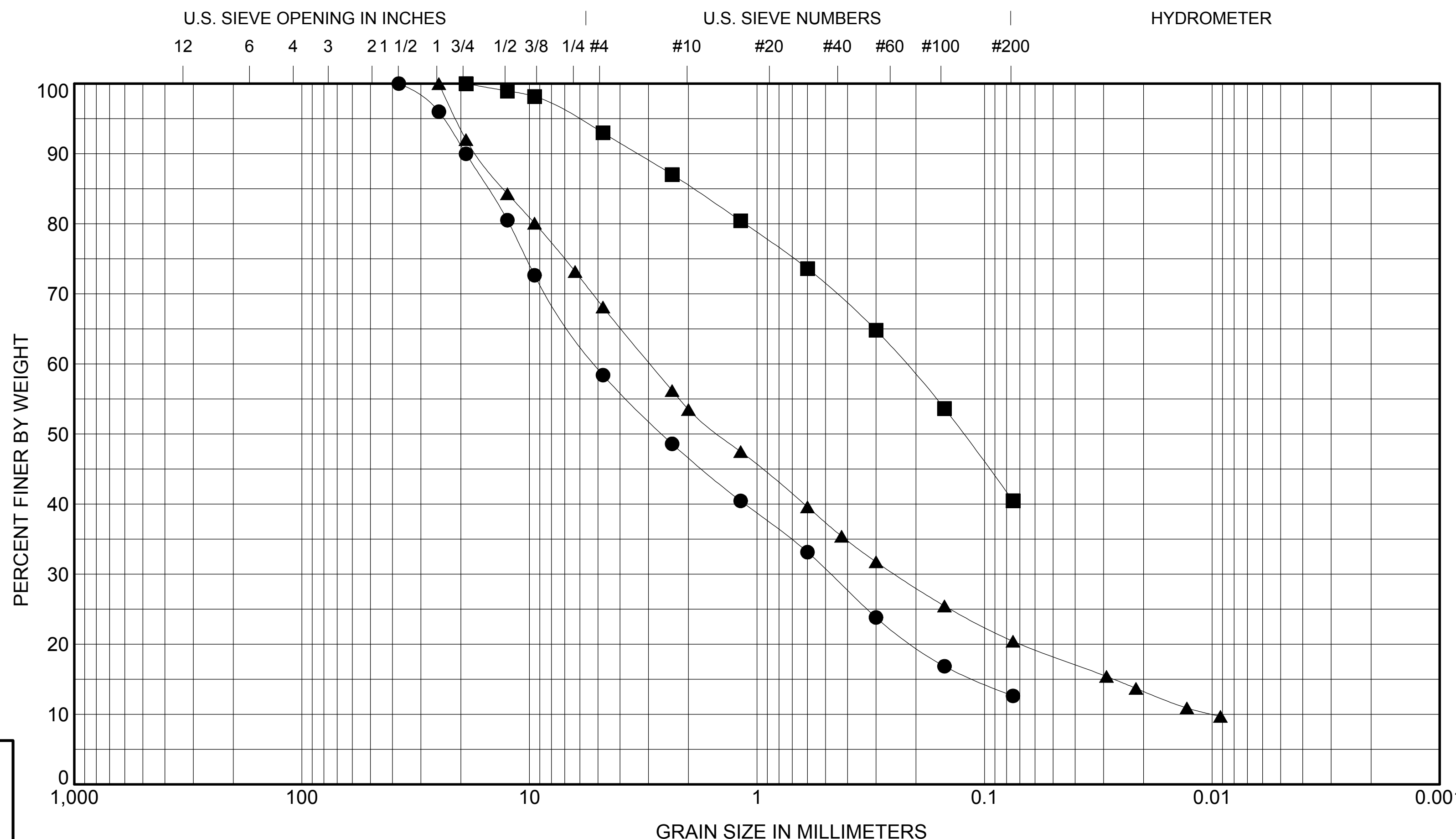
Geotechnical and Environmental Consultants

Fig. A-14
Sheet 2 of 6



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-04 S6**	**15.0 - 16.5**	**Silty, gravelly SAND (SM)**					
■	**B-05 S1**	**0.0 - 1.5**	**Slightly gravelly, silty SAND (SM)**					
▲	**B-05 S3**	**5.0 - 6.5**	**Silty, gravelly SAND (SM)**				**2.1**	**294.7**

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt / %Clay
●	**B-04 S6**	**15.0 - 16.5**	**37.5**	**5.13**	**0.48**		**42**	**46**	**13**
■	**B-05 S1**	**0.0 - 1.5**	**19**	**0.22**			**7**	**52**	**40**
▲	**B-05 S3**	**5.0 - 6.5**	**25**	**2.95**	**0.25**	**0.01**	**32**	**48**	**20**

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Fig. A-14
Sheet 3 of 6

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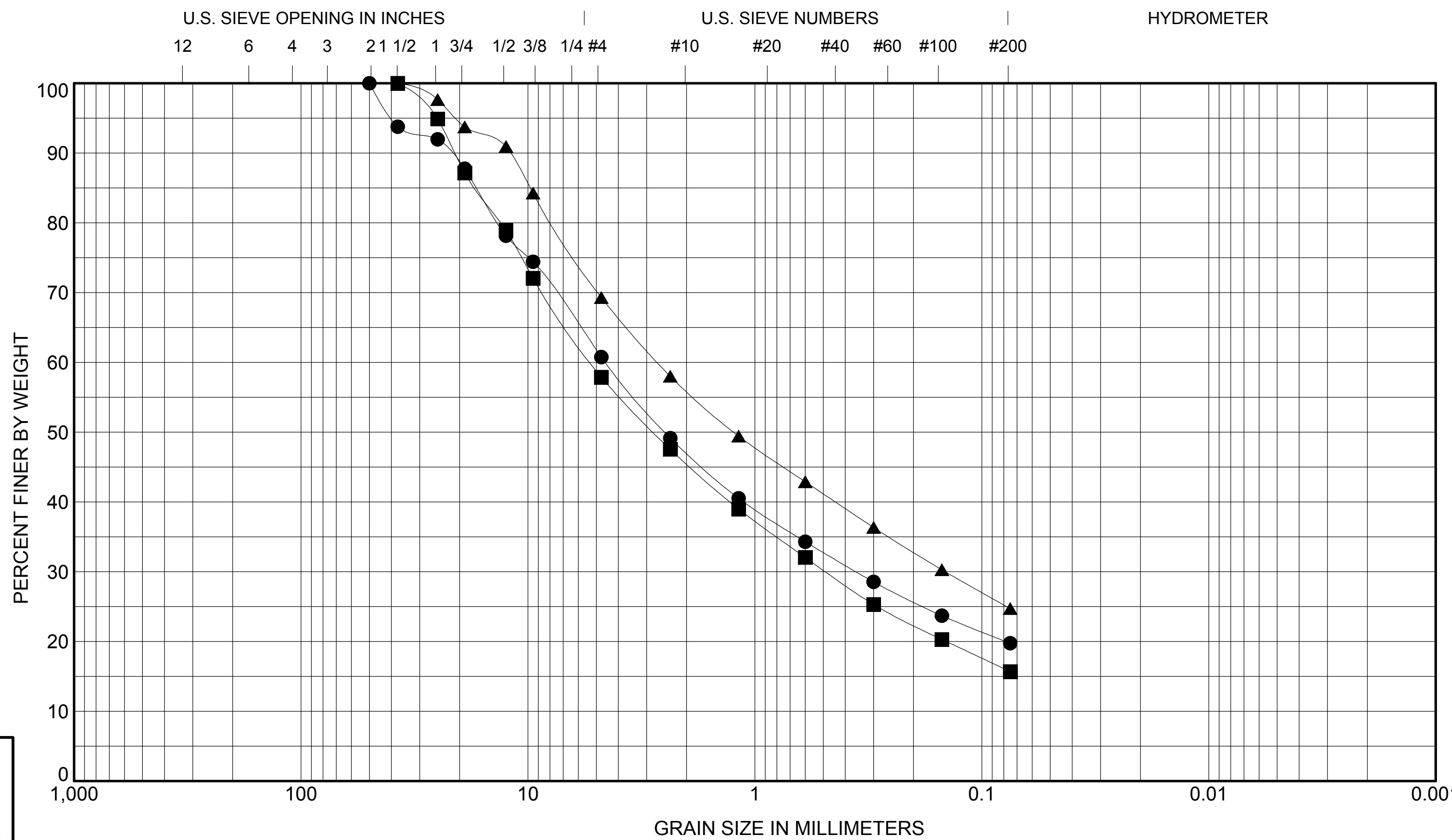
GRAIN SIZE CLASSIFICATION

June 2010 32-1-02055-002



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-07 S1**	**0.0 - 2.0**	**Silty, gravelly SAND (SM)**					
■	**B-07 S4**	**7.5 - 9.0**	**Silty, gravelly SAND (SM)**					
▲	**B-08 S1**	**0.0 - 2.0**	**SIlty, gravelly SAND (SM)**					

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-07 S1**	**0.0 - 2.0**	**50**	**4.54**	**0.36**		**39**	**41**	**20**	
■	**B-07 S4**	**7.5 - 9.0**	**37.5**	**5.27**	**0.49**		**42**	**42**	**16**	
▲	**B-08 S1**	**0.0 - 2.0**	**37.5**	**2.67**	**0.14**		**31**	**45**	**25**	

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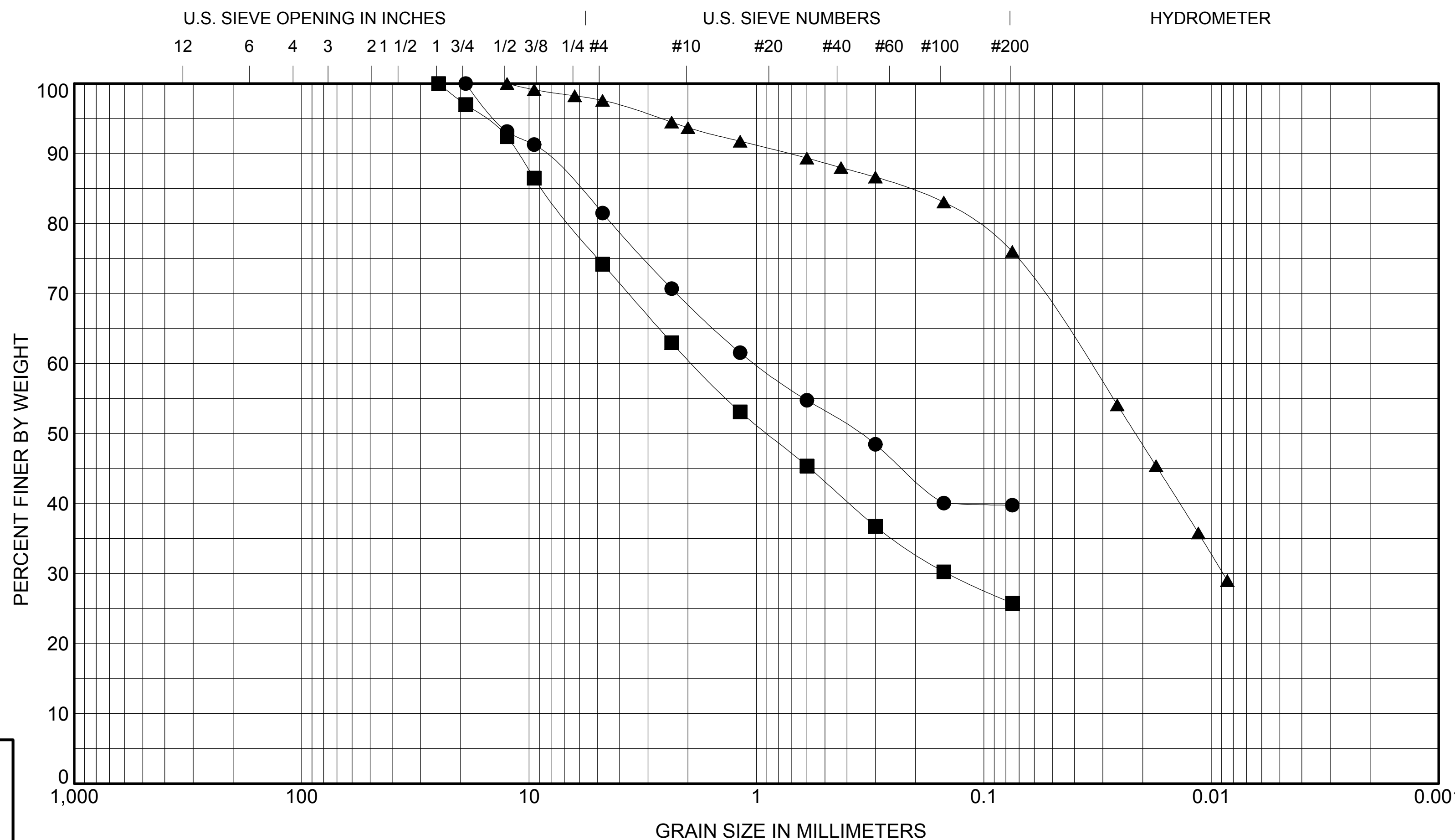
Fig. A-14
Sheet 4 of 6



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-09 S2**	**2.5 - 4.0**	**Gravelly, silty SAND (SM)**					
■	**B-09 S4**	**7.5 - 9.0**	**Silty, gravelly SAND (SM)**					
▲	**B-10 S2**	**2.5 - 4.0**	**Sandy SILT (ML)**					

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-09 S2**	**2.5 - 4.0**	**19**	**1.01**			**19**	**42**	**40**	
■	**B-09 S4**	**7.5 - 9.0**	**25**	**1.91**	**0.14**		**26**	**48**	**26**	
▲	**B-10 S2**	**2.5 - 4.0**	**12.5**	**0.03**	**0.01**		**2**	**22**	**76**	

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GRAIN SIZE CLASSIFICATION

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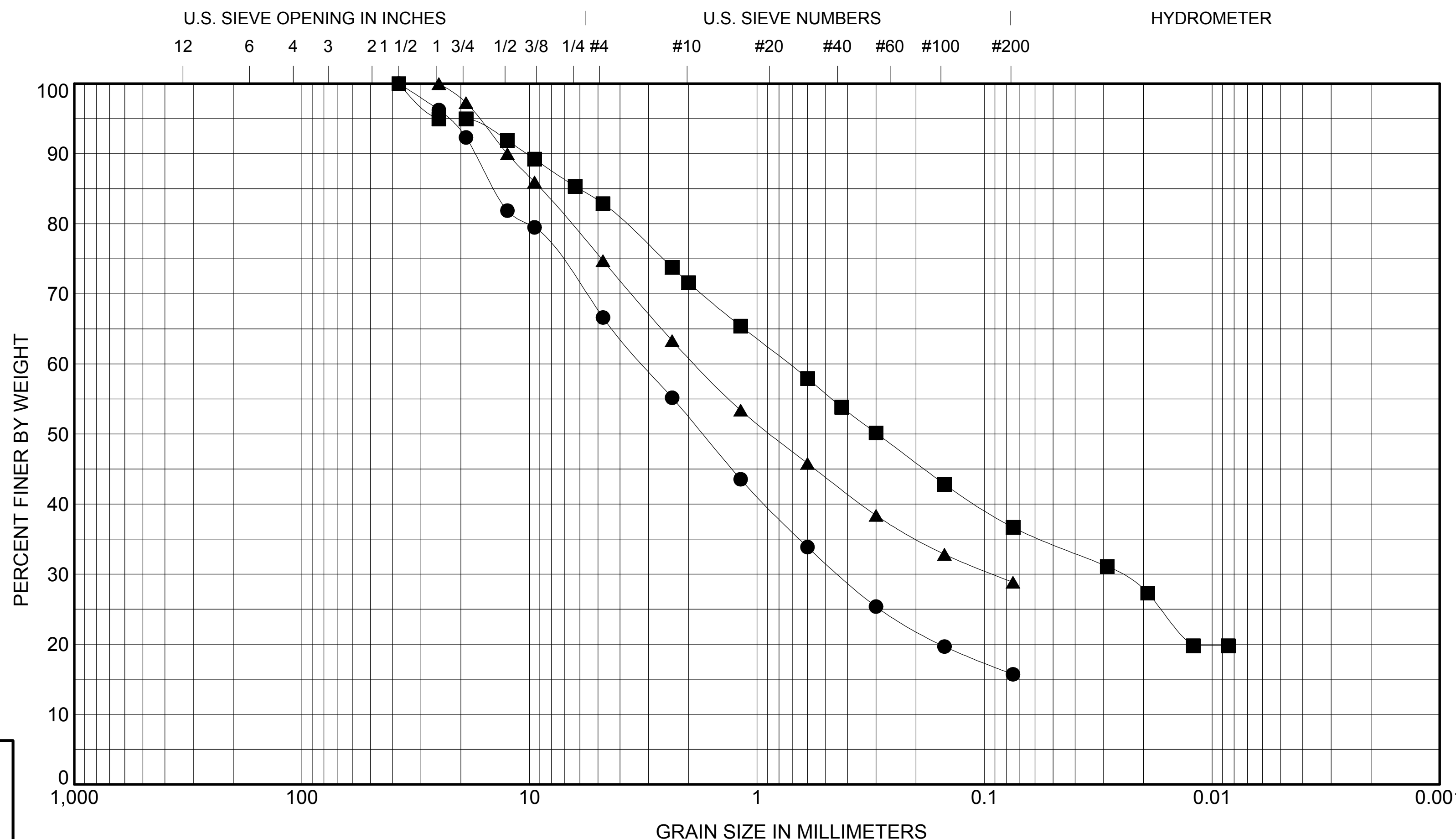
Fig. A-14
Sheet 5 of 6



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**B-10 S5**	**10.0 - 11.5**	**Silty, gravelly SAND (SM)**					
■	**B-11 S3**	**5.0 - 6.5**	**Gravelly, silty SAND (SM)**					
▲	**B-11 S4**	**7.5 - 9.0**	**Gravelly, silty SAND (SM)**					

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-10 S5**	**10.0 - 11.5**	**37.5**	**3.17**	**0.44**		**33**	**51**	**16**	
■	**B-11 S3**	**5.0 - 6.5**	**37.5**	**0.72**	**0.03**		**17**	**46**	**37**	
▲	**B-11 S4**	**7.5 - 9.0**	**25**	**1.87**	**0.09**		**25**	**46**	**29**	

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GRAIN SIZE CLASSIFICATION

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SHANNON & WILSON, INC.
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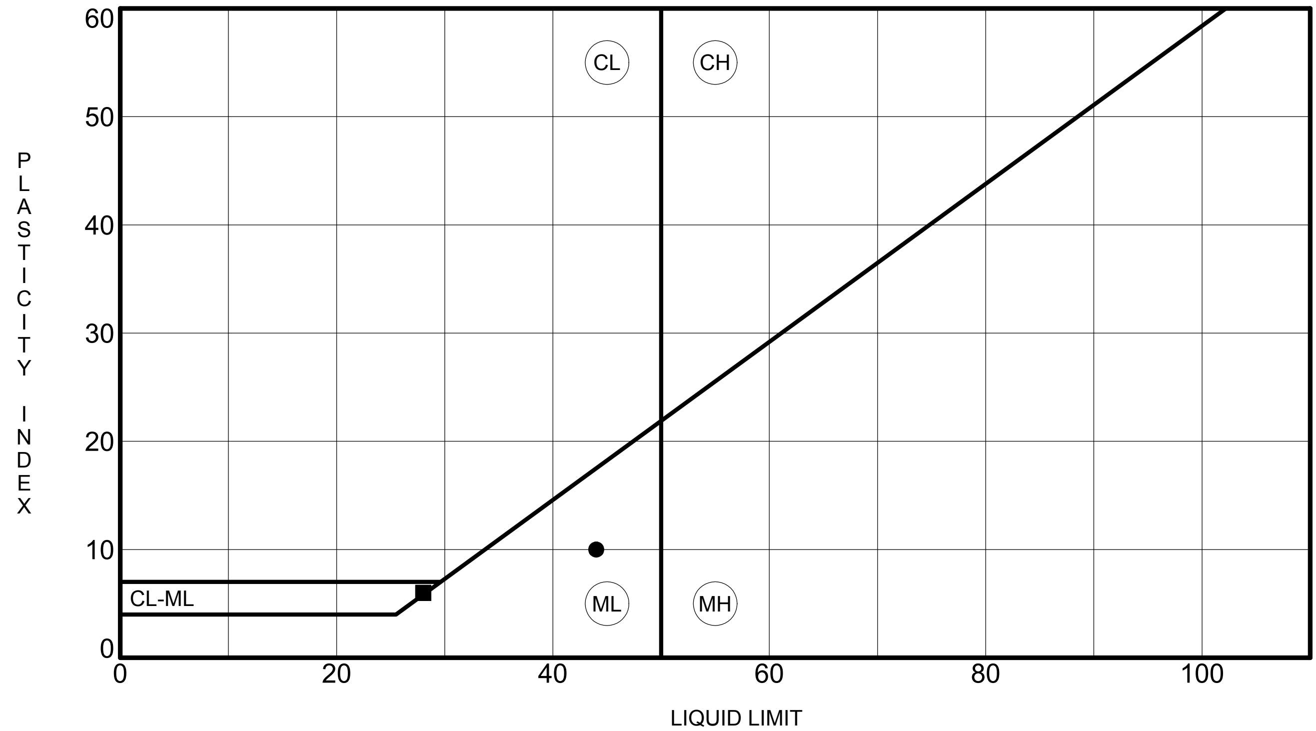
Fig. A-14
Sheet 6 of 6



	Boring	Depth, Ft	LL	PL	PI	Fines	Classification
●	**B-04**	**10.0 - 11.5**	**44**	**34**	**10**		**ML**
■	**B-06**	**5.0 - 6.5**	**28**	**22**	**6**		**CL-ML**

Mountain Air Drive Extension
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ATTERBERG LIMITS RESULTS

June 2010

32-1-02055-002

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Fig. A-15

APPENDIX B

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors, which were considered in the development of the report, have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland