Fir Island Farm Final Design and Permitting
Geotechnical and Hydrogeologic Data Report
Skagit County, Washington

May 30, 2014

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

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FIR ISLAND FARM FINAL DESIGN AND PERMITTING
GEOTECHNICAL AND HYDROGEOLOGIC DATA REPORT
SKAGIT COUNTY, WASHINGTON

1.0 INTRODUCTION

This geotechnical and hydrogeologic data report presents the results of our 2010, 2013, and 2014 field exploration programs, in situ testing, and laboratory testing for the proposed Fir Island Farm restoration project in Skagit County, Washington. The purpose of this study was to evaluate subsurface conditions at the site to support engineering efforts for the dike setback and interior drainage design.

We prepared a draft geotechnical and hydrogeologic data report on September 11, 2013. Golder Associates provided draft report comments on April 10, 2014. The comment resolution form and our responses are included in Appendix D.

Our services were conducted in accordance with the contract and scope of services stated in the Washington State Department of Fish and Wildlife (WDFW) Contract No. 10-1431, Amendment 7, dated May 1, 2013.

2.0 SITE AND PROJECT DESCRIPTION

The Fir Island Farm restoration project is located on the WDFW Snow Goose Reserve at Fir Island. The project site is located south of Fir Island Road, approximately 3.1 miles west of Conway, Washington (Figure 1). The WDFW Snow Goose Reserve is comprised of 245 acres that are currently farmed with special provisions to meet the reserve's snow goose management objectives. The reserve has four major interior drainage areas: Brown Slough – located west of the project site, Claude O. Davis and No Name Slough – located in the project site, and Dry Slough – located east of the project site.

Natural tidal exchange to the site has been eliminated by the historic construction of coastal dikes along Skagit Bay. Brown, No Name, and Dry Sloughs each have two, 48-inch-diameter tide gates through the existing coastal dikes that provide interior farm drainage and block the inflow of tidal water to the farms. Brown Slough also has a 48-inch-diameter tide gate for drainage west of the Fir Island Farm parking area.

The project will reclaim approximately 127 acres of tidal marsh land and restore the tidal process to the site. The project will include:

- Breaching the existing coastal dike along Skagit Bay.
- Using the breach material to fill existing channels adjacent to the coastal dike.
- Raising the existing coastal dike near Brown Slough.
- Constructing a new setback dike.
- Dredging and expanding historical tidal channels and excavating marsh pilot channels.
- Constructing a storage pond and pump station north of the new setback dike.
- Replacing two tide gates on No Name Slough and installing one tide gate and two slide gates on Dry Slough.

The approximate locations of these elements are shown in Figure 1, Site and Exploration Plan.

3.0 SCOPE OF SERVICES

As a part of the 60 percent design submittal, our scope of services included obtaining subsurface information along the proposed dike alignment, the proposed storage pond, the proposed drainage channels, and the existing coastal dike alignment, and presenting this information in a geotechnical and hydrogeologic data report. Specific tasks included:

- Subcontracting a driller to drill and sample nine borings and install observation wells in six of the borings.
- Observing drilling, sampling, and observation well installation for the borings.
- Performing hydrogeologic testing in the observation wells.
- Observing excavation of test pits.
- Performing drilling and sampling for hand auger borings.
- Reviewing field logs and soil samples.
- Performing laboratory testing on select soil samples.
- Interpreting geologic units, producing exploration logs, and developing generalized subsurface profiles.
- Subcontracting cone penetration tests (CPTs) and providing CPT logs.
- Preparing a draft report, responding to draft report comments, and preparing a final report.

4.0 BASELINE STUDY

Shannon & Wilson, Inc. performed a baseline study in 2011 for the proposed WDFW Fir Island Farm restoration project (Shannon & Wilson, 2011). As part of this effort, Shannon & Wilson, Inc.:

- Researched background information, including: geologic records, historical maps, aerial photographs, and as-built drawings.
- Interviewed Dike District 22 personnel regarding dike construction, repair, and embankment stability issues.
- Performed a field reconnaissance of the existing dike system to identify evidence of recent erosion, overtopping, seepage, settlement, slope instability, and general soil conditions that could affect setback dike design.
- Performed 12 subsurface explorations using geoprobes.
- Performed laboratory testing on select soil samples to characterize geotechnical and hydrogeologic properties, including strength, compressibility, and hydraulic conductivity.
- Performed geotechnical engineering analyses to develop concept-level dike design recommendations, including dike side slope stability, settlement, soil suitability, and seepage.

Geoprobe logs and laboratory testing results from the baseline study are presented in Appendices A and C, respectively. Information about the geoprobe explorations and the laboratory testing procedures are discussed in the following sections.

5.0 SUBSURFACE EXPLORATIONS

Under Amendment 7, Shannon & Wilson performed six hand borings, nine soil borings, eight CPTs, and 37 test pits to improve our understanding of the subsurface conditions in the project area. The subsurface explorations are designated by the type of exploration method, a number, and the year drilled (e.g., B-1-13). Explorations with observation wells are designated with a lower-case “w” (e.g., B-6w-13). Exploration locations, including the 2010 geoprobes, are shown in Figure 1. Locations of the observation wells were surveyed by WDFW. We located the hand borings, the borings without observation wells, the test pits, and the 2010 geoprobes using a hand-held Global Positioning System (GPS) unit.

Shannon & Wilson subcontracted with Boart Longyear, Inc. (Boart) of Fife, Washington, to perform mud rotary and hollow-stem auger (HSA) drilling. We subcontracted with In Situ

Engineering (In Situ) of Snohomish, Washington to perform CPTs. We subcontracted with Catapult Heavy Construction (Catapult) of Mount Vernon, Washington to excavate test pits. Equinox Research Consulting International (ERCI) of Concrete Washington was contracted to perform archaeological observation services during field exploration operations. ERCI provided a separate report in 2013 regarding field exploration archaeological observations.

5.1 Preparatory Tasks

Shannon & Wilson prepared a site health and safety plan (SHSP) for field activities. The purpose of the SHSP was to protect Shannon & Wilson field personnel from physical and chemical hazards associated with the work. Shannon & Wilson field personnel received a written copy of the SHSP and were required to read the plan and comply with its requirements.

Prior to exploration operations, Shannon & Wilson performed a site reconnaissance to mark proposed exploration locations and to record relevant field observations including access and visible utility conflicts. We used a handheld GPS unit to locate the exploration locations in the field. After marking the exploration locations, we notified the Call Before You Dig Utility Notification Center, and subcontracted with Applied Professional Services, a private utility locate service, to identify and locate utilities near the marked exploration locations.

5.2 Soil Borings

Boart used a CME 850 track-mounted drill rig to drill and sample nine borings between June 17 and 20, 2013. Boart used mud-rotary drilling techniques for the borings designated B-1-13 through B-3-13 along the proposed dike alignment. Mud-rotary borings extended about 41.5 to 81.5 feet below ground surface (bgs). Boart used HSA drilling techniques for paired borings designated B-4w-13 through B-9w-13 on the landside of the proposed dike. Each pair of HSA borings consisted of one boring drilled to 21.5 feet bgs and one boring drilled to 3.0 to 4.5 feet bgs. HSA borings were drilled primarily to install observation wells and to observe groundwater conditions. ECRI performed archeological monitoring during the soil boring explorations.

5.2.1 Drilling Procedures

Mud-rotary drilling involves a bentonite slurry drilling mud that is pumped out of a tank at the ground surface, down the drill rods, out through the tri-cone bit, up the annulus of the hole between the drill rods and borehole sidewalls, and back into the mud tank. The circulation of drilling mud removes the cuttings generated during the drilling process from the hole, and carries them to the surface where they are screened and removed from the recirculating mud. The

drilling mud also maintains the integrity of the borehole, thereby significantly reducing caving or collapsing during drilling and sampling. Samples are obtained by removing the drill rods, attaching the split-spoon or thin-walled sampler to the drill rods, and lowering the sampler to the borehole bottom.

HSA drilling consists of advancing continuous-flight augers to remove the soil from the borehole. During drilling, the auger center is filled with rods connected to a plug at the bottom. Once the desired depth is reached, the center plug and rods can be pulled out, leaving the augers in place. The hollow augers hold the borehole open, and samples are obtained by lowering a sampler through the hollow stem.

We observed 1 to 5 feet of heave between approximately 5 and 20 feet bgs during HSA drilling in borings B-4w-13 and B-6w-13, as noted on the boring logs presented in Appendix A. Heaving occurred when the drillers removed the drill rods with attached plug or the sampler from the hollow, central portion of the augers. With the plug and the sampler absent from the auger bottom, sand flowed (heaved) into hollow portion of the augers. To remove heaved sand from the auger, the driller extracted the auger from the hole while adding water, forcing the sand out the bottom of the auger. To help mitigate heave, the driller added water inside the auger to reduce the water pressure differential while removing the plug or sampler.

Waste cuttings removed from mud-rotary and HSA borings during the drilling process were collected in 55-gallon drums. Boart disposed of the cuttings offsite.

Borings B-1-13 through B-3-13 were backfilled with bentonite chips. Boart installed observation wells in borings B-4w-13 through B-9w-13 with stick-up monuments.

5.2.2 Split-spoon Sampling

We collected disturbed soil samples with a split-spoon sampler in conjunction with the Standard Penetration Test (SPT). SPTs were performed in accordance with ASTM International (ASTM) Designation: D 1586, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils (ASTM, 2012). The SPT consists of a 2-inch-outside diameter (O.D.), 1.375-inch-inside-diameter, split-spoon sampler driven 18 inches into the bottom of the borehole with a 140-pound hammer free falling 30 inches. The number of blows required to cause the last 12 inches of penetration is termed the Standard Penetration Resistance (N-value). The N-values are plotted on the boring logs presented in Appendix A. These values provide an empirical means for evaluating the relative density of granular soil and the relative consistency

(stiffness) of cohesive soil. The relative density or consistency as it related to the SPT N-value is shown in Figure A-1.

We generally performed SPTs every 2.5 feet to a depth of 20 feet and then every 5 feet thereafter. Where heave occurred in borings B-4w-13 and B-6w-13, the N-values may not be representative. We did not perform SPTs in borings B-5w-13 and B-9w-13.

A Shannon & Wilson field representative described each sample in the field. Split-spoon samples were sealed in plastic jars to preserve moisture, stored in boxes, and returned to our laboratory for further analyses and testing. Sample depth intervals are shown on the boring logs in Appendix A.

5.2.3 Thin-walled Tube Sampling

At select locations, we obtained relatively undisturbed samples using a 30-inch-long, 3-inch-O.D., thin-walled, steel tube sampler. We attempted one direct-push sample in boring B-1-13 at 17.5 feet. The direct-push sample was collected in accordance with ASTM Designation: D 1587, Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes (ASTM, 2012). We collected two piston (Osterberg) samples from borings B-1-13 and B-4w-13. Piston samples were collected in accordance with ASTM D 6519, Standard Practice for Sampling of Soil Using the Hydraulically Operated Stationary Piston Sampler (ASTM, 2012).

For the direct-push method, the steel thin-walled tube is connected to a sampling head that is attached to the drill rods. The tube is slowly pushed by the hydraulic rams of the drill rig into the soil below the bottom of the drill hole and then retracted to retrieve the sample. Because of poor sample recovery when using the direct push method in B-1-13, we changed to the piston sampling technique for subsequent thin-walled samples. In the piston method, the steel, thin-walled tube is placed inside of a sample barrel that is attached to the drill rods. Water is then pumped down the drill rods and into the sample barrel. An inner sampler head, seated on the top of the thin-walled tube, is forced downward by the water pressure inside of the sample barrel. As the inner sampler head moves downward, the thin-walled tube is pushed past the piston and into the soil below the bottom of the borehole. The tube and sampler are then extracted from the borehole.

After extraction from the drill holes, we sealed the ends of the tube samples using plastic lids and tape to preserve the moisture content. These samples were placed in an upright position and transported to our laboratory for further analyses and testing. We stored each tube in an

upright position and in a temperature- and humidity-controlled environment in the Shannon & Wilson, Inc. laboratory. During sample extraction, we pushed the sample out of the tube in the same direction it entered the tube onto a continuously supported tray. A Shannon & Wilson, Inc. geologist described and logged the soil, and then cut the sample into appropriate lengths for additional testing. Sample depth intervals are shown on the boring logs in Appendix A.

5.2.4 Grab Sampling

We collected grab samples from borings B-5w-13 and B-9w-13 using a split-spoon sampler pounded 12 inches at select depths in the boring. These two borings were drilled for long-term, shallow groundwater observation. We collected samples to classify the soil in the well screen zone. A Shannon & Wilson field representative classified each sample in the field, sealed the samples in plastic jars to preserve moisture, and returned them to our laboratory for further analyses and testing. Sample depth intervals are shown on the boring logs in Appendix A.

5.3 Cone Penetration Tests (CPTs)

Shannon & Wilson subcontracted with In Situ to perform CPT explorations using a track-mounted rig on June 19, 2013. The CPTs were completed in accordance with the procedures outlined in ASTM Designation: D5778, Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils (ASTM, 2012). The CPT develops a continuous subsurface profile at a particular location, but does not retrieve soil samples for laboratory testing. The piezocone apparatus used for the CPT explorations by In Situ is a Hogentogler system. During the test, steel rods with a cone tip on the end is pushed hydraulically into the soil at a relatively constant rate of approximately 2 centimeters (cm) per second (0.8 inch per second). Readings are recorded every 5 cm (2 inches). The CPTs, designated CPT-1-13 through CPT-8-13, advanced to about 50 feet bgs. Logs of the CPT probes are presented in Appendix A.

In Situ conducted 14 pore pressure dissipation tests at depths ranging from about 3 to 37 feet bgs. During cone penetration, excess pore pressure may develop. During a pause in the cone advancement, the dissipation of excess pore pressure with time is measured and recorded. Dissipation data can then be plotted onto a dissipation curve consisting of pore water pressure (u) verses time (t). The shapes of dissipation curves are useful in evaluating soil type, drainage, and groundwater level. The shape of the dissipation curve and the time of dissipation can be used to estimate the coefficient of consolidation and the horizontal permeability coefficient. Dissipation test curves are presented in Appendix A.

5.4 Test Pit Excavation

Catapult excavated 37 test pits using a track-mounted backhoe. Test pit depths ranged from about 3.5 to 10.5 feet. Shallow groundwater, caving soil, and flowing sand limited test pit depths. Catapult backfilled test pits in the farm fields using the excavation spoils in 1- to 2-foot lifts tamped with the back of the backhoe bucket. Test pits backfilled in the existing coastal dike were backfilled in 1-foot lifts tamped with the back of the backhoe bucket. Tamping the backfill soil in the existing dike resulted in 6- to 12-inch-deep depressions because the material was compacted to a higher density than the existing conditions. Catapult filled the depressions with imported material tamped in 6- to 12-inch lifts with the back of the backhoe bucket. The backfill efforts were coordinated with Consolidated Dike and Drainage District No. 22 (CDD-22).

Shannon & Wilson retrieved disturbed soil samples from the test pits. Small samples intended for classification and index testing were collected in jars. About 5- to 60-pound samples intended for classification, index testing, and compaction (proctor) testing were collected in bags. Sample intervals are shown on the test pit logs presented in Appendix A. ECRI performed archeological monitoring during test pit explorations.

5.5 Geoprobes

Twelve geoprobes, designated GP-01-10 through GP-12-10, were advanced between October 5 and 7, 2010. Geoprobe GP-01-10 was advanced to about 40 feet bgs. Geoprobes GP-02-10 through GP-12-10 were advanced to about 30 feet bgs. A Shannon & Wilson, Inc. representative observed the geoprobe explorations, collected representative soil samples for laboratory testing, and prepared field logs. Logs of the geoprobes are presented in Appendix A.

A geoprobe is a direct-push coring rig with a 2-inch-O.D. casing that is advanced using a percussive force to core soil in its path. The geoprobe is advanced followed by driving a 5-foot-long, 2-inch-O.D., plastic-lined sampler tube to retrieve a soil sample.

After geoprobe tubes were retrieved from the tool string, they were cut open lengthwise on site for sampling and classification. Geotechnical grab samples were taken from the plastic tubes at selected depth locations, as noted in the geoprobe logs in Appendix A. Geotechnical samples were stored in plastic jars and transported to the Shannon & Wilson, Inc. laboratory for testing. ECRI performed archeological monitoring during the geoprobe explorations.

5.6 Hand Borings

Shannon & Wilson, Inc. representatives drilled six hand borings, designated HB-1-14 through HB-6-14, on April 17, 2014. The borings are located at the proposed storage pond. The hand borings were augered to depths of about 3 to 5 feet bgs.

Grab samples were collected using a bucket auger while advancing the hand borings. A Shannon & Wilson field representative classified each sample in the field, sealed the samples in plastic jars to preserve moisture, and returned them to our laboratory for further analyses and testing. Sample depth intervals are shown on the boring logs in Appendix A.

5.7 Observation Well Construction

5.7.1 Soil Borings

Boart installed groundwater observation wells in borings B-4w-13 through B-9w-13. Three pairs of shallow and deeper observation wells were constructed. Each of the observation wells consist of a 2-inch-diameter, polyvinyl chloride (PVC) well casing with a portion that is slotted to allow groundwater inflow. Slots are 0.01 inch wide (#10 slot). Slotted sections are about 10 feet long in borings B-4w-13, B-6w-13, and B-8w-13. Slotted sections are 1.3 feet long in B-5w-13, 2.3 feet long in B-7w-13, and 0.8 foot long in B-9w-13. A sand pack (size 10–20) was placed around the slotted portion of the pipe to act as a filter against the adjacent soil. The depth of the slotted section for each well was selected based on soil units encountered in the boring and anticipated groundwater levels. An end cap (sump) is attached to the bottom of the slotted section. A steel monument was placed above ground to protect the top of the pipe. Catapult placed ecology blocks around the monuments to protect the wells from farming activities.

5.7.2 Geoprobes

Observation wells were installed in geoprobes GP-01-10, GP-02-10, and GP-03-10 in 2010 to evaluate groundwater depth and salinity. Following geoprobe sampling, a 3.5-inch-O.D. steel casing fitted with a conical tip was driven to the proposed well depth. The conical tip was then detached from the casing and left in the hole. The well screen and riser pipe were installed through the casing. The casing was then removed gradually as the annular space between the boring and well screen was filled with sand, bentonite, and concrete.

The observation wells were constructed of new, commercially fabricated, threaded, flush-jointed, 2-inch-diameter Schedule 40 PVC. Well screen consisted of 0.01-inch-wide machine

slotted screen. A silica sand filter pack was poured in the annular space between the geoprobe hole and well screen to a depth about 2 feet above the screen. A bentonite seal was placed in the annulus above the filter pack to within 2 feet of the ground surface. The wells were completed flush with the elevation of the surrounding grade by placing an 8-inch-diameter flush-mount steel monument over the top of the borehole. The steel monuments were set in place with quick-set concrete. These observation wells were destroyed in 2012. The local property owner and farmer removed the wells without consulting WDFW.

5.8 Environmental Screening

We understand that lead shot may be present from hunting activities at the site. During explorations, our field representatives looked for lead shot in each of the soil samples collected. In addition, we made visual and olfactory observations of samples collected to look for evidence of other types of soil contamination. We did not observe lead shot or other evidence of contamination during drilling, augering, or test pit excavations.

6.0 HYDROGEOLOGIC STUDIES

Following the completion of drilling and observation well installation, we developed, tested, and monitored observation wells to provide hydrogeologic data for the project. Groundwater monitoring data are presented in our Interior Drainage Engineering Report dated April 30, 2014. The data loggers remain active on site.

6.1 Observation Well Development

Shannon & Wilson, Inc. developed the observation wells on June 21, 2013. Well development increases the hydraulic connection between the well and the aquifer by reducing skin effects from drilling and removing fines from the filter pack and formation adjacent to the well screen. To develop each well, a Shannon & Wilson, Inc. representative surged and pumped groundwater in the well with a check valve-type inertial pump (Waterra). The Waterra pump is connected to clean, high density polyethylene tubing with a plastic check valve. A surge block is attached to the check valve to facilitate the movement of water back and forth through the well screen during the development process. We purged approximately 35 gallons at deeper well locations (B-4w-13, B-6w-13, and B-8w-13). At the time of development, the shallow wells (B-5w-13, B-7w-13, and B-9w-13) did not have enough groundwater present to develop them. Therefore, approximately 5 gallons of tap water was added to each of the shallow wells to flush the fines out of the filter pack. The added water was then surged and pumped by the same method as the groundwater well development at the deep wells. Between 5 and 10 gallons were removed from

each of the shallow wells. Development continued until our field representative did not observe sediment in the discharge water.

6.2 In Situ Hydraulic Conductivity Testing

Shannon & Wilson, Inc. performed slug tests at observations wells B-4w-13, B-6w-13, and B-8w-13. Observation wells B-5w-13, B-7w-13, and B-9w-13 did not have enough water in them to perform a slug test. Slug testing is a method for estimating the in situ hydraulic conductivity of the saturated material surrounding the screened zone of an observation well. Slug tests have a small radius of influence. As such, they do not provide data regarding large-scale aquifer properties, aquifer geometry, or boundary conditions affecting groundwater flow. Pumping tests are necessary to provide data related to large-scale aquifer properties.

Slug testing involves rapidly raising or lowering the water level in a well and measuring the subsequent change in water level as it recovers to the original static position. Raising the water level in a well is achieved by quickly lowering a slug (in this case a sealed 1.25-inch-diameter polyvinyl chloride pipe filled with silica sand) into the well to displace water within the well casing. The subsequent falling of the water level to the original static position is referred to as a falling head slug test. Removing the slug and monitoring the rising water level constitutes a rising head slug test. A pressure transducer and data logger records the water level in the well during the slug tests.

6.3 Slug Test Analyses

The slug test analysis consists of plotting the water level versus time, fitting a line to the data, and using an analytical solution to calculate the hydraulic conductivity based on the fit line. Several analytical solutions are available for calculating the hydraulic conductivity from a slug test. The analytical solution used to calculate the hydraulic conductivity depends on the aquifer parameters. We interpret that the aquifer we tested is confined, due to the presence of alluvial silt and clayey silt overlying silty sand. We interpret the aquifer has an under-damped response, based on our observations during drilling and results of the slug tests. An under-damped response is when the water level recovery during a slug test oscillates above and below the initial static water level with decreasing amplitude with time. We used two different solutions to analyze the slug tests. The two solutions provide a range of hydraulic conductivity values and account for variability of the aquifer parameters. The solutions include the Bouwer and Rice (1989) method, which is used for analyzing slug tests in confined aquifers, and the Butler (1998) method, which is used for analyzing slug tests in a confined aquifer with an under-damped

response. We used the computer program AQTESOLV to plot the slug test results, match the fit line to the results, and calculate the hydraulic conductivity using different solutions. A summary of the hydraulic conductivity calculated from the slug tests and the data plots with fit lines is provided in Appendix B.

6.4 Groundwater Monitoring

At each observation well a Solinst – Level Logger data logger/pressure transducer system was placed at the bottom of the well screen and programmed to record the groundwater level every 15 minutes. The groundwater data is presented in our Interior Drainage Engineering Report dated April 30, 2014.

7.0 GEOTECHNICAL LABORATORY TESTING

We performed geotechnical laboratory testing on select soil samples retrieved from the hand borings, soil borings, test pits, and geoprobes. The laboratory testing program included tests to classify the soil and to provide data for engineering studies. We visually described each of the retrieved soil samples. Index testing, including water content determinations, grain size distributions, organic content, and Atterberg Limits, were performed on select soil samples. Consolidated-undrained triaxial compression tests and one-dimensional consolidation soil strength tests were performed on relatively undisturbed soil samples. Compaction (moisture-density) curves were performed on grab samples from the test pits.

The following sections describe the laboratory test procedures. Laboratory test results are presented in Appendix C.

7.1 Visual Classification

We visually described soil samples retrieved from the hand borings, soil borings, test pits, and geoprobes using a system based on ASTM 2487, Standard Practice for Classification of Soils for Engineering Purposes, and ASTM D 2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 2012). These ASTM standards use the Unified Soil Classification System (USCS) and are described in Figure A-1. We checked our visual descriptions using index testing to classify select soil samples as discussed in the next sections.

7.2 Water Content

We measured the water content of select soil samples in accordance with ASTM D 2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and

Rock by Mass (ASTM, 2012). Comparison of the water content of a soil with its index properties can be useful in characterizing soil unit weight, consistency, compressibility, and strength. The water content is shown graphically on the exploration logs presented in Appendix A and in tabular format in Appendix C.

7.3 Organic Content

The organic content of select soil samples was measured in accordance with ASTM D 2974, Standard Test Methods for Moisture, Ash and Organic Matter of Peat and Other Organic Soils (ASTM, 2012). The moisture content of the samples was measured by drying the soil in an oven at 105 degrees Celsius (°C). The organic content of the sample was obtained by igniting the oven-dried soil in a muffle furnace at 440 °C. Organic contents are presented in Table C-1 of Appendix C.

7.4 Atterberg Limits Tests

We performed Atterberg Limits tests on select fine-grained soil samples. The tests were performed in accordance with ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM, 2012). The Atterberg Limits include Liquid Limit (LL), Plastic Limit (PL), and Plasticity Index (PI = LL - PL). They are used to assist in classifying soil, to indicate soil consistency (when compared with natural water content), and to provide correlation with soil properties including compressibility and strength. The Atterberg Limits are shown graphically on the boring logs presented in Appendix A and are plotted on the plasticity charts presented in Appendix C. The plasticity charts provide USCS group symbols, sample descriptions, and water contents.

7.5 Grain Size Distribution Analyses

We measured the grain size distribution of select soil samples in accordance with ASTM D 422, Standard Test Method for Particle-Size Analysis of Soils, and ASTM D 1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (0.075 millimeter) Sieve (ASTM, 2012). Grain size distributions included sieve and sieve plus hydrometer tests. Grain size distribution is used to assist in classifying soils and to provide correlation with soil properties, including permeability, shear strength, liquefaction potential, capillary action, and sensitivity to moisture. Percent fines results are shown graphically on the boring logs presented in Appendix A. Grain size distributions are plotted as gradation curves presented in Appendix C. The gradation plots provide the USCS group symbols, sample descriptions, and water contents.

We were unable to segregate organics from soil particles; therefore, organics present in the samples are included in the grain size distributions.

7.6 Consolidation Tests

We performed one-dimensional consolidation tests on two relatively undisturbed samples in accordance with ASTM D 2435, Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading (ASTM, 2012). The samples were incrementally loaded in a fixed-ring consolidometer. During each load increment, the change in sample height with time was recorded. Each load increment was approximately double the previous load to a predetermined maximum consolidation pressure. Drainage was allowed from the top and bottom of the sample. The samples were inundated with distilled water after the seating load increment. Load increments were generally applied at the beginning of each day. An unload-reload cycle was performed after incrementally loading past preconsolidation stress. During the unload-reload cycle, the sample was unloaded in steps of about one-fourth the previous load. Individual test results are presented in Appendix C. They include summary plots of percent settlement and void ratio versus the logarithmic of consolidation stress. Specimen data are included on the data sheets.

7.7 Consolidated-undrained (CU) Triaxial Compression Tests

CU triaxial compression tests with pore pressure measurements were performed on select, relatively undisturbed tube samples in accordance with ASTM D4767, Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils (ASTM, 2012). Prior to consolidation and shearing, each sample was saturated using back pressure. The degree of saturation was evaluated by measuring the pore pressure coefficient B. Sample side drains consisting of thin strips of filter paper were used to facilitate consolidation. A displacement-controlled compression machine was used for shearing. Axial load, deformation, and pore pressure data were collected continuously at five-second intervals using an automatic data acquisition system.

Appendix C includes individual test data sheets and plots of pore pressure versus axial strain, principal effective stress ratio versus axial strain, Mohr diagrams for the failure conditions, and stress path plots. On these exhibits, p refers to mean stress, p' refers to effective mean stress, and q refers to deviatoric stress.

7.8 Moisture-density (Compaction) Tests

We performed moisture-density tests on five samples collected in large bag samples from test pits. We performed tests in accordance with ASTM D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/ft^3 [2,700 kN-m/m^3]) (ASTM, 2012a). Compaction curves are presented in Appendix C.

8.0 GEOLOGY

8.1 Geologic Setting

The Skagit River delta is located in the northern portion of the Puget Lowland, which is an elongated, north-south depression situated between the Olympic Mountains and the Cascade Range. The Puget Lowland was subjected to six or more major glacial advances over the past several million years. The most recent of these advances, termed "Vashon," covered the region between about 18,000 and 13,500 years ago. Extensive erosion and sedimentation during the Vashon glaciation produced many of the deposits and landforms that make up the surface of the Puget Lowland.

Among the more prominent glacially derived landforms in the Puget Lowland are north-south-trending troughs, like those now occupied by Puget Sound. These troughs were scoured by meltwater streams that flowed beneath Vashon ice (Booth, 1994). Skagit River deltaic deposits likely occupy a trough eroded by subglacial meltwater streams (Dragovich and others, 2002).

The trough existed as a marine embayment following retreat of the Vashon ice sheet north of the Strait of Juan de Fuca. Relatively rapid deltaic sedimentation of the Skagit River subsequently filled the marine embayment. Within the past 5,000 years, the Skagit River delta front is thought to have prograded about 5 miles from Mount Vernon to its current position (Dragovich and others, 2002). High depositional rates may be attributed, in part, to sediment input from volcanic debris flows (*lahars*) originating from Glacier Peak volcano (Dragovich and others, 2000; 2002).

Surficial geologic maps show that the Skagit Valley deltaic deposits consist of Holocene marsh, estuarine, tidal flat, alluvial, and lahar-derived deposits (Wunder, 1976; Pessl and others, 1989; Dragovich and others, 2002). In the subsurface, these deposits form complex sequences that interfinger with one another, and which have soil characteristics that vary laterally and vertically. Marsh, estuarine, and tidal flat deposits in the Skagit River delta sequence typically consist of soft clay and silt and/or loose fine sand. These deposits are mapped as unit Qn by Dragovich and

others (2002) in the vicinity of Fir Island Farm. Alluvial and lahar-derived deposits typically consist of loose sand and gravel.

The Devils Mountain fault extends east-west across the Skagit River delta approximately 2 miles north of the project site. This left-lateral oblique fault extends for at least 80 miles between the Cascade Mountains and eastern Strait of Juan de Fuca. The Strawberry Point fault extends west-northwest across northern Whidbey Island, approximately 3 miles west of the project site. The oblique-slip, transpressional fault has four splays. Both faults are considered to be active; however, no information exists on earthquake recurrence interval on these two faults (Johnson and others, 2001).

8.2 Geologic Units

Our interpretation of the subsurface conditions is based on historical information we reviewed as a part of our 2011 baseline study, the samples recovered from the explorations, and the CPTs. We interpret five soil units: dike fill (Hf), an agricultural layer, Holocene mudflat deposits (Hm), Holocene alluvium (Ha), and Holocene estuarine deposits (He). A general description of the subsurface conditions is presented below. Detailed soil descriptions are presented in the exploration logs in Appendix A. Generalized subsurface profiles of the soil and groundwater encountered along the proposed dike alignment and the detention pond are included as Figures 3 through 5. The generalized subsurface profile legend and notes are shown in Figure 2.

Dike fill (Hf) at the site primarily consists of locally derived, near-surface soil that was pushed into place during dike construction. Hf generally consists of a ½- to 2-foot-thick silty, sandy gravel layer with cobbles underlain by a 5- to 7-foot-thick silt layer with variable amounts of clay and sand with iron-oxide staining. The silt layer resembles Holocene mudflat deposits. Test pits TP-19-13, TP-20-13, TP-22-13, and TP-26-13 encountered sand layers with variable amounts of silt. Portions of the dike have been repaired using imported riprap, sand, and gravel.

Native deltaic deposits at the site are overlain by an agricultural layer. The agricultural layer generally consists of 1 to 4 feet of slightly clayey to clayey silt that appears disturbed. The disturbance is likely the result of farming practices, such as tilling. Dike district managers report, and historic photographs show, that former Skagit River distributary channels were filled at the site along the margins of Brown, Claude O. Davis and Dry Sloughs.

The agricultural layer is underlain by a 1- to 7-foot-thick layer of slightly clayey to clayey silt and fine sandy silt locally interbedded with layers of silty fine sand. In this report, we assign the geologic unit Holocene mudflat (Hm) to these deposits. Test pits encountered layers and pockets

of organic silt within the Hm layers that are composed primarily of fibrous organics. We observed iron-oxide staining within this layer. Hm represents deposits that may have accumulated from a combination of tidal flat, estuarine, and alluvial overbank deposition. The unit is analogous to the Quaternary nearshore (Qn) unit of Dragovich and others (2002).

Holocene alluvium (Ha) underlies Hm. Ha typically consists of clean to slightly silty sand. Locally, the deposits contain layers of silty sand, scattered shell fragments, and wood debris. The dark gray color of the sand suggests its origin is largely volcanic, and that the Ha may be related to lahars from Glacier Peak. Explorations typically encountered Ha layers below about elevation 0 to 5 feet. Below about elevation -10 to -20 feet, Ha layers are interbedded with underlying estuarine deposits.

Holocene estuarine (He) deposits form layers of very loose silt, sandy silt, and silty sand, and very soft slightly clayey to clayey silt that are interlayered with Ha. We observed interbedded He and Ha typically between elevations -10 and -40 feet. We observed shells and shell fragments in some He layers.

8.3 Hydrogeologic Conditions

The hydrogeologic conditions at the site are based on our geologic interpretation, groundwater level observations, and slug testing. Our interpretation of the site hydrogeologic conditions includes three layers: an overlying confining layer (Hm), a confined aquifer (Ha), and the base of the aquifer (He). Our explorations encountered the top of the Ha aquifer between elevations 0 and 5 feet. The base of the aquifer is at the contact between Ha and He, and is between elevations -10 and -20 feet. The water levels in the observation wells installed in the Ha unit were typically above the top of the Ha unit, which indicates the aquifer is confined. The Ha aquifer is continuous across the site. Slug tests performed within the wells installed in the Ha aquifer have a range of hydraulic conductivity between 2.2×10^{-1} and 2.0×10^{-2} centimeters per second (620 and 57 feet per day). The collected data has a geomean range of hydraulic conductivity between 1.4×10^{-1} and 3.3×10^{-2} centimeters per second (390 and 94 feet per day).

9.0 LIMITATIONS

The purpose of this report is to present the information obtained from our data reviews, the subsurface explorations, in situ testing, and laboratory testing for the Fir Island Farm restoration project. We used this information to interpret the subsurface conditions at the site. Our interpretations are based on site conditions as they existed at the time of our site visits and explorations, and as identified in the historical records included in our geotechnical baseline

study (Shannon & Wilson, 2011). It should be understood that the interpretations presented in this report may be different from conditions encountered at the time of construction. If subsurface conditions different from those described in this report are observed or appear to be present during construction, we should be advised at once so that we can review these conditions and reconsider our conclusions, where necessary.

This report was prepared for the exclusive use of WDFW. It should be made available to prospective contractors for information on factual data only, and not as a warranty of subsurface conditions, such as those interpreted from the exploration logs and discussions of geology and subsurface conditions included in this report. Unanticipated soil and groundwater conditions are commonly encountered and cannot be fully determined merely by taking soil samples from a limited number of explorations.

Within the limitations of the scope, schedule, and budget, the interpretations, analyses, and conclusions presented in this report were prepared in accordance with generally accepted geotechnical and hydrogeological engineering principles and practices in this area at the time this report was prepared. We make no other warranty, either express or implied.

The scope of our services did not include any environmental assessment or evaluation of hazardous or toxic materials in the soil, surface water, groundwater, or air on or below or around the site beyond those identified in this report. Shannon & Wilson, Inc. has qualified personnel to assist you with these services should they be necessary. We have prepared Appendix E, "Important Information About Your Geotechnical/Environmental Report," to assist you and others in understanding the use and limitations of our report.

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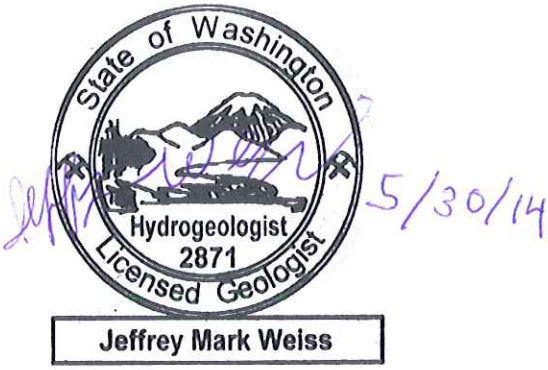

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JKP:JMW:BSR:CAR/jkp

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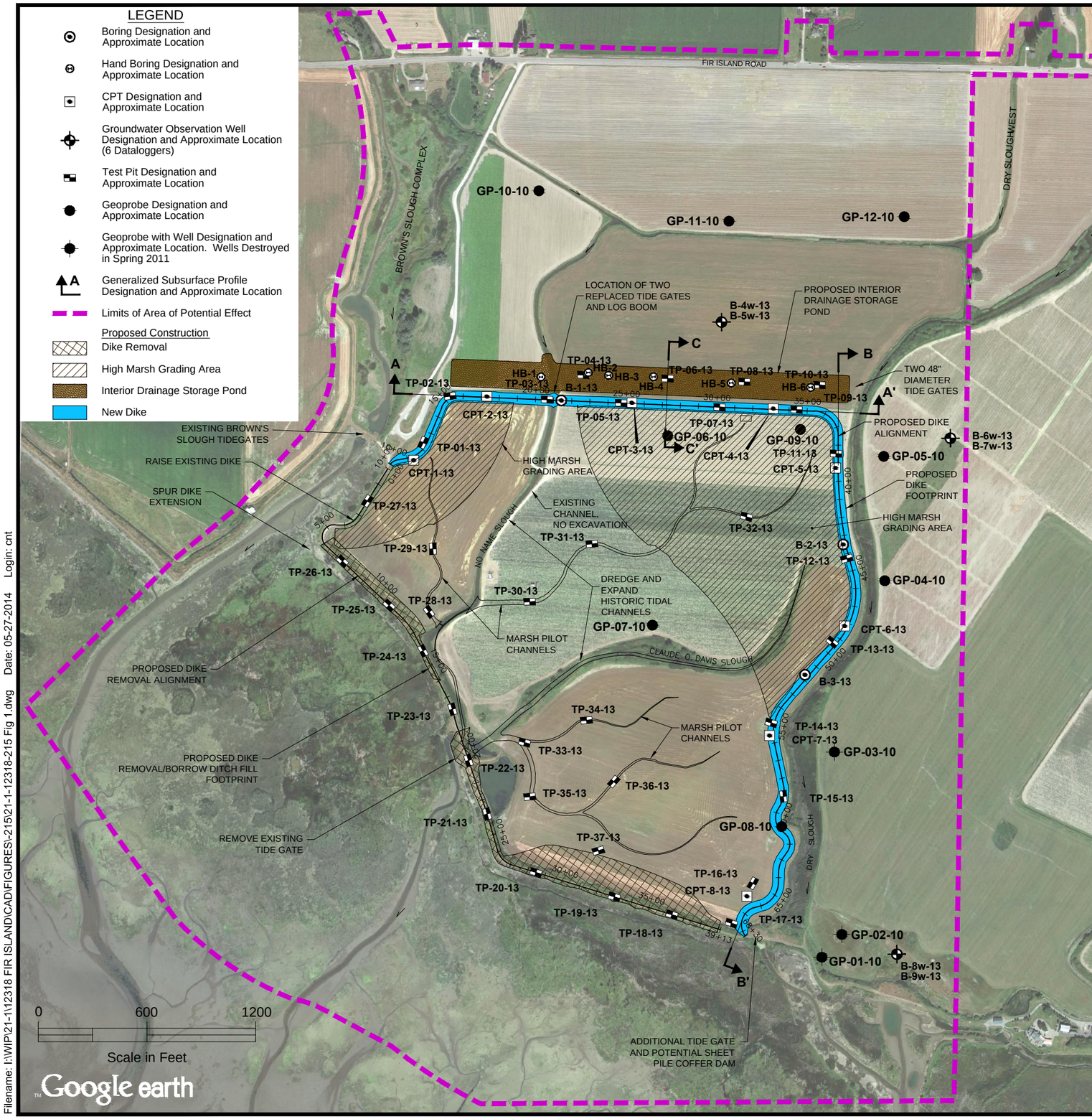

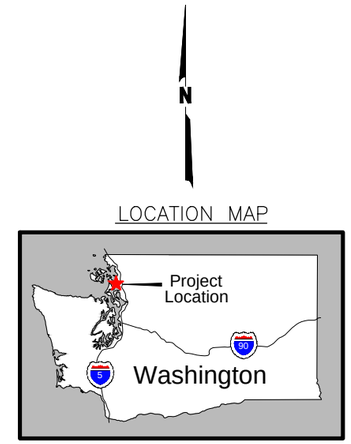

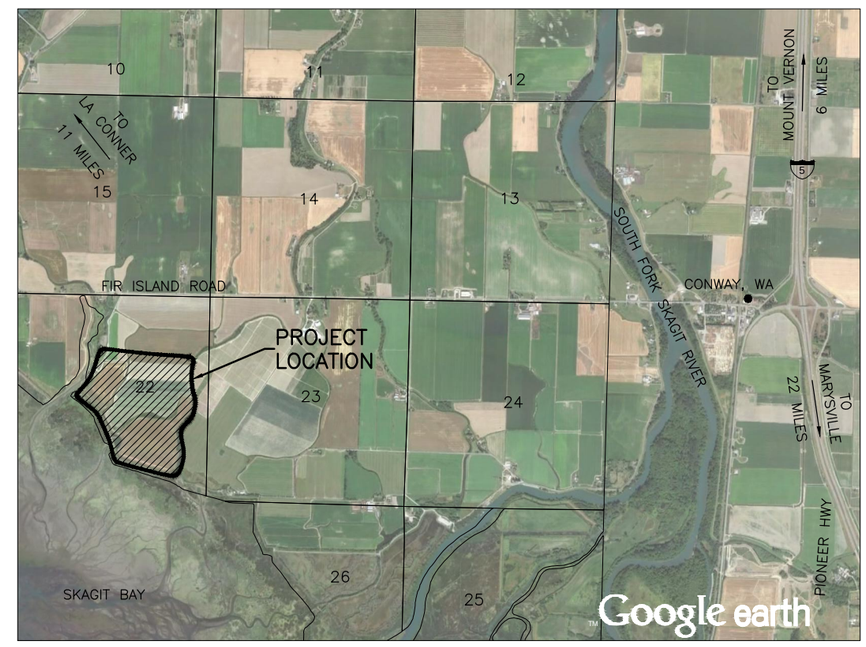

VICINITY MAP

0 2000 4000

Scale in Feet

NOTE

This figure is adapted from *R004113c004.dwg*, dated December 2011. Aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth ™ Mapping Service.

Fir Island Farm
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Skagit County, Washington

SITE AND EXPLORATION PLAN

May 2014 | 21-1-12318-215

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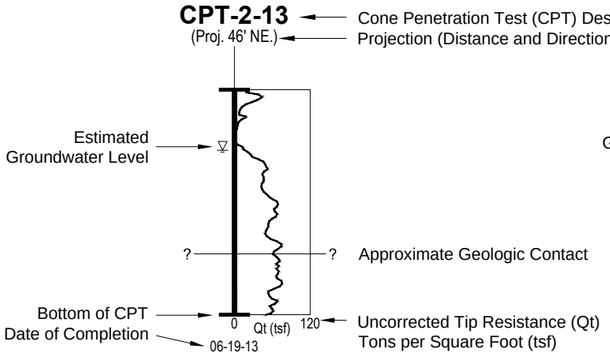
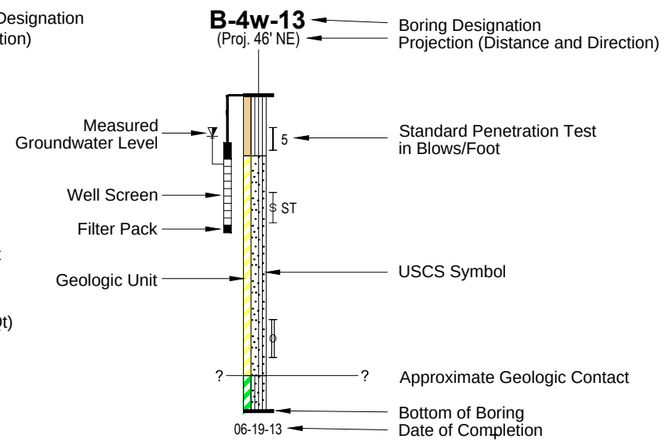
FIG. 1

Filename: I:\WIP\21-1\12318 FIR ISLAND\CAD\FIGURES\-215\21-1-12318-215 Fig 1.dwg Date: 05-27-2014 Login: cnt

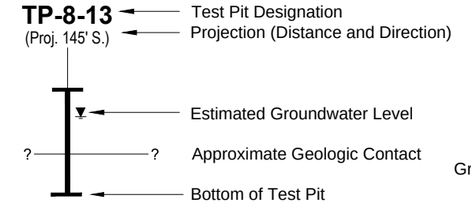
CONE PENETRATION TEST LEGEND



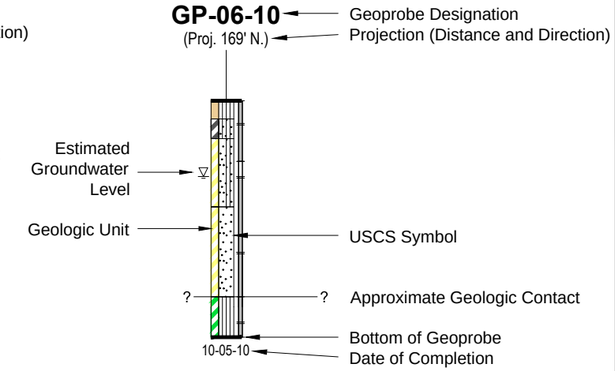
BORING LOG LEGEND



TEST PIT LEGEND



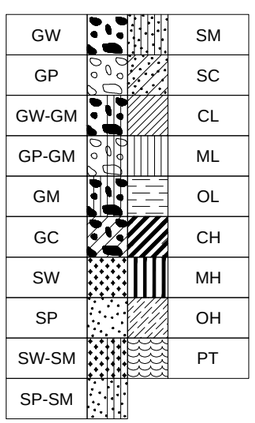
GEOPROBE LEGEND



SOIL OR ROCK AND SAMPLING LEGEND

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

(From USACE Tech Memo 3-357)



SAMPLE TYPES

*	Sample Not Recovered
I	2" O.D. Split Spoon Sample with 140 lb. Hammer (standard penetration test - SPT)
ST	3" O.D. Direct Push Thin-Walled Sample
	3" O.D. Piston (Osterberg) Thin-Walled Sample
	Geoprobe Run with Soil Recovery
	Geoprobe Run without Soil Recovery

1. Dual Symbols (symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND) are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.
2. Borderline symbols (symbols separated by a slash, i.e., CL/ML, silty CLAY/clayey SILT; GW/SW, sandy GRAVEL/gravelly SAND) indicate that the soil may fall into one of two possible basic groups, based on ASTM D 2488 Visual Manual Classification System. The graphic symbol of only the first group symbol is shown on the profile.

GENERALIZED GEOLOGY TYPE EXPLANATION

	AGRICULTURAL LAYER
Hm	**HOLOCENE MUDFLAT DEPOSITS**
Ha	**HOLOCENE ALLUVIUM**
He	**HOLOCENE ESTUARY DEPOSITS**

RELATIVE DENSITY / CONSISTENCY

COARSE-GRAINED SOILS		FINE-GRAINED/COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
0 - 4	Very loose	<2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
Over 50	Very dense	15 - 30	Very stiff
		Over 30	Hard

Reference: Oregon State Department of Transportation, 1987, Soil and Rock Classification Manual, p.18.

NOTES

1. This profile is constructed from surface elevations and project alignment, received from Washington Department of Fish and Wildlife, on 10-30-2010. The subsurface conditions shown are interpreted from the explorations conducted by Shannon & Wilson, Inc. Soil descriptions for CPTs are interpreted from the soil behavior type presented on In-Situ Engineering's CPT log and nearby borings. The geology, as encountered in the explorations, has been projected into the plane of the profile or section. Elevations and contacts should be considered approximate. Where layers are described as interbedded, the geologic unit observed to be more dominant is listed first and shown as the geologic symbol. Variations between the profile and actual conditions are likely to exist.
2. Water levels shown were measured on various dates. Groundwater fluctuations should be expected.
3. Estimated groundwater levels are based on observations made while drilling borings, excavating test pits and pushing geoprobes. Evidence of groundwater includes wet samples, visible seepage, and water standing in an open hole. We estimated the groundwater level in CPTs using porewater pressure measurements and pore pressure dissipation tests. The actual groundwater level may differ from our estimates.
4. The locations and extents of proposed structures should be considered approximate. Project alignments presented in exhibits were developed by Shannon & Wilson, Inc.

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GEOLOGIC PROFILE LEGEND AND NOTES

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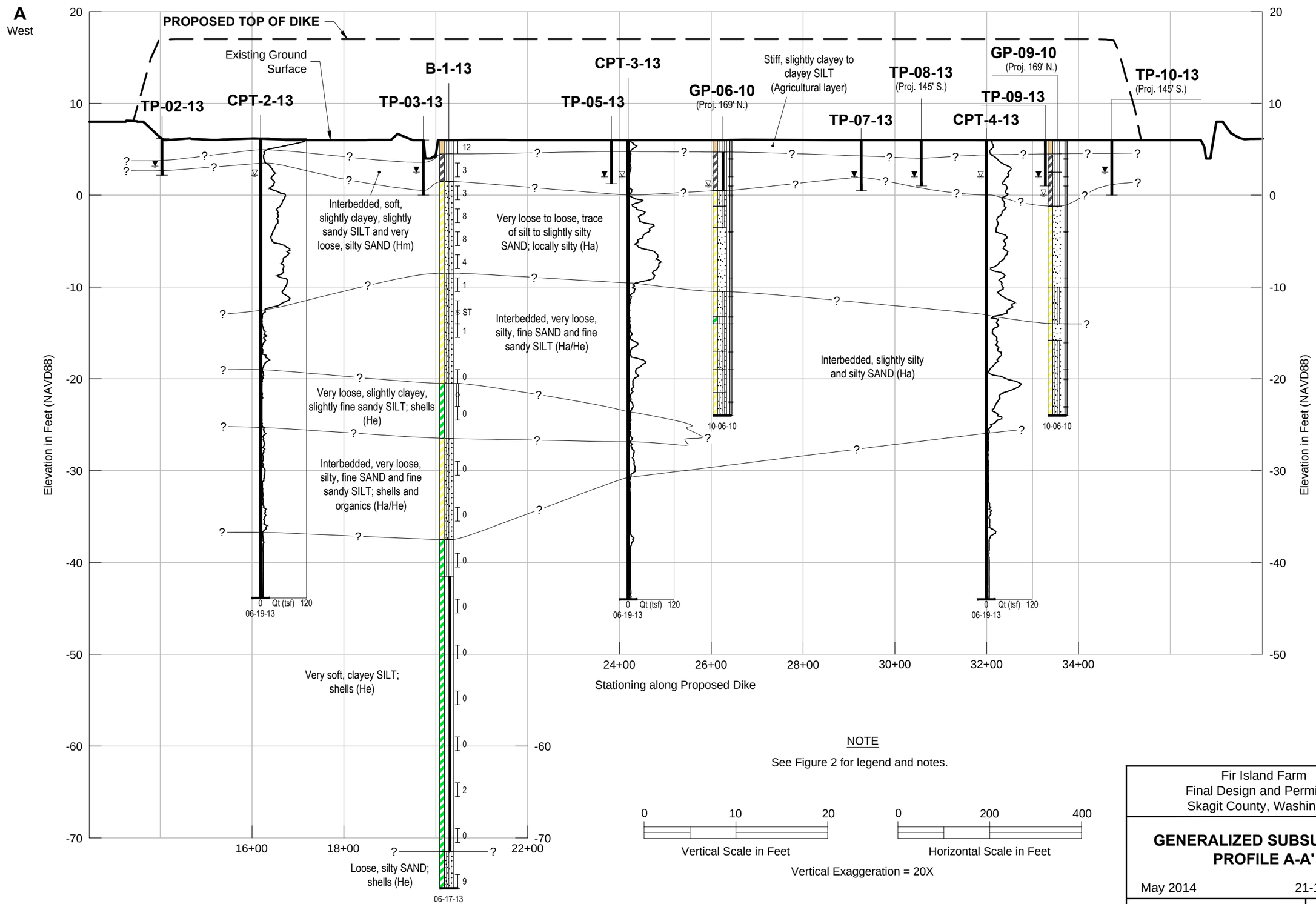
FIG. 2

Filename: I:\WIP\21-1\12318 Fir Island\CAD\FIGURES\-215\21-1-12318-215 Fig 2.dwg Date: 05-22-2014 Login: cnt



NOTE

See Figure 2 for legend and notes.

0 10 20
Vertical Scale in Feet

0 200 400
Horizontal Scale in Feet

Vertical Exaggeration = 20X

Fir Island Farm
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GENERALIZED SUBSURFACE PROFILE A-A'

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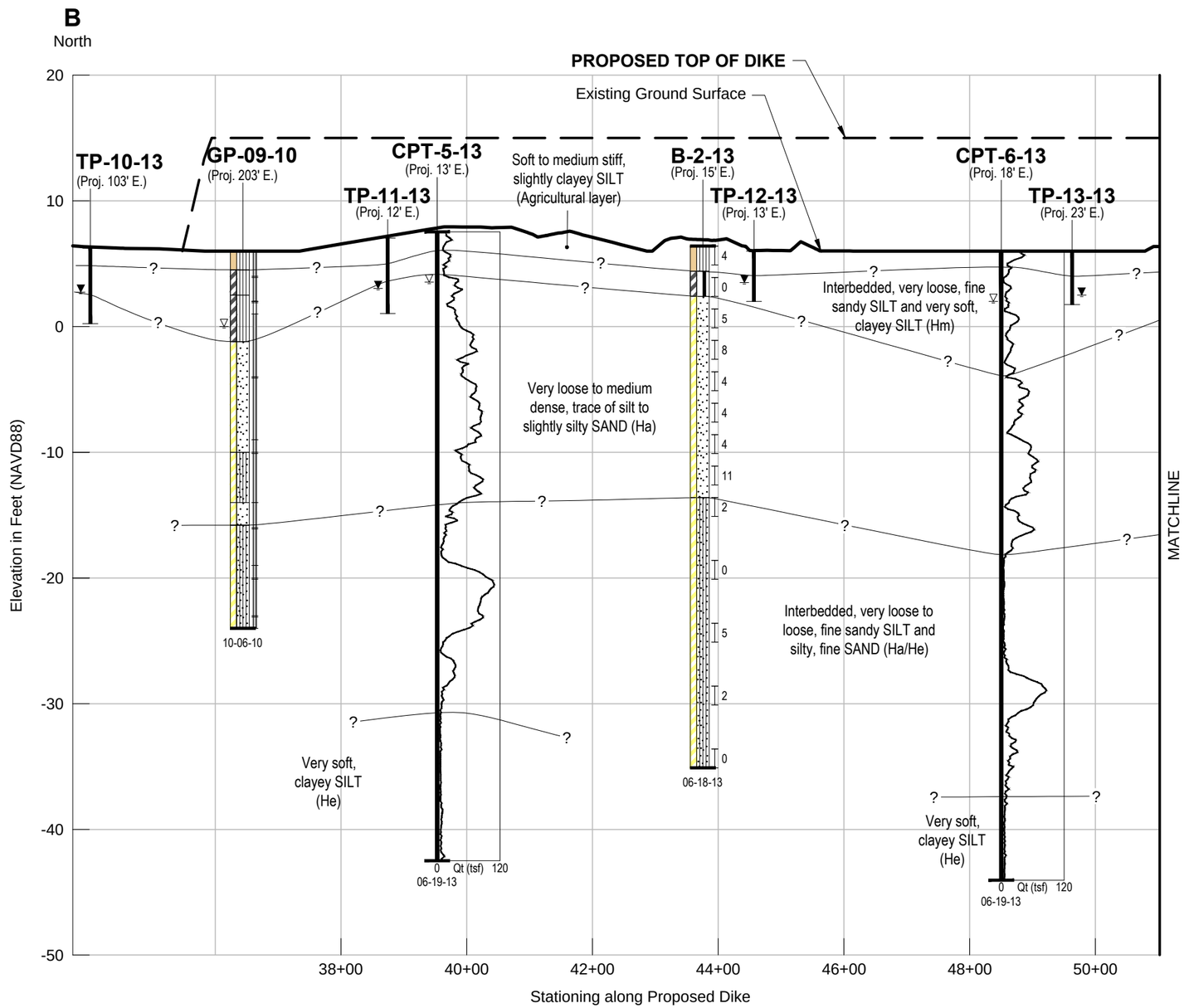
FIG. 3

Filename: I:\WIP\21-1\12318 FIR ISLAND\CAD\FIGURES\-215\21-1-12318-215 Fig 3 - Profiles.dwg Date: 05-22-2014 Login: cnt



NOTE

See Figure 2 for legend and notes.

0 10 20 — Vertical Scale in Feet

0 200 400 — Horizontal Scale in Feet

Vertical Exaggeration = 20X

Fir Island Farm
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Skagit County, Washington

GENERALIZED SUBSURFACE PROFILE B-B'

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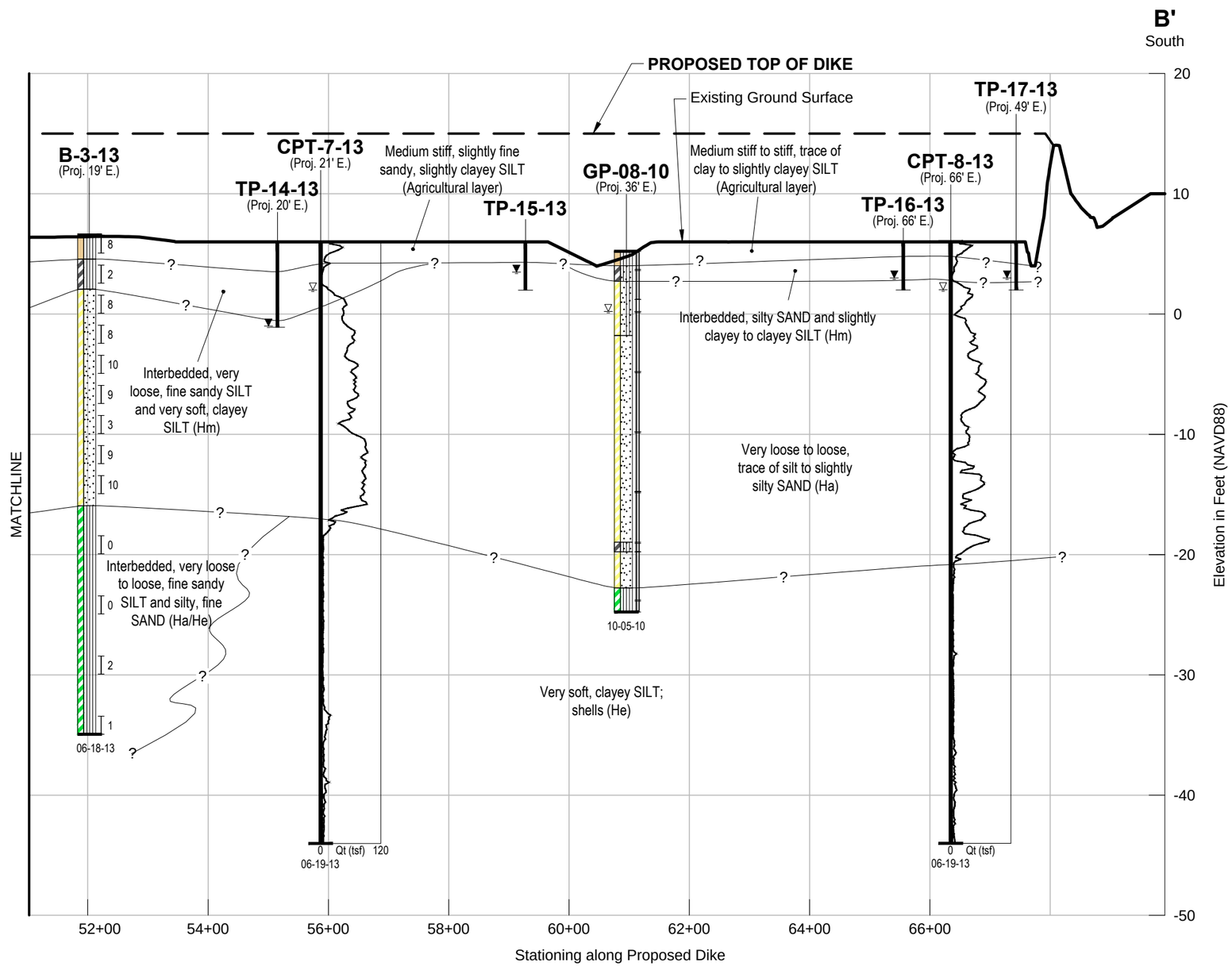
FIG. 4
Sheet 1 of 2

Filename: I:\WIP\21-1\12318 FIR ISLAND\CAD\FIGURES\-215\21-1-12318-215 Fig 3 - Profiles.dwg Date: 05-22-2014 Login: cnt



NOTE

See Figure 2 for legend and notes.

0 10 20 — Vertical Scale in Feet

0 200 400 — Horizontal Scale in Feet

Vertical Exaggeration = 20X

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

GENERALIZED SUBSURFACE PROFILE B-B'

May 2014 | 21-1-12318-215

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FIG. 4
Sheet 2 of 2

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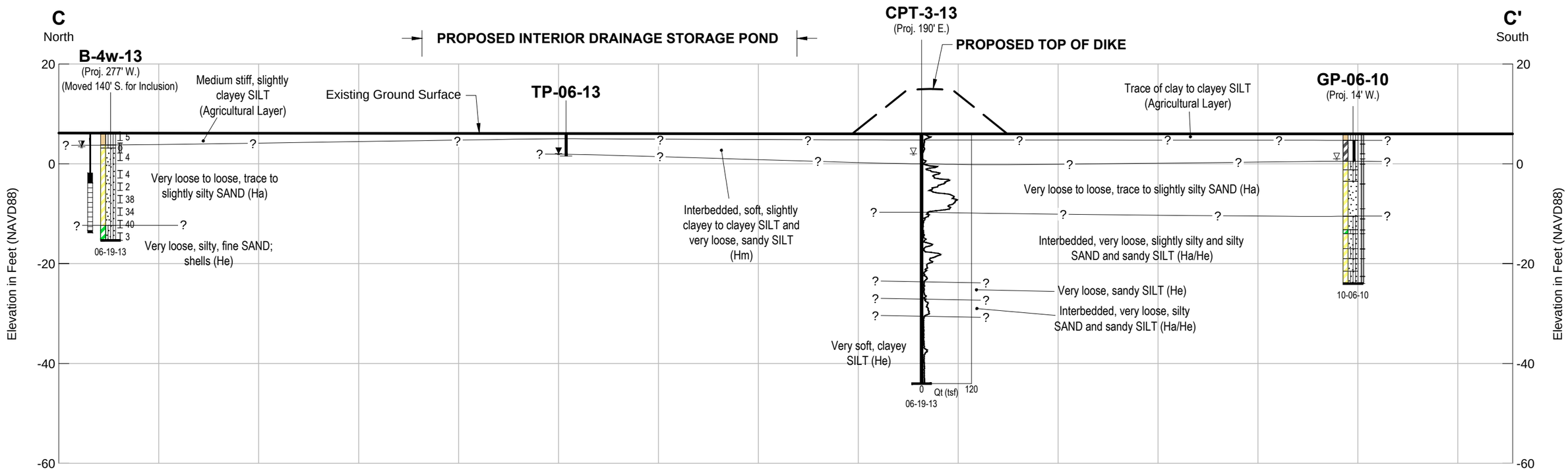

NOTE

See Figure 2 for legend and notes.

0 20 40

Vertical Scale in Feet

0 40 80

Horizontal Scale in Feet

Vertical Exaggeration = 2X

Fir Island Farm
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GENERALIZED SUBSURFACE PROFILE C-C'

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FIG. 5

Filename: I:\WIP\21-1\12318 FIR ISLAND\CAD\FIGURES\-215\21-1-12318-215 Fig 3 - Profiles.dwg Date: 05-22-2014 Login: cnt

APPENDIX A

SUBSURFACE EXPLORATION LOGS

APPENDIX A

SUBSURFACE EXPLORATION LOGS

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FIGURES (cont.)

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A-37 Log of Test Pit TP-05-13
A-38 Log of Test Pit TP-06-13
A-39 Log of Test Pit TP-07-13
A-40 Log of Test Pit TP-08-13
A-41 Log of Test Pit TP-09-13
A-42 Log of Test Pit TP-10-13
A-43 Log of Test Pit TP-11-13
A-44 Log of Test Pit TP-12-13
A-45 Log of Test Pit TP-13-13
A-46 Log of Test Pit TP-14-13
A-47 Log of Test Pit TP-15-13
A-48 Log of Test Pit TP-16-13
A-49 Log of Test Pit TP-17-13
A-50 Log of Test Pit TP-18-13
A-51 Log of Test Pit TP-19-13
A-52 Log of Test Pit TP-20-13
A-53 Log of Test Pit TP-21-13
A-54 Log of Test Pit TP-22-13
A-55 Log of Test Pit TP-23-13
A-56 Log of Test Pit TP-24-13
A-57 Log of Test Pit TP-25-13
A-58 Log of Test Pit TP-26-13
A-59 Log of Test Pit TP-27-13
A-60 Log of Test Pit TP-28-13
A-61 Log of Test Pit TP-29-13
A-62 Log of Test Pit TP-30-13
A-63 Log of Test Pit TP-31-13
A-64 Log of Test Pit TP-32-13
A-65 Log of Test Pit TP-33-13
A-66 Log of Test Pit TP-34-13
A-67 Log of Test Pit TP-35-13
A-68 Log of Test Pit TP-36-13
A-69 Log of Test Pit TP-37-13
A-70 Log of Geoprobe GP-01-10 (2 sheets)
A-71 Log of Geoprobe GP-02-10 (2 sheets)
A-72 Log of Geoprobe GP-03-10 (2 sheets)
A-73 Log of Geoprobe GP-04-10 (2 sheets)
A-74 Log of Geoprobe GP-05-10 (2 sheets)
A-75 Log of Geoprobe GP-06-10 (2 sheets)
A-76 Log of Geoprobe GP-07-10 (2 sheets)
A-77 Log of Geoprobe GP-08-10 (2 sheets)
A-78 Log of Geoprobe GP-09-10 (2 sheets)

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FIGURES (cont.)

A-79 Log of Geoprobe GP-10-10 (2 sheets)
A-80 Log of Geoprobe GP-11-10 (2 sheets)
A-81 Log of Geoprobe GP-12-10 (2 sheets)
A-82 Log of Hand Boring HB-1-14
A-83 Log of Hand Boring HB-2-14
A-84 Log of Hand Boring HB-3-14
A-85 Log of Hand Boring HB-4-14
A-86 Log of Hand Boring HB-5-14
A-87 Log of Hand Boring HB-6-14

Shannon & Wilson, Inc. (S&W), uses a soil classification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on these three pages. Soil descriptions are based on visual-manual procedures (ASTM D 2488-93) unless otherwise noted.

S&W CLASSIFICATION OF SOIL CONSTITUENTS

MAJOR constituents compose more than 50 percent, by weight, of the soil. Major consituents are capitalized (e.g., SAND).

Minor constituents compose 12 to 50 percent of the soil and precede the major constituents (i.e., silty SAND). Minor constituents preceded by "slightly" compose 5 to 12 percent of the soil (e.g., slightly silty SAND).

Trace constituents compose 0 to 5 percent of the soil (e.g., slightly silty SAND, trace of gravel).

Clean is similar to trace but is used when the fines content is less than 5 percent of the soil (e.g. clean SAND).

(Xxxx) Primary geologic unit interpreted from soil samples.

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer: 140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-dia. cathead 2-1/4 rope turns, > 100 rpm

NOTE: If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for higher efficiency of hammer.

Sampler: 18- to 30-inches long
Shoe ID = 1.375 inches
Barrel ID = 1.5 inches
Barrel OD = 2 inches

N-Value: Sum blow counts for second and third of three 6-inch increments.
Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

GRAIN SIZE DEFINITION

DESCRIPTION	SIEVE NUMBER AND/OR SIZE
FINES	< #200 (0.08 mm)
SAND*	
- Fine	#200 to #40 (0.08 to 0.4 mm)
- Medium	#40 to #10 (0.4 to 2 mm)
- Coarse	#10 to #4 (2 to 5 mm)
GRAVEL*	
- Fine	#4 to 3/4 inch (5 to 19 mm)
- Coarse	3/4 to 3 inches (19 to 76 mm)
COBBLES	3 to 12 inches (76 to 305 mm)
BOULDERS	> 12 inches (305 mm)

* Unless otherwise noted, sand and gravel, when present, range from fine to coarse in grain size.

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS (FINE-GRAINED)	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
0 - 4	Very loose	Under 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
Over 50	Very dense	15 - 30	Very stiff
		Over 30	Hard

WELL AND OTHER SYMBOLS

Bent. Cement Grout	Surface Cement Seal
Bentonite Grout	Asphalt or Cap
Bentonite Chips	Slough
Silica Sand	Bedrock
PVC Screen	Peat
Vibrating Wire	

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SOIL CLASSIFICATION AND LOG KEY

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
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FIG. A-1
Sheet 1 of 3

BORING_CLASS1-OF-3 21-12318.GPJ SWNEW.GDT 5/30/14

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(From USACE Tech Memo 3-357)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL		TYPICAL DESCRIPTION
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)*	GW		Well-graded gravels, gravels, gravel/sand mixtures, little or no fines
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravels with Fines *(more than 12% fines)*	GM		Silty gravels, gravel-sand-silt mixtures
			GC		Clayey gravels, gravel-sand-clay mixtures
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Clean Sands *(less than 5% fines)*	SW		Well-graded sands, gravelly sands, little or no fines
			SP		Poorly graded sand, gravelly sands, little or no fines
		Sands with Fines *(more than 12% fines)*	SM		Silty sands, sand-silt mixtures
			SC		Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML		Inorganic silts of low to medium plasticity, rock flour, sandy silts, gravelly silts, or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		Organic	OL		Organic silts and organic silty clays of low plasticity
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH		Inorganic silts, micaceous or diatomaceous fine sands or silty soils, elastic silt
			CH		Inorganic clays or medium to high plasticity, sandy fat clay, or gravelly fat clay
		Organic	OH		Organic clays of medium to high plasticity, organic silts
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT		Peat, humus, swamp soils with high organic content (see ASTM D 4427)

NOTE: No. 4 size = 5 mm; No. 200 size = 0.075 mm

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, slightly silty fine SAND)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, silty CLAY/clayey SILT; GW/SW, sandy GRAVEL/gravelly SAND)* indicate that the soil may fall into one of two possible basic groups.

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SOIL CLASSIFICATION AND LOG KEY

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FIG. A-1
Sheet 2 of 3

BORING_CLASS2-OF-3 21-12318.GPJ SWNEW.GDT 5/30/14

OTHER GEOLOGIC TERMS AND DEFINITIONS

STRUCTURE	*CRITERIA*
Parting	< 1/16" (1.6 mm) thickness
Seam	1/16" - 1/2" (1.6 - 12.7 mm) thickness
Layer	> 1/2" (12.7 mm) thickness
Lamination (thin)	< 1/4" (6 mm) thickness, typically alternating
Lamination (thick)	1/4" - 3/4" (6 - 20 mm) thickness, typically alternating
Pocket	Irregular, discontinuous zone
Clast	An individual soil fragment
Bedded	Arranged in layers
Interbedded	Alternating layers
Lensed	Small pockets of different soil types
Fractured	Breaks easily along definite planes
Slickensided	Polished, glossy, striated, fractured planes
Blocky, Diced	Easily breaks into small angular pieces
Sheared	Disturbed texture, mix of strengths
Homogeneous	Uniform color and appearance
Mottled	Irregular patches of different colors
Weathered	Alteration of soil (e.g. discoloration, softening, or pitting of grains) by exposure to the atmosphere
Stringer	Zone of soil with closely spaced, parallel to sub-parallel fractures
Spongy	Light weight, springy, squishy feel
Bioturbated	Soil disturbance or mixing by plants or animals
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix

ORGANIC CONTENT	*CRITERIA*
Trace	0 - 5 percent by volume
Scattered	5 - 15 percent by volume
Abundant	15 - 30 percent by volume
Organic	30 - 50 percent by volume
Peat/Wood	> 50 percent by volume

PARTICLE SHAPE	*CRITERIA*
Angular	Sharp edges and unpolished plane surfaces
Subangular	Similar to angular but with rounded edges
Subrounded	Nearly plane sides with well-rounded edges
Rounded	Smoothly curved sides and no edges
Flat	Particles with width/thickness ratio > 3
Elongated	Particles with length/width ratio < 3

GRADATION	*CRITERIA*
Well Graded	Full range and even distribution of grain sizes present
Poorly Graded	Narrow range of grain sizes present
Uniformly Graded	Consists predominantly of one grain size
Gap Graded	Within the range of grain sizes present, one or more sizes are missing

OTHER	*CRITERIA*
Cuttings	Material brought to surface by drilling
Slough	Material that caved from sides of borehole

MOISTURE CONTENT	*CRITERIA*
Dry	Absence of Moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually from below water table

ACRONYMNS AND ABBREVIATIONS

ATD	At Time of Drilling
CDF	Controlled Density Fill
DM	Dames & Moore Sampler
dia.	Diameter
Elev.	Elevation
ft	feet
FeO	Iron Oxide
MgO	Magnesium Oxide
HSA	Hollow Stem Auger
ID	Inside Diameter
in	inches
lbs	pounds
Mon.	Monument cover
N	Blows for last two 6-inch increments
NA	Not applicable or not available
NP	Non plastic
OD	Outside diameter
Oster.	Osterberg Sampler
OW	Observation Well
PID	Photo-ionization detector
PMT	Pressuremeter Test
ppm	parts per million
psi	pounds per square inch
PVC	Polyvinyl Chloride
RPM	Rotations per Minute
SS	Split spoon sampler
SPT	Standard penetration test
TW	Thin-Walled Tube Sampler
UCS	Uniaxial (Unconfined) Compressive Strength
USCS	Unified Soil Classification System
VWP	Vibrating Wire Piezometer
WLI	Water level indicator
WOH	Weight of Hammer
WOR	Weight of Rods

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SOIL CLASSIFICATION AND LOG KEY

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FIG. A-1
Sheet 3 of 3

BORING_CLASS3-OF-3 21-12318.GPJ SWNEW.GDT 5/30/14

Total Depth:	81.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

Stiff, gray-brown, slightly clayey SILT, trace of fine sand; moist; trace of organics, iron-oxide staining; (Agricultural layer) ML.

1.5

Interbedded, soft, gray-brown, slightly clayey, fine sandy SILT and very loose, dark gray, silty, fine to medium SAND; wet; abundant wood and organics, iron-oxide staining; (Hm) ML/SM.

4.5

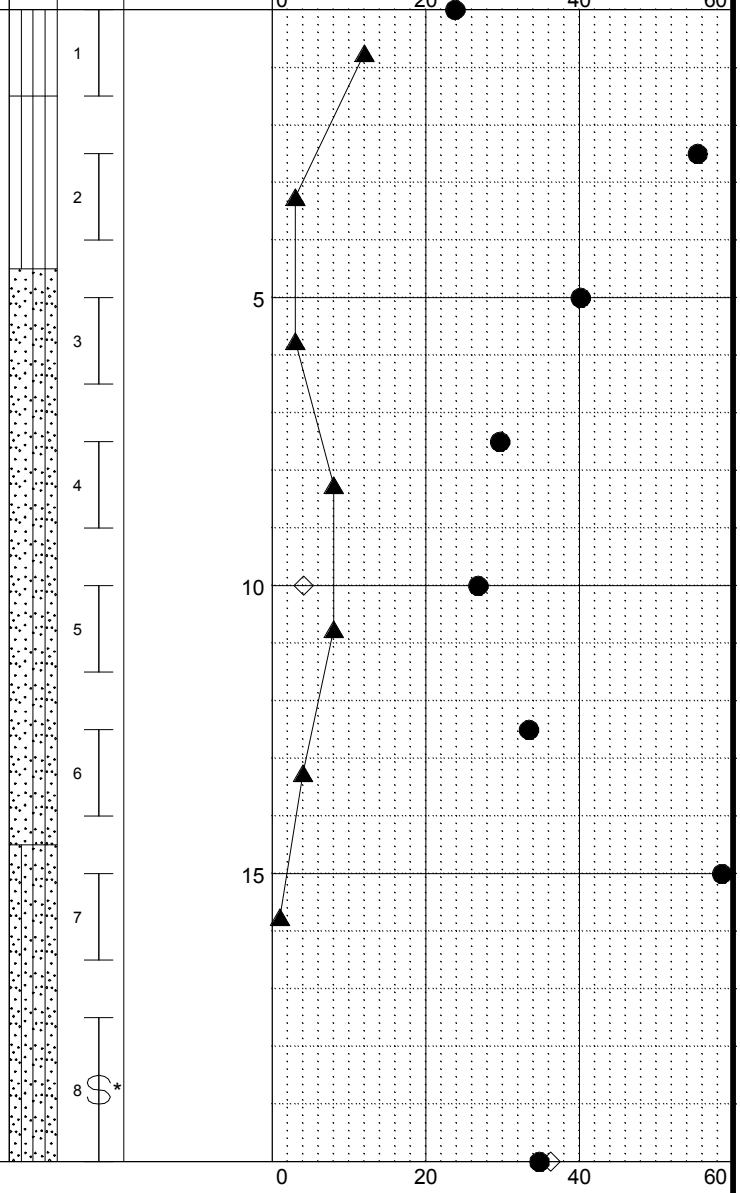
Very loose to loose, gray, trace of silt to slightly silty, fine to medium SAND; wet; abundant organics above 7 feet, trace of organics below 7 feet, iron-oxide staining, strong sulfur odor from 10 to 15 feet; (Ha) SP-SM/SP.

14.5

Very loose, gray, silty, fine to medium SAND to fine sandy SILT; wet; trace of fine to coarse shells and organics; (Ha/He) SM/ML.

- 1-inch-thick slightly clayey silt beds and scattered organics above 20 feet.

CONTINUED NEXT SHEET



LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- 3" O.D. Thin-Walled Tube
- 3.0" O.D. Osterberg Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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LOG OF BORING B-1-13

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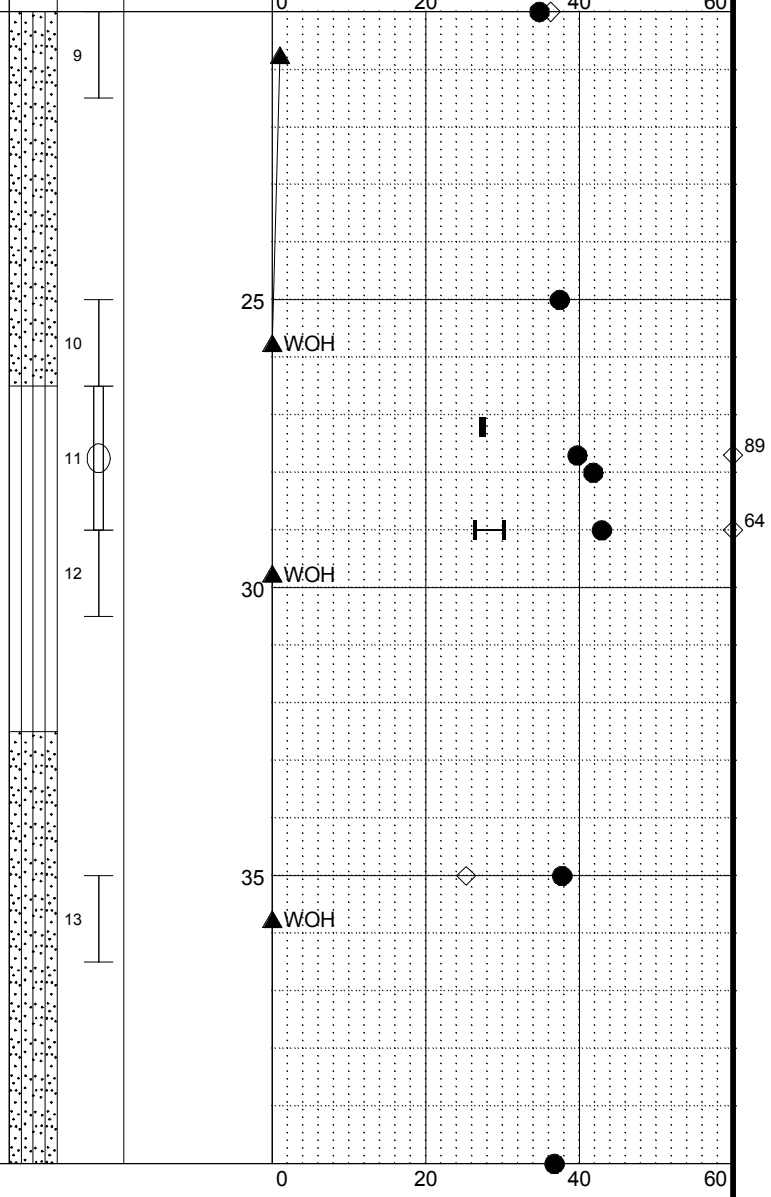
FIG. A-2
Sheet 1 of 5

MASTER_LOG_E_21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	81.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.
Very loose, gray-brown, trace of clay to slightly clayey, trace of fine sand to fine sandy SILT; wet; scattered shells, trace of organics; (He) ML.	26.5
Very loose, gray-brown, silty, fine SAND to fine sandy SILT, trace of clay; wet; trace of shells and organics; (Ha/He) SM/ML.	32.5
CONTINUED NEXT SHEET	



LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- 3" O.D. Thin-Walled Tube
- 3.0" O.D. Osterberg Sample

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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LOG OF BORING B-1-13

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FIG. A-2
Sheet 2 of 5

Log: JMW Rev: JKP Typ: LKN

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14

Total Depth:	81.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

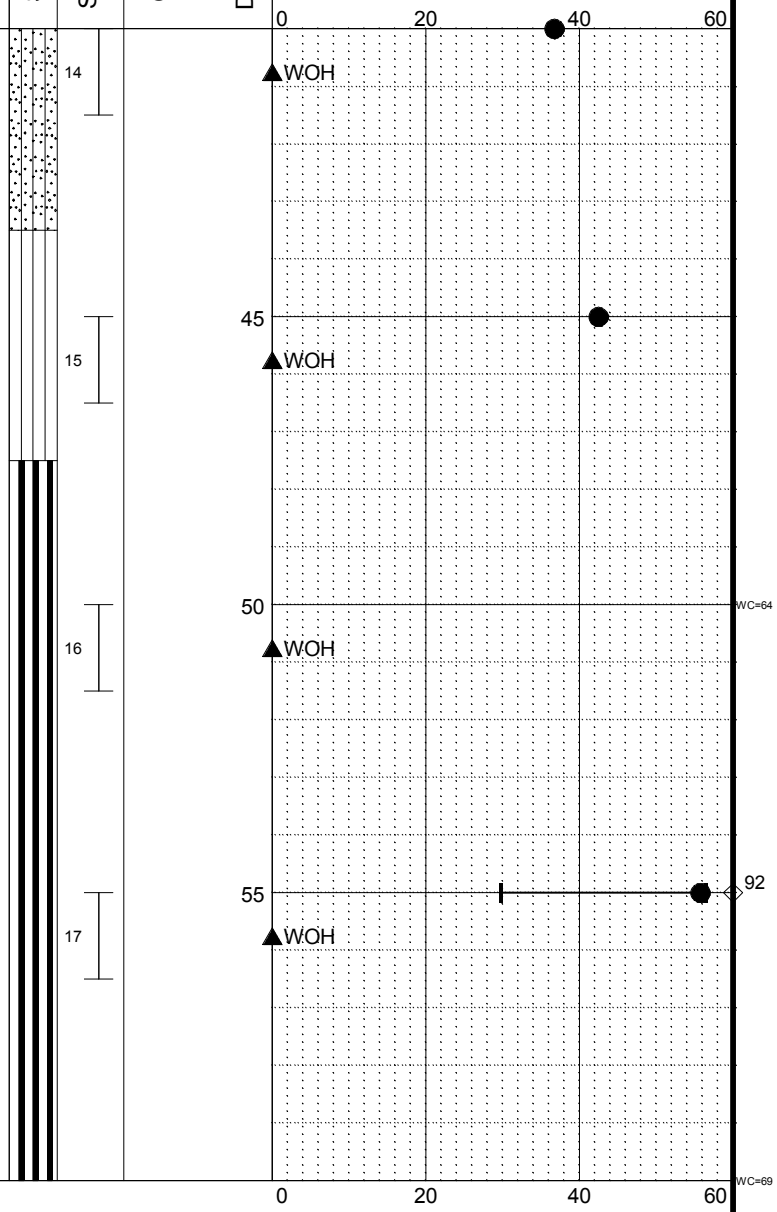
43.5

Very soft, gray-brown, slightly clayey, fine sandy SILT; wet; trace to scattered shells and organics; (He) ML.

47.5

Very soft, gray-brown, clayey SILT, trace of fine sand; wet; trace of shell fragments; (He) MH.

CONTINUED NEXT SHEET



LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- 3" O.D. Thin-Walled Tube
- 3.0" O.D. Osterberg Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-2
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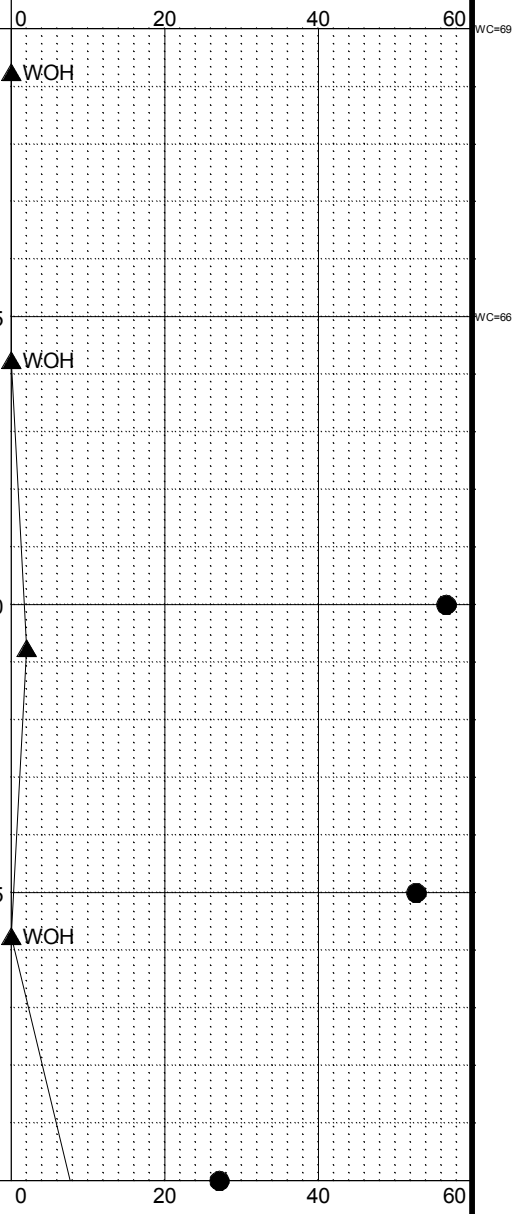
MASTER_LOG_E 21-12318.GPJ SHAN WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	81.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE (blows/foot) ▲ Hammer Wt. & Drop: 140 lbs / 30 inches
- Sandy below about 73 feet.			18, 19, 20, 21		65, 70, 75	WOH, WOH, WOH; WC=69, WC=66
Loose, gray-brown, silty, fine to medium SAND; wet; abundant coarse shells; (He) SM.	77.5					
CONTINUED NEXT SHEET						



LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- 3" O.D. Thin-Walled Tube
- 3.0" O.D. Osterberg Sample

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-2
Sheet 4 of 5

MASTER_LOG_E_21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	81.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE (blows/foot) ▲ Hammer Wt. & Drop: 140 lbs / 30 inches 0 20 40 60
			22			
BOTTOM OF BORING COMPLETED 6/17/2013	81.5					
					85	
					90	
					95	
						0 20 40 60

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- 3" O.D. Thin-Walled Tube
- 3.0" O.D. Osterberg Sample

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-2
Sheet 5 of 5

Total Depth:	41.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soft, gray-brown, slightly clayey SILT; moist; silty sand seams, iron-oxide staining, scattered organics; (Agricultural layer) ML.

2.0

Very soft, gray-brown, clayey SILT, trace of fine sand; wet; laminated, iron-oxide staining, scattered organics, dark gray organic silt pockets; (Hm) MH.

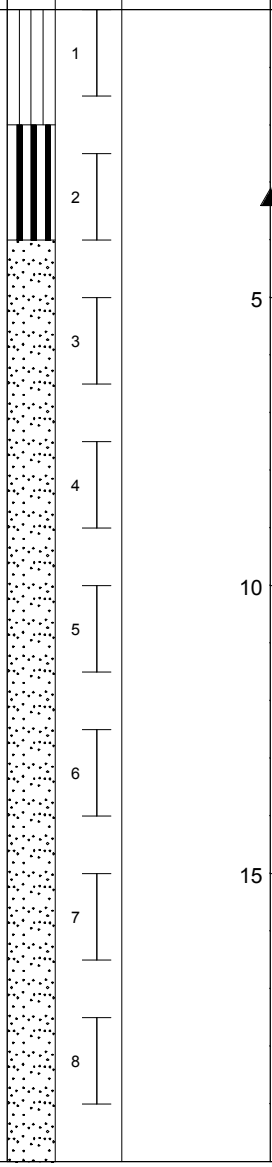
4.0

Loose to medium dense, dark gray, trace of silt to slightly silty SAND; wet; trace of organics, strong sulfur smell below 15 feet; (Ha) SP/SP-SM.

- Abundant organics from 5 to 7 feet.

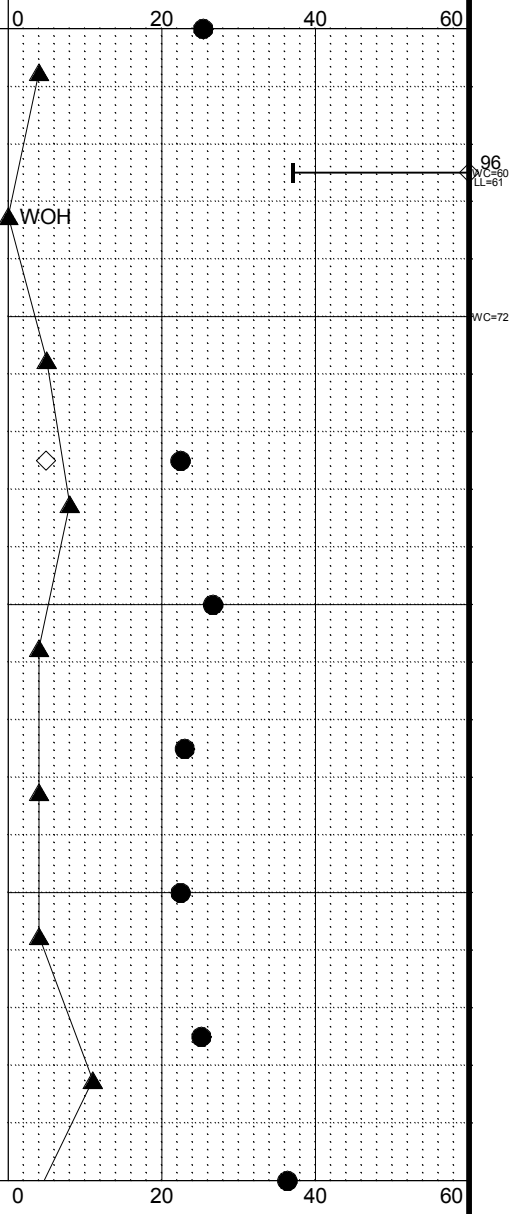
CONTINUED NEXT SHEET

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.



PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF BORING B-2-13

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SHANNON & WILSON, INC.
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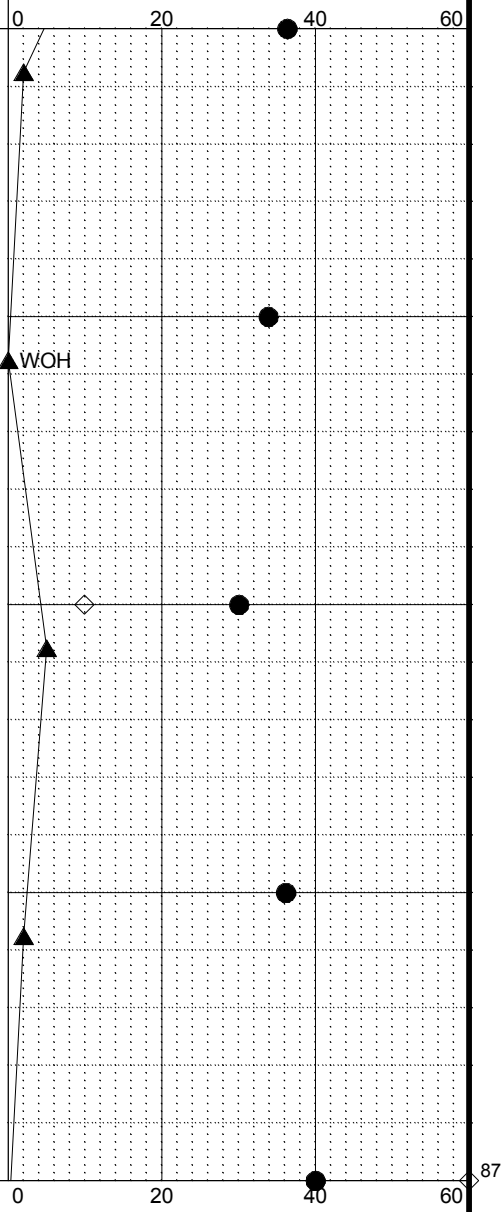
FIG. A-3
Sheet 1 of 3

MASTER_LOG_E_21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	41.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE (blows/foot) ▲ Hammer Wt. & Drop: 140 lbs / 30 inches
Interbedded, very loose to loose, gray-brown, slightly silty to silty, fine SAND and fine sandy SILT; wet; trace of shells and organics; (Ha/He) SM/ML/SP-SM.	20.0		9			
			10		25	WOH
- Scattered organics at 30 feet.			11		30	
			12		35	
CONTINUED NEXT SHEET						



LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-3
Sheet 2 of 3

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	*41.5 ft.*	Northing:	~	Drilling Method:	*Mud Rotary*	Hole Diam.:	*4 in.*
Top Elevation:	~	Easting:	~	Drilling Company:	*Boart Longyear*	Rod Diam.:	*NWJ*
Vert. Datum:		Station:	~	Drill Rig Equipment:	*CME 850 Track*	Hammer Type:	*Automatic*
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE (blows/foot) ▲ Hammer Wt. & Drop: *140 lbs / 30 inches*
			13			▲WOH
BOTTOM OF BORING COMPLETED 6/18/2013	41.5					
					45	
					50	
					55	

0 20 40 60

LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-3
Sheet 3 of 3

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	41.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

Medium stiff, gray-brown, trace to slightly fine sandy, slightly clayey SILT; moist; iron-oxide staining, trace of organics; (Agricultural layer) ML.

2.0

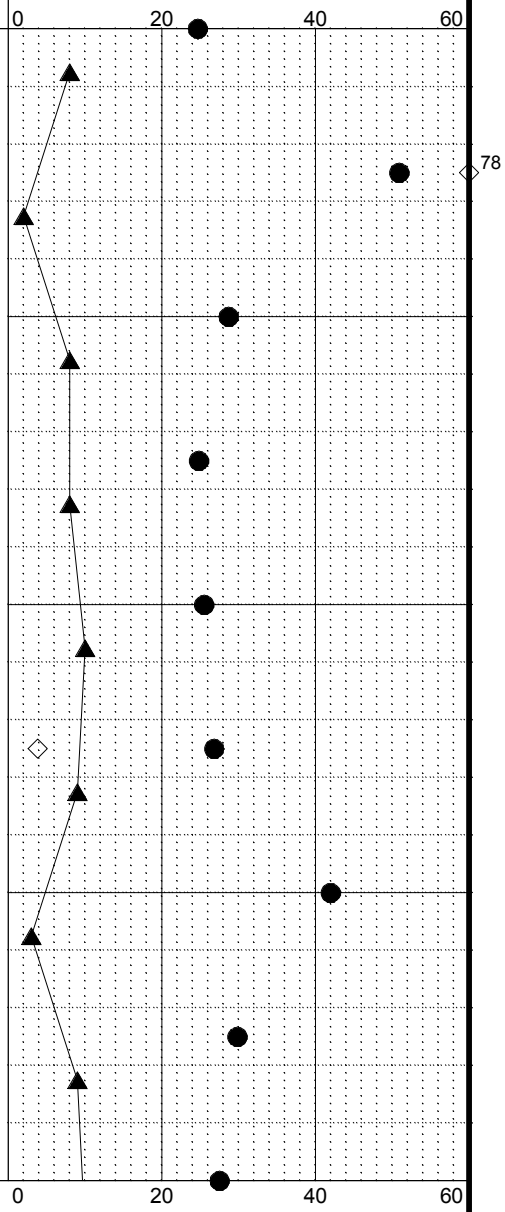
Very loose, dark gray-brown, fine to medium sandy SILT; wet; abundant organics, iron-oxide staining; (Hm) ML.

4.5

Very loose to loose, dark gray-brown, fine to medium SAND, trace of silt; wet; sulfur odor below 17.5 feet, trace of organics; (Ha) SP.

- Silty layer at about 15 feet.

CONTINUED NEXT SHEET



LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-4
Sheet 1 of 3

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

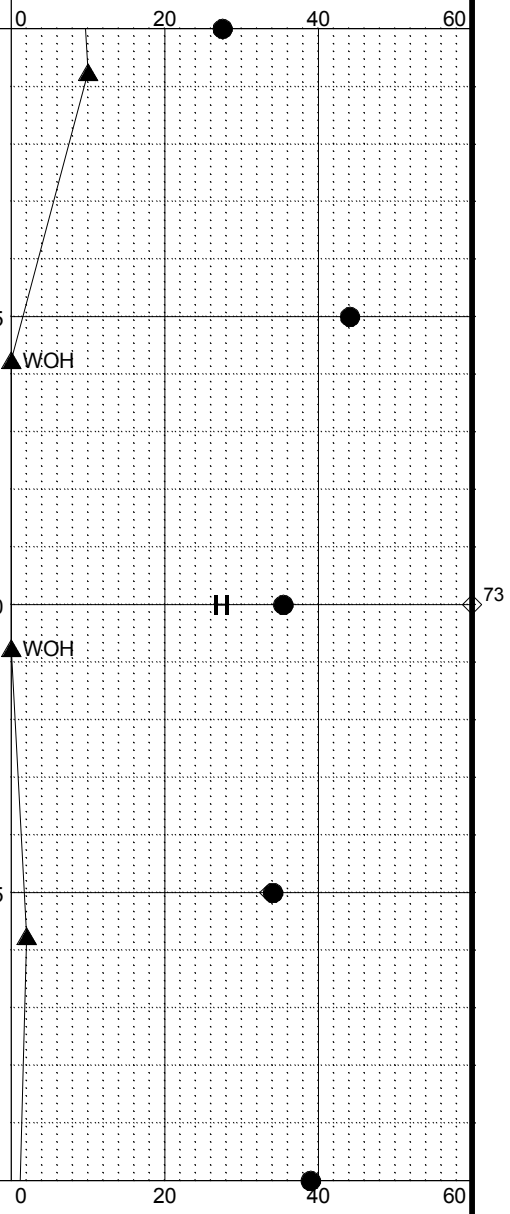
Total Depth:	41.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
			9		
	22.5				
Very loose, dark gray-brown, fine sandy SILT; wet; trace of shells and organics; (He) ML.					
- Slightly clayey layer at 25 feet.			10		25
			11		30
- Silty, fine sand layer at 35 feet.			12		35

CONTINUED NEXT SHEET

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: *140 lbs / 30 inches*



LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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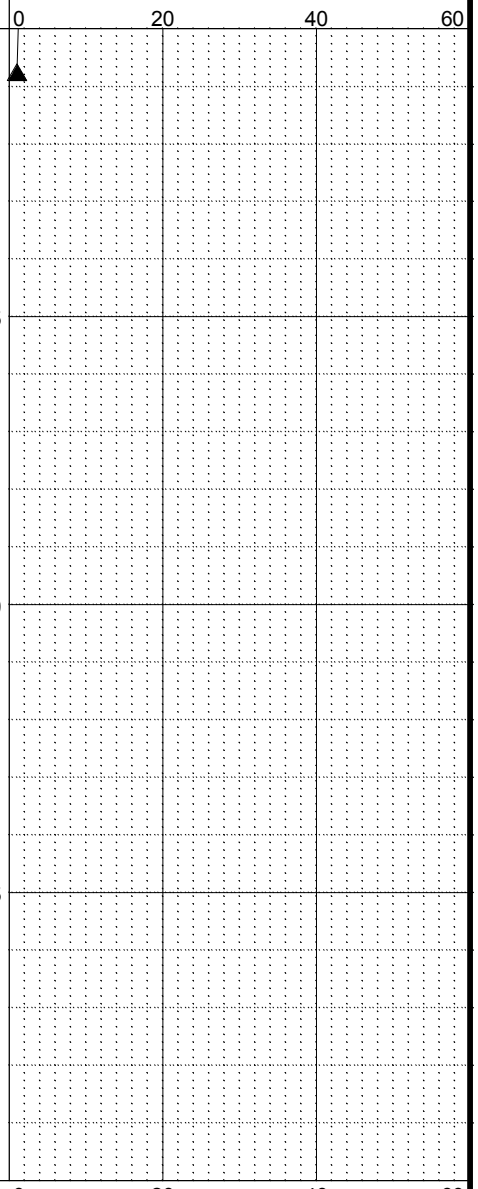
FIG. A-4
Sheet 2 of 3

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	41.5 ft.	Northing:	~	Drilling Method:	Mud Rotary	Hole Diam.:	4 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE (blows/foot) ▲ Hammer Wt. & Drop: 140 lbs / 30 inches
- Scattered organics at about 40 feet.			13			
BOTTOM OF BORING COMPLETED 6/18/2013	41.5					



LEGEND

* Sample Not Recovered

2.0" O.D. Split Spoon Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-4
Sheet 3 of 3

MASTER_LOG_E_21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	21.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	7 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Medium stiff, gray-brown, slightly clayey SILT, trace of fine sand; moist; abundant iron-oxide staining and roots near ground surface; (Agricultural layer) ML.

2.4

Laminated, gray-brown, fine sandy SILT and SILT; moist; iron-oxide stains; (Hm) ML.

3.0

Very loose to loose, dark gray-brown, trace of silt to slightly silty, fine to medium SAND; wet; locally trace of fine gravel; (Ha) SP-SM/SP

- Iron-oxide stains above 3.5 feet.
- Silty sand layer from about 7 to 9 feet.
- Brown, slightly clayey silt layer from about 10.2 to 10.5 feet.
- Three feet of heave while sampling S-6, S-7, and S-8. Blow counts for those samples may not be accurate.
- Trace of shells below 17 feet.

18.5

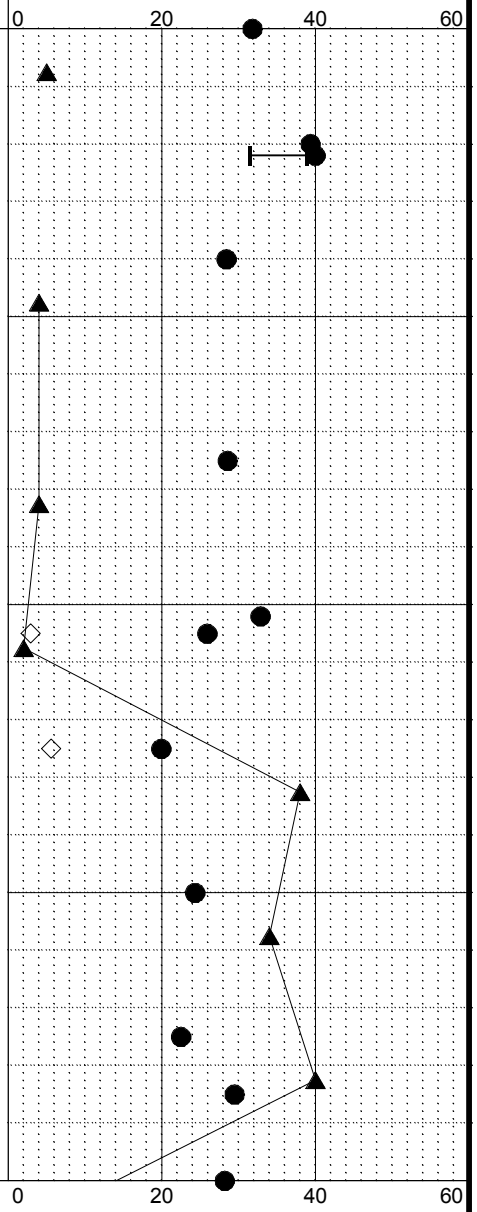
Very loose, dark gray-brown, silty, fine SAND; wet; abundant shells, strong sulfur smell; (He) SM.

CONTINUED NEXT SHEET

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- 3.0" O.D. Osterberg Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in Well

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-5
Sheet 1 of 2

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	21.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	7 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE (blows/foot) ▲ Hammer Wt. & Drop: 140 lbs / 30 inches
			9			
BOTTOM OF BORING COMPLETED 6/19/2013	21.5					
					25	
					30	
					35	

0 20 40 60

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- 3.0" O.D. Osterberg Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in Well

◇ % Fines (<0.075mm)
● % Water Content
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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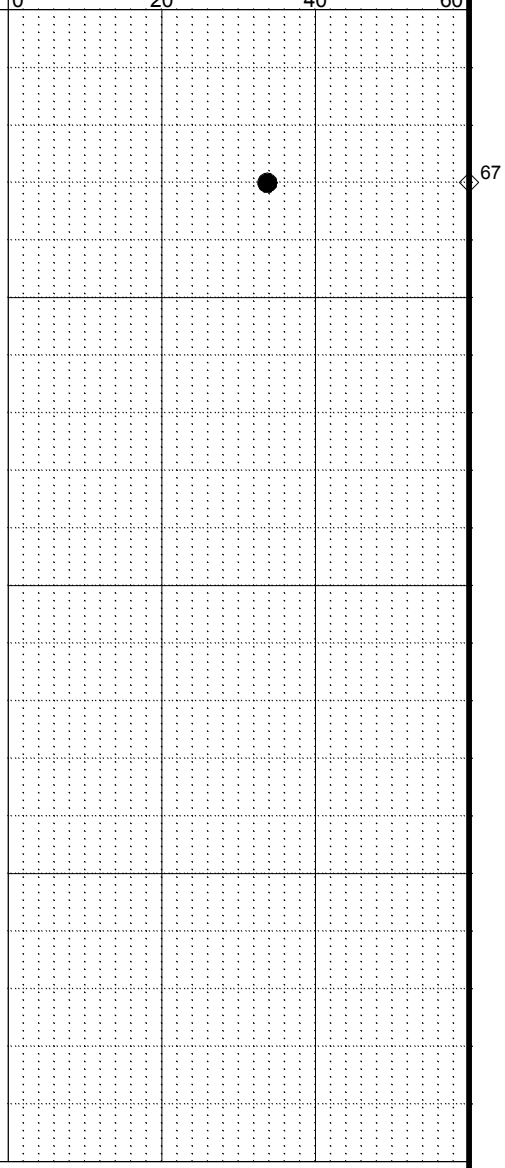
FIG. A-5
Sheet 2 of 2

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	3.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	8 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
Gray-brown, fine to medium sandy SILT; moist; iron-oxide staining, trace of organics; (Agricultural layer) ML.			1 G		
BOTTOM OF BORING COMPLETED 6/19/2013	3.5				

Note: Grab sample collected using a split spoon pounded 12 inches.



LEGEND

- * Sample Not Recovered
- G Grab Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in Well
- ◇ % Fines (<0.075mm)
- ● % Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-6

MASTER_LOG_E_21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	21.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	7 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches

Soft to medium stiff, gray-brown, slightly clayey SILT, trace of fine sand; moist; iron-oxide staining, trace of organics; (Agricultural layer) ML.

- Wet below 3.5 feet.

- Interbedded with silty, fine sand below about 5 feet.

6.0

Very loose to loose, dark gray, fine to coarse SAND, trace of silt; wet; (Ha) SP.

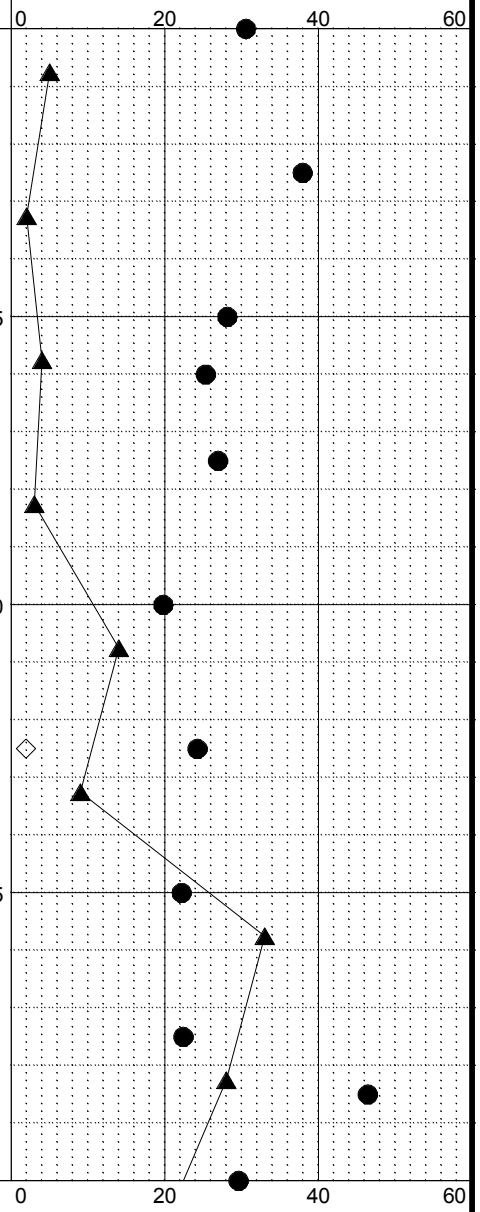
- Blow counts for samples S-5 and S-7 may be artificially high due to heave.

- Blow counts for samples S-8 and S-9 may be artificially high due to heave.

18.5

Medium dense, dark gray-brown, silty, fine SAND; wet; scattered shells, trace of organics;

CONTINUED NEXT SHEET



◇ % Fines (<0.075mm)

● % Water Content

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in Well

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-7
Sheet 1 of 2

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	21.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	7 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE (blows/foot) ▲ Hammer Wt. & Drop: 140 lbs / 30 inches
(He) SM.			9			
BOTTOM OF BORING COMPLETED 6/19/2013	21.5					
					25	
					30	
					35	

0 20 40 60

0 20 40 60

◇ % Fines (<0.075mm)
● % Water Content

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in Well

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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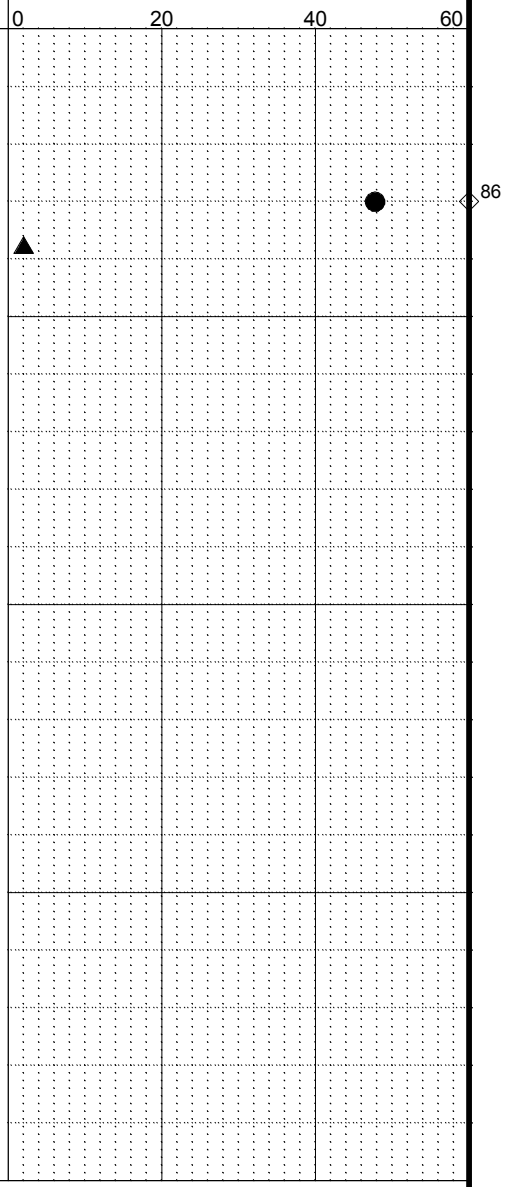
FIG. A-7
Sheet 2 of 2

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	4.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	7 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE (blows/foot) ▲ Hammer Wt. & Drop: 140 lbs / 30 inches
Soft, gray-brown, trace to slightly clayey, fine sandy SILT; moist; trace of organics, iron-oxide staining; (Agricultural layer) ML.			1			
BOTTOM OF BORING COMPLETED 6/20/2013	4.5					



LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in Well
- ◇ % Fines (<0.075mm)
- ● % Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

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FIG. A-8

MASTER_LOG_E_21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	21.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	7 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.

Soft, gray, slightly clayey, slightly fine sandy SILT; moist; abundant organics (roots), iron-oxide staining; (Agricultural layer) ML.

3.0

Very loose to loose, dark gray-brown, trace of silt to slightly silty, fine to coarse SAND; wet; locally trace of fine gravel, scattered to abundant organics; (Ha) SP/SP-SM.

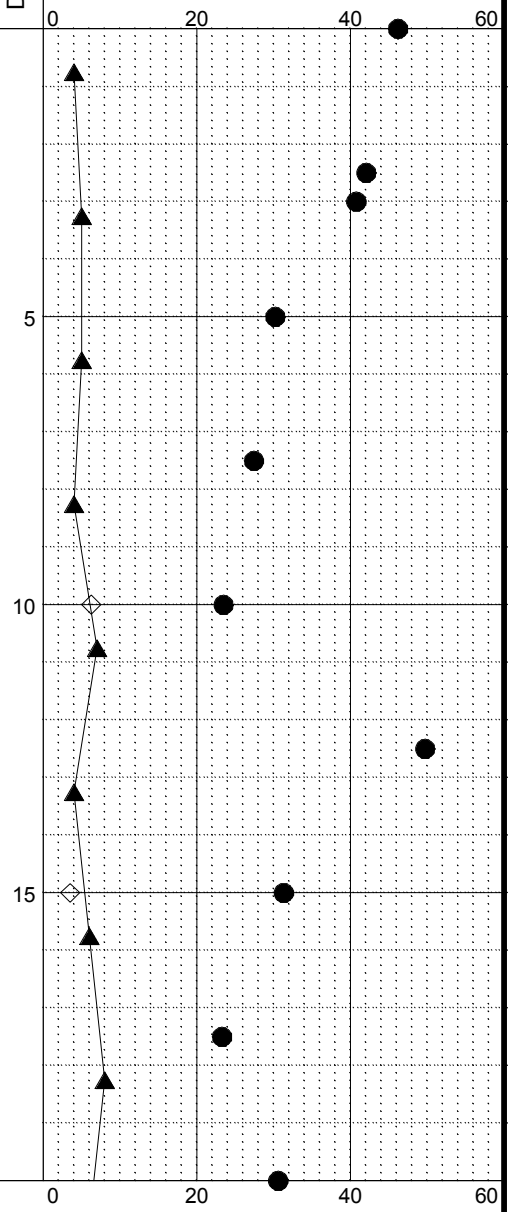
- Trace of organics below about 15 feet.

CONTINUED NEXT SHEET

Depth, ft. | Symbol | Samples | Ground Water | Depth, ft.

PENETRATION RESISTANCE (blows/foot)

▲ Hammer Wt. & Drop: 140 lbs / 30 inches



◇ % Fines (<0.075mm)

● % Water Content

LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in Well

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF BORING B-8w-13

May 2014 | 21-1-12318-001

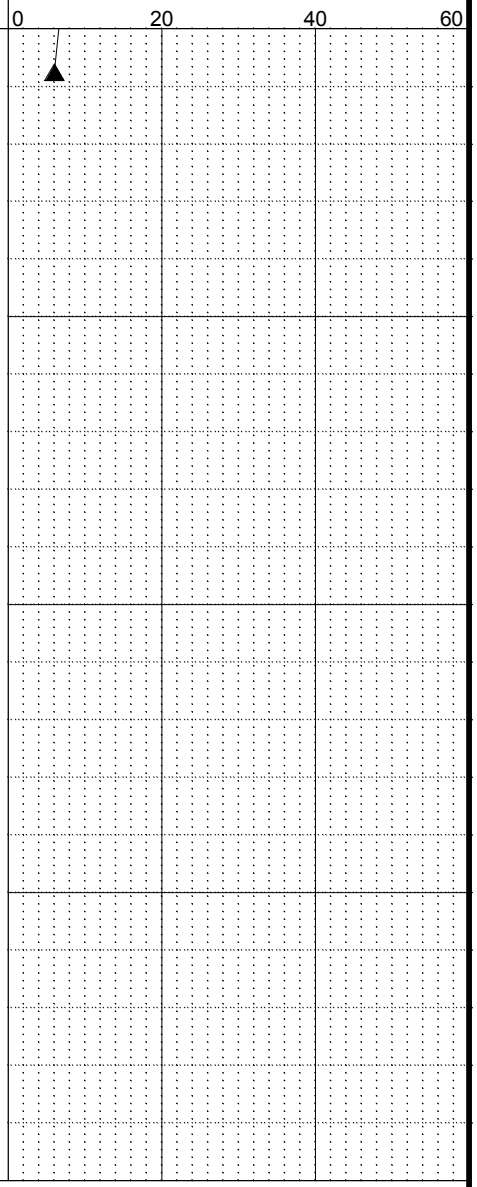
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-9
Sheet 1 of 2

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	21.5 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	7 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE (blows/foot) ▲ Hammer Wt. & Drop: 140 lbs / 30 inches
- Silt seams at about 20 feet.			9			
BOTTOM OF BORING COMPLETED 6/20/2013	21.5					
					25	
					30	
					35	



LEGEND

- * Sample Not Recovered
- 2.0" O.D. Split Spoon Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in Well
- ◇ % Fines (<0.075mm)
- ● % Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF BORING B-8w-13

May 2014 | 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

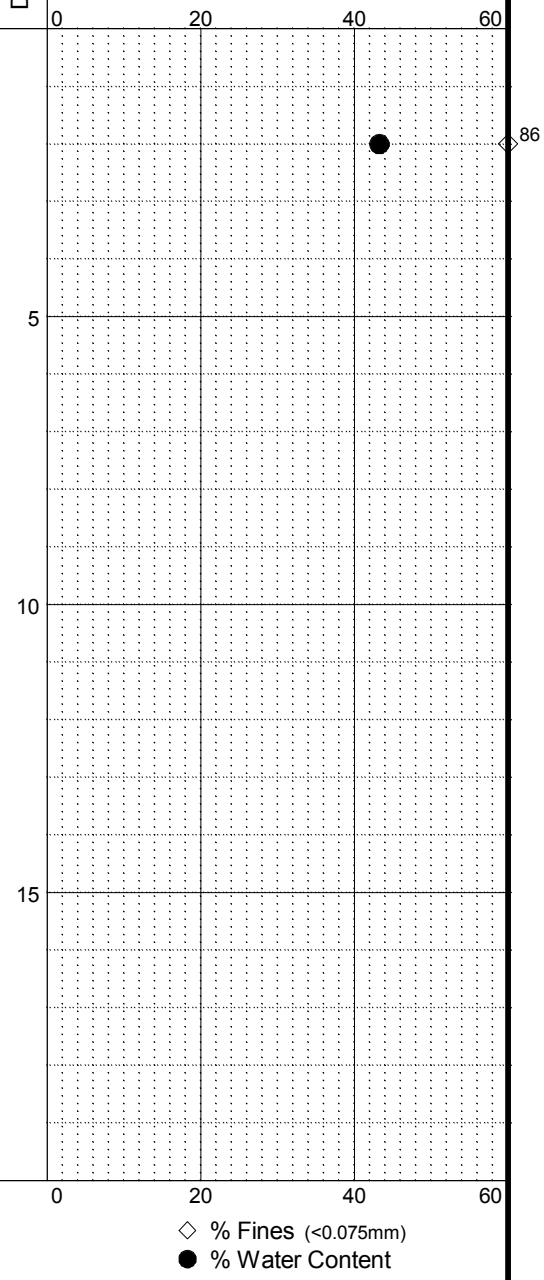
FIG. A-9
Sheet 2 of 2

MASTER_LOG_E_21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Total Depth:	3 ft.	Northing:	~	Drilling Method:	Hollow Stem Auger	Hole Diam.:	7 in.
Top Elevation:	~	Easting:	~	Drilling Company:	Boart Longyear	Rod Diam.:	NWJ
Vert. Datum:		Station:	~	Drill Rig Equipment:	CME 850 Track	Hammer Type:	Automatic
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
Gray-brown, slightly clayey, fine to medium sandy SILT; moist; abundant organics; (Agricultural layer) ML.			1 G		
BOTTOM OF BORING COMPLETED 6/20/2013	3.0				

Note: Grab sample collected using a split spoon pounded 12 inches.



◇ % Fines (<0.075mm)
● % Water Content

LEGEND

- * Sample Not Recovered
- G Grab Sample
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout
- Ground Water Level in Well

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location was measured from existing site features and should be considered approximate.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF BORING B-9w-13

May 2014 | 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

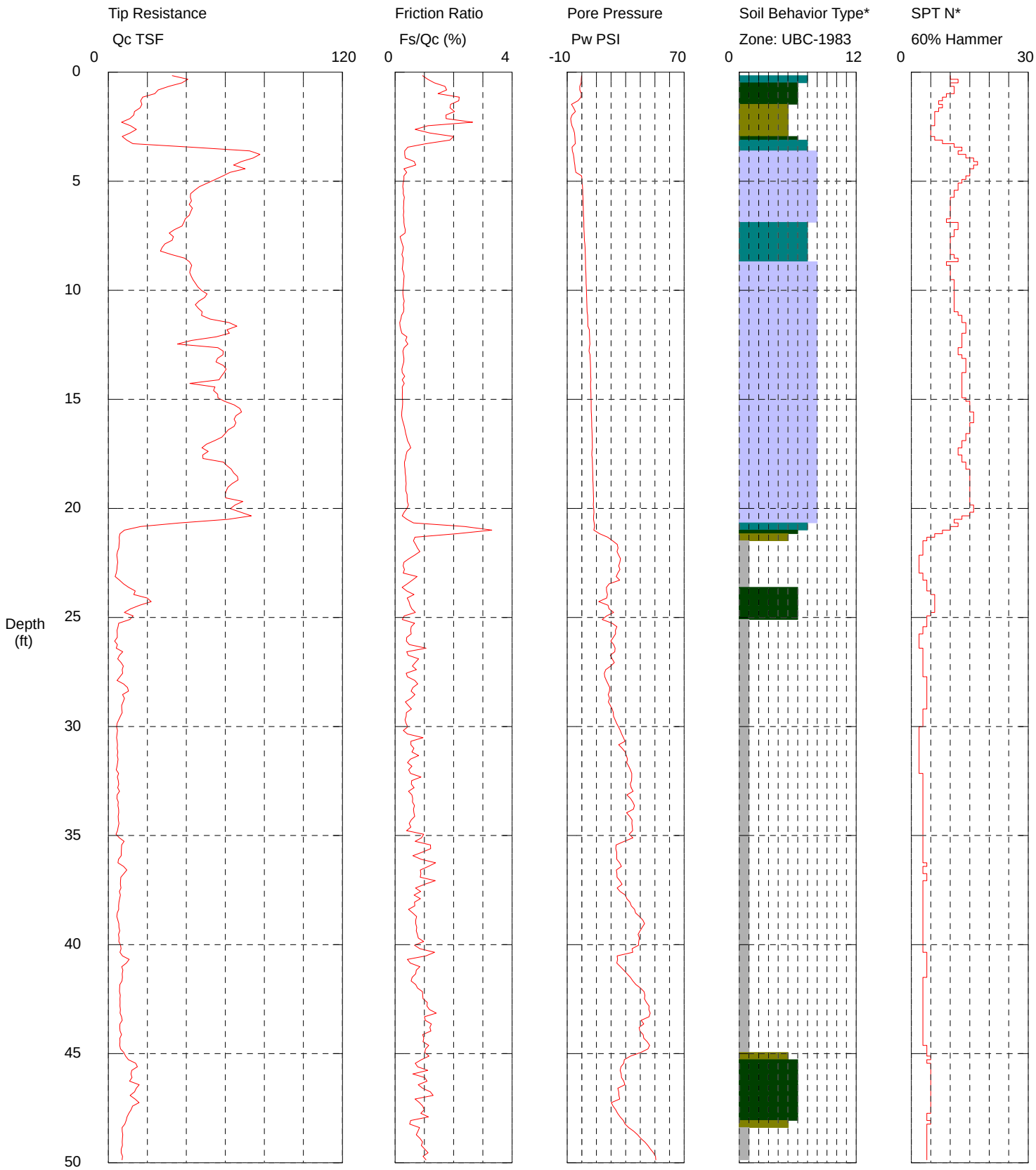
FIG. A-10

MASTER_LOG_E_21-12318.GPJ SHAN_WIL.GDT 5/22/14 Log: JMW Rev: JKP Typ: LKN

Shannon & Wilson

Operator: Gerdes
Sounding: CPT-01-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 6:26:18 PM
Location: Fir Island WA
Job Number: 21-1-12318-215



Maximum Depth = 50.03 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

InSitu Engineering

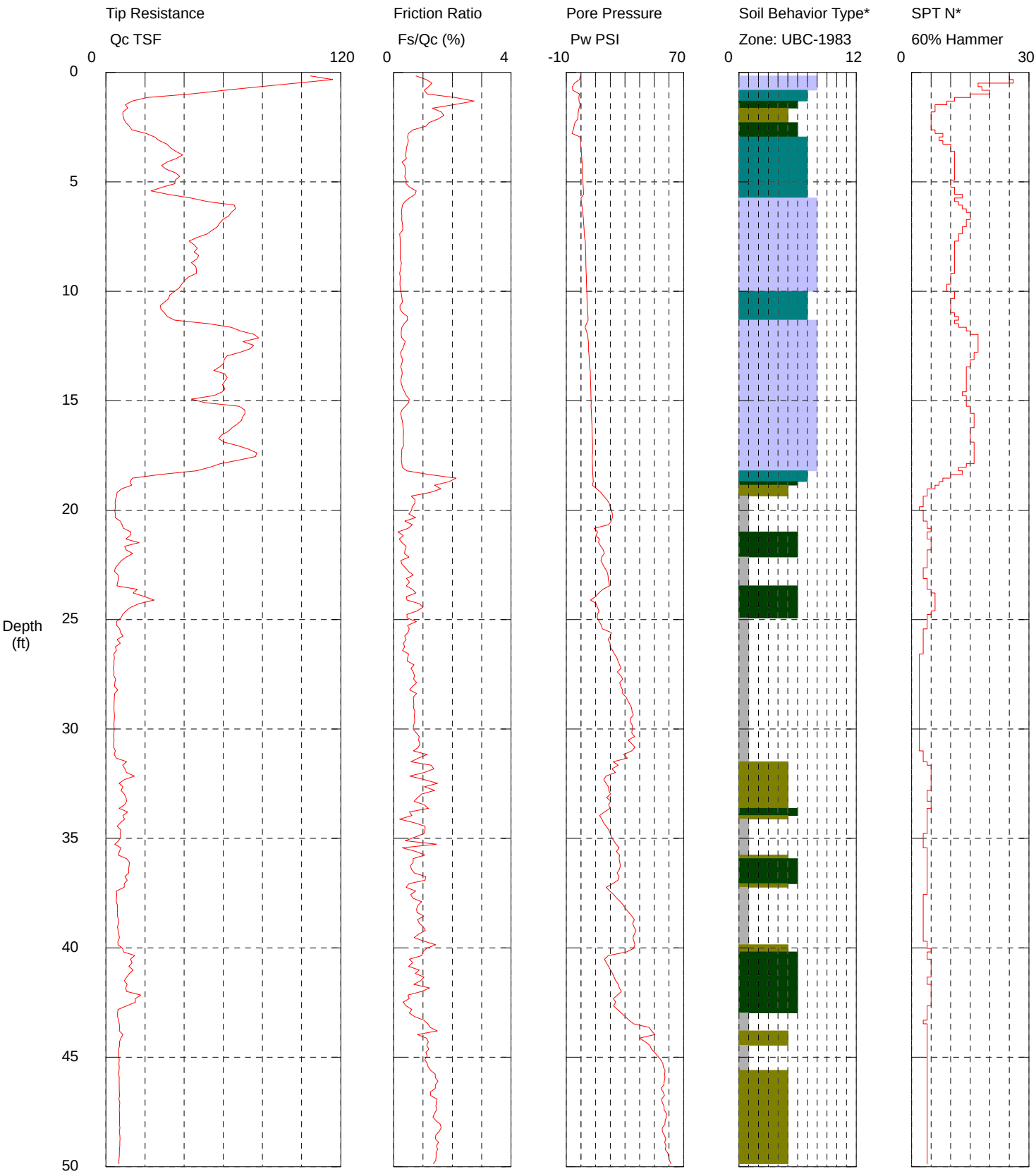
Fig. A-11

*Soil behavior type and SPT based on data from UBC-1983

Shannon & Wilson

Operator: Gerdes
Sounding: CPT-02-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 4:45:35 PM
Location: Fir Island WA
Job Number: 21-1-12318-215



Maximum Depth = 50.03 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

InSitu Engineering

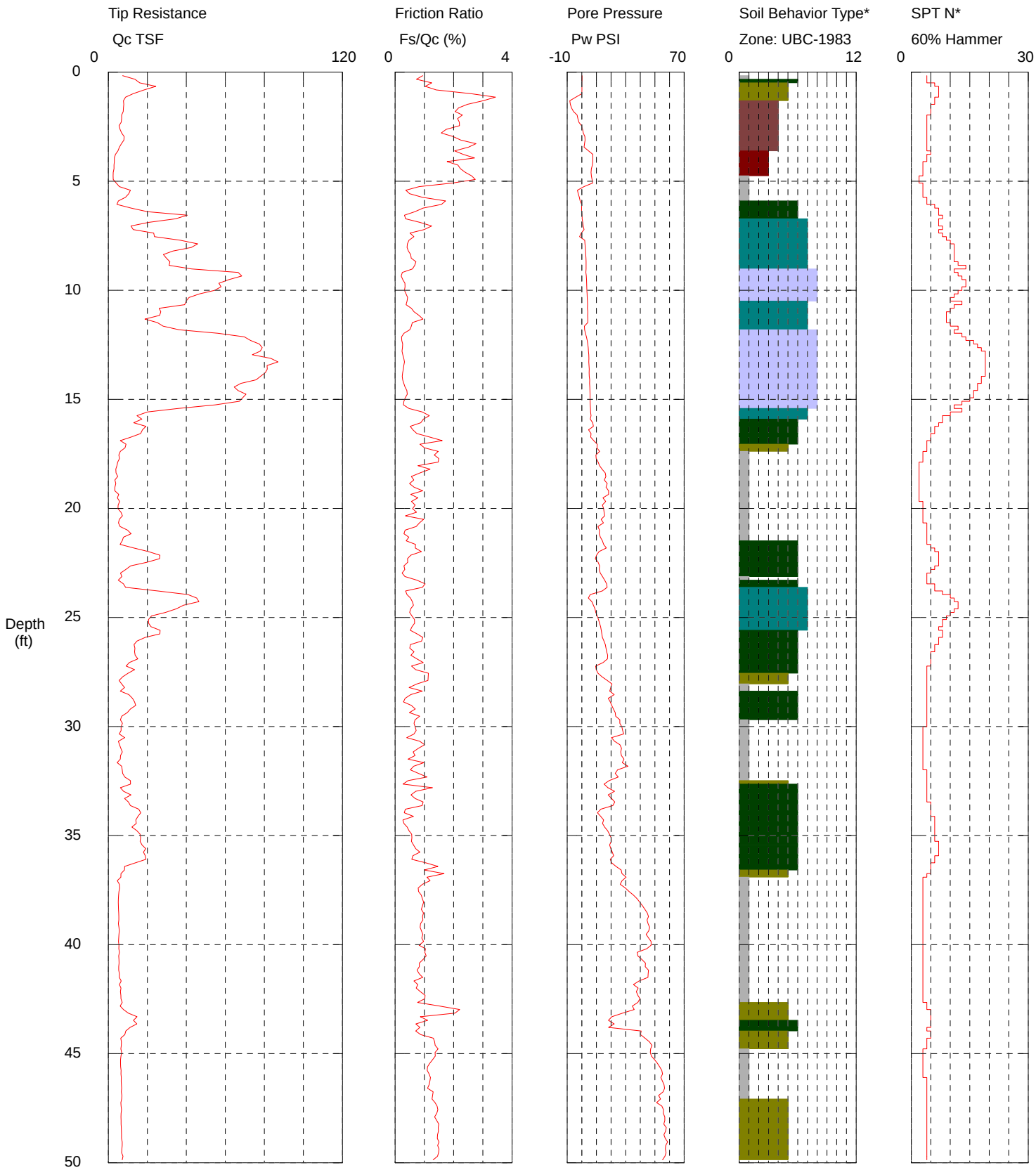
Fig. A-12

*Soil behavior type and SPT based on data from UBC-1983

Shannon & Wilson

Operator: Gerdes
Sounding: CPT-03-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 3:34:21 PM
Location: Fir Island WA
Job Number: 21-1-12318-215



Maximum Depth = 50.03 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

InSitu Engineering

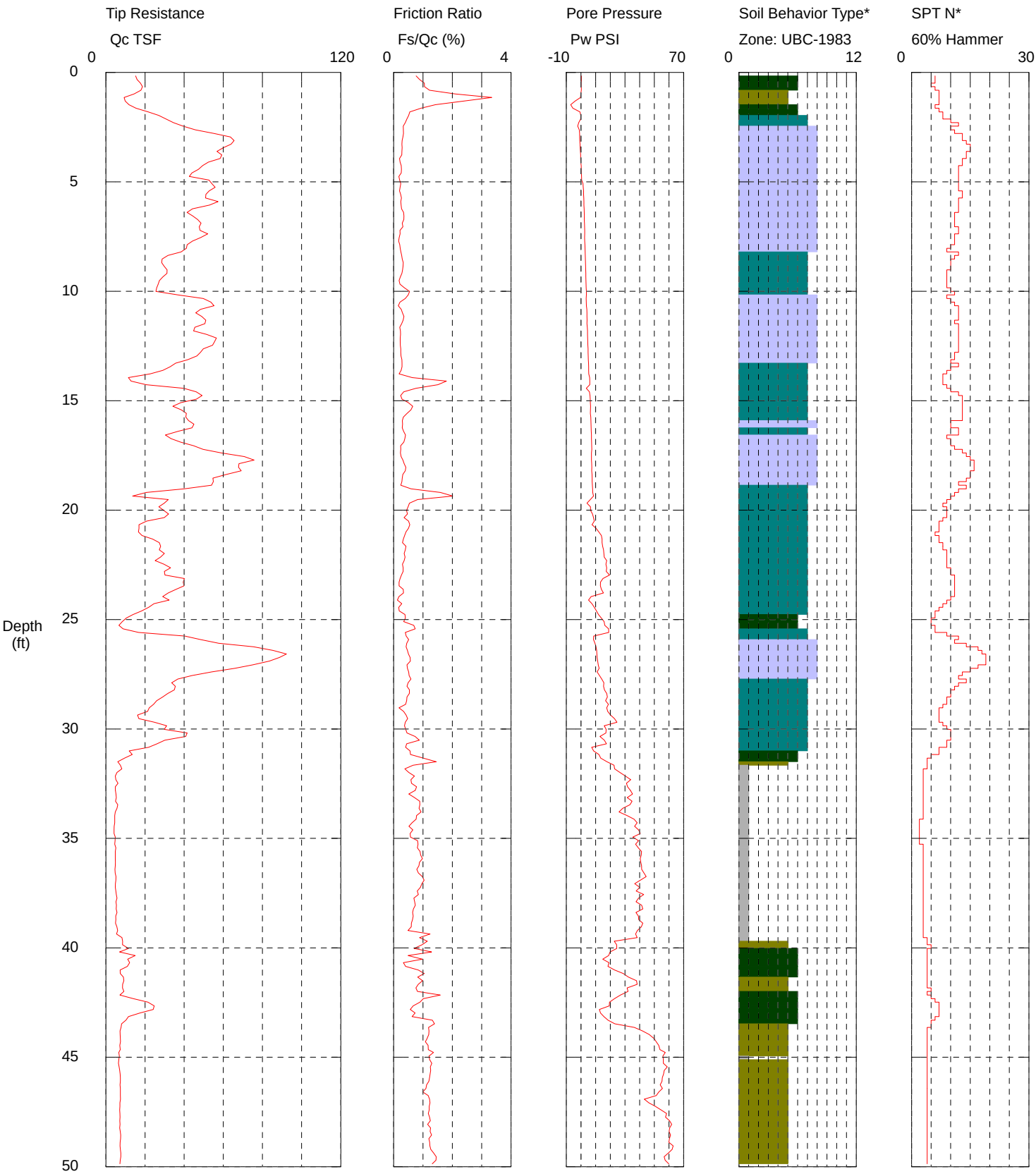
Fig. A-13

*Soil behavior type and SPT based on data from UBC-1983

Shannon & Wilson

Operator: Gerdes
Sounding: CPT-04-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 2:02:58 PM
Location: Fir Island WA
Job Number: 21-1-12318-215



Maximum Depth = 50.03 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

InSitu Engineering

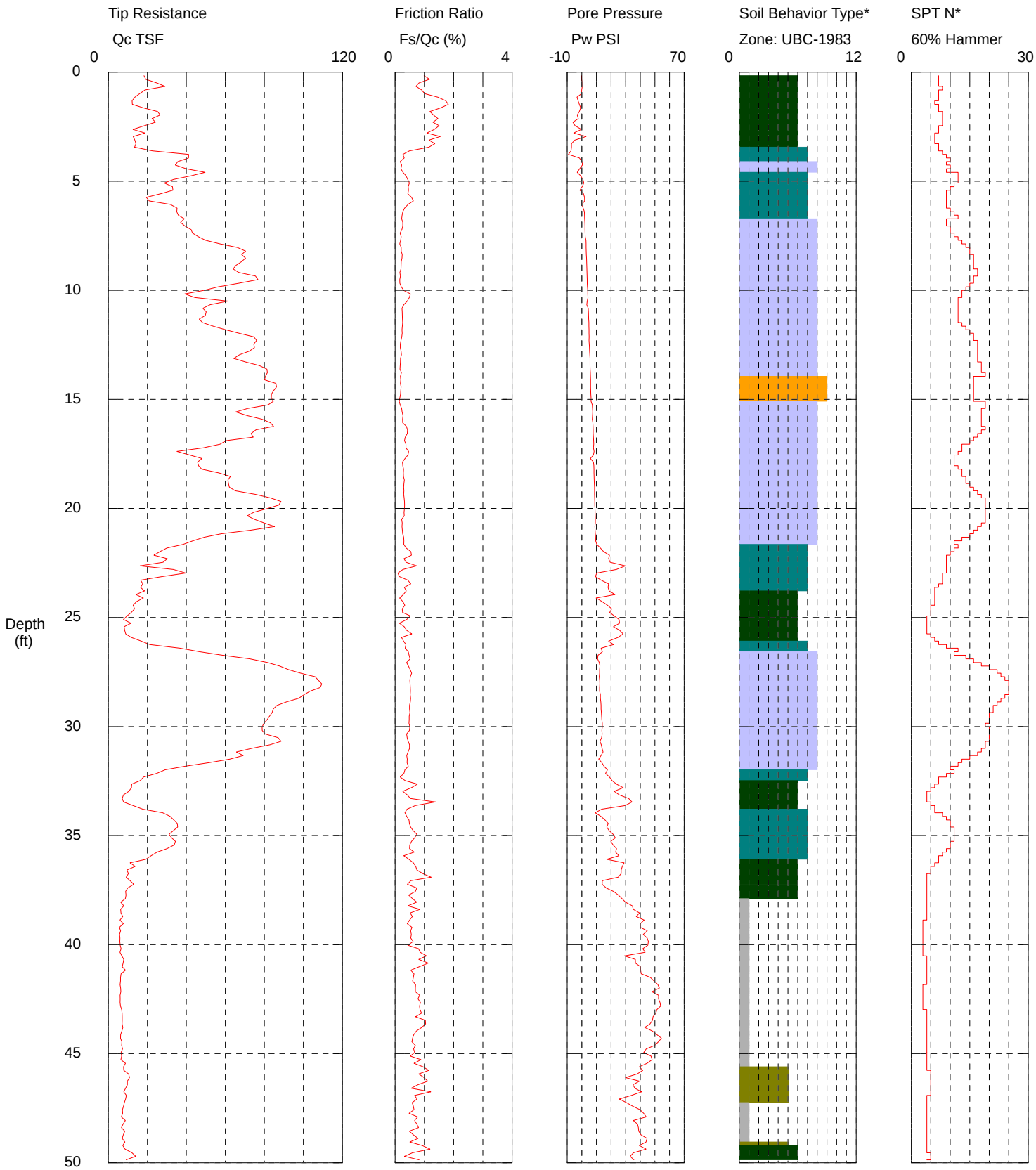
Fig. A-14

*Soil behavior type and SPT based on data from UBC-1983

Shannon & Wilson

Operator: Gerdes
Sounding: CPT-05-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 12:50:37 PM
Location: Fir Island WA
Job Number: 21-1-12318-215



Maximum Depth = 50.03 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

InSitu Engineering

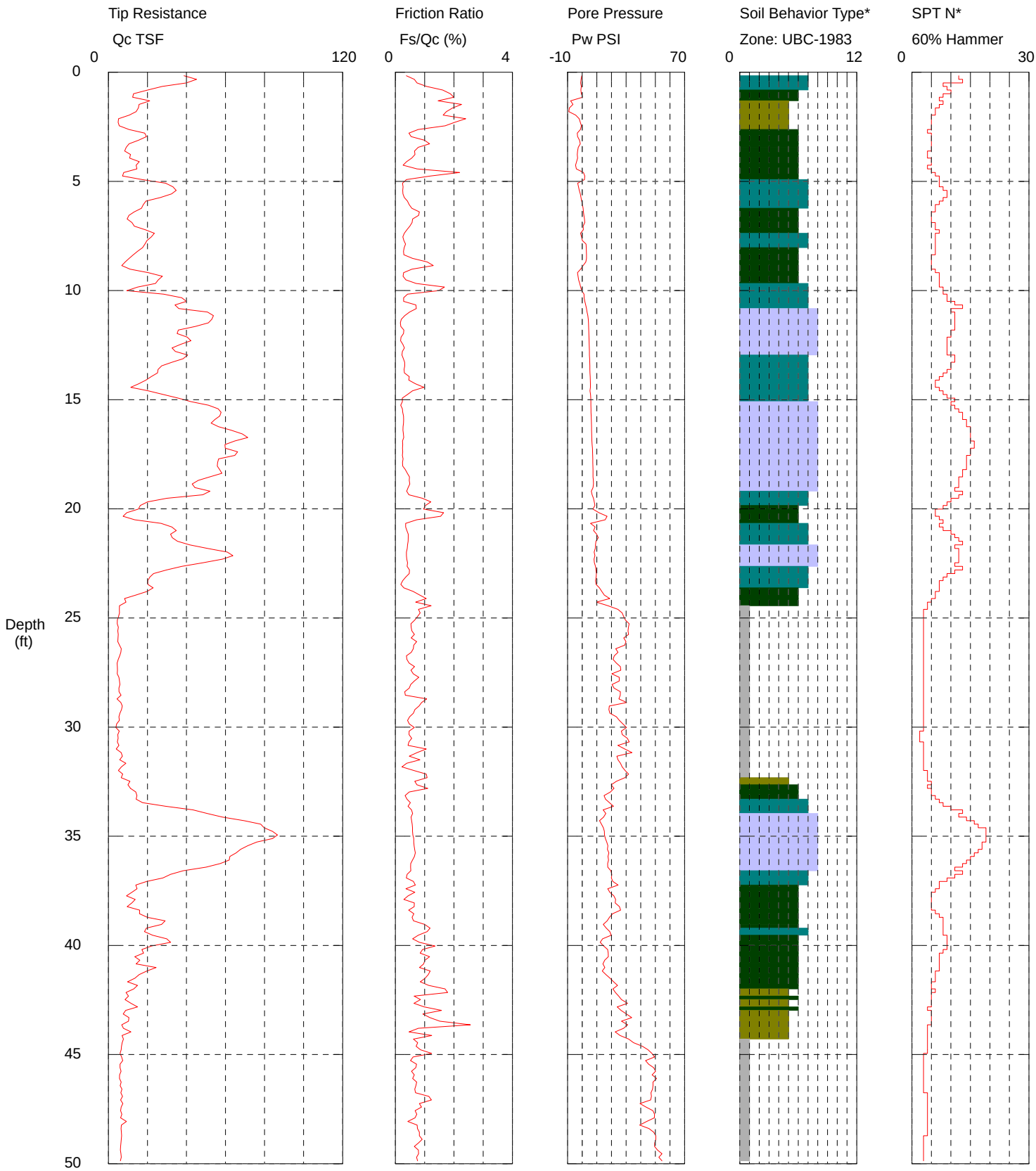
Fig. A-15

*Soil behavior type and SPT based on data from UBC-1983

Shannon & Wilson

Operator: Gerdes
Sounding: CPT-06-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 11:04:08 AM
Location: Fir Island WA
Job Number: 21-1-12318-215



Maximum Depth = 50.03 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

InSitu Engineering

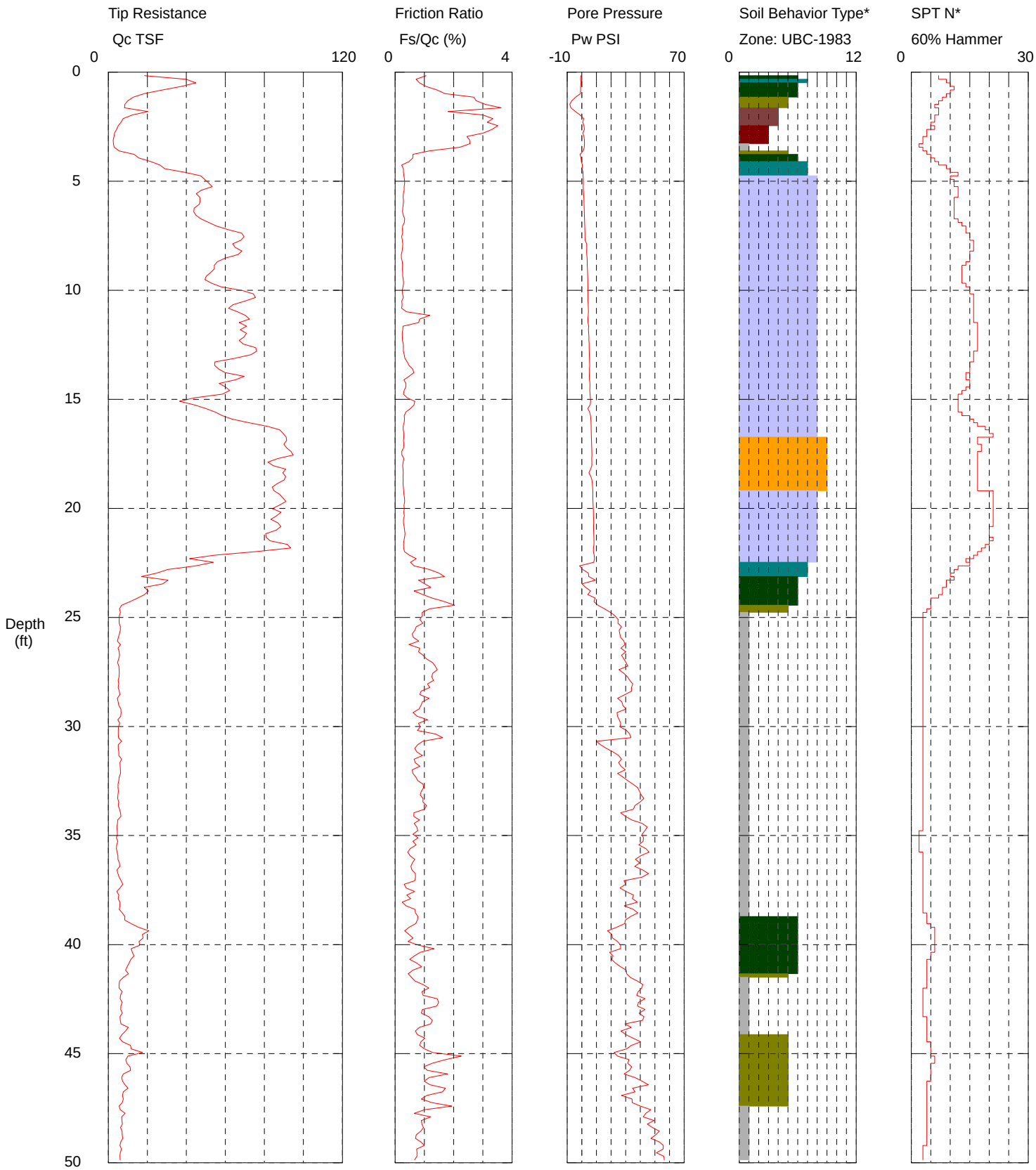
Fig. A-16

*Soil behavior type and SPT based on data from UBC-1983

Shannon & Wilson

Operator: Gerdes
Sounding: CPT-07-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 9:15:32 AM
Location: Fir Island WA
Job Number: 21-1-12318-215



Maximum Depth = 50.03 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

InSitu Engineering

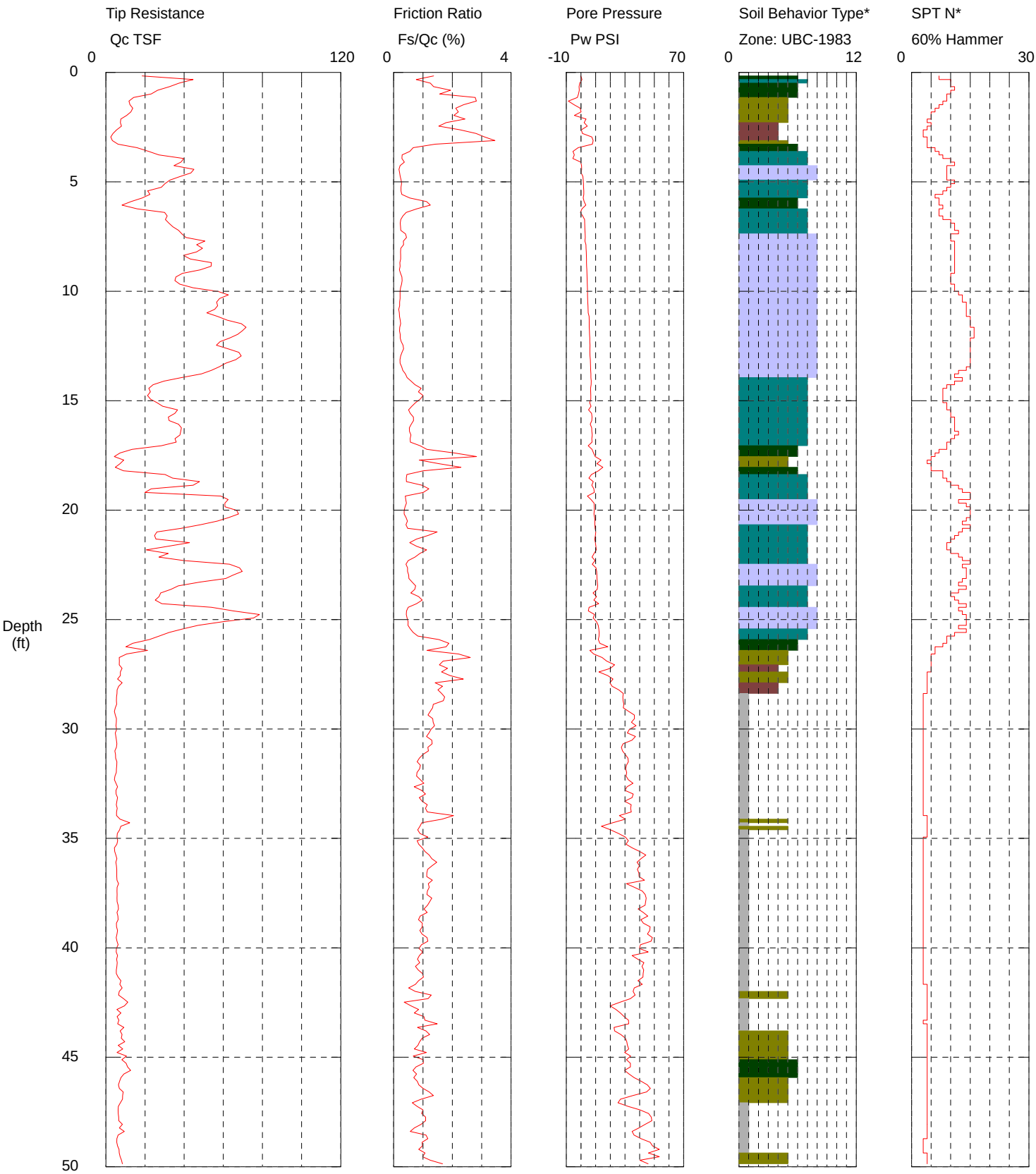
Fig. A-17

*Soil behavior type and SPT based on data from UBC-1983

Shannon & Wilson

Operator: Gerdes
Sounding: CPT-08-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 7:57:15 AM
Location: Fir Island WA
Job Number: 21-1-12318-215



Maximum Depth = 50.03 feet

Depth Increment = 0.164 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

InSitu Engineering

Fig. A-18

*Soil behavior type and SPT based on data from UBC-1983

Shannon & Wilson

Operator Gerdes
Sounding: CPT-01-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 6:26:18 PM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

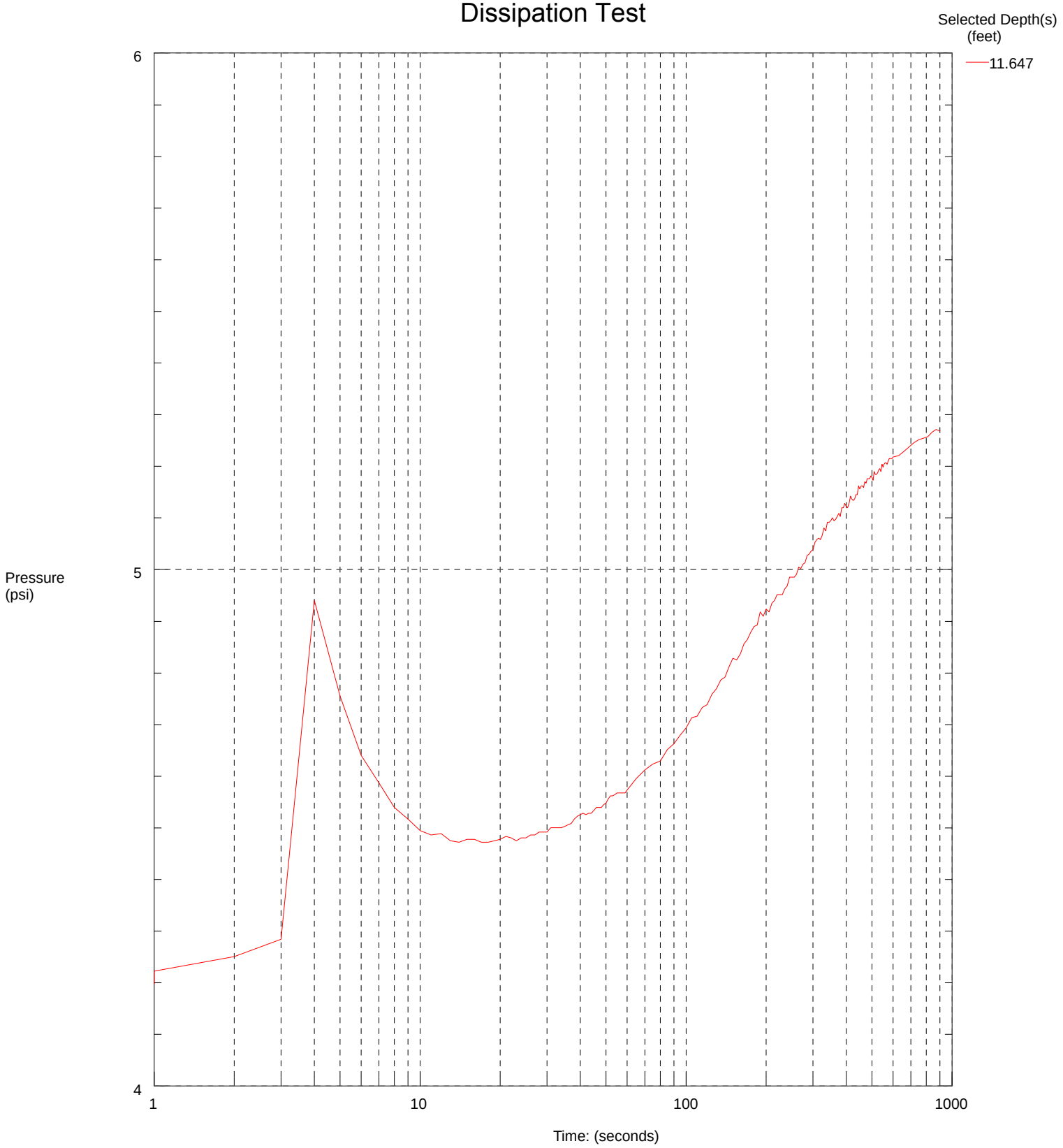


Fig. A-19

Shannon & Wilson

Operator Gerdes
Sounding: CPT-02-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 4:45:35 PM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

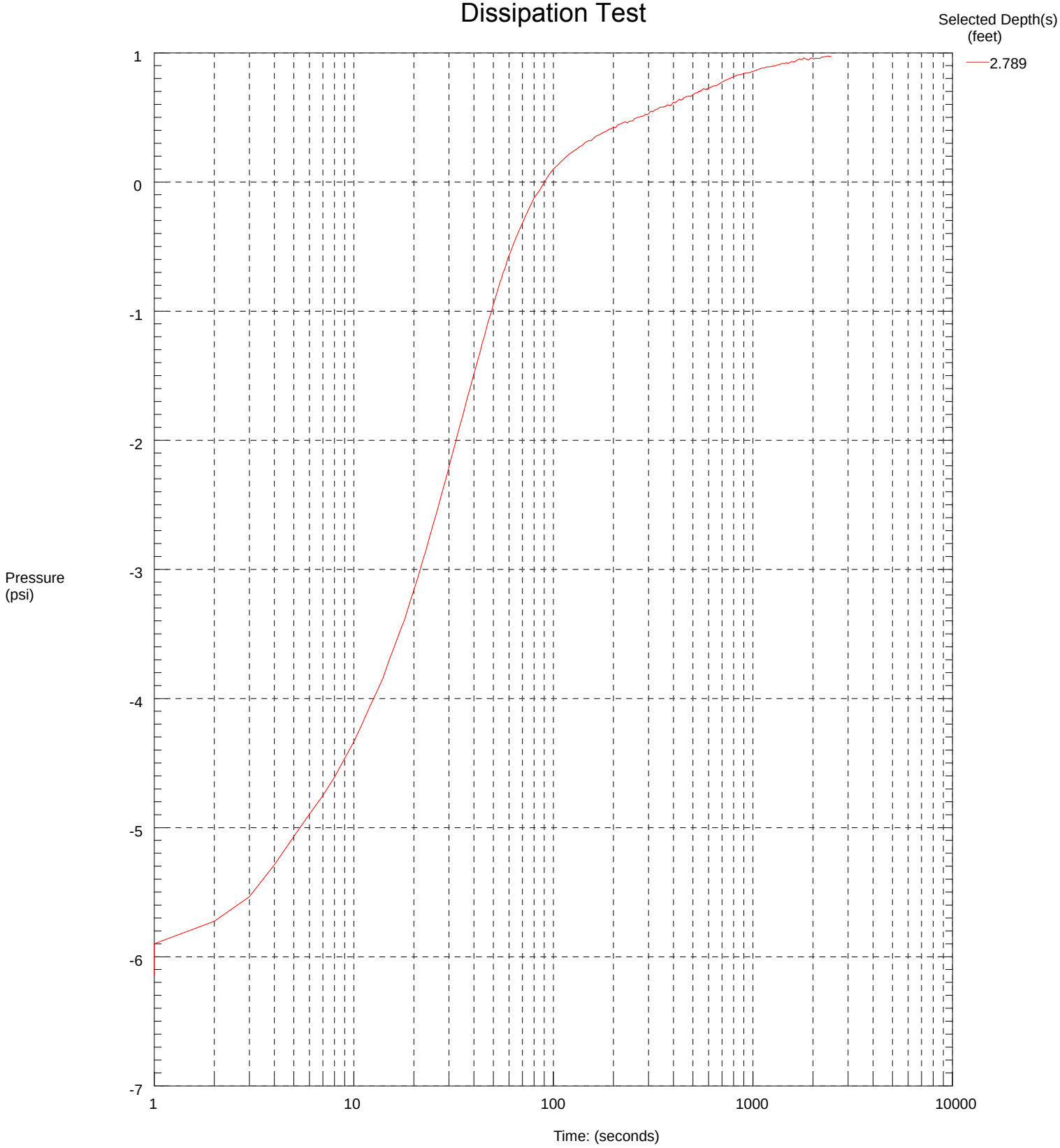


Fig. A-20

Shannon & Wilson

Operator Gerdes
Sounding: CPT-02-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 4:45:35 PM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

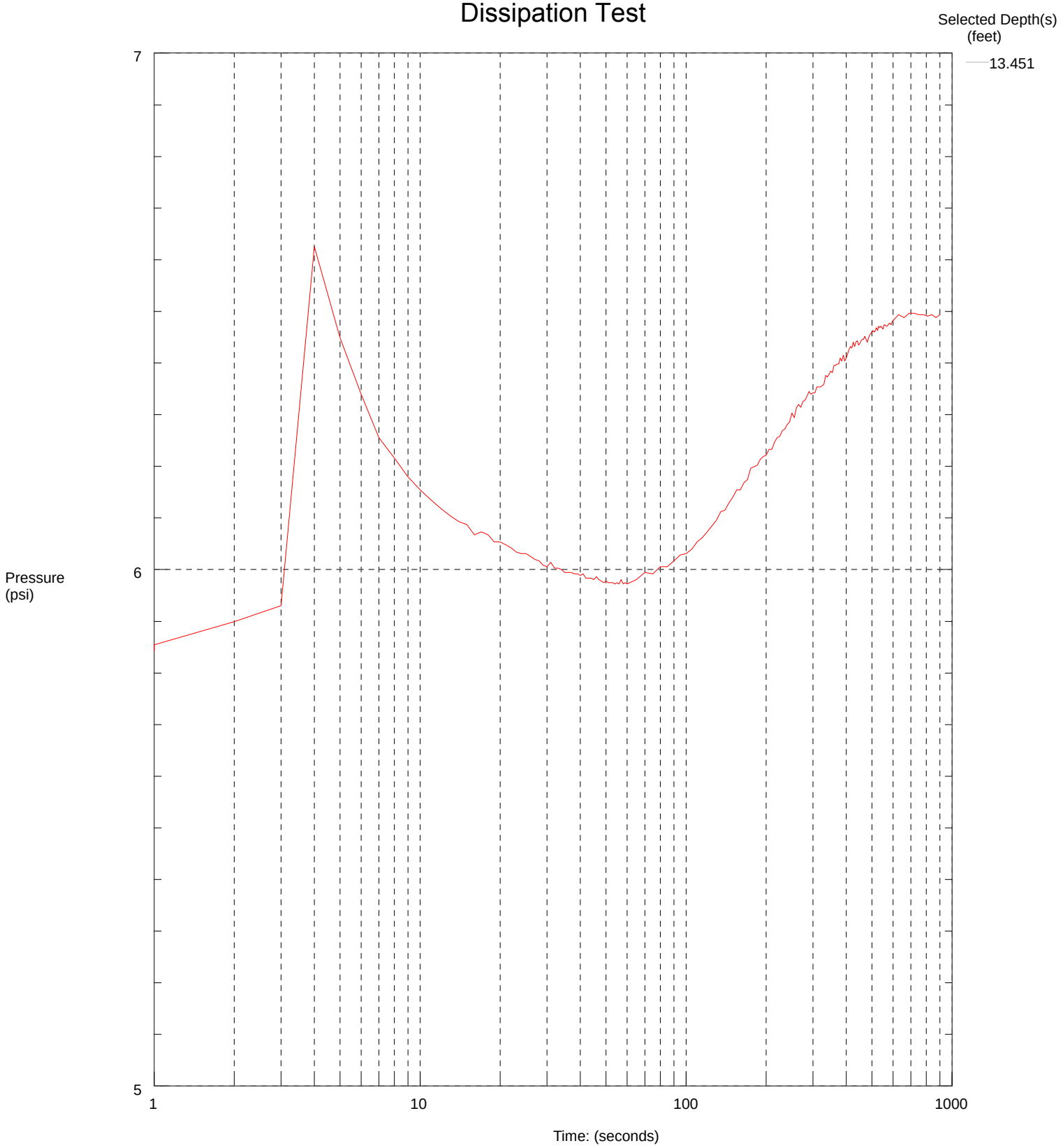


Fig. A-21

Shannon & Wilson

Operator Gerdes
Sounding: CPT-03-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 3:34:21 PM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

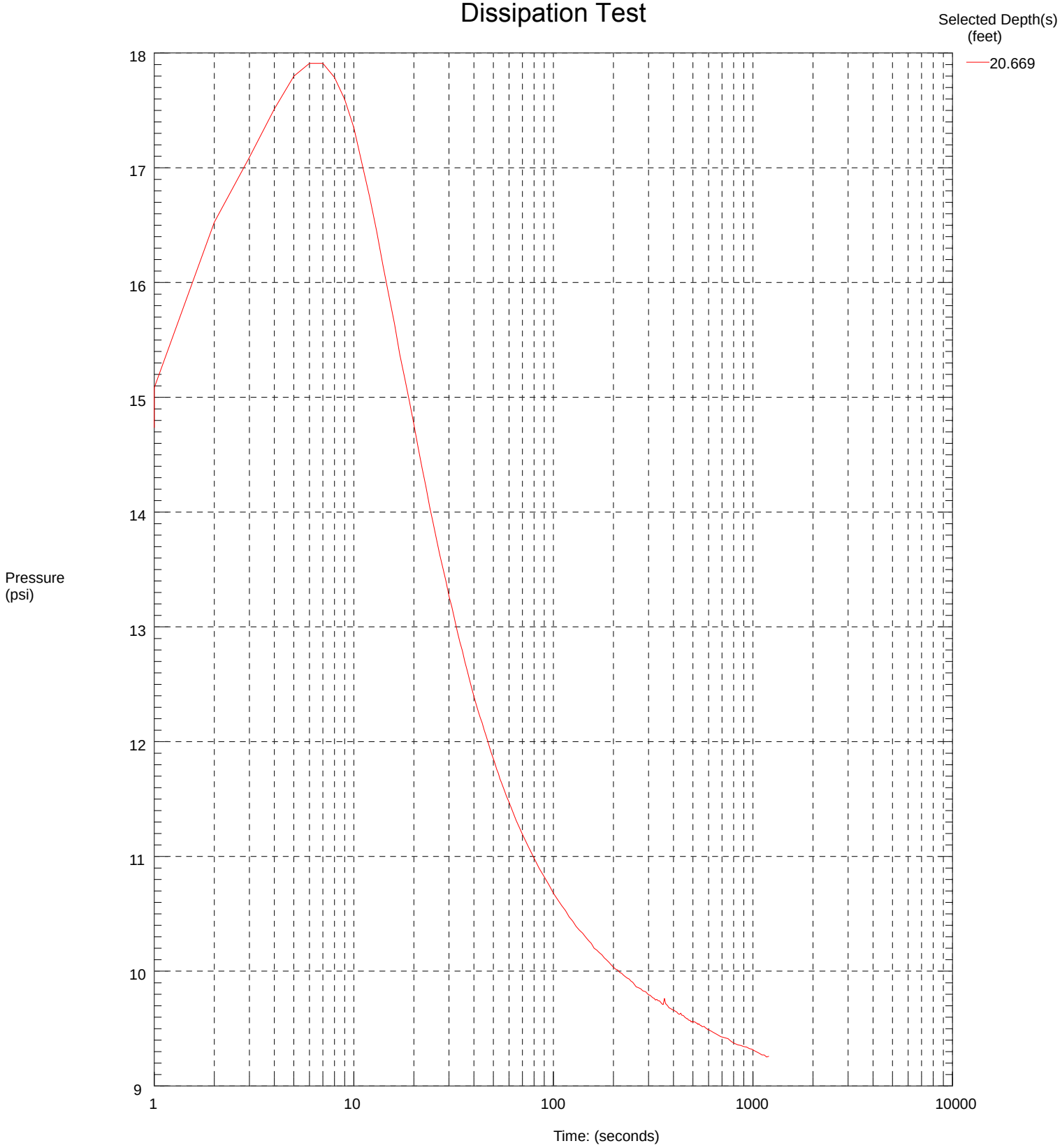


Fig. A-22

Shannon & Wilson

Operator Gerdes
Sounding: CPT-04-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 2:02:58 PM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

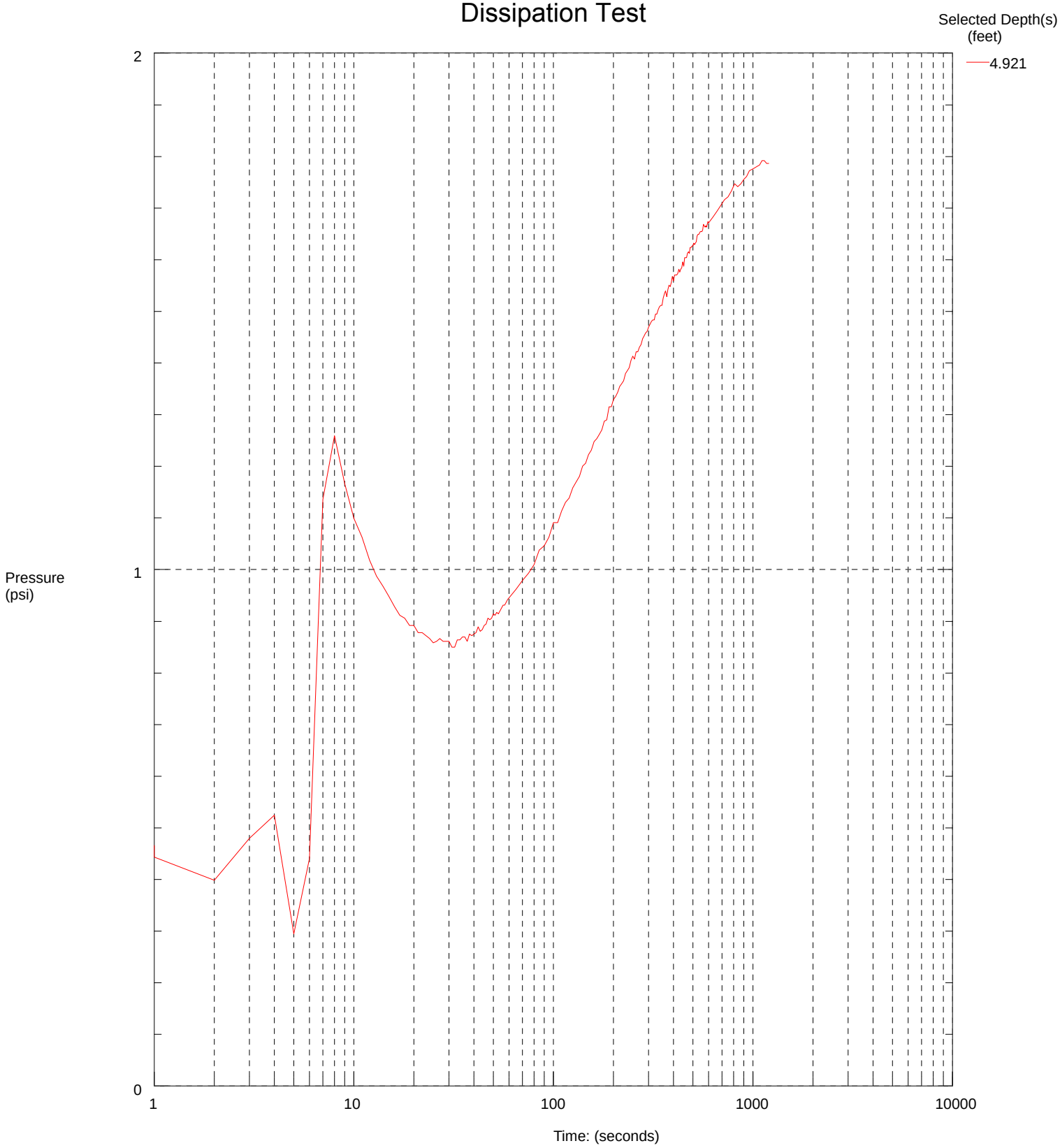


Fig. A-23

Shannon & Wilson

Operator Gerdes
Sounding: CPT-04-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 2:02:58 PM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

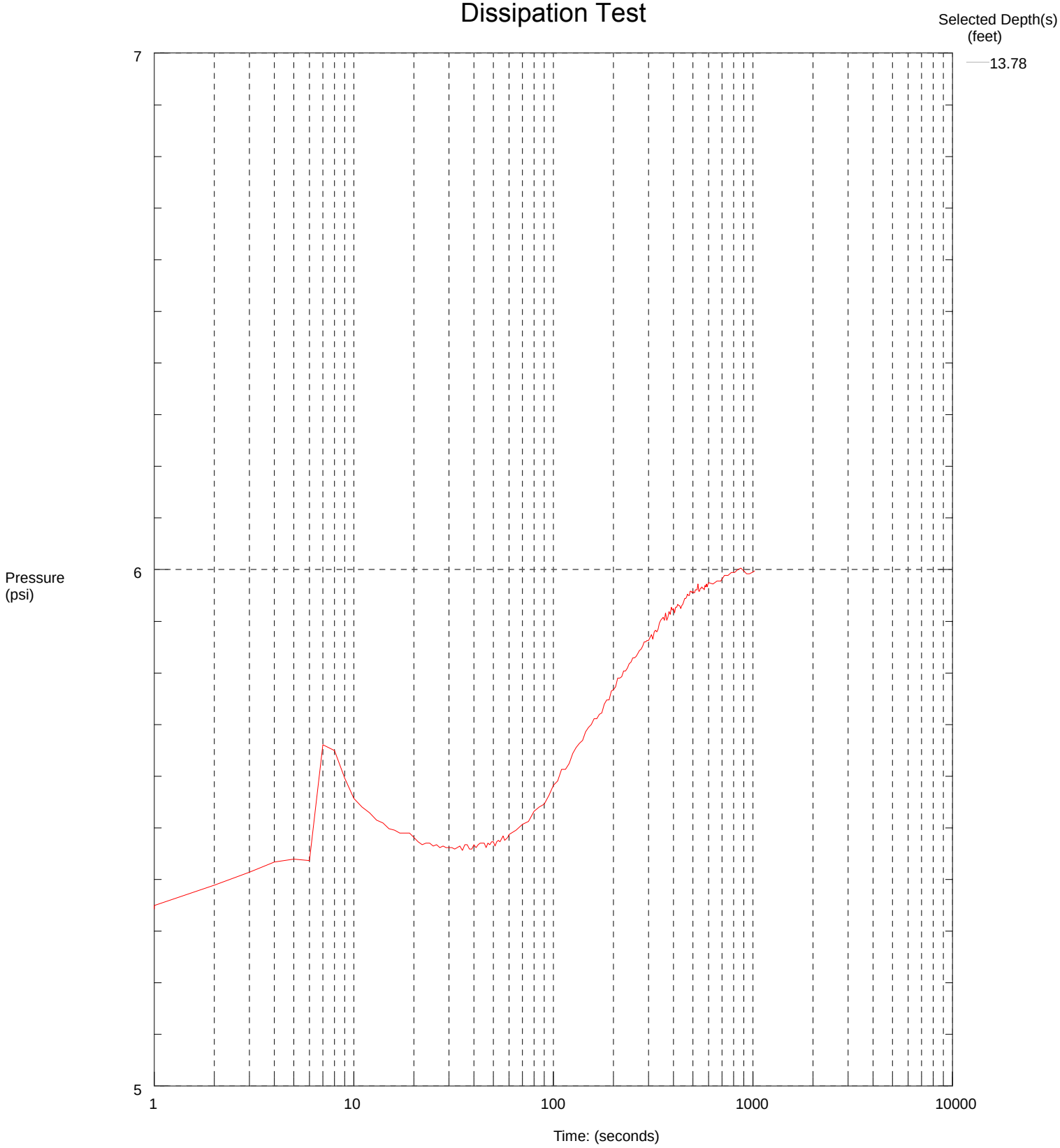


Fig. A-24

Shannon & Wilson

Operator Gerdes
Sounding: CPT-05-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 12:50:37 PM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

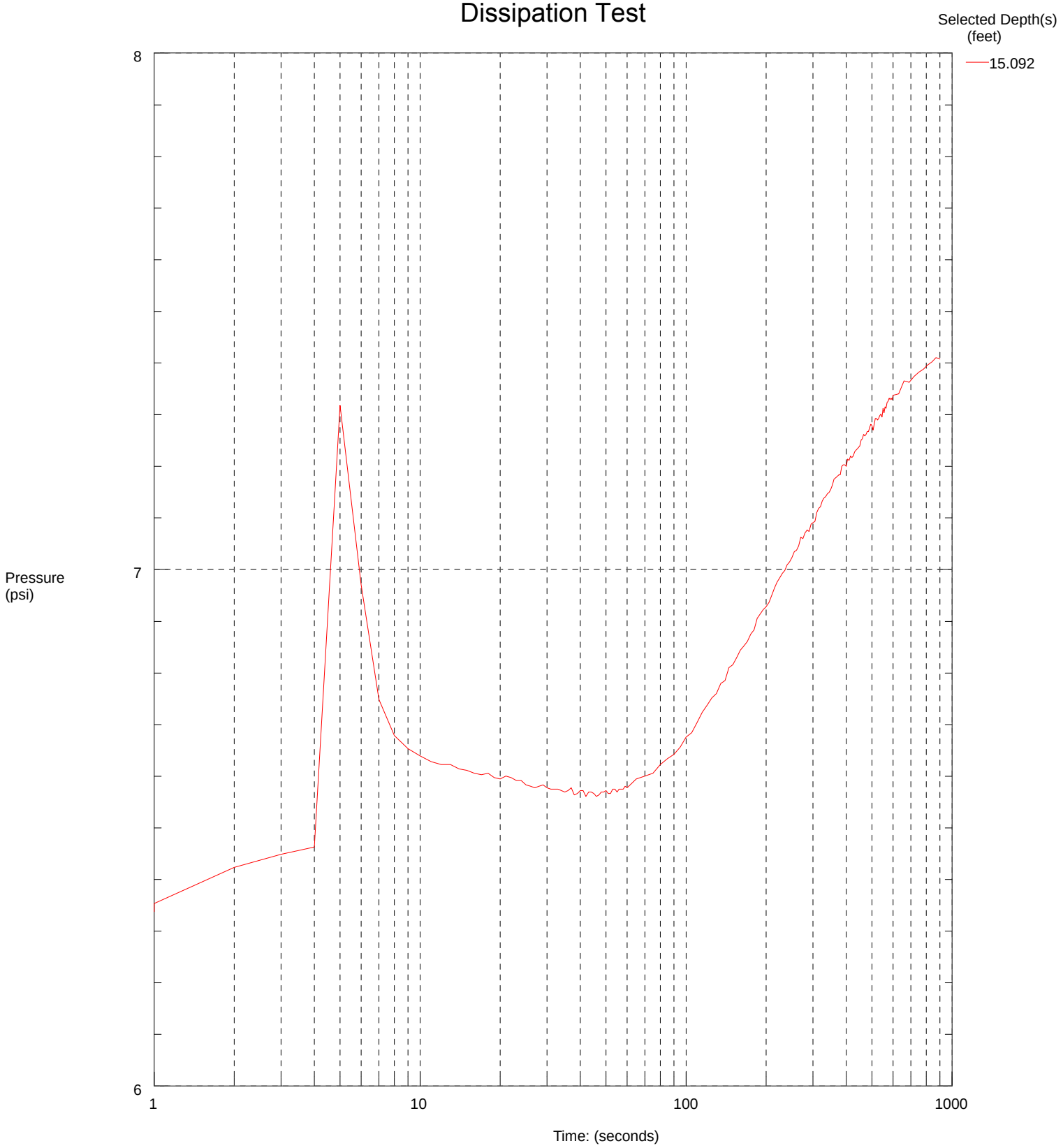


Fig. A-25

Shannon & Wilson

Operator Gerdes
Sounding: CPT-05-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 12:50:37 PM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

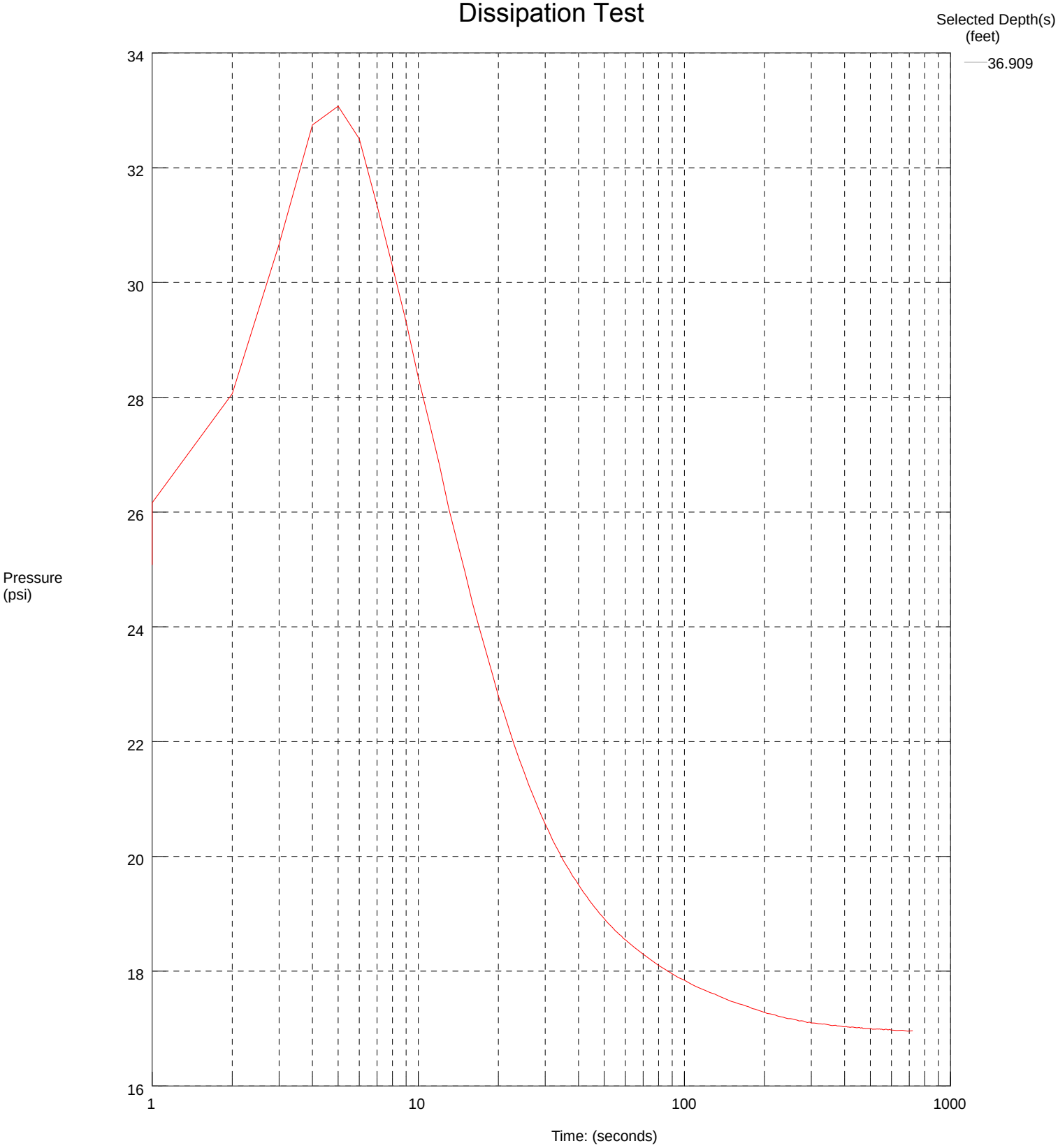


Fig. A-26

Shannon & Wilson

Operator Gerdes
Sounding: CPT-06-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 11:04:08 AM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

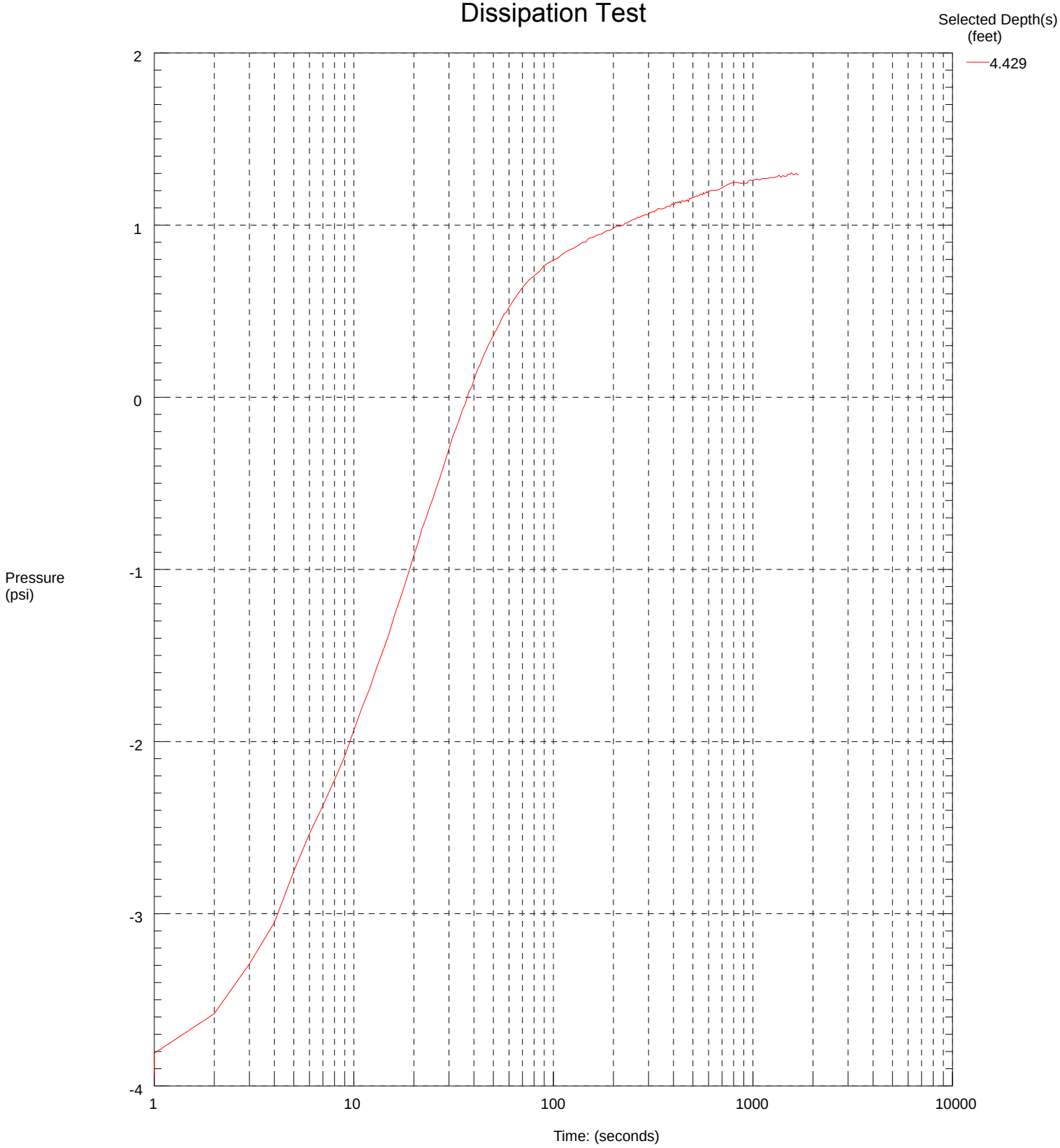


Fig. A-27

Shannon & Wilson

Operator Gerdes
Sounding: CPT-06-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 11:04:08 AM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

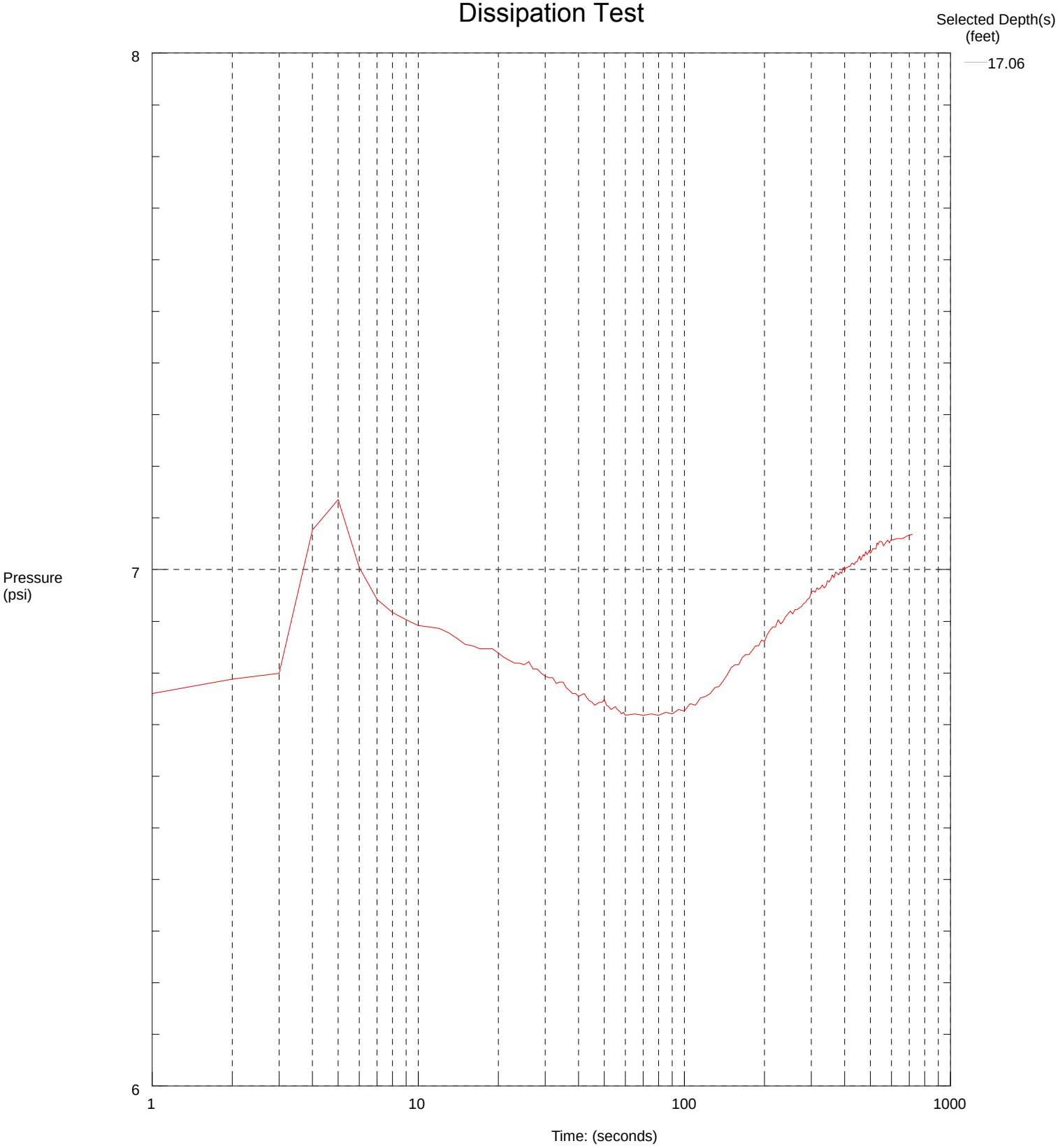


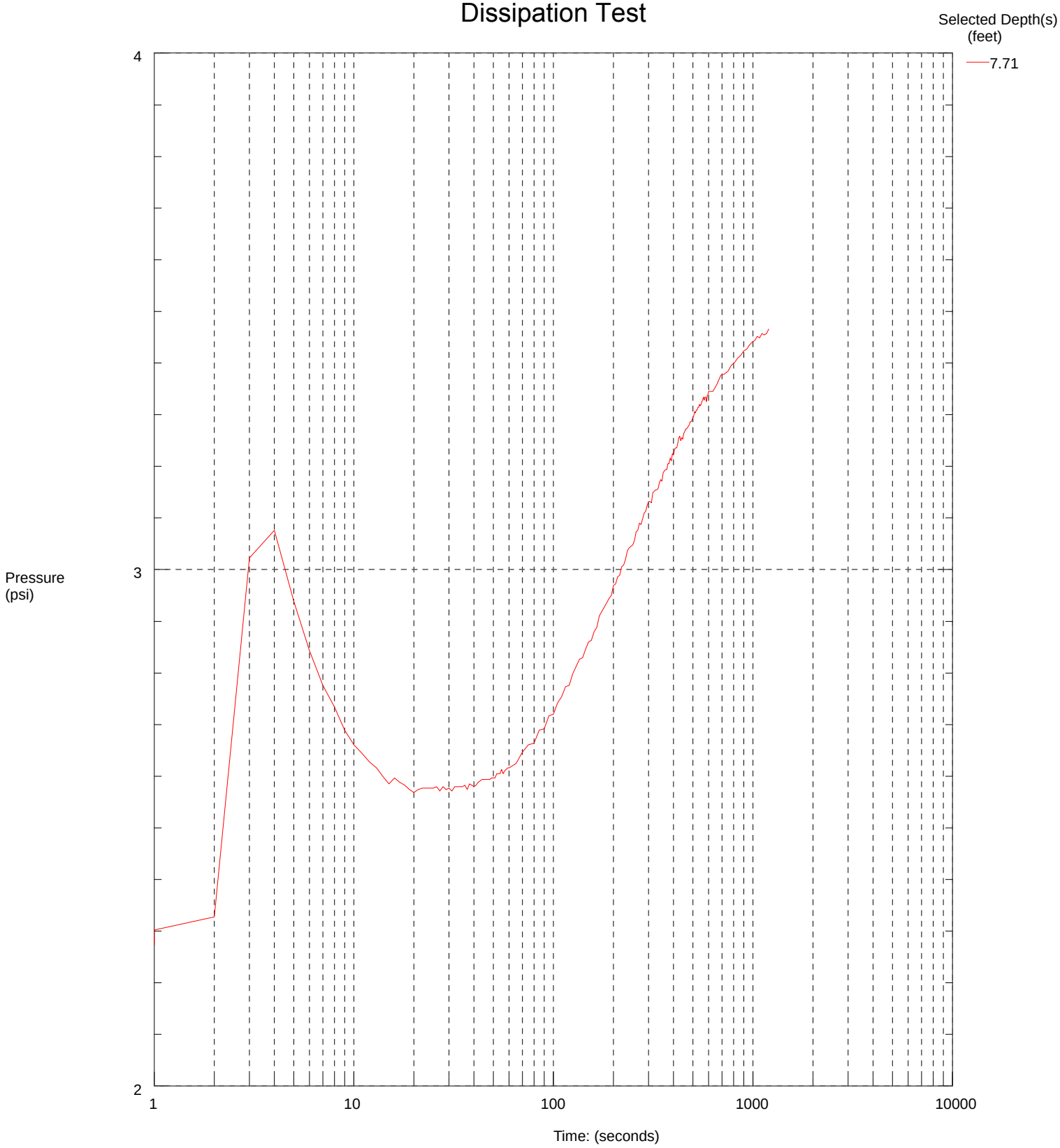
Fig. A-28

Shannon & Wilson

Operator Gerdes
Sounding: CPT-07-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 9:15:32 AM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test



Shannon & Wilson

Operator Gerdes
Sounding: CPT-07-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 9:15:32 AM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

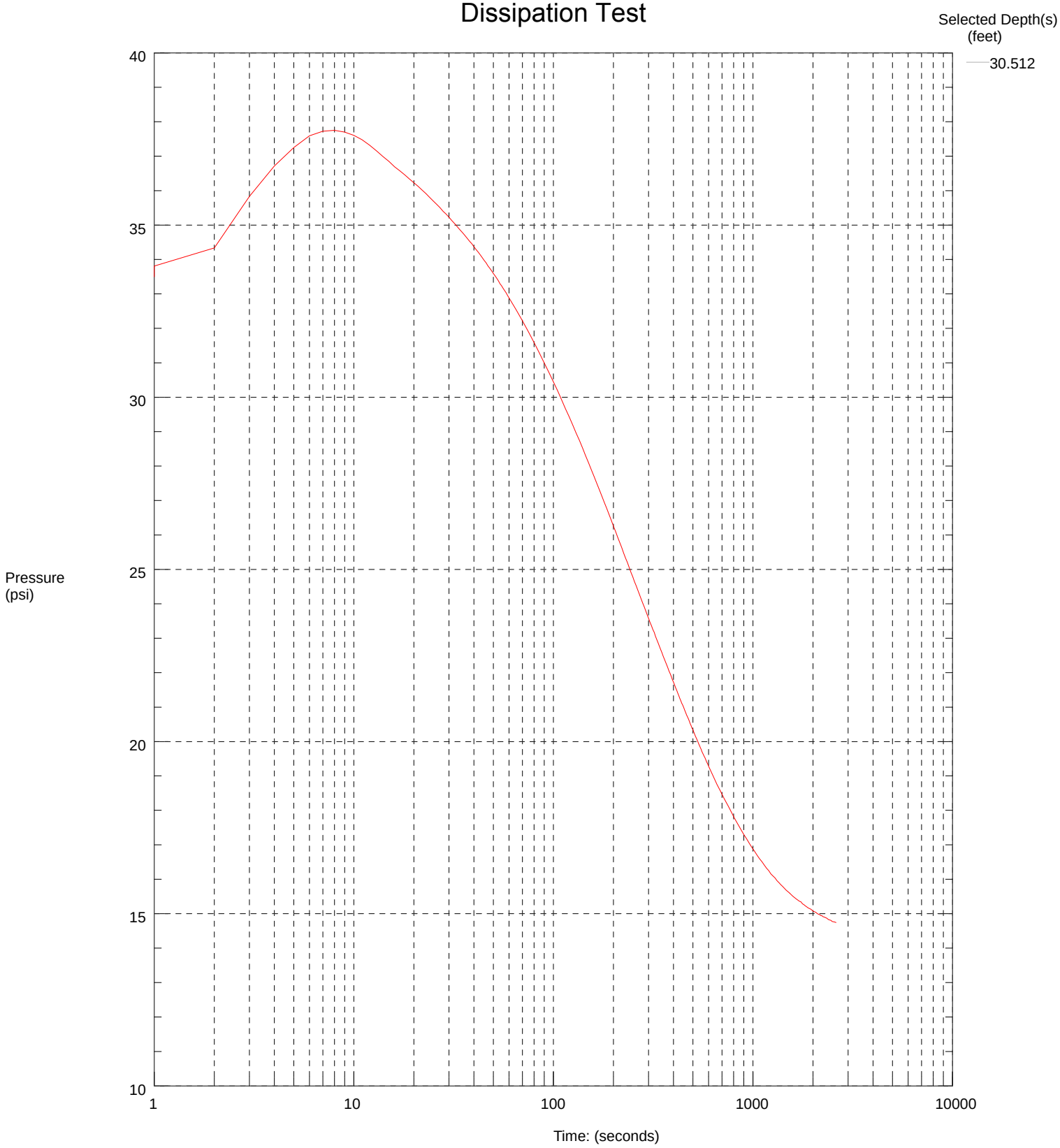


Fig. A-30

Shannon & Wilson

Operator Gerdes
Sounding: CPT-08-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 7:57:15 AM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

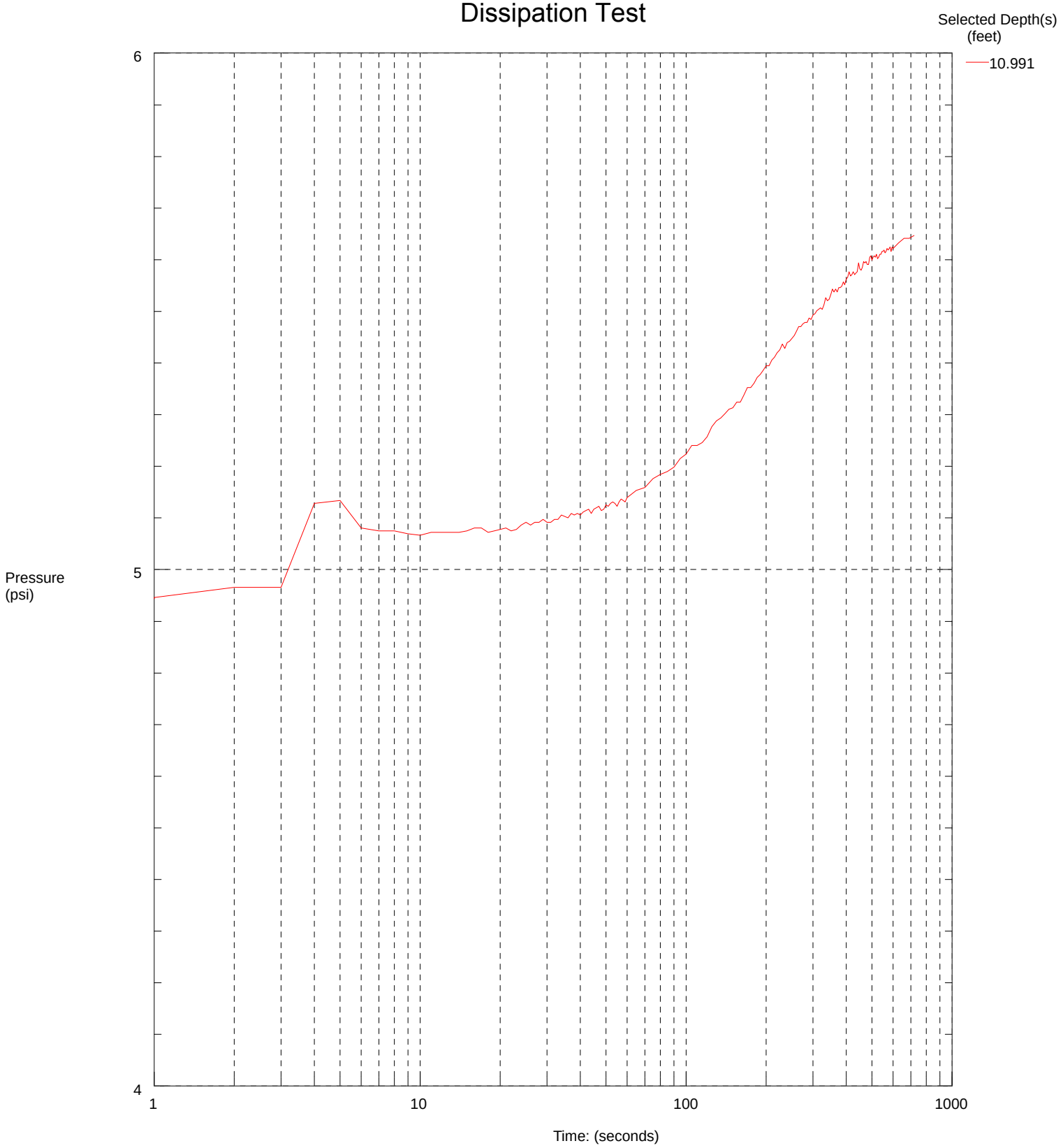


Fig. A-31

Shannon & Wilson

Operator Gerdes
Sounding: CPT-08-13
Cone Used: DDG1237

CPT Date/Time: 6/19/2013 7:57:15 AM
Location: Fir Island WA
Job Number: 21-1-12318-215

Dissipation Test

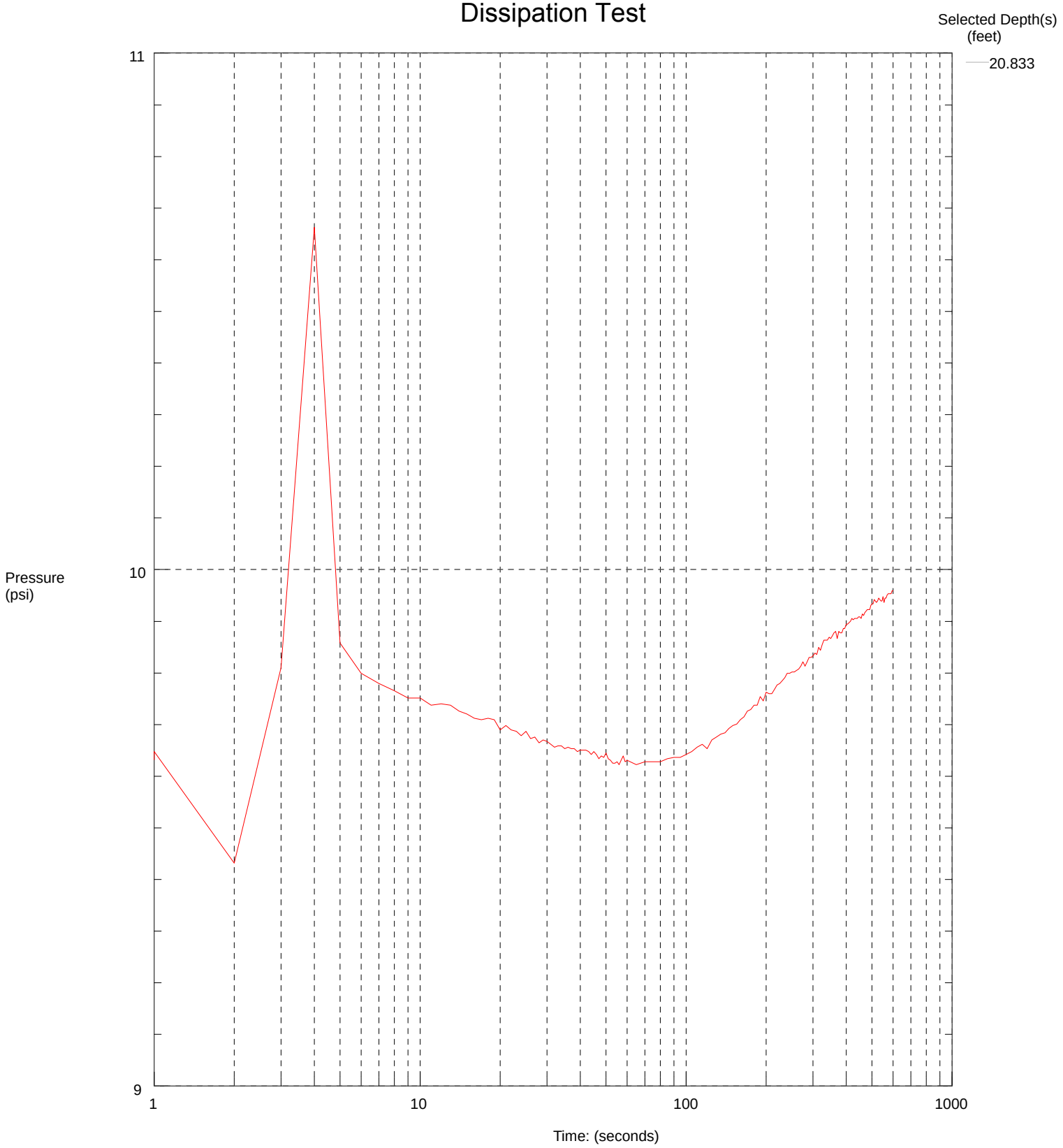


Fig. A-32

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

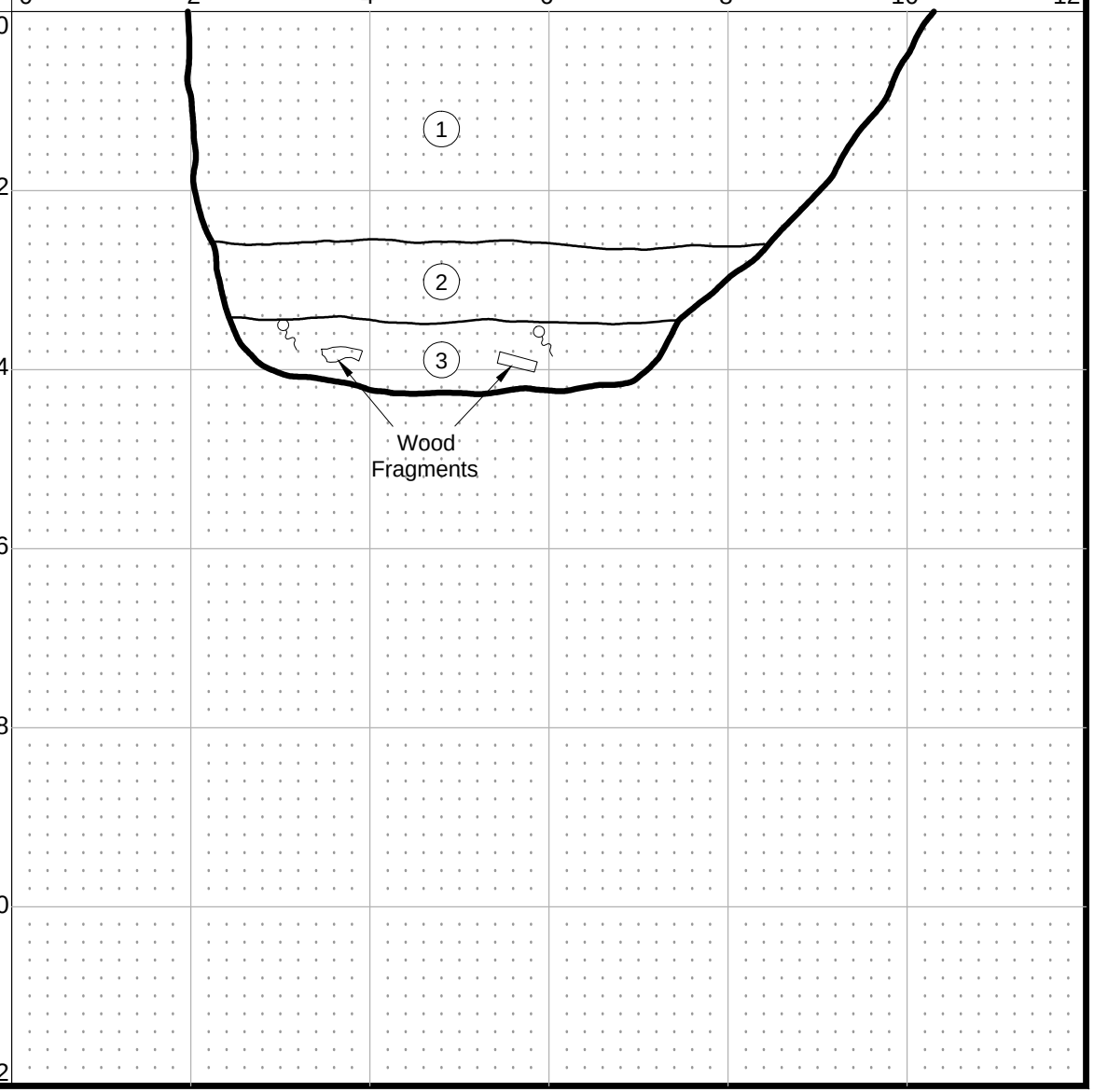
LOG OF TEST PIT TP-01-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples
(1) Brown and gray, slightly clayey SILT; moist; abundant iron-oxide staining, scattered organics; (Hm) ML.		44	S-1
(2) Gray, slightly clayey, fine sandy SILT; moist; abundant fine organics, iron-oxide staining; (Hm) ML.			
(3) Very loose to loose, gray, slightly silty, fine to medium SAND; wet; trace of organics and wood, slight sulfur smell; (Ha) SP-SM.	▽	54	S-2
		33	S-3

Sketch of ___North___ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-33

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

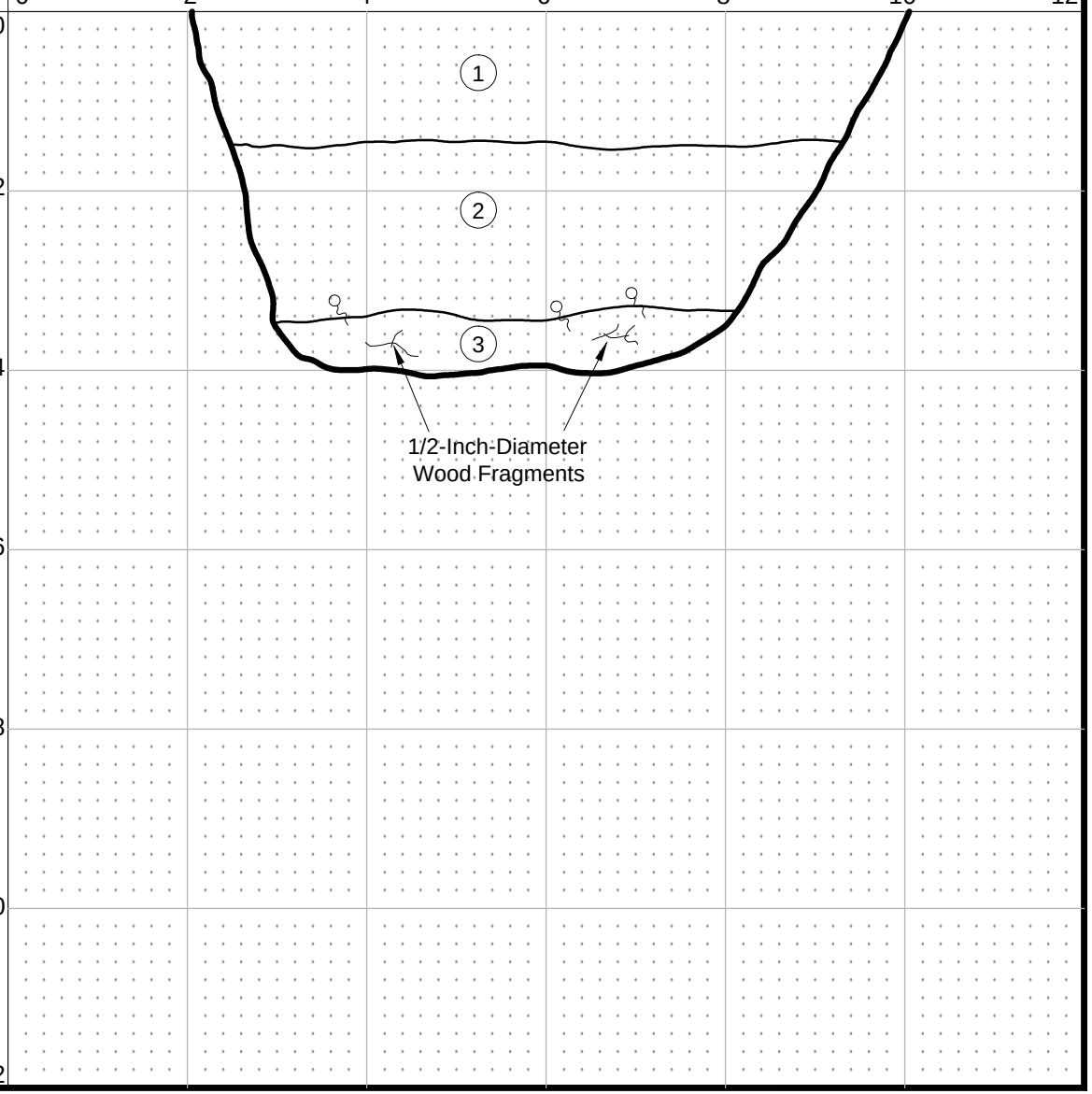
LOG OF TEST PIT TP-02-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, brown, slightly clayey to clayey SILT; moist; iron-oxide staining, scattered organics; (Agricultural layer) ML.		21	S-1	0
(2) Very soft, gray, slightly fine sandy, clayey SILT; moist; wet below 3 feet, iron-oxide staining, scattered organics; (Hm) ML/MH.	▽	29	S-2	2
(3) Very loose to loose, dark gray, fine to medium SAND, trace of silt; wet; trace of organics and wood; (Ha) SP.		26	S-3	4
				6
				8
				10
				12

Sketch of ___North___ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in large bags.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-34

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

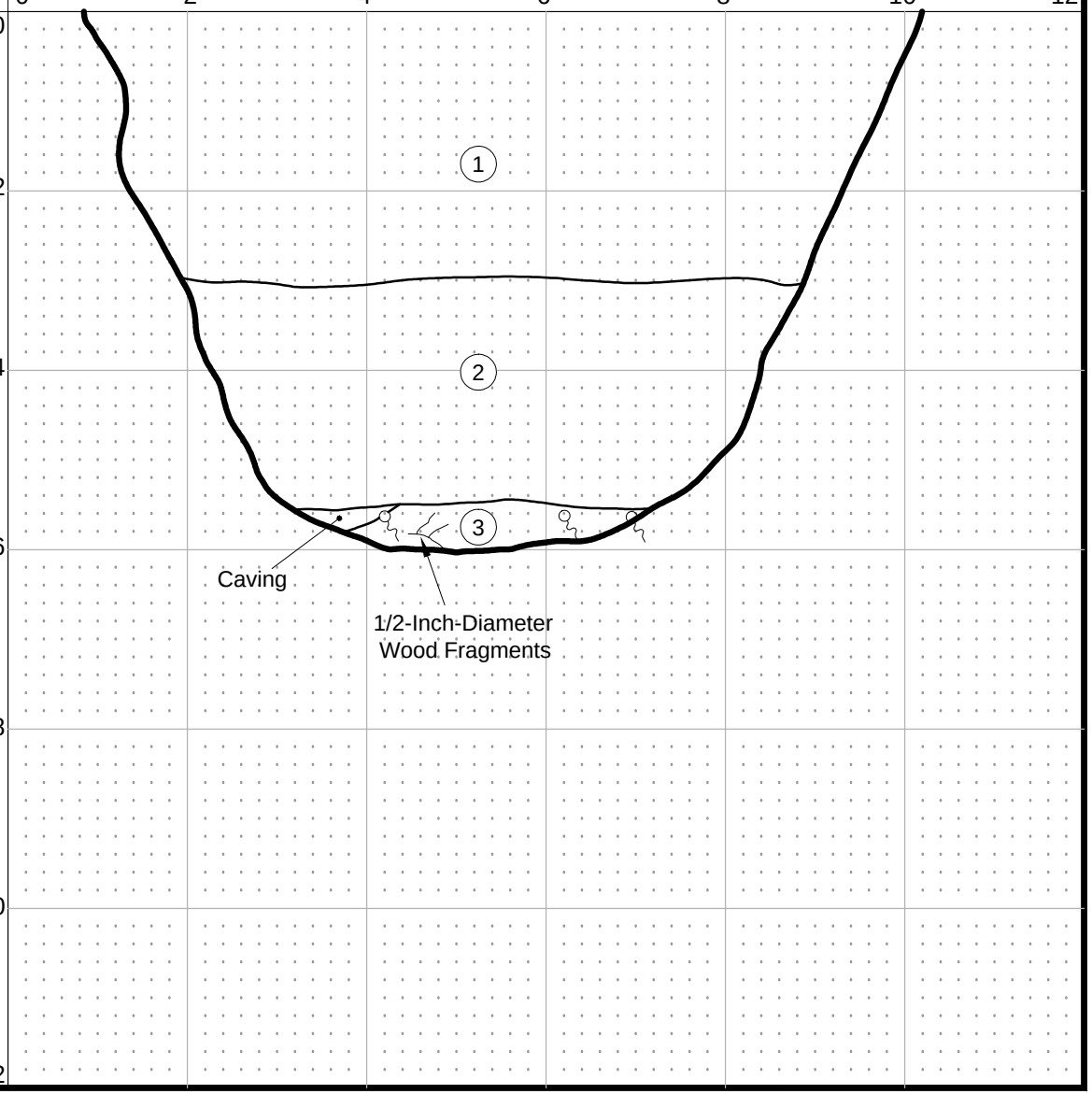
LOG OF TEST PIT TP-03-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft to stiff, brown and gray SILT, trace of clay and fine sand; moist; abundant iron-oxide staining below 3 feet, trace of organics; (Agricultural layer) ML.		45	S-1	0
(2) Very loose, dark gray, slightly fine sandy SILT, trace of clay; moist; wet below 3.5 feet, abundant fine organics; (Hm) ML.		49	S-2	2
(3) Very loose to loose, dark gray, slightly silty, fine to medium SAND; wet; scattered organics; (Ha) SP-SM.	▽	37	S-3	4
				6
				8
				10
				12

Sketch of ____East____ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-35

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

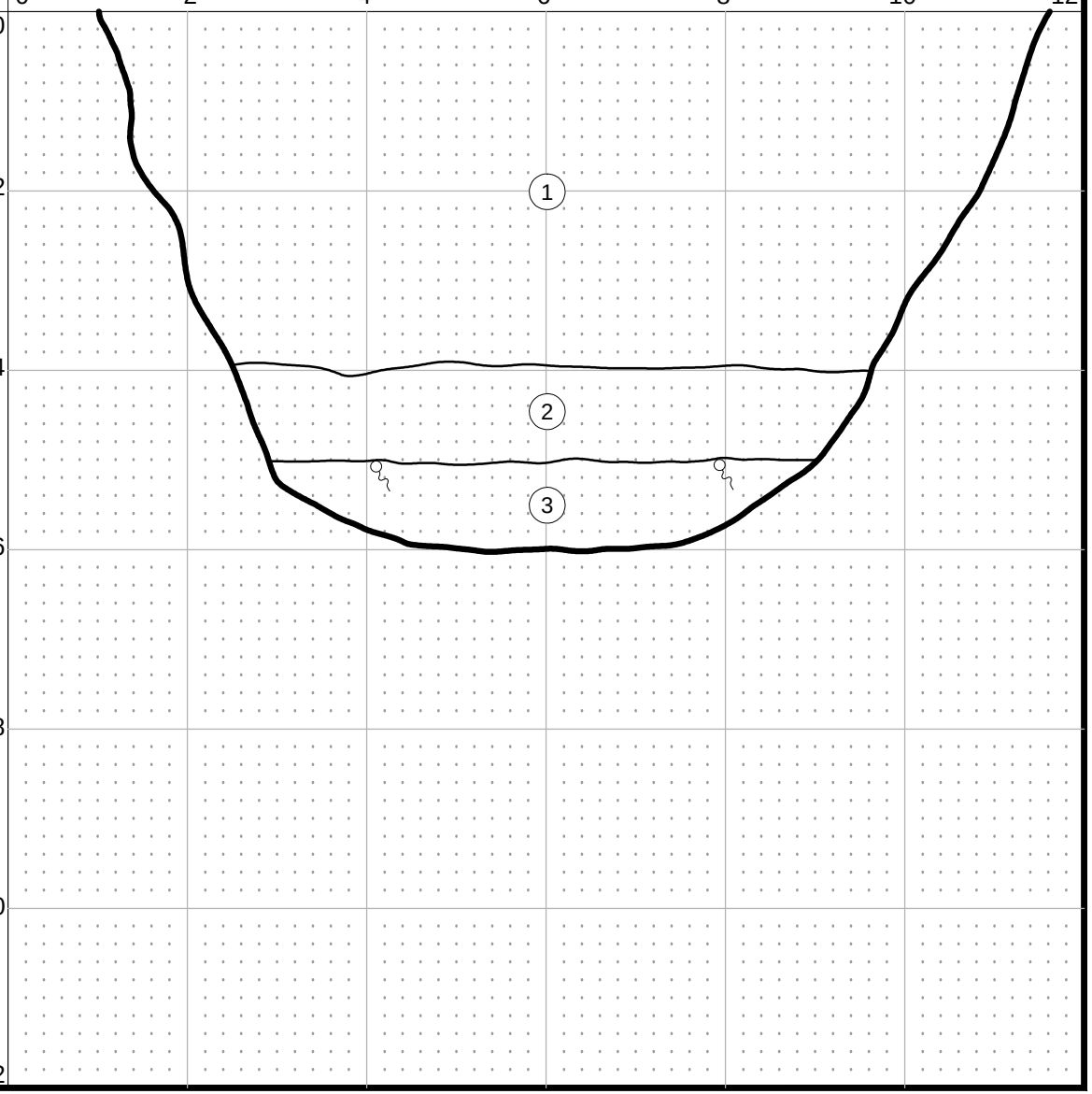
LOG OF TEST PIT TP-04-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft to stiff, brown, slightly clayey to clayey SILT, trace of fine sand; moist; abundant iron-oxide staining below 2 feet; (Agricultural layer) ML.				0
(2) Very loose, gray SILT, trace of fine sand; wet; abundant iron-oxide staining, abundant organics; (Hm) ML.		24	S-1	2
(3) Very loose to loose, gray, slightly silty, fine SAND; wet; scattered organics; (Ha) SP-SM.	▽	46	S-2	4
		49	S-3	6
				8
				10
				12

Sketch of ___South___ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in large bags.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-36

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

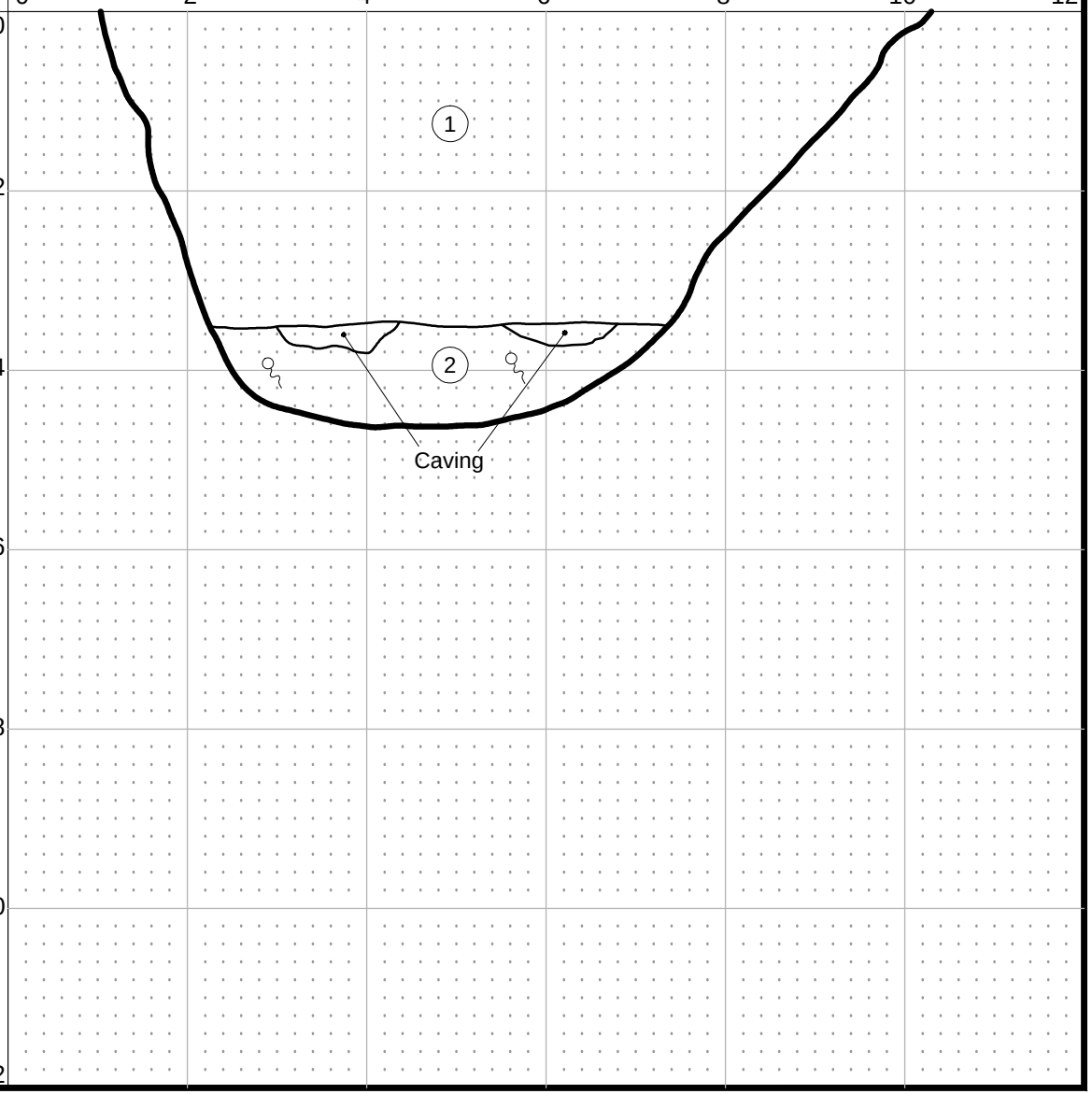
LOG OF TEST PIT TP-05-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft to medium stiff, brown, clayey SILT to fine sandy SILT; moist; abundant iron-oxide staining below 1.5 feet; (Agricultural layer) ML.		30	S-1	0
(2) Very loose to loose, gray-brown, silty, fine to medium SAND; moist; wet below 4 feet, scattered organics; (Ha) SM.	▽	30	S-2	2, 4
				6, 8, 10, 12

Sketch of South Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-37

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

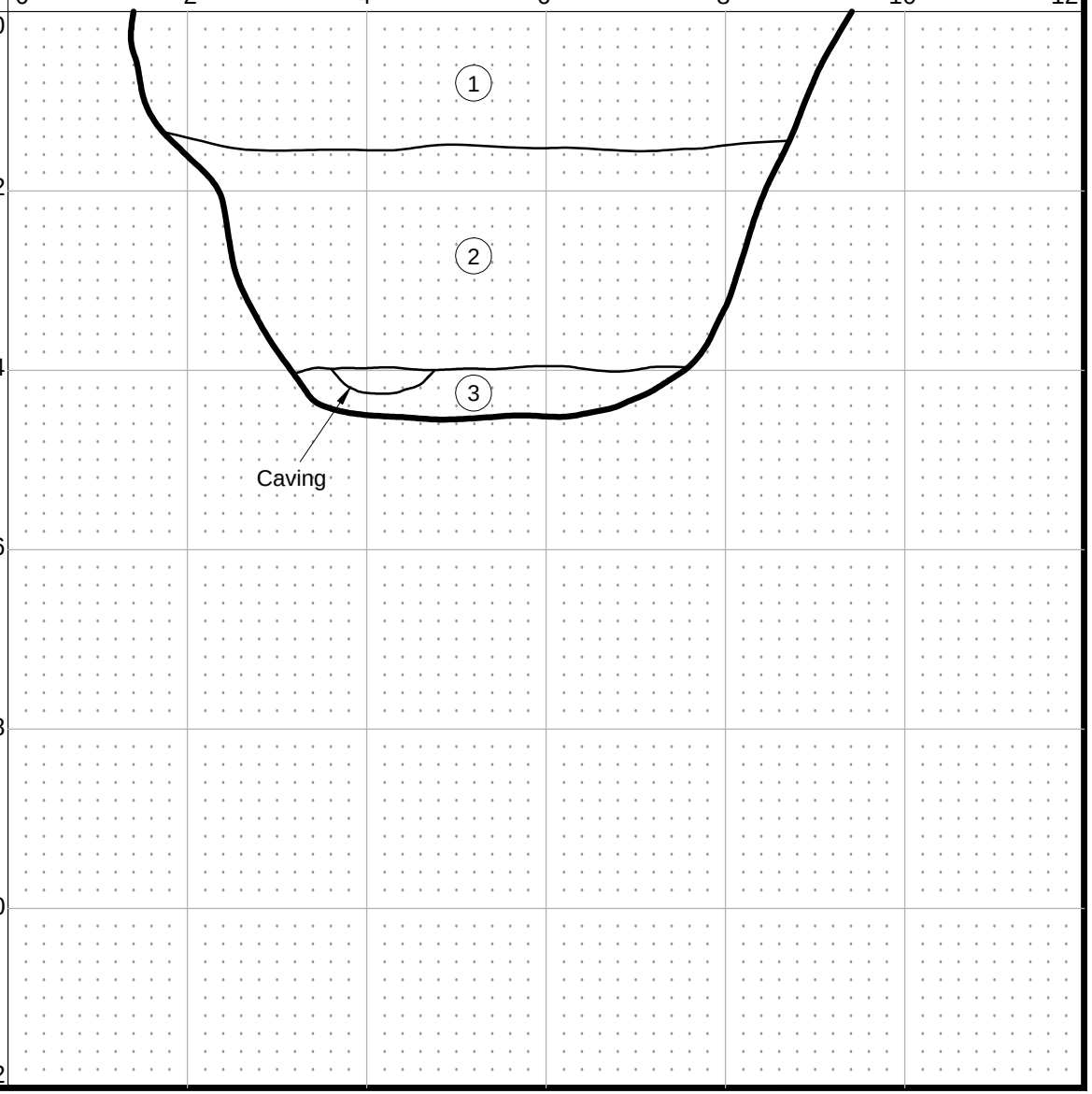
LOG OF TEST PIT TP-06-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft to medium stiff, brown, trace of clay to clayey SILT, trace of fine sand; moist; iron-oxide staining, trace of fine organics; (Agricultural layer) ML.		29	S-1	0
(2) Very loose, gray-brown, fine to medium sandy SILT; moist; abundant iron-oxide staining, abundant organics; (Hm) ML.		54	S-2	2
(3) Very loose to loose, gray, slightly silty, fine SAND; wet; (Ha) SP-SM.	▽	32	S-3	4
				6
				8
				10
				12

Sketch of South Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-38

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

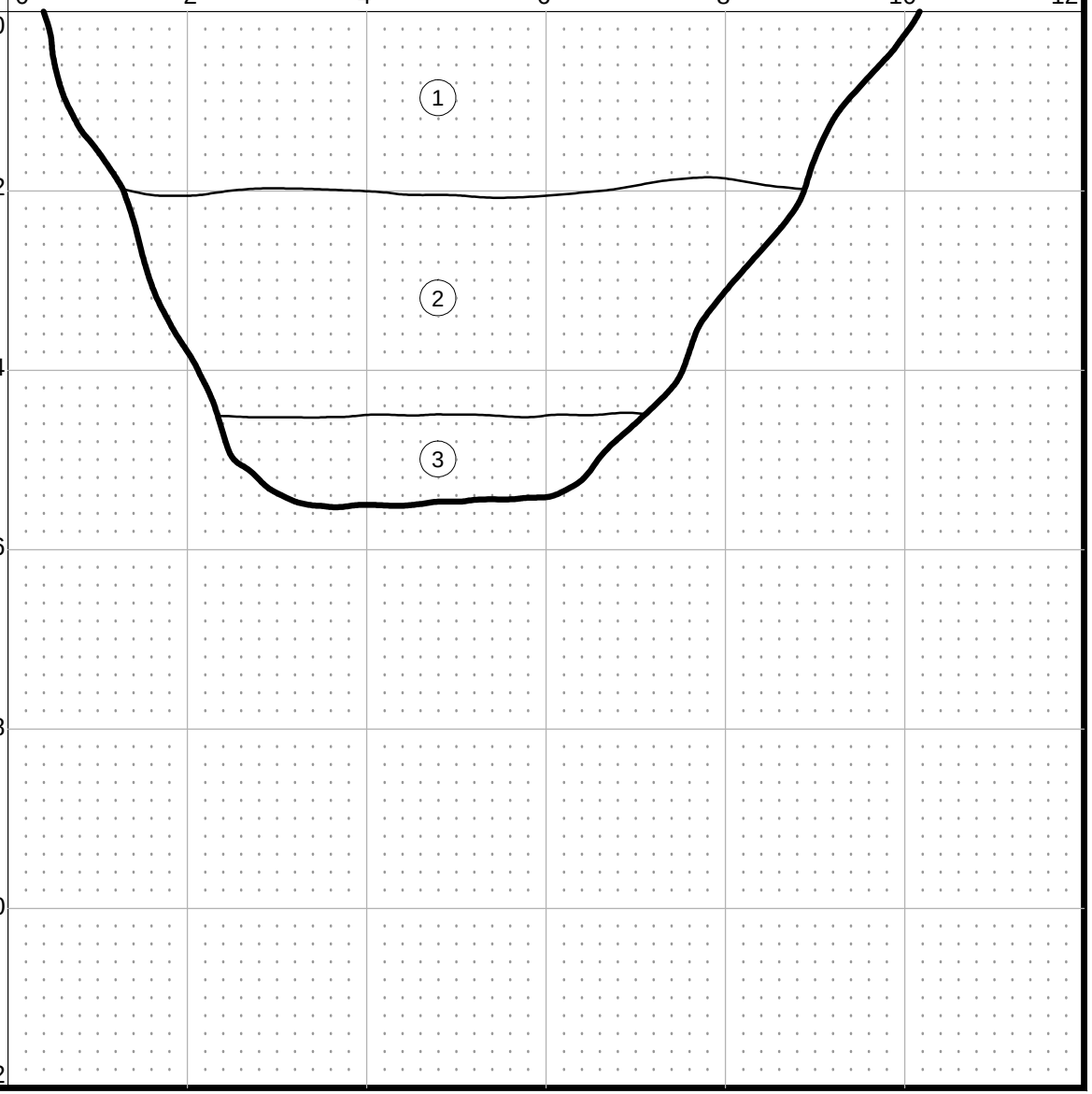
LOG OF TEST PIT TP-07-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium stiff, brown, clayey SILT; moist; (Agricultural layer) MH.				0
		25	S-1	
(2) Loose, gray-brown, fine to medium sandy SILT; moist; wet below 4 feet, abundant iron-oxide staining; (Hm) ML.				2
		41	S-2	
(3) Loose, dark gray, fine to medium SAND, trace of silt; wet; (Ha) SP.	▽			4
		24	S-3	
				6
				8
				10
				12

Sketch of South Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-39

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

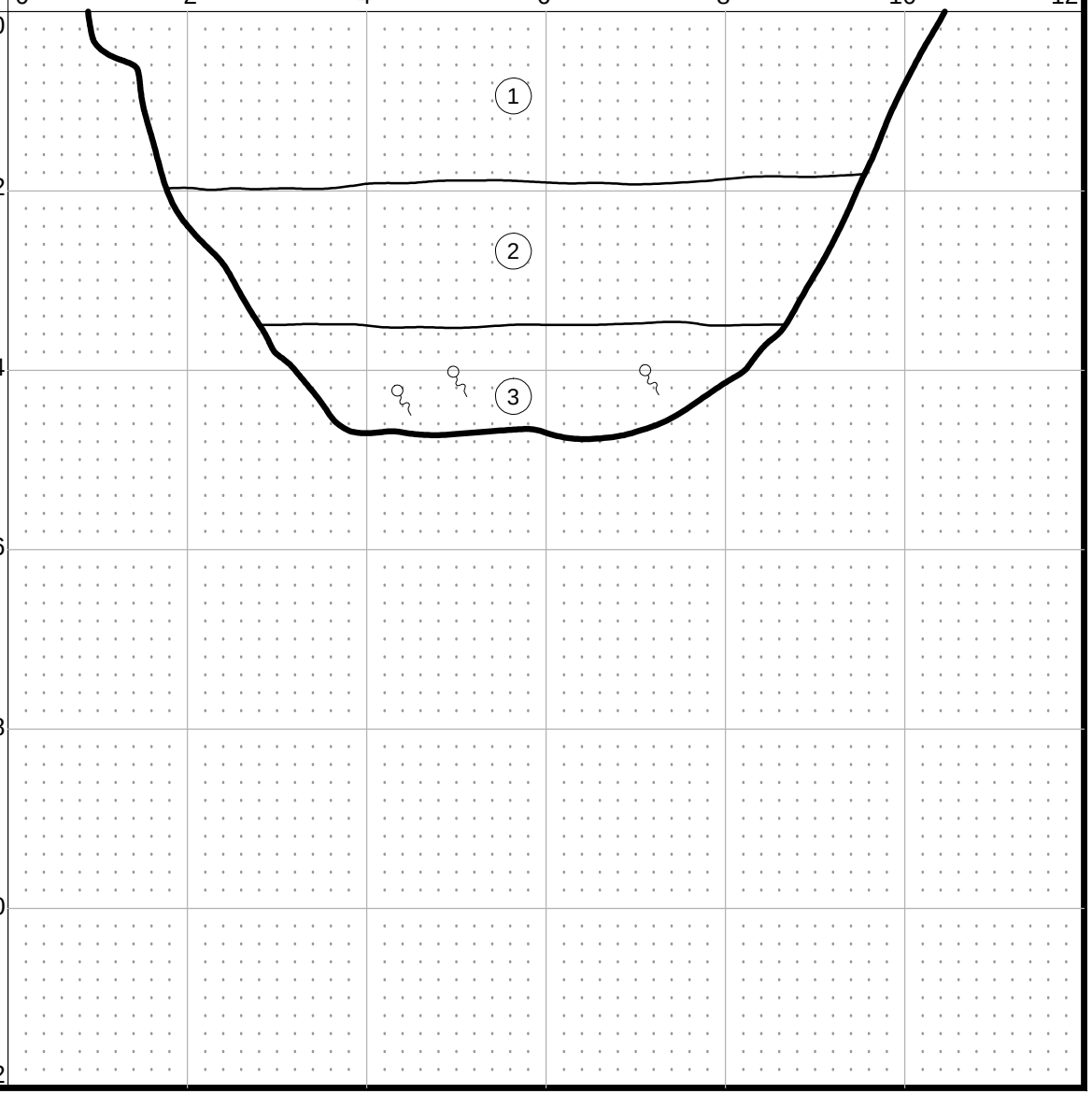
LOG OF TEST PIT TP-08-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium stiff, brown, clayey SILT; moist; trace of organics, trace of iron-oxide staining; (Agricultural layer) MH.		27	S-1	0
(2) Loose, gray-brown, fine sandy SILT; moist; abundant iron-oxide staining, scattered organics; (Hm) ML.		48	S-2	2
(3) Loose, dark gray, fine sandy SILT; wet; scattered organics; (Hm) ML.	▽	41	S-3	4
				6
				8
				10
				12

Sketch of West Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Groundwater seepage at 4 feet prevented excavation from extending deeper.
2. Samples collected in jars.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-40

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

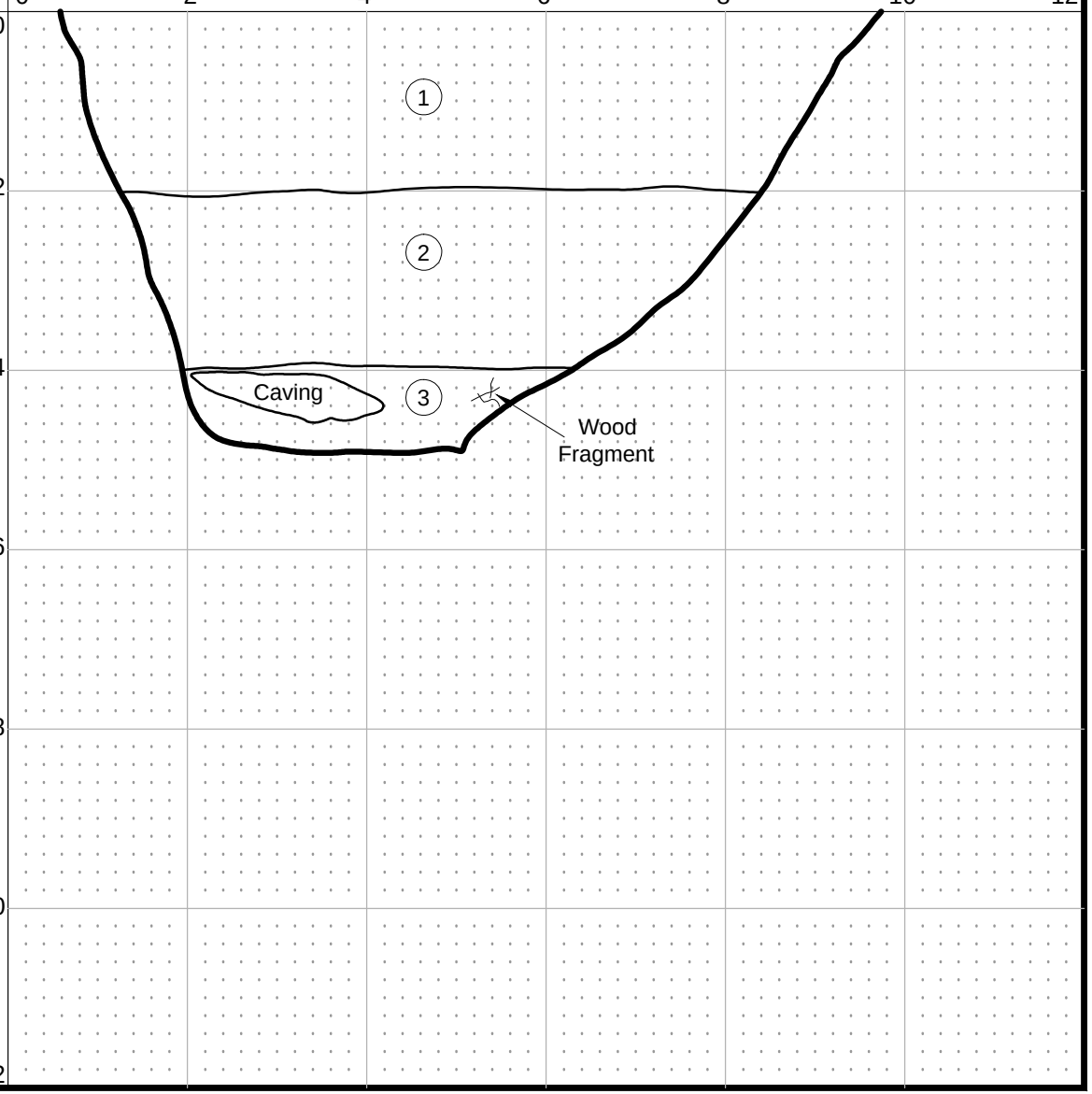
LOG OF TEST PIT TP-09-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium stiff, brown, clayey SILT; moist; trace of iron-oxide staining, trace of organics; (Agricultural layer) MH.		33	S-1	0
(2) Loose, brown and gray, fine to medium sandy SILT; moist; abundant iron-oxide staining, laminated, abundant organics; (Hm) ML.				2
(3) Loose, gray, fine to medium SAND, trace of silt; wet; trace of organics (wood); (Ha) SP.		43	S-2	
	▽	30	S-3	4
				6
				8
				10
				12

Sketch of South Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Caving at 4 feet due to wet sand.
2. Samples collected in jars.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-41

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

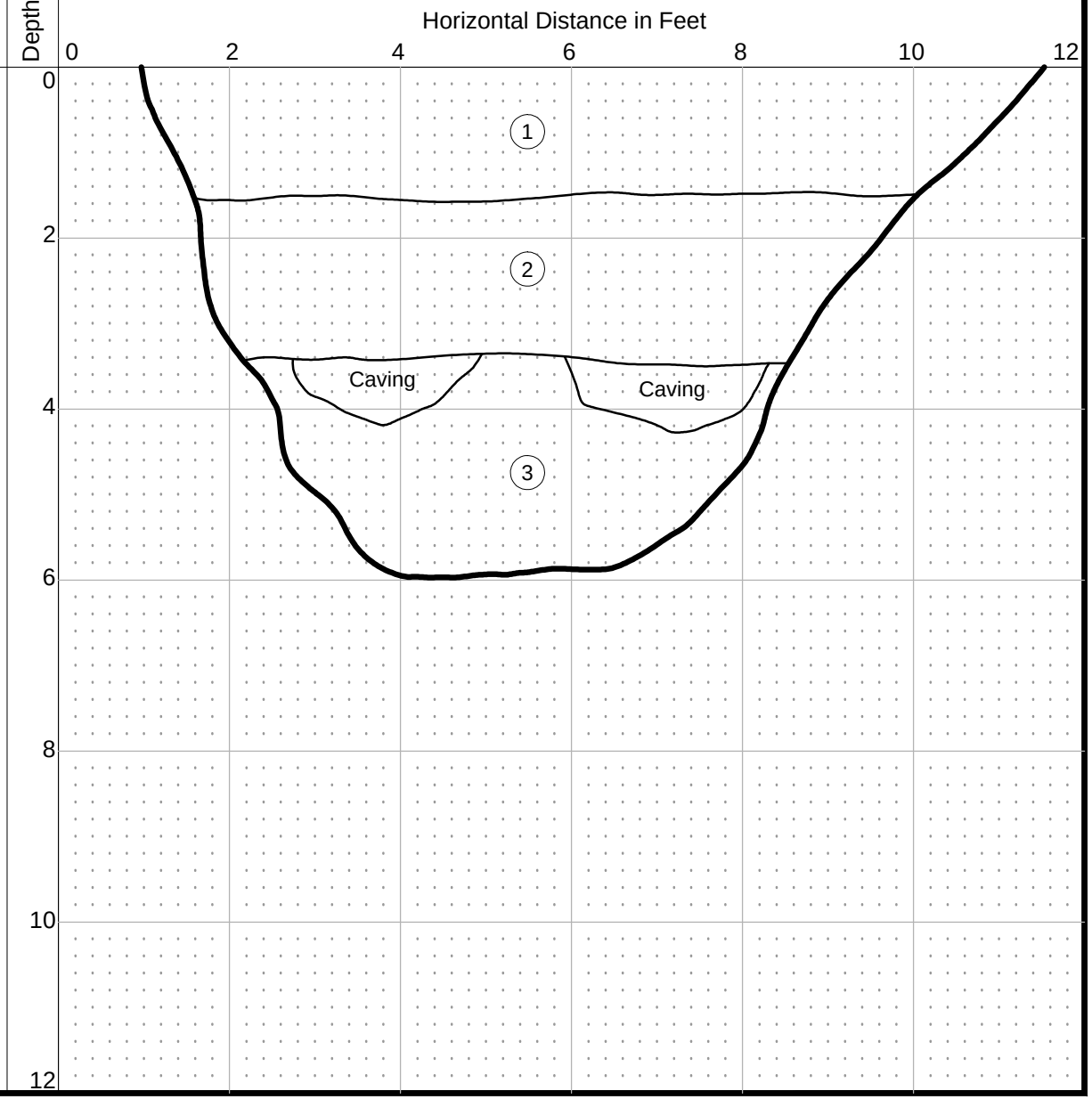
LOG OF TEST PIT TP-10-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples
(1) Medium stiff, brown, clayey SILT; moist; trace of organics; (Agricultural layer) MH.		30	S-1
(2) Loose, gray-brown, fine sandy SILT, trace of clay; moist; abundant iron-oxide staining and organics; (Hm) ML.		47	S-2
(3) Loose, dark gray, slightly silty, fine to medium SAND; wet; trace of organics and wood; (Ha) SW-SM.	▽	23	S-3

Sketch of West Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Test pit caved at 4 feet due to sand and groundwater.
2. Samples collected in large bags.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-42

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

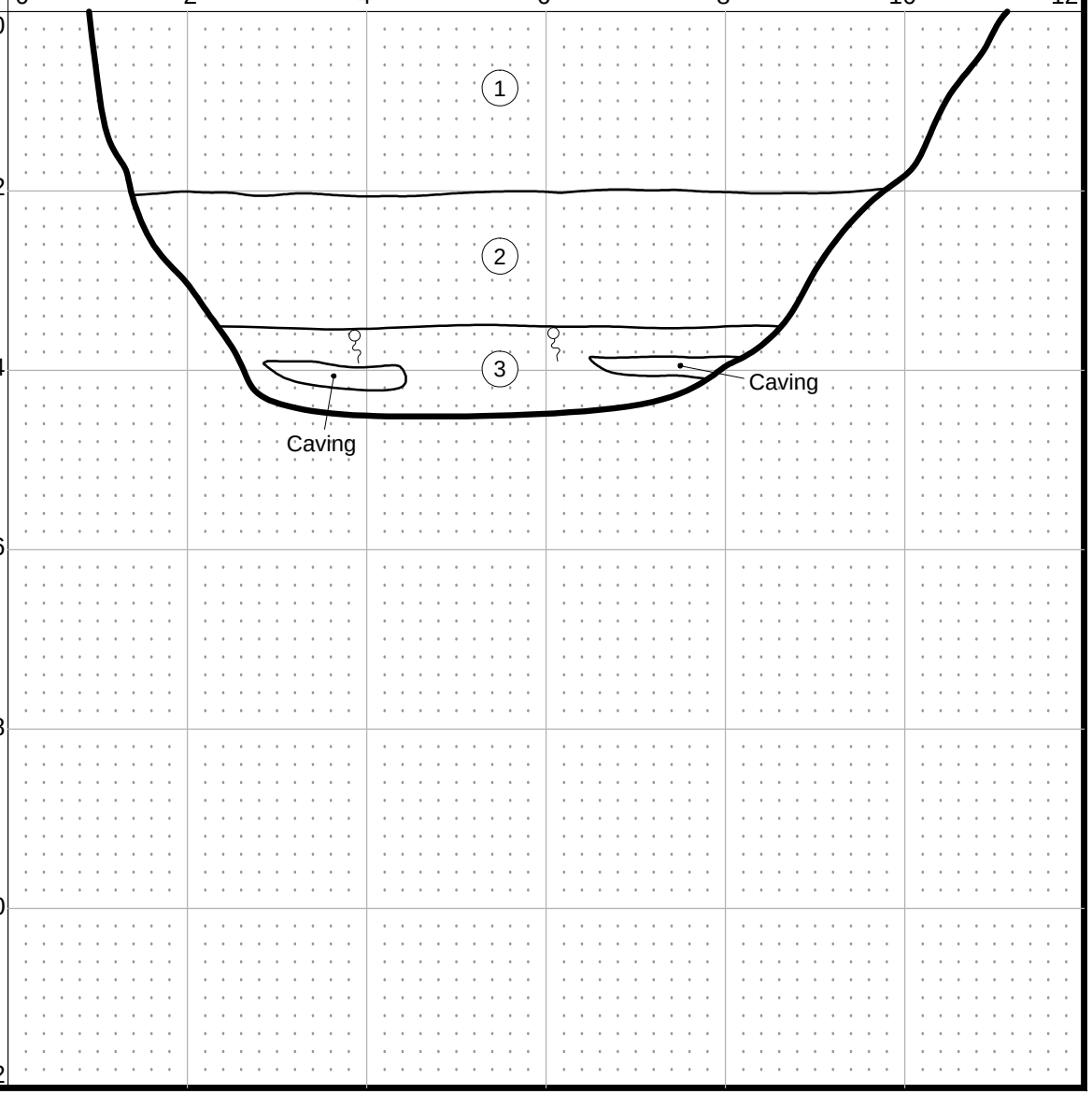
LOG OF TEST PIT TP-11-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium stiff, brown, clayey SILT; moist; (Agricultural layer) MH.				0
(2) Soft, gray-brown, slightly clayey, slightly fine sandy SILT; moist; abundant iron-oxide staining, trace of organics; (Hm) ML.		21	S-1	
		43	S-2	2
(3) Loose, dark gray-brown, slightly silty, fine SAND; wet; scattered organics including wood; (Ha) SP-SM.	▽	31	S-3	4
				6
				8
				10
				12

Sketch of ___West___ Pit Side Surface Elevation: Approx. 7 Ft.



NOTES

1. Test pit caved at 4 feet due to sand and groundwater.
2. Samples collected in jars.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-43

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

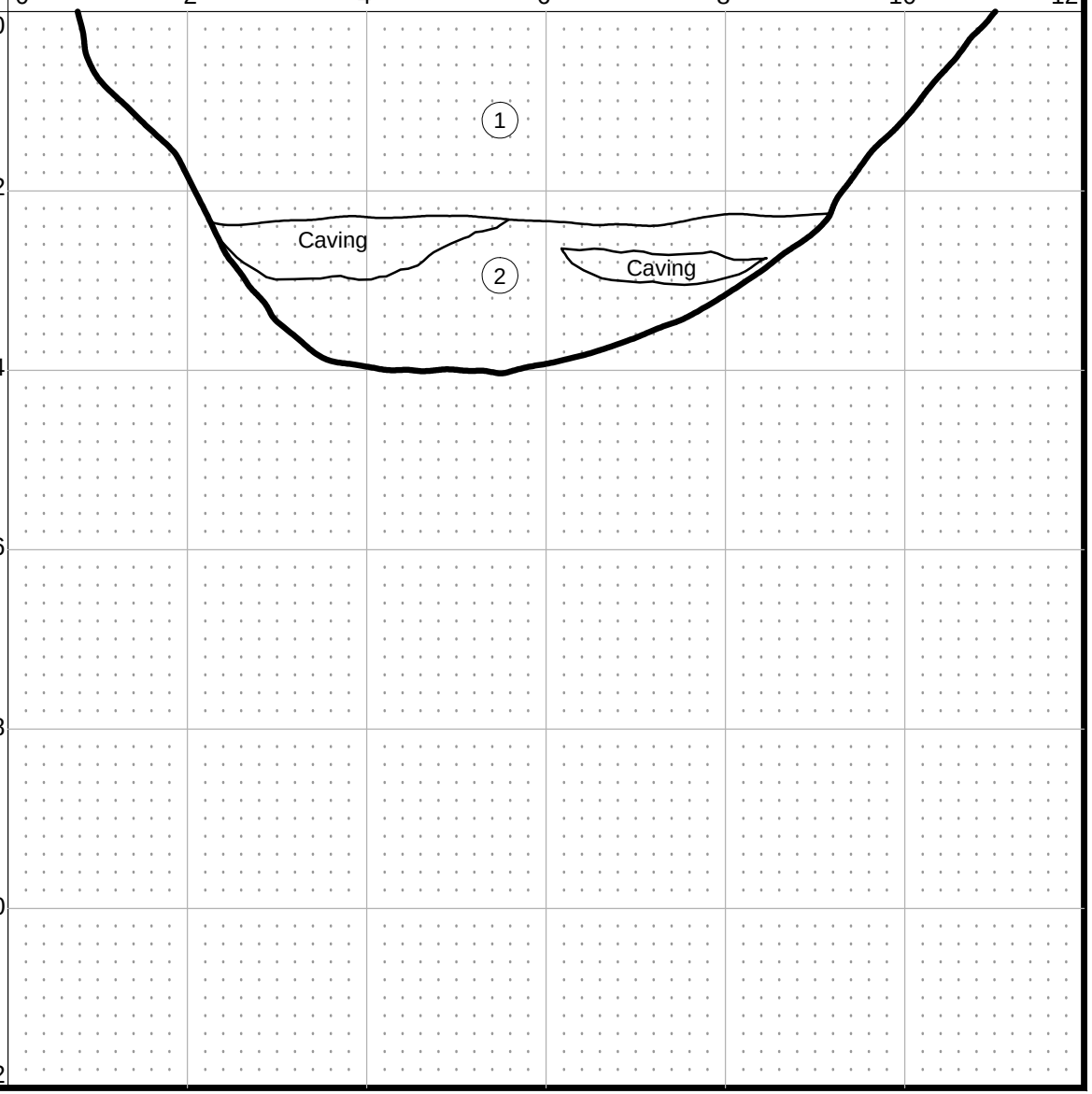
LOG OF TEST PIT TP-12-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, brown, slightly clayey SILT, trace of fine sand; moist; trace of iron-oxide staining and organics; (Agricultural layer) ML.		21	S-1	0
(2) Loose, gray-brown, slightly silty, fine to medium SAND; wet; trace of organics; (Ha) SP-SM.	▽	19	S-2	2
				4
				6
				8
				10
				12

Sketch of West Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Hole caved at 2.5 feet.
2. Samples collected in large bags.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-44

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

LOG OF TEST PIT TP-13-13

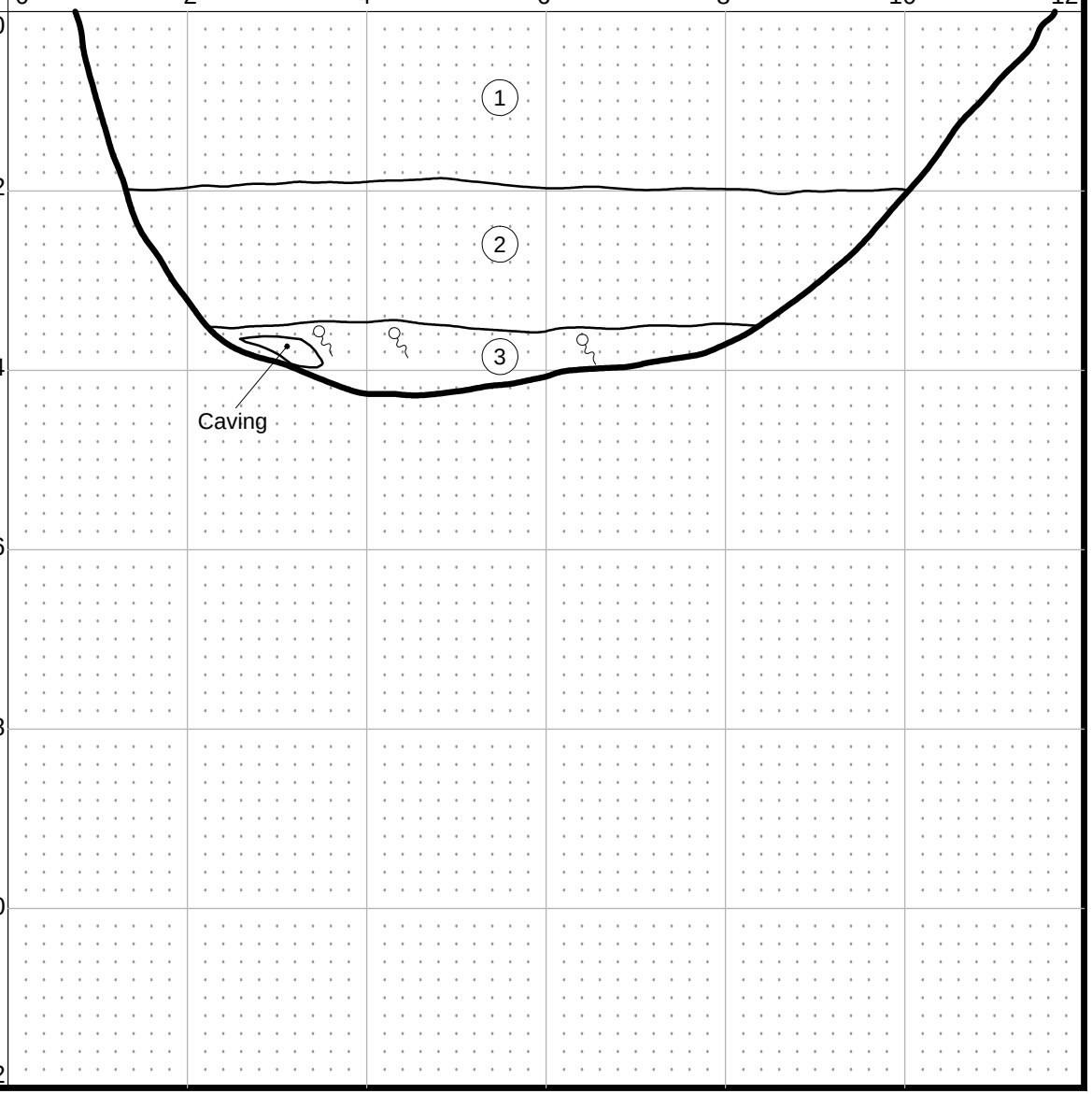
JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium stiff, brown to gray, slightly clayey SILT; moist; iron-oxide staining, trace of organics; (Agricultural layer) ML.		22	S-1	0
(2) Very loose, gray, fine sandy SILT; moist; abundant iron-oxide staining, trace of organics; (Hm) ML.		37	S-2	2
(3) Very loose to loose, gray-brown, slightly silty, fine SAND; wet; scattered organics; (Ha) SP-SM.	▽	41	S-3	4
				6
				8
				10
				12

Sketch of South Pit Side

Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-45

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

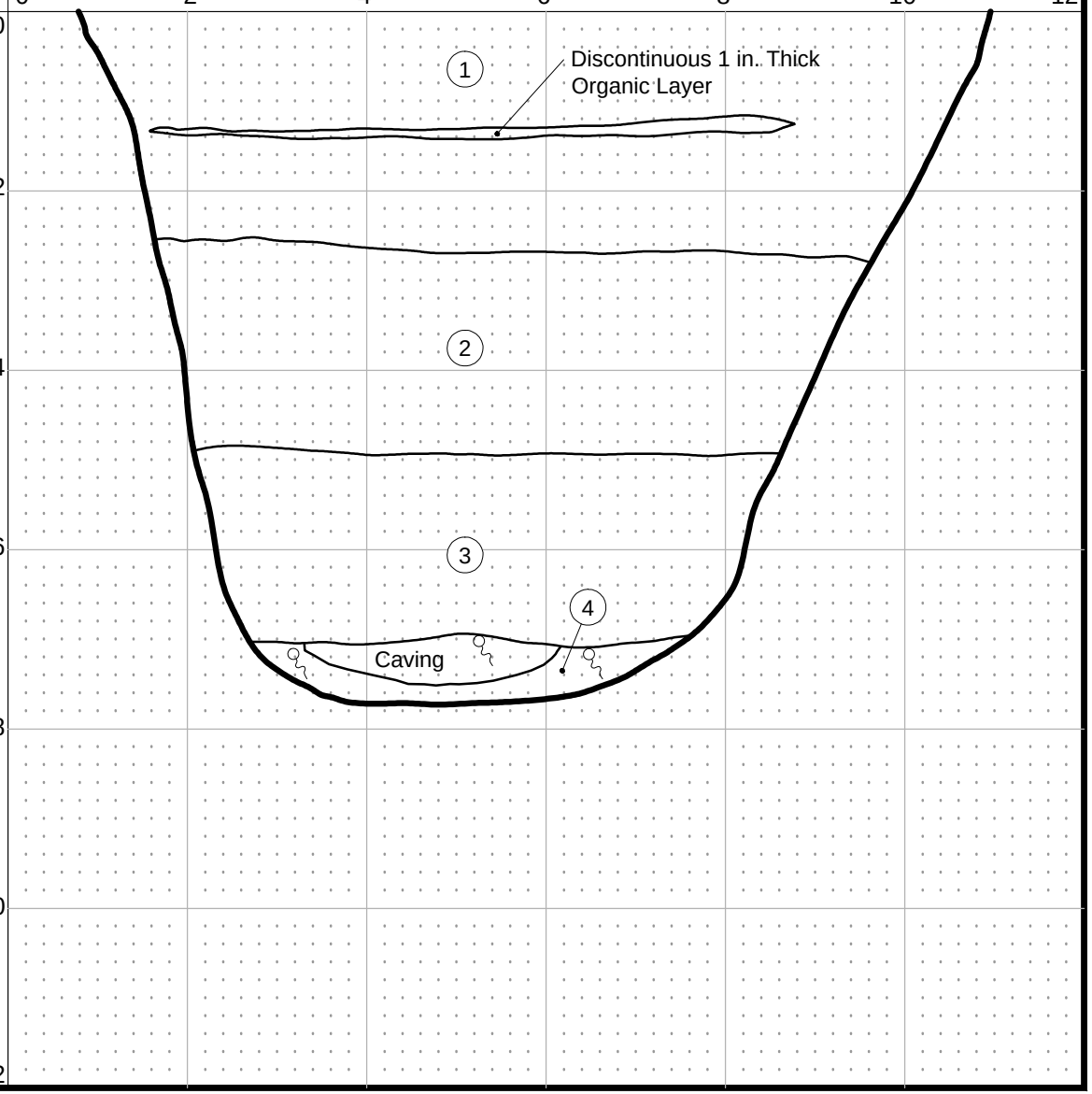
LOG OF TEST PIT TP-14-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium stiff, gray-brown, slightly clayey, slightly fine sandy SILT; moist; abundant organics, 1-inch-thick discontinuous organic layer, sand pockets; (Agricultural layer) ML.		39	S-1	0
(2) Very soft, dark gray, slightly fine sandy, slightly clayey SILT; wet; abundant iron-oxide staining, scattered fine organics, organic odor; (Hm) ML.				2
(3) Very soft, dark gray, organic SILT; wet; organic odor; (Hm) OH.		41	S-2	4
(4) Loose, dark gray, sandy SILT; wet; water flows into excavation rapidly at 7 feet; (Hm) ML.	▽	77	S-3	6
				8
				10
				12

Sketch of West Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples S-1 and S-3 collected in jars. Sample S-2 collected in a large bag.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-46

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

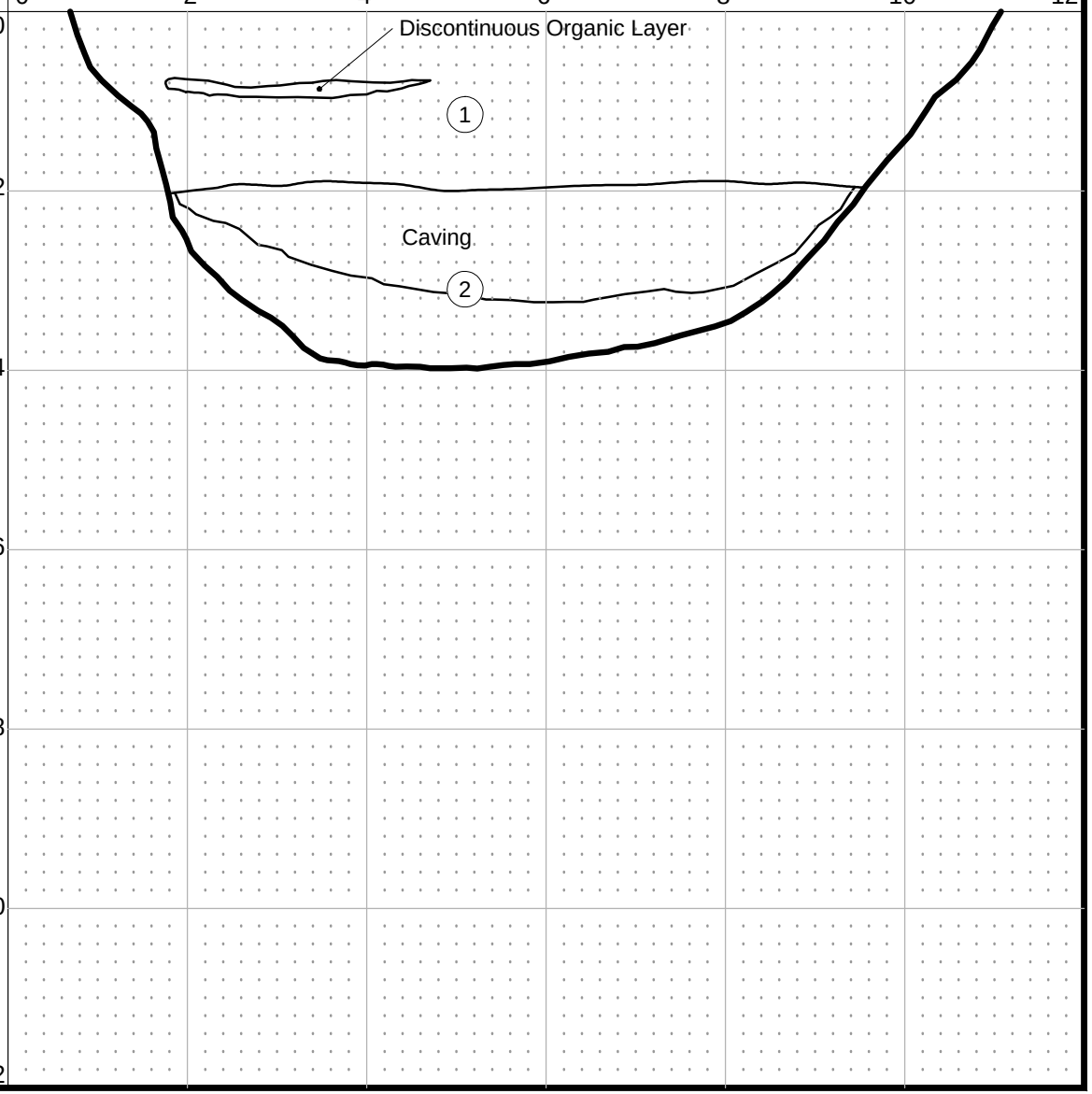
LOG OF TEST PIT TP-15-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, brown to dark gray, slightly clayey SILT; moist; abundant iron-oxide staining, 2 inch discontinuous organic layer at 1 foot, abundant sand pockets, abundant organics; (Agricultural layer) ML.	▽	48	S-1	0
(2) Very loose to loose, dark gray, slightly silty, fine to medium SAND; moist; wet below 3 feet, iron-oxide staining; (Ha) SP-SM.		21	S-2	2, 4
				6, 8, 10, 12

Sketch of South Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Rapid caving at 2 feet.
2. Samples collected in jars.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-47

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

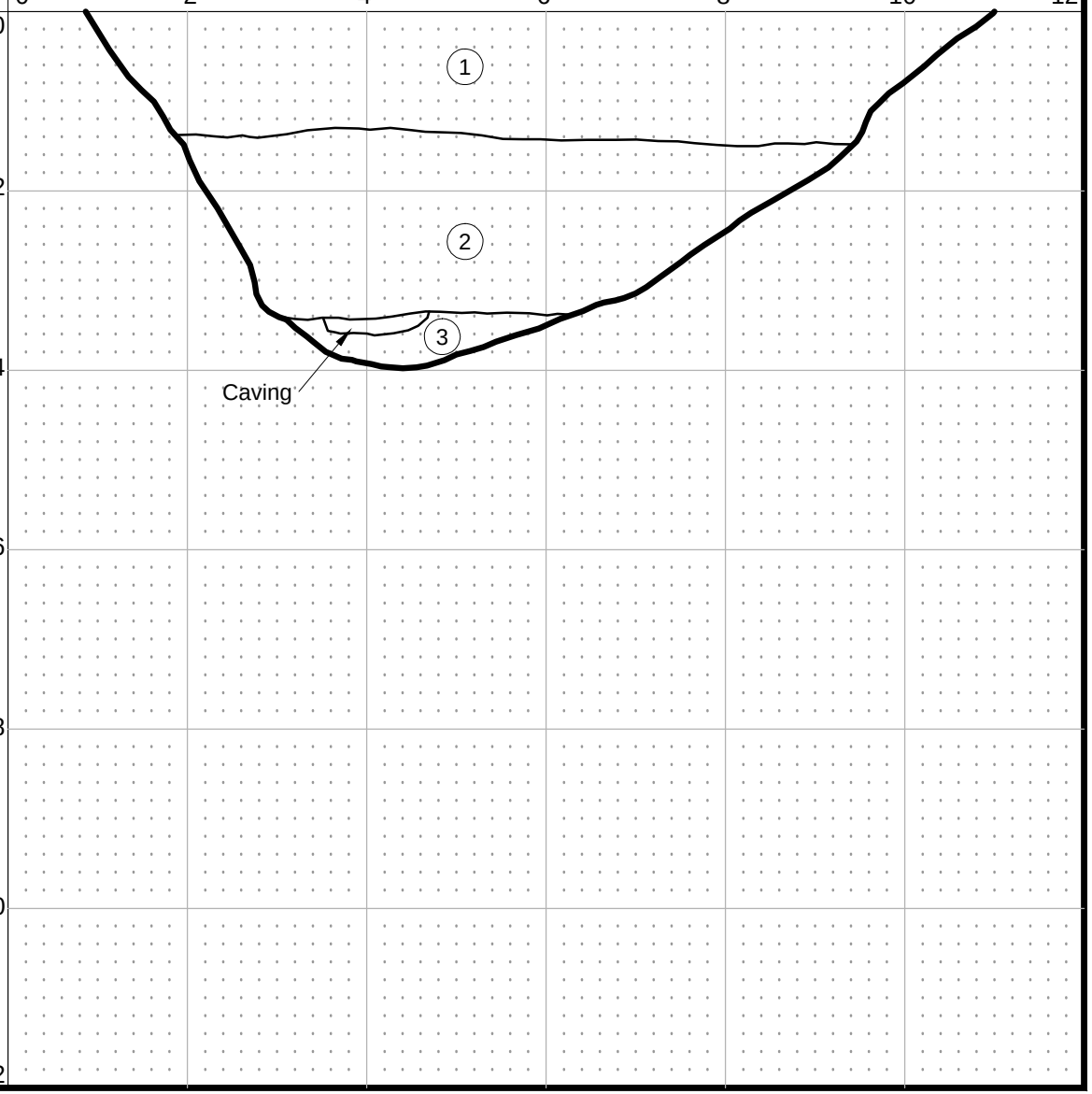
LOG OF TEST PIT TP-16-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Stiff, brown, clayey SILT; moist; trace of organics and iron-oxide staining; (Agricultural layer) MH.		29	S-1	0
(2) Very loose to loose, gray, slightly clayey, fine to medium sandy SILT; moist; wet below 3 feet; abundant iron-oxide staining, abundant organics; (Hm) ML.	▽	59	S-2	2
(3) Very loose to loose, dark gray, fine to medium SAND, trace of silt; wet; trace of organics; (Ha) SP.		29	S-3	4
				6
				8
				10
				12

Sketch of ___West___ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in large bags.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-48

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

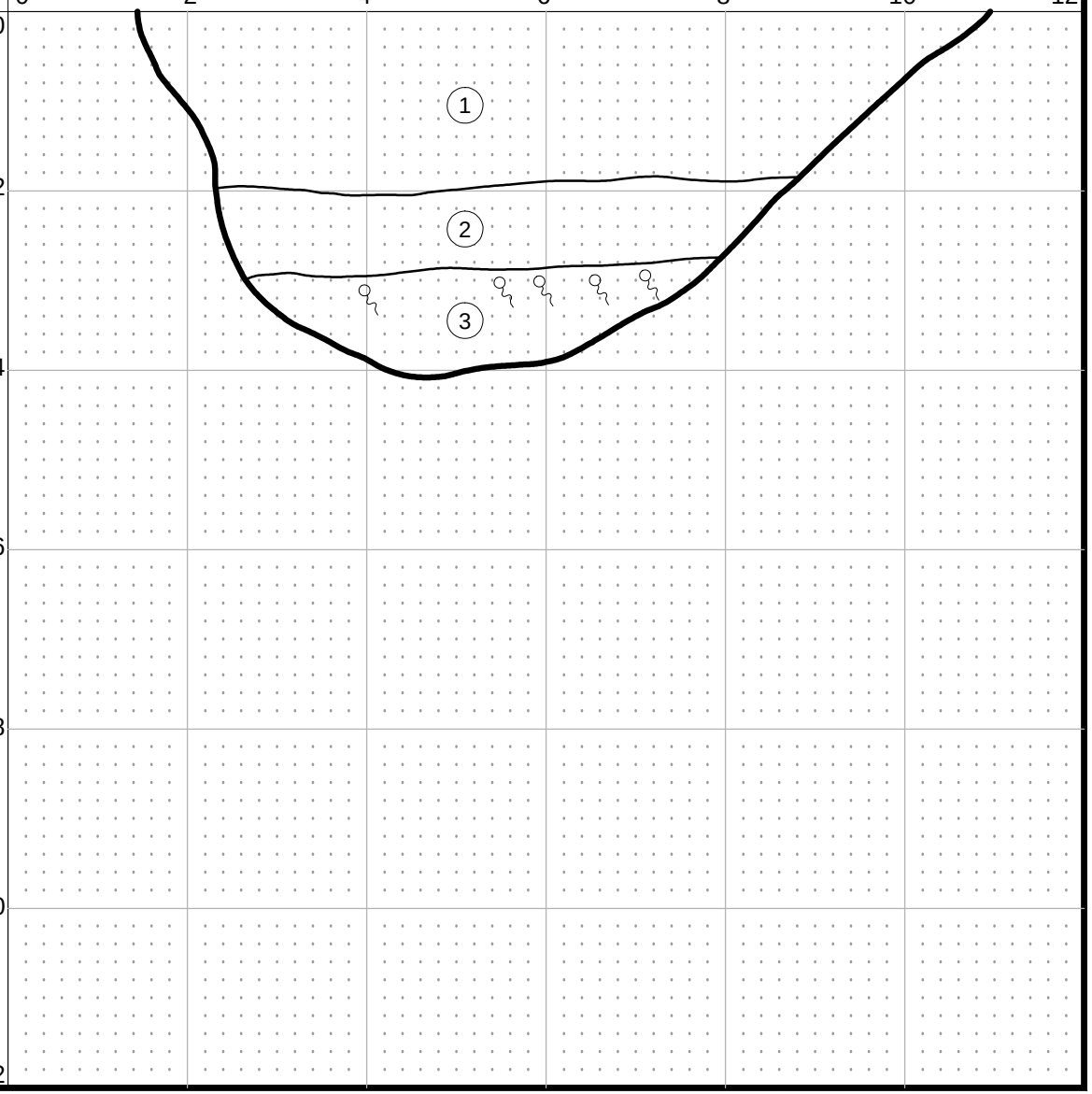
LOG OF TEST PIT TP-17-13

JOB NO: 21-1-12318-215 DATE: 6-24-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Stiff, gray-brown, slightly clayey SILT; moist; abundant iron-oxide staining, abundant roots; (Agricultural layer) ML.		36	S-1	0
(2) Soft, dark gray, slightly clayey SILT; moist; abundant organics, abundant iron-oxide staining; (Hm) ML.		57	S-2	2
(3) Very loose to loose, dark gray, silty, fine to medium SAND; wet; (Ha) SM.	▽	34	S-3	4
				6
				8
				10
				12

Sketch of West Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Flowing sand at 3.5 feet.
2. Samples collected in jars.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-49

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

LOG OF TEST PIT TP-18-13

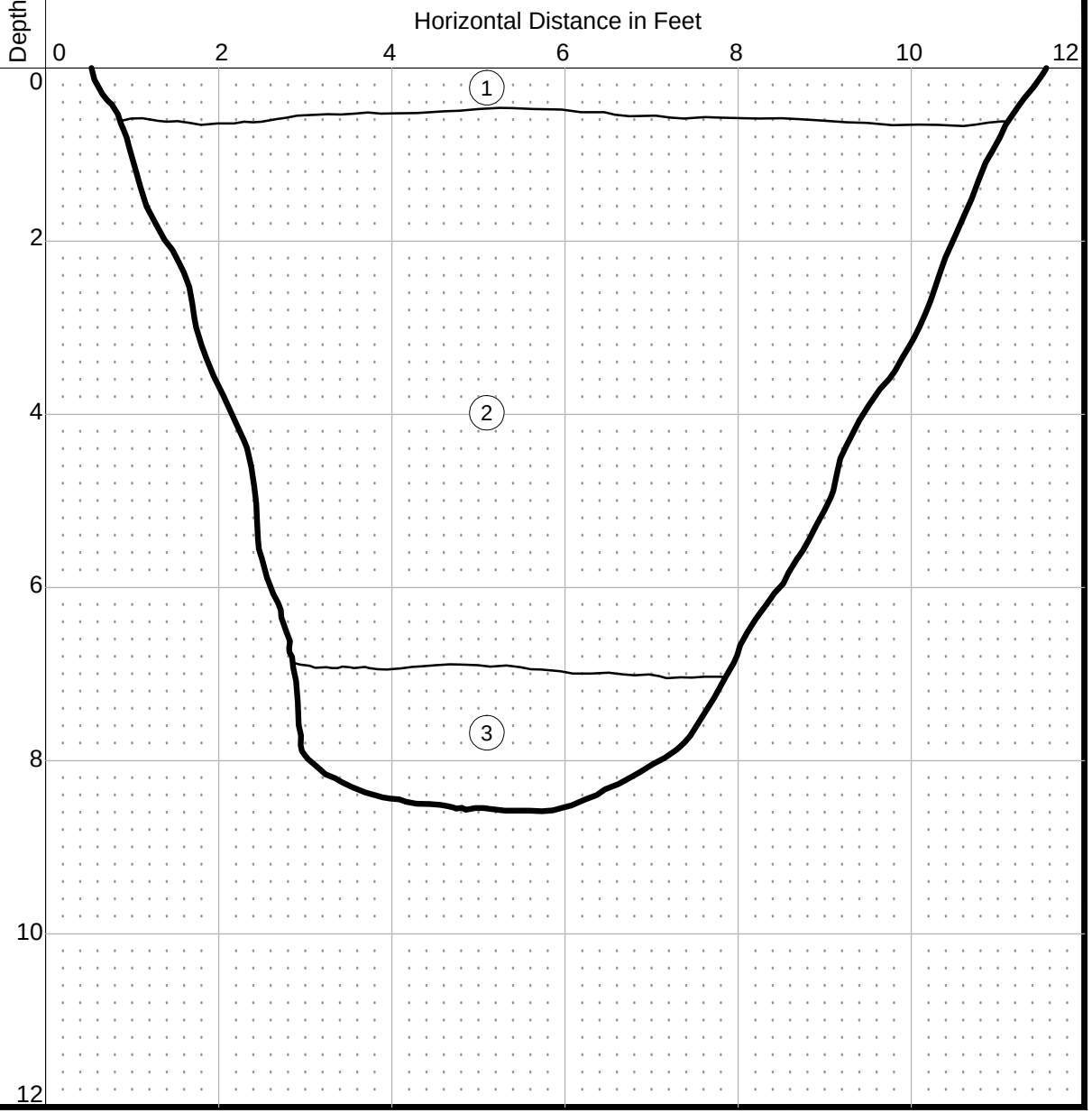
JOB NO: 21-1-12318-215 DATE: 6-26-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples
(1) Dense, gray, silty, fine sandy GRAVEL; moist; angular 1 to 2 inch gravel, abundant roots; (Dike Fill) GM.	None Observed	7	S-1
(2) Loose, gray-brown, slightly fine sandy SILT, trace of clay; moist; abundant organics, abundant iron-oxide staining; (Dike Fill) ML.		43	S-2
(3) Soft, dark gray, clayey SILT; moist; abundant organics, abundant iron-oxide staining; (Hm) MH.		65	S-3

Sketch of West Pit Side

Surface Elevation: Approx. 14 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-50

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

LOG OF TEST PIT TP-19-13

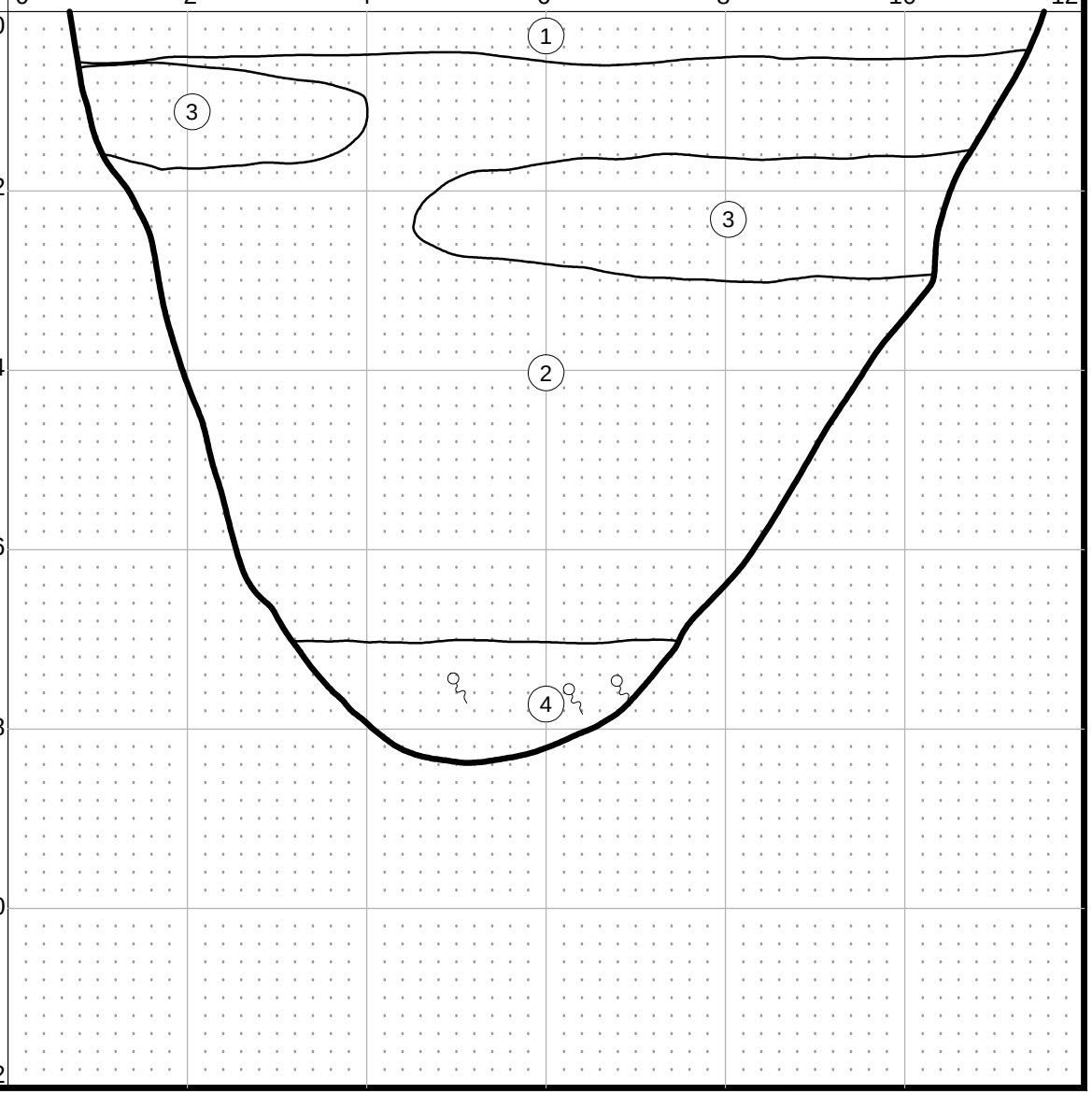
JOB NO: 21-1-12318-215 DATE: 6-26-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium dense, gray-brown, silty, sandy GRAVEL; moist; subrounded to angular gravel, abundant roots; (Dike Fill) GM.		4	S-1	0
		29	S-2	
		6	S-3	2
(2) Loose, gray-brown, slightly fine to medium sandy SILT; moist; abundant organics, abundant iron-oxide staining; (Dike Fill) ML.				
(3) Loose, gray-brown, fine to medium SAND, trace of silt; moist; scattered organics, scattered silt pockets; (Dike Fill) SP.				4
(4) Soft, dark gray, slightly clayey to clayey SILT; abundant organics; (Hm) ML.				6
	▽	74	S-4	8
				10
				12

Sketch of West Pit Side

Surface Elevation: Approx. 14 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-51

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

LOG OF TEST PIT TP-20-13

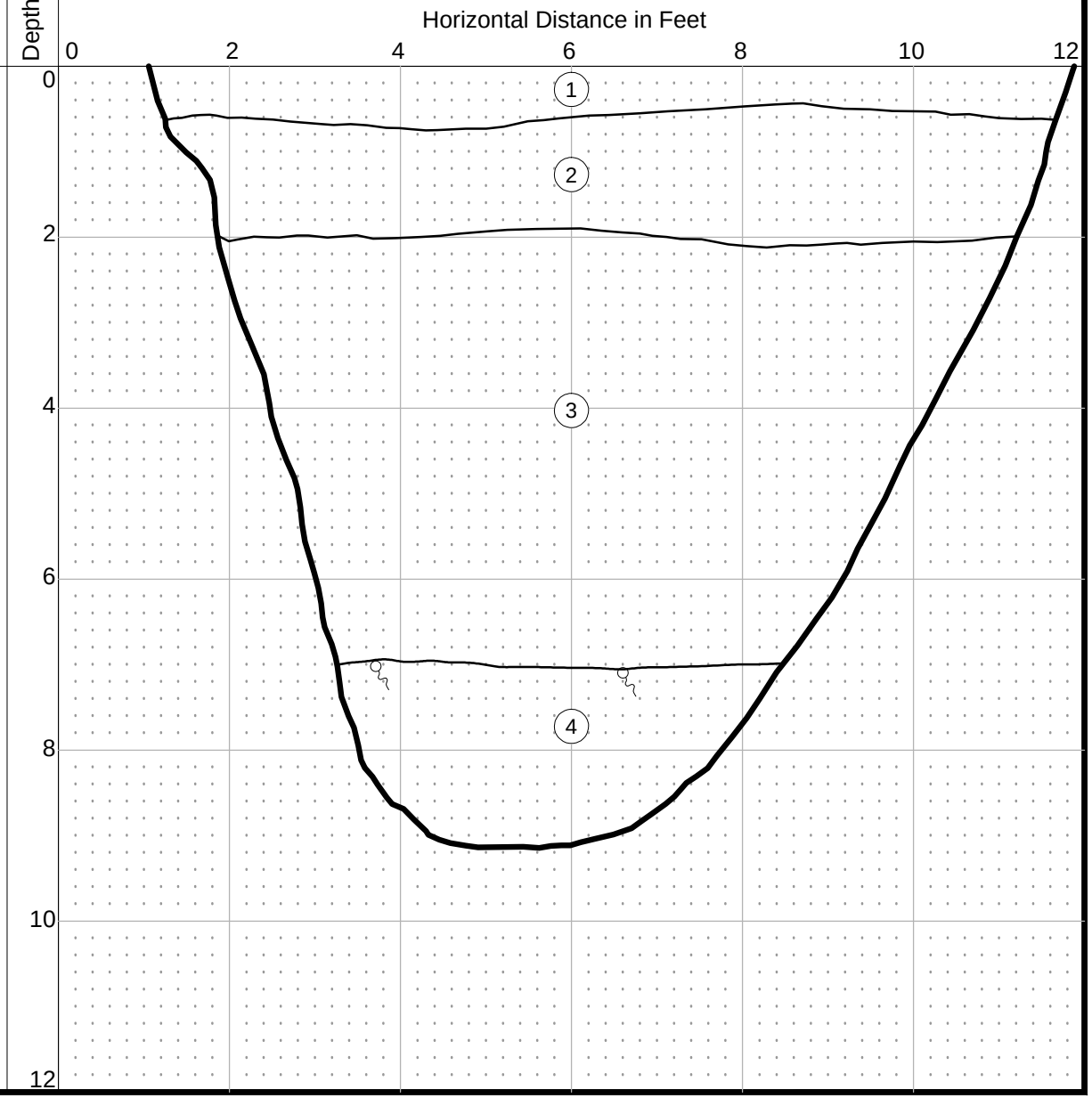
JOB NO: 21-1-12318-215 DATE: 6-26-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples
(1) Medium dense, brown, silty, sandy, fine GRAVEL; moist; subangular to angular gravel, abundant roots; (Dike Fill) GM.		2	S-1
		18	S-2
(2) Loose, gray-brown, silty, fine SAND; moist; abundant organics, silt pockets; (Dike Fill) SM.		52	S-3
(3) Soft to medium stiff, gray-brown, slightly clayey SILT, trace of fine sand; moist; abundant iron-oxide staining, abundant roots; (Dike Fill) ML.			
(4) Soft, dark gray, clayey SILT; abundant organics; (Hm) MH.	▽	59	S-4

Sketch of West Pit Side

Surface Elevation: Approx. 14 Ft.



NOTES

1. Very slow groundwater seepage at 7 feet.
2. Samples collected in jars.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-52

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

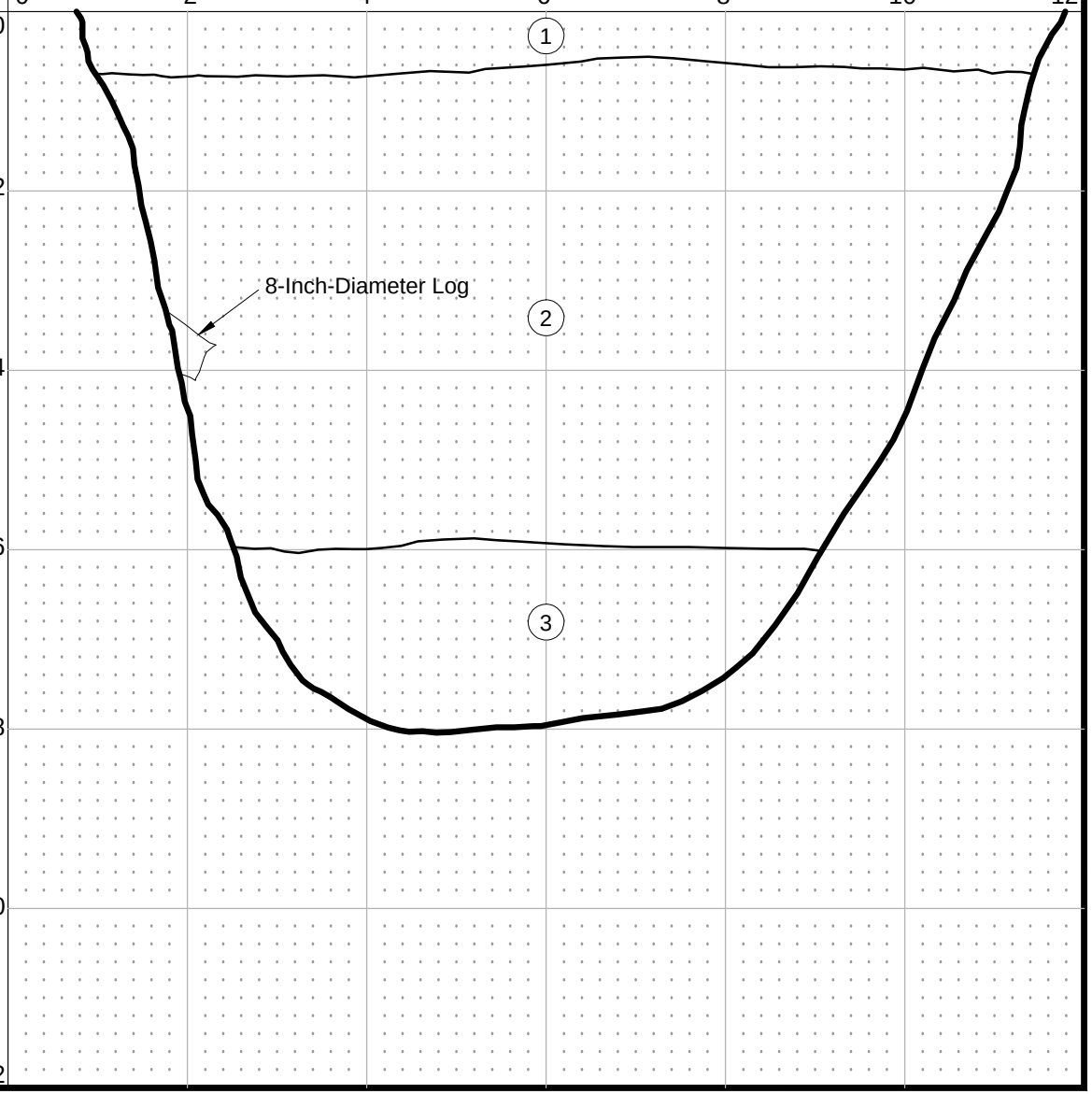
LOG OF TEST PIT TP-21-13

JOB NO: 21-1-12318-215 DATE: 6-26-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium dense, gray, silty, fine sandy GRAVEL; moist; subangular to angular, fine to coarse gravel, abundant roots; (Dike Fill) GM.	None Observed	10	S-1	0
(2) Soft, gray, slightly fine sandy, slightly clayey SILT; moist; abundant organics, abundant iron-oxide staining; (Dike Fill) ML.		51	S-2	2
(3) Loose, dark gray, fine sandy SILT, trace of clay; wet; scattered iron-oxide stains, abundant organics; (Hm) ML.		47	S-3	4, 6, 8, 10, 12

Sketch of West Pit Side Surface Elevation: Approx. 14 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-53

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 05-27-2014 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

LOG OF TEST PIT TP-22-13

JOB NO: 21-1-12318-215 DATE: 6-26-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Dense, gray, silty, sandy, coarse GRAVEL; moist; subangular to angular gravel and cobbles up to 12 inches in diameter; (Dike Fill) GM.	None Observed	5	S-1	0
(2) Medium dense, fine gravelly, silty SAND; moist; 1- to 8-inch subangular to subrounded gravel and cobbles, wood; (Dike Fill) SM.		12	S-2	2
(3) Soft, dark gray, slightly clayey SILT, trace of fine sand; moist; scattered iron-oxide staining, abundant organics; (Hm) ML.		52	S-3	4, 6, 8, 10, 12

NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

Sketch of ___West___ Pit Side Surface Elevation: Approx. 14 Ft.

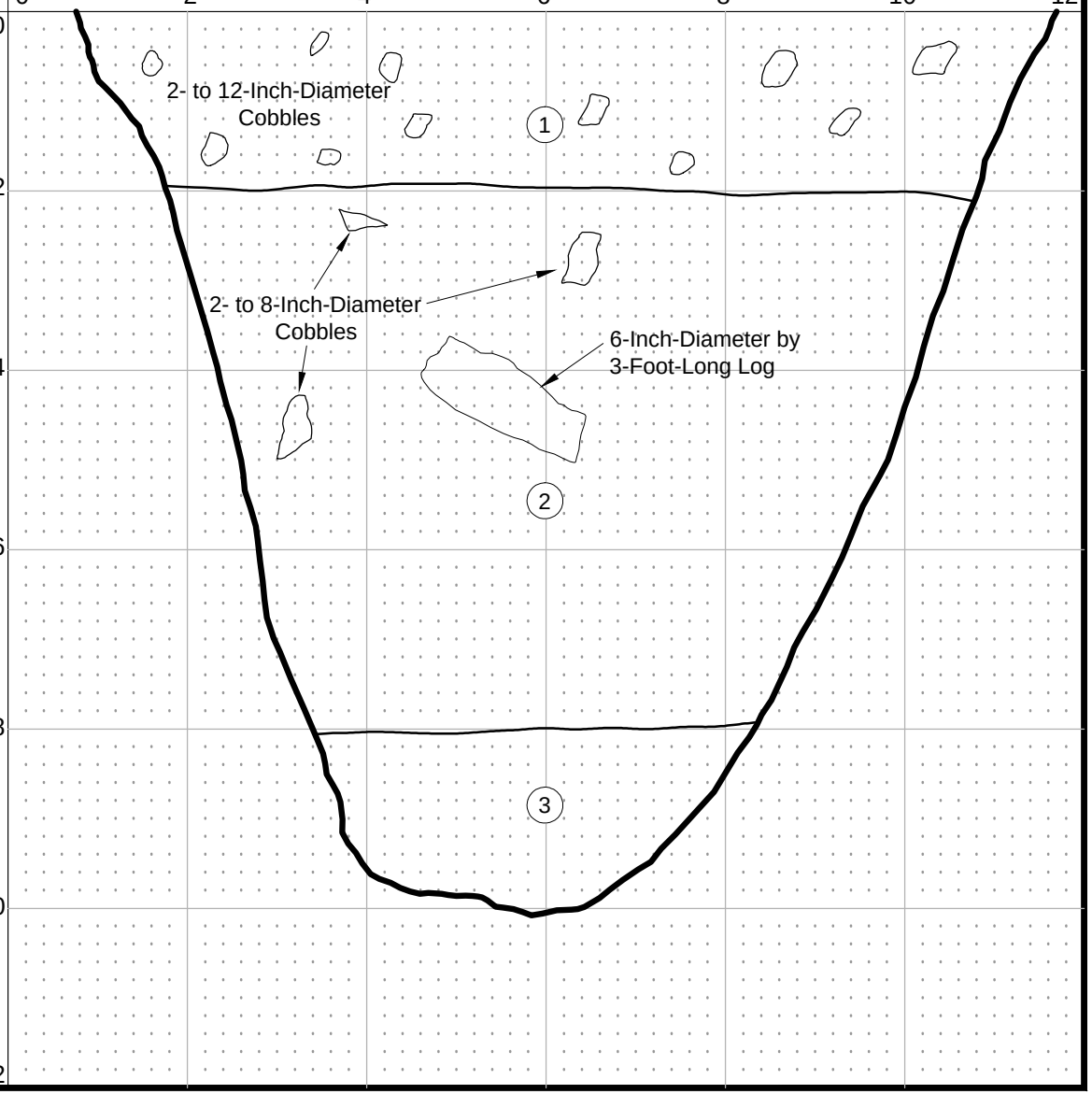


FIG. A-54

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

LOG OF TEST PIT TP-23-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium dense, light gray, silty, sandy GRAVEL; moist; coarse, angular gravel and cobbles to 4 inches in diameter, scattered roots; (Dike Fill) GM.	None Observed	4	S-1	0
(2) Soft, gray, clayey SILT, trace of fine sand; moist; scattered wood up to 2 feet long; (Dike Fill) ML.				2
(3) Soft, dark gray, slightly clayey SILT, trace of fine to medium sand; moist; scattered to abundant organics, iron-oxide staining; (Hm) ML.		50	S-2	4
				6
		68	S-3	8
				10
				12

NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

Sketch of West Pit Side Surface Elevation: Approx. 14 Ft.

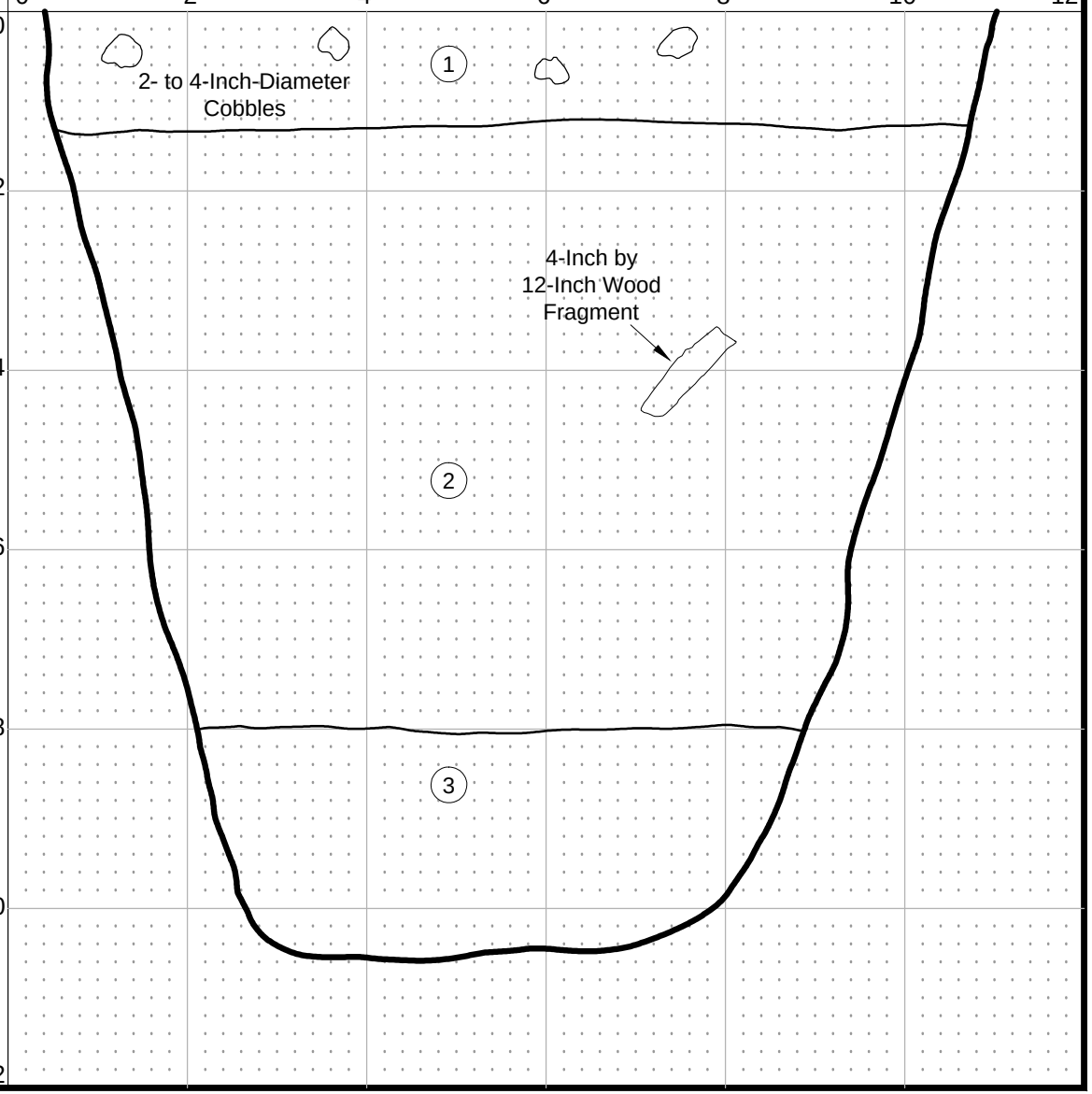


FIG. A-55

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

LOG OF TEST PIT TP-24-13

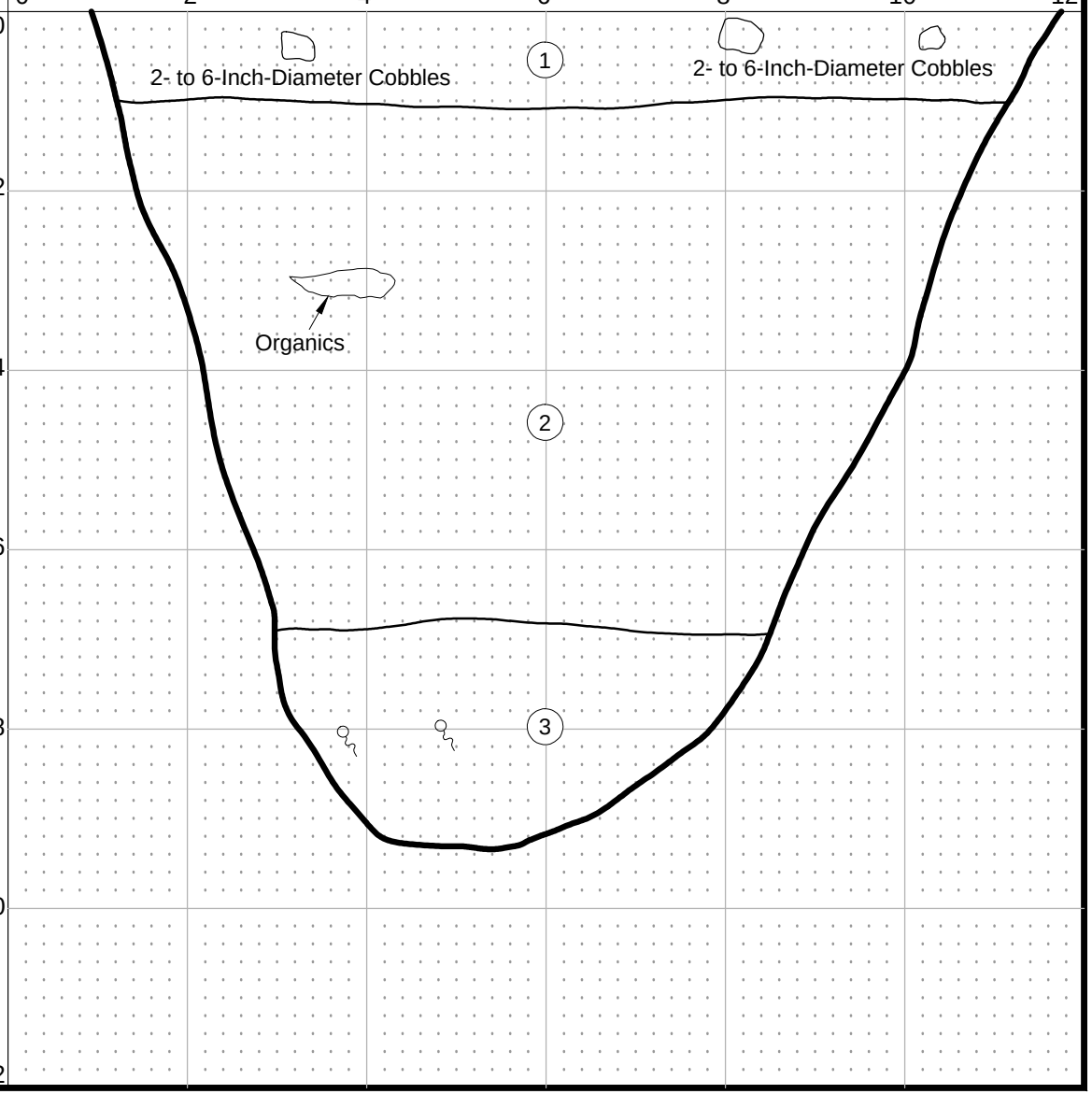
JOB NO: 21-1-12318-215 DATE: 6-26-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium dense, gray-brown, sandy GRAVEL; dry; subangular to angular gravel and cobbles up to 6 inches in diameter, abundant roots; (Dike Fill) GM.		2	S-1	0
(2) Soft, gray-brown, slightly fine to medium sandy, clayey SILT; moist; abundant iron-oxide staining, abundant roots and organics; (Dike Fill) MH.		32	S-2	2
(3) Soft, dark gray, slightly clayey to clayey SILT, trace of fine sand; moist; silty sand seams, ground water seepage at 8 feet, scattered organics, organic odor, iron-oxide staining; (Hm) ML.	▽	55	S-3	4, 6, 8, 10, 12

Sketch of West Pit Side

Surface Elevation: Approx. 14 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-56

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

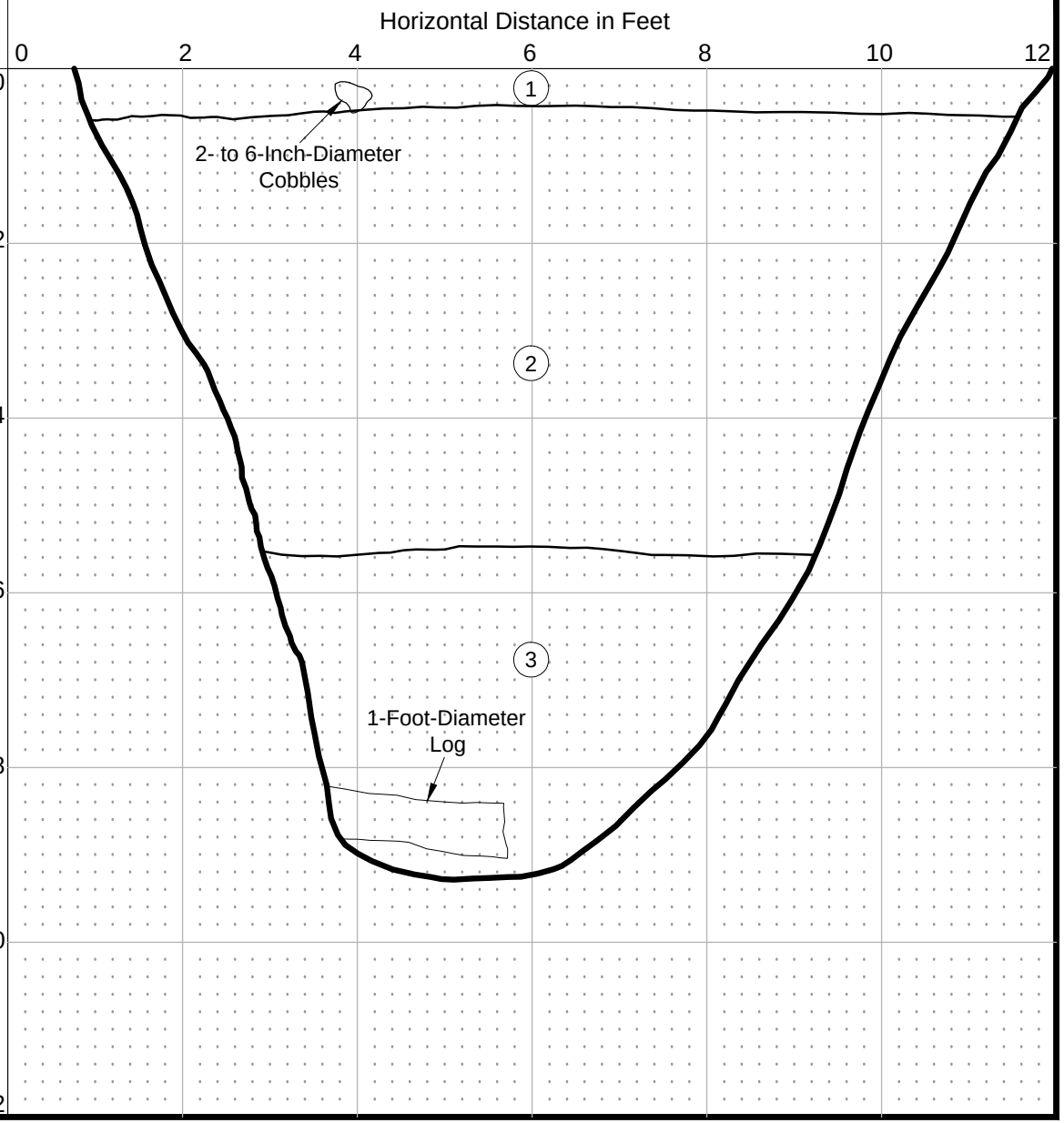
LOG OF TEST PIT TP-25-13

JOB NO: 21-1-12318-215 DATE: 6-26-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Medium dense, gray-brown, slightly sandy, silty GRAVEL; moist; abundant organics, grass in upper 3 inches, subrounded to angular gravel and cobbles up to 6 inches in diameter; (Dike Fill) GM.	None Observed	6	S-1	0
(2) Soft, gray-brown, slightly fine sandy, clayey SILT; moist; abundant iron-oxide staining, abundant organics; (Dike Fill) MH.		30	S-2	2
(3) Soft, dark gray, clayey SILT; moist; abundant organics, locally mostly organics, 1 foot diameter log; (Hm) ML.		79	S-3	4, 6

Sketch of West Pit Side Surface Elevation: Approx. 14 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-57

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 05-27-2014 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

LOG OF TEST PIT TP-26-13

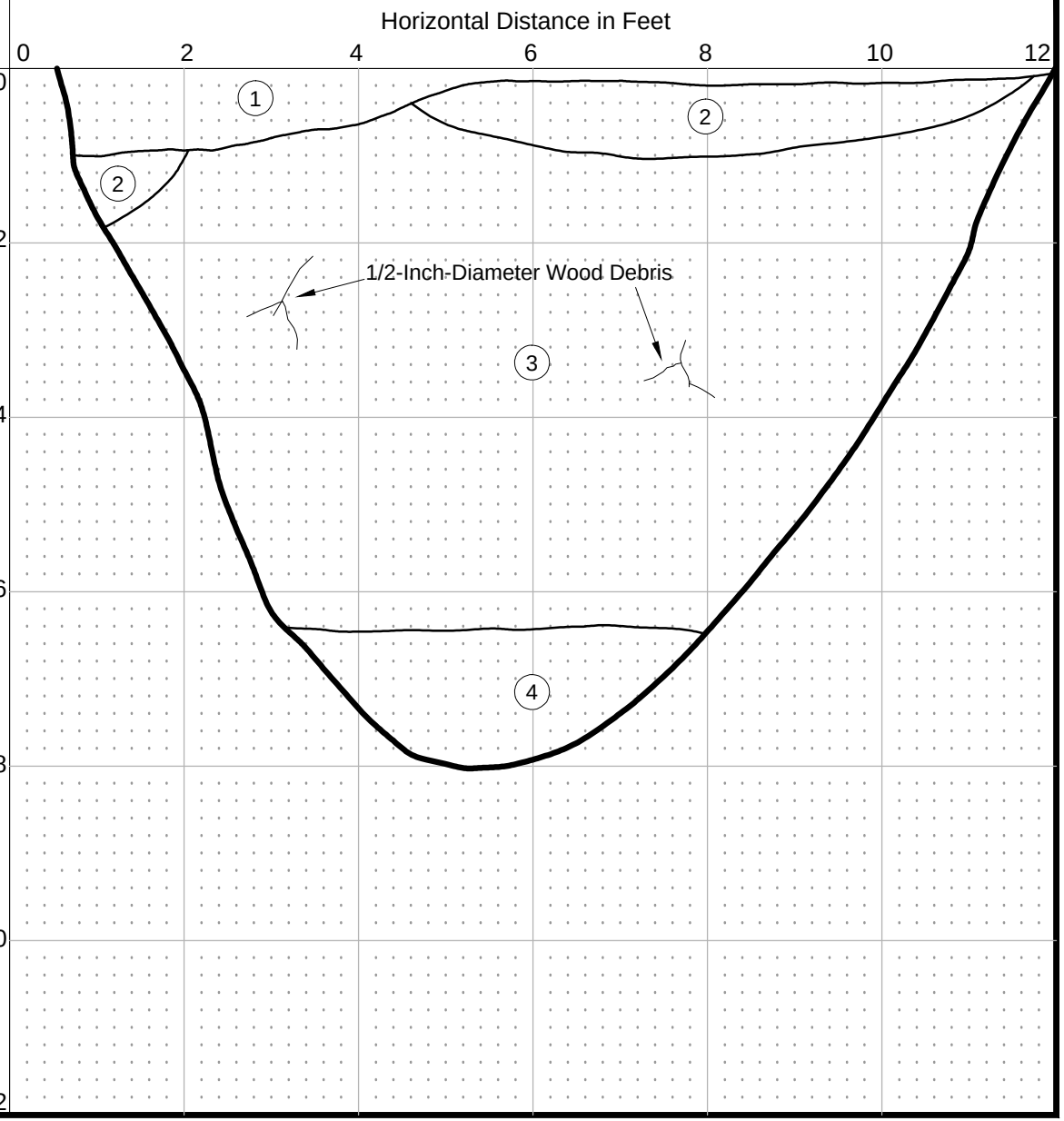
JOB NO: 21-1-12318-215 DATE: 6-26-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples
(1) Medium dense, gray-brown, silty, sandy GRAVEL; moist; 2 to 3 inch subangular to angular gravel, local 4- to 6-inch diameter cobbles, abundant roots; (Dike Fill) GM.	None Observed	4	S-1
		13	S-2
(2) Discontinuous, loose, gray, slightly silty to silty, fine to medium SAND; moist; scattered organics, silt pockets; (Dike Fill) SM/SP-SM.		49	S-3
(3) Loose, gray, slightly fine to medium sandy SILT; moist; abundant organics, abundant iron-oxide staining; (Dike Fill) ML.			
(4) Soft, dark gray, slightly clayey SILT; moist; abundant organics; (Hm) ML.		56	S-4

Sketch of West Pit Side

Surface Elevation: Approx. 14 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-58

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

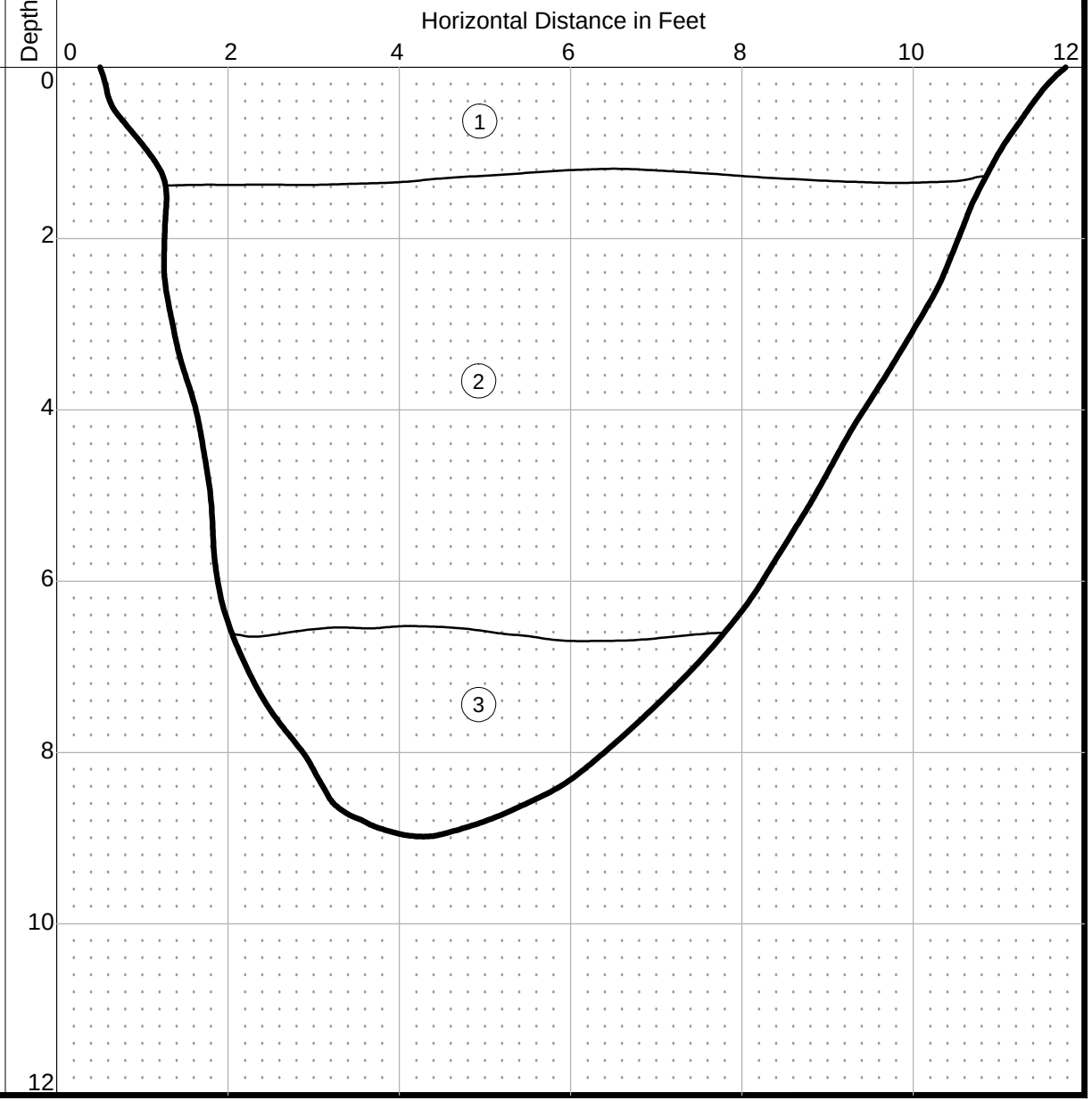
LOG OF TEST PIT TP-27-13

JOB NO: 21-1-12318-215 DATE: 6-26-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples
(1) Medium dense, gray-brown, silty, sandy GRAVEL; dry; angular gravel and cobbles, scattered organics; (Dike Fill) GM.	None Observed	2	S-1
(2) Loose, brown to gray SILT, trace of sand and clay; moist; abundant roots, abundant iron-oxide staining; (Dike Fill) ML.		31	S-2
(3) Soft, dark gray, slightly clayey, slightly fine sandy SILT; moist; abundant organics; (Hm) ML.		51	S-2

Sketch of West Pit Side Surface Elevation: Approx. 14 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-59

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

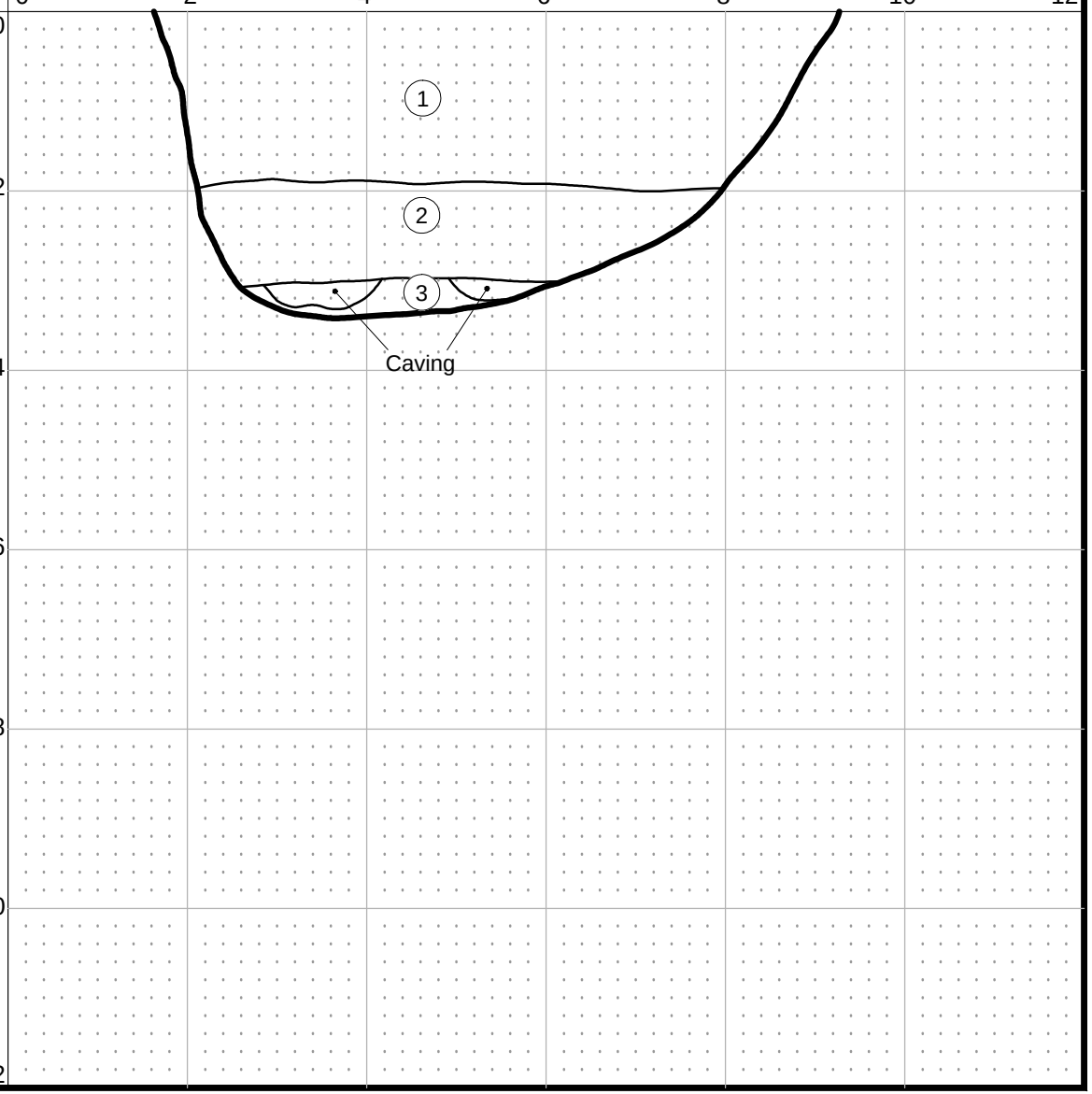
LOG OF TEST PIT TP-28-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, gray-brown, clayey SILT; moist; sand seams, iron-oxide staining, trace of organics; (Agricultural layer) ML.		26	S-1	0
(2) Soft, dark gray, slightly fine sandy, slightly clayey SILT; moist; zones of abundant organics and iron-oxide staining, organic odor; (Hm) ML.	▽	57	S-2	2
(3) Loose, dark gray, fine to medium SAND, trace of silt; wet; (Ha) SP.		34	S-3	4
				6
				8
				10
				12

Sketch of ___West___ Pit Side Surface Elevation: Approx. 4 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-60

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

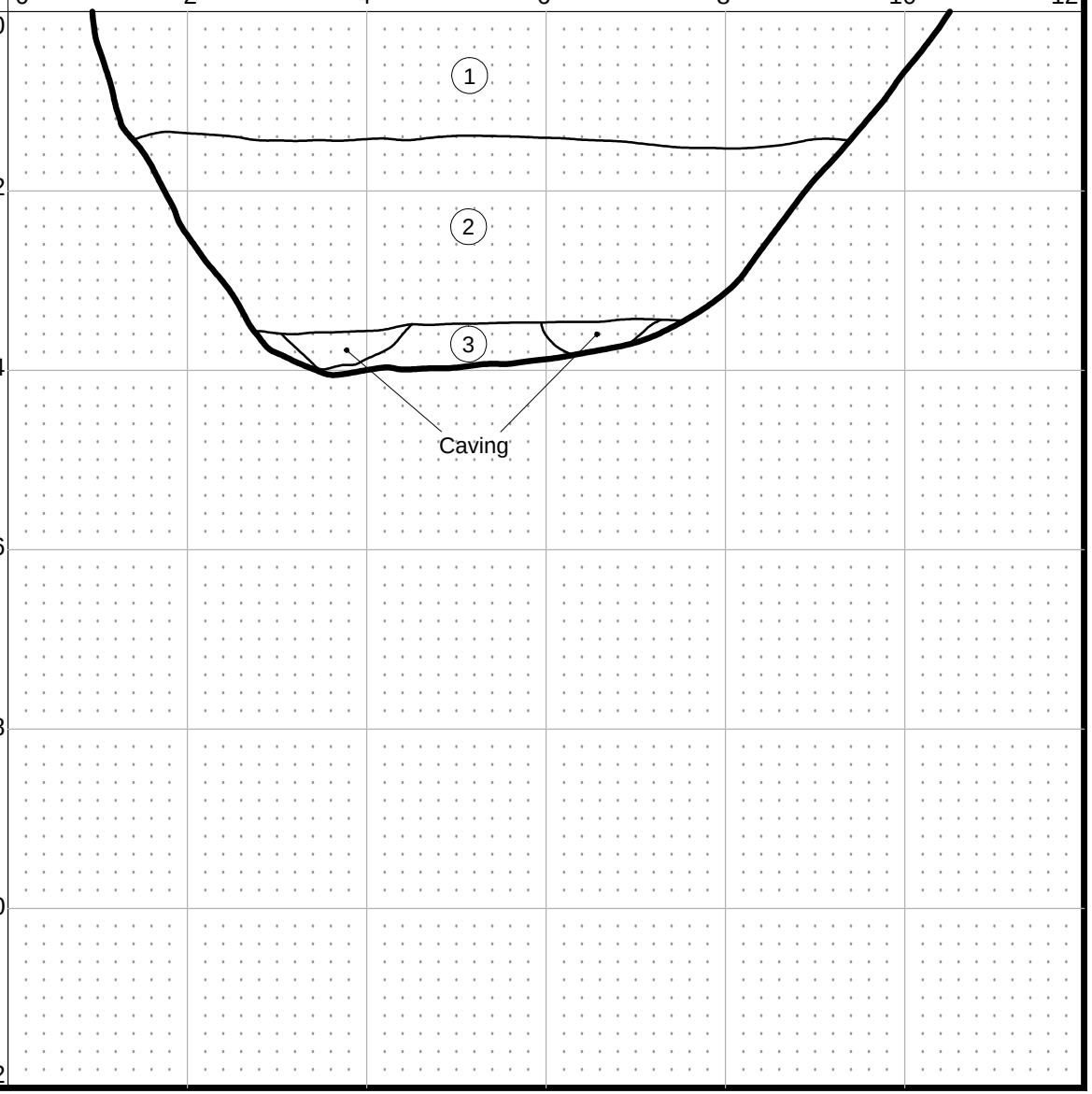
LOG OF TEST PIT TP-29-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, brown, clayey SILT; moist; scattered organics; (Agricultural layer) MH.		29	S-1	0
(2) Soft, gray-brown, slightly clayey SILT; moist; zones of abundant organics and iron-oxide staining; (Hm) ML.	▽	54	S-2	2
(3) Loose, dark gray-brown, fine to medium SAND, trace of silt; wet; (Ha) SP.		21	S-3	4
				6
				8
				10
				12

Sketch of ___West___ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-61

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

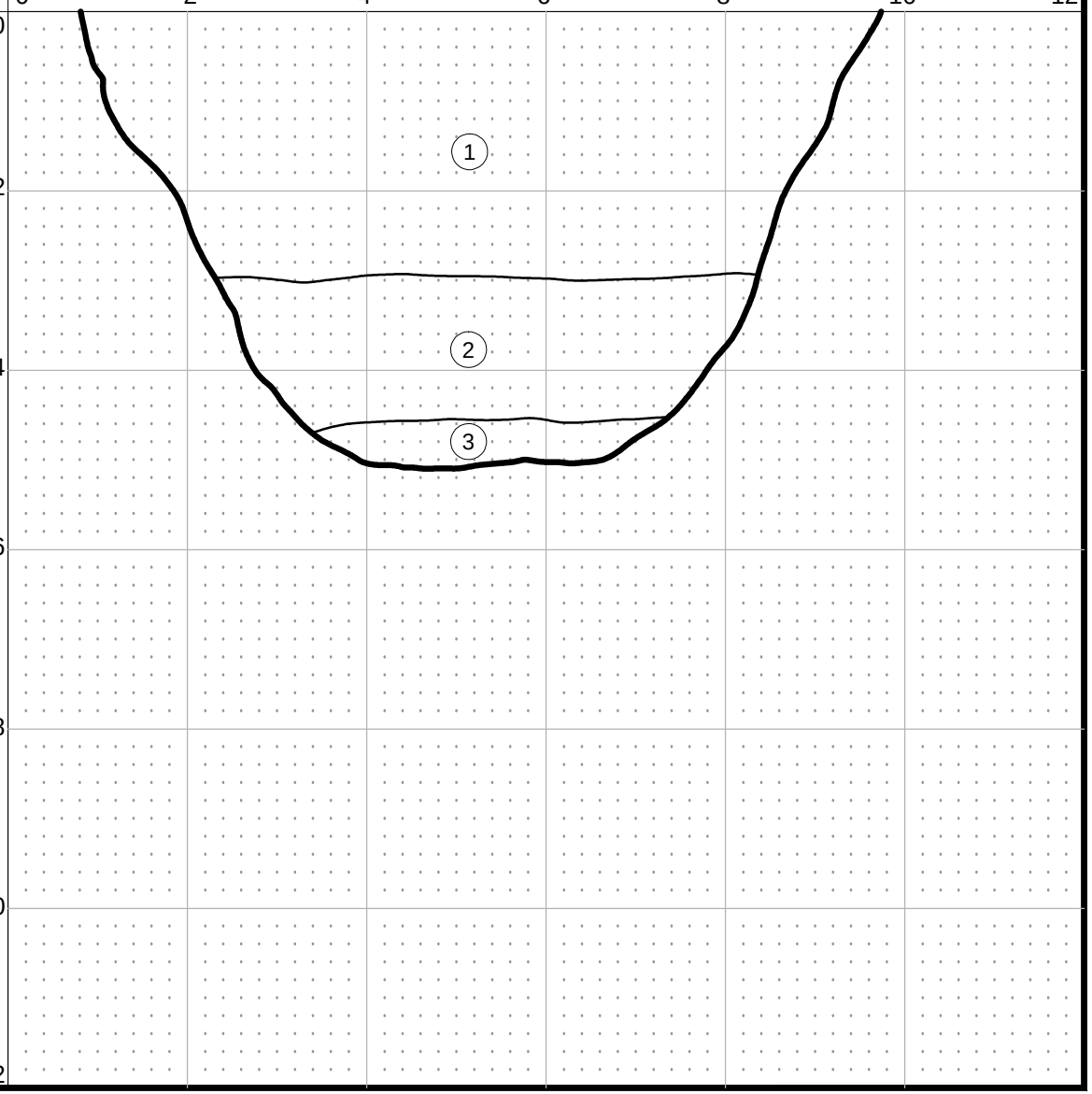
LOG OF TEST PIT TP-30-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, gray-brown, slightly fine to medium sandy, slightly clayey SILT; moist; scattered iron-oxide staining and organics; (Agricultural layer) ML.				0
(2) Loose, gray, slightly fine sandy SILT, trace of clay; moist; wet below 4 feet, abundant organics and iron-oxide staining, local pockets that are mostly organics; (Hm) ML.		46	S-1	2
		50	S-2	
(3) Loose, gray, slightly silty, fine SAND; wet; scattered organics; (Ha) SP-SM.	▽	40	S-3	4
				6
				8
				10
				12

Sketch of ___South___ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in large bags.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-62

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

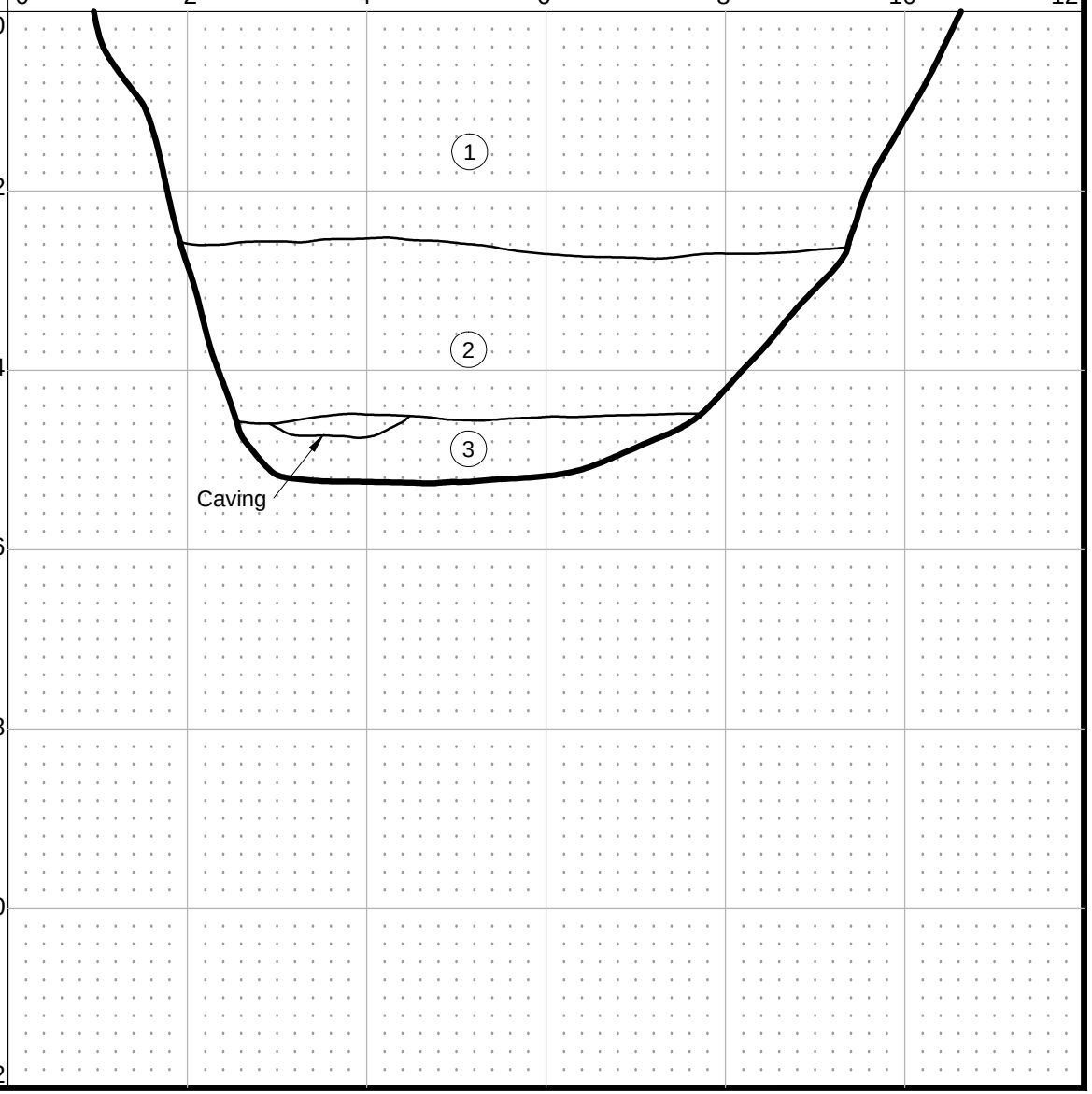
LOG OF TEST PIT TP-31-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, gray-brown, clayey SILT; moist; abundant iron-oxide staining, abundant organics; (Agricultural layer) MH.		55	S-1	0
(2) Loose, gray, fine sandy SILT, trace of clay; moist; wet below 4 feet, abundant organics; (Hm) ML.				2
(3) Loose, dark gray, silty, fine SAND; wet; scattered organics; (Ha) SM.	▽	48	S-2	4
		40	S-3	6
				8
				10
				12

Sketch of South Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Groundwater rapidly filled excavation.
2. Samples collected in jars.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-63

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

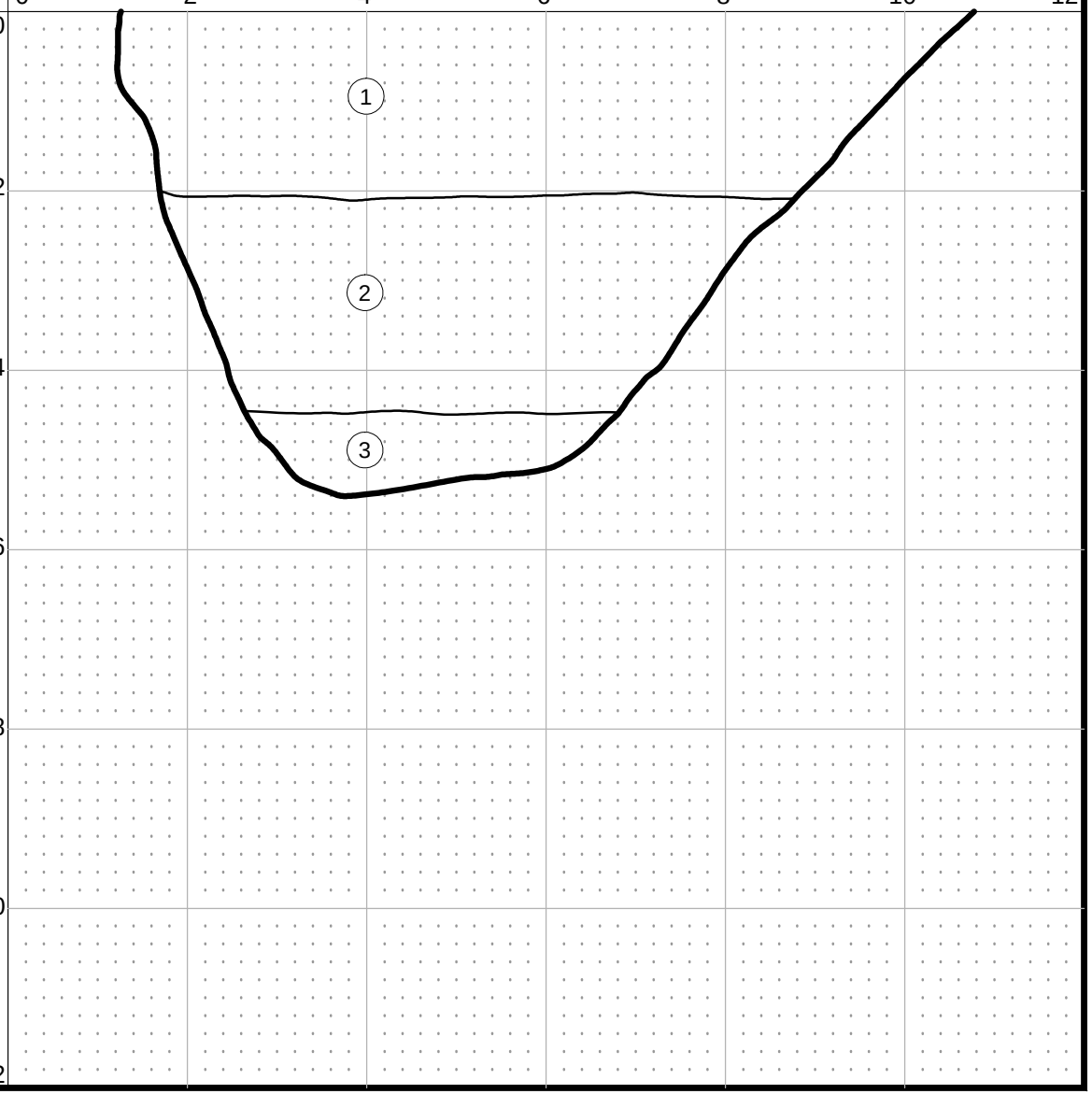
LOG OF TEST PIT TP-32-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, brown, slightly clayey SILT; moist; abundant organics, trace of iron-oxide staining; (Agricultural layer) ML.		27	S-1	0
(2) Soft, gray, slightly clayey SILT; moist; zones of abundant organics and iron-oxide staining; (Hm) ML.		63	S-2	2
(3) Loose, gray, silty, fine SAND; wet; (Ha) SM.	▽	37	S-3	4
				6
				8
				10
				12

Sketch of West Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-64

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

LOG OF TEST PIT TP-33-13

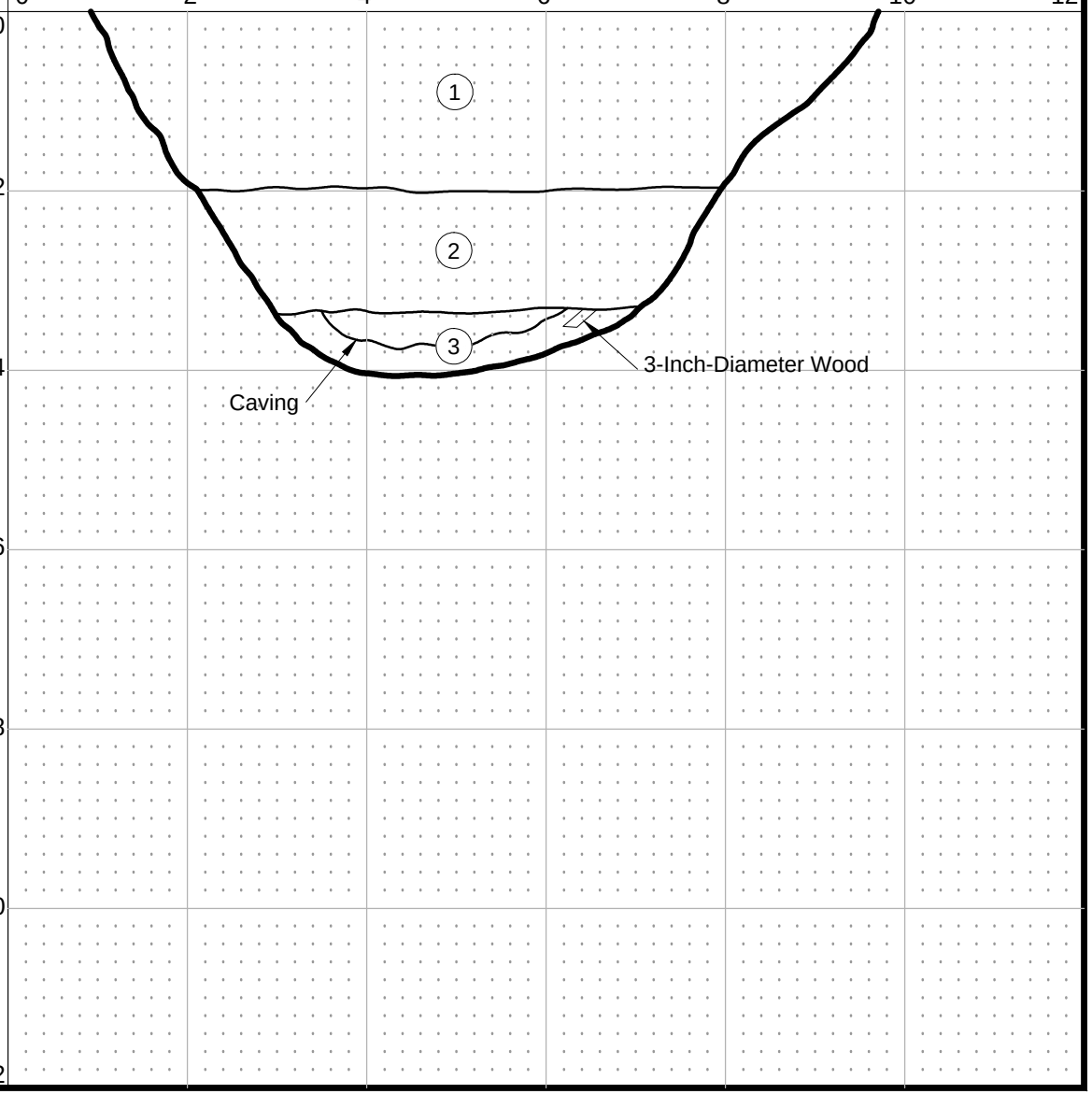
JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, brown, clayey SILT; moist; trace of organics and iron-oxide staining; (Agricultural layer) ML.		32	S-1	0
(2) Loose, dark gray, fine sandy SILT; moist; zones of abundant organics and iron-oxide staining; (Hm) ML.		37	S-2	2
(3) Loose, gray-brown, silty, fine to medium SAND; wet; trace of organics and wood; (Ha) SM.	▽	42	S-3	4
				6
				8
				10
				12

Sketch of ___North___ Pit Side

Surface Elevation: Approx. 5.5 Ft.



NOTES

1. Groundwater rapidly filled excavation.
2. Samples collected in large bags.
3. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-65

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

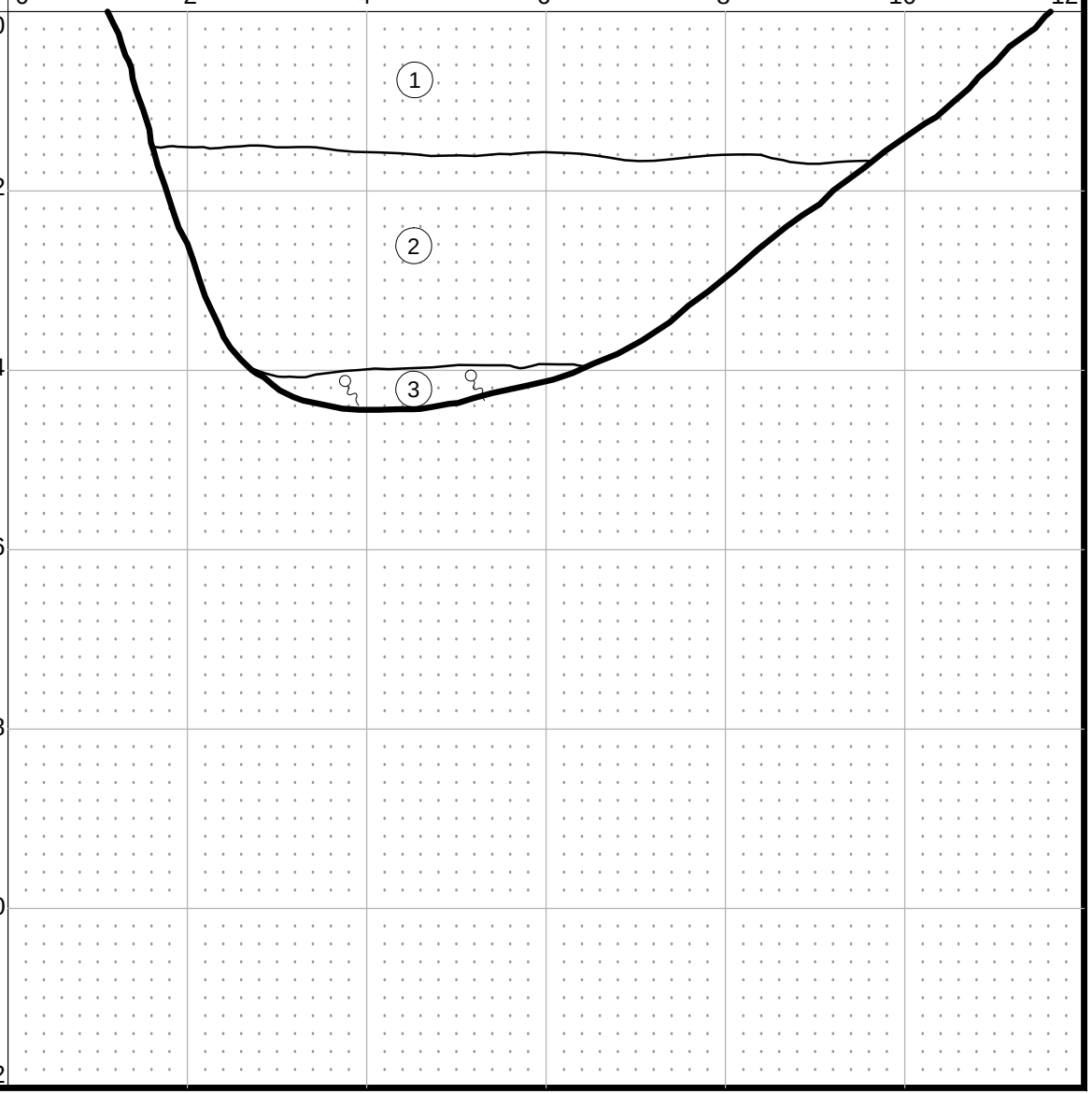
LOG OF TEST PIT TP-34-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, brown, clayey SILT; moist; trace of organics and iron-oxide staining; (Agricultural layer) MH/ML.		30	S-1	0
(2) Loose, gray, fine to medium sandy SILT; moist; abundant organics and iron-oxide staining; (Hm) ML.		51	S-2	2
(3) Loose, gray-brown, silty, fine to medium SAND; wet; (Ha) SM.	▽	38	S-3	4
				6
				8
				10
				12

Sketch of ___West___ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-66

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

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Geotechnical and Environmental Consultants

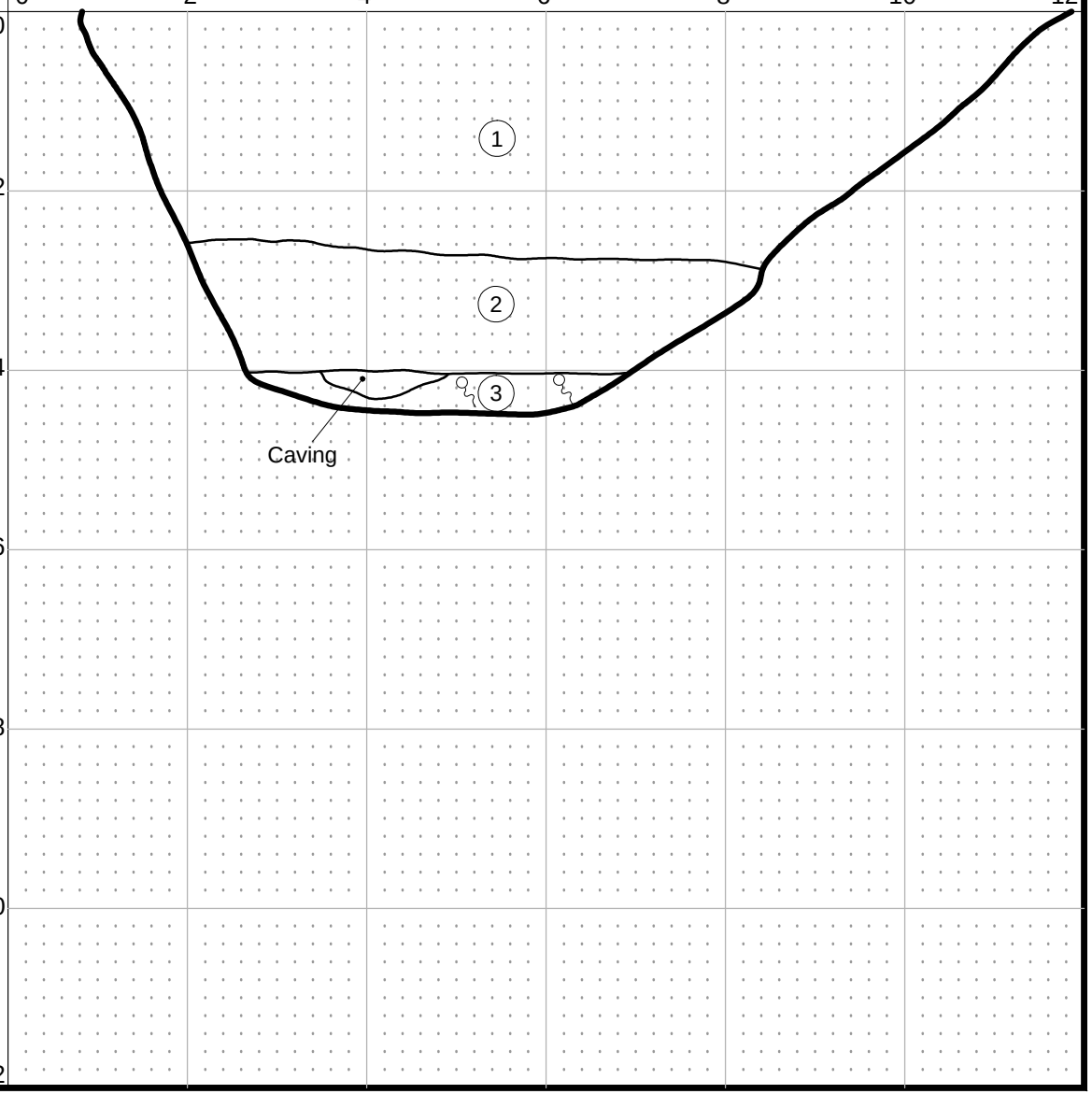
LOG OF TEST PIT TP-35-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, brown, fine to medium sandy, clayey SILT; moist; trace of iron-oxide staining and organics; (Agricultural layer) MH.		27	S-1	0
(2) Soft, gray, slightly clayey, slightly fine sandy SILT; moist; wet below 3 feet, iron-oxide staining, abundant organics, zones that are mostly organics; (Hm) ML.	▽	51	S-2	2
(3) Loose, gray, silty, fine to medium SAND; wet; scattered to abundant organics, wood; (Ha) SM.		41	S-3	4
				6
				8
				10
				12

Sketch of ___West___ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in large bags.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-67

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

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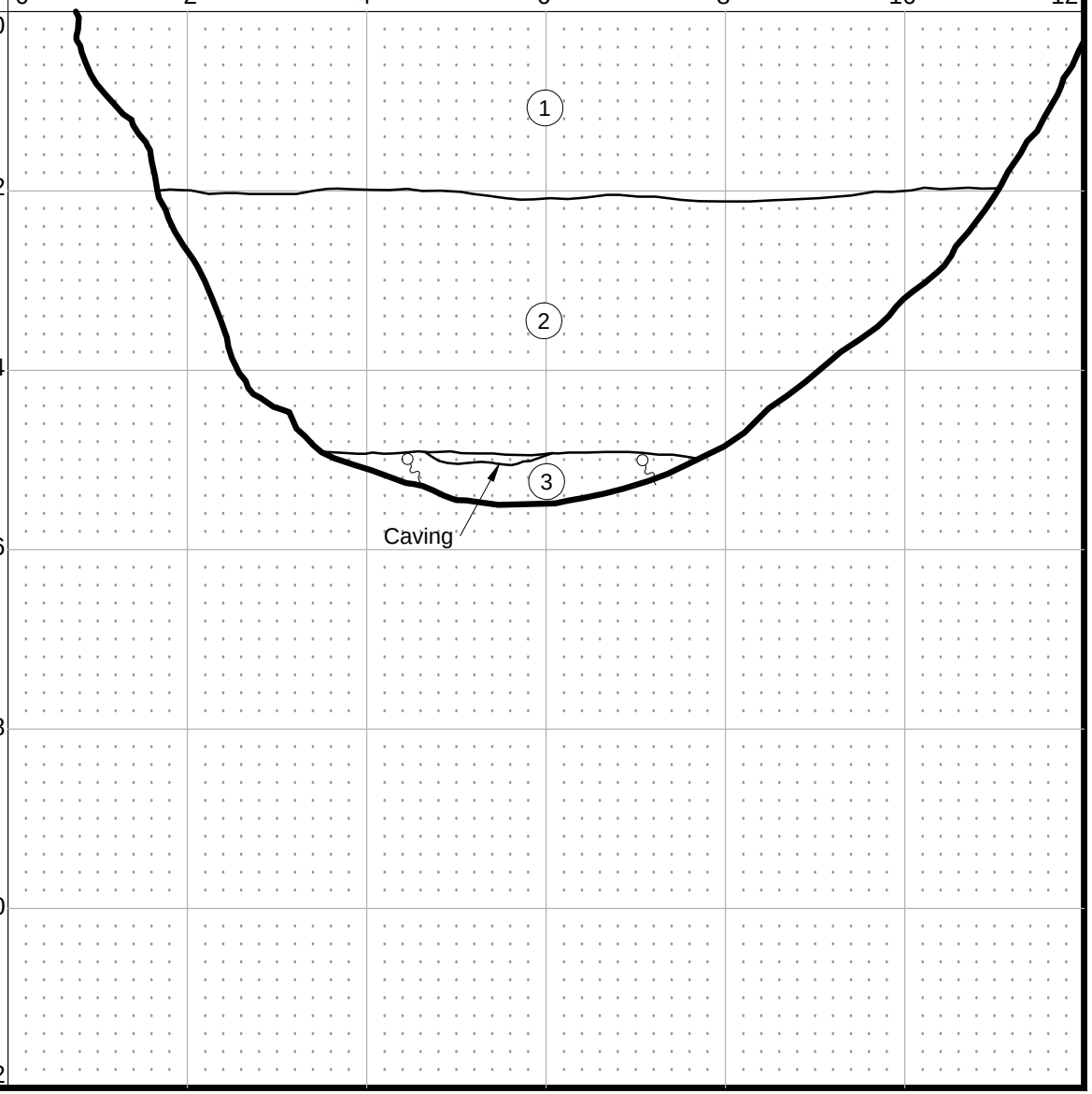
LOG OF TEST PIT TP-36-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, gray-brown, clayey SILT; moist; trace of iron-oxide staining and organics; (Agricultural layer) ML/MH.		40	S-1	0
(2) Loose, gray, slightly fine sandy SILT; moist; zones of abundant organics and iron-oxide staining; (Hm) ML.		55	S-2	2
(3) Loose, gray, silty, fine to medium SAND; wet; scattered organics; (Ha) SM.	▽	29	S-3	4
				6
				8
				10
				12

Sketch of ___West___ Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-68

Filename: J:\211\12318-215\21-1-12318-215 TPs.dwg Date: 08-29-2013 Login: cnt

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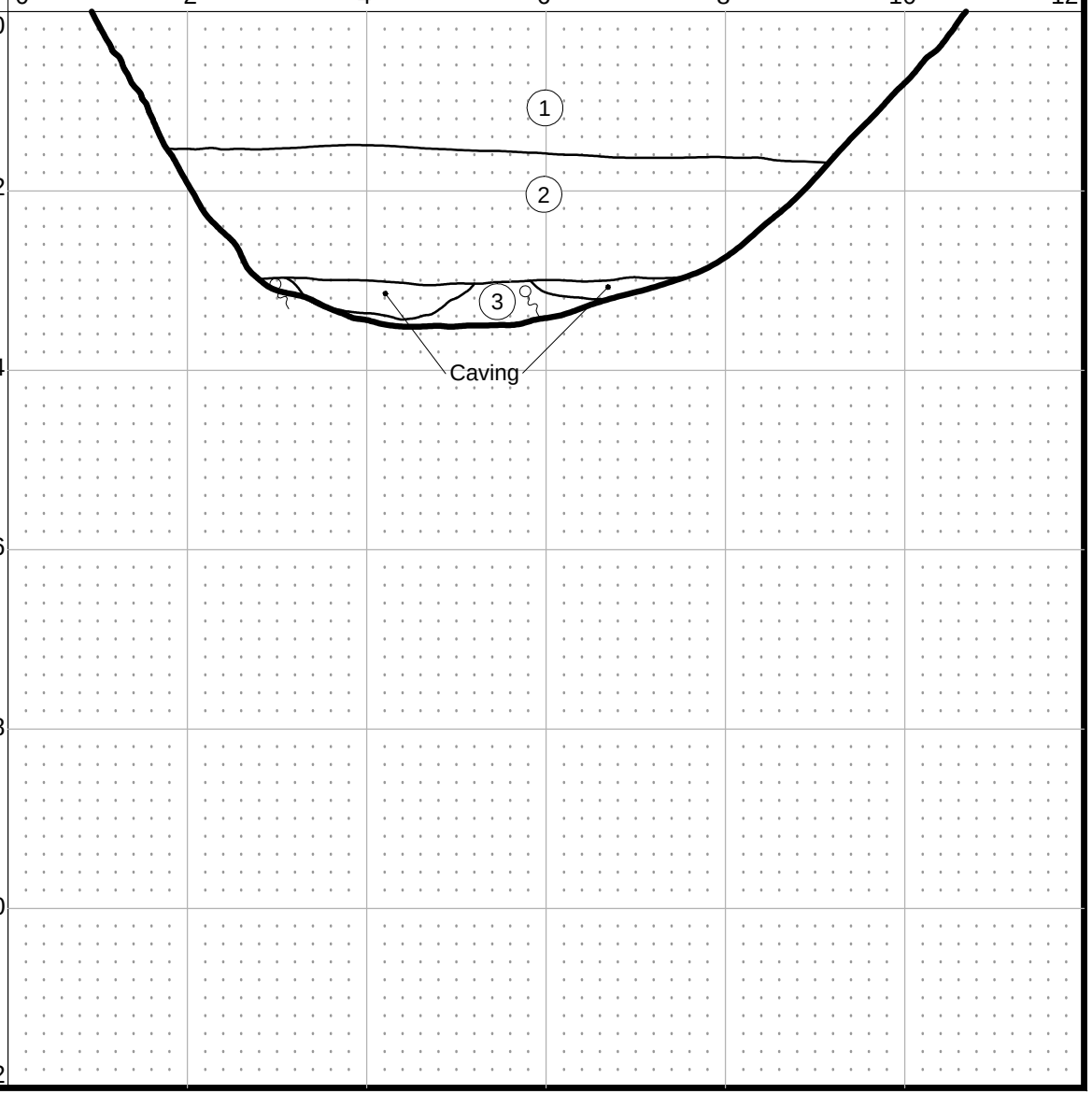
LOG OF TEST PIT TP-37-13

JOB NO: 21-1-12318-215 DATE: 6-25-2013 LOCATION: See Site and Exploration Plan

PROJECT: Fir Island

SOIL DESCRIPTION	Ground Water	% Water Content	Samples	Depth, Ft.
(1) Soft, gray-brown, clayey SILT; moist; trace of iron-oxide staining and organics; (Agricultural layer) MH/ML.		30	S-1	0
(2) Loose, gray, SILT, trace of clay and sand; moist; wet below 2.5 feet, abundant organics, pockets that are primarily organics, trace of iron-oxide staining; (Hm) ML.	▽	71	S-2	2
(3) Loose, gray-brown, silty, fine to medium SAND; wet; (Ha) SM.		27	S-3	4
				6
				8
				10
				12

Sketch of South Pit Side Surface Elevation: Approx. 6 Ft.



NOTES

1. Samples collected in jars.
2. Density and consistencies presented are estimated based on field observations and values recorded in nearby borings and cone penetration tests (CPT).

FIG. A-69

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 14.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *40.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown SILT, trace of sand; moist; (Hf) ML.					S-1 (1 - 2')	
		Gray-brown, fine to medium SAND, trace of silt; dry; (Hf) SP.	2.8				S-2 (2.8 - 3.8')	
		Brown SILT, trace of fine sand; moist; iron-oxide-stained locally; (Hf) ML.	3.8				S-3 (4 - 5')	
5	2	Gray-brown, fine to medium SAND, trace of silt; dry; (Hf) SP.	5.5				S-4 (5.5 - 6.2')	5
		Gray and orange-brown, slightly clayey to clayey SILT; moist; scattered layers or pockets of fine sand, irregular iron-oxide staining, scattered tubers (marsh plants); (Hf) ML.	6.2				S-5 (7 - 8')	
10	3	Gray SILT, trace of clay and fine sand; moist to wet; locally slightly clayey to clayey, trace tubers (marsh plants) above 11.5 feet; (Hm) ML.	10.5			10/7/2010	S-6 (11 - 12')	10
15	4	Gray, trace to slightly silty, fine to medium SAND; wet; locally coarse sand; (Ha) SP/SP-SM. - 1-inch clayey silt layer at 16.5 feet. - 1-inch clayey silt layer at 18 feet.	15.3				S-7 (16 - 17.5')	15
20	5	- 2-inch-thick slightly clayey, slightly fine sandy silt layer at 23 feet.						20
25	6	- 1-inch-diameter wood fragment at 24.5 feet. - 1.5-inch-diameter wood fragment at 27.8 feet.					S-8 (25 - 26.5')	25

Refer to the report text for a proper understanding of the subsurface materials and probing methods. The stratification lines indicated below represent the approximate boundaries between soil types. Actual boundaries may be different if soil shifted inside sample tubes during extraction.

CONTINUED NEXT PAGE

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

- 3 — 2" Plastic Tube - No Soil Recovery
- 2" Plastic Tube with Soil Recovery
- *Run No.*
- Ground Water Level in Well
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-01-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
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FIG. A-70
Sheet 1 of 2

GEOPROBE_WELL 21-12318.GPJ 21-20447.GPJ 5/22/14 Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 14.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *40.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	7							
		Gray, trace to slightly silty, fine SAND; wet; (Ha) SP/SP-SM.	32.5					
		- 1-inch-thick silt layer at 32.5 feet.					S-9 (33 - 34.5')	
35	8							35
							S-10 (38.5 - 40')	
		- 1.5-inch-diameter wood chunk at 39 feet.						
40		BOTTOM OF BORING COMPLETED 10/6/2010	40.0					40
		Note: Hole diameter widened to 3.5 inches during installation of monitoring well.						
45		Note (2013): Well was destroyed during farming activites.						45
50								50
55								55

Soil Description: Refer to the report text for a proper understanding of the subsurface materials and probing methods. The stratification lines indicated below represent the approximate boundaries between soil types. Actual boundaries may be different if soil shifted inside sample tubes during extraction.

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

- 3 — 2" Plastic Tube - No Soil Recovery
- 2" Plastic Tube with Soil Recovery
- *Run No.*
- Ground Water Level in Well
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-01-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-70
Sheet 2 of 2

GEOPROBE_WELL 21-12318.GPJ 21-20447.GPJ 5/22/14 Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 5.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown SILT, trace of fine sand, trace of clay; moist; scattered roots; (Agricultural layer) ML. Note: Poor soil recovery in upper 5 feet. Layer thickness may be overestimated. Agricultural layer encountered in other nearby geoprobes is typically about 1.5 feet thick.				10/7/2010	S-1 (0 - 1')	
5	2	Gray to gray-brown, slightly clayey to clayey SILT, trace of fine sand; wet; scattered wood fragments; (Hm) MH/ML.	5.0				S-2 (6 - 7')	5
		Gray, trace of silt to slightly silty, fine to medium SAND; wet; locally trace of gravel; (Ha) SP-SM/SP.	7.5					
10	3	- 0.5-inch-thick layer of woody debris at 13.2 feet.					S-3 (10 - 11.5')	10
15	4	- 2-inch-thick layer of rounded woody debris at 17.8 feet. - 3/4-inch-thick piece of branch at 18.5 feet.					S-4 (15 - 16.5')	15

CONTINUED NEXT PAGE

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

- 2" Plastic Tube - No Soil Recovery
- 2" Plastic Tube with Soil Recovery
- *Run No.*
- Ground Water Level in Well
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-02-10

May 2014 | 21-1-12318-001

SHANNON & WILSON, INC.
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FIG. A-71
Sheet 1 of 2

GEOPROBE_WELL 21-12318.GPJ 21-20447.GPJ 5/22/14 Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 5.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5	- 1-inch-thick layer of wood debris at 20.5 feet. - Local zones of fine sand and scattered wood fragments below 22 feet.					S-5 (20 - 21.5')	
25	6						S-6 (25 - 26.5')	25
		Gray, silty, fine SAND; wet; scattered clayey silt laminae; (Ha) SM.	28.2				S-7 (28.5 - 29.5')	
30		BOTTOM OF BORING COMPLETED 10/6/2010 Note: Hole diameter widened to 3.5 inches during installation of monitoring well. Note (2013): Well was destroyed during farming activites.	30.0					30
35								35

Soil Description: *Refer to the report text for a proper understanding of the subsurface materials and probing methods. The stratification lines indicated below represent the approximate boundaries between soil types. Actual boundaries may be different if soil shifted inside sample tubes during extraction.*

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

- 3 — 2" Plastic Tube - No Soil Recovery
- 2" Plastic Tube with Soil Recovery
- *Run No.*
- Ground Water Level in Well
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-02-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
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FIG. A-71
Sheet 2 of 2

GEOPROBE_WELL 21-12318.GPJ 21-20447.GPJ 5/22/14 Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/7/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 7.0 feet*
Date Completed *10/7/10*		**Typical Run Length** *4 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown, slightly fine sandy SILT, trace of clay; moist; trace of roots and organics; (Agricultural layer) ML.					S-1 (0.8 - 1.2')	
		Interbedded, gray and orange-brown, slightly fine sandy, slightly clayey SILT and silty, fine SAND; moist; iron-oxide staining, mottled; (Hm) ML/SM.	1.5				S-2 (2 - 3')	
		- 2-inch layer of silty sand at 2.5 feet.						
	2					10/7/2010		
5		Gray, trace of clay to slightly clayey, slightly fine sandy, SILT; moist; (Hm) ML.	5.0				S-3 (5 - 6')	5
		Gray, trace to slightly silty, fine to medium SAND; wet; (Ha) SP/SP-SM.	6.0					
	3						S-4 (8 - 9')	
10								10
		- 6-inch layer of wood debris at 11.5 feet.						
	4							
15		- 2-inch layer of wood debris at 15 feet. Odor of decaying organics.					S-5 (14.5 - 15.5')	15
	5							

Refer to the report text for a proper understanding of the subsurface materials and probing methods. The stratification lines indicated below represent the approximate boundaries between soil types. Actual boundaries may be different if soil shifted inside sample tubes during extraction.

CONTINUED NEXT PAGE

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

- 3 — 2" Plastic Tube - No Soil Recovery
- 2" Plastic Tube with Soil Recovery
- *Run No.*
- Ground Water Level in Well
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-03-10

May 2014 — 21-1-12318-001

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FIG. A-72
Sheet 1 of 2

GEOPROBE_WELL 21-12318.GPJ 21-20447.GPJ 5/22/14 Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/7/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 7.0 feet*
Date Completed *10/7/10*		**Typical Run Length** *4 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	6	Gray, trace of silt to slightly silty, fine to medium SAND; wet; scattered wood debris, scattered shells at 23.5 feet; (Ha) SP/SP-SM.	20.0				S-6 (21 - 22')	
	7							
25								25
		Gray, silty, fine to medium SAND, trace of clay; moist to wet; (Ha) SM.	25.5				S-7 (26 - 26.5')	
	8	Gray, fine to medium SAND, trace of silt; wet; occasional wood fragments and shell fragments; (Ha) SP.	28.0					
		Gray, slightly clayey SILT, trace of fine sand; moist to wet; (He) ML.	29.0				S-8 (29 - 30')	
30		BOTTOM OF BORING COMPLETED 10/7/2010	30.0					30
35								35

Note: Hole diameter widened to 3.5 inches during installation of monitoring well.

Note (2013): Well was destroyed during farming activites.

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

- 2" Plastic Tube - No Soil Recovery
- 2" Plastic Tube with Soil Recovery
- *Run No.*
- Ground Water Level in Well
- Piezometer Screen and Sand Filter
- Bentonite-Cement Grout
- Bentonite Chips/Pellets
- Bentonite Grout

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-03-10

May 2014 | 21-1-12318-001

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FIG. A-72
Sheet 2 of 2

GEOPROBE_WELL 21-12318.GPJ 21-20447.GPJ 5/22/14 Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 6.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown SILT, trace of fine sand; moist; (Agricultural layer); ML.					S-1 (0.5 - 1')	
		Gray SILT, trace of clay, trace of fine sand; moist; locally fine sand, iron-oxide-stained, mottled; (Hm) ML.	1.0				S-2 (2 - 3')	
5	2	Gray, slightly clayey SILT, trace of fine sand; wet; increasing fine sand content with depth; (Hm) ML.	5.0			During Drilling	S-3 (5 - 6')	5
		Gray, trace to slightly silty, fine to medium and medium to coarse SAND; wet; locally trace of gravel; (Ha) SP/SP-SM.	7.5					
		- 3-inch-thick silty sand layer at 9 feet.						
10	3						S-4 (10 - 11.5')	10
		- 2-inch-thick layer of wood debris at 13 feet.						
15	4						S-5 (15 - 16.5')	15
		Gray, silty, fine SAND; wet; laminated in upper 3 inches; (Ha) SM.	19.0					

CONTINUED NEXT PAGE

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Estimated Water Level
Run No.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-04-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-73
Sheet 1 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 6.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5	Gray, trace of silt to slightly silty, medium to coarse SAND; wet; locally trace of fine gravel; (Ha) SP/SP-SM.	20.0				S-6 (20 - 21.5')	
		Gray-brown, slightly clayey SILT, trace of fine sand; wet; trace of organics; (He) ML.	23.0					
		Gray, silty, fine SAND; wet; (Ha) SM.	23.5					
25	6	Gray, slightly silty, fine to medium and fine to coarse SAND; wet; (Ha) SP-SM.	25.0				S-7 (25 - 26.5')	25
		Gray, fine sandy SILT; wet; trace of shell fragments; (He) ML.	27.2				S-8 (29 - 30')	
30		BOTTOM OF BORING COMPLETED 10/5/2010	30.0					30
35								35

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Run No.
Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-04-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
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FIG. A-73
Sheet 2 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 6.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown, fine sandy SILT; moist; (Agricultural layer); ML.					S-1 (0.5 - 1.3')	
		Brown, slightly clayey SILT; moist; scattered fine sand zones; (Hm) ML.	1.5				S-2 (2 - 2.5')	
		Gray, slightly silty to silty, medium to coarse SAND; wet; (Ha) SP-SM/SM.	3.5				S-3 (3.5 - 4')	
5	2	Gray, trace to slightly silty, fine to medium SAND, trace of fine gravel; wet; locally medium to coarse sand; (Ha) SP/SP-SM.	5.0			During Drilling ▽		5
		- 3-inch-thick layer of wood debris at 7.5 feet.					S-4 (8 - 9')	
10	3	- Pocket of wood debris at 11.2 feet.						10
							S-5 (13 - 14.3')	
15	4	- Slightly fine gravelly, medium to coarse sand between 17 and 18.5 feet.					S-6 (17 - 18.5')	15
		Gray-brown, fine sandy SILT, trace of clay; wet; scattered sand interbeds, scattered tan, silty laminae, scattered shell fragments; (Ha)	19.0					

CONTINUED NEXT PAGE

Soil Description: *Refer to the report text for a proper understanding of the subsurface materials and probing methods. The stratification lines indicated below represent the approximate boundaries between soil types. Actual boundaries may be different if soil shifted inside sample tubes during extraction.*

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery
Run No.
▽ Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-05-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-74
Sheet 1 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 6.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5	ML.					S-7 (20 - 21.5')	
		Gray-brown, silty, fine SAND; wet; scattered shell fragments, locally trace of clay; (Ha) SM.	21.5					
		- Trace of shells below approximately 23.5 feet.						
25	6						S-8 (25 - 25.8')	25
							S-9 (29 - 30')	
30		BOTTOM OF BORING COMPLETED 10/5/2010	30.0					30
35								35

Refer to the report text for a proper understanding of the subsurface materials and probing methods. The stratification lines indicated below represent the approximate boundaries between soil types. Actual boundaries may be different if soil shifted inside sample tubes during extraction.

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Run No.
Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-05-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-74
Sheet 2 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 7.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown SILT, trace of clay; moist; scattered roots; (Agricultural layer) ML.	1.3					
		Brown and orange-brown, slightly clayey to clayey SILT, trace of fine sand; moist; numerous roots, scattered organics, iron-oxide-stained, iron-oxide nodules; (Hm) MH/ML.					S-1 (2 - 3')	
5	2	Gray, silty, fine SAND; wet; trace of organics; (Ha) SM.	5.5			During Drilling	S-2 (6 - 7')	5
		Gray, slightly silty SAND; moist to wet; locally silty, locally only trace of silt; (Ha) SP-SM.	7.2					
10	3	Gray, fine to medium and fine to coarse SAND, trace of silt; wet; locally slightly silty; (Ha) SP.	9.5				S-3 (10 - 11.5')	10
15	4							15
		Gray, slightly silty, fine to medium SAND; wet; (Ha) SP-SM.	16.5				S-4 (17 - 18.5')	
		Gray-brown, trace of clay to slightly clayey, slightly sandy SILT; wet;	19.2				S-5 (19.2 - 20')	

CONTINUED NEXT PAGE

Typ: LKN
Rev: PHZ
Log: PHZ

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Estimated Water Level
Run No.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-06-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-75
Sheet 1 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 7.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5	(He) ML.	20.0					
		Gray, slightly silty, fine to medium SAND; wet; (Ha) SP-SM.						
		Gray-brown, silty, fine SAND; wet; scattered shell fragments; (Ha) SM.	23.0				S-6 (23 - 24.5')	
25	6	Gray, slightly silty, fine to medium SAND; wet; locally coarse sand; (Ha) SP-SM.	25.0					25
		Gray, silty, fine SAND; wet; scattered shell fragments; (Ha) SM.	27.5				S-7 (28.5 - 30')	
30		BOTTOM OF BORING COMPLETED 10/6/2010	30.0					30
35								35

Typ: LKN
Rev: PHZ
Log: PHZ

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery
Run No.
Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-06-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-75
Sheet 2 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 6.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown SILT, trace of fine sand, trace of clay; moist; disturbed appearance; (Agricultural layer) ML.					S-1 (0.5 - 1.5')	
		Gray-brown and orange-brown, trace of clay to slightly clayey, slightly fine sandy SILT; moist; numerous roots and organics; iron-oxide-stained; (Hm) ML/MH.	1.8				S-2 (2 - 3')	
5	2	Gray-brown, silty, fine SAND, trace of clay; wet; scattered organics and twigs; (Ha) SM.	5.5			During Drilling	S-3 (6 - 7')	5
		Gray, slightly silty, fine to medium SAND; wet; trace of wood fragments, locally trace of gravel; (Ha) SP-SM.	7.5					
10	3						S-4 (10 - 11.5')	10
		Gray SAND, trace of gravel; wet; scattered rounded wood fragments; (Ha) SP.	12.0				S-5 (13 - 14.5')	
15	4							15
							S-6 (18.5 - 20')	

Soil Description: Refer to the report text for a proper understanding of the subsurface materials and probing methods. The stratification lines indicated below represent the approximate boundaries between soil types. Actual boundaries may be different if soil shifted inside sample tubes during extraction.

CONTINUED NEXT PAGE

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery
Run No.
Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-07-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-76
Sheet 1 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 6.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5							
		Gray-brown, silty CLAY; wet; trace of fine shell fragments; (He) CL.	24.0				S-7 (24 - 25')	
25	6	Gray, trace of silt to slightly silty SAND, trace of gravel; wet; (Ha) SP/SP-SM.	25.0				S-8 (26 - 27.5')	25
		Gray-brown, trace of sand to slightly sandy, clayey SILT; wet; scattered shell fragments; (He) ML.	29.0				S-9 (29 - 30')	
30		BOTTOM OF BORING COMPLETED 10/6/2010	30.0					30
35								35

Soil Description: *Refer to the report text for a proper understanding of the subsurface materials and probing methods. The stratification lines indicated below represent the approximate boundaries between soil types. Actual boundaries may be different if soil shifted inside sample tubes during extraction.*

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — *Run No.*
Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-07-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-76
Sheet 2 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 5.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown, slightly fine sandy SILT, trace of clay; moist; (Agricultural layer) ML.						
		Interbedded, gray and orange, silty, fine SAND and slightly clayey to clayey SILT; moist; trace of organics; (Hm) SM and ML.	1.2				S-1 (1.5 - 2.5')	
		Gray, slightly silty, fine to medium SAND, trace of fine gravel; wet; (Ha) SP-SM.	2.5					
5	2					During Drilling	S-2 (5 - 6.5')	5
		Gray SAND, trace of fine gravel, trace of silt; wet; (Ha) SP.	7.0					
		- 3-inch-thick layer of silty, fine sand with wood fragments at 8 feet.						
10	3						S-3 (10 - 11.5')	10
15	4						S-4 (15 - 16.5')	15

CONTINUED NEXT PAGE

Typ: LKN Rev: PHZ Log: PHZ

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Estimated Water Level
Run No.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-08-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-77
Sheet 1 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 5.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5	- 2-inch-thick layer of silty sand at 22.5 feet.					S-5 (20 - 21.5')	
		Gray-brown, fine sandy SILT to silty, fine SAND; moist; laminated, scattered organic partings; (He) ML/SM.	24.2				S-6 (24.2 - 25')	
25	6	Gray, trace of silt to slightly silty, fine to medium SAND; wet; (Ha) SP/SP-SM.	25.0					25
		Dark gray-brown, clayey SILT; wet; trace of shell fragments; (He) ML.	28.0				S-7 (29 - 30')	
30		BOTTOM OF BORING COMPLETED 10/5/2010	30.0					30
35								35

Typ: LKN
Rev: PHZ
Log: PHZ

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Estimated Water Level
Run No.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-08-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-77
Sheet 2 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 6.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown SILT, trace of fine sand, trace of clay; moist; disturbed appearence; (Agricultural layer) ML.						
		Interbedded, gray and orange-brown, slightly clayey SILT and silty, fine SAND; moist; scattered organics and iron-oxide staining; (Hm) ML/SM.	1.5				S-1 (2 - 3')	
		Gray-brown, slightly fine sandy, slightly clayey SILT grading to silty, fine SAND, trace of clay; wet; (Hm) ML/SM.	3.5				S-2 (4 - 5')	
5	2	- Trace of organics at approximately 6 feet.				During Drilling ▽		5
		Gray, trace of silt to slightly silty, fine to medium SAND, trace of fine gravel; moist to wet; local zones of coarser sand; (Ha) SP/SP-SM. - 4-inch-thick layer with abundant wood debris and twigs at 8 feet.	7.2					
10	3	- Scattered wood debris at 12 feet. - Scattered wood debris at 14 feet.					S-3 (10 - 11.5')	10
15	4	Gray, silty, fine to medium SAND; wet; local pockets of slightly silty sand, scattered shell fragments; (Ha) SM. - Wood fragments between 18 and 18.5 feet. - Scattered twigs between 18.5 and 19.5 feet.	16.0				S-4 (16 - 17')	15

CONTINUED NEXT PAGE

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — ▽ Estimated Water Level
Run No.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-09-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
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FIG. A-78
Sheet 1 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/6/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 6.0 feet*
Date Completed *10/6/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5	Gray, medium to coarse SAND, trace of fine gravel; moist to wet; (Ha) SP.	20.0					
		Gray-brown, silty, fine to medium SAND; wet; numerous shell fragments; (Ha) SM. - 1-inch-thick clayey silt layers at 22.8 and 23.2 feet. - 2-inch-thick clayey silt layer at 23.4 feet. - Coarser sand between 25 and 26 feet.	21.8				S-5 (22 - 23.5')	
25	6						S-6 (26 - 27')	25
							S-7 (29 - 30')	
30		BOTTOM OF BORING COMPLETED 10/6/2010	30.0					30
35								35

Typ: LKN
Rev: PHZ
Log: PHZ

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery
Run No.
Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-09-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-78
Sheet 2 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 7.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown SILT, trace of fine sand; moist; disturbed appearance; (Agricultural layer) ML.						
		Gray-brown and orange-brown, slightly clayey SILT, trace of fine sand; moist; scattered to numerous organics and iron-oxide-stained pockets; (Hm) ML.	1.2				S-1 (2 - 3')	
		Interbedded, gray, silty, fine SAND and fine sandy SILT, trace of clay; moist to wet; numerous roots and organics; (Ha) SM/ML.	3.2				S-2 (4 - 5')	
5	2	Gray, slightly silty, fine to medium SAND; wet; (Ha) SP-SM.	5.0			During Drilling		5
		- 1-inch-thick slightly clayey silt layer at 7.5 feet. - Coarser sand between 8 to 9 feet.						
10	3						S-3 (10 - 11.5')	10
		- Coarser sand pocket from 13 to 14 feet.						
15	4						S-4 (15 -16.5')	15
		- Coarser sand with scattered shell fragments below 17 feet.						
		Gray-brown, slightly clayey SILT; wet; (He) ML.	18.5					
		Gray-brown, silty, fine SAND; wet; (Ha) SM.	19.5					

CONTINUED NEXT PAGE

Typ: LKN
Rev: PHZ
Log: PHZ

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery
Run No.
Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-10-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-79
Sheet 1 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 7.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5	Gray, slightly silty to silty, fine SAND; wet; (Ha) SP-SM/SM.	20.0				S-5 (20 - 21.5')	
		Gray-brown, trace of clay to slightly clayey, slightly sandy SILT; wet; (He) ML.	23.0					
		Gray to gray-brown, silty, fine SAND; wet; (Ha) SM.	23.8				S-6 (24 - 25')	
25	6	Gray, trace to slightly silty, medium to coarse SAND; wet; (Ha) SP/SP-SM.	25.0					25
		Gray-brown, fine sandy SILT to silty, fine SAND, trace of clay; wet; (He) ML/SM.	26.5					
		Gray-brown, silty, fine SAND; wet; trace of fine shell fragments; (Ha) SM.	27.5				S-7 (29 - 30')	
30		BOTTOM OF BORING COMPLETED 10/5/2010	30.0					30
35								35

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Run No.
Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-10-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-79
Sheet 2 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 8.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown SILT, trace of fine sand; moist; disturbed appearance; (Agricultural layer) ML.						
		Gray and brown, slightly clayey SILT, trace of fine to medium sand; moist; scattered organics and iron-oxide staining; (Hm) MH.	1.5				S-1 (2 - 3')	
		Gray, fine sandy SILT, trace of clay; wet; trace of organics; (Hm) ML.	3.0				S-2 (4 - 5')	
5	2	Gray, slightly silty, fine to medium SAND; wet; (Ha) SP-SM.	5.0			During Drilling		5
		Gray-brown, slightly clayey SILT, trace of fine sand; wet; (He) ML.	7.5					
		Gray, trace of silt to slightly silty, fine to medium SAND; wet; locally medium to coarse sand; (Ha) SP-SM/SP.	8.0					
10	3						S-3 (10 - 11.5')	10
		- 1-inch-thick layer of wood debris at 13 feet.						
15	4						S-4 (15 - 16.5')	15
		- 2-inch-thick layer of wood debris at 17.5 feet.						
		Gray-brown, silty, fine SAND; wet; scattered shell fragments; (Ha) SM.	18.0					

CONTINUED NEXT PAGE

Typ: LKN
Rev: PHZ
Log: PHZ

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Estimated Water Level
Run No.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-11-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
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FIG. A-80
Sheet 1 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 8.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5	Gray, silty, fine SAND; wet; locally trace of clay, locally trace to scattered shell fragments, trace of organics; (Ha) SM.	20.5				S-5 (21 - 22')	
25	6	Gray, trace of silt to slightly silty, fine to medium SAND; wet; (Ha) SP/SP-SM.	25.0 / 25.5				S-6 (25 - 26')	25
		Gray, silty, fine SAND; wet; trace of shell fragments; (Ha) SM.					S-7 (29 - 30')	
30		BOTTOM OF BORING COMPLETED 10/5/2010	30.0					30
35								35

Typ: LKN *Rev: PHZ* *Log: PHZ*

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Estimated Water Level
Run No.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-11-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
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FIG. A-80
Sheet 2 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 8.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	1	Brown SILT, trace of clay, trace of fine sand; moist; trace of roots and organics; (Agricultural layer) ML.					S-1 (0.5 - 1')	
		Interbedded, gray and orange-brown, slightly sandy SILT, trace of clay and silty, fine sand; wet; locally iron-oxide-stained, mottled; (Hm) ML/SM.	1.5					
5	2					During Drilling	S-2 (4 - 5')	5
		Gray, trace to slightly silty, fine to medium SAND; wet; local pockets of medium to coarse sand with trace of gravel; (Ha) SP/SP-SM.	6.2					
10	3						S-3 (10 - 11.5')	10
		- 4-inch-thick layer of wood debris at 14 feet.					S-4 (14 - 15')	
15	4							15
		Gray, silty, fine SAND; wet; (Ha) SM.	17.0					
		Gray, slightly silty to silty, fine to medium SAND; wet; locally interbedded with layers of silt; locally numerous shell fragments; (Ha) SP-SM/SM.	18.2					

CONTINUED NEXT PAGE

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — Estimated Water Level
Run No.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-12-10

May 2014 — 21-1-12318-001

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FIG. A-81
Sheet 1 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

LOG OF GEOPROBE

Date Started *10/5/10*	**Location** *Fir Island, Skagit County, Washington*	**Ground Elevation:** *Approx. 8.0 feet*
Date Completed *10/5/10*		**Typical Run Length** *5 feet*
Total Depth (ft) *30.0*	**Drilling Company:** *Cascade Drilling*	**Hole Diameter:** *2 inches*

Depth (ft)	Probe Run	Soil Description	Depth, ft.	Symbol	PID, ppm	Ground Water	Sample Number, Description, and Results	Depth (ft)
	5						S-5 (20 - 21.5')	
		Gray, silty, fine to medium SAND; wet; scattered wood and shell fragments; (Ha) SM.	21.8					
25	6	Gray, trace of silt to slightly silty, fine to medium SAND; wet; pockets of medium to coarse sand, trace of fine gravel; (Ha) SP-SM/SP.	25.0				S-6 (26 - 27.5')	25
		- Grades to silty below 29 feet.	29.5					
30		Gray, slightly fine sandy SILT; wet; (He) ML.	30.0				S-7 (29.5 - 30')	30
		BOTTOM OF BORING COMPLETED 10/5/2010						
35								35

Soil Description

Refer to the report text for a proper understanding of the subsurface materials and probing methods. The stratification lines indicated below represent the approximate boundaries between soil types. Actual boundaries may be different if soil shifted inside sample tubes during extraction.

NOTES

1. In some cases where recovery was low in the upper part of the run, the soil sample may have slid down in the tube prior to removal from the ground.
2. Groundwater level, if indicated above, was estimated during probing and should be considered approximate.
3. Refer to KEY for definitions and explanation of symbols.
4. CT = corrosion test sample; TR = thermal resistivity sample; EN = environmental sample; GE = geotechnical sample; AR = archeological sample.

LEGEND

3 — 2" Plastic Tube - No Soil Recovery
2" Plastic Tube with Soil Recovery — *Run No.*
Estimated Water Level

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF GEOPROBE GP-12-10

May 2014 — 21-1-12318-001

SHANNON & WILSON, INC.
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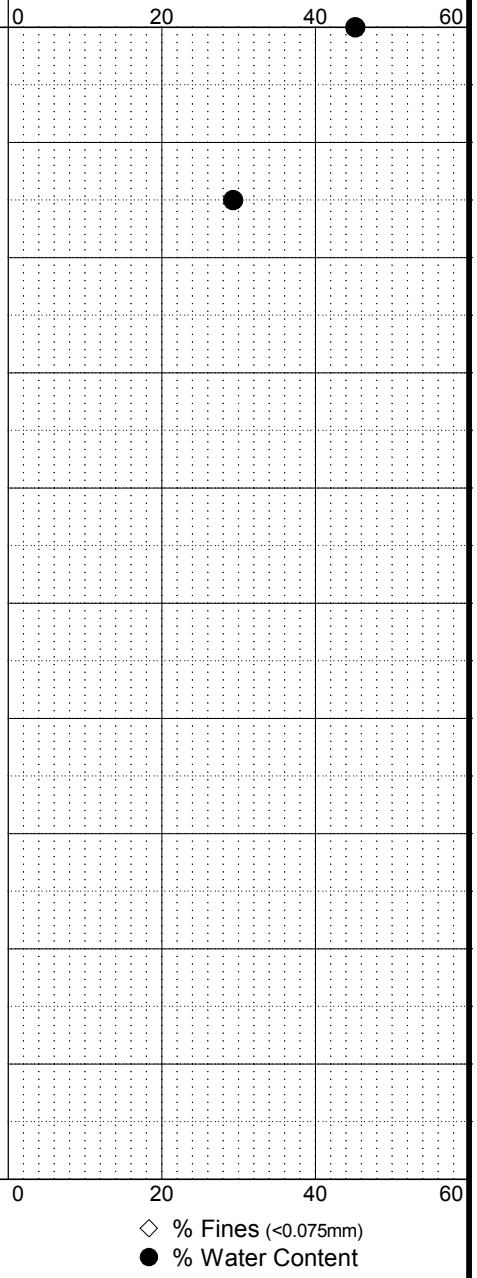
FIG. A-81
Sheet 2 of 2

GEOPROBE 21-12318.GPJ 21-16604.GPJ 5/22/14
Log: PHZ Rev: PHZ Typ: LKN

Total Depth:	3.25 ft.	Northing:		Drilling Method:	Hand Auger	Hole Diam.:	3 in.
Top Elevation:	~	Easting:		Drilling Company:	Shannon & Wilson, Inc.	Rod Diam.:	
Vert. Datum:		Station:		Drill Rig Equipment:	Hand Boring	Hammer Type:	
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
Brown, SILT; moist; (Agricultural layer) ML.				None Observed During Drilling	
Gray-brown, sandy SILT; moist; trace of organics; (Hm) ML.	1.0		1 G		
Gray, silty, fine to medium SAND; wet; (Hm) SM.	2.5 3.0		2 G		
Gray, fine to medium SAND; wet; (Ha) SP.	3.3				
BOTTOM OF BORING COMPLETED 4/17/2014					



LEGEND

* Sample Not Recovered

G Grab Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF HAND BORING HB-1-14

May 2014 21-1-12318-215

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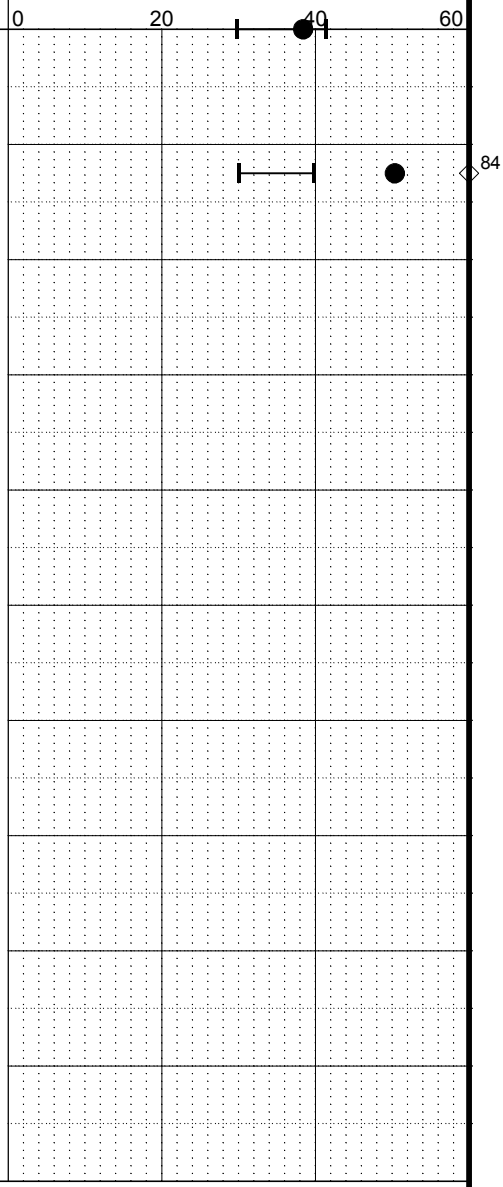
FIG. A-82

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/30/14 Log: JMW Rev: JMW Typ: LKN

Total Depth:	5 ft.	Northing:		Drilling Method:	Hand Auger	Hole Diam.:	3 in.
Top Elevation:	~	Easting:		Drilling Company:	Shannon & Wilson, Inc.	Rod Diam.:	
Vert. Datum:		Station:		Drill Rig Equipment:	Hand Boring	Hammer Type:	
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
Gray-brown, clayey SILT, trace of sand; moist; trace of organics (Agricultural layer) ML.	1.0		1 G	None Observed During Drilling	
Gray, fine to medium sandy, clayey SILT; wet below 2 feet; trace of organics; (Hm) ML.	5.0		2 G		
BOTTOM OF BORING COMPLETED 4/17/2014					



LEGEND

* Sample Not Recovered

G Grab Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

Fir Island Farm
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LOG OF HAND BORING HB-2-14

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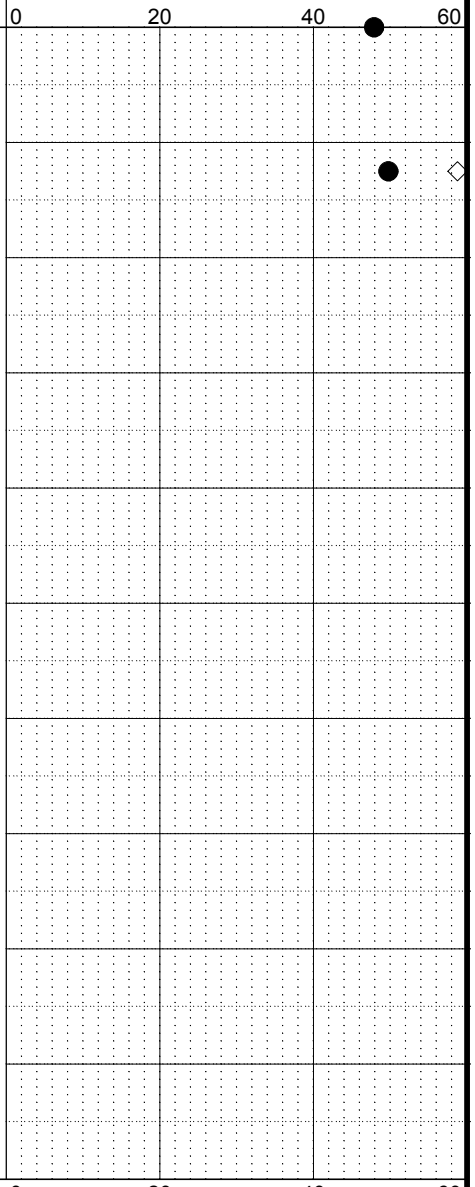
FIG. A-83

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/30/14 Log: JMW Rev: JMW Typ: LKN

Total Depth:	4.5 ft.	Northing:		Drilling Method:	Hand Auger	Hole Diam.:	3 in.
Top Elevation:	~	Easting:		Drilling Company:	Shannon & Wilson, Inc.	Rod Diam.:	
Vert. Datum:		Station:		Drill Rig Equipment:	Hand Boring	Hammer Type:	
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
Brown, SILT, trace of sand; moist; scattered iron-oxide staining; (Agricultural layer) ML.	1.5		1 G	None Observed During Drilling	
Gray, fine to medium sandy SILT, trace of clay; wet below 3.5 feet; scattered organics; (Hm) ML.	4.0		2 G		
Gray, slightly silty, fine to medium SAND; wet; (Ha) SP-SM.	4.5				
BOTTOM OF BORING COMPLETED 4/17/2014					



◇ % Fines (<0.075mm)
● % Water Content

LEGEND

* Sample Not Recovered
G Grab Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

Fir Island Farm
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Skagit County, Washington

LOG OF HAND BORING HB-3-14

May 2014 21-1-12318-215

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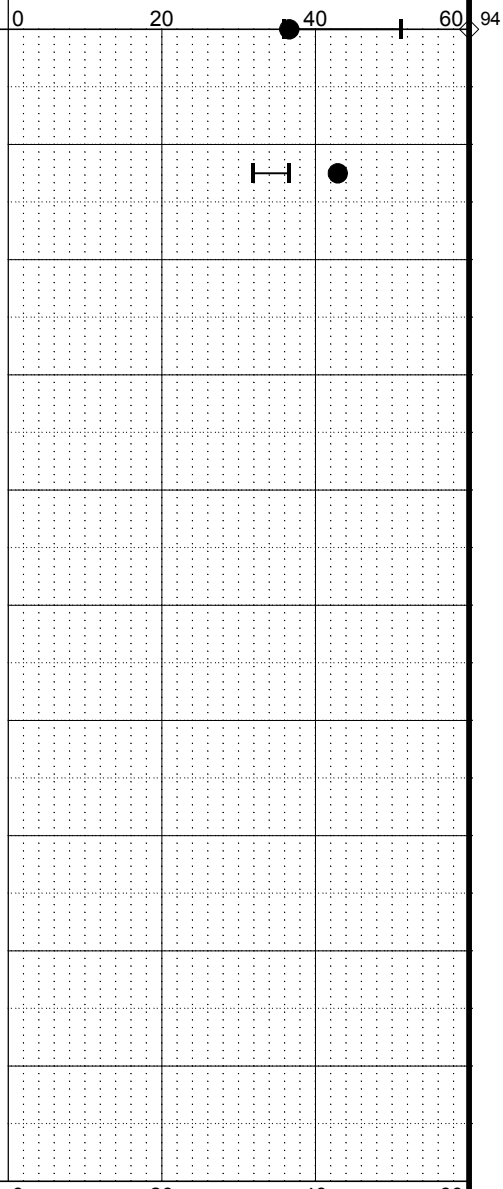
FIG. A-84

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/30/14 Log: JMW Rev: JMW Typ: LKN

Total Depth:	5 ft.	Northing:		Drilling Method:	Hand Auger	Hole Diam.:	3 in.
Top Elevation:	~	Easting:		Drilling Company:	Shannon & Wilson, Inc.	Rod Diam.:	
Vert. Datum:		Station:		Drill Rig Equipment:	Hand Boring	Hammer Type:	
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
Brown, slightly fine sandy, clayey SILT; moist; (Agricultural layer) MH.	1.0			None Observed During Drilling	
Brown, clayey SILT, trace of sand; moist to 3.5 feet; trace of organics; scattered iron-oxide staining; (Hm) ML.	4.5		1 G, 2 G		2, 4
Gray, slightly silty, fine to medium SAND; wet; (Ha) SP-SM.	5.0				
BOTTOM OF BORING COMPLETED 4/17/2014					6, 8, 10, 12, 14, 16, 18



LEGEND

* Sample Not Recovered

G Grab Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

Fir Island Farm
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Skagit County, Washington

LOG OF HAND BORING HB-4-14

May 2014 21-1-12318-215

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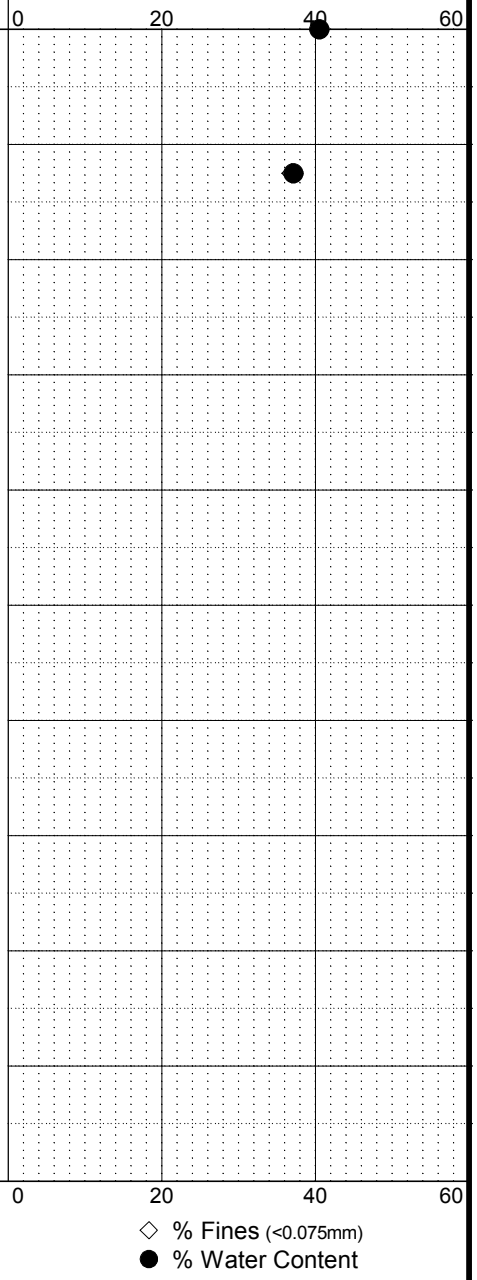
FIG. A-85

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/30/14 Log: JMW Rev: JMW Typ: LKN

Total Depth:	5 ft.	Northing:		Drilling Method:	Hand Auger	Hole Diam.:	3 in.
Top Elevation:	~	Easting:		Drilling Company:	Shannon & Wilson, Inc.	Rod Diam.:	
Vert. Datum:		Station:		Drill Rig Equipment:	Hand Boring	Hammer Type:	
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
Brown, SILT; moist; (Agricultural layer) ML.	1.0		1 G	None Observed During Drilling	
Gray-brown, silty fine to medium SAND; wet below 3 feet; (Hm) SM.	4.5		2 G		
Gray, slightly silty, fine to medium SAND; wet; (Ha) SP-SM.	5.0				
BOTTOM OF BORING COMPLETED 4/17/2014					



LEGEND

* Sample Not Recovered

G Grab Sample

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

Fir Island Farm
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Skagit County, Washington

LOG OF HAND BORING HB-5-14

May 2014 21-1-12318-215

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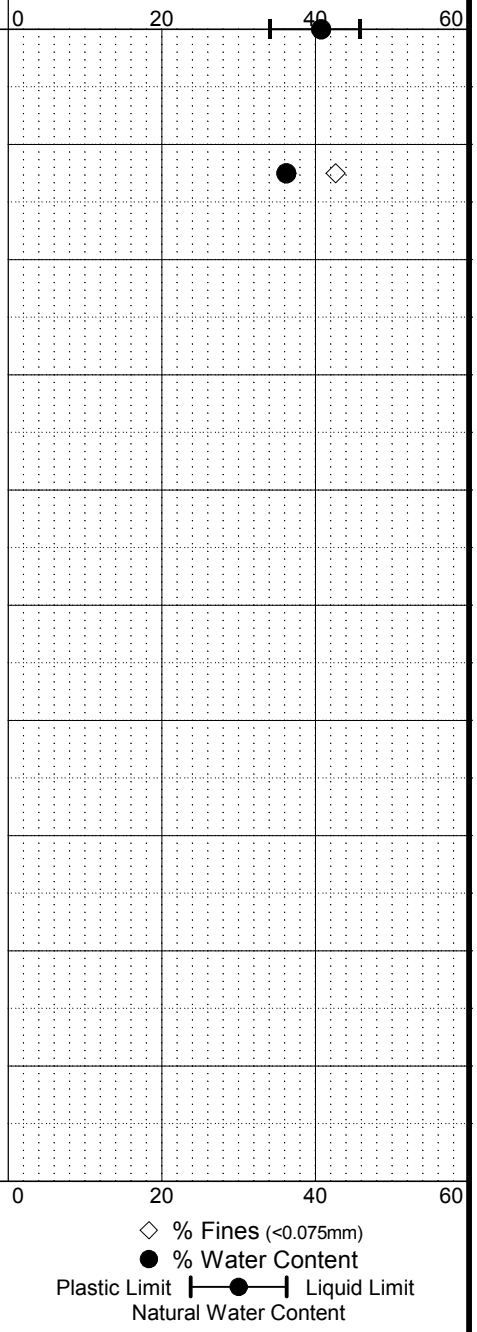
FIG. A-86

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/30/14 Log: JMW Rev: JMW Typ: LKN

Total Depth:	5 ft.	Northing:		Drilling Method:	Hand Auger	Hole Diam.:	3 in.
Top Elevation:	~	Easting:		Drilling Company:	Shannon & Wilson, Inc.	Rod Diam.:	
Vert. Datum:		Station:		Drill Rig Equipment:	Hand Boring	Hammer Type:	
Horiz. Datum:		Offset:		Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between material types, and the transition may be gradual.*	Depth, ft.	Symbol	Samples	Ground Water	Depth, ft.
Brown, clayey SILT; moist; trace of organics; (Agricultural layer) ML.	1.0		1 G	None Observed During Drilling	
Gray, fine sandy SILT; moist; (Hm) ML.	2.5		2 G		
Brown-gray, silty fine to medium SAND; trace of organics; some iron-oxide staining; (Hm) SM.	4.0				
Gray, slightly silty, fine to medium SAND; wet; (Ha) SP-SM.	5.0				
BOTTOM OF BORING COMPLETED 4/17/2014					



LEGEND

* Sample Not Recovered

G Grab Sample

◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

LOG OF HAND BORING HB-6-14

May 2014 21-1-12318-215

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FIG. A-87

MASTER_LOG_E 21-12318.GPJ SHAN_WIL.GDT 5/30/14 Log: JMW Rev: JMW Typ: LKN

APPENDIX B

HYDROGEOLOGIC FIELD TEST RESULTS

APPENDIX B

HYDROGEOLOGIC FIELD TEST RESULTS

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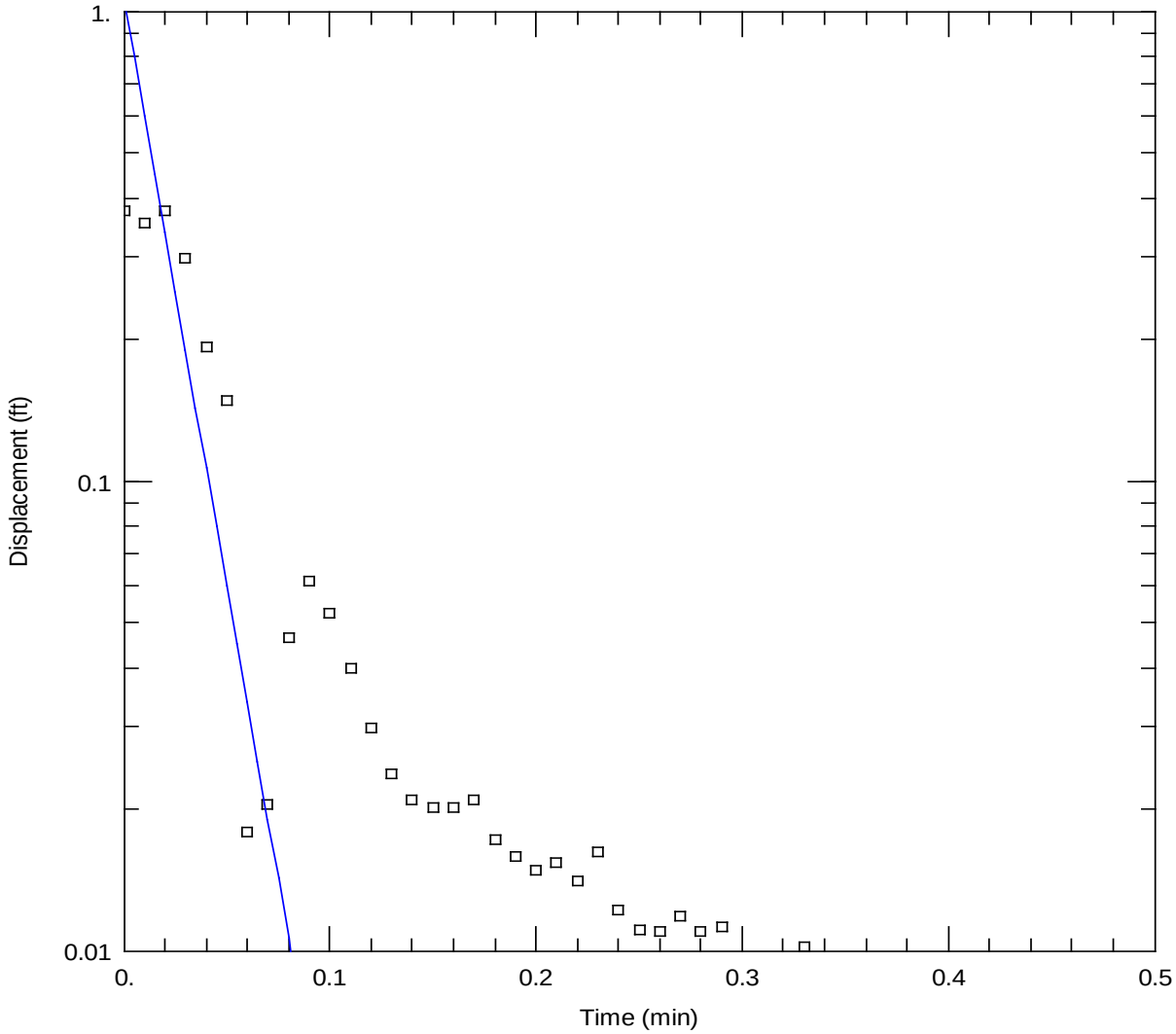
Table B-1
Summary of Slug Testing

Observation Well	Date Tested	Test Number	Static Water Level Depth[a] (feet bgs)	Hydraulic Conductivity Calculated Using the Butler Method		Hydraulic Conductivity Calculated Using the Bouwer and Rice Method		Interpreted Primary Geologic Unit Tested[b]
				ft/day	cm/sec	ft/day	cm/sec	
B-4w-13	6/26/2013	Falling Head Test 1	2.6	340	1.2E-01	113	4.0E-02	Ha
		Falling Head Test 2		453	1.6E-01	170	6.0E-02	
		Falling Head Test 3		396	1.4E-01	142	5.0E-02	
		Falling Head Test 4		425	1.5E-01	113	4.0E-02	
		Rising Head Test 1		226	8.0E-02	85	3.0E-02	
		Rising Head Test 2		283	1.0E-01	113	4.0E-02	
		Rising Head Test 3		425	1.5E-01	170	6.0E-02	
		Rising Head Test 4		255	9.0E-02	142	5.0E-02	
		Geomean		**340**	**1.2E-01**	**128**	**4.5E-02**	
B-6w-13	6/26/2013	Falling Head Test 1	3.1	481	1.7E-01	57	2.0E-02	Ha
		Falling Head Test 2		283	1.0E-01	113	4.0E-02	
		Falling Head Test 3		283	1.0E-01	142	5.0E-02	
		Falling Head Test 4		283	1.0E-01	57	2.0E-02	
		Rising Head Test 1		170	6.0E-02	85	3.0E-02	
		Rising Head Test 2		283	1.0E-01	113	4.0E-02	
		Rising Head Test 3		311	1.1E-01	113	4.0E-02	
		Rising Head Test 4		170	6.0E-02	113	4.0E-02	
		Geomean		**269**	**9.5E-02**	**94**	**3.3E-02**	
B-8w-13	6/26/2013	Falling Head Test 1	1.2	340	1.2E-01	170	6.0E-02	Ha
		Falling Head Test 2		283	1.0E-01	198	7.0E-02	
		Falling Head Test 3		623	2.2E-01	283	1.0E-01	
		Falling Head Test 4		453	1.6E-01	170	6.0E-02	
		Rising Head Test 1		368	1.3E-01	170	6.0E-02	
		Rising Head Test 2		340	1.2E-01	198	7.0E-02	
		Rising Head Test 3		368	1.3E-01	198	7.0E-02	
		Rising Head Test 4		396	1.4E-01	170	6.0E-02	
		Geomean		**386**	**1.4E-01**	**192**	**6.8E-02**	

Notes:
(a) Static water level measured just prior to the start of slug testing.

(b) If a well was screened across more than one interpreted geologic unit, the most pervious unit was considered to the the unit tested.
bgs = below ground surface
cm/sec = centimeters per second
ft/day = feet per day



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.04072 cm/sec
y0 = 1.068 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
FALLING HEAD TEST 1
BOUWER AND RICE

May 2014 21-1-12318-215

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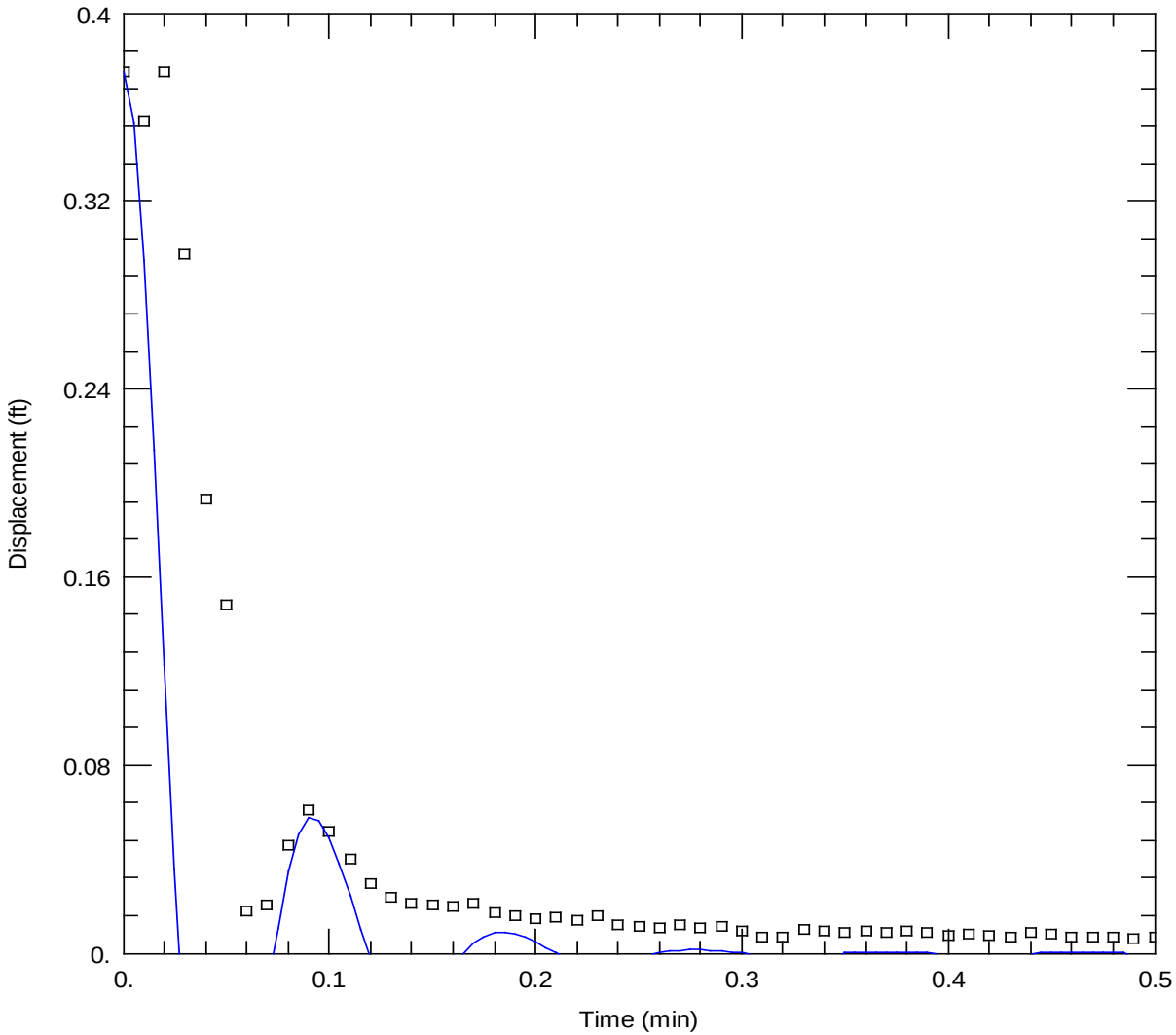
EXHIBIT B-1

EXH. B-1



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1202 cm/sec
Le = 22.75 ft
C(D) = 0.2849
L = 12.15 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-2

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
FALLING HEAD TEST 1
BUTLER

May 2014 21-1-12318-215

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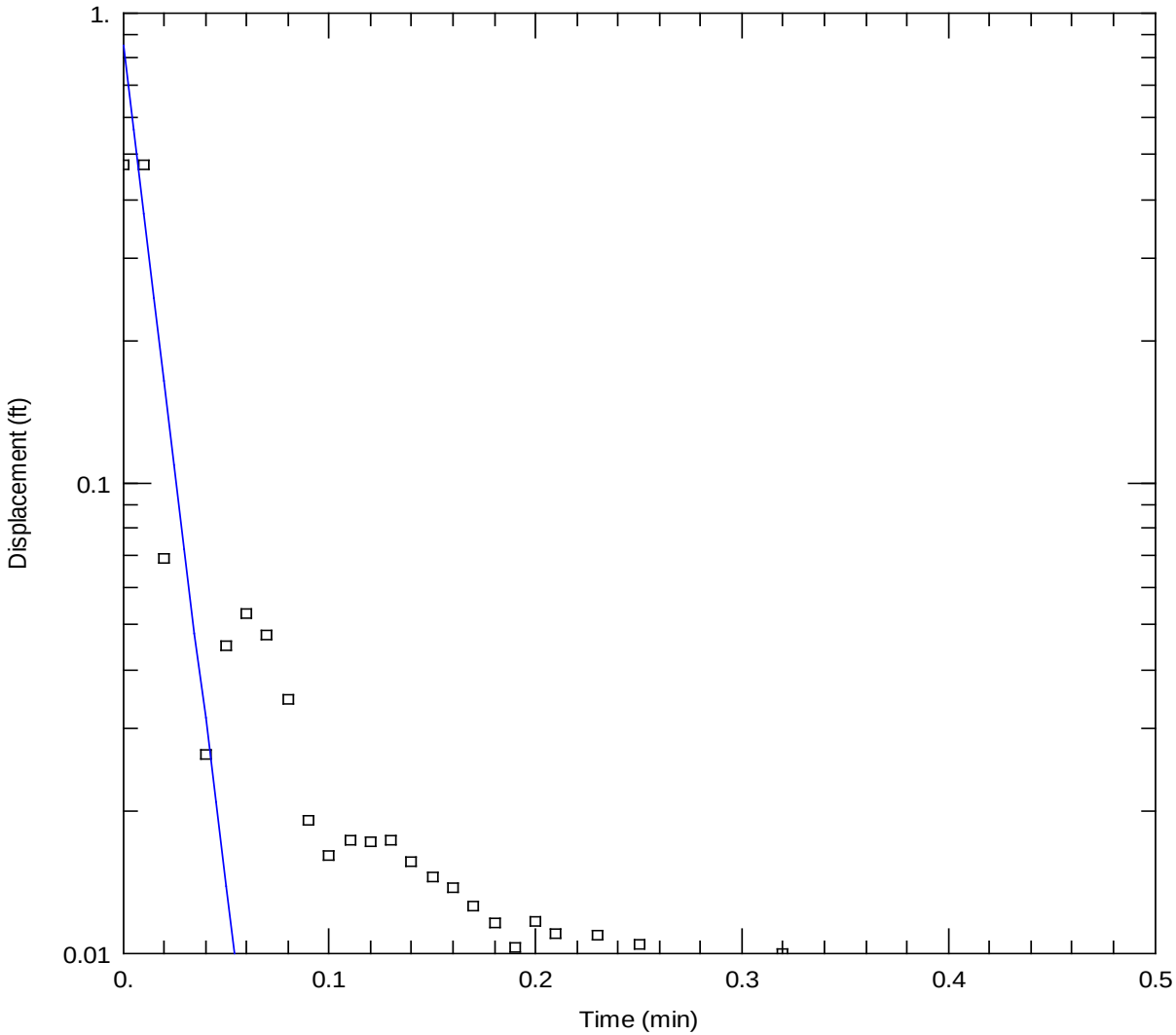
EXHIBIT B-2



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.0582 cm/sec
y0 = 0.8509 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
FALLING HEAD TEST 2
BOUWER AND RICE

May 2014 21-1-12318-215

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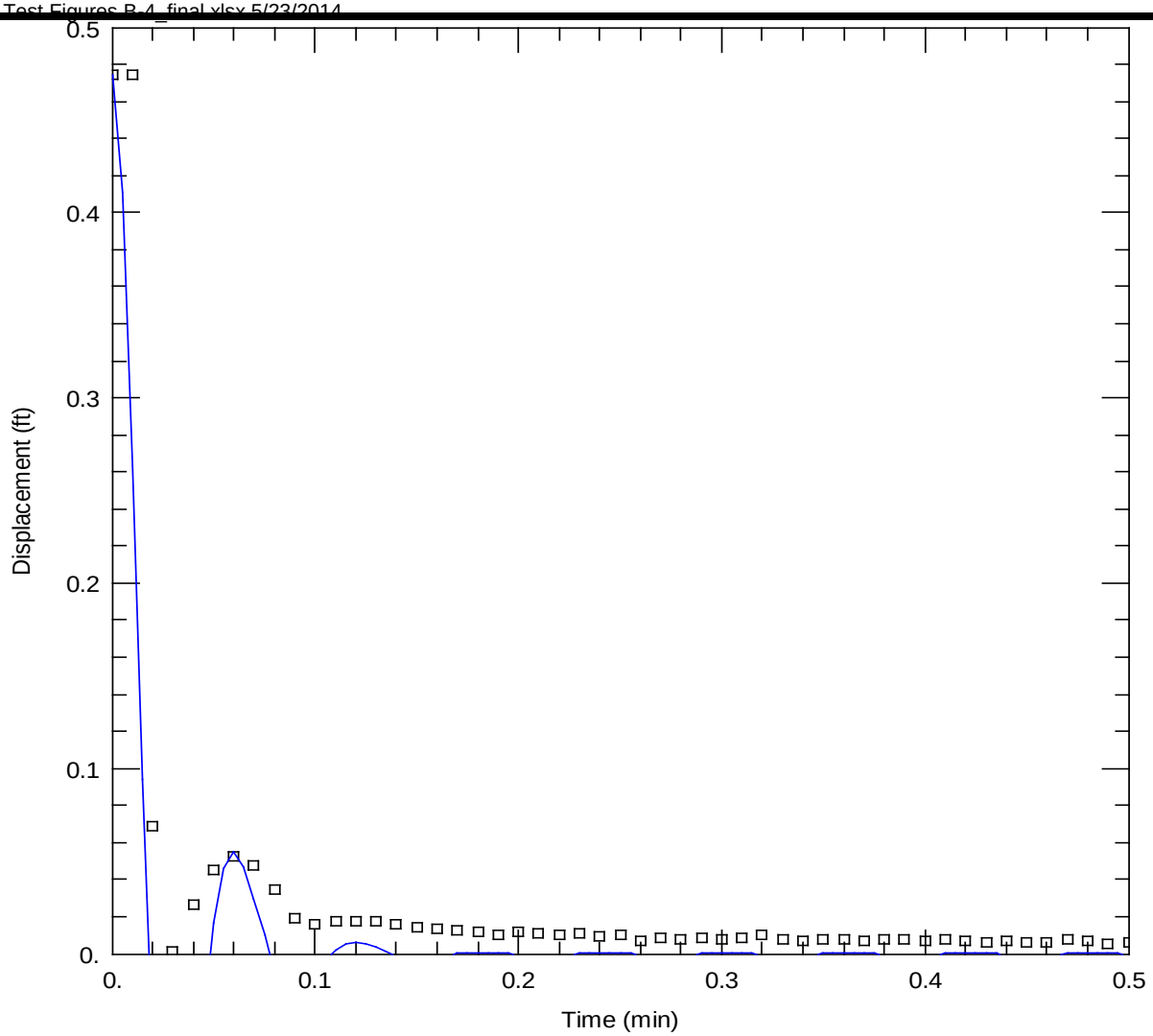
EXHIBIT B-3

EXH. B-3



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.164 cm/sec
Le = 9.393 ft
C(D) = 0.325
L = 12.15 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-4

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
FALLING HEAD TEST 2
BUTLER

May 2014 21-1-12318-215

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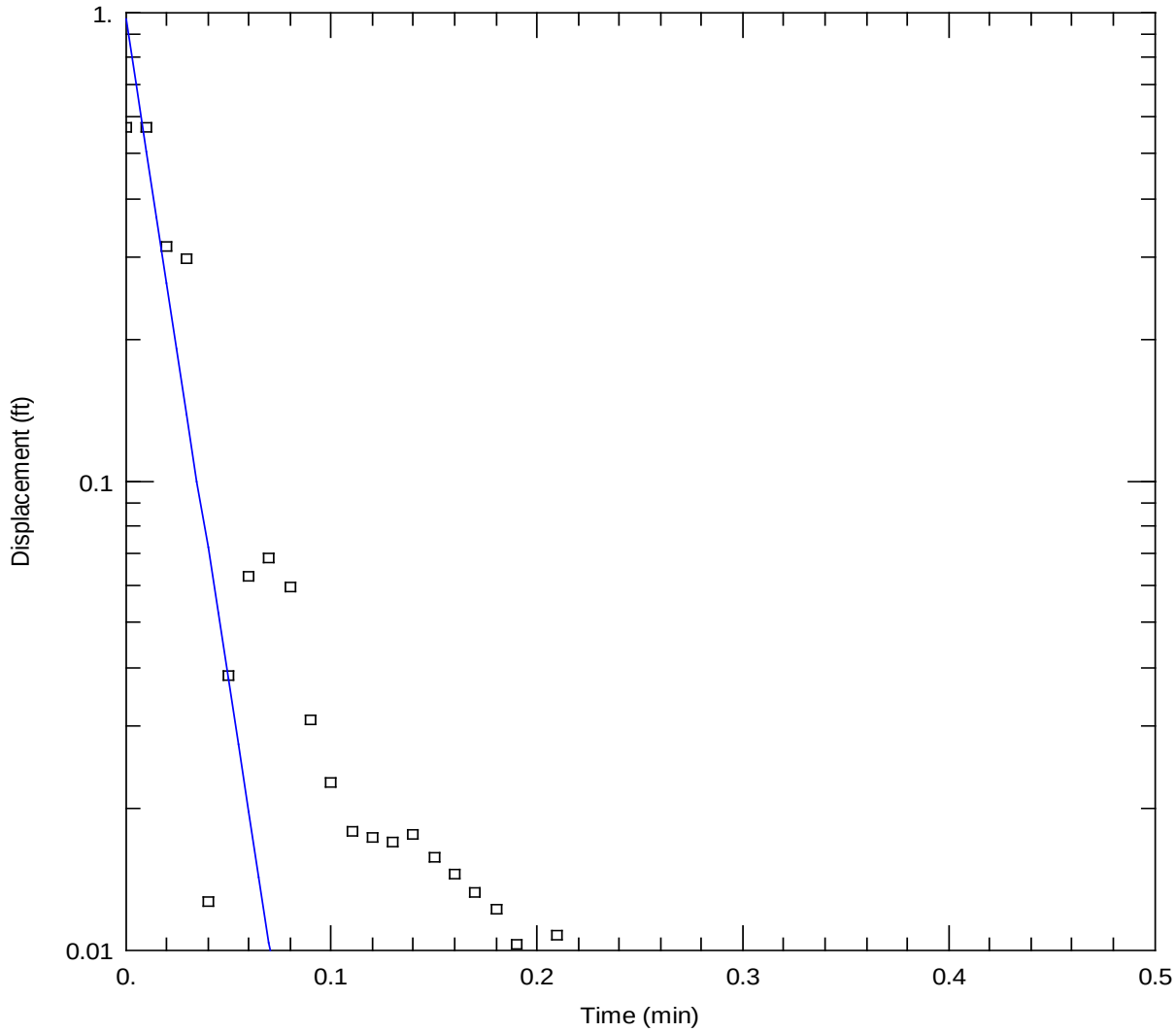
EXHIBIT B-4



Obs. Wells
B-4W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.04583 cm/sec
y0 = 0.9655 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
FALLING HEAD TEST 3
BOUWER AND RICE

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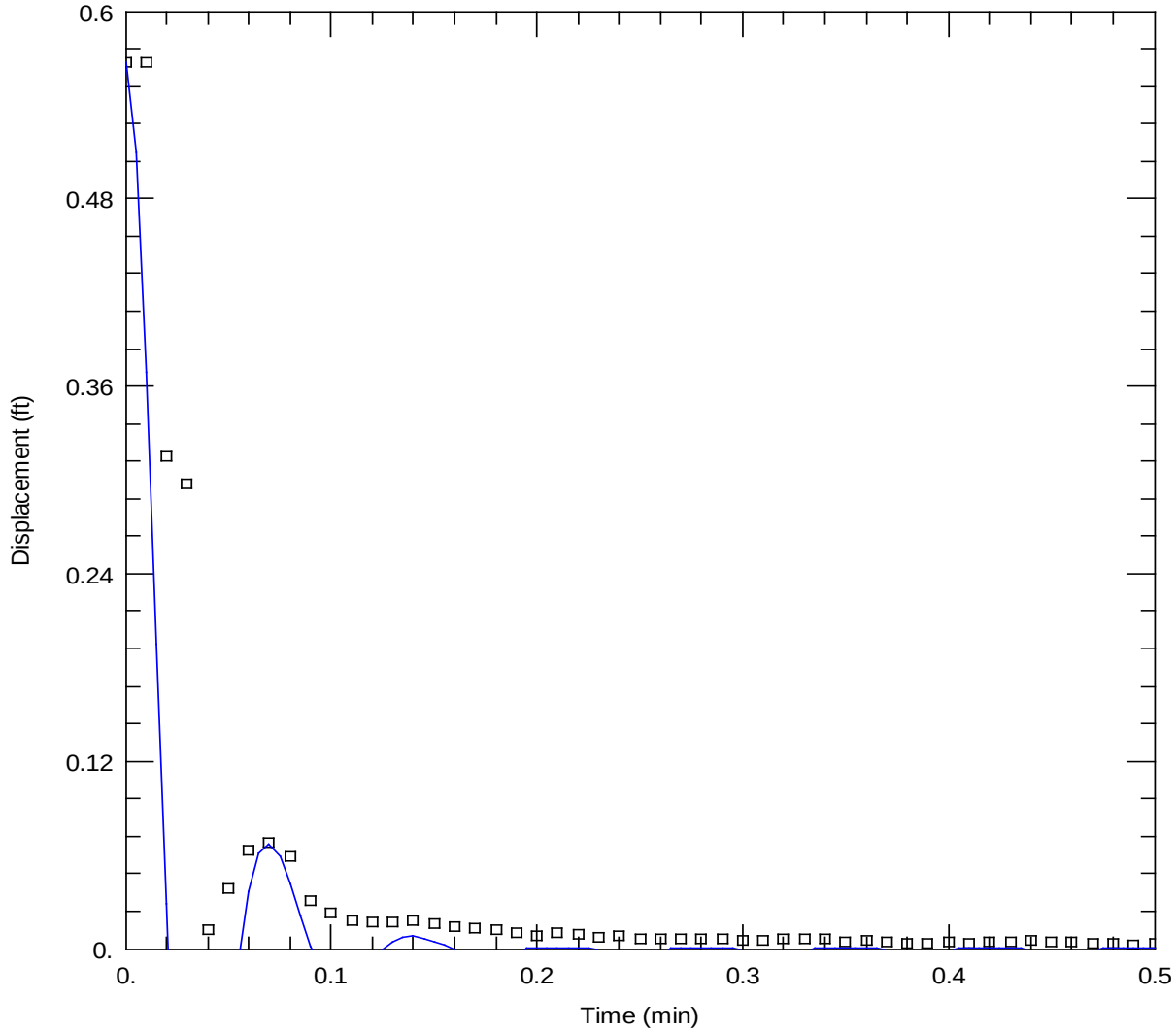
EXHIBIT B-5

EXH. B-5



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1428 cm/sec
Le = 12.68 ft
C(D) = 0.3212
L = 12.15 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-6

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
FALLING HEAD TEST 3
BUTLER

May 2014 21-1-12318-215

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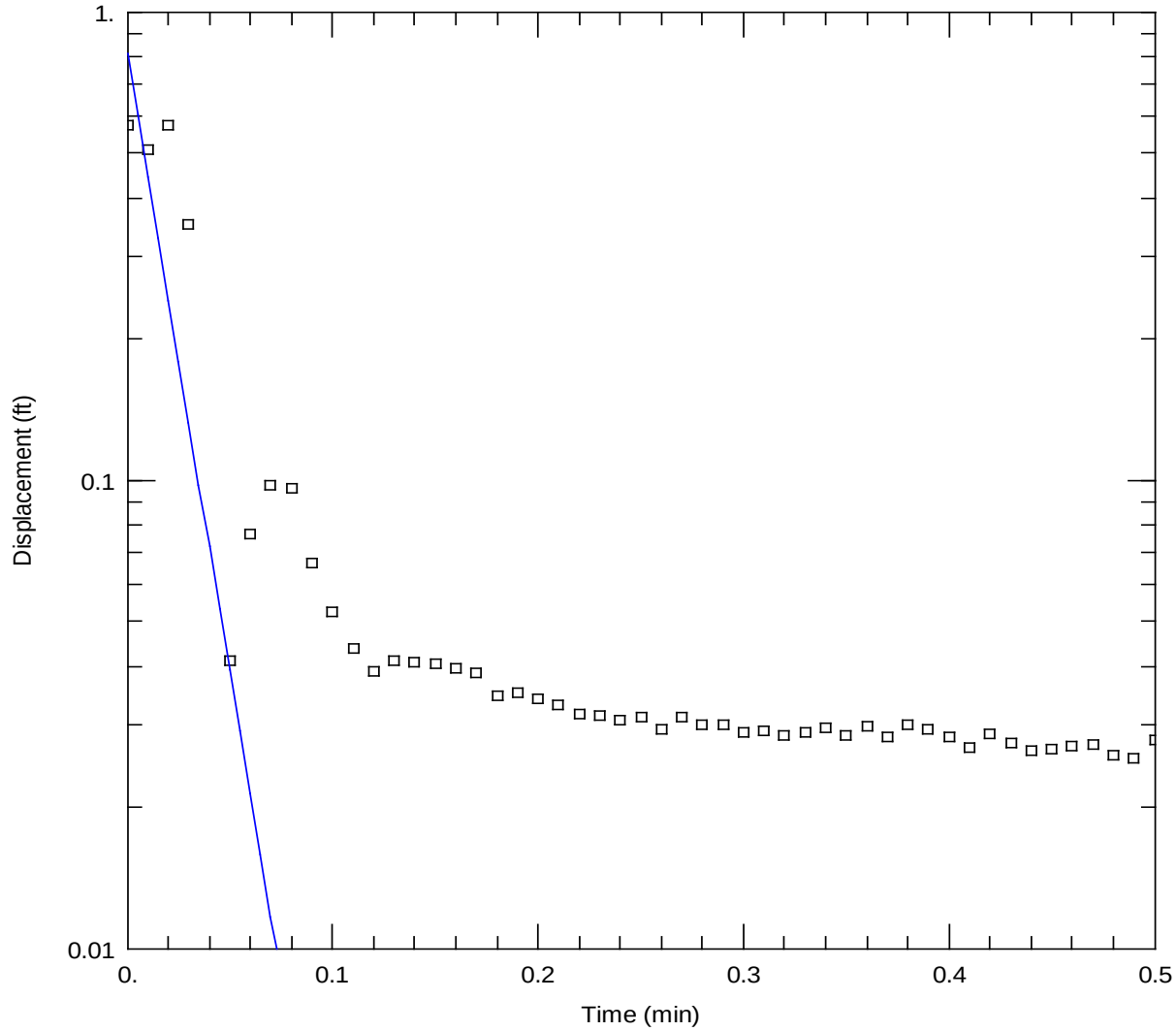
EXHIBIT B-6



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.04287 cm/sec
y0 = 0.8141 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
FALLING HEAD TEST 4
BOUWER AND RICE

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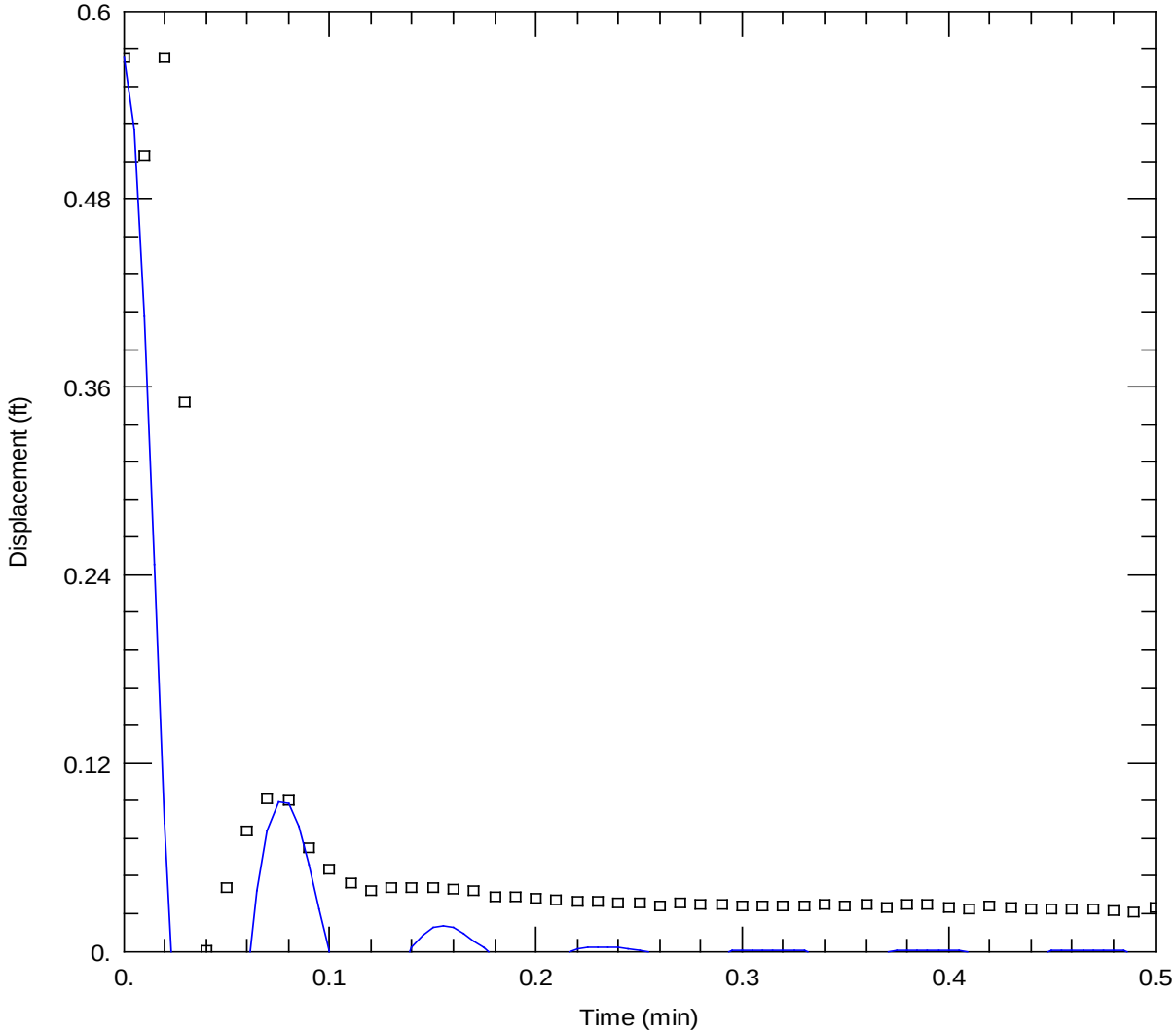
EXHIBIT B-7

EXH. B-7



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1491 cm/sec
Le = 16.25 ft
C(D) = 0.2716
L = 12.15 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-8

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
FALLING HEAD TEST 4
BUTLER

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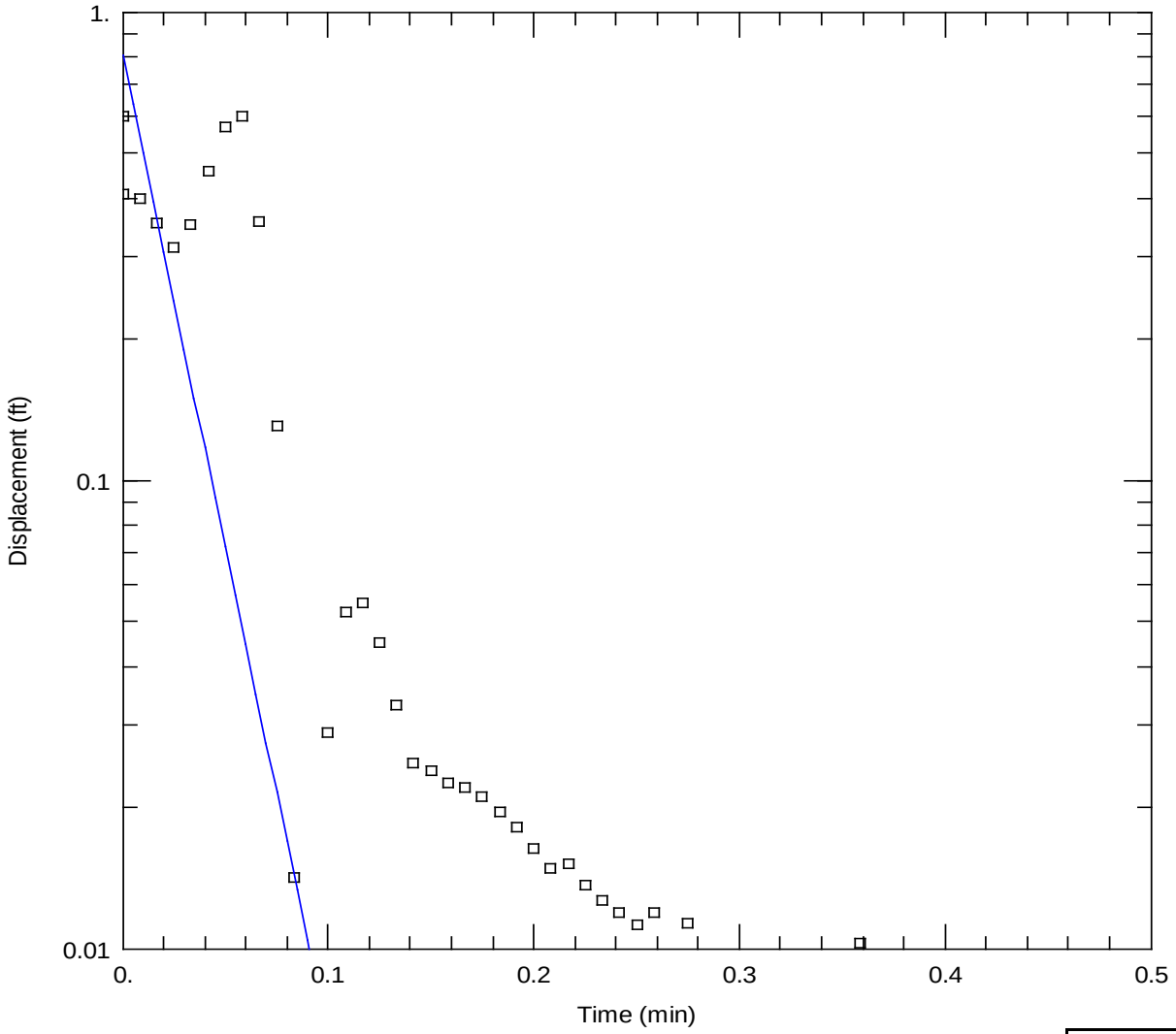
EXHIBIT B-8



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.03417 cm/sec
y0 = 0.8089 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
RISING HEAD TEST 1
BOUWER AND RICE

May 2014 21-1-12318-215

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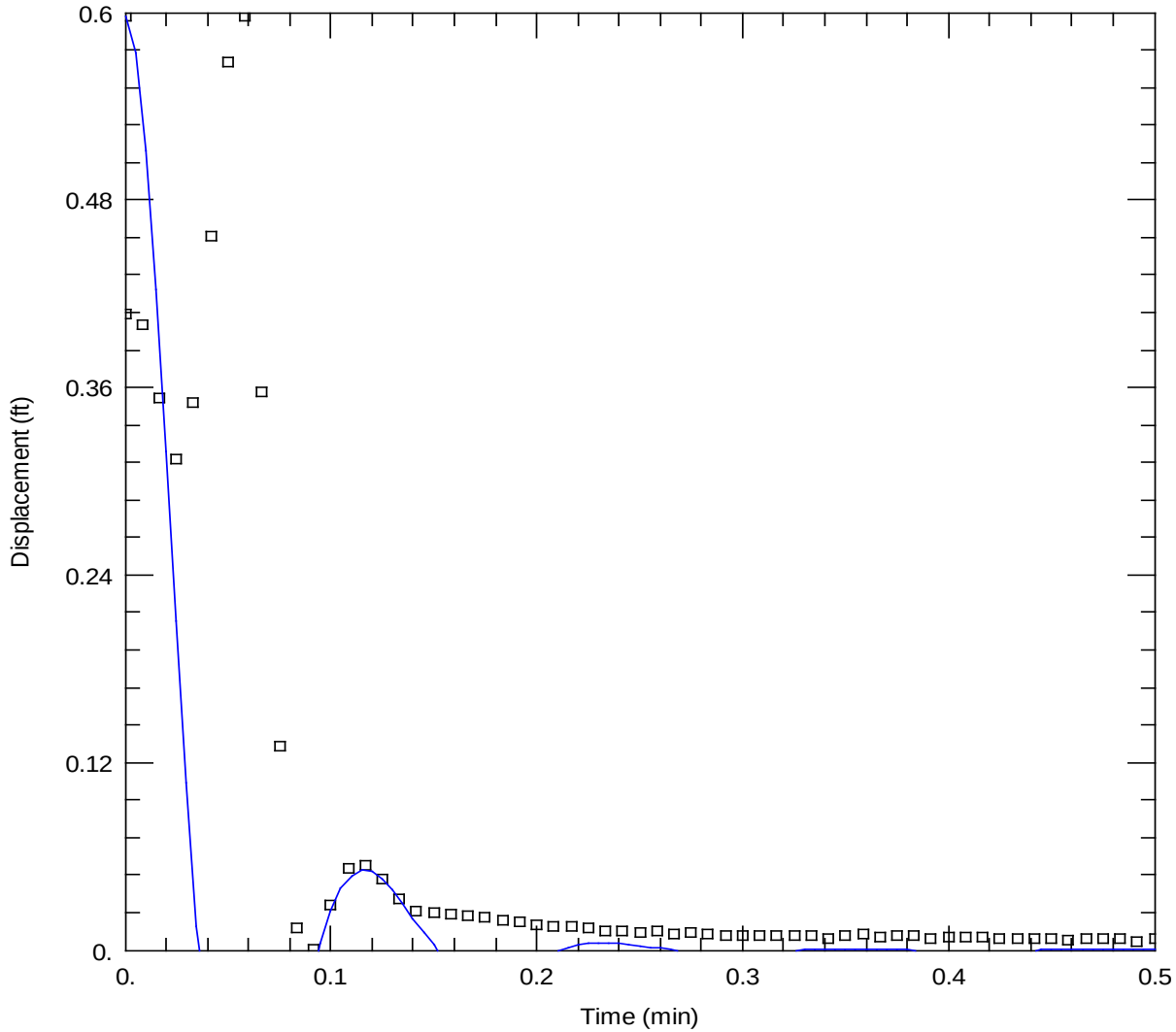
EXHIBIT B-9

EXH. B-9



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.07664 cm/sec
Le = 34.33 ft
C(D) = 0.3637
L = 12.15 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-10

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
RISING HEAD TEST 1
BUTLER

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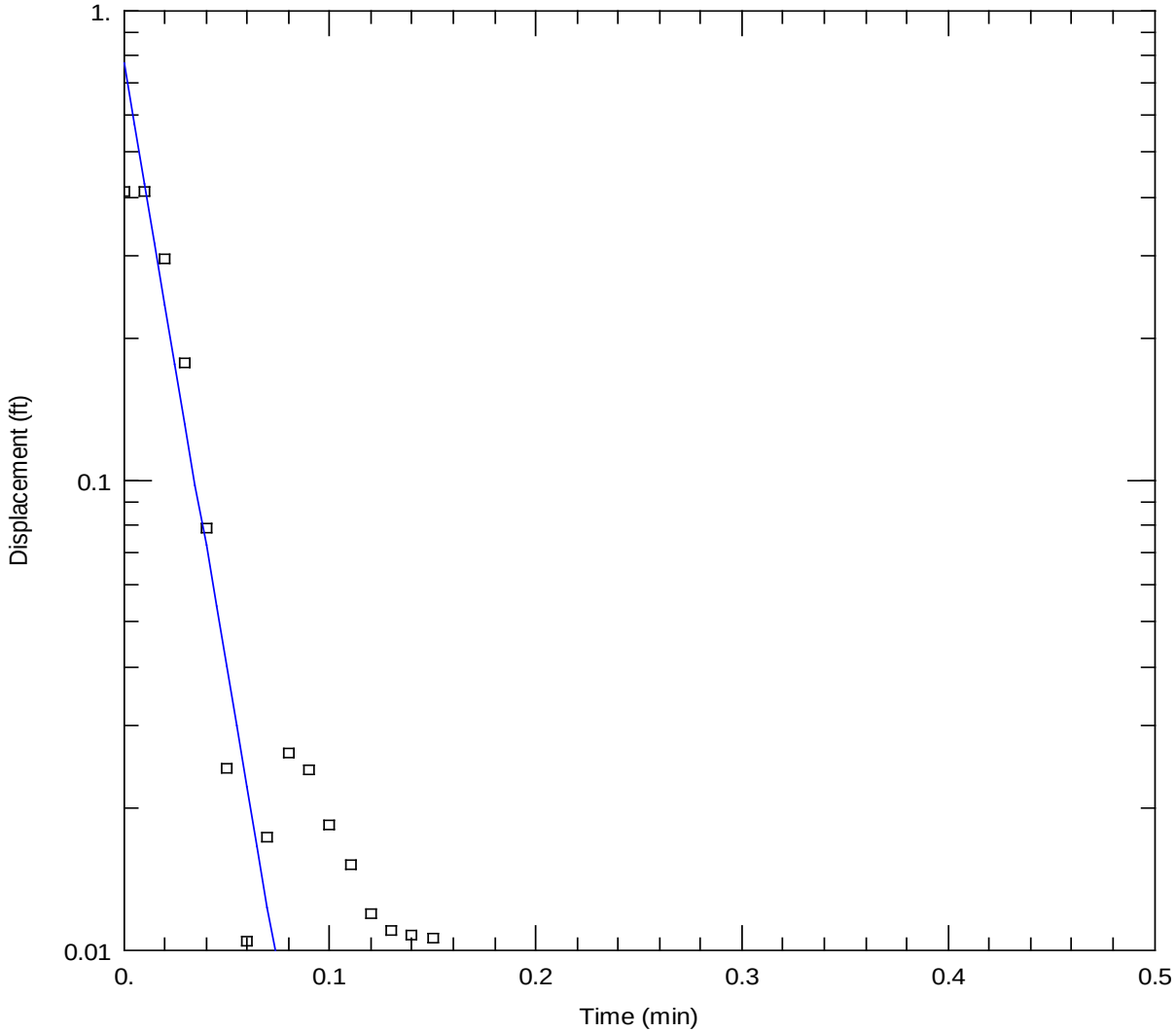
EXHIBIT B-10



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.04179 cm/sec
y0 = 0.7714 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
RISING HEAD TEST 2
BOUWER AND RICE

May 2014 21-1-12318-215

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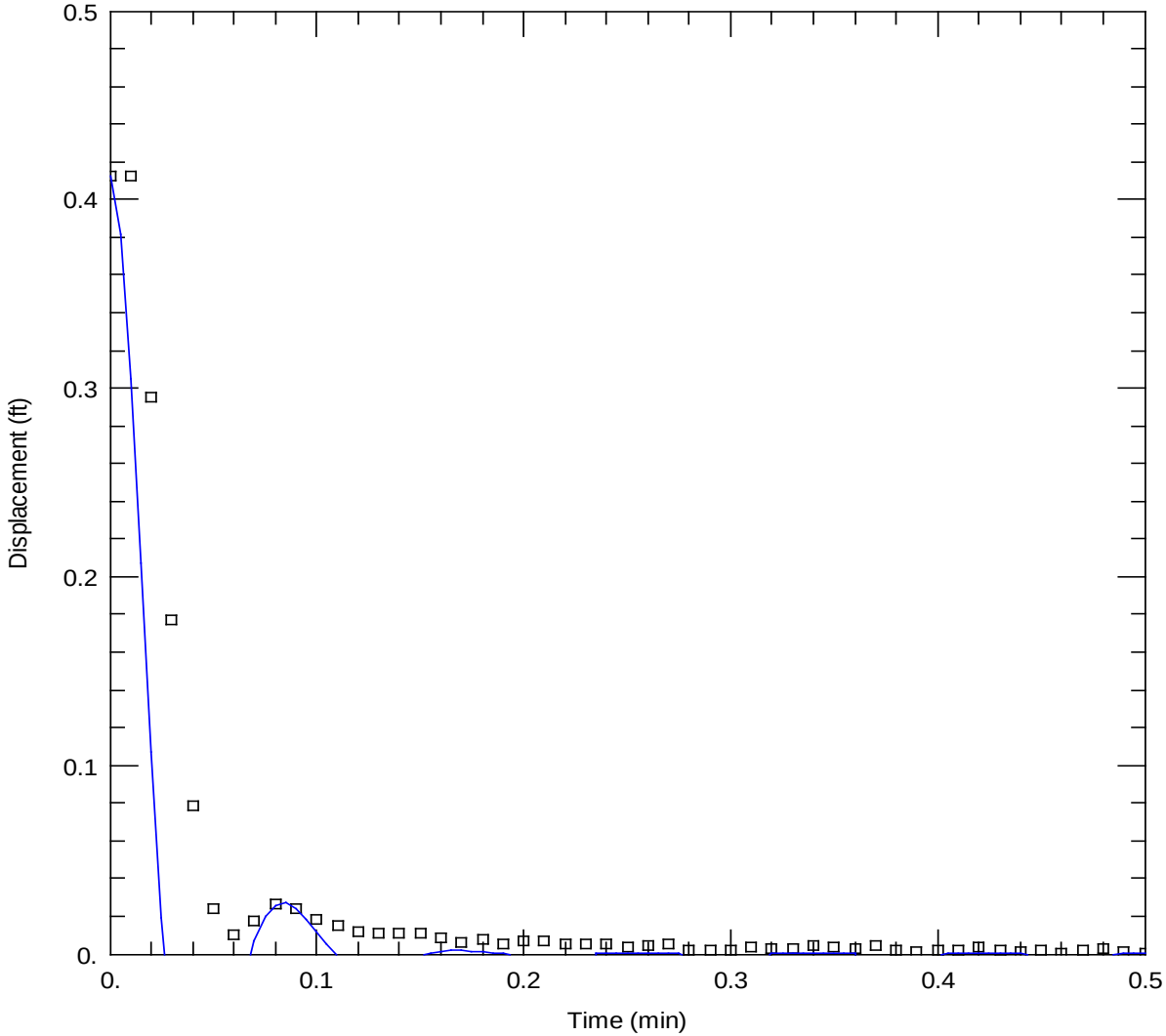
EXHIBIT B-11

EXH. B-11



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.09913 cm/sec
Le = 17.21 ft
C(D) = 0.3972
L = 12.15 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-12

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
RISING HEAD TEST 2
BUTLER

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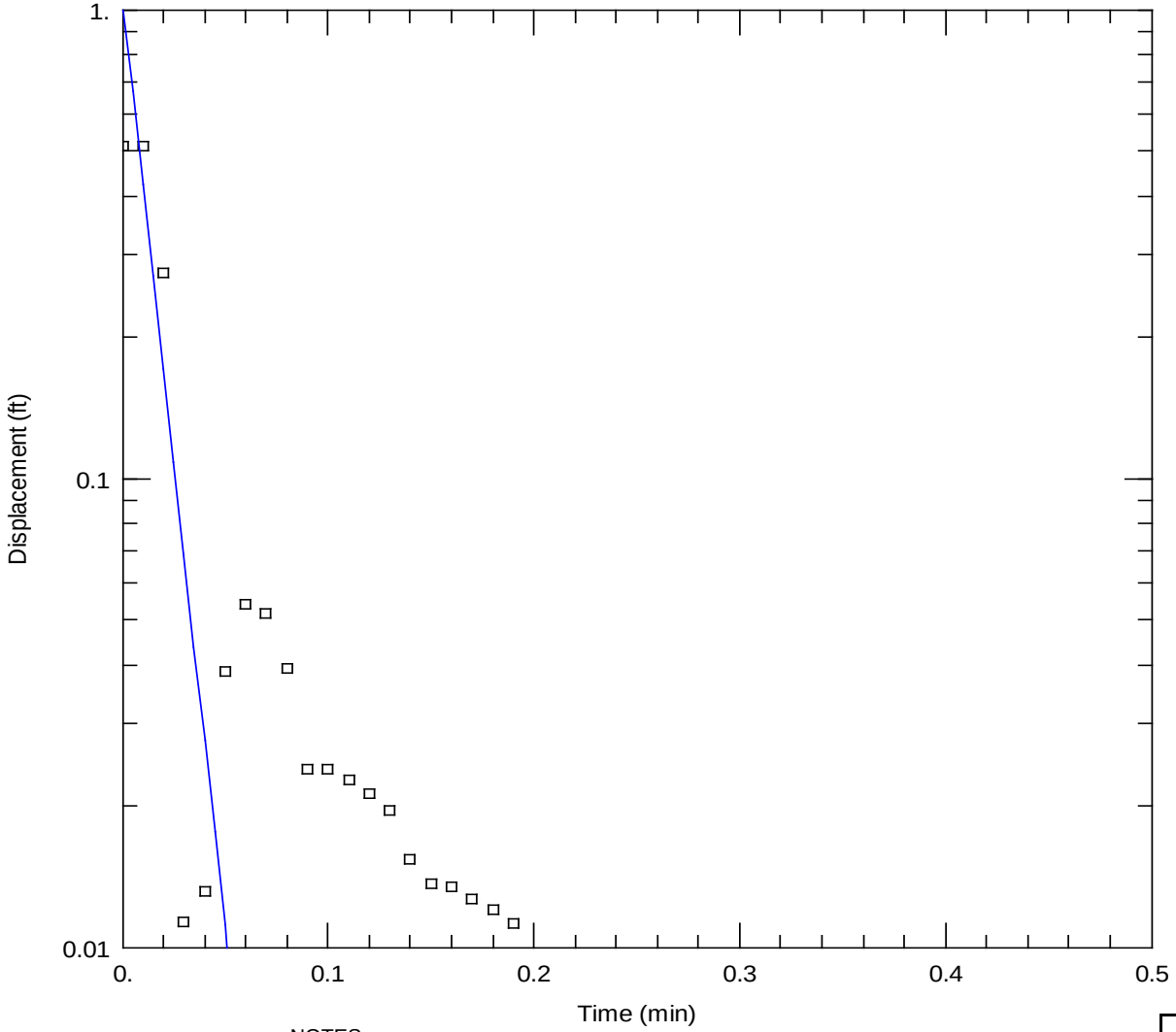
EXHIBIT B-12



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.06434 cm/sec
y0 = 1.054 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-13

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
RISING HEAD TEST 3
BOUWER AND RICE

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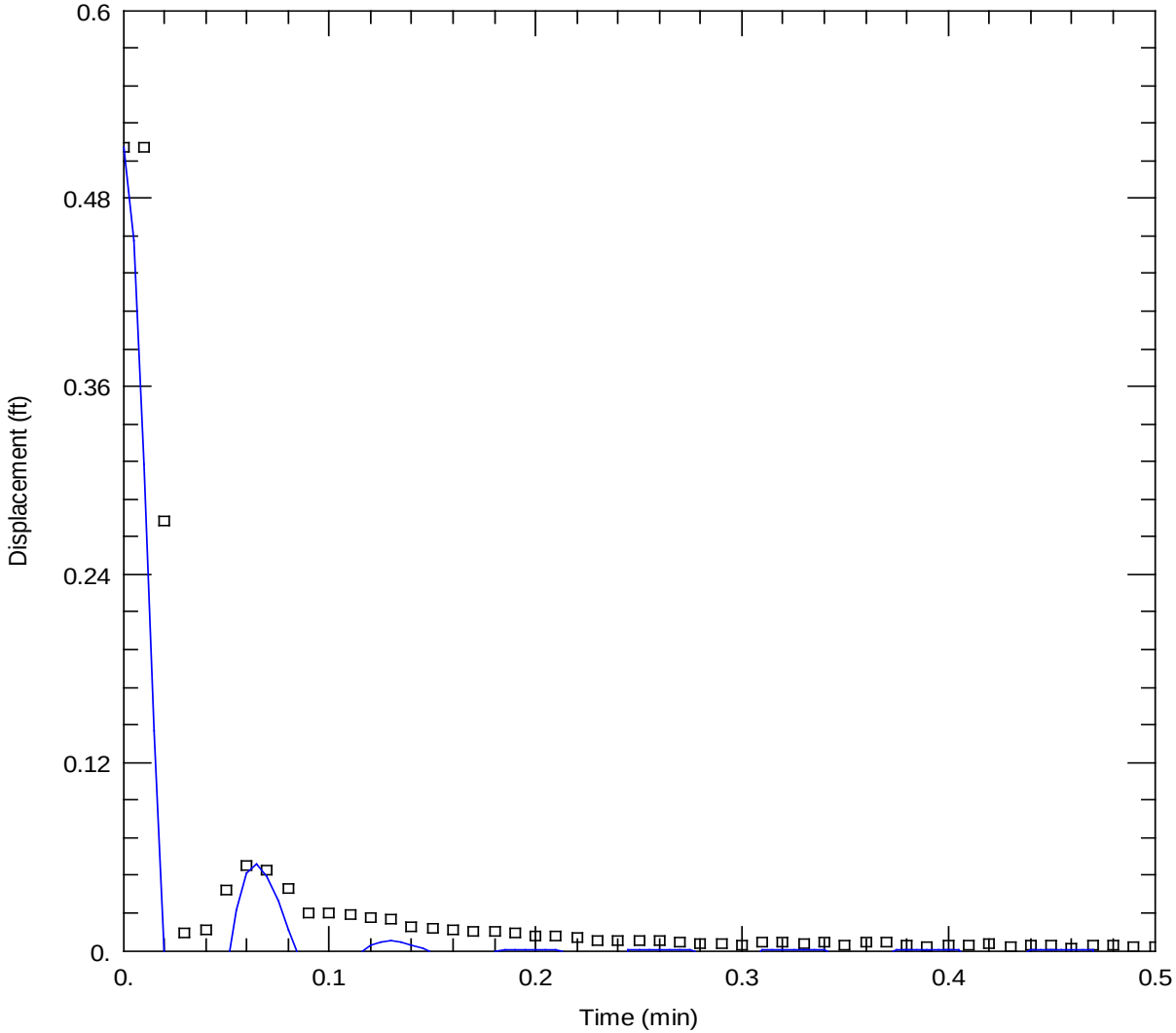
EXHIBIT B-13



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1492 cm/sec
Le = 10.81 ft
C(D) = 0.333
L = 12.15 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-14

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
RISING HEAD TEST 3
BUTLER

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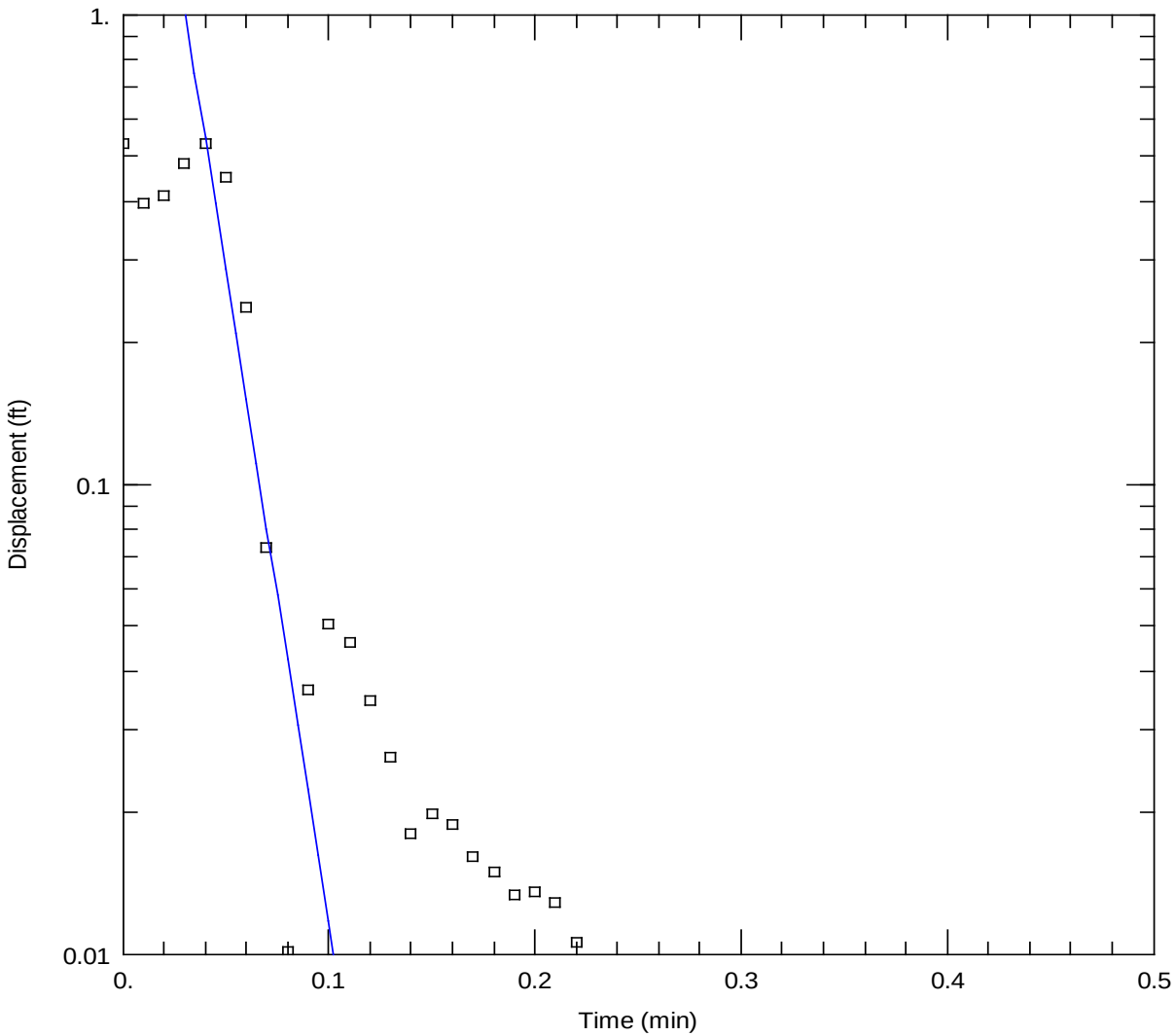
EXHIBIT B-14



Obs. Wells
B-4W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.04521 cm/sec
y0 = 7.034 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-15

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
RISING HEAD TEST 4
BOUWER AND RICE

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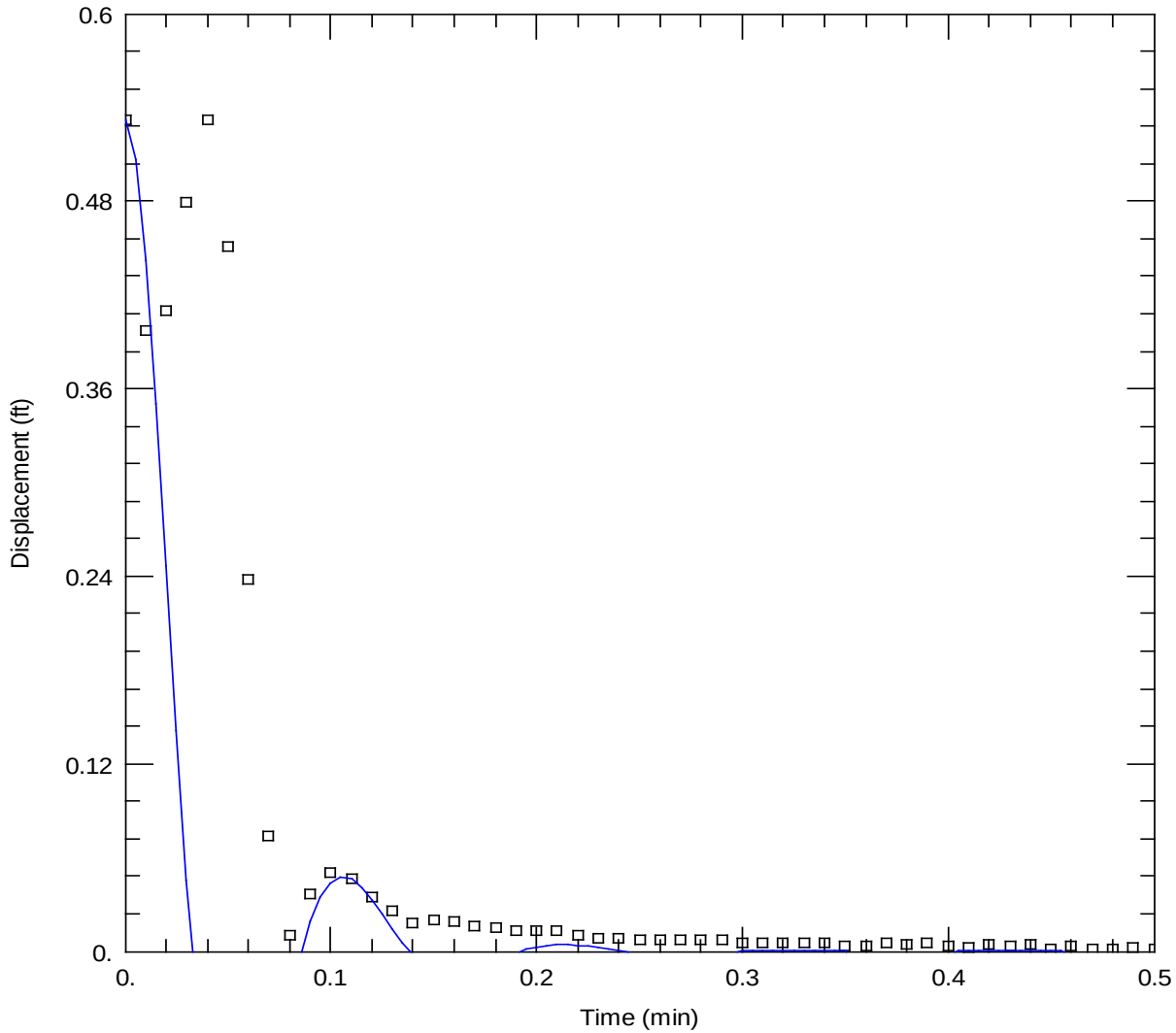
EXHIBIT B-15



Obs. Wells
- B-4W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.08501 cm/sec
Le = 28.7 ft
C(D) = 0.3586
L = 12.15 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-4w-13
RISING HEAD TEST 4
BUTLER

May 2014 21-1-12318-215

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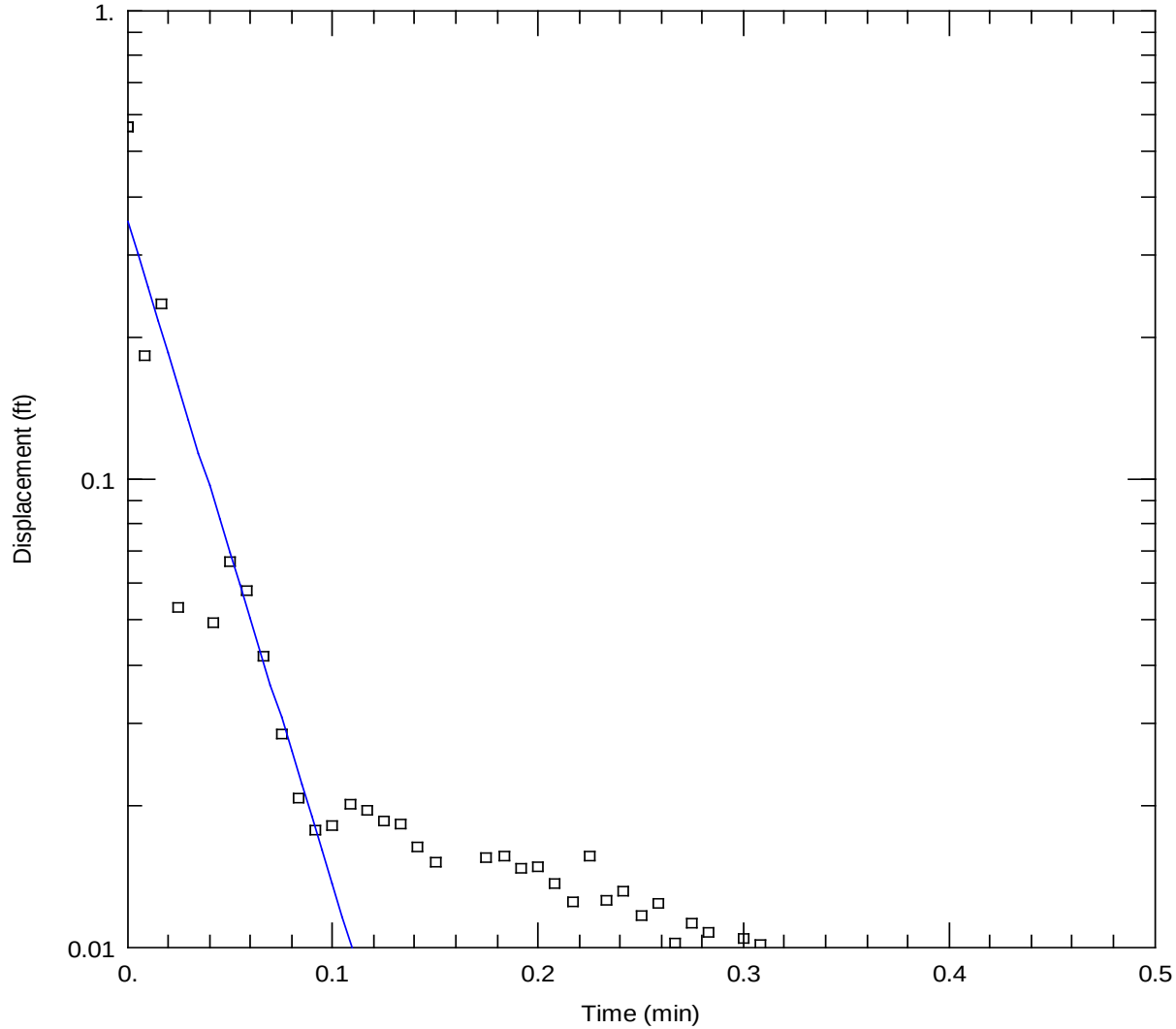
EXHIBIT B-16

EXH. B-16



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.02084 cm/sec
y0 = 0.3551 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-6w-13
FALLING HEAD TEST 1
BOUWER AND RICE

May 2014 21-1-12318-215

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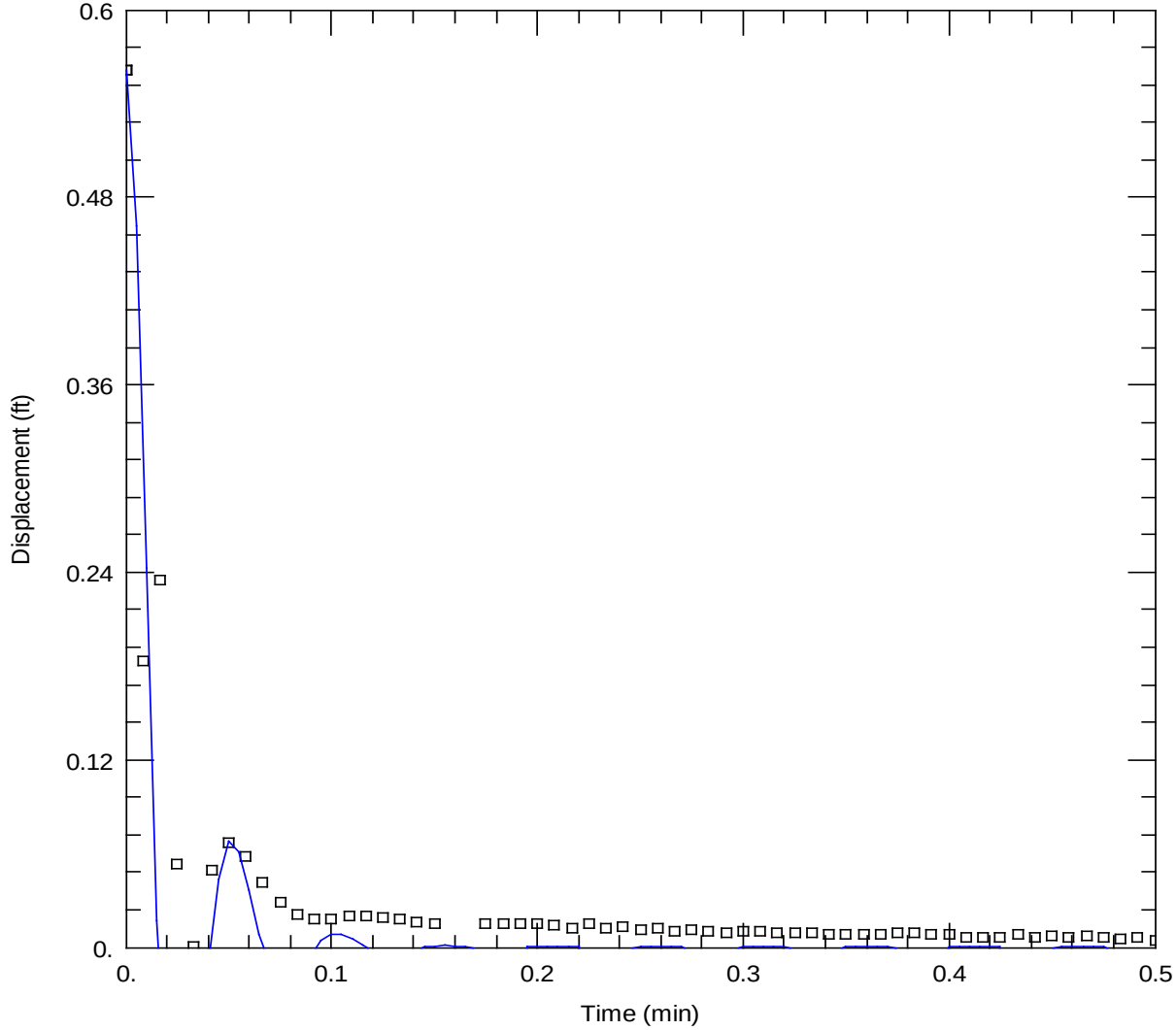
EXHIBIT B-17

EXH. B-17



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1712 cm/sec
Le = 6.921 ft
C(D) = 0.3167
L = 10.22 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-18

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-6w-13
FALLING HEAD TEST 1
BUTLER

May 2014 21-1-12318-215

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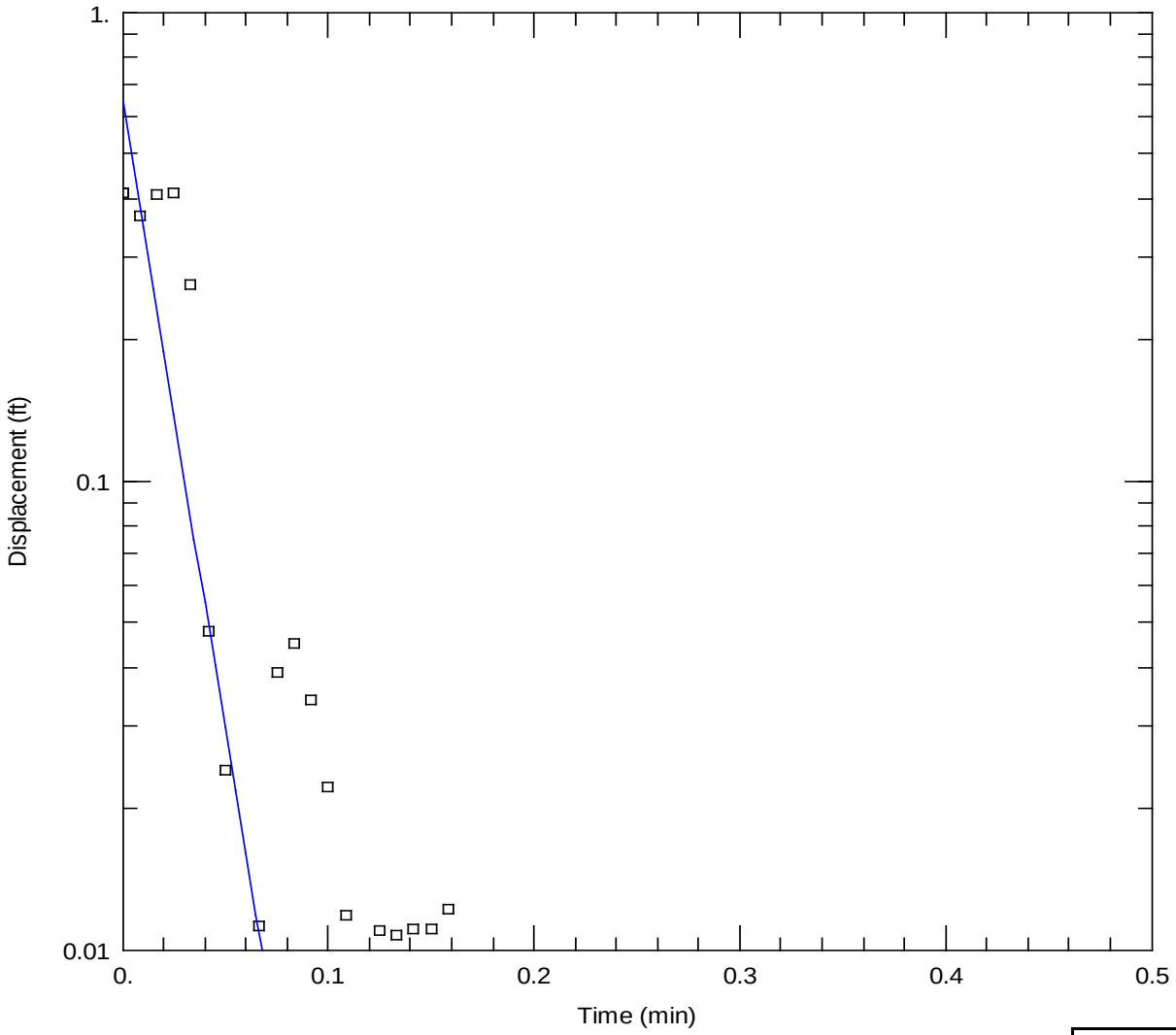
EXHIBIT B-18



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.03933 cm/sec
y0 = 0.6428 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-6w-13
FALLING HEAD TEST 2
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
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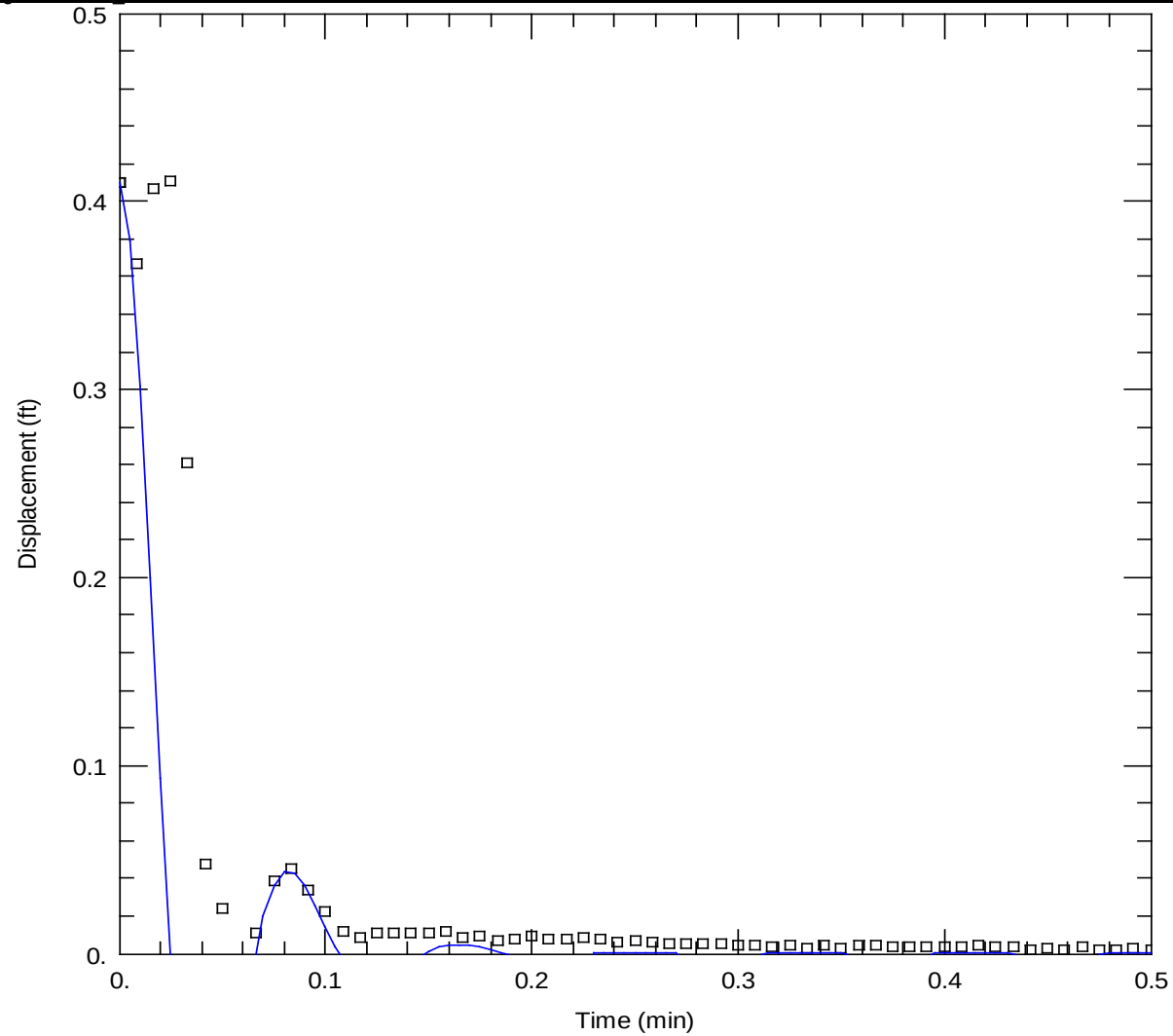
EXHIBIT B-19

EXH. B-19



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1022 cm/sec
Le = 17.49 ft
C(D) = 0.3337
L = 10.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-20

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-6w-13
FALLING HEAD TEST 2
BUTLER

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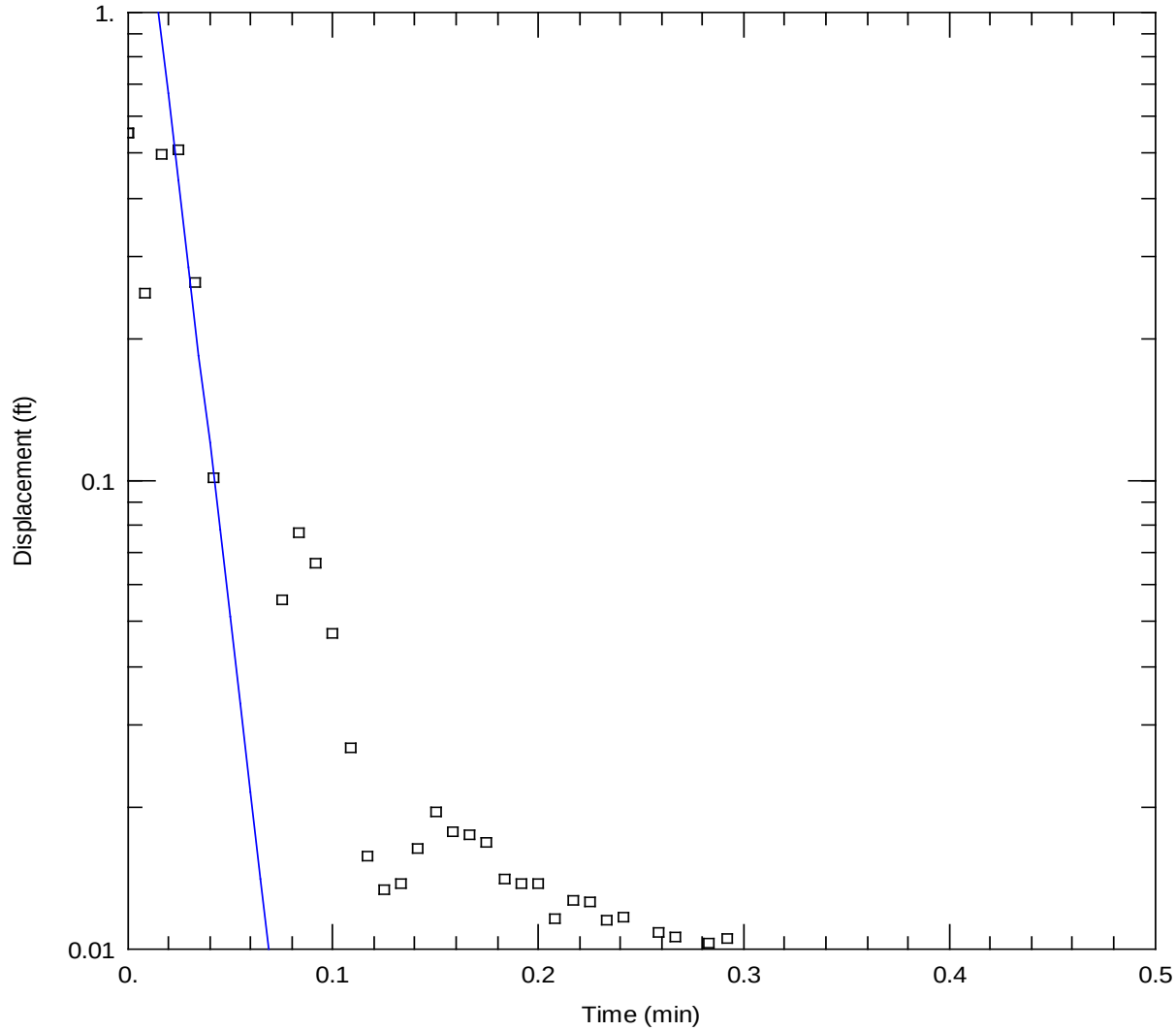
EXHIBIT B-20



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.05492 cm/sec
y0 = 3.734 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

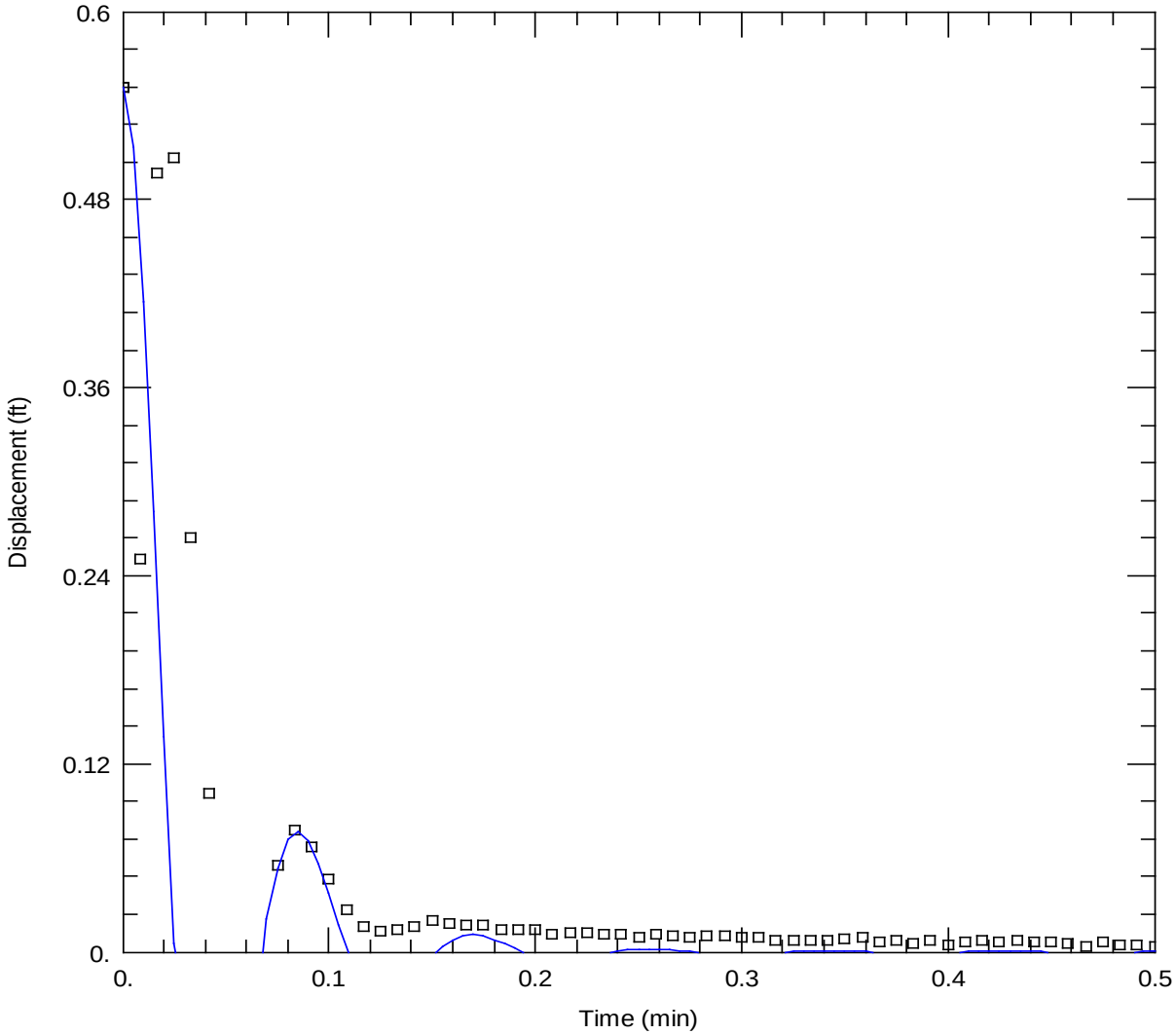
SLUG TEST RESULTS B-6w-13
FALLING HEAD TEST 3
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-21

EXH. B-21



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1092 cm/sec
Le = 19.11 ft
C(D) = 0.2988
L = 10.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-22

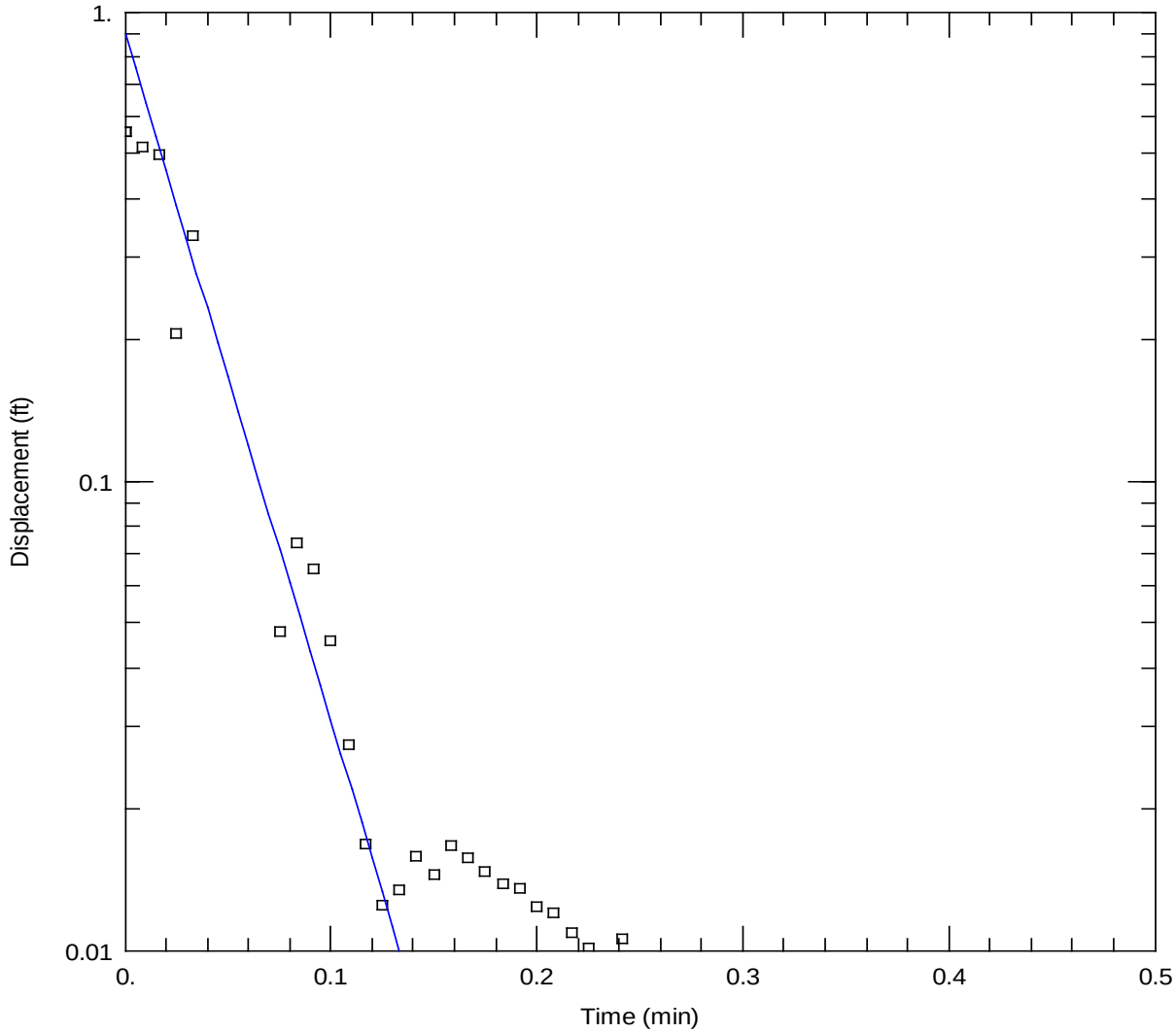
Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-6w-13
FALLING HEAD TEST 3
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-22



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.02155 cm/sec
y0 = 0.8994 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

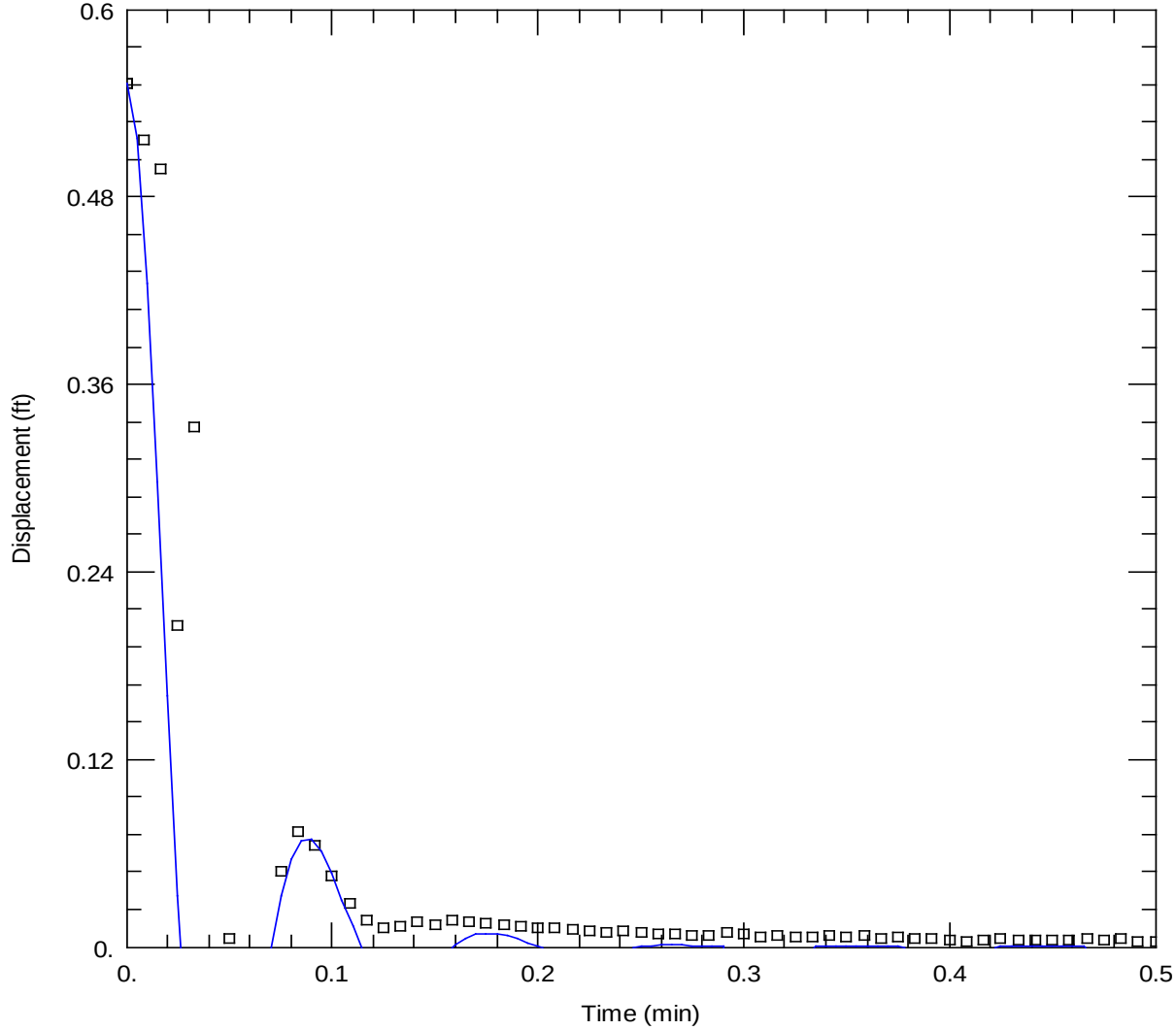
SLUG TEST RESULTS B-6w-13
FALLING HEAD TEST 4
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-23

EXH. B-23



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1009 cm/sec
Le = 20.43 ft
C(D) = 0.313
L = 10.22 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

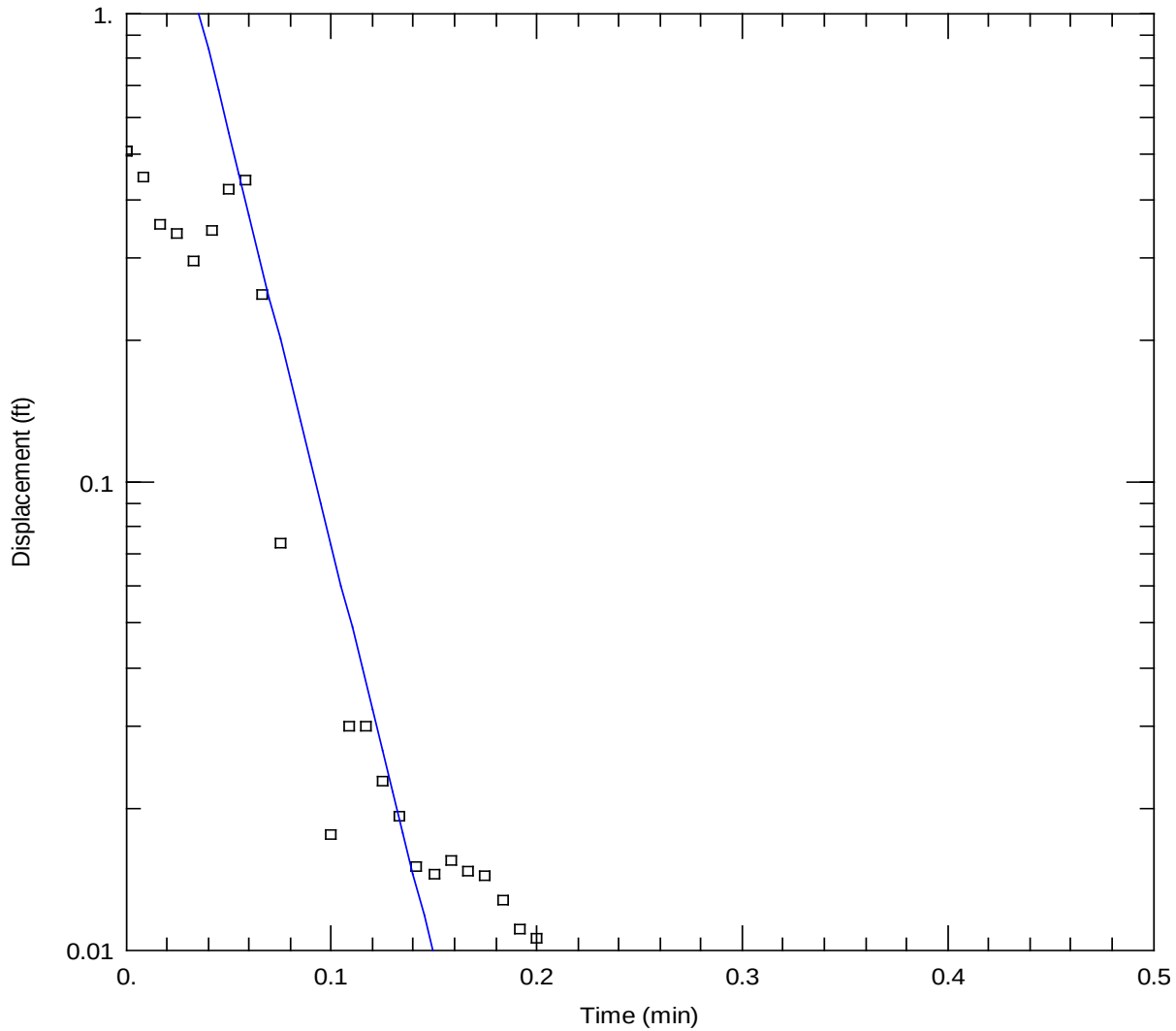
SLUG TEST RESULTS B-6w-13
FALLING HEAD TEST 4
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-24

EXH. B-24



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.02593 cm/sec
y0 = 4.227 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

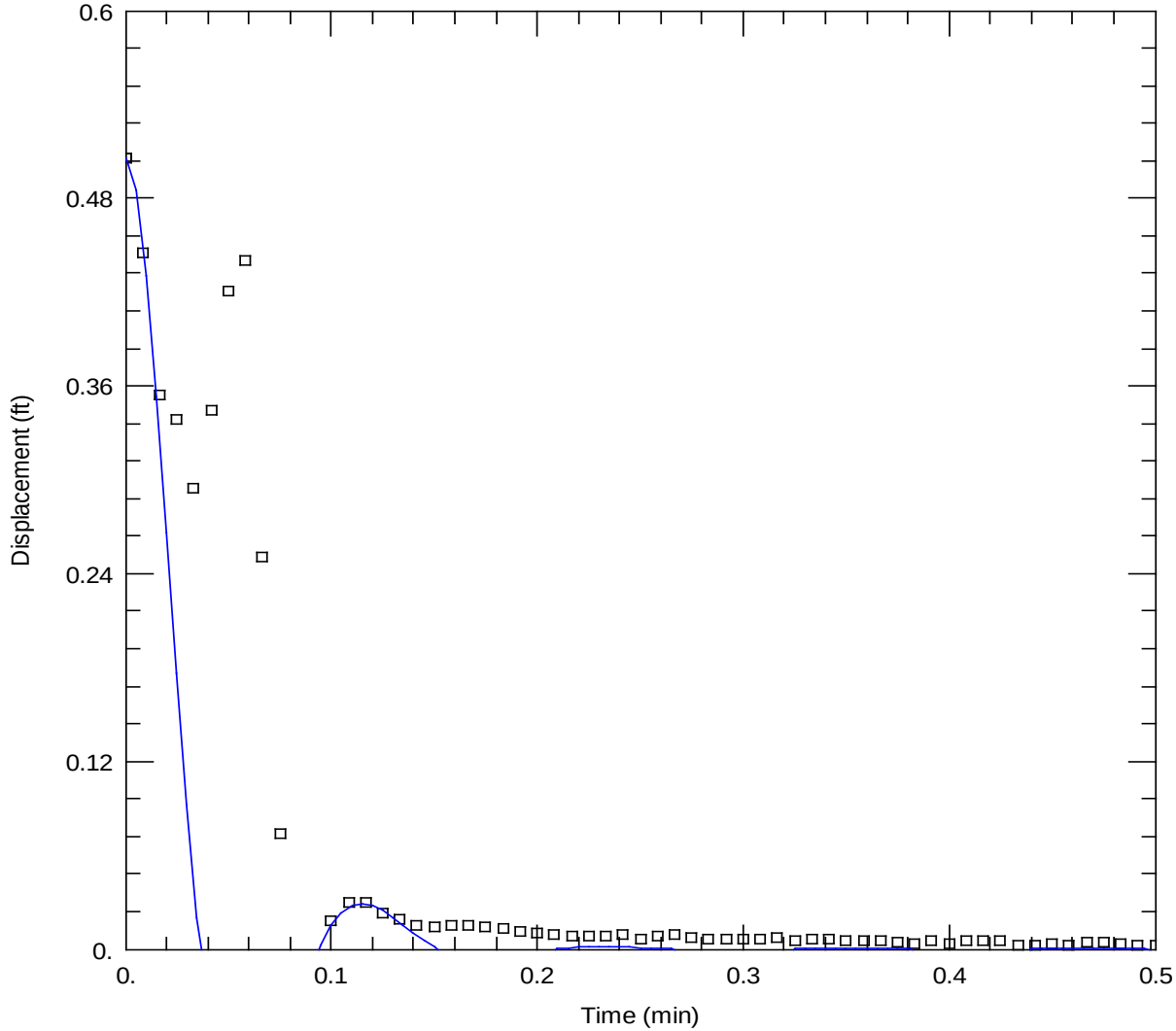
SLUG TEST RESULTS B-6w-13
RISING HEAD TEST 1
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-25

EXH. B-25



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.0608 cm/sec
Le = 32.21 ft
C(D) = 0.4135
L = 10.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

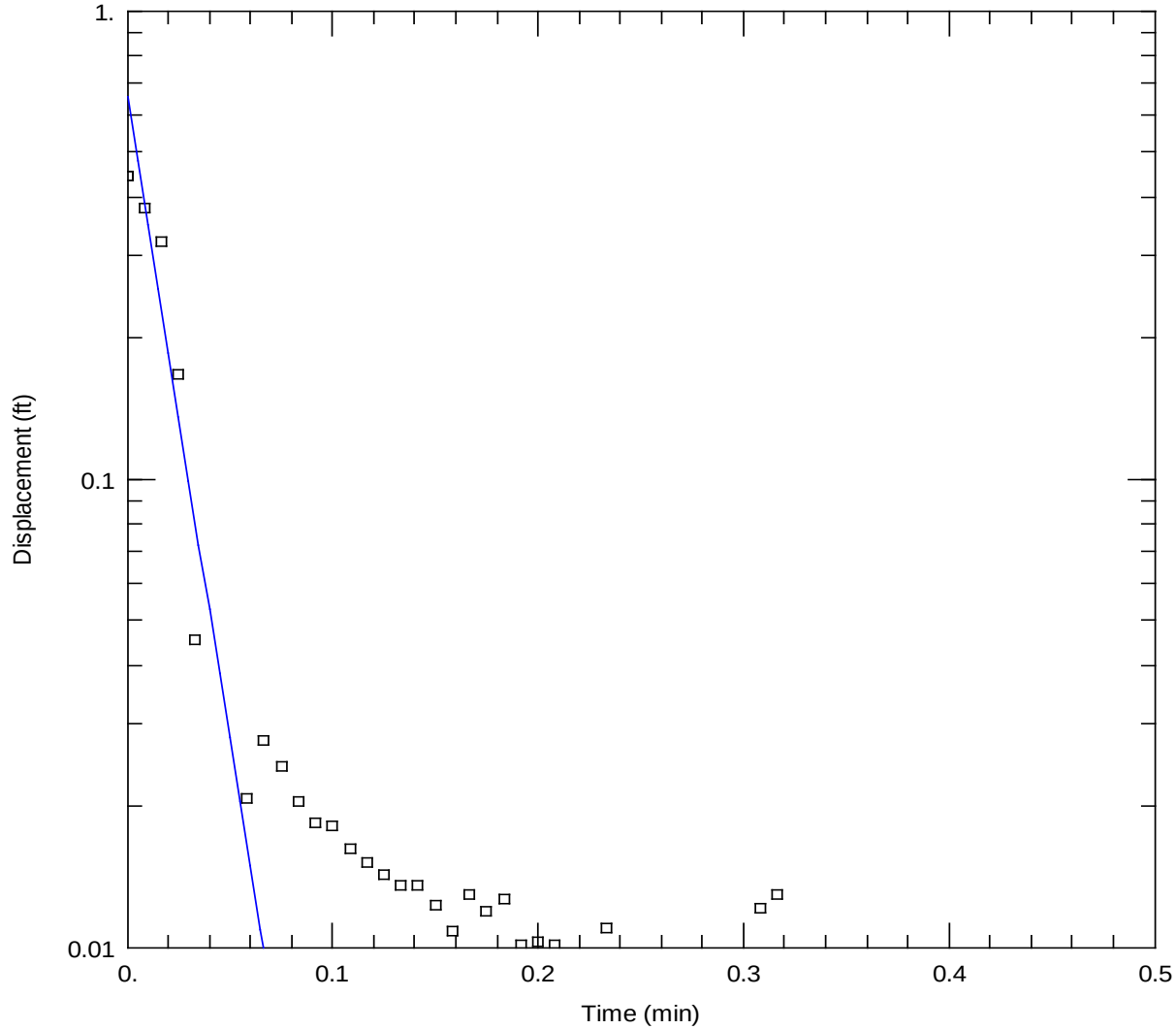
SLUG TEST RESULTS B-6w-13
RISING HEAD TEST 1
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-26

EXH. B-26



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.04029 cm/sec
y0 = 0.6548 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

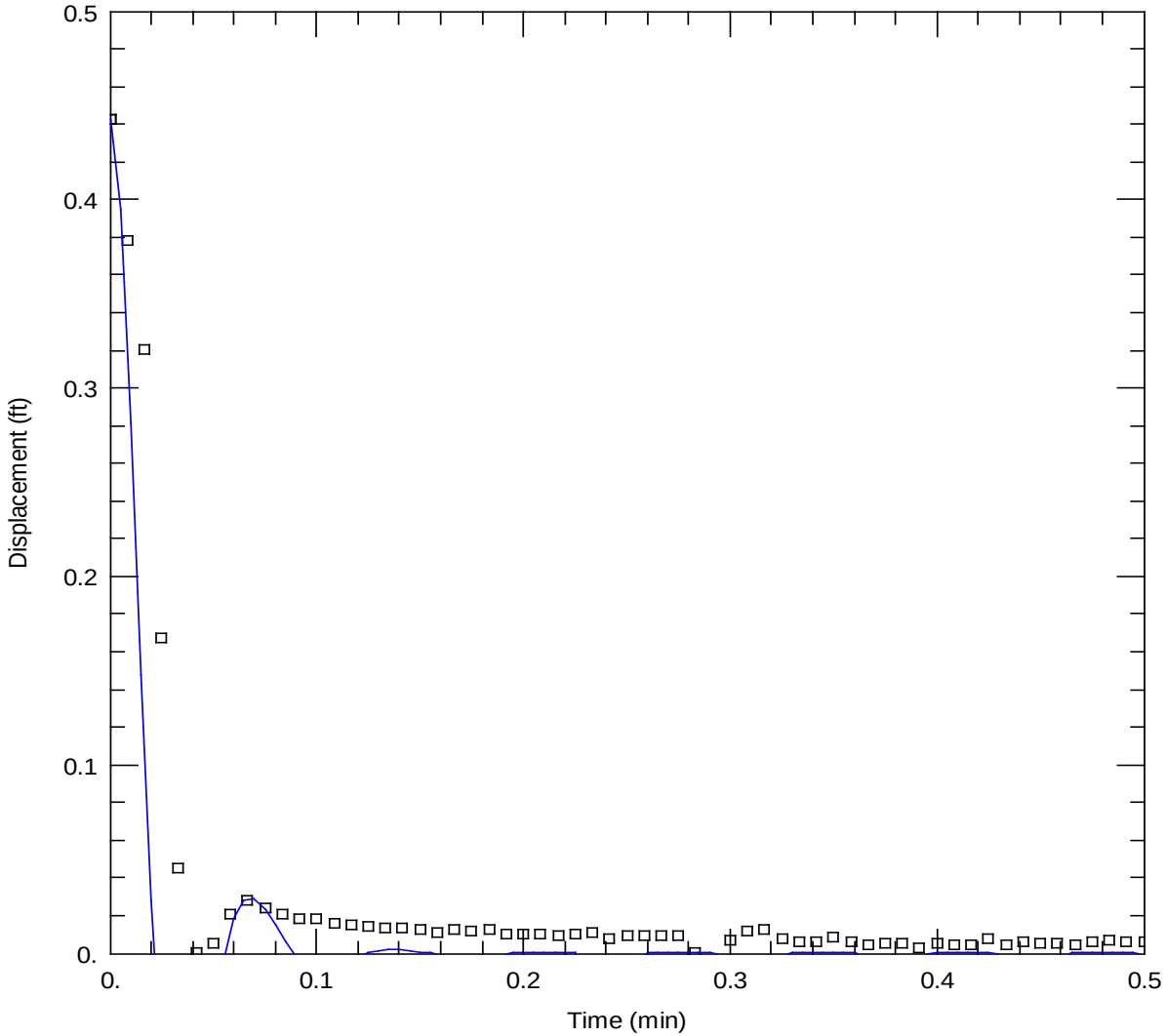
SLUG TEST RESULTS B-6w-13
RISING HEAD TEST 2
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-27

EXH. B-27



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1063 cm/sec
Le = 11.43 ft
C(D) = 0.397
L = 10.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-28

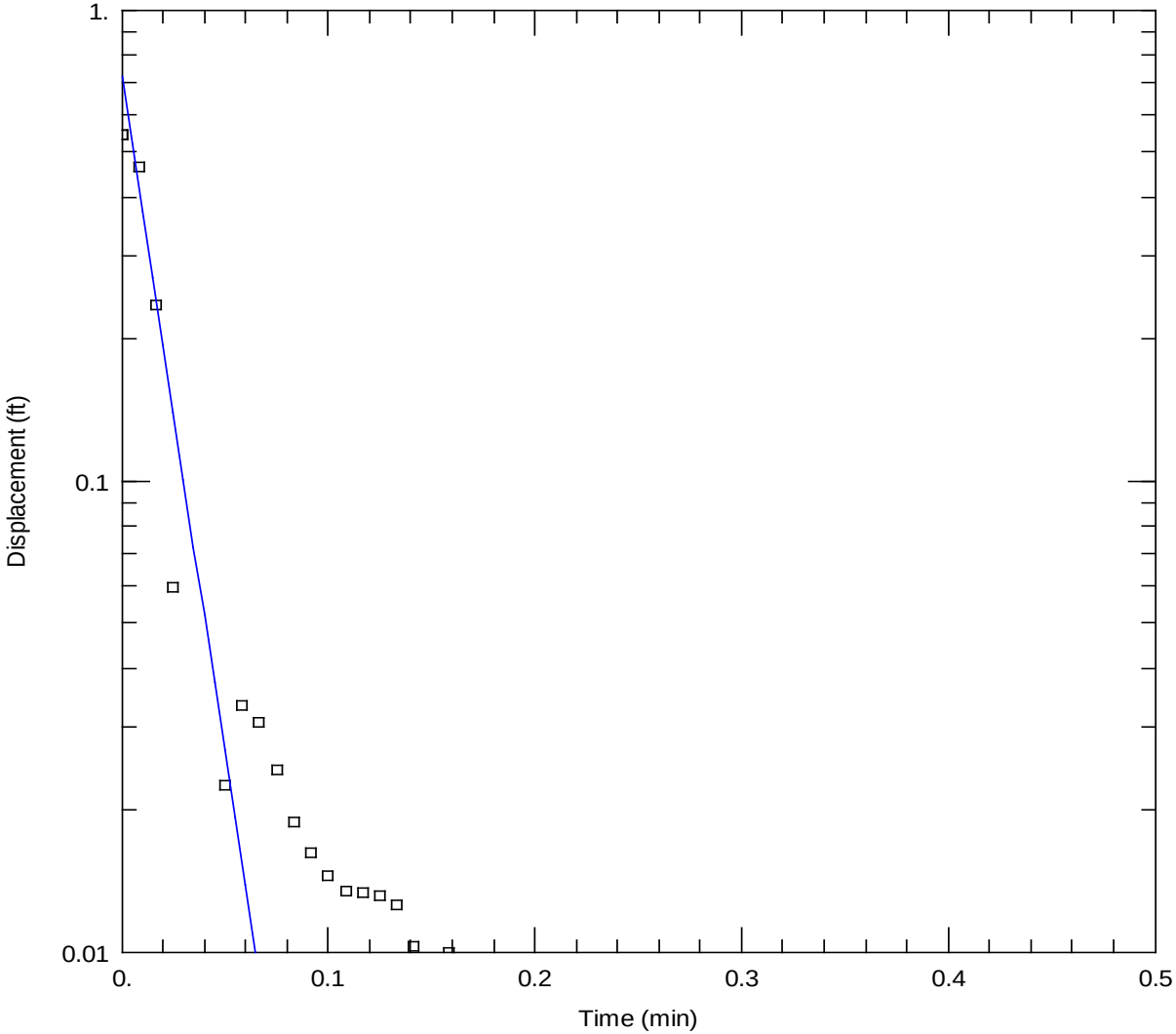
Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-6w-13
RISING HEAD TEST 2
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-28



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.04221 cm/sec
y0 = 0.7242 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

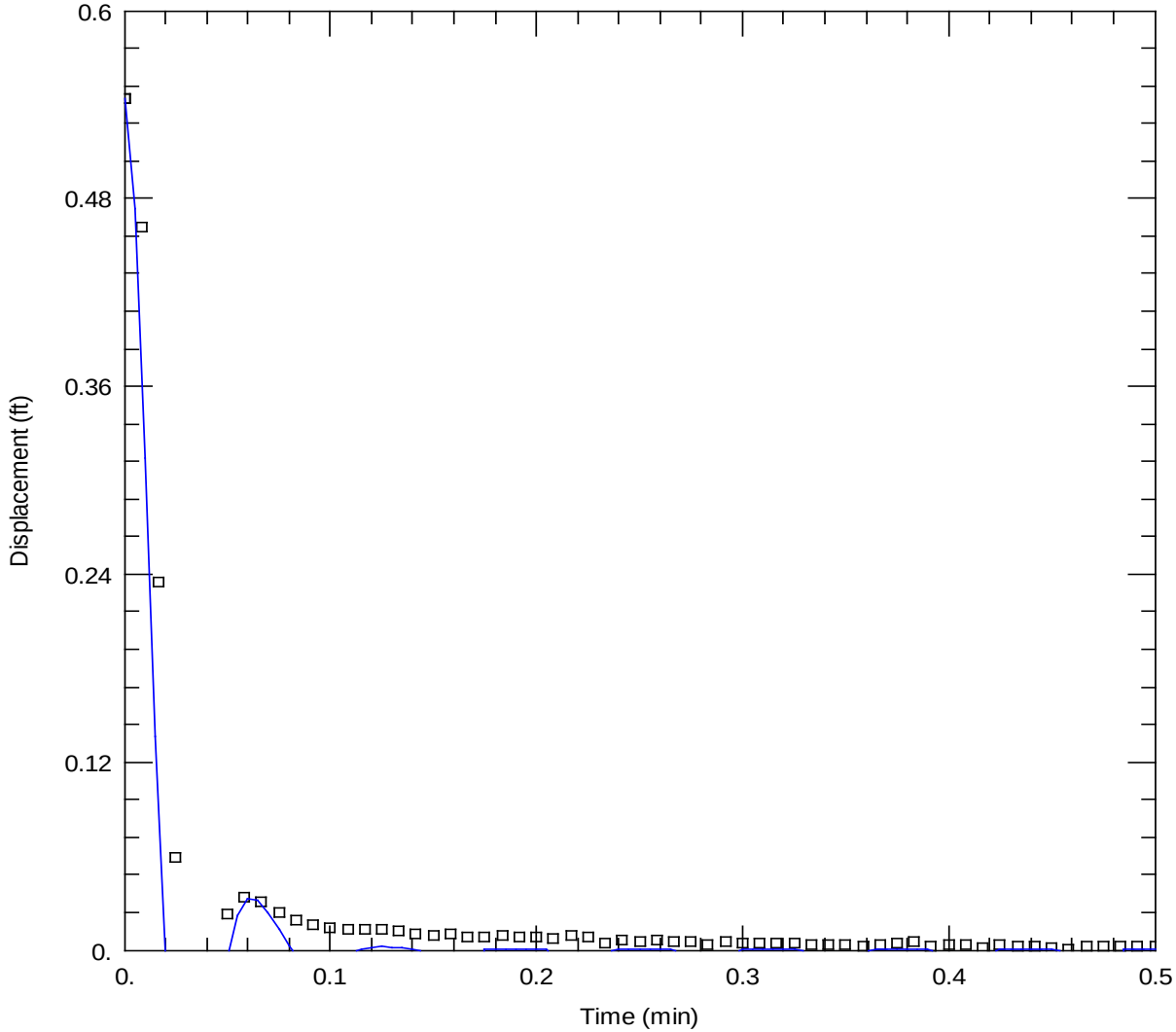
SLUG TEST RESULTS B-6w-13
RISING HEAD TEST 3
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-29

EXH. B-29



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1148 cm/sec
Le = 9.433 ft
C(D) = 0.4047
L = 10.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-30

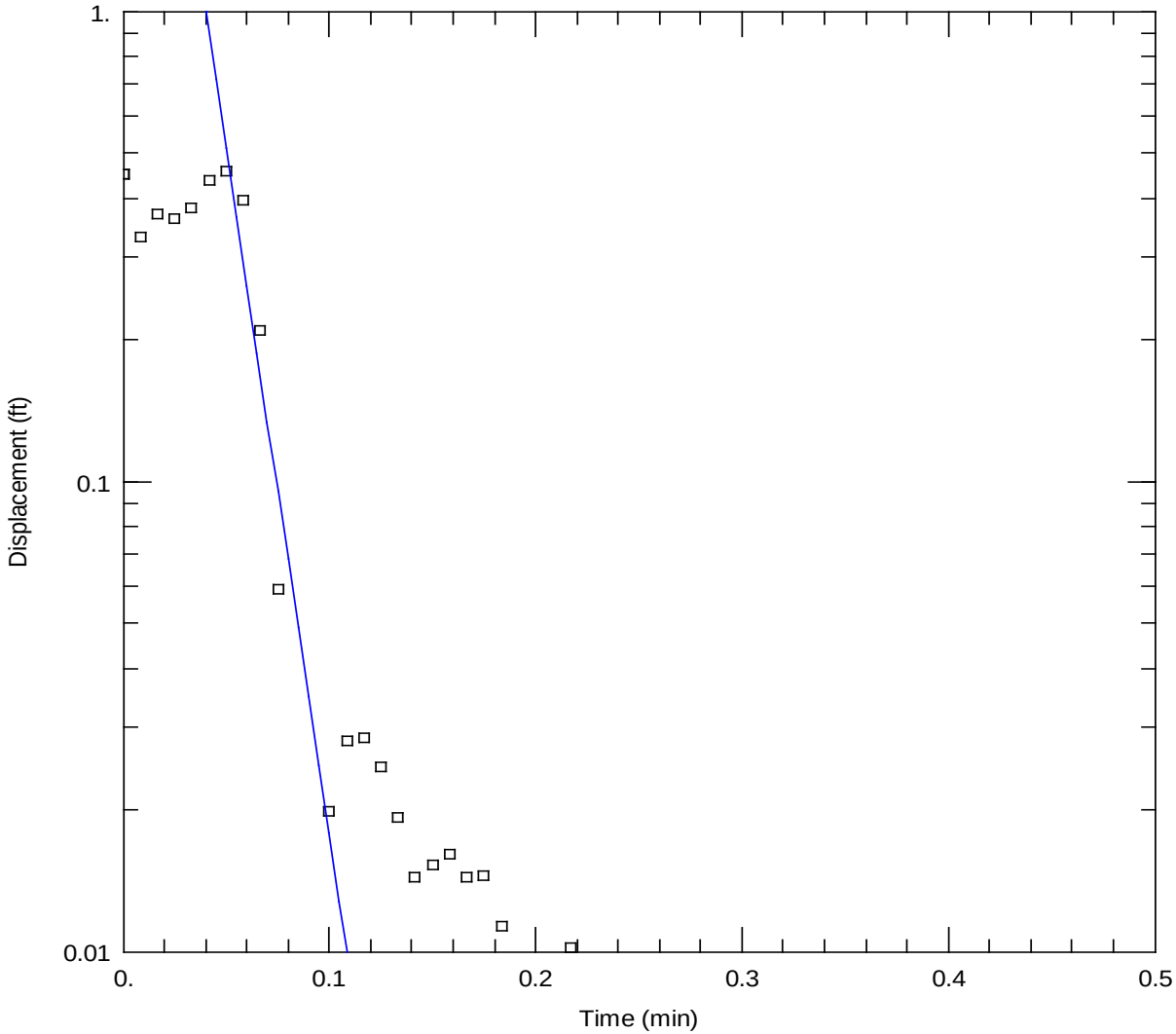
Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-6w-13
RISING HEAD TEST 3
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-30



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.04291 cm/sec
y0 = 14.63 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

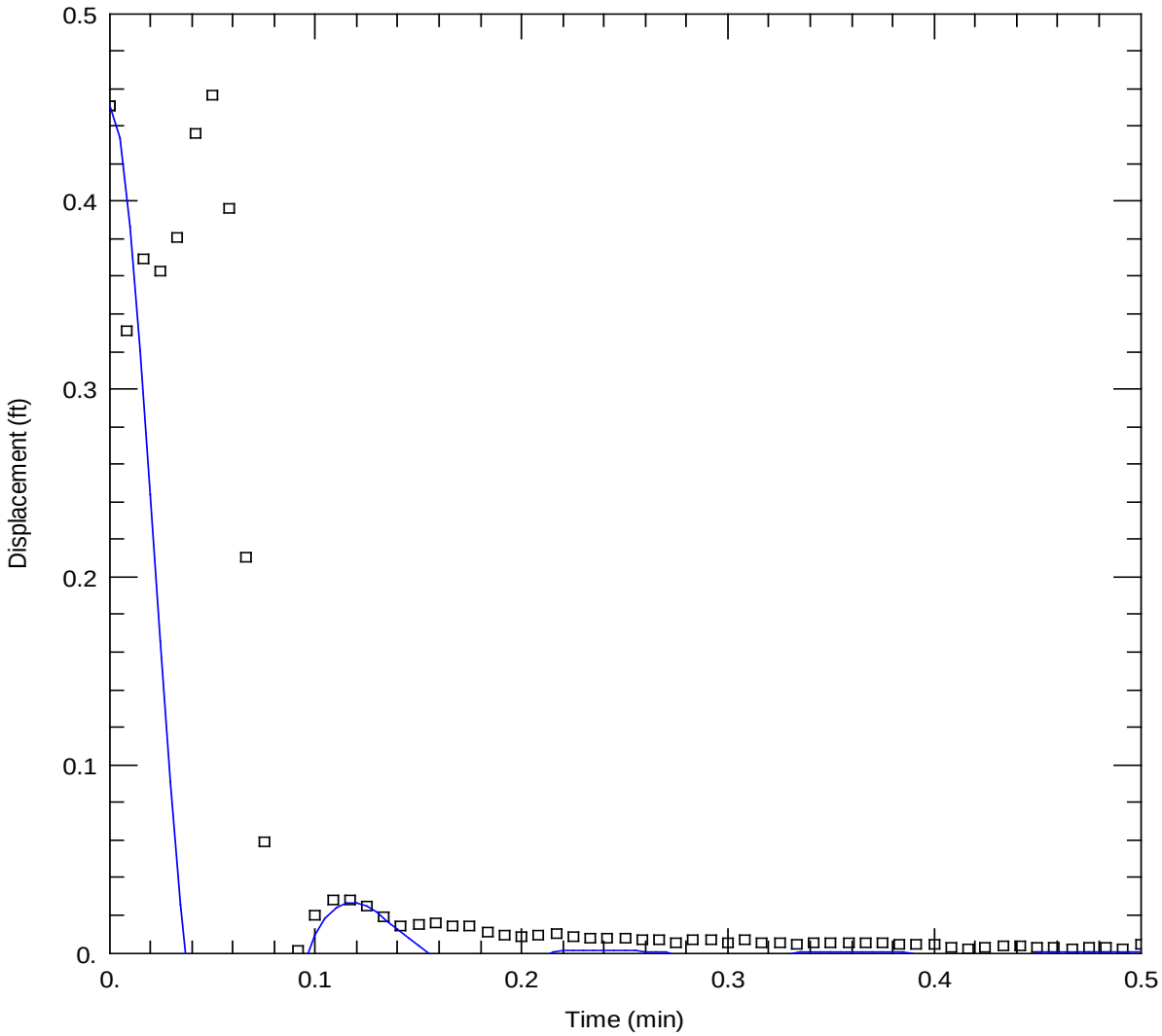
SLUG TEST RESULTS B-6w-13
RISING HEAD TEST 4
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-31

EXH. B-31



Obs. Wells
- B-6W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.06001 cm/sec
Le = 33.73 ft
C(D) = 0.4093
L = 10.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

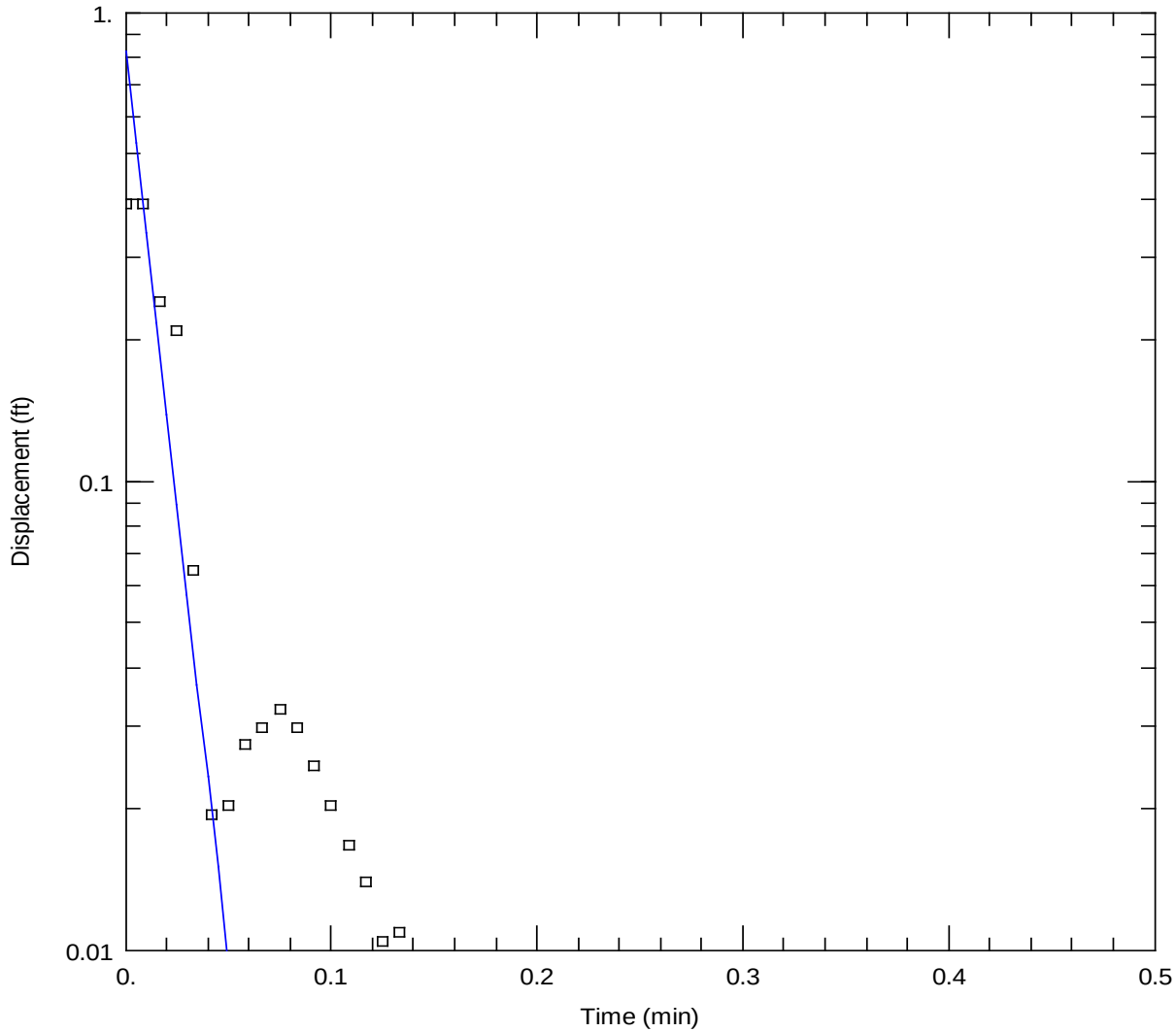
SLUG TEST RESULTS B-6w-13
RISING HEAD TEST 4
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-32

EXH. B-32



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.06285 cm/sec
y0 = 0.8245 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

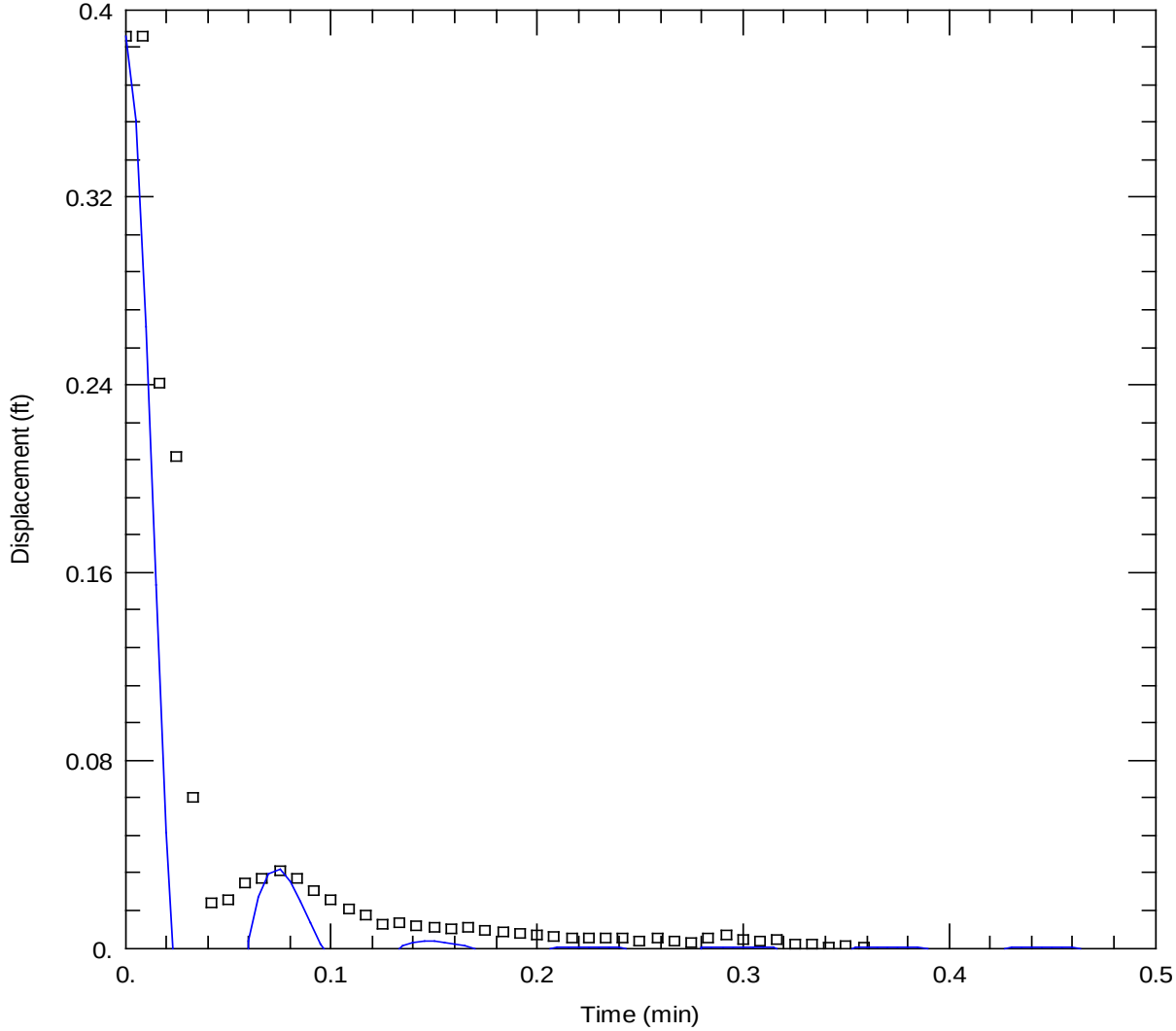
SLUG TEST RESULTS B-8w-13
FALLING HEAD TEST 1
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-33

EXH. B-33



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1214 cm/sec
Le = 13.74 ft
C(D) = 0.3628
L = 14.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-34

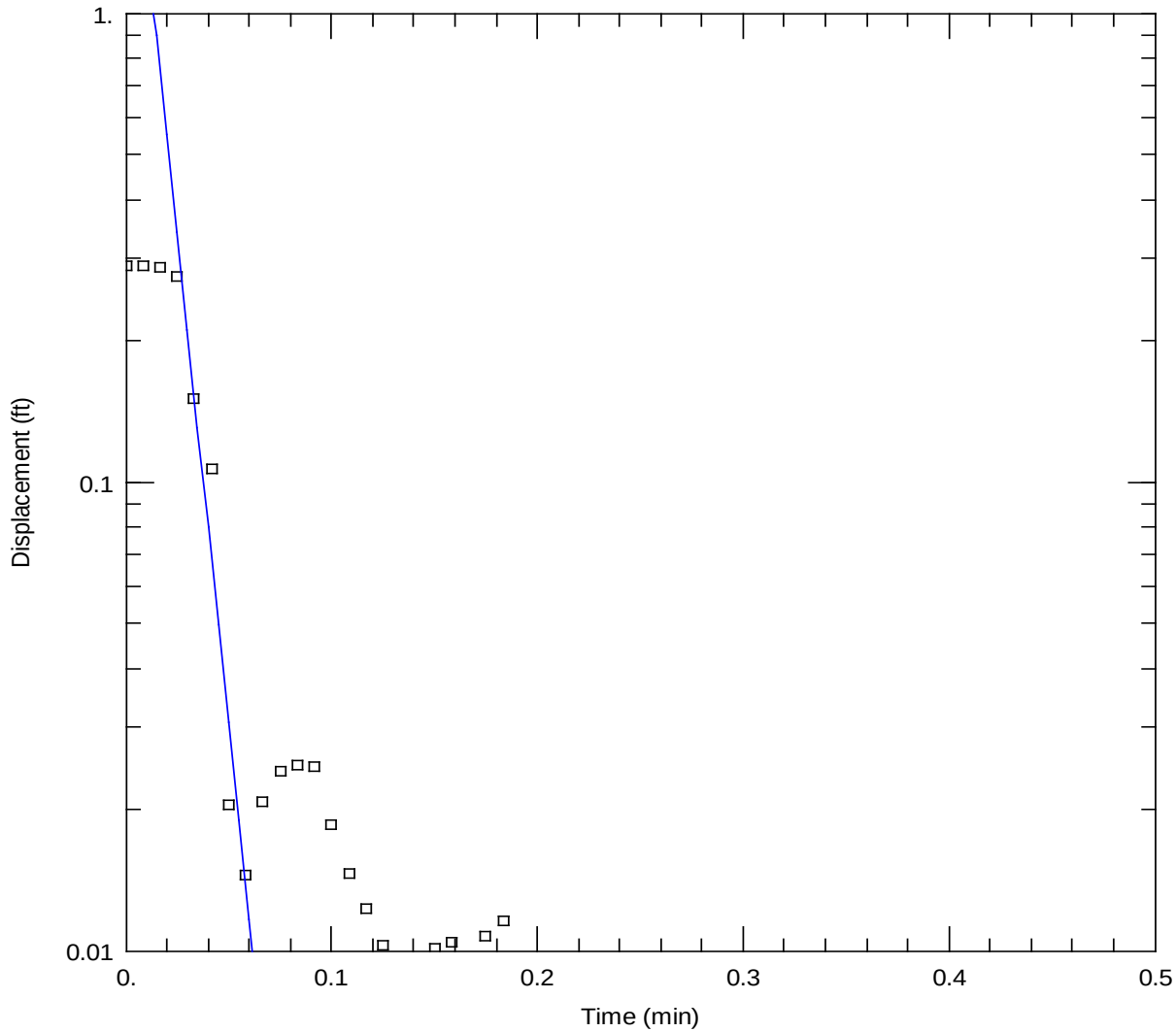
Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-8w-13
FALLING HEAD TEST 1
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-34



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.06807 cm/sec
y0 = 3.794 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

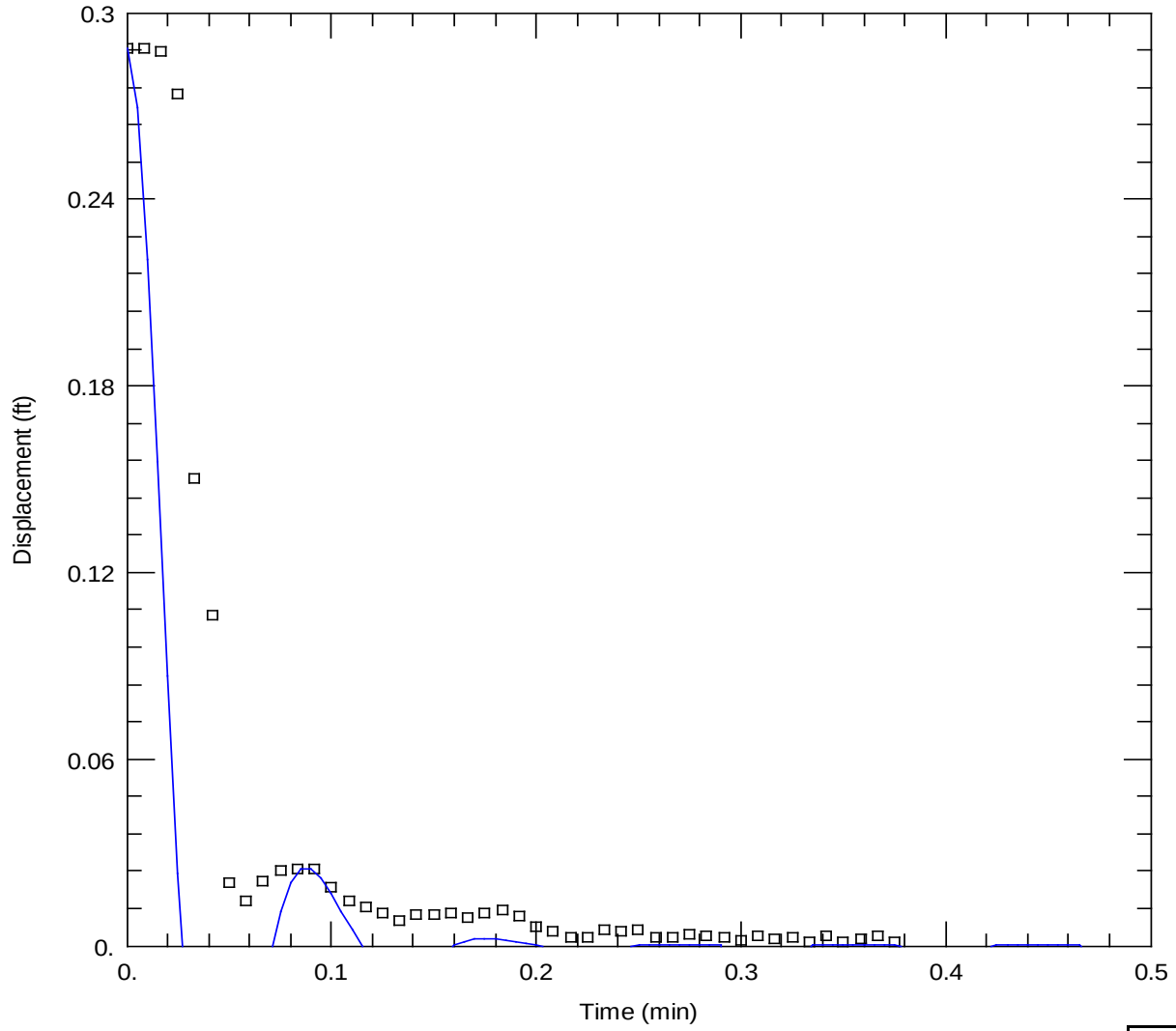
SLUG TEST RESULTS B-8w-13
FALLING HEAD TEST 2
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-35

EXH. B-35



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1019 cm/sec
Le = 19.65 ft
C(D) = 0.3614
L = 14.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

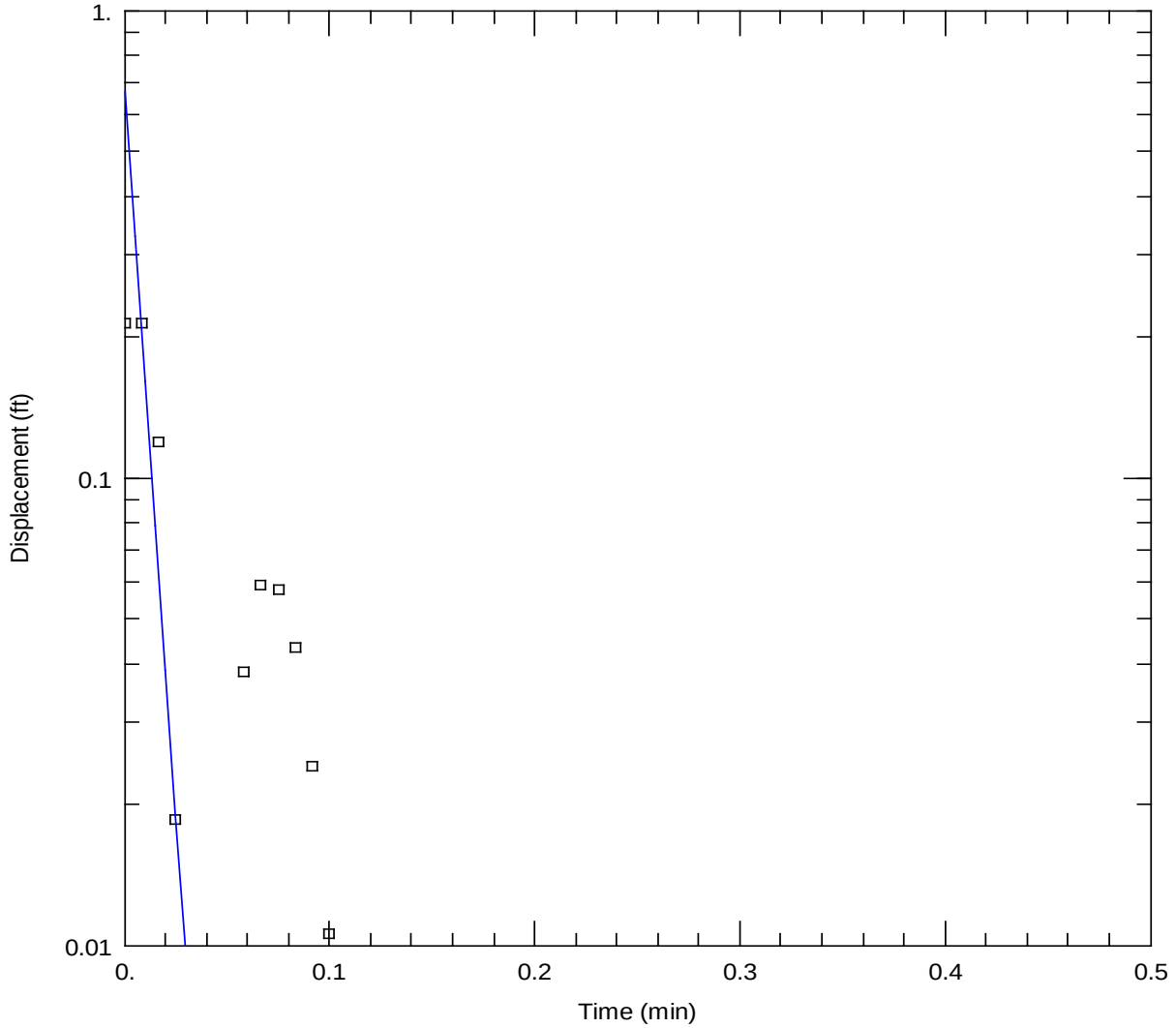
SLUG TEST RESULTS B-8w-13
FALLING HEAD TEST 2
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-36

EXH. B-36



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.1006 cm/sec
y0 = 0.6677 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

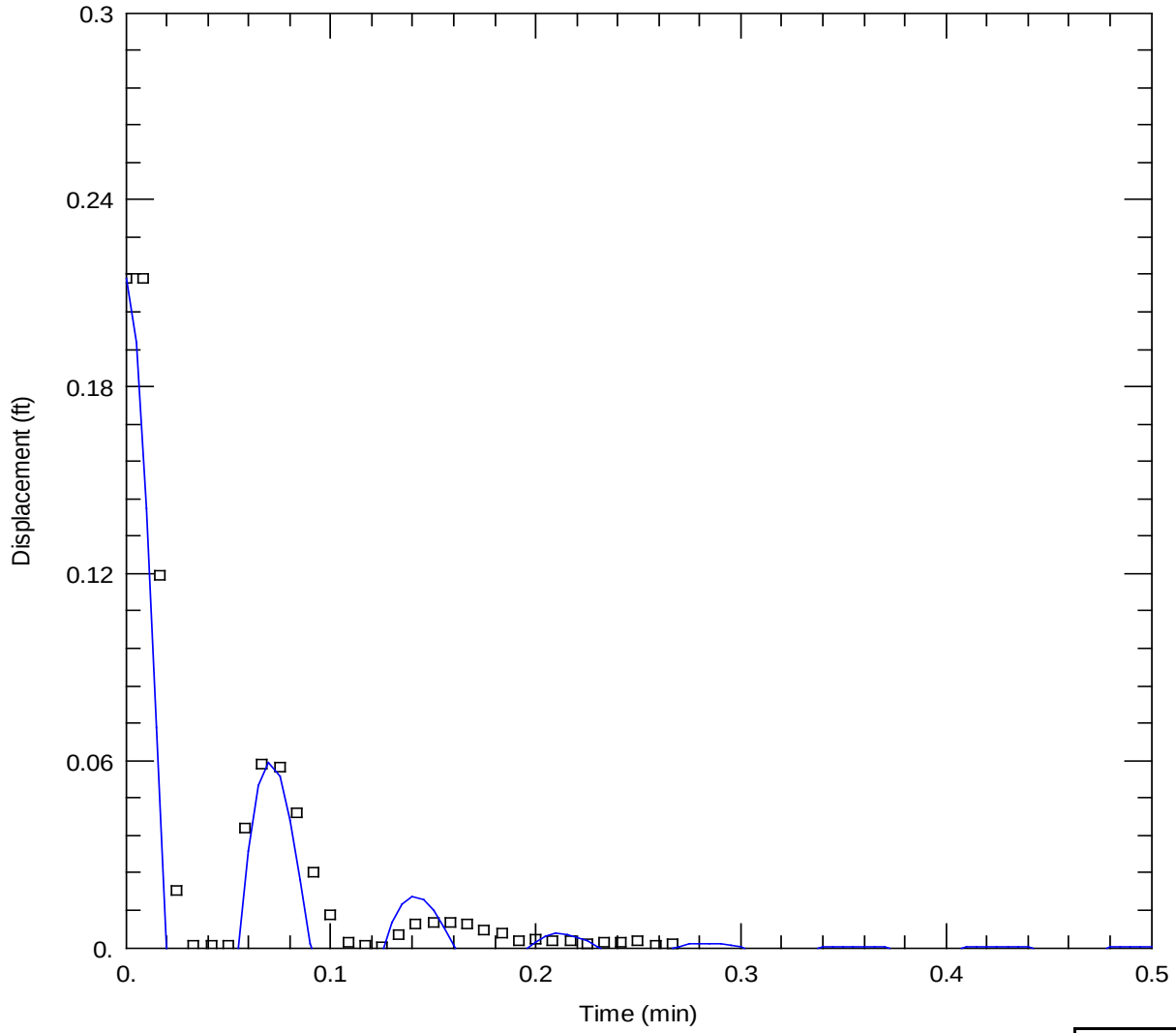
SLUG TEST RESULTS B-8w-13
FALLING HEAD TEST 3
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-37

EXH. B-37



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.2184 cm/sec
Le = 14. ft
C(D) = 0.1998
L = 14.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

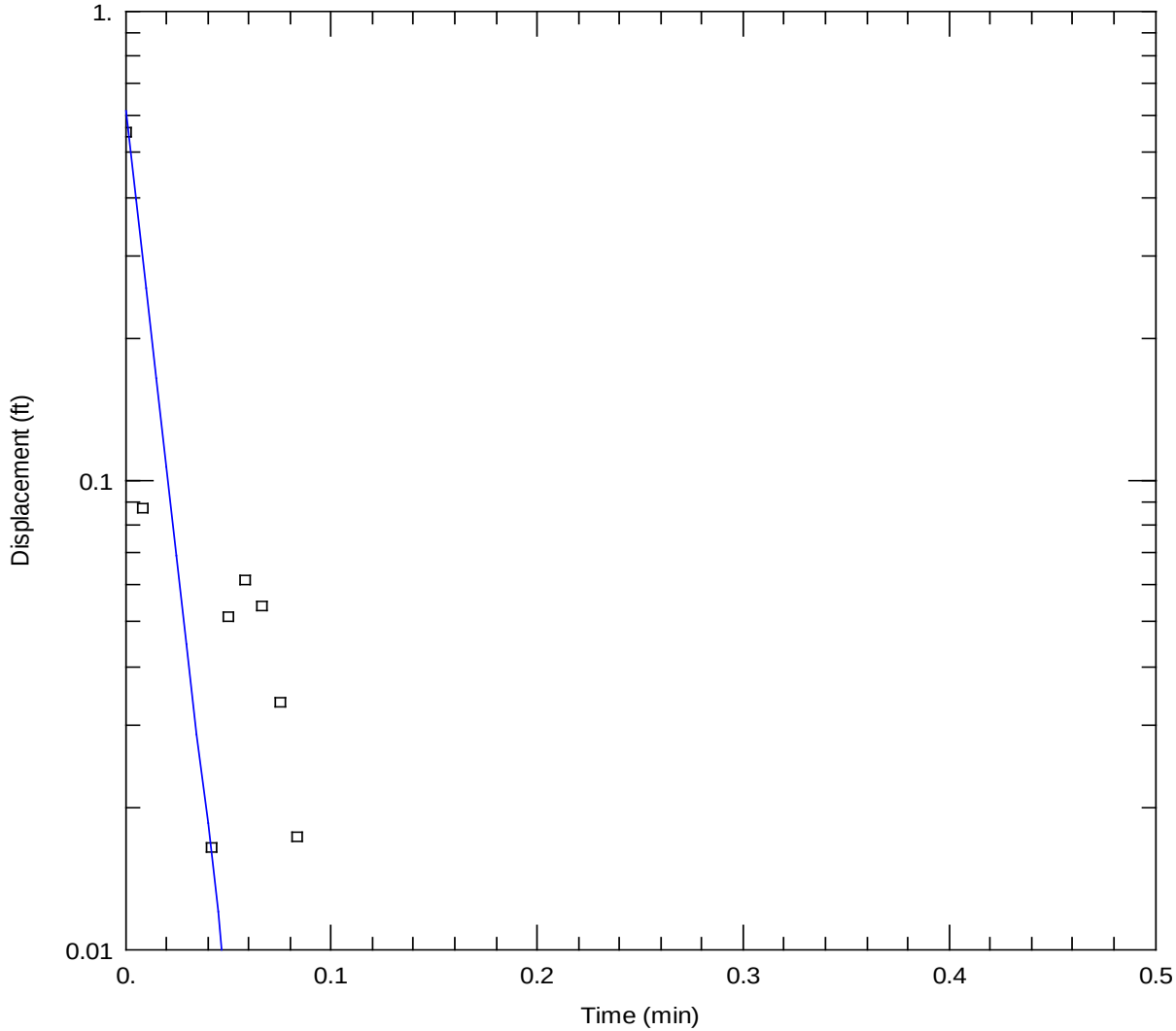
SLUG TEST RESULTS B-8w-13
FALLING HEAD TEST 3
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-38

EXH. B-38



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.06168 cm/sec
y0 = 0.6118 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

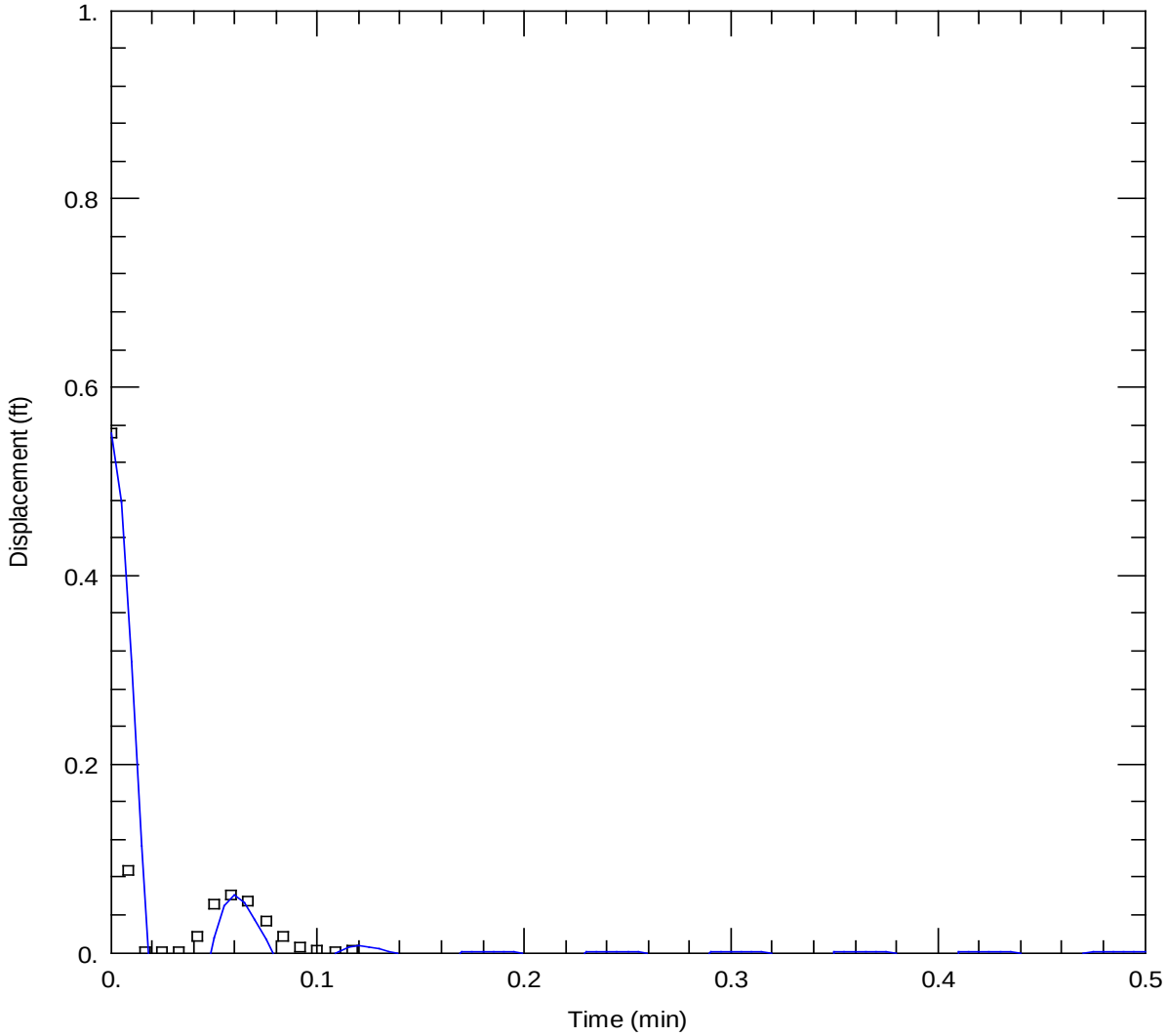
SLUG TEST RESULTS B-8w-13
FALLING HEAD TEST 4
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-39

EXH. B-39



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.16 cm/sec
Le = 9.472 ft
C(D) = 0.3316
L = 14.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

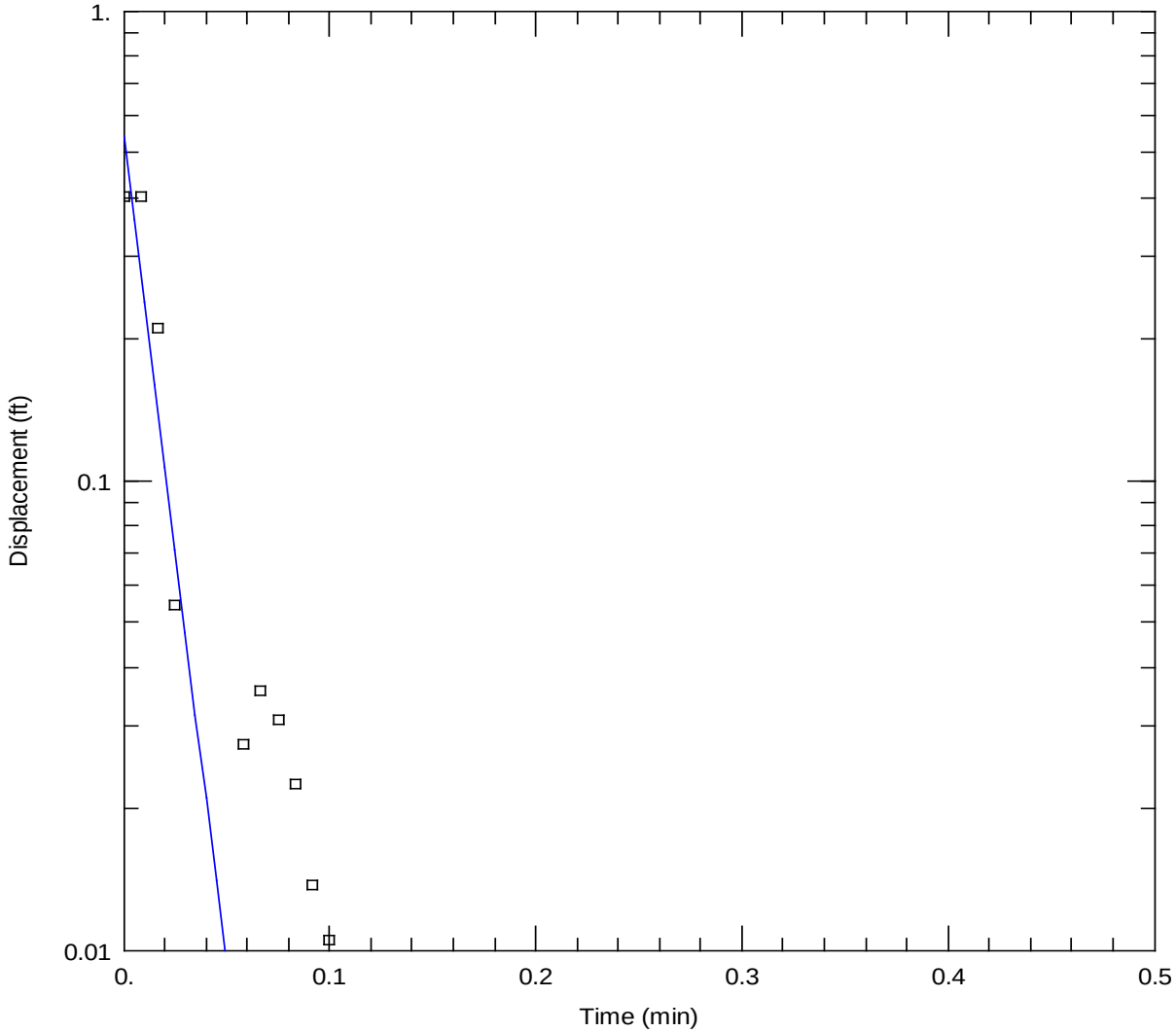
SLUG TEST RESULTS B-8w-13
FALLING HEAD TEST 4
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-40

EXH. B-40



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.05719 cm/sec
y0 = 0.5372 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

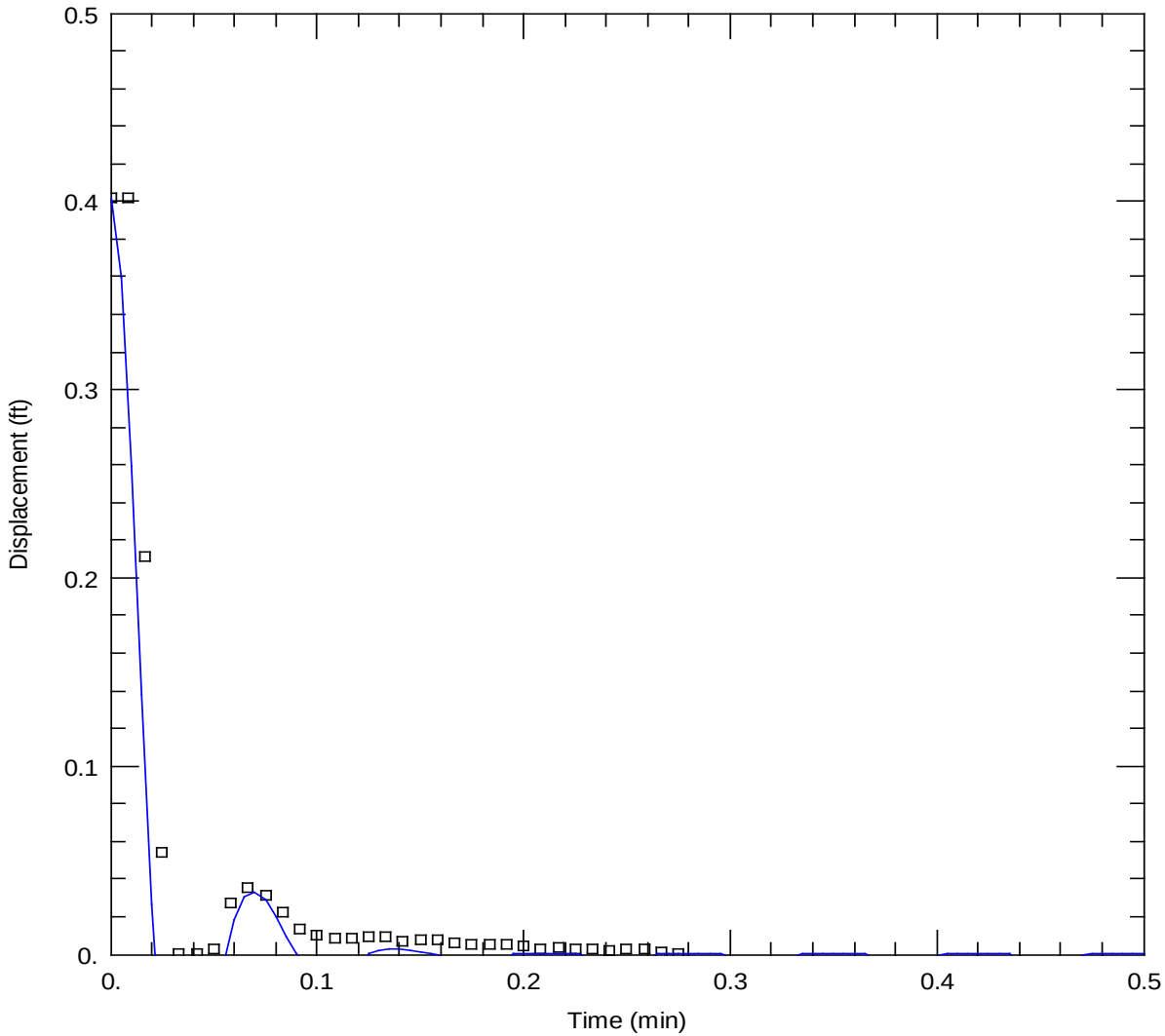
SLUG TEST RESULTS B-8w-13
RISING HEAD TEST 1
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-41

EXH. B-41



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1277 cm/sec
Le = 12.09 ft
C(D) = 0.3677
L = 14.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

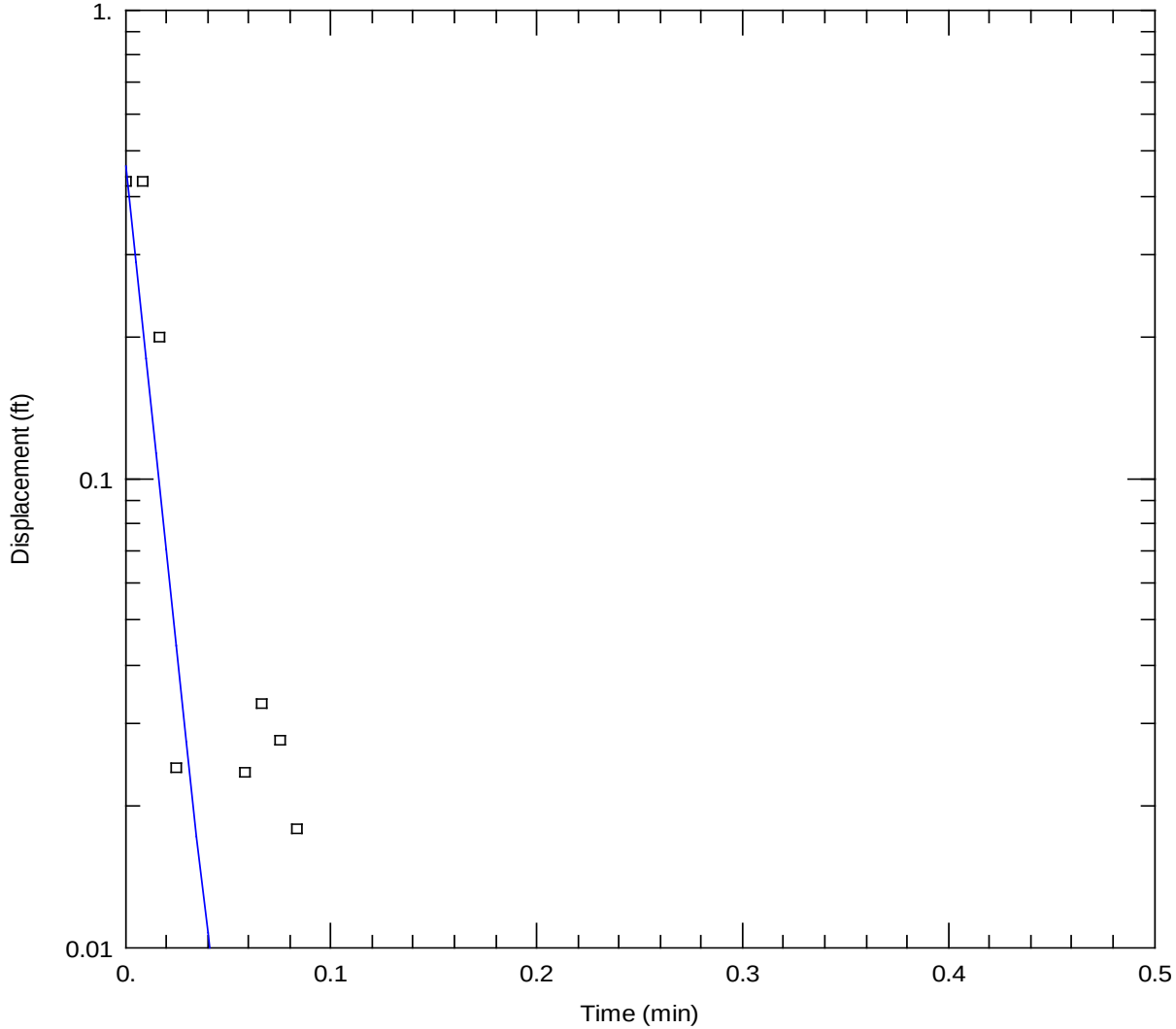
SLUG TEST RESULTS B-8w-13
RISING HEAD TEST 1
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-42

EXH. B-42



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.06646 cm/sec
y0 = 0.4626 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

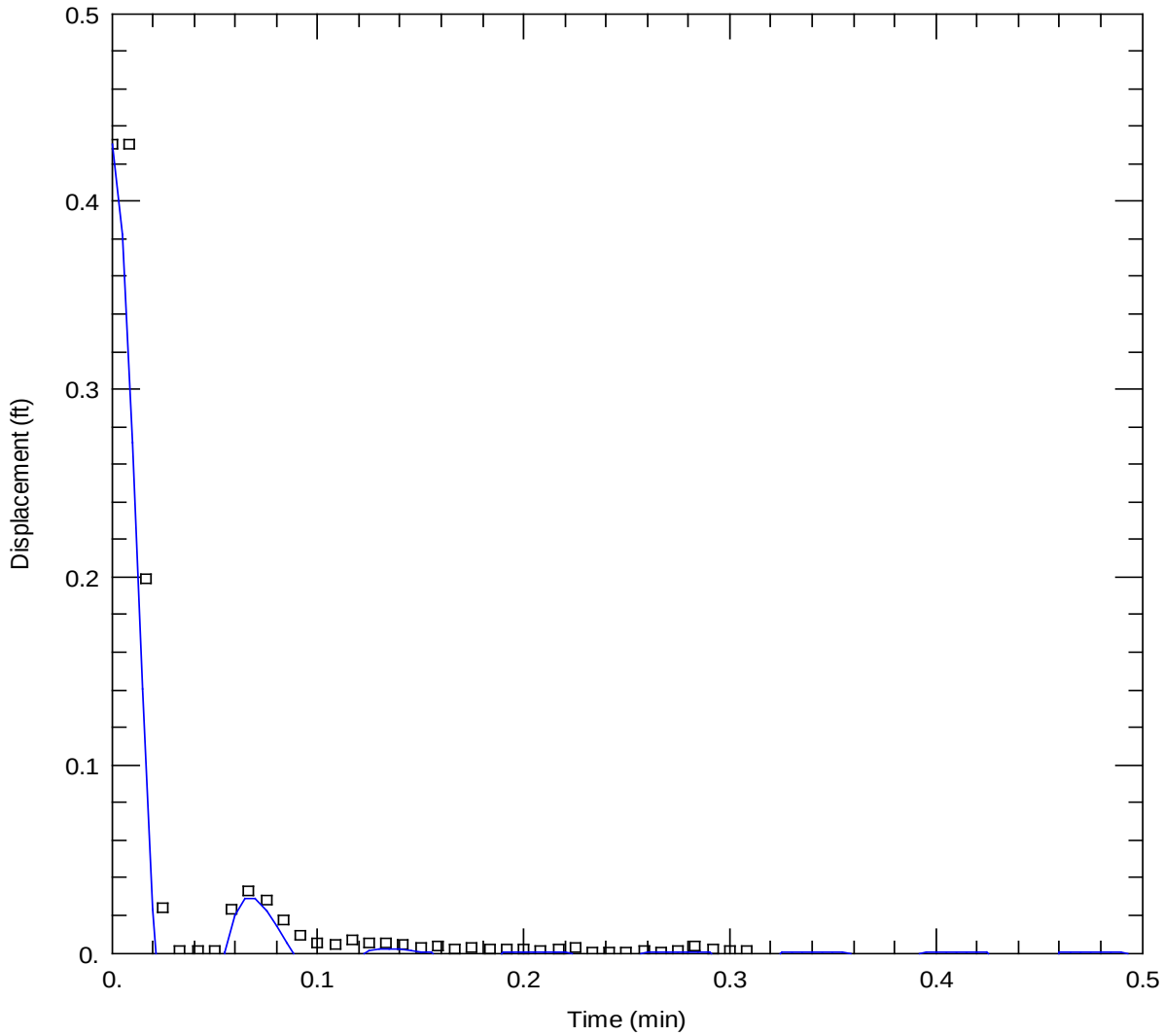
SLUG TEST RESULTS B-8w-13
RISING HEAD TEST 2
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-43

EXH. B-43



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1242 cm/sec
Le = 11.28 ft
C(D) = 0.3915
L = 14.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

EXH. B-44

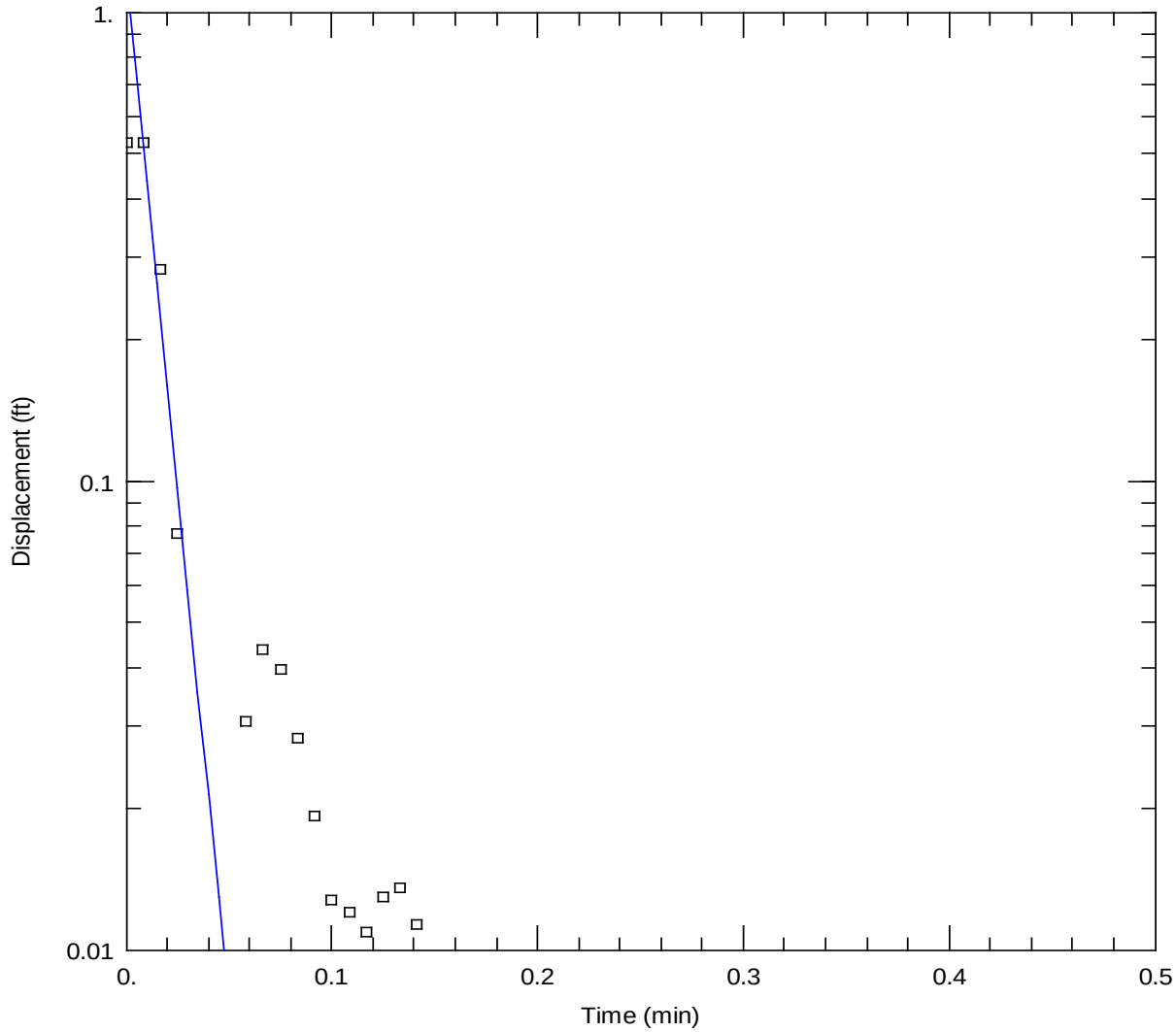
Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-8w-13
RISING HEAD TEST 2
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-44



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.0709 cm/sec
y0 = 1.189 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-8w-13
RISING HEAD TEST 3
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
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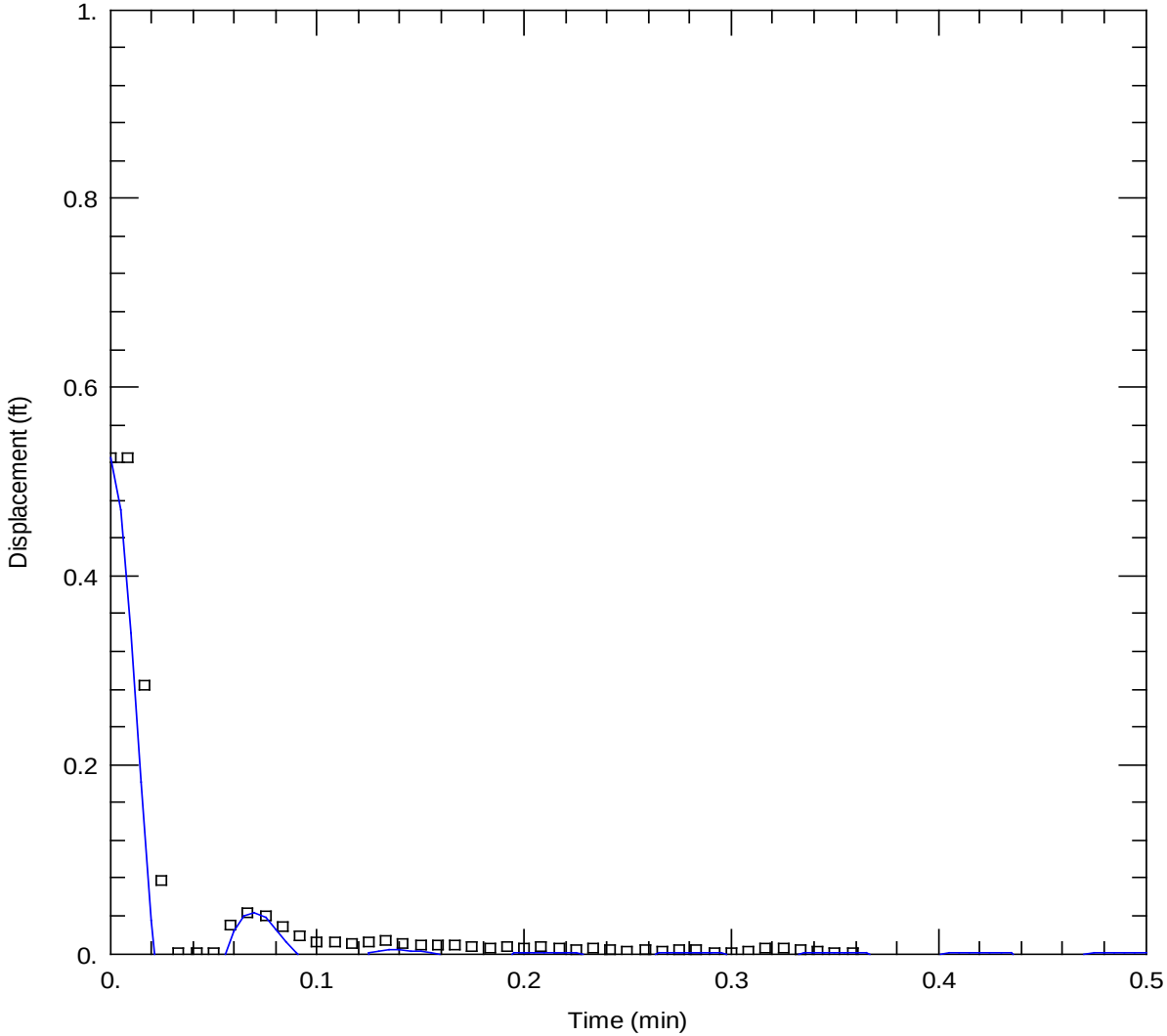
EXHIBIT B-45

EXH. B-45



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.1278 cm/sec
Le = 12.1 ft
C(D) = 0.3674
L = 14.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-8w-13
RISING HEAD TEST 3
BUTLER

May 2014 21-1-12318-215

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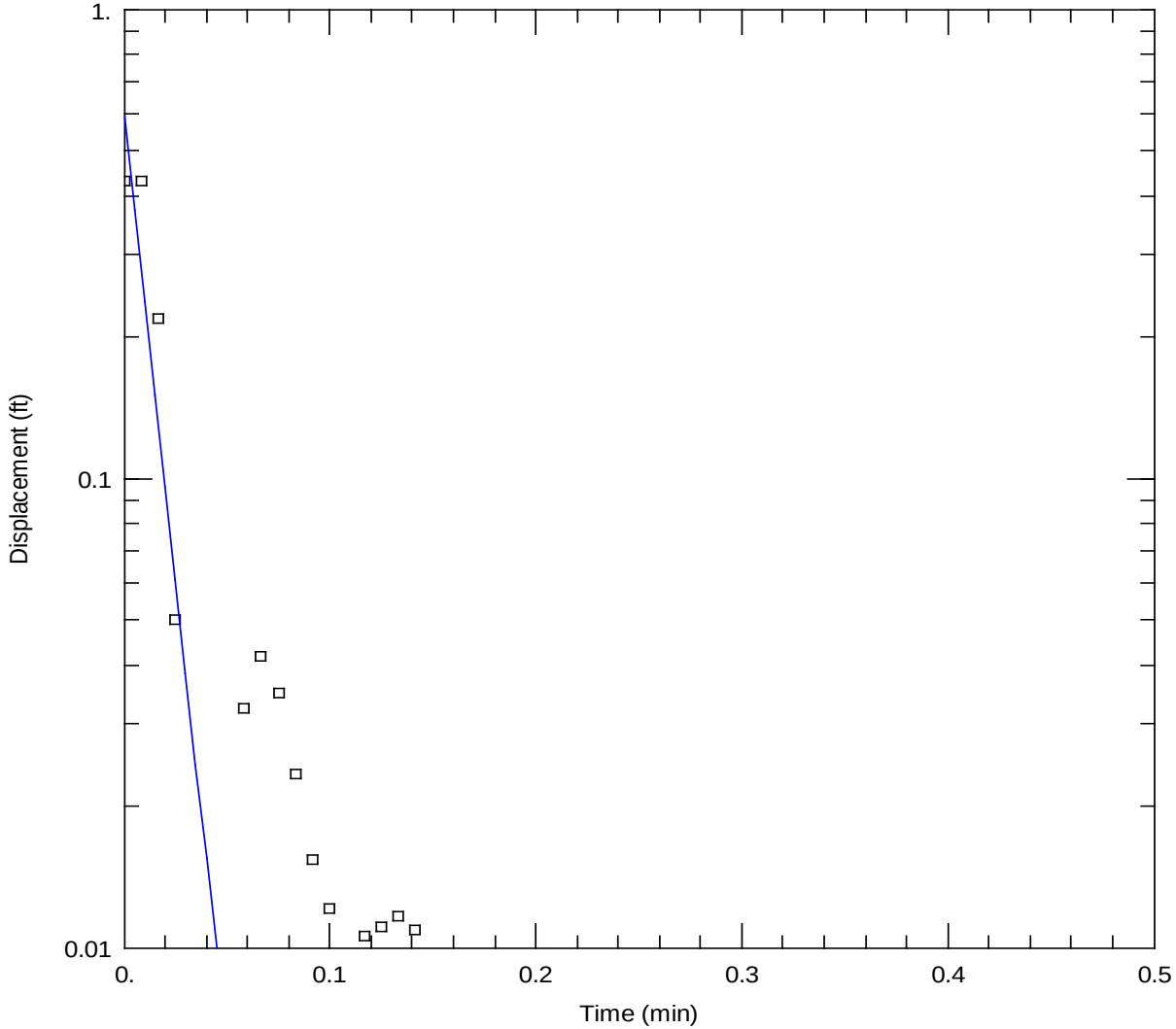
EXHIBIT B-46

EXH. B-46



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 0.06421 cm/sec
y0 = 0.5892 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Bouwer and Rice (1976)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

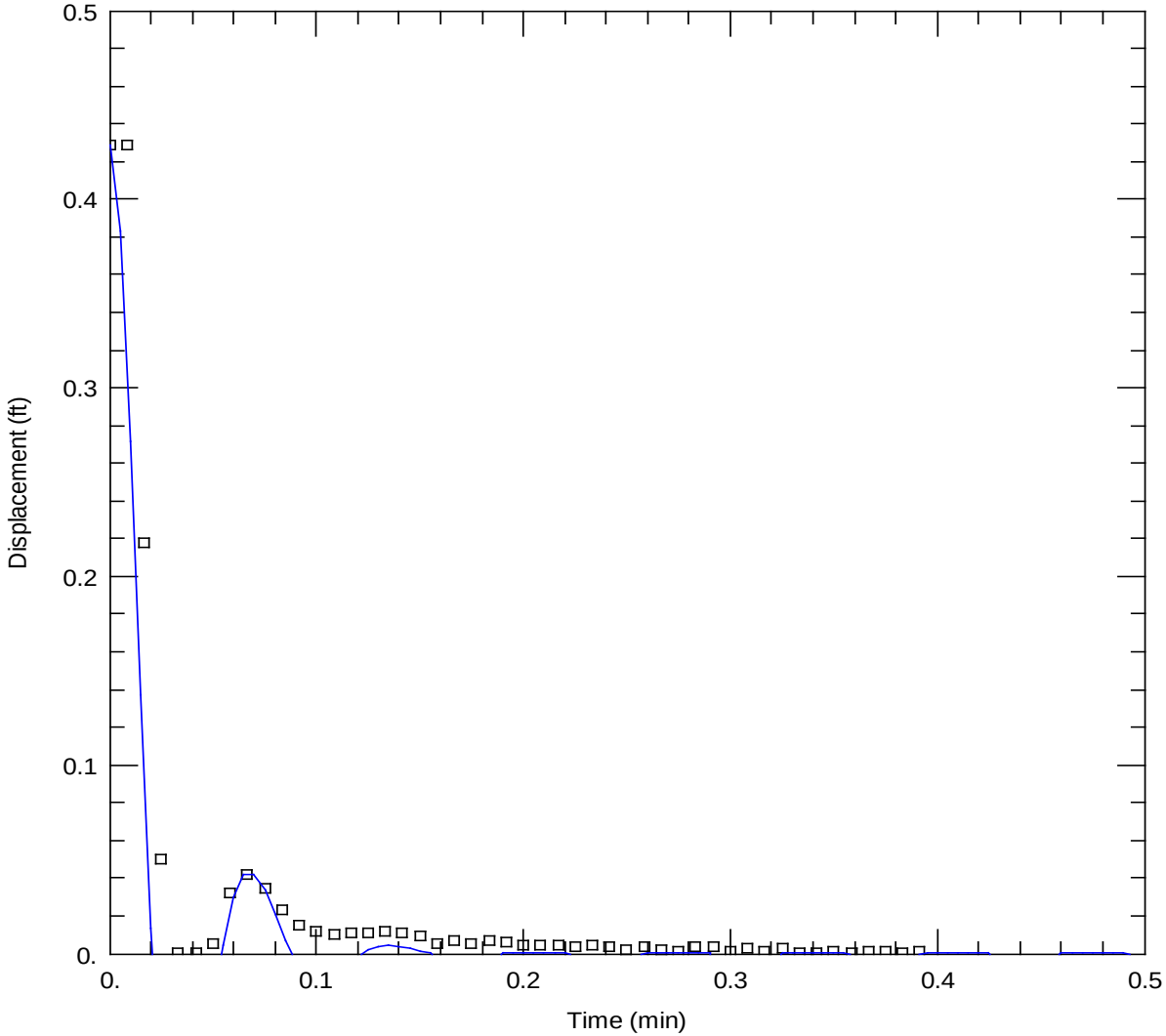
SLUG TEST RESULTS B-8w-13
RISING HEAD TEST 4
BOUWER AND RICE

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-47

EXH. B-47



Obs. Wells
- B-8W-13

Aquifer Model
Confined

Solution
Butler
Critically damped when C(D)=1

Parameters
K = 0.139 cm/sec
Le = 11.77 ft
C(D) = 0.3424
L = 14.2 ft

NOTES

1. Observed test data represented by squares in plot
2. Modeled line in plot is selected based on Butler (1998)

cm= centimeters
ft = feet
min = minute
sec = second

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

SLUG TEST RESULTS B-8w-13
RISING HEAD TEST 4
BUTLER

May 2014 21-1-12318-215

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

EXHIBIT B-48

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APPENDIX C

GEOTECHNICAL LABORATORY TESTING

APPENDIX C

GEOTECHNICAL LABORATORY TESTING

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TABLE C-1
LABORATORY TESTING SUMMARY

Exploration	Sample Number	Top Depth (feet)	Water Content (%)	Organic Content (%)	Percent Gravel	Percent Sand	Percent Fines[1]	Percent Smaller Than 2 micron	LL[2]	PL[3]	PI[4]	OLL[5]	OLL/LL (%)[2,5]	CU[6] Test Performed	Consolidation[7] Test Performed	Moisture-Density Test Performed	USCS[8]	Interpreted Geologic Unit[9]	Soil Description[10]
B-1-13	1	0.0	23.8														ML	Agricultural layer	
B-1-13	2	2.5	55.4														ML	Hm	
B-1-13	3	5.0	40.2														SP-SM	Ha	
B-1-13	4	7.5	29.7														SP-SM	Ha	
B-1-13	5	10.0	26.8		0	96	4.1										SP	Ha	Gray, fine to medium SAND, trace of silt
B-1-13	6	12.5	33.4														SP-SM	Ha	
B-1-13	7	15.0	58.6														SM	Ha	
B-1-13	9	20.0	34.8		2	61	36.3	5									SM	Ha	Gray, silty, fine to medium SAND (+ No. 10 material mostly composed of shell fragments)
B-1-13	10	25.0	37.4														SM	Ha	
B-1-13	11	26.7	41.5											X			ML	He	Gray, fine sandy SILT, trace of clay; scattered fine organics, scattered shells
B-1-13	11	27.2	44.4						28	27	1			X			ML	He	Gray, fine sandy SILT, trace of clay; scattered fine organics, scattered shells
B-1-13	11	27.7	39.7			11	89.5	11									ML	He	Gray, slightly fine sandy SILT, trace of clay
B-1-13	11	28.0	42.0												X		ML	He	Gray-brown SILT, trace of sand and clay
B-1-13	12	29.0	42.9			36	63.8	11	30	26	4						ML	He	Gray-brown, slightly fine sandy, slightly clayey SILT
B-1-13	13	35.0	37.7			75	25.2	4									SM	Ha	Gray-brown, silty, fine SAND (+ No. 10 material composed of one shell)
B-1-13	14	40.0	36.7														SM	Ha	
B-1-13	15	45.0	42.5														ML	He	
B-1-13	16	50.0	63.7														MH	He	
B-1-13	17	55.0	55.8			8	91.8	20	56	30	26						MH	He	Gray-brown, clayey SILT
B-1-13	18	60.0	69.1														MH	He	
B-1-13	19	65.0	66.0														MH	He	
B-1-13	20	70.0	56.6														MH	He	
B-1-13	21	75.0	52.7														MH	He	
B-1-13	22	80.0	27.1														SM	He	

TABLE C-1
LABORATORY TESTING SUMMARY

Exploration	Sample Number	Top Depth (feet)	Water Content (%)	Organic Content (%)	Percent Gravel	Percent Sand	Percent Fines[1]	Percent Smaller Than 2 micron	LL[2]	PL[3]	PI[4]	OLL[5]	OLL/LL (%)[2,5]	CU[6] Test Performed	Consolidation[7] Test Performed	Moisture-Density Test Performed	USCS[8]	Interpreted Geologic Unit[9]	Soil Description[10]
B-2-13	1	0.0	25.4														ML	Agricultural layer	
B-2-13	2	2.5	60.1			4	96.4	13	61	37	24						MH	Hm	Gray-brown, clayey SILT, trace of fine sand
B-2-13	3	5.0	72.2														SP	Ha	
B-2-13	4	7.5	22.4		1	95	4.9										SP	Ha	Dark gray SAND, trace of silt
B-2-13	5	10.0	26.7														SP	Ha	
B-2-13	6	12.5	23.0														SP	Ha	
B-2-13	7	15.0	22.4														SP	Ha	
B-2-13	8	17.5	25.1														SP	Ha	
B-2-13	9	20.0	36.3														SM	Ha	
B-2-13	10	25.0	33.9														SM	Ha	
B-2-13	11	30.0	30.1			90	9.9										SP-SM	Ha	Gray-brown, slightly silty, fine SAND
B-2-13	12	35.0	36.2														SM	Ha	
B-2-13	13	40.0	40.0			13	86.8	9									ML	Ha	Gray-brown, fine sandy SILT
B-3-13	1	0.0	24.7														ML	Agricultural layer	
B-3-13	2	2.5	50.9			22	78	2									ML	Hm	Dark gray-brown, fine to medium sandy SILT; abundant organics
B-3-13	3	5.0	28.7														SP	Ha	
B-3-13	4	7.5	24.8														SP	Ha	
B-3-13	5	10.0	25.5														SP	Ha	
B-3-13	6	12.5	26.8		0	96	3.9										SP	Ha	Dark gray-brown, fine to medium SAND, trace of silt
B-3-13	7	15.0	42.0														SP	Ha	
B-3-13	8	17.5	29.8														SP	Ha	
B-3-13	9	20.0	27.5														SP	Ha	
B-3-13	10	25.0	44.1														ML	He	
B-3-13	11	30.0	35.4			27	72.7	8	28	27	1						ML	He	Dark gray-brown, fine sandy SILT, trace of clay
B-3-13	12	35.0	34.1		1	66	33.6	4.2									SM	He	Dark gray-brown, silty, fine SAND (+ No. 10 material mostly composed of shell fragments)
B-3-13	13	40.0	39.0														ML	He	

TABLE C-1
LABORATORY TESTING SUMMARY

Exploration	Sample Number	Top Depth (feet)	Water Content (%)	Organic Content (%)	Percent Gravel	Percent Sand	Percent Fines[1]	Percent Smaller Than 2 micron	LL[2]	PL[3]	PI[4]	OLL[5]	OLL/LL (%)[2,5]	CU[6] Test Performed	Consolidation[7] Test Performed	Moisture-Density Test Performed	USCS[8]	Interpreted Geologic Unit[9]	Soil Description[10]
B-4w-13	1	0.0	31.8														ML	Agricultural layer	
B-4w-13	2	2.0	39.4														ML	Agricultural layer	
B-4w-13	2	2.2	40.0						39	31	8				X		ML	Agricultural layer	Gray-brown, slightly clayey SILT; silty fine sand laminations, trace of organics
B-4w-13	3	4.0	28.4														SP-SM	Ha	
B-4w-13	4	7.5	28.6														SP-SM	Ha	
B-4w-13	5	10.2	32.9														SP-SM	Ha	
B-4w-13	5	10.5	25.9		0	97	3.0										SP	Ha	Dark gray-brown, fine to medium SAND, trace of silt
B-4w-13	6	12.5	19.9		1	94	5.6										SP-SM	Ha	Dark gray-brown, slightly silty SAND, trace of fine gravel
B-4w-13	7	15.0	24.3														SP-SM	Ha	
B-4w-13	8	17.5	22.5														SP-SM	Ha	
B-4w-13	8	18.5	29.5														SM	He	
B-4w-13	9	20.0	28.2														SM	He	
B-5w-13	1	3.0	33.7			33	66.5	8									ML	Agricultural layer	Gray-brown, fine to medium sandy SILT
B-6w-13	1	0.0	30.6														ML	Agricultural layer	
B-6w-13	2	2.5	37.9														ML	Agricultural layer	
B-6w-13	3	5.0	28.1														ML	Agricultural layer	
B-6w-13	3	6.0	25.3														SP	Ha	
B-6w-13	4	7.5	26.9														SP	Ha	
B-6w-13	5	10.0	19.8														SP	Ha	
B-6w-13	6	12.5	24.2		0	98	1.9										SP	Ha	Dark gray SAND, trace of silt
B-6w-13	7	15.0	22.2														SP	Ha	
B-6w-13	8	17.5	22.4														SP	Ha	
B-6w-13	8	18.5	46.4														SM	He	
B-6w-13	9	20.0	29.6														SM	He	
B-7w-13	1	3.0	47.8			14	85.5	9									ML	Agricultural layer	Gray-brown, slightly clayey, fine sandy SILT

TABLE C-1
LABORATORY TESTING SUMMARY

Exploration	Sample Number	Top Depth (feet)	Water Content (%)	Organic Content (%)	Percent Gravel	Percent Sand	Percent Fines[1]	Percent Smaller Than 2 micron	LL[2]	PL[3]	PI[4]	OLL[5]	OLL/LL (%)[2,5]	CU[6] Test Performed	Consolidation[7] Test Performed	Moisture-Density Test Performed	USCS[8]	Interpreted Geologic Unit[9]	Soil Description[10]
B-8w-13	1	0.0	46.2														ML	Agricultural layer	
B-8w-13	2	2.5	42.1														ML	Agricultural layer	
B-8w-13	2	3.0	40.8														SP	Ha	
B-8w-13	3	5.0	30.2														SP	Ha	
B-8w-13	4	7.5	27.4														SP	Ha	
B-8w-13	5	10.0	23.5		2	92	6.2										SP-SM	Ha	Dark gray-brown, slightly silty SAND, trace of fine gravel
B-8w-13	6	12.5	49.7														SP	Ha	
B-8w-13	7	15.0	31.3			97	3.5										SP	Ha	Dark gray-brown, fine to medium SAND, trace of silt; abundant organics
B-8w-13	8	17.5	23.3														SP	Ha	
B-8w-13	9	20.0	30.6														SP	Ha	
B-9w-13	1	2.0	43.2			14	85.9	13									ML	Agricultural layer	Gray-brown, slightly clayey, fine to medium sandy SILT; abundant organics
TP-1-13	1	1.0	44.0			7	93.3	13	44	31	13						ML	Hm	Brown, slightly clayey SILT
TP-1-13	2	2.9	54.4															Hm	
TP-1-13	3	4.0	33.5															Ha	
TP-2-13	1	0.5	21.2															Agricultural layer	
TP-2-13	2	2.0	28.6															Hm	
TP-2-13	3	3.5	26.3		1	98	1.8										SP	Ha	Dark gray, fine to medium SAND, trace of silt
TP-3-13	1	1.0	44.6															Hm	
TP-3-13	2	3.5	49.4			11	88.5	8									ML	Hm	Dark gray, slightly fine sandy SILT, trace of clay
TP-3-13	3	5.5	37.1															Ha	
TP-4-13	1	2.0	25.2			3	97.0	20								X	ML	Agricultural layer	Brown, clayey SILT, trace of fine sand
TP-4-13	2	4.0	45.5															Hm	
TP-4-13	3	5.0	48.5															Ha	
TP-5-13	1	1.0	30.2															Agricultural layer	
TP-5-13	2	3.5	30.1			85	14.6										SM	Ha	Gray-brown, silty, fine to medium SAND
TP-6-13	1	0.5	29.3															Agricultural layer	
TP-6-13	2	2.5	54.2			15	85.4	6									ML	Hm	Gray-brown, fine to medium sandy SILT
TP-6-13	3	4.0	32.0															Ha	
TP-7-13	1	1.0	24.6															Agricultural layer	
TP-7-13	2	2.5	41.1			19	80.9	5									ML	Hm	Gray-brown, fine to medium sandy SILT
TP-7-13	3	4.5	24.5															Ha	

TABLE C-1
LABORATORY TESTING SUMMARY

Exploration	Sample Number	Top Depth (feet)	Water Content (%)	Organic Content (%)	Percent Gravel	Percent Sand	Percent Fines[1]	Percent Smaller Than 2 micron	LL[2]	PL[3]	PI[4]	OLL[5]	OLL/LL (%)[2,5]	CU[6] Test Performed	Consolidation[7] Test Performed	Moisture-Density Test Performed	USCS[8]	Interpreted Geologic Unit[9]	Soil Description[10]
TP-8-13	1	1.0	26.8															Agricultural layer	
TP-8-13	2	2.0	48.2															Hm	
TP-8-13	3	4.0	41.4			47	53.3	3									ML	Hm	Gray, fine sandy SILT (+ No. 40 material mostly composed of organics)
TP-9-13	1	0.5	32.9															Agricultural layer	
TP-9-13	2	3.0	43.3			29	71.2	4									ML	Hm	Gray, fine to medium sandy SILT
TP-9-13	3	4.0	29.7															Ha	
TP-10-13	1	0.5	29.7															Agricultural layer	
TP-10-13	2	2.5	46.7	2.7												X		Hm	Gray-brown, slightly fine sandy, clayey SILT
TP-10-13	3	5.0	23.0		0	90	10.1										SW-SM	Ha	Dark gray, slightly silty, fine to medium SAND
TP-11-13	1	1.0	21.1															Agricultural layer	
TP-11-13	2	2.0	42.8															Hm	
TP-11-13	3	3.5	30.9			94	6.1	0									SP-SM	Ha	Dark gray-brown, slightly silty, fine SAND
TP-12-13	1	1.0	20.7															Agricultural layer	
TP-12-13	2	2.5	19.5															Ha	
TP-13-13	1	0.5	22.1															Agricultural layer	
TP-13-13	2	1.5	36.8															Hm	
TP-13-13	3	3.5	40.7			88	11.7										SP-SM	Ha	Gray-brown, slightly silty, fine SAND (+ No. 40 material mostly composed of organics)
TP-14-13	1	1.0	38.9															Agricultural layer	
TP-14-13	2	3.5	41.4															Hm	
TP-14-13	3	6.0	76.7			7	93.0	10	54	36	18	34	63%				OH	Hm	Dark gray, organic SILT (Oven-Dried Liquid Limit 63% of Natural Liquid Limit)
TP-15-13	1	1.0	48.3															Agricultural layer	
TP-15-13	2	3.5	21.0			94	6.1										SP-SM	Ha	Dark gray, slightly silty, fine to medium SAND
TP-16-13	1	0.5	28.7															Agricultural layer	
TP-16-13	2	2.0	59.0			12	87.6										ML	Hm	Gray, slightly clayey, fine to medium sandy SILT (+ No. 200 material mostly composed of organics)
TP-16-13	3	3.5	29.0															Ha	
TP-17-13	1	0.0	36.2															Agricultural layer	
TP-17-13	2	2.0	56.9															Hm	
TP-17-13	3	3.0	34.1			77	23.0										SM	Ha	Dark gray, silty, fine to medium SAND

TABLE C-1
LABORATORY TESTING SUMMARY

Exploration	Sample Number	Top Depth (feet)	Water Content (%)	Organic Content (%)	Percent Gravel	Percent Sand	Percent Fines[1]	Percent Smaller Than 2 micron	LL[2]	PL[3]	PI[4]	OLL[5]	OLL/LL (%)[2,5]	CU[6] Test Performed	Consolidation[7] Test Performed	Moisture-Density Test Performed	USCS[8]	Interpreted Geologic Unit[9]	Soil Description[10]
TP-18-13	1	0.0	7.3															Dike Fill	
TP-18-13	2	2.0	43.4			7	93.4										ML	Dike Fill	Gray-brown, slightly fine sandy SILT, trace of clay (+ No. 60 material mostly composed of organics)
TP-18-13	3	7.0	64.5															Hm	
TP-19-13	1	0.0	4.0															Dike Fill	
TP-19-13	2	1.0	28.5			9	91.0										ML	Dike Fill	Gray-brown, slightly fine to medium sandy SILT (+ No. 60 material mostly composed of organics)
TP-19-13	3	1.5	5.7															Dike Fill	
TP-19-13	4		74.3															Hm	
TP-20-13	1	0.3	1.9															Dike Fill	
TP-20-13	2	1.0	18.3															Dike Fill	
TP-20-13	3	2.0	52.4															Dike Fill	
TP-20-13	4	7.5	58.9						55	34	21						MH	Hm	Dark gray, clayey SILT
TP-21-13	1	0.0	9.5															Dike Fill	
TP-21-13	2	3.0	50.8			7	93.0										ML	Dike Fill	Gray, slightly fine sandy, slightly clayey SILT (+ No. 100 material mostly composed of organics)
TP-21-13	3	6.0	47.1															Hm	
TP-22-13	1	1.0	5.4															Dike Fill	
TP-22-13	2	3.0	11.7		18	44	38.3										SM	Dike Fill	Gray, fine gravelly, silty SAND
TP-22-13	3	8.0	51.5															Hm	
TP-23-13	1	0.5	3.7															Dike Fill	
TP-23-13	2	5.0	49.8															Dike Fill	
TP-23-13	3	8.5	67.8			3	96.5	16									ML	Hm	Dark gray, slightly clayey SILT, trace of fine to medium sand
TP-24-13	1	0.5	1.9															Dike Fill	
TP-24-13	2	2.0	32.3			11	89.3										MH	Dike Fill	Gray-brown, slightly fine to medium sandy, clayey SILT (+ No. 60 material mostly composed of organics)
TP-24-13	3	7.0	54.7															Hm	
TP-25-13	1	0.0	5.9															Dike Fill	
TP-25-13	2	3.0	30.2						53	36	17						MH	Dike Fill	Gray-brown, slightly fine sandy, clayey SILT
TP-25-13	3	6.0	78.9															Hm	
TP-26-13	1	0.0	3.7															Dike Fill	
TP-26-13	2	1.0	13.2															Dike Fill	
TP-26-13	3	3.0	49.2			7	93.0	17									ML	Dike Fill	Gray, slightly fine to medium sandy SILT
TP-26-13	4	6.5	55.5															Hm	

TABLE C-1
LABORATORY TESTING SUMMARY

Exploration	Sample Number	Top Depth (feet)	Water Content (%)	Organic Content (%)	Percent Gravel	Percent Sand	Percent Fines[1]	Percent Smaller Than 2 micron	LL[2]	PL[3]	PI[4]	OLL[5]	OLL/LL (%)[2,5]	CU[6] Test Performed	Consolidation[7] Test Performed	Moisture-Density Test Performed	USCS[8]	Interpreted Geologic Unit[9]	Soil Description[10]
TP-27-13	1	0.5	1.9															Dike Fill	
TP-27-13	2	2.0	30.6															Dike Fill	
TP-27-13	3	7.0	51.4			18	81.7	3	38	34	4						ML	Hm	Dark gray, slightly clayey, slightly fine sandy SILT
TP-28-13	1	1.0	26.2															Hm	
TP-28-13	2	2.5	56.9			9	91.1										ML	Hm	Dark gray, slightly fine sandy, slightly clayey SILT (+ No. 60 material mostly composed of organics)
TP-28-13	3	3.0	33.5															Ha	
TP-29-13	1	1.0	29.1															Agricultural layer	
TP-29-13	2	2.0	54															Hm	
TP-29-13	3	3.5	21.4			96	4.3										SP	Ha	Dark gray-brown, fine to medium SAND, trace of silt
TP-30-13	1	2.0	46.2			6	94.4										ML	Agricultural layer	Gray-brown, slightly fine to medium sandy, slightly clayey SILT (+ No. 60 material mostly composed of organics)
TP-30-13	2	3.0	49.8	2.8														Hm	
TP-30-13	3	4.5	40															Ha	
TP-31-13	1	1.0	54.9															Hm	
TP-31-13	2	3.0	48.3			22	78.3										ML	Hm	Gray, fine sandy SILT, trace of clay (+ No. 60 material mostly composed of organics)
TP-31-13	3	4.5	39.5															Ha	
TP-32-13	1	0.5	27															Agricultural layer	
TP-32-13	2	2.5	62.6															Hm	
TP-32-13	3	4.5	36.9			75	24.7										SM	Ha	Gray, silty, fine SAND
TP-33-13 [11]	1	1.0	32.3	2.6												X		Agricultural layer	Gray-brown, fine to medium sandy, clayey SILT
TP-33-13 [11]	2	2.0	37.3													X		Hm	Gray-brown, fine to medium sandy, clayey SILT
TP-33-13	3	3.5	42.1			78	21.9										SM	Ha	Gray-brown, silty, fine to medium SAND (+ No. 20 material mostly composed of organics)
TP-34-13	1	0.5	30.2															Agricultural layer	
TP-34-13	2	2.0	50.7			24	75.9										ML	Hm	Gray, fine to medium sandy SILT (+ No. 40 material mostly composed of organics)
TP-34-13	3	4.0	37.5															Ha	
TP-35-13 [11]	1	1.0	26.7			16	84.5									X	MH	Agricultural layer	Brown, fine to medium sandy, clayey SILT
TP-35-13	2	2.5	50.8	3.3														Hm	
TP-35-13	3	4.0	41.1															Ha	
TP-36-13	1	1.0	39.7															Agricultural layer	
TP-36-13	2	2.0	55.1															Hm	
TP-36-13	3	5.0	28.5		0	81	19.0										SM	Ha	Gray, silty, fine to medium SAND

(see Page 9 for Notes)

TABLE C-1
LABORATORY TESTING SUMMARY

Exploration	Sample Number	Top Depth (feet)	Water Content (%)	Organic Content (%)	Percent Gravel	Percent Sand	Percent Fines[1]	Percent Smaller Than 2 micron	LL[2]	PL[3]	PI[4]	OLL[5]	OLL/LL (%)[2,5]	CU[6] Test Performed	Consolidation[7] Test Performed	Moisture-Density Test Performed	USCS[8]	Interpreted Geologic Unit[9]	Soil Description[10]
TP-37-13	1	0.5	29.6															Agricultural layer	
TP-37-13	2	2.0	70.6															Hm	
TP-37-13	3	3.0	26.8			78	22.3										SM	Ha	Gray-brown, silty, fine to medium SAND
GP-01-10	6	11.0	46.8						42	37	5						ML	Hm	Gray SILT, trace of fine sand and clay; trace of fine organics
GP-01-10	7	16.0	21.5		1	96	3.0										SP	Ha	Gray SAND, trace of silt and fine gravel
GP-01-10	8	25.0	24.4			91	8.6										SP-SM	Ha	Gray, slightly silty SAND
GP-01-10	9	33.0	25.9				4.0										SP	Ha	Gray, fine SAND, trace of silt; trace of organics
GP-02-10	2	6.0	58.8						51	38	13						MH	Hm	Gray-brown, slightly clayey SILT, trace of sand; scattered fine organics
GP-02-10	4	15.0	22.2		2	93	5.7										SP-SM	Ha	Gray, slightly silty SAND, trace of fine gravel
GP-02-10	6	25.0	20.3		0	95	5.2										SP-SM	Ha	Gray, slightly silty SAND
GP-03-10	5	14.5	21.9		0	96	3.7										SP	Ha	Gray, fine to medium SAND, trace of silt
GP-03-10	6	21.0	24.4			97	3.5										SP	Ha	Gray, fine to medium SAND, trace of silt
GP-04-10	4	10.0	20.5		1	97	2.5										SP	Ha	Gray SAND, trace of silt and fine gravel
GP-04-10	8	29.0	28.7						NP	NP	NP						ML	He	Gray, fine sandy SILT; trace of shell fragments, trace of fine organics
GP-05-10	4	8.0	27.7				1.5										SP	Ha	Gray SAND, trace of silt; trace of wood fragments
GP-05-10	8	25.0	35.9				26.1										SM	Ha	Gray, silty SAND; scattered organics
GP-06-10	1	2.0	56.4						59	37	22						MH	Hm	Brown, slightly sandy, clayey SILT; scattered organics, scattered iron oxide nodules
GP-06-10	2	6.0	37.9				20.4										SM	Ha	Gray, silty, fine to medium SAND; trace of organics
GP-06-10	3	10.0	26.8		0	96	4.2										SP	Ha	Gray, fine to medium SAND, trace of silt
GP-07-10	2	2.0	53.6						48	36	12						ML	Hm	Brown, slightly clayey SILT; trace of organics, trace of iron oxide
GP-07-10	3	6.0	45.0				25.6										SM	Ha	Gray, silty, fine SAND, trace of clay; scattered organics
GP-07-10	5	13.0	23.0		3	94	3.4										SP	Ha	Gray SAND, trace of silt and fine gravel
GP-07-10	8	26.0	21.0		1	94	4.8										SP	Ha	Gray SAND, trace of silt and fine gravel
GP-08-10	2	5.0	27.6		1	92	7.8										SP-SM	Ha	Gray, slightly silty SAND, trace of fine gravel
GP-08-10	4	15.0	26.3				3.0										SP	Ha	Gray SAND, trace of silt
GP-08-10	7	29.0	50.3						43	28	15						ML	He	Dark gray-brown, clayey SILT, trace of fine sand
GP-09-10	3	10.0	23.0				1.3										SP	Ha	Gray SAND, trace of silt

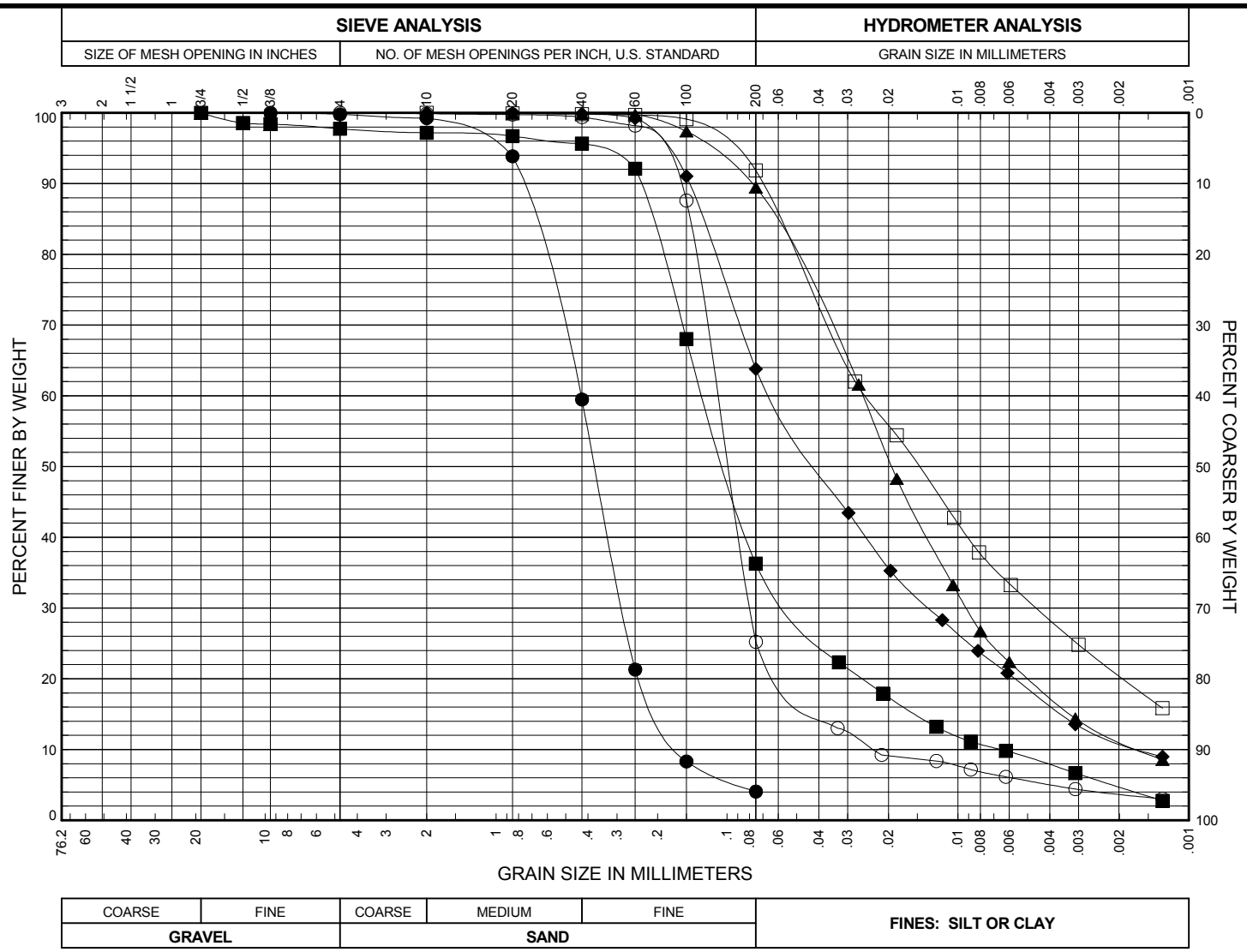
(see Page 9 for Notes)

TABLE C-1
LABORATORY TESTING SUMMARY

Exploration	Sample Number	Top Depth (feet)	Water Content (%)	Organic Content (%)	Percent Gravel	Percent Sand	Percent Fines[1]	Percent Smaller Than 2 micron	LL[2]	PL[3]	PI[4]	OLL[5]	OLL/LL (%)[2,5]	CU[6] Test Performed	Consolidation[7] Test Performed	Moisture-Density Test Performed	USCS[8]	Interpreted Geologic Unit[9]	Soil Description[10]
GP-10-10	3	10.0	25.4			93	7.2										SP-SM	Ha	Gray, slightly silty, fine to medium SAND
GP-11-10	1	2.0	53.5						51	39	12						MH	Hm	Gray-brown, slightly clayey SILT, trace of fine to medium sand; scattered organics
GP-11-10	3	10.0	23.9		0	91	8.4										SP-SM	Ha	Gray, slightly silty SAND
GP-11-10	5	21.0	32.9				16.6										SM	Ha	Gray, silty, fine SAND; scattered shell fragments, trace of organics
GP-12-10	3	10.0	25.5		0	95	4.8										SP	Ha	Gray, fine to medium SAND, trace of silt
HB-1	1	0.0	45.2	3.3														Agricultural layer	
HB-1	2	3.0	29.3															Ha	
HB-2	1	0.0	38.4						41	30	11						ML	Agricultural layer	Gray-brown, clayey SILT, trace of sand; trace of organics
HB-2	2	2.5	50.3	2.2		16	83.8	11	40	30	10						ML	Hm	Gray, fine to medium sandy, clayey SILT; trace of organics
HB-3	1	0.0	47.9	3.5														Agricultural layer	
HB-3	2	2.5	49.8			41	58.7	4									ML	Hm	Gray, fine to medium sandy SILT, trace of clay; trace organics
HB-4	1	0.0	36.6			6	93.7	20	51	36	15						MH	Agricultural layer	Brown, slightly fine sandy, clayey SILT; trace of organics
HB-4	2	2.5	42.9	3.6					37	32	5						ML	Hm	Brown, clayey SILT, trace of sand; trace of organics
HB-5	1	0.0	40.5	2.7														Agricultural layer	
HB-5	2	2.5	37.1			63	36.9	2									SM	Hm	Gray-brown, silty, fine to medium SAND
HB-6	1	0.0	40.7						46	34	12						ML	Agricultural layer	Brown, clayey SILT; trace of organics
HB-6	2	2.5	36.2			57	42.6	2									SM	Hm	Brown-gray, silty, fine to medium SAND

Notes:
1. Fines are defined as particle size smaller than 0.075 millimeter.
2. LL = Liquid Limit
3. PL = Plastic Limit
4. PI = Plasticity Index
5. OLL = Organic Liquid Limit
6. CU = Consolidated-Undrained Triaxial Compression Test
7. Consolidation = One-dimensional Consolidation Test
8. USCS = Unified Soil Classification System
9. Brief descriptions of the interpreted geologic units can be found in the Geology section in the main report text.
10. Soil descriptions have been abbreviated and simplified; more complete descriptions can be found in the borings logs in Appendix A.
11. Organic content performed on Samples S-1 and S-2 combined. Moisture-density test performed on TP-33-13 S-1, TP-33-13 S-2, and TP-35-13 S-1 combined.

% = percent



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● B-1-13, S-5	10.0	SP	Gray, fine to medium SAND, trace of silt	0	96	4.1			26.8	2.7	1.2	AKV	JFL	D422
■ B-1-13, S-9*	20.0	SM	Gray, silty, fine to medium SAND (+ No. 10 material mostly composed of shell fragments)	2	61	36.3		5	34.8			AKV	JFL	D422
▲ B-1-13, S-11	27.7	ML	Gray, slightly fine sandy SILT, trace of clay		11	89.5		11	39.7			AKV	JFL	D422
◆ B-1-13, S-12	29.0	ML	Gray-brown, slightly clayey, fine sandy SILT		36	63.8		11	42.9			AKV	JFL	D422
○ B-1-13, S-13	35.0	SM	Gray-brown, silty, fine SAND (+ No. 10 material composed of one shell)		75	25.2		4	37.7			JFL	JFL	D422
□ B-1-13, S-17*	55.0	MH	Gray-brown, slightly fine sandy, clayey SILT		8	91.8		20	55.8			AKV	JFL	D422

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FIG. C-1
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FIG. C-1

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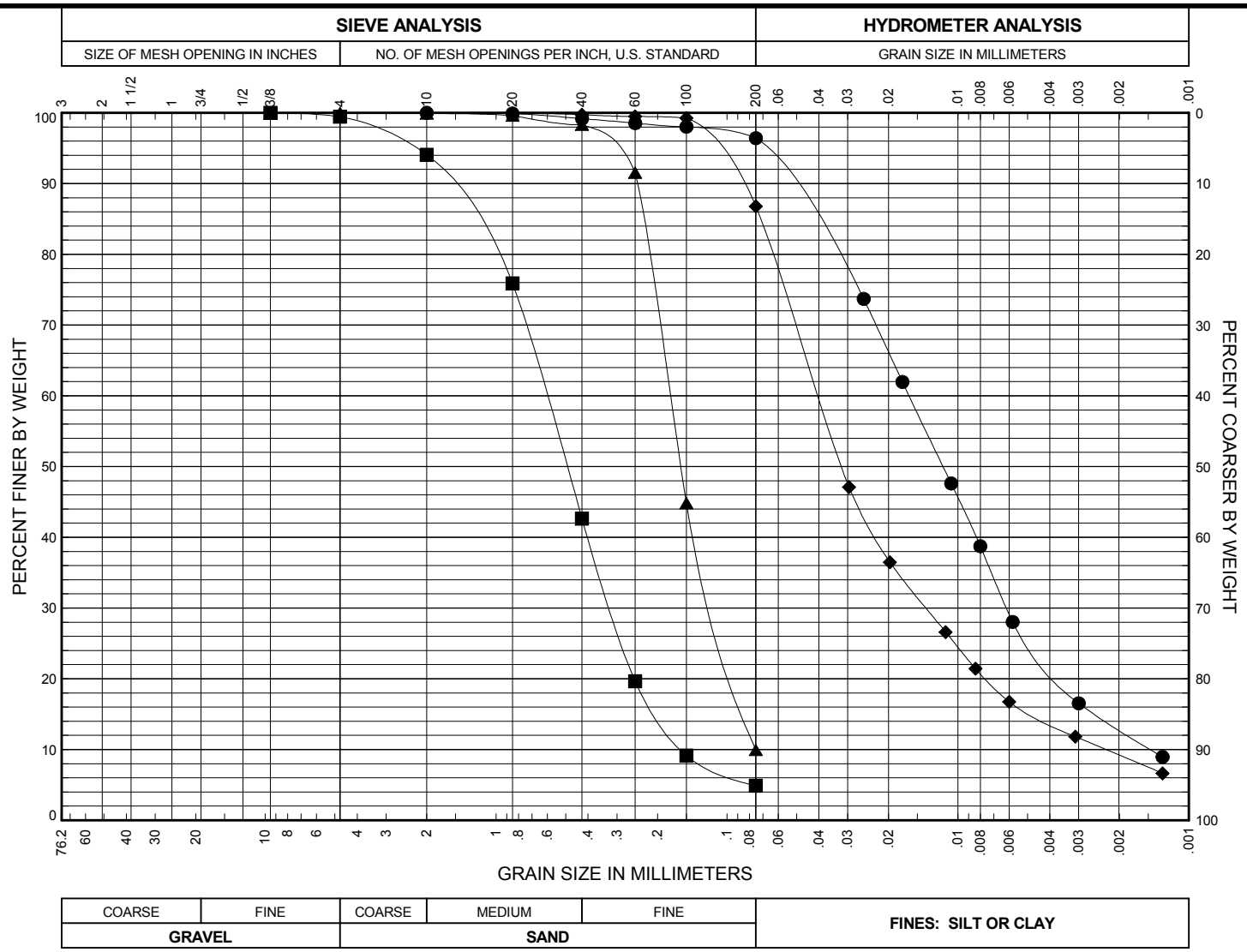

LEGEND

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*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● B-2-13, S-2*	2.5	MH	Gray-brown, clayey SILT, trace of fine sand		4	96.4		13	60.1			AKV	JFL	D422
■ B-2-13, S-4	7.5	SP	Dark gray SAND, trace of silt	1	95	4.9			22.4	3.9	1.1	AKV	JFL	D422
▲ B-2-13, S-11	30.0	SP-SM	Gray-brown, slightly silty, fine SAND		90	9.9			30.1	2.4	0.9	JFL	JFL	D422
◆ B-2-13, S-13	40.0	ML	Gray-brown, fine sandy SILT		13	86.8		9	40.0			JFL	JFL	D422

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FIG. C-2
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FIG. C-2

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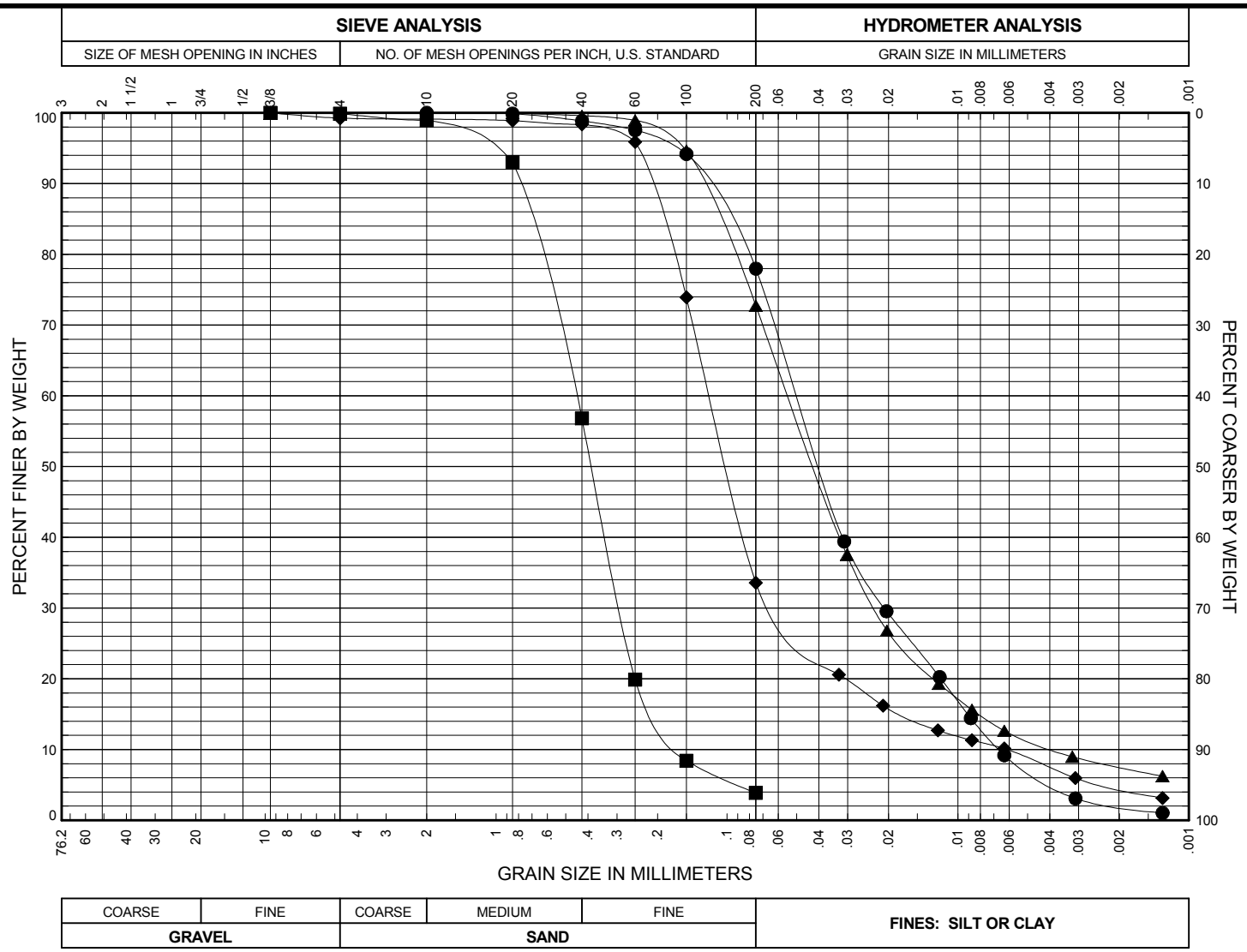

LEGEND

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COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

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Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● B-3-13, S-2	2.5	ML	Dark gray-brown, fine to medium sandy SILT; abundant organics		22	78.0		2	50.9			JFL	JFL	D422
■ B-3-13, S-6	12.5	SP	Dark gray-brown, fine to medium SAND, trace of silt	0	96	3.9			26.8	2.8	1.1	AKV	JFL	D422
▲ B-3-13, S-11	30.0	ML	Dark gray-brown, fine sandy SILT, trace of clay		27	72.7		8	35.4			AKV	JFL	D422
◆ B-3-13, S-12*	35.0	SM	Dark gray-brown, silty, fine SAND (+ No. 10 material mostly composed of shell fragments)	1	66	33.6		5	34.1			JFL	JFL	D422

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FIG. C-3
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FIG. C-3

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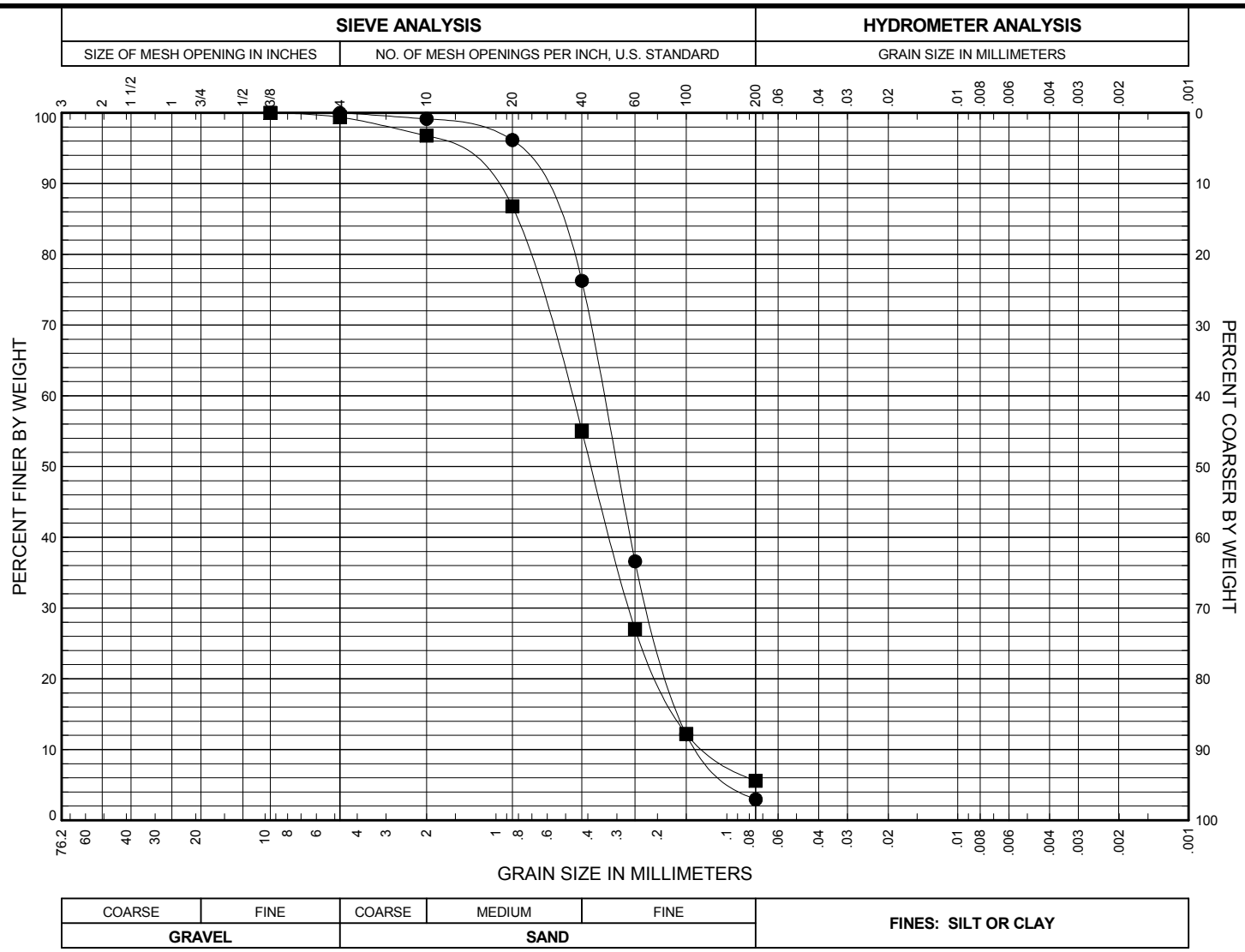

LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● B-4w-13, S-5	10.5	SP	Dark gray-brown, fine to medium SAND, trace of silt	0	97	3.0			25.9	2.7	1.1	AKV	JFL	D422
■ B-4w-13, S-6	12.5	SP-SM	Dark gray-brown, slightly silty SAND, trace of fine gravel	1	94	5.6			19.9	4.0	1.2	JFL	JFL	D422

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FIG. C-4
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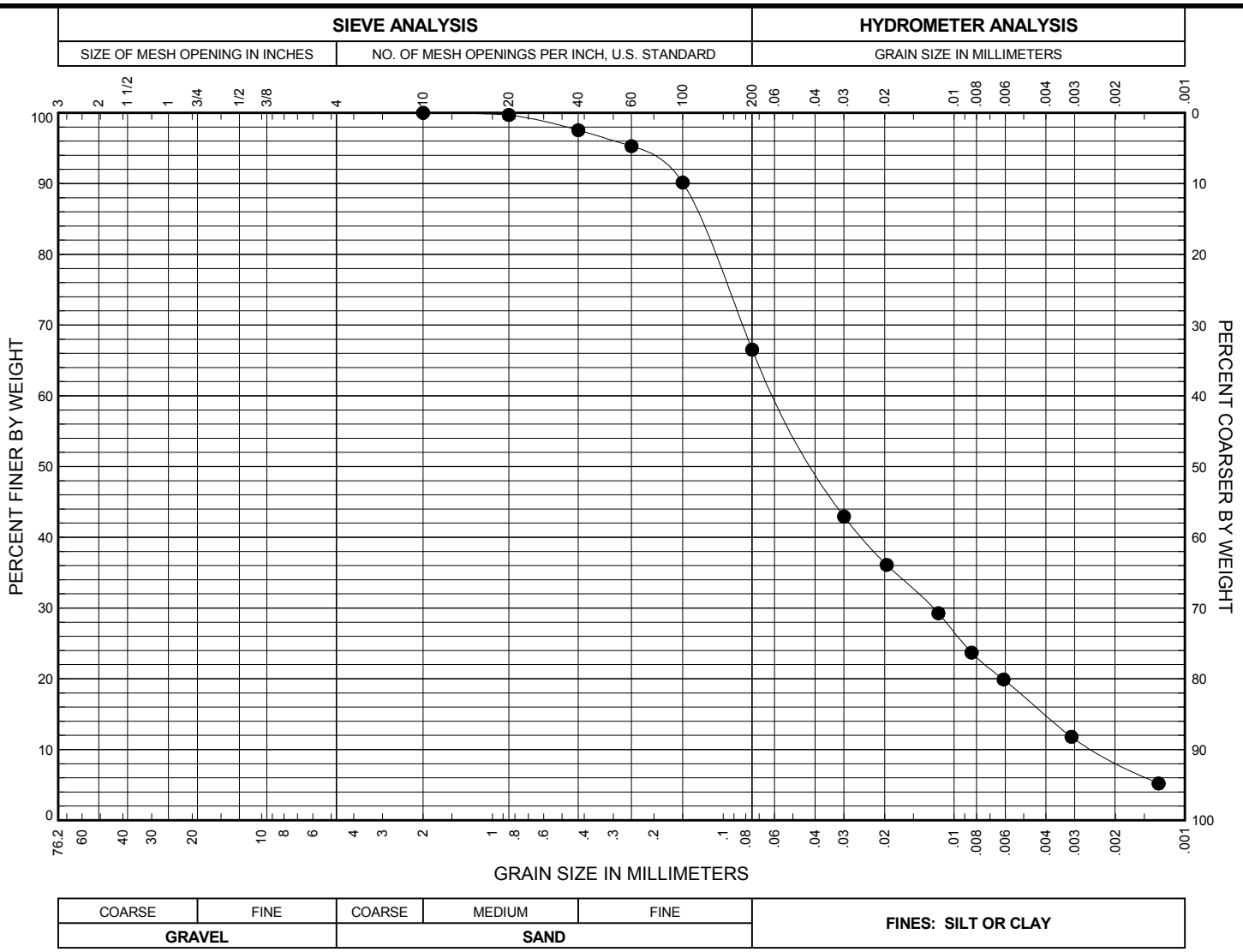
FIG. C-4



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● B-5w-13, S-1	3.0	ML	Gray-brown, fine to medium sandy SILT		33	66.5		8	33.7			JFL	JFL	D422

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FIG. C-5
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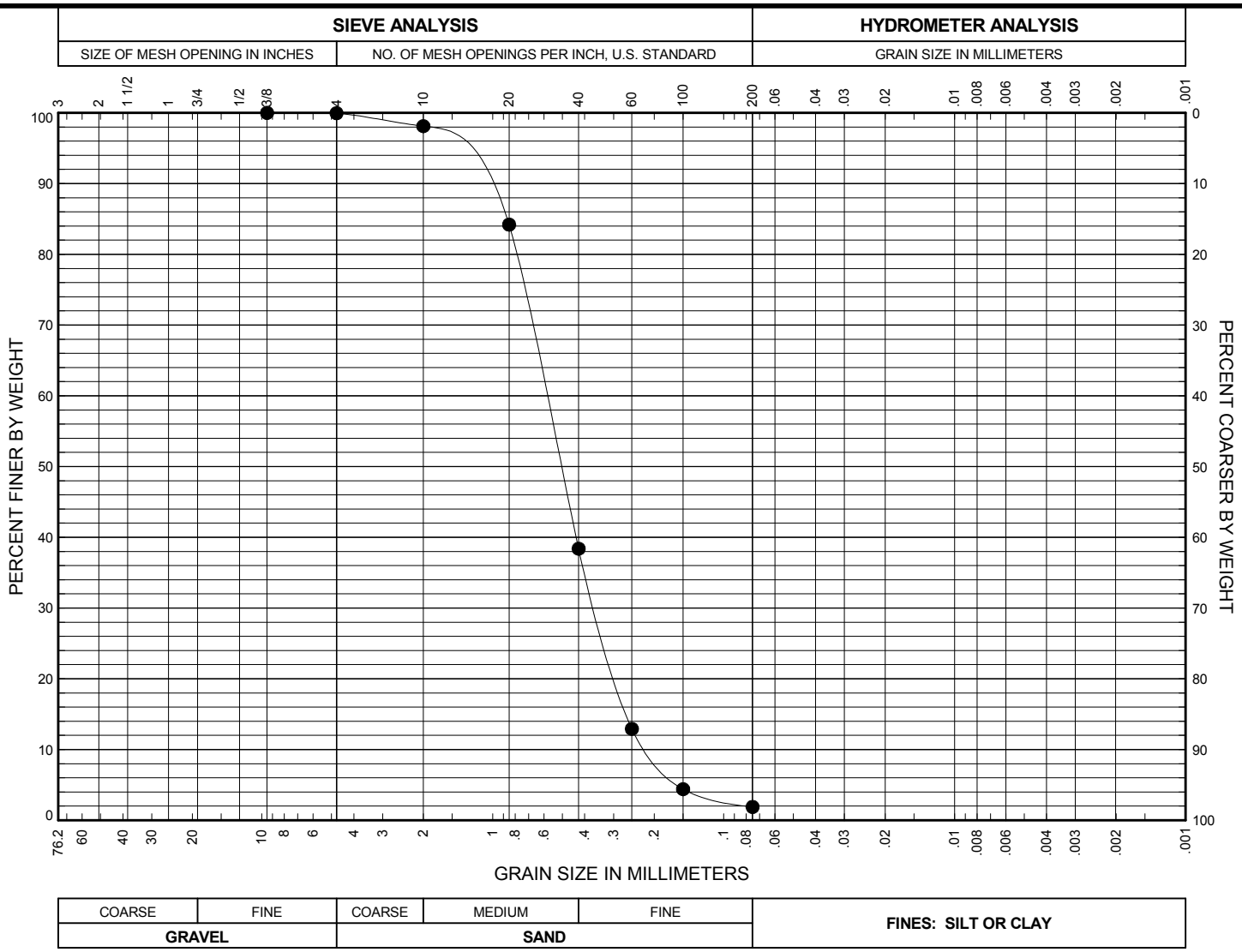
FIG. C-5



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● B-6w-13, S-6	12.5	SP	Dark gray SAND, trace of silt	0	98	1.9			24.2	2.8	1.0	JFL	JFL	D422

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BORING B-6w-13

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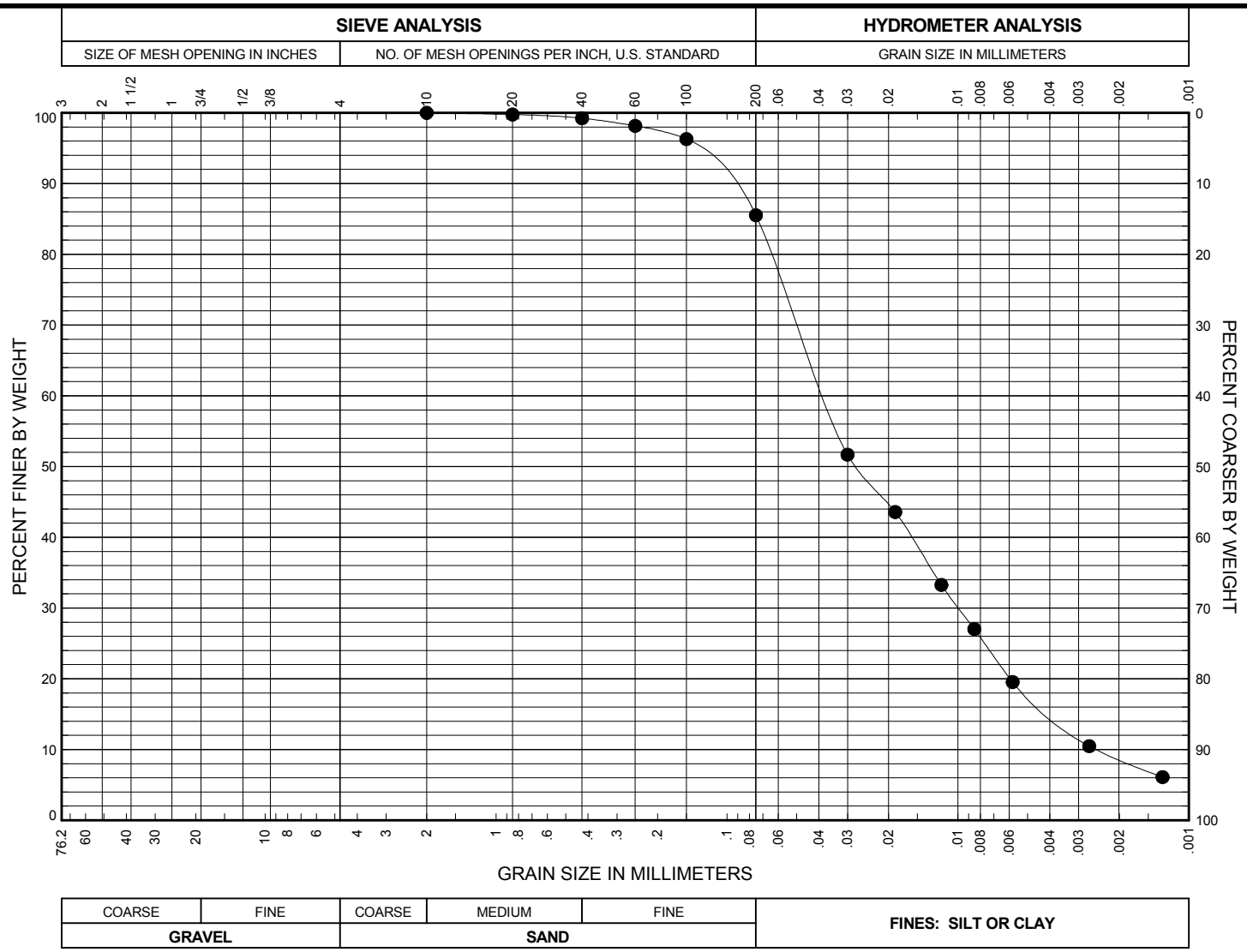
FIG. C-6
Sheet 1 of 1

FIG. C-6

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● B-7w-13, S-1	3.0	ML	Gray-brown, slightly clayey, fine sandy SILT		14	85.5		9	47.8			JFL	JFL	D422

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BORING B-7w-13

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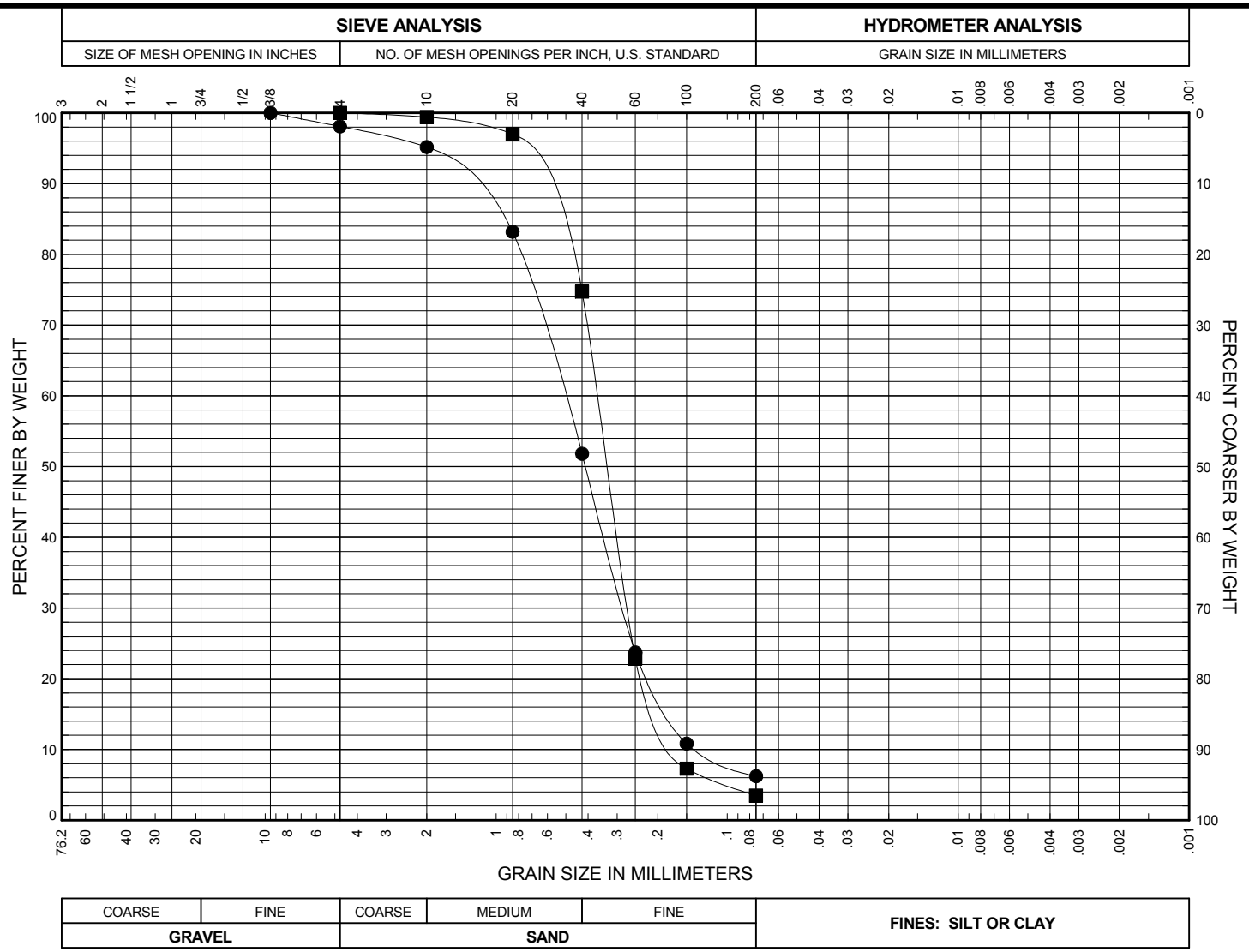
FIG. C-7
Sheet 1 of 1

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14

FIG. C-7



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● B-8w-13, S-5*	10.0	SP-SM	Dark gray-brown, slightly silty SAND, trace of fine gravel	2	92	6.2			23.5	3.8	1.2	JFL	JFL	D422
■ B-8w-13, S-7	15.0	SP	Dark gray-brown, fine to medium SAND, trace of silt; abundant organics		97	3.5			31.3	2.2	1.2	JFL	JFL	D422

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BORING B-8w-13

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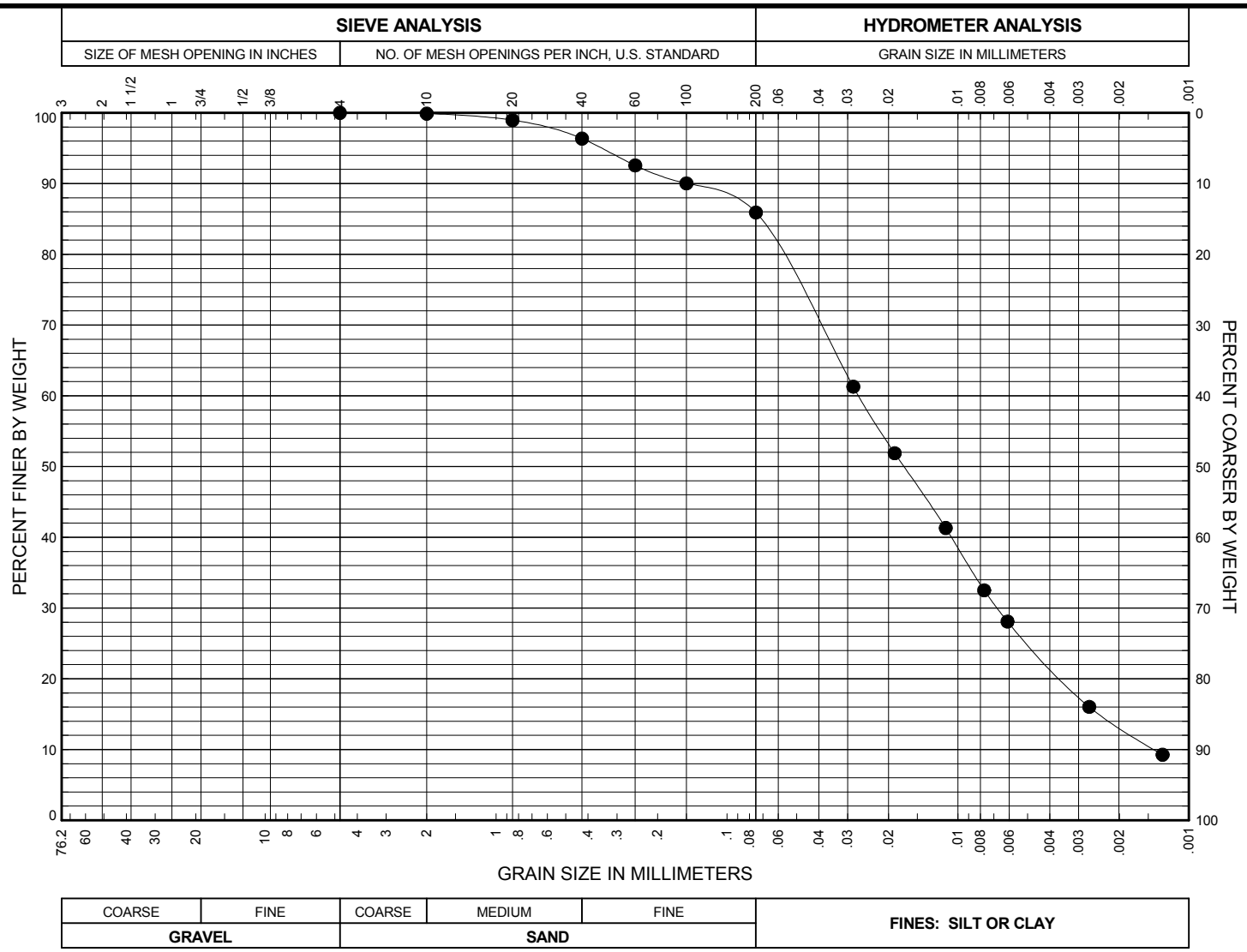
FIG. C-8
Sheet 1 of 1

FIG. C-8

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● B-9w-13, S-1	2.0	ML	Gray-brown, slightly clayey, fine to medium sandy SILT; abundant organics		14	85.9		13	43.2			JFL	JFL	D422

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BORING B-9w-13

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FIG. C-9
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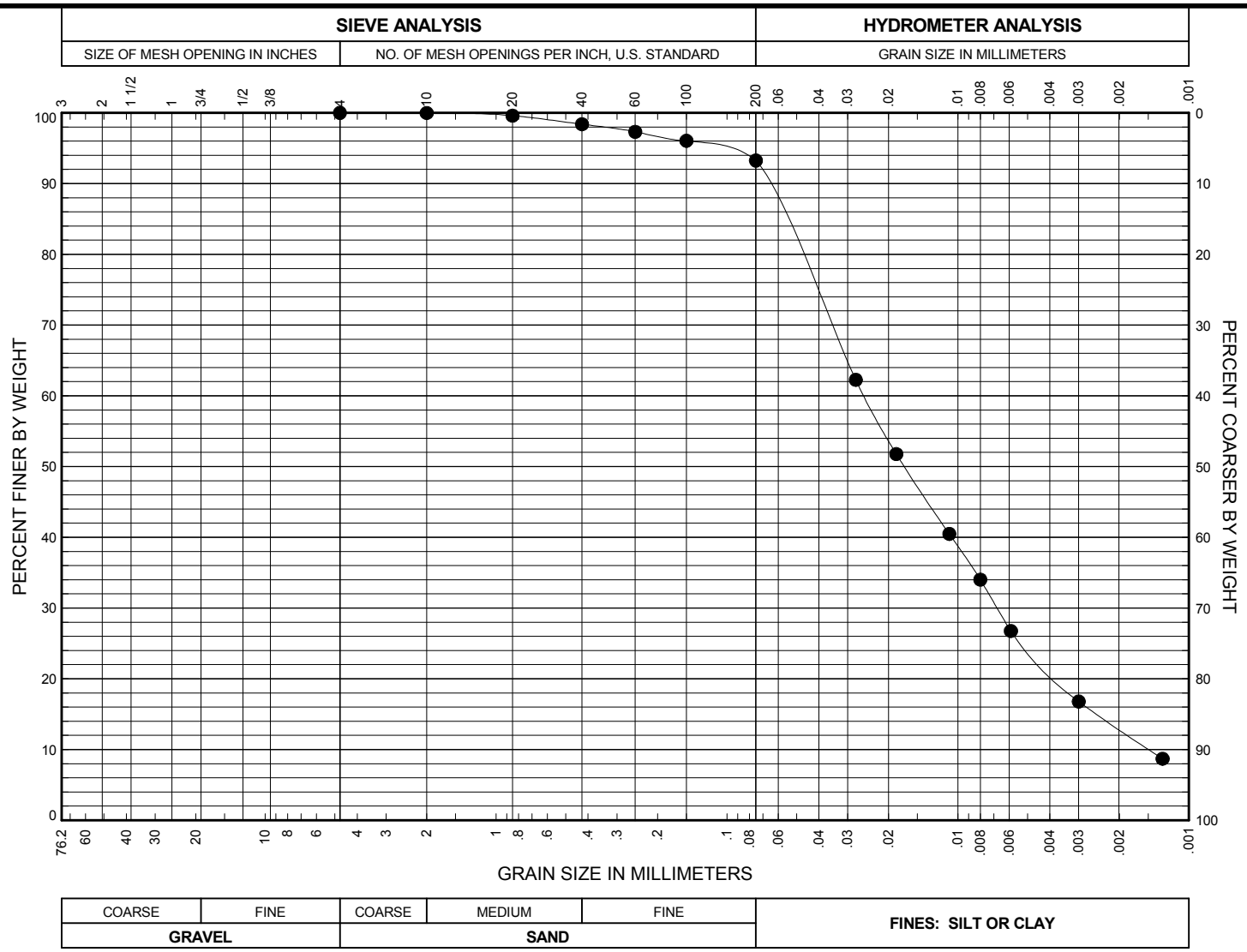
FIG. C-9

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-1-13, S-1	1.0	ML	Brown, slightly fine to medium sandy, slightly clayey SILT		7	93.3		13	44.0			AKV	JFL	D422

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TEST PIT TP-1-13

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FIG. C-10
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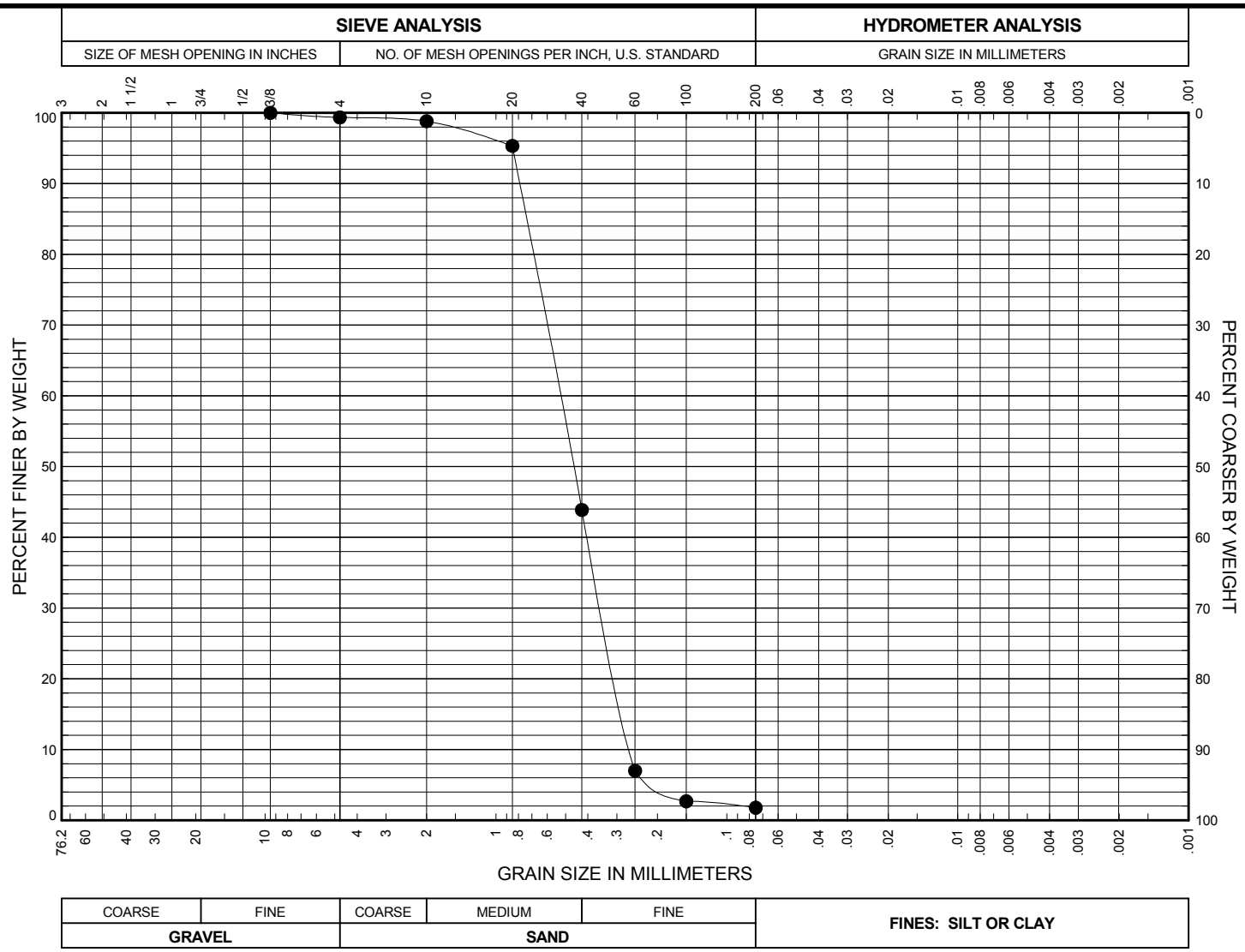
FIG. C-10

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-2-13, S-3	3.5	SP	Dark gray, fine to medium SAND, trace of silt	1	98	1.8			26.3	2.0	0.9	AKV	JFL	D422

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TEST PIT TP-2-13

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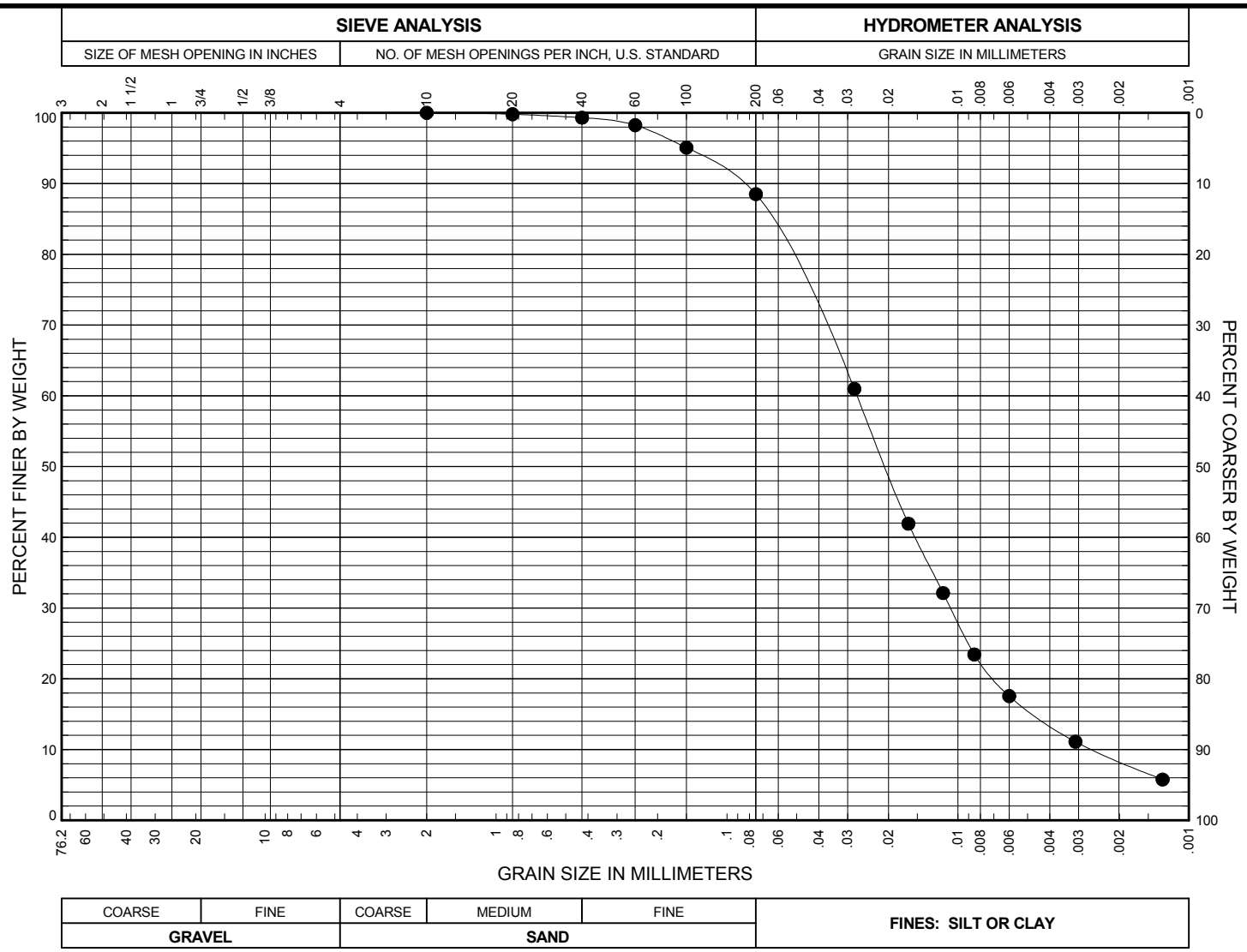
FIG. C-11
Sheet 1 of 1

FIG. C-11

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-3-13, S-2	3.5	ML	Dark gray, slightly fine sandy SILT, trace of clay		11	88.5		8	49.4			JFL	JFL	D422

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FIG. C-12
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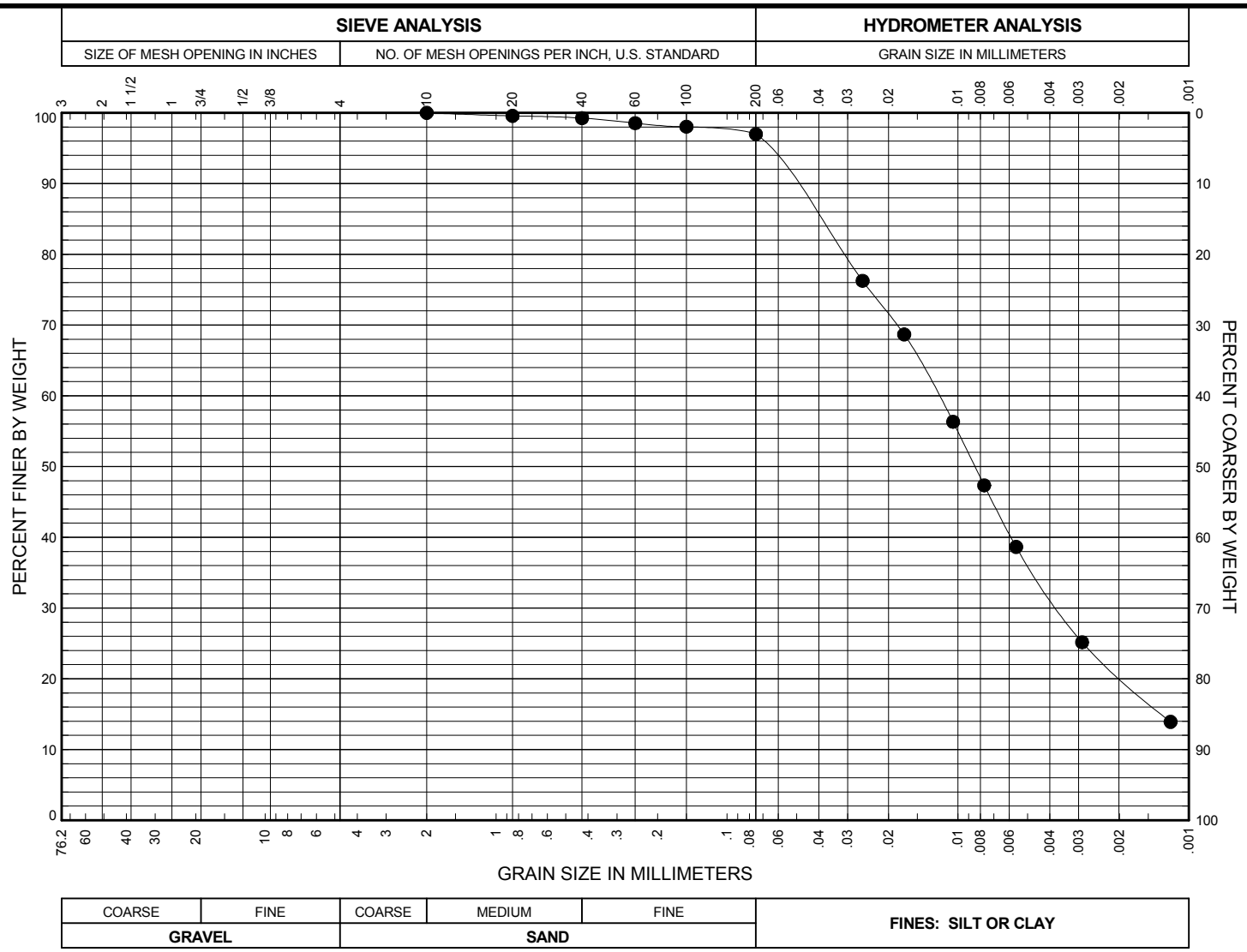
FIG. C-12

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-4-13, S-1	2.0	ML	Brown, clayey SILT, trace of fine sand		3	97.0		20	25.2			JFL	JFL	D422

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FIG. C-13
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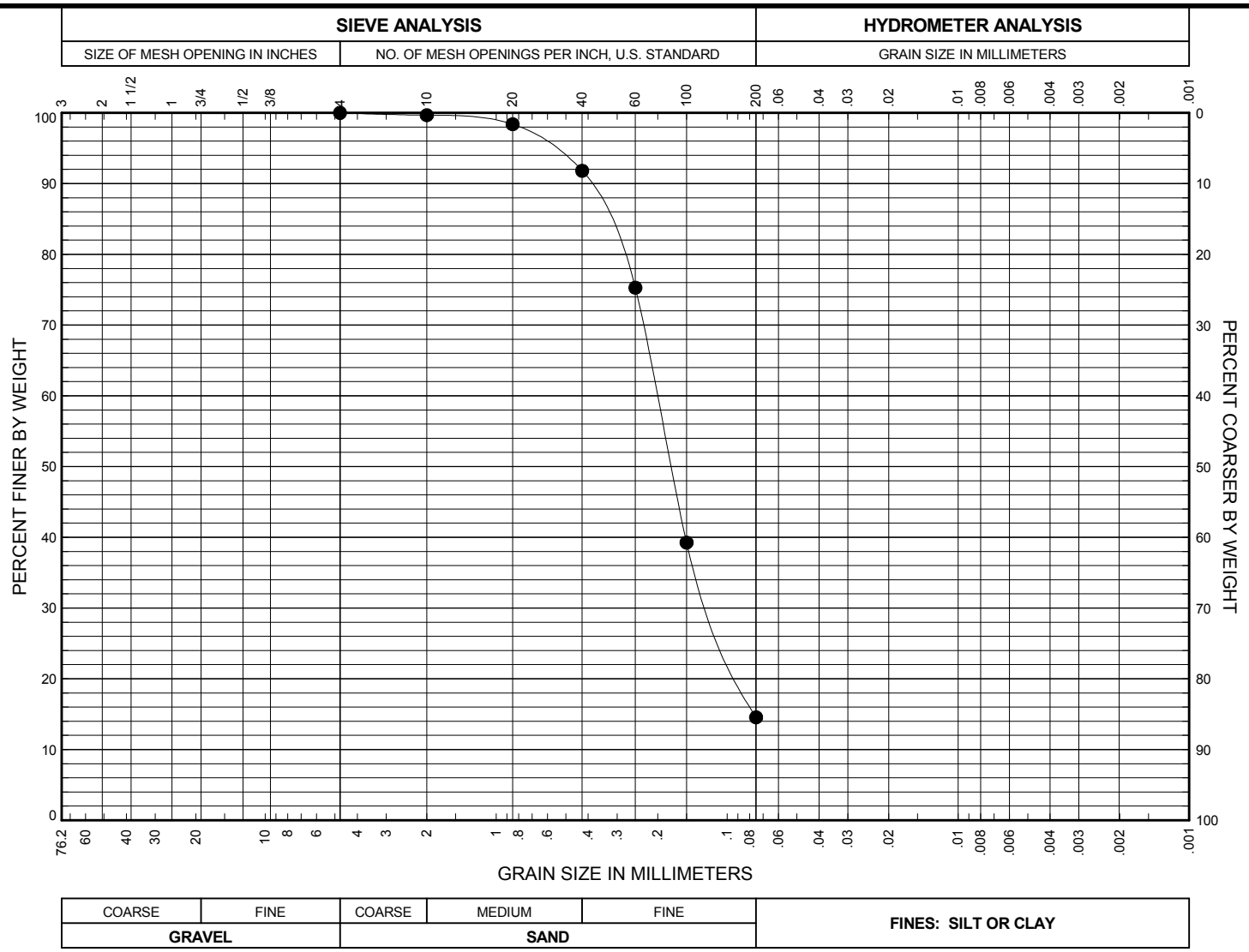
FIG. C-13

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-5-13, S-2	3.5	SM	Gray-brown, silty, fine to medium SAND		85	14.6			30.1			AKV	JFL	D422

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FIG. C-14
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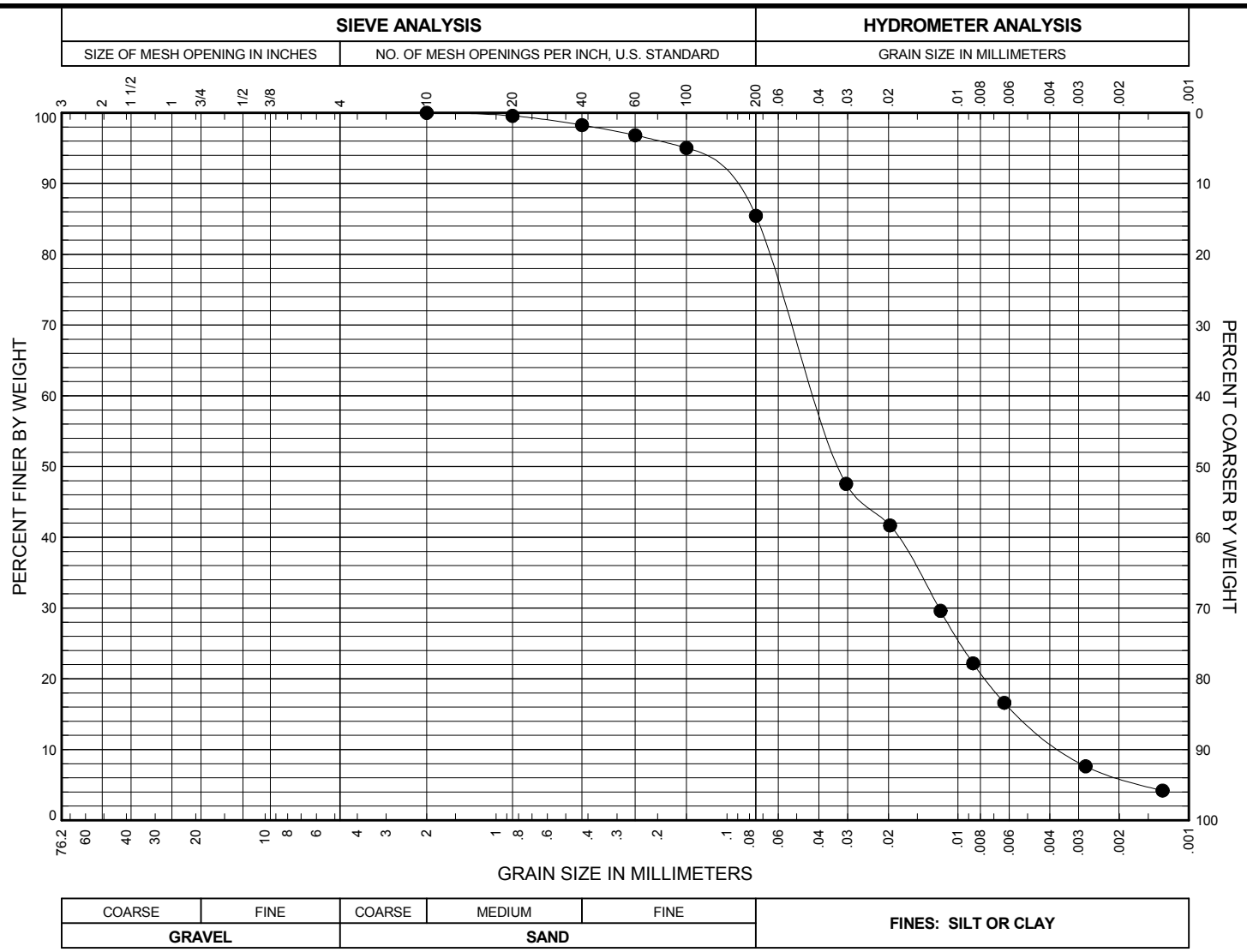
FIG. C-14

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-6-13, S-2	2.5	ML	Gray-brown, fine to medium sandy SILT		15	85.4		6	54.2			JFL	JFL	D422

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FIG. C-15
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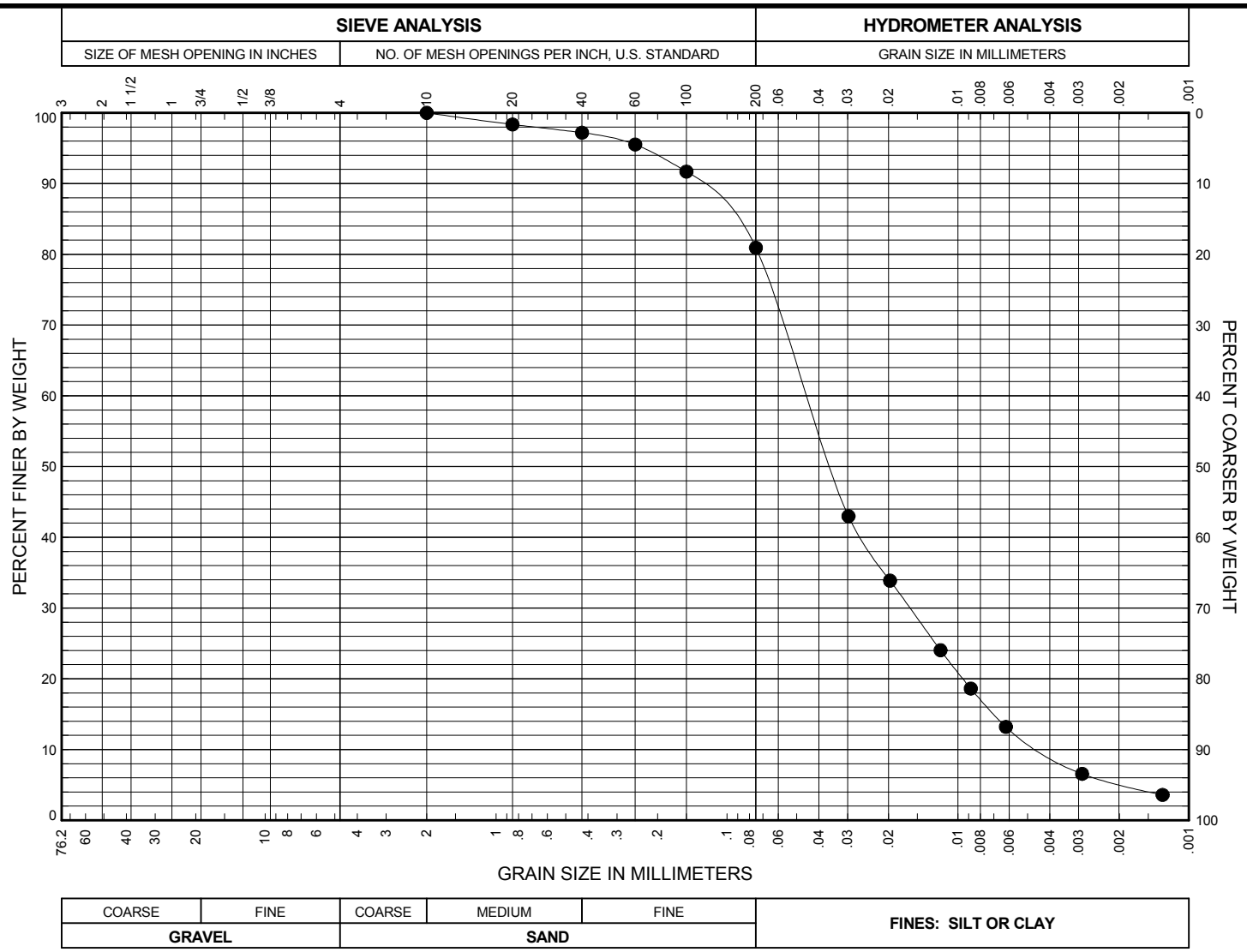
FIG. C-15

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-7-13, S-2	2.5	ML	Gray-brown, fine to medium sandy SILT		19	80.9		5	41.1			JFL	JFL	D422

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FIG. C-16
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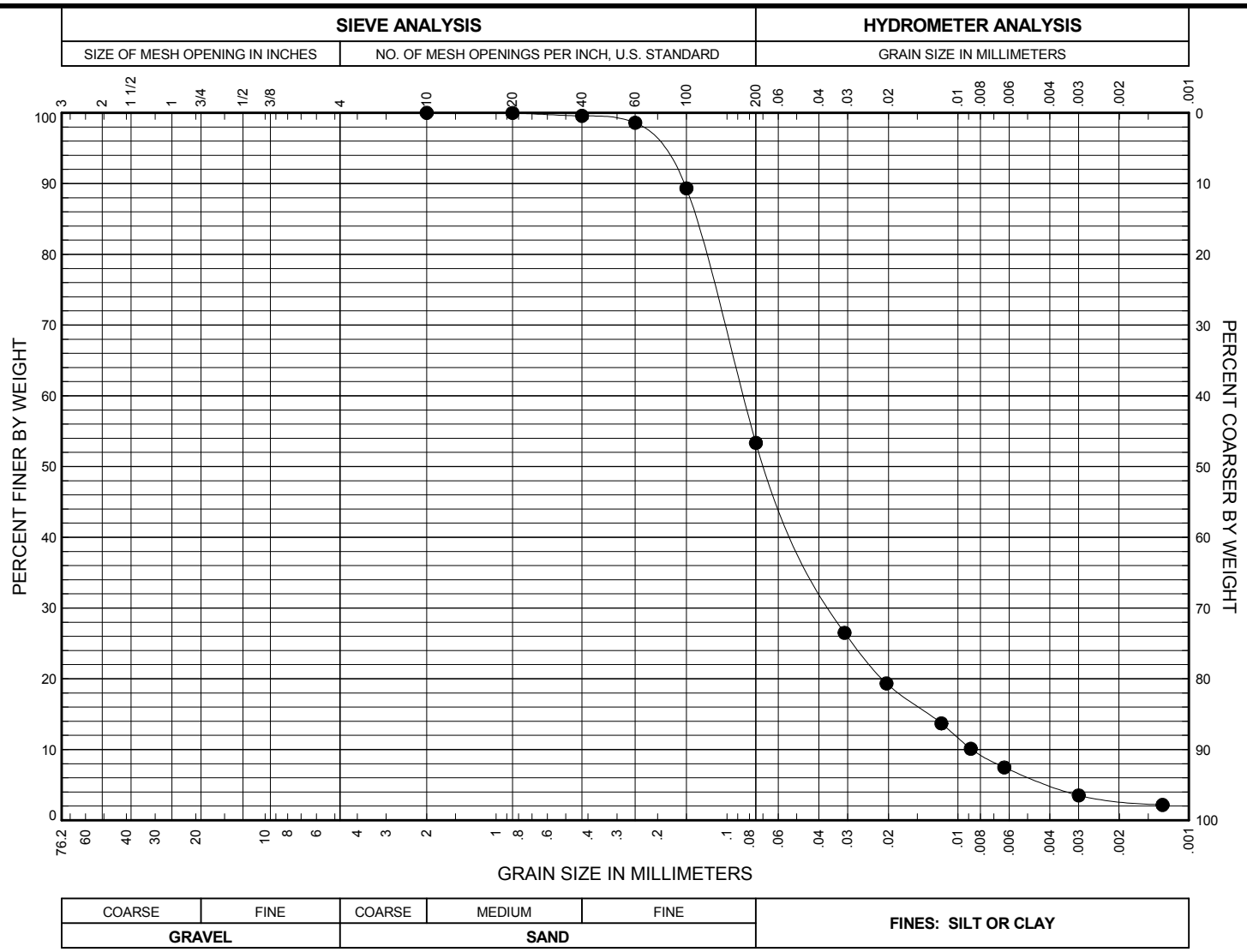
FIG. C-16

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-8-13, S-3	4.0	ML	Gray, fine sandy SILT (+ No. 40 material mostly composed of organics)		47	53.3		3	41.4			JFL	JFL	D422

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FIG. C-17
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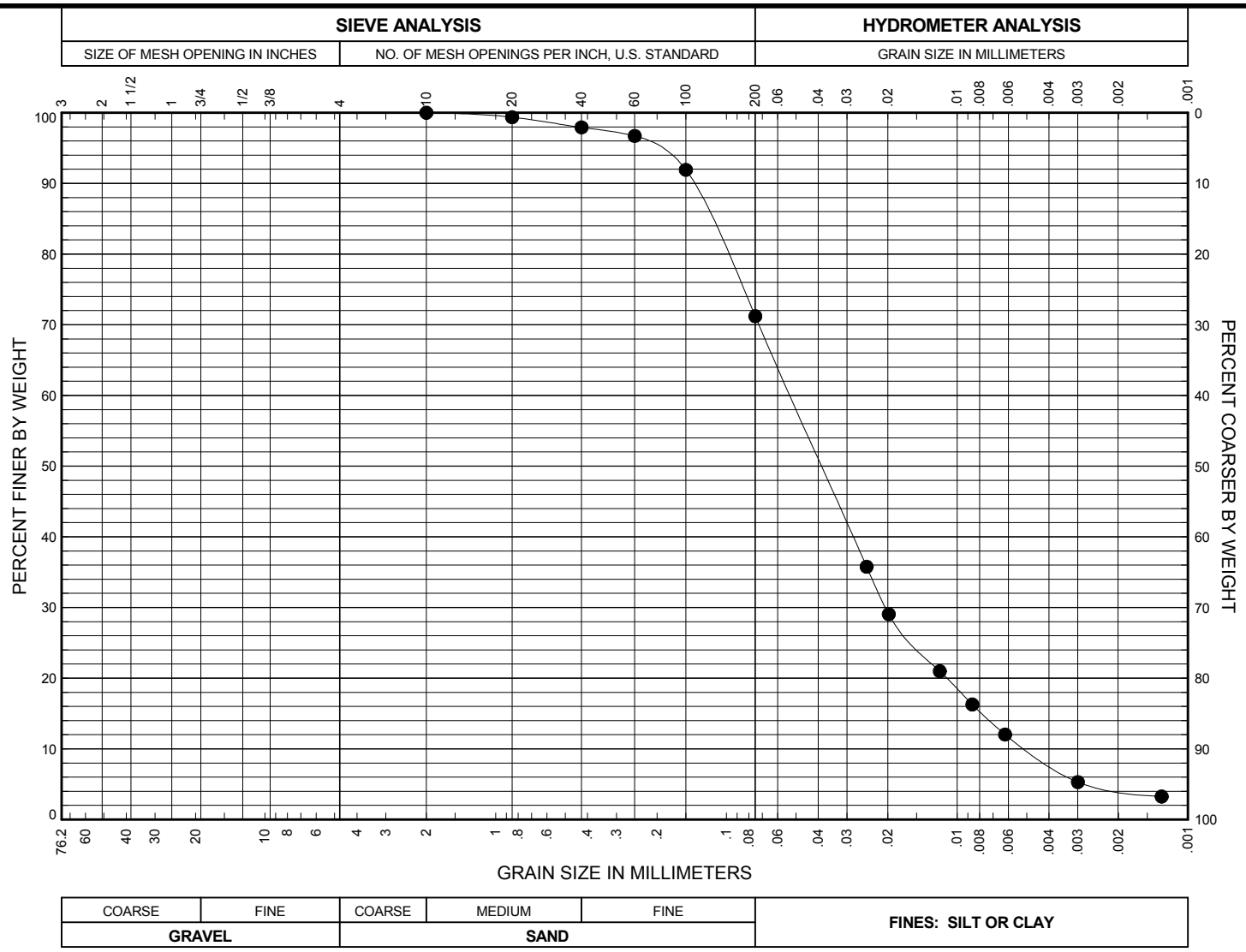
FIG. C-17

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-9-13, S-2	3.0	ML	Gray, fine to medium sandy SILT		29	71.2		4	43.3			AKV	JFL	D422

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FIG. C-18
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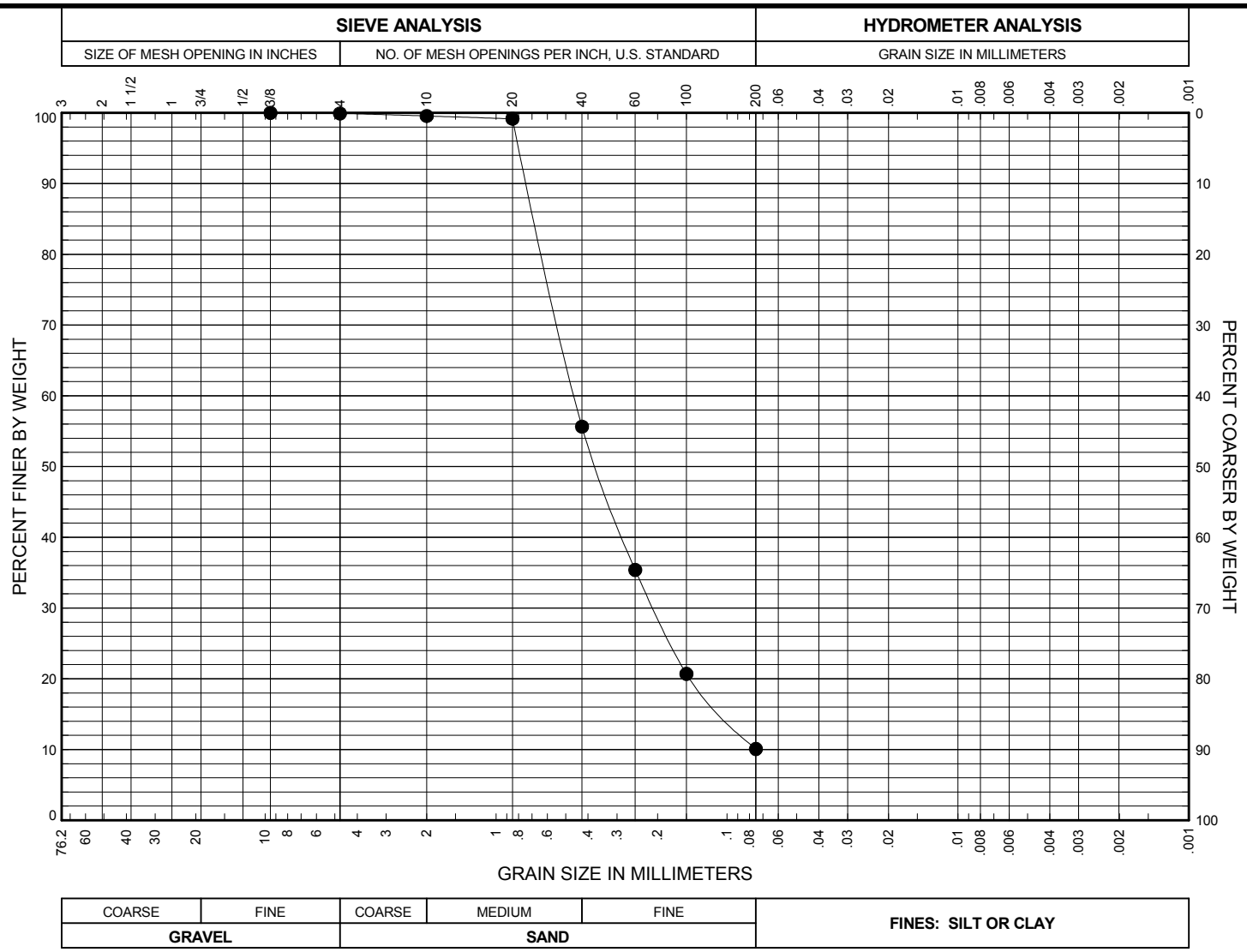
FIG. C-18

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-10-13, S-3	5.0	SW-SM	Dark gray, slightly silty, fine to medium SAND	0	90	10.1			23.0	6.1	1.3	AKV	JFL	D422

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FIG. C-19
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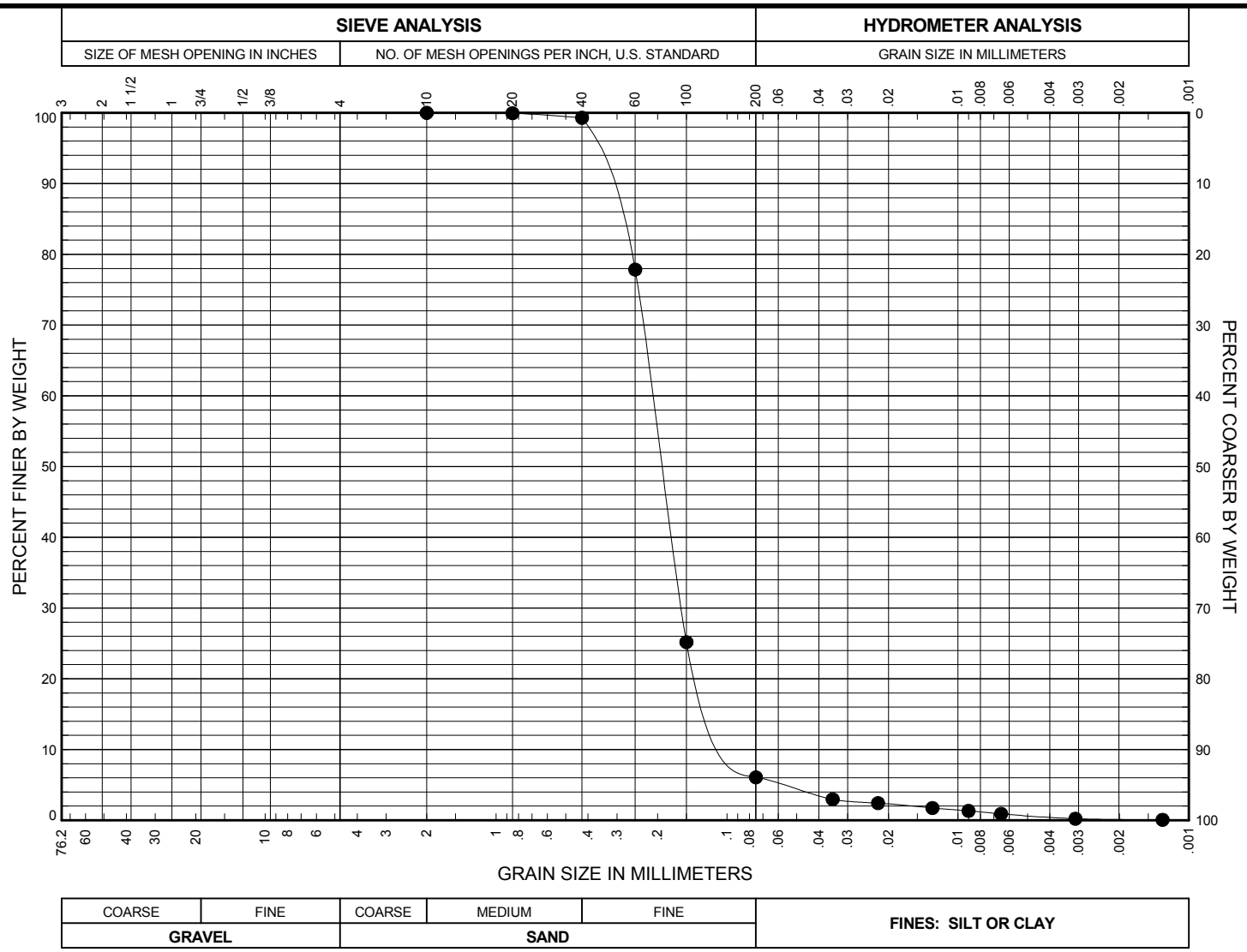
FIG. C-19

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-11-13, S-3	3.5	SP-SM	Dark gray-brown, slightly silty, fine SAND		94	6.1		0	30.9	2.4	1.4	JFL	JFL	D422

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FIG. C-20
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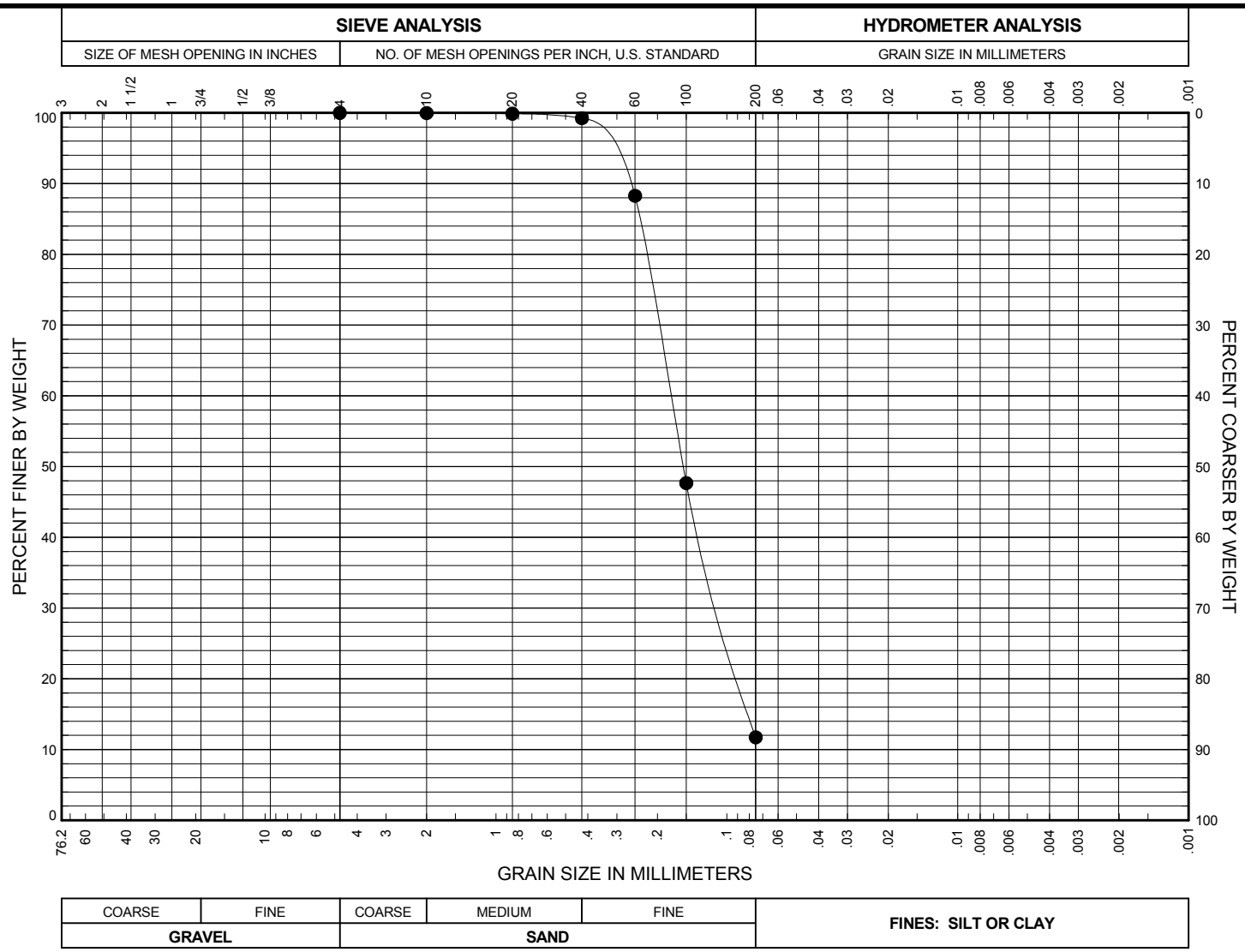
FIG. C-20

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-13-13, S-3	3.5	SP-SM	Gray-brown, slightly silty, fine SAND (+ No. 40 material mostly composed of organics)		88	11.7			40.7	2.4	0.9	AKV	JFL	D422

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FIG. C-21
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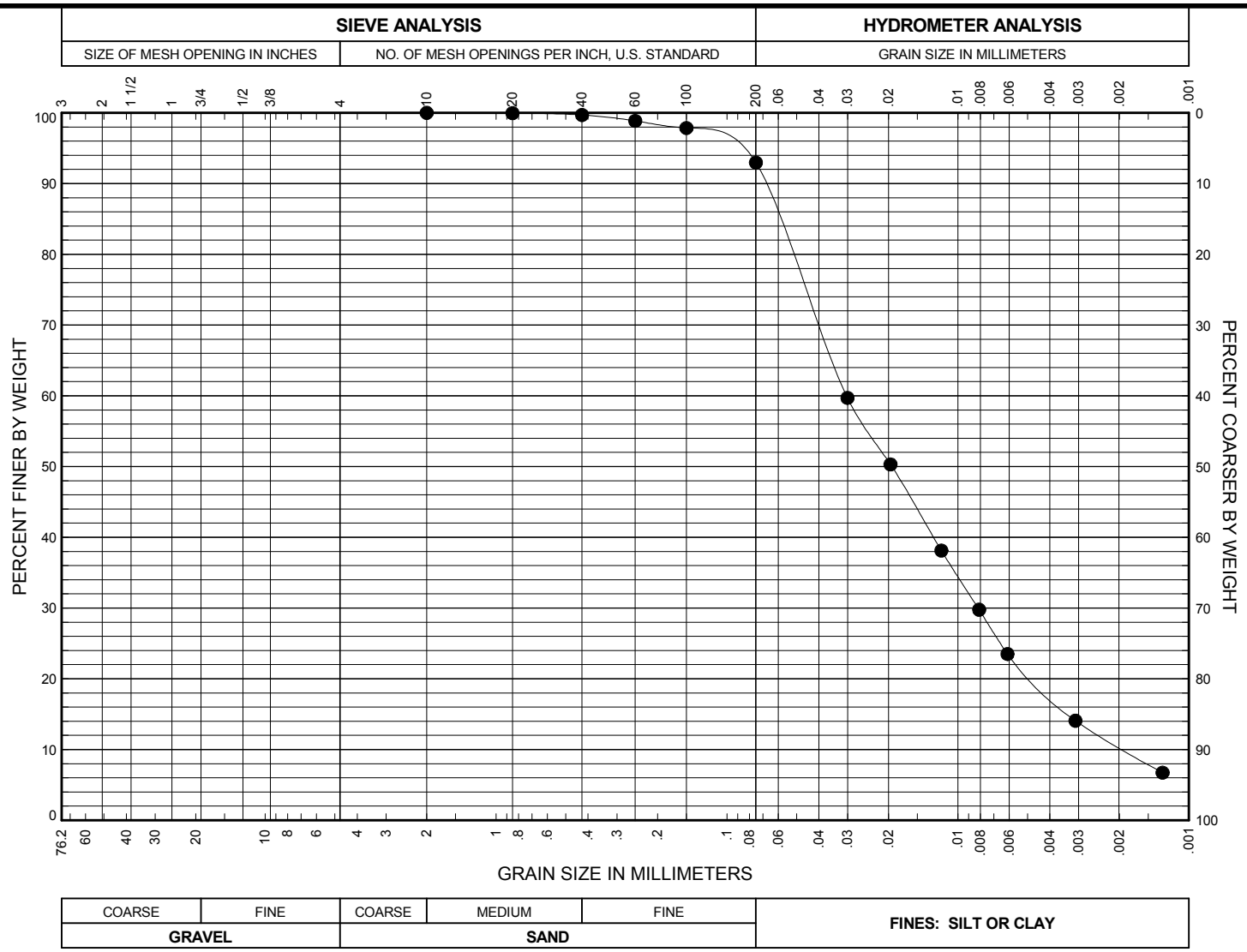
FIG. C-21

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-14-13, S-3*	6.0	OH	Dark gray, slightly fine sandy, organic SILT (Oven-Dried Liquid Limit 63% of Natural Liquid Limit)		7	93.0		10	76.7			AKV	JFL	D422

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FIG. C-22
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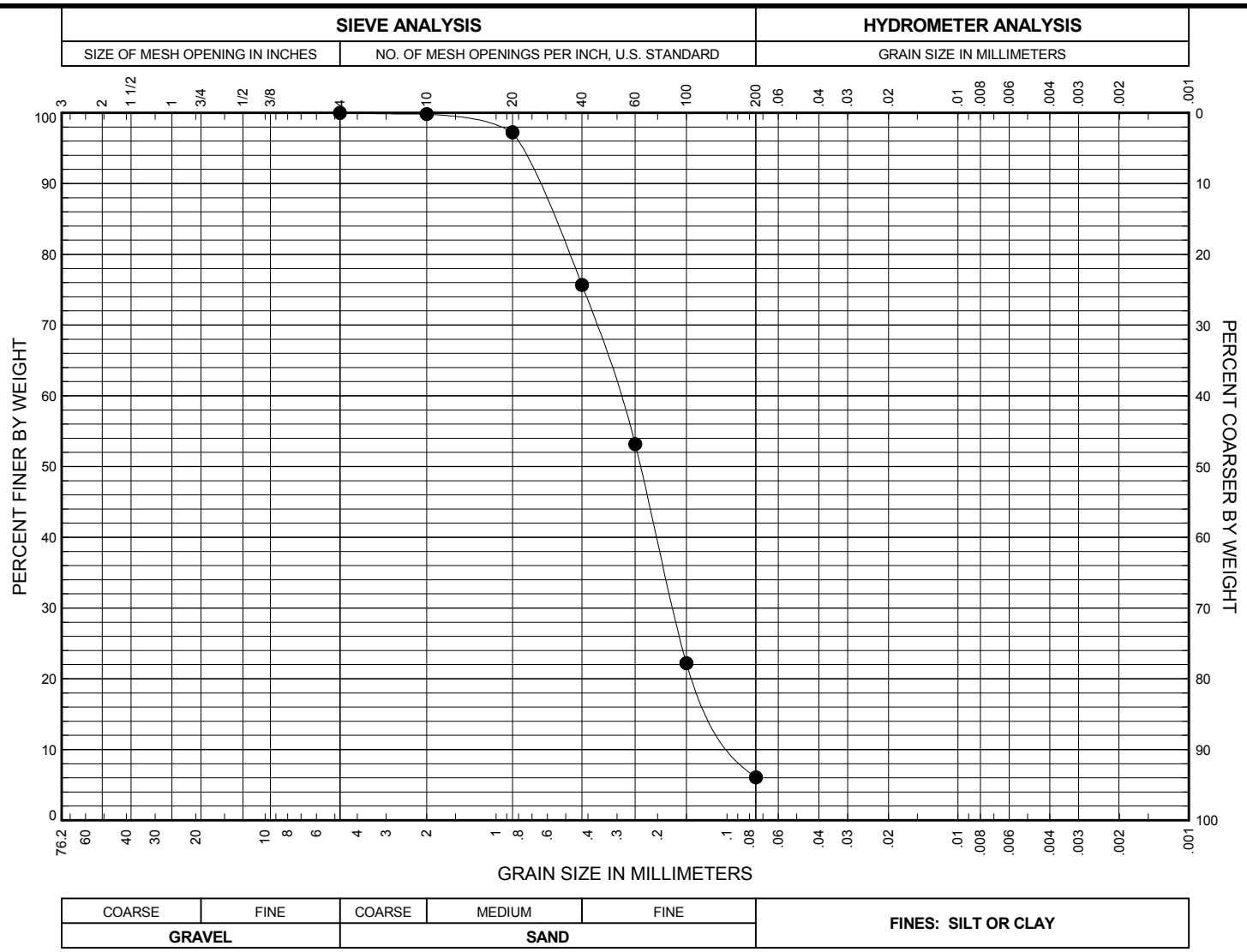
FIG. C-22

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-15-13, S-2	3.5	SP-SM	Dark gray, slightly silty, fine to medium SAND		94	6.1			21.0	3.3	1.1	AKV	JFL	D422

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FIG. C-23
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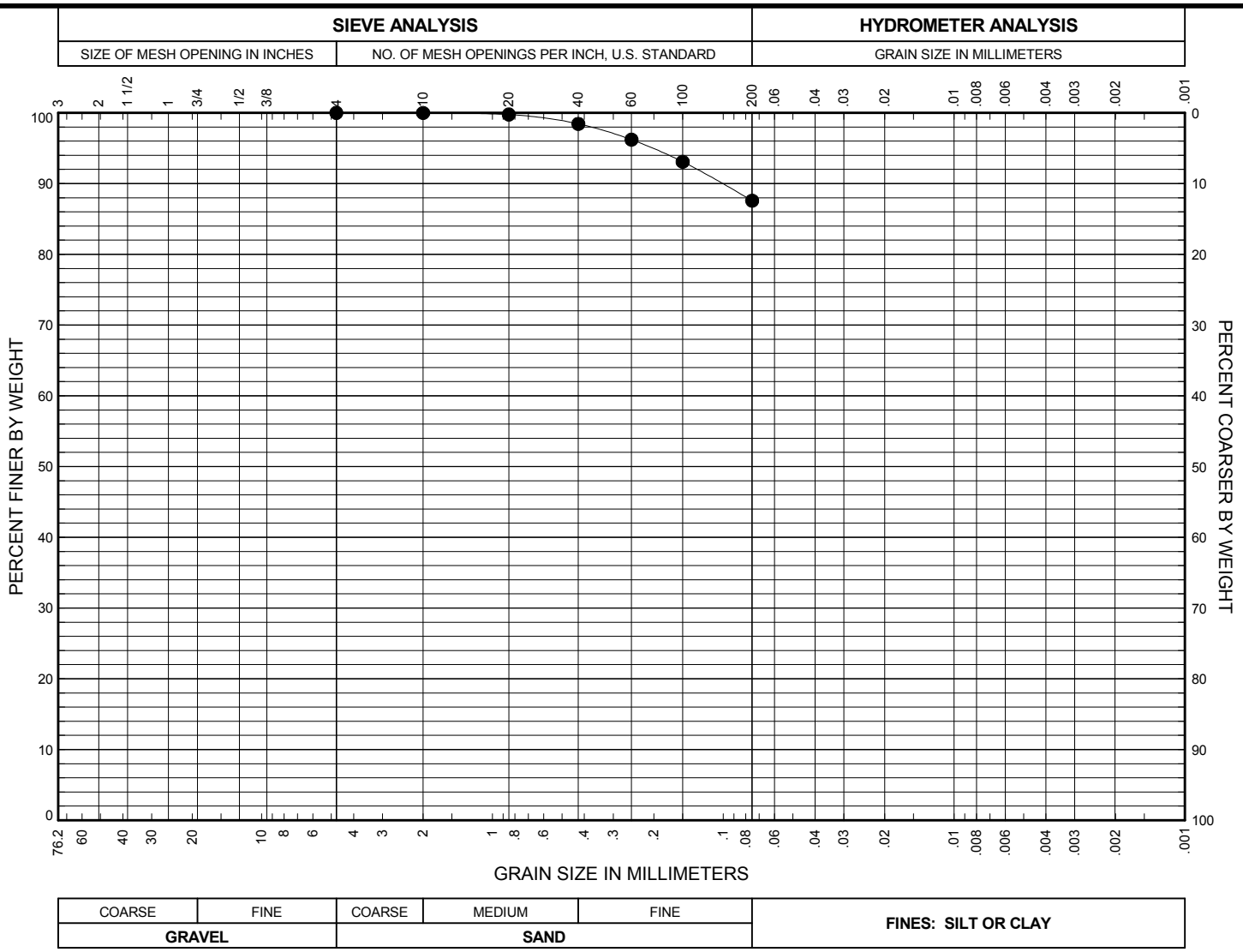
FIG. C-23

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-16-13, S-2	2.0	ML	Gray, slightly clayey, fine to medium sandy SILT (+ No. 200 material mostly composed of organics)		12	87.6			59.0			AKV	JFL	D422

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FIG. C-24
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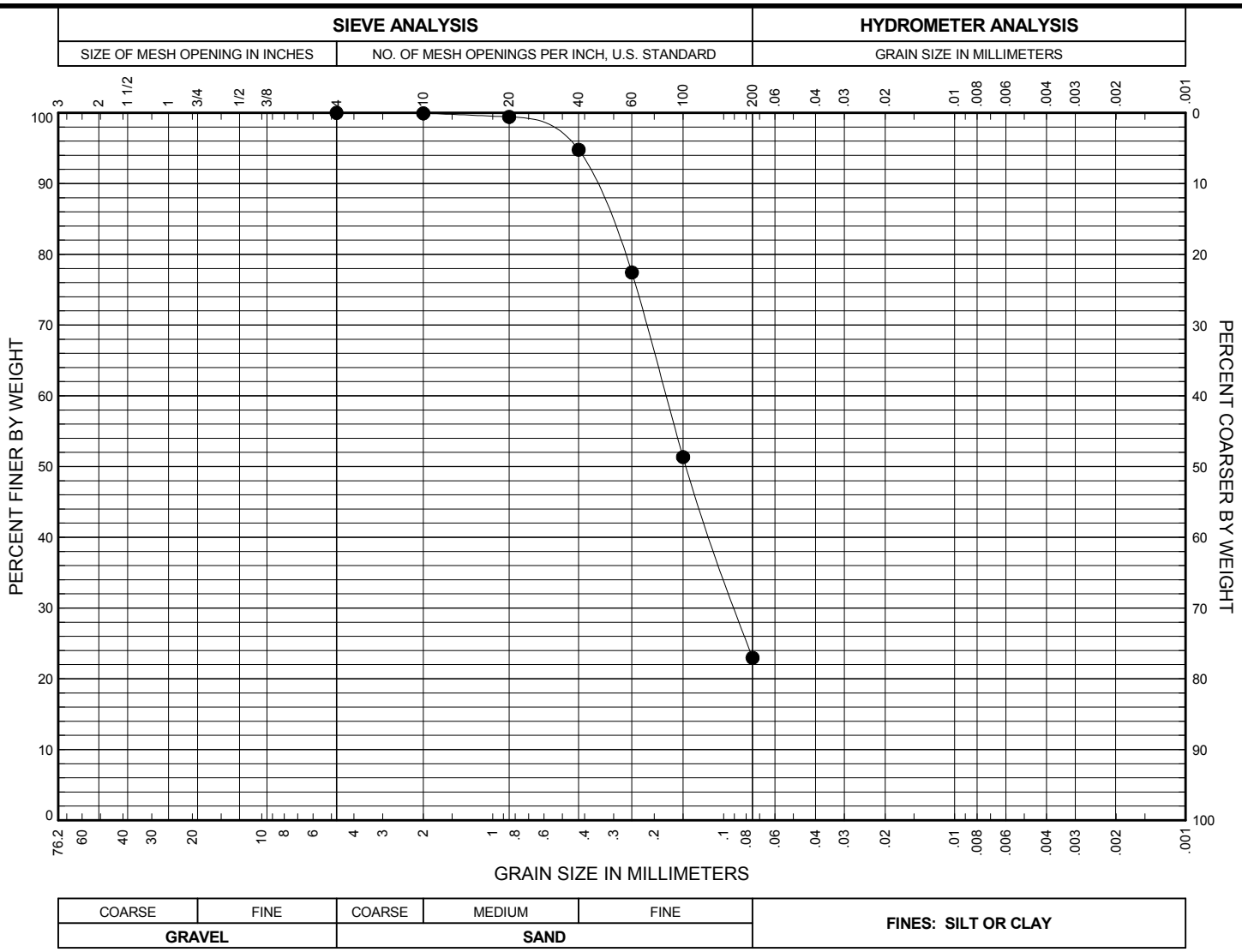
FIG. C-24

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-17-13, S-3	3.0	SM	Dark gray, silty, fine to medium SAND		77	23.0			34.1			AKV	JFL	D422

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FIG. C-25
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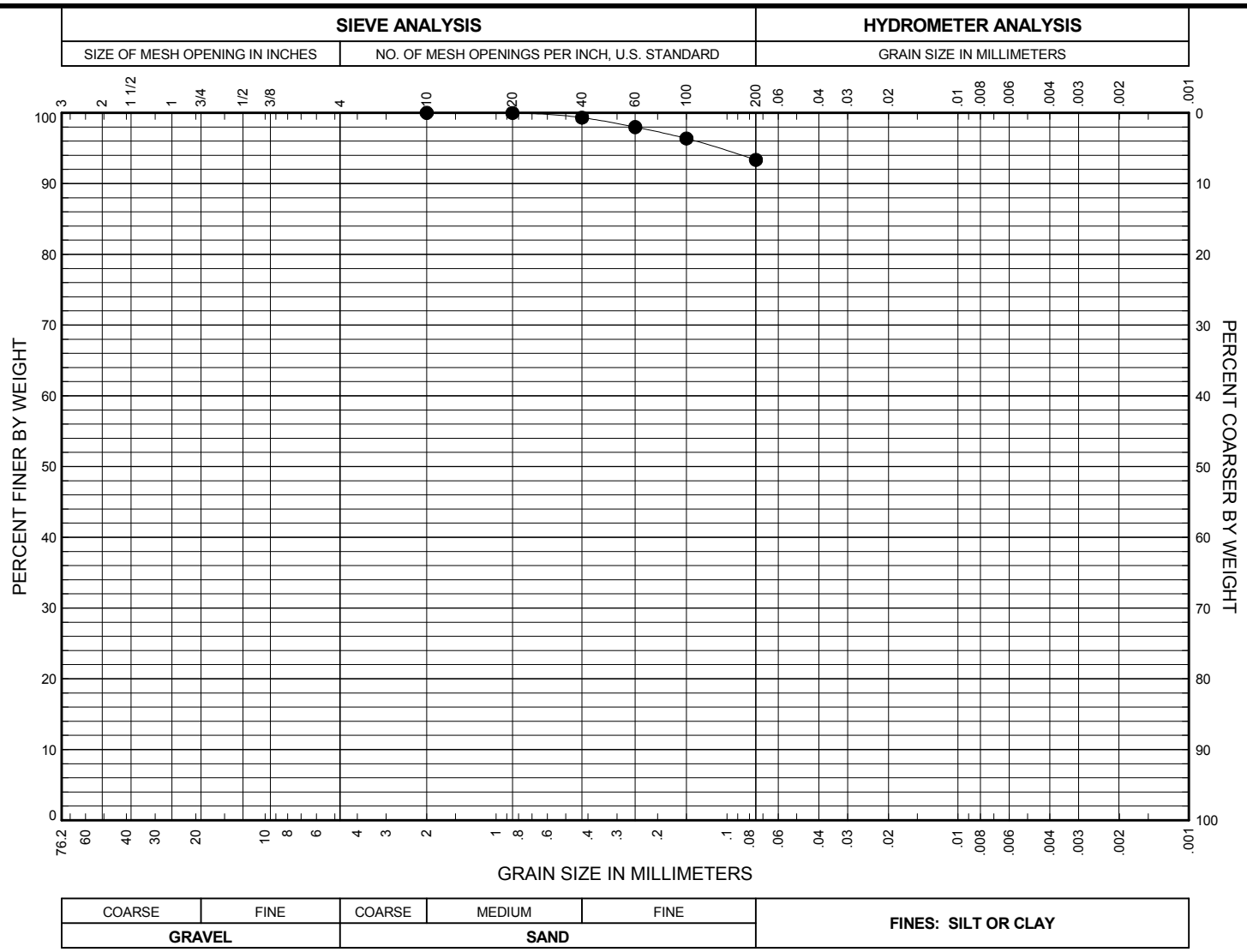
FIG. C-25

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-18-13, S-2	2.0	ML	Gray-brown, slightly fine sandy SILT, trace of clay (+ No. 60 material mostly composed of organics)		7	93.4			43.4			AKV	JFL	D422

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FIG. C-26
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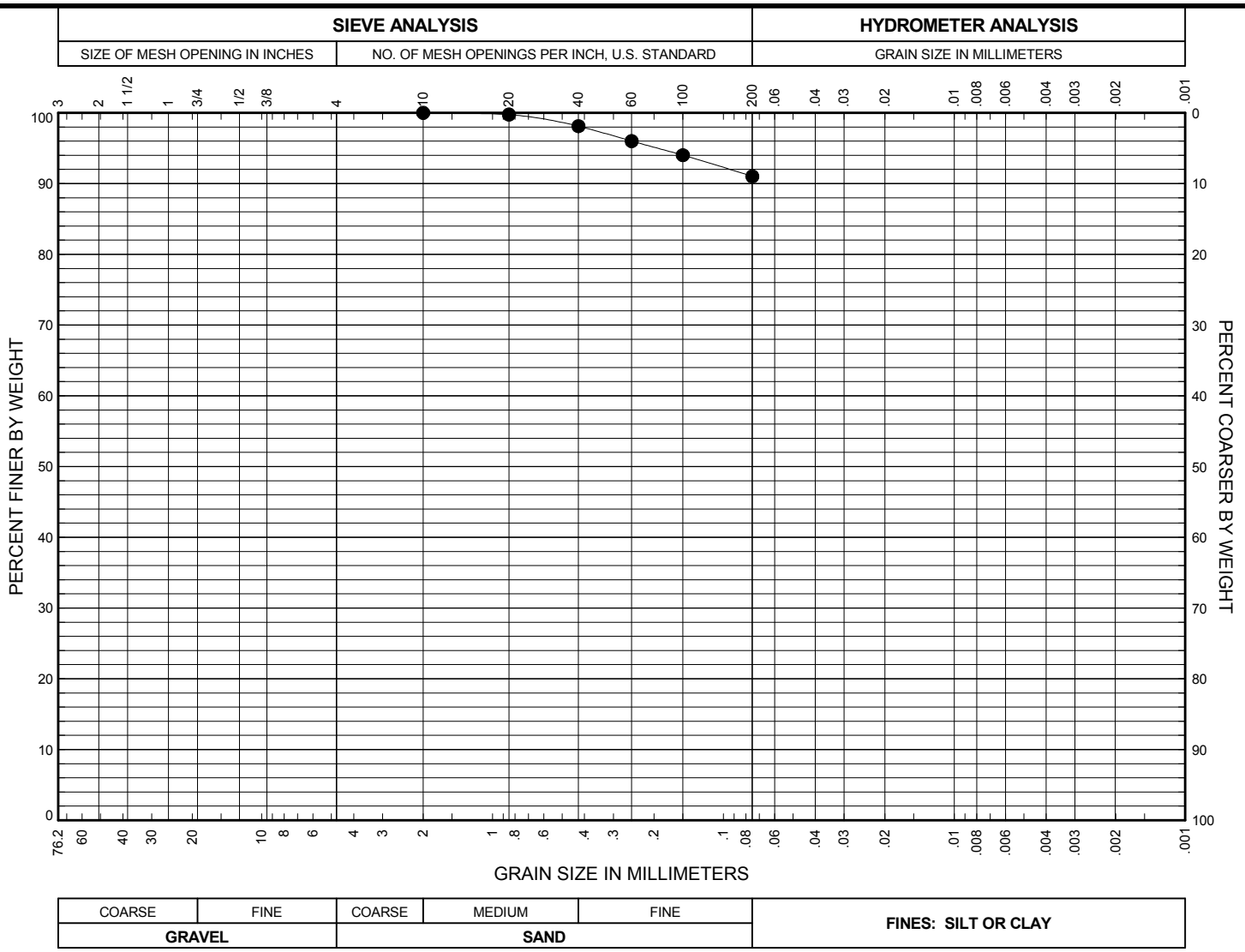
FIG. C-26

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-19-13, S-2*	1.0	ML	Gray-brown, slightly fine to medium sandy SILT (+ No. 60 material mostly composed of organics)		9	91.0			28.5			AKV	JFL	D422

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FIG. C-27
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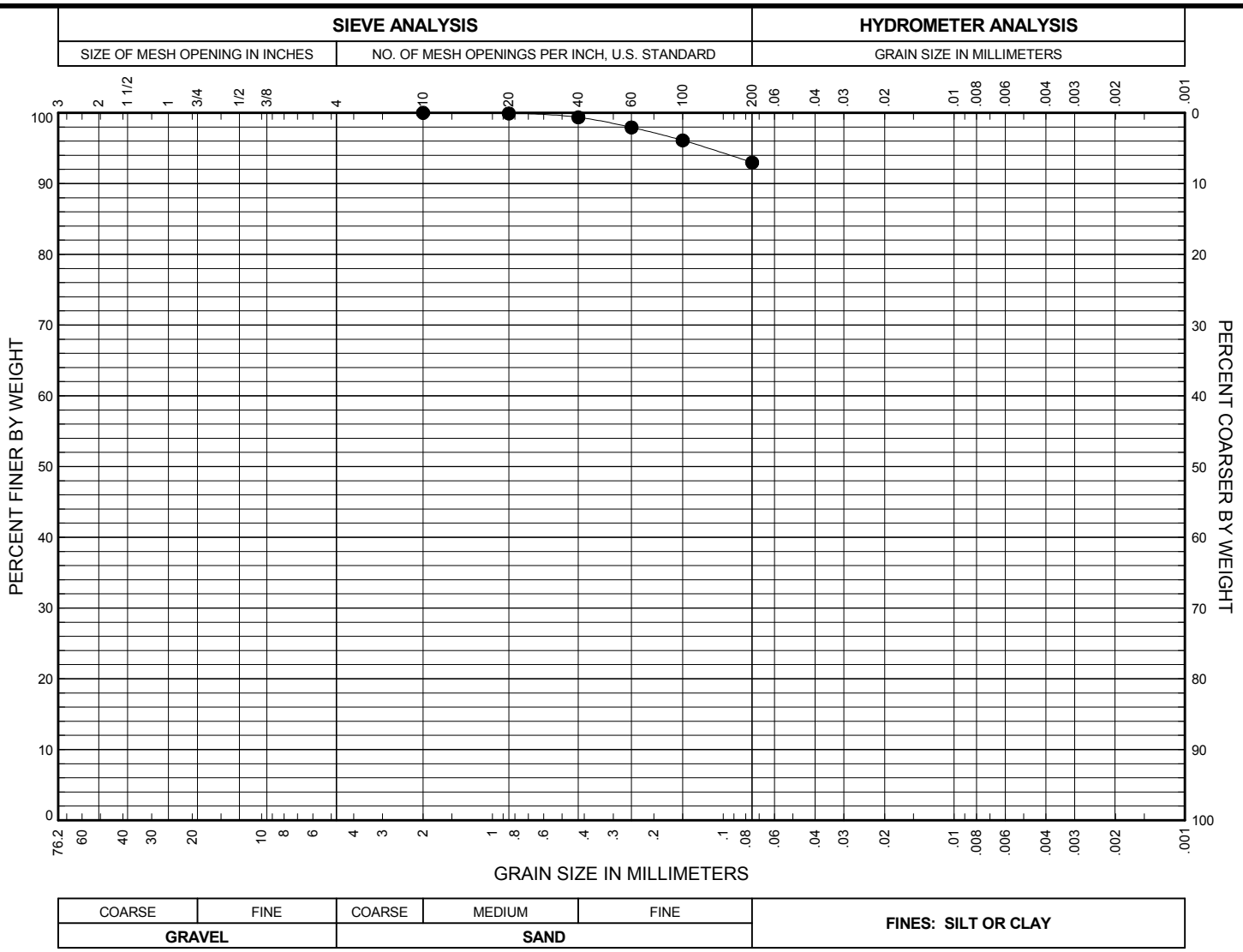
FIG. C-27

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-21-13, S-2*	3.0	ML	Gray, slightly fine sandy, slightly clayey SILT (+ No. 100 material mostly composed of organics)		7	93.0			50.8			AKV	JFL	D422

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FIG. C-28
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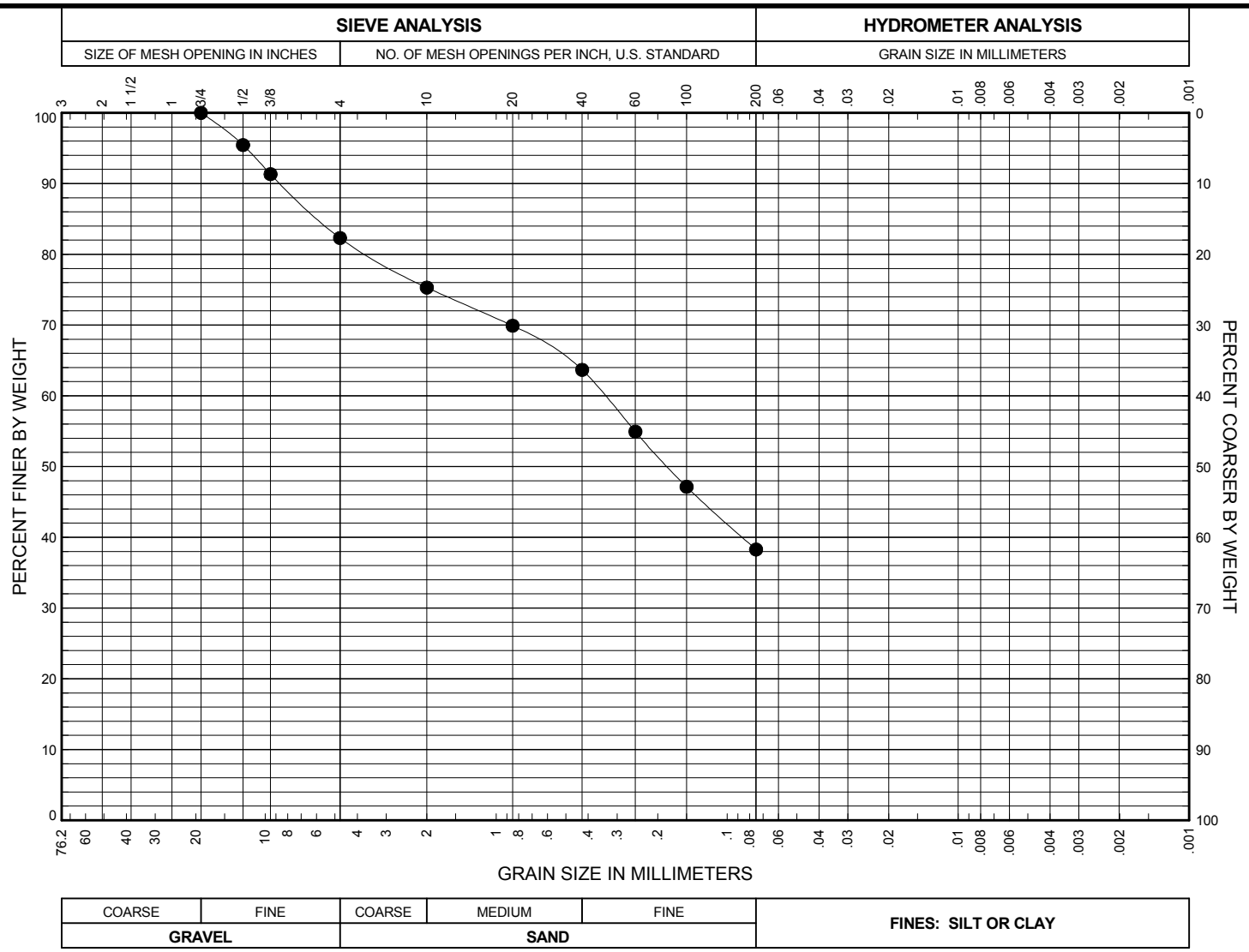
FIG. C-28

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-22-13, S-2*	3.0	SM	Gray, fine gravelly, silty SAND	18	44	38.3			11.7			AKV	JFL	D422

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FIG. C-29
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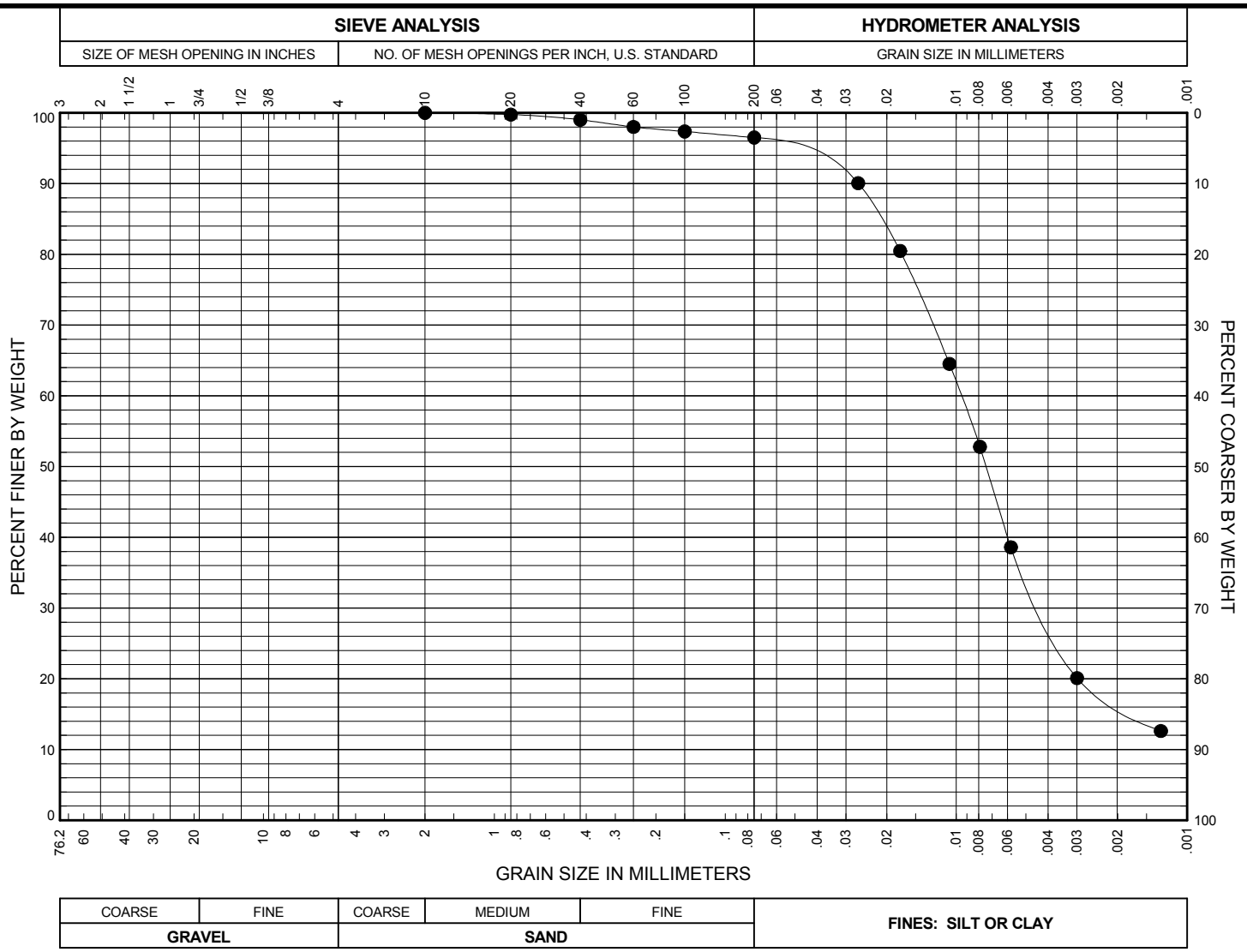
FIG. C-29

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-23-13, S-3*	8.5	ML	Dark gray, slightly clayey SILT, trace of fine to medium sand		3	96.5		16	67.8			JFL	JFL	D422

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FIG. C-30
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FIG. C-30

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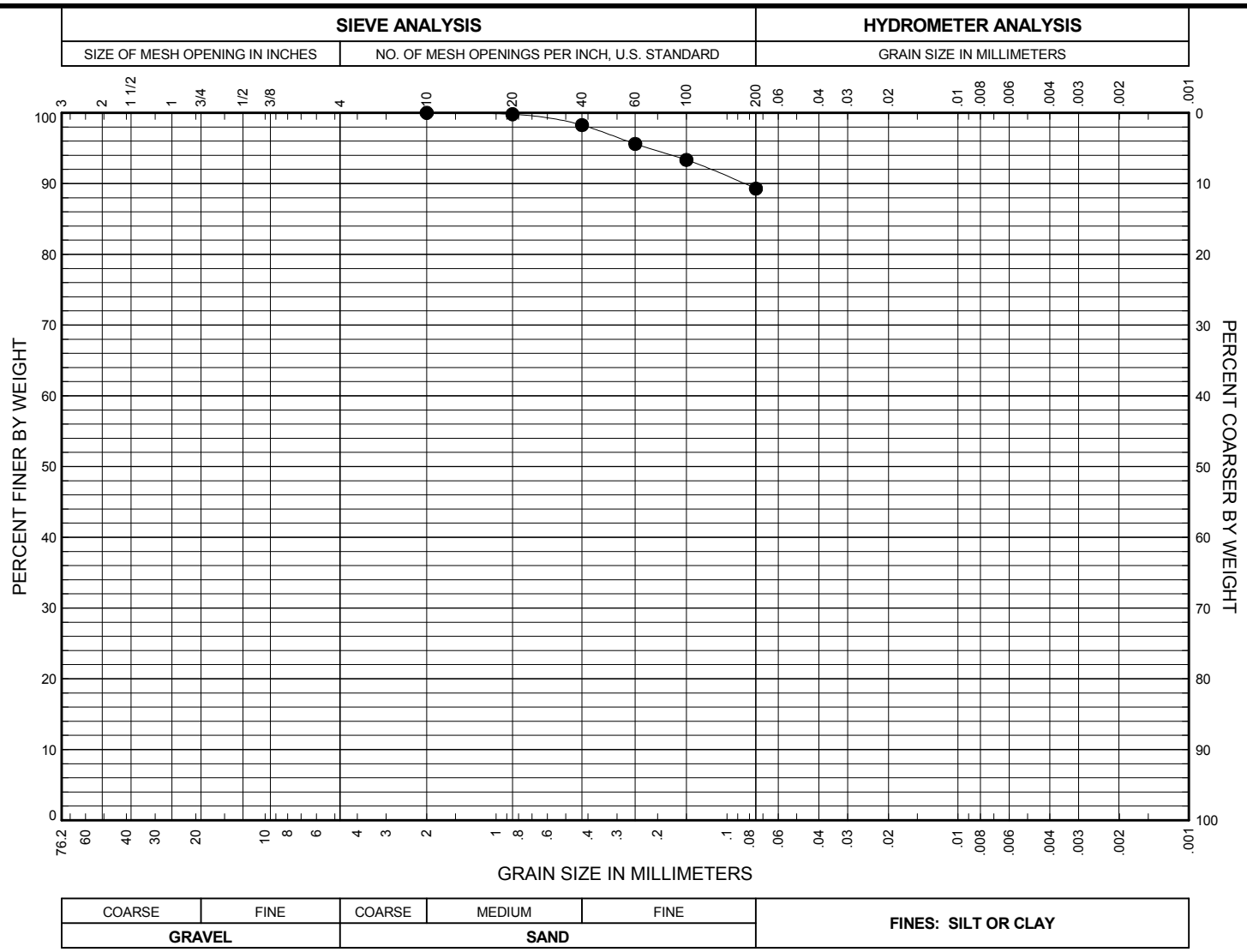

LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-24-13, S-2	2.0	MH	Gray-brown, slightly fine to medium sandy, clayey SILT (+ No. 60 material mostly composed of organics)		11	89.3			32.3			AKV	JFL	D422

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FIG. C-31
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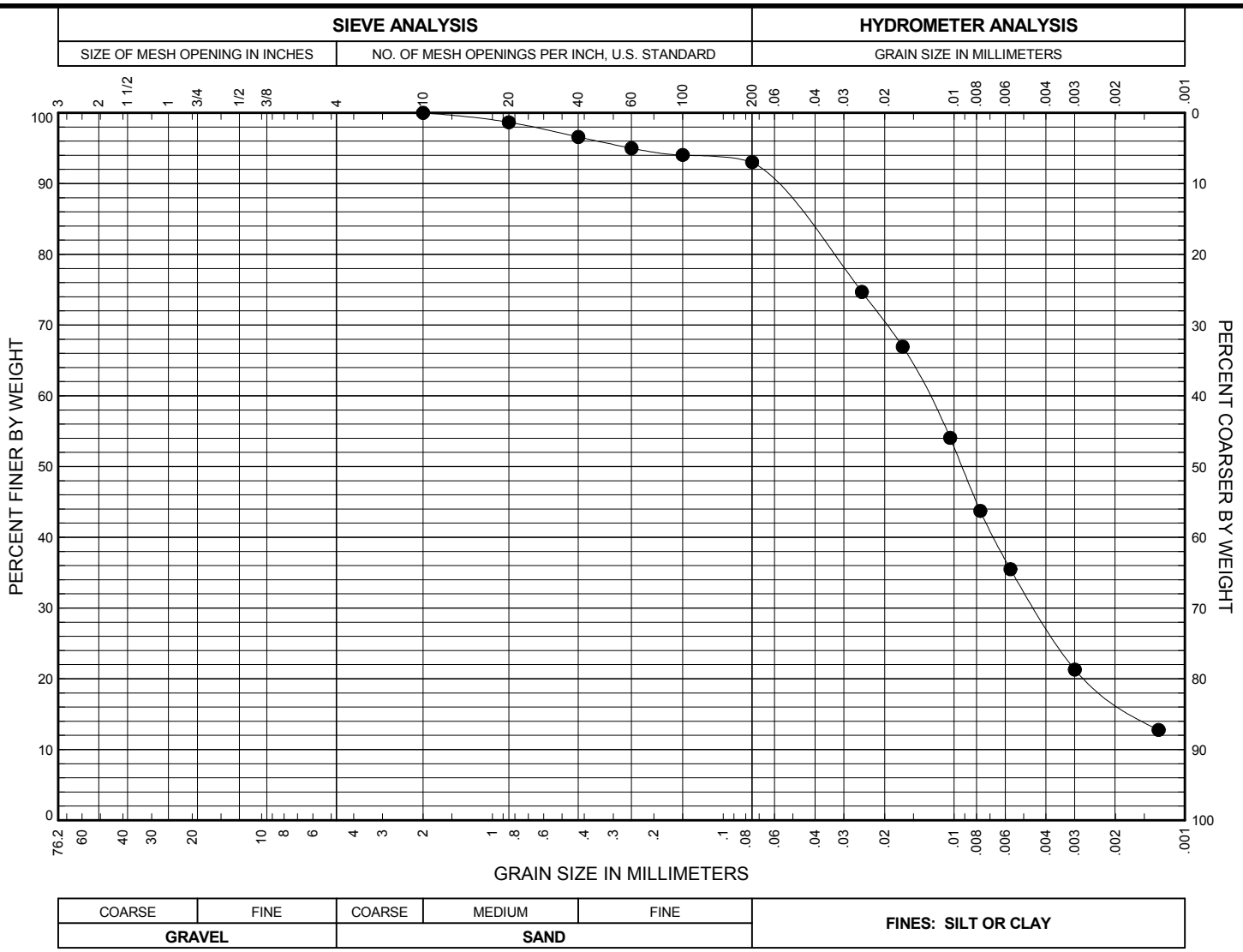
FIG. C-31

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-26-13, S-3	3.0	ML	Gray, slightly fine to medium sandy SILT		7	93.0		17	49.2			AKV	JFL	D422

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FIG. C-32
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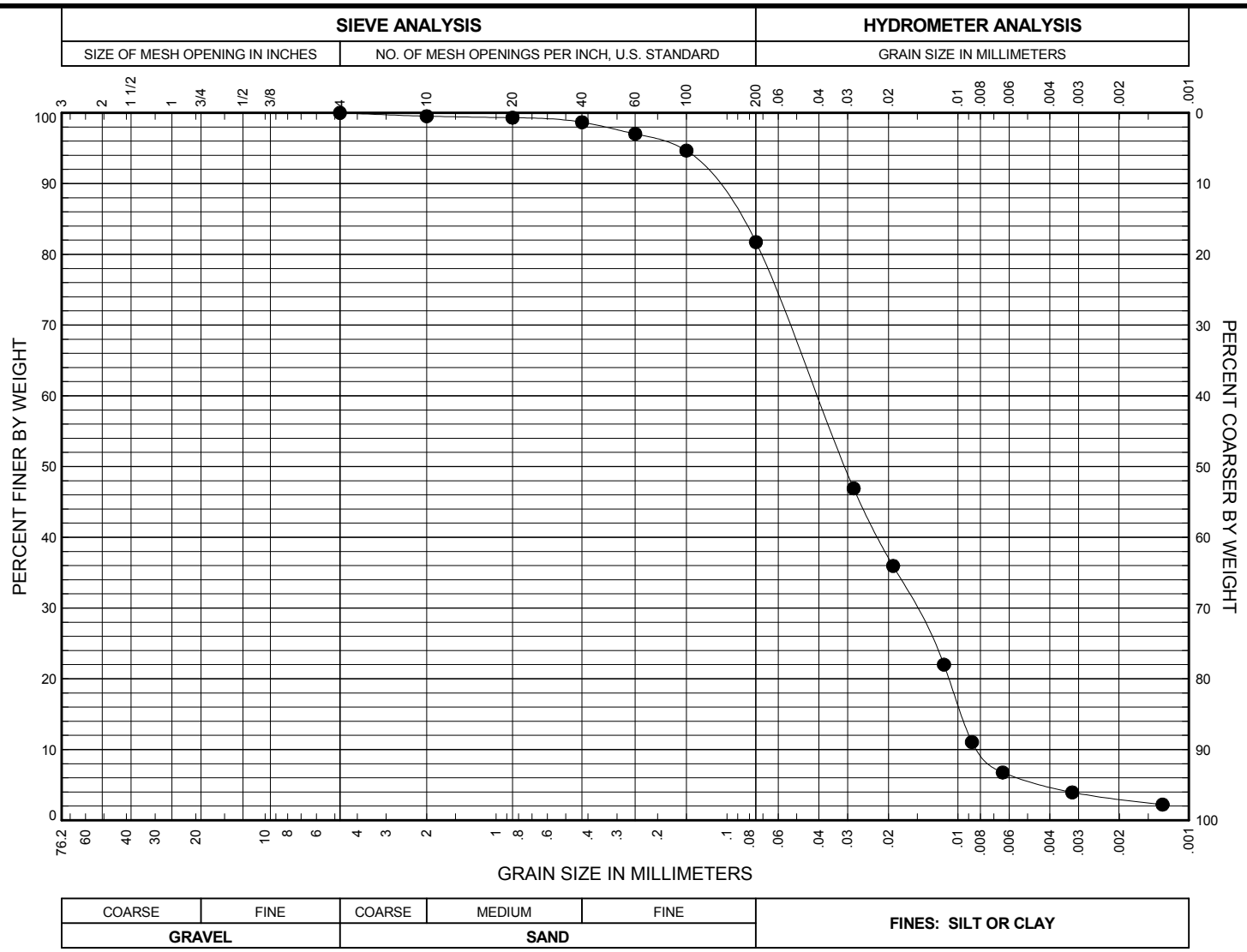
FIG. C-32

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-27-13, S-3	7.0	ML	Dark gray, slightly clayey, fine sandy SILT		18	81.7		3	51.4			AKV	JFL	D422

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FIG. C-33
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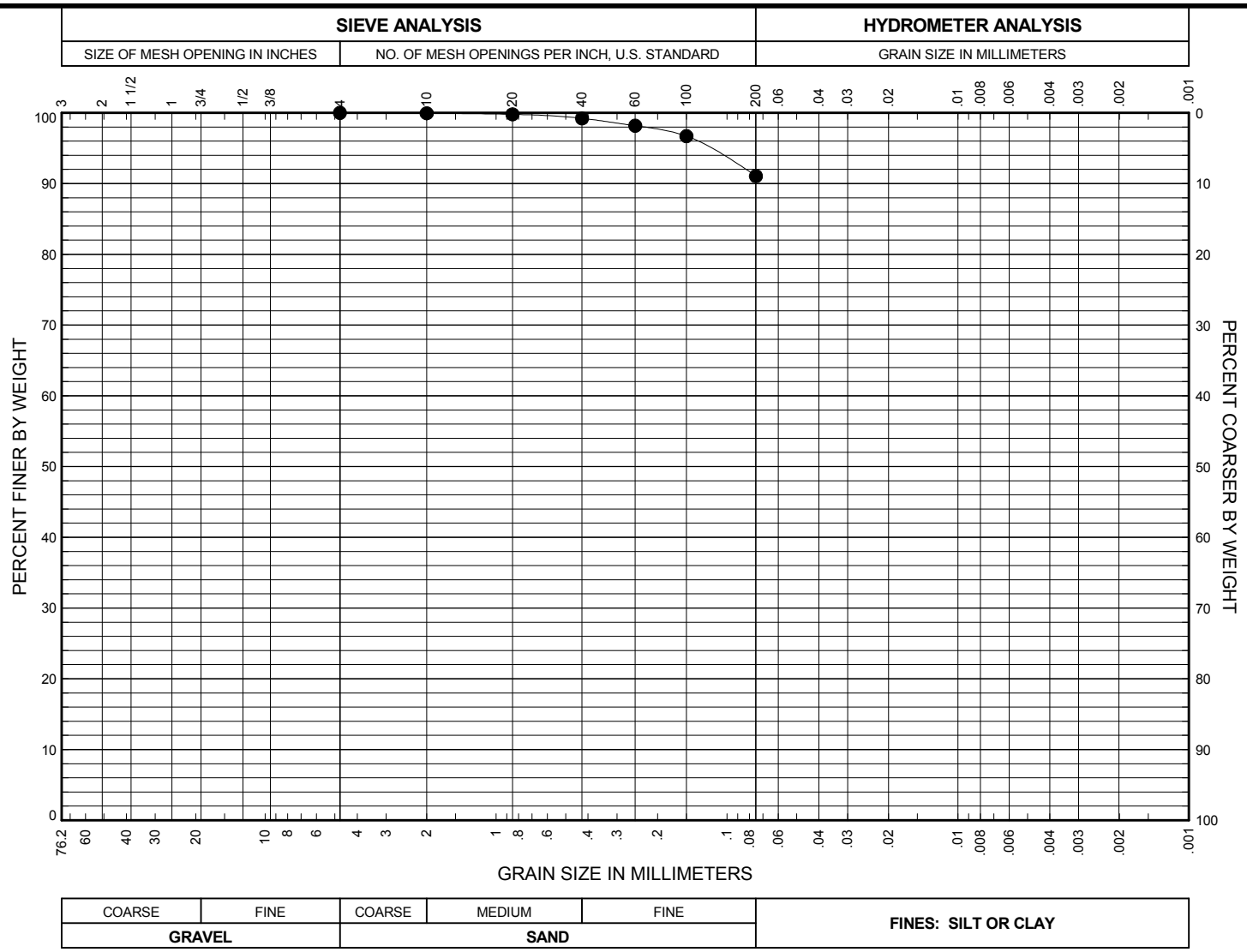
FIG. C-33

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-28-13, S-2	2.5	ML	Dark gray, slightly fine sandy, slightly clayey SILT (+ No. 60 material mostly composed of organics)		9	91.1			56.9			AKV	JFL	D422

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FIG. C-34
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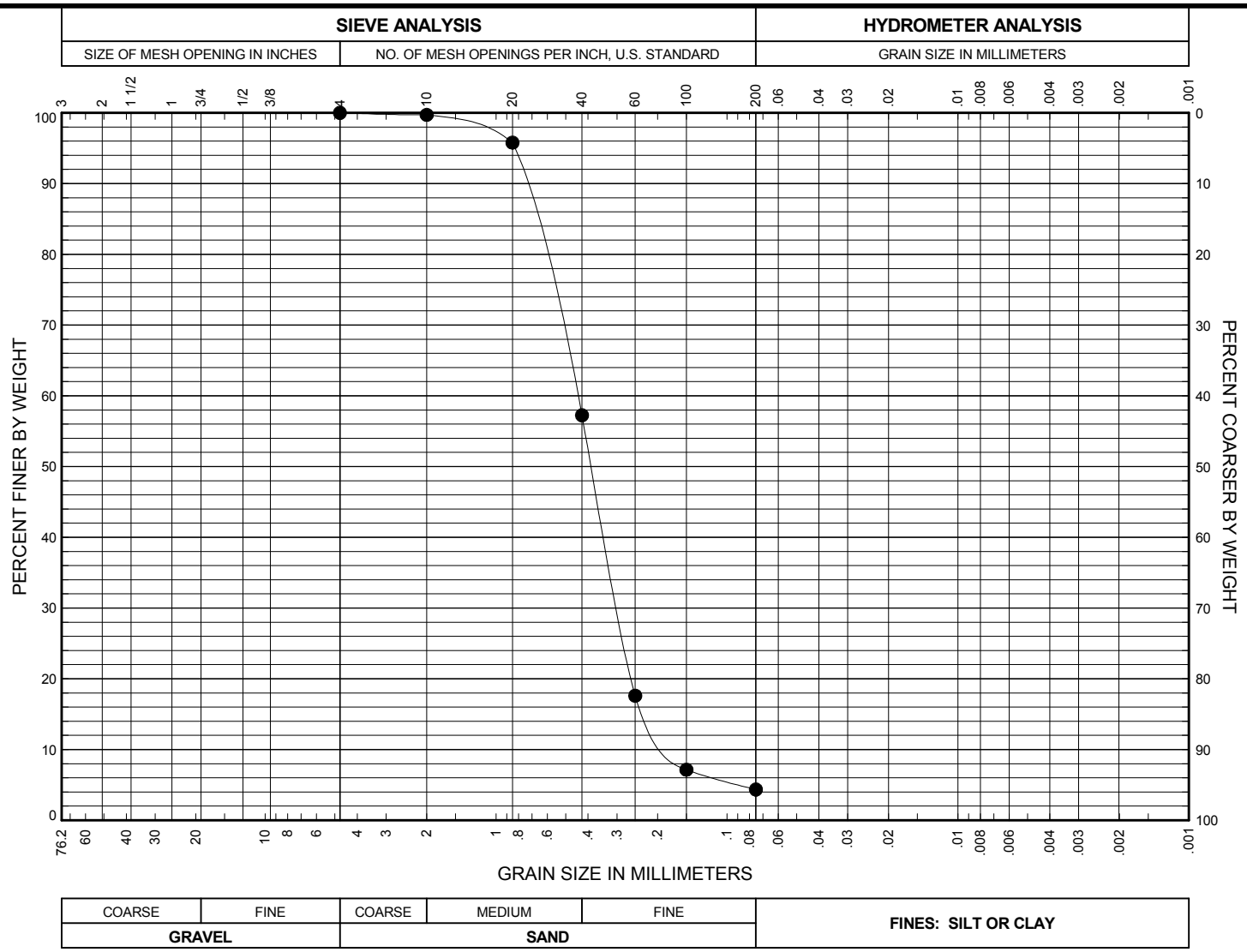
FIG. C-34

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-29-13, S-3	3.5	SP	Dark gray-brown, fine to medium SAND, trace of silt		96	4.3			21.4	2.6	1.1	AKV	JFL	D422

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FIG. C-35
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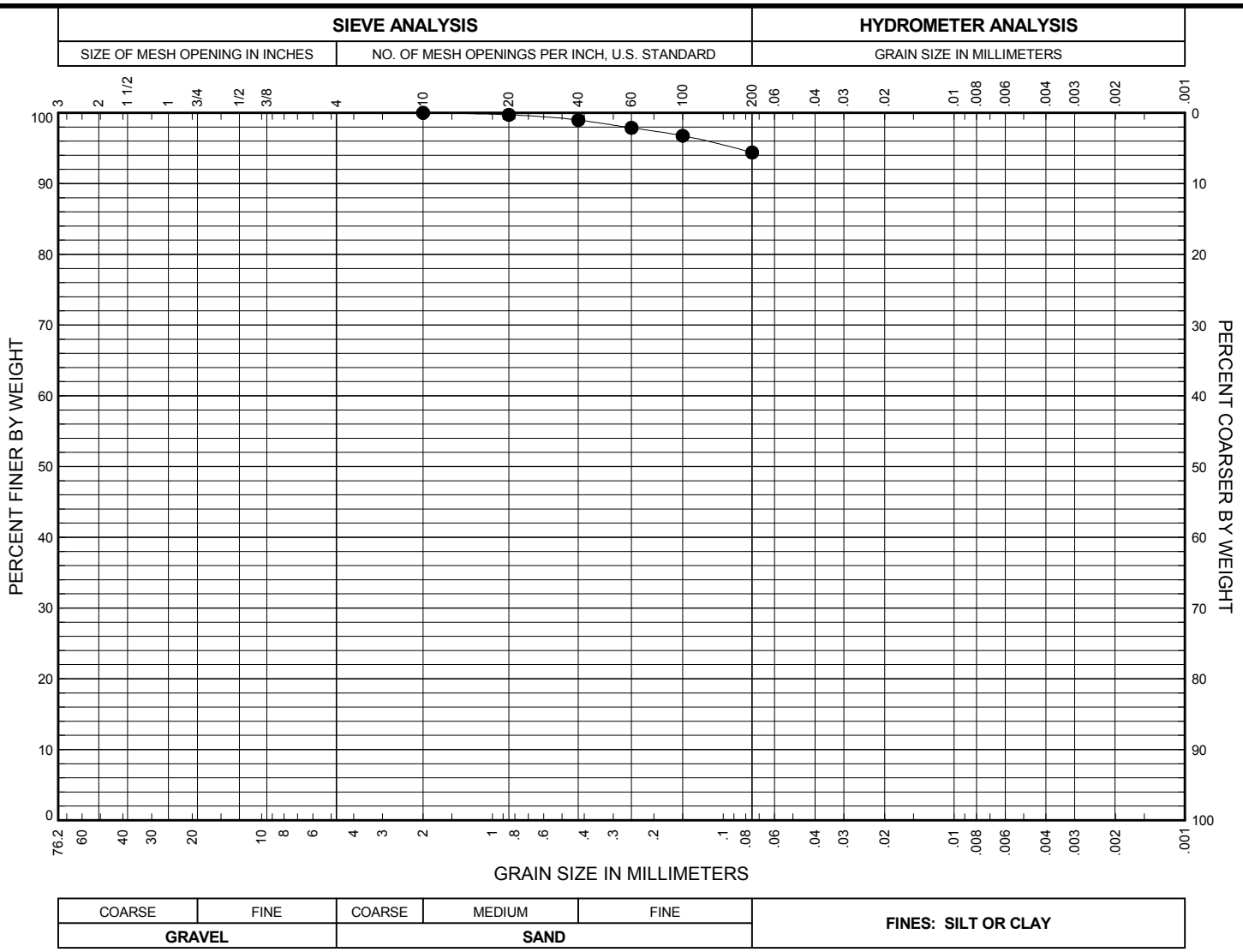
FIG. C-35

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-30-13, S-1	2.0	ML	Gray-brown, slightly fine to medium sandy, slightly clayey SILT (+ No. 60 material mostly composed of organics)		6	94.4			46.2			AKV	JFL	D422

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FIG. C-36
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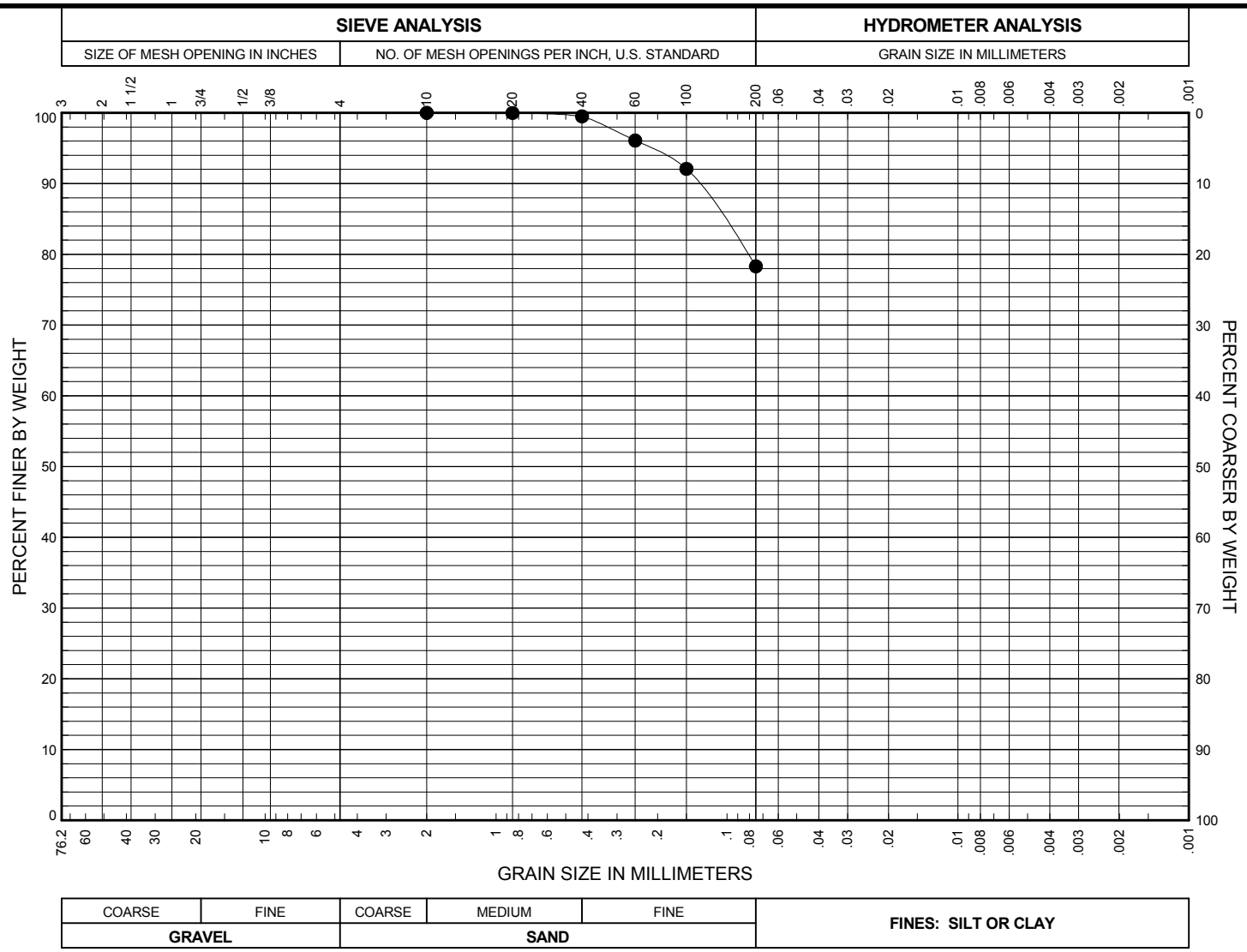
FIG. C-36

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-31-13, S-2	3.0	ML	Gray, fine sandy SILT, trace of clay (+ No. 60 material mostly composed of organics)		22	78.3			48.3			AKV	JFL	D422

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FIG. C-37
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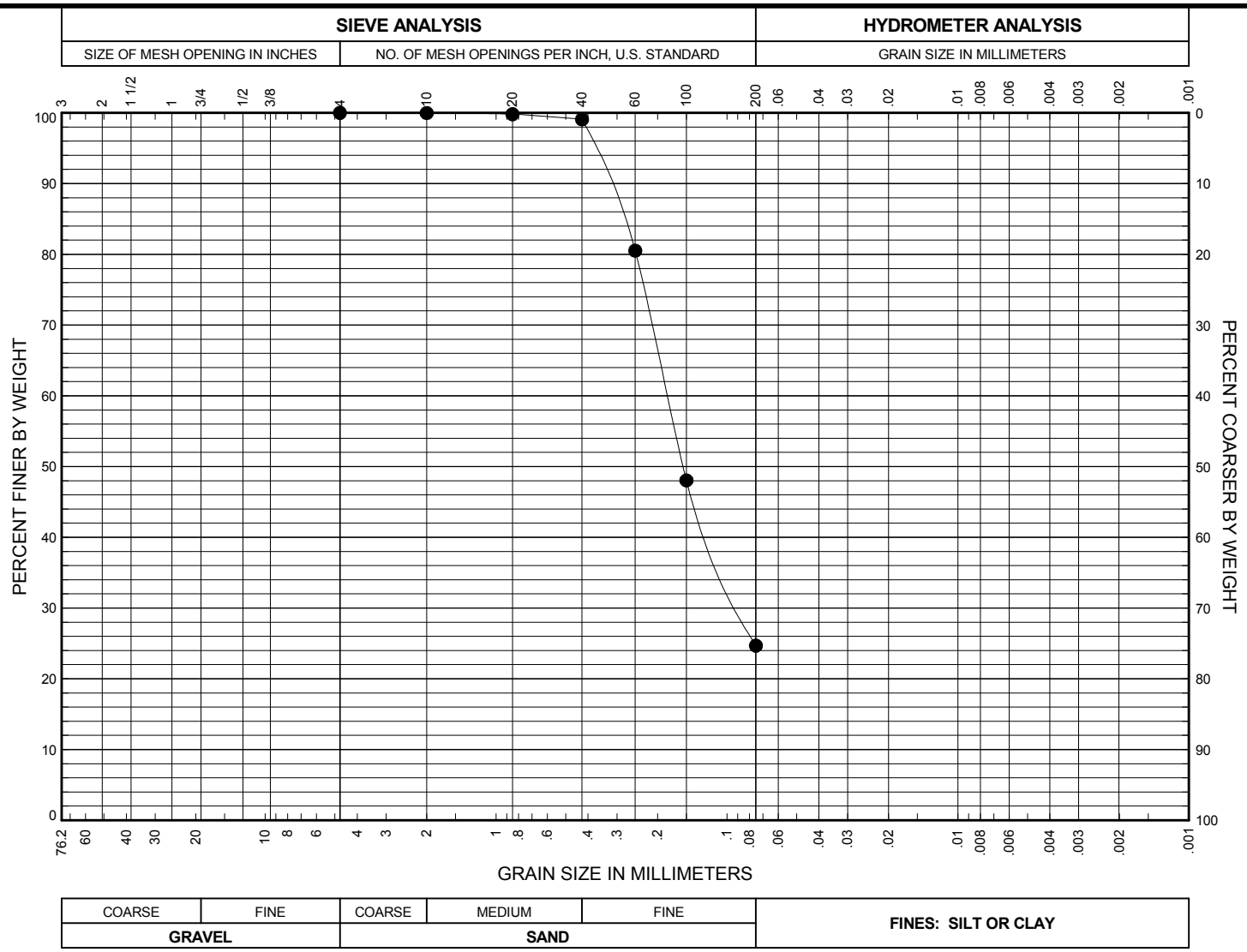
FIG. C-37

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-32-13, S-3	4.5	SM	Gray, silty, fine SAND		75	24.7			36.9			AKV	JFL	D422

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TEST PIT TP-32-13

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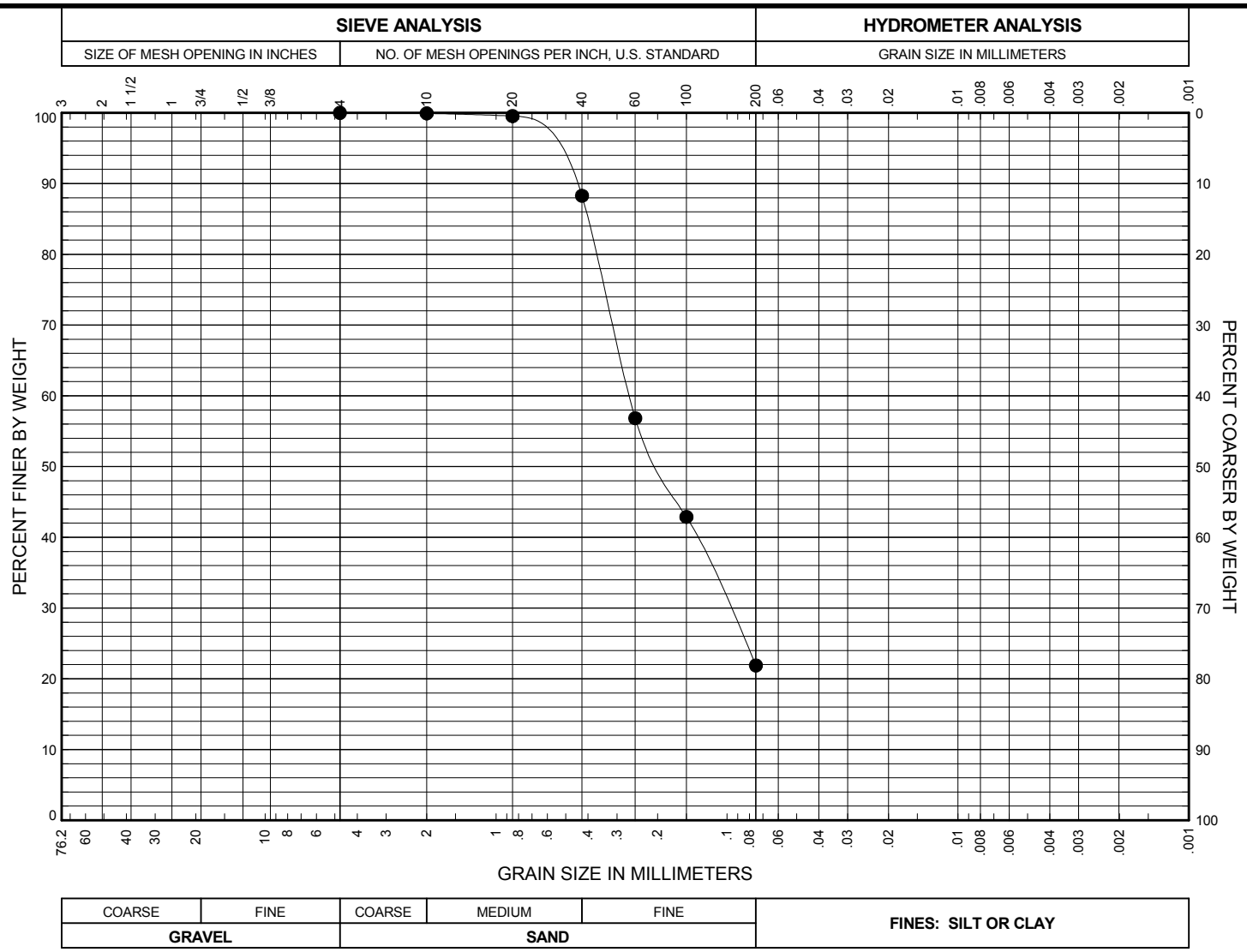
FIG. C-38
Sheet 1 of 1

FIG. C-38

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-33-13, S-3	3.5	SM	Gray-brown, silty, fine to medium SAND (+ No. 20 material mostly composed of organics)		78	21.9			42.1			AKV	JFL	D422

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FIG. C-39
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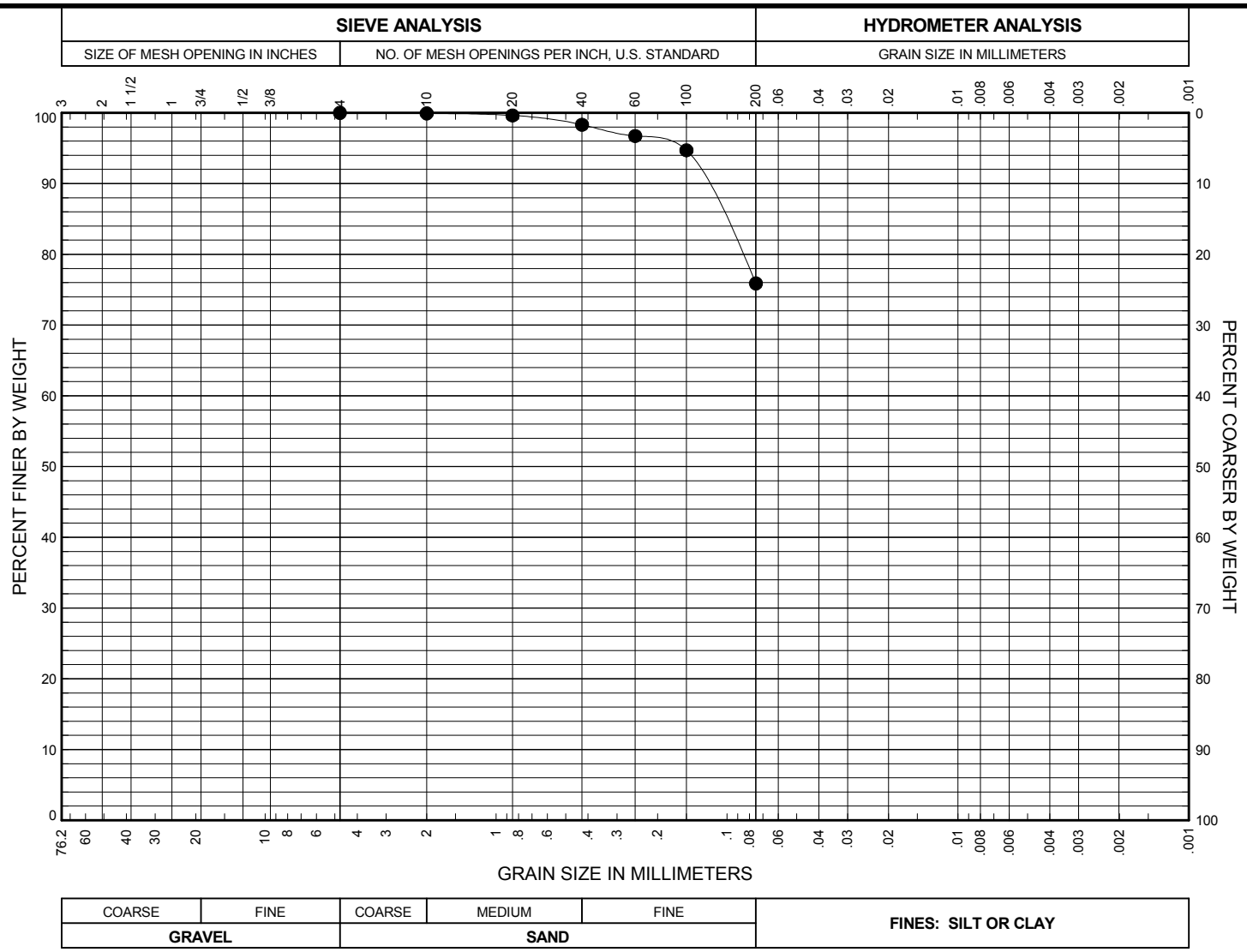
FIG. C-39

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-34-13, S-2	2.0	ML	Gray, fine to medium sandy SILT (+ No. 40 material mostly composed of organics)		24	75.9			50.7			AKV	JFL	D422

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FIG. C-40
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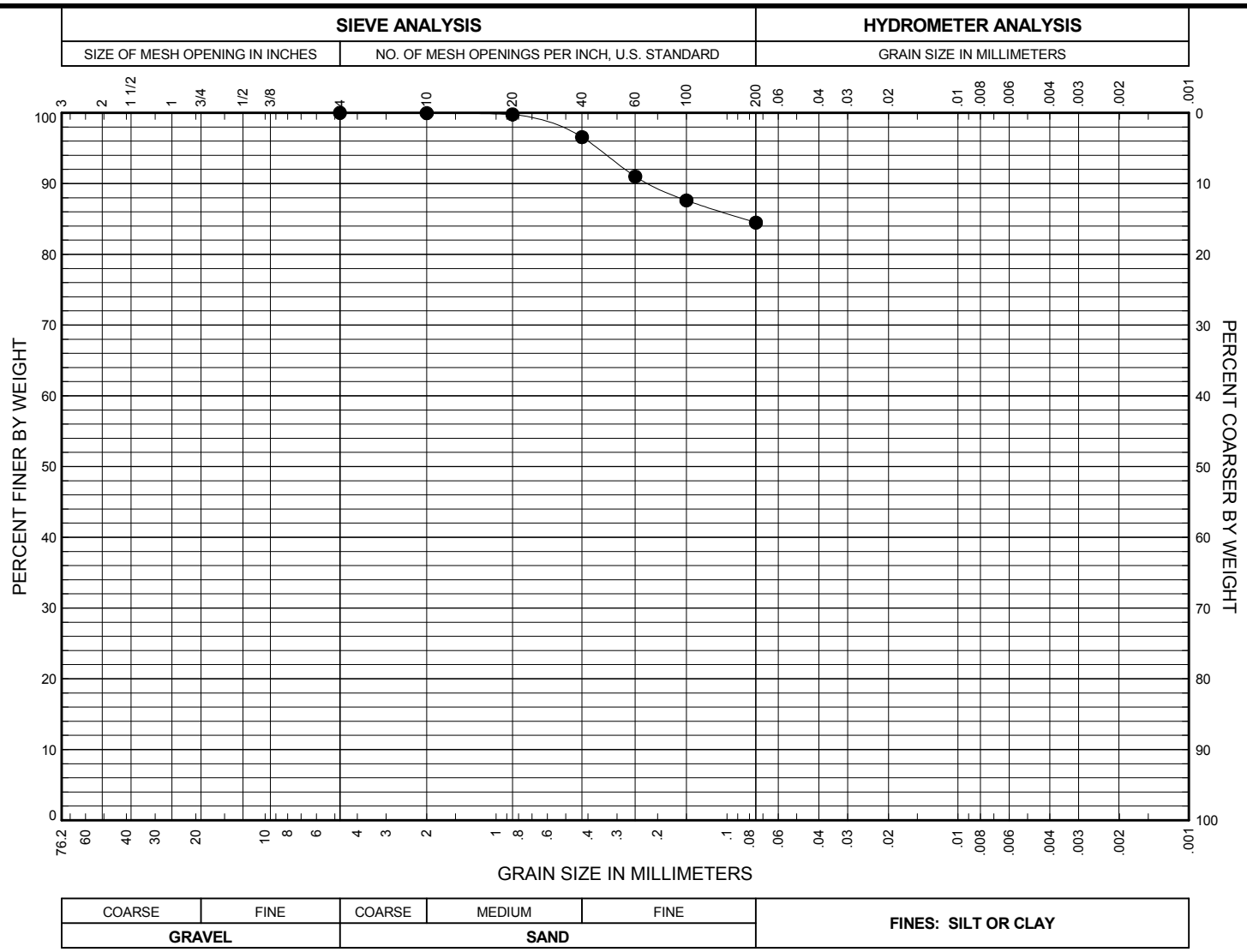
FIG. C-40

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-35-13, S-1	1.0	MH	Brown, fine to medium sandy, clayey SILT		16	84.5			26.7			AKV	JFL	D422

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FIG. C-41
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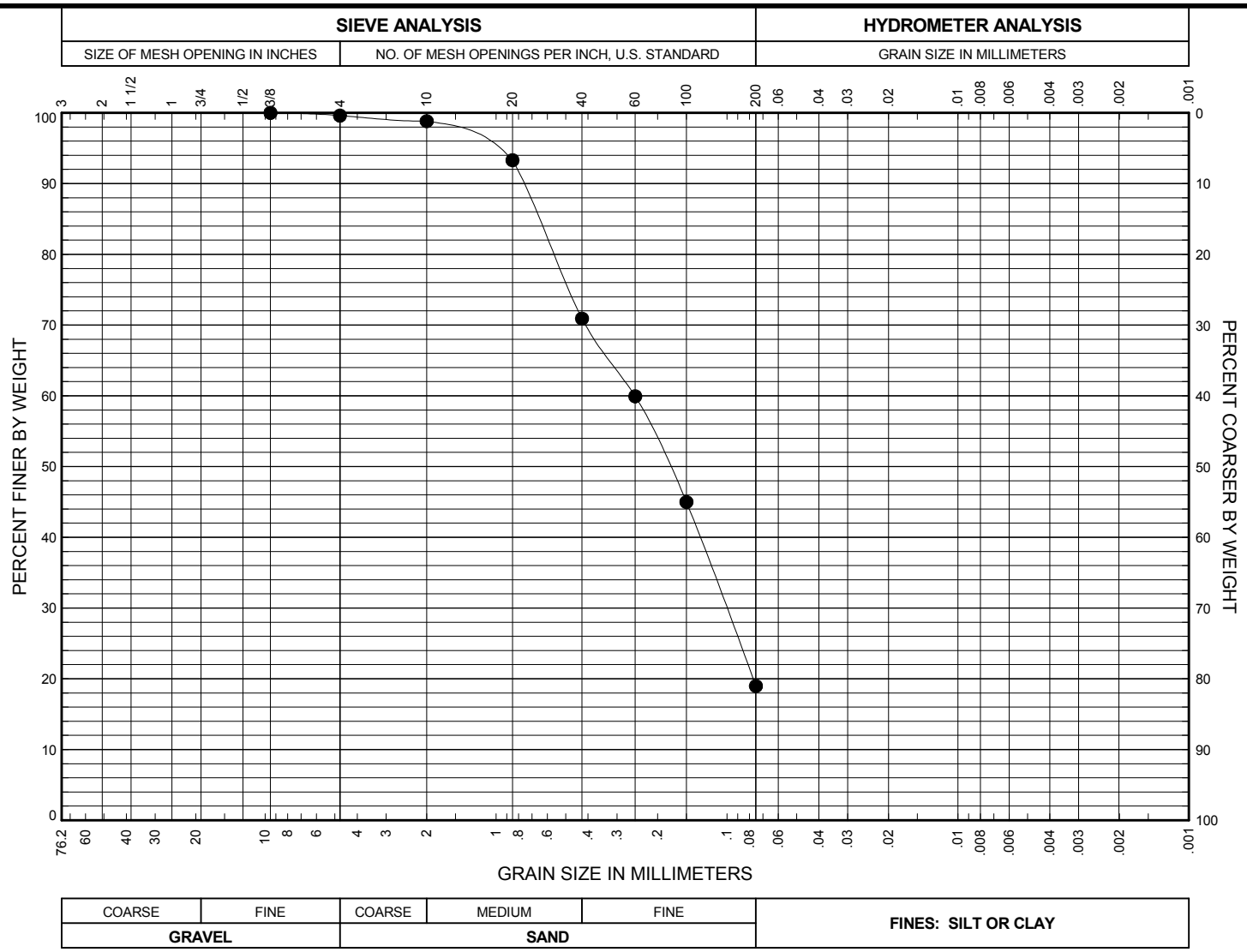
FIG. C-41

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

*: ***Sample specimen weight did not meet required minimum mass for ASTM test method.***

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-36-13, S-3*	5.0	SM	Gray, silty, fine to medium SAND	0	81	19.0			28.5			AKV	JFL	D422

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FIG. C-42
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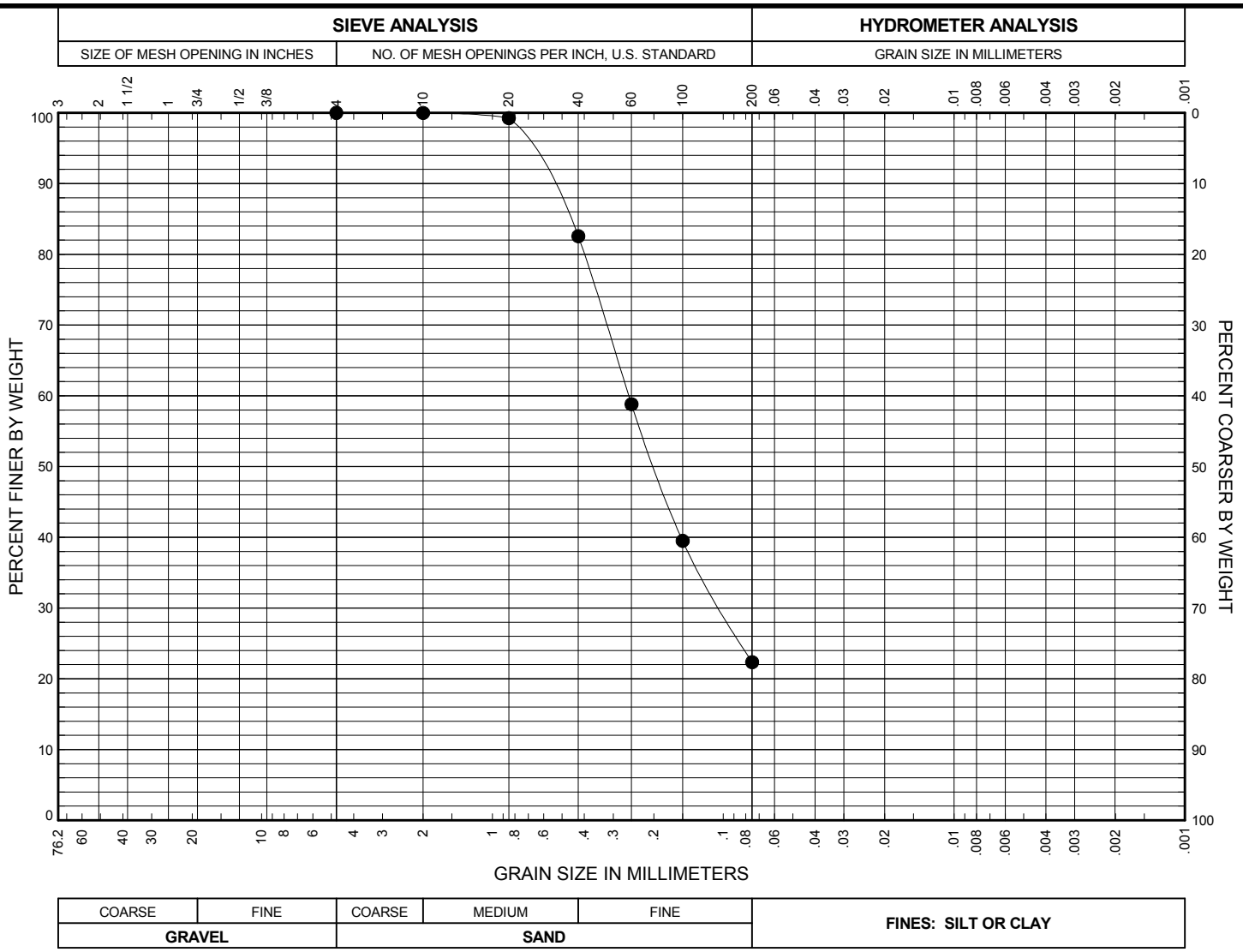
FIG. C-42

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● TP-37-13, S-3	3.0	SM	Gray-brown, silty, fine to medium SAND		78	22.3			26.8			AKV	JFL	D422

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FIG. C-43
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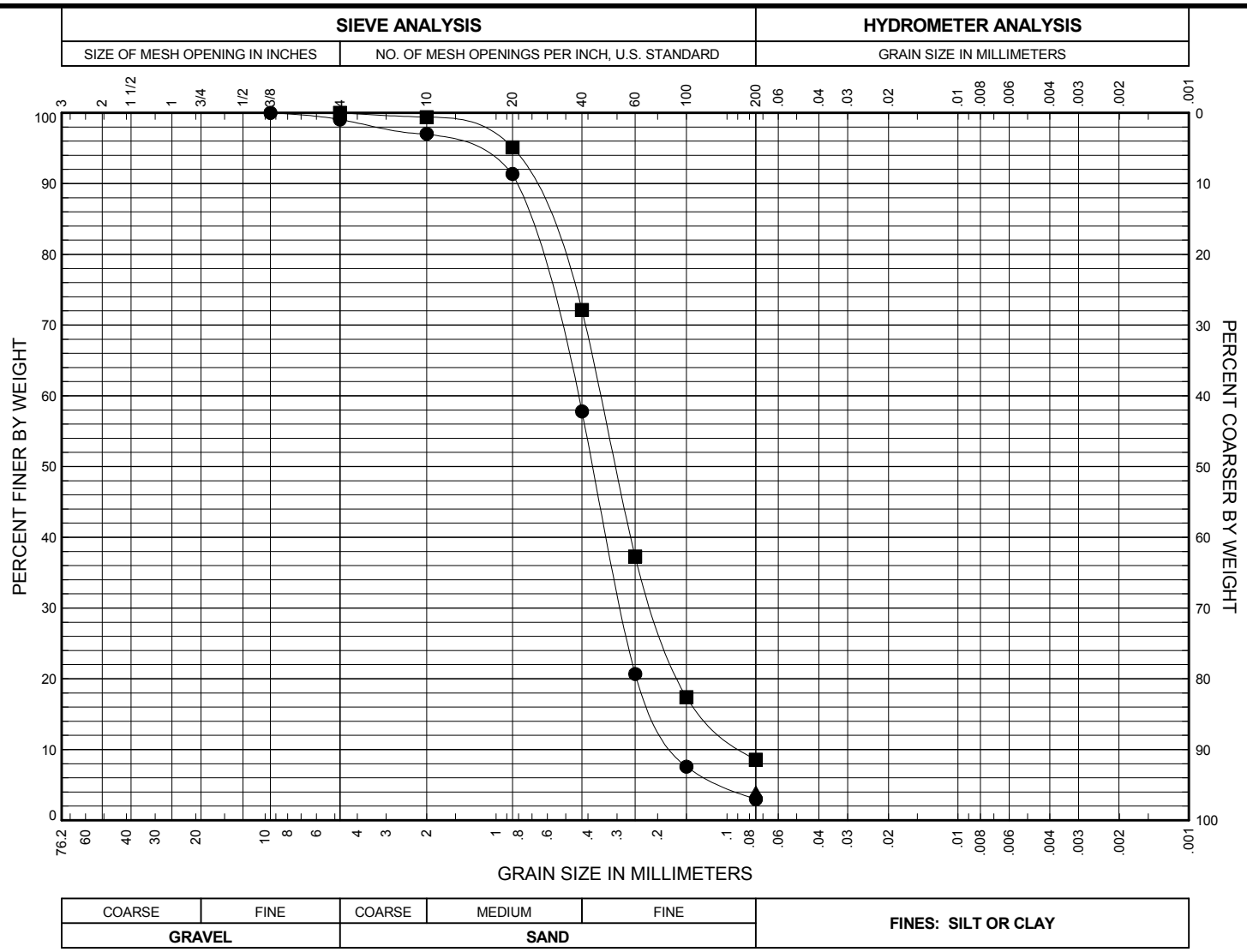
FIG. C-43

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-01-10	16.0	SP	Gray SAND, trace of silt and fine gravel	1	96	3.0			21.5	2.7	1.1	CRM	JFL	D422
■ GP-01-10, S-6	25.0	SP-SM	Gray, slightly silty SAND		91	8.6			24.4	4.2	1.5	CRM	JFL	D422
▲ GP-01-10, S-7	33.0	SP	Gray, fine SAND, trace of silt; trace of organics			4.0			25.9			AFW	JFL	D1140

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FIG. C-44
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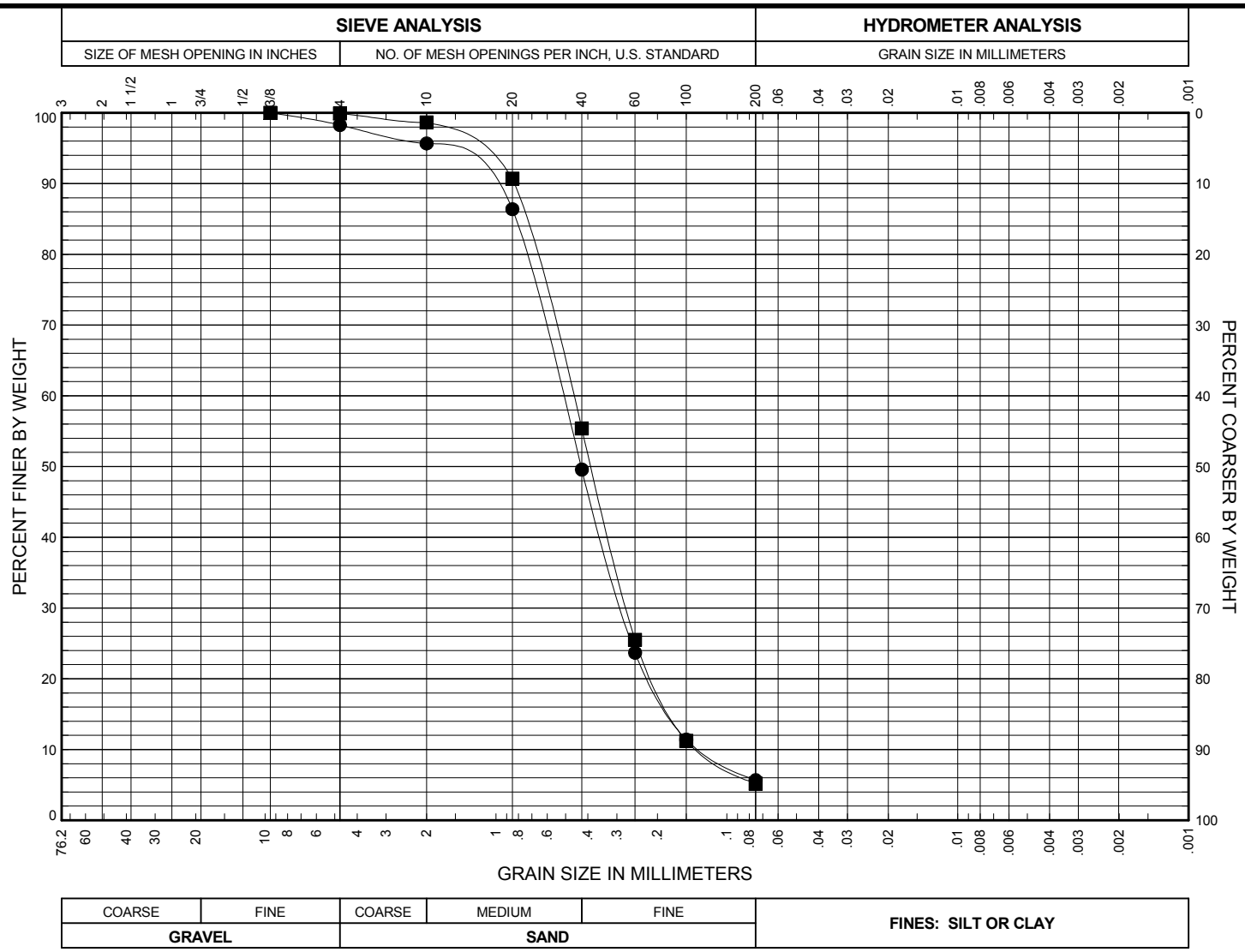
FIG. C-44

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-02-10	15.0	SP-SM	Gray, slightly silty SAND, trace of fine gravel	2	93	5.7			22.2	4.1	1.2	AFW	JFL	D422
■ GP-02-10	25.0	SP-SM	Gray, slightly silty SAND	0	95	5.2			20.3	3.6	1.2	CRM	JFL	D422

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FIG. C-45
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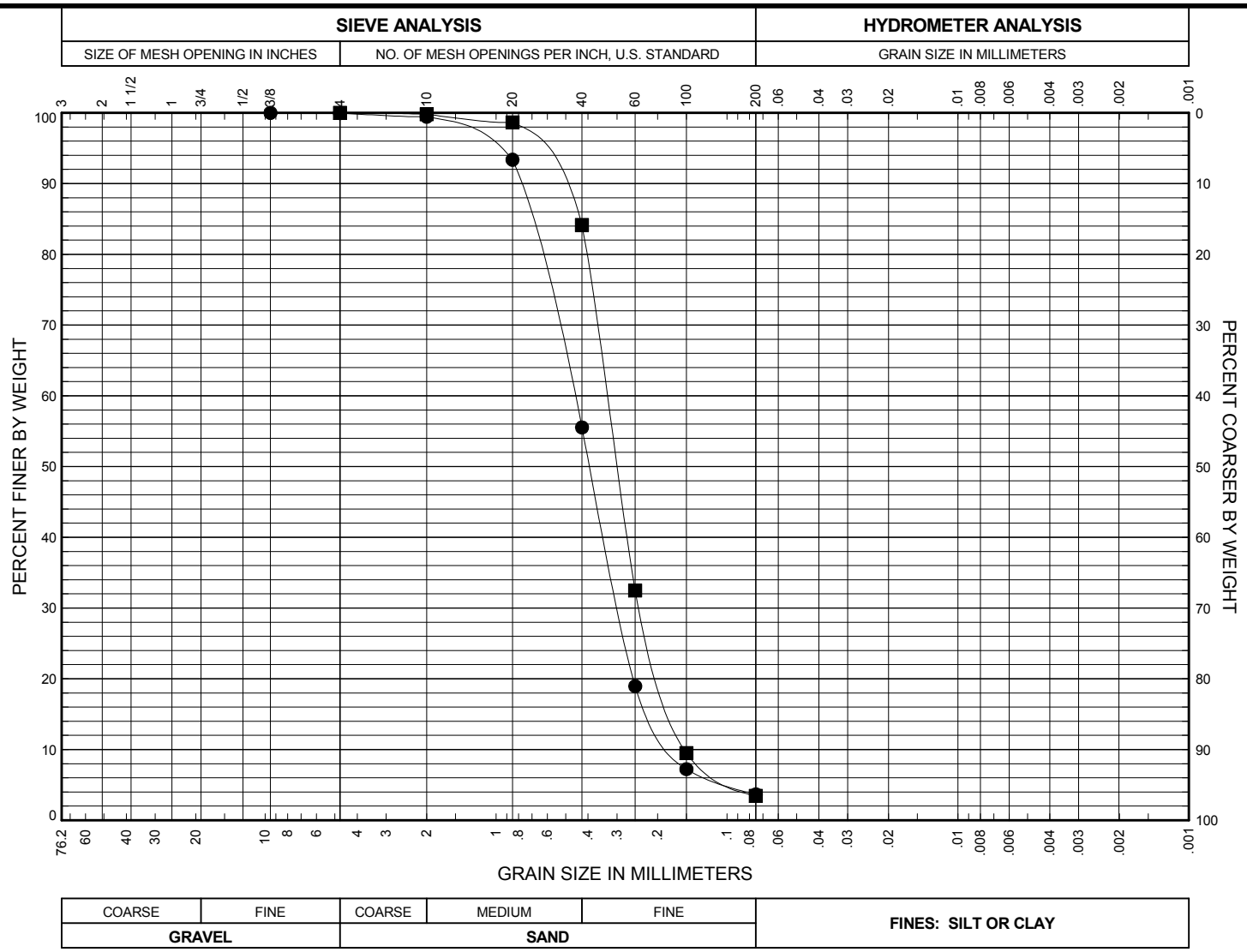
FIG. C-45

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-03-10	14.5	SP	Gray, fine to medium SAND, trace of silt	0	96	3.7			21.9	2.7	1.1	CRM	JFL	D422
■ GP-03-10	21.0	SP	Gray, fine to medium SAND, trace of silt		97	3.5			24.4	2.2	1.1	AFW	JFL	D422

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FIG. C-46
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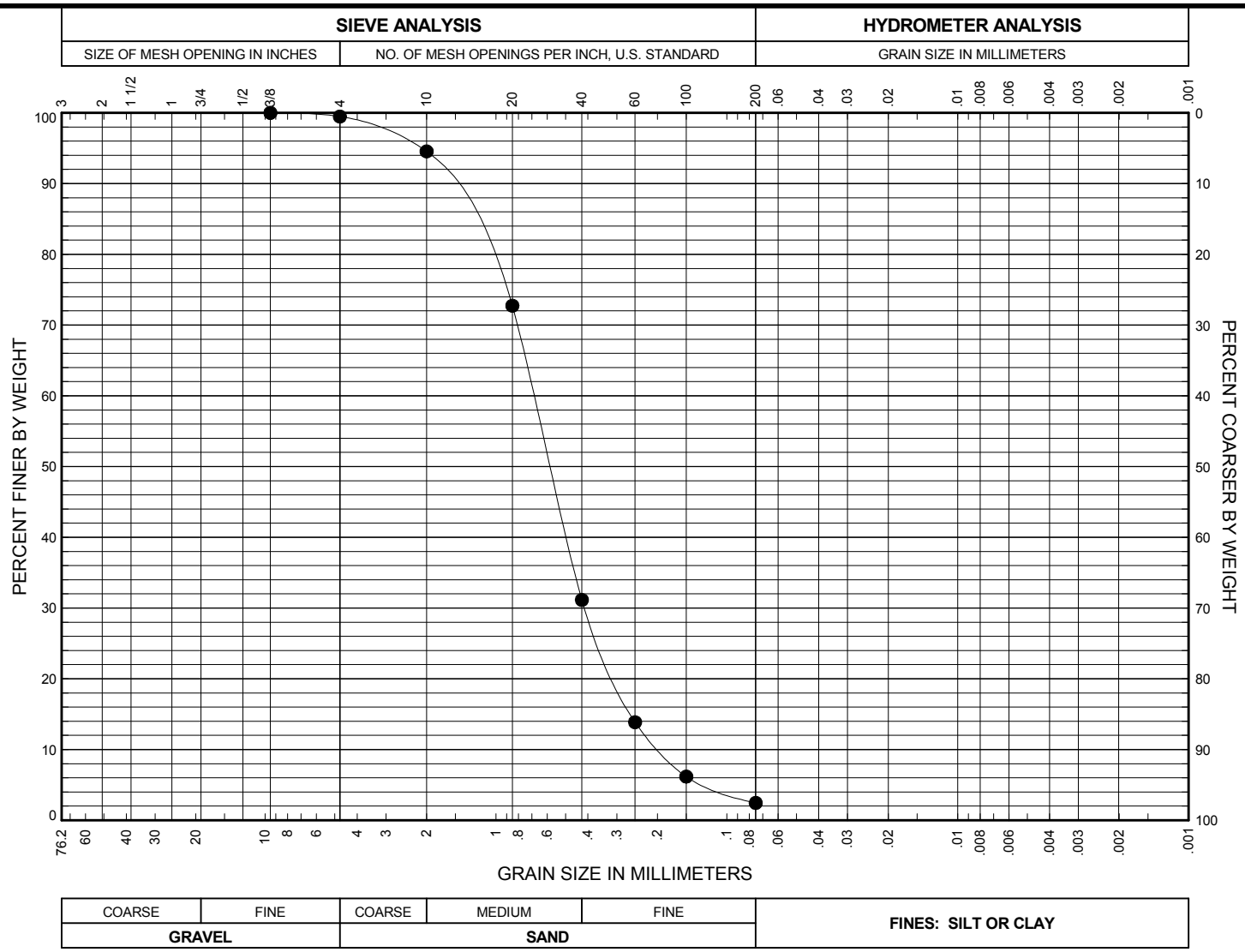
FIG. C-46

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-04-10	10.0	SP	Gray SAND, trace of silt and fine gravel	1	97	2.5			20.5	3.6	1.3	AKV	JFL	D422

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FIG. C-47
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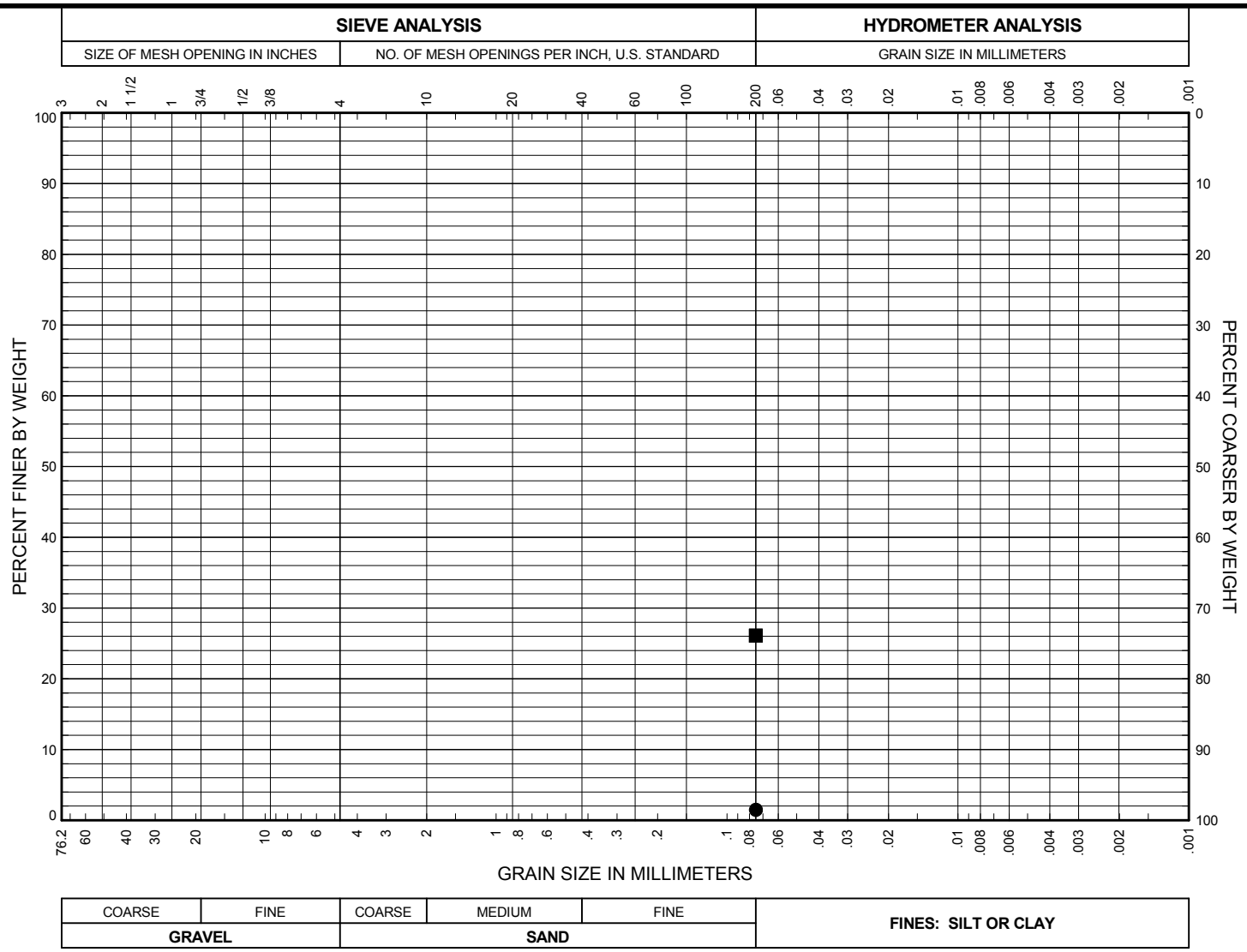
FIG. C-47

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-05-10	8.0	SP	Gray SAND, trace of silt; trace of wood fragments			1.5			27.7			EJK	JFL	D1140
■ GP-05-10	25.0	SM	Gray, silty SAND; scattered organics			26.1			35.9			AFW	JFL	D1140

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FIG. C-48
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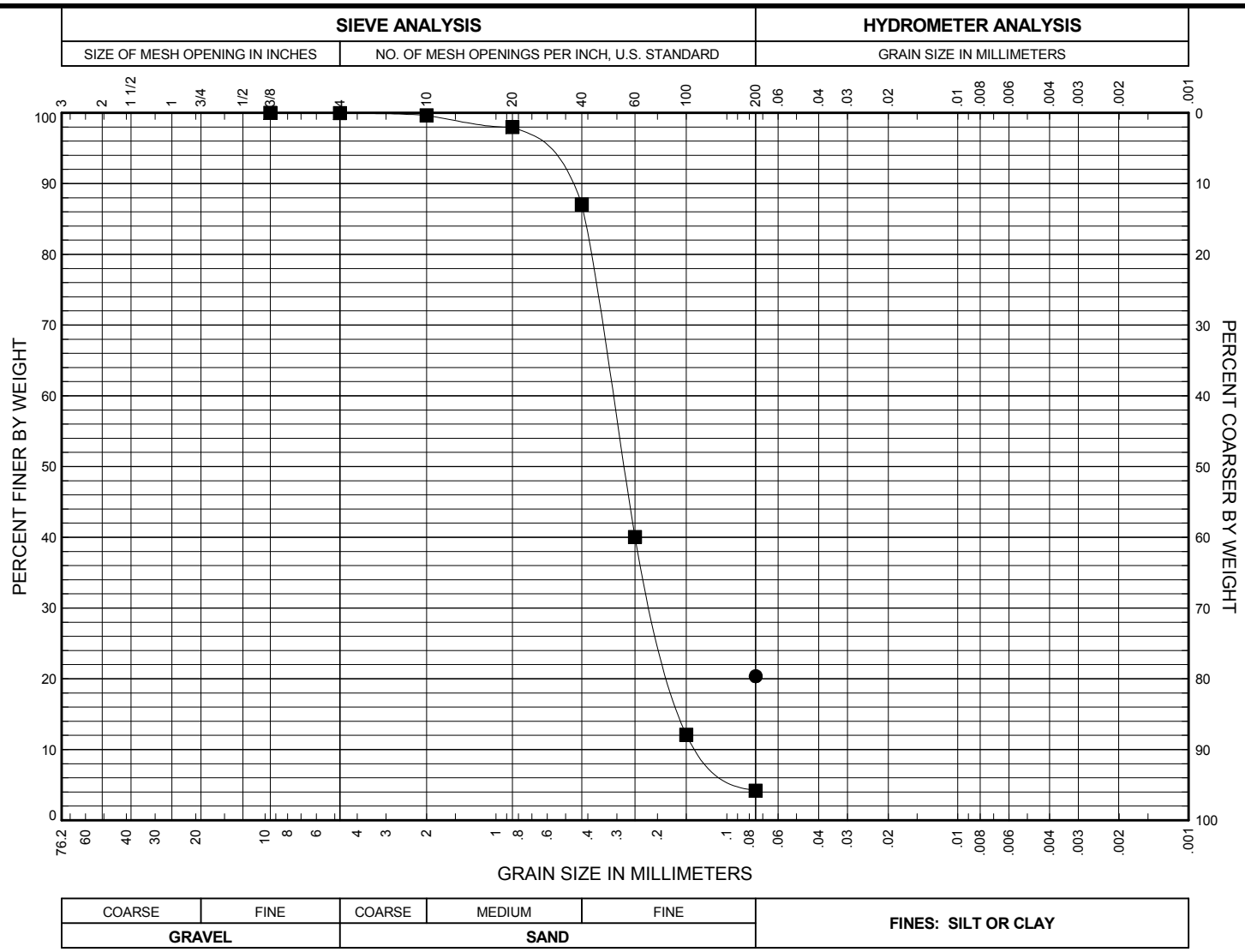
FIG. C-48

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-06-10	6.0	SM	Gray, silty, fine to medium SAND; trace of organics			20.4			37.9			AFW	JFL	D1140
■ GP-06-10	10.0	SP	Gray, fine to medium SAND, trace of silt	0	96	4.2			26.8	2.5	1.1	AFW	JFL	D422

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FIG. C-49
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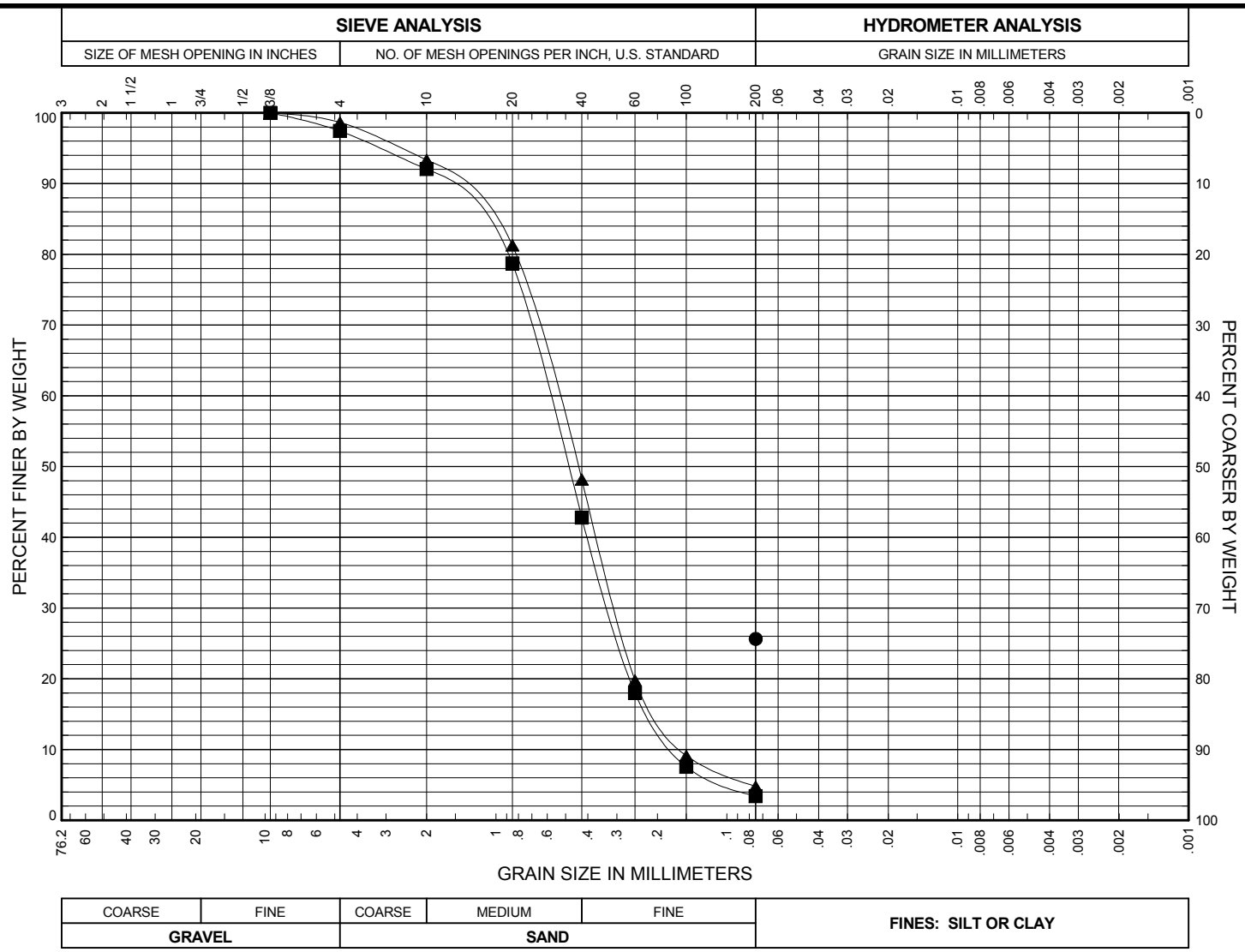
FIG. C-49

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-07-10	6.0	SM	Gray, silty, fine SAND, trace of clay; scattered organics			25.6			45.0			EJK	JFL	D1140
■ GP-07-10	13.0	SP	Gray SAND, trace of silt and fine gravel	3	94	3.4			23.0	3.5	1.0	CRM	JFL	D422
▲ GP-07-10	26.0	SP	Gray SAND, trace of silt and fine gravel	1	94	4.8			21.0	3.5	1.1	AFW	JFL	D422

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FIG. C-50
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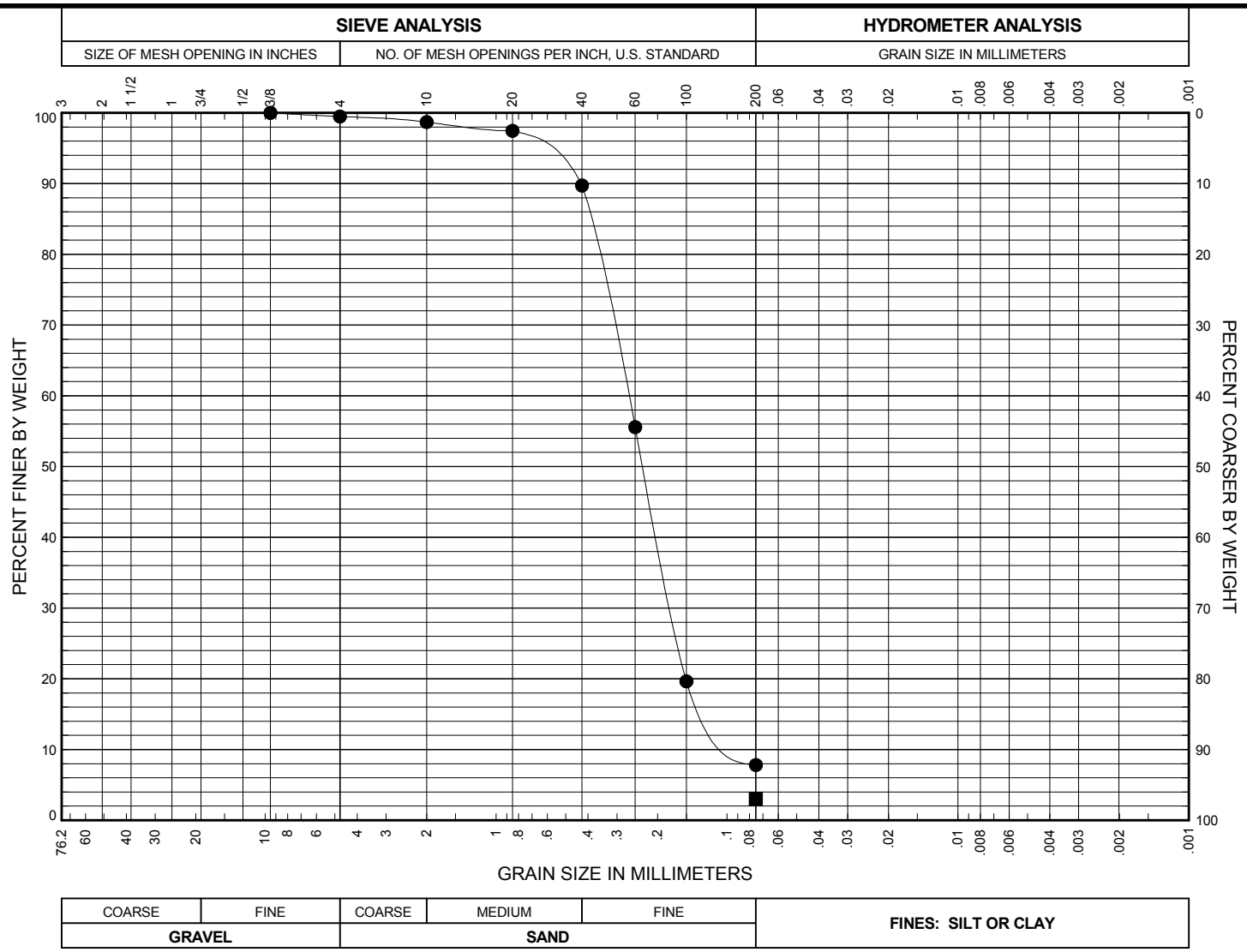
FIG. C-50

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-08-10	5.0	SP-SM	Gray, slightly silty SAND, trace of fine gravel	1	92	7.8			27.6	3.1	1.3	AFW	JFL	D422
■ GP-08-10	15.0	SP	Gray SAND, trace of silt			3.0			26.3			AFW	JFL	D1140

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FIG. C-51
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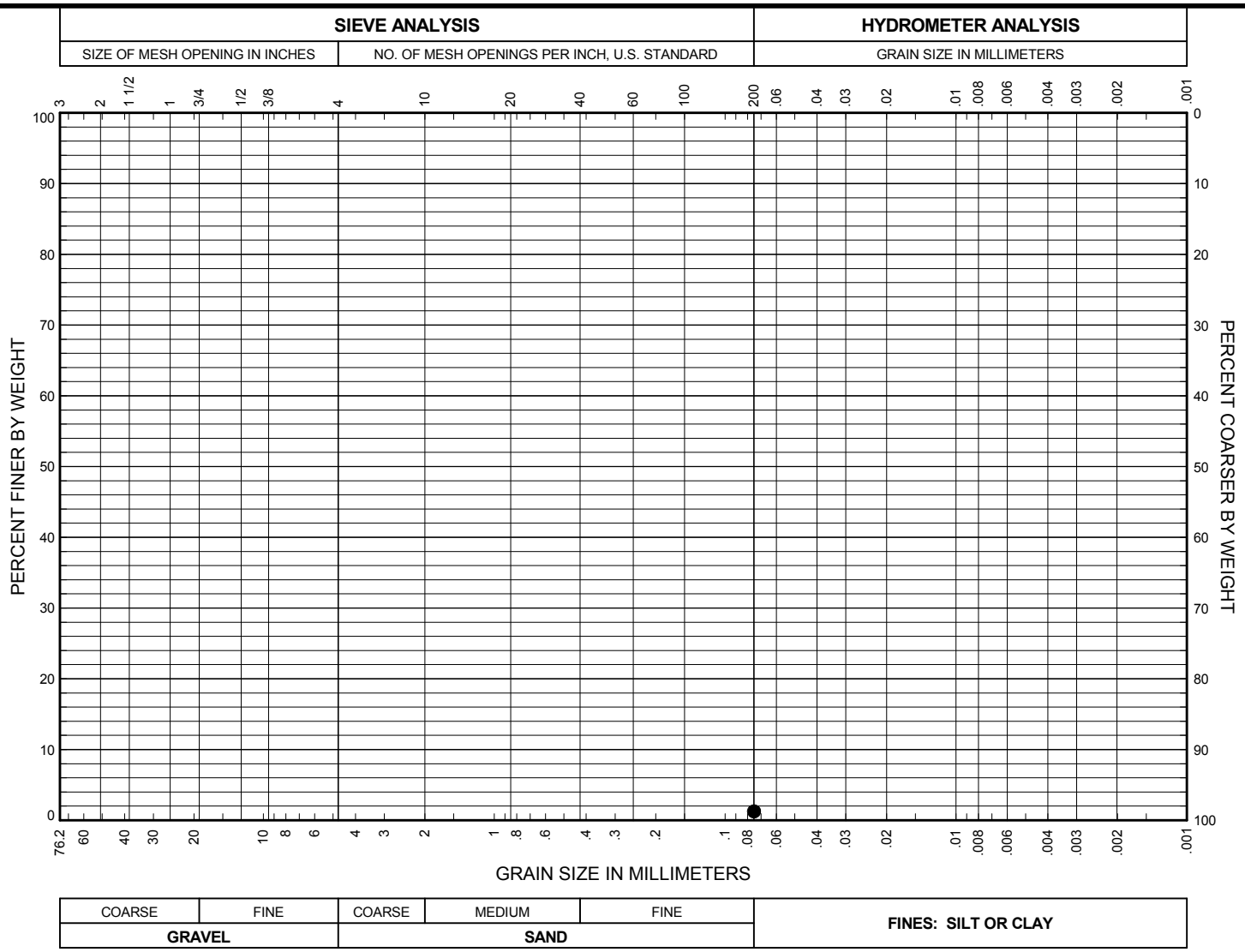
FIG. C-51

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

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Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-09-10	10.0	SP	Gray SAND, trace of silt			1.3			23.0			EJK	JFL	D1140

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FIG. C-52
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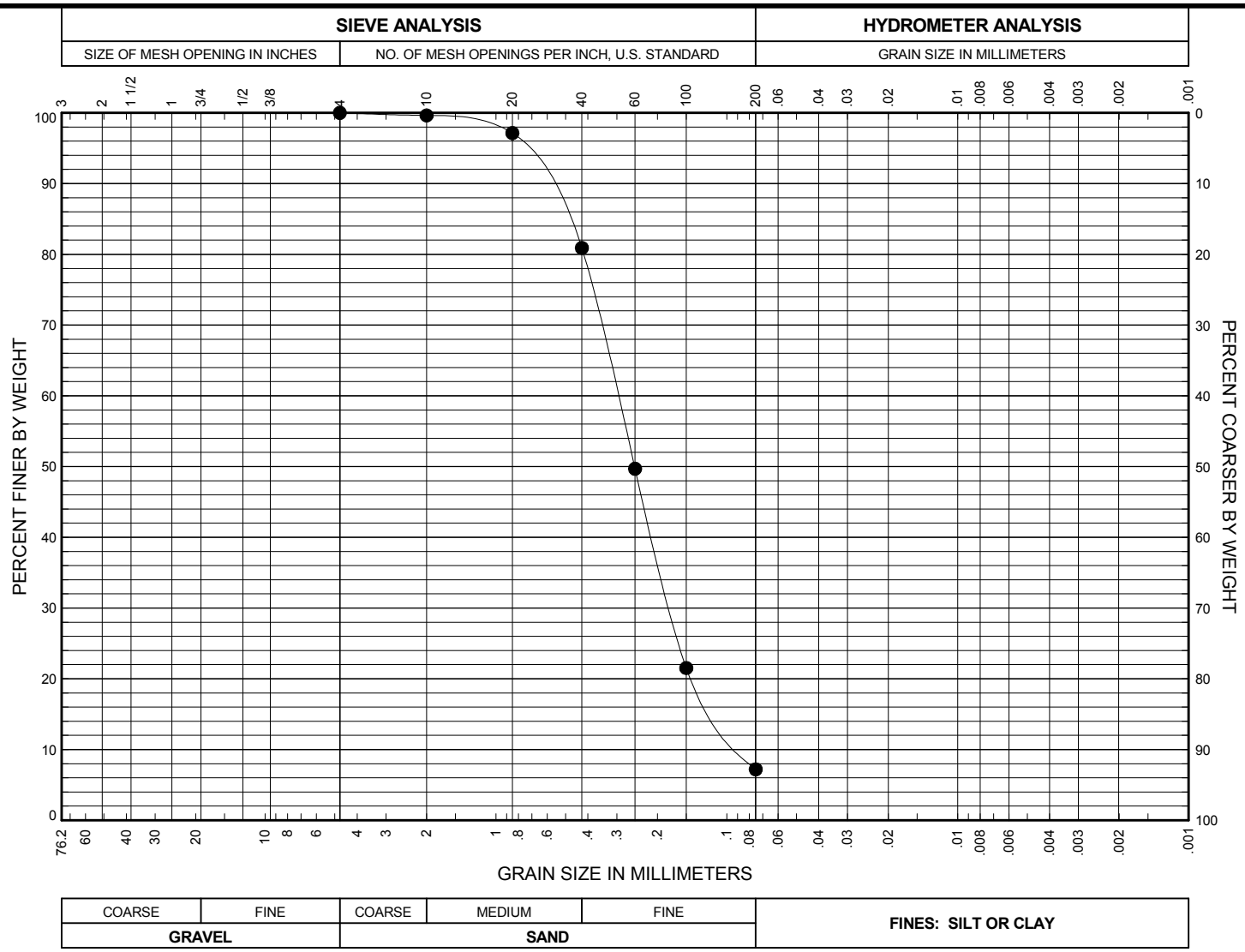
FIG. C-52

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-10-10	10.0	SP-SM	Gray, slightly silty, fine to medium SAND		93	7.2			25.4	3.5	1.2	AFW	JFL	D422

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GRAIN SIZE DISTRIBUTION
GEOPROBE GP-10-10

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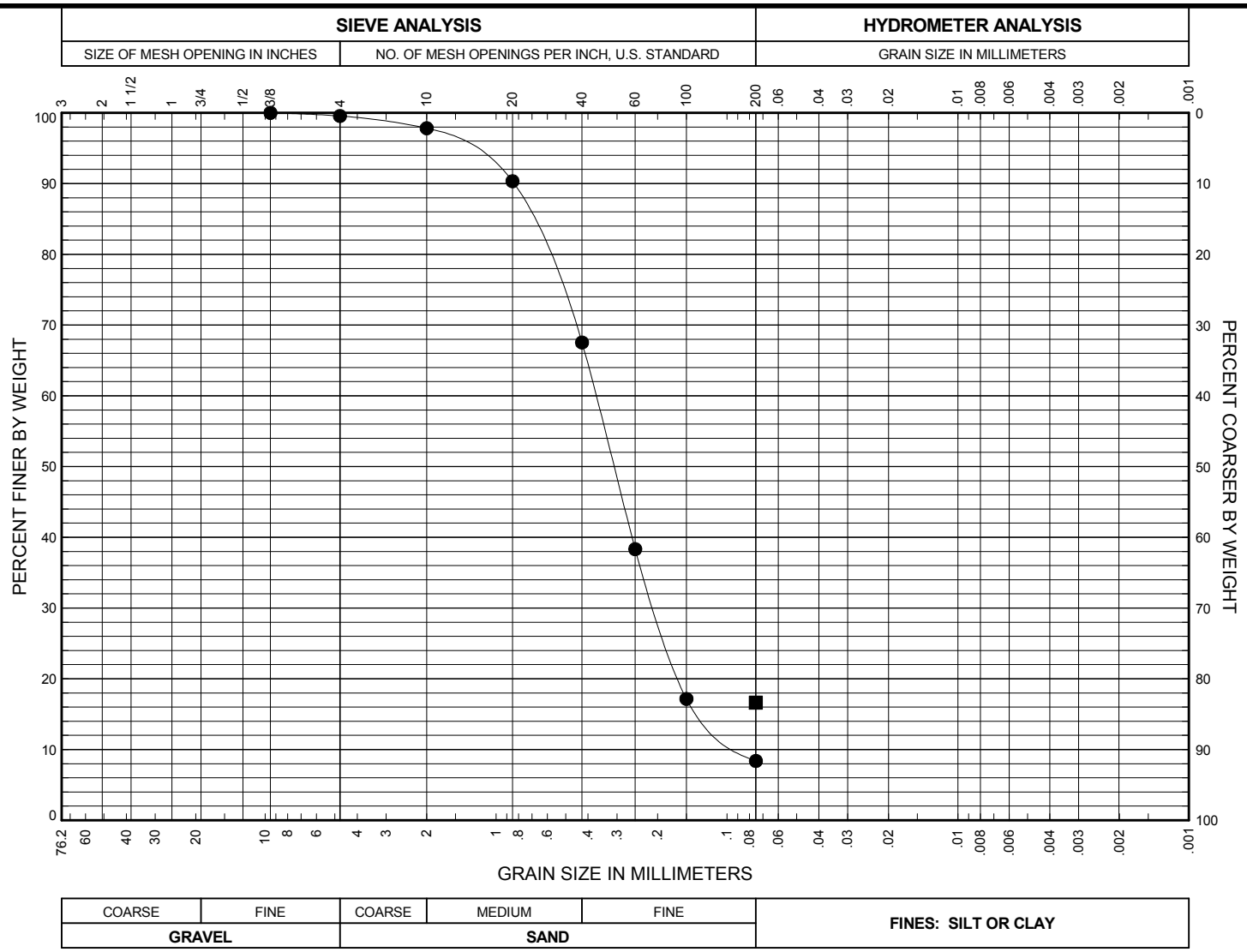
FIG. C-53
Sheet 1 of 1

FIG. C-53

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-11-10	10.0	SP-SM	Gray, slightly silty SAND	0	91	8.4			23.9	4.3	1.3	CRM	JFL	D422
■ GP-11-10	21.0	SM	Gray, silty, fine SAND; scattered shell fragments, trace of organics			16.6			32.9			EJK	JFL	D1140

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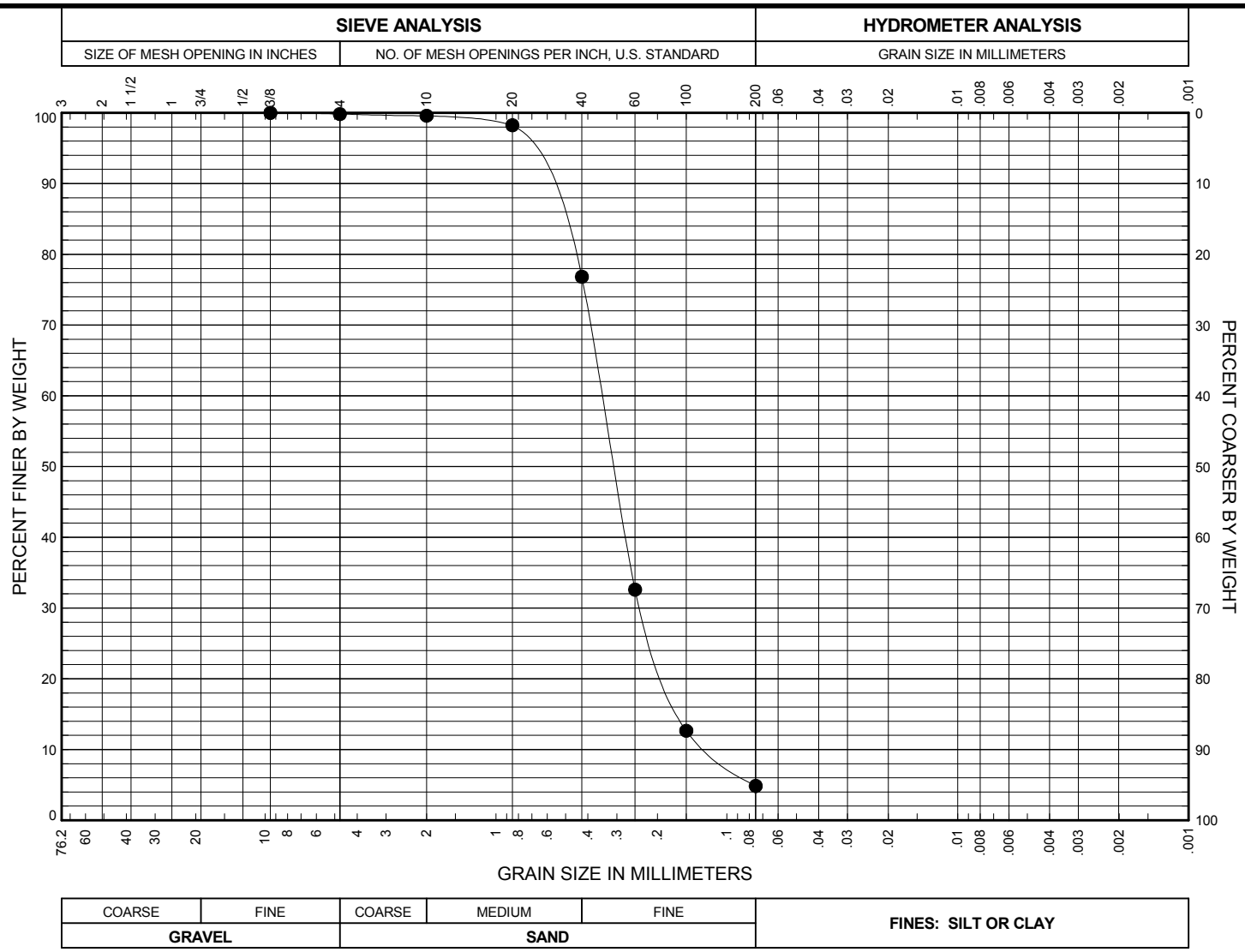
FIG. C-54
Sheet 1 of 1

FIG. C-54

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● GP-12-10	10.0	SP	Gray, fine to medium SAND, trace of silt	0	95	4.8			25.5	2.9	1.3	CRM	JFL	D422

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FIG. C-55
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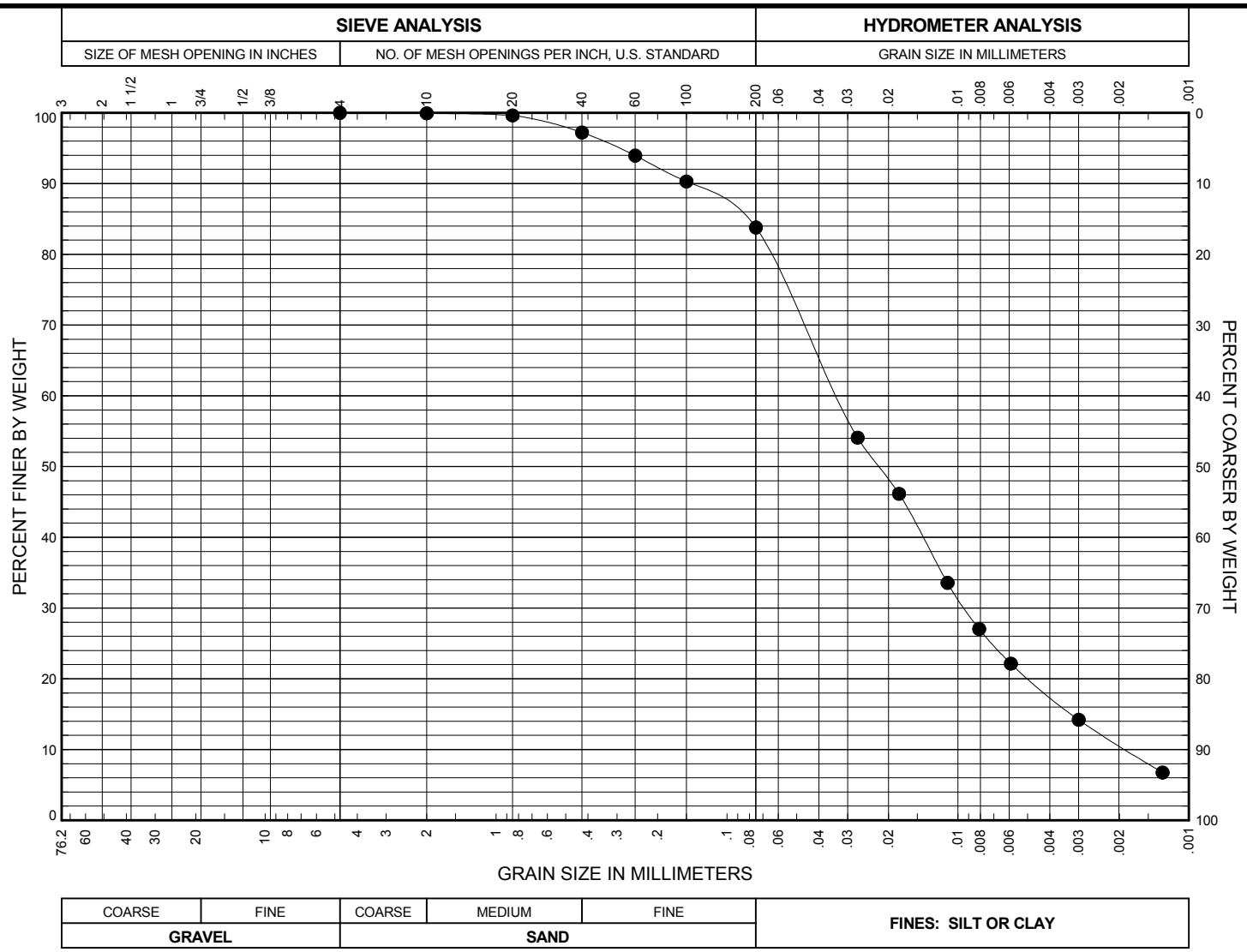
FIG. C-55

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/27/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● HB-2-14, S-2	2.5	ML	Gray, fine to medium sandy, clayey SILT; trace of organics		16	83.8		11	50.3			AKV	JFL	D422

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BORING HB-2-14

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FIG. C-56
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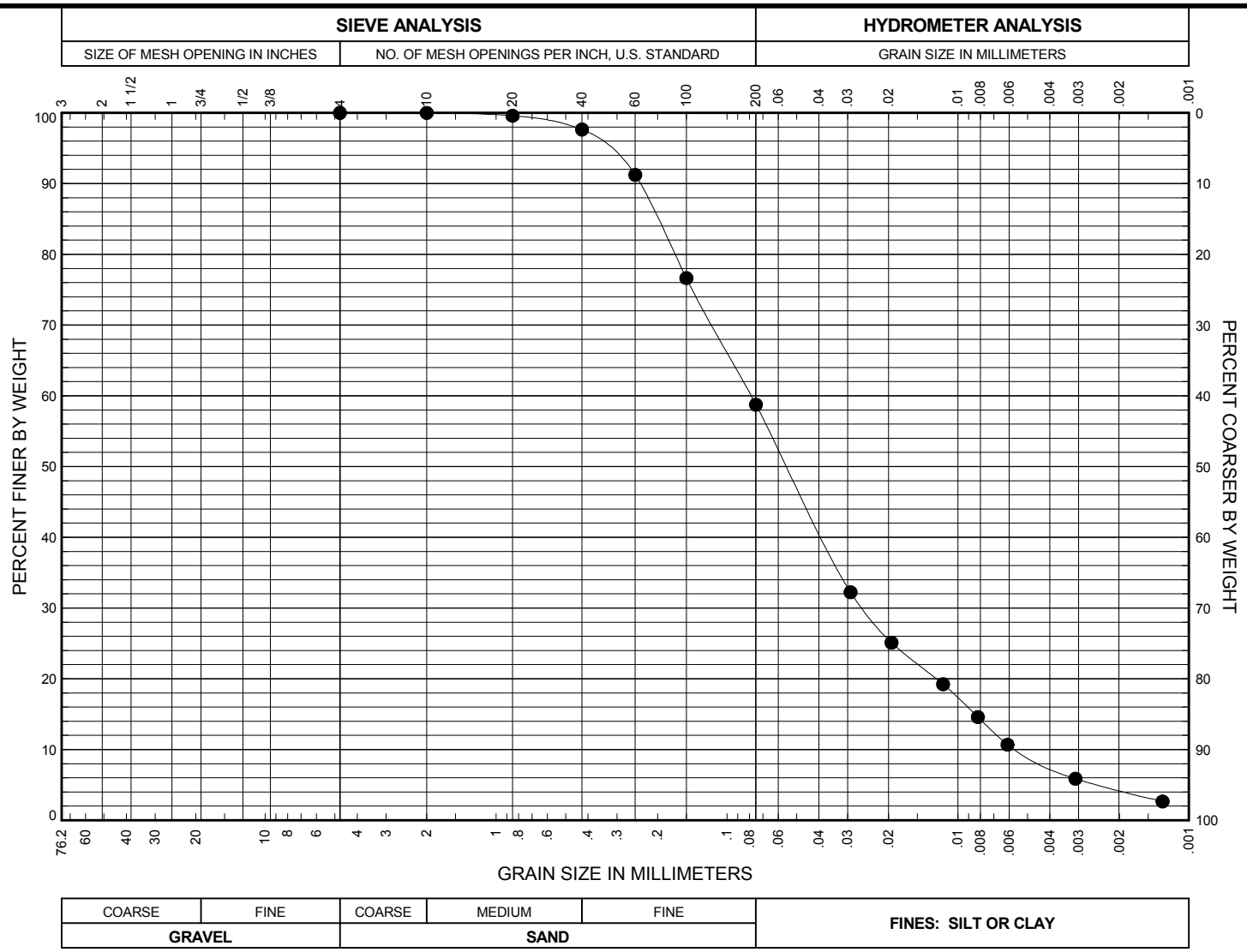
FIG. C-56

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/28/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● HB-3-14, S-2	2.5	ML	Gray, fine to medium sandy SILT, trace of clay; trace organics		41	58.7		4	49.8			AKV	JFL	D422

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BORING HB-3-14

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FIG. C-57
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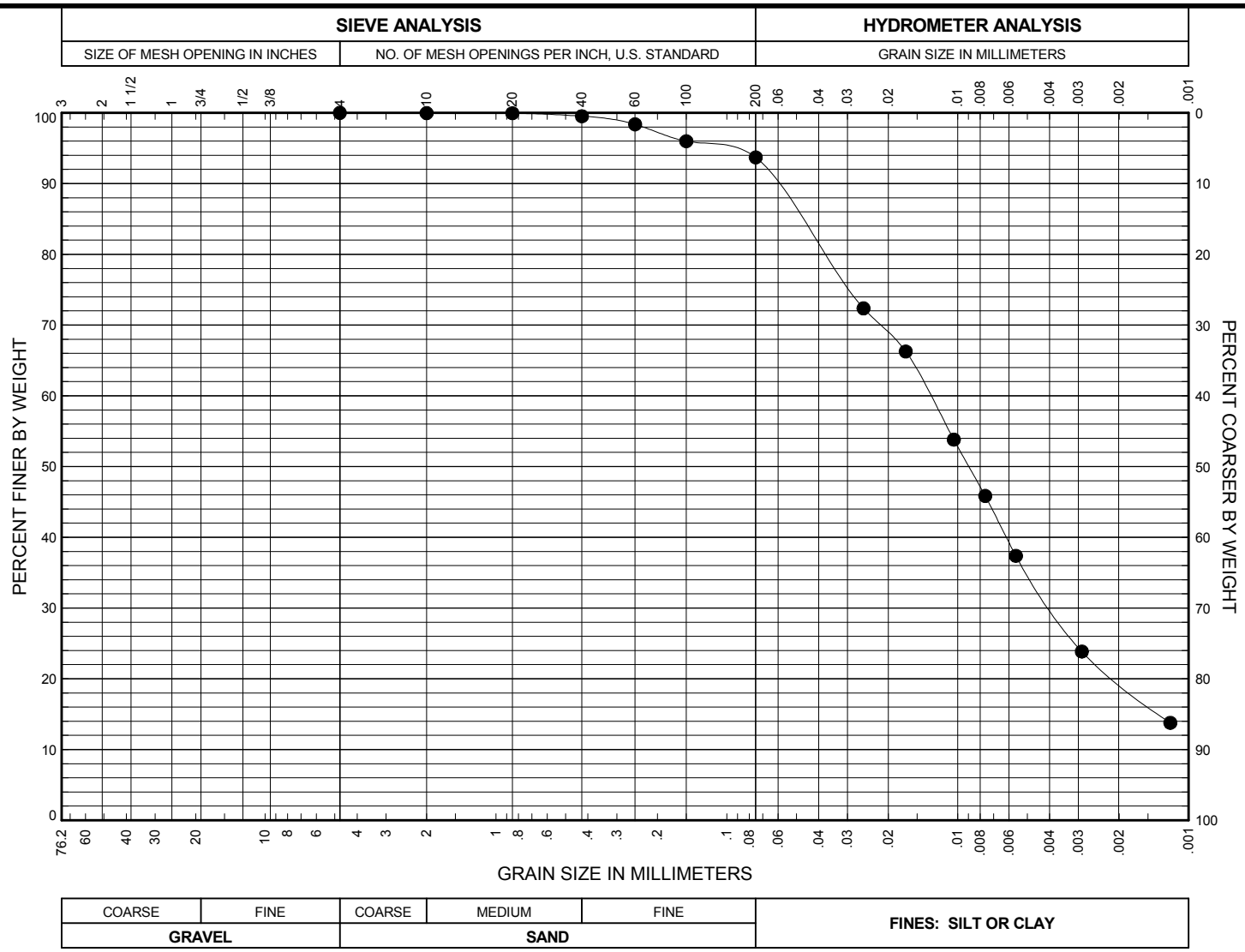
FIG. C-57

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/28/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● HB-4-14, S-1	0.0	MH	Brown, slightly fine sandy, clayey SILT; trace of organics		6	93.7		20	36.6			AKV	JFL	D422

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FIG. C-58
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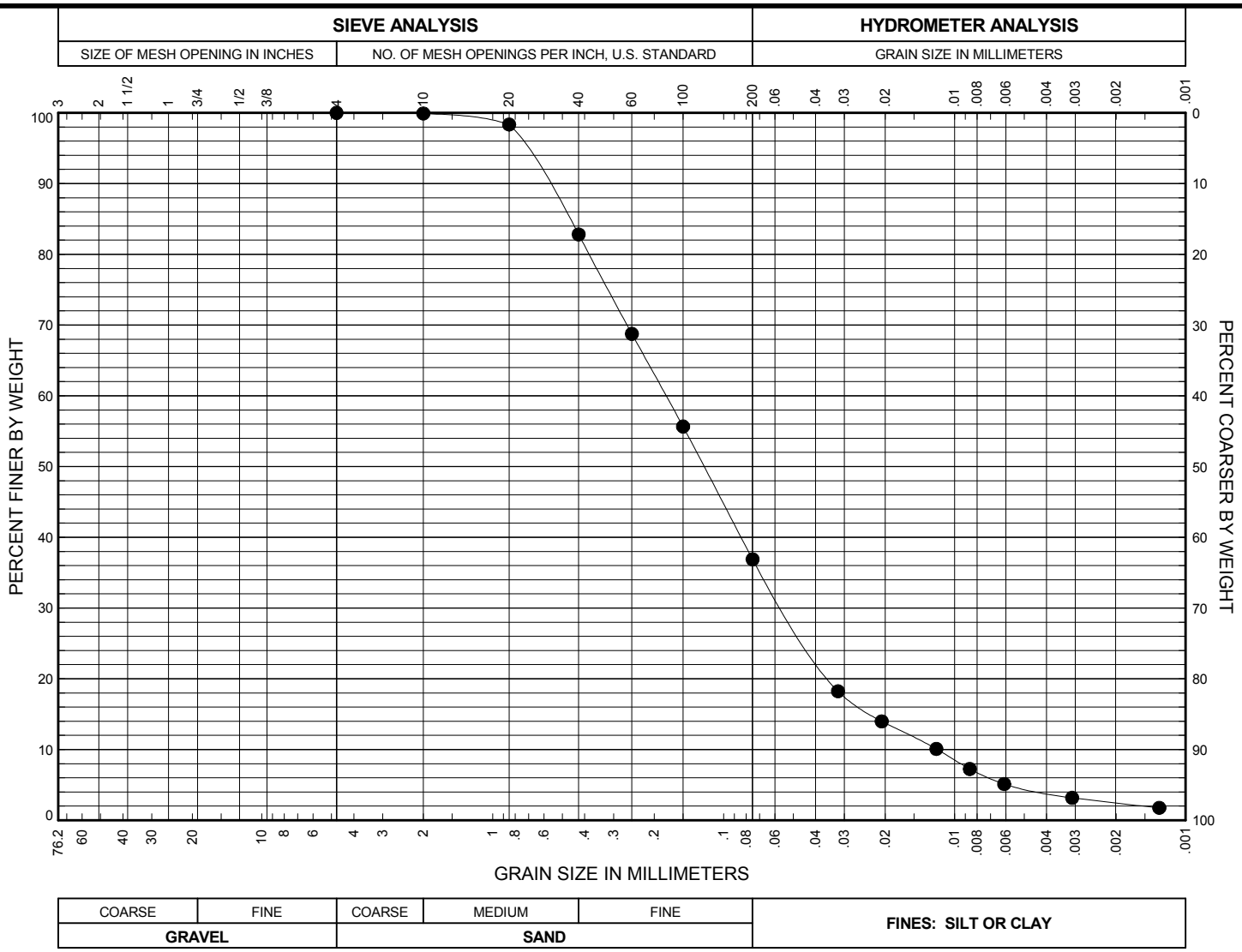
FIG. C-58

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/28/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● HB-5-14, S-2	2.5	SM	Gray-brown, silty, fine to medium SAND		63	36.9		2	37.1			AKV	JFL	D422

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BORING HB-5-14

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FIG. C-59
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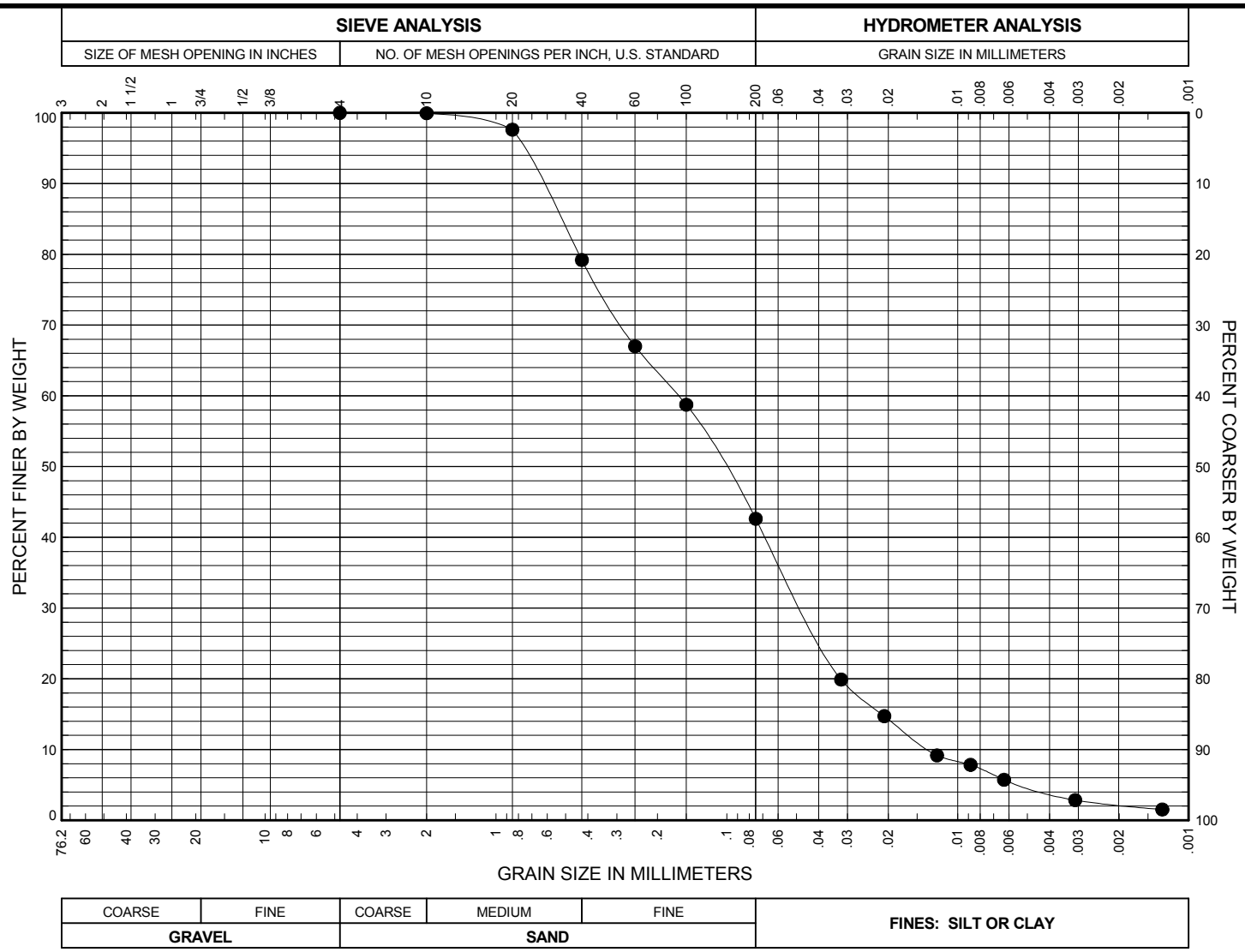
FIG. C-59

AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/28/14



LEGEND

USCS: Unified Soil Classification System

COBBLE REM %: Percentage of cobbles removed from specimen; based on pre-removal total dry mass

< 2 µm %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

NAT WC %: Natural water content

Cu: Coefficient of uniformity

Cc: Coefficient of curvature

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	USCS SYMBOL	SOIL CLASSIFICATION	GRAVEL %	SAND %	FINES %	COBBLE REM %	< 2 µm %	NAT WC %	Cu	Cc	TEST BY	REVIEW BY	ASTM DES
● HB-6-14, S-2	2.5	SM	Brown-gray, silty, fine to medium SAND		57	42.6		2	36.2			AKV	JFL	D422

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FIG. C-60
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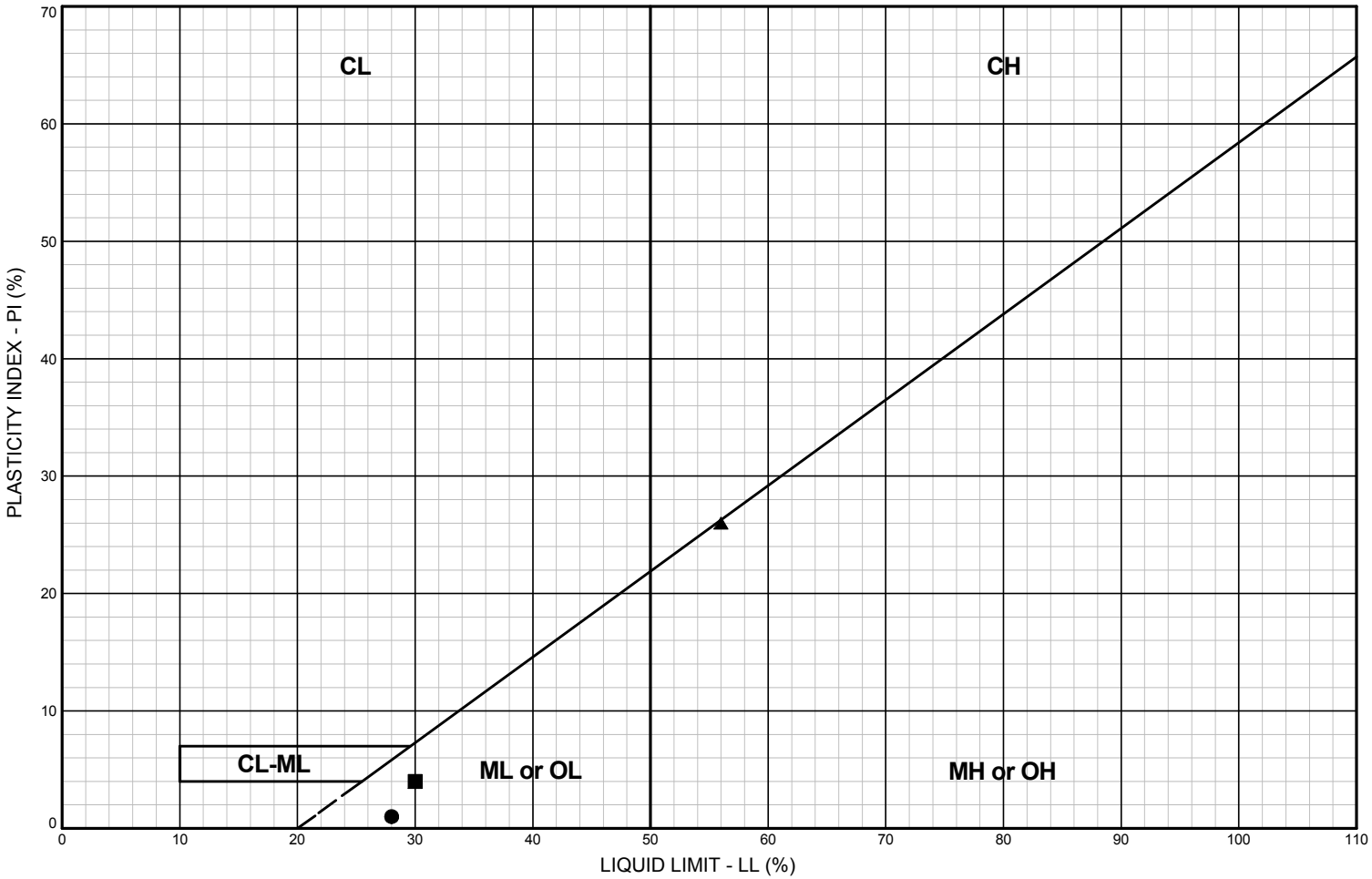
AASHTO GSA MAIN 3INCHMINUS 21-12318.GPJ 5/28/14

FIG. C-60



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

CL-ML: Silty clays and clayey silts

OL: Organic silts and clays of low plasticity

OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅˅ : Nonplastic

˄˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● B-1-13, S-11	27.2	ML	Gray-brown, fine sandy SILT, trace of clay	28	27	1				AKV	JFL	D4318
■ B-1-13, S-12	29.0	ML	Gray-brown, slightly clayey, fine sandy SILT	30	26	4	42.9	63.8	11	AKV	JFL	D4318
▲ B-1-13, S-17	55.0	MH	Gray-brown, slightly fine sandy, clayey SILT	56	30	26	55.8	91.8	20	AKV	JFL	D4318

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PLASTICITY CHART
BORING B-1-13

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FIG. C-61
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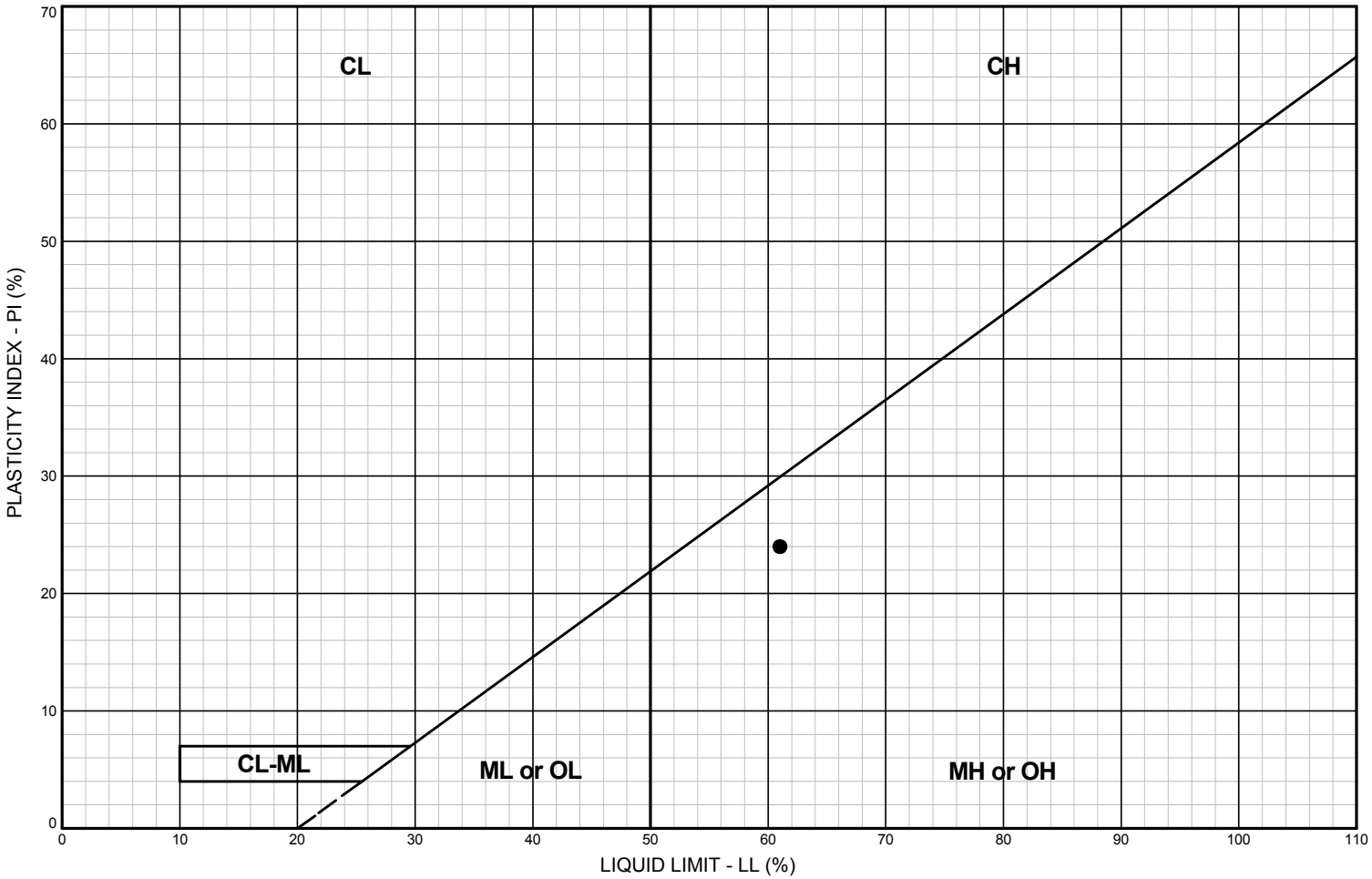
FIG. C-61

AASHTO ATT MAIN 21-12318.GPJ 5/27/14



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

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ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● B-2-13, S-2	2.5	MH	Gray-brown, clayey SILT, trace of fine sand	61	37	24	60.1	96.4	13	JFL	JFL	D4318

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PLASTICITY CHART
BORING B-2-13

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FIG. C-62
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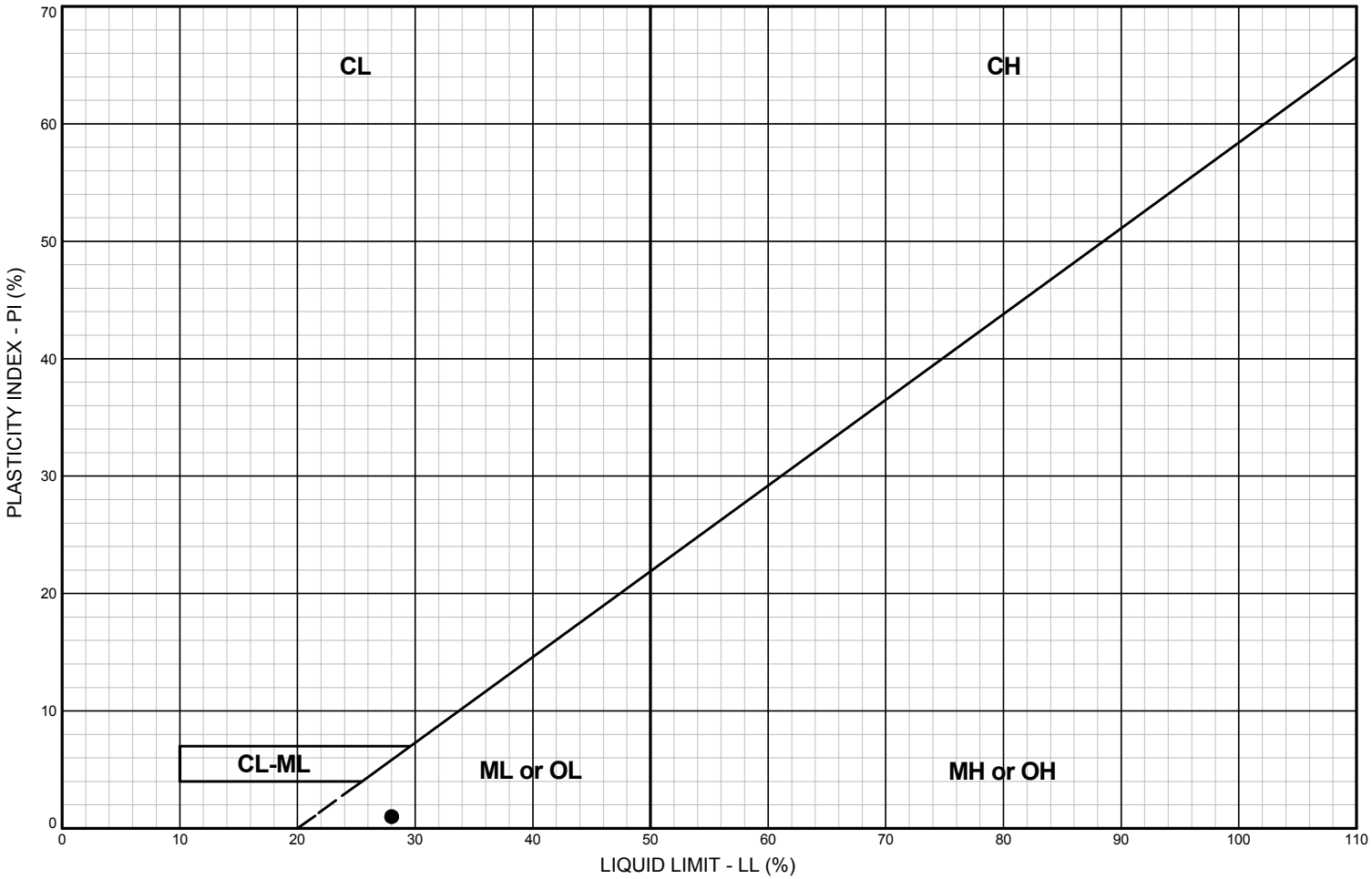
AASHTO_ATT_MAIN 21-12318.GPJ 5/27/14

FIG. C-62



LEGEND

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LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● B-3-13, S-11	30.0	ML	Dark gray-brown, fine sandy SILT, trace of clay	28	27	1	35.4	72.7	8	JFL	JFL	D4318

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BORING B-3-13

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FIG. C-63
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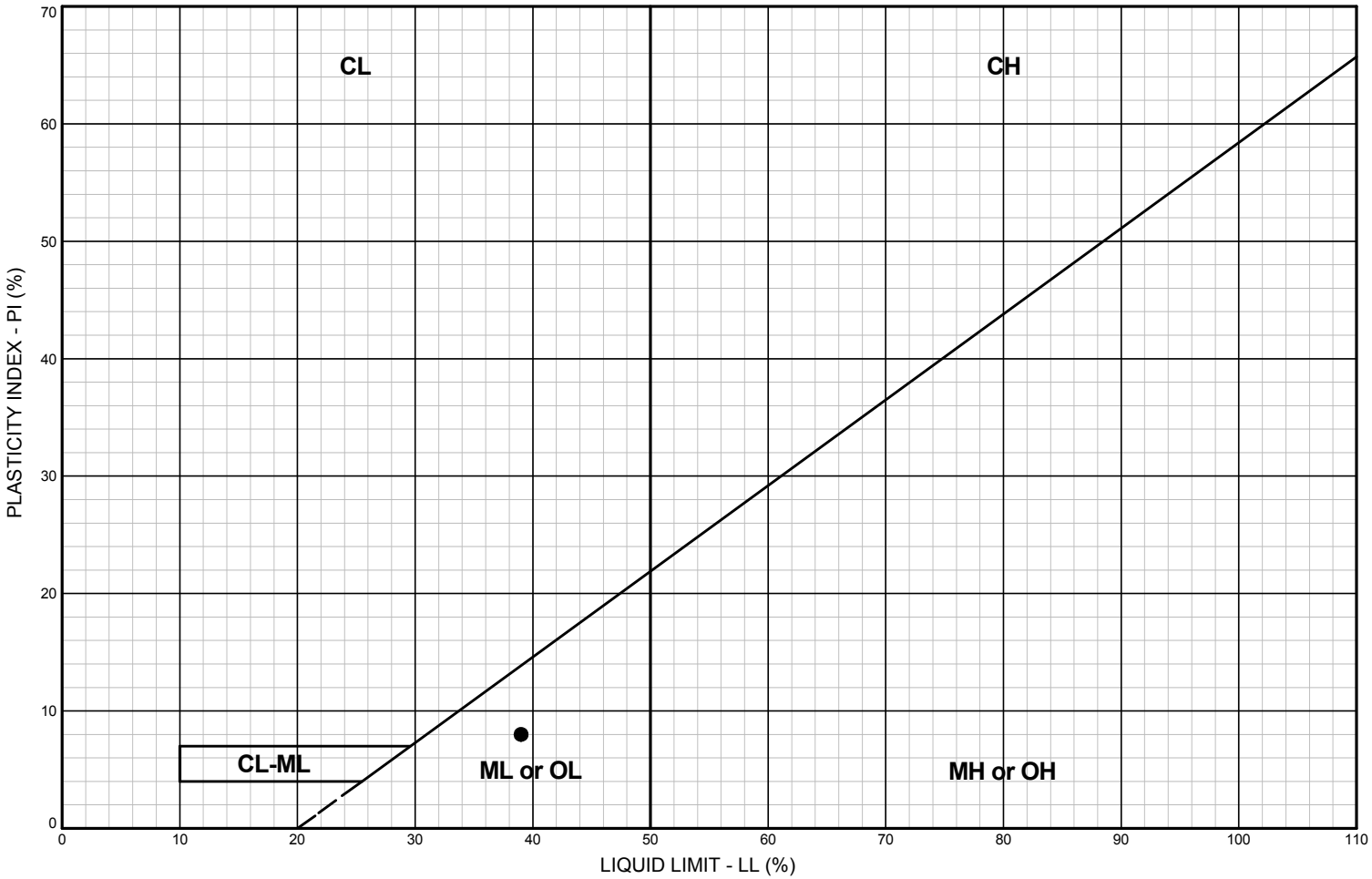
AASHTO_ATT_MAIN 21-12318.GPJ 5/27/14

FIG. C-63



LEGEND

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ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● B-4w-13, S-2	2.2	ML	Gray-brown, slightly clayey SILT, trace of fine sand	39	31	8	40.0			JFL	JFL	D4318

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PLASTICITY CHART
BORING B-4w-13

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FIG. C-64
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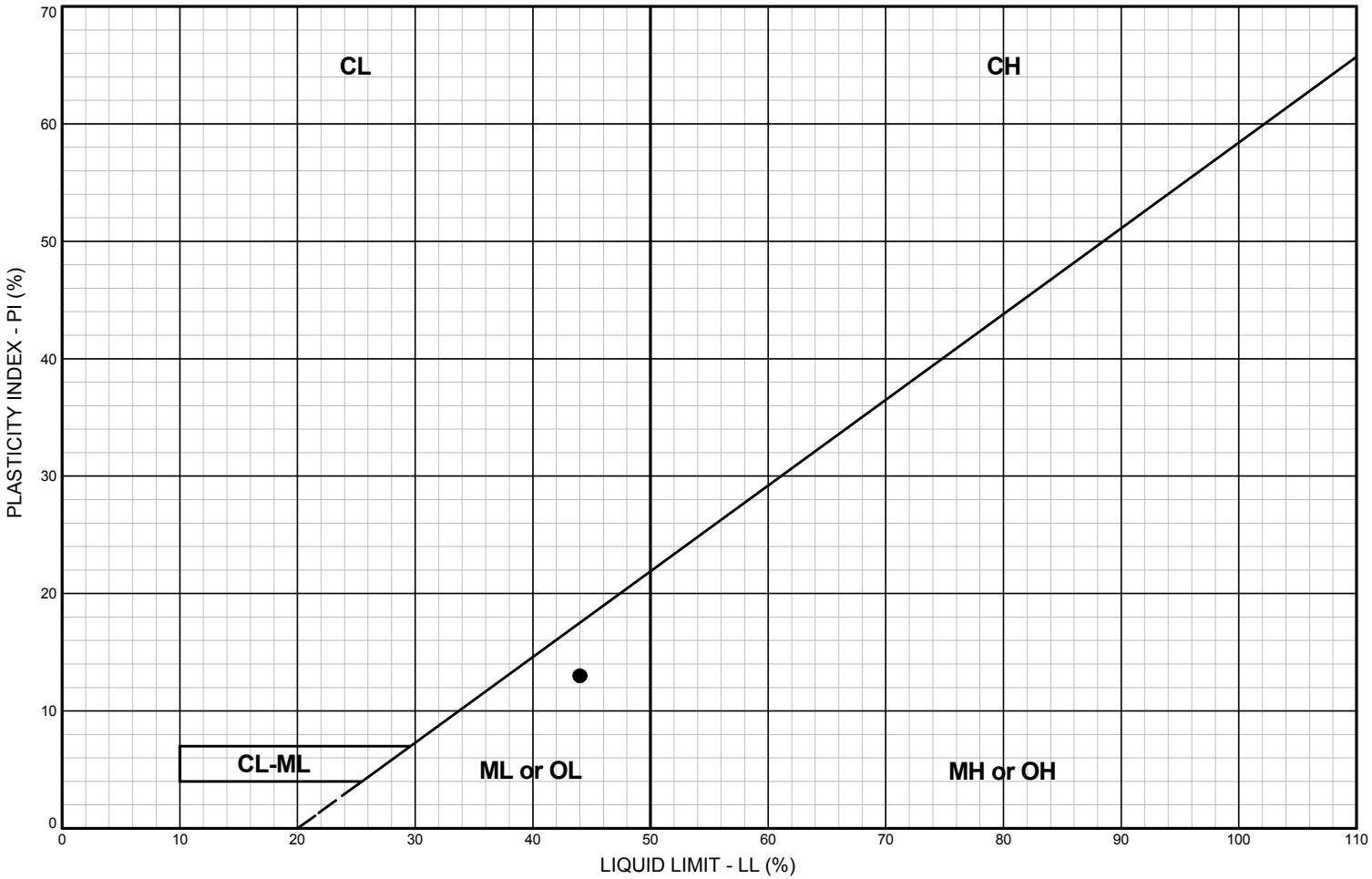
FIG. C-64

AASHTO ATT MAIN 21-12318.GPJ 5/27/14



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

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ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● TP-1-13, S-1	1.0	ML	Brown, slightly fine to medium sandy, slightly clayey SILT	44	31	13	44.0	93.3	13	JFL	JFL	D4318

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PLASTICITY CHART
TEST PIT TP-1-13

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FIG. C-65
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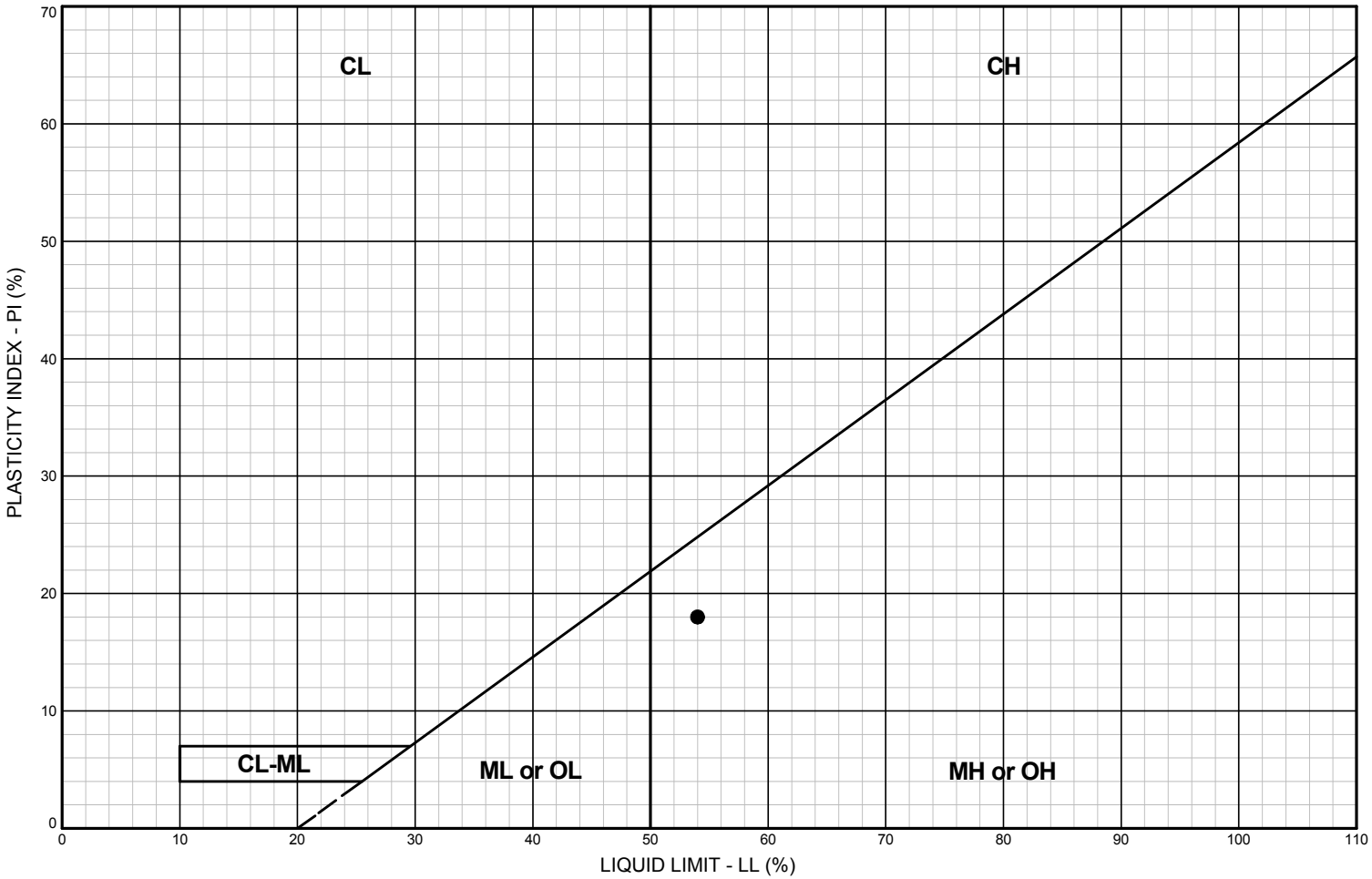
FIG. C-65

AASHTO ATT MAIN 21-12318.GPJ 5/27/14



LEGEND

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MH: Inorganic silts and clayey silts of high plasticity

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OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● TP-14-13, S-3	6.0	OH	Dark gray, slightly fine sandy, organic SILT (Oven-Dried Liquid Limit 63% of Natural Liquid Limit)	54	36	18	76.7	93.0	10	AKV/JFL	JFL	D4318

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PLASTICITY CHART
TEST PIT TP-14-13

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FIG. C-66
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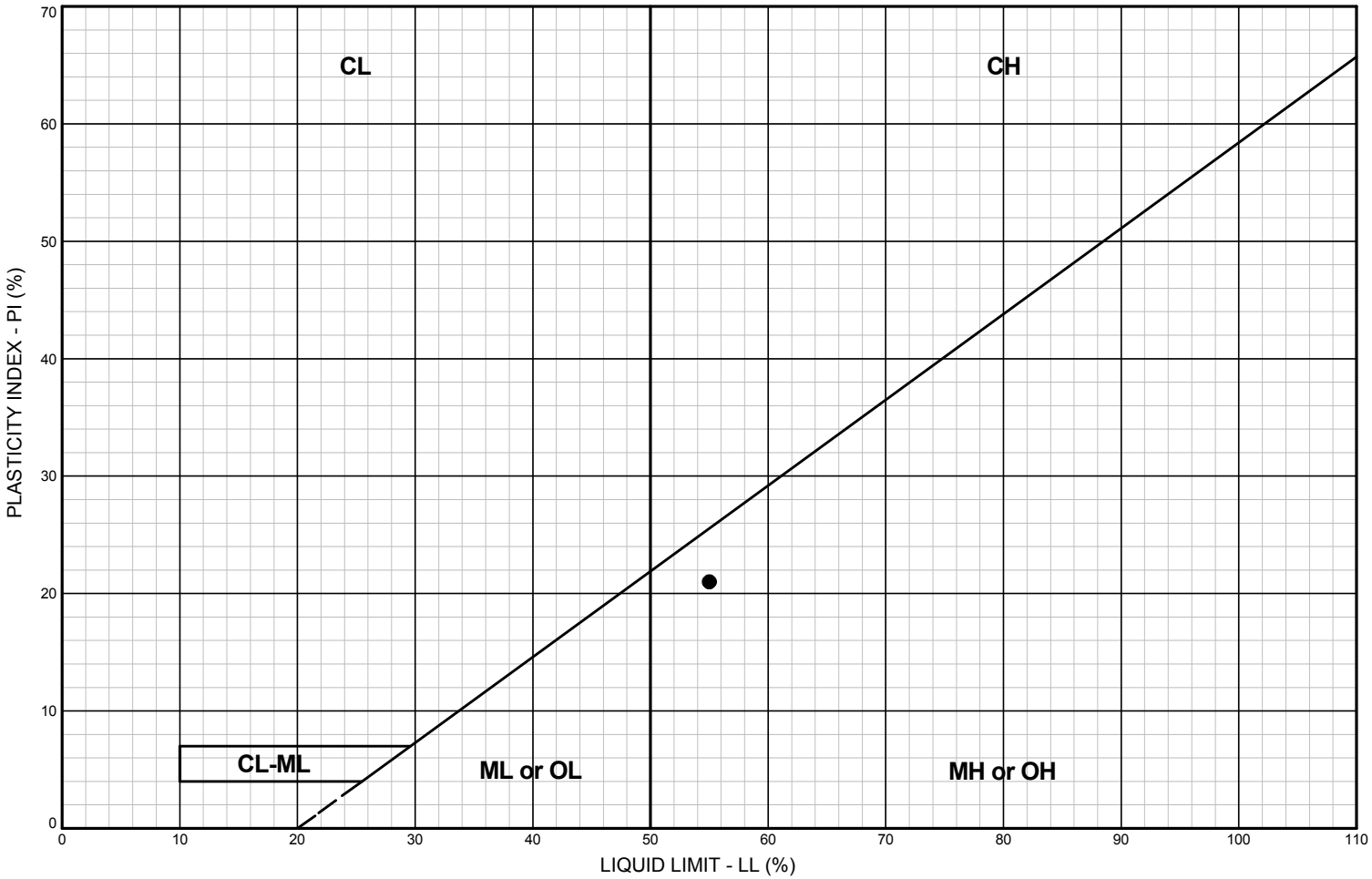
FIG. C-66

AASHTO ATT MAIN 21-12318.GPJ 5/27/14



LEGEND

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MH: Inorganic silts and clayey silts of high plasticity

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LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● TP-20-13, S-4	7.5	MH	Dark gray, clayey SILT	55	34	21	58.9			JFL/AKV	JFL	D4318

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PLASTICITY CHART
TEST PIT TP-20-13

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FIG. C-67
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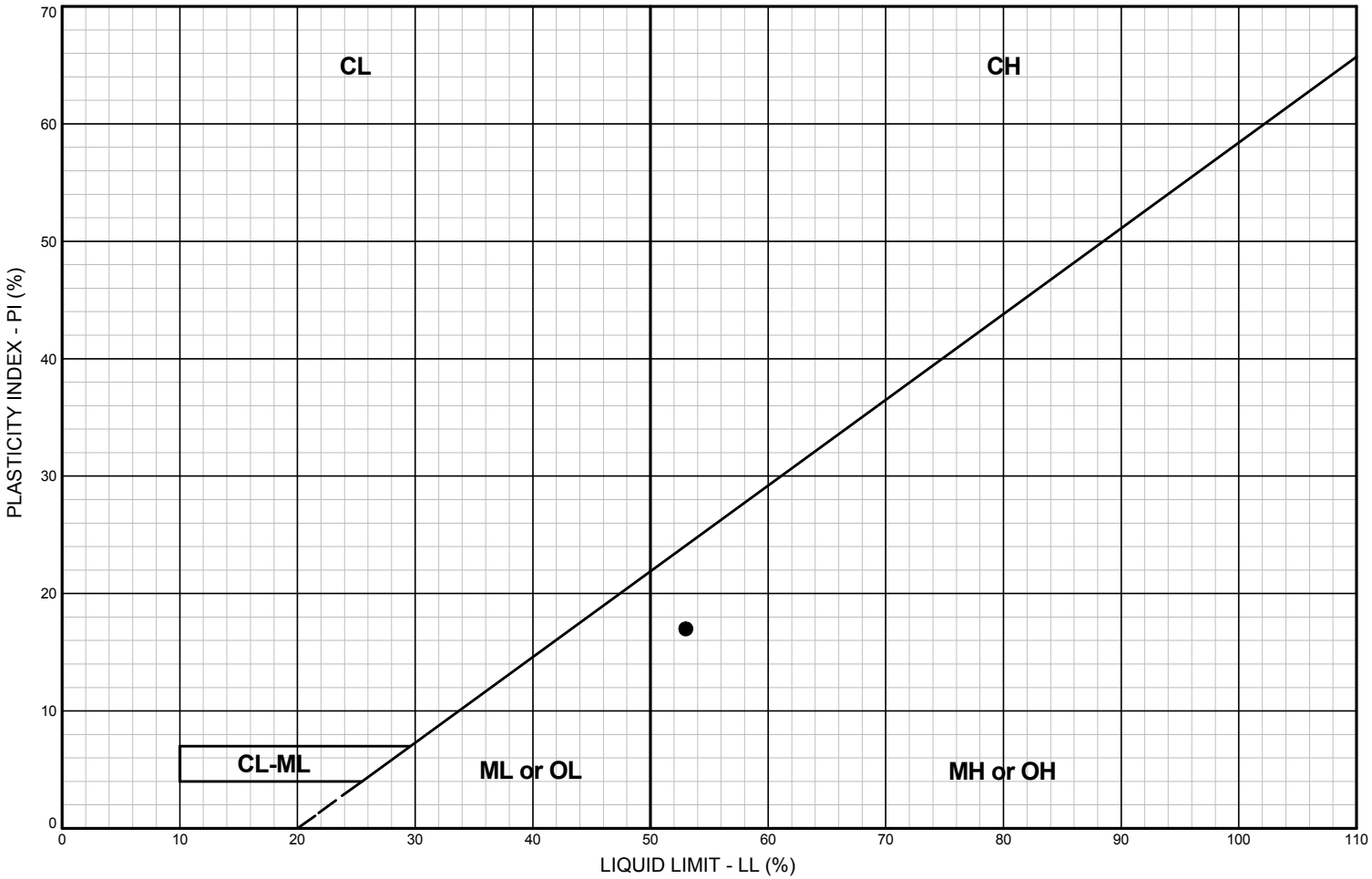
AASHTO_ATT_MAIN 21-12318.GPJ 5/27/14

FIG. C-67



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

CL-ML: Silty clays and clayey silts

OL: Organic silts and clays of low plasticity

OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● TP-25-13, S-2	3.0	MH	Gray-brown, slightly fine sandy, clayey SILT	53	36	17	30.2			AKV	JFL	D4318

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PLASTICITY CHART
TEST PIT TP-25-13

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FIG. C-68
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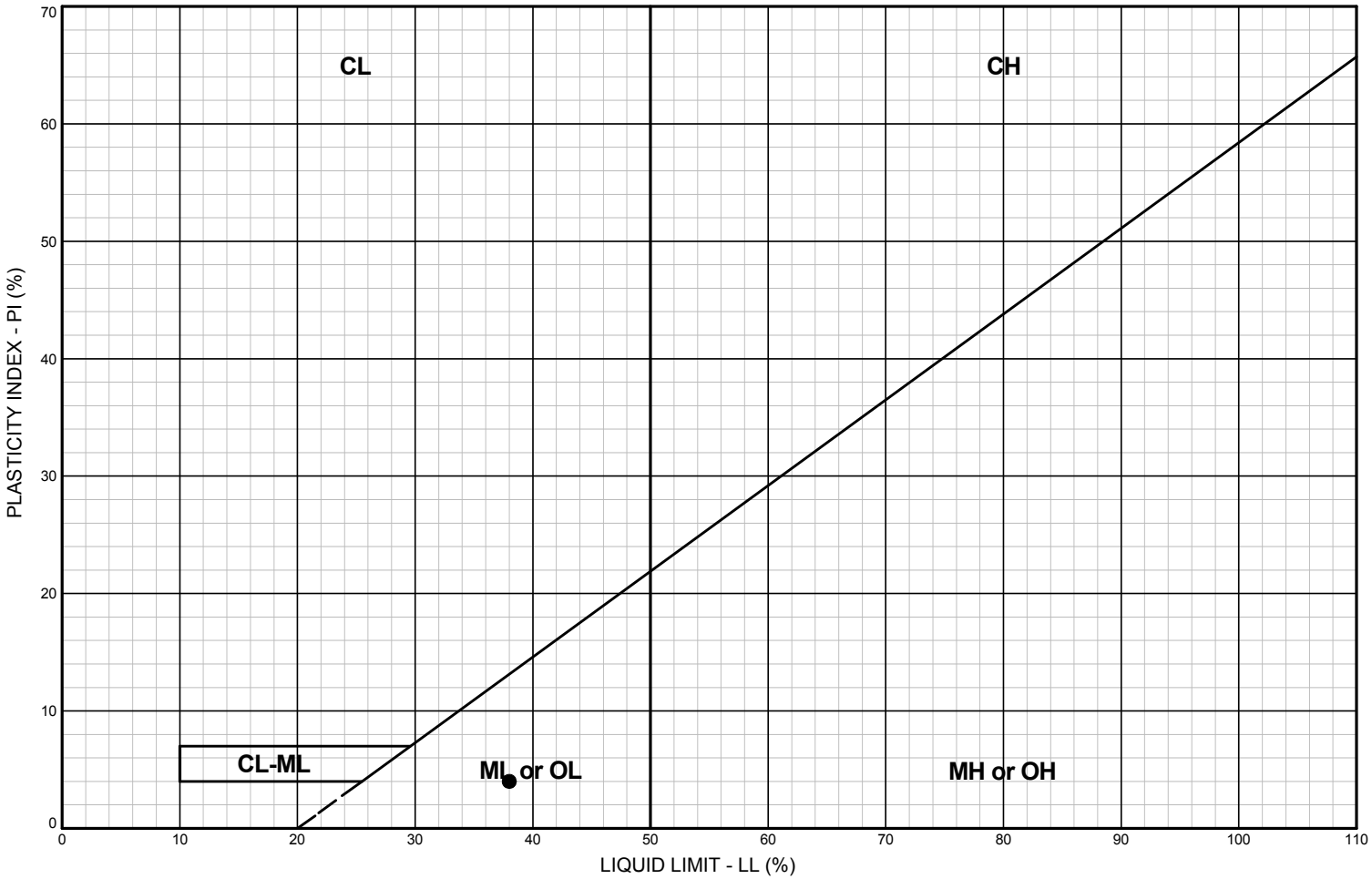
FIG. C-68

AASHTO ATT MAIN 21-12318.GPJ 5/27/14



LEGEND

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PL: Plastic limit

PI: Plasticity index; PI=LL-PL

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FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● TP-27-13, S-3	7.0	ML	Dark gray, slightly clayey, fine sandy SILT	38	34	4	51.4	81.7	3	AKV	JFL	D4318

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PLASTICITY CHART
TEST PIT TP-27-13

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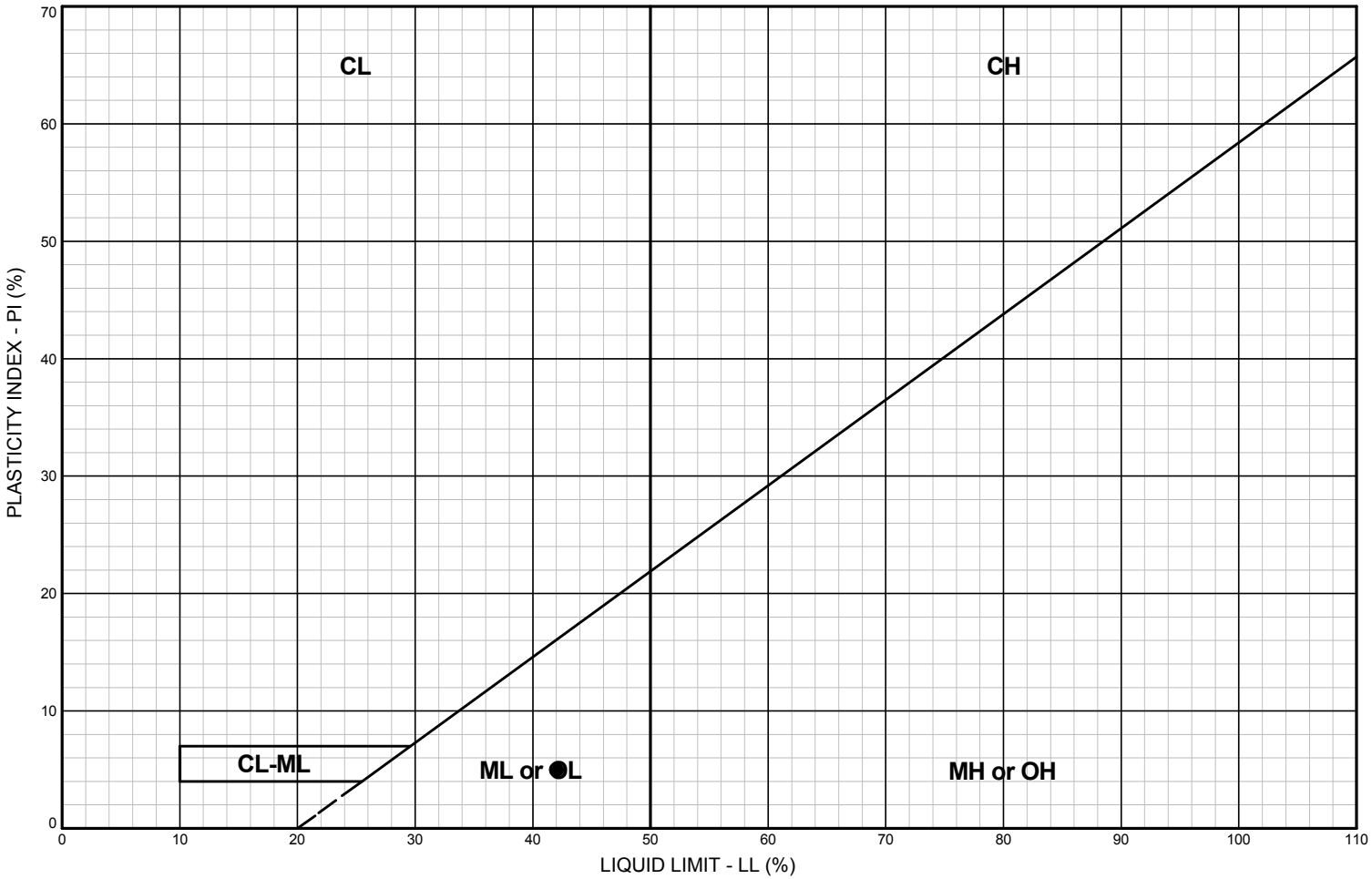
FIG. C-69
Sheet 1 of 1

AASHTO_ATT_MAIN 21-12318.GPJ 5/27/14

FIG. C-69



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● GP-01-10	11.0	ML	Gray SILT, trace of fine sand and clay; trace of fine organics	42	37	5	46.8			JFL	JFL	D4318

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GEOPROBE GP-01-10

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FIG. C-70
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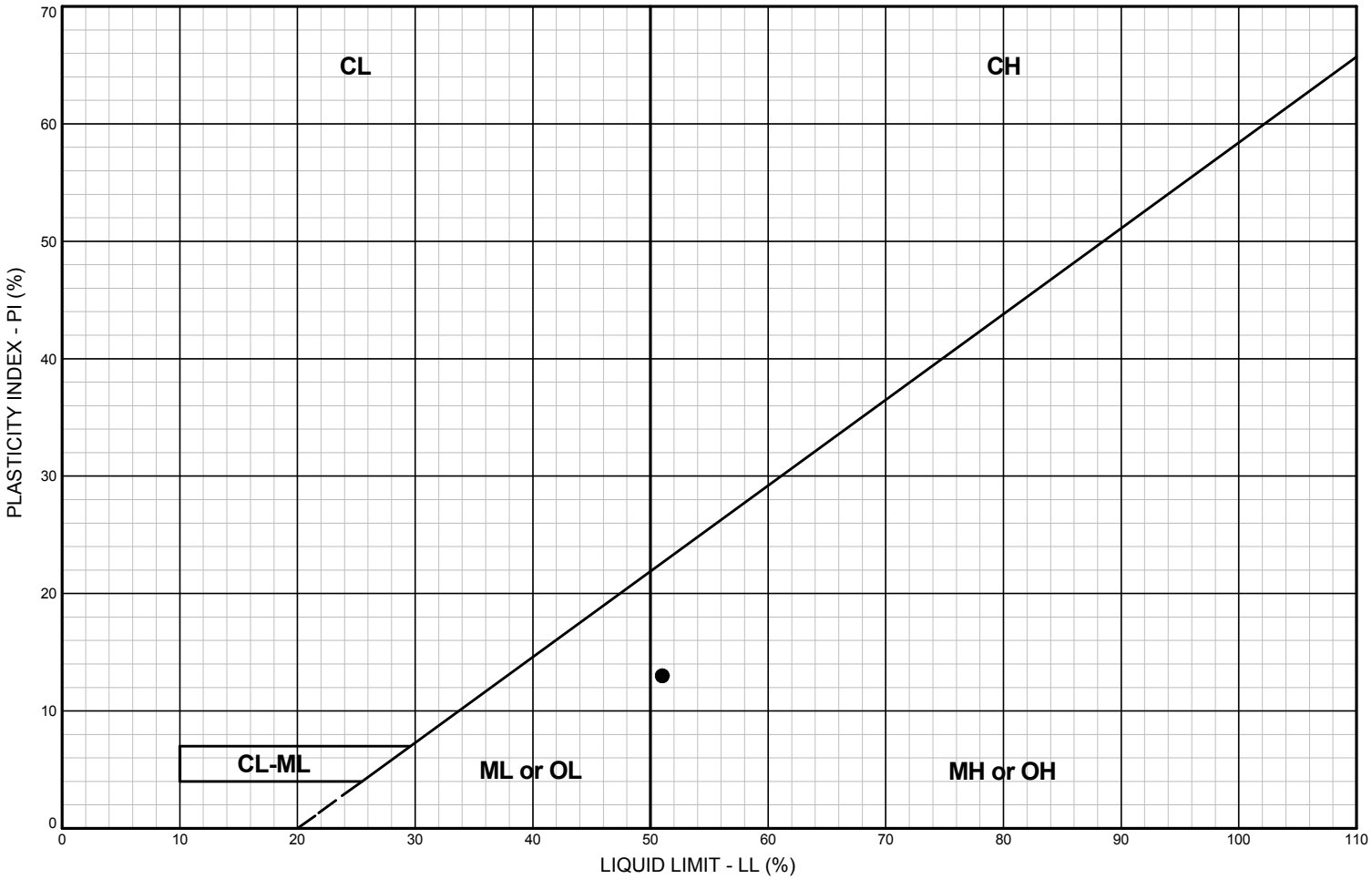
AASHTO_ATT_MAIN 21-12318.GPJ 5/27/14

FIG. C-70



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● GP-02-10	6.0	MH	Gray-brown, slightly clayey SILT, trace of sand; scattered fine organics	51	38	13	58.8			AKV	JFL	D4318

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GEOPROBE GP-02-10

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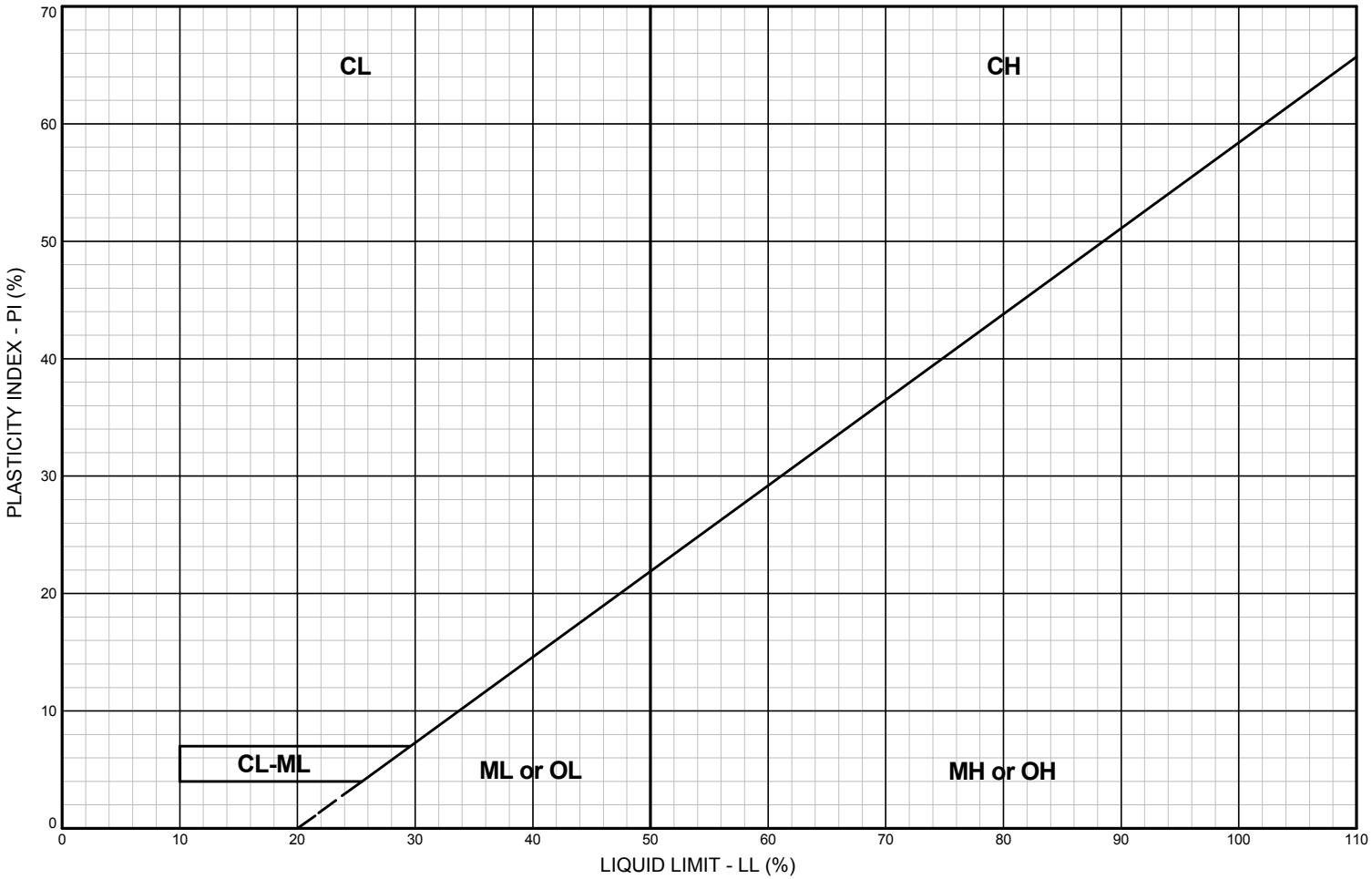
FIG. C-71
Sheet 1 of 1

AASHTO ATT MAIN 21-12318.GPJ 5/27/14



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

CL-ML: Silty clays and clayey silts

OL: Organic silts and clays of low plasticity

OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
GP-04-10	29.0	ML	Gray, fine sandy SILT; trace of shell fragments, trace of fine organics	**NP**	**NP**	**NP**	28.7			JFL	JFL	D4318

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GEOPROBE GP-04-10

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FIG. C-72
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FIG. C-72

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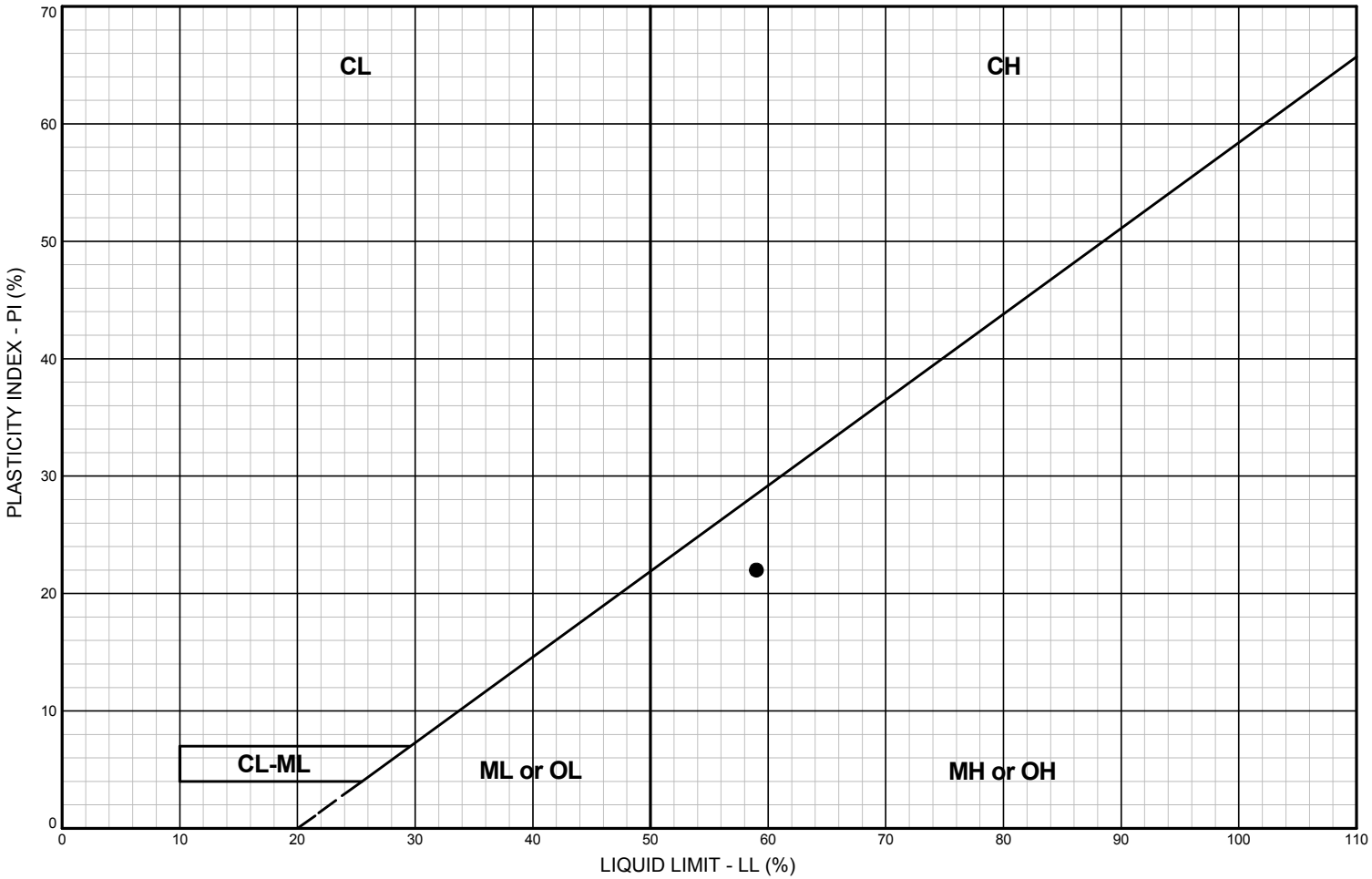

LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● GP-06-10, S-1	2.0	MH	Brown, slightly sandy, clayey SILT; scattered organics, scattered iron oxide nodules	59	37	22	56.4			JFL	JFL	D4318

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PLASTICITY CHART
GEOPROBE GP-06-10

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FIG. C-73
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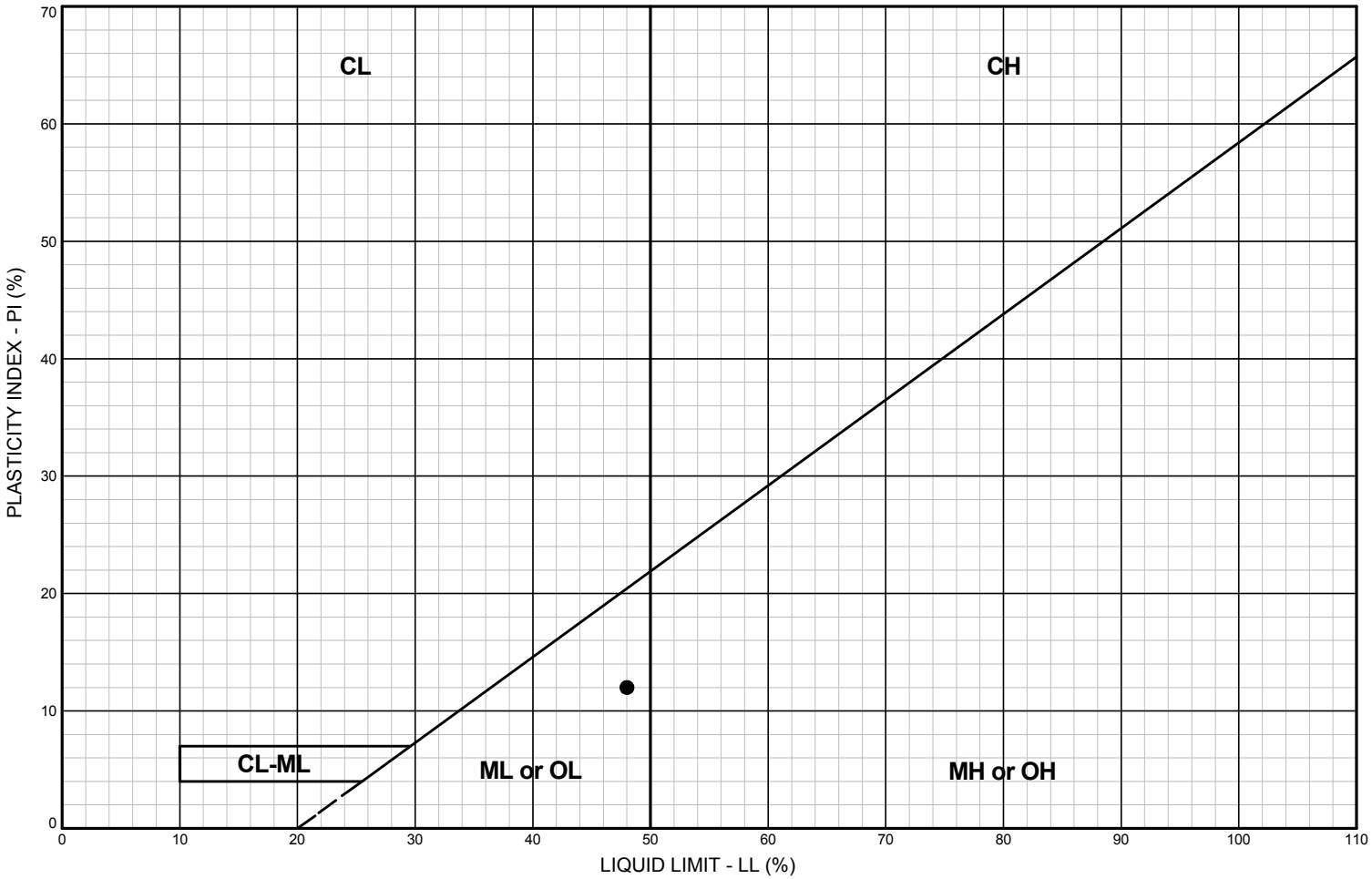
FIG. C-73

AASHTO ATT MAIN 21-12318.GPJ 5/27/14



LEGEND

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ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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OH: Organic silts and clays of high plasticity

LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● GP-07-10	2.0	ML	Brown, slightly clayey SILT; trace of organics, trace of iron oxide	48	36	12	53.6			JJM	JFL	D4318

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PLASTICITY CHART
GEOPROBE GP-07-10

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FIG. C-74
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FIG. C-74

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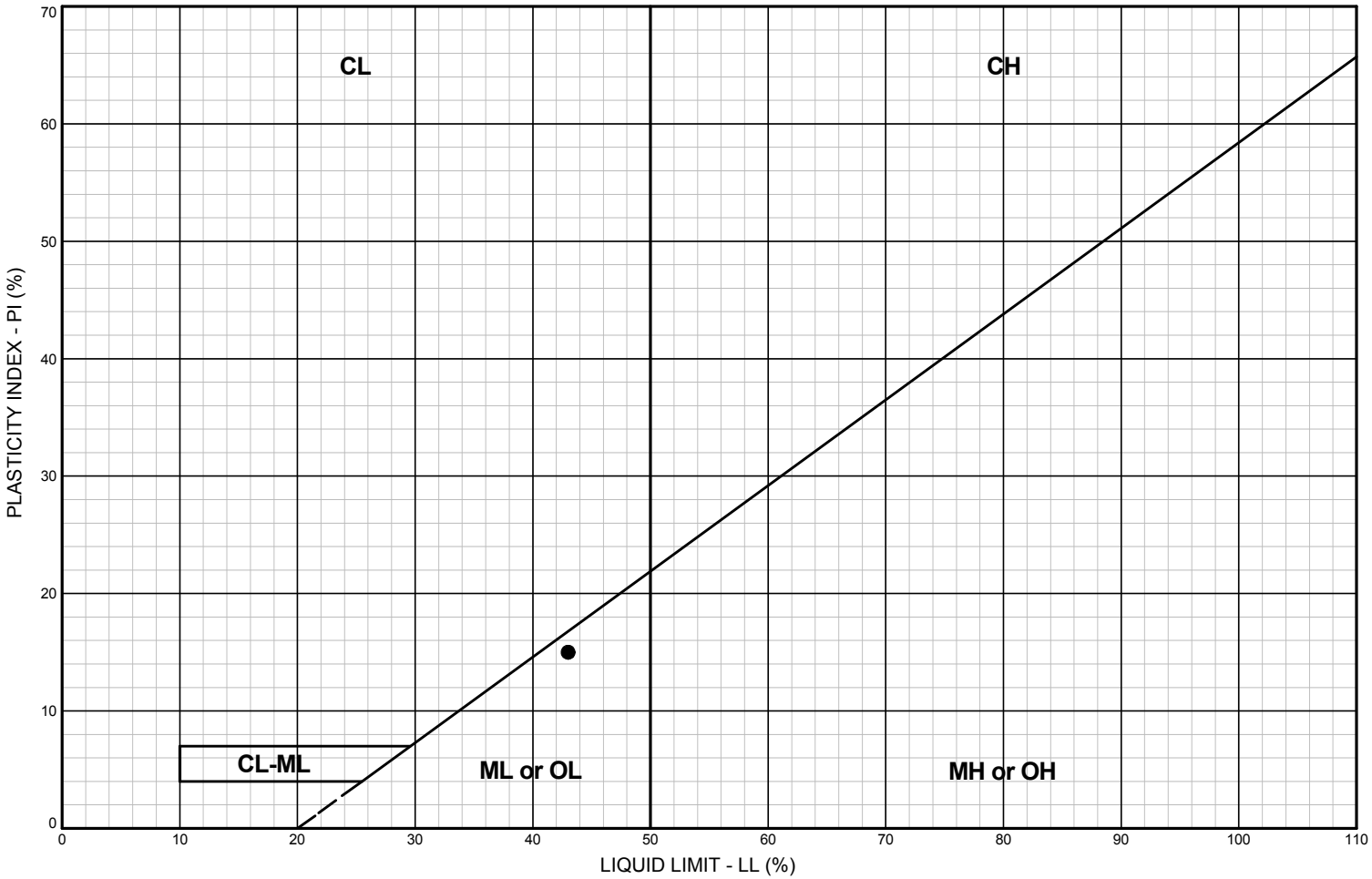

LEGEND

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ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● GP-08-10	29.0	ML	Dark gray-brown, clayey SILT, trace of fine sand	43	28	15	50.3			AKV	JFL	D4318

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PLASTICITY CHART
GEOPROBE GP-08-10

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FIG. C-75
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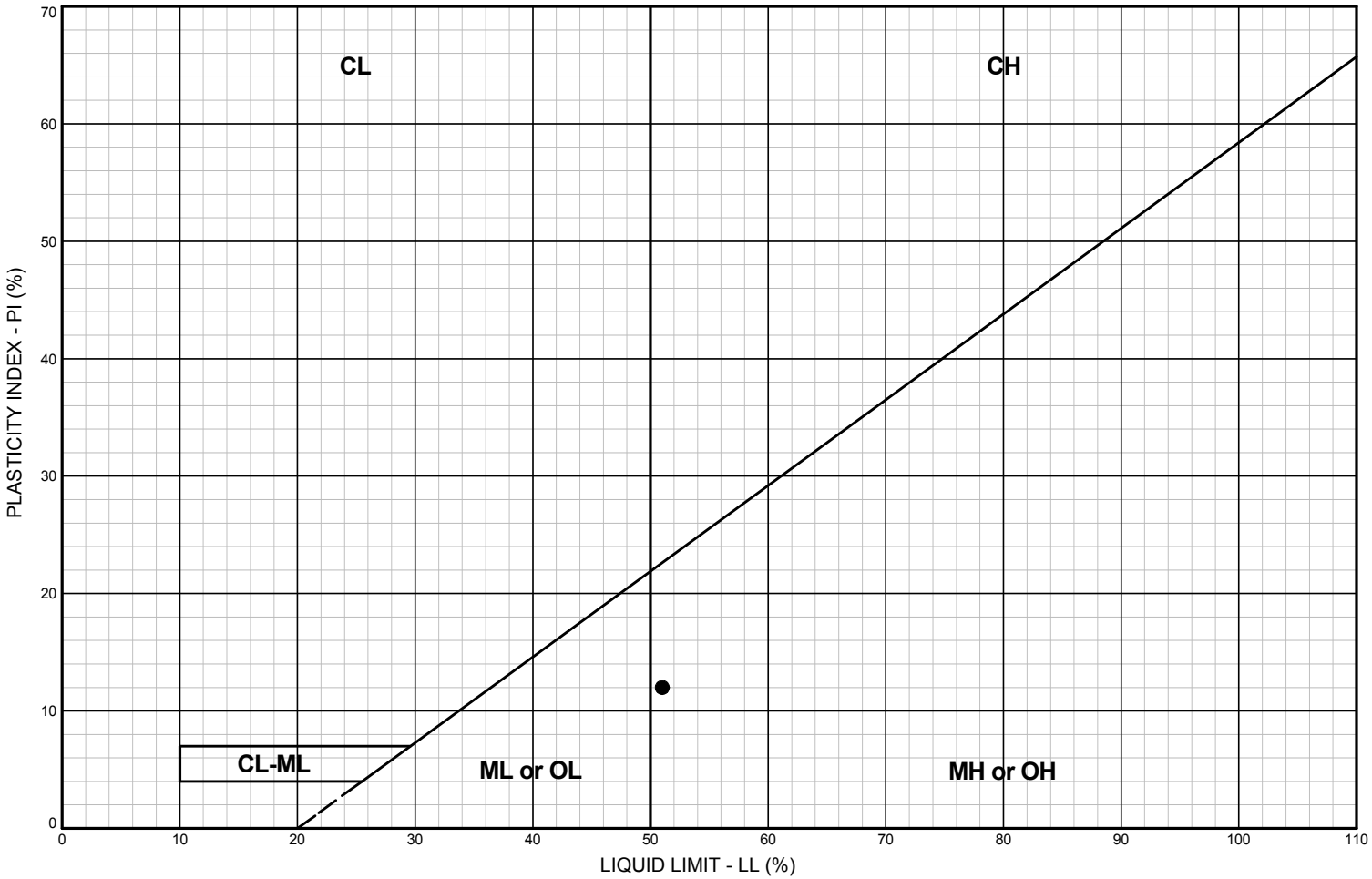
FIG. C-75



LEGEND

CL: Low plasticity inorganic clays; sandy and silty clays

CH: High plasticity inorganic clays

ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● GP-11-10	2.0	MH	Gray-brown, slightly clayey SILT, trace of fine to medium sand; scattered organics	51	39	12	53.5			AKV	JFL	D4318

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PLASTICITY CHART
GEOPROBE GP-11-10

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FIG. C-76
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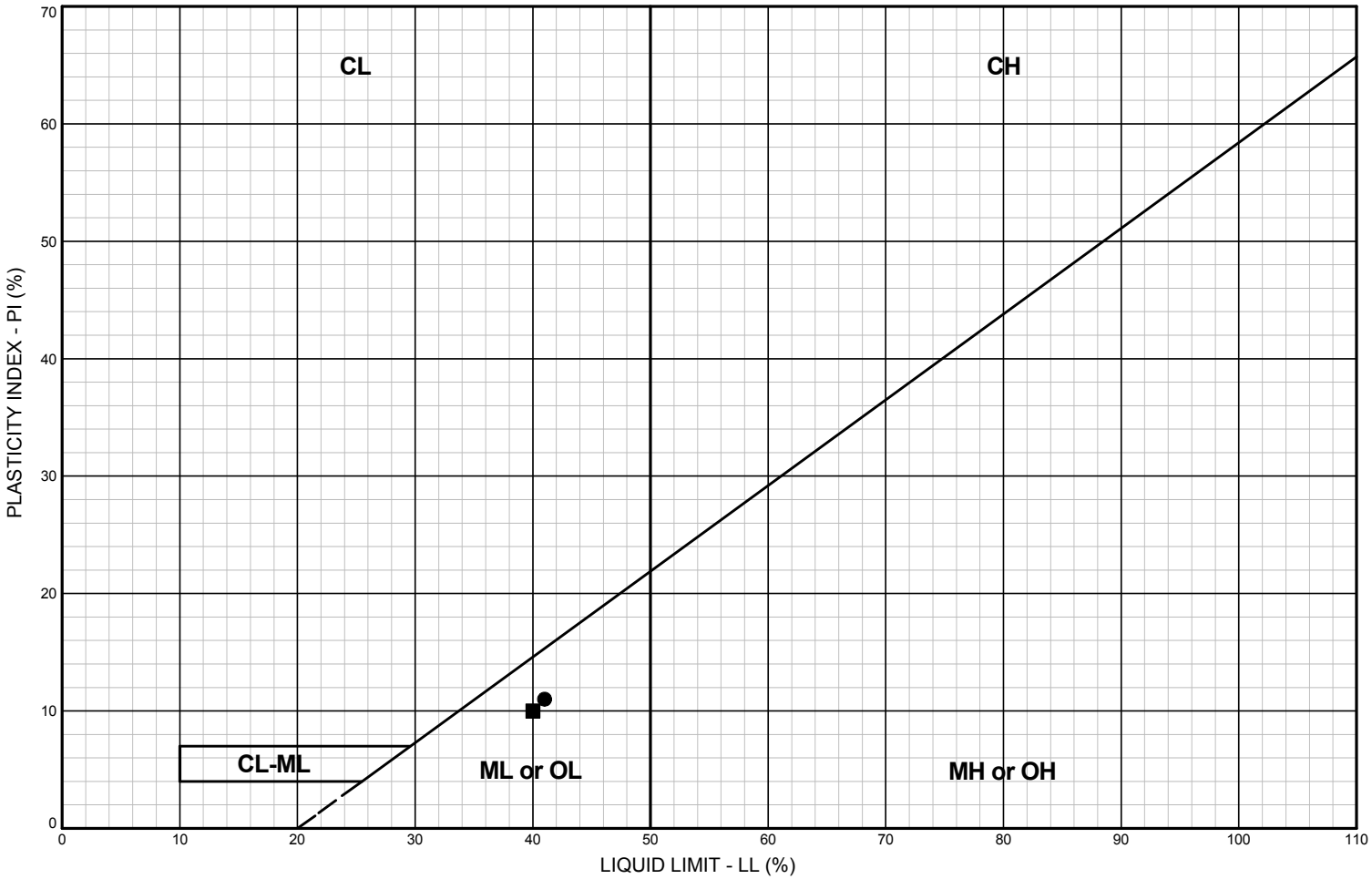
FIG. C-76



LEGEND

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CH: High plasticity inorganic clays

ML: Inorganic silts and clayey silts of low plasticity

MH: Inorganic silts and clayey silts of high plasticity

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LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● HB-2-14, S-1	0.0	ML	Gray-brown, clayey SILT, trace of sand; trace of organics	41	30	11	38.4			AKV	JFL	D4318
■ HB-2-14, S-2	2.5	ML	Gray, fine to medium sandy, clayey SILT; trace of organics	40	30	10	50.3	83.8	11	AKV	JFL	D4318

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PLASTICITY CHART
BORING HB-2-14

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FIG. C-77
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FIG. C-77

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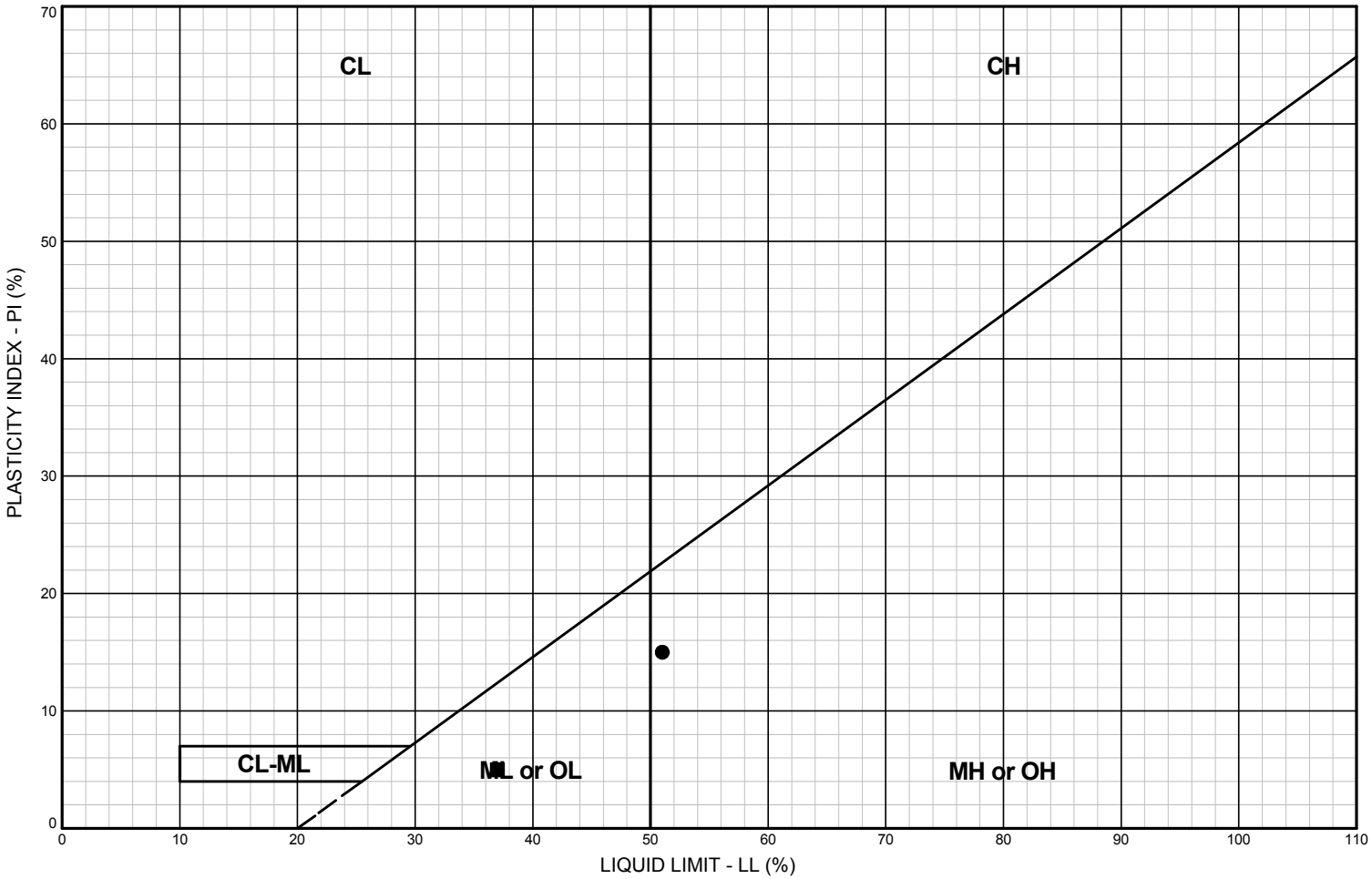

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MH: Inorganic silts and clayey silts of high plasticity

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PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● HB-4-14, S-1	0.0	MH	Brown, slightly fine sandy, clayey SILT; trace of organics	51	36	15	36.6	93.7	20	AKV	JFL	D4318
■ HB-4-14, S-2	2.5	ML	Brown, clayey SILT, trace of sand; trace of organics	37	32	5	42.9			AKV	JFL	D4318

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PLASTICITY CHART
BORING HB-4-14

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FIG. C-78
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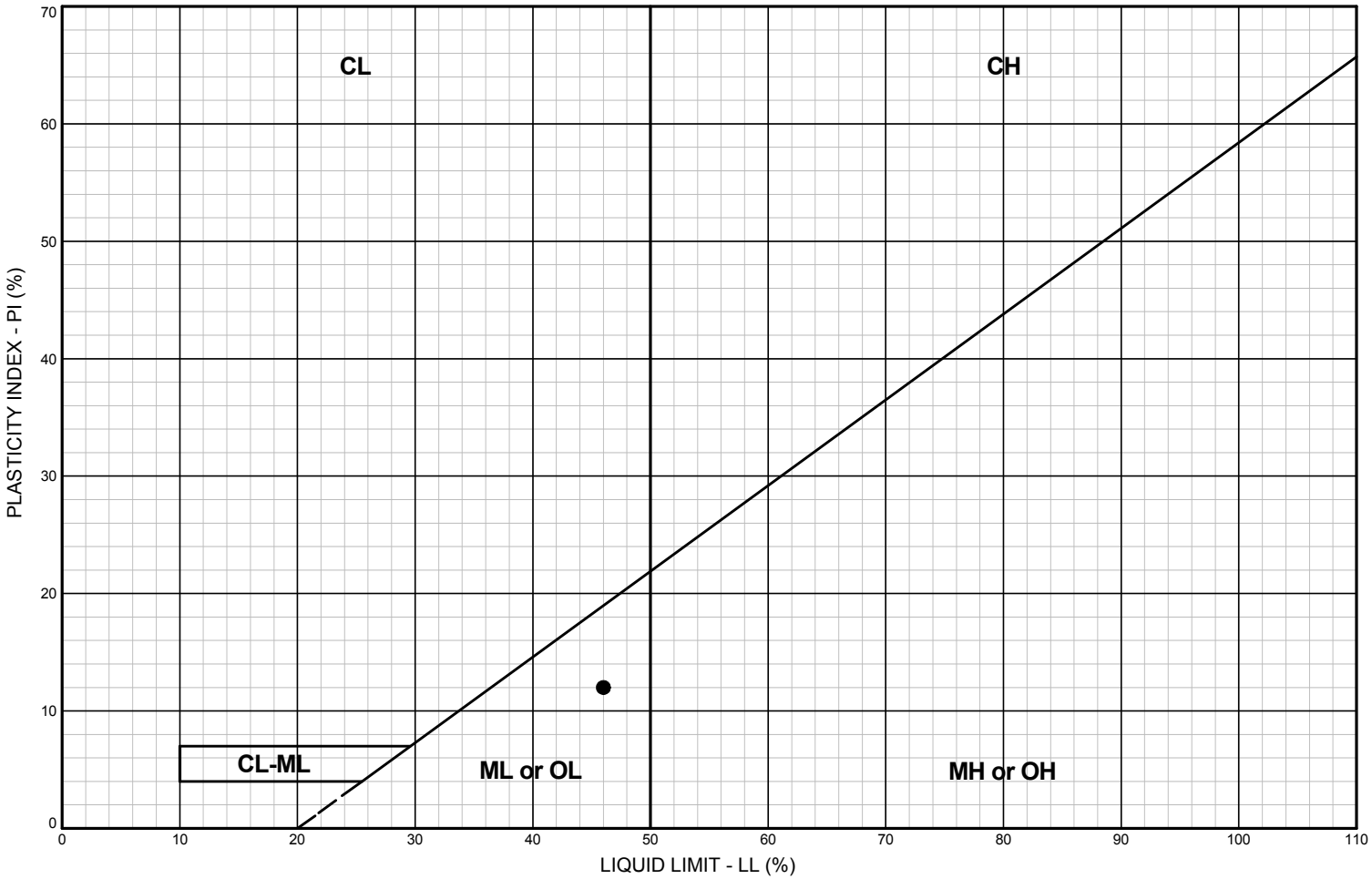
FIG. C-78

AASHTO ATT MAIN 21-12318.GPJ 5/28/14



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MH: Inorganic silts and clayey silts of high plasticity

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LL: Liquid limit

PL: Plastic limit

PI: Plasticity index; PI=LL-PL

NP: Nonplastic

˅ : Nonplastic

˄,>>: Test value exceeds limit of graph

FINES %: Percentage of specimen mass passing the No. 200 sieve

NAT WC%: Natural water content

< 2 um %: Percentage of soil particles finer than 2 micrometers (0.002 mm); clay-size fraction

ASTM DES: ASTM International test standard designation

BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SOIL CLASSIFICATION - ASTM D2487 GROUP NAME	LL %	PL %	PI %	NAT WC %	FINES %	< 2 µm %	TEST BY	REVIEW BY	ASTM DES
● HB-6-14, S-1	0.0	ML	Brown, clayey SILT; trace of organics	46	34	12	40.7			AKV	JFL	D4318

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PLASTICITY CHART
BORING HB-6-14

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FIG. C-79
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AASHTO ATT MAIN 21-12318.GPJ 5/28/14

FIG. C-79

ONE DIMENSIONAL CONSOLIDATION TEST

Boring	B-1-13	Tested By	AKV/JFL
Sample	S-11	Calculated By	AKV
Depth, ft	28	Checked By	JFL

SAMPLE CLASSIFICATION:
Gray-brown SILT, trace of sand and clay; ML

SAMPLE DATA:
Specific Gravity (estimated) 2.7

SPECIMEN DATA:	Before Inundation	First Load	Final Load
Height, inches	0.787	0.787	0.621
Diameter, inches	2.503	2.503	2.503
Sample Volume, cuin	3.872	3.872	3.053
Wet Density, pcf	107.8	107.8	121.5
Dry Density, pcf	76.0	76.0	96.4
Water Content, %	42%	42%	26%
Void Ratio	1.22	1.22	0.75
Saturation, %	93%	93%	94%

Increment	Applied Stress, tsf	ΔH at t_{100}, in	ΔH / H_o	Void Ratio	t_{50}, min	Coeff. of Comp., MPa^{-1}	Coeff. of Consol., cm^2/sec	Coeff. of Perm., cm/sec
1	0.05	0.001	0.2%	1.213	0.1	0.91	2.5E-02	9.9E-07
2	0.10	0.007	0.9%	1.197	0.2	3.33	2.2E-02	3.2E-06
3	0.23	0.016	2.1%	1.171	0.2	2.16	2.1E-02	2.0E-06
4	0.45	0.024	3.1%	1.149	0.1	1.01	2.3E-02	1.1E-06
5	0.90	0.031	4.0%	1.129	0.1	0.46	2.4E-02	5.0E-07
6	1.80	0.046	5.8%	1.089	0.1	0.47	2.5E-02	5.4E-07
7	3.61	0.063	8.0%	1.040	0.1	0.28	2.5E-02	3.3E-07
8	0.90	0.070	8.8%	1.021	0.2	-0.07	1.3E-02	4.6E-08
9	0.23	0.068	8.6%	1.026	0.9	0.08	3.2E-03	1.2E-08
10	0.06	0.067	8.5%	1.029	0.2	0.23	1.8E-02	1.9E-07
11	0.23	0.066	8.4%	1.032	0.1	-0.14	1.9E-02	1.3E-07
12	0.90	0.068	8.7%	1.024	0.2	0.11	1.8E-02	9.5E-08
13	1.80	0.070	8.9%	1.020	0.2	0.05	1.5E-02	3.4E-08
14	3.61	0.072	9.2%	1.014	0.0	0.04	5.6E-02	1.0E-07
15	7.21	0.082	10.4%	0.986	0.1	0.08	4.6E-02	1.8E-07
16	14.42	0.101	12.8%	0.933	0.1	0.08	5.0E-02	1.9E-07
17	28.85	0.124	15.7%	0.869	0.1	0.05	4.5E-02	1.0E-07
18	57.70	0.148	18.8%	0.800	0.1	0.02	3.2E-02	4.2E-08
19	14.42	0.153	19.5%	0.785	0.2	0.00	9.1E-03	1.9E-09
20	3.61	0.153	19.4%	0.786	0.1	0.00	1.7E-02	1.4E-09
21	0.90	0.149	18.9%	0.798	0.1	0.04	1.6E-02	4.0E-08
22	0.23	0.146	18.6%	0.804	0.1	0.10	1.5E-02	8.1E-08

NOTES:
1. Abbreviations:
   cm = centimeter
   cm^2 = square centimeter
   Coeff. = Coefficient
   Comp. = Compressibility
   Consol. = Consolidation
   cu in = cubic inch
   ft = feet
   H_o = initial height
   ΔH = change in height
   in = inch
   min = minute
   MPa = megapascal
   pcf = pounds per cubic foot
   Perm. = Permeability
   sec = second
   t_n = time at n% of primary consolidation
   tsf = tons per square foot

Fir Island Farm
Final Design and Permitting
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ONE DIMENSIONAL CONSOLIDATION TEST SUMMARY
BORING B-1-13, SAMPLE S-11 @28ft

May 2014 21-1-12318-215

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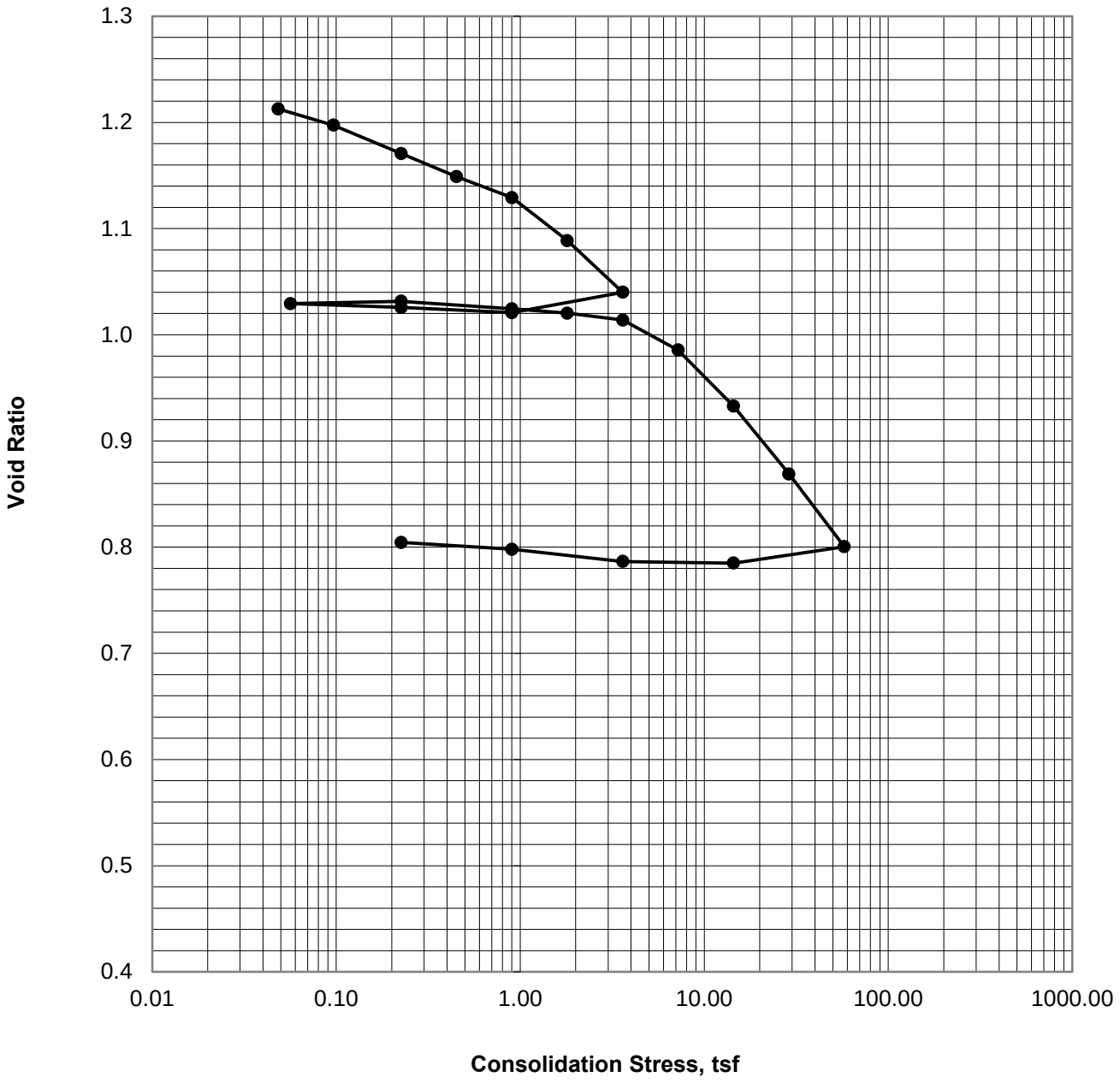
FIG. C-80

ONE DIMENSIONAL CONSOLIDATION TEST

Boring	B-1-13	Tested By	AKV/JFL
Sample	S-11	Calculated By	AKV
Depth, ft	28	Checked By	JFL



Maximum Load, tsf 57.70

NOTES:
1. Abbreviations:
   ft = feet
   tsf = tons per square foot

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

ONE DIMENSIONAL CONSOLIDATION
VOID RATIO vs STRESS PLOT
BORING B-1-13, SAMPLE S-11 @28ft

May 2014 21-1-12318-215

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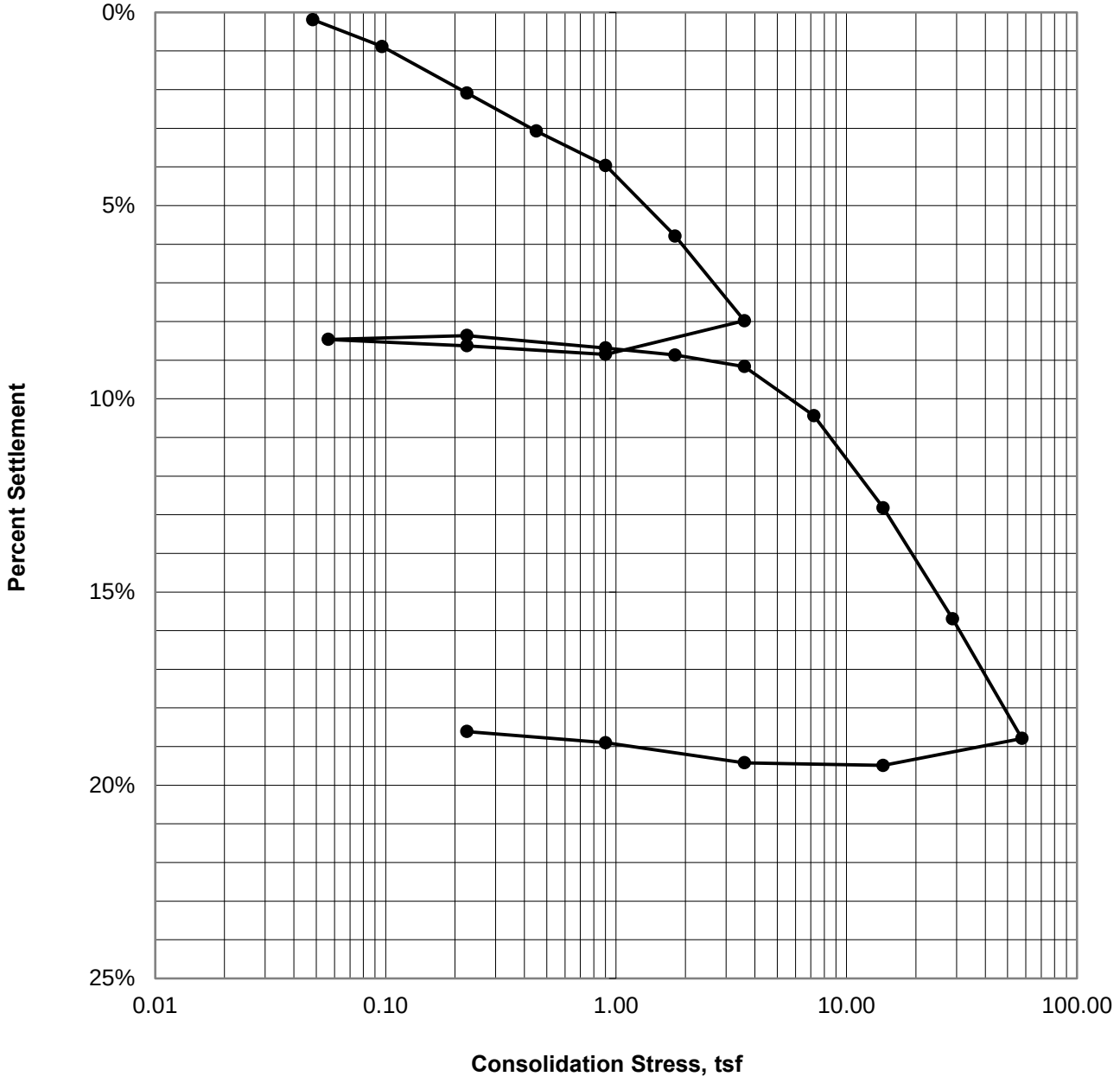
FIG. C-81

ONE DIMENSIONAL CONSOLIDATION TEST

Boring	B-1-13	Tested By	AKV/JFL
Sample	S-11	Calculated By	AKV
Depth, ft	28	Checked By	JFL



Maximum Load, tsf 57.70

NOTES:
1. Abbreviations:
   ft = feet
   tsf = tons per square foot

Fir Island Farm
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ONE DIMENSIONAL CONSOLIDATION PERCENT SETTLEMENT vs STRESS PLOT BORING B-1-13, SAMPLE S-11 @28ft

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FIG. C-82

ONE DIMENSIONAL CONSOLIDATION TEST

Boring	B-4w-13	Tested By	AKV/JFL
Sample	S-2	Calculated By	JFL
Depth, ft	2.2	Checked By	JFL

SAMPLE CLASSIFICATION:
Gray-brown, slightly clayey SILT; silty fine sand laminations, trace of organics; ML

SAMPLE DATA:

Specific Gravity (estimated)	2.7
Liquid Limit	39
Plastic Limit	31
Plasticity Index	8

SPECIMEN DATA:

	Before Inundation	First Load	Final Load
Height, inches	0.786	0.786	0.646
Diameter, inches	2.503	2.503	2.503
Sample Volume, cuin	3.870	3.870	3.179
Wet Density, pcf	107.8	107.8	122.0
Dry Density, pcf	77.0	76.9	93.7
Water Content, %	40%	40%	30%
Void Ratio	1.19	1.19	0.80
Saturation, %	91%	91%	100%

Increment	Applied Stress, tsf	ΔH at t_{100}, in	ΔH / H_o	Void Ratio	t_{50}, min	Coeff. of Comp., MPa^{-1}	Coeff. of Consol., cm^2/sec	Coeff. of Perm., cm/sec
1	0.10	0.001	0.1%	1.188	0.8	0.18	4.2E-03	3.3E-08
2	0.19	0.005	0.6%	1.176	0.7	1.34	4.8E-03	2.9E-07
3	0.39	0.014	1.7%	1.152	0.5	1.27	7.0E-03	4.0E-07
4	0.77	0.025	3.1%	1.121	0.5	0.84	6.4E-03	2.5E-07
5	1.55	0.037	4.8%	1.086	0.4	0.48	8.4E-03	1.9E-07
6	3.09	0.054	6.8%	1.040	0.3	0.31	8.3E-03	1.2E-07
7	6.18	0.075	9.6%	0.980	0.3	0.20	9.1E-03	8.9E-08
8	1.55	0.079	10.1%	0.970	0.2	-0.02	1.4E-02	1.6E-08
9	0.39	0.074	9.4%	0.984	0.5	0.13	5.7E-03	3.8E-08
10	0.10	0.068	8.6%	1.001	2.0	0.58	1.4E-03	4.0E-08
11	0.39	0.066	8.4%	1.005	0.2	-0.18	1.1E-02	9.7E-08
12	1.55	0.072	9.2%	0.989	0.2	0.15	1.1E-02	8.4E-08
13	6.18	0.083	10.5%	0.959	0.1	0.07	1.8E-02	5.9E-08
14	12.36	0.102	13.0%	0.905	0.3	0.09	8.7E-03	4.0E-08
15	49.44	0.160	20.4%	0.744	0.1	0.05	1.7E-02	4.0E-08
16	12.36	0.162	20.6%	0.738	0.2	0.00	1.3E-02	1.2E-09
17	3.09	0.154	19.6%	0.760	0.5	0.03	4.3E-03	6.1E-09
18	0.77	0.149	19.0%	0.774	1.0	0.06	2.1E-03	7.5E-09
19	0.19	0.136	17.3%	0.812	10.7	0.68	2.1E-04	7.7E-09

NOTES:
1. Abbreviations:
   cm = centimeter
   cm^2 = square centimeter
   Coeff. = Coefficient
   Comp. = Compressibility
   Consol. = Consolidation
   cu in = cubic inch
   ft = feet
   H_o = initial height
   ΔH = change in height
   in = inch
   min = minute
   MPa = megapascal
   pcf = pounds per cubic foot
   Perm. = Permeability
   sec = second
   t_n = time at n% of primary consolidation
   tsf = tons per square foot

Fir Island Farm
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ONE DIMENSIONAL CONSOLIDATION TEST SUMMARY
BORING B-4w-13, SAMPLE S-2 @2.2ft

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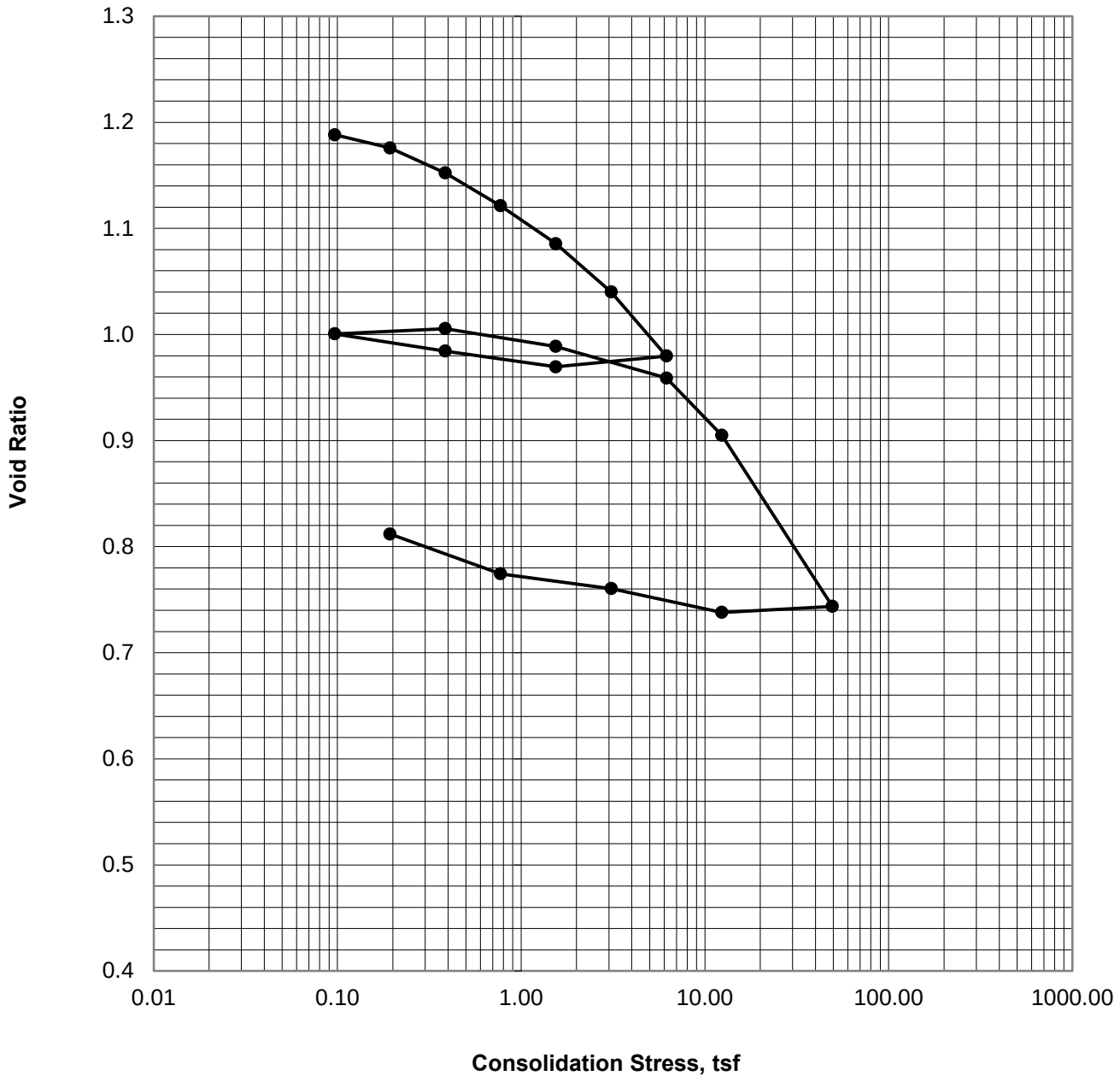
FIG. C-83

ONE DIMENSIONAL CONSOLIDATION TEST

Boring	B-4w-13	Tested By	AKV/JFL
Sample	S-2	Calculated By	JFL
Depth, ft	2.2	Checked By	JFL



Maximum Load, tsf 49.44

NOTES:
1. Abbreviations:
   ft = feet
   tsf = tons per square foot

Fir Island Farm
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ONE DIMENSIONAL CONSOLIDATION
VOID RATIO vs STRESS PLOT
BORING B-4w-13, SAMPLE S-2 @2.2ft

May 2014 21-1-12318-215

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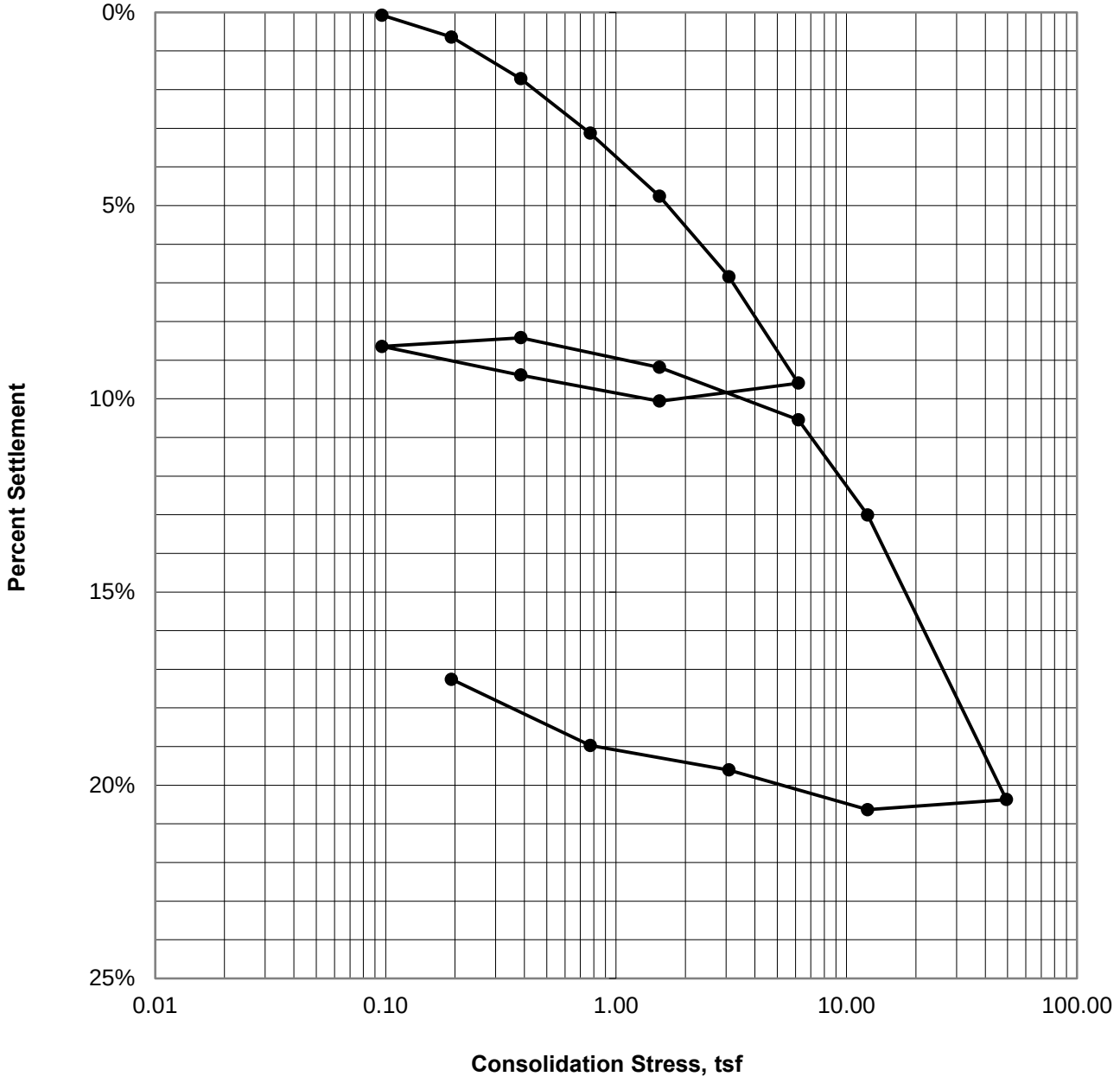
FIG. C-84

ONE DIMENSIONAL CONSOLIDATION TEST

Boring	B-4w-13	Tested By	AKV/JFL
Sample	S-2	Calculated By	JFL
Depth, ft	2.2	Checked By	JFL



Maximum Load, tsf 49.44

NOTES:
1. Abbreviations:
   ft = feet
   tsf = tons per square foot

Fir Island Farm
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ONE DIMENSIONAL CONSOLIDATION PERCENT SETTLEMENT vs STRESS PLOT BORING B-4w-13, SAMPLE S-2 @2.2ft

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FIG. C-85

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
SUMMARY OF TEST DATA

Boring B-1-13
Sample S-11
Depth, ft 26.7

Tested By JFL
Calculated By JFL
Finalized By JFL

SAMPLE CLASSIFICATION:
Gray, fine sandy SILT, trace of clay; scattered fine organics, scattered shells; ML.

SAMPLE DATA:

B-Value at End of Saturation	1.00
Consolidation Stress, psf	1296
Cell Pressure during Shear, psf	4752
Initial Pore Pressure, psf	3413
Shear Rate, in/min	0.0088

SPECIMEN DATA:

	Initial	Post-Consol	Post-Shear
Height, inches	5.597	5.570	4.456
Diameter, inches	2.483	2.483	
Aspect Ratio	2.25	2.24	
Wet Weight, grams	756.35	731.27	731.27
Water Content	41.5%	36.8%	36.8%
Wet Density, pcf	106.3	103.3	103.3
Dry Density, pcf	75.1	75.5	75.5

Axial Strain, in/in	Deviator Stress, psf	Excess Pore Pres., psf	Major Eff. Prin. Stress, psf	Minor Eff. Prin. Stress, psf	Prin. Eff. Stress Ratio	Stress Path Parameters, psf p	p'	q
0.0067	921	576	1641	720	2.28	1756	1180	460
0.0132	1090	720	1666	576	2.89	1841	1121	545
0.0199	1196	778	1714	518	3.31	1894	1116	598
0.0266	1273	806	1763	490	3.60	1933	1126	637
0.0333	1327	806	1817	490	3.71	1960	1153	664
0.0399	1389	806	1878	490	3.84	1990	1184	694
0.0465	1432	792	1936	504	3.84	2012	1220	716
0.0532	1480	792	1984	504	3.94	2036	1244	740
0.0600	1536	778	2054	518	3.96	2064	1286	768
0.0665	1555	763	2088	533	3.92	2073	1310	777
0.0733	1603	763	2136	533	4.01	2098	1334	802
0.0798	1632	749	2179	547	3.98	2112	1363	816
0.0865	1668	734	2230	562	3.97	2130	1396	834
0.0930	1701	734	2263	562	4.03	2147	1412	851
0.0999	1725	720	2301	576	3.99	2158	1438	862
0.1062	1749	720	2325	576	4.04	2170	1450	874
0.1130	1774	706	2364	590	4.00	2183	1477	887
0.1199	1801	691	2406	605	3.98	2196	1505	900
0.1262	1818	677	2437	619	3.94	2205	1528	909
0.1331	1829	677	2448	619	3.95	2210	1533	914
0.1399	1846	677	2465	619	3.98	2219	1542	923
0.1462	1849	662	2483	634	3.92	2221	1558	925
0.1531	1858	648	2506	648	3.87	2225	1577	929
0.1599	1867	648	2515	648	3.88	2230	1582	934
0.1662	1857	634	2519	662	3.80	2224	1591	928
0.1731	1853	634	2515	662	3.80	2222	1589	926
0.1799	1848	634	2511	662	3.79	2220	1586	924
0.1863	1840	619	2517	677	3.72	2216	1597	920
0.1931	1837	619	2514	677	3.71	2215	1596	919
0.2000	1823	619	2500	677	3.69	2207	1588	911

NOTES:
1. Abbreviations:
   ft = feet
   in = inch
   min = minute
   pcf = pounds per cubic foot
   psf = pounds per square foot
   Pres. = Pressure
   Eff. = Effective
   Prin. = Principal
   CU = Consolidated Undrained

Fir Island Farms
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Skagit County, Washington

CU TRIAXIAL TEST SUMMARY
BORING B-1-13, SAMPLE S-11 @ 26.7 ft

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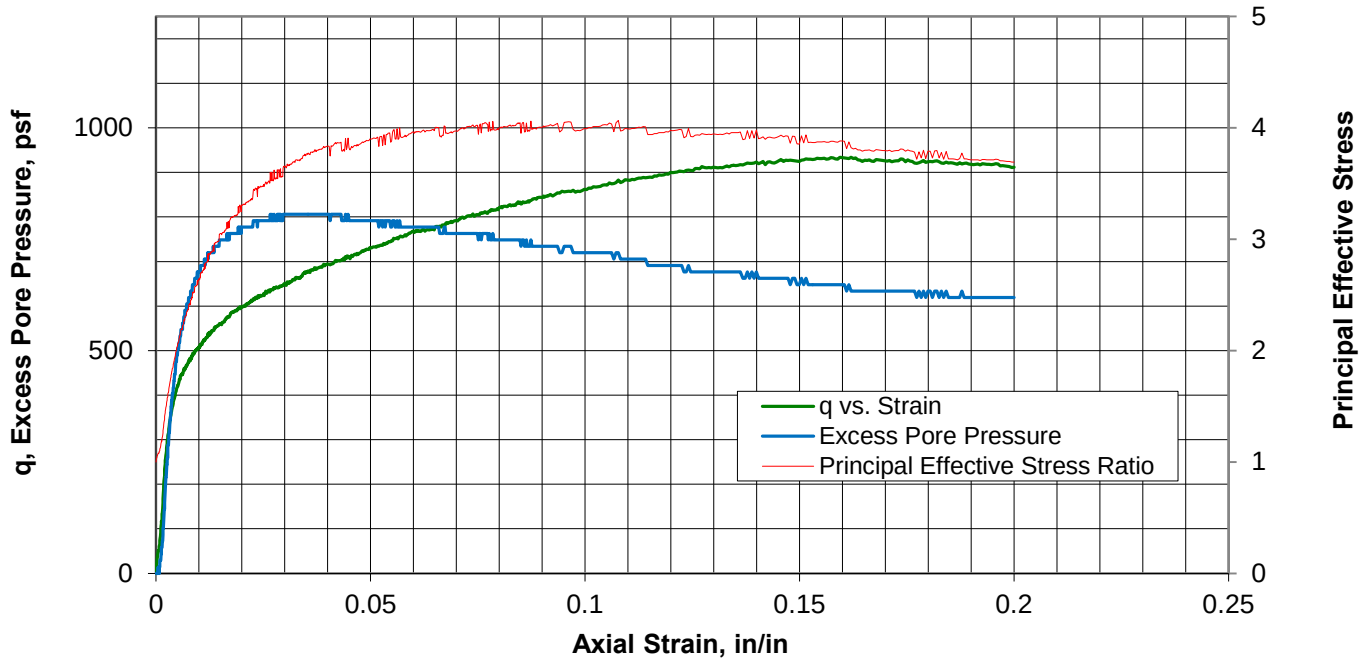
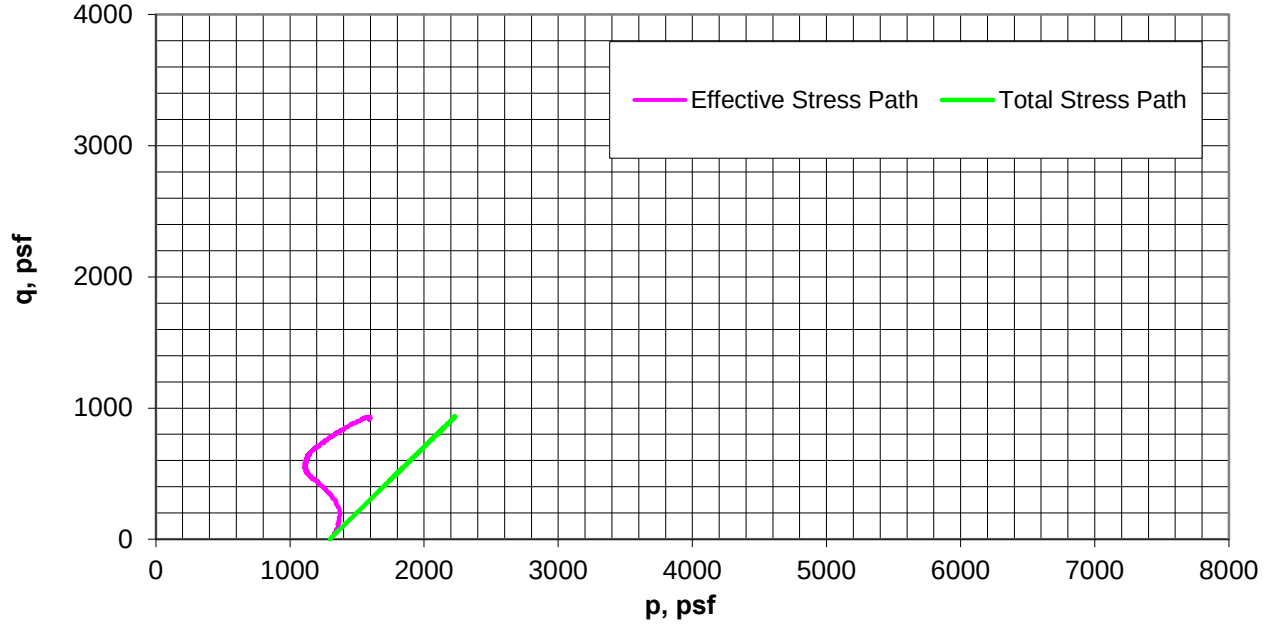
FIG. C-86
Sheet 1 of 2

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

Boring B-1-13
Sample S-11
Depth, ft 26.7

Tested By JFL
Calculated By JFL
Finalized By JFL





Effective Stress at End-of-Consolidation, psf	1296
Cell Pressure during Shear, psf	4752

NOTES:
1. Abbreviations:
   ft = feet
   in = inch
   psf = pounds per square foot
   CU = Consolidated Undrained

Fir Island Farms
Final Design and Permitting
Skagit County, Washington

CU TRIAXIAL TEST SUMMARY
BORING B-1-13, SAMPLE S-11 @ 26.7 ft

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FIG. C-86
Sheet 2 of 2

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
SUMMARY OF TEST DATA

Boring B-1-13
Sample S-11
Depth, ft 27.2

Tested By JFL
Calculated By JFL
Finalized By JFL

SAMPLE CLASSIFICATION:
Gray, fine sandy SILT, trace of clay; scattered fine organics, scattered shells; ML; LL= 28; PL= 27.

SAMPLE DATA:

B-Value at End of Saturation	0.98
Consolidation Stress, psf	3456
Cell Pressure during Shear, psf	6912
Initial Pore Pressure, psf	3413
Shear Rate, in/min	0.0088

SPECIMEN DATA:

	Initial	Post-Consol	Post-Shear
Height, inches	5.177	5.083	4.068
Diameter, inches	2.486	2.486	
Aspect Ratio	2.08	2.04	
Wet Weight, grams	738.15	711.28	711.28
Water Content	44.4%	39.1%	39.1%
Wet Density, pcf	111.9	109.8	109.8
Dry Density, pcf	77.5	78.9	78.9

Axial Strain, in/in	Deviator Stress, psf	Excess Pore Pres., psf	Major Eff. Prin. Stress, psf	Minor Eff. Prin. Stress, psf	Prin. Eff. Stress Ratio	Stress Path Parameters, psf p	p'	q
0.0066	2136	1670	3922	1786	2.20	4524	2854	1068
0.0133	2349	2189	3616	1267	2.85	4631	2442	1175
0.0199	2437	2376	3517	1080	3.26	4675	2299	1219
0.0265	2507	2477	3486	979	3.56	4709	2233	1253
0.0332	2580	2534	3502	922	3.80	4746	2212	1290
0.0398	2645	2549	3552	907	3.92	4778	2229	1322
0.0463	2719	2563	3612	893	4.05	4816	2252	1360
0.0530	2792	2578	3671	878	4.18	4852	2274	1396
0.0599	2852	2563	3744	893	4.19	4882	2319	1426
0.0665	2917	2563	3809	893	4.27	4914	2351	1458
0.0731	2986	2549	3893	907	4.29	4949	2400	1493
0.0796	3057	2534	3978	922	4.32	4984	2450	1528
0.0862	3110	2520	4046	936	4.32	5011	2491	1555
0.0931	3182	2506	4132	950	4.35	5047	2541	1591
0.0997	3224	2491	4189	965	4.34	5068	2577	1612
0.1062	3280	2477	4259	979	4.35	5096	2619	1640
0.1131	3319	2462	4313	994	4.34	5116	2653	1660
0.1191	3353	2448	4361	1008	4.33	5133	2685	1677
0.1261	3385	2434	4408	1022	4.31	5149	2715	1693
0.1330	3385	2419	4422	1037	4.27	5149	2730	1693
0.1391	3381	2405	4433	1051	4.22	5147	2742	1691
0.1460	3361	2405	4412	1051	4.20	5136	2731	1680
0.1529	3327	2390	4393	1066	4.12	5119	2729	1663
0.1590	3280	2390	4345	1066	4.08	5096	2705	1640
0.1659	3204	2405	4256	1051	4.05	5058	2653	1602
0.1728	3120	2419	4157	1037	4.01	5016	2597	1560
0.1789	3069	2434	4092	1022	4.00	4991	2557	1535
0.1858	3013	2434	4035	1022	3.95	4962	2529	1506
0.1928	2938	2448	3946	1008	3.91	4925	2477	1469
0.1997	2885	2462	3879	994	3.90	4899	2436	1443

NOTES:
1. Abbreviations:
   ft = feet
   in = inch
   min = minute
   pcf = pounds per cubic foot
   psf = pounds per square foot
   Pres. = Pressure
   Eff. = Effective
   Prin. = Principal
   CU = Consolidated Undrained

Fir Island Farms
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CU TRIAXIAL TEST SUMMARY
BORING B-1-13, SAMPLE S-11 @ 27.2 ft

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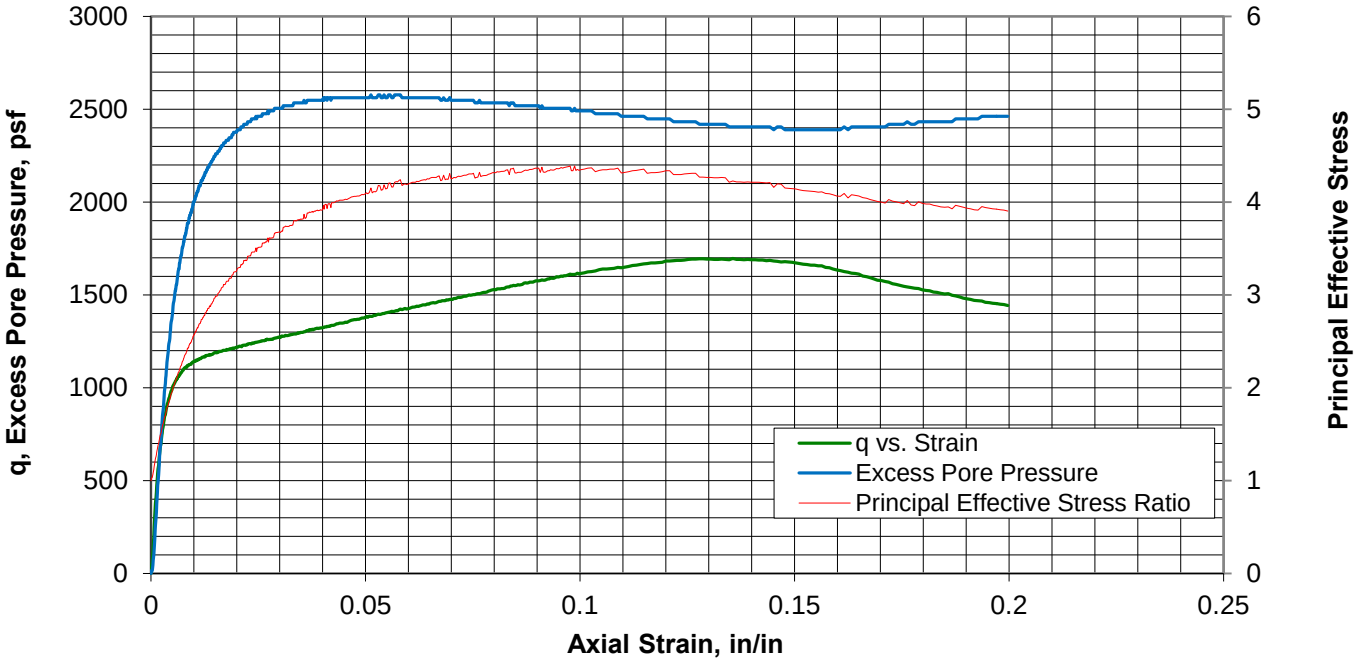
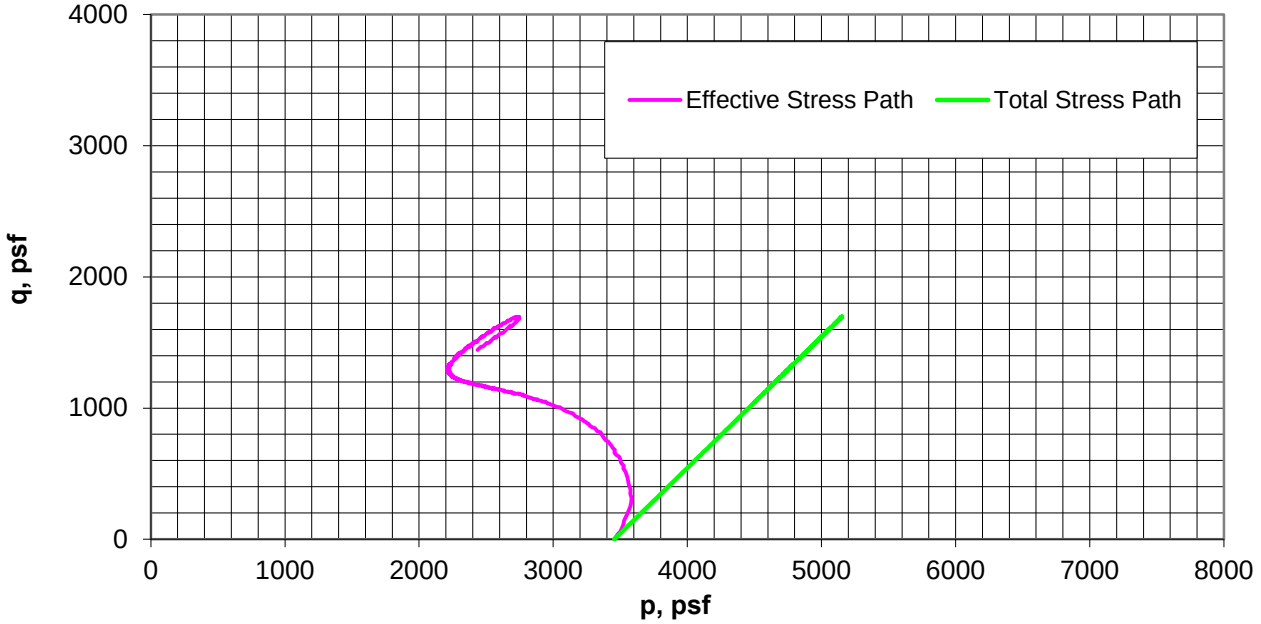
FIG. C-87
Sheet 1 of 2

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

Boring B-1-13
Sample S-11
Depth, ft 27.2

Tested By JFL
Calculated By JFL
Finalized By JFL





Effective Stress at End-of-Consolidation, psf	3456
Cell Pressure during Shear, psf	6912

NOTES:
1. Abbreviations:
   ft = feet
   in = inch
   psf = pounds per square foot
   CU = Consolidated Undrained

Fir Island Farms
Final Design and Permitting
Skagit County, Washington

CU TRIAXIAL TEST SUMMARY
BORING B-1-13, SAMPLE S-11 @ 27.2 ft

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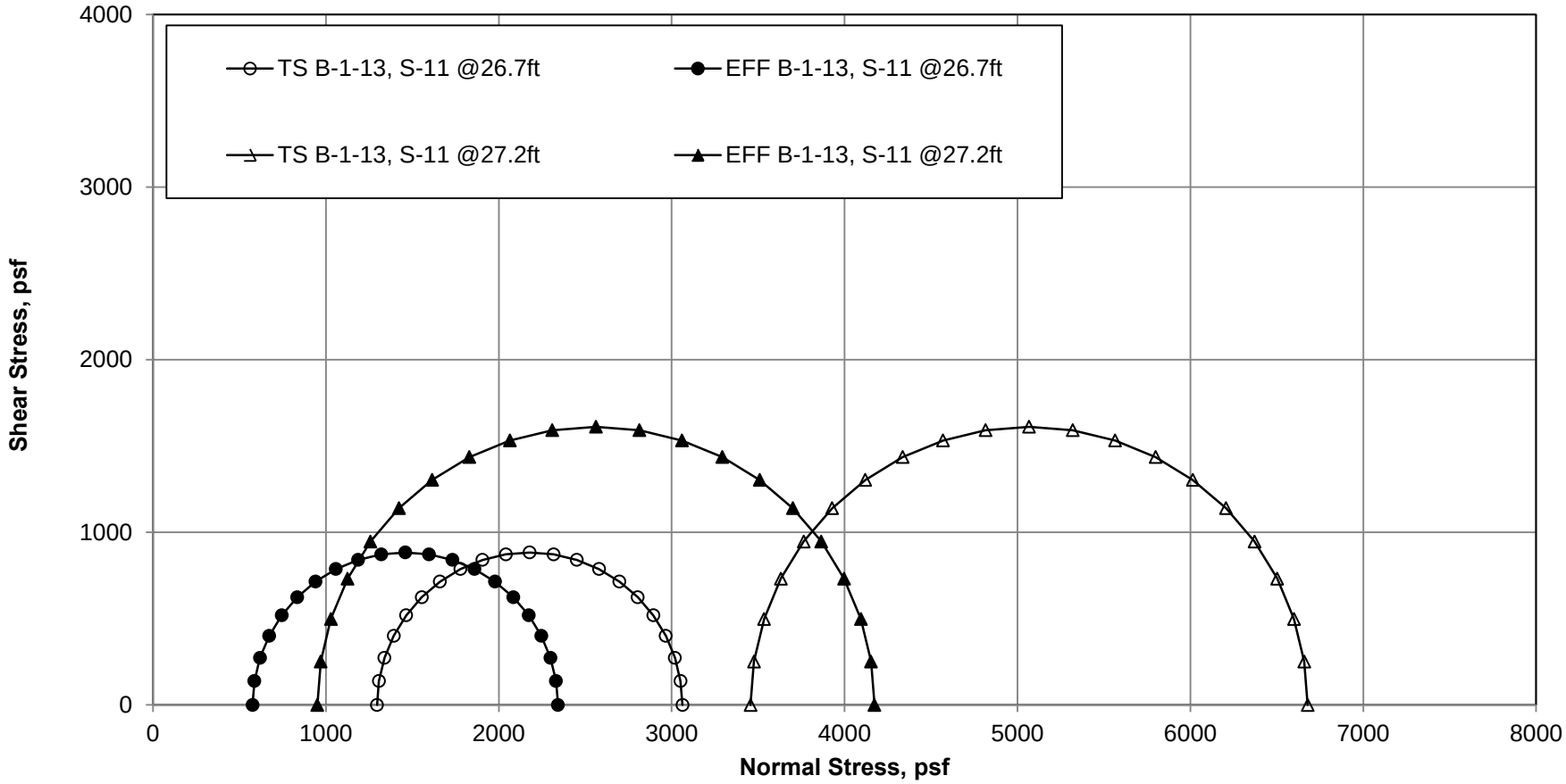
FIG. C-87
Sheet 2 of 2



NOTES

1. The Mohr's circles in this plot are based on total or effective stresses computed from results of triaxial testing.

2. The Mohr's circles in this plot are based on the **maximum principal effective stress ratio** observed during loading.

3. Abbreviations:
   ft = feet
   psf = pounds per square foot
   TS = total stress
   EFF = effective stress
   CU = Consolidated Undrained

Fir Island Farms
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CU TRIAXIAL TEST
MOHR'S CIRCLE PLOT
BORING B-1-13, SAMPLE S-11

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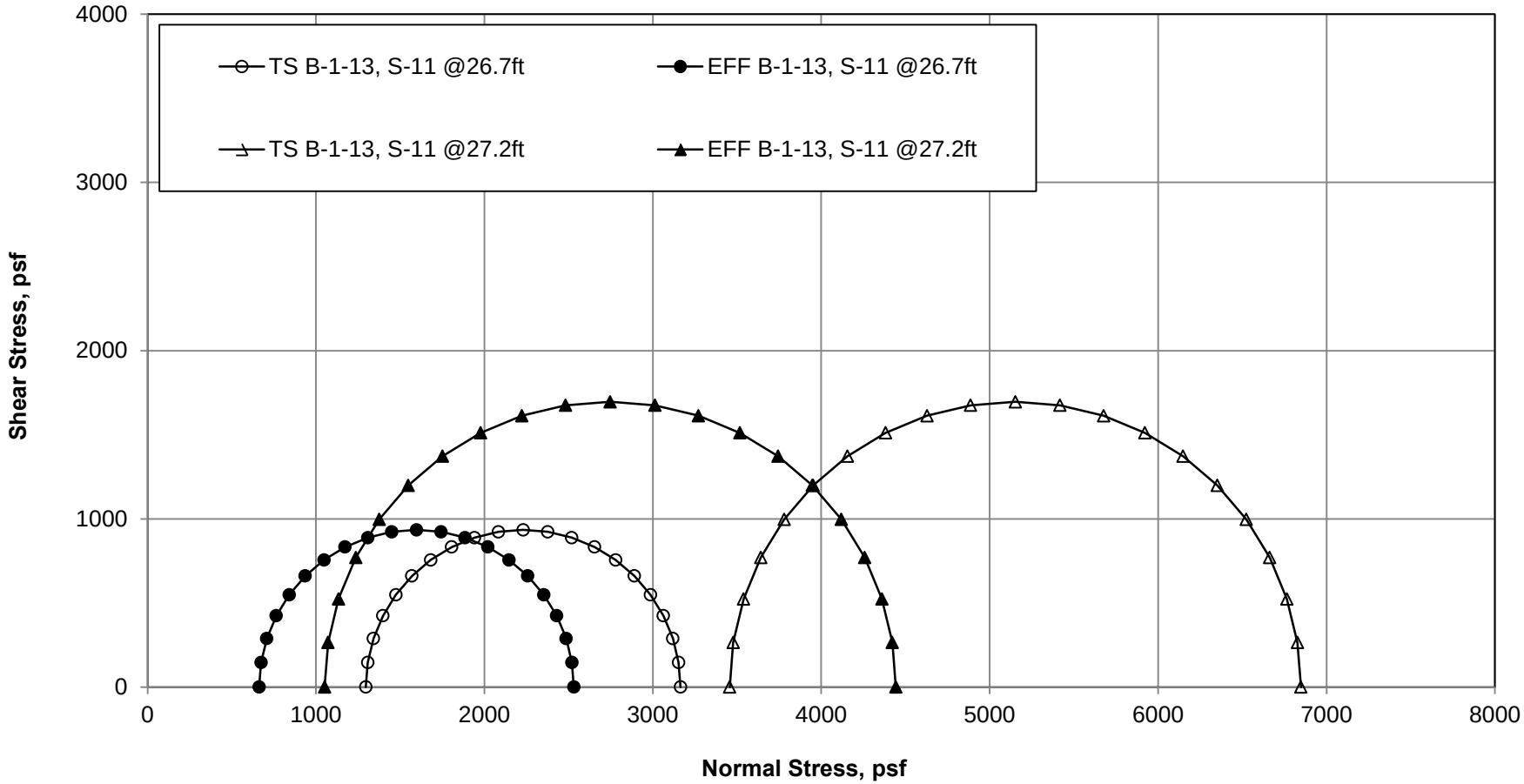
FIG. C-88
Sheet 1 of 2

FIG. C-85
Sheet 1 of 2



NOTES

1. The Mohr's circles in this plot are based on total or effective stresses computed from results of triaxial testing.

2. The Mohr's circles in this plot are based on the **maximum principal stress difference** observed during loading.

3. Abbreviations:
   ft = feet
   psf = pounds per square foot
   TS = total stress
   EFF = effective stress
   CU = Consolidated Undrained

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CU TRIAXIAL TEST
MOHR'S CIRCLE PLOT
BORING B-1-13, SAMPLE S-11

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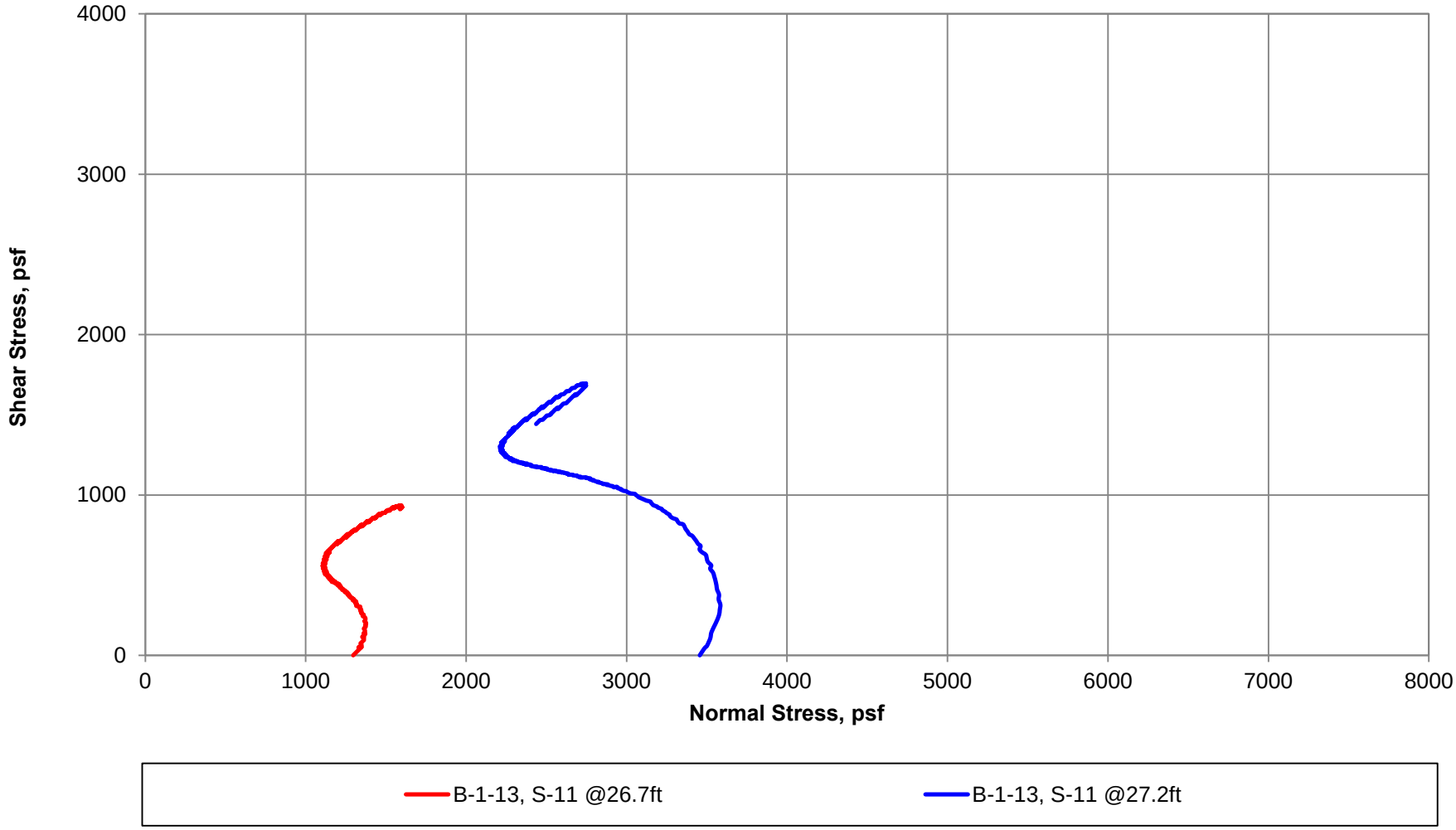
FIG. C-88
Sheet 2 of 2

FIG. C-85
Sheet 2 of 2



NOTES

1. Effective stress paths are computed from results of triaxial testing.

2. Abbreviation:
   ft = feet
   psf = pounds per square foot
   CU = Consolidated Undrained

FIG. C-86

Fir Island Farms
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Skagit County, Washington

CU TRIAXIAL TEST
EFFECTIVE STRESS PATH PLOT
BORING B-1-13, SAMPLE S-11

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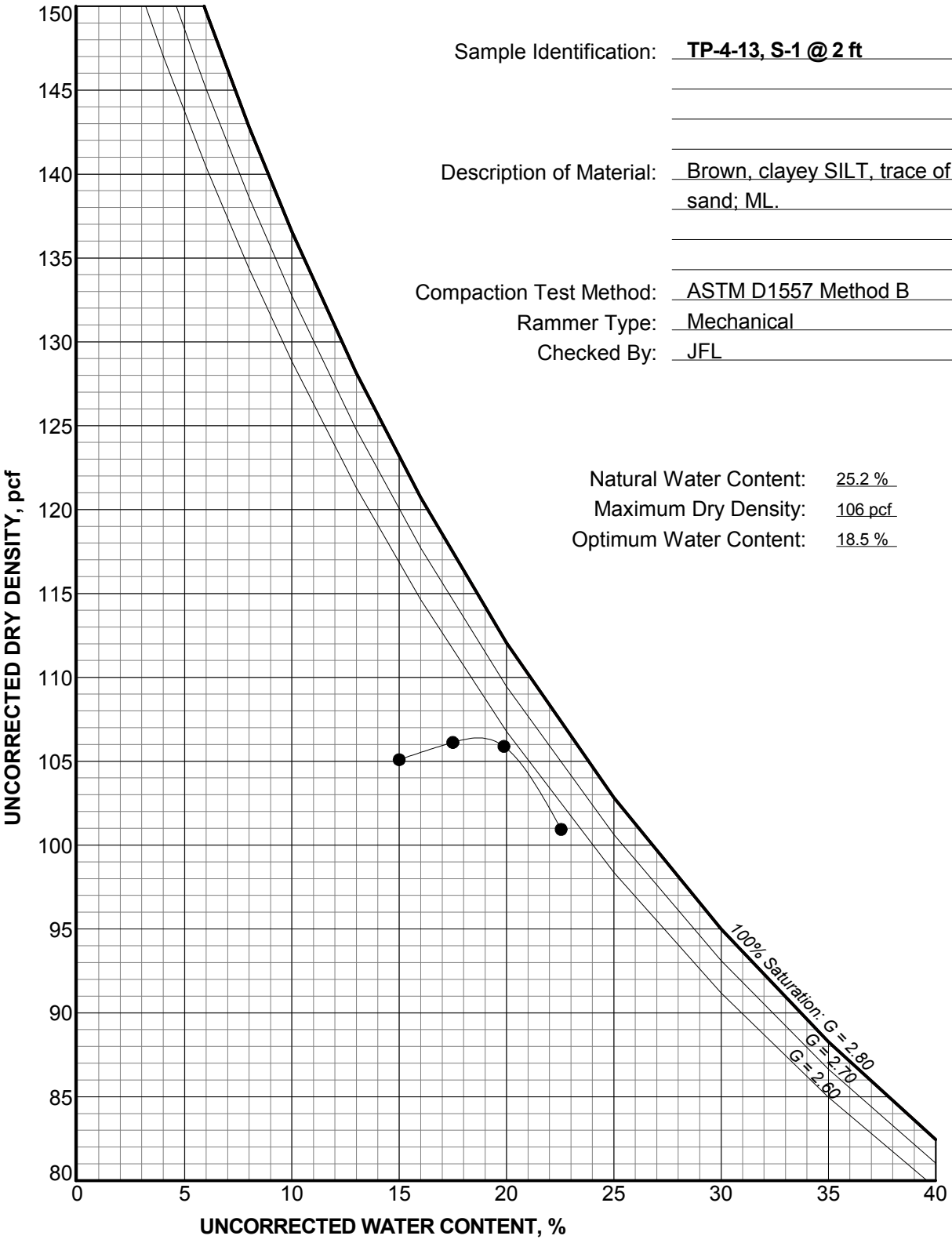
FIG. C-89



Sample Identification: **TP-4-13, S-1 @ 2 ft**

Description of Material: Brown, clayey SILT, trace of fine sand; ML.

Compaction Test Method: ASTM D1557 Method B

Rammer Type: Mechanical

Checked By: JFL

Natural Water Content: 25.2 %

Maximum Dry Density: 106 pcf

Optimum Water Content: 18.5 %

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

MOISTURE-DENSITY TEST
TEST PIT TP-4-13

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FIG. C-90
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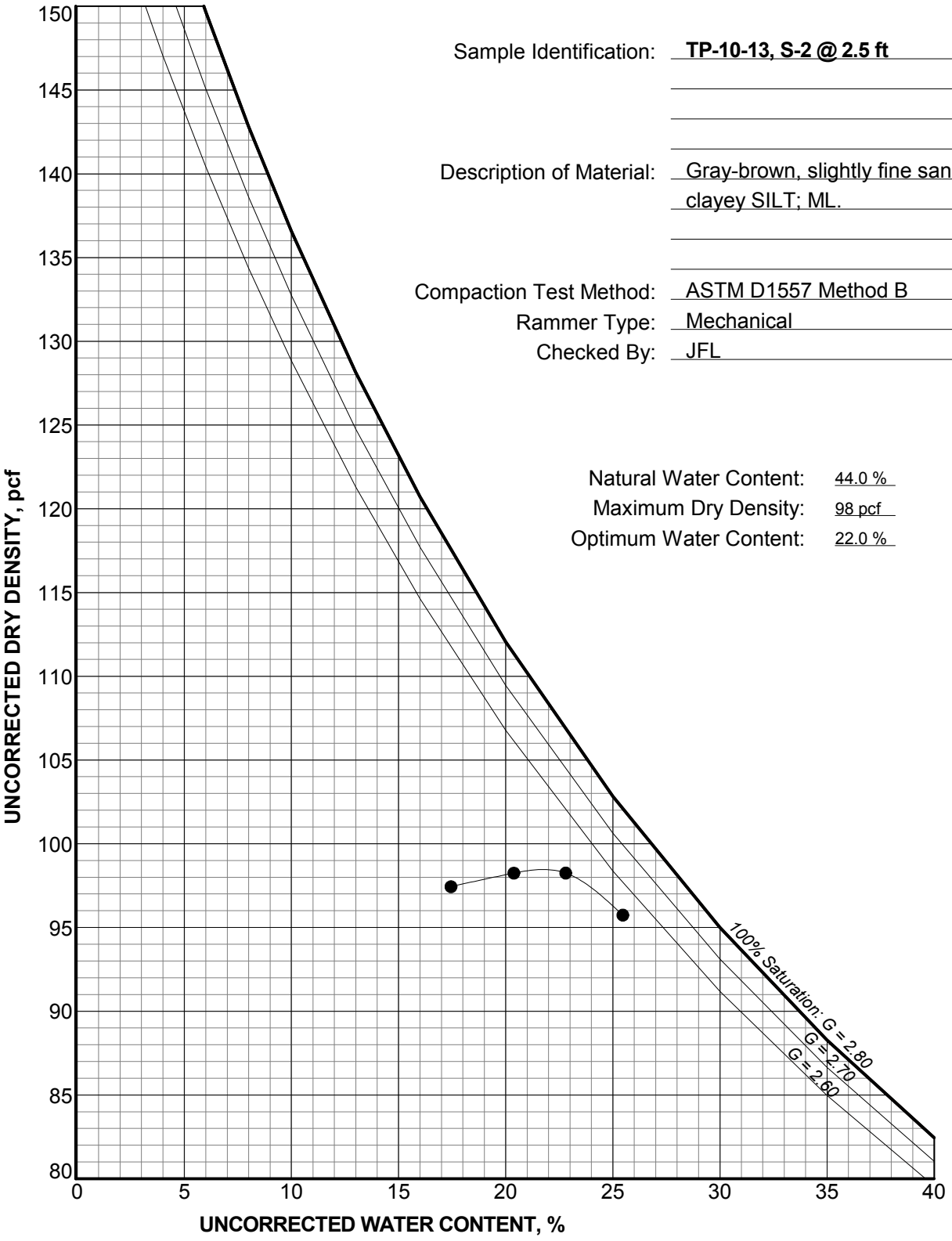

Sample Identification: **TP-10-13, S-2 @ 2.5 ft**

Description of Material: Gray-brown, slightly fine sandy, clayey SILT; ML.

Compaction Test Method: ASTM D1557 Method B

Rammer Type: Mechanical

Checked By: JFL

Natural Water Content: 44.0 %

Maximum Dry Density: 98 pcf

Optimum Water Content: 22.0 %

OTHER TEST RESULTS

ORGANIC CONTENT: % Organic: 2.7

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

MOISTURE-DENSITY TEST
TEST PIT TP-10-13

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FIG. C-91
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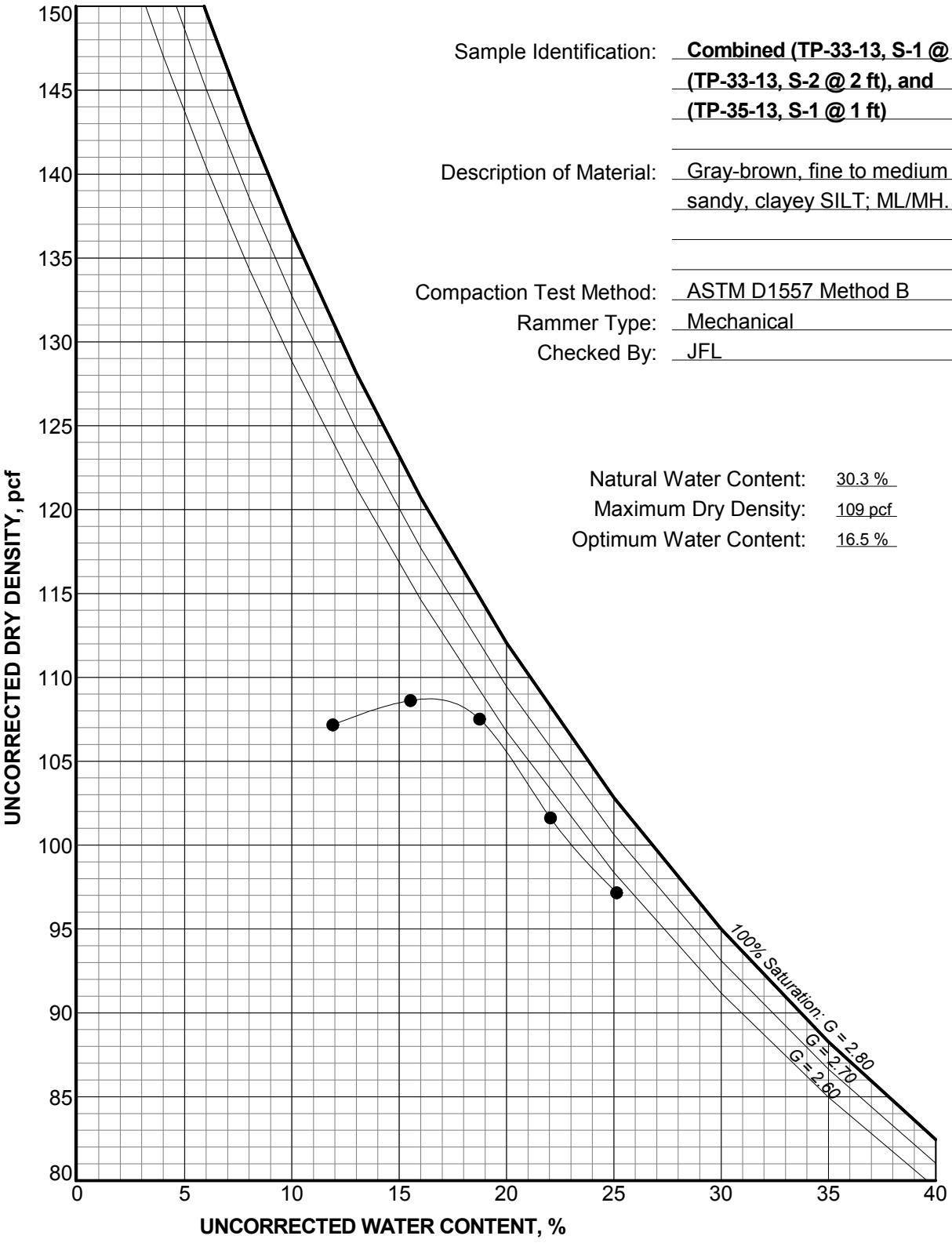

Sample Identification: **Combined (TP-33-13, S-1 @ 1 ft), (TP-33-13, S-2 @ 2 ft), and (TP-35-13, S-1 @ 1 ft)**

Description of Material: Gray-brown, fine to medium sandy, clayey SILT; ML/MH.

Compaction Test Method: ASTM D1557 Method B

Rammer Type: Mechanical

Checked By: JFL

Natural Water Content: 30.3 %

Maximum Dry Density: 109 pcf

Optimum Water Content: 16.5 %

OTHER TEST RESULTS

ORGANIC CONTENT: % Organic: 2.6

Fir Island Farm
Final Design and Permitting
Skagit County, Washington

MOISTURE-DENSITY TEST
TEST PITS TP-33-13 AND TP-35-13

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FIG. C-92
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APPENDIX D

DRAFT REPORT COMMENT RESOLUTION FORM

Independent Review Technical Comment Form

Owner	**Washington Department of Fish & Wildlife**
Project	**Fir Island Farm - Estuary Restoration Project, Final Design and Permitting**
Reviewer Name	**Deb Ladd PE, LHg, Andrew J Walker, PE**
Reviewer Firm	**Golder Associates**
Reviewer Email	dladd@golder.com
Reviewer Phone	425 883 0777
Date of Review:	10-Apr-14

No.	Report Name	Report Section, Page, Paragraph	Reviewer	Reviewer Comment	Responder	Responder Response	ITR Backcheck Complete
1	Draft Geotechnical and Hydrogeologic Data Report, September 11, 2013	Overall	D Ladd, A Walker	The data report is clearly organized and information is well presented. The level of investigation appears adequate for the future anticipated design.	Brian Reznick	No response required.	
2	Draft Geotechnical and Hydrogeologic Data Report, September 11, 2013	Global	D Ladd	Wells are identified as B-4w-13 (note lowercase w) and B-5W-13 (caps). IDs in text should be consistent with well IDs in data report (cap "W")	Brian Reznick	Corrections made for consistency. Wells are identified in the text and the figures with a lower case "w".	
3	Draft Geotechnical and Hydrogeologic Data Report, September 11, 2013	Section 4.4 Page 7	D Ladd	Were dissipation curves used to calculate horizontal permeability or are they planned to be used?	Dave Cline	CPT dissipation tests were included in our revised Interior Drainage Engineering Report (April 2014) for estimating hydraulic conductivities.	
4	Draft Geotechnical and Hydrogeologic Data Report, September 11, 2013	Section 5.2 Page 9	D Ladd	Text mentions 3 geoprobe/wells that were destroyed (GP-01, 02, 03). Were any measurements other than those noted on the logs taken before the wells were destroyed? Are there any measures that WDFW should take to properly abandon these wells as part of project work?	Dave Cline	Previous groundwater data measurements are presented in Technical Memo 1.2.1 Interior Drainage (June 2011). These measurements were considered in the current phase of study. With respect to decomissioning, we will notify the Washington Department of Ecology of the abandoned wells.	
5	Draft Geotechnical and Hydrogeologic Data Report, September 11, 2013	Section 6.3 Page 11	D Ladd	It would be helpful to explain if either Butler or Bouwer-Rice provides the better fit to data or is considered more applicable (in the Interior Drainage report it appears that the Bouwer Rice results were used).	Dave Cline	Discussion of the fit is presented in the Interior Drainage Enginering Report - Appendix B (April 2014).	
6	Draft Geotechnical and Hydrogeologic Data Report, September 11, 2013	Section 8.3 Page 16	D Ladd	The stated range of hydraulic conductivity appears to be only for the geomean's of the tests, not the full range (see Table B-1). That should be clearly stated or different values encompassing the full test range should be provided.	Dave Cline, Brian Reznick	Both the full range and the geomean range are now included in the report text. Additional information on the range of hydraulic conductivity values is provided in the Interior Drainage Engineering Report - Appendix B (April 2014).	
7	Draft Geotechnical and Hydrogeologic Data Report, September 11, 2013	General	AJ Walker	It would be helpful to show the recommended design parameters determined from the data, e.g., strength and consolidation parameters. Also c_h and k_h could have been derived from the pore pressure dissipation testing.	Brian Reznick	Soil design parameters interpreted from the information presented here are provided in the Draft Geotechnical Engineering Report (April 2014)	
8							

APPENDIX E

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