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Design Hydrogeologic Study

Lincoln County Landfill, Phase 4
Crouse, Lincoln County, North Carolina

Prepared for

Lincoln County
Solid Waste Division
Crouse, North Carolina

Prepared by:

Municipal Engineering Services Company, P.A.
PO Box 97
Garner, NC 27529
Corporate License Number: C-0281

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Steven R. Gandy, Ph.D., P.E.
Senior Project Manager

Jonathan Pfohl
Environmental Specialist

NORTH CAROLINA PROFESSIONAL SEAL 31020 ENGINEER STEVEN R. GANDY

11/3/15

Municipal Services
P.O. BOX 97 GARNER, N.C. 27529
(919) 772-5393

Engineering Company, P.A.
P.O. BOX 349 BOONE, N.C. 28607
(828) 262-1767

LICENSE NUMBER: C-0281

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The North Carolina Solid Waste Management Rule 15A NCAC 13B .1 623 (b) and Solid Waste Management Law require that a Design Hydrogelogic Study be performed and a report be submitted in the application for the Permit to Construct a new Subtitle D solid waste landfill. This Design Hydrogoelogic Report has been prepared for the proposed Phase 4 municipal solid waste landfill (MSWLF) for Lincoln County, North Carolina. The site is located at 5291 Crouse Road in Crouse, North Carolina (Figures 1 and 2). The purpose of this study was to determine hydrogeologic and engineering properties of the subsurface, to perform evaluations of hydrogeologic and geologic conditions and to identify base grade elevations for compliance with vertical separation requirements. The findings of this report were then used to develop a Water Quality Monitoring Plan and a Landfill Gas Monitoring Plan, transmitted under separate cover, which were designed for early detection of a release. Results of and procedures used for field and laboratory testing are included in Appendices A and B. Calculations are included in Appendix C, hydrogeologic drawings are included in Appendix D and data from previous studies are included in Appendix E.

1.0 PROJECT DESCRIPTION

Lincoln County is proposing to expand its solid waste management facility situated on an approximate 280-acre tract of land owned by Lincoln County. The proposed Phase 4 landfill is located adjacent to and south of the existing and lined municipal solid waste (MSW) landfill Phase 3. The proposed Phase 4 waste area will cover approximately 10.3 acres of land and will provide Lincoln County with approximately 5 years of available air space. The study area consists of the proposed landfill expansion footprint and the relative point of compliance boundary along its hydraulically down and side gradient margins.

2.0 SITE CONDITIONS

The proposed Phase 4 landfill footprint area currently consists of land that was clear cut timbered before 1993. A review of topographic and aerial photographs over time indicates that minimal excavation has occurred within the proposed study area. Erosion control devices including a shallow sediment trap and diversion berms were constructed for existing Phase 3 in 2006. In general, the proposed Phase 4 fill area has been graded so that the area is relatively flat and is bounded on the west by an elevated gravel road used to access the leachate storage tanks. The southern extents of the proposed Phase 4 landfill area, not believed to ever been excavated, are grass covered and grade gently toward the southwest. The topographic surface elevations within the proposed Phase 4 landfill area range from approximately 840 feet (NGVD) in the northeastern comer of the area to 810 feet (NGVD) in the southwestern portion of the area, as shown on Sheet 1: Boring Location Plan.

The predominant drainage features for the Lincoln County property are drainage features that approximately coincident with the eastern and western property boundaries. Each drainage feature flows to the south and are unnamed intermittent tributaries to Indian Creek. Drainage from the southern part of the landfill is to Indian Creek via several small, southward-flowing drainage features. Indian Creek, which is the southern property boundary, is perennial and flows generally eastward, discharging into the Catawba River off site.

Subsurface conditions encountered during advancement of geotechnical borings within the proposed Phase 4 area indicate similar subsurface strata and groundwater conditions as those encountered during previous exploration for the existing Phase 3 MSW landfill area and consistent with those described in published documents. Data acquired from the previous studies that were used for the Phase 4 study are incorporated throughout this report.

3.0 REGIONAL HYDROGEOLOGY

The site lies in the Inner Piedmont Belt of the Piedmont Physiographic Province of North Carolina. The area is underlain by crystalline metamorphic rock mantled by a thick layer of residual soil and weathered rock (regolith) in most places. Groundwater occurs in the soil/weathered rock layer and in the hydraulically connected underlying bedrock. Springs and seeps may be common along drainage features and surface water bodies.

3.1 Geology and Topography

This region of North Carolina is predominantly underlain by igneous and metamorphic rock which is covered by a thick layer of residual soil and weathered rock (regolith). The hydrogeology of the Piedmont and Blue Ridge Provinces of the Eastern and Southeastern United States is described by LeGrand (1967), Heath (1984) and Swain and others (1991). The site is located within the Indian Creek Basin of NC in which hydrogeologic conditions, aquifer properties and recharge rates were characterized to develop a digital ground-water flow model which was published by the USGS (Daniell C and others 1997). The geology of the area has been mapped in detail by Goldsmith and others (1988) and as part of the State geologic map by Brown and Parker (1985). Stratified rocks thinly layered mica schist and biotite gnesiss, which are interlayered with lesser amounts of hornblende gneiss, amphibolites, quartzite, and some rare calc-silicate rock and marble. Local changes in rock types are common while large homogeneous masses of a single type are rare (LeGrand, 1961).

While numerous types of rock occur in Lincoln County, mica schist, gneiss and granite are the most prevalent rock types within the landfill property and surrounding area. A portion of the Charlotte Geologic Map is included as Figure 3 and shows the approximate site location on the map and the predominate rock types.

The topography and relief of the Piedmont has developed from differential weathering of the igneous and metamorphic rock. Ridges and hills have developed over the more resistant rock, whereas gently rolling, subdued topography has developed on the more easily weathered and erodible rock. Because of continued weathering, the rock in the Piedmont Province is now generally covered with a mantle of soil that has formed from the in-place weathering of the parent bedrock. The soils that overlie bedrock have variable thicknesses, and are generally referred to as residuum (residual soils) and saprolite. The residuum is typically finer grained, has a higher clay content, and retains less of the original rock and mineral structure than the underlying saprolite because of the advanced weathering. Similarly, the soils typically become coarser grained with increasing depth because of decreased weathering. As the degree of weathering decreases, residuum grades into saprolite, which generally retains the overall appearance, texture, gradation, foliation and structure of the parent rock. Saprolite generally grades into partially weathered rock and fractured rock with increasing depth as the unweathered bedrock is approached. The transition between residuum, saprolite and partially weathered rock is gradational and varies laterally and vertically.

Lincoln County is in the Piedmont Plateau section of the state. The topography is characterized by broad rolling hills separated by the declivities of stream valleys. The highest altitude is in the northwest comer of the county where several hills stand out above the general level of the upland. The lowest part of the county is the southeast comer toward the Catawba River.

The ground surface elevation in the northern portion (adjoining S.R. 1169) of the property is approximately 930 feet (NGVD). Ground surface elevations in the southern portion of the property (the flood plain of Indian Creek) range from 770 to 789 feet (NGVD).

3.2 Hydrogeology

Groundwater generally occurs within the residuum and saprolite under unconfined aquifer conditions. Because of the heterogeneous texture and structure of saprolite, alternating layers of differing moisture content are common. The residuum and saprolite typically have a high total porosity, but a low permeability. Therefore, these soils store water from precipitation and slowly recharge the underlying bedrock aquifer by downward infiltration. The partially weathered rock (PWR) layer is a transition layer from the overlying saprolite to the underlying bedrock, and is often more permeable than the underlying material, depending on the percentage of fine-grained sediment and secondary porosity.

Groundwater occurs in the bedrock along fractures, joints and other openings created by weathering. The groundwater surface may occur within the bedrock when the bedrock is relatively close to the ground surface. Throughout the area, bedrock is only exposed in areas of rugged topography or in stream channels where erosion has removed the regolith (Daniel C and others). Rock outcroppings were not identified within the study area. Within the Piedmont, low permeable units or aquitards do not typically exist that would result in a confining layer separating the bedrock from the overlying soils. Thus the soils and bedrock are generally in hydraulic connection. The number of fractures in the bedrock generally decreases with depth. As a result, the highest water bearing zones generally are encountered within the upper 30 feet of the bedrock.

Groundwater percolation to deeper portions of the bedrock is restricted by the decrease in available flow paths (fractures) with depth. The groundwater is forced to follow fractures to discharge points near streams and springs. Thus, movement of groundwater is from recharge areas (topographic highs) to discharge areas (streams and springs). A spring was identified near a valley slope within the proposed Phase 4 compliance boundary, located 132 feet southwest of MW-35 as shown on Sheet 2. The spring is likely a contact spring, created by seepage from the small area upgradient recharge area that is not sealed with the composite liner beneath Phase 3. Bedrock or groundwater elevations do not converge at this location; therefore, the spring is not a depression spring. Water quality discharging from this spring has and will continue to be monitored as SW-3.

Groundwater level fluctuations are typically the result of changes in precipitation and seasonal evapotranspiration. Groundwater levels generally peak around April then decline due to increasing evapotranspiration then continues to decline through October/November after plants become dormant and temperatures decrease. Long-term changes in the groundwater levels occur due to abnormal wet or dry periods. During winter months, precipitation recharges the aquifer as evapotranspiration losses decrease and with an increase in frontal-type rainfall events. Groundwater fluctuations due to withdrawal by pumped wells are not great in the region (LeGrand, 1961). In the Lincoln County area, most industrial and domestic water supplies are obtained from wells. Dug and bored wells are common in rural areas and obtain water from the weathered zone above bedrock. Wells drilled into bedrock typically have higher yields than bored or dug wells. However, drilled wells that do not intersect water-bearing fractures can have very low yields. As a result, individual wells show a great range of yield in the area. Generally, wells drilled on ridges and hills are lower producing than wells drilled on flat areas and in draws and valleys. Withdrawal of groundwater by pumping of wells is not great in the Indian Creek basin (Daniels 1997).

The depth to groundwater table varies from zero in valleys, to more than 100 ft below the ground surface on sharply rising hills. Groundwater fluctuations are also a product of topographical setting with wells located on ridges exhibiting significantly higher fluctuations than wells located near discharge features. In general, and under natural conditions, the groundwater surface is a subdued reflection of the land surface.

3.3 Soil Survey

To aid in the evaluation of the upper most subsurface soils in the proposed Phase 4 area, the Lincoln County Soil Survey was utilized to compare soil characteristics on site (Soil Survey Staff 1995). A soil survey map depicting the soils in the proposed Phase 4 area is included as Figure 4. Based on the soil survey map, only two predominant soil sequences are found within the proposed Phase 4 area, the Pacolet Series, sandy clay loam and Appling Series, sandy loam.

One soil type of the Pacolet Series is located within the majority of the proposed Phase 4 area, PeB2 (Pacolet sandy clay loam, 2 to 8 percent slopes, eroded). Soil type PeB2 is found on the narrow ridges of the uplands, is well drained and has moderate permeability. Parent material for this soil is residuum weathered from felsic, metamorphic and igneous rocks. Soil survey describes ApB soil as 39 inches thick; therefore, most is expected to be removed during excavation of proposed Phase 4.

The other soil type located within the west to southwestern portion of the Phase 4 area is ApB (Appling sandy loam, 1 to 6 percent slopes). Soil type ApB is found on the broad smooth ridges of the uplands, is well drained and has moderate permeability. Parent material for this soil is residuum weathered from felsic, metamorphic and igneous rocks. The majority of ApB soil will remain following landfill construction as maps indicate it is located along the west and south west margins of proposed Phase 4.

4.0 GEOTECHNICAL AND HYDROGEOLOGICAL EVALUATION

4.1 Field Exploration

To evaluate subsurface characteristics in the Phase 4 area, MESCO used data previously collected from the proximal Phase 3 Hydrogeologic Study (MW-33, MW-33A, MW-34, MW-35 and MW-35A), data from the Phase 3 monitoring well (MW-32R) and performed new soil test borings (OW4-1, OW4-2, OW4-3S, OW4-3D, OW4-4, OW4-5, OW4-6S, OW4-6D, OW4-7, OW4-8, OW4-9S, OW4-9D, OW4-10 and OW4-11). A total of 20 borings were used from 15 different locations as shown on the boring location plan on Sheet 1. Twenty borings were used to investigate the "area of investigation" which was defined by the SWS on January 16, 2015 as "generally the footprint". The designed footprint is 10.3 acres and Rule 15A NCAC 13B .1623(b)(1) requires one boring per area of investigation. Since the 20 borings performed exceeds the number of acres within the footprint (11) the Rule has been satisfied. Nested pairs (i.e. OW4-3S/OW4-3D) are counted as one boring location and the deeper of the two borings is designated with either an "A" or "D" suffix. A detailed description of field exploration procedures and boring logs which include lithologic characteristics, depth to groundwater and well installation details are located in Appendix A.

At three of the boring locations (MW-33, MW-34 and MW-35), two or three borings were advanced. The first boring, indicated by a "B" prefix, was advanced to the depth of auger refusal to collect geotechnical and lithologic data and rock core samples. The second adjacent boring was advanced to a selected depth below land surface for the installation of a shallow observation well ("OW" prefix). At the nested well locations, a third boring was advanced to a selected depth for the installation of deep well ("OW" prefix and "A" suffix). All of the geotechnical "B" borings were reported by S&ME to have been abandoned in-place by grouting to the land surface after boring termination according to the 2C Well Construction Standards (15A NCAC 13B .1623 (b)(2)O)). The geotechnical data obtained from the "B" borings were used for the observation well logs. Throughout this report the boring ID will be associated with the existing well ID where applicable. For example lithologic data collected from abandoned boring B-30 which is adjacent to existing MW-34 will be referenced as MW-34/B-30.

Three of the borings (OW4-6D, MW-34/B-30 and MW-35A/B-31) terminated at auger refusal. Twelve of the borings (OW4-1, OW4-2, OW4-3S, OW4-4, OW4-5, OW4-6S, OW4-7, OW4-9S, OW4-10, OW4-11, MW-33 and MW-35) terminated in saprolite. Four borings (MW-33A/OW-29A, OW4-3D, OW4-8 and OW4-9D) terminated in bedrock.

Seven borings (OW4-3D, OW4-6D, OW4-8, OW4-9D, MW-34/B-30 MW-33A/OW-29A and MW-35A/B-31) encountered tricone or auger refusal ranging in depth from 47 to 101 feet below land surface. Rock cores were collected in four borings (OW4-3D, OW4-8, OW4-9D and MW-33A/OW-29A). Rock core pictures, with core run information, are located in Appendix I with their respective boring logs. MESCO selected the new boring locations based on spatial relationships with respect to the proposed footprint and site conditions following a preliminary consultation with Mr. Perry Sugg of the NC SWS on January 16, 2015. All observation well locations used in this study were surveyed for horizontal and vertical control. Table 1 summarizes elevation data and boring/well construction information for the observation wells used for this study. The soil test borings were advanced to depths ranging from 23 to 101 feet below the existing ground surface using ATV mounted drill rigs equipped with continuous flight hollow-stem augers, mud rotary and NQ rock coring tools. Standard penetration tests were performed at designated intervals in the soil test borings in accordance with ASTM D 1586-84 to provide an index for estimating soil strength and relative density. In conjunction with the penetration testing, split-spoon soil samples were recovered for classification and laboratory testing. Undisturbed samples (shelby tubes) were also collected in accordance with ASTM D 1587 in select boring locations for classification and laboratory testing.

In order to evaluate the hydrologic characteristics of subsurface materials, 20 observation or monitoring wells were installed at 15 locations within the proposed Phase 4 landfill area. In-situ permeability tests (slug tests) were performed in each observation well to evaluate the horizontal permeability or hydraulic conductivity of the subsurface materials. In-situ "slug" tests were performed using rising and falling head techniques. Slug tests were also performed in the open bedrock core holes through the sealed core casing at OW4-3D and OW4-9D with slug test data identified as B4-3D and B4-9D respectively. A slug test was not attempted in bedrock at location OW4-8 as planned since the core casing was believed to have not provided an adequate seal; thus, results may have been ambiguous. The drawdown data for these tests were analyzed using the Bouwer and Rice method using commercial *Super Slug Aquifer slug Test Analysis* software as presented in Appendix B. Test results are summarized in Table 4A, Permeability Data Summary and in Appendix B.

Uppermost groundwater is in the thick saprolite zone with horizontal hydraulic conductivity values ranging from 4.47E-03 centimeters per second (cm/sec) to 9.17E-06 cm/sec and a geometric average of 4.32E-04 cm/sec. These values are within the range of reported values for silty sands (Heath, 1983).

4.3 Laboratory Testing

Representative samples of the on-site soils obtained during the field exploration were tested in three geotechnical laboratories. Soil classification tests included grain size distribution with hydrometers, United Classification System (UCS) classifications, Atterberg limits, specific gravity tests and permeability tests. Results of the laboratory classification tests are presented on Table 7, Summary of Laboratory Test Data. The laboratory testing procedures along with the laboratory test data sheets are included in Appendix B, grouped by boring ID.

4.4 Calculations Based on Laboratory Data

Total and effective porosity values were estimated for each soil sample in which a grain size with hydrometer laboratory test was performed. Estimates calculated from grain size were based on the soil classifications, table of "Variation of Porosity, Specific Yield, and Specific Retention with Grain Size" (Bear 1972) in conjunction with Johnson textural classification triangles for unconsolidated materials showing the relationship between particle size and specific yield (Fetter 1994). All calculated porosity values were within ranges found in published research documents. Calculations are presented in Appendix C. The estimates are included in Table 5, Porosity Data Summary.

4.5 Subsurface Conditions

The subsurface conditions in the expansion area consist of residual soils and partially weathered rock (PWR) which have formed by the in-place weathering of the parent bedrock. The residual soils grade with depth into an indistinct transition zone which consists of PWR and saprolite that overlie the underlying bedrock. In general, the transition between the material types is gradual (in the vertical and horizontal dimensions) and may not be an abrupt change as indicated in the soil test boring records or Cross Sections (Sheets 6 and 7). For general soil descriptions and lithology at particular boring locations, refer to the respective boring logs in Appendices A and E.

Residuum:

Residuum is the weathered, unconsolidated material usually found beneath the topsoil. Very little of the physical characteristics of the parent bedrock are retained. The residuum, when identified and encountered in the landfill borings, ranged from silty sand to lean clay. The residuum extended to a maximum depth of 17 feet below land surface at OW4-6S/D. The majority of residuum is planned to be removed when the footprint is excavated to proposed subgrade depths. Estimated total primary porosity values based on grain size distributions for the residuum that will remain following Phase 4 construction averaged 41%. Laboratory values of vertical permeability in the residuum ranged from 7.70E-7 to l.09E-4 cm/sec with a geometric mean of 1.42E-5 cm/sec. Hydraulic conductivity values of residuum are not obtainable since it was only encountered in the unsaturated zone.

Saprolite:

Saprolite is the product of weathered bedrock and usually retains some physical characteristics of the parent bedrock. Saprolite is an unconsolidated material that usually grades with depth into PWR or bedrock. The saprolite encountered in the landfill borings consists of silty sands and sandy silts. The saprolite extends to depths ranging from 0 to 97 feet below land surface at MW-35/A. Estimated total porosity values for the saprolite has a geometric average of 43% to 45% based on grain size distributions. Laboratory values of vertical permeability in the saprolite ranged from 1.92E-7 to 4.70E-5 cm/sec with a geometric average of 7.81-6 cm/sec. Field permeability tests for the wells predominately screened within saprolite yielded a geometric average horizontal hydraulic conductivity of 4.32E-4 cm/sec.

Partially Weathered Rock (PWR):

MESCO defines PWR as material exhibiting Standard Penetration Resistances in excess of 100 blows per foot and is often classified as penetrable, residual materials which when sampled typically become coarse to fine sandy silts or silty coarse to fine sands. Lithologically, the PWR found in the borings for the proposed landfill area is described as well graded sand (SW). The PWR extended to depths ranging from 43 to 101 ft below land surface and was encountered in 5 borings. The estimated total primary porosity value for the PWR ranges between 30-40% based on published values for uniform sand (Bear 1972).

Bedrock:

When sampled, the bedrock from the core samples was classified as sillimanite mica schist, biotite gneiss and amphibolites with photographs presented in Appendix A. Fragments of quartzite were also observed at the surface on site but outside the area of investigation. Horizontal to high-angle fractures are present in the upper ten feet of bedrock. Many fractures are iron stained indicating flow of oxidizing groundwater. Bedrock was encountered at depths ranging from 51.5 to 101 feet below land surface in the borings. Estimated total primary porosity values based on visual inspection of the cores ranged from 0.5% to 5%. Secondary porosity values within fractures and/or joints of similar crystalline metamorphic rocks typically are considered 5% higher (Davis 1969). Horizontal hydraulic conductivity values of uppermost bedrock were lower than lithologies above, which ranged from 4.76E-5 to 8.0E-4 cm/sec with a geometric average of 1.56E-5 cm/sec.

Rock core samples were collected from four borings (OW4-3D, OW4-8, OW4-9D and MW-33A) ranging in length from 10 to 28 linear feet. Dominant rock types present in core include sillimanite mica schist, biotite gneiss and amphibolites. Compositional banding and foliation is almost perpendicular to core length. Low lying (shallow dipping) foliation and compositional banding is characteristic of rock types in the Inner Piedmont. Recovery (REC) and rock quality designations (RQD) for the cores ranged from 0% to 100%. Our findings are consistent with the geology expected at the site (Figure 3, Geologic Map). The estimated configuration of the top of competent, relatively unweathered fresh bedrock, that is believed to not be rippable with conventional excavation machinery is presented on the Top of Bedrock map, Sheet 4, in Appendix D. Depth to auger refusal and rock core examinations from 7 additional borings performed in support of previous hydrogeologic studies (OW-19, B-23, B-24, B-25, B-26 and B-28) were also used to improve top of bedrock contours projecting from the northern portion of Phase 2 with boring logs in Appendix E.

5.0 SITE HYDROGEOLOGY

5.1 Observation Well Installation

To evaluate the groundwater flow regime at the site, 20 observation wells were installed in soil test borings at 15 locations. Observation wells were constructed as Type B by a North Carolina certified well contractor in accordance with the NC Well Construction Standards (15A NCAC 2C .0108) and the requirements of the NC Water Quality Monitoring Guidance Document for Solid Waste Facilities. The observation wells are designated with an "OW4-" prefix and existing well locations used that are proximal to Phase 4 are MW-32R, MW-33, MW-34 and MW-35. At five locations, shallow (“S”-suffix) and deep ("A" or “D”suffix) observation wells were constructed to evaluate the variation of vertical hydraulic gradients.

Observation well construction logs and well construction records (form GW-1) are included in Appendix A. In general, the shallow well screens, or sand packs, were placed to intersect the groundwater surface. The observation wells were constructed with either five, ten or fifteen-foot lengths of machine slotted, two-inch diameter PVC screen with PVC casing extending to above ground surface. The annular space between each screen and borehole was filled with fine sand to generally one foot above the top of the slotted screen. For each observation well, a minimum two-foot-thick bentonite seal was placed above the sand pack, and the remaining annular space was grouted to the ground surface. All wells have a concrete surface pad with locked steel protective casing.

5.2 Groundwater Levels and Groundwater Surface

Water levels were measured in the observation wells at time of installation; at 24-hours following installation and full sets of stabilized readings were taken periodically. A summary of all water levels measured during this study period and of those recorded since October 2004 is provided on Table 2**.** Water levels from shallow wells collected on July 24, 2015 and the site topography were used to create the Groundwater Surface map which is presented on the Groundwater Surface map (Sheet 2) in Appendix D.

A very slight bend in equiopotential groundwater contours is apparent near well OW4-7 which may be caused by concentrated surface water recharge from the sediment trap. The designed sediment trap bottom is located in an area that is planned to be excavated to achieve proposed subgrade. No man-made or natural processes appear to have the potential to cause an increase in water table elevations within the study area. By contrast the water table is expected to subside beneath the lined landfills overtime as recharge is inhibited by the composite liner system.

Based on the Groundwater Surface Map for the proposed Phase 4 area, the groundwater surface slopes predominantly to the southwest and southeast toward the two surface water features. The horizontal hydraulic gradient in the proposed Phase 4 fill area ranged from approximately 0.01 ft/ft (OW4-6S, OW4-10) to 0.06 ft/ft (OW4-2) with an average of 0.02 ft/ft. Calculations for the horizontal hydraulic gradients measured on July 24, 2015 are present in Appendix C and the data summarized in Table 6, Groundwater Flow Velocities and Directions.

Vertical hydraulic gradient conditions were evaluated at five nested well location (MW-33/MW-33A, MW-35/MW-35A, OW4-3S/OW4-3D, OW4-6S/OW4-6D and OW4-9S/OW4-9D) by dividing the difference in water level elevations by the difference in the mid-point elevations of the saturated portion of the sand pack or open interval. Calculations, comparisons and time-series graphs for the vertical gradients are located in Appendix C. Based on the groundwater levels between the shallow and deep wells, there is a downward component of groundwater flow at each evaluated location during every period monitored. Average downward vertical hydraulic gradients ranged between 0.0219 ft/ft (MW-33/3D) to 0.044 ft/ft (OW4-3S/D).

5.3 Seasonal High Groundwater

The on-site monitor well hydrographs from 1989 to 2015 indicate that seasonal high water levels occur during the month of April with highest recorded levels for older "MW" wells occurring in April 2005 and newer "OW4" wells on May 5, 2015. This pattern is typical of the long-term seasonal pattern for this area. The long-term pattern (LeGrand,1954) for ground-water levels is for the seasonal high to occur in late winter or early spring, typically in March or April. Once the growing season starts, ground-water levels typically follow a long decline until the growing season ends in September or October. In December or January, late fall and early winter rains cause a rise in water levels that continues until the next growing season begins. In the Indian Creek area, the decline of groundwater levels extends over a longer aggregate period during a year and is more gradual than the rise of ground-water levels. In spite of the difference between the aggregate periods of water-level rise and water level decline, in most years recharge to the groundwater system is approximately equal to the discharge from it, so that ground-water levels at the end of the year are at about the same level as at the beginning of the year (Daniel 1997).

Groundwater fluctuations were calculated as the difference between maximum water levels and minimum water levels as shown on Table 2. The observed groundwater fluctuations ranged from approximately 2.65 feet in OW4-3D to 11.95 feet in MW-35.

Based on more than eleven years of historical water level data from existing groundwater monitoring wells and levels recorded from the new Phase 4 observation wells over six months taking local precipitation data under consideration, a conservative seasonal high water table (SHWT) was determined. The seasonal high groundwater calculations are tabulated in Appendix C and a Seasonal High Groundwater Surface map was generated from this data shown on Sheet 3.

The SH groundwater elevations for four monitoring wells (MW-32R, MW-33, MW-34 and MW-35) were calculated by adding one standard deviation to the mean (average) of the highest observed annual levels, under one standard deviation (Z Score 1.0) represents the 84.1% quantile. The seasonal high groundwater levels were calculated to be the average high water levels given a season with typical precipitation. A conservative assumption was made that an unusually wet period may occur approximately every ten years, thus the 84.1% quantile was selected.

For the new observation wells ("OW4") the 2015 seasonal high was observed on May 5; however, local precipitation between January-October was below normal. The SH at these observation wells was derived by pairing each observation well with a monitoring well ("Index well"). Pairing of the observation well with its index well was determined by the level of statistical correlation of observed water fluctuations. Statistical correlation of fluctuation between wells was very high (98.4% - 99.8%) with coefficients shown in Appendix C. The highest levels observed in 2015 were brought up to SH levels to account for the lower than normal precipitation. The SH levels of the observation wells were determined by adjusting the 2015 observed high by the same ratio exhibited between the SH and observed 2015 high of its respective "index well" using the following relationship:

Depth to SHWT of on-site "OW4" wells = Depth to WT at on-site "OW4" wells on 5/5/15 x (Depth to SHWT at on-site"MW" wells / Depth to WT at the on site "MW" wells on 5/5/15).

The average upward adjustment between the 2015 observed high and SH is approximately three feet.

Hydrographs of the water levels were developed for the on-site monitoring wells to evaluate both seasonal high and long-term seasonal high water levels relative to precipitation. Hydrographs of the observation wells were also developed to evaluate the trend in water level elevations on-site during this evaluation period. Groundwater level data used for the evaluation and historical monthly rainfall data are presented in Appendix C. Precipitation amounts between January through August 2015 were 37% below normal.

The on-site water level data was also evaluated against two USGS wells that are screened in the regolith closest to the site. Well (BK-127) is 39 feet deep and located 29 miles from the site, and well (GS-289) is 80 feet deep located 7 miles from the facility. Groundwater fluctuations observed on-site during 2015 strongly correlated (0.76 to 0.98) with those from GS-289 and poorly correlated (-0.13 to -0.77) with BK-127 as shown on the hydrograph in Appendix C.

The USGS well closer to the site (GS-289) experienced similar fluctuation patterns but magnitude of fluctuations (standard deviation) was more pronounced than observed on site. The higher magnitude of fluctuations at the BK-127 USGS well compared to on-site is expected since the USGS well is located on a ridge top topographic setting. The proposed landfill topographic setting is slope and a valley which is more similar to the USGS well (BK-127) that exhibited lower groundwater fluctuations. Magnitude of groundwater fluctuations in the Phase 4 expansion are likely to diminish over time as recharge is reduced by the composite liner placed beneath the landfills upgradient.

5.4 Long-Term Seasonal High Groundwater

The estimated long-term seasonal high (LTSH) calculation was performed statistically to take into account the high water levels recorded during unseasonably wet periods. The estimated LTSH was calculated as the highest water levels that could be achieved on-site based on historical site specific water levels and historical precipitation data. Data was used from all of the newer shallow observation wells and the shallow proximal monitoring wells (MW-32R, MW-33, MW-34 and MW-35).

To evaluate the estimated LTSH groundwater elevations for each monitoring well, historical water level data and hydrographs were assessed. The majority of highest water levels for the evaluated wells occurred on April 20, 2005. Monthly precipitation levels were not above normal until the preceding September, November and December which may indicate a recharge delay of more than 4 months. A one month lag time is generally considered typical for sites located in this hydrogeologic basin (Daniels 1997).

The percent quantile of the highest water level elevation observed compared to its historical data was determined at monitoring wells (MW-32R, MW-33, MW-34 and MW-35) which ranged from 96.16% to 99.41%. Among these 4 “index wells”, the highest percent quantile achieved (MW-33 = 99.41%) was used for all of the wells so that no historical data would exceed the estimated calculated LTSH. The estimated LTSH groundwater elevations were calculated for the monitoring wells by adding the mean (average) of the last 11 annually observed highest levels to 2.52 times the standard deviation. Under normal distribution, the factor of 2.52 represents the 99.41% quantile. For the new observation wells installed in 2015 where long-term historical water level data is not available, the LTSH at these observation wells were derived by pairing each observation well with a monitoring well (“Index well”) using the same proportional relationship used to determine SH. Which observation well to pair with an “index well” was determined by the highest level of correlation of observed water fluctuations which was very high (98-100%). The LTSH levels of the observation wells was determined by adjusting the 2015 observed high by the same ratio exhibited between the LTSH and observed 2015 high of its respective “index well”. The average conservative upward adjustment of all new observation wells between the 2015 observed high and its respective estimated LTSH is approximately nine feet. The estimated LTSH calculations are tabulated in Appendix C and a Long Term Seasonal High Groundwater Surface map was generated from this data shown on Sheet 5.

5.4 Groundwater Flow Regime

Movement of groundwater through the flow system is controlled by the hydraulic properties of the bedrock and overlying regolith, the distribution of these properties and the distribution of potentiometric heads within the system.

Based on Groundwater Surface Map (Sheet 2), the horizontal hydraulic gradients of the groundwater surface in the expansion area ranged from 0.01 ft/ft to 0.06 ft/ft, with an arithmetic average of approximately 0.02 ft/ft. Horizontal hydraulic gradients were calculated by dividing the difference in elevation head by the distance between two end points of a projected groundwater flow path to the observation well, that intersects the up gradient equiopotential contour. Procedures and calculations are shown in Appendix C.

Horizontal groundwater flow rates in the Phase 4 area observation wells and monitoring wells were calculated and presented on Table 6. These flow rates are based on the horizontal hydraulic gradients in the Phase 4 area obtained from Sheet 2 , Groundwater Surface map in Appendix D, the estimated effective porosity for the predominant lithologic unit in the saturated interval of the screen, and the calculated hydraulic conductivity based on the in-situ permeability tests. As presented in Table 6, groundwater flow rates could range from 1 to 799 feet per year (geometric average of 71 feet per year) in the Phase 4 area.

Based on the horizontal hydraulic gradients and the permeability of the uppermost aquifer, groundwater flow in the uppermost aquifer is expected to follow the same general trend as the groundwater surface and in the direction perpendicular to the groundwater contours shown on Sheet 2, Groundwater Surface map in Appendix D. Horizontal isotropic flow directions were radial ranging from S43E to S54W with an average of S19W as shown on Table 6.

Groundwater flow paths were calculated at four nested well locations (OW4-3S/D, OW4-6S/D, OW4-9S/D, MW-33/A and MW-35/A) using ellipses created by their horizontal and vertical hydraulic conductivity values as shown on the corresponding cross-sections in Appendix C. The groundwater flow paths at each nested well location were established by creating cross-sections perpendicular to groundwater flow in the vicinity of the nested monitoring wells. Cross-sections were created with existing topography, groundwater elevation data for July 24, 2015, and depths of screened intervals. The water level elevation in the deep well (i.e. 786.14 ft in OW4-3D) was projected horizontally from the well until it contacted the groundwater surface (dashed line on cross-section). The point of intersection with the groundwater surface was connected to the base of the casing for the deep well, which established the cross-sectional equipotential (green lines on cross-section).

Once the equiopotential contours were created, a hydraulic conductivity ellipse was developed at the groundwater surface at the shallow well using the technique documented in Appendix C by Fetter to create a groundwater flow path. Please note that measured *Kv* values were not available for two of the nested well pairs, so estimated *Kv* values (Kv_{EST}) were obtained by comparing *Kh* and predominate soil types in the screened intervals of wells that did have measured K*v* values. The horizontal to vertical hydraulic conductivity anisotropy ratios for the nested pairs ranged from 1:1,949 at OW4-3S/D to 20:1 at OW4-6S/D. The high anisotropy ratios is a product of the low vertical permeability of the regolith. Calculations and cross-sections showing groundwater flow paths are located in Appendix C.

The predominant groundwater discharge areas are expected to be the drainage features located east and west of the Phase 4 area and ultimately Indian Creek south of the landfill. In general, the uppermost aquifer in the landfill area is expected to be typical of local and regional conditions. Recharge areas are expected to be in northern upgradient highland areas which are not sealed by the composite liner system that underlies Phases 1-3.

6.0 VERTICAL SUBGRADE SEPERATION CRITERIA

Rule .1623(n)(1)A) requires adequate information to demonstrate compliance with vertical separation requirements. These requirements state that a minimum 4-foot separation shall be maintained between the bottom of the landfill liner system and the seasonal high water table and the top of bedrock. Criteria has been met since separation between the proposed subgrade and seasonal high water table is at least 7.6 feet and at least 62.6 feet from bedrock as shown in Table 8.

7.0 WELL ABANDONMENT

All wells located within the proposed footprint (OW4-1, OW4-4, OW4-5, OW4-7, OW4-11, OW4-9S, OW4-9D and MW-34) shall be permanently abandoned in place with grout following receipt of Permit to Construct and prior to commencement of Phase 4 construction. Wells will be abandoned in strict accordance with 15 NCAC 02C .0113(b). In areas where soil is to be undercut wells and borings will not be grouted to pre-grade land surface, but to the base grade surface to prevent having to cut excess grout and possibly damage the wells. Locations of the eight wells planned to be abandoned are shown on Sheet 8 with details shown on Table 9. All other wells on site are planned to remain for future water quality monitoring or used for additional hydrogeologic data.

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TABLES

Table 1 Survey and Well Construction Groundwater Level Elevations

Table 2 Geologic and Hydrogeologic Data

Table 3 Permeability Data via Field Slug Tests Summary

Table 4A Permeability Data via Laboratory Analysis Summary

Table 4B Permeability Data via Laboratory Analysis Summary

Table 5 Porosity Data Summary

Table 6 Groundwater Flow Velocities and Directions

Table 7 Laboratory Analysis of Soil Samples Summary

Table 8 Vertical Seperation from Proposed Subgrade

Table 9 Well Abandonment Summary

Table 1
Survey and Well Construction Data

Well ID	Nothing	Easting	Ground Elevation	Top of Casing Elevation	Stickup	Riser Interval		Screen Interval		Filter Pack Interval		Seal Bentonite Interval		Grout Interval		Locked Metal Protective Case
						From	To	From	To	From	To	From	To	From	To	
			(ft msl)	(ft msl)	(ft als)	(ft bls)		(ft bls)		(ft bls)		(ft bls)		(ft bls)		
OW4-1	616051.03	1298102.30	832.40	835.40	3.00	0.00	22.75	22.75	37.75	21.50	38.00	19.00	21.50	0.00	19.00	Yes
OW4-2	615787.48	1298299.66	812.43	815.43	3.00	0.00	15.78	15.78	30.78	14.00	31.50	12.00	14.00	0.00	12.00	Yes
OW4-3S	615570.15	1298065.54	824.05	827.05	3.00	0.00	30.95	30.95	45.95	29.50	46.50	27.00	29.50	0.00	27.00	Yes
OW4-3D	615566.39	1298059.95	823.62	826.62	3.00	0.00	52.08	52.08	62.08	51.00	63.00	49.00	51.00	0.00	49.00	Yes
OW4-4	615788.18	1297899.15	819.05	822.05	3.00	0.00	16.90	16.90	31.90	15.00	32.00	13.00	15.00	0.00	13.00	Yes
OW4-5	615853.53	1298023.51	822.57	825.57	3.00	0.00	16.25	16.25	31.25	15.00	32.00	13.00	15.00	0.00	13.00	Yes
OW4-6S	615719.11	1297614.98	814.97	817.97	3.00	0.00	17.05	17.05	32.05	16.00	32.50	14.00	16.00	0.00	14.00	Yes
OW4-6D	615718.19	1297621.89	815.34	818.34	3.00	0.00	59.48	59.48	69.48	58.50	71.00	56.50	58.50	0.00	56.50	Yes
OW4-7	615958.06	1297525.09	816.60	819.60	3.00	0.00	17.05	17.05	32.05	16.00	32.50	14.00	16.00	0.00	14.00	Yes
OW4-8	615912.50	1297179.34	808.81	811.81	3.00	0.00	9.04	9.04	24.04	8.00	25.00	6.00	8.00	0.00	6.00	Yes
OW4-9S	615987.89	1297756.13	819.21	822.21	3.00	0.00	14.26	14.26	29.26	13.00	29.50	11.00	13.00	0.00	11.00	Yes
OW4-9D	615985.62	1297763.02	819.39	822.39	3.00	0.00	51.58	51.58	61.58	50.50	63.00	48.50	50.50	0.00	48.50	Yes
OW4-10	616210.97	1297283.33	811.70	814.70	3.00	0.00	7.43	7.43	22.43	6.00	23.00	4.00	6.00	0.00	4.00	Yes
OW4-11	616229.53	1297566.90	819.97	822.97	3.00	0.00	16.65	16.65	31.65	15.00	32.00	13.00	15.00	0.00	13.00	Yes
MW-32R	616660.19	1297469.93	825.89	827.25	1.36	0.00	10	10	26.58	8	26.58	6	8	0	6	Yes
MW-33	616453.83	1297404.52	816.33	819.38	3.05	0.00	7	7	22.38	5	22.38	3	5	0	3	Yes
MW-33A	616445.42	1297396.03	815.94	818.67	2.73	0.00	56.5	56.5	61.96	54.5	61.96	52.5	55	0	52.5	Yes
MW-34	616216.01	1297872.44	829.82	832.77	2.95	0.00	19	19	32.47	15	32.47	13	15	0	13	Yes
MW-35	616124.02	1298412.08	836.85	839.64	2.79	0.00	19	19	34.61	17	34.61	15	17	0	15	Yes
MW-35A	616126.28	1298417.52	836.77	839.83	3.06	0.00	60	60	66.67	58	66.67	56	58	0	56	Yes

NOTES:

1. Older wells ("MW") bottom of screen depth as measured in field by MESCO on August 25, 2015.
   Slight variation compared to their respective documentation previously reported by S&ME. Dimensions of materials above this not corrected.
2. Stick-Ups for "OW4" wells are 3.00 feet. Riser was meticulously measured from natural land surface prior to cutting. Top of casing was then surveyed.
   This procedure maintains consistency since land elevation is subjective and subject to change after drilling due to depth of concrete pad.
3. All wells are Type II (2" nominal PVC).

Table 2
Groundwater Level Elevations

Well ID	Land Surface (LS) Elevation (ft-msl)	Top of Casing (TOC) Elevation (ft-msl)	While Drilling		GW SET		GW 24 Hours After		GW 7 Days After		10/13/04		1/7/05		4/20/05		10/19/05		4/25/06		10/4/06		4/9/07		10/15/07		Well ID
			DTW-BLS	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	
			(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	
OW4-1	832.73	835.40	29.50	803.23	32.35	803.05	32.05	803.35	31.55	803.85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-1
OW4-2	812.80	815.43	19.00	793.80	21.05	794.38	21.01	794.42	nm	nm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-2
OW4-3S	824.18	827.05	36.50	787.68	38.76	788.29	38.63	788.42	nm	nm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-3S
OW4-3D	823.44	826.62	37.00	786.44	38.82	787.80	38.93	787.69	38.90	787.72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-3D
OW4-4	819.57	822.05	21.50	798.07	21.87	800.18	21.57	800.48	21.07	800.98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-4
OW4-5	822.84	825.57	23.00	799.84	24.85	800.72	24.55	801.02	24.06	801.51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-5
OW4-6S	815.26	817.97	22.00	793.26	22.61	795.36	23.29	794.68	nm	nm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-6S
OW4-6D	815.24	818.34	23.00	792.24	24.59	793.75	24.59	793.75	24.48	793.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-6D
OW4-7	816.97	819.60	22.50	794.47	23.34	796.26	23.33	796.27	nm	nm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-7
OW4-8	808.61	811.81	13.00	795.61	15.75	796.06	15.75	796.06	15.41	796.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-8
OW4-9S	819.50	822.21	22.00	797.50	22.43	799.78	24.11	798.10	23.88	798.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-9S
OW4-9D	819.52	822.39	23.00	796.52	24.11	798.28	25.88	796.51	25.55	796.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-9D
OW4-10	811.85	814.70	13.00	798.85	15.11	799.59	15.09	799.61	nm	nm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-10
OW4-11	820.22	822.97	22.00	798.22	22.99	799.98	22.69	800.28	22.61	800.36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-11
MW-8	837.62	840.03	nm	nm	nm	nm	nm	nm	nm	nm	27.23	812.80	25.40	814.63	23.88	816.15	27.65	812.38	28.82	811.21	30.87	809.16	28.88	811.15	Dry >32.22	Dry <807.81	MW-8
MW-9	838.01	840.20	nm	nm	nm	nm	nm	nm	nm	nm	27.77	812.43	26.51	813.69	24.99	815.21	28.22	811.98	29.57	810.63	31.54	808.66	29.57	810.63	35.12	805.08	MW-9
MW-32R	825.89	827.25	nm	nm	nm	nm	nm	nm	nm	nm	-	-	-	-	-	-	-	-	15.30	811.95	16.25	811.00	14.80	812.45	19.33	807.92	MW-32R
MW-33	816.33	819.38	nm	nm	nm	819.38	11.74	807.64	nm	nm	10.51	808.87	11.74	807.64	10.51	808.87	13.33	806.05	13.48	805.90	14.40	804.98	13.20	806.18	18.22	801.16	MW-33
MW-33A	815.94	818.67	nm	nm	nm	818.67	12.22	806.45	nm	nm	-	-	12.22	806.45	11.04	807.63	13.52	805.15	13.77	804.90	14.62	804.05	13.53	805.14	18.36	800.31	MW-33A
MW-34	829.82	832.77	nm	nm	nm	832.77	23.62	809.15	nm	nm	-	-	23.68	809.09	22.51	810.26	24.23	808.54	26.55	806.22	26.33	806.44	21.35	811.42	30.58	802.19	MW-34
MW-35	836.85	839.64	nm	nm	nm	839.64	26.79	812.85	nm	nm	-	-	26.77	812.87	24.60	815.04	28.20	811.44	28.84	810.80	30.63	809.01	28.41	811.23	34.70	804.94	MW-35
MW-35A	836.77	839.83	nm	nm	nm	839.83	20.15	819.68	nm	nm	-	-	28.05	811.78	26.50	813.33	nm	nm	30.33	809.50	32.43	807.40	32.18	807.65	36.14	803.69	MW-35A

Well ID	Land Surface (LS) Elevation (ft-msl)	Top of Casing (TOC) Elevation (ft-msl)	4/23/08		10/13/08		4/20/09		10/12/09		4/19/10		10/11/10		4/8/11		10/12/11		4/6/12		10/8/12		4/23/13		10/8/13		Well ID
			DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	
			(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	
OW4-1	832.73	835.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-1
OW4-2	812.80	815.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-2
OW4-3S	824.18	827.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-3S
OW4-3D	823.44	826.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-3D
OW4-4	819.57	822.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-4
OW4-5	822.84	825.57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-5
OW4-6S	815.26	817.97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-6S
OW4-6D	815.24	818.34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-6D
OW4-7	816.97	819.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-7
OW4-8	808.61	811.81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-8
OW4-9S	819.50	822.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-9S
OW4-9D	819.52	822.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-9D
OW4-10	811.85	814.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-10
OW4-11	820.22	822.97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	OW4-11
MW-8	837.62	840.03	Dry >32.22	Dry <807.81	Dry >32.22	Dry <807.81	Dry >32.22	Dry <807.81	Dry >32.22	Dry <807.81	27.10	812.93	Dry >32.22	Dry <807.81	30.54	809.49	Dry >32.22	Dry <807.81	Dry >32.22	Dry <807.81	Dry >32.22	Dry <807.81	Dry >32.22	Dry <807.81	Dry >32.22	Dry <807.81	MW-8
MW-9	838.01	840.20	33.33	806.87	35.12	805.08	30.95	809.25	34.58	805.62	29.19	811.01	33.59	806.61	31.20	809.00	36.61	803.59	31.41	808.79	36.61	803.59	31.71	808.49	32.08	808.12	MW-9
MW-32R	825.89	827.25	15.73	811.52	17.10	810.15	14.00	813.25	17.57	809.68	13.95	813.30	17.52	809.73	14.71	812.54	17.57	809.68	15.93	811.32	18.74	808.51	14.99	812.26	17.60	809.65	MW-32R
MW-33	816.33	819.38	13.71	805.67	14.81	804.57	12.20	807.18	15.22	804.16	12.54	806.84	15.24	804.14	12.45	806.93	15.32	804.06	13.65	805.73	16.28	803.10	12.87	806.51	15.05	804.33	MW-33
MW-33A	815.94	818.67	14.10	804.57	15.00	803.67	12.80	805.87	15.31	803.36	12.97	805.70	15.31	803.36	12.96	805.71	15.43	803.24	13.91	804.76	16.22	802.45	13.31	805.36	14.94	803.73	MW-33A
MW-34	829.82	832.77	29.59	803.18	31.85	800.92	27.58	805.19	30.27	802.50	24.64	808.13	28.49	804.28	26.58	806.19	30.25	802.52	27.13	805.64	31.51	801.26	27.40	805.37	27.25	805.52	MW-34
MW-35	836.85	839.64	33.10	806.54	35.14	804.50	30.89	808.75	34.36	805.28	26.41	813.23	32.50	807.14	30.55	809.09	35.21	804.43	30.54	809.10	36.55	803.09	31.51	808.13	31.09	808.55	MW-35
MW-35A	836.77	839.83	34.06	805.77	35.94	803.89	32.08	807.75	35.32	804.51	28.81	811.02	34.13	805.70	32.06	807.77	36.06	803.77	32.01	807.82	37.28	802.55	32.65	807.18	32.39	807.44	MW-35A

Well ID	Land Surface (LS) Elevation (ft-msl)	Top of Casing (TOC) Elevation (ft-msl)	4/15/14		10/8/14		3/27/15		5/5/15		5/28/15		6/26/15		7/24/15		8/25/15	
			DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV
			(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)
OW4-1	832.73	835.40	-	-	-	-	31.55	803.85	31.34	804.06	31.68	803.72	32.83	802.57	34.16	801.24	35.16	800.24
OW4-2	812.80	815.43	-	-	-	-	20.71	794.72	20.50	794.93	20.88	794.55	21.75	793.68	23.95	791.48	22.81	792.62
OW4-3S	824.18	827.05	-	-	-	-	38.51	788.54	37.51	789.54	37.90	789.15	38.97	788.08	40.41	786.64	40.02	787.03
OW4-3D	823.44	826.62	-	-	-	-	38.82	787.80	37.83	788.79	38.51	788.11	39.47	787.15	40.48	786.14	40.05	786.57
OW4-4	819.57	822.05	-	-	-	-	21.07	800.98	20.73	801.32	21.80	800.25	23.06	798.99	24.35	797.70	24.55	797.50
OW4-5	822.84	825.57	-	-	-	-	24.06	801.51	23.68	801.89	24.57	801.00	26.00	799.57	27.49	798.08	28.29	797.28
OW4-6S	815.26	817.97	-	-	-	-	22.56	795.41	21.70	796.27	22.58	795.39	24.01	793.96	25.63	792.34	26.31	791.66
OW4-6D	815.24	818.34	-	-	-	-	23.86	794.48	23.27	795.07	24.08	794.26	25.44	792.90	27.02	791.32	27.73	790.61
OW4-7	816.97	819.60	-	-	-	-	23.01	796.59	22.93	796.67	23.86	795.74	25.27	794.33	26.85	792.75	27.88	791.72
OW4-8	808.61	811.81	-	-	-	-	15.21	796.60	15.02	796.79	16.17	795.64	17.67	794.14	19.28	792.53	20.29	791.52
OW4-9S	819.50	822.21	-	-	-	-	22.12	800.09	22.15	800.06	23.20	799.01	24.62	797.59	26.11	796.10	26.58	795.63
OW4-9D	819.52	822.39	-	-	-	-	23.89	798.50	23.51	798.88	24.34	798.05	25.65	796.74	27.13	795.26	27.93	794.46
OW4-10	811.85	814.70	-	-	-	-	15.17	799.53	15.14	799.56	16.42	798.28	17.85	796.85	19.88	794.82	20.36	794.34
OW4-11	820.22	822.97	-	-	-	-	22.61	800.36	22.59	800.38	23.58	799.39	24.89	798.08	26.43	796.54	27.53	795.44
MW-8	837.62	840.03	27.46	812.57	Dry >32.22	<807.81	nm	nm	nm	nm	nm	nm	nm	nm	Dry >32.22	<807.81	Dry >32.22	<807.81
MW-9	838.01	840.20	28.36	811.84	33.04	807.16	nm	nm	nm	nm	nm	nm	nm	nm	33.41	806.79	34.31	805.89
MW-32R	825.89	827.25	13.82	813.43	17.86	809.39	nm	nm	15.29	811.96	16.50	810.75	17.32	809.93	18.90	808.35	19.18	808.07
MW-33	816.33	819.38	11.89	807.49	15.23	804.15	nm	nm	13.27	806.11	14.40	804.98	15.52	803.86	16.52	802.86	16.74	802.64
MW-33A	815.94	818.67	12.48	806.19	15.31	803.36	nm	nm	13.60	805.07	14.51	804.16	15.54	803.13	16.45	802.22	16.63	802.04
MW-34	829.82	832.77	24.71	808.06	28.97	803.80	nm	nm	26.77	806.00	27.13	805.64	27.90	804.87	28.86	803.91	29.93	802.84
MW-35	836.85	839.64	27.38	812.26	32.36	807.28	nm	nm	30.22	809.42	30.11	809.53	31.09	808.55	32.45	807.19	33.54	806.10
MW-35A	836.77	839.83	29.10	810.73	33.61	806.22	nm	nm	31.15	808.68	31.51	808.32	32.50	807.33	33.71	806.12	34.65	805.18

Minimum (Lowest ELEV)		Average		Maximum (Highest ELEV)		Observed Fluctuation (Highest to Lowest ELEV)	Well ID
DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV	DTW-TOC	WL-ELEV		
(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft-bls)	(ft-msl)	(ft)	
35.16	800.24	33.39	802.02	31.34	804.06	3.82	OW4-1
23.95	791.48	22.31	793.12	20.50	794.93	3.45	OW4-2
40.41	786.64	39.20	787.85	37.51	789.54	2.90	OW4-3S
40.48	786.14	39.47	787.15	37.83	788.79	2.65	OW4-3D
24.55	797.50	23.17	798.88	20.73	801.32	3.82	OW4-4
28.29	797.28	26.39	799.18	23.68	801.89	4.61	OW4-5
26.31	791.66	24.42	793.55	21.70	796.27	4.61	OW4-6S
27.73	790.61	25.88	792.47	23.27	795.07	4.46	OW4-6D
27.88	791.72	25.78	793.82	22.93	796.67	4.95	OW4-7
20.29	791.52	18.12	793.69	15.02	796.79	5.27	OW4-8
26.58	795.63	24.87	797.34	22.12	800.09	4.46	OW4-9S
27.93	794.46	26.08	796.31	23.51	798.88	4.42	OW4-9D
20.36	794.34	18.34	796.37	15.14	799.56	5.22	OW4-10
27.53	795.44	25.02	797.95	22.59	800.38	4.94	OW4-11
Dry >32.22	<807.81	27.78	812.25	23.88	816.15	>8.34	MW-8
36.61	803.59	31.82	808.38	24.99	815.21	11.62	MW-9
19.33	807.92	16.64	810.61	14.00	813.25	5.33	MW-32R
18.22	801.16	14.16	805.22	10.51	808.87	7.71	MW-33
18.36	800.31	14.53	804.14	11.04	807.63	7.32	MW-33A
31.85	800.92	27.55	805.22	21.35	811.42	10.50	MW-34
36.55	803.09	31.25	808.39	24.60	815.04	11.95	MW-35
37.28	802.55	32.77	807.06	26.50	813.33	10.78	MW-35A

NOTES:
TOC = Top of PVC well casing
DTW-TOC = Depth to water below top of PVC well casing
WL-ELEV = Water level elevation
nm = Not measured
Depths before 2015 reported by S&ME
Highest groundwater

Table 3
Geologic and Hydrogeologic Data

Well ID	Residuum Interval	Saprolite Interval	PWR Interval	Top of Bedrock	Total Borehole Depth	Screen Interval	Water Level on 7/24/15	Predeominate Geologic Unit of Screened Interval
	(ft-bls)	(ft-bls)	(ft-bls)	(ft-bls)	(ft-bls)	(ft-bls)	(ft-bls)	
OW4-1	0 - 8.0	8 - 38.0	n/e - n/e	n/e	38.0	22.75 - 37.75	31.16	SAP
OW4-2	0 - 7.0	7 - 31.5	n/e - n/e	n/e	31.5	15.78 - 30.78	20.95	SAP
OW4-3S	n/e - n/e	0 - 46.5	n/e - n/e	n/e	46.5	30.95 - 45.95	37.41	SAP
OW4-3D	n/e - n/e	n/e - 46.0	46.0 - 62.0	62.0	78.5	52.08 - 62.08	37.48	PWR
OW4-4	n/e - n/e	n/e - 32.0	n/e - n/e	n/e	32.0	16.90 - 31.90	21.35	SAP
OW4-5	0 - 12.0	12 - 36.0	n/e - n/e	n/e	36.0	16.25 - 31.25	24.49	SAP
OW4-6S	0 - 17.0	17 - 32.5	n/e - n/e	n/e	32.5	17.05 - 32.05	22.63	SAP
OW4-6D	0 - 17.0	17 - 68.5	68.5 - 81.5	81.5	81.5	59.48 - 69.48	24.02	SAP
OW4-7	0 - 11.0	11 - 32.5	n/e - n/e	n/e	32.5	17.05 - 32.05	23.85	SAP
OW4-8	0 - 6.0	6 - 43.0	43* - 70.0	70.0	75.0	9.04 - 24.04	16.28	SAP
OW4-9S	0 - 11.0	11 - 29.5	n/e - n/e	n/e	29.5	14.26 - 29.26	23.11	SAP
OW4-9D	0 - 11.0	11 - 72.0	72.0 - 86.0	86.0	98.0	51.58 - 61.58	24.13	SAP
OW4-10	0 - 8.0	8 - 23.0	n/e - n/e	n/e	23.0	7.43 - 22.43	16.88	SAP
OW4-11	0 - 5.5	5.5 - 32.0	n/e - n/e	n/e	32.0	16.65 - 31.65	23.43	SAP
MW-33	0 - 7	7 - 22.0	n/e - n/e	n/e	22.5	7 - 22.38	13.47	SAP
MW-33A	0 - 7	7 - 78.5	78.5* - 51.5	51.5	62.0	62 - 61.96	13.72	Bedrock
B-30 (abnd)	0 - 12	12 - 78.5	78.5 - 101.0	101.0	101.0	na - na	na	na
MW-34	0 - 12	12 - 32.5	n/e - n/e	n/e	32.5	7 - 32.47	25.91	SAP
B-31 (abnd)	0 - 7	7 - 97.0	n/e - n/e	97.0	97.0	na - na	na	na
MW-35	0 - 7	7 - 35.0	n/e - n/e	n/e	35.0	19 - 34.61	29.66	SAP
MW-35A	0 - 7	7 - 67.0	n/e - n/e	n/e	67.0	60 - 66.67	30.65	SAP

NOTES:

1. Older wells (“MW”) bottom of screen depth as measured in field by MESCO on August 25, 2015.
   Slight variation compared to their respective documentation previously reported by S&ME. Top of screen depth not adjusted.
2. * PWR interlayered with saprolite

Table 4A
Permeability Data via Field Slug Tests Summary

Well ID	Saturated Depth of Screen Interval on Test Day	Predominant Soil Description in Saturated Screened Interval	Predominant Geologic Unit in Saturated Screened Interval	Slug Test Method	Maximum Displacement	Hydraulic Conductivity	
	(ft-bls)				(ft)	(cm/sec)	(ft/day)
OW4-1	35.16-37.75	Silty Fine Sand (ML)	Saprolite	Rising Head	1.12	7.59E-04	2.15
OW4-2	22.81-30.78	Silty Sand (SM)	Saprolite	Rising Head	0.93	3.18E-04	0.90
OW4-3S	40.02-45.95	Silty Sand (SM)	Saprolite	Rising Head	1.23	4.47E-03	12.67
OW4-3D	52.08-62.08	Sand (SW)	PWR	Rising Head	3.80	7.21E-04	2.05
B4-3D	62.08-78.5	Schist	Bedrock	Falling Head	6.81	4.76E-05	0.13
OW4-4	24.55-31.90	Silt (ML)	Saprolite	Rising Head	1.12	2.77E-04	0.79
OW4-5	28.29-31.25	Sand (SM)	Saprolite	Rising Head	0.66	3.50E-03	9.92
OW4-6S	26.31-32.05	Silty Sand (SM)	Saprolite	Rising Head	1.45	5.36E-04	1.49
OW4-6D	59.48-69.48	Sand (SW)	PWR	Rising Head	8.49	8.88E-04	2.52
OW4-7	27.88-32.05	Silty (ML)	Saprolite	Rising Head	1.24	1.39E-04	0.39
OW4-8	20.29-24.04	Silty Sand (SM)	Saprolite	Rising Head	1.01	4.22E-04	1.20
OW4-9S	26.58-29.26	Clayey Silt (ML)	Saprolite	Rising Head	0.98	2.25E-04	0.64
OW4-9D	51.58-61.58	Silty Sand (SM)	Saprolite	Falling Head	4.72	2.38E-03	6.72
B4-9D	86-98	Gneiss	Bedrock	Falling Head	5.49	9.94E-05	0.28
OW4-10	20.36-22.43	Sandy Silt (ML)	Saprolite	Rising Head	0.68	4.25E-04	1.21
OW4-11	27.53-31.65	Sandy Silt (ML)	Saprolite	Rising Head	0.98	3.17E-04	0.90
MW-32R	16.50-26.58	Sand (SM)	Saprolite	Rising Head	Na	9.17E-06	0.03
MW-33	9-22	Sand (SM)	Saprolite	Rising Head	3.22	1.10E-03	3.12
MW-33A	56.5-61.5	Gneiss	Bedrock	Rising Head	4.73	8.00E-04	2.27
MW-34	29.93-32.47	Sand (SM)	Saprolite	Rising Head	1.08	3.52E-04	1.00
MW-35	24-34	Silt (ML)	Saprolite	Rising Head	2.27	1.70E-04	0.48
MW-35A	60-65	Sand (SM)	Saprolite	Rising Head	3.97	4.40E-04	1.25
Geometric Average (All)						3.97E-04	1.32
Arithmetic Average (All)						8.36E-04	2.37
Geometric Average (Saprolite)						4.32E-04	1.51
Arithmetic Average (Saprolite)						9.32E-04	2.64
Geometric Average (PWR)						8.00E-04	2.27
Arithmetic Average (PWR)						8.05E-04	2.28
Geometric Average (Bedrock)						1.56E-04	0.44
Arithmetic Average (Bedrock)						3.16E-04	0.9
Geometric Average (ML)						2.84E-04	1.32
Arithmetic Average (ML)						3.30E-04	0.94
Geometric Average (SM)						5.90E-04	1.51
Arithmetic Average (SM)						5.90E-04	1.00

NOTES:

1. Slug Test data sheets are located in Appendix II.
2. Slug Tests were performed by MESCO with the exception of MW-32R, MW-33, MW-33A, MW-35 and MW-35A performed by S&ME in January 2005.
3. Geometric averages were obtained by taking the natural log of the individual hydraulic conductivity values, finding the mean of the natural logs for the geologic unit, and then obtaining the exponential of that value.

Table 4B
Summary of Permeability Data via Laboratory Analysis

Sample No.	Depth (ft)			Sample Type	Geologic Unit	USCS Symbol	USCS Classification	Vertical Hydraulic Conductivity (cm/sec)
OW4-3D	34	-	36	UD	SAP	SM	Silty Sand	2.30E-06
OW4-4	10	-	12	UD	SAP	SM	Silty Sand	7.70E-06
OW4-5	11.5	-	13.5	UD	SAP	SM	Silty Sand	4.70E-05
OW4-6D	12	-	14	UD	RES	ML	Sandy Silt	3.38E-05
OW4-6D	35	-	37	UD	SAP	ML	Sandy Silt	2.60E-05
OW4-8	7	-	9	UD	SAP	ML	Sandy Silt	1.92E-07
OW4-8	17	-	19	UD	SAP	ML	Sandy Silt	5.07E-06
OW4-11	10	-	12	UD	SAP	ML	Sandy Silt	8.40E-05
MW-35/B-31	2	-	4	UD	RES	MH	Elastic Silt	1.09E-04
MW-33A/OW-29A	2	-	4	UD	RES	CL	Lean Clay	7.70E-07
Geometric Average (All)								9.33E-06
Arithmetic Average (All)	14	-	16					3.16E-05
Geometric Average (RES)								1.42E-05
Arithmetic Average (RES)	5	-	7					4.79E-05
Geometric Average (SAP)								7.81E-06
Arithmetic Average (SAP)	18	-	20					2.46E-05
Geometric Average (SM)								9.41E-06
Arithmetic Average (SM)	19	-	21					1.90E-05
Geometric Average (ML)								9.36E-06
Arithmetic Average (ML)	16	-	18					2.98E-05

NOTES:

1. Laboratory Data Sheets are Located in Appendix II.

2. Geometric averages were obtained by taking the natural log of the individual hydraulic conductivity values, finding the mean of the natural logs for the geologic unit, and then obtaining the exponential of that value.

Table 5
Porosity Data Summary

Sample ID	Depth (ft-bls)			Sample Type	Geologic Unit	USCS Symbol	AGU Classification	AGU Grain Size Distribution			Effective Porosity	Total Porosity	
								Sand	Silt	Clay		From Lab Permeability	From Lab Hydrometer
OW4-2	25	-	28	Bag	SAP	SM	Clay-Sand	0.54	0.23	0.23	0.08		0.45
OW4-3D	34	-	36	UD	SAP	SM	Silty Sand	0.74	0.16	0.10	0.22	0.54	
OW4-4	10	-	12	UD	SAP	SM	Silty Sand	0.63	0.28	0.09	0.21	0.44	
OW4-5	11.5	-	13.5	UD	SAP	SM	Clay-Sand	0.58	0.21	0.21	0.10	0.47	
OW4-6D	12	-	14	UD	RES	ML	Sandy Clay	0.47	0.22	0.32	0.04	0.28	
OW4-6D	35	-	37	UD	SAP	ML	Silty Sand	0.48	0.40	0.12	0.16	0.28	
OW4-8	7	-	9	UD	SAP	ML	Clay-Silt	0.45	0.26	0.29	0.05	0.40	
OW4-8	17	-	19	UD	SAP	ML	Silty Sand	0.53	0.36	0.11	0.18	0.48	
OW4-10	15	-	17	Bag	SAP	ML	Clay-Silt	0.32	0.43	0.25	0.07		0.46
OW4-11	10	-	12	UD	SAP	ML	Clay-Sand	0.46	0.25	0.29	0.05	0.47	
MW-34/B-30	23.5	-	30	SS	SAP	SM	Silty Sand	0.62	0.3	0.08	0.21	0.44	
MW-35/B-31	2	-	4	UD	RES	MH	Silty Clay	0.19	0.42	0.39	0.03	0.50	
MW-35/B-31	23.5	-	30	SS	SAP	ML	Sandy Silt	0.40	0.48	0.12	0.16		0.44
MW-35/B-31	63.5	-	70	SS	SAP	SM	Silty Sand	0.57	0.34	0.09	0.20		0.45
MW-33A/OW-29A	2	-	4	UD	RES	CL	Sandy Clay	0.49	0.18	0.33	0.07*	0.46	
MW-33A/OW-29A	13.5	-	20	SS	SAP	SM	Silty Sand	0.77	0.18	0.04	0.27		0.45
Geometric Average (All)											0.11	0.42	0.45
Arithmetic Average (All)	19	-	22					0.52	0.29	0.19	0.13	0.43	0.45
Geometric Average (RES)											0.04	0.40	
Arithmetic Average (RES)	5	-	7					0.38	0.27	0.34	0.05	0.41	
Geometric Average (SAP)											0.12	0.43	0.45
Arithmetic Average (SAP)	22	-	26					0.48	0.31	0.21	0.13	0.44	0.45
Geometric Average (SM)											0.16	0.47	0.45
Arithmetic Average (SM)	28	-	32					0.61	0.25	0.13	0.19	0.47	0.45
Geometric Average (ML)											0.08	0.38	0.45
Arithmetic Average (ML)	17	-	20					0.45	0.34	0.21	0.10	0.37	0.45

NOTE:

1. Porosity from lab calculated permeabilities was calculated from its corresponding void ratio by using the using the equation n = e/(e+1) where n and e denote the porosity and void ratio.

2. Total Porosity from lab hydrometer was calculated graphically from Bear diagrams based on AGU grain distributions (graphical calculation in Appendix C)

3. The proportions of sand, silt, and clay displayed in Table 5 are in accordance with the recommendation made by the America Geophysical Union (AGU) Subcommittee on Sediment Terminology. This particle-size classification system is widely adopted in recent USGS publications. Because the AGU soil classification system is different for that defined in the Unified Soil Classification System (USCS), the grain sizes for a soil sample were recalculated. Note that determining particle-size distribution by the AGU classification system is a prerequisite for using Johnson's trilinear graph for effective porosity calculation.

4. Johnson's trilinear graphs were used to graphically determine the effective porosity of a soil sample. (Appendix C)

5. * Effective porosity of MW-33A/OW-29A (2-4') fell into an “area of no samples” on the trilinear graph thus the average value of sandy clay published by Johnson in 1967 was used.

Table 6
Groundwater Flow Velocity and Directions

Well ID	Hydraulic Conductivity (cm/sec)	Effective Porosity (%)	Hydraulic Gradient (ft/ft)	Average Linear Velocity Rate (ft/yr)	Flow Direction	Depth to Groundwater (ft btoc)	Groundwater Potentiometric Elevation (ft amsl)	Predominate Screened Lithology (USCS)
OW4-1	7.59E-04	8	0.02	155	S14W	34.16	801.24	Silty Fine Sand (ML)
OW4-2	3.18E-04	8.2	0.06	238	S26E	23.95	791.48	Silty Sand (SM)
OW4-3S	4.47E-03	22.3	0.04	799	S23E	40.41	786.64	Silty Sand (SM)
OW4-4	2.77E-04	8	0.02	80	S17W	24.35	797.70	Silt (ML)
OW4-5	3.50E-03	16	0.03	709	S02E	27.49	798.08	Silty Sand (SM)
OW4-6S	5.36E-04	16	0.01	45	S48W	25.63	792.34	Silty Sand (SM)
OW4-7	1.39E-04	8	0.02	28	S36W	26.85	792.75	Silt (ML)
OW4-8	4.22E-04	18.2	0.01	23	S25W	19.28	792.53	Sandy Silt (ML)
OW4-9S	2.25E-04	8	0.03	73	S45W	26.11	796.10	Clayey Silt (ML)
OW4-10	4.25E-04	6.6	0.01	86	S41W	19.88	794.82	Sandy Silt (ML)
OW4-11	3.17E-04	8	0.02	82	S36W	26.43	796.54	Sandy Silt (ML)
MW-32R	9.17E-06	16	0.02	1	S54W	18.90	808.35	Sand (SM)
MW-33	1.10E-03	27.1	0.02	99	S37W	16.52	802.86	Sand (SM)
MW-34	3.52E-04	21.4	0.03	57	S30W	28.86	803.91	Sand (SM)
MW-35	1.70E-04	15.9	0.03	34	S43E	32.45	807.19	Sandy Silt (ML)
Minimum	9.17E-06	7	0.01	1	S43E	16.52	786.64	-
A Average	3.85E-04	12.5	0.02	167	S19W	26.08	797.50	-
G Average	3.85E-04	12.5	0.02	71	-	-	-	-
Maximum	4.47E-03	27.1	0.06	799	S54W	40.41	808.35	-

NOTES:

1. Values for hydraulic conductivity determined via slug tests. Appendix B.
2. Values for effective porosity from laboratory analysis if sample from submerged screened interval. Denoted by one decimal place.

Values for effective porosity if no sample collected within the submerged screen interval taken from geometric average of other wells with same lithology. Denoted by whole number.

3. Hydrologic gradient calculated from groundwater elevations recorded on July 24, 2015 details in Appendix C.
4. Flow directions shown assumes isotropic conditions. Flow path perpendicular to upgradient contours on Sheet 2:Groundwater Surface.
5. Average linear velocity rate (Q) is defined by modified Darcy's equation:

K = hydraulic conductivity
ne = effective porosity
dh = head difference
dl = horizontal distance

$$Q = -\frac{K}{n_e} \cdot \frac{dh}{dl}$$

Table 7
Laboratory Analysis of Soil Samples Summary

Sample No.	Depth (ft)			Sample Type	Geologic Unit	USCS Symbol	USCS Classification	USCS Grain Size Distribution (%)			Natural Moisture Content (%)	Specific Gravity	Atterberg Limits			Dry Density (pcf)	Vertical Hydraulic Conductivity (cm/sec)
								Gravel	Sand	Silt & Clay			LL	PL	PI		
OW4-2	25	-	28	Bag	SAP	SM	Silty Sand	0.00	52.50	47.50	30.1	2.69	NP	NP	NP	na	na
OW4-3D	34	-	36	UD	SAP	SM	Silty Sand	0.00	72.40	27.60	26.6	2.71	NP	NP	NP	84.3	2.30E-06
OW4-4	10	-	12	UD	SAP	SM	Silty Sand	0.00	61.00	39.00	26.8	2.73	NP	NP	NP	95.3	7.70E-06
OW4-5	11.5	-	13.5	UD	SAP	SM	Silty Sand	0.00	56.10	43.90	24.1	2.64	41	41	0	87.1	4.70E-05
OW4-6D	12	-	14	UD	RES	ML	Sandy Silt	0.00	47.10	52.90	38.0	2.67	43	51	8	120.7	3.38E-05
OW4-6D	35	-	37	UD	SAP	ML	Sandy Silt	0.00	44.60	55.40	29.1	2.66	NP	NP	NP	120.0	2.60E-05
OW4-8	7	-	9	UD	SAP	ML	Sandy Silt	0.00	44.20	55.80	28.8	2.70	NP	NP	NP	98.7	1.92E-07
OW4-8	17	-	19	UD	SAP	ML	Sandy Silt	0.00	48.70	51.30	41.6	2.69	NP	NP	NP	85.2	5.07E-06
OW4-10	15	-	17	Bag	SAP	ML	Sandy Silt	0.00	31.50	68.50	44.4	2.65	NP	NP	NP	na	na
OW4-11	10	-	12	UD	SAP	ML	Sandy Silt	0.00	44.20	55.80	25.9	2.69	NP	NP	NP	90.2	8.40E-05
MW-34/B-30	23.5	-	30.0	SS	SAP	SM	Silty Sand	0.50	59.80	39.70	26.4	2.65	31	26	5	na	na
MW-35/B-31	2	-	4	UD	RES	MH	Elastic Silt	0.00	19.90	80.10	31.6	2.75	58	36	22	86.6	1.09E-04
MW-35/B-31	23.5	-	30	SS	SAP	ML	Sandy Silt	0.00	39.50	60.50	43.7	2.65	43	43	0	na	na
MW-35/B-31	63.5	-	70	SS	SAP	SM	Silty Sand	17.20	51.30	31.50	36.0	2.65	37	32	5	na	na
MW-33A/OW-29A	2	-	4	UD	RES	CL	Lean Clay	0.80	49.00	50.20	18.7	2.66	40	20	20	90.0	7.70E-07
MW-33A/OW-29A	13.5	-	20	SS	SAP	SM	Silty Sand	1.10	79.40	19.50	na	2.65	NP	NP	NP	na	na
Geometric Average (All)																	9.33E-06
Arithmetic Average (All)	19	-	22					1.23	50.08	48.70	31.5	2.68	18	16	4	95.8	3.16E-05
Geometric Average (RES)																	1.42E-05
Arithmetic Average (RES)	5	-	7					0.27	38.67	61.07	29.4	2.69	47	36	17	99.1	4.79E-05
Geometric Average (SAP)																	7.81E-06
Arithmetic Average (SAP)	22	-	26					1.45	52.71	45.85	32.0	2.67	12	13	1	94.4	2.46E-05
Geometric Average (SM)																	9.41E-06
Arithmetic Average (SM)	28	-	32					2.95	58.85	38.20	28.3	2.68	18	19	2	88.9	1.90E-05
Geometric Average (ML)																	6.79E-06
Arithmetic Average (ML)	17	-	20					0.00	42.83	57.17	35.9	2.67	12	13	1	103.0	2.98E-05

Notes:

1. Laboratory data is located in AppendixB.

2. Geometric averages were obtained by taking the natural log of the individual hydraulic conductivity values, finding the mean of the natural logs For the geologic unit, and then obtaining the exponential of that value.

RES = Residuum

SAP = Saprolite

Table 8
Vertical Separation from Proposed Subgrade

Well ID	Well		Proposed Subgrade		Seasonal High Groundwater			Estimated Long Term Seasonal High Groundwater			Bedrock		
	Total Depth of Screen	Ground Elevation	Depth	Elev.	Depth	Elev.	Vertical Separation	Depth	Elev.	Vertical Separation	Depth	Elev.	Vertical Separation
	(ft bls)	(ft msl)	(ft bls)	(ft msl)	(ft bls)	(ft msl)	(ft)	(ft bls)	(ft msl)	(ft)	(ft bls)	(ft msl)	(ft)
OW4-1	37.75	832.40	12.98	819.42	25.34	807.06	**12.36**	21.46	810.94	8.48	95	738	**82**
OW4-4	31.90	819.05	6.21	812.84	13.81	805.24	**7.60**	11.65	807.40	5.44	73	746	**67**
OW4-5	31.25	822.57	6.84	815.73	15.78	806.79	**8.94**	13.31	809.26	6.47	77	746	**70**
OW4-7	32.05	816.60	9.74	806.86	17.93	798.67	**8.19**	14.80	801.80	5.06	79	738	**69**
OW4-9S	29.26	819.21	7.40	811.81	14.76	804.45	**7.36**	12.45	806.76	5.05	86.00	733.21	**78.60**
OW4-11	31.65	819.97	9.37	810.60	17.67	802.30	**8.30**	14.58	805.39	5.21	72	748	**63**
MW-34	32.47	829.82	13.13	816.69	20.78	809.04	**7.65**	17.15	812.67	4.02	101.00	728.82	**87.87**

Notes:

1. Proposed Subgrade elevation from Application for Permit to Construct. Subgrade was designed based on information gathered from this report.
2. Seasonal High and Long-Term Seasonal High based on elevations applicable from Design Hydrogeologic StudySheets 3 and 5.
3. Top of competent Rock Elevations were based on corresponding adjacent clustered deep well or extrapolated from Design Hydrogeologic Study Sheet 4. Two decimal places indicates encountered in the field others are extrapolated.

Table 9
Well Abandonment Plan Summary

Well ID	Land Surface Elevation (ft-msl)	Top of Casing Elevation (ft-msl)	Well Screen Bottom		Proposed Subgrade		Permanently Abandon	
			Depth (ft-bls)	Elev. (ft-msl)	Depth (ft-bls)	Elev. (ft-msl)	Depth (ft-bls)	Elev. (ft-msl)
OW4-1	832.73	835.40	37.75	794.98	13.31	819.42	13.31 to 37.75	819.42 to 794.98
OW4-4	819.57	822.05	31.90	787.67	6.73	812.84	6.73 to 31.90	787.67 to 812.84
OW4-5	822.84	825.57	31.25	791.59	7.11	815.73	7.11 to 31.25	791.59 to 815.73
OW4-7	816.97	819.60	32.05	784.92	10.11	806.86	10.11 to 32.05	784.92 to 806.86
OW4-9S	819.50	822.21	29.26	790.24	7.69	811.81	7.59 to 29.26	790.24 to 811.81
OW4-9D	819.52	822.39	61.58	757.94	7.59	811.93	7.60 to 61.58	757.94 to 811.93
OW4-11	820.22	822.97	31.65	788.57	9.62	810.60	9.62 to 31.65	788.57 to 810.60
MW-34	829.82	832.77	32.47	797.35	13.23	816.59	13.23 to 32.47	816.59 to 797.35

Notes:
All wells located within the footprint will be abandoned per 2C rules. All other wells not listed in the table will remain.
ft-msl = Feet-mean sea level
ft-bls = Feet-below land surface

FIGURES

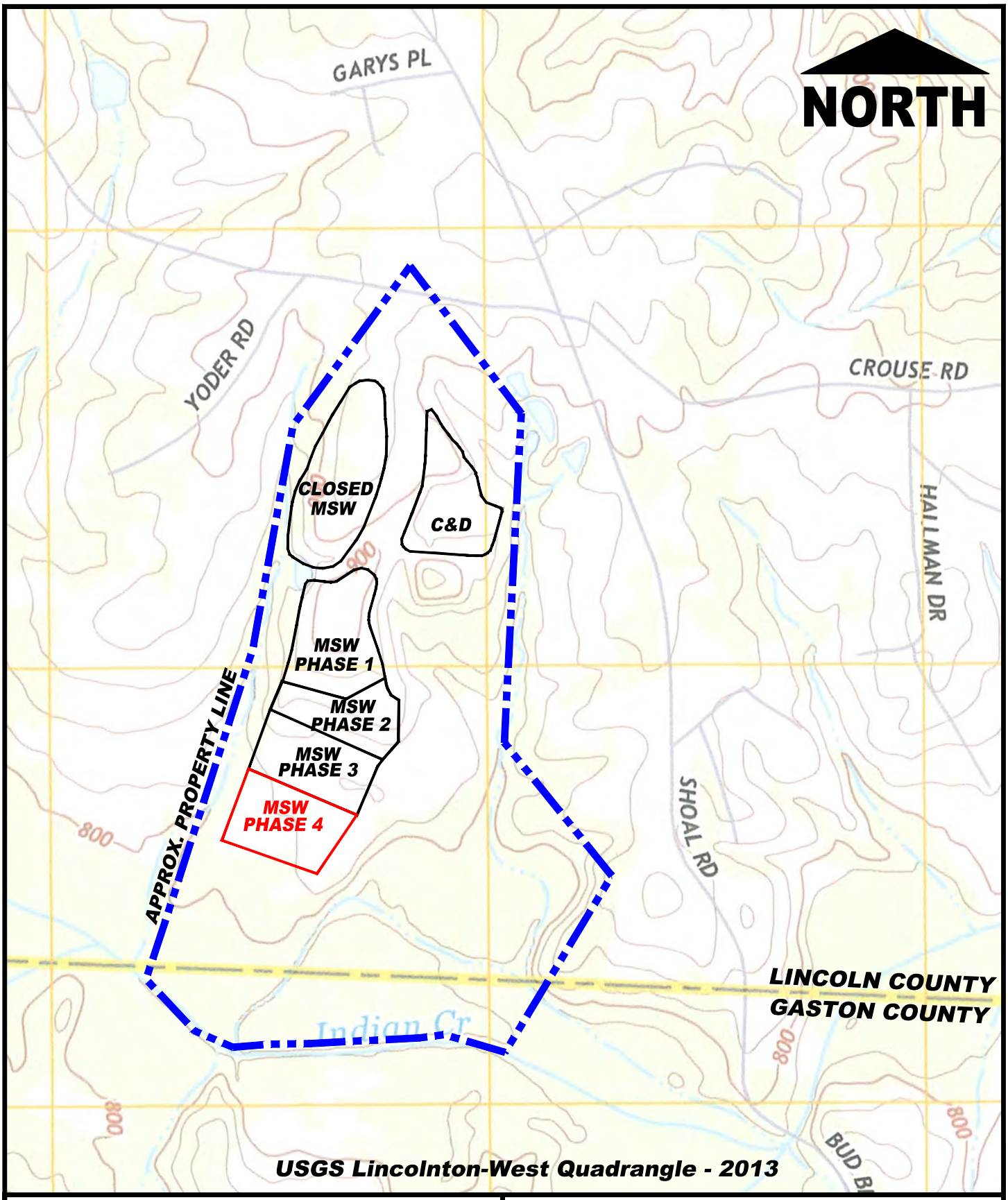
Figure 1 Site Location Map (USGS Topo)

Figure 2 Site Location Aerial

Figure 3 Geologic Map

Figure 4 Soil Survey Map

Figure5 Typical Type II Observation Well Schematic



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P.O. BOX 349 BOONE, N.C. 28607
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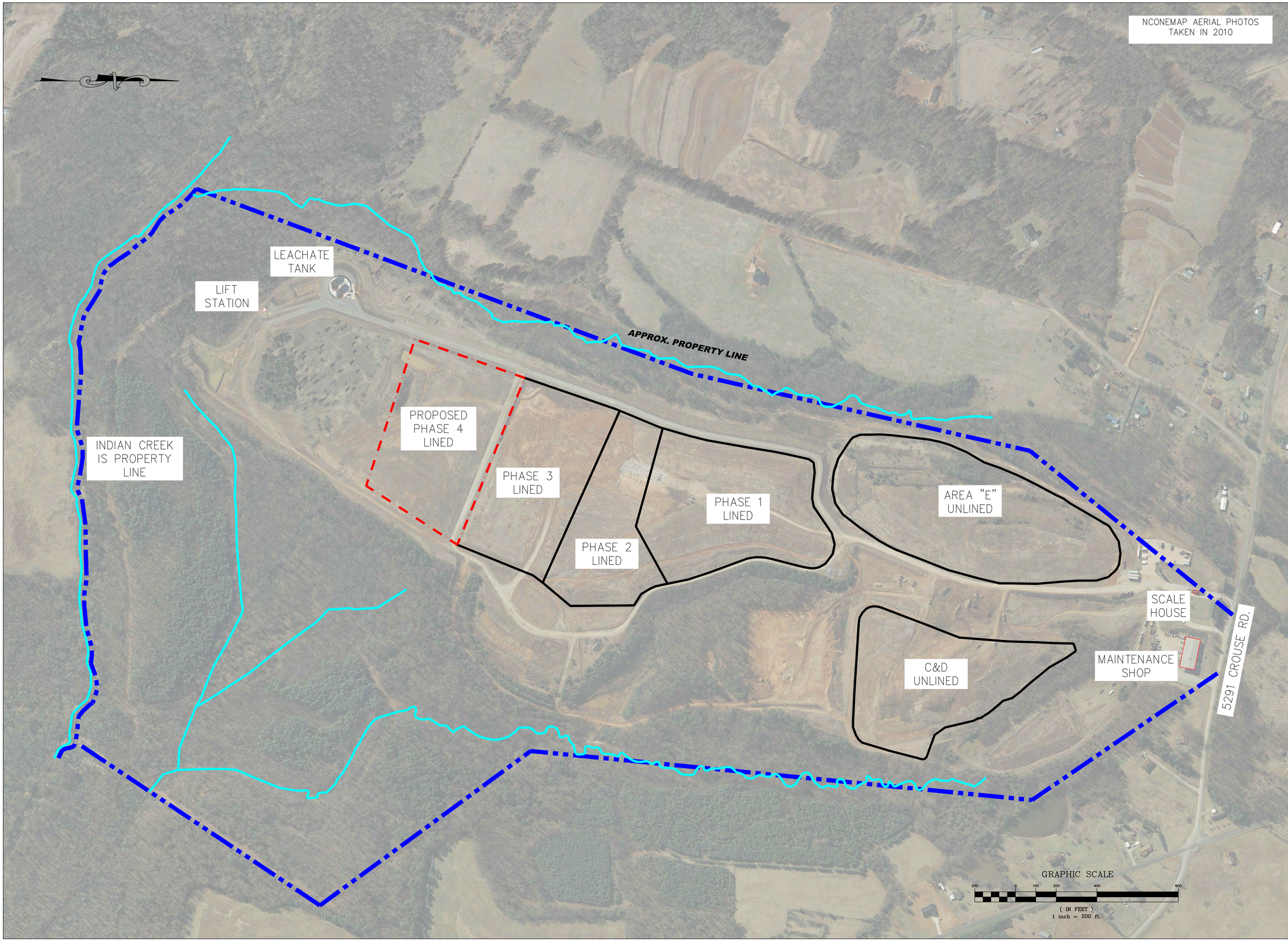
LICENSE NUMBER: C-0281

FIGURE 1
SITE LOCATION (USGS TOPO)

Lincoln County Landfill, Phase 4
Crouse, North Carolina

SCALE:	DATE:	PROJECT NO.:
1" = 1000'	8/10/2015	G15041



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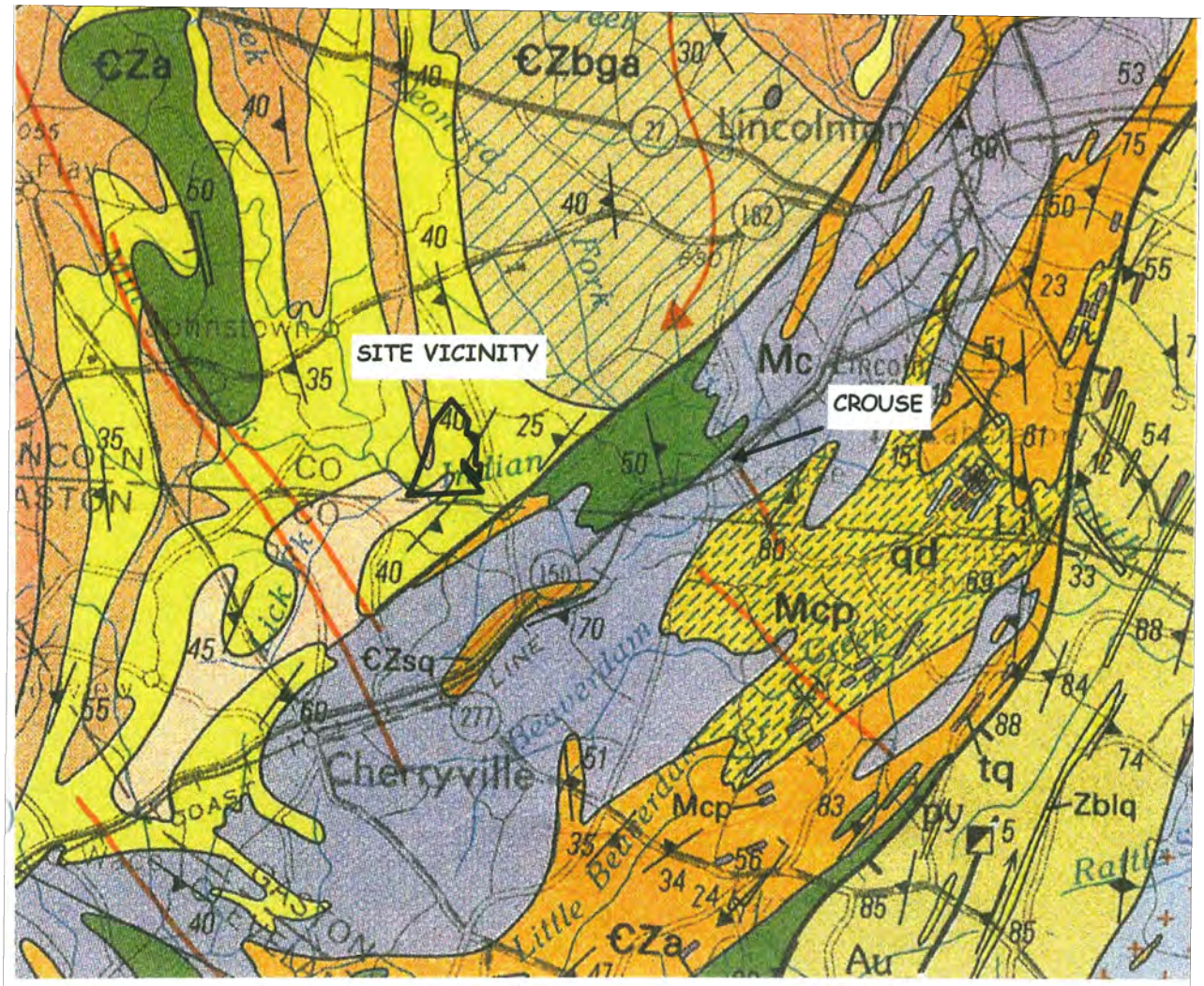
MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY
CROUSE, NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SITE LOCATION AERIAL

SCALE:	1" = 200'
DATE:	10-12-2015
DRWN. BY:	R.MOSS
CHKD. BY:	W. SULLIVAN
PROJECT NUMBER	G15141.6
DRAWING NO.	SHEET NO. FIG. 2



€Zss	**Sillimanite-mica schist**—Thin- to thick-bedded sillimanite-mica schist and gneiss, variably garnetiferous, locally pyritic. Sillimanite commonly altered to sericite. Subordinate layers and lenses of biotite gneiss (metawacke), and subordinate quartz schist, micaceous quartzite, and calc-silicate rock. Unit is heterogeneous in texture and proportions of minerals. Weathers white, pale purple, yellow and reddish orange. In part equivalent to white-mica schist (€Zs) but at higher metamorphic grade
€Zbg	**Biotite gneiss** — Gray to dark-gray, thin- to thick-layered biotite-quartz-feldspar gneiss, in part garnetiferous, locally inequigranular and porphyroblastic. Interlayered with calc-silicate rock, sillimanite-mica schist, mica schist, and amphibolite. Locally contains small masses of granite. Gradational into and interlayered with white-mica schist (€Zs) and sillimanite-mica schist (€Zss). Unit may include some fine-grained Henderson Gneiss (€h)
O€tg	**Toluca Granite* (Early Ordovician and Cambrian)**—Light-gray, medium-grained, weakly to well-foliated biotite monzogranite and subordinate granodiorite. Garnet, monazite, and muscovite are common accessories. Forms masses generally conformable with the regional foliation

SOURCE: GEOLOGIC MAP OF THE CHARLOTTE 1° X 2° QUADRANGLE, NORTH AND SOUTH CAROLINA 1988

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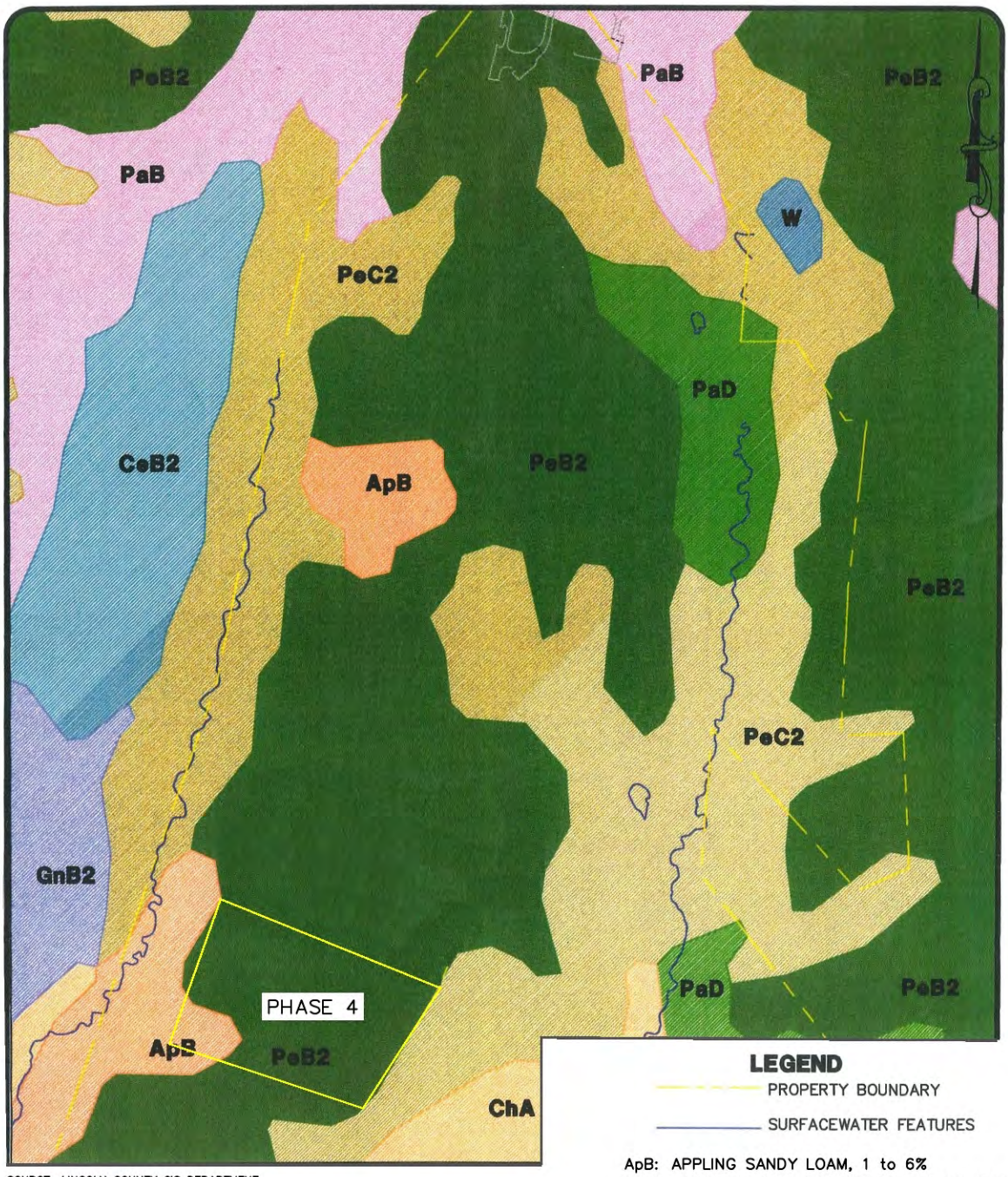
FIGURE 3
GEOLOGIC MAP

Lincoln County Landfill, Phase 4
Crouse, North Carolina

SCALE:	DATE:	PROJECT NO.:
NOT TO SCALE	8/10/2015	G15041



SOURCE: LINCOLN COUNTY GIS DEPARTMENT

LEGEND

PROPERTY BOUNDARY

SURFACEWATER FEATURES

ApB: APPLING SANDY LOAM, 1 to 6%

PeB2: PACOLET SANDY CLAY LOAM, 2–8%, ERODED

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FIGURE 4
SOIL SURVEY MAP

Lincoln County Landfill, Phase 4
Crouse, North Carolina

SCALE:	DATE:	PROJECT NO.:
NOT TO SCALE	8/10/2015	G15041

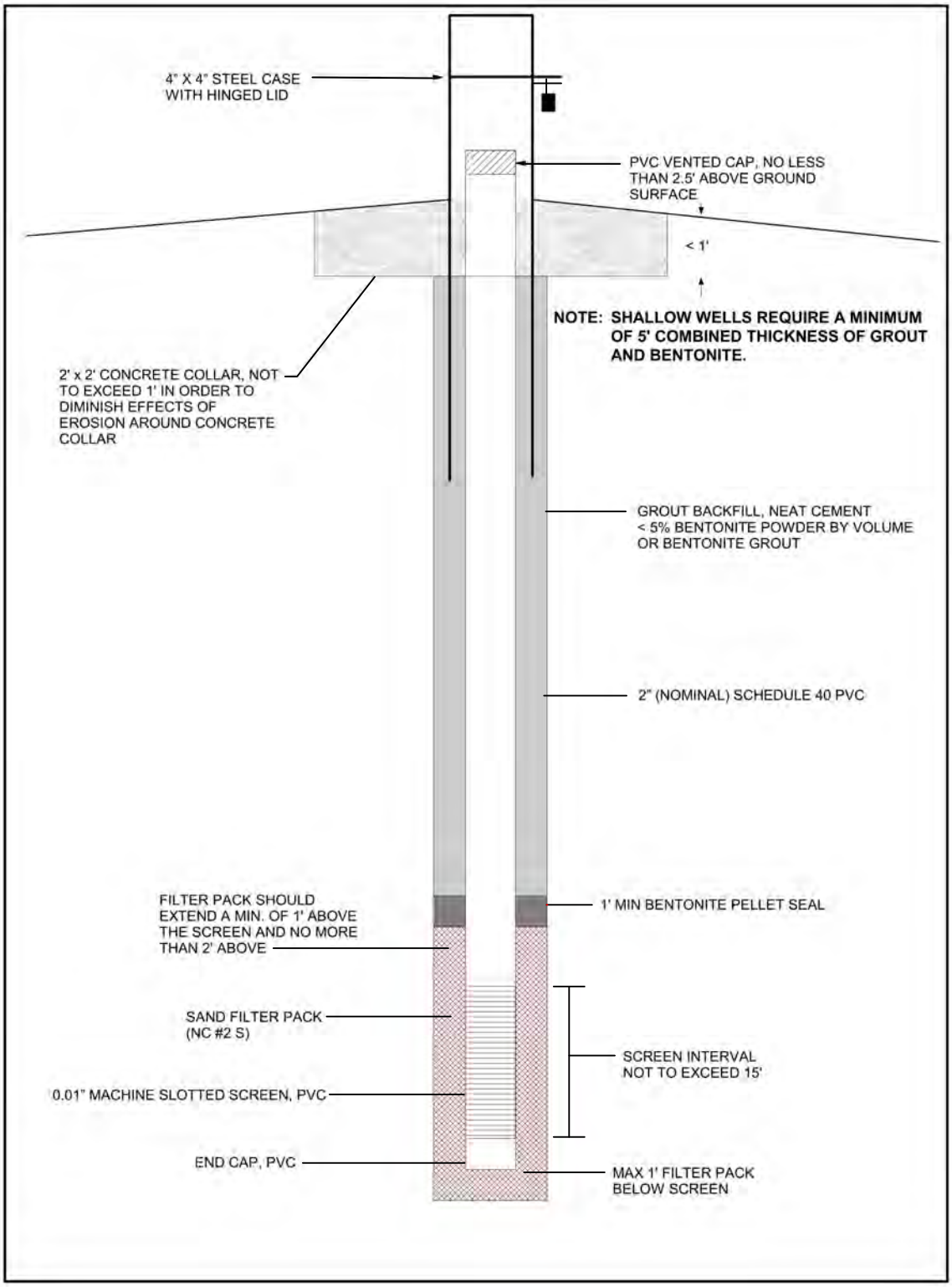

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FIGURE 5

TYPICAL TYPE II OBSERVATION WELL SCHEMATIC

Lincoln County Landfill, Phase 4
Crouse, North Carolina

SCALE:	DATE:	PROJECT NO.:
NOT TO SCALE	8/10/2015	G15041

APPENDIX A

BORING LOGS, RECORDS and ROCK CORE PHOTOGRAPHS

FIELD EXPLORATIONS PROCEDURES DESCRIPTION

BORING LOGS

WELL CONSTRUCTION RECORDS (Form GW-1)

ROCK CORE PHOTOGRAPHS

FIELD EXPLORATION PROCEDURES

Soil Test Boring: Twenty (20) soil test borings (20 observation wells) were drilled at the locations shown on the Boring Location Plan, Sheet 1. Soil sampling and penetration testing were performed in accordance with ASTM D 1586-84.

The borings were advanced with either hollow-stem augers or tricone mud rotary techniques, and soil samples were obtained at the observation well locations at standard intervals with a standard 1.4-inch I.D., 2-inch O.D., split-tube sampler. The sampler was first seated six (6) inches to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows is designated the "Standard Penetration Resistance", when properly evaluated, is an index to soil strength, relative density, and ability to support foundations.

The samples were classified in the field by a senior geoscientist. Representative portions of each soil sample were placed in glass jars and delivered to geotechnical laboratories. Test Boring Records are attached showing the soil descriptions and Standard Penetration Resistances.

Rock Coring: At four (4) locations, rock coring procedures were utilized to determine the character and continuity of the refusal materials. Core drilling procedures were carried out in accordance with ASTM Specification D 2113-70. Initially, casing was set through the overburden soil to keep the hole from collapsing. Refusal materials were then cored with a diamond-studded bit fastened to the end of a hollow double-tube core barrel. The cuttings were brought to the surface during coring by circulating water. Rock core samples of the materials penetrated were protected and retained in a swivel-mounted inner tube. Upon completion of each core run, the core barrel was brought to the surface and the samples removed and placed in boxes. Samples were then taken to the office where the rock was identified and the "Recovery" and Rock Quality Designation (RQD) determined.

The "Recovery" is the ratio of the sample length obtained to the length drilled, expressed as a percent. The RQD is the percentage of the length of the core recovered which has core segments four or more inches long compared to the total length of the run. The RQD value applies to rock cored with either an NX or NQ bit size. The percent recovery and RQD are related to rock soundness and continuity. Deere (Ref.6:13, Sowers and Sowers) denotes rock quality by the RQD value as follows:

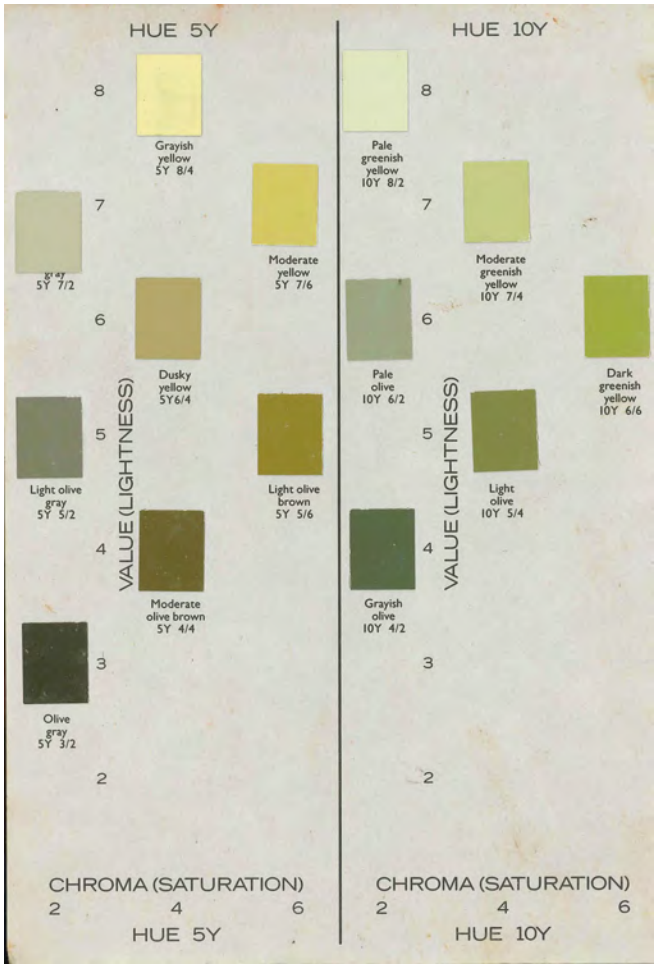
RQD (%)	ROCK QUALITY
90 to 100	Excellent
75 to 90	Good
50 to 75	Fair
25 to 50	Poor

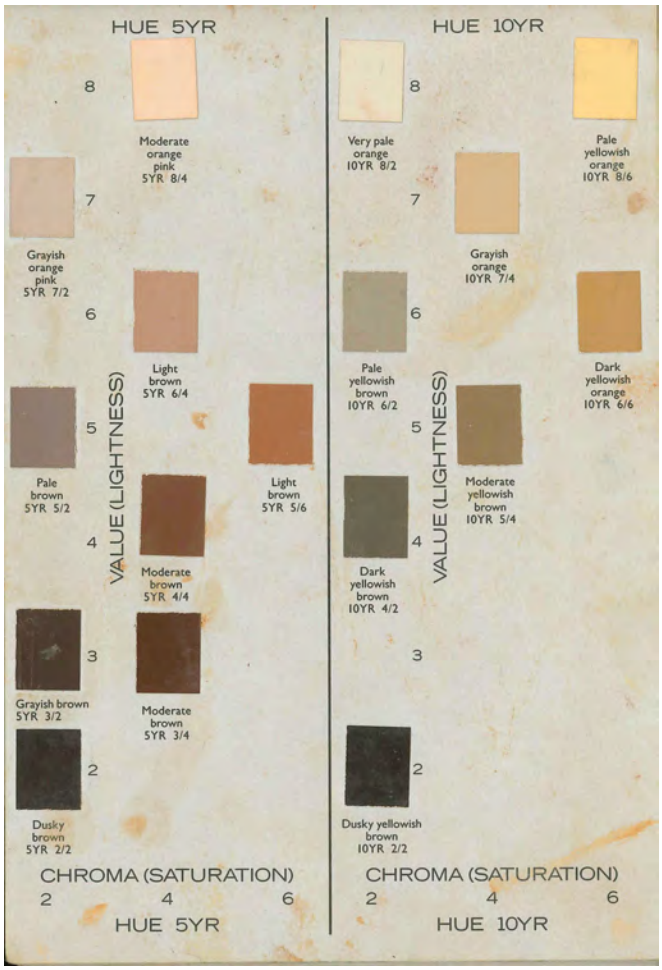
Generalized rock descriptions, percent recovery, and RQD values are shown on the appropriate Core Picture. An NQ size bit was used for the coring which designates bits which obtain samples 1-7/8 inches in diameter.

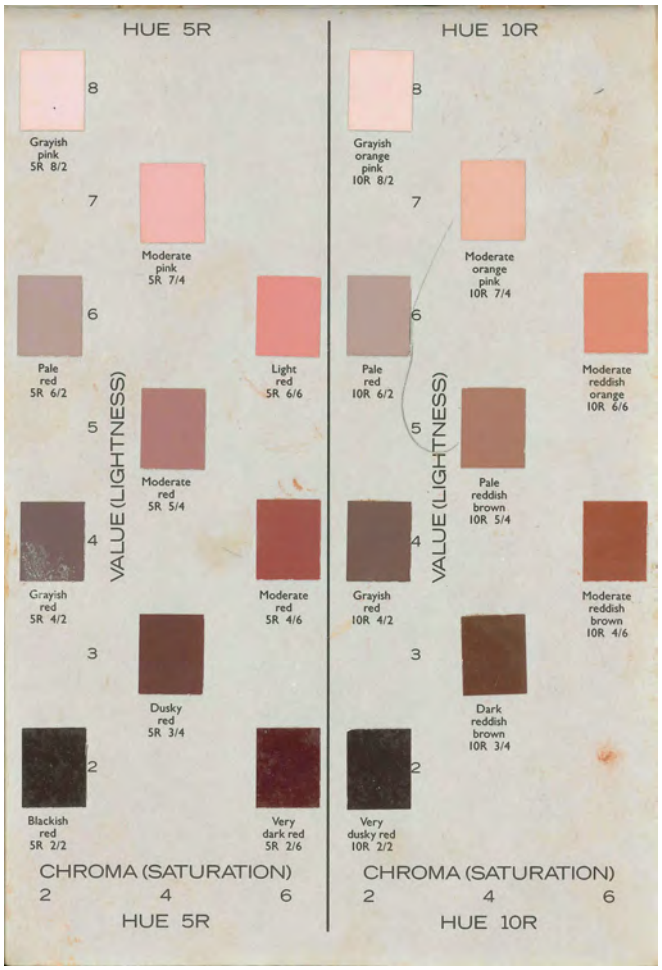
Undisturbed Sampling: Split-spoon samples obtained during penetration testing are suitable for visual examination and classification tests, but are not sufficiently intact for quantitative laboratory testing. Relatively undisturbed samples were obtained by forcing a section of three-inch (3") O.D., 16 gauge steel tubing into the soil at the desired sampling levels. This sample procedure is described by ASTM Designation D-1587. The tube, together with the encased soil, was carefully removed from the ground and made airtight. The locations and depths of undisturbed samples are shown on the appropriate Test Boring Records in Appendix A.

Soil & Rock Color Chart
Munsell® color chips
Used on Boring Logs

PYO	Pale Yellowish Orange 10YR 8/6
LB	Light Brown 5YR 5/6
DYO	Dark Yellowish Orange 10YR 6/6
MYB	Moderate Yellowish Brown 10YR 5/4
MB	Moderate Brown 5YR 4/4
DYB	Dark Yellowish Brown 10YR 4/2
LOG	Light Olive Gray 5YR 5/2
YG	Yellowish Gray 5Y 8/1
OG	Olive Gray 5YR 4/1
MRB	Moderate Reddish Brown 10 YR 4/6
VPO	Very Pale Orange10YR 8/2
PYB	Pale Yellowish Brown 10YR 5/4







LEGEND SUPPLEMENT

In addition to the terms and abbreviations listed on the Legend Sheet, the following will be used to further describe rock quality on this project. Because of limited space on the logs, abbreviations are in parenthesis.

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer in crystalline.
Very Slight (V. SLI.)	Rock generally fresh, joints stained, some joints may show thin clay coatings if open, crystals on a broken specimen face shine brightly. Rock rings under hammer blows if of a crystalline nature.
Slight (SLI.)	Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in.). Open joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored.
Moderate (MOD.)	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored, some show clay. Rock has dull sound under hammer blows and show significant loss of strength as compared with fresh rock.
Moderately Severe (MOD. SEV.)	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and a majority show kaolinization. Rock shows severe loss of strength & can be excavated with geologist's pick. Rock gives "clunk" sound when struck. **Comparable to hard weathered rock.**
Severe (SEV.)	All rocks except quartz discolored or stained. Rock "fabric" clear and evident but reduced in strength to strong soil. In granitoid rocks all feldspars are kaolinized to some extent. Some fragments of strong rock usually remain. **Comparable to soft weathered rock.**
Very Severe (V. SEV.)	All rock except quartz discolored or stained. Rock fabric elements are discernible but the mass is effectively reduced to soil status, with only fragments of strong rock remaining. Saprolite is an example of rock weathered to a degree such that only minor vestiges of the original rock fabric remain. **Comparable to soil.**
Complete	Rock reduced to soil. Rock fabric not discernible only in small and scattered concentrations. Quartz may be present as dikes or stringers. Saprolite is also an example. **Comparable to soil.**

ROCK CONTINUITY

Sound	Core pieces larger than 200 mm.
Slightly Fractured (SLI. FRAC.)-	Core pieces between 100 mm and 200 mm
Moderately Fractured (MOD. FRAC.) -	Core pieces between 25 mm and 100 mm
Extremely Fractured (EXT. FRAC.) -	Core pieces less than 25 mm

JOINT SPACING

Average Discontinuity Spacing (ADS)

The average measured distance (in centimeters) between joints in the same set. Will not apply to individual joints.

JOINT THICKNESS

Average Discontinuity Thickness (ADT)

The average thickness or width of gap in the joint.

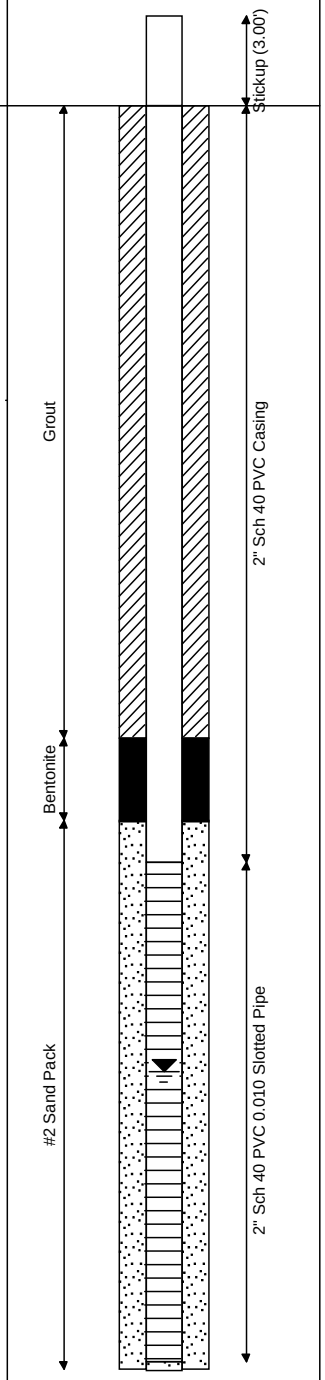
LOG OF BORING: OW4-1

Lincoln Co. MSWLF Ph. 4 **Project No. G15141.6**

Drilling contractor:	Bluestone	Date started:	3/20/2015	Surface elevation:	832.40 ft (MSL)
Drill rig & method:	6.5" OD HSA w/ SPT	Date ended:	3/20/2015	Top of pipe elevation:	835.40 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	38.00 ft	Depth to water (TOB):	29.50 ft
		Stickup height:	3.00 ft	Depth to water (24hrs):	29.05 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	8			RESIDUUM; (CL), PYO LEAN CLAY w/ lenses of RO fine grained sand, med. stiff, med. plastic, faint relict structure, trace roots, dry.
	8			RESIDUUM; (CL), LB LEAN CLAY w/ lenses of RO fine grained sand, med. stiff, med. plastic, faint relict structure, trace black manganese partings, dry.
5	5			RESIDUUM; (CL), LB LEAN CLAY w/ lenses of RO fine grained sand, med. stiff density, med. plastic, faint relict structure, trace black manganese partings, trace white feldspar nodules, dry.
10	5			SAPROLITE; (ML) LB SILT with fine sand, low plastic, medium density, trace white and black partings, dry.
	6			SAPROLITE; (ML) LB SILT with fine sand, low plastic, medium density, trace black manganese staining, dry.
15				
	7			SAPROLITE; (ML) DYO SILT with fine sand, non-plastic, few white feldspar and black manganese partings, medium density, dry.
20				
	7			SAPROLITE; (ML) YO SILT with fine sand, trace cohesive clay, medium density, few white feldspar and black manganese partings, no mottles, dry.
25				
	9			SAPROLITE; (ML) YO SILT with fine sand, stiff density, few white feldspar and black manganese partings, no mottles, wet.
30				
	11			SAPROLITE; (ML) YO SILT with fine sand, stiff density, few white feldspar and black manganese partings, no mottles, wet.
35				
				NO Auger Refusal - Neither PWR nor Bedrock encountered >794.65 ft amsl
				Boring terminated at 38.0 feet

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

OW4-1

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/20/15 **Well ID#** OW4-1

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.419887 N 81.356199 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 37.75, Sand 38.00 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 32.05 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
29.05 ft.	>38.00 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	6.83 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
22.75 ft.	37.75 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0.0 ft.	3.0 ft.	Concrete	Gravity >100 lbs. solids
3.0 ft.	19.0 ft.	Bent. Grout	Tremie 55 lbs. solids
19.0 ft.	21.5 ft.	Bent. Chips	Gravity 40 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
21.5 ft.	38.0 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	38 ft.	SOIL; Brown, soft
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Temporary observation well for hydrogeologic study

for future Ph 4 MSWLF

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

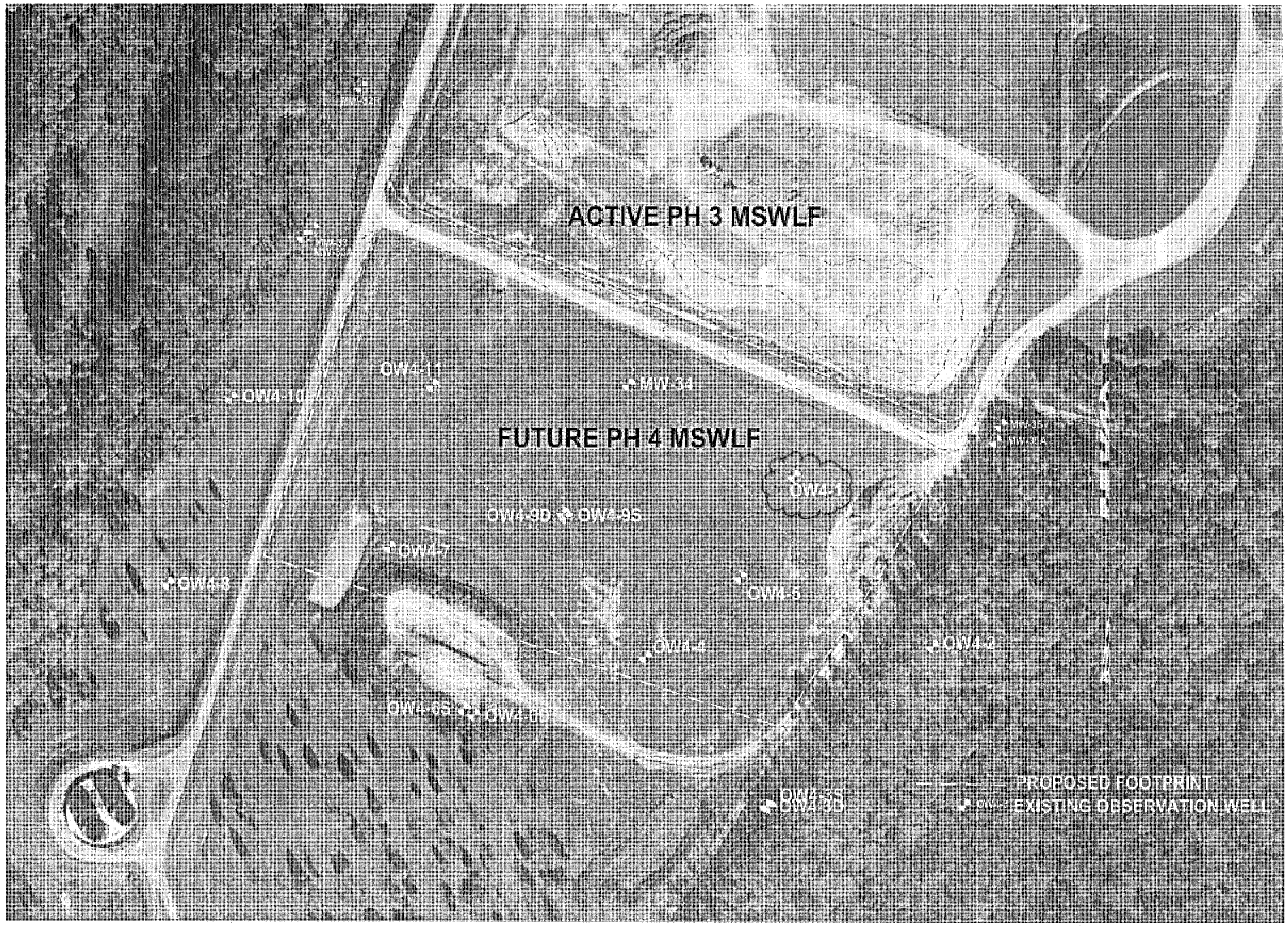
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-2

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

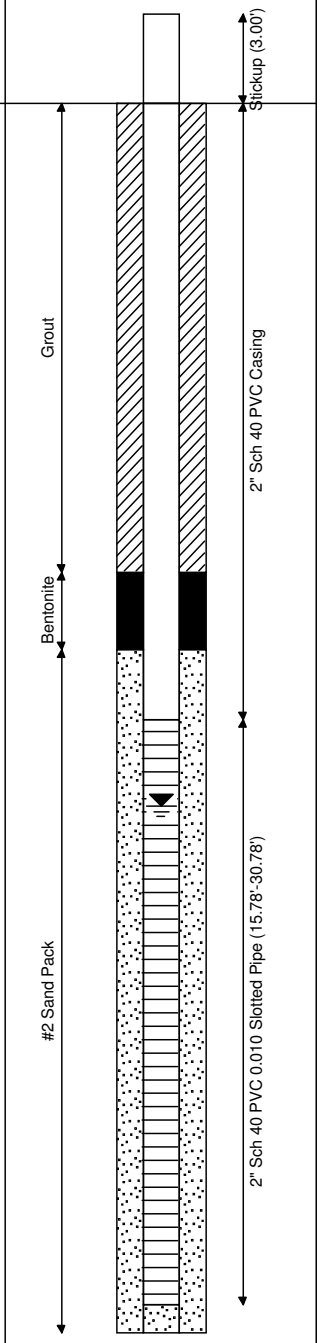
Drilling contractor: Bluestone
Drill rig & method: 8.5" OD HSA w/ SPT
Logged by: J. Pfohl

Date started: 3/23/2015
Date ended: 3/23/2015
Completion depth: 31.50 ft
Stickup height: 3.00 ft

Surface elevation: 812.43 ft (MSL)
Top of pipe elevation: 815.43 ft (MSL)
Depth to water (TOB): 18.50 ft
Depth to water (24hrs): 18.01 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	7			RESIDUUM; (SM), MB SILTY SAND, loose density, non-uniform medium to coarse grains, organic root debris, dry.
	7			RESIDUUM; (SM), MYB SILTY SAND, loose density, fine grains, faint relict structure, trace micas., dry.
5				
	10			SAPROLITE; (SM) MYB SILTY SAND, low plastic, loose density, relict structure, white feldspar and black manganeze partings, uniform fine grained sand, trace medium grained sands, micas., no mottles, dry.
10				
	10			SAPROLITE; (SM) MYB SILTY SAND, low plastic, loose density, relict structure, white feldspar and black manganeze partings, uniform fine grained sand, trace medium grained sands, micas., no mottles, dry.
15				
	12			SAPROLITE; (SM) MYB SILTY SAND, non-plastic, loose density, trace white feldspar and black manganese partings, no mottles, micas., moist.
20				
	13			SAPROLITE; (SM) MYB SILTY SAND, non-plastic, medium density, micas., moist.
25				BULK SAMPLE - Lab Tested as (SM) "Tan Silty Sand" (52.5% sand, 22.3% silt, 25.2% clay).
	15			SAPROLITE; (SM) DYB SILTY FINE SAND, non-plastic, medium density, micas., saturated.
30				
				NO Auger Refusal - Neither PWR nor Bedrock encountered >781.65 ft amsl
				Boring terminated at 31.5 feet

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/23/15 **Well ID#** OW4-2

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.419208 N 81.355372 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 30.78, Sand 31.50 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 21.01 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 8.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
18.01 ft.	>31.50 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	15.78 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
15.78 ft.	30.78 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0.0 ft.	3.0 ft.	Concrete	Gravity >200 lbs. solids
3.0 ft.	12.0 ft.	Bent. Grout	Tremie 50 lbs. solids
12.0 ft.	14.0 ft.	Bent. Chips	Gravity 55 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
14.0 ft.	31.5 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0.0 ft.	31.5 ft.	SOIL; Brown, soft
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Temporary observation well for hydrogeologic study

for future MSWLF Phase 4

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

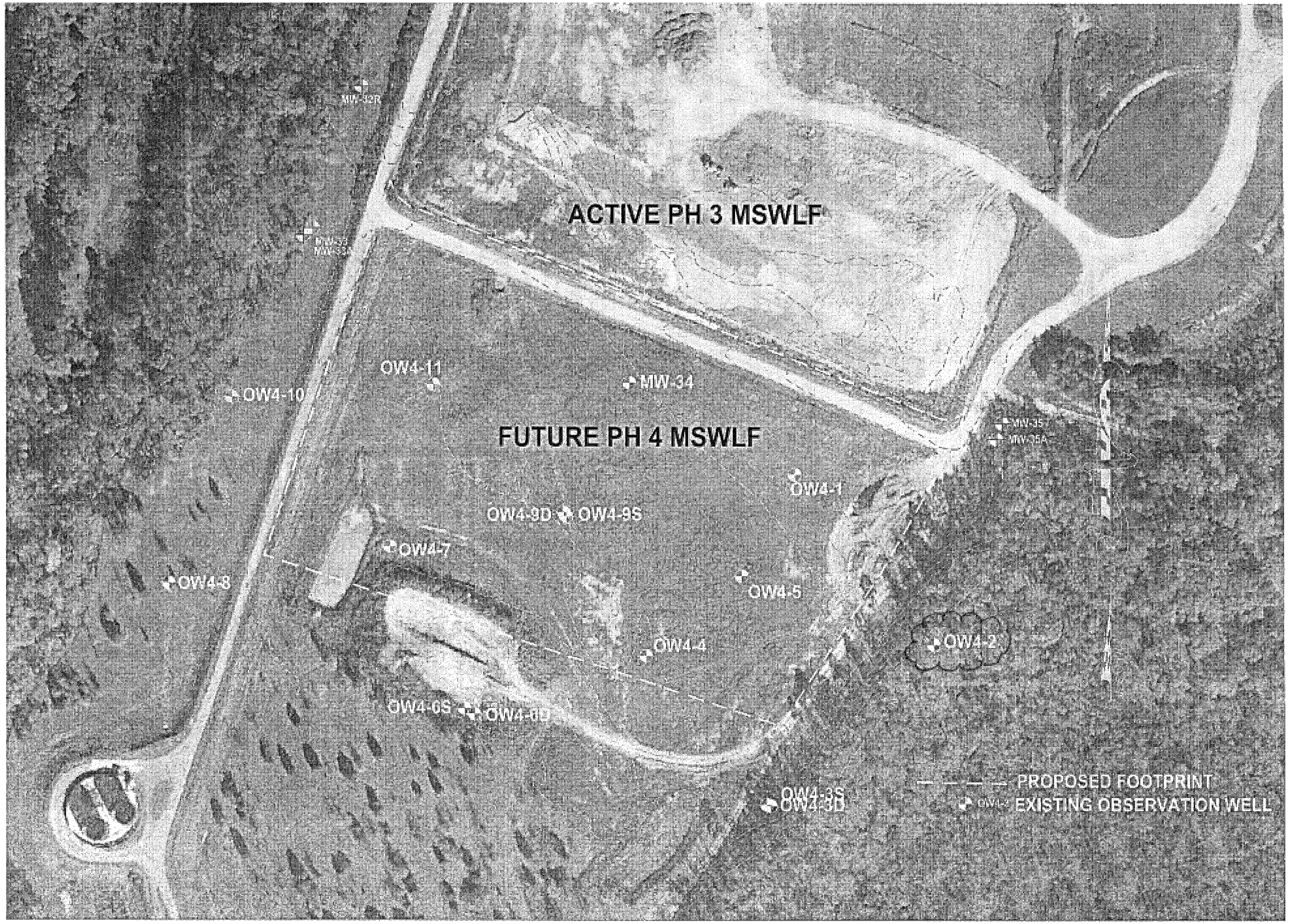
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-3S

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

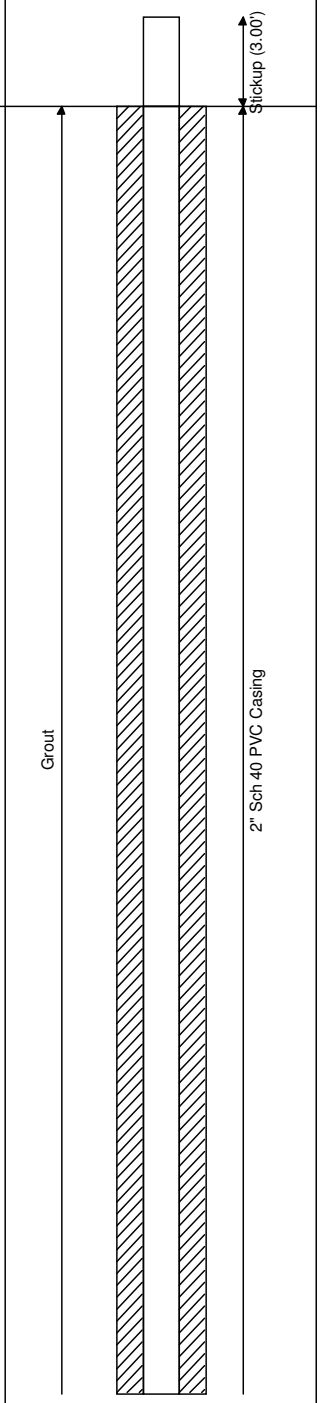
Drilling contractor: Bluestone
Drill rig & method: 8.5" OD HSA NO SPT
Logged by: J. Pfohl

Date started: 3/23/2015
Date ended: 3/23/2015
Completion depth: 46.50 ft
Stickup height: 3.00 ft

Surface elevation: 824.05 ft (MSL)
Top of pipe elevation: 827.05 ft (MSL)
Depth to water (TOB): 36.00 ft
Depth to water (24hrs): 35.63 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
				NO SPT PERFORMED IN OW4-3S. HOWEVER SPT PERFORMED IN ADJACENT OW4-3D AND DESCRIPTIONS RE-TRANSCRIBED.
	19			SAPROLITE; (SM) MYB SILTY SAND w/ clay, low plastic, moderate density, black manganese partings, dry.
5				
	19			SAPROLITE; (SM) LB SILTY SAND, fine grained, black manganese partiings, 2" white coarse angular grained quartz seam, medium density, dry.
10				
	18			SAPROLITE; (SM) LB SILTY SAND, cap-graded fine & medium grained, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
15				
	22			SAPROLITE; (SM) LB SILTY SAND, cap-graded fine & medium grained, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
20				
	16			SAPROLITE; (SM) LB SILTY SAND, cap-graded fine & medium grained, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
25				

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

LOG OF BORING: OW4-3S

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

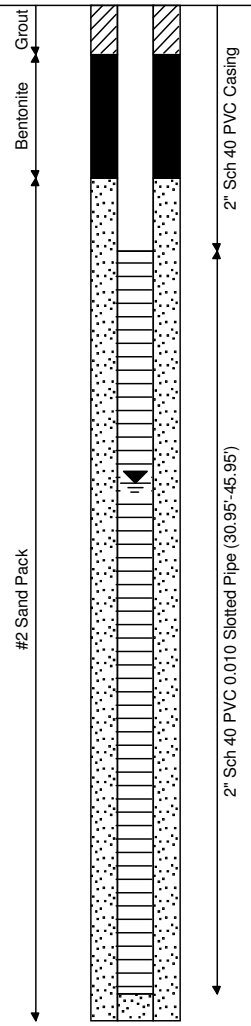
Drilling contractor: Bluestone
Drill rig & method: 8.5" OD HSA NO SPT
Logged by: J. Pfohl

Date started: 3/23/2015
Date ended: 3/23/2015
Completion depth: 46.50 ft
Stickup height: 3.00 ft

Surface elevation: 824.05 ft (MSL)
Top of pipe elevation: 827.05 ft (MSL)
Depth to water (TOB): 36.00 ft
Depth to water (24hrs): 35.63 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
30	21			SAPROLITE; (SM) LB SILTY SAND, cap-graded fine & coarse grained, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
35				SAPROLITE - Undisturbed sample collected from adjacent OW4-3D (34'-36') lab tested as (SM) "Light brown SILTY SAND" (72.4% sand, 16.7% silt, 10.9% clay).
40	23			SAPROLITE; (SM) LB SILTY SAND, well graded, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
45	34			SAPROLITE; (SM) LOG SAND, cap-graded fine & medium grained, few black manganese partings, pronounced relict structure, trace white medium grained angular white quartz fragments, medium density, moist.
				No HSA refusal at OW4-3S. Tricone refusal at 62.08' or 761.54' amsl in directly adjacent OW4-3D.
				Boring terminated at 46.5 feet
50				

Well Diagram



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OW4-3S

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:	
☐Agricultural	☐Municipal/Public
☐Geothermal (Heating/Cooling Supply)	☐Residential Water Supply (single)
☐Industrial/Commercial	☐Residential Water Supply (shared)
☐Irrigation	
Non-Water Supply Well:	
☑Monitoring	☐Recovery
Injection Well:	
☐Aquifer Recharge	☐Groundwater Remediation
☐Aquifer Storage and Recovery	☐Salinity Barrier
☐Aquifer Test	☐Stormwater Drainage
☐Experimental Technology	☐Subsidence Control
☐Geothermal (Closed Loop)	☐Tracer
☐Geothermal (Heating/Cooling Return)	☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/23/15 **Well ID#** OW4-3S

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minntes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.418429 N 81.356210 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells ONLY with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 45.95, Sand 46.50 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 38.63 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 8.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
35.82 ft.	>46.50 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	30.95 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
30.95 ft.	45.95 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0.0 ft.	3.0 ft.	Concrete	Gravity >190 lbs. solids
3.0 ft.	27.0 ft.	Bent. Grout	Tremie 130 lbs. solids
27.0 ft.	29.50 ft.	Bent. Chips	Gravity 65 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
29.5 ft.	46.5 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0.0 ft.	42.0 ft.	SOIL; Silty Sand, residuum, mod. density
42.0 ft.	46.5 ft.	SOIL; Saprolite, more dense
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Observation well for hydrogeologic study for future Ph 4 LF

Shallower counterpart to adjacent nested well OW4-3D

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

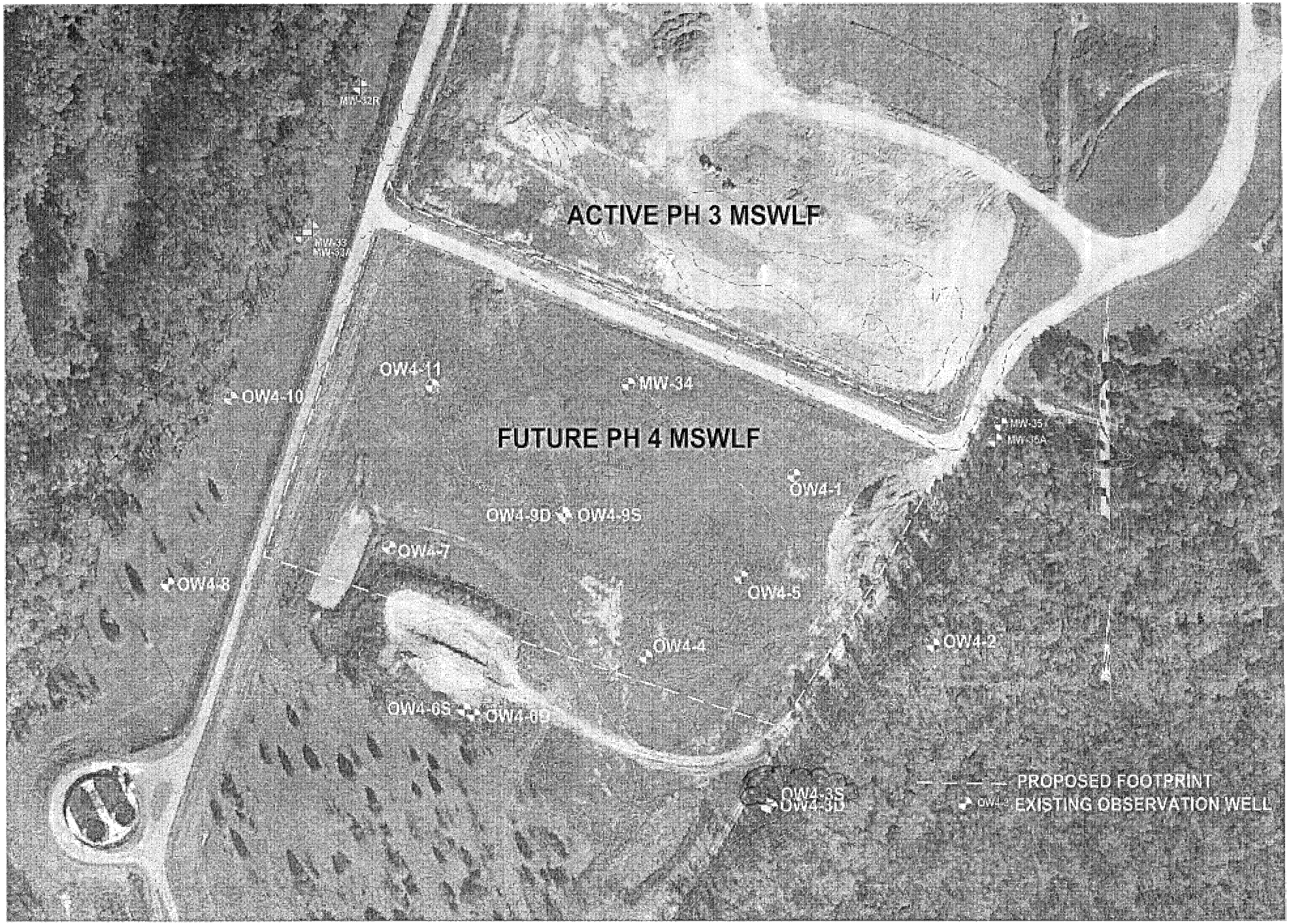
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-3D

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

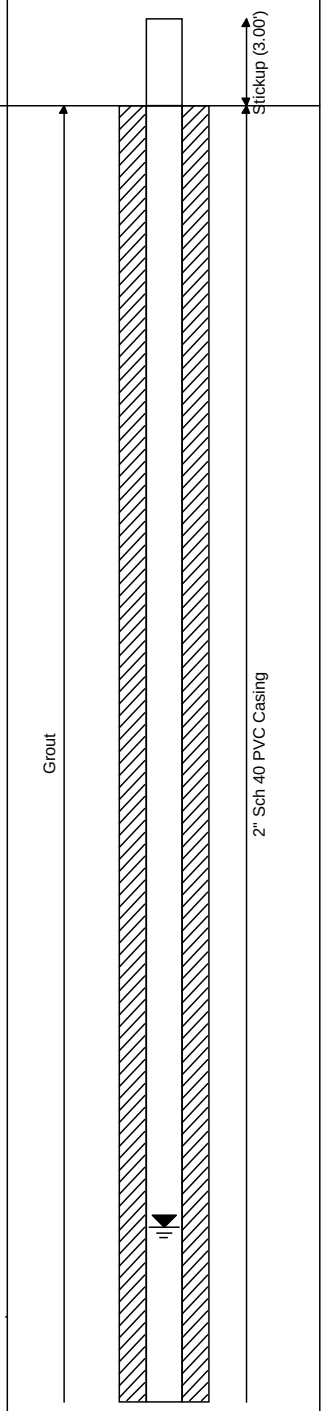
Drilling contractor: Bluestone
Drill rig & method: 6" OD mud rotary, NQ core, SPT
Logged by: J. Pfohl

Date started: 2/24/2015
Date ended: 2/24/2015
Completion depth: 78.50 ft
Stickup height: 3.00 ft

Surface elevation: 823.62 ft (MSL)
Top of pipe elevation: 826.62 ft (MSL)
Depth to water (TOB): 39.00 ft
Depth to water (24hrs): 38.93 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	19			SAPROLITE; (SM) MYB SILTY SAND w/ clay, low plastic, moderate density, black manganese partings, dry.
5				
	19			SAPROLITE; (SM) LB SILTY SAND, fine grained, black manganese partiings, 2" white coarse angular grained quartz seam, medium density, dry.
10				
	18			SAPROLITE; (SM) LB SILTY SAND, cap-graded fine & medium grained, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
15				
	22			SAPROLITE; (SM) LB SILTY SAND, cap-graded fine & medium grained, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
20				
	16			SAPROLITE; (SM) LB SILTY SAND, cap-graded fine & medium grained, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
25				
	21			SAPROLITE; (SM) LB SILTY SAND, cap-graded fine & coarse grained, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
30				
				UNDISTURBED "Shelby tube" SAMPLE - Lab Tested as (SM) "Light brown SILTY SAND" (72.4 % sand, 16.7% silt, 10.9% clay).
35				
	23			SAPROLITE; (SM) LB SILTY SAND, well graded, pronounced relict structure, white feldspar & black manganese partings, medium density, dry.
40				
	34			SAPROLITE; (SM) LOG SAND, cap-graded fine & medium grained, few black manganese partings, pronounced relict structure, trace white medium grained angular white quartz fragments, medium density, moist.
45				

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

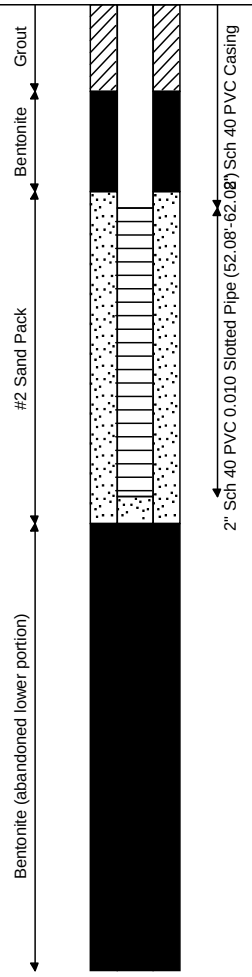
LOG OF BORING: OW4-3D

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

Drilling contractor:	Bluestone	Date started:	2/24/2015	Surface elevation:	823.62 ft (MSL)
Drill rig & method:	6" OD mud rotary, NQ core, SPT	Date ended:	2/24/2015	Top of pipe elevation:	826.62 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	78.50 ft	Depth to water (TOB):	39.00 ft
		Stickup height:	3.00 ft	Depth to water (24hrs):	38.93 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
50	30			WEATHERED ROCK (VERY SEVERELY); (SM) YG & GO SAND, uniformly graded medium grained, few translucent medium grained angular quartz fragments, medium density, moist.
55	50/5"			WEATHERED ROCK (VERY SEVERELY); (SW) YG SAND, uniformly graded medium grained, very dense, several angular translucent quartz fragments, moist.
				NO SPT attempted at 59' bls since judged to be too dense for recovery.
60				ROCK; Tricone (metal not carbide bit) refusal 62.08' bls.
65				BEDROCK RUN #1 (62.0-63.5') REC=80%, RQD=0%; Silliminite schist, light gray with brownish red garnet porphyroblasts, shallow foliations, slighltly weathered, highly fractured, iron stained.
				BEDROCK RUN #2 (63.5'-68.5') REC=47%, RQD=0%; Silliminite schist, light gray with brownish red garnet porphyroblasts, shallow foliations, slighltly weathered, highly fractured, iron stained.
70				BEDROCK RUN #3 (68.5'-73.5') REC=100%, RQD=9%; Silliminite schist, light gray with brownish red garnet porphyroblasts, shallow foliations, slighltly weathered, highly fractured, iron stained.
75				BEDROCK RUN #4 (73.5'-78.5') REC=72%, RQD=0%; Silliminite schist, light gray with brownish red garnet porphyroblasts, shallow foliations, slighltly weathered, fractured.
80				Boring terminated at 78.5 feet
85				
90				

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

ROCK CORE DETAILS

Municipal Services Engineering Company, P.A.
Garner, NC Boone, NC
Municipal Engineering Services Company, P.A.
Garner and Boone, North Carolina

Boring ID:	Site Name:	Classification:	Core Depths (ft-bls)	Total Core Length (ft)
OW4-3D	Lincoln Co. MSWLF, Ph 4	Sillimanite Schist	62.0'-78.5'	16.5'

Run #1 1.5'	Run #2 5.0'	Run #3 5.0'	Run #4 5.0'
From: 62.0' to 63.5' = 1.5'	**From:** 63.5' to 68.5' = 5.0'	**From:** 68.5' to 73.5' = 5.0'	**From:** 73.5' to 78.5' = 5.0'
REC: 80.0% **RQD:** 0.0%	**REC:** 47.0% **RQD:** 0.0%	**REC:** 100.0% **RQD:** 9.0%	**REC:** 72.0% **RQD:** 0.0%

0 0.5 1 1.5 2

FEET

OW4-3D

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public
☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)
☐Industrial/Commercial ☐Residential Water Supply (shared)
☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation
☐Aquifer Storage and Recovery ☐Salinity Barrier
☐Aquifer Test ☐Stormwater Drainage
☐Experimental Technology ☐Subsidence Control
☐Geothermal (Closed Loop) ☐Tracer
☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 2/24/15 **Well ID#** OW4-3D

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.418429 N 81.356210 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

For multiple injection or non-water supply wells ONLY with the same construction, you can submit one form.

9. Total well depth below land surface: Screen 62.08, Sand 63.00 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 38.93 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6 **(in.)**

12. Well construction method: mud rotary, rock core

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
35.51 ft.	62.08 ft.	Unconfined uppermost aquifer in soil
62.08 ft.	78.5 ft.	in fractures in rock

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	52.08 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
52.08 ft.	62.08 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0.0 ft.	3.0 ft.	Concrete	Gravity >95 lbs. solids
3.0 ft.	49.0 ft.	Bent. Grout	Tremie 140 lbs. solids
49,63 ft.	51,78 ft.	Bent. Chips	Tremie 30, 230 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
51 ft.	63 ft.	#2 Silica Sand	Tremie
63 ft.	78 ft.	Bent. Chips	Tremie 230 lbs. chips

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0.0 ft.	42.0 ft.	SOIL; Silty Sand, residuum, mod. density
42.0 ft.	52.0 ft.	SOIL; Saprolite, more dense
52.0 ft.	62.0 ft.	Slightly Weathered Rock; White, very dense
62.0 ft.	78.5 ft.	Rock; White, highly fractured.
ft.	ft.	
ft.	ft.	Abandoned lower part of boring 63'-98'
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Observation well for hydrogeologic study for future Ph 4 LF

Deeper counterpart to adjacent nested well OW4-6S

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

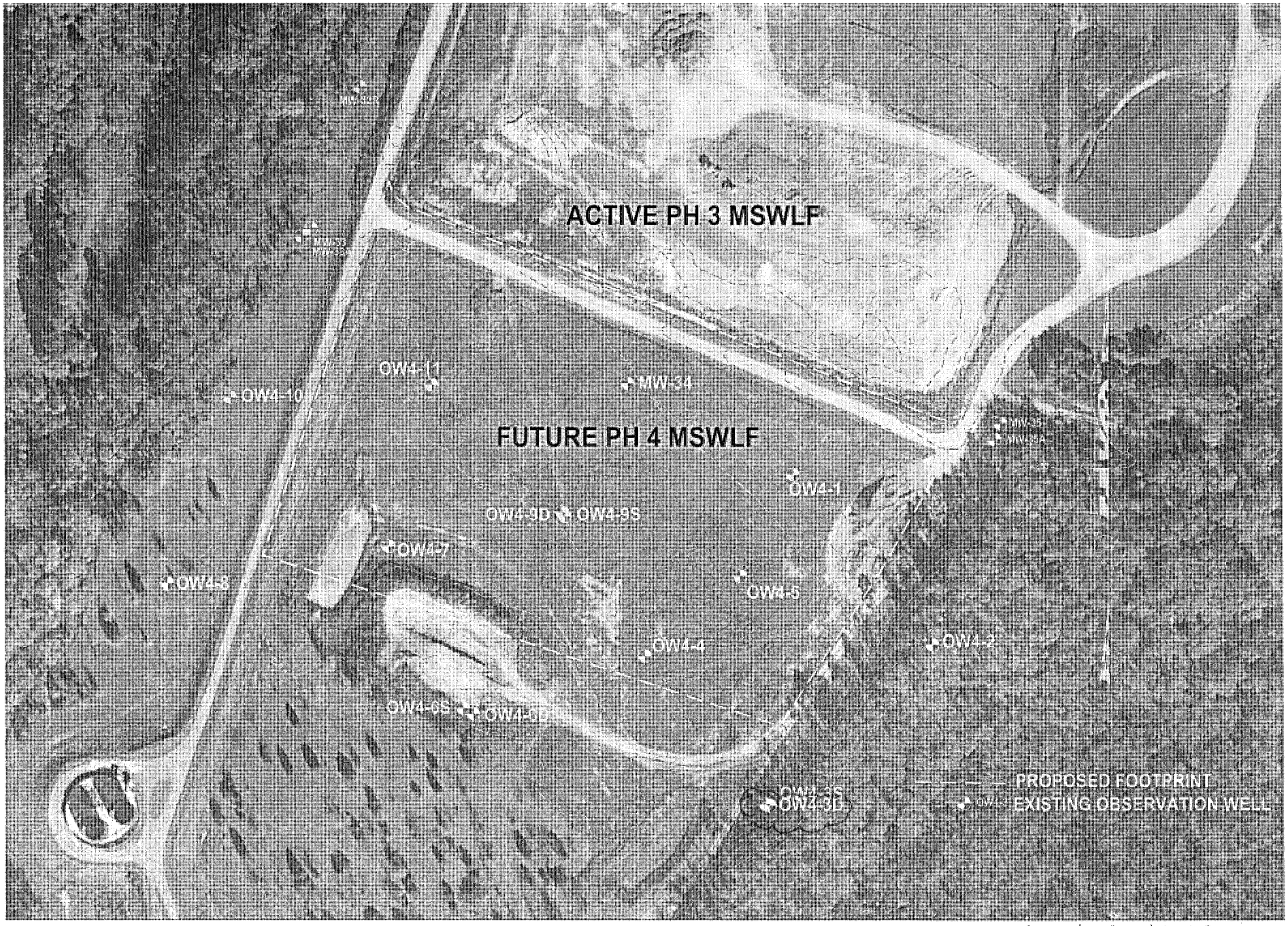
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-4

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

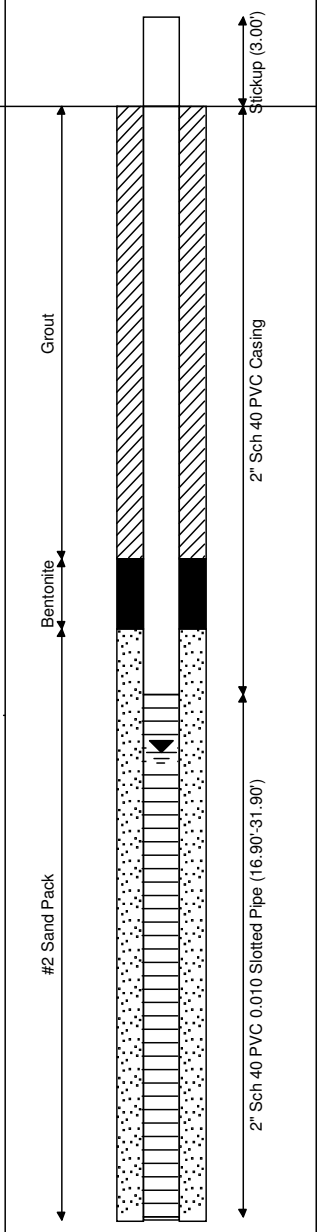
Drilling contractor: Bluestone
Drill rig & method: 6.5" OD HSA w/ SPT
Logged by: J. Pfohl

Date started: 3/20/2015
Date ended: 3/20/2015
Completion depth: 32.00 ft
Stickup height: 3.00 ft

Surface elevation: 819.05 ft (MSL)
Top of pipe elevation: 822.05 ft (MSL)
Depth to water (TOB): 19.00 ft
Depth to water (24hrs): 18.57 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	18			SAPROLITE; (SM) YO SILTY SAND; uniform fine grained, medium dense, few black manganese and white feldspar partings, trace mica, dry.
	20			SAPROLITE; (SM) YO SILTY SAND; uniform fine grained, medium dense, few black manganese and white feldspar partings, trace mica, dry.
5	6			SAPROLITE; (SM) OG SILTY SAND; uniform very fine grained, medium dense, few black manganese and white feldspar partings, trace mica, dry.
10				UNDISTURBED "Shelby tube" SAMPLE - Lab Tested as (SM) "Pinkish brown SILTY SAND" (61% sand, 28.3% silt, 10.7% clay).
	11			SAPROLITE; (SM) RB SILTY SAND, cap-graded very fine to fine grained, medium density, few white feldspar and black manganeze partings, no mottles, dry.
15	11			SAPROLITE; (SM) RB SILTY SAND, cap-graded very fine to fine grained, medium density, few white feldspar and black manganeze partings, no mottles, dry.
20	5			SAPROLITE; (ML) RB SILT with fine grained sand, medium stiff density, few white feldspar and black manganeze partings, no mottles, trace angular translucent quartz fragments, dry.
25	7			SAPROLITE; (ML) OG SILT with trace fiine grained sand, medium stiff density, few white feldspar and black manganeze partings, no mottles, trace mica, moist.
30	8			SAPROLITE; (ML) OG SILT with trace fiine grained sand, medium stiff density, few white feldspar and black manganeze partings, no mottles, trace mica, moist.
				NO Auger Refusal - Neither PWR nor Bedrock encountered >787.15 ft amsl
				Boring terminated at 32.0 feet
35				

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

OW4-4

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/20/15 **Well ID#** OW4-4

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.419087 N 81.356643 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 31.9, Sand 32.0 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 21.57 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disiufection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
18.57 ft.	>32.00 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.0 ft.	16.9 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
16.9 ft.	31.9 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	Concrete	Gravity >95 lbs. solids
3 ft.	13 ft.	Bent. Grout	Tremie 35 lbs. solids
13 ft.	15 ft.	Bent. Chips	Gravity 35 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
15 ft.	32 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	32 ft.	SOIL; Sandy Silt, soft,
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Temporary observation well for future MSWLF Ph 4

hydrogeologic study

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

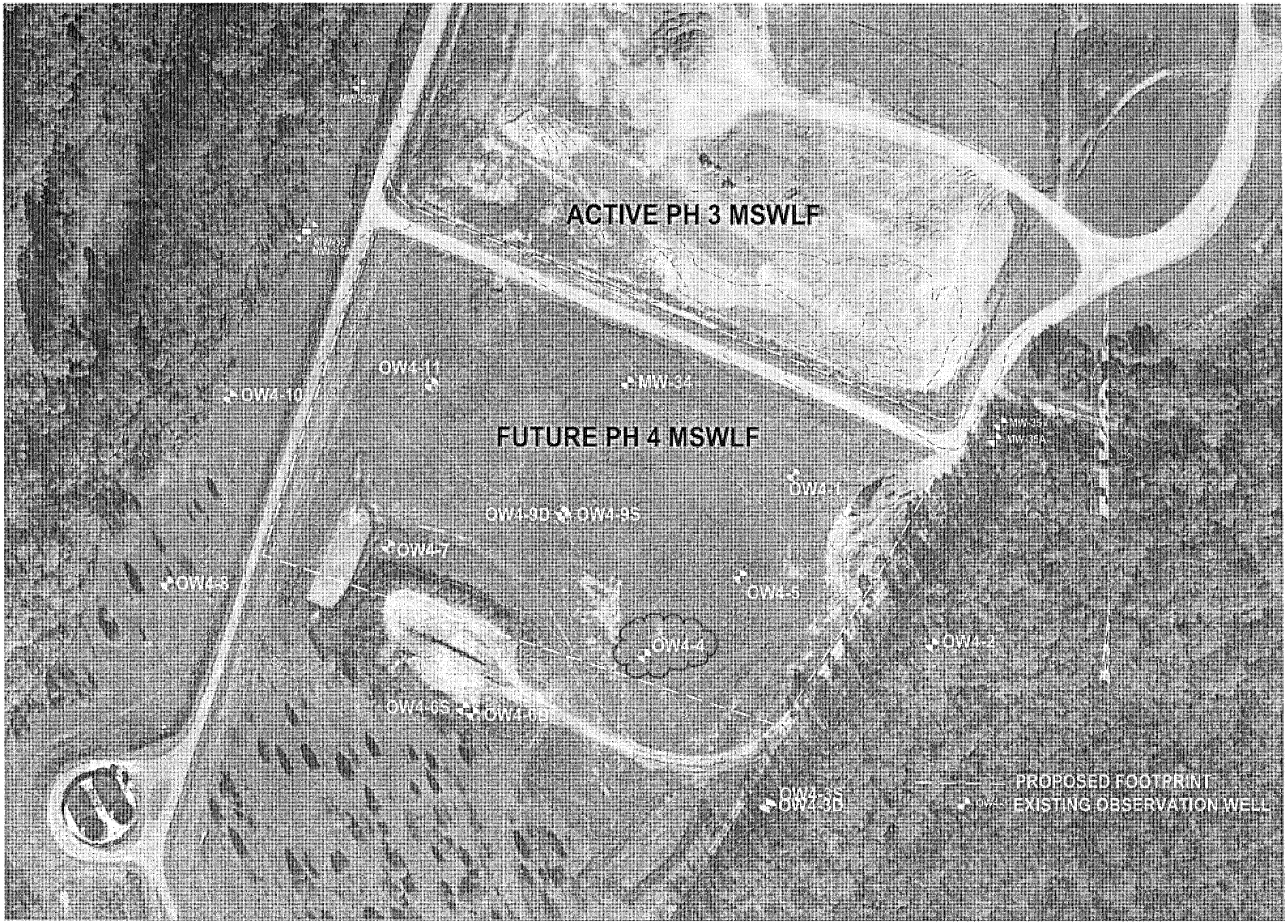
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-5

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

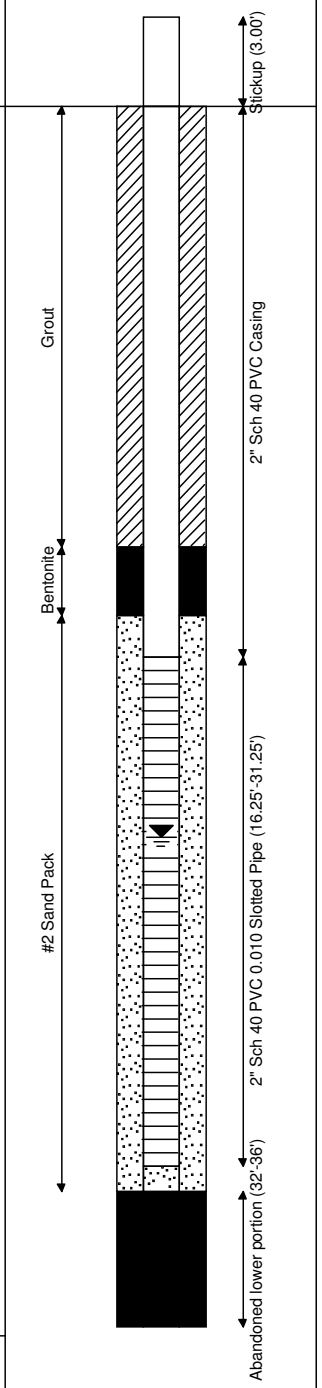
Drilling contractor: Bluestone
Drill rig & method: 6.5" OD HSA w/ SPT
Logged by: J. Pfohl

Date started: 3/20/2015
Date ended: 3/20/2015
Completion depth: 36.00 ft
Stickup height: 3.00 ft

Surface elevation: 822.57 ft (MSL)
Top of pipe elevation: 825.57 ft (MSL)
Depth to water (TOB): 22.00 ft
Depth to water (24hrs): 21.55 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	8			RESIDUUM; (SM) MB SILTY SAND, cap-graded fine to med. grained, loose density, trace mica, dry.
	6			RESIDUUM; (SM) MB SILTY SAND, cap-graded fine to med. grained, loose density, trace mica, dry.
5				
10	6			RESIDUUM; (SM) MB SILTY SAND, cap-graded fine to med. grained, loose density, trace cohesive clay, dry.
				UNDISTURBED "Shelby tube" SAMPLE - Lab Tested as (SM) "Dark brown and orange SILTY SAND" (56.1 % sand, 21% silt, 22.5% clay).
	6			SAPROLITE; (SM) RB SILTY SAND, cap-graded very fine to fine grained, medium density, trace white feldspar and black manganeze partings, no mottles, dry.
15				
	6			SAPROLITE; (SM) LB SILTY SAND, fine grained, loose density, few white feldspar and black manganeze partings, no mottles, dry.
20				
	12			SAPROLITE; (SM) LB SILTY SAND, fiine grained, medium density, trace white feldspar and black manganeze partings, less relict structure than above, no mottles, moist.
25				
	14			SAPROLITE; (SM) LB SILTY SAND; fiine grained, medium density, few white feldspar and black manganeze partings, no mottles, trace mica, moist.
30				NO Auger Refusal - Neither PWR nor Bedrock encountered >787.15 ft amsl
	23			SAPROLITE; (SM) DYB SILTY SAND; fiine grained, medium density, few white feldspar and black manganeze partings, no mottles, trace mica, moist.
35				
				Boring terminated at 36.0 feet

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

OW4-5

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/20/15 **Well ID#** OW4-5

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.419470 N 81.356273 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 31.25, Sand 32.00 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 24.55 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
21.55 ft.	>32.00 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.0 ft.	16.9 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
16.9 ft.	31.9 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	Concrete	Gravity >95 lbs. solids
3 ft.	13 ft.	Bent. Grout	Tremie 305 lbs. solids
13,32 ft.	15,36 ft.	Bent. Chips	Gravity 35, 60 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
15 ft.	32 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	36 ft.	SOIL; Residuum to saprolite, soft,
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Temporary observation well for hydrogeologic study

for future MSWLF Phase 4

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

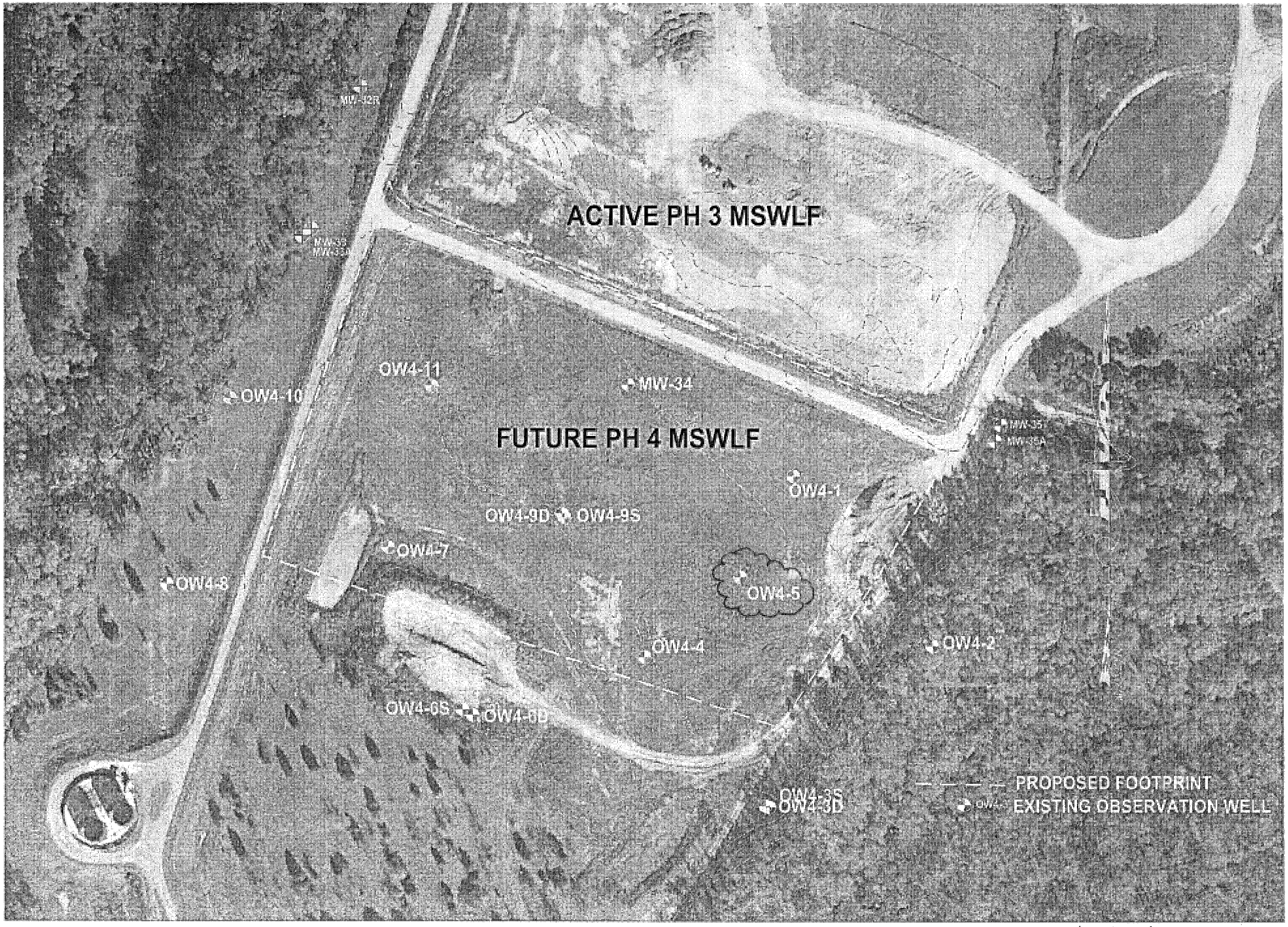
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

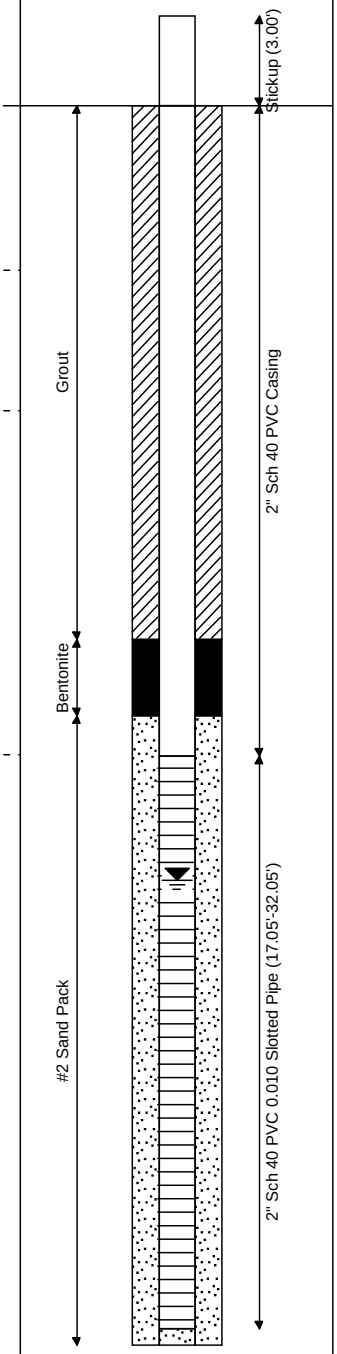
LOG OF BORING: OW4-6S

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

Drilling contractor:	Bluestone	Date started:	3/23/2015	Surface elevation:	814.97 ft (MSL)
Drill rig & method:	8.5" OD HSA NO SPT	Date ended:	3/23/2015	Top of pipe elevation:	817.97 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	32.50 ft	Depth to water (TOB):	21.50 ft
		Stickup height:	3.00 ft	Depth to water (24hrs):	20.29 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
				NO SPT PERFORMED IN OW4-6S. HOWEVER SPT PERFORMED IN ADJACENT CLUSTER WELL OW4-6D AND DESCRIPTIONS RE-TRANSCRIBED.
	9			RESIDUUM; (ML), LB CLAYEY FINE SAND, stiff density, uniformly fine grained, homogenous, low plasticity, organic root debris, dry.
5	13			RESIDUUM; (ML), LB SILTY SAND, stiff density, uniformly fine grained, homogenous, low plasticity, dry.
	12			RESIDUUM; (MH), LB SANDY ELASTIC SILT, stiff density, low-medium plasticity, dry.
10				RESIDUUM- Undisturbed sample collected from adjacent OW4-6D (12'-14') - Lab Tested as (MH) "Orangish brown sandy elastic SILT" (47.1% sand, 18.4% silt, 34.5% clay).
15	11			RESIDUUM; (MH), LB SANDY ELASTIC SILT, stiff density, low plasticity, dry.
	22			SAPROLITE; (SM) PYB SILTY SAND, well graded, medium density, no mottles, dry.
20				
	52			SAPROLITE; (SM) DYB SILTY SAND, well graded, very dense, no mottles, dry.
25				
	70			SAPROLITE; (SM) DYB SILTY SAND, well graded, very dense, pronounced relict structure, white feldspar & black manganese partings, dry.
30				
				NO Auger Refusal - Neither PWR nor Bedrock encountered in OW4-6S. However rock encountered at adjacent cluster well OW4-6D at 81.5' bls (733.84 ft amsl).
				Boring terminated at 32.5 feet

Well Diagram



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Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

OW4-6S

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/23/15 **Well ID#** OW4-6S

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.418803 N 81.357685 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 32.05, Sand 32.50 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 23.29 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 8.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
20.29 ft.	>32.50 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	17.05 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
17.05 ft.	32.05 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	Concrete	Gravity >190 lbs. solids
3 ft.	14 ft.	Bent. Grout	Tremie 60 lbs. solids
14 ft.	16 ft.	Bent. Chips	Gravity 55 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
16.0 ft.	32.5 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0.0 ft.	22.0 ft.	SOIL; Silty Sand, residuum, soft
22.0 ft.	32.5 ft.	SOIL; Saprolite, increasingly dense
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Observation well for hydrogeologic study for future Ph 4 LF

Shallower counterpart to adjacent nested well OW4-6D

22. Certification:

Signature of Certified Well Contractor — Date: 3/30/15

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

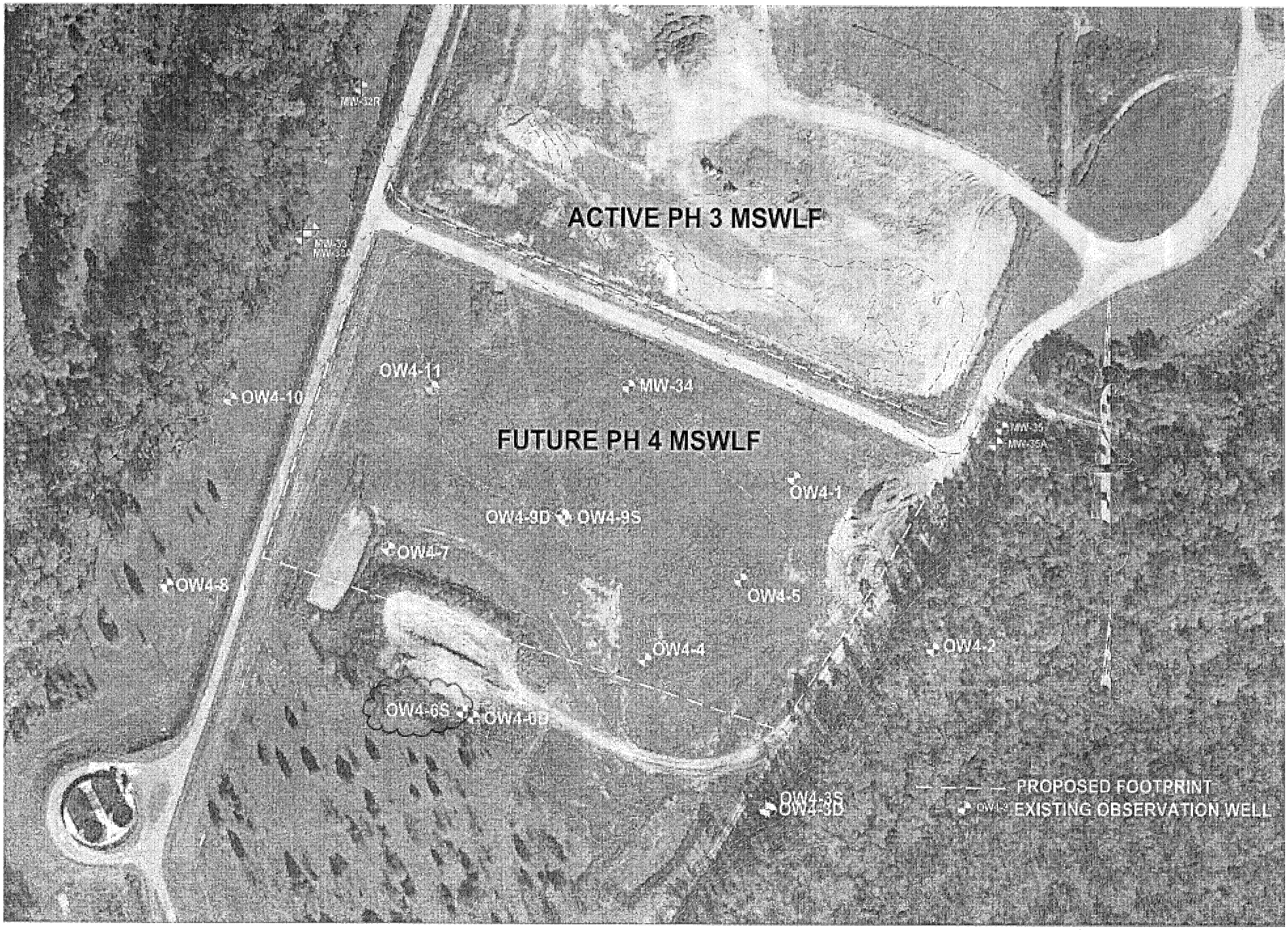
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-6D

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

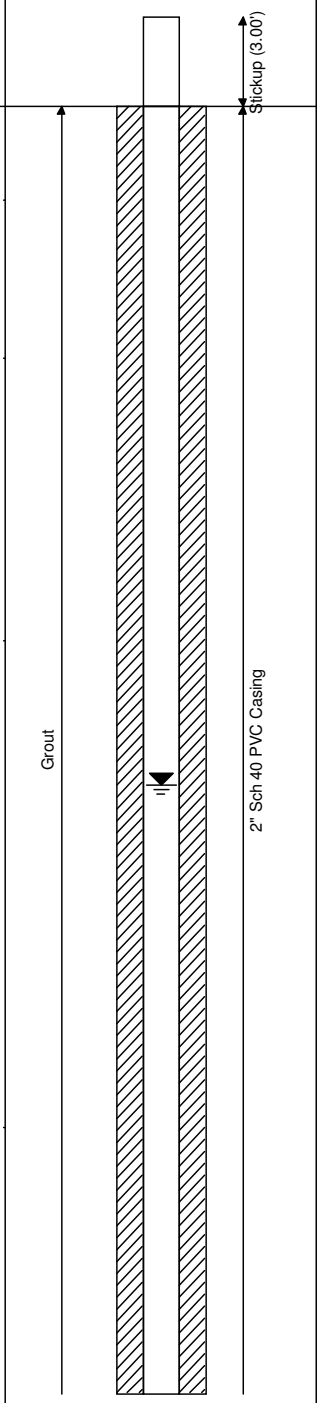
Drilling contractor: Bluestone
Drill rig & method: 6" OD mud rotary w/ SPT
Logged by: J. Pfohl

Date started: 2/25/2015
Date ended: 2/25/2015
Completion depth: 81.50 ft
Stickup height: 3.00 ft

Surface elevation: 815.34 ft (MSL)
Top of pipe elevation: 818.34 ft (MSL)
Depth to water (TOB): 22.00 ft
Depth to water (24hrs): 21.59 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	9			RESIDUUM; (ML), LB CLAYEY FINE SAND, stiff density, uniformly fine grained, homogenous, low plasticity, organic root debris, dry.
5	13			RESIDUUM; (ML), LB SILTY SAND, stiff density, uniformly fine grained, homogenous, low plasticity, dry.
10	12			RESIDUUM; (MH), LB SANDY ELASTIC SILT, stiff density, low-medium plasticity, dry.
				UNDISTURBED "Shelby tube" SAMPLE - Lab Tested as (MH) "Orangish brown sandy elastic SILT" (47.1% sand, 18.4% silt, 34.5% clay).
15	11			RESIDUUM; (MH), LB SANDY ELASTIC SILT, stiff density, low plasticity, dry.
20	22			SAPROLITE; (SM) PYB SILTY SAND, well graded, medium density, no mottles, dry.
25	52			SAPROLITE; (SM) DYB SILTY SAND, well graded, very dense, no mottles, dry.
30	70			SAPROLITE; (SM) DYB SILTY SAND, well graded, very dense, pronounced relict structure, white feldspar & black manganese partings, dry.
	47			SAPROLITE; (SM) LB SANDY SILT, hard, non-plastic, micas., wet.
35				UNDISTURBED "Shelby tube" SAMPLE - Lab Tested as (ML) "Red SANDY SILT" (44.6% sand, 42.5% silt, 12.8% clay).
40	45			SAPROLITE; (SM) LB SANDY SILT, hard, non-plastic, micas., wet.

Well Diagram



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LOG OF BORING: OW4-6D

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

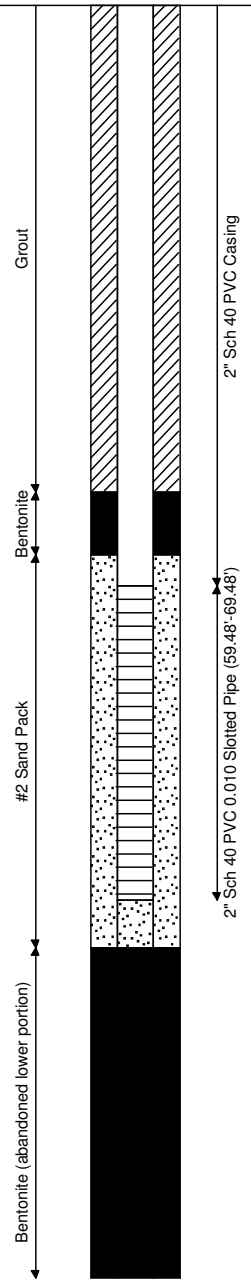
Drilling contractor: Bluestone
Drill rig & method: 6" OD mud rotary w/ SPT
Logged by: J. Pfohl

Date started: 2/25/2015
Date ended: 2/25/2015
Completion depth: 81.50 ft
Stickup height: 3.00 ft

Surface elevation: 815.34 ft (MSL)
Top of pipe elevation: 818.34 ft (MSL)
Depth to water (TOB): 22.00 ft
Depth to water (24hrs): 21.59 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
45	19			SAPROLITE; (SM) LB SILTY SAND, medium density, uniformly fine grained sand mottled with DYO silt, black and white partings, trace gravel size translucent quartz fragments, moist. LOG SAND, cap-graded fine & medium grained, few black manganese partings, pronounced relict structure, trace white medium grained angular white quartz fragments, medium density, moist.
50	20			SAPROLITE; (SM) LB SILTY SAND, medium density, uniformly fine grained, black manganese staining and white feldspar partings, moist.
55	35			SAPROLITE; (SM) LB SILTY SAND, dense, uniformly fine grained, black manganese staining and white feldspar partings, coarse grained angular translucent quartz fragments, moist.
60	27			SAPROLITE; (SM) LB SILTY SAND, dense, uniformly fine grained, black manganese staining and white feldspar partings, trace coarse grained angular translucent quartz fragments, moist.
65	57			SAPROLITE; (SW) PO SAND, well graded, very dense, black manganese staining and white feldspar partings, trace coarse grained angular translucent quartz fragments, trace mica, moist.
70	34-50/3"			WEATHERED ROCK (VERY SEVERELY); (SW) PO SAND, well graded, very dense, platy, dry.
75	50/3"			WEATHERED ROCK (VERY SEVERELY); (SW) PO SAND, well graded, very dense, platy, moist.
80				NO SPT attempted at 79' bls since judged to be too dense for recovery. Tricone barely cutting weathered rock. ROCK; Tricone (metal not carbide bit) refusal 81.50' bls. (733.84 ' amsl)
				Boring terminated at 81.5 feet

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

OW4-6D

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 2/25/15 **Well ID#** OW4-6D

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.418803 N 81.357685 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 69.48, Sand 71.00 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 24.59 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6 **(in.)**

12. Well construction method: mud rotary

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
21.59 ft.	79.00 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	59.48 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
59.48 ft.	69.48 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0.0 ft.	3.0 ft.	Concrete	Gravity >190 lbs. solids
3.0 ft.	56.5 ft.	Bent. Grout	Tremie 150 lbs. solids
56.5 ft.	58.5 ft.	Bent. Chips	Tremie 30 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
50.5 ft.	63.0 ft.	#2 Silica Sand	Tremie
71 ft.	79 ft.	Bent. Chips	Tremie 125 lbs. chips

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0.0 ft.	22.0 ft.	SOIL; Silty Sand, residuum, soft
22.0 ft.	69.0 ft.	SOIL; Saprolite, increasingly dense
69.0 ft.	81.5 ft.	Moderately Weathered Rock, more dense
81.5 ft.	ft.	Tricone Refusal; believe bedrock
ft.	ft.	
ft.	ft.	Abandoned lower part of boring 63'-98'
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Observation well for hydrogeologic study for future Ph 4 LF

Deeper counterpart to adjacent nested well OW4-6S

22. Certification:

John Thompson

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

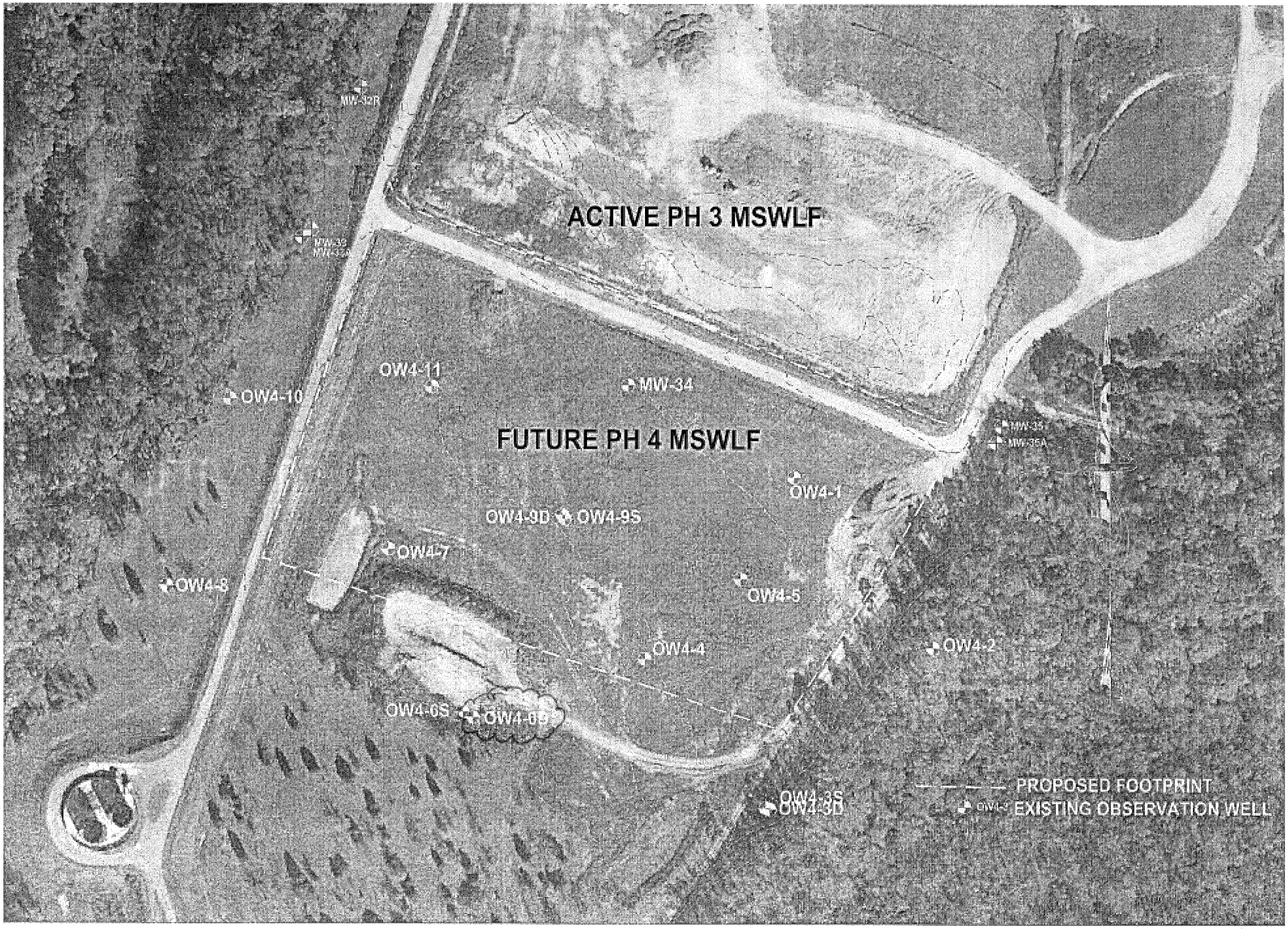
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-7

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

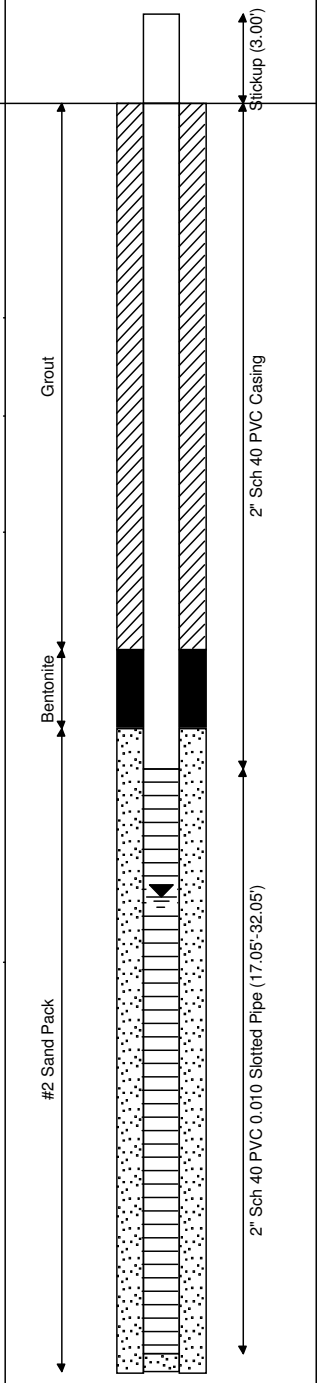
Drilling contractor: Bluestone
Drill rig & method: 6.5" OD HSA w/ SPT
Logged by: J. Pfohl

Date started: 3/23/2015
Date ended: 3/23/2015
Completion depth: 32.50 ft
Stickup height: 3.00 ft

Surface elevation: 816.60 ft (MSL)
Top of pipe elevation: 819.60 ft (MSL)
Depth to water (TOB): 21.00 ft
Depth to water (24hrs): 20.33 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	21			RESIDUUM; (CL), MRB LEAN CLAY, lenses of YO fine grained sand, medium plasticity, very stiff, trace mica, moist.
	14			RESIDUUM; (CL), MRB LEAN CLAY, lenses of YO fine grained sand, medium plasticity, stiff, trace mica, moist.
5				
	18			RESIDUUM; (ML), LB SILT, trace RB clay, low plasticity, very stiff, trace mica, dry.
	12			RESIDUUM; (CL), MRB LEAN CLAY, lenses of fine grained sand, medium plasticity, stiff, dry.
10				
	12			SAPROLITE; (ML) DRB SILTY SAND, fine grained, medium density, relict structure, white feldspar and black manganeze partings, trace angular translucent quartz fragments, no mottles, dry.
15				
	10			SAPROLITE; (ML) DRB SILTY SAND, fine grained, loose density, relict structure, white feldspar and black manganeze partings, trace angular translucent quartz fragments, no mottles, dry.
20				
	4			SAPROLITE; (ML) MYR SILT, trace white feldspar partings, soft density, non-plastic, moist.
25				
	5			SAPROLITE; (ML) MYR SILT, trace white feldspar partings, medium density, non-plastic, wet.
30				
				NO Auger Refusal - Neither PWR nor Bedrock encountered >784.55 ft amsl
				Boring terminated at 32.5 feet

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

OW4-7

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/23/15 **Well ID#** OW4-7

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.419634 N 81.358117 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 32.05, Sand 32.50 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 23.33 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
20.33 ft.	>32.50 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	17.05 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
17.05 ft.	32.05 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	Concrete	Gravity >95 lbs. solids
3 ft.	14 ft.	Bent. Grout	Tremie 35 lbs. solids
14 ft.	16 ft.	Bent. Chips	Gravity 30 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
16.0 ft.	32.5 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0.0 ft.	32.5 ft.	SOIL; Residuum to saprolite, soft
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Temporary observation well for hydrogeologic study

for future MSWLF Phase 4

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

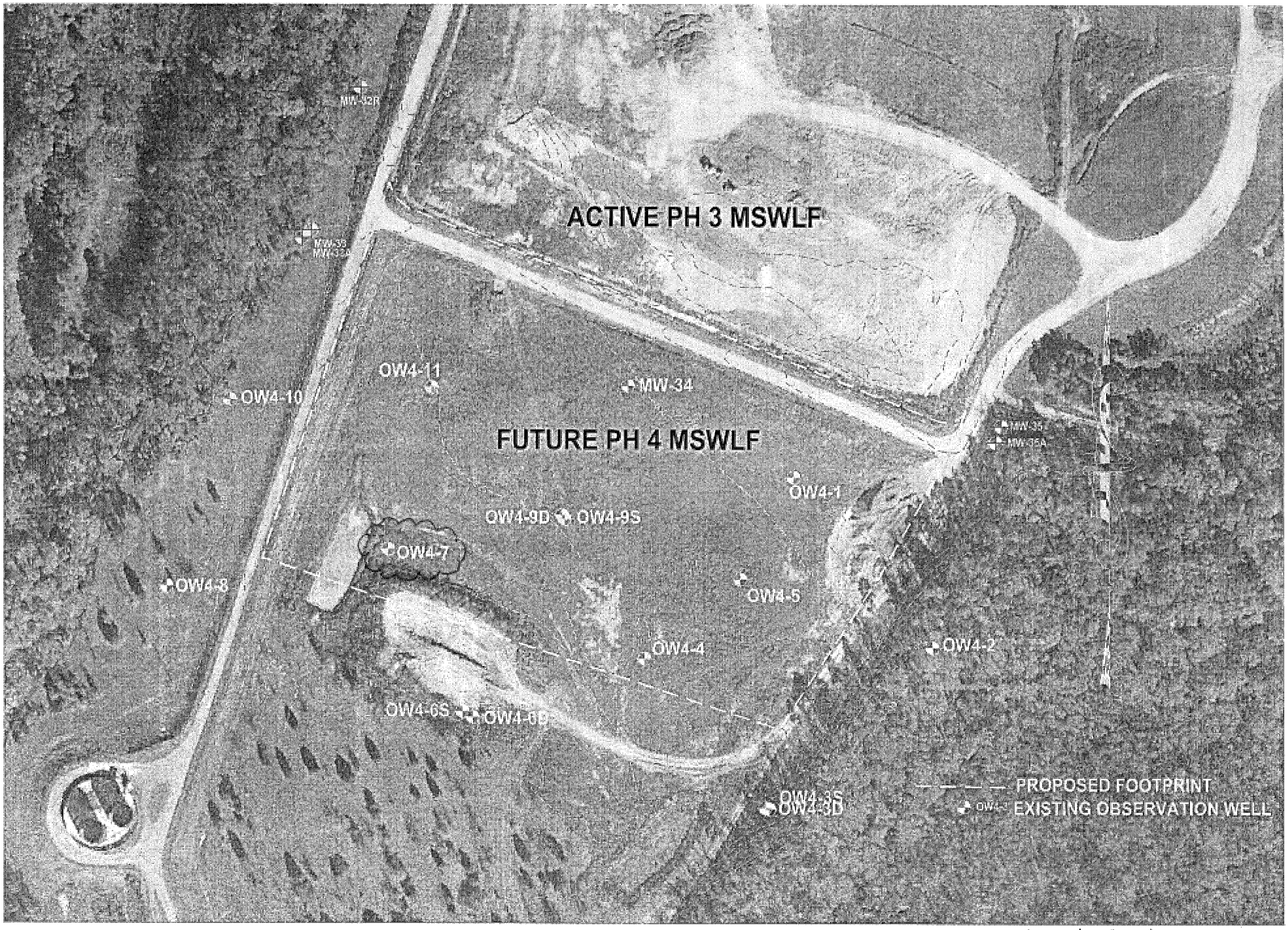
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

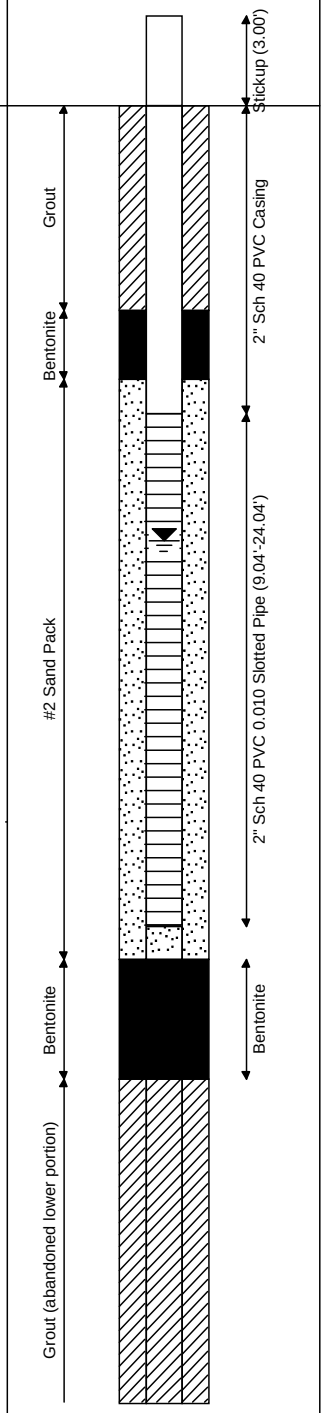
LOG OF BORING: OW4-8

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

Drilling contractor:	Bluestone	Date started:	2/25/2015	Surface elevation:	808.81 ft (MSL)
Drill rig & method:	6" OD mud rotary, NQ rock core, SPT	Date ended:	2/25/2015	Top of pipe elevation:	811.81 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	75.00 ft	Depth to water (TOB):	13.00 ft
		Stickup height:	3.00 ft	Depth to water (24hrs):	12.75 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	5			RESIDUUM; (ML) VPO SANDY SILT; high plasticity, homogeneous, medium stiff density, moist.
5	5			RESIDUUM; (ML) VPO SANDY SILT; high plasticity, homogeneous, medium stiff density, moist.
				UNDISTURBED "Shelby tube" SAMPLE; Lab tested as "Orangish Brown SANDY SILT" (44.2% sand, 25.1% silt, 30.7% clay).
10	10			SAPROLITE; (ML) VPO SANDY SILT; medium plasticity, no mottles, stiff density, moist.
15	9			SAPROLITE; (CL) PYB SANDY SILT, medium plasticity, mottled, stiff density, moist.
				UNDISTURBED "Shelby tube" SAMPLE; Lab tested as "Gray and orange SANDY SILT" (48.7% sand, 38.2% silt, 13.1% clay).
20	11			SAPROLITE; (CL) GO SANDY SILT, low plasticity, stiff density, wet.
25	13			SAPROLITE; (SM) PYB SILTY SAND, cap-graded medium to coarse grained, medium denisty, white and blak partings, wet.
30	17			SAPROLITE; (SM) LB SILTY SAND, cap-graded medium to coarse grained, medium denisty, white and blak partings, wet.
35	14			SAPROLITE; (SM) PYB SILTY SAND, cap graded fine to med. grains, medium density, trace manganese staining, moist.

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

LOG OF BORING: OW4-8

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

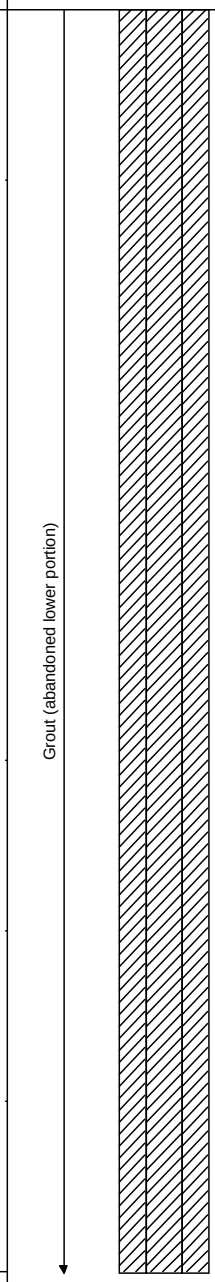
Drilling contractor: Bluestone
Drill rig & method: 6" OD mud rotary, NQ rock core, SPT
Logged by: J. Pfohl

Date started: 2/25/2015
Date ended: 2/25/2015
Completion depth: 75.00 ft
Stickup height: 3.00 ft

Surface elevation: 808.81 ft (MSL)
Top of pipe elevation: 811.81 ft (MSL)
Depth to water (TOB): 13.00 ft
Depth to water (24hrs): 12.75 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
40	10			SAPROLITE; (SM) PYB SILTY SAND, cap graded fine to med. grains, medium density, trace manganese staining, moist.
	50/3""			WEATHERED ROCK (HIGHLY); (SP) LOG SAND, cap-graded fine to medium grained, very dense, moist.
45				REFUSAL of Tricone (metal not carbide bit) at 47' bls (761.81' amsl) WEATHERED ROCK (MODERATELY) RUN #1 (47-50') REC=50%, RQD=0%; Brown, interlayered with saprolite.
50				WEATHERED ROCK (MODERATELY) RUN #2 (50-55') REC=46%, RQD=0%; Brown, interlayered with saprolite.
55				WEATHERED ROCK (MODERATELY) RUN #3 (55-60') REC=88%, RQD=0%;Brown, interlayered with saprolite.
60				SAPROLITE RUN #4 (60-65') REC=0%, RQD=0%; No core recovery as saprolite washed away during coring process.
65				WEATHERED ROCK (MODERATELY) #5 (65-70') REC=17%, RQD=0%; gray, interlayered with saprolite.
70				BEDROCK RUN #6 (70-75') REC=90%, RQD=0%; Sillimanite schist; White with light gray shallow dipping foliations; 70'-71' slighlty weathered, gray, iron stained, 71'-75' faintly weathered.
75				Boring terminated at 75.0 feet

Well Diagram



ROCK CORE DETAILS

Municipal Services Engineering Company, P.A.
Garner, NC Boone, NC
Municipal Engineering Services Company, P.A.
Garner and Boone, North Carolina

Boring ID:	Site Name:	Classification:	Core Depths (ft-bls)	Total Core Length (ft)
OW4-8	Lincoln Co. MSWLF, Ph 4	Sillimanite Schist	47.0'-75.0'	28.0'

Run #1 3.0'	Run #2 5.0'	Run #3 5.0'	Run #4 5.0'	Run #5 5.0'	Run #6 5.0'
From: 47.0' to 50.0 ' = 3.0'	**From:** 50.0' to 55.0' = 5.0'	**From:** 55.0' to 60.0' = 5.0'	**From:** 60' to 65' = 5.0'	**From:** 65.0' to 70.0' = 5.0'	**From:** 70.0' to 75.0' = 5.0'
REC: 50.0% **RQD:** 0.0%	**REC:** 46.0% **RQD:** 0.0%	**REC:** 88.0% **RQD:** 0.0%	**REC:** 0.0% **RQD:** 0.0%	**REC:** 17.0% **RQD:** 0.0%	**REC:** 90.0% **RQD:** 39.0%

0 0.5 1 1.5 2

FEET

OW4-8

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 2/25/15 **Well ID#** OW4-8

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.419216 N 81.359375 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 24.04, Sand 25.00 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 15.75 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6 **(in.)**

12. Well construction method: mud rotary, rock core

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
12.75 ft.	47.00 ft.	Unconfined uppermost aquifer in soil
47.00 ft.	75.00 ft.	in slightly weathered and fractured rock

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	9.04 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
9.04 ft.	24.04 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	Concrete	Gravity >260 lbs. solids
3,25 ft.	6,47 ft.	Bent. Grout	Tremie 10,60 lbs. solids
6,47 ft.	8,75 ft.	Bent. Chips	Tremie 28, 200 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
8.0 ft.	25.0 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	43 ft.	SOIL; Silt residuum, soft
43 ft.	47 ft.	Highly weathered rock; White, wet
47 ft.	75 ft.	Rock; White, Very fractured, poor RQD
ft.	ft.	
ft.	ft.	
ft.	ft.	25'-75' abandoned beneath well
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Temporary observation well for hydrogeologic study

for future MSWLF Phase 4

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

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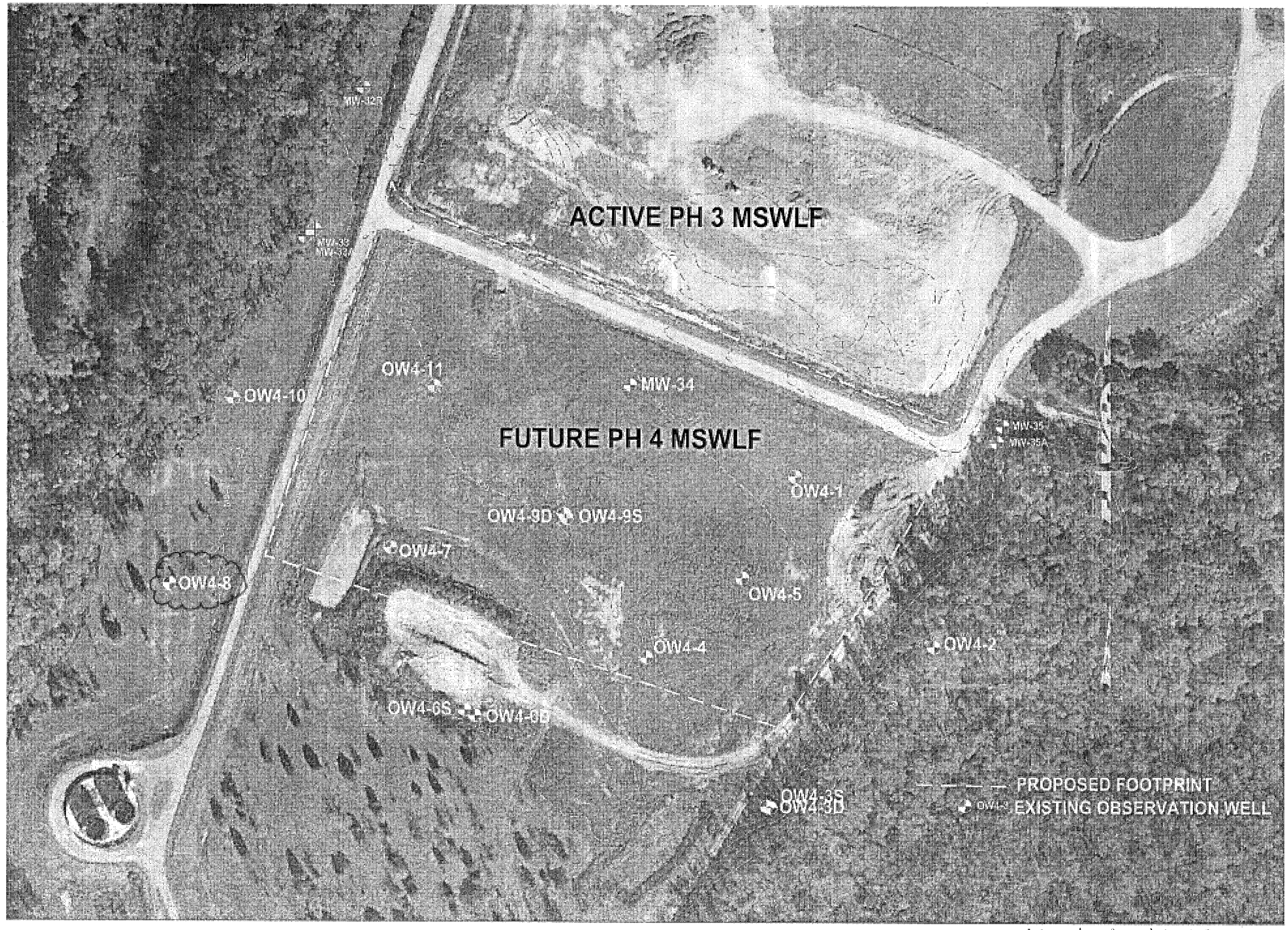
24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-9S

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

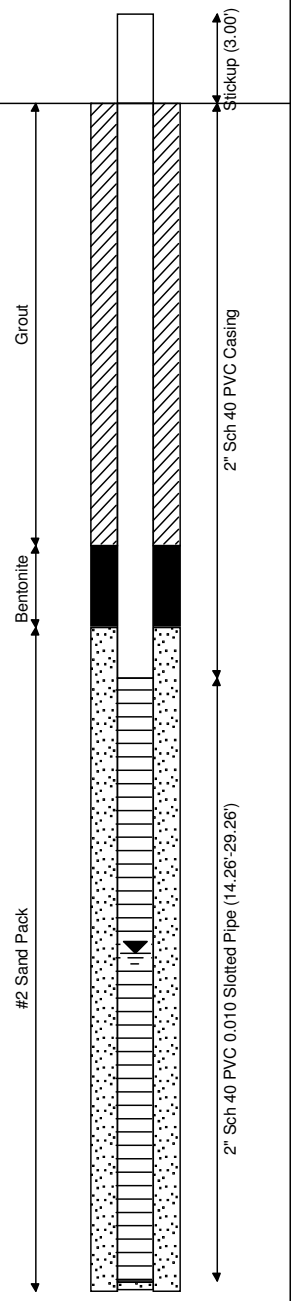
Drilling contractor: Bluestone
Drill rig & method: 8.5" OD HSA NO SPT
Logged by: J. Pfohl

Date started: 2/27/2015
Date ended: 2/27/2015
Completion depth: 29.50 ft
Stickup height: 3.00 ft

Surface elevation: 819.21 ft (MSL)
Top of pipe elevation: 822.21 ft (MSL)
Depth to water (TOB): 22.00 ft
Depth to water (24hrs): 21.11 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
				NO SPT PERFORMED IN OW4-3S. HOWEVER SPT PERFORMED IN ADJACENT OW4-3D AND DESCRIPTIONS RE-TRANSCRIBED HERE.
	13			RESIDUUM; (CL) MB LEAN CLAY; high plasticity, homogeneous, stiff density, moist.
5	13			RESIDUUM; (CL) MB LEAN CLAY; high plasticity, homogeneous, stiff density, moist.
10	12			RESIDUUM; (MH) CLAYEY SILT w/ sand; medium plasticity, homogeneous, stiff density, moist. UNDISTURBED "Shelby tube" SAMPLE; Collected but not lab tested as accidently dropped which may have disturbed sample thus effected results.
15	6			SAPROLITE; (CL) LB LEAN CLAY with sand; medium plasticity, mottled, medium density, moist.
20	8			SAPROLITE; (CL) LB CLAYEY SILT with sand; medium plasticity, stiff density, no mottles, moist.
25	6			SAPROLITE; (CL) LB CLAYEY SILT with sand; medium plasticity, stiff density, no mottles, moist.
30	5			SAPROLITE; (ML) LB CLAYEY SILT with sand; medium plasticity, medium density, few black manganese partings, moist. NO Auger Refusal - Neither PWR nor Bedrock encountered in OW4-9S. However rock encountered at adjacent cluster well OW4-9D at 86' bls (733.39 ft amsl).
				Boring terminated at 29.5 feet

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

OW4-9S

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 2/27/15 **Well ID#** OW4-9S

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.419707 N 81.357202 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 29.26, Sand 29.50 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 24.11 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 8.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
22.88 ft.	>29.50 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	14.26 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
14.26 ft.	29.26 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	Concrete	Gravity >190 lbs. solids
3 ft.	11 ft.	Bent. Grout	Tremie 50 lbs. solids
11 ft.	13 ft.	Bent. Chips	Gravity 55 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
13.0 ft.	29.5 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0.0 ft.	29.5 ft.	SOIL; Residuum to saprolite, soft
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Observation well for hydrogeologic study for future Ph 4 LF

Shallower counterpart to adjacent nested well OW4-9D

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

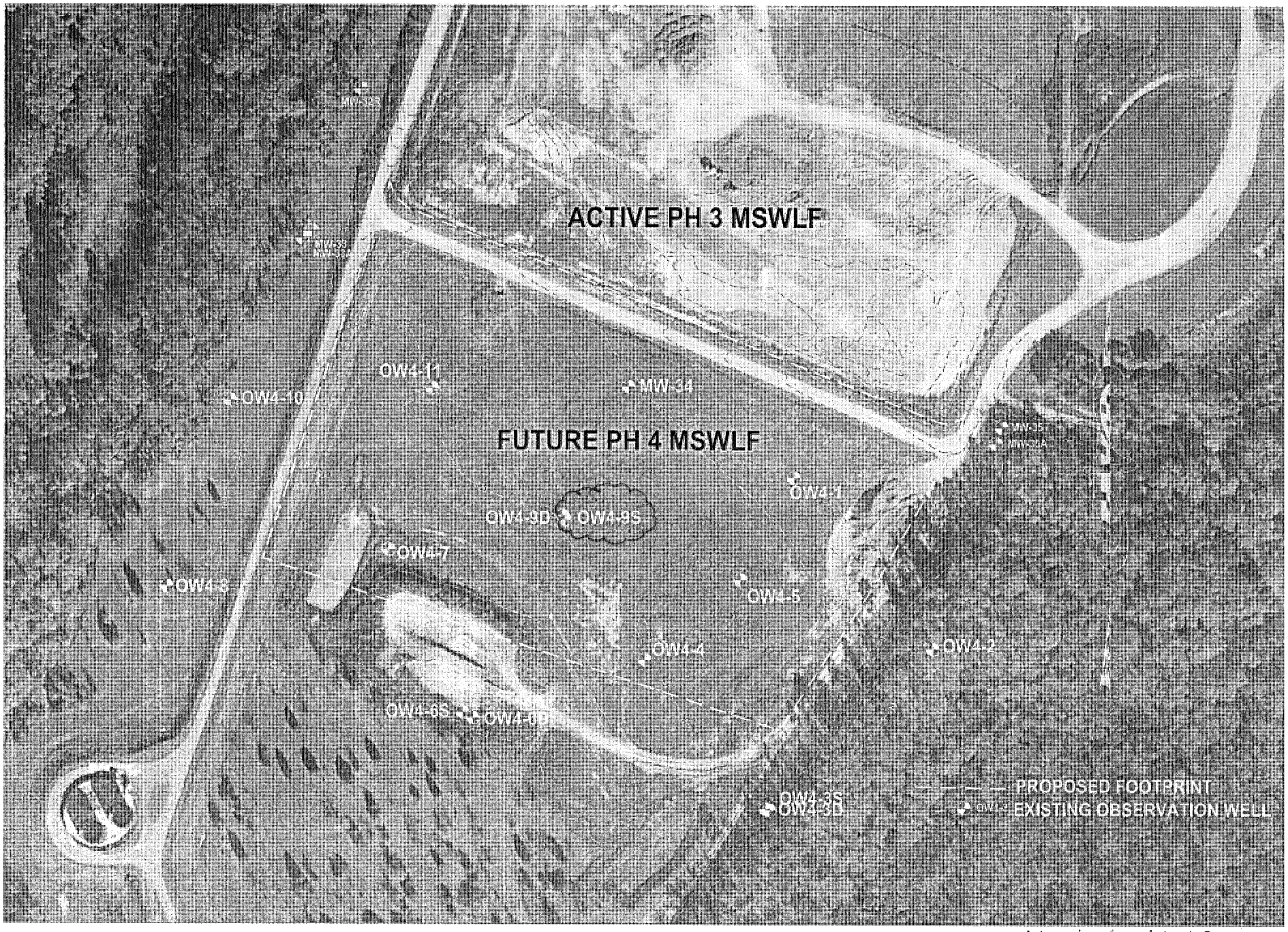
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

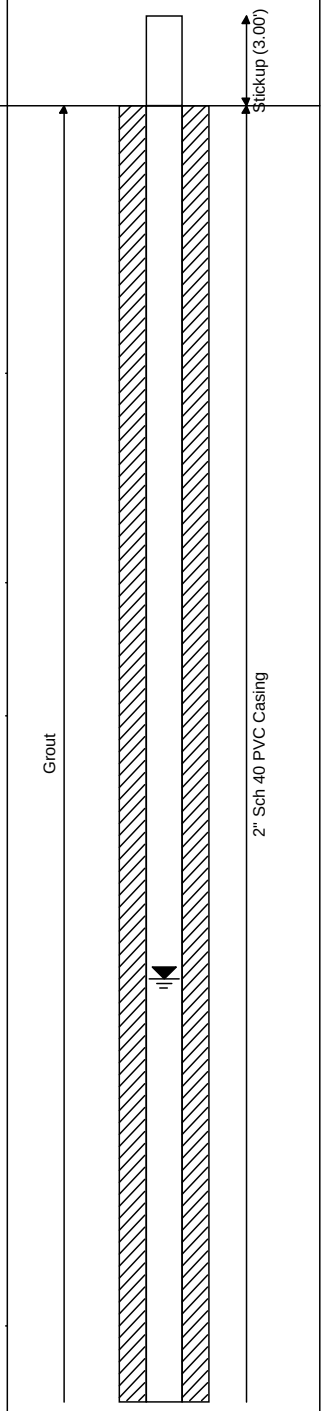
LOG OF BORING: OW4-9D

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

Drilling contractor:	Bluestone	Date started:	3/3/2015	Surface elevation:	819.39 ft (MSL)
Drill rig & method:	8.5" OD HSA, NQ core, SPT	Date ended:	3/3/2015	Top of pipe elevation:	822.39 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	98.00 ft	Depth to water (TOB):	23.00 ft
		Stickup height:	3.00 ft	Depth to water (24hrs):	22.88 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	13			RESIDUUM; (CL) MB LEAN CLAY; high plasticity, homogeneous, stiff density, moist.
5	13			RESIDUUM; (CL) MB LEAN CLAY; high plasticity, homogeneous, stiff density, moist.
10	12			RESIDUUM; (MH) CLAYEY SILT w/ sand; medium plasticity, homogeneous, stiff density, moist. UNDISTURBED "Shelby tube" SAMPLE; Collected but not lab tested as accidently dropped which may have disturbed sample thus effected results.
15	6			SAPROLITE; (CL) LB LEAN CLAY with sand; medium plasticity, mottled, medium density, moist.
20	8			SAPROLITE; (CL) LB CLAYEY SILT with sand; medium plasticity, stiff density, no mottles, moist.
25	6			SAPROLITE; (CL) LB CLAYEY SILT with sand; medium plasticity, stiff density, no mottles, moist.
30	5			SAPROLITE; (ML) LB CLAYEY SILT with sand; medium plasticity, medium density, few black manganese partings, moist.
	16			SAPROLITE; (ML) LB SANDY SILT w/ clay; medium plasticity, very stiff density, few white feldspar & black manganese partings, moist.

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

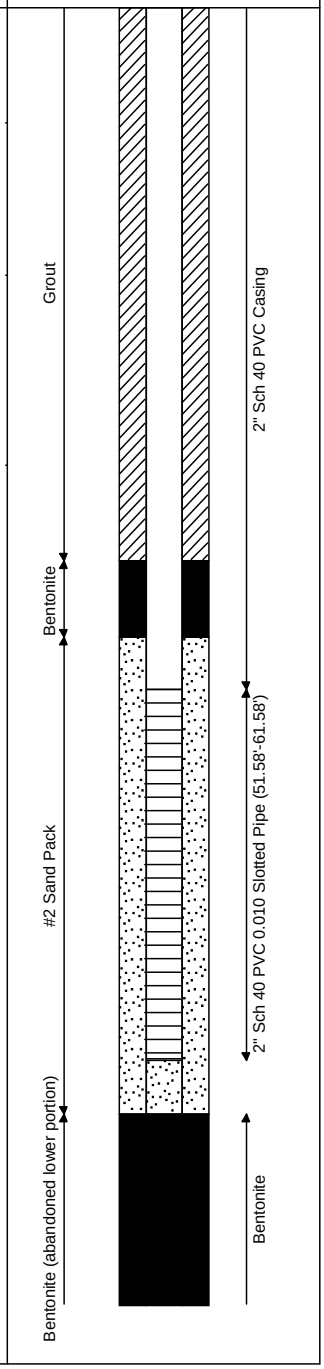
LOG OF BORING: OW4-9D

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

Drilling contractor:	Bluestone	Date started:	3/3/2015	Surface elevation:	819.39 ft (MSL)
Drill rig & method:	8.5" OD HSA, NQ core, SPT	Date ended:	3/3/2015	Top of pipe elevation:	822.39 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	98.00 ft	Depth to water (TOB):	23.00 ft
		Stickup height:	3.00 ft	Depth to water (24hrs):	22.88 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
35				
	16			SAPROLITE; (ML) LB CLAYEY SILT with sand; low plasticity, very stiff density, few black manganese partings, wet.
40				
	21			SAPROLITE; (SC) LB CLAYEY SAND; low plasticity, medium density, uniformly fine grained, trace mica, wet.
45				
	23			SAPROLITE; (SM) DYO SILTY SAND; trace clay, low plasticity, medium density, white feldspar and black manganese partings, trace mica, wet.
50				
	57			SAPROLITE; (SM) DYB SILTY SAND; trace clay, low plasticity, very dense, white feldspar and black manganese partings, trace translucent angular coarse grained quartz fragments, wet.
55				-Softer at 58' bls. Additional water bearing zone.
	27			SAPROLITE; (SM) DYB SILTY SAND; trace clay, low plasticity, medium density, white feldspar and black manganese partings, trace mica, wet.
60				
	53			SAPROLITE; (SM) MYB SILTY SAND; very dense, white feldspar and black manganese partings, pronounced relict structure, trace mica, moist.
65				

Well Diagram



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Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

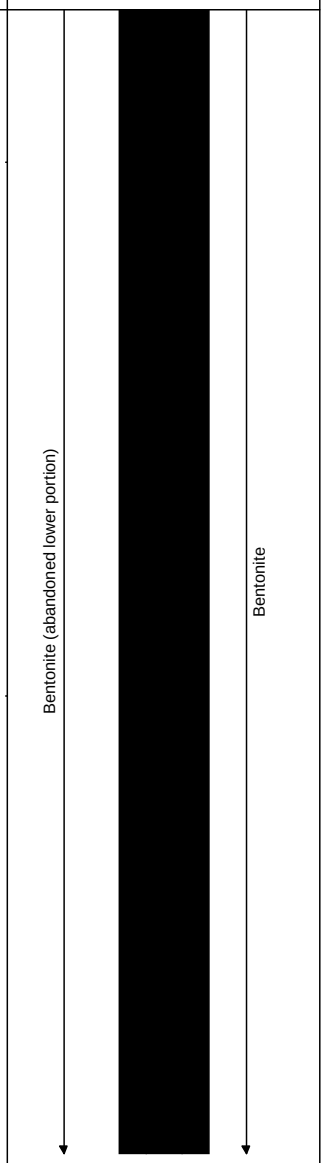
LOG OF BORING: OW4-9D

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

Drilling contractor:	Bluestone	Date started:	3/3/2015	Surface elevation:	819.39 ft (MSL)
Drill rig & method:	8.5" OD HSA, NQ core, SPT	Date ended:	3/3/2015	Top of pipe elevation:	822.39 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	98.00 ft	Depth to water (TOB):	23.00 ft
		Stickup height:	3.00 ft	Depth to water (24hrs):	22.88 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	53			SAPROLITE; (SM) MYB SILTY SAND; very dense, white feldspar and black manganese partings, pronounced relict structure, trace mica, moist.
70				
	41-50/3""			WEATHERED ROCK (VERY SEVERELY); (SP) LOG SAND, cap-graded fine to medium grained, very dense, white and black partings, micas., moist.
75				
	50/2"			WEATHERED ROCK (VERY SEVERELY); (SP) LOG SAND, cap-graded fine to medium grained, very dense, white and black partings, abundant mica, moist.
80				
	50/2"			WEATHERED ROCK (VERY SEVERELY); No recovery since too dense.
85				ROCK; Tricone (metal not carbide bit) refusal 62.08' bls.
				BEDROCK RUN #1 (86-88") REC=100%, RQD=17%; Biotite gneiss, rubbilized to very weathered, brown, iron stained fractures 86-87.5'.
90				
				BEDROCK RUN #2 (88-93') REC=100%, RQD=37.6%; Biotite gneiss, fresh. Iron stained fractures 92' and 92.5', quartzose, shallow dipping foliations.
95				
				BEDROCK RUN #3 (93-98') REC=100%, RQD=52.8%; Biotite gneiss, fresh. 96.7'-98' white amphibolite, less banding with near horizontal fracture and annealed joints.
				Boring terminated at 98.0 feet
100				

Well Diagram



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PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

ROCK CORE DETAILS

Municipal Services Engineering Company, P.A.
Garner, NC Boone, NC
Municipal Engineering Services Company, P.A.
Garner and Boone, North Carolina

Boring ID:	Site Name:	Classification:	Core Depths (ft-bls)	Total Core Length (ft)
OW4-9D	Lincoln Co. MSWLF, Ph 4	Biotite Gneiss	86.0'-98.0'	12.0'

Run #1 2.0'	Run #2 5.0'	Run #3 5.0'
From: 86.0' to 88.0' = 2.0'	**From:** 88.0' to 93.0' = 5.0'	**From:** 93.0' to 98.0' = 5.0'
REC: 100.0% **RQD:** 17.0%	**REC:** 100.0% **RQD:** 37.6%	**REC:** 100.0% **RQD:** 52.8%

0 0.5 1 1.5 2

FEET

OW4-9D

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/3/15 **Well ID#** OW4-9D

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.419707 N 81.357202 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells ONLY with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 61.58, Sand 63.00 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 25.88 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 8.5 **(in.)**

12. Well construction method: auger, rock core

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

For Internal Use ONLY:

14. WATER ZONES

FROM	TO	DESCRIPTION
21.11 ft.	86.00 ft.	Unconfined uppermost aquifer in soil
86.00 ft.	98.00 ft.	Fractures in rock

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	51.58 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
51.58 ft.	61.58 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	Concrete	Gravity >190 lbs. solids
3,63 ft.	48.5,86 ft.	Bent. Grout	Tremie 250, 120 lbs. solids
48.5 ft.	50.5 ft.	Bent. Chips	Tremie 55 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
50.5 ft.	63.0 ft.	#2 Silica Sand	Tremie
86 ft.	98 ft.	Bent. Chips	Tremie 75 lbs. chips

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0.0 ft.	75 ft.	SOIL; Residuum to saprolite, soft
75 ft.	86 ft.	WEATHERED ROCK; More dense with deptl
86 ft.	98 ft.	ROCK;Gray, fractured, poor RQD
ft.	ft.	
ft.	ft.	
ft.	ft.	Abandoned lower part of boring 63'-98'
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Observation well for hydrogeologic study for future Ph 4 LF

Deeper counterpart to adjacent nested well OW4-9S

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0108 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

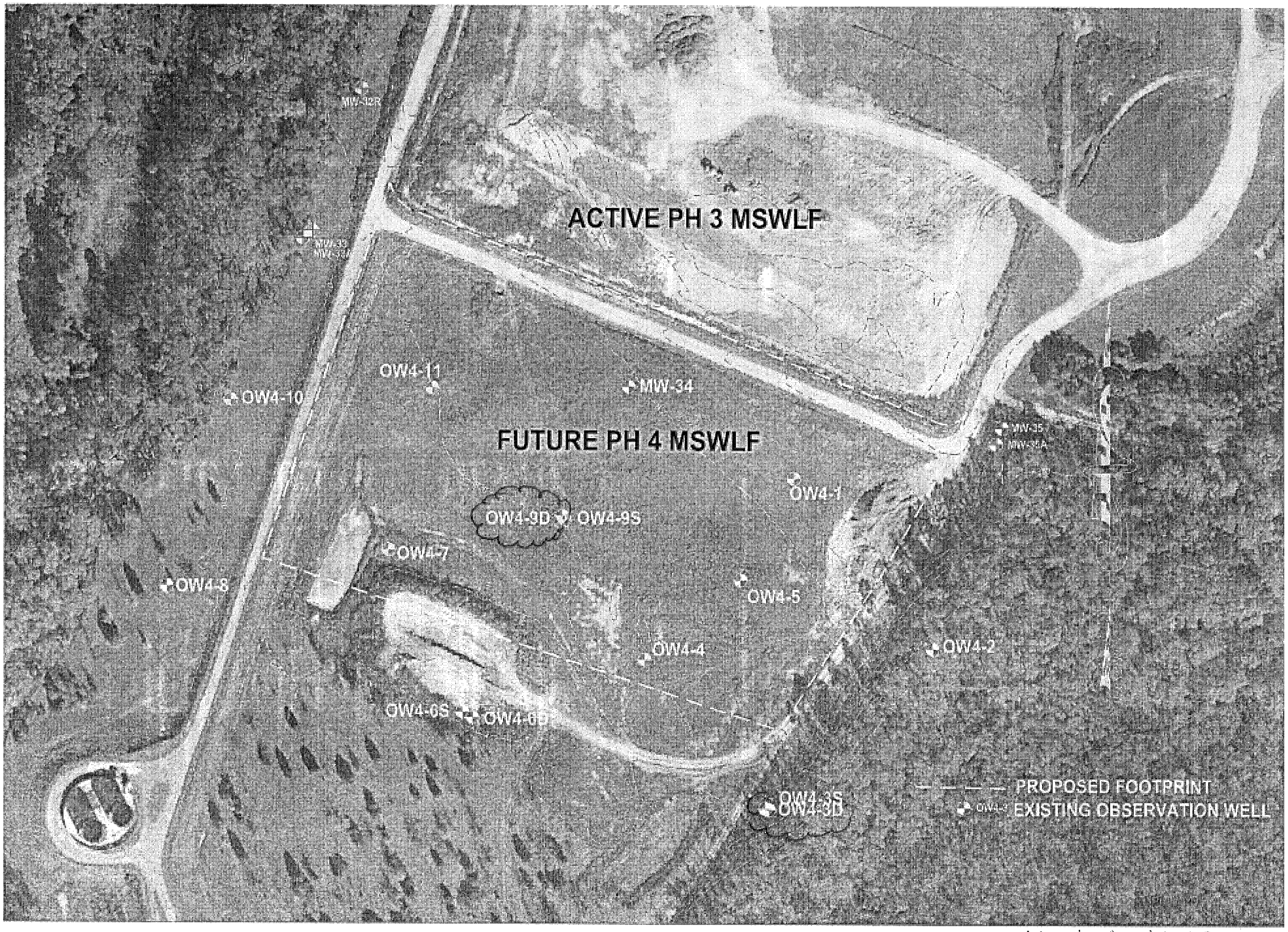
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-10

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

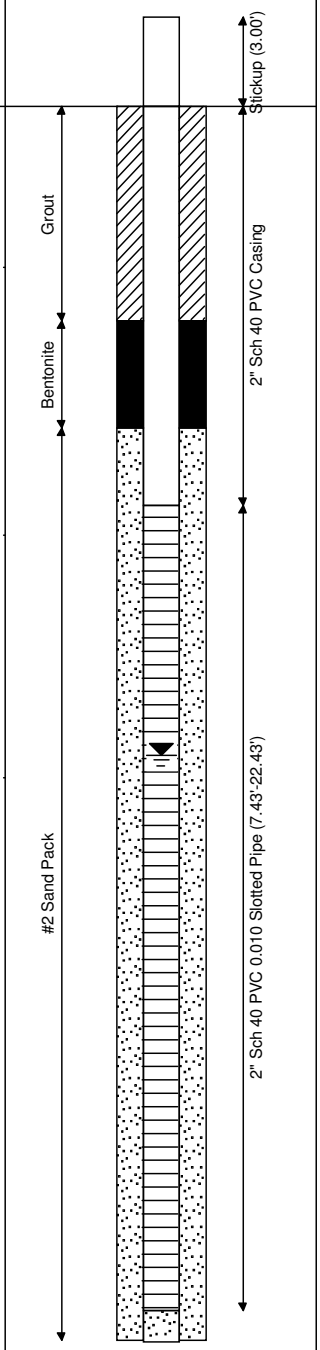
Drilling contractor: Bluestone
Drill rig & method: 8.5" OD HSA w/ SPT
Logged by: J. Pfohl

Date started: 3/23/2015
Date ended: 3/23/2015
Completion depth: 23.00 ft
Stickup height: 3.00 ft

Surface elevation: 811.70 ft (MSL)
Top of pipe elevation: 814.70 ft (MSL)
Depth to water (TOB): 13.00 ft
Depth to water (24hrs): 12.09 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	14			RESIDUUM; (SM), MB SILTY SAND, cap-graded fine to medium grained, trace plastic clay nodules, medium density, organic root debris, moist.
5	13			RESIDUUM; (CL), MYB LEAN CLAY,high plasticity, few subrounded coarse grained opaque sand fragments, homogenous, moist.
10	27			SAPROLITE; (SM) MYB & VPO SILTY SAND, fine grained, medium density, relict structure, white feldspar and black manganeze partings, few angular translucent quartz fragments, no mottles, dry.
15	32			SAPROLITE; (ML) DYO SANDY SILT, hard density, white feldspar and black manganeze partings, moist. BULK SAMPLE - Lab Tested as (ML) "Orangish brown SANDY SILT" (31.5% sand, 41.3% silt, 27.2% clay).
20	27			SAPROLITE; (ML) DYO SANDY SILT, very stiff density, relict structure, white feldspar and black manganeze partings, wet.
				NO Auger Refusal - Neither PWR nor Bedrock encountered >789.27 ft amsl
				Boring terminated at 23.0 feet

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

OW4-10

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

For Internal Use ONLY:

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

☐Agricultural ☐Municipal/Public

☐Geothermal (Heating/Cooling Supply) ☐Residential Water Supply (single)

☐Industrial/Commercial ☐Residential Water Supply (shared)

☐Irrigation

Non-Water Supply Well:

☑Monitoring ☐Recovery

Injection Well:

☐Aquifer Recharge ☐Groundwater Remediation

☐Aquifer Storage and Recovery ☐Salinity Barrier

☐Aquifer Test ☐Stormwater Drainage

☐Experimental Technology ☐Subsidence Control

☐Geothermal (Closed Loop) ☐Tracer

☐Geothermal (Heating/Cooling Return) ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/23/15 **Well ID#** OW4-10

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.420144 N 81.358955 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 22.43, Sand 23.00 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 15.09 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 8.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

14. WATER ZONES

FROM	TO	DESCRIPTION
12.09 ft.	>23.00 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	7.43 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
7.43 ft.	22.43 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	4 ft.	Concrete	Gravity >260 lbs. solids
ft.	ft.		
4 ft.	6 ft.	Bent. Chips	Gravity 55 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
6.0 ft.	23.0 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	23 ft.	SOIL; Residuum to saprolite, soft
ft.	ft.	saturated 14-23' BGS
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Temporary observation well for hydrogeologic study

for future MSWLF Phase 4

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

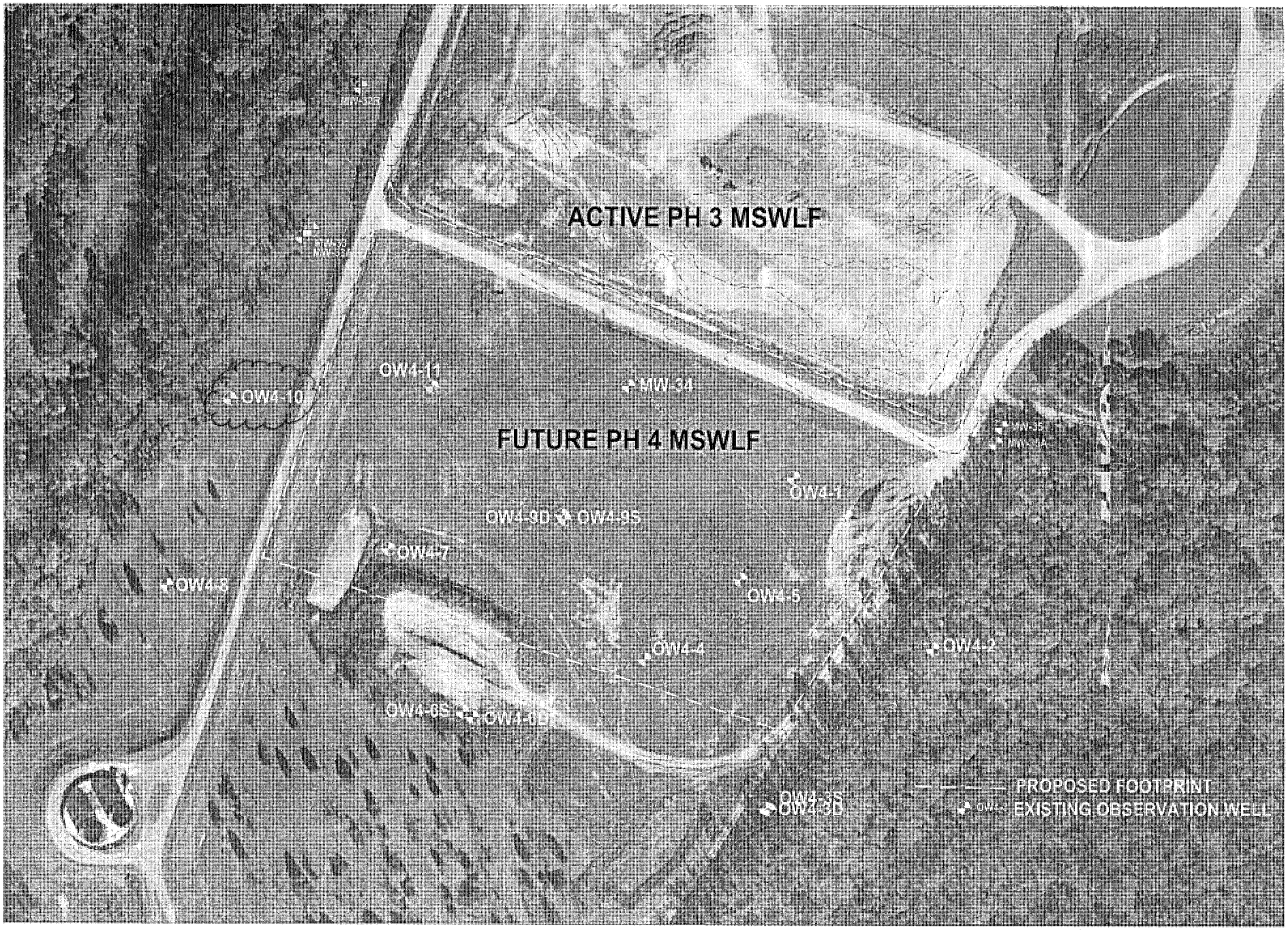
Division of Water Resources, Information Processing Unit,
1617 Mail Service Center, Raleigh, NC 27699-1617

24b. For Injection Wells ONLY: In addition to sending the form to the address in 24a above, also submit a copy of this form within 30 days of completion of well construction to the following:

Division of Water Resources, Underground Injection Control Program,
1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

Also submit one copy of this form within 30 days of completion of well construction to the county health department of the county where constructed.



Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

LOG OF BORING: OW4-11

Lincoln Co. MSWSLF Ph. 4 **Project No. G15141.6**

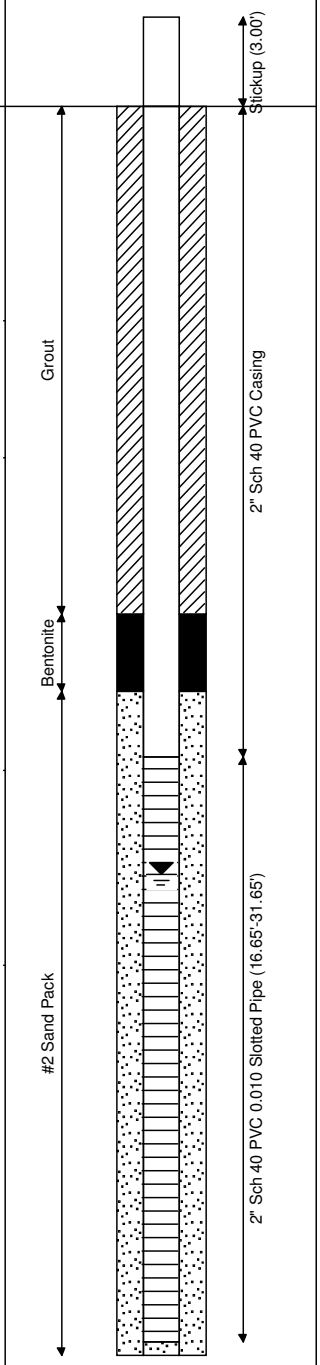
Drilling contractor: Bluestone
Drill rig & method: 6.5" OD HSA w/ SPT
Logged by: J. Pfohl

Date started: 3/20/2015
Date ended: 3/20/2015
Completion depth: 32.00 ft
Stickup height: 3.00 ft

Surface elevation: 819.97 ft (MSL)
Top of pipe elevation: 822.97 ft (MSL)
Depth to water (TOB): 20.00 ft
Depth to water (24hrs): 19.69 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	11			RESIDUUM; (CL), B LEAN CLAY, high plasticity, homogenous, stiff, organic soil with root debris near surface, dry.
	10			RESIDUUM; (CL), B LEAN CLAY with fine sand, high plasticity, stiff, homogenous, dry.
5				
	11			SAPROLITE; (SC) MYB CLAYEY SAND, fine grained, medium density, relict structure, white feldspar and black manganeze partings, low plasticity, dry.
10				UNDISTURBED "Shelby tube" SAMPLE - Lab Tested as (ML) "Orangish brown SANDY SILT" (44.2 % sand, 24.3% silt, 31.5% clay).
	17			SAPROLITE; (ML) MYB SANDY SILT, stiff, few medium plastic clay nodules, white feldspar and black manganese partings, dry.
	18			SAPROLITE; (ML) MYB SANDY SILT, stiff, few medium plastic clay nodules, white feldspar and black manganese partings, no mottles, dry.
15				
	8			SAPROLITE; (SM) MYB SILTY SAND, fine grained, loose density, faint relict structure, trace black manganese partings, wet.
20				
	9			SAPROLITE; (SM) MYB SANDY SILT, loose density, faint relict structure, OG silt mottles, wet.
25				
	9			SAPROLITE; (SM) DYB SANDY SILT, fine grained, stiff density, white feldspar and black manganese partings, wet.
30				
				NO Auger Refusal - Neither PWR nor Bedrock encountered >788.32 ft amsl
				Boring terminated at 32.0 feet

Well Diagram



Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

OW4-11

WELL CONSTRUCTION RECORD

This form can be used for single or multiple wells

For Internal Use ONLY:

1. Well Contractor Information:

John Thompson

Well Contractor Name

3579-A

NC Well Contractor Certification Number

Bluestone Environmental, LLC

Company Name

2. Well Construction Permit #: _____

List all applicable well permits (i.e. County, State, Variance, Injection, etc.)

3. Well Use (check well use):

Water Supply Well:

- ☐Agricultural
- ☐Municipal/Public
- ☐Geothermal (Heating/Cooling Supply)
- ☐Residential Water Supply (single)
- ☐Industrial/Commercial
- ☐Residential Water Supply (shared)
- ☐Irrigation

Non-Water Supply Well:

- ☑Monitoring
- ☐Recovery

Injection Well:

- ☐Aquifer Recharge
- ☐Groundwater Remediation
- ☐Aquifer Storage and Recovery
- ☐Salinity Barrier
- ☐Aquifer Test
- ☐Stormwater Drainage
- ☐Experimental Technology
- ☐Subsidence Control
- ☐Geothermal (Closed Loop)
- ☐Tracer
- ☐Geothermal (Heating/Cooling Return)
- ☐Other (explain under #21 Remarks)

4. Date Well(s) Completed: 3/20/15 **Well ID#** OW4-11

5a. Well Location:

Lincoln Co MSWLF, Ph 4 (future)

Facility/Owner Name

Facility ID# (if applicable)

5291 Crouse Rd Crouse NC 28033

Physical Address, City, and Zip

Lincoln

County

2691874263

Parcel Identification No. (PIN)

5b. Latitude and Longitude in degrees/minutes/seconds or decimal degrees:
(if well field, one lat/long is sufficient)

35.420384 N 81.357907 W

6. Is (are) the well(s): ☐**Permanent** or ☑**Temporary**

7. Is this a repair to an existing well: ☐**Yes** or ☑**No**

If this is a repair, fill out known well construction information and explain the nature of the repair under #21 remarks section or on the back of this form.

8. Number of wells constructed: 1

*For multiple injection or non-water supply wells **ONLY** with the **same construction**, you can submit one form.*

9. Total well depth below land surface: Screen 31.65, Sand 32.00 **(ft.)**

For multiple wells list all depths if different (example- 3@200' and 2@100')

10. Static water level below top of casing: 22.69 (24 hrs. after set) **(ft.)**

If water level is above casing, use "+"

11. Borehole diameter: 6.5 **(in.)**

12. Well construction method: auger

(i.e. auger, rotary, cable, direct push, etc.)

FOR WATER SUPPLY WELLS ONLY:

13a. Yield (gpm) _____ **Method of test:** _____

13b. Disinfection type: _____ **Amount:** _____

14. WATER ZONES

FROM	TO	DESCRIPTION
19.69 ft.	>32.00 ft.	Unconfined uppermost aquifer in soil
ft.	ft.	

15. OUTER CASING (for multi-cased wells) OR LINER (if applicable)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
ft.	ft.	in.		

16. INNER CASING OR TUBING (geothermal closed-loop)

FROM	TO	DIAMETER	THICKNESS	MATERIAL
+3.00 ft.	16.65 ft.	2 in.	Sch 40	PVC flush thread
ft.	ft.	in.		

17. SCREEN

FROM	TO	DIAMETER	SLOT SIZE	THICKNESS	MATERIAL
16.65 ft.	31.65 ft.	2 in.	0.01"	Sch 40	PVC
ft.	ft.	in.	1/4" space		

18. GROUT

FROM	TO	MATERIAL	EMPLACEMENT METHOD & AMOUNT
0 ft.	3 ft.	Concrete	Gravity >95 lbs. solids
3 ft.	13 ft.	Bent. Grout	Tremie 40 lbs. solids
13 ft.	15 ft.	Bent. Chips	Gravity 32 lbs. hydrated

19. SAND/GRAVEL PACK (if applicable)

FROM	TO	MATERIAL	EMPLACEMENT METHOD
15 ft.	32 ft.	#2 Silica Sand	Gravity
ft.	ft.		

20. DRILLING LOG (attach additional sheets if necessary)

FROM	TO	DESCRIPTION (color, hardness, soil/rock type, grain size, etc.)
0 ft.	32 ft.	SOIL; residuum to saprolite, mod. dense
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	
ft.	ft.	2'X2' concrete pad with locked steel case

21. REMARKS

Temporary observation well for hydrogeologic study

for future MSWLF Phase 4

22. Certification:

Signature of Certified Well Contractor

3/30/15

Date

By signing this form, I hereby certify that the well(s) was (were) constructed in accordance with 15A NCAC 02C .0100 or 15A NCAC 02C .0200 Well Construction Standards and that a copy of this record has been provided to the well owner.

23. Site diagram or additional well details:

You may use the back of this page to provide additional well site details or well construction details. You may also attach additional pages if necessary.

SUBMITTAL INSTUCTIONS

24a. For All Wells: Submit this form within 30 days of completion of well construction to the following:

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1636 Mail Service Center, Raleigh, NC 27699-1636

24c. For Water Supply & Injection Wells:

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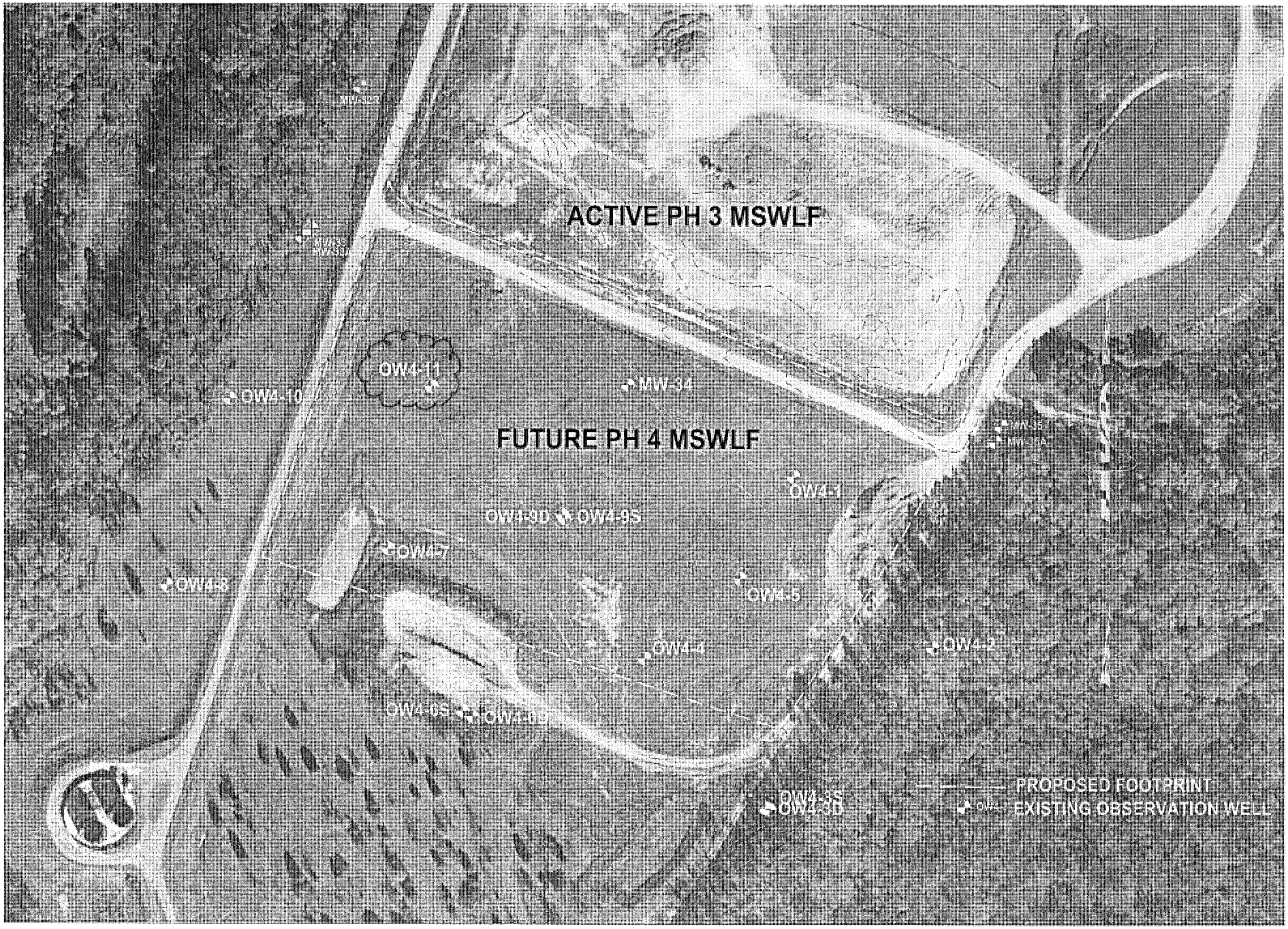


Lincoln Co. MSWLF
5291 Crouse Rd
Crouse NC 28033

N

MW-33A/OW-29A

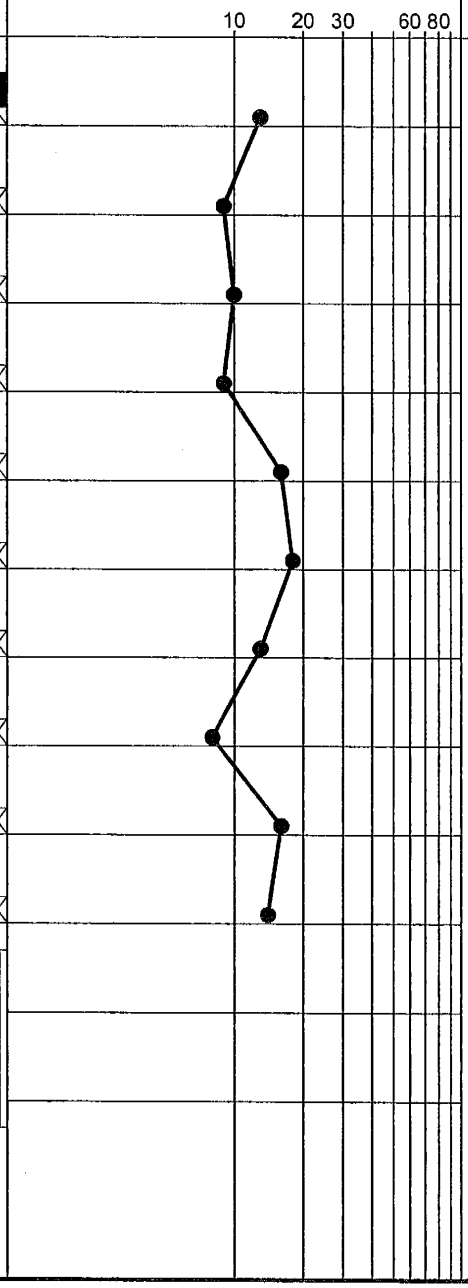
PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG OW-29A
DATE DRILLED: 12/30/04	ELEVATION: 815.9
DRILLING METHOD: 4¼" H.S.A.	BORING DEPTH: 61.5
LOGGED BY: Julie Petersen	WATER LEVEL:
DRILLER: Jay Little, NC Cert No. 2717	DRILL RIG: CME-45

NOTES: Current Observation Well for Phase III Hydro Study.

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
	TOPSOIL/ROOTMAT			
	RESIDUUM: Brown Coarse to Fine Sandy Silty **CLAY (CL)**			
5	RESIDUUM: Grayish Tan Silty Medium to Fine Sandy **CLAY**	810.9	1	13
	SAPROLITE: Reddish Yellow Silty Medium to Fine **SAND**			
10		805.9	2	9
	SAPROLITE: Tan and White Slightly Clayey Silty Coarse to Medium **SAND (SM)**			
15		800.9	3	10
20		795.9	4	9
25		790.9	5	16
30		785.9	6	18
	SAPROLITE: Reddish Brown Slightly Clayey Medium to Fine Sandy **SILT** with Managense Staining			
35		780.9	7	13
	SAPROLITE: White Slightly Clayey Silty Coarse to Fine **SAND**			
40		775.9	8	8
	SAPROLITE: Tannish Brown Micaceous Slightly Clayey Medium to Fine Sandy **SILT**			
45		770.9	9	16
	AUGER REFUSAL AT 51.5 FT BLS			
50		765.9	10	14
	BEDROCK: Sampled as Biotite Gneiss			
55	Run#1: 51.5 to 55 ft bls REC = 97% , RQD = 69%	760.9		
	Run #2: 55 to 60 ft bls REC = 98% , RQD = 92%			
60		755.9		
	Run#3: 60 to 61.5 ft bls REC = 100% , RQD = 100%			

WATER LEVEL

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG NEWLOGS.GPJ S&ME.GDT 2/22/05

1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
2. *PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.*

S&ME
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ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, NC 28273

ROCK CORE DETAILS

Boring ID:	Job Name and Number:	Classification:
OW-29A	Lincoln County Landfill Phase III, 1356-03-255A	Biotite Gneiss

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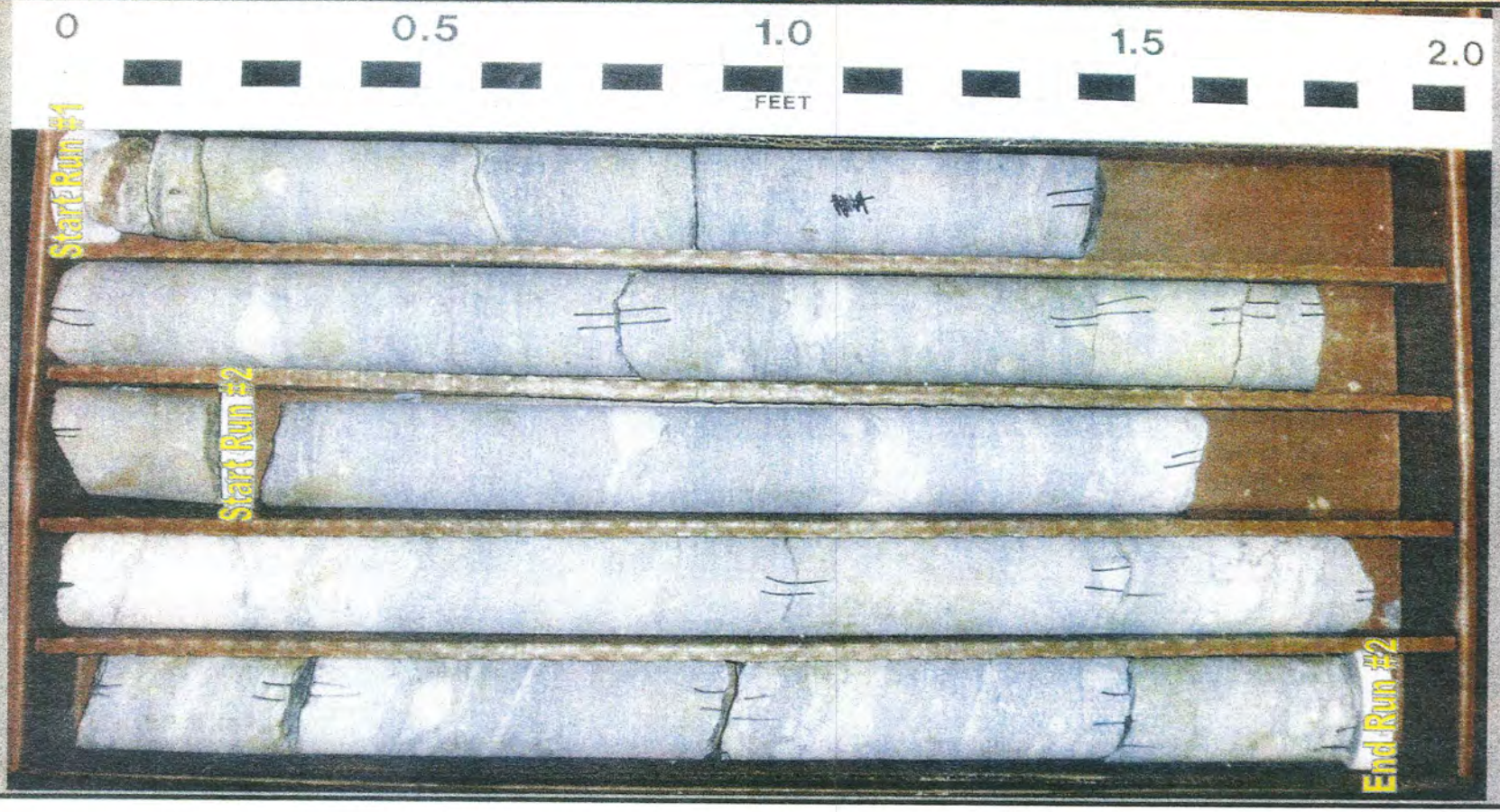
Core Depths (ft-bls):	Total Core Length (ft):
From: 51.5 To: 61.5	10 feet

Run #1	3.5'	Run #2	5'	Run #3	1.5'	Run #	
From: 51.5'	To: 55'	From: 55'	To: 60'	From: 60'	To: 61.5'	From:	To:
Core Length:	3.4'	Core Length:	4.9'	Core Length:	1.9'	Core Length:	
Rec: 97%	RQD: 69%	Rec: 98%	RQD: 92%	Rec: 100%	RQD: 100%	Rec:	RQD:

Page 1 of 2



MW-33A/OW-29A

ROCK CORE DETAILS

Boring ID:	Job Name and Number:	Classification:
OW-29A	Lincoln County Landfill Phase III, 1356-03-255A	Biotite Gneiss

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ENVIRONMENTAL SERVICES

Core Depths (ft-bls):	Total Core Length (ft):
From: 51.5 To: 61.5	10 feet

Run #1	3.5'	Run #2	5'	Run #3	1.5'	Run #	
From: 51.5'	To: 55'	From: 55'	To: 60'	From: 60'	To: 61.5'	From:	To:
Core Length:	3.4'	Core Length:	4.9'	Core Length:	1.9'	Core Length:	
Rec: 97%	RQD: 69%	Rec: 98%	RQD: 92%	Rec: 100%	RQD: 100%	Rec:	RQD:

Page 2 of 2

MW-33A/OW-29A

WELL CONSTRUCTION RECORD
(OW-29A)

North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section

WELL CONTRACTOR (INDIVIDUAL) NAME (prin Jay Little **CERTIFICATION #** 2717

WELL CONTRACTOR COMPANY NAME S&ME, Inc. **PHONE #** 704-523-4726

STATE WELL CONSTRUCTION PERMIT# _____ **ASSOCIATED WQ PERMIT#** _____
(if applicable) (if applicable)

1. WELL USE (Check Applicable Box): Residential ☐ Municipal/Public ☐ Industrial ☐ Agricultral ☐ Monitoring ☐ Recovery ☐ Heat Pump Water Injection ☐ Other ☑ If Other, List Use observation well

2. WELL LOCATION:
Nearest Town: Crouse County Lincoln
Lincoln County Landfill
(Street Name, Numbers, Community, Sudivision, Lot No.,Zip Code)

Topographic/Land setting
☐ Ridge ☐ Slope ☐ Valley ☑ Flat
(check appropriate box)
Latitude/longitude of well location
(degrees/minutes/seconds)
Latitude/longitude scource: ☐GPS ☐Topographic Map
(check box)

3. OWNER: Lincoln County Landfill
Address 5291 Crouse Road
(Street or Route No.)
Crouse NC 28033
City or Town State Zip Code
(704) 732-9030
Area code - Phone Number

4. DATE DRILLED 12/30/2004
5. TOTAL DEPTH 61.5
6. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☑
7. STATIC WATER LEVEL Below Top of Casing: 12.22 ft.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 2.73 FT. Above Land Surface*
***Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C .0118.**
9. YIELD (gpm) n/a METHOD OF TEST n/a
10. WATER ZONES (depth): n/a

DEPTH From	To	DRILLING LOG Formation Descrpition
(see attached boring log)		

11. DISINFECTION: Type n/a Amount n/a
12. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 56.5	Ft.	2-inch	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

13. GROUT:

	Depth		Material	Method
From 0	To 52.5	Ft.	Neat Cement	Pour
From 52.5	To 54.5	Ft.	Bentonite	Pour

14. SCREEN:

	Depth		Diameter		Slot Size		Material
From 56.5	To 61.5	Ft.	2-inch	in.	0.01	in.	PVC
From	To	Ft.		in.		in.	

15. SAND/GRAVEL PACK:

	Depth		Size	Material
From 54.5	To 61.5	Ft.	#2	Silica Sand
From	To	Ft.		

LOCATION SKETCH
Show direction and distance in miles from at least two State Roads or County Roads. Include the road numbers and common names.

(see attached site map)

16. REMARKS: _____

I DO HERE BY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

Jay G. Little 2-23-05
SIGNATURE OF PERSON CONSTRUCTING THE WELL DATE

Submit the original to the Division of Water Quality, Groundwater Section, 1636 Mail Service Center - Raleigh, NC 27699-1636 Phone No. (919) 733-3221, within 30 days.

GW-1 REV. 07/2001

MW-34/B-30 (Abnd)

PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-30

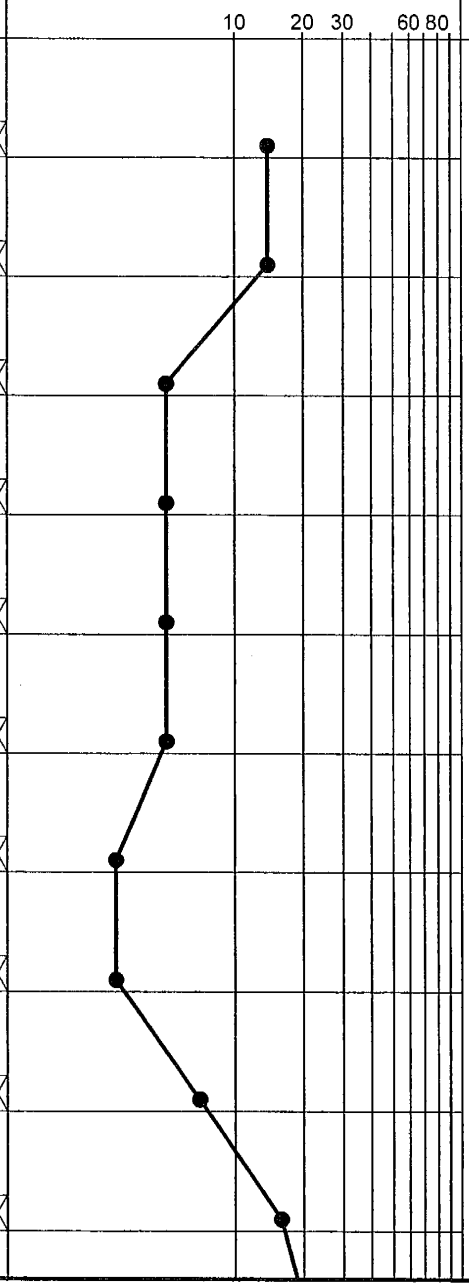
DATE DRILLED: 12/21/04	ELEVATION: 829.8	NOTES: Abandoned geotechnical boring for OW-30 location - Phase III Hydro Study. Boring abandoned after completion by grouting.
DRILLING METHOD: Mud Rotary	BORING DEPTH: 101.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Jay Little, NC Cert No. 2717	DRILL RIG: CME-45	

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
	RESIDUUM: Reddish Brown Clayey Medium to Fine Sandy **SILT**			
5		824.8	1	14
	RESIDUUM: Red Fine Sandy Silty **CLAY**			
10		819.8	2	14
	SAPROLITE: Red and Gray Mottled Medium to Fine Sandy Silty **CLAY**			
15		814.8	3	5
	SAPROLITE: Red and Gray Mottled Medium to Fine Sandy Clayey **SILT**			
20		809.8	4	5
	SAPROLITE: Tan and White Slightly Clayey Silty Coarse to Fine **SAND (SM)**			
25		804.8	5	5
30		799.8	6	5
	SAPROLITE: Tan and Gray Clayey Silty Medium to Fine **SAND**			
35		794.8	7	3
	SAPROLITE: Greenish Tan Clayey Silty Fine **SAND**			
40		789.8	8	3
	SAPROLITE: Tan Clayey Fine Sandy **SILT** with Manganese Staining			
45		784.8	9	7
	SAPROLITE: Tan and Green Slightly Clayey Silty Medium to Fine **SAND**			
50		779.8	10	16

WATER LEVEL

GRAPHIC LOG

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG NEWLOGS.GPJ S&ME.GDT 3/2/05

1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
2. *PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.*

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Charlotte, NC 28273

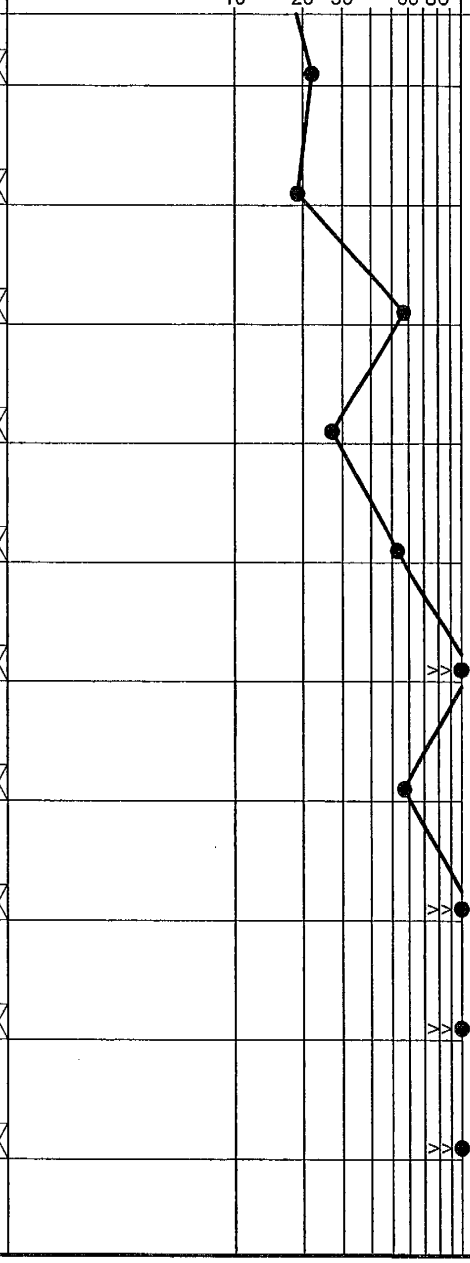
MW-34/B-30 (Abnd)

PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-30

DATE DRILLED: 12/21/04	ELEVATION: 829.8	NOTES: Abandoned geotechnical boring for OW-30 location - Phase III Hydro Study. Boring abandoned after completion by grouting.
DRILLING METHOD: Mud Rotary	BORING DEPTH: 101.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Jay Little, NC Cert No. 2717	DRILL RIG: CME-45	

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
55	SAPROLITE: Greenish Black and White Silty Medium to Fine **SAND**	774.8	11	22
60	SAPROLITE: Tan Slightly Clayey Silty Medium to Fine **SAND**	769.8	12	19
65	SAPROLITE: Pale Greenish Tan Silty Coarse to Fine **SAND**	764.8	13	57
70	SAPROLITE: Tan Slightly Clayey Silty Medium to Fine **SAND**	759.8	14	27
75	SAPROLITE: Greenish Tan Medium to Fine Sandy **SILT**	754.8	15	53
80	PARTIALLY WEATHERED ROCK: When Sampled Becomes Greenish Tan and White to Dark Green Silty Coarse to Fine **SAND**	749.8	16	>> 50/3
85	SAPROLITE: Reddish Tan Slightly Clayey Silty Medium to Fine **SAND**	744.8	17	57
90	PARTIALLY WEATHERED ROCK: When Sampled Becomes Brown and White Medium to Fine Sandy **SILT**	739.8	18	>> 50/5
95	PARTIALLY WEATHERED ROCK: When Sampled Becomes Brown Slightly Clayey Medium to Fine Sandy **SILT** **AUGER REFUSAL AT 101 FT BLS**	734.8	19	>> 50/4
100		729.8	20	>> 50/5

STANDARD PENETRATION TEST DATA (blows/ft)



WATER LEVEL

GRAPHIC LOG

BORING LOG NEWLOGS.GPJ S&ME.GDT 3/2/05

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2. *PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.*

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, NC 28273

COMPLETION REPORT OF WELL No. OW-30

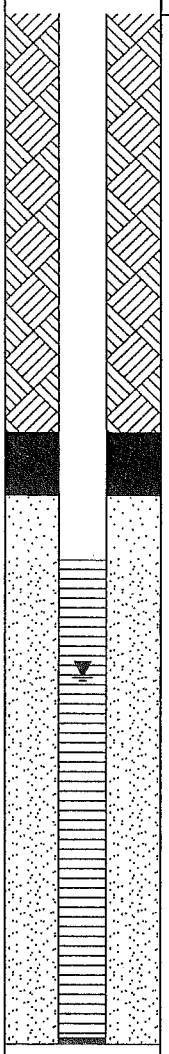
PROJECT: **Lincoln County Landfill Phase III**
PROJECT NO: **1356-03-255A**
PROJECT LOCATION: **Crouse, North Carolina**

WATER LEVEL: **20.67 ft bls at 24 hrs**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **832.77**
DATUM: **MSL**
LOGGED BY: **Julie Petersen**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **12/21/04**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
RESIDUUM: Reddish Brown Clayey Medium to Fine Sandy **SILT**		0		0.00	GS	829.82
RESIDUUM: Red Fine Sandy Silty **CLAY**		5, 10				
SAPROLITE: Red and Gray Mottled Medium to Fine Sandy Silty **CLAY**		15		13.00	CG	816.82
				15.00	BS	814.82
SAPROLITE: Red and Gray Mottled Medium to Fine Sandy Clayey **SILT**		20				
SAPROLITE: Tan and White Slightly Clayey Silty Coarse to Fine **SAND (SM)**		25, 30		32.00	FP	797.82



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: **2-inch**
Type: **Sch. 40 PVC**
Interval: **0 to 17 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 13 ft bls**

SEAL
Type: **Bentonite**
Interval: **13 to 15 ft bls**

FILTERPACK
Type: **#2 Filter Sand**
Interval: **15 to 32 ft bls**

SCREEN
Diameter: **2-inch**
Type: **0.010 Slot Sch. 40 PVC**
Interval: **17 to 32 ft bls**

LEGEND
- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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ENVIRONMENTAL SERVICES
9751 Southern Pine Blvd.
Charlotte, NC 28273

COMPLETION REPORT OF WELL No. OW-30

MW-34/OW-30

WELL CONSTRUCTION RECORD
(OW-30)

North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section

WELL CONTRACTOR (INDIVIDUAL) NAME (prin Jay Little **CERTIFICATION #** 2717

WELL CONTRACTOR COMPANY NAME S&ME, Inc. **PHONE #** 704-523-4726

STATE WELL CONSTRUCTION PERMIT# _____ **ASSOCIATED WQ PERMIT#** _____

(if applicable) (if applicable)

1. WELL USE (Check Applicable Box): Residential ☐ Municipal/Public ☐ Industrial ☐ Agricultral ☐ Monitoring ☐ Recovery ☐ Heat Pump Water Injection ☐ Other ☑ If Other, List Use observation well

2. WELL LOCATION:
   Nearest Town: Crouse County Lincoln
   Lincoln County Landfill
   (Street Name, Numbers, Community, Sudivision, Lot No.,Zip Code)

   Topographic/Land setting
   ☐ Ridge ☐ Slope ☐ Valley ☑ Flat
   (check appropriate box)
   Latitude/longitude of well location
   _____
   (degrees/minutes/seconds)
   Latitude/longitude scource: ☐GPS ☐Topographic Map
   (check box)

3. OWNER: Lincoln County Landfill
   Address 5291 Crouse Road
   (Street or Route No.)
   Crouse NC 28033
   City or Town State Zip Code
   (704) 732-9030
   Area code - Phone Number

4. DATE DRILLED 12/21/2004
5. TOTAL DEPTH 32
6. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☑
7. STATIC WATER LEVEL Below Top of Casing: 23.62 ft.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 2.95 FT. Above Land Surface*
   ***Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C .0118.**
9. YIELD (gpm) n/a METHOD OF TEST n/a
10. WATER ZONES (depth): n/a

DEPTH From	DEPTH To	DRILLING LOG Formation Descrpition
(see attached boring log)		

11. DISINFECTION: Type n/a Amount n/a
12. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 17	Ft.	2-inch	Sch. 40	PVC
From	To	Ft.			
From	To	Ft.			

13. GROUT:

	Depth		Material	Method
From 0	To 13	Ft.	Neat Cement	Pour
From 13	To 15	Ft.	Bentonite	Pour

14. SCREEN:

	Depth		Diameter	Slot Size	Material
From 17	To 32	Ft.	2-inch in.	0.01 in.	PVC
From	To	Ft.	in.	in.	

15. SAND/GRAVEL PACK:

	Depth		Size	Material
From 15	To 32	Ft.	#2	Silica Sand
From	To	Ft.		

LOCATION SKETCH

Show direction and distance in miles from at least two State Roads or County Roads. Include the road numbers and common names.

(see attached site map)

16. REMARKS: _____

I DO HERE BY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

Jay C. Little 2-23-05

SIGNATURE OF PERSON CONSTRUCTING THE WELL DATE

Submit the original to the Division of Water Quality, Groundwater Section, 1636 Mail Service Center - Raleigh, NC 27699-1636 Phone No. (919) 733-3221, within 30 days.

GW-1 REV. 07/2001

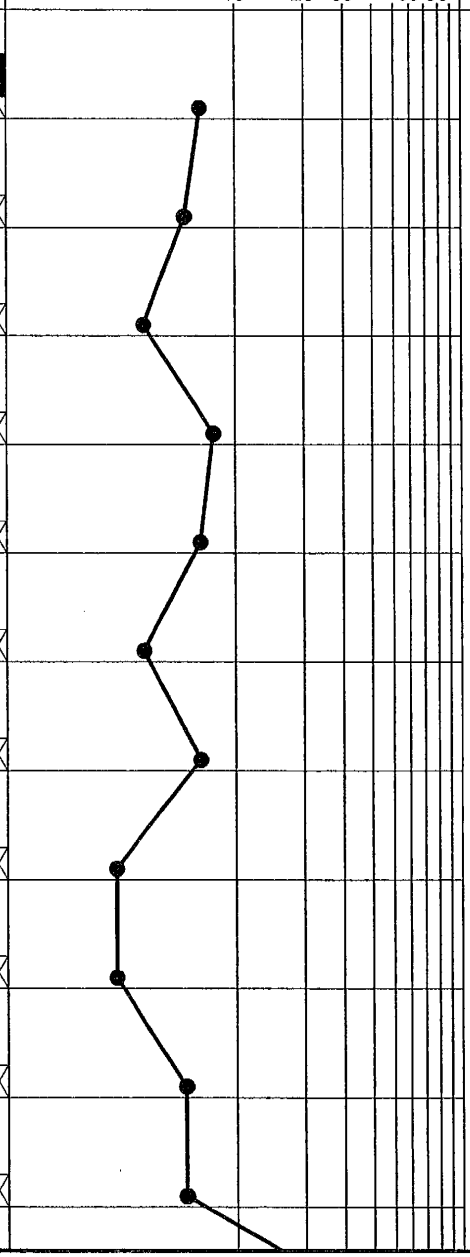
MW-35A/B-31 (Abnd)

PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-31

DATE DRILLED: **12/27/04**	ELEVATION: **836.9**	NOTES: **Abandoned geotechnical boring for OW-31/31A location - Phase III Hydro Study. Boring abandoned after completion by grouting.**
DRILLING METHOD: **Mud Rotary**	BORING DEPTH: **97.0**	
LOGGED BY: **Julie Petersen**	WATER LEVEL:	
DRILLER: **Jay Little, NC Cert No. 2717**	DRILL RIG: **CME-45**	

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
		ROOTMAT/TOPSOIL				
		RESIDUUM: Red Clayey **SILT** with Sand **(MH)**				
5				831.9	1	7
		SAPROLITE: Reddish Yellow to Red and Brown Micaceous Clayey Medium to Fine Sandy **SILT (ML)** with Manganese Staining				
10				826.9	2	6
15				821.9	3	4
20				816.9	4	8
25				811.9	5	7
30				806.9	6	4
35				801.9	7	7
40				796.9	8	3
45				791.9	9	3
50				786.9	10	6
55				781.9	11	6

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG NEWLOGS.GPJ S&ME.GDT 3/2/05

1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
2. *PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.*

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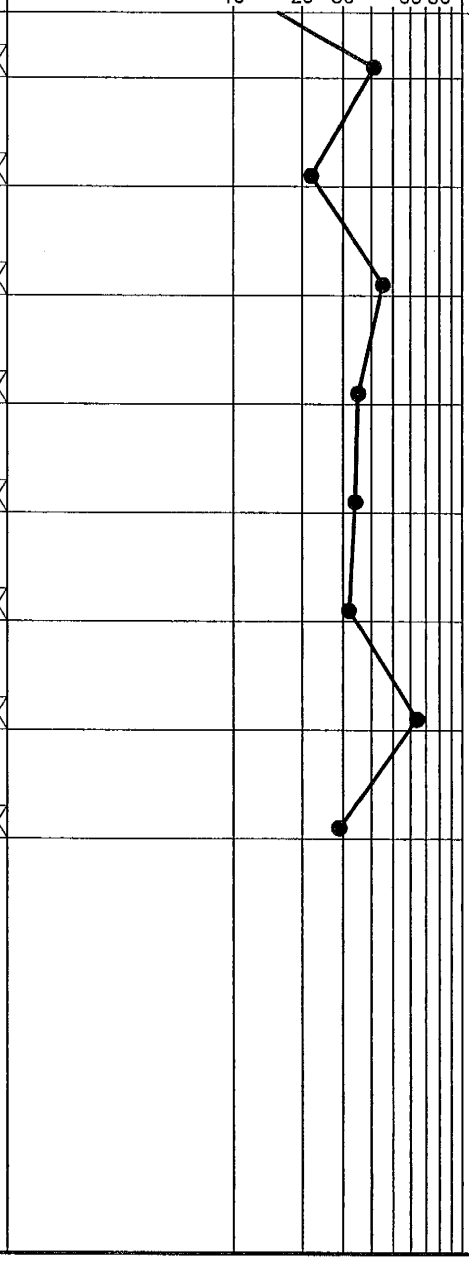
9751 Southern Pine Blvd.
Charlotte, NC 28273

PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-31
DATE DRILLED: 12/27/04	ELEVATION: 836.9
DRILLING METHOD: Mud Rotary	BORING DEPTH: 97.0
LOGGED BY: Julie Petersen	WATER LEVEL:
DRILLER: Jay Little, NC Cert No. 2717	DRILL RIG: CME-45

NOTES: Abandoned geotechnical boring for OW-31/31A location - Phase III Hydro Study. Boring abandoned after completion by grouting.

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
60	SAPROLITE: Brown Clayey Medium to Fine Sandy **SILT** with Manganese Staining	776.9	12	41
65	SAPROLITE: Brown and White Slightly Clayey Silty **SAND (SM)** with Gravel	771.9	13	22
70		766.9	14	45
75	SAPROLITE: Red, Green and White Slightly Clayey Silty Coarse to Fine **SAND** with Rock Fragments	761.9	15	35
80		756.9	16	34
85	SAPROLITE: Brown Micaceous Slightly Clayey Silty Medium to Fine **SAND** (Schistose Structure)	751.9	17	32
90		746.9	18	64
95	SAPROLITE: Red and White Silty Clayey Medium to Fine **SAND** **AUGER REFUSAL AT 97 FT BLS**	741.9	19	29

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG NEWLOGS.GPJ S&ME.GDT 3/2/05

1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
2. *PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.*

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COMPLETION REPORT OF WELL No. OW-31A

PROJECT: **Lincoln County Landfill Phase III**
PROJECT NO: **1356-03-255A**
PROJECT LOCATION: **Crouse, North Carolina**

WATER LEVEL: **17.09 ft bls at 24 hrs**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **839.83**
DATUM: **MSL**
LOGGED BY: **Julie Petersen**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **12/28/04**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
ROOTMAT/TOPSOIL		0		0.00	GS	836.77
RESIDUUM: Red Clayey **SILT** with Sand **(MH)**		5				
SAPROLITE: Reddish Yellow to Red and Brown Micaceous Clayey Medium to Fine Sandy **SILT (ML)** with Manganese Staining		10, 15, 20, 25, 30, 35, 40, 45, 50, 55				
				56.00	CG	780.77
				58.00	BS	778.77
SAPROLITE: Brown Clayey Medium to Fine Sandy **SILT** with Manganese Staining		60				
SAPROLITE: Brown and White Slightly Clayey Silty **SAND (SM)** with Gravel		65		65.00	FP	771.77

WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: **2-inch**
Type: **Sch. 40 PVC**
Interval: **0 to 60 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 56 ft bls**

SEAL
Type: **Bentonite**
Interval: **56 to 58 ft bls**

FILTERPACK
Type: **#2 Filter Sand**
Interval: **58 to 65 ft bls**

SCREEN
Diameter: **2-inch**
Type: **0.010 Slot Sch. 40 PVC**
Interval: **60 to 65 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, NC 28273

COMPLETION REPORT OF WELL No. OW-31A

MW-35A/OW-31A

WELL CONSTRUCTION RECORD
(OW-31A)

North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section

WELL CONTRACTOR (INDIVIDUAL) NAME (prin Jay Little **CERTIFICATION #** 2717

WELL CONTRACTOR COMPANY NAME S&ME, Inc. **PHONE #** 704-523-4726

STATE WELL CONSTRUCTION PERMIT# _____ **ASSOCIATED WQ PERMIT#** _____

(if applicable) (if applicable)

1. WELL USE (Check Applicable Box): Residential ☐ Municipal/Public ☐ Industrial ☐ Agricultral ☐
   Monitoring ☐ Recovery ☐ Heat Pump Water Injection ☐ Other ☑ If Other, List Use observation well
2. WELL LOCATION:
   Nearest Town: Crouse County Lincoln
   Lincoln County Landfill
   (Street Name, Numbers, Community, Sudivision, Lot No.,Zip Code)

   Topographic/Land setting
   ☐ Ridge ☑ Slope ☐ Valley ☐ Flat
   (check appropriate box)
   Latitude/longitude of well location
   _____
   (degrees/minutes/seconds)
   Latitude/longitude scource: ☐GPS ☐Topographic Map
   (check box)
3. OWNER: Lincoln County Landfill
   Address 5291 Crouse Road
   (Street or Route No.)
   Crouse NC 28033
   City or Town State Zip Code
   (704) 732-9030
   Area code - Phone Number
4. DATE DRILLED 12/28/2004
5. TOTAL DEPTH 65
6. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☑
7. STATIC WATER LEVEL Below Top of Casing: 20.15 ft.
   (Use "+" if Above Top of Casing)
8. TOP OF CASING IS 3.06 FT. Above Land Surface*
   ***Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C .0118.**
9. YIELD (gpm) n/a METHOD OF TEST n/a
10. WATER ZONES (depth): n/a
11. DISINFECTION: Type n/a Amount n/a
12. CASING:

	Depth			Diameter	Wall Thickness or Weight/Ft.	Material
From	0	To 60	Ft.	2-inch	Sch. 40	PVC
From		To	Ft.			
From		To	Ft.			

13. GROUT:

	Depth			Material	Method
From	0	To 56	Ft.	Neat Cement	Pour
From	56	To 58	Ft.	Bentonite	Pour

14. SCREEN:

	Depth			Diameter	Slot Size	Material
From	60	To 65	Ft.	2-inch in.	0.01 in.	PVC
From		To	Ft.	in.	in.	

15. SAND/GRAVEL PACK:

	Depth			Size	Material
From	58	To 65	Ft.	#2	Silica Sand
From		To	Ft.		

DEPTH From	DEPTH To	DRILLING LOG Formation Descrpition
(see attached boring log)		

LOCATION SKETCH

Show direction and distance in miles from at least two State Roads or County Roads. Include the road numbers and common names.

(see attached site map)

16. REMARKS: _____

I DO HERE BY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

Jay A. Little 2-23-05

SIGNATURE OF PERSON CONSTRUCTING THE WELL DATE

Submit the original to the Division of Water Quality, Groundwater Section, 1636 Mail Service Center - Raleigh, NC 27699-1636 Phone No. (919) 733-3221, within 30 days.

GW-1 REV. 07/2001

COMPLETION REPORT OF WELL No. OW-31

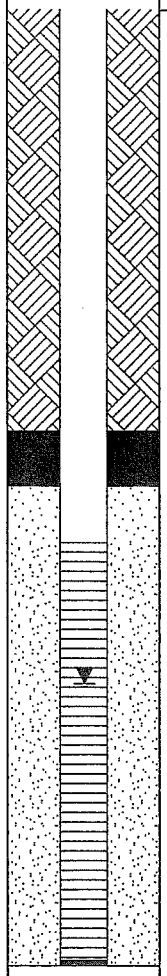
PROJECT: **Lincoln County Landfill Phase III**
PROJECT NO: **1356-03-255A**
PROJECT LOCATION: **Crouse, North Carolina**

WATER LEVEL: **24 ft bls at 24 hrs**

LATITUDE:
LONGITUDE:
TOP OF CASING ELEVATION: **839.64**
DATUM: **MSL**
LOGGED BY: **Julie Petersen**

DRILLING CONTRACTOR: **S&ME, Inc.**
DRILLING METHOD: **4¼" H.S.A.**
DATE DRILLED: **12/28/04**

STRATA DESCRIPTION	SYMBOL	DEPTH (ft.)	WELL DETAILS	DEPTH (ft.)	LEGEND	ELEVATION (ft.)
ROOTMAT/TOPSOIL / RESIDUUM: Red Clayey **SILT** with Sand **(MH)**		0		0.00	GS	836.85
SAPROLITE: Reddish Yellow to Red and Brown Micaceous Clayey Medium to Fine Sandy **SILT (ML)** with Manganese Staining		5, 10, 15, 20, 25, 30		15.00	CG	821.85
				17.00	BS	819.85
				34.00	FP	802.85



WELL CONSTRUCTION DETAILS

PROTECTIVE CASING
Diameter:
Type:
Interval:

RISER CASING
Diameter: **2-inch**
Type: **Sch. 40 PVC**
Interval: **0 to 19 ft bls**

GROUT
Type: **Neat Cement**
Interval: **0 to 15 ft bls**

SEAL
Type: **Bentonite**
Interval: **15 to 17 ft bls**

FILTERPACK
Type: **#2 Filter Sand**
Interval: **17 to 34 ft bls**

SCREEN
Diameter: **2-inch**
Type: **0.010 Slot Sch. 40 PVC**
Interval: **19 to 34 ft bls**

LEGEND

- FILTER PACK
- BENTONITE
- CEMENT GROUT
- CUTTINGS / BACKFILL
- STATIC WATER LEVEL

TOC	TOP OF CASING
GS	GROUND SURFACE
BS	BENTONITE SEAL
FP	FILTER PACK
TSC	TOP OF SCREEN
BSC	BOTTOM OF SCREEN
TD	TOTAL DEPTH
CG	CEMENT GROUT

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Charlotte, NC 28273

COMPLETION REPORT OF WELL No. OW-31

MW-35/OW-31

WELL CONSTRUCTION RECORD
(OW-31)

North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section

WELL CONTRACTOR (INDIVIDUAL) NAME (prin Jay Little **CERTIFICATION #** 2717

WELL CONTRACTOR COMPANY NAME S&ME, Inc. **PHONE #** 704-523-4726

STATE WELL CONSTRUCTION PERMIT# _____ **ASSOCIATED WQ PERMIT#** _____
(if applicable) (if applicable)

1. WELL USE (Check Applicable Box): Residential ☐ Municipal/Public ☐ Industrial ☐ Agricultral ☐
Monitoring ☐ Recovery ☐ Heat Pump Water Injection ☐ Other ☑ If Other, List Use observation well

2. WELL LOCATION:
Nearest Town: Crouse County Lincoln
Lincoln County Landfill
(Street Name, Numbers, Community, Sudivision, Lot No.,Zip Code)

Topographic/Land setting
☐ Ridge ☑ Slope ☐ Valley ☐ Flat
(check appropriate box)
Latitude/longitude of well location
(degrees/minutes/seconds)
Latitude/longitude scource: ☐GPS ☐Topographic Map
(check box)

3. OWNER: Lincoln County Landfill
Address 5291 Crouse Road
(Street or Route No.)
Crouse NC 28033
City or Town State Zip Code
(704) 732-9030
Area code - Phone Number

4. DATE DRILLED 12/28/2004
5. TOTAL DEPTH 34
6. DOES WELL REPLACE EXISTING WELL? YES ☐ NO ☑
7. STATIC WATER LEVEL Below Top of Casing: 26.79 ft.
(Use "+" if Above Top of Casing)
8. TOP OF CASING IS 2.79 FT. Above Land Surface*
***Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C .0118.**
9. YIELD (gpm) n/a METHOD OF TEST n/a
10. WATER ZONES (depth): n/a

DEPTH From	To	DRILLING LOG Formation Descrpition
(see attached boring log)		

11. DISINFECTION: Type n/a Amount n/a
12. CASING:

	Depth From	To	Ft.	Diameter	Wall Thickness or Weight/Ft.	Material
	0	19		2-inch	Sch. 40	PVC

13. GROUT:

	Depth From	To	Ft.	Material	Method
	0	15		Neat Cement	Pour
	15	17		Bentonite	Pour

14. SCREEN:

	Depth From	To	Ft.	Diameter	in.	Slot Size	in.	Material
	19	34		2-inch		0.01		PVC

15. SAND/GRAVEL PACK:

	Depth From	To	Ft.	Size	Material
	17	34		#2	Silica Sand

LOCATION SKETCH
Show direction and distance in miles from at least two State Roads or County Roads. Include the road numbers and common names.

(see attached site map)

16. REMARKS: _____

I DO HERE BY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER

Jay A. Little 2-23-05
SIGNATURE OF PERSON CONSTRUCTING THE WELL DATE

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GW-1 REV. 07/2001

APPENDIX B

FIELD AND LABORATORY DATA SHEETS

SLUG TEST DATA SHEETS

SOIL LABORATORY DATA SHEETS

SLUG TEST DATA SHEETS

LABORATORY PROCEDURES

Moisture Content: The moisture content is the ratio, expressed as a percentage, of the weight of water in a given mass of soil to the weight of the solid particles. This test was conducted in accordance with ASTM Designation D 2216.

Grain Size Test with Hydrometer: Grain size tests were performed to determine the particle size and distribution of the samples tested. The grain size distribution of soils coarser than a No. 200 sieve was determined by passing the samples through a set of nested sieves. The soil particles passing the No. 200 sieve were suspended in solution and the grain size distribution determined from the rate of settlement.

Soil Plasticity Test (Atterberg Limits Test): Representative samples were selected for Atterberg Limits testing to determine the soil's plasticity characteristics. The Plasticity Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL). The Liquid Limit is the moisture content at which the soil will flow as a heavy viscous fluid. The Plastic Limit is the moisture content at which the soil begins to lose its plasticity. Although some samples had high proportion of clay and silt ECS Carolinas reported the samples were not able to roll to 1/8 in diameter and stay intact therefore reported as non-plastic (NP).

Specific Gravity: The specific gravity of the permeability test samples was determined. The specific gravity is the ratio of the weight, in air, of a given volume of soil particles to the weight in air, of an equal volume of water. This test conducted in accordance with ASTM Designation D-854-58.

Unit Weight: In the laboratory, a section of each selected undisturbed sample, still in its steel tube, was measured and weighed to determine gross weight and volume. The sample was then extruded from its steel tube and the net weight and volume of the sample determined for the calculation of the soil wet unit weight in pounds per cubic foot. The dry unit weight was then calculated from the net unit weight and the natural moisture content.

Permeability Test: The coefficient of permeability, k, of selected samples was estimated in the laboratory by testing the samples in a constant head permeameter. The sample and apparatus dimensions were carefully measured and the sample saturated prior to initiating the test. A head was then applied to the sample to provide flow, and the change in head was measured over a corresponding time interval. The coefficient of permeability was then calculated from the measured dimensions, head change and elapsed test time. This test was conducted in accordance with ASTM Designation D-5084.

OW4-1

Rising Head "Slug-Out"

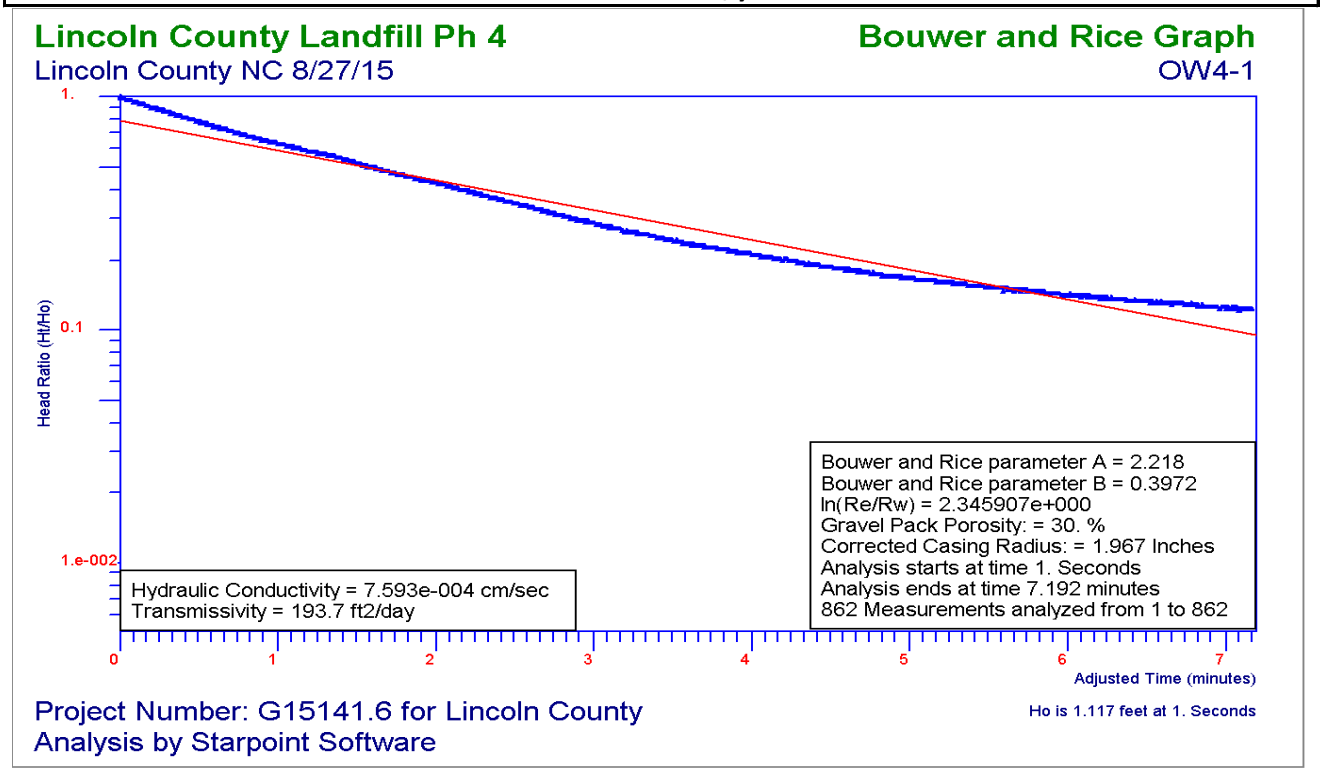
Site Name:	Lincoln County Landfill Ph 4	
Location:	Lincoln County NC	
Test Date:	8/26/2015	
Client:	Lincoln County	
Project Number:	G15141.6	
Well Label:	OW4-1	
Aquifer Thickness:	85 feet	to bedrock
Screen Length:	15. feet	
Casing Radius:	1. Inches	
Effective Radius:	3.25 Inches	
Static Water Level BTOC:	35.16 feet	manually measured
Water Table to Screen Bottom:	6.56 feet	
Method:	Slug Out (1.315" diameter solid slug)	
Anisotropy Ratio:	1	
Time Adjustment:	1 Seconds	
Test starts with trial:	1	
There are 862 time and drawdown measurements		
Maximum head :	1.12 feet	
Minimum head:	0 feet	

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **7.59E-04 cm/sec**

K= **785.48 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	1.0	0.0	36.28	1.12	1.0000
4	2.5	1.5	36.27	1.11	0.9893
7	4.0	3.0	36.25	1.09	0.9767
10	5.5	4.5	36.24	1.08	0.9660
12	6.5	5.5	36.23	1.07	0.9570
15	8.0	7.0	36.22	1.06	0.9472
18	9.5	8.5	36.20	1.04	0.9338
21	11.0	10.0	36.19	1.03	0.9230
24	12.5	11.5	36.18	1.02	0.9123
27	14.0	13.0	36.17	1.01	0.9015
31	16.0	15.0	36.15	0.99	0.8872
34	17.5	16.5	36.14	0.98	0.8765
37	19.0	18.0	36.13	0.97	0.8657
40	20.5	19.5	36.12	0.96	0.8559
43	22.0	21.0	36.10	0.95	0.8460
46	23.5	22.5	36.09	0.93	0.8353
49	25.0	24.0	36.08	0.92	0.8263
52	26.5	25.5	36.07	0.91	0.8156
55	28.0	27.0	36.06	0.90	0.8048
59	30.0	29.0	36.05	0.89	0.7941
63	32.0	31.0	36.03	0.87	0.7816
66	33.5	32.5	36.02	0.86	0.7717
69	35.0	34.0	36.01	0.85	0.7628
73	37.0	36.0	36.00	0.84	0.7520
77	39.0	38.0	35.99	0.83	0.7404
81	41.0	40.0	35.98	0.82	0.7296
85	43.0	42.0	35.96	0.80	0.7162
89	45.0	44.0	35.95	0.79	0.7055
94	47.5	46.5	35.94	0.78	0.6965
97	49.0	48.0	35.93	0.77	0.6876
101	51.0	50.0	35.92	0.76	0.6786
105	53.0	52.0	35.91	0.75	0.6679
108	54.5	53.5	35.90	0.74	0.6589
114	57.5	56.5	35.88	0.72	0.6482
118	59.5	58.5	35.87	0.71	0.6392
122	61.5	60.5	35.86	0.70	0.6303
128	64.5	63.5	35.85	0.69	0.6213
133	67.0	66.0	35.84	0.68	0.6115
138	69.5	68.5	35.83	0.67	0.6025
143	72.0	71.0	35.82	0.66	0.5936
148	74.5	73.5	35.81	0.65	0.5846
154	77.5	76.5	35.80	0.64	0.5748
159	80.0	79.0	35.79	0.63	0.5640
166	83.5	82.5	35.78	0.62	0.5542
171	86.0	85.0	35.77	0.61	0.5443

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
176	88.5	87.5	35.76	0.60	0.5354
181	91.0	90.0	35.75	0.59	0.5255
185	93.0	92.0	35.74	0.58	0.5166
190	95.5	94.5	35.73	0.57	0.5058
196	98.5	97.5	35.71	0.55	0.4942
202	101.5	100.5	35.70	0.54	0.4852
207	104.0	103.0	35.69	0.53	0.4763
213	107.0	106.0	35.68	0.52	0.4673
220	110.5	109.5	35.67	0.51	0.4575
227	114.0	113.0	35.66	0.50	0.4485
233	117.0	116.0	35.65	0.49	0.4396
240	120.5	119.5	35.64	0.48	0.4306
247	124.0	123.0	35.63	0.47	0.4199
255	128.0	127.0	35.62	0.46	0.4100
262	131.5	130.5	35.61	0.45	0.3993
269	135.0	134.0	35.60	0.44	0.3903
277	139.0	138.0	35.59	0.43	0.3805
286	143.5	142.5	35.57	0.41	0.3697
294	147.5	146.5	35.56	0.40	0.3590
303	152.0	151.0	35.55	0.39	0.3474
312	156.5	155.5	35.54	0.38	0.3384
321	161.0	160.0	35.53	0.37	0.3277
330	165.5	164.5	35.52	0.36	0.3187
338	169.5	168.5	35.51	0.35	0.3098
347	174.0	173.0	35.49	0.34	0.2999
358	179.5	178.5	35.48	0.33	0.2910
368	184.5	183.5	35.47	0.31	0.2811
379	190.0	189.0	35.46	0.30	0.2722
391	196.0	195.0	35.45	0.29	0.2623
405	203.0	202.0	35.44	0.28	0.2534
421	211.0	210.0	35.43	0.27	0.2426
435	218.0	217.0	35.42	0.26	0.2328
455	228.0	227.0	35.41	0.25	0.2238
471	236.0	235.0	35.40	0.24	0.2131
498	249.5	248.5	35.39	0.23	0.2032
519	260.0	259.0	35.38	0.22	0.1943
544	272.5	271.5	35.37	0.21	0.1853
570	285.5	284.5	35.36	0.20	0.1755
601	301.0	300.0	35.35	0.19	0.1665
637	319.0	318.0	35.34	0.18	0.1567
673	337.0	336.0	35.33	0.17	0.1477
739	370.0	369.0	35.31	0.16	0.1388
795	398.0	397.0	35.31	0.15	0.1298
638	319.5	318.5	35.34	0.18	0.1594
673	337.0	336.0	35.33	0.17	0.1477
739	370.0	369.0	35.31	0.16	0.1388

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
795	398.0	397.0	35.31	0.15	0.1298
862	431.5	430.5	35.30	0.14	0.1235

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-2

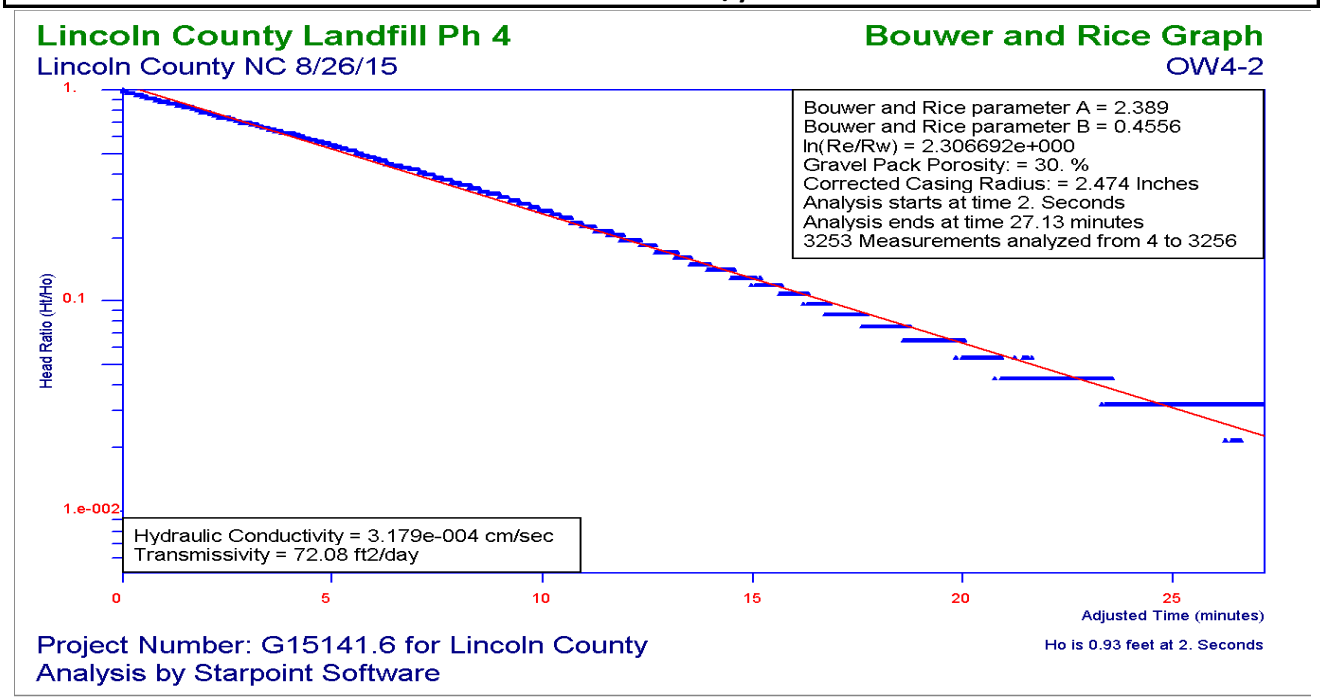
Rising Head "Slug-Out"

Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/26/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-2
Aquifer Thickness:	57 feet to bedrock
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	4.25 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.474 Inches
Static Water Level:	22.81 feet
Water Table to Screen Bottom:	10.97 feet
Method:	Slug Out (1.315" diameter solid slug)
Anisotropy Ratio:	1
Time Adjustment:	2 Seconds
Test starts with trial:	4
There are 3,256 time and drawdown measurements	
Maximum head :	0.93 feet
Minimum head:	0.03 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K =	**3.18E-04 cm/sec**
K=	**328.87 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-1.0	22.81	0.00	0.000
2	1.0	0.0	23.74	0.93	1.000
8	4.0	3.0	23.73	0.92	0.989
19	9.5	8.5	23.72	0.91	0.979
30	15.0	14.0	23.71	0.90	0.968
42	21.0	20.0	23.70	0.89	0.957
53	26.5	25.5	23.69	0.88	0.946
65	32.5	31.5	23.68	0.87	0.936
78	39.0	38.0	23.67	0.86	0.925
90	45.0	44.0	23.66	0.85	0.914
101	50.5	49.5	23.65	0.84	0.903
127	63.5	62.5	23.63	0.82	0.882
139	69.5	68.5	23.62	0.81	0.871
140	70.0	69.0	23.63	0.82	0.882
141	70.5	69.5	23.62	0.81	0.871
150	75.0	74.0	23.61	0.80	0.860
151	75.5	74.5	23.62	0.81	0.871
154	77.0	76.0	23.61	0.80	0.860
165	82.5	81.5	23.60	0.79	0.850
179	89.5	88.5	23.59	0.78	0.839
180	90.0	89.0	23.60	0.79	0.850
181	90.5	89.5	23.59	0.78	0.839
191	95.5	94.5	23.58	0.77	0.828
204	102.0	101.0	23.57	0.76	0.817
218	109.0	108.0	23.56	0.75	0.807
232	116.0	115.0	23.55	0.74	0.796
244	122.0	121.0	23.54	0.73	0.785
256	128.0	127.0	23.53	0.72	0.774
270	135.0	134.0	23.52	0.71	0.763
299	149.5	148.5	23.50	0.69	0.742
314	157.0	156.0	23.49	0.68	0.731
327	163.5	162.5	23.48	0.67	0.720
343	171.5	170.5	23.47	0.66	0.710
357	178.5	177.5	23.46	0.65	0.699
372	186.0	185.0	23.45	0.64	0.688
390	195.0	194.0	23.44	0.63	0.677
405	202.5	201.5	23.43	0.62	0.667
425	212.5	211.5	23.42	0.61	0.656
442	221.0	220.0	23.41	0.60	0.645
460	230.0	229.0	23.40	0.59	0.634
476	238.0	237.0	23.39	0.58	0.624
491	245.5	244.5	23.38	0.57	0.613
493	246.5	245.5	23.39	0.58	0.624
495	247.5	246.5	23.38	0.57	0.613

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
524	262.0	261.0	23.36	0.55	0.591
543	271.5	270.5	23.35	0.54	0.581
560	280.0	279.0	23.34	0.53	0.570
580	290.0	289.0	23.33	0.52	0.559
598	299.0	298.0	23.32	0.51	0.548
599	299.5	298.5	23.33	0.52	0.559
600	300.0	299.0	23.32	0.51	0.548
611	305.5	304.5	23.31	0.50	0.538
612	306.0	305.0	23.32	0.51	0.548
613	306.5	305.5	23.31	0.50	0.538
631	315.5	314.5	23.30	0.49	0.527
649	324.5	323.5	23.29	0.48	0.516
692	346.0	345.0	23.27	0.46	0.495
708	354.0	353.0	23.26	0.45	0.484
709	354.5	353.5	23.27	0.46	0.495
710	355.0	354.0	23.26	0.45	0.484
727	363.5	362.5	23.25	0.44	0.473
742	371.0	370.0	23.24	0.43	0.462
757	378.5	377.5	23.23	0.42	0.452
759	379.5	378.5	23.24	0.43	0.462
761	380.5	379.5	23.23	0.42	0.452
800	400.0	399.0	23.21	0.40	0.430
801	400.5	399.5	23.22	0.41	0.441
802	401.0	400.0	23.21	0.40	0.430
803	401.5	400.5	23.22	0.41	0.441
804	402.0	401.0	23.21	0.40	0.430
826	413.0	412.0	23.20	0.39	0.419
850	425.0	424.0	23.19	0.38	0.409
871	435.5	434.5	23.18	0.37	0.398
872	436.0	435.0	23.19	0.38	0.409
873	436.5	435.5	23.18	0.37	0.398
894	447.0	446.0	23.17	0.36	0.387
945	472.5	471.5	23.15	0.34	0.366
968	484.0	483.0	23.14	0.33	0.355
994	497.0	496.0	23.13	0.32	0.344
996	498.0	497.0	23.14	0.33	0.355
997	498.5	497.5	23.13	0.32	0.344
1000	500.0	499.0	23.14	0.33	0.355
1001	500.5	499.5	23.13	0.32	0.344
1025	512.5	511.5	23.12	0.31	0.333
1051	525.5	524.5	23.11	0.30	0.323
1080	540.0	539.0	23.10	0.29	0.312
1136	568.0	567.0	23.08	0.27	0.290
1165	582.5	581.5	23.07	0.26	0.280
1191	595.5	594.5	23.06	0.25	0.269
1226	613.0	612.0	23.05	0.24	0.258

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1227	613.5	612.5	23.06	0.25	0.269
1228	614.0	613.0	23.05	0.24	0.258
1286	643.0	642.0	23.03	0.22	0.237
1317	658.5	657.5	23.02	0.21	0.226
1392	696.0	695.0	23.00	0.19	0.204
1393	696.5	695.5	23.01	0.20	0.215
1402	701.0	700.0	23.00	0.19	0.204
1429	714.5	713.5	22.99	0.18	0.194
1431	715.5	714.5	23.00	0.19	0.204
1434	717.0	716.0	22.99	0.18	0.194
1436	718.0	717.0	23.00	0.19	0.204
1437	718.5	717.5	22.99	0.18	0.194
1526	763.0	762.0	22.97	0.16	0.172
1527	763.5	762.5	22.98	0.17	0.183
1530	765.0	764.0	22.97	0.16	0.172
1581	790.5	789.5	22.96	0.15	0.161
1583	791.5	790.5	22.97	0.16	0.172
1588	794.0	793.0	22.96	0.15	0.161
1675	837.5	836.5	22.94	0.13	0.140
1680	840.0	839.0	22.95	0.14	0.151
1681	840.5	839.5	22.94	0.13	0.140
1744	872.0	871.0	22.93	0.12	0.129
1747	873.5	872.5	22.94	0.13	0.140
1748	874.0	873.0	22.93	0.12	0.129
1879	939.5	938.5	22.91	0.10	0.108
1946	973.0	972.0	22.90	0.09	0.097
1949	974.5	973.5	22.91	0.10	0.108
1961	980.5	979.5	22.90	0.09	0.097
2115	1058.0	1057.0	22.88	0.07	0.075
2236	1118.0	1117.0	22.87	0.06	0.065
2242	1121.0	1120.0	22.88	0.07	0.075
2243	1122.0	1121.0	22.87	0.06	0.065
2244	1122.0	1121.0	22.88	0.07	0.075
2246	1123.0	1122.0	22.87	0.06	0.065
2247	1124.0	1123.0	22.88	0.07	0.075
2249	1125.0	1124.0	22.87	0.06	0.065
2250	1125.0	1124.0	22.88	0.07	0.075
2251	1126.0	1125.0	22.87	0.06	0.065
2491	1246.0	1245.0	22.85	0.04	0.043
2495	1248.0	1247.0	22.86	0.05	0.054
2512	1256.0	1255.0	22.85	0.04	0.043
2513	1257.0	1256.0	22.86	0.05	0.054
2514	1257.0	1256.0	22.85	0.04	0.043
2548	1274.0	1273.0	22.86	0.05	0.054
2549	1275.0	1274.0	22.85	0.04	0.043
2573	1287.0	1286.0	22.86	0.05	0.054

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
2574	1287.0	1286.0	22.85	0.04	0.043
2575	1288.0	1287.0	22.86	0.05	0.054
2576	1288.0	1287.0	22.85	0.04	0.043
2577	1289.0	1288.0	22.86	0.05	0.054
2580	1290.0	1289.0	22.85	0.04	0.043
2586	1293.0	1292.0	22.86	0.05	0.054
2587	1294.0	1293.0	22.85	0.04	0.043
2597	1299.0	1298.0	22.86	0.05	0.054
2600	1300.0	1299.0	22.85	0.04	0.043
2602	1301.0	1300.0	22.86	0.05	0.054
2603	1302.0	1301.0	22.85	0.04	0.043
2798	1399.0	1398.0	22.84	0.03	0.032
2799	1400.0	1399.0	22.85	0.04	0.043
2809	1405.0	1404.0	22.84	0.03	0.032
2810	1405.0	1404.0	22.85	0.04	0.043
2812	1406.0	1405.0	22.84	0.03	0.032
2814	1407.0	1406.0	22.85	0.04	0.043
2815	1408.0	1407.0	22.84	0.03	0.032
2816	1408.0	1407.0	22.85	0.04	0.043
2818	1409.0	1408.0	22.84	0.03	0.032
2825	1413.0	1412.0	22.85	0.04	0.043
2829	1415.0	1414.0	22.84	0.03	0.032
3256	1628.0	1627.0	22.84	0.03	0.032

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-3S

Rising Head "Slug-Out"

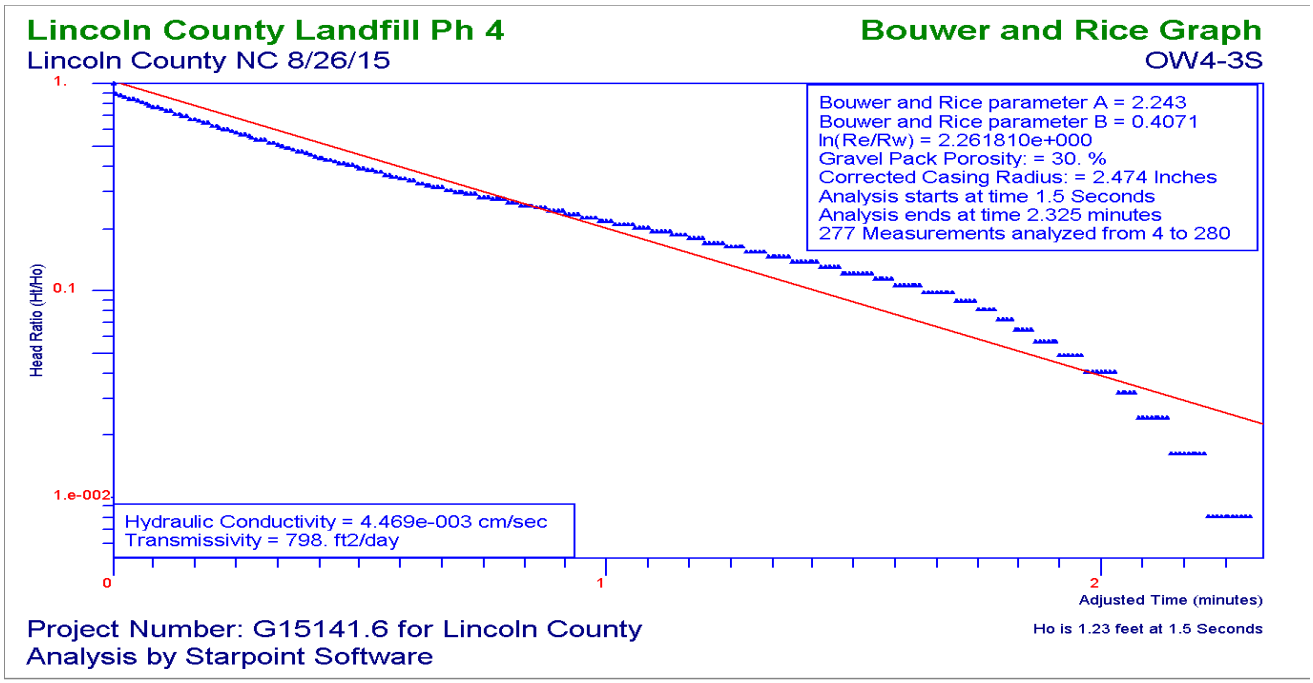
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/26/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-3S
Aquifer Thickness:	63 feet to rock
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	4.25 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.474 Inches
Static Water Level:	40.02 feet
Water Table to Screen Bottom:	8.93 feet
Method:	Slug Out (1.315" diameter solid slug)
Anisotropy Ratio:	1
Time Adjustment:	1.5 Seconds
Test starts with trial:	3
There are 280 time and drawdown measurements	
Maximum head :	1.23 feet
Minimum head:	0.01 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **4.47E-03 cm/sec**

K= **4,624.55 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-1.5	40.02	0.00	0.0000
3	1.0	-0.5	40.02	0.00	0.0000
4	1.5	0.0	41.25	1.23	1.0000
5	2.0	0.5	41.12	1.10	0.8943
6	2.5	1.0	41.10	1.08	0.8780
8	3.5	2.0	41.07	1.05	0.8537
10	4.5	3.0	41.04	1.02	0.8293
11	5.0	3.5	41.02	1.00	0.8130
12	5.5	4.0	41.01	0.99	0.8049
14	6.5	5.0	40.98	0.96	0.7805
15	7.0	5.5	40.97	0.95	0.7724
16	7.5	6.0	40.95	0.93	0.7561
17	8.0	6.5	40.94	0.92	0.7480
19	9.0	7.5	40.91	0.89	0.7236
21	10.0	8.5	40.89	0.87	0.7073
23	11.0	9.5	40.86	0.84	0.6829
25	12.0	10.5	40.84	0.82	0.6667
26	12.5	11.0	40.83	0.81	0.6585
28	13.5	12.0	40.80	0.78	0.6341
30	14.5	13.0	40.78	0.76	0.6179
32	15.5	14.0	40.76	0.74	0.6016
34	16.5	15.0	40.74	0.72	0.5854
35	17.0	15.5	40.73	0.71	0.5772
37	18.0	16.5	40.71	0.69	0.5610
39	19.0	17.5	40.69	0.67	0.5447
42	20.5	19.0	40.66	0.64	0.5203
45	22.0	20.5	40.64	0.62	0.5041
47	23.0	21.5	40.62	0.60	0.4878
49	24.0	22.5	40.60	0.58	0.4715
52	25.5	24.0	40.58	0.56	0.4553
54	26.5	25.0	40.56	0.54	0.4390
56	27.5	26.0	40.55	0.53	0.4309
59	29.0	27.5	40.53	0.51	0.4146
63	31.0	29.5	40.51	0.49	0.3984
66	32.5	31.0	40.49	0.47	0.3821
68	33.5	32.0	40.48	0.46	0.3740
72	35.5	34.0	40.46	0.44	0.3577
76	37.5	36.0	40.44	0.42	0.3415
80	39.5	38.0	40.42	0.40	0.3252
82	40.5	39.0	40.41	0.39	0.3171
87	43.0	41.5	40.39	0.37	0.3008
93	46.0	44.5	40.37	0.35	0.2846
100	49.5	48.0	40.35	0.33	0.2683
107	53.0	51.5	40.33	0.31	0.2520
114	56.5	55.0	40.31	0.29	0.2358
118	58.5	57.0	40.30	0.28	0.2276

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
126	62.5	61.0	40.28	0.26	0.2114
135	67.0	65.5	40.26	0.24	0.1951
144	71.5	70.0	40.24	0.22	0.1789
148	73.5	72.0	40.23	0.21	0.1707
158	78.5	77.0	40.21	0.19	0.1545
169	84.0	82.5	40.19	0.17	0.1382
181	90.0	88.5	40.17	0.15	0.1220
189	94.0	92.5	40.16	0.14	0.1138
201	100.0	98.5	40.14	0.12	0.0976
214	106.5	105.0	40.12	0.10	0.0813
223	111.0	109.5	40.10	0.08	0.0650
234	116.5	115.0	40.08	0.06	0.0488
248	123.5	122.0	40.06	0.04	0.0325
253	126.0	124.5	40.05	0.03	0.0244
270	134.5	133.0	40.03	0.01	0.0081
280	139.5	138.0	40.03	0.01	0.0081

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-3D

Falling Head "Slug-In"

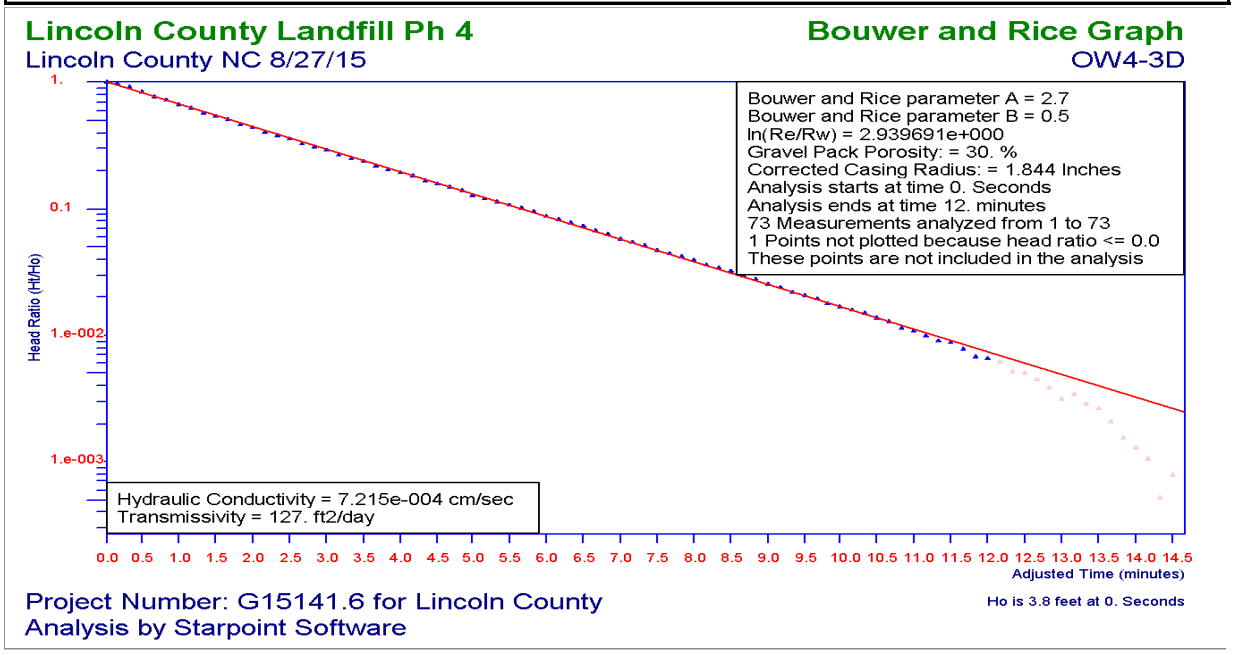
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/27/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-3D
Aquifer Thickness:	62 feet to bedrock
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level BTOC:	43.85 feet
Water Table to Screen Bottom:	40.05 feet
Anisotropy Ratio:	1
Method:	Slug In (2.5 gallons of water injected)
Time Adjustment:	1.5 Seconds
Test starts with trial:	1
There are 89 time and drawdown measurements	
Maximum head :	3.8 feet
Minimum head:	0 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **7.21E-04 cm/sec**

K= **746.43 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0	0	40.05	3.80	1.0000
2	10	10	40.07	3.78	0.9947
3	20	20	40.36	3.49	0.9195
4	30	30	40.62	3.24	0.8513
5	40	40	40.85	3.00	0.7895
6	50	50	41.06	2.79	0.7329
7	60	60	41.26	2.59	0.6811
8	70	70	41.44	2.41	0.6332
9	80	80	41.61	2.24	0.5884
10	90	90	41.77	2.08	0.5468
11	100	100	41.91	1.94	0.5092
12	110	110	42.05	1.80	0.4739
13	120	120	42.17	1.68	0.4418
14	130	130	42.29	1.56	0.4116
15	140	140	42.39	1.46	0.3834
16	150	150	42.49	1.36	0.3576
17	160	160	42.58	1.27	0.3337
18	170	170	42.67	1.18	0.3111
19	180	180	42.74	1.11	0.2908
20	190	190	42.82	1.03	0.2711
21	200	200	42.89	0.96	0.2537
22	210	210	42.95	0.90	0.2368
23	220	220	43.01	0.84	0.2216
24	230	230	43.06	0.79	0.2074
25	240	240	43.11	0.74	0.1937
26	250	250	43.16	0.69	0.1816
27	260	260	43.20	0.65	0.1697
28	270	270	43.25	0.60	0.1589
29	280	280	43.28	0.57	0.1492
30	290	290	43.32	0.53	0.1395
31	300	300	43.35	0.50	0.1311
32	310	310	43.38	0.47	0.1224
33	320	320	43.41	0.44	0.1147
34	330	330	43.44	0.41	0.1079
35	340	340	43.47	0.38	0.1011
36	350	350	43.49	0.36	0.0950
37	360	360	43.51	0.34	0.0884
38	370	370	43.53	0.32	0.0832
39	380	380	43.55	0.30	0.0784
40	390	390	43.57	0.28	0.0732
41	400	400	43.59	0.26	0.0684
42	410	410	43.61	0.24	0.0642
43	420	420	43.63	0.23	0.0592
44	430	430	43.64	0.21	0.0558

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
45	440	440	43.65	0.20	0.0521
46	450	450	43.67	0.18	0.0482
47	460	460	43.68	0.17	0.0453
48	470	470	43.69	0.16	0.0424
50	490	490	43.71	0.14	0.0368
51	500	500	43.72	0.13	0.0342
53	520	520	43.74	0.11	0.0295
55	540	540	43.75	0.10	0.0255
57	560	560	43.77	0.09	0.0224
59	580	580	43.77	0.08	0.0197
62	610	610	43.79	0.06	0.0158
65	640	640	43.80	0.05	0.0129
68	670	670	43.81	0.04	0.0100
72	710	710	43.82	0.03	0.0068
78	770	770	43.84	0.02	0.0039
86	850	850	43.85	0.00	0.0011
89	880	880	43.85	0.00	0.0003

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

B4-3D(Rock)

Falling Head "Slug-In"

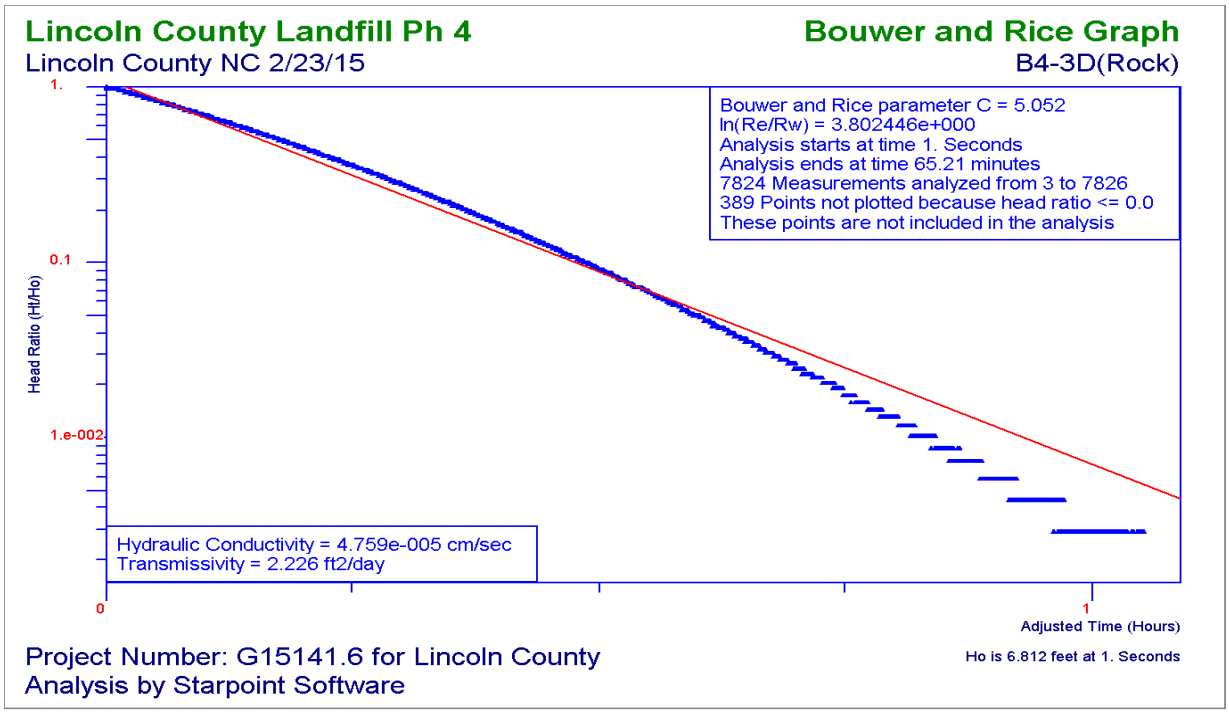
Site Name:	Lincoln County Landfill Ph 4	
Location:	Lincoln County NC	
Test Date:	2/23/2015	
Client:	Lincoln County	
Project Number:	G15141.6	
Well Label:	B4-3D(Rock)	
Aquifer Thickness:	16.5 feet	Length core hole
Open Rock Hole Length:	16.5 feet	Open core hole
Core Casing Radius:	1.19 Inches	NQ Core Casing
Effective Radius:	1.49 Inches	NQ Core hole
Static Water Level BTOC:	37.02 feet	
Water Table to Screen Bottom:	42.68 feet	
Method:	Slug In (1.2 gallonds of water injected)	
Anisotropy Ratio:	0	
Time Adjustment:	1 Seconds	
Test starts with trial:	2	
There are 7,836 time and drawdown measurements		
Maximum head :	6.812 feet	
Minimum head:	0 feet	

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **4.76E-05 cm/sec**

K= **49.24 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-1.0	37.02	0.00	0.00000
3	1.0	0.0	43.83	6.81	1.00000
4	1.5	0.5	43.79	6.77	0.99380
6	2.5	1.5	43.80	6.78	0.99530
10	4.5	3.5	43.82	6.80	0.99820
40	19.5	18.5	43.80	6.78	0.99530
45	22.0	21.0	43.79	6.77	0.99380
54	26.5	25.5	43.77	6.75	0.99090
59	29.0	28.0	43.76	6.74	0.98940
68	33.5	32.5	43.74	6.72	0.98650
75	37.0	36.0	43.72	6.70	0.98360
84	41.5	40.5	43.70	6.68	0.98060
87	43.0	42.0	43.69	6.67	0.97920
94	46.5	45.5	43.67	6.65	0.97620
102	50.5	49.5	43.65	6.63	0.97330
109	54.0	53.0	43.63	6.61	0.97030
112	55.5	54.5	43.62	6.60	0.96890
118	58.5	57.5	43.60	6.58	0.96590
125	62.0	61.0	43.58	6.56	0.96300
132	65.5	64.5	43.56	6.54	0.96010
138	68.5	67.5	43.54	6.52	0.95710
145	72.0	71.0	43.52	6.50	0.95420
148	73.5	72.5	43.51	6.49	0.95270
154	76.5	75.5	43.49	6.47	0.94980
160	79.5	78.5	43.47	6.45	0.94690
166	82.5	81.5	43.45	6.43	0.94390
170	84.5	83.5	43.44	6.42	0.94250
176	87.5	86.5	43.42	6.40	0.93950
182	90.5	89.5	43.40	6.38	0.93660
189	94.0	93.0	43.38	6.36	0.93360
193	96.0	95.0	43.37	6.35	0.93220
198	98.5	97.5	43.35	6.33	0.92920
205	102.0	101.0	43.33	6.31	0.92630
211	105.0	104.0	43.31	6.29	0.92340
218	108.5	107.5	43.29	6.27	0.92040
224	111.5	110.5	43.27	6.25	0.91750
227	113.0	112.0	43.26	6.24	0.91600
233	116.0	115.0	43.24	6.22	0.91310
239	119.0	118.0	43.22	6.20	0.91020
245	122.0	121.0	43.20	6.18	0.90720
248	123.5	122.5	43.19	6.17	0.90580
255	127.0	126.0	43.17	6.15	0.90280
261	130.0	129.0	43.15	6.13	0.89990
268	133.5	132.5	43.13	6.11	0.89690

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
270	134.5	133.5	43.12	6.10	0.89550
277	138.0	137.0	43.10	6.08	0.89250
283	141.0	140.0	43.08	6.06	0.88960
290	144.5	143.5	43.06	6.04	0.88670
296	147.5	146.5	43.04	6.02	0.88370
302	150.5	149.5	43.02	6.00	0.88080
306	152.5	151.5	43.01	5.99	0.87930
312	155.5	154.5	42.99	5.97	0.87640
318	158.5	157.5	42.97	5.95	0.87350
325	162.0	161.0	42.95	5.93	0.87050
328	163.5	162.5	42.94	5.92	0.86910
334	166.5	165.5	42.92	5.90	0.86610
340	169.5	168.5	42.90	5.88	0.86320
347	173.0	172.0	42.88	5.86	0.86020
351	175.0	174.0	42.87	5.85	0.85880
357	178.0	177.0	42.85	5.83	0.85580
364	181.5	180.5	42.83	5.81	0.85290
370	184.5	183.5	42.81	5.79	0.85000
376	187.5	186.5	42.79	5.77	0.84700
383	191.0	190.0	42.77	5.75	0.84410
387	193.0	192.0	42.76	5.74	0.84260
393	196.0	195.0	42.74	5.72	0.83970
399	199.0	198.0	42.72	5.70	0.83680
407	203.0	202.0	42.70	5.68	0.83380
410	204.5	203.5	42.69	5.67	0.83240
417	208.0	207.0	42.67	5.65	0.82940
423	211.0	210.0	42.65	5.63	0.82650
429	214.0	213.0	42.63	5.61	0.82350
433	216.0	215.0	42.62	5.60	0.82210
440	219.5	218.5	42.60	5.58	0.81910
446	222.5	221.5	42.58	5.56	0.81620
454	226.5	225.5	42.56	5.54	0.81330
460	229.5	228.5	42.54	5.52	0.81030
467	233.0	232.0	42.52	5.50	0.80740
470	234.5	233.5	42.51	5.49	0.80590
476	237.5	236.5	42.49	5.47	0.80300
483	241.0	240.0	42.47	5.45	0.80010
490	244.5	243.5	42.45	5.43	0.79710
493	246.0	245.0	42.44	5.42	0.79570
499	249.0	248.0	42.42	5.40	0.79270
507	253.0	252.0	42.40	5.38	0.78980
513	256.0	255.0	42.38	5.36	0.78680
517	258.0	257.0	42.37	5.35	0.78540
524	261.5	260.5	42.35	5.33	0.78240
530	264.5	263.5	42.33	5.31	0.77950

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
538	268.5	267.5	42.31	5.29	0.77660
544	271.5	270.5	42.29	5.27	0.77360
552	275.5	274.5	42.27	5.25	0.77070
554	276.5	275.5	42.26	5.24	0.76920
561	280.0	279.0	42.24	5.22	0.76630
568	283.5	282.5	42.22	5.20	0.76340
575	287.0	286.0	42.20	5.18	0.76040
578	288.5	287.5	42.19	5.17	0.75900
585	292.0	291.0	42.17	5.15	0.75600
593	296.0	295.0	42.15	5.13	0.75310
599	299.0	298.0	42.13	5.11	0.75010
603	301.0	300.0	42.12	5.10	0.74870
610	304.5	303.5	42.10	5.08	0.74570
618	308.5	307.5	42.08	5.06	0.74280
624	311.5	310.5	42.06	5.04	0.73990
631	315.0	314.0	42.04	5.02	0.73690
638	318.5	317.5	42.02	5.00	0.73400
642	320.5	319.5	42.01	4.99	0.73250
649	324.0	323.0	41.99	4.97	0.72960
657	328.0	327.0	41.97	4.95	0.72670
664	331.5	330.5	41.95	4.93	0.72370
668	333.5	332.5	41.94	4.92	0.72230
675	337.0	336.0	41.92	4.90	0.71930
682	340.5	339.5	41.90	4.88	0.71640
690	344.5	343.5	41.88	4.86	0.71340
693	346.0	345.0	41.87	4.85	0.71200
700	349.5	348.5	41.85	4.83	0.70900
708	353.5	352.5	41.83	4.81	0.70610
715	357.0	356.0	41.81	4.79	0.70320
723	361.0	360.0	41.79	4.77	0.70020
730	364.5	363.5	41.77	4.75	0.69730
734	366.5	365.5	41.76	4.74	0.69580
741	370.0	369.0	41.74	4.72	0.69290
748	373.5	372.5	41.72	4.70	0.69000
756	377.5	376.5	41.70	4.68	0.68700
760	379.5	378.5	41.69	4.67	0.68560
767	383.0	382.0	41.67	4.65	0.68260
774	386.5	385.5	41.65	4.63	0.67970
782	390.5	389.5	41.63	4.61	0.67670
786	392.5	391.5	41.62	4.60	0.67530
794	396.5	395.5	41.60	4.58	0.67230
801	400.0	399.0	41.58	4.56	0.66940
809	404.0	403.0	41.56	4.54	0.66650
816	407.5	406.5	41.54	4.52	0.66350
824	411.5	410.5	41.52	4.50	0.66060

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
828	413.5	412.5	41.51	4.49	0.65910
836	417.5	416.5	41.49	4.47	0.65620
844	421.5	420.5	41.47	4.45	0.65330
852	425.5	424.5	41.45	4.43	0.65030
856	427.5	426.5	41.44	4.42	0.64890
864	431.5	430.5	41.42	4.40	0.64590
872	435.5	434.5	41.40	4.38	0.64300
879	439.0	438.0	41.38	4.36	0.64000
884	441.5	440.5	41.37	4.35	0.63860
892	445.5	444.5	41.35	4.33	0.63560
899	449.0	448.0	41.33	4.31	0.63270
907	453.0	452.0	41.31	4.29	0.62980
915	457.0	456.0	41.29	4.27	0.62680
923	461.0	460.0	41.27	4.25	0.62390
928	463.5	462.5	41.26	4.24	0.62240
936	467.5	466.5	41.24	4.22	0.61950
944	471.5	470.5	41.22	4.20	0.61660
952	475.5	474.5	41.20	4.18	0.61360
956	477.5	476.5	41.19	4.17	0.61220
964	481.5	480.5	41.17	4.15	0.60920
973	486.0	485.0	41.15	4.13	0.60630
980	489.5	488.5	41.13	4.11	0.60330
984	491.5	490.5	41.12	4.10	0.60190
993	496.0	495.0	41.10	4.08	0.59890
1001	500.0	499.0	41.08	4.06	0.59600
1009	504.0	503.0	41.06	4.04	0.59310
1019	509.0	508.0	41.04	4.02	0.59010
1026	512.5	511.5	41.02	4.00	0.58720
1031	515.0	514.0	41.01	3.99	0.58570
1040	519.5	518.5	40.99	3.97	0.58280
1047	523.0	522.0	40.97	3.95	0.57990
1056	527.5	526.5	40.95	3.93	0.57690
1061	530.0	529.0	40.94	3.92	0.57550
1070	534.5	533.5	40.92	3.90	0.57250
1073	536.0	535.0	40.91	3.89	0.57110
1082	540.5	539.5	40.89	3.87	0.56810
1091	545.0	544.0	40.87	3.85	0.56520
1100	549.5	548.5	40.85	3.83	0.56220
1109	554.0	553.0	40.83	3.81	0.55930
1117	558.0	557.0	40.81	3.79	0.55640
1122	560.5	559.5	40.80	3.78	0.55490
1132	565.5	564.5	40.78	3.76	0.55200
1140	569.5	568.5	40.76	3.74	0.54900
1148	573.5	572.5	40.74	3.72	0.54610
1153	576.0	575.0	40.73	3.71	0.54460

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1163	581.0	580.0	40.71	3.69	0.54170
1171	585.0	584.0	40.69	3.67	0.53880
1181	590.0	589.0	40.67	3.65	0.53580
1185	592.0	591.0	40.66	3.64	0.53440
1193	596.0	595.0	40.64	3.62	0.53140
1203	601.0	600.0	40.62	3.60	0.52850
1212	605.5	604.5	40.60	3.58	0.52550
1221	610.0	609.0	40.58	3.56	0.52260
1230	614.5	613.5	40.56	3.54	0.51970
1235	617.0	616.0	40.55	3.53	0.51820
1245	622.0	621.0	40.53	3.51	0.51530
1254	626.5	625.5	40.51	3.49	0.51230
1263	631.0	630.0	40.49	3.47	0.50940
1268	633.5	632.5	40.48	3.46	0.50790
1278	638.5	637.5	40.46	3.44	0.50500
1287	643.0	642.0	40.44	3.42	0.50210
1297	648.0	647.0	40.42	3.40	0.49910
1302	650.5	649.5	40.41	3.39	0.49770
1310	654.5	653.5	40.39	3.37	0.49470
1320	659.5	658.5	40.37	3.35	0.49180
1330	664.5	663.5	40.35	3.33	0.48880
1339	669.0	668.0	40.33	3.31	0.48590
1350	674.5	673.5	40.31	3.29	0.48300
1354	676.5	675.5	40.30	3.28	0.48150
1365	682.0	681.0	40.28	3.26	0.47860
1374	686.5	685.5	40.26	3.24	0.47560
1384	691.5	690.5	40.24	3.22	0.47270
1389	694.0	693.0	40.23	3.21	0.47120
1399	699.0	698.0	40.21	3.19	0.46830
1410	704.5	703.5	40.19	3.17	0.46540
1420	709.5	708.5	40.17	3.15	0.46240
1424	711.5	710.5	40.16	3.14	0.46100
1434	716.5	715.5	40.14	3.12	0.45800
1445	722.0	721.0	40.12	3.10	0.45510
1454	726.5	725.5	40.10	3.08	0.45210
1465	732.0	731.0	40.08	3.06	0.44920
1476	737.5	736.5	40.06	3.04	0.44630
1481	740.0	739.0	40.05	3.03	0.44480
1491	745.0	744.0	40.03	3.01	0.44190
1502	750.5	749.5	40.01	2.99	0.43890
1512	755.5	754.5	39.99	2.97	0.43600
1517	758.0	757.0	39.98	2.96	0.43450
1529	764.0	763.0	39.96	2.94	0.43160
1539	769.0	768.0	39.94	2.92	0.42870
1550	774.5	773.5	39.92	2.90	0.42570

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1555	777.0	776.0	39.91	2.89	0.42430
1566	782.5	781.5	39.89	2.87	0.42130
1576	787.5	786.5	39.87	2.85	0.41840
1588	793.5	792.5	39.85	2.83	0.41540
1599	799.0	798.0	39.83	2.81	0.41250
1611	805.0	804.0	39.81	2.79	0.40960
1616	807.5	806.5	39.80	2.78	0.40810
1627	813.0	812.0	39.78	2.76	0.40520
1638	818.5	817.5	39.76	2.74	0.40220
1650	824.5	823.5	39.74	2.72	0.39930
1654	826.5	825.5	39.73	2.71	0.39780
1666	832.5	831.5	39.71	2.69	0.39490
1678	838.5	837.5	39.69	2.67	0.39200
1689	844.0	843.0	39.67	2.65	0.38900
1695	847.0	846.0	39.66	2.64	0.38760
1706	852.5	851.5	39.64	2.62	0.38460
1719	859.0	858.0	39.62	2.60	0.38170
1730	864.5	863.5	39.60	2.58	0.37870
1741	870.0	869.0	39.58	2.56	0.37580
1754	876.5	875.5	39.56	2.54	0.37290
1760	879.5	878.5	39.55	2.53	0.37140
1771	885.0	884.0	39.53	2.51	0.36850
1784	891.5	890.5	39.51	2.49	0.36550
1797	898.0	897.0	39.49	2.47	0.36260
1802	900.5	899.5	39.48	2.46	0.36110
1814	906.5	905.5	39.46	2.44	0.35820
1827	913.0	912.0	39.44	2.42	0.35530
1839	919.0	918.0	39.42	2.40	0.35230
1845	922.0	921.0	39.41	2.39	0.35090
1859	929.0	928.0	39.39	2.37	0.34790
1872	935.5	934.5	39.37	2.35	0.34500
1884	941.5	940.5	39.35	2.33	0.34200
1896	947.5	946.5	39.33	2.31	0.33910
1910	954.5	953.5	39.31	2.29	0.33620
1916	957.5	956.5	39.30	2.28	0.33470
1928	963.5	962.5	39.28	2.26	0.33180
1942	970.5	969.5	39.26	2.24	0.32880
1955	977.0	976.0	39.24	2.22	0.32590
1962	980.5	979.5	39.23	2.21	0.32440
1974	986.5	985.5	39.21	2.19	0.32150
1989	994.0	993.0	39.19	2.17	0.31860
2003	1001.0	1000.0	39.17	2.15	0.31560
2008	1003.0	1003.0	39.16	2.14	0.31420
2022	1010.0	1010.0	39.14	2.12	0.31120
2035	1017.0	1016.0	39.12	2.10	0.30830

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
2050	1025.0	1024.0	39.10	2.08	0.30530
2065	1032.0	1031.0	39.08	2.06	0.30240
2078	1039.0	1038.0	39.06	2.04	0.29950
2086	1043.0	1042.0	39.05	2.03	0.29800
2100	1050.0	1049.0	39.03	2.01	0.29510
2113	1056.0	1055.0	39.01	1.99	0.29210
2128	1064.0	1063.0	38.99	1.97	0.28920
2134	1067.0	1066.0	38.98	1.96	0.28770
2150	1075.0	1074.0	38.96	1.94	0.28480
2164	1082.0	1081.0	38.94	1.92	0.28190
2179	1089.0	1088.0	38.92	1.90	0.27890
2186	1093.0	1092.0	38.91	1.89	0.27750
2200	1100.0	1099.0	38.89	1.87	0.27450
2216	1108.0	1107.0	38.87	1.85	0.27160
2231	1115.0	1114.0	38.85	1.83	0.26860
2248	1124.0	1123.0	38.83	1.81	0.26570
2262	1131.0	1130.0	38.81	1.79	0.26280
2271	1135.0	1134.0	38.80	1.78	0.26130
2287	1143.0	1142.0	38.78	1.76	0.25840
2303	1151.0	1150.0	38.76	1.74	0.25540
2317	1158.0	1157.0	38.74	1.72	0.25250
2326	1163.0	1162.0	38.73	1.71	0.25100
2341	1170.0	1169.0	38.71	1.69	0.24810
2360	1180.0	1179.0	38.69	1.67	0.24520
2375	1187.0	1186.0	38.67	1.65	0.24220
2384	1192.0	1191.0	38.66	1.64	0.24080
2400	1200.0	1199.0	38.64	1.62	0.23780
2418	1209.0	1208.0	38.62	1.60	0.23490
2434	1217.0	1216.0	38.60	1.58	0.23190
2450	1225.0	1224.0	38.58	1.56	0.22900
2468	1234.0	1233.0	38.56	1.54	0.22610
2477	1238.0	1237.0	38.55	1.53	0.22460
2494	1247.0	1246.0	38.53	1.51	0.22170
2514	1257.0	1256.0	38.51	1.49	0.21870
2531	1265.0	1264.0	38.49	1.47	0.21580
2540	1270.0	1269.0	38.48	1.46	0.21430
2541	1270.0	1269.0	38.49	1.47	0.21580
2542	1271.0	1270.0	38.48	1.46	0.21430
2559	1279.0	1278.0	38.46	1.44	0.21140
2578	1289.0	1288.0	38.44	1.42	0.20850
2597	1298.0	1297.0	38.42	1.40	0.20550
2607	1303.0	1302.0	38.41	1.39	0.20410
2625	1312.0	1311.0	38.39	1.37	0.20110
2645	1322.0	1321.0	38.37	1.35	0.19820
2664	1332.0	1331.0	38.35	1.33	0.19520

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
2685	1342.0	1341.0	38.33	1.31	0.19230
2704	1352.0	1351.0	38.31	1.29	0.18940
2716	1358.0	1357.0	38.30	1.28	0.18790
2734	1366.0	1366.0	38.28	1.26	0.18500
2756	1378.0	1377.0	38.26	1.24	0.18200
2778	1389.0	1388.0	38.24	1.22	0.17910
2789	1394.0	1393.0	38.23	1.21	0.17760
2810	1405.0	1404.0	38.21	1.19	0.17470
2834	1417.0	1416.0	38.19	1.17	0.17180
2854	1427.0	1426.0	38.17	1.15	0.16880
2865	1432.0	1431.0	38.16	1.14	0.16740
2890	1445.0	1444.0	38.14	1.12	0.16440
2911	1455.0	1454.0	38.12	1.10	0.16150
2936	1468.0	1467.0	38.10	1.08	0.15850
2958	1479.0	1478.0	38.08	1.06	0.15560
2984	1492.0	1491.0	38.06	1.04	0.15270
2996	1497.0	1497.0	38.05	1.03	0.15120
3023	1511.0	1510.0	38.03	1.01	0.14830
3045	1522.0	1521.0	38.01	0.99	0.14530
3071	1535.0	1534.0	37.99	0.97	0.14240
3085	1542.0	1541.0	37.98	0.96	0.14090
3113	1556.0	1555.0	37.96	0.94	0.13800
3137	1568.0	1567.0	37.94	0.92	0.13510
3162	1580.0	1580.0	37.92	0.90	0.13210
3178	1589.0	1588.0	37.91	0.89	0.13070
3179	1589.0	1588.0	37.92	0.90	0.13210
3180	1590.0	1589.0	37.91	0.89	0.13070
3206	1603.0	1602.0	37.89	0.87	0.12770
3236	1618.0	1617.0	37.87	0.85	0.12480
3266	1633.0	1632.0	37.85	0.83	0.12180
3296	1648.0	1647.0	37.83	0.81	0.11890
3324	1662.0	1661.0	37.81	0.79	0.11600
3341	1670.0	1669.0	37.80	0.78	0.11450
3371	1685.0	1684.0	37.78	0.76	0.11160
3405	1702.0	1701.0	37.76	0.74	0.10860
3438	1719.0	1718.0	37.74	0.72	0.10570
3455	1727.0	1726.0	37.73	0.71	0.10420
3492	1745.0	1745.0	37.71	0.69	0.10130
3525	1762.0	1761.0	37.69	0.67	0.09836
3526	1763.0	1762.0	37.70	0.68	0.09982
3527	1763.0	1762.0	37.69	0.67	0.09836
3560	1780.0	1779.0	37.67	0.65	0.09542
3580	1790.0	1789.0	37.66	0.64	0.09395
3617	1808.0	1807.0	37.64	0.62	0.09102
3654	1827.0	1826.0	37.62	0.60	0.08808

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
3696	1848.0	1847.0	37.60	0.58	0.08514
3735	1867.0	1866.0	37.58	0.56	0.08221
3778	1889.0	1888.0	37.56	0.54	0.07927
3800	1900.0	1899.0	37.55	0.53	0.07780
3841	1920.0	1919.0	37.53	0.51	0.07487
3888	1944.0	1943.0	37.51	0.49	0.07193
3889	1944.0	1943.0	37.52	0.50	0.07340
3890	1945.0	1944.0	37.51	0.49	0.07193
3943	1971.0	1970.0	37.49	0.47	0.06900
3960	1979.0	1979.0	37.48	0.46	0.06753
3961	1980.0	1979.0	37.49	0.47	0.06900
3962	1981.0	1980.0	37.48	0.46	0.06753
4016	2007.0	2007.0	37.46	0.44	0.06459
4065	2032.0	2031.0	37.44	0.42	0.06166
4066	2033.0	2032.0	37.45	0.43	0.06312
4068	2034.0	2033.0	37.44	0.42	0.06166
4117	2058.0	2057.0	37.42	0.40	0.05872
4151	2075.0	2074.0	37.41	0.39	0.05725
4153	2076.0	2075.0	37.42	0.40	0.05872
4154	2077.0	2076.0	37.41	0.39	0.05725
4210	2105.0	2104.0	37.39	0.37	0.05432
4269	2134.0	2133.0	37.37	0.35	0.05138
4334	2167.0	2166.0	37.35	0.33	0.04844
4407	2203.0	2202.0	37.33	0.31	0.04551
4408	2204.0	2203.0	37.34	0.32	0.04698
4409	2204.0	2203.0	37.33	0.31	0.04551
4477	2238.0	2237.0	37.31	0.29	0.04257
4514	2257.0	2256.0	37.30	0.28	0.04110
4593	2296.0	2295.0	37.28	0.26	0.03817
4673	2336.0	2335.0	37.26	0.24	0.03523
4674	2337.0	2336.0	37.27	0.25	0.03670
4676	2338.0	2337.0	37.26	0.24	0.03523
4679	2339.0	2338.0	37.27	0.25	0.03670
4680	2340.0	2339.0	37.26	0.24	0.03523
4772	2386.0	2385.0	37.24	0.22	0.03230
4820	2410.0	2409.0	37.23	0.21	0.03083
4822	2411.0	2410.0	37.24	0.22	0.03230
4823	2411.0	2410.0	37.23	0.21	0.03083
4924	2462.0	2461.0	37.21	0.19	0.02789
5031	2515.0	2514.0	37.19	0.17	0.02496
5032	2516.0	2515.0	37.20	0.18	0.02642
5034	2517.0	2516.0	37.19	0.17	0.02496
5035	2517.0	2516.0	37.20	0.18	0.02642
5036	2518.0	2517.0	37.19	0.17	0.02496
5161	2580.0	2579.0	37.17	0.15	0.02202

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
5237	2618.0	2617.0	37.16	0.14	0.02055
5386	2693.0	2692.0	37.14	0.12	0.01762
5562	2781.0	2780.0	37.12	0.10	0.01468
5563	2781.0	2780.0	37.13	0.11	0.01615
5565	2782.0	2781.0	37.12	0.10	0.01468
5785	2892.0	2891.0	37.10	0.08	0.01174
6025	3012.0	3011.0	37.08	0.06	0.00881
6026	3013.0	3012.0	37.09	0.07	0.01028
6048	3024.0	3023.0	37.08	0.06	0.00881
6049	3024.0	3023.0	37.09	0.07	0.01028
6050	3025.0	3024.0	37.08	0.06	0.00881
6051	3025.0	3024.0	37.09	0.07	0.01028
6053	3026.0	3025.0	37.08	0.06	0.00881
6054	3027.0	3026.0	37.09	0.07	0.01028
6055	3027.0	3026.0	37.08	0.06	0.00881
6389	3194.0	3193.0	37.06	0.04	0.00587
6588	3294.0	3293.0	37.05	0.03	0.00440
6589	3294.0	3293.0	37.06	0.04	0.00587
6596	3298.0	3297.0	37.05	0.03	0.00440
6600	3300.0	3299.0	37.06	0.04	0.00587
6601	3300.0	3299.0	37.05	0.03	0.00440
6602	3301.0	3300.0	37.06	0.04	0.00587
6603	3301.0	3300.0	37.05	0.03	0.00440
6605	3302.0	3301.0	37.06	0.04	0.00587
6607	3303.0	3302.0	37.05	0.03	0.00440
6609	3304.0	3303.0	37.06	0.04	0.00587
6610	3304.0	3304.0	37.05	0.03	0.00440
6611	3305.0	3304.0	37.06	0.04	0.00587
6612	3305.0	3304.0	37.05	0.03	0.00440
6613	3306.0	3305.0	37.06	0.04	0.00587
6617	3308.0	3307.0	37.05	0.03	0.00440
6618	3309.0	3308.0	37.06	0.04	0.00587
6621	3310.0	3309.0	37.05	0.03	0.00440
6622	3311.0	3310.0	37.06	0.04	0.00587
6640	3319.0	3318.0	37.05	0.03	0.00440
6641	3320.0	3319.0	37.06	0.04	0.00587
6643	3321.0	3320.0	37.05	0.03	0.00440
6644	3322.0	3321.0	37.06	0.04	0.00587
6650	3325.0	3324.0	37.05	0.03	0.00440
7402	3701.0	3700.0	37.03	0.01	0.00147
7836	3918.0	3917.0	37.03	0.01	0.00147

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-4

Rising Head "Slug-Out"

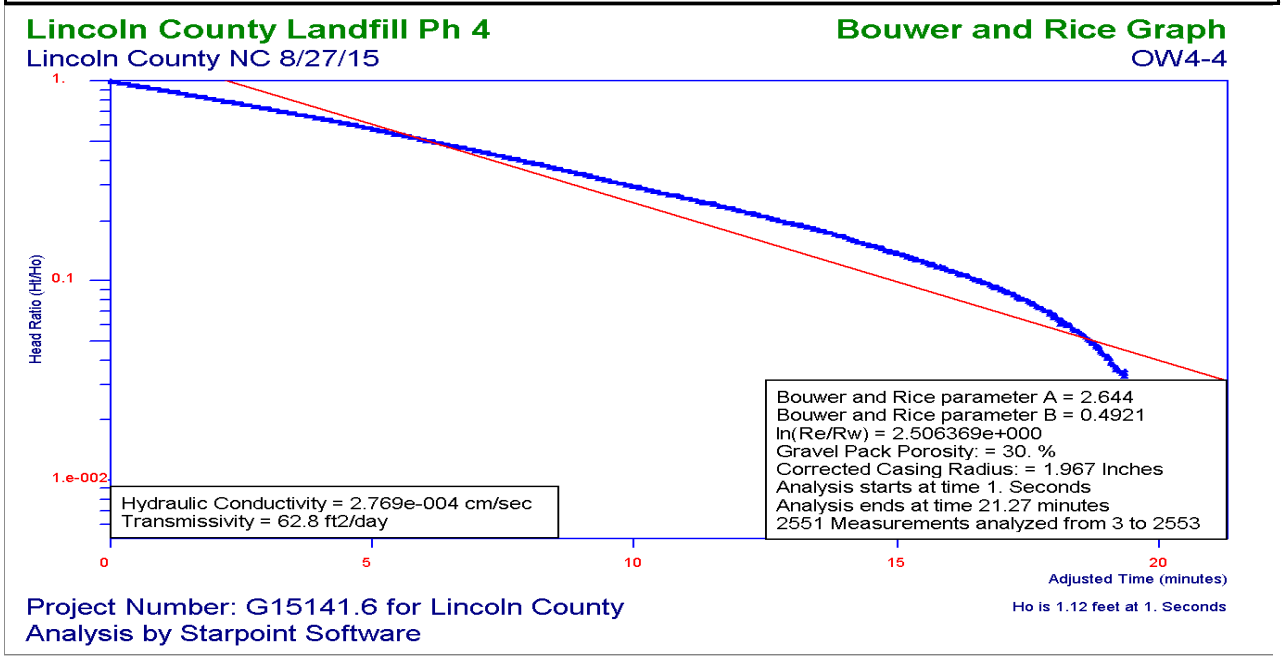
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/27/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-4
Aquifer Thickness:	73 feet to bedrock
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3.25 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.967 Inches
Static Water Level:	24.55 feet
Water Table to Screen Bottom:	10.35 feet
Method:	Slug Out (1.315" diameter solid slug)
Anisotropy Ratio:	1
Time Adjustment:	1.5 Seconds
Test starts with trial:	2
There are 2,553 time and drawdown measurements	
Maximum head :	1.12 feet
Minimum head:	0.02 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **2.77E-04 cm/sec**

K= **286.53 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-1.0	24.55	0.00	0.0000
3	1.0	0.0	25.67	1.12	1.0000
7	3.0	2.0	25.66	1.12	0.9955
30	14.5	13.5	25.64	1.09	0.9768
41	20.0	19.0	25.63	1.08	0.9679
61	30.0	29.0	25.61	1.07	0.9509
85	42.0	41.0	25.59	1.05	0.9330
107	53.0	52.0	25.57	1.03	0.9152
108	53.5	52.5	25.58	1.03	0.9161
109	54.0	53.0	25.57	1.02	0.9134
132	65.5	64.5	25.55	1.00	0.8964
145	72.0	71.0	25.54	0.99	0.8875
166	82.5	81.5	25.52	0.98	0.8705
189	94.0	93.0	25.50	0.96	0.8527
213	106.0	105.0	25.48	0.93	0.8339
226	112.5	111.5	25.47	0.92	0.8250
250	124.5	123.5	25.45	0.91	0.8080
274	136.5	135.5	25.43	0.89	0.7902
298	148.5	147.5	25.41	0.87	0.7723
327	163.0	162.0	25.39	0.84	0.7536
340	169.5	168.5	25.38	0.83	0.7446
365	182.0	181.0	25.36	0.82	0.7277
391	195.0	194.0	25.34	0.80	0.7098
392	195.5	194.5	25.35	0.80	0.7107
394	196.5	195.5	25.34	0.79	0.7071
421	210.0	209.0	25.32	0.78	0.6920
450	224.5	223.5	25.30	0.75	0.6723
464	231.5	230.5	25.29	0.74	0.6643
492	245.5	244.5	25.27	0.72	0.6464
521	260.0	259.0	25.25	0.71	0.6295
549	274.0	273.0	25.23	0.69	0.6116
563	281.0	280.0	25.22	0.67	0.6018
589	294.0	293.0	25.20	0.66	0.5848
619	309.0	308.0	25.18	0.63	0.5661
650	324.5	323.5	25.16	0.61	0.5482
683	341.0	340.0	25.14	0.59	0.5295
699	349.0	348.0	25.13	0.58	0.5214
728	363.5	362.5	25.11	0.57	0.5045
729	364.0	363.0	25.12	0.57	0.5054
730	364.5	363.5	25.11	0.57	0.5045
764	381.5	380.5	25.09	0.55	0.4866
799	399.0	398.0	25.07	0.53	0.4687
838	418.5	417.5	25.05	0.50	0.4500
839	419.0	418.0	25.06	0.51	0.4509
840	419.5	418.5	25.05	0.50	0.4491

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
858	428.5	427.5	25.04	0.49	0.4411
893	446.0	445.0	25.02	0.47	0.4232
931	465.0	464.0	25.00	0.46	0.4062
970	484.5	483.5	24.98	0.44	0.3884
972	485.5	484.5	24.99	0.44	0.3893
973	486.0	485.0	24.98	0.43	0.3857
992	495.5	494.5	24.97	0.42	0.3786
993	496.0	495.0	24.98	0.43	0.3795
994	496.5	495.5	24.97	0.42	0.3786
1034	516.5	515.5	24.95	0.41	0.3616
1076	537.5	536.5	24.93	0.39	0.3437
1122	560.5	559.5	24.91	0.37	0.3259
1170	584.5	583.5	24.89	0.34	0.3071
1194	596.5	595.5	24.88	0.33	0.2982
1247	623.0	622.0	24.86	0.32	0.2812
1305	652.0	651.0	24.84	0.30	0.2634
1308	653.5	652.5	24.85	0.30	0.2643
1309	654.0	653.0	24.84	0.30	0.2634
1366	682.5	681.5	24.82	0.28	0.2455
1431	715.0	714.0	24.80	0.25	0.2268
1432	715.5	714.5	24.81	0.26	0.2286
1434	716.5	715.5	24.80	0.25	0.2268
1435	717.0	716.0	24.81	0.26	0.2277
1436	717.5	716.5	24.80	0.25	0.2259
1464	731.5	730.5	24.79	0.24	0.2179
1465	732.0	731.0	24.80	0.25	0.2188
1466	732.5	731.5	24.79	0.24	0.2170
1531	765.0	764.0	24.77	0.23	0.2009
1606	802.5	801.5	24.75	0.21	0.1830
1607	803.0	802.0	24.76	0.21	0.1839
1608	803.5	802.5	24.75	0.21	0.1830
1681	840.0	839.0	24.73	0.19	0.1652
1684	841.5	840.5	24.74	0.19	0.1661
1685	842.0	841.0	24.73	0.18	0.1634
1715	857.0	856.0	24.72	0.17	0.1554
1716	857.5	856.5	24.73	0.18	0.1563
1717	858.0	857.0	24.72	0.17	0.1554
1793	896.0	895.0	24.70	0.16	0.1384
1875	937.0	936.0	24.68	0.13	0.1196
1877	938.0	937.0	24.69	0.14	0.1214
1881	940.0	939.0	24.68	0.14	0.1205
1888	943.5	942.5	24.69	0.14	0.1214
1889	944.0	943.0	24.68	0.13	0.1196
1972	985.5	984.5	24.66	0.12	0.1027
2068	1034.0	1033.0	24.64	0.09	0.0839

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
2069	1034.0	1033.0	24.65	0.10	0.0848
2070	1035.0	1034.0	24.64	0.09	0.0839
2071	1035.0	1034.0	24.65	0.10	0.0857
2072	1036.0	1035.0	24.64	0.09	0.0839
2115	1057.0	1056.0	24.63	0.08	0.0750
2116	1058.0	1057.0	24.64	0.09	0.0768
2118	1059.0	1058.0	24.63	0.08	0.0750
2201	1100.0	1099.0	24.61	0.07	0.0580
2280	1140.0	1139.0	24.59	0.05	0.0402
2281	1140.0	1139.0	24.60	0.05	0.0411
2282	1141.0	1140.0	24.59	0.05	0.0402
2283	1141.0	1140.0	24.60	0.05	0.0420
2285	1142.0	1141.0	24.59	0.05	0.0402
2396	1198.0	1197.0	24.57	0.02	0.0179
2553	1276.0	1275.0	24.56	0.01	0.0089

Trials with head change <0.01 feet not shown but used in calculations

OW4-5

Rising Head "Slug-Out"

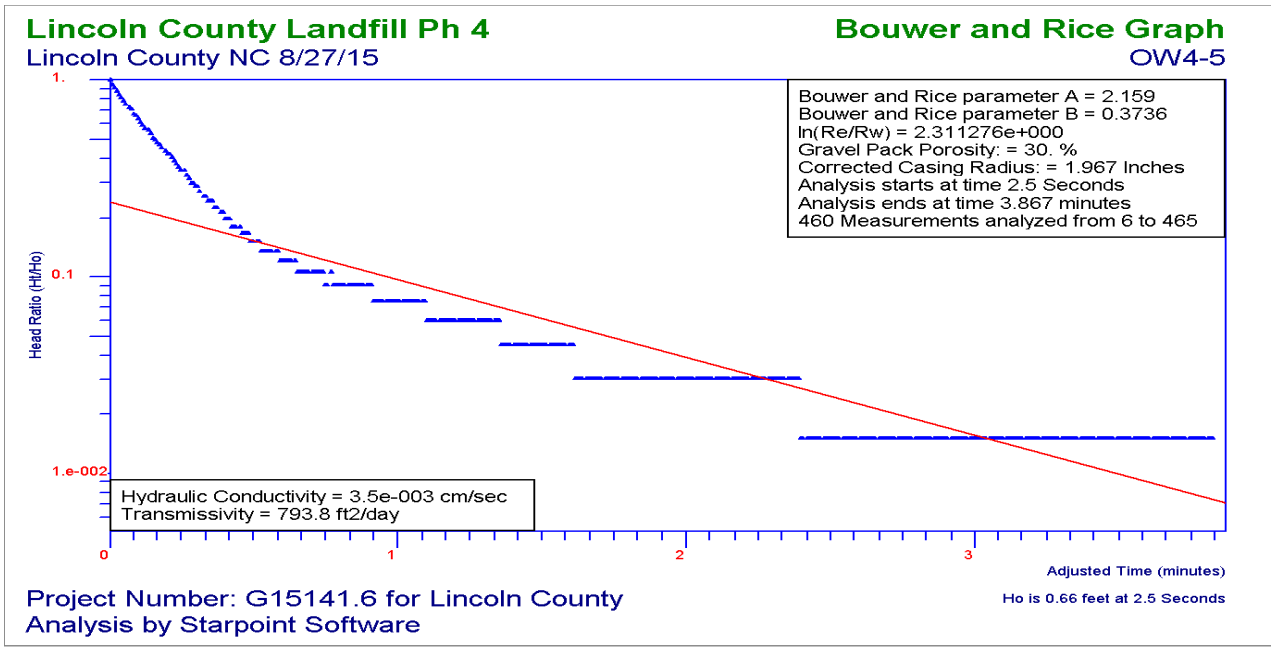
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/26/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-5
Aquifer Thickness:	77 feet to bedrock
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3.25 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.967 Inches
Static Water Level:	28.29 feet
Water Table to Screen Bottom:	5.96 feet
Method:	Slug Out (1.315" diameter solid slug)
Anisotropy Ratio:	1
Time Adjustment:	2.5 Seconds
Test starts with trial:	5
There are 465 time and drawdown measurements	
Maximum head :	0.66 feet
Minimum head:	0 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **3.50E-03 cm/sec**

K= **4,953.05 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-2.5	28.29	0.00	0.000
6	2.5	0.0	28.95	0.66	1.000
7	3.0	0.5	28.92	0.63	0.955
8	3.5	1.0	28.90	0.61	0.924
9	4.0	1.5	28.87	0.58	0.879
10	4.5	2.0	28.85	0.56	0.849
11	5.0	2.5	28.83	0.54	0.818
12	5.5	3.0	28.81	0.52	0.788
13	6.0	3.5	28.79	0.50	0.758
14	6.5	4.0	28.77	0.48	0.727
16	7.5	5.0	28.74	0.45	0.682
17	8.0	5.5	28.73	0.44	0.667
18	8.5	6.0	28.71	0.42	0.636
19	9.0	6.5	28.70	0.41	0.621
20	9.5	7.0	28.68	0.39	0.591
22	10.5	8.0	28.66	0.37	0.561
24	11.5	9.0	28.63	0.34	0.515
26	12.5	10.0	28.61	0.32	0.485
28	13.5	11.0	28.59	0.30	0.455
30	14.5	12.0	28.57	0.28	0.424
33	16.0	13.5	28.55	0.26	0.394
34	16.5	14.0	28.54	0.25	0.379
36	17.5	15.0	28.52	0.23	0.349
39	19.0	16.5	28.50	0.21	0.318
42	20.5	18.0	28.48	0.19	0.288
44	21.5	19.0	28.47	0.18	0.273
47	23.0	20.5	28.45	0.16	0.242
52	25.5	23.0	28.43	0.14	0.212
57	28.0	25.5	28.41	0.12	0.182
65	32.0	29.5	28.39	0.10	0.152
69	34.0	31.5	28.38	0.09	0.136
84	41.5	39.0	28.36	0.07	0.106
116	57.5	55.0	28.34	0.05	0.076
169	84.0	81.5	28.32	0.03	0.045
294	146.5	144.0	28.30	0.01	0.015
465	232.0	229.5	28.30	0.01	0.015

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-6S

Rising Head "Slug-Out"

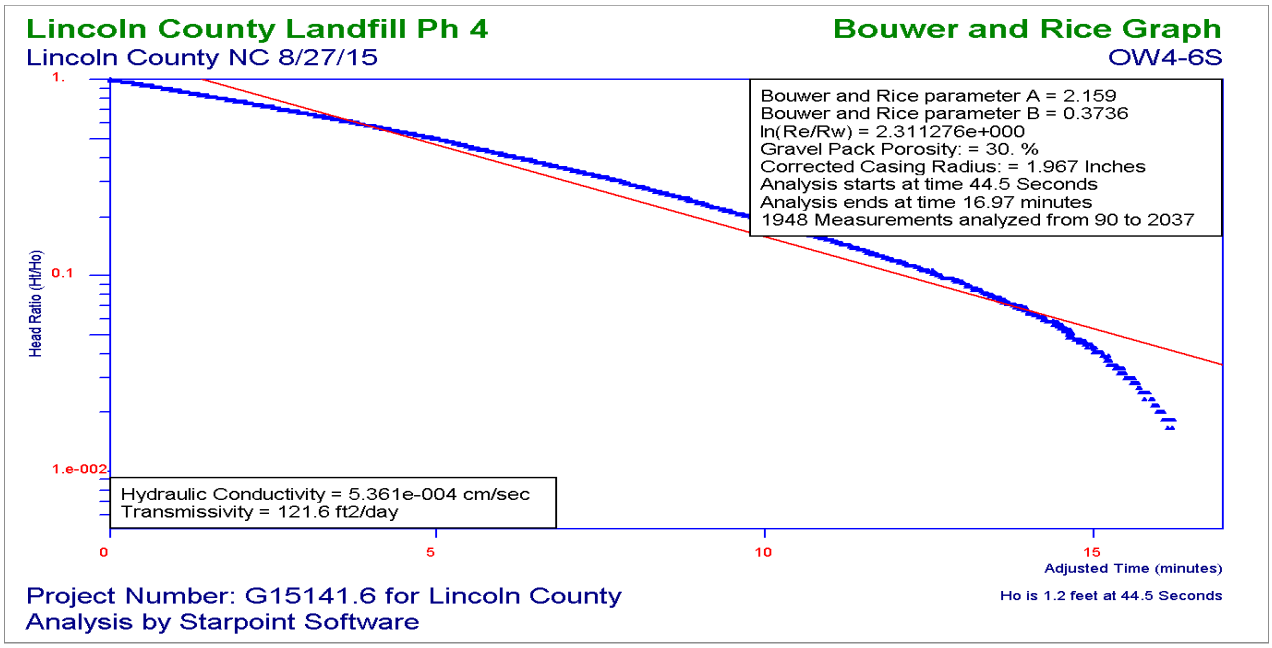
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/26/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-6S
Aquifer Thickness:	80 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3.25 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.967 Inches
Static Water Level:	26.31 feet
Water Table to Screen Bottom:	5.96 feet
Method:	Slug Out (1.315" diameter solid slug)
Anisotropy Ratio:	1
Time Adjustment:	44.5 Seconds
Test starts with trial:	90
There are 2,037 time and drawdown measurements	
Maximum head :	1.454 feet
Minimum head:	0 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **5.36E-04 cm/sec**

K= **544.80 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-44.5	26.31	0.00	0.0000
4	1.5	-43.0	27.76	1.45	1.0000
8	3.5	-41.0	27.75	1.44	0.9924
14	6.5	-38.0	27.74	1.43	0.9842
19	9.0	-35.5	27.73	1.42	0.9773
23	11.0	-33.5	27.72	1.41	0.9697
28	13.5	-31.0	27.71	1.40	0.9615
32	15.5	-29.0	27.70	1.39	0.9539
37	18.0	-26.5	27.69	1.38	0.9470
41	20.0	-24.5	27.68	1.37	0.9402
44	21.5	-23.0	27.67	1.36	0.9326
48	23.5	-21.0	27.65	1.34	0.9243
51	25.0	-19.5	27.64	1.33	0.9168
54	26.5	-18.0	27.63	1.32	0.9099
58	28.5	-16.0	27.62	1.31	0.9010
61	30.0	-14.5	27.61	1.30	0.8941
65	32.0	-12.5	27.60	1.29	0.8858
68	33.5	-11.0	27.58	1.28	0.8769
71	35.0	-9.5	27.57	1.27	0.8700
74	36.5	-8.0	27.56	1.25	0.8624
76	37.5	-7.0	27.55	1.24	0.8556
79	39.0	-5.5	27.54	1.23	0.8473
82	40.5	-4.0	27.53	1.22	0.8384
86	42.5	-2.0	27.52	1.21	0.8315
91	45.0	0.5	27.51	1.20	0.8239
100	49.5	5.0	27.50	1.19	0.8171
113	56.0	11.5	27.49	1.18	0.8102
123	61.0	16.5	27.48	1.17	0.8026
131	65.0	20.5	27.47	1.16	0.7957
141	70.0	25.5	27.46	1.15	0.7882
150	74.5	30.0	27.45	1.14	0.7813
157	78.0	33.5	27.44	1.13	0.7744
168	83.5	39.0	27.42	1.11	0.7655
177	88.0	43.5	27.41	1.10	0.7586
186	92.5	48.0	27.40	1.09	0.7510
194	96.5	52.0	27.39	1.08	0.7442
202	100.5	56.0	27.38	1.07	0.7373
211	105.0	60.5	27.37	1.06	0.7297
221	110.0	65.5	27.36	1.05	0.7228
229	114.0	69.5	27.35	1.04	0.7153
238	118.5	74.0	27.34	1.03	0.7084
247	123.0	78.5	27.33	1.02	0.7015
256	127.5	83.0	27.32	1.01	0.6939
268	133.5	89.0	27.31	1.00	0.6857
277	138.0	93.5	27.30	0.99	0.6781

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
285	142.0	97.5	27.29	0.98	0.6713
297	148.0	103.5	27.28	0.97	0.6644
305	152.0	107.5	27.26	0.96	0.6568
315	157.0	112.5	27.25	0.95	0.6499
324	161.5	117.0	27.24	0.93	0.6424
334	166.5	122.0	27.23	0.92	0.6355
346	172.5	128.0	27.22	0.91	0.6286
354	176.5	132.0	27.21	0.90	0.6210
365	182.0	137.5	27.20	0.89	0.6142
375	187.0	142.5	27.19	0.88	0.6073
386	192.5	148.0	27.18	0.87	0.5997
394	196.5	152.0	27.17	0.86	0.5928
406	202.5	158.0	27.16	0.85	0.5853
416	207.5	163.0	27.15	0.84	0.5784
428	213.5	169.0	27.14	0.83	0.5715
438	218.5	174.0	27.13	0.82	0.5646
451	225.0	180.5	27.12	0.81	0.5564
461	230.0	185.5	27.11	0.80	0.5488
473	236.0	191.5	27.10	0.79	0.5420
482	240.5	196.0	27.09	0.78	0.5344
493	246.0	201.5	27.08	0.77	0.5275
504	251.5	207.0	27.07	0.76	0.5206
516	257.5	213.0	27.06	0.75	0.5131
530	264.5	220.0	27.05	0.74	0.5062
540	269.5	225.0	27.04	0.73	0.4993
549	274.0	229.5	27.03	0.72	0.4917
560	279.5	235.0	27.02	0.71	0.4849
574	286.5	242.0	27.00	0.69	0.4773
588	293.5	249.0	26.99	0.68	0.4677
602	300.5	256.0	26.98	0.67	0.4601
614	306.5	262.0	26.97	0.66	0.4532
628	313.5	269.0	26.96	0.65	0.4450
642	320.5	276.0	26.95	0.64	0.4381
653	326.0	281.5	26.94	0.63	0.4312
666	332.5	288.0	26.93	0.62	0.4237
681	340.0	295.5	26.92	0.61	0.4168
694	346.5	302.0	26.91	0.60	0.4099
706	352.5	308.0	26.89	0.59	0.4023
717	358.0	313.5	26.89	0.58	0.3955
730	364.5	320.0	26.87	0.56	0.3879
743	371.0	326.5	26.86	0.55	0.3796
753	376.0	331.5	26.85	0.54	0.3728
767	383.0	338.5	26.84	0.53	0.3652
783	391.0	346.5	26.83	0.52	0.3583
794	396.5	352.0	26.82	0.51	0.3508

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
812	405.5	361.0	26.81	0.50	0.3432
824	411.5	367.0	26.80	0.49	0.3356
840	419.5	375.0	26.79	0.48	0.3287
859	429.0	384.5	26.78	0.47	0.3205
875	437.0	392.5	26.77	0.46	0.3129
891	445.0	400.5	26.75	0.45	0.3061
906	452.5	408.0	26.74	0.43	0.2985
924	461.5	417.0	26.73	0.42	0.2916
939	469.0	424.5	26.72	0.41	0.2847
957	478.0	433.5	26.71	0.40	0.2772
976	487.5	443.0	26.70	0.39	0.2696
996	497.5	453.0	26.69	0.38	0.2620
1012	505.5	461.0	26.68	0.37	0.2552
1030	514.5	470.0	26.67	0.36	0.2483
1045	522.0	477.5	26.66	0.35	0.2407
1062	530.5	486.0	26.65	0.34	0.2338
1081	540.0	495.5	26.64	0.33	0.2263
1100	549.5	505.0	26.63	0.32	0.2194
1119	559.0	514.5	26.62	0.31	0.2125
1139	569.0	524.5	26.61	0.30	0.2050
1157	578.0	533.5	26.60	0.29	0.1981
1178	588.5	544.0	26.59	0.28	0.1905
1198	598.5	554.0	26.58	0.27	0.1836
1221	610.0	565.5	26.57	0.26	0.1754
1247	623.0	578.5	26.56	0.25	0.1685
1278	638.5	594.0	26.54	0.23	0.1602
1303	651.0	606.5	26.53	0.22	0.1527
1325	662.0	617.5	26.52	0.21	0.1458
1358	678.5	634.0	26.51	0.20	0.1376
1386	692.5	648.0	26.50	0.19	0.1307
1414	706.5	662.0	26.49	0.18	0.1238
1444	721.5	677.0	26.48	0.17	0.1162
1478	738.5	694.0	26.47	0.16	0.1087
1508	753.5	709.0	26.46	0.15	0.1018
1550	774.5	730.0	26.45	0.14	0.0935
1590	794.5	750.0	26.43	0.13	0.0860
1637	818.0	773.5	26.42	0.11	0.0777
1669	834.0	789.5	26.41	0.10	0.0708
1709	854.0	809.5	26.40	0.09	0.0633
1757	878.0	833.5	26.39	0.08	0.0557
1798	898.5	854.0	26.38	0.07	0.0488
1844	921.5	877.0	26.37	0.06	0.0413
1893	946.0	901.5	26.36	0.05	0.0337
1939	969.0	924.5	26.35	0.04	0.0261
2000	999.5	955.0	26.34	0.03	0.0179

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
2037	1018.0	973.5	26.33	0.02	0.0151

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-6D

Falling Head "Slug-In"

Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/25/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-6D
Aquifer Thickness:	81.5 feet to bedrock
Screen Length:	10. feet
Casing Radius:	1. Inches
Effective Radius:	3 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level BTOC:	27.73 feet
Water Table to Screen Bottom:	44.75 feet
Method:	Slug In (1.5 gallons of water injected)
Anisotropy Ratio:	1
Time Adjustment:	2 Seconds
Test starts with trial:	5
There are 89 time and drawdown measurements	
Maximum head :	8.493 feet
Minimum head:	0 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **8.88E-04 cm/sec**

K= **919.44 ft/year**

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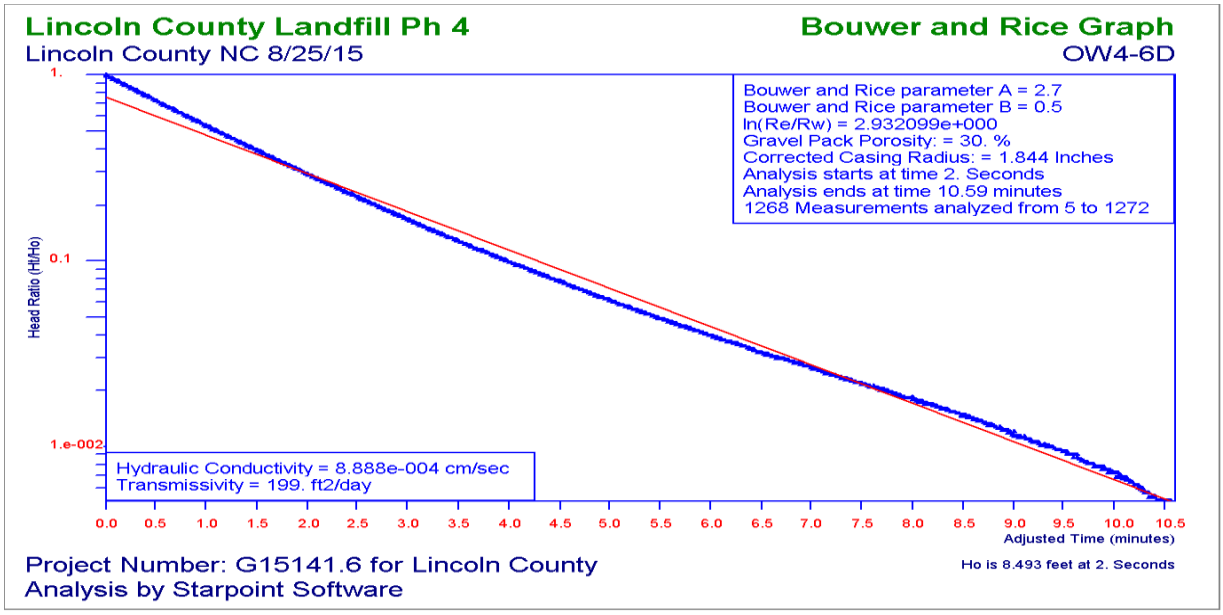


Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-2.0	27.73	0.00	0.0000
3	1.0	-1.0	36.19	8.46	0.9965
4	1.5	-0.5	36.20	8.47	0.9974
5	2.0	0.0	36.22	8.49	1.0000
6	2.5	0.5	36.19	8.46	0.9961
7	3.0	1.0	36.17	8.44	0.9934
8	3.5	1.5	36.14	8.41	0.9902
9	4.0	2.0	36.10	8.37	0.9858
10	4.5	2.5	36.06	8.33	0.9812
11	5.0	3.0	36.02	8.29	0.9760
12	5.5	3.5	35.98	8.25	0.9709
13	6.0	4.0	35.94	8.21	0.9662
14	6.5	4.5	35.89	8.16	0.9610
15	7.0	5.0	35.85	8.12	0.9563
16	7.5	5.5	35.81	8.08	0.9516
17	8.0	6.0	35.77	8.04	0.9469
18	8.5	6.5	35.73	8.00	0.9418
19	9.0	7.0	35.69	7.96	0.9368
20	9.5	7.5	35.65	7.92	0.9321
21	10.0	8.0	35.60	7.87	0.9270
22	10.5	8.5	35.56	7.83	0.9223
23	11.0	9.0	35.52	7.79	0.9173
24	11.5	9.5	35.48	7.75	0.9127
25	12.0	10.0	35.44	7.71	0.9078
26	12.5	10.5	35.40	7.67	0.9030
27	13.0	11.0	35.36	7.63	0.8982
28	13.5	11.5	35.32	7.59	0.8934
29	14.0	12.0	35.28	7.55	0.8886
30	14.5	12.5	35.24	7.51	0.8839
31	15.0	13.0	35.20	7.47	0.8792
32	15.5	13.5	35.15	7.43	0.8742
33	16.0	14.0	35.12	7.39	0.8697
34	16.5	14.5	35.08	7.35	0.8650
35	17.0	15.0	35.04	7.31	0.8605
36	17.5	15.5	35.00	7.27	0.8559
37	18.0	16.0	34.96	7.23	0.8511
38	18.5	16.5	34.92	7.19	0.8466
39	19.0	17.0	34.88	7.15	0.8420
40	19.5	17.5	34.84	7.11	0.8375
41	20.0	18.0	34.80	7.08	0.8330
42	20.5	18.5	34.77	7.04	0.8284
43	21.0	19.0	34.73	7.00	0.8238
44	21.5	19.5	34.69	6.96	0.8195
45	22.0	20.0	34.65	6.92	0.8152

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
46	22.5	20.5	34.62	6.89	0.8109
47	23.0	21.0	34.58	6.85	0.8067
48	23.5	21.5	34.54	6.81	0.8021
49	24.0	22.0	34.51	6.78	0.7980
50	24.5	22.5	34.47	6.74	0.7934
51	25.0	23.0	34.43	6.71	0.7894
52	25.5	23.5	34.40	6.67	0.7854
53	26.0	24.0	34.36	6.63	0.7810
54	26.5	24.5	34.33	6.60	0.7770
55	27.0	25.0	34.29	6.56	0.7729
56	27.5	25.5	34.26	6.53	0.7689
57	28.0	26.0	34.23	6.50	0.7649
58	28.5	26.5	34.19	6.46	0.7610
59	29.0	27.0	34.16	6.43	0.7569
60	29.5	27.5	34.12	6.40	0.7529
61	30.0	28.0	34.09	6.36	0.7488
62	30.5	28.5	34.06	6.33	0.7450
63	31.0	29.0	34.03	6.30	0.7412
64	31.5	29.5	33.99	6.26	0.7371
65	32.0	30.0	33.96	6.23	0.7333
66	32.5	30.5	33.92	6.20	0.7294
67	33.0	31.0	33.89	6.16	0.7256
68	33.5	31.5	33.86	6.13	0.7216
69	34.0	32.0	33.83	6.10	0.7178
70	34.5	32.5	33.80	6.07	0.7143
71	35.0	33.0	33.76	6.03	0.7103
72	35.5	33.5	33.73	6.00	0.7066
73	36.0	34.0	33.70	5.97	0.7028
74	36.5	34.5	33.67	5.94	0.6990
75	37.0	35.0	33.64	5.91	0.6954
76	37.5	35.5	33.61	5.88	0.6918
77	38.0	36.0	33.58	5.85	0.6883
78	38.5	36.5	33.55	5.82	0.6849
79	39.0	37.0	33.52	5.79	0.6813
80	39.5	37.5	33.49	5.76	0.6776
81	40.0	38.0	33.46	5.73	0.6741
82	40.5	38.5	33.43	5.70	0.6706
83	41.0	39.0	33.39	5.67	0.6670
84	41.5	39.5	33.36	5.63	0.6633
85	42.0	40.0	33.33	5.61	0.6599
86	42.5	40.5	33.31	5.58	0.6566
87	43.0	41.0	33.28	5.55	0.6533
88	43.5	41.5	33.25	5.52	0.6498
89	44.0	42.0	33.22	5.49	0.6464
90	44.5	42.5	33.19	5.46	0.6431

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
91	45.0	43.0	33.16	5.43	0.6396
92	45.5	43.5	33.14	5.41	0.6365
93	46.0	44.0	33.11	5.38	0.6330
94	46.5	44.5	33.08	5.35	0.6299
95	47.0	45.0	33.05	5.32	0.6266
96	47.5	45.5	33.02	5.29	0.6234
97	48.0	46.0	33.00	5.27	0.6203
98	48.5	46.5	32.97	5.24	0.6168
99	49.0	47.0	32.94	5.21	0.6137
100	49.5	47.5	32.92	5.19	0.6106
101	50.0	48.0	32.89	5.16	0.6074
102	50.5	48.5	32.86	5.13	0.6040
103	51.0	49.0	32.83	5.10	0.6009
104	51.5	49.5	32.81	5.08	0.5978
105	52.0	50.0	32.78	5.05	0.5949
106	52.5	50.5	32.76	5.03	0.5918
107	53.0	51.0	32.73	5.00	0.5887
108	53.5	51.5	32.70	4.97	0.5857
109	54.0	52.0	32.68	4.95	0.5827
110	54.5	52.5	32.65	4.93	0.5799
111	55.0	53.0	32.63	4.90	0.5767
112	55.5	53.5	32.60	4.87	0.5738
113	56.0	54.0	32.58	4.85	0.5709
114	56.5	54.5	32.55	4.82	0.5678
115	57.0	55.0	32.53	4.80	0.5647
116	57.5	55.5	32.51	4.78	0.5622
117	58.0	56.0	32.48	4.75	0.5592
118	58.5	56.5	32.45	4.73	0.5563
119	59.0	57.0	32.43	4.70	0.5536
120	59.5	57.5	32.41	4.68	0.5505
121	60.0	58.0	32.38	4.66	0.5480
122	60.5	58.5	32.36	4.63	0.5452
123	61.0	59.0	32.34	4.61	0.5425
124	61.5	59.5	32.31	4.58	0.5396
125	62.0	60.0	32.29	4.56	0.5368
126	62.5	60.5	32.27	4.54	0.5341
127	63.0	61.0	32.24	4.51	0.5315
128	63.5	61.5	32.22	4.49	0.5287
129	64.0	62.0	32.20	4.47	0.5260
130	64.5	62.5	32.18	4.45	0.5234
131	65.0	63.0	32.15	4.42	0.5206
132	65.5	63.5	32.13	4.40	0.5181
133	66.0	64.0	32.11	4.38	0.5155
134	66.5	64.5	32.09	4.36	0.5130
135	67.0	65.0	32.06	4.33	0.5103

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
136	67.5	65.5	32.04	4.31	0.5077
137	68.0	66.0	32.02	4.29	0.5051
138	68.5	66.5	32.00	4.27	0.5027
139	69.0	67.0	31.98	4.25	0.5001
140	69.5	67.5	31.96	4.23	0.4976
141	70.0	68.0	31.93	4.20	0.4950
142	70.5	68.5	31.91	4.18	0.4925
143	71.0	69.0	31.89	4.16	0.4900
144	71.5	69.5	31.87	4.14	0.4872
145	72.0	70.0	31.85	4.12	0.4849
146	72.5	70.5	31.83	4.10	0.4827
147	73.0	71.0	31.81	4.08	0.4801
148	73.5	71.5	31.79	4.06	0.4776
149	74.0	72.0	31.77	4.04	0.4754
150	74.5	72.5	31.75	4.02	0.4729
151	75.0	73.0	31.73	4.00	0.4706
152	75.5	73.5	31.70	3.98	0.4680
153	76.0	74.0	31.68	3.96	0.4656
155	77.0	75.0	31.64	3.91	0.4609
156	77.5	75.5	31.63	3.90	0.4588
157	78.0	76.0	31.61	3.88	0.4564
158	78.5	76.5	31.59	3.86	0.4540
159	79.0	77.0	31.57	3.84	0.4518
160	79.5	77.5	31.55	3.82	0.4495
161	80.0	78.0	31.53	3.80	0.4473
162	80.5	78.5	31.51	3.78	0.4448
163	81.0	79.0	31.49	3.76	0.4428
164	81.5	79.5	31.47	3.74	0.4405
165	82.0	80.0	31.45	3.72	0.4384
167	83.0	81.0	31.42	3.69	0.4339
168	83.5	81.5	31.40	3.67	0.4319
169	84.0	82.0	31.38	3.65	0.4296
170	84.5	82.5	31.36	3.63	0.4274
171	85.0	83.0	31.34	3.61	0.4254
173	86.0	84.0	31.31	3.58	0.4211
174	86.5	84.5	31.29	3.56	0.4187
175	87.0	85.0	31.27	3.54	0.4171
176	87.5	85.5	31.25	3.52	0.4149
178	88.5	86.5	31.22	3.49	0.4107
179	89.0	87.0	31.20	3.47	0.4088
180	89.5	87.5	31.18	3.45	0.4066
182	90.5	88.5	31.15	3.42	0.4024
183	91.0	89.0	31.13	3.40	0.4007
185	92.0	90.0	31.10	3.37	0.3963
186	92.5	90.5	31.08	3.35	0.3945

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
187	93.0	91.0	31.06	3.33	0.3925
188	93.5	91.5	31.05	3.32	0.3905
189	94.0	92.0	31.03	3.30	0.3887
190	94.5	92.5	31.01	3.28	0.3867
191	95.0	93.0	31.00	3.27	0.3849
192	95.5	93.5	30.98	3.25	0.3830
194	96.5	94.5	30.95	3.22	0.3790
195	97.0	95.0	30.93	3.20	0.3771
197	98.0	96.0	30.90	3.17	0.3733
198	98.5	96.5	30.89	3.16	0.3717
199	99.0	97.0	30.87	3.14	0.3699
200	99.5	97.5	30.86	3.13	0.3680
201	100.0	98.0	30.84	3.11	0.3663
203	101.0	99.0	30.81	3.08	0.3626
204	101.5	99.5	30.79	3.07	0.3609
206	102.5	100.5	30.76	3.04	0.3573
207	103.0	101.0	30.75	3.02	0.3553
208	103.5	101.5	30.73	3.00	0.3535
209	104.0	102.0	30.72	2.99	0.3521
211	105.0	103.0	30.69	2.96	0.3485
212	105.5	103.5	30.67	2.95	0.3467
213	106.0	104.0	30.66	2.93	0.3451
214	106.5	104.5	30.64	2.92	0.3432
215	107.0	105.0	30.63	2.90	0.3417
217	108.0	106.0	30.60	2.87	0.3384
218	108.5	106.5	30.59	2.86	0.3366
219	109.0	107.0	30.57	2.85	0.3350
221	110.0	108.0	30.55	2.82	0.3317
222	110.5	108.5	30.53	2.81	0.3302
223	111.0	109.0	30.52	2.79	0.3283
225	112.0	110.0	30.49	2.76	0.3254
226	112.5	110.5	30.48	2.75	0.3236
227	113.0	111.0	30.47	2.74	0.3222
228	113.5	111.5	30.45	2.72	0.3204
230	114.5	112.5	30.42	2.70	0.3173
231	115.0	113.0	30.41	2.68	0.3159
233	116.0	114.0	30.38	2.65	0.3125
235	117.0	115.0	30.36	2.63	0.3098
237	118.0	116.0	30.33	2.60	0.3065
238	118.5	116.5	30.32	2.59	0.3053
240	119.5	117.5	30.30	2.57	0.3020
241	120.0	118.0	30.28	2.55	0.3005
242	120.5	118.5	30.27	2.54	0.2992
244	121.5	119.5	30.25	2.52	0.2963
246	122.5	120.5	30.22	2.49	0.2935

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
248	123.5	121.5	30.20	2.47	0.2908
250	124.5	122.5	30.17	2.44	0.2877
251	125.0	123.0	30.16	2.43	0.2865
253	126.0	124.0	30.14	2.41	0.2838
254	126.5	124.5	30.13	2.40	0.2825
256	127.5	125.5	30.10	2.37	0.2795
257	128.0	126.0	30.09	2.36	0.2782
259	129.0	127.0	30.07	2.34	0.2758
261	130.0	128.0	30.05	2.32	0.2729
262	130.5	128.5	30.04	2.31	0.2714
263	131.0	129.0	30.02	2.30	0.2702
265	132.0	130.0	30.00	2.27	0.2676
267	133.0	131.0	29.98	2.25	0.2652
268	133.5	131.5	29.97	2.24	0.2639
270	134.5	132.5	29.95	2.22	0.2612
272	135.5	133.5	29.93	2.20	0.2589
274	136.5	134.5	29.91	2.18	0.2564
276	137.5	135.5	29.89	2.16	0.2539
277	138.0	136.0	29.88	2.15	0.2526
279	139.0	137.0	29.86	2.13	0.2504
281	140.0	138.0	29.84	2.11	0.2479
282	140.5	138.5	29.82	2.10	0.2466
285	142.0	140.0	29.79	2.06	0.2431
287	143.0	141.0	29.77	2.04	0.2407
289	144.0	142.0	29.75	2.02	0.2383
291	145.0	143.0	29.73	2.01	0.2360
293	146.0	144.0	29.72	1.99	0.2341
295	147.0	145.0	29.70	1.97	0.2318
297	148.0	146.0	29.68	1.95	0.2299
299	149.0	147.0	29.66	1.93	0.2273
301	150.0	148.0	29.64	1.91	0.2253
303	151.0	149.0	29.63	1.90	0.2231
305	152.0	150.0	29.61	1.88	0.2214
307	153.0	151.0	29.59	1.86	0.2191
309	154.0	152.0	29.57	1.84	0.2171
311	155.0	153.0	29.55	1.82	0.2148
313	156.0	154.0	29.54	1.81	0.2129
315	157.0	155.0	29.52	1.79	0.2111
318	158.5	156.5	29.50	1.77	0.2081
320	159.5	157.5	29.48	1.75	0.2061
321	160.0	158.0	29.47	1.74	0.2050
323	161.0	159.0	29.45	1.73	0.2031
326	162.5	160.5	29.43	1.70	0.2003
329	164.0	162.0	29.41	1.68	0.1976
331	165.0	163.0	29.39	1.66	0.1959

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
333	166.0	164.0	29.38	1.65	0.1940
335	167.0	165.0	29.36	1.63	0.1923
338	168.5	166.5	29.34	1.61	0.1896
341	170.0	168.0	29.32	1.59	0.1871
343	171.0	169.0	29.30	1.58	0.1854
345	172.0	170.0	29.29	1.56	0.1836
348	173.5	171.5	29.27	1.54	0.1811
351	175.0	173.0	29.25	1.52	0.1786
353	176.0	174.0	29.23	1.50	0.1770
355	177.0	175.0	29.22	1.49	0.1753
358	178.5	176.5	29.20	1.47	0.1731
361	180.0	178.0	29.18	1.45	0.1705
364	181.5	179.5	29.16	1.43	0.1683
367	183.0	181.0	29.14	1.41	0.1661
368	183.5	181.5	29.13	1.41	0.1654
372	185.5	183.5	29.11	1.38	0.1624
375	187.0	185.0	29.09	1.36	0.1601
378	188.5	186.5	29.07	1.34	0.1578
381	190.0	188.0	29.05	1.32	0.1557
383	191.0	189.0	29.04	1.31	0.1543
386	192.5	190.5	29.02	1.29	0.1521
389	194.0	192.0	29.00	1.27	0.1499
393	196.0	194.0	28.98	1.25	0.1474
395	197.0	195.0	28.97	1.24	0.1458
398	198.5	196.5	28.95	1.22	0.1441
402	200.5	198.5	28.93	1.20	0.1416
406	202.5	200.5	28.91	1.18	0.1393
410	204.5	202.5	28.89	1.16	0.1369
412	205.5	203.5	28.88	1.15	0.1358
417	208.0	206.0	28.86	1.13	0.1326
420	209.5	207.5	28.84	1.11	0.1311
424	211.5	209.5	28.82	1.09	0.1288
429	214.0	212.0	28.80	1.07	0.1261
431	215.0	213.0	28.79	1.06	0.1252
435	217.0	215.0	28.77	1.04	0.1227
439	219.0	217.0	28.75	1.02	0.1206
444	221.5	219.5	28.73	1.00	0.1177
446	222.5	220.5	28.72	0.99	0.1169
451	225.0	223.0	28.70	0.97	0.1147
456	227.5	225.5	28.68	0.95	0.1124
460	229.5	227.5	28.66	0.93	0.1101
466	232.5	230.5	28.64	0.91	0.1074
469	234.0	232.0	28.63	0.90	0.1062
474	236.5	234.5	28.61	0.88	0.1041
479	239.0	237.0	28.59	0.86	0.1018

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
485	242.0	240.0	28.57	0.84	0.0994
491	245.0	243.0	28.55	0.82	0.0969
494	246.5	244.5	28.54	0.81	0.0956
501	250.0	248.0	28.52	0.79	0.0929
506	252.5	250.5	28.50	0.77	0.0911
512	255.5	253.5	28.48	0.75	0.0889
516	257.5	255.5	28.47	0.74	0.0876
523	261.0	259.0	28.45	0.72	0.0851
530	264.5	262.5	28.43	0.70	0.0828
536	267.5	265.5	28.41	0.68	0.0805
544	271.5	269.5	28.39	0.66	0.0781
548	273.5	271.5	28.38	0.65	0.0768
555	277.0	275.0	28.36	0.63	0.0747
563	281.0	279.0	28.34	0.61	0.0723
571	285.0	283.0	28.32	0.59	0.0700
581	290.0	288.0	28.30	0.57	0.0676
585	292.0	290.0	28.29	0.56	0.0664
594	296.5	294.5	28.27	0.54	0.0641
604	301.5	299.5	28.25	0.52	0.0617
613	306.0	304.0	28.23	0.50	0.0595
619	309.0	307.0	28.22	0.49	0.0582
630	314.5	312.5	28.20	0.47	0.0559
642	320.5	318.5	28.18	0.45	0.0534
654	326.5	324.5	28.16	0.43	0.0511
667	333.0	331.0	28.14	0.41	0.0487
672	335.5	333.5	28.13	0.40	0.0476
688	343.5	341.5	28.11	0.38	0.0451
702	350.5	348.5	28.09	0.36	0.0429
703	351.0	349.0	28.10	0.37	0.0430
704	351.5	349.5	28.09	0.36	0.0428
719	359.0	357.0	28.07	0.34	0.0406
736	367.5	365.5	28.05	0.32	0.0381
744	371.5	369.5	28.04	0.31	0.0370
765	382.0	380.0	28.02	0.29	0.0345
783	391.0	389.0	28.00	0.28	0.0324
808	403.5	401.5	27.98	0.25	0.0299
819	409.0	407.0	27.97	0.24	0.0288
846	422.5	420.5	27.95	0.22	0.0264
848	423.5	421.5	27.96	0.23	0.0265
849	424.0	422.0	27.95	0.22	0.0263
875	437.0	435.0	27.93	0.20	0.0239
906	452.5	450.5	27.91	0.18	0.0216
944	471.5	469.5	27.89	0.16	0.0192
957	478.0	476.0	27.88	0.15	0.0182
961	480.0	478.0	27.89	0.16	0.0184

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
965	482.0	480.0	27.88	0.15	0.0179
1005	502.0	500.0	27.86	0.13	0.0157
1049	524.0	522.0	27.84	0.11	0.0134
1092	545.5	543.5	27.82	0.09	0.0112
1093	546.0	544.0	27.83	0.10	0.0114
1094	546.5	544.5	27.82	0.09	0.0111
1097	548.0	546.0	27.83	0.10	0.0115
1100	549.5	547.5	27.82	0.09	0.0109
1157	578.0	576.0	27.80	0.07	0.0087
1158	578.5	576.5	27.81	0.08	0.0091
1161	580.0	578.0	27.80	0.07	0.0087
1191	595.0	593.0	27.79	0.06	0.0076
1193	596.0	594.0	27.80	0.07	0.0078
1194	596.5	594.5	27.79	0.06	0.0075
1255	627.0	625.0	27.77	0.04	0.0052
1272	635.5	633.5	27.77	0.04	0.0052

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-7

Rising Head "Slug-Out"

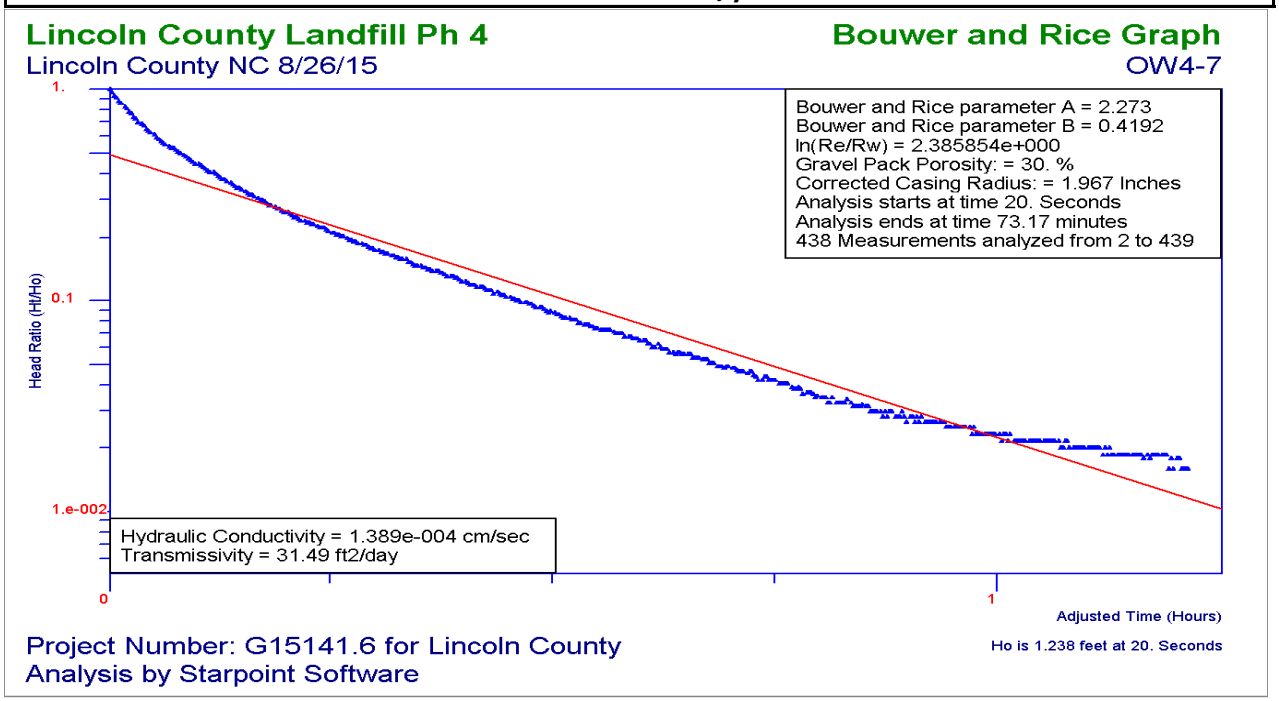
Site Name:	Lincoln County Landfill Ph 4	
Location:	Lincoln County NC	
Test Date:	8/26/2015	
Client:	Lincoln County	
Project Number:	G15141.6	
Well Label:	OW4-7	
Aquifer Thickness:	79 feet	to bedrock
Screen Length:	15. feet	
Casing Radius:	1. Inches	
Effective Radius:	3.25 Inches	
Gravel Pack Porosity:	30.00%	
Static Water Level BTOC:	27.88 feet	manually measured
Water Table to Screen Bottom:	7.17 feet	
Method:	Slug Out (1.315" diameter solid slug)	
Anisotropy Ratio:	1	
Time Adjustment:	20 Seconds	
Test starts with trial:	2	
There are 439 time and drawdown measurements		
Maximum head :	1.24 feet	
Minimum head:	0.02 feet	

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **1.39E-04 cm/sec**

K= **143.66 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	10	-10	27.88	0.00	0.000
2	20	0	29.12	1.24	1.000
3	30	10	29.08	1.20	0.968
4	40	20	29.05	1.17	0.941
5	50	30	29.01	1.13	0.914
6	60	40	28.98	1.10	0.887
7	70	50	28.94	1.07	0.860
8	80	60	28.92	1.04	0.837
9	90	70	28.89	1.01	0.813
10	100	80	28.86	0.98	0.792
11	110	90	28.83	0.95	0.770
12	120	100	28.81	0.93	0.750
13	130	110	28.78	0.90	0.730
14	140	120	28.76	0.88	0.710
15	150	130	28.74	0.86	0.691
16	160	140	28.72	0.84	0.675
17	170	150	28.69	0.81	0.658
18	180	160	28.68	0.80	0.643
19	190	170	28.66	0.78	0.628
20	200	180	28.64	0.76	0.612
21	210	190	28.62	0.74	0.599
22	220	200	28.61	0.73	0.587
23	230	210	28.59	0.72	0.578
24	240	220	28.58	0.70	0.565
25	250	230	28.57	0.69	0.556
26	260	240	28.56	0.68	0.545
27	270	250	28.54	0.66	0.536
28	280	260	28.53	0.65	0.527
29	290	270	28.52	0.64	0.517
30	300	280	28.51	0.63	0.508
31	310	290	28.50	0.62	0.499
32	320	300	28.49	0.61	0.491
33	330	310	28.48	0.60	0.482
34	340	320	28.47	0.59	0.473
36	360	340	28.45	0.57	0.456
38	380	360	28.43	0.55	0.444
40	400	380	28.41	0.53	0.430
42	420	400	28.40	0.52	0.416
44	440	420	28.38	0.50	0.404
46	460	440	28.36	0.48	0.389
48	480	460	28.35	0.47	0.379
50	500	480	28.34	0.46	0.368
52	520	500	28.32	0.44	0.356
54	540	520	28.31	0.43	0.347
56	560	540	28.30	0.42	0.336

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
58	580	560	28.28	0.40	0.326
60	600	580	28.27	0.39	0.316
62	620	600	28.26	0.38	0.308
64	640	620	28.25	0.37	0.299
66	660	640	28.24	0.36	0.290
69	690	670	28.22	0.35	0.279
72	720	700	28.21	0.33	0.269
75	750	730	28.20	0.32	0.259
78	780	760	28.19	0.31	0.249
81	810	790	28.18	0.30	0.241
84	840	820	28.17	0.29	0.232
88	880	860	28.16	0.28	0.222
91	910	890	28.14	0.26	0.213
94	940	920	28.13	0.25	0.205
99	990	970	28.12	0.24	0.196
104	1040	1020	28.11	0.23	0.187
108	1080	1060	28.10	0.22	0.179
114	1140	1120	28.09	0.21	0.168
120	1200	1180	28.08	0.20	0.158
125	1250	1230	28.06	0.19	0.149
133	1330	1310	28.05	0.17	0.140
140	1400	1380	28.04	0.16	0.130
147	1470	1450	28.03	0.15	0.121
156	1560	1540	28.02	0.14	0.112
165	1650	1630	28.01	0.13	0.103
175	1750	1730	28.00	0.12	0.093
185	1850	1830	27.98	0.10	0.084
199	1990	1970	27.97	0.09	0.074
217	2170	2150	27.96	0.08	0.065
231	2310	2290	27.95	0.07	0.056
251	2510	2490	27.94	0.06	0.048
278	2780	2760	27.93	0.05	0.039
310	3100	3080	27.92	0.04	0.030
387	3870	3850	27.90	0.03	0.020

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-8

Rising Head "Slug-Out"

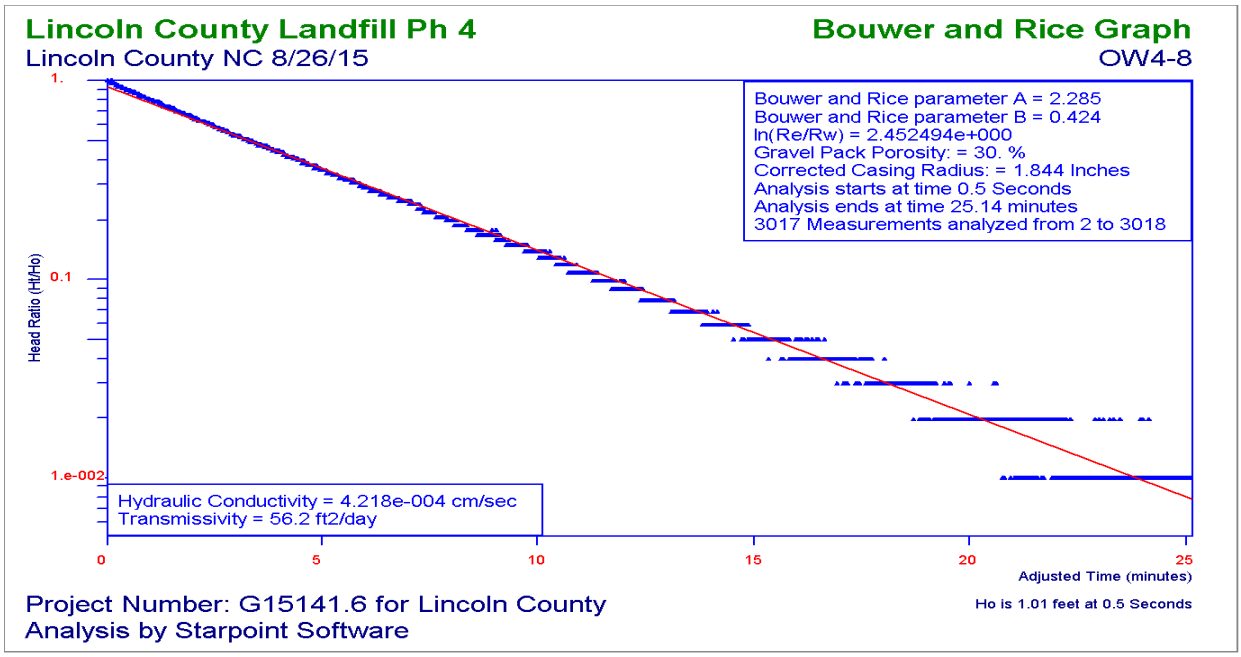
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/26/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-8
Aquifer Thickness:	65 feet to bedrock
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.844 Inches
Static Water Level:	20.29 feet
Water Table to Screen Bottom:	6.75 feet
Method:	Slug Out (1.315" diameter solid slug)
Anisotropy Ratio:	1
Time Adjustment:	0.5 Seconds
Test starts with trial:	1
There are 3,017 time and drawdown measurements	
Maximum head :	1.01 feet
Minimum head:	0 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **4.22E-04 cm/sec**

K= **436.54 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-0.5	20.29	0.00	0.0000
2	0.5	0.0	21.30	1.01	1.0000
8	3.5	3.0	21.29	1.00	0.9901
14	6.5	6.0	21.30	1.01	1.0000
15	7.0	6.5	21.28	0.99	0.9802
18	8.5	8.0	21.27	0.98	0.9703
19	9.0	8.5	21.28	0.99	0.9802
20	9.5	9.0	21.27	0.98	0.9703
30	14.5	14.0	21.25	0.96	0.9505
40	19.5	19.0	21.23	0.94	0.9307
47	23.0	22.5	21.22	0.93	0.9208
58	28.5	28.0	21.20	0.91	0.9010
59	29.0	28.5	21.21	0.92	0.9109
60	29.5	29.0	21.20	0.91	0.9010
72	35.5	35.0	21.18	0.89	0.8812
84	41.5	41.0	21.16	0.87	0.8614
98	48.5	48.0	21.14	0.85	0.8416
104	51.5	51.0	21.13	0.84	0.8317
120	59.5	59.0	21.11	0.82	0.8119
131	65.0	64.5	21.09	0.80	0.7921
133	66.0	65.5	21.10	0.81	0.8020
134	66.5	66.0	21.09	0.80	0.7921
148	73.5	73.0	21.07	0.78	0.7723
154	76.5	76.0	21.06	0.77	0.7624
168	83.5	83.0	21.04	0.75	0.7426
187	93.0	92.5	21.02	0.73	0.7228
189	94.0	93.5	21.03	0.74	0.7327
190	94.5	94.0	21.02	0.73	0.7228
196	97.5	97.0	21.00	0.71	0.7030
197	98.0	97.5	21.01	0.72	0.7129
198	98.5	98.0	21.00	0.71	0.7030
215	107.0	106.5	20.98	0.69	0.6832
216	107.5	107.0	20.99	0.70	0.6931
217	108.0	107.5	20.98	0.69	0.6832
224	111.5	111.0	20.97	0.68	0.6733
225	112.0	111.5	20.98	0.69	0.6832
226	112.5	112.0	20.97	0.68	0.6733
243	121.0	120.5	20.95	0.66	0.6535
258	128.5	128.0	20.93	0.64	0.6337
278	138.5	138.0	20.91	0.62	0.6139
297	148.0	147.5	20.89	0.60	0.5941
306	152.5	152.0	20.88	0.59	0.5842

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
324	161.5	161.0	20.86	0.57	0.5644
326	162.5	162.0	20.87	0.58	0.5743
327	163.0	162.5	20.86	0.57	0.5644
347	173.0	172.5	20.84	0.55	0.5446
373	186.0	185.5	20.82	0.53	0.5248
382	190.5	190.0	20.81	0.52	0.5149
404	201.5	201.0	20.79	0.50	0.4950
406	202.5	202.0	20.80	0.51	0.5050
407	203.0	202.5	20.79	0.50	0.4950
427	213.0	212.5	20.77	0.48	0.4752
428	213.5	213.0	20.78	0.49	0.4851
429	214.0	213.5	20.77	0.48	0.4752
454	226.5	226.0	20.75	0.46	0.4554
478	238.5	238.0	20.73	0.44	0.4356
480	239.5	239.0	20.74	0.45	0.4455
481	240.0	239.5	20.73	0.44	0.4356
495	247.0	246.5	20.72	0.43	0.4257
523	261.0	260.5	20.70	0.41	0.4059
524	261.5	261.0	20.71	0.42	0.4158
525	262.0	261.5	20.70	0.41	0.4059
547	273.0	272.5	20.68	0.39	0.3861
548	273.5	273.0	20.69	0.40	0.3960
549	274.0	273.5	20.68	0.39	0.3861
551	275.0	274.5	20.69	0.40	0.3960
552	275.5	275.0	20.68	0.39	0.3861
553	276.0	275.5	20.69	0.40	0.3960
554	276.5	276.0	20.68	0.39	0.3861
577	288.0	287.5	20.66	0.37	0.3663
580	289.5	289.0	20.67	0.38	0.3762
581	290.0	289.5	20.66	0.37	0.3663
586	292.5	292.0	20.67	0.38	0.3762
587	293.0	292.5	20.66	0.37	0.3663
613	306.0	305.5	20.64	0.35	0.3465
629	314.0	313.5	20.63	0.34	0.3366
664	331.5	331.0	20.61	0.32	0.3168
665	332.0	331.5	20.62	0.33	0.3267
668	333.5	333.0	20.61	0.32	0.3168
704	351.5	351.0	20.59	0.30	0.2970
705	352.0	351.5	20.60	0.31	0.3069
706	352.5	352.0	20.59	0.30	0.2970
737	368.0	367.5	20.57	0.28	0.2772
766	382.5	382.0	20.56	0.27	0.2673
814	406.5	406.0	20.54	0.25	0.2475
868	433.5	433.0	20.52	0.23	0.2277
869	434.0	433.5	20.53	0.24	0.2376

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
871	435.0	434.5	20.52	0.23	0.2277
916	457.5	457.0	20.50	0.21	0.2079
973	486.0	485.5	20.48	0.19	0.1881
975	487.0	486.5	20.49	0.20	0.1980
979	489.0	488.5	20.48	0.19	0.1881
1006	502.5	502.0	20.47	0.18	0.1782
1083	541.0	540.5	20.45	0.16	0.1584
1084	541.5	541.0	20.46	0.17	0.1683
1088	543.5	543.0	20.45	0.16	0.1584
1089	544.0	543.5	20.46	0.17	0.1683
1090	544.5	544.0	20.45	0.16	0.1584
1091	545.0	544.5	20.46	0.17	0.1683
1092	545.5	545.0	20.45	0.16	0.1584
1094	546.5	546.0	20.46	0.17	0.1683
1096	547.5	547.0	20.45	0.16	0.1584
1164	581.5	581.0	20.43	0.14	0.1386
1172	585.5	585.0	20.44	0.15	0.1485
1173	586.0	585.5	20.43	0.14	0.1386
1251	625.0	624.5	20.41	0.12	0.1188
1252	625.5	625.0	20.42	0.13	0.1287
1254	626.5	626.0	20.41	0.12	0.1188
1256	627.5	627.0	20.42	0.13	0.1287
1258	628.5	628.0	20.41	0.12	0.1188
1259	629.0	628.5	20.42	0.13	0.1287
1260	629.5	629.0	20.41	0.12	0.1188
1261	630.0	629.5	20.42	0.13	0.1287
1262	630.5	630.0	20.41	0.12	0.1188
1264	631.5	631.0	20.42	0.13	0.1287
1265	632.0	631.5	20.41	0.12	0.1188
1273	636.0	635.5	20.42	0.13	0.1287
1274	636.5	636.0	20.41	0.12	0.1188
1289	644.0	643.5	20.40	0.11	0.1089
1291	645.0	644.5	20.41	0.12	0.1188
1293	646.0	645.5	20.40	0.11	0.1089
1297	648.0	647.5	20.41	0.12	0.1188
1298	648.5	648.0	20.40	0.11	0.1089
1307	653.0	652.5	20.41	0.12	0.1188
1308	653.5	653.0	20.40	0.11	0.1089
1409	704.0	703.5	20.38	0.09	0.0891
1410	704.5	704.0	20.39	0.10	0.0990
1415	707.0	706.5	20.38	0.09	0.0891
1416	707.5	707.0	20.39	0.10	0.0990
1419	709.0	708.5	20.38	0.09	0.0891
1428	713.5	713.0	20.39	0.10	0.0990
1430	714.5	714.0	20.38	0.09	0.0891

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1431	715.0	714.5	20.39	0.10	0.0990
1434	716.5	716.0	20.38	0.09	0.0891
1436	717.5	717.0	20.39	0.10	0.0990
1437	718.0	717.5	20.38	0.09	0.0891
1439	719.0	718.5	20.39	0.10	0.0990
1440	719.5	719.0	20.38	0.09	0.0891
1573	786.0	785.5	20.36	0.07	0.0693
1574	786.5	786.0	20.37	0.08	0.0792
1576	787.5	787.0	20.36	0.07	0.0693
1577	788.0	787.5	20.37	0.08	0.0792
1579	789.0	788.5	20.36	0.07	0.0693
1582	790.5	790.0	20.37	0.08	0.0792
1583	791.0	790.5	20.36	0.07	0.0693
1744	871.5	871.0	20.34	0.05	0.0495
1745	872.0	871.5	20.35	0.06	0.0594
1770	884.5	884.0	20.34	0.05	0.0495
1771	885.0	884.5	20.35	0.06	0.0594
1772	885.5	885.0	20.34	0.05	0.0495
1774	886.5	886.0	20.35	0.06	0.0594
1777	888.0	887.5	20.34	0.05	0.0495
1778	888.5	888.0	20.35	0.06	0.0594
1787	893.0	892.5	20.34	0.05	0.0495
1843	921.0	920.5	20.33	0.04	0.0396
1844	921.5	921.0	20.34	0.05	0.0495
1880	939.5	939.0	20.33	0.04	0.0396
1881	940.0	939.5	20.34	0.05	0.0495
1885	942.0	941.5	20.33	0.04	0.0396
1887	943.0	942.5	20.34	0.05	0.0495
1899	949.0	948.5	20.33	0.04	0.0396
1902	950.5	950.0	20.34	0.05	0.0495
1904	951.5	951.0	20.33	0.04	0.0396
1917	958.0	957.5	20.34	0.05	0.0495
1924	961.5	961.0	20.33	0.04	0.0396
1926	962.5	962.0	20.34	0.05	0.0495
1930	964.5	964.0	20.33	0.04	0.0396
1932	965.5	965.0	20.34	0.05	0.0495
1934	966.5	966.0	20.33	0.04	0.0396
1948	973.5	973.0	20.34	0.05	0.0495
1949	974.0	973.5	20.33	0.04	0.0396
1952	975.5	975.0	20.34	0.05	0.0495
1953	976.0	975.5	20.33	0.04	0.0396
1963	981.0	980.5	20.34	0.05	0.0495
1964	981.5	981.0	20.33	0.04	0.0396
1965	982.0	981.5	20.34	0.05	0.0495
1966	982.5	982.0	20.33	0.04	0.0396

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1978	988.5	988.0	20.34	0.05	0.0495
1981	990.0	989.5	20.33	0.04	0.0396
1999	999.0	998.5	20.34	0.05	0.0495
2000	999.5	999.0	20.33	0.04	0.0396
2244	1122.0	1121.0	20.31	0.02	0.0198
2245	1122.0	1122.0	20.32	0.03	0.0297
2265	1132.0	1132.0	20.31	0.02	0.0198
2266	1133.0	1132.0	20.32	0.03	0.0297
2270	1135.0	1134.0	20.31	0.02	0.0198
2271	1135.0	1135.0	20.32	0.03	0.0297
2272	1136.0	1135.0	20.31	0.02	0.0198
2273	1136.0	1136.0	20.32	0.03	0.0297
2276	1138.0	1137.0	20.31	0.02	0.0198
2279	1139.0	1139.0	20.32	0.03	0.0297
2281	1140.0	1140.0	20.31	0.02	0.0198
2282	1141.0	1140.0	20.32	0.03	0.0297
2284	1142.0	1141.0	20.31	0.02	0.0198
2285	1142.0	1142.0	20.32	0.03	0.0297
2288	1144.0	1143.0	20.31	0.02	0.0198
2289	1144.0	1144.0	20.32	0.03	0.0297
2290	1145.0	1144.0	20.31	0.02	0.0198
2292	1146.0	1145.0	20.32	0.03	0.0297
2301	1150.0	1150.0	20.31	0.02	0.0198
2303	1151.0	1151.0	20.32	0.03	0.0297
2304	1152.0	1151.0	20.31	0.02	0.0198
2310	1155.0	1154.0	20.32	0.03	0.0297
2311	1155.0	1155.0	20.31	0.02	0.0198
2331	1165.0	1165.0	20.32	0.03	0.0297
2332	1166.0	1165.0	20.31	0.02	0.0198
2343	1171.0	1171.0	20.32	0.03	0.0297
2348	1174.0	1173.0	20.31	0.02	0.0198
2402	1201.0	1200.0	20.32	0.03	0.0297
2403	1201.0	1201.0	20.31	0.02	0.0198
2473	1236.0	1236.0	20.32	0.03	0.0297
2475	1237.0	1237.0	20.31	0.02	0.0198
2476	1238.0	1237.0	20.32	0.03	0.0297
2477	1238.0	1238.0	20.31	0.02	0.0198
3018	1509.0	1508.0	20.30	0.01	0.0099

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-9S

Rising Head "Slug-Out"

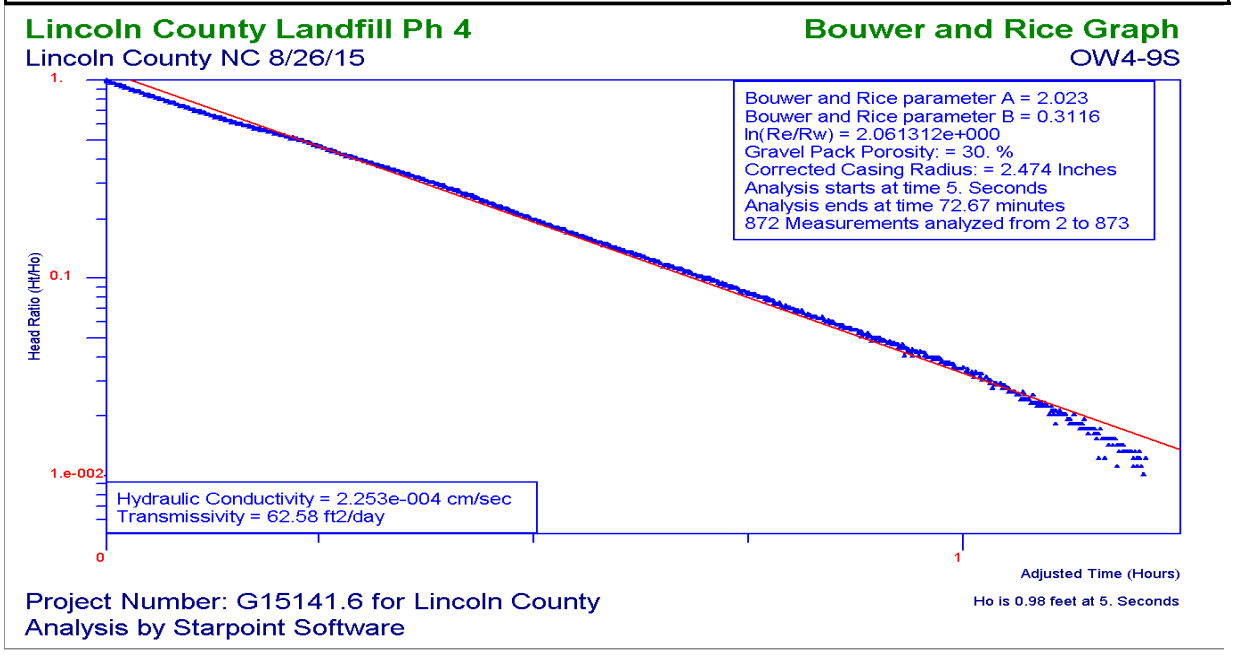
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/26/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-9S
Aquifer Thickness:	86 feet to rock
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	4.25 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.474 feet
Static Water Level BTOC:	26.58 feet
Water Table to Screen Bottom:	5.68 feet
Method:	Slug Out (1.315" diameter solid slug)
Anisotropy Ratio:	1
Time Adjustment:	5 Seconds
Test starts with trial:	0
There are 873 time and drawdown measurements	
Maximum head :	0.98 feet
Minimum head:	0 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **2.25E-04 cm/sec**

K= **233.09 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0	-5	26.58	0.00	0.00
2	5	0	27.56	0.98	1.00
4	15	10	27.55	0.97	0.99
6	25	20	27.54	0.96	0.98
10	45	40	27.52	0.94	0.96
15	70	65	27.50	0.92	0.94
20	95	90	27.48	0.90	0.92
22	105	100	27.47	0.89	0.91
27	130	125	27.45	0.87	0.89
32	155	150	27.43	0.85	0.87
38	185	180	27.41	0.83	0.85
43	210	205	27.39	0.81	0.83
45	220	215	27.38	0.80	0.82
51	250	245	27.36	0.78	0.80
57	280	275	27.34	0.76	0.78
62	305	300	27.32	0.74	0.76
69	340	335	27.30	0.72	0.74
72	355	350	27.29	0.71	0.73
78	385	380	27.27	0.69	0.71
83	410	405	27.25	0.68	0.69
84	415	410	27.26	0.68	0.69
85	420	415	27.25	0.67	0.69
91	450	445	27.23	0.66	0.67
95	470	465	27.22	0.64	0.66
102	505	500	27.20	0.62	0.64
111	550	545	27.18	0.60	0.62
118	585	580	27.16	0.59	0.60
128	635	630	27.14	0.56	0.58
133	660	655	27.13	0.55	0.56
143	710	705	27.11	0.53	0.54
153	760	755	27.09	0.52	0.53
164	815	810	27.07	0.49	0.50
174	865	860	27.05	0.47	0.48
178	885	880	27.04	0.46	0.47
187	930	925	27.02	0.44	0.45
197	980	975	27.00	0.42	0.43
207	1030	1025	26.98	0.40	0.41
213	1060	1055	26.97	0.39	0.40
226	1125	1120	26.95	0.38	0.38
239	1190	1185	26.93	0.35	0.36
251	1250	1245	26.91	0.34	0.34
265	1320	1315	26.89	0.32	0.32
272	1355	1350	26.88	0.30	0.31
286	1425	1420	26.86	0.29	0.29

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
301	1500	1495	26.84	0.26	0.27
317	1580	1575	26.82	0.24	0.25
334	1665	1660	26.80	0.22	0.23
342	1705	1700	26.79	0.21	0.22
361	1800	1795	26.77	0.20	0.20
382	1905	1900	26.75	0.18	0.18
407	2030	2025	26.73	0.16	0.16
420	2095	2090	26.72	0.14	0.15
421	2100	2095	26.73	0.15	0.15
424	2115	2110	26.72	0.14	0.15
453	2260	2255	26.70	0.13	0.13
454	2265	2260	26.71	0.13	0.13
455	2270	2265	26.70	0.12	0.13
487	2430	2425	26.68	0.11	0.11
488	2435	2430	26.69	0.11	0.11
491	2450	2445	26.68	0.11	0.11
492	2455	2450	26.69	0.11	0.11
493	2460	2455	26.68	0.10	0.11
534	2665	2660	26.66	0.08	0.08
535	2670	2665	26.67	0.09	0.09
537	2680	2675	26.66	0.08	0.09
589	2940	2935	26.64	0.06	0.07
591	2950	2945	26.65	0.07	0.07
592	2955	2950	26.64	0.06	0.07
627	3130	3125	26.63	0.05	0.06
713	3560	3555	26.61	0.04	0.04
833	4160	4155	26.59	0.02	0.02
834	4165	4160	26.60	0.02	0.02
835	4170	4165	26.59	0.01	0.01
836	4175	4170	26.60	0.02	0.02
837	4180	4175	26.59	0.02	0.02
873	4360	4355	26.59	0.01	0.01

Trials with head change <0.01 feet not shown but used in calculations

OW4-9D

Falling Head "Slug-In"

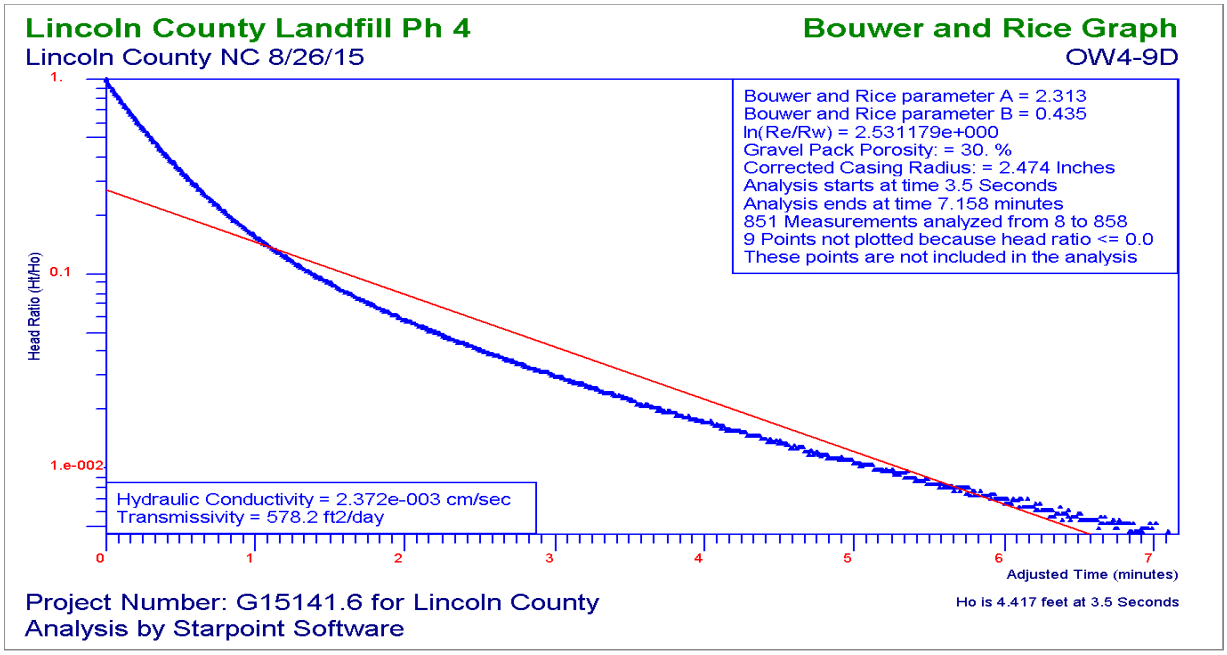
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/25/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-9D
Aquifer Thickness:	86 feet to rock
Screen Length:	10. feet
Casing Radius:	1. Inches
Effective Radius:	4.25 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.474 Inches
Static Water Level BTOC:	27.93 feet
Water Table to Screen Bottom:	36.65 feet
Method:	Slug In (0.8 gallons of water injected)
Anisotropy Ratio:	1
Time Adjustment:	3.5 Seconds
Test starts with trial:	2
There are 858 time and drawdown measurements	
Maximum head :	4.724 feet
Minimum head:	0 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **2.38E-03 cm/sec**

K= **2,454.26 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-3.5	27.93	0.00	0.0000
3	1.0	-2.5	32.65	4.72	1.0000
4	1.5	-2.0	32.63	4.70	0.9941
5	2.0	-1.5	32.57	4.64	0.9814
6	2.5	-1.0	32.50	4.57	0.9680
7	3.0	-0.5	32.43	4.50	0.9517
8	3.5	0.0	32.35	4.42	0.9350
9	4.0	0.5	32.26	4.33	0.9174
10	4.5	1.0	32.18	4.25	0.8994
11	5.0	1.5	32.09	4.16	0.8810
12	5.5	2.0	32.01	4.08	0.8637
13	6.0	2.5	31.93	4.00	0.8459
14	6.5	3.0	31.85	3.92	0.8296
15	7.0	3.5	31.77	3.84	0.8133
16	7.5	4.0	31.70	3.77	0.7974
17	8.0	4.5	31.62	3.69	0.7813
18	8.5	5.0	31.55	3.62	0.7661
19	9.0	5.5	31.48	3.55	0.7508
20	9.5	6.0	31.41	3.48	0.7365
21	10.0	6.5	31.34	3.41	0.7221
22	10.5	7.0	31.27	3.35	0.7081
23	11.0	7.5	31.21	3.28	0.6943
24	11.5	8.0	31.15	3.22	0.6808
25	12.0	8.5	31.09	3.16	0.6683
26	12.5	9.0	31.03	3.10	0.6554
27	13.0	9.5	30.97	3.04	0.6429
28	13.5	10.0	30.91	2.98	0.6310
29	14.0	10.5	30.85	2.92	0.6190
30	14.5	11.0	30.80	2.87	0.6077
31	15.0	11.5	30.75	2.82	0.5963
32	15.5	12.0	30.69	2.76	0.5851
33	16.0	12.5	30.64	2.71	0.5745
34	16.5	13.0	30.60	2.67	0.5644
35	17.0	13.5	30.55	2.62	0.5540
36	17.5	14.0	30.50	2.57	0.5442
37	18.0	14.5	30.45	2.52	0.5341
38	18.5	15.0	30.41	2.48	0.5246
39	19.0	15.5	30.36	2.43	0.5152
40	19.5	16.0	30.32	2.39	0.5064
41	20.0	16.5	30.28	2.35	0.4975
42	20.5	17.0	30.24	2.31	0.4886
43	21.0	17.5	30.20	2.27	0.4807
44	21.5	18.0	30.16	2.23	0.4723
45	22.0	18.5	30.12	2.19	0.4638
46	22.5	19.0	30.09	2.16	0.4562

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
47	23.0	19.5	30.05	2.12	0.4481
48	23.5	20.0	30.01	2.08	0.4409
49	24.0	20.5	29.98	2.05	0.4335
50	24.5	21.0	29.94	2.01	0.4261
51	25.0	21.5	29.91	1.98	0.4189
52	25.5	22.0	29.88	1.95	0.4119
53	26.0	22.5	29.84	1.91	0.4052
54	26.5	23.0	29.81	1.88	0.3986
55	27.0	23.5	29.78	1.85	0.3918
56	27.5	24.0	29.75	1.82	0.3855
57	28.0	24.5	29.72	1.79	0.3798
58	28.5	25.0	29.69	1.76	0.3734
59	29.0	25.5	29.67	1.74	0.3677
60	29.5	26.0	29.64	1.71	0.3618
61	30.0	26.5	29.61	1.68	0.3561
62	30.5	27.0	29.58	1.66	0.3503
63	31.0	27.5	29.56	1.63	0.3448
64	31.5	28.0	29.53	1.60	0.3395
65	32.0	28.5	29.51	1.58	0.3343
66	32.5	29.0	29.48	1.56	0.3292
67	33.0	29.5	29.46	1.53	0.3243
68	33.5	30.0	29.44	1.51	0.3188
69	34.0	30.5	29.41	1.49	0.3144
70	34.5	31.0	29.39	1.46	0.3095
71	35.0	31.5	29.37	1.44	0.3050
72	35.5	32.0	29.35	1.42	0.3004
73	36.0	32.5	29.33	1.40	0.2961
74	36.5	33.0	29.31	1.38	0.2919
75	37.0	33.5	29.29	1.36	0.2875
76	37.5	34.0	29.27	1.34	0.2834
77	38.0	34.5	29.25	1.32	0.2794
78	38.5	35.0	29.23	1.30	0.2750
79	39.0	35.5	29.21	1.28	0.2716
80	39.5	36.0	29.19	1.26	0.2674
81	40.0	36.5	29.18	1.25	0.2638
82	40.5	37.0	29.16	1.23	0.2597
83	41.0	37.5	29.14	1.21	0.2561
84	41.5	38.0	29.12	1.19	0.2525
85	42.0	38.5	29.11	1.18	0.2489
86	42.5	39.0	29.09	1.16	0.2458
87	43.0	39.5	29.07	1.14	0.2422
89	44.0	40.5	29.05	1.12	0.2362
90	44.5	41.0	29.03	1.10	0.2329
91	45.0	41.5	29.01	1.08	0.2295
92	45.5	42.0	29.00	1.07	0.2261

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
93	46.0	42.5	28.98	1.05	0.2231
94	46.5	43.0	28.97	1.04	0.2206
96	47.5	44.0	28.94	1.02	0.2149
97	48.0	44.5	28.93	1.00	0.2121
99	49.0	45.5	28.91	0.98	0.2068
100	49.5	46.0	28.89	0.96	0.2039
101	50.0	46.5	28.88	0.95	0.2013
103	51.0	47.5	28.86	0.93	0.1962
105	52.0	48.5	28.84	0.91	0.1916
106	52.5	49.0	28.82	0.89	0.1890
108	53.5	50.0	28.80	0.87	0.1844
109	54.0	50.5	28.79	0.86	0.1823
111	55.0	51.5	28.77	0.84	0.1776
113	56.0	52.5	28.75	0.82	0.1744
115	57.0	53.5	28.73	0.80	0.1698
116	57.5	54.0	28.72	0.79	0.1681
118	58.5	55.0	28.70	0.77	0.1638
121	60.0	56.5	28.68	0.75	0.1583
123	61.0	57.5	28.66	0.73	0.1547
126	62.5	59.0	28.64	0.71	0.1499
127	63.0	59.5	28.63	0.70	0.1480
129	64.0	60.5	28.61	0.69	0.1450
132	65.5	62.0	28.59	0.66	0.1406
135	67.0	63.5	28.57	0.64	0.1359
138	68.5	65.0	28.55	0.62	0.1317
140	69.5	66.0	28.54	0.61	0.1291
143	71.0	67.5	28.52	0.59	0.1249
147	73.0	69.5	28.50	0.57	0.1207
150	74.5	71.0	28.48	0.55	0.1169
152	75.5	72.0	28.47	0.54	0.1147
156	77.5	74.0	28.45	0.52	0.1105
160	79.5	76.0	28.43	0.50	0.1061
164	81.5	78.0	28.41	0.48	0.1025
169	84.0	80.5	28.39	0.46	0.0980
172	85.5	82.0	28.38	0.45	0.0957
176	87.5	84.0	28.36	0.44	0.0921
183	91.0	87.5	28.34	0.41	0.0874
189	94.0	90.5	28.32	0.39	0.0832
195	97.0	93.5	28.30	0.37	0.0792
198	98.5	95.0	28.29	0.36	0.0771
206	102.5	99.0	28.27	0.34	0.0728
214	106.5	103.0	28.25	0.33	0.0688
223	111.0	107.5	28.23	0.30	0.0644
227	113.0	109.5	28.22	0.30	0.0625
238	118.5	115.0	28.20	0.28	0.0582

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
250	124.5	121.0	28.18	0.25	0.0536
263	131.0	127.5	28.16	0.24	0.0498
279	139.0	135.5	28.14	0.21	0.0451
286	142.5	139.0	28.13	0.20	0.0432
304	151.5	148.0	28.11	0.19	0.0392
325	162.0	158.5	28.09	0.16	0.0347
348	173.5	170.0	28.07	0.15	0.0307
381	190.0	186.5	28.05	0.12	0.0263
396	197.5	194.0	28.04	0.11	0.0241
397	198.0	194.5	28.05	0.12	0.0246
398	198.5	195.0	28.04	0.11	0.0241
438	218.5	215.0	28.02	0.09	0.0197
494	246.5	243.0	28.00	0.08	0.0159
568	283.5	280.0	27.98	0.05	0.0114
574	286.5	283.0	27.99	0.06	0.0116
575	287.0	283.5	27.98	0.05	0.0110
624	311.5	308.0	27.97	0.04	0.0093
765	382.0	378.5	27.95	0.03	0.0053
767	383.0	379.5	27.96	0.03	0.0057
768	383.5	380.0	27.95	0.03	0.0053
769	384.0	380.5	27.96	0.03	0.0055
775	387.0	383.5	27.95	0.02	0.0051
776	387.5	384.0	27.96	0.03	0.0055
779	389.0	385.5	27.95	0.03	0.0053
780	389.5	386.0	27.96	0.03	0.0057
781	390.0	386.5	27.95	0.02	0.0051
787	393.0	389.5	27.96	0.03	0.0055
789	394.0	390.5	27.95	0.02	0.0051
790	394.5	391.0	27.96	0.03	0.0055
791	395.0	391.5	27.95	0.02	0.0051
875	437.0	435.0	27.93	0.20	0.0239
906	452.5	450.5	27.91	0.18	0.0216
944	471.5	469.5	27.89	0.16	0.0192
957	478.0	476.0	27.88	0.15	0.0182
961	480.0	478.0	27.89	0.16	0.0184
965	482.0	480.0	27.88	0.15	0.0179
1005	502.0	500.0	27.86	0.13	0.0157
1049	524.0	522.0	27.84	0.11	0.0134
1092	545.5	543.5	27.82	0.09	0.0112
1093	546.0	544.0	27.83	0.10	0.0114
1094	546.5	544.5	27.82	0.09	0.0111
1097	548.0	546.0	27.83	0.10	0.0115
1100	549.5	547.5	27.82	0.09	0.0109
1157	578.0	576.0	27.80	0.07	0.0087
1158	578.5	576.5	27.81	0.08	0.0091

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1161	580.0	578.0	27.80	0.07	0.0087
1191	595.0	593.0	27.79	0.06	0.0076
1193	596.0	594.0	27.80	0.07	0.0078
1194	596.5	594.5	27.79	0.06	0.0075
1255	627.0	625.0	27.77	0.04	0.0052
1272	635.5	633.5	27.77	0.04	0.0052

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

B4-9D(Rock)

Falling Head "Slug-In"

Site Name:	Lincoln County Landfill Ph 4	
Location:	Lincoln County NC	
Test Date:	3/2/2015	
Client:	Lincoln County	
Project Number:	G15141.6	
Well Label:	B4-9D(Rock)	
Aquifer Thickness:	12 feet	Length core hole
Screen Length:	12 feet	Open core hole
Casing Radius:	1.19 Inches	NQ Core Casing
Effective Radius:	1.49 Inches	NQ Core hole
Static Water Level BTOC:	22.77 feet	
Water Table to Screen Bottom:	74.93 feet	
Method:	Slug In (1 gallon of water injected)	
Anisotropy Ratio:	1	
Time Adjustment:	1 Seconds	
Test starts with trial:	2	
There are 5,040 time and drawdown measurements		
Maximum head :	5.494 feet	
Minimum head:	0 feet	

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **9.94E-05 cm/sec**

K= **102.82 ft/year**

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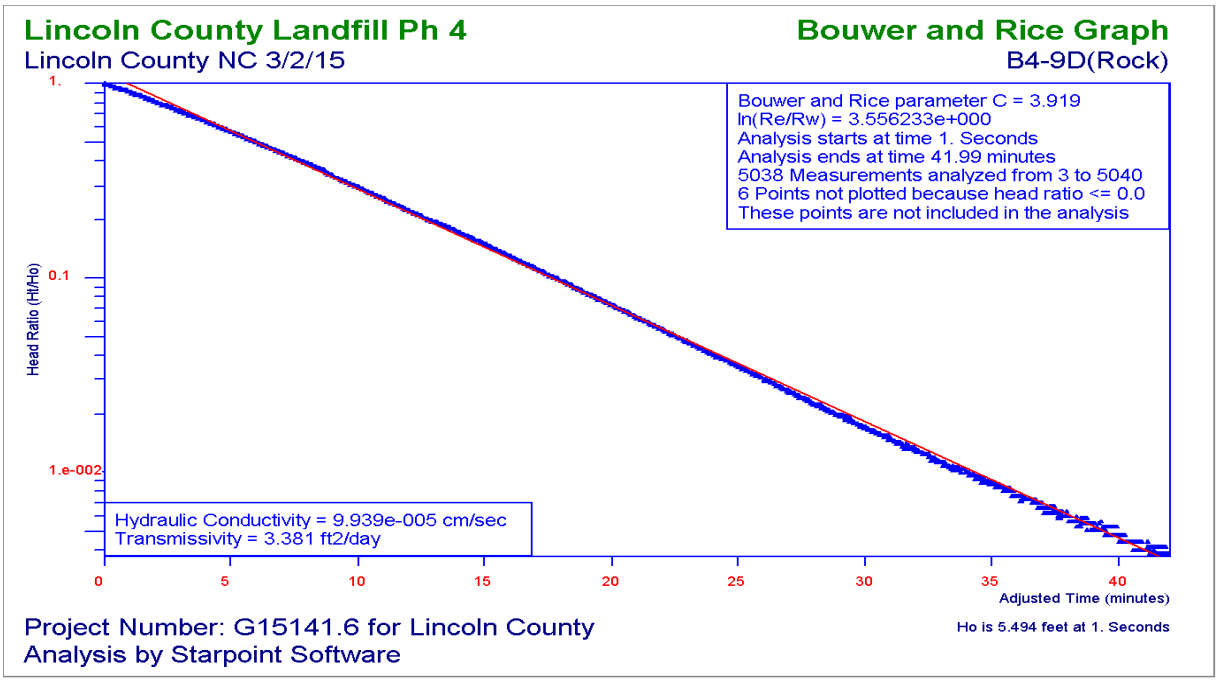


Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-1.0	22.77	0.00	0.0000
3	1.0	0.0	28.26	5.49	1.0000
7	3.0	2.0	28.25	5.49	0.9984
14	6.5	5.5	28.23	5.46	0.9942
16	7.5	6.5	28.22	5.45	0.9924
20	9.5	8.5	28.20	5.43	0.9889
25	12.0	11.0	28.18	5.41	0.9847
31	15.0	14.0	28.16	5.39	0.9816
36	17.5	16.5	28.14	5.37	0.9782
40	19.5	18.5	28.13	5.36	0.9760
44	21.5	20.5	28.11	5.35	0.9729
49	24.0	23.0	28.09	5.33	0.9692
54	26.5	25.5	28.07	5.30	0.9654
59	29.0	28.0	28.05	5.28	0.9612
61	30.0	29.0	28.04	5.27	0.9594
65	32.0	31.0	28.02	5.25	0.9561
71	35.0	34.0	28.00	5.23	0.9519
77	38.0	37.0	27.98	5.21	0.9485
79	39.0	38.0	27.97	5.20	0.9470
85	42.0	41.0	27.95	5.18	0.9432
90	44.5	43.5	27.93	5.16	0.9390
94	46.5	45.5	27.91	5.15	0.9365
99	49.0	48.0	27.89	5.12	0.9319
101	50.0	49.0	27.88	5.11	0.9301
106	52.5	51.5	27.86	5.09	0.9270
111	55.0	54.0	27.84	5.07	0.9228
115	57.0	56.0	27.82	5.05	0.9199
120	59.5	58.5	27.80	5.03	0.9161
123	61.0	60.0	27.79	5.02	0.9137
127	63.0	62.0	27.77	5.00	0.9104
131	65.0	64.0	27.75	4.98	0.9072
136	67.5	66.5	27.73	4.96	0.9030
138	68.5	67.5	27.72	4.95	0.9015
142	70.5	69.5	27.70	4.93	0.8981
147	73.0	72.0	27.68	4.91	0.8941
152	75.5	74.5	27.66	4.89	0.8899
156	77.5	76.5	27.64	4.87	0.8864
158	78.5	77.5	27.63	4.86	0.8846
162	80.5	79.5	27.61	4.84	0.8815
166	82.5	81.5	27.59	4.82	0.8780
171	85.0	84.0	27.57	4.80	0.8740
175	87.0	86.0	27.55	4.78	0.8706
177	88.0	87.0	27.54	4.77	0.8686
181	90.0	89.0	27.52	4.75	0.8653

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
186	92.5	91.5	27.50	4.73	0.8611
190	94.5	93.5	27.48	4.71	0.8580
192	95.5	94.5	27.47	4.70	0.8562
197	98.0	97.0	27.45	4.68	0.8524
201	100.0	99.0	27.43	4.66	0.8489
206	102.5	101.5	27.41	4.64	0.8449
211	105.0	104.0	27.39	4.62	0.8407
212	105.5	104.5	27.38	4.62	0.8400
217	108.0	107.0	27.36	4.59	0.8362
221	110.0	109.0	27.34	4.57	0.8325
226	112.5	111.5	27.32	4.55	0.8284
231	115.0	114.0	27.30	4.53	0.8247
233	116.0	115.0	27.29	4.52	0.8227
237	118.0	117.0	27.27	4.50	0.8198
241	120.0	119.0	27.25	4.49	0.8163
247	123.0	122.0	27.23	4.46	0.8122
249	124.0	123.0	27.22	4.45	0.8103
253	126.0	125.0	27.20	4.44	0.8072
258	128.5	127.5	27.18	4.41	0.8034
263	131.0	130.0	27.16	4.39	0.7998
268	133.5	132.5	27.14	4.37	0.7956
271	135.0	134.0	27.13	4.36	0.7932
275	137.0	136.0	27.11	4.34	0.7903
279	139.0	138.0	27.09	4.33	0.7872
284	141.5	140.5	27.07	4.30	0.7834
289	144.0	143.0	27.05	4.28	0.7798
292	145.5	144.5	27.04	4.27	0.7774
296	147.5	146.5	27.02	4.25	0.7741
301	150.0	149.0	27.00	4.23	0.7707
306	152.5	151.5	26.98	4.21	0.7668
309	154.0	153.0	26.97	4.20	0.7647
314	156.5	155.5	26.95	4.18	0.7608
318	158.5	157.5	26.93	4.17	0.7581
323	161.0	160.0	26.91	4.14	0.7539
328	163.5	162.5	26.89	4.12	0.7506
331	165.0	164.0	26.88	4.11	0.7483
335	167.0	166.0	26.86	4.10	0.7454
341	170.0	169.0	26.84	4.07	0.7412
346	172.5	171.5	26.82	4.05	0.7377
351	175.0	174.0	26.80	4.03	0.7339
354	176.5	175.5	26.79	4.02	0.7321
358	178.5	177.5	26.77	4.01	0.7290
364	181.5	180.5	26.75	3.99	0.7253
369	184.0	183.0	26.73	3.96	0.7215
372	185.5	184.5	26.72	3.95	0.7191

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
377	188.0	187.0	26.70	3.93	0.7155
382	190.5	189.5	26.68	3.91	0.7120
388	193.5	192.5	26.66	3.89	0.7082
393	196.0	195.0	26.64	3.87	0.7050
395	197.0	196.0	26.63	3.86	0.7033
401	200.0	199.0	26.61	3.84	0.6995
407	203.0	202.0	26.59	3.82	0.6959
413	206.0	205.0	26.57	3.80	0.6920
418	208.5	207.5	26.55	3.78	0.6886
421	210.0	209.0	26.54	3.77	0.6867
426	212.5	211.5	26.52	3.75	0.6833
432	215.5	214.5	26.50	3.73	0.6791
437	218.0	217.0	26.48	3.71	0.6758
439	219.0	218.0	26.47	3.70	0.6742
445	222.0	221.0	26.45	3.68	0.6700
450	224.5	223.5	26.43	3.66	0.6667
456	227.5	226.5	26.41	3.64	0.6629
461	230.0	229.0	26.39	3.62	0.6594
464	231.5	230.5	26.38	3.61	0.6576
469	234.0	233.0	26.36	3.59	0.6542
475	237.0	236.0	26.34	3.57	0.6500
480	239.5	238.5	26.32	3.55	0.6467
486	242.5	241.5	26.30	3.53	0.6429
489	244.0	243.0	26.29	3.52	0.6411
494	246.5	245.5	26.27	3.51	0.6380
500	249.5	248.5	26.25	3.48	0.6341
506	252.5	251.5	26.23	3.46	0.6305
509	254.0	253.0	26.22	3.45	0.6285
514	256.5	255.5	26.20	3.43	0.6250
520	259.5	258.5	26.18	3.41	0.6210
526	262.5	261.5	26.16	3.39	0.6178
532	265.5	264.5	26.14	3.37	0.6139
535	267.0	266.0	26.13	3.36	0.6118
540	269.5	268.5	26.11	3.34	0.6087
545	272.0	271.0	26.09	3.33	0.6052
552	275.5	274.5	26.07	3.30	0.6010
558	278.5	277.5	26.05	3.28	0.5977
561	280.0	279.0	26.04	3.27	0.5957
567	283.0	282.0	26.02	3.25	0.5921
573	286.0	285.0	26.00	3.23	0.5886
579	289.0	288.0	25.98	3.21	0.5848
583	291.0	290.0	25.97	3.20	0.5826
588	293.5	292.5	25.95	3.18	0.5795
594	296.5	295.5	25.93	3.16	0.5757
601	300.0	299.0	25.91	3.14	0.5715

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
607	303.0	302.0	25.89	3.12	0.5683
610	304.5	303.5	25.88	3.11	0.5663
616	307.5	306.5	25.86	3.09	0.5630
622	310.5	309.5	25.84	3.07	0.5595
628	313.5	312.5	25.82	3.06	0.5561
635	317.0	316.0	25.80	3.03	0.5522
639	319.0	318.0	25.79	3.02	0.5499
645	322.0	321.0	25.77	3.00	0.5466
651	325.0	324.0	25.75	2.98	0.5431
658	328.5	327.5	25.73	2.96	0.5395
661	330.0	329.0	25.72	2.95	0.5375
667	333.0	332.0	25.70	2.94	0.5342
674	336.5	335.5	25.68	2.91	0.5304
680	339.5	338.5	25.66	2.90	0.5269
687	343.0	342.0	25.64	2.87	0.5231
691	345.0	344.0	25.63	2.86	0.5213
697	348.0	347.0	25.61	2.84	0.5175
704	351.5	350.5	25.59	2.83	0.5142
711	355.0	354.0	25.57	2.80	0.5104
718	358.5	357.5	25.55	2.78	0.5066
722	360.5	359.5	25.54	2.77	0.5044
728	363.5	362.5	25.52	2.76	0.5015
735	367.0	366.0	25.50	2.73	0.4976
742	370.5	369.5	25.48	2.71	0.4938
746	372.5	371.5	25.47	2.70	0.4920
753	376.0	375.0	25.45	2.68	0.4882
760	379.5	378.5	25.43	2.66	0.4843
767	383.0	382.0	25.41	2.64	0.4811
774	386.5	385.5	25.39	2.62	0.4776
777	388.0	387.0	25.38	2.61	0.4758
785	392.0	391.0	25.36	2.59	0.4722
792	395.5	394.5	25.34	2.58	0.4687
800	399.5	398.5	25.32	2.55	0.4645
807	403.0	402.0	25.30	2.53	0.4610
810	404.5	403.5	25.29	2.52	0.4592
818	408.5	407.5	25.27	2.50	0.4554
825	412.0	411.0	25.25	2.48	0.4521
832	415.5	414.5	25.23	2.47	0.4487
837	418.0	417.0	25.22	2.45	0.4463
844	421.5	420.5	25.20	2.43	0.4430
852	425.5	424.5	25.18	2.41	0.4394
859	429.0	428.0	25.16	2.40	0.4359
867	433.0	432.0	25.14	2.37	0.4321
871	435.0	434.0	25.13	2.36	0.4303
879	439.0	438.0	25.11	2.35	0.4268

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
887	443.0	442.0	25.09	2.32	0.4228
895	447.0	446.0	25.07	2.31	0.4195
904	451.5	450.5	25.05	2.28	0.4154
908	453.5	452.5	25.04	2.27	0.4139
915	457.0	456.0	25.02	2.26	0.4104
925	462.0	461.0	25.00	2.23	0.4066
933	466.0	465.0	24.98	2.22	0.4032
938	468.5	467.5	24.97	2.20	0.4010
946	472.5	471.5	24.95	2.18	0.3975
955	477.0	476.0	24.93	2.16	0.3939
964	481.5	480.5	24.91	2.14	0.3902
973	486.0	485.0	24.89	2.12	0.3861
977	488.0	487.0	24.88	2.11	0.3844
986	492.5	491.5	24.86	2.09	0.3811
994	496.5	495.5	24.84	2.08	0.3777
1004	501.5	500.5	24.82	2.06	0.3740
1013	506.0	505.0	24.80	2.03	0.3702
1018	508.5	507.5	24.79	2.02	0.3684
1026	512.5	511.5	24.77	2.01	0.3649
1036	517.5	516.5	24.75	1.98	0.3608
1046	522.5	521.5	24.73	1.96	0.3575
1050	524.5	523.5	24.71	1.94	0.3533
1051	525.0	524.0	24.69	1.92	0.3502
1053	526.0	525.0	24.68	1.91	0.3480
1064	531.5	530.5	24.66	1.89	0.3447
1074	536.5	535.5	24.64	1.87	0.3409
1079	539.0	538.0	24.63	1.86	0.3391
1088	543.5	542.5	24.61	1.84	0.3356
1098	548.5	547.5	24.59	1.82	0.3318
1108	553.5	552.5	24.57	1.80	0.3284
1118	558.5	557.5	24.55	1.78	0.3245
1122	560.5	559.5	24.54	1.77	0.3229
1133	566.0	565.0	24.52	1.75	0.3193
1142	570.5	569.5	24.50	1.74	0.3158
1152	575.5	574.5	24.48	1.72	0.3122
1158	578.5	577.5	24.47	1.70	0.3100
1169	584.0	583.0	24.45	1.68	0.3065
1178	588.5	587.5	24.43	1.67	0.3031
1189	594.0	593.0	24.41	1.64	0.2992
1202	600.5	599.5	24.39	1.62	0.2954
1208	603.5	602.5	24.38	1.61	0.2932
1217	608.0	607.0	24.36	1.59	0.2901
1229	614.0	613.0	24.34	1.57	0.2865
1239	619.0	618.0	24.32	1.56	0.2830
1253	626.0	625.0	24.30	1.53	0.2787

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1258	628.5	627.5	24.29	1.52	0.2772
1269	634.0	633.0	24.27	1.50	0.2738
1280	639.5	638.5	24.25	1.49	0.2703
1292	645.5	644.5	24.23	1.46	0.2665
1298	648.5	647.5	24.22	1.45	0.2647
1310	654.5	653.5	24.20	1.43	0.2610
1322	660.5	659.5	24.18	1.42	0.2576
1334	666.5	665.5	24.16	1.40	0.2539
1347	673.0	672.0	24.14	1.37	0.2501
1354	676.5	675.5	24.13	1.36	0.2483
1367	683.0	682.0	24.11	1.34	0.2446
1379	689.0	688.0	24.09	1.33	0.2412
1393	696.0	695.0	24.07	1.30	0.2373
1407	703.0	702.0	24.05	1.28	0.2332
1413	706.0	705.0	24.04	1.27	0.2319
1426	712.5	711.5	24.02	1.26	0.2284
1440	719.5	718.5	24.00	1.23	0.2246
1456	727.5	726.5	23.98	1.21	0.2210
1463	731.0	730.0	23.97	1.20	0.2190
1477	738.0	737.0	23.95	1.19	0.2157
1492	745.5	744.5	23.93	1.17	0.2120
1507	753.0	752.0	23.91	1.14	0.2082
1522	760.5	759.5	23.89	1.12	0.2044
1530	764.5	763.5	23.88	1.11	0.2026
1543	771.0	770.0	23.86	1.10	0.1993
1560	779.5	778.5	23.84	1.07	0.1955
1570	784.5	783.5	23.85	1.08	0.1962
1574	786.5	785.5	23.84	1.07	0.1955
1590	794.5	793.5	23.82	1.06	0.1920
1600	799.5	798.5	23.81	1.04	0.1898
1615	807.0	806.0	23.79	1.02	0.1864
1633	816.0	815.0	23.77	1.00	0.1827
1651	825.0	824.0	23.75	0.98	0.1791
1668	833.5	832.5	23.73	0.97	0.1756
1680	839.5	838.5	23.72	0.95	0.1735
1697	848.0	847.0	23.70	0.93	0.1700
1714	856.5	855.5	23.68	0.92	0.1665
1734	866.5	865.5	23.66	0.90	0.1629
1754	876.5	875.5	23.64	0.87	0.1591
1764	881.5	880.5	23.63	0.86	0.1573
1784	891.5	890.5	23.61	0.84	0.1536
1804	901.5	900.5	23.59	0.82	0.1500
1825	912.0	911.0	23.57	0.80	0.1463
1837	918.0	917.0	23.56	0.79	0.1443
1859	929.0	928.0	23.54	0.77	0.1405

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1877	938.0	937.0	23.52	0.75	0.1372
1902	950.5	949.5	23.50	0.73	0.1336
1923	961.0	960.0	23.48	0.72	0.1301
1938	968.5	967.5	23.47	0.70	0.1280
1961	980.0	979.0	23.45	0.68	0.1245
1983	991.0	990.0	23.43	0.67	0.1210
2009	1004.0	1003.0	23.41	0.65	0.1174
2038	1019.0	1018.0	23.39	0.62	0.1134
2050	1025.0	1024.0	23.38	0.61	0.1118
2079	1039.0	1038.0	23.36	0.59	0.1079
2105	1052.0	1051.0	23.34	0.58	0.1047
2135	1067.0	1066.0	23.32	0.56	0.1010
2153	1076.0	1075.0	23.31	0.54	0.0987
2183	1091.0	1090.0	23.29	0.52	0.0954
2212	1106.0	1105.0	23.27	0.51	0.0919
2246	1123.0	1122.0	23.25	0.48	0.0881
2281	1140.0	1139.0	23.23	0.46	0.0845
2299	1149.0	1148.0	23.22	0.45	0.0826
2332	1166.0	1165.0	23.20	0.44	0.0792
2377	1188.0	1187.0	23.18	0.41	0.0754
2419	1209.0	1208.0	23.16	0.39	0.0717
2462	1231.0	1230.0	23.14	0.37	0.0679
2480	1240.0	1239.0	23.13	0.36	0.0663
2481	1240.0	1239.0	23.14	0.37	0.0668
2482	1241.0	1240.0	23.13	0.36	0.0663
2483	1241.0	1240.0	23.14	0.37	0.0664
2484	1242.0	1241.0	23.13	0.36	0.0663
2526	1263.0	1262.0	23.11	0.35	0.0628
2527	1263.0	1262.0	23.12	0.35	0.0632
2528	1264.0	1263.0	23.11	0.35	0.0628
2578	1289.0	1288.0	23.09	0.32	0.0590
2632	1316.0	1315.0	23.07	0.30	0.0553
2658	1329.0	1328.0	23.06	0.29	0.0533
2659	1329.0	1328.0	23.07	0.30	0.0539
2660	1330.0	1329.0	23.06	0.29	0.0533
2715	1357.0	1356.0	23.04	0.27	0.0497
2774	1387.0	1386.0	23.02	0.26	0.0464
2841	1420.0	1419.0	23.00	0.23	0.0426
2843	1421.0	1420.0	23.01	0.24	0.0430
2845	1422.0	1421.0	23.00	0.23	0.0426
2913	1456.0	1455.0	22.98	0.21	0.0390
2914	1456.0	1456.0	22.99	0.22	0.0395
2915	1457.0	1456.0	22.98	0.22	0.0391
2916	1458.0	1457.0	22.99	0.22	0.0395
2917	1458.0	1457.0	22.98	0.22	0.0391

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
2963	1481.0	1480.0	22.97	0.20	0.0370
3038	1518.0	1518.0	22.95	0.19	0.0337
3039	1519.0	1518.0	22.96	0.19	0.0339
3040	1520.0	1519.0	22.95	0.18	0.0335
3130	1565.0	1564.0	22.93	0.16	0.0299
3131	1565.0	1564.0	22.94	0.17	0.0302
3135	1567.0	1566.0	22.93	0.16	0.0299
3234	1617.0	1616.0	22.91	0.15	0.0264
3235	1617.0	1616.0	22.92	0.15	0.0266
3238	1619.0	1618.0	22.91	0.14	0.0262
3239	1619.0	1618.0	22.92	0.15	0.0266
3240	1620.0	1619.0	22.91	0.14	0.0262
3241	1620.0	1619.0	22.92	0.15	0.0266
3242	1621.0	1620.0	22.91	0.14	0.0262
3357	1678.0	1677.0	22.89	0.12	0.0226
3358	1679.0	1678.0	22.90	0.13	0.0229
3359	1679.0	1678.0	22.89	0.12	0.0226
3429	1714.0	1713.0	22.88	0.11	0.0208
3430	1715.0	1714.0	22.89	0.12	0.0211
3431	1715.0	1714.0	22.88	0.11	0.0208
3432	1716.0	1715.0	22.89	0.12	0.0211
3433	1716.0	1715.0	22.88	0.11	0.0208
3582	1791.0	1790.0	22.86	0.10	0.0173
3586	1793.0	1792.0	22.87	0.10	0.0177
3587	1793.0	1792.0	22.86	0.10	0.0173
3776	1888.0	1887.0	22.84	0.08	0.0137
3777	1888.0	1887.0	22.85	0.08	0.0140
3781	1890.0	1889.0	22.84	0.08	0.0137
3782	1890.0	1890.0	22.85	0.08	0.0140
3785	1892.0	1891.0	22.84	0.08	0.0137
3795	1897.0	1896.0	22.85	0.08	0.0142
3796	1897.0	1897.0	22.84	0.08	0.0137
3813	1906.0	1905.0	22.85	0.08	0.0138
3814	1907.0	1906.0	22.84	0.07	0.0135
4055	2027.0	2026.0	22.82	0.06	0.0100
4057	2028.0	2027.0	22.83	0.06	0.0104
4059	2029.0	2028.0	22.82	0.06	0.0100
4061	2030.0	2029.0	22.83	0.06	0.0104
4075	2037.0	2036.0	22.82	0.06	0.0100
4079	2039.0	2038.0	22.83	0.06	0.0104
4080	2040.0	2039.0	22.82	0.06	0.0100
4260	2130.0	2129.0	22.81	0.04	0.0080
4261	2130.0	2129.0	22.82	0.05	0.0084
4263	2131.0	2130.0	22.81	0.04	0.0080
4266	2133.0	2132.0	22.82	0.05	0.0084

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
4270	2135.0	2134.0	22.81	0.04	0.0080
4273	2136.0	2135.0	22.82	0.05	0.0084
4274	2137.0	2136.0	22.81	0.04	0.0080
4277	2138.0	2137.0	22.82	0.05	0.0084
4278	2139.0	2138.0	22.81	0.04	0.0080
4285	2142.0	2141.0	22.82	0.05	0.0084
4286	2143.0	2142.0	22.81	0.04	0.0080
4804	2402.0	2401.0	22.79	0.02	0.0044
4805	2402.0	2401.0	22.80	0.03	0.0047
4807	2403.0	2402.0	22.79	0.02	0.0044
4808	2404.0	2403.0	22.80	0.03	0.0047
4813	2406.0	2405.0	22.79	0.02	0.0044
4814	2407.0	2406.0	22.80	0.03	0.0047
4815	2407.0	2406.0	22.79	0.02	0.0044
4816	2408.0	2407.0	22.80	0.03	0.0047
4820	2410.0	2409.0	22.79	0.02	0.0044
4821	2410.0	2409.0	22.80	0.03	0.0047
4822	2411.0	2410.0	22.79	0.02	0.0044
4823	2411.0	2410.0	22.80	0.03	0.0047
4825	2412.0	2411.0	22.79	0.02	0.0044
4826	2413.0	2412.0	22.80	0.03	0.0047
4829	2414.0	2413.0	22.79	0.02	0.0044
4830	2415.0	2414.0	22.80	0.03	0.0047
4833	2416.0	2415.0	22.79	0.02	0.0044
4835	2417.0	2416.0	22.80	0.03	0.0047
4837	2418.0	2417.0	22.79	0.02	0.0044
5040	2520.0	2519.0	22.79	0.02	0.0038

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

OW4-10

Rising Head "Slug-Out"

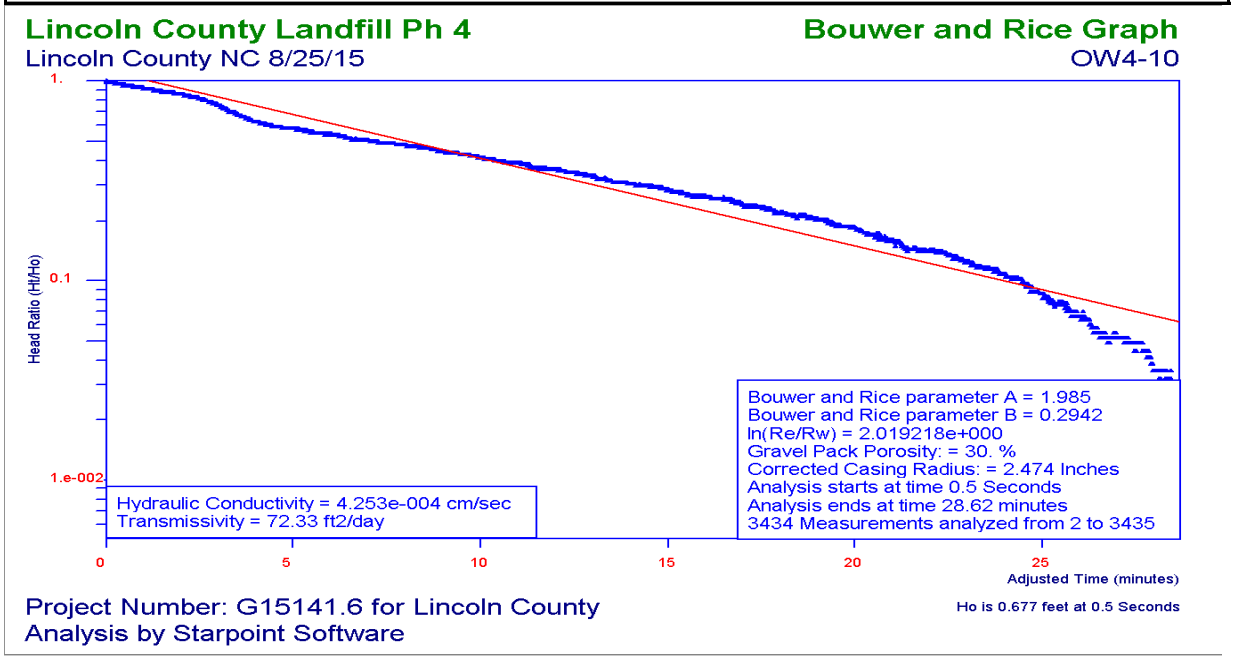
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/25/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-10
Aquifer Thickness:	59 feet to rock
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	4.25 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.474 Inches
Static Water Level BTOC:	20.36 feet
Water Table to Screen Bottom:	5.07 feet
Method:	Slug Out (1.315" diameter solid slug)
Anisotropy Ratio:	1
Time Adjustment:	0.5 Seconds
Test starts with trial:	1
There are 3,435 time and drawdown measurements	
Maximum head :	0.68 feet
Minimum head:	0 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **4.25E-04 cm/sec**

K= **439.83 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-0.5	20.36	0.00	0.000
2	0.5	0.0	21.04	0.68	1.000
28	13.5	13.0	21.03	0.67	0.984
50	24.5	24.0	21.02	0.66	0.968
72	35.5	35.0	21.00	0.65	0.953
97	48.0	47.5	21.00	0.64	0.938
130	64.5	64.0	20.98	0.63	0.923
156	77.5	77.0	20.98	0.62	0.908
181	90.0	89.5	20.96	0.60	0.892
214	106.5	106.0	20.95	0.59	0.877
245	122.0	121.5	20.94	0.58	0.863
269	134.0	133.5	20.93	0.57	0.846
292	145.5	145.0	20.92	0.56	0.832
309	154.0	153.5	20.91	0.55	0.815
326	162.5	162.0	20.90	0.54	0.801
340	169.5	169.0	20.89	0.53	0.784
357	178.0	177.5	20.88	0.52	0.768
370	184.5	184.0	20.87	0.51	0.753
381	190.0	189.5	20.86	0.50	0.739
389	194.0	193.5	20.85	0.49	0.722
401	200.0	199.5	20.84	0.48	0.708
420	209.5	209.0	20.83	0.47	0.688
437	218.0	217.5	20.82	0.46	0.674
450	224.5	224.0	20.81	0.45	0.659
466	232.5	232.0	20.80	0.44	0.643
482	240.5	240.0	20.79	0.43	0.628
508	253.5	253.0	20.77	0.41	0.612
550	274.5	274.0	20.76	0.40	0.594
598	298.5	298.0	20.75	0.39	0.579
650	324.5	324.0	20.74	0.38	0.563
674	336.5	336.0	20.73	0.37	0.548
760	379.5	379.0	20.72	0.36	0.530
791	395.0	394.5	20.71	0.35	0.516
862	430.5	430.0	20.70	0.34	0.498
940	469.5	469.0	20.69	0.33	0.482
1004	501.5	501.0	20.68	0.32	0.467
1063	531.0	530.5	20.66	0.31	0.451
1120	559.5	559.0	20.66	0.30	0.436
1179	589.0	588.5	20.65	0.29	0.421
1228	613.5	613.0	20.63	0.27	0.405
1295	647.0	646.5	20.62	0.26	0.390
1360	679.5	679.0	20.61	0.25	0.374
1454	726.5	726.0	20.60	0.24	0.358
1539	769.0	768.5	20.59	0.23	0.340

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1587	793.0	792.5	20.58	0.22	0.324
1671	835.0	834.5	20.57	0.21	0.309
1778	888.5	888.0	20.56	0.20	0.290
1842	920.5	920.0	20.55	0.19	0.275
1943	971.0	970.5	20.54	0.18	0.260
2023	1011.0	1011.0	20.52	0.17	0.244
2117	1058.0	1058.0	20.51	0.15	0.228
2196	1098.0	1097.0	20.50	0.14	0.213
2315	1157.0	1157.0	20.49	0.13	0.195
2407	1203.0	1203.0	20.48	0.12	0.179
2475	1237.0	1237.0	20.47	0.11	0.163
2562	1281.0	1280.0	20.46	0.10	0.145
2711	1355.0	1355.0	20.45	0.09	0.129
2844	1421.0	1421.0	20.43	0.08	0.111
2950	1475.0	1474.0	20.42	0.06	0.095
3020	1510.0	1509.0	20.41	0.05	0.078
3125	1562.0	1562.0	20.40	0.04	0.064
3297	1648.0	1648.0	20.39	0.03	0.044
3435	1717.0	1717.0	20.38	0.02	0.030

Trials with head change <0.01 feet not shown but used in calculations

OW4-11

Rising Head "Slug-Out"

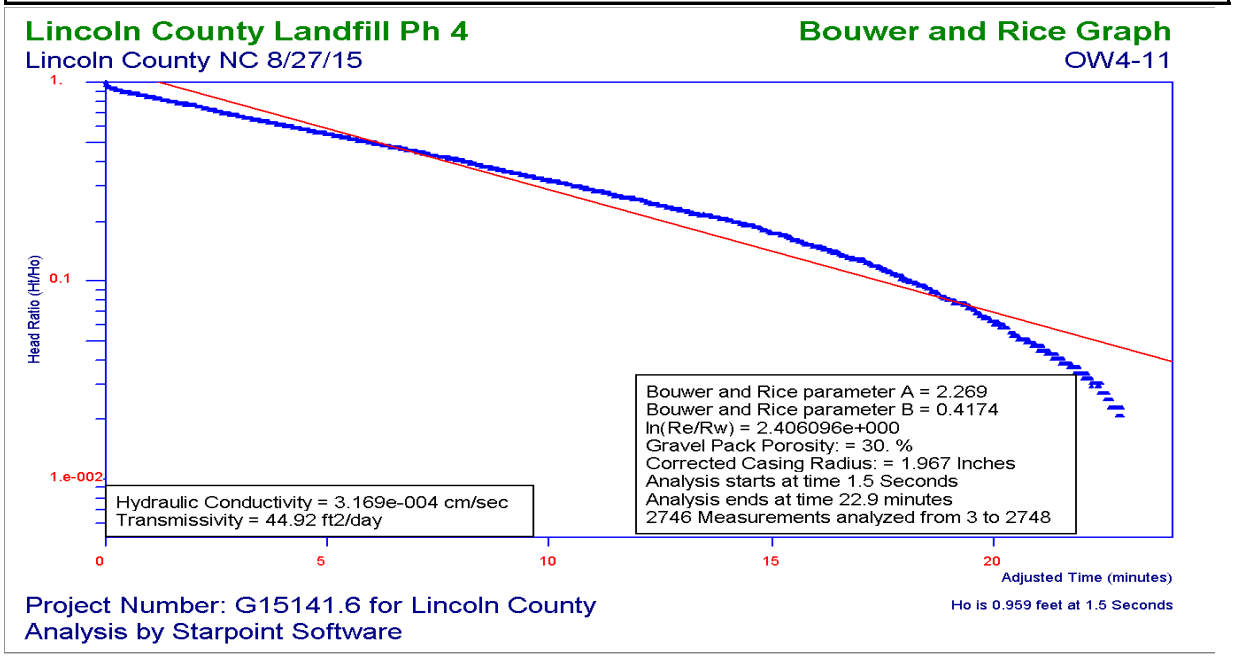
Site Name:	Lincoln County Landfill Ph 4
Location:	Lincoln County NC
Test Date:	8/27/2015
Client:	Lincoln County
Project Number:	G15141.6
Well Label:	OW4-11
Aquifer Thickness:	72 feet to rock
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	3.25 Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	1.967 Inches
Static Water Level BTOC:	20.36 feet
Water Table to Screen Bottom:	7.12 feet
Method:	Slug Out (1.315" diameter solid slug)
Anisotropy Ratio:	1
Time Adjustment:	1.5 Seconds
Test starts with trial:	1
There are 2,748 time and drawdown measurements	
Maximum head :	0.984 feet
Minimum head:	0 feet

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **3.17E-04 cm/sec**

K= **327.92 ft/year**



Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
1	0.0	-1.5	27.53	0.00	0.0000
2	1.0	-0.50	28.51	0.98	1.0000
3	1.5	0.00	28.49	0.96	0.9746
4	2.0	0.50	28.46	0.93	0.9492
11	5.5	4.00	28.45	0.92	0.9309
20	10.0	8.50	28.43	0.91	0.9197
28	14.0	12.50	28.42	0.90	0.9096
37	18.5	17.00	28.41	0.88	0.8984
50	25.0	23.50	28.40	0.87	0.8882
61	30.5	29.00	28.39	0.86	0.8780
75	37.5	36.00	28.38	0.85	0.8669
88	44.0	42.50	28.37	0.84	0.8567
102	51.0	49.50	28.36	0.83	0.8465
118	59.0	57.50	28.35	0.82	0.8354
134	67.0	65.50	28.34	0.81	0.8232
148	74.0	72.50	28.33	0.80	0.8120
163	81.5	80.00	28.32	0.79	0.8018
178	89.0	87.50	28.31	0.78	0.7907
195	97.5	96.00	28.30	0.77	0.7795
210	105.0	103.50	28.29	0.76	0.7693
229	114.5	113.00	28.28	0.75	0.7581
248	124.0	122.50	28.27	0.74	0.7480
263	131.5	130.00	28.26	0.73	0.7378
273	136.5	135.00	28.25	0.72	0.7266
286	143.0	141.50	28.23	0.71	0.7165
305	152.5	151.00	28.22	0.69	0.7033
323	161.5	160.00	28.21	0.68	0.6911
338	169.0	167.50	28.20	0.67	0.6809
352	176.0	174.50	28.19	0.66	0.6697
371	185.5	184.00	28.18	0.65	0.6596
387	193.5	192.00	28.17	0.64	0.6484
407	203.5	202.00	28.16	0.63	0.6382
427	213.5	212.00	28.15	0.62	0.6280
445	222.5	221.00	28.14	0.61	0.6169
465	232.5	231.00	28.13	0.60	0.6067
487	243.5	242.00	28.12	0.59	0.5955
509	254.5	253.00	28.11	0.58	0.5854
527	263.5	262.00	28.10	0.57	0.5752
550	275.0	273.50	28.09	0.56	0.5640
569	284.5	283.00	28.07	0.55	0.5539
591	295.5	294.00	28.06	0.53	0.5427
619	309.5	308.00	28.05	0.52	0.5315
641	320.5	319.00	28.04	0.51	0.5213
666	333.0	331.50	28.03	0.50	0.5112
693	346.5	345.00	28.02	0.49	0.5000

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
716	358.0	356.50	28.01	0.48	0.4898
742	371.0	369.50	28.00	0.47	0.4787
773	386.5	385.00	27.99	0.46	0.4665
802	401.0	399.50	27.98	0.45	0.4563
823	411.5	410.00	27.97	0.44	0.4461
858	429.0	427.50	27.96	0.43	0.4360
875	437.5	436.00	27.95	0.42	0.4248
903	451.5	450.00	27.94	0.41	0.4146
944	472.0	470.50	27.93	0.40	0.4024
972	486.0	484.50	27.92	0.39	0.3923
998	499.0	497.50	27.90	0.38	0.3811
1023	511.5	510.00	27.89	0.37	0.3709
1052	526.0	524.50	27.89	0.36	0.3608
1083	541.5	540.00	27.87	0.34	0.3496
1123	561.5	560.00	27.86	0.33	0.3374
1153	576.5	575.00	27.85	0.32	0.3262
1193	596.5	595.00	27.84	0.31	0.3161
1227	613.5	612.00	27.83	0.30	0.3059
1265	632.5	631.00	27.82	0.29	0.2947
1309	654.5	653.00	27.81	0.28	0.2825
1350	675.0	673.50	27.80	0.27	0.2713
1386	693.0	691.50	27.79	0.26	0.2612
1440	720.0	718.50	27.78	0.25	0.2510
1476	738.0	736.50	27.77	0.24	0.2398
1528	764.0	762.50	27.75	0.22	0.2276
1576	788.0	786.50	27.74	0.21	0.2165
1654	827.0	825.50	27.73	0.20	0.2043
1699	849.5	848.00	27.72	0.19	0.1941
1753	876.5	875.00	27.71	0.18	0.1829
1801	900.5	899.00	27.70	0.17	0.1707
1851	925.5	924.00	27.69	0.16	0.1596
1895	947.5	946.00	27.68	0.15	0.1494
1958	979.0	977.50	27.67	0.14	0.1372
2018	1009.0	1008.00	27.65	0.12	0.1260
2089	1045.0	1043.00	27.64	0.11	0.1138
2137	1069.0	1067.00	27.63	0.10	0.1026
2198	1099.0	1098.00	27.62	0.09	0.0925
2258	1129.0	1128.00	27.61	0.08	0.0813
2350	1175.0	1174.00	27.60	0.07	0.0691
2403	1202.0	1200.00	27.59	0.06	0.0589
2490	1245.0	1244.00	27.58	0.05	0.0478
2585	1293.0	1291.00	27.57	0.04	0.0376
2689	1345.0	1343.00	27.56	0.03	0.0264
2748	1374.0	1373.00	27.55	0.02	0.0224

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

MW-34
Rising Head "Slug-Out"

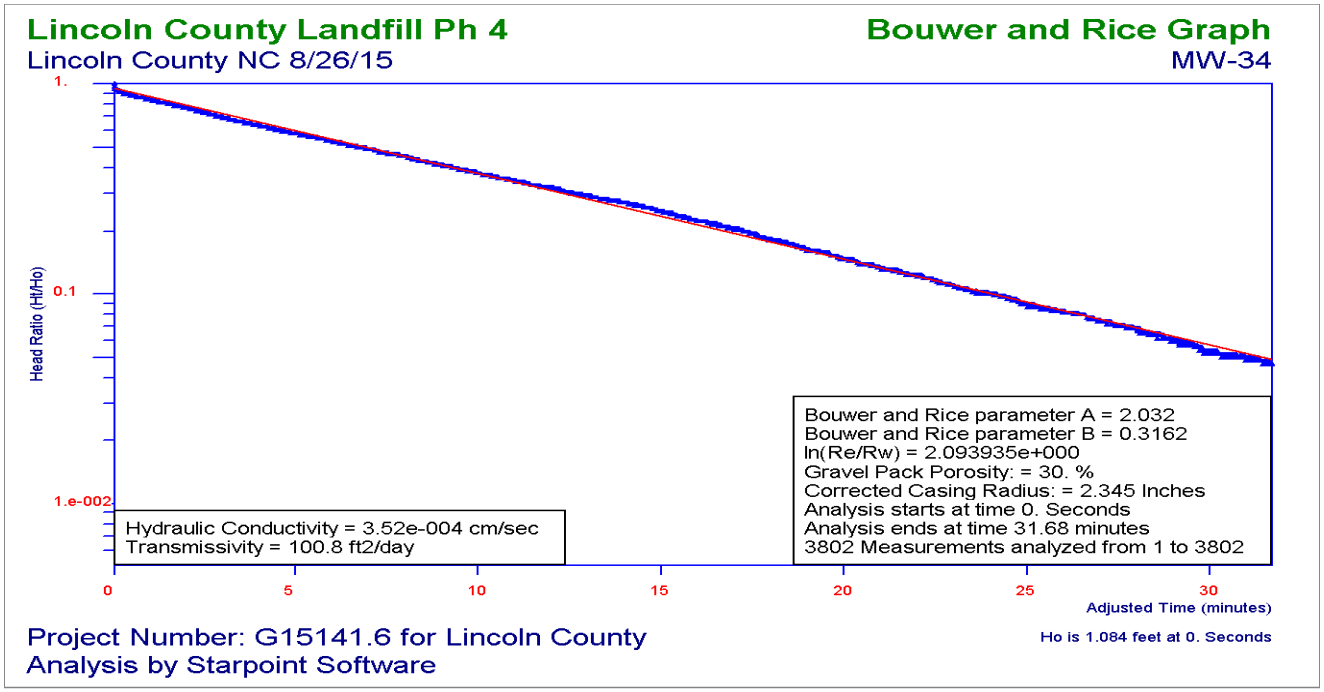
Site Name:	Lincoln County Landfill Ph 4	
Location:	Lincoln County NC	
Test Date:	8/26/2015	
Client:	Lincoln County	
Project Number:	G15141.6	
Well Label:	MW-34	
Aquifer Thickness:	101 feet	to bedrock
Screen Length:	15. feet	
Casing Radius:	1. Inches	
Effective Radius:	4. Inches	per S&ME boring logs
Gravel Pack Porosity:	30.00%	
Corrected Casing Radius:	2.345 Inches	
Static Water Level BTOC:	29.93 feet	manually measured
Water Table to Screen Bottom:	5.49 feet	
Method:	Slug Out (1.315" diameter solid slug)	
Anisotropy Ratio:	1	
Time Adjustment:	0 Seconds	
Test starts with trial:	0	
There are 3,802 time and drawdown measurements		
Maximum head :	1.084 feet	
Minimum head:	0 feet	

Hydraulic Conductivity Values (K)

(via Bouwer and Rice Graphical Method with gravel pack porosity adjustment):

K = **3.52E-04 cm/sec**

K= **364.12 ft/year**



Trial	Time (Seconds)	Adjusted Time (Seconds)	Drawdown (feet)	Head (feet)	Head Ratio
1	0.0	0.0	31.01	1.08	1.00000
2	0.5	0.5	30.99	1.06	0.97690
3	1.0	1.0	30.96	1.03	0.95390
10	4.5	4.5	30.95	1.02	0.93730
19	9.0	9.0	30.93	1.01	0.92710
28	13.5	13.5	30.92	0.99	0.91700
36	17.5	17.5	30.91	0.98	0.90770
49	24.0	24.0	30.90	0.97	0.89850
60	29.5	29.5	30.89	0.96	0.88930
74	36.5	36.5	30.88	0.95	0.87920
87	43.0	43.0	30.87	0.94	0.86990
104	51.5	51.5	30.86	0.93	0.85790
119	59.0	59.0	30.85	0.92	0.84870
133	66.0	66.0	30.84	0.91	0.83950
147	73.0	73.0	30.83	0.90	0.82930
162	80.5	80.5	30.82	0.89	0.82010
177	88.0	88.0	30.81	0.88	0.81000
194	96.5	96.5	30.80	0.87	0.79980
209	104.0	104.0	30.79	0.86	0.79060
228	113.5	113.5	30.78	0.85	0.78040
247	123.0	123.0	30.77	0.84	0.77120
262	130.5	130.5	30.76	0.83	0.76200
272	135.5	135.5	30.74	0.82	0.75180
285	142.0	142.0	30.73	0.81	0.74260
300	149.5	149.5	30.73	0.80	0.73340
316	157.5	157.5	30.71	0.78	0.72320
332	165.5	165.5	30.70	0.77	0.71400
345	172.0	172.0	30.69	0.76	0.70390
361	180.0	180.0	30.68	0.75	0.69460
380	189.5	189.5	30.67	0.74	0.68540
399	199.0	199.0	30.66	0.73	0.67530
415	207.0	207.0	30.65	0.72	0.66610
435	217.0	217.0	30.64	0.71	0.65590
458	228.5	228.5	30.63	0.70	0.64670
478	238.5	238.5	30.62	0.69	0.63750
498	248.5	248.5	30.61	0.68	0.62730
518	258.5	258.5	30.60	0.67	0.61720
537	268.0	268.0	30.59	0.66	0.60790
561	280.0	280.0	30.58	0.65	0.59780
583	291.0	291.0	30.57	0.64	0.58860
605	302.0	302.0	30.56	0.63	0.57840
630	314.5	314.5	30.55	0.62	0.56920
655	327.0	327.0	30.54	0.61	0.56000
683	341.0	341.0	30.53	0.60	0.54980
709	354.0	354.0	30.52	0.59	0.54060

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
731	365.0	365.0	30.51	0.58	0.53040
755	377.0	377.0	30.50	0.57	0.52120
788	393.5	393.5	30.48	0.55	0.51110
811	405.0	405.0	30.47	0.54	0.50090
846	422.5	422.5	30.46	0.53	0.49170
868	433.5	433.5	30.45	0.52	0.48150
888	443.5	443.5	30.44	0.51	0.47230
916	457.5	457.5	30.43	0.50	0.46310
957	478.0	478.0	30.42	0.49	0.45390
980	489.5	489.5	30.41	0.48	0.44460
1006	502.5	502.5	30.40	0.47	0.43450
1039	519.0	519.0	30.39	0.46	0.42340
1067	533.0	533.0	30.38	0.45	0.41330
1100	549.5	549.5	30.37	0.44	0.40410
1133	566.0	566.0	30.36	0.43	0.39480
1168	583.5	583.5	30.35	0.42	0.38470
1200	599.5	599.5	30.34	0.41	0.37550
1250	624.5	624.5	30.32	0.39	0.36350
1289	644.0	644.0	30.31	0.38	0.35420
1320	659.5	659.5	30.30	0.37	0.34500
1364	681.5	681.5	30.29	0.36	0.33490
1403	701.0	701.0	30.28	0.35	0.32560
1463	731.0	731.0	30.27	0.34	0.31370
1495	747.0	747.0	30.26	0.33	0.30440
1544	771.5	771.5	30.25	0.32	0.29520
1594	796.5	796.5	30.24	0.31	0.28510
1660	829.5	829.5	30.23	0.30	0.27580
1708	853.5	853.5	30.22	0.29	0.26660
1765	882.0	882.0	30.21	0.28	0.25650
1800	899.5	899.5	30.20	0.27	0.24720
1850	924.5	924.5	30.19	0.26	0.23710
1894	946.5	946.5	30.18	0.25	0.22790
1950	974.5	974.5	30.17	0.24	0.21860
2007	1003.0	1003.0	30.16	0.23	0.20850
2066	1033.0	1033.0	30.15	0.22	0.19930
2118	1059.0	1059.0	30.14	0.21	0.18910
2173	1086.0	1086.0	30.13	0.20	0.17990
2232	1116.0	1116.0	30.11	0.19	0.17070
2293	1146.0	1146.0	30.10	0.17	0.16050
2376	1188.0	1188.0	30.09	0.16	0.14940
2452	1226.0	1226.0	30.08	0.15	0.13930
2542	1271.0	1271.0	30.07	0.14	0.13010
2663	1331.0	1331.0	30.06	0.13	0.11900
2749	1374.0	1374.0	30.05	0.12	0.10980
2890	1445.0	1445.0	30.04	0.11	0.09871

Trial	Time	Adjusted Time	Drawdown	Head	Head Ratio
	(Seconds)	(Seconds)	(feet)	(feet)	
3001	1500.0	1500.0	30.02	0.09	0.08672
3204	1602.0	1602.0	30.01	0.08	0.07565
3362	1681.0	1681.0	30.00	0.07	0.06642
3553	1776.0	1776.0	29.99	0.06	0.05535
3802	1901.0	1901.0	29.98	0.05	0.04613

Data in table reduced for brevity. Only changes >=0.01 feet shown but all used in graph/calculation

MW-33

OW-29 Slug Out

Site Name: **LCLF Phase III - Hydrogeologic Study**
Location: **Crouse, North Carolina**
Test Date: **01/07/2005**
Client: **Lincoln County**
Project Number: **1356-03-255A**

Well Label:	OW-29
Aquifer Thickness:	18.1 feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	4. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.35 Inches
Static Water Level:	11.9 feet
Water Table to Screen Bottom:	13.1 feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds

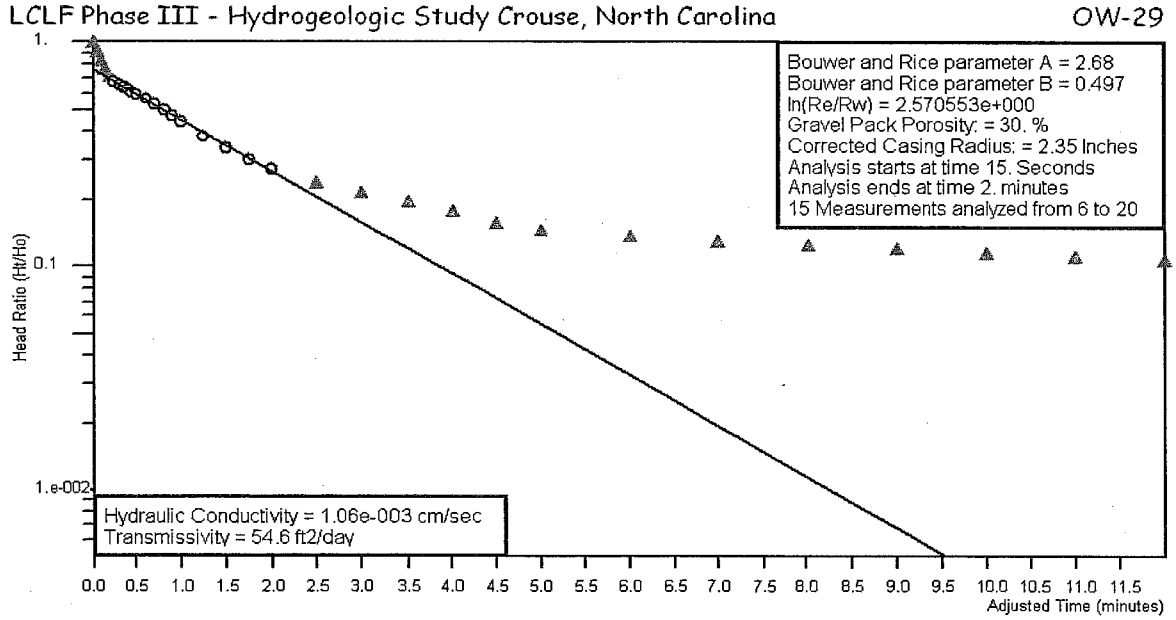
Test starts with trial 0
There are 33 time and drawdown measurements
Maximum head is 3.22 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	0	0	15.2	3.22	1
2	5.00E-02	5.00E-02	14.9	2.93	0.91
3	0.1	0.1	14.6	2.69	0.836
4	0.15	0.15	14.4	2.46	0.762
5	0.2	0.2	14.2	2.28	0.709
6	0.25	0.25	14.1	2.16	0.671
7	0.3	0.3	14	2.08	0.645
8	0.35	0.35	14	2.02	0.628
9	0.4	0.4	13.9	1.98	0.613
10	0.45	0.45	13.9	1.93	0.599
11	0.5	0.5	13.8	1.9	0.588
12	0.6	0.6	13.8	1.81	0.562
13	0.7	0.7	13.7	1.71	0.531
14	0.8	0.8	13.6	1.61	0.501
15	0.9	0.9	13.5	1.52	0.471
16	1	1	13.4	1.43	0.442

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
17	1.25	1.25	13.2	1.23	0.383
18	1.5	1.5	13	1.09	0.337
19	1.75	1.75	12.9	0.972	0.302
20	2	2	12.8	0.882	0.274
21	2.5	2.5	12.7	0.769	0.239
22	3	3	12.6	0.7	0.217
23	3.5	3.5	12.6	0.63	0.195
24	4	4	12.5	0.568	0.176
25	4.5	4.5	12.4	0.509	0.158
26	5	5	12.4	0.47	0.146
27	6	6	12.4	0.439	0.136
28	7	7	12.4	0.419	0.13
29	8	8	12.3	0.4	0.124
30	9	9	12.3	0.384	0.119
31	10	10	12.3	0.369	0.114
32	11	11	12.3	0.357	0.111
33	12	12	12.3	0.343	0.106

OW-29 Slug Out January 7, 2005 Bouwer and Rice Graph

LCLF Phase III - Hydrogeologic Study Crouse, North Carolina OW-29



Project Number: 1356-03-255A for Lincoln County

Analysis by Julie Petersen of S&ME, Inc.

Ho is 3.22 feet at 0. Seconds

MW-33A

OW-29A Slug Out

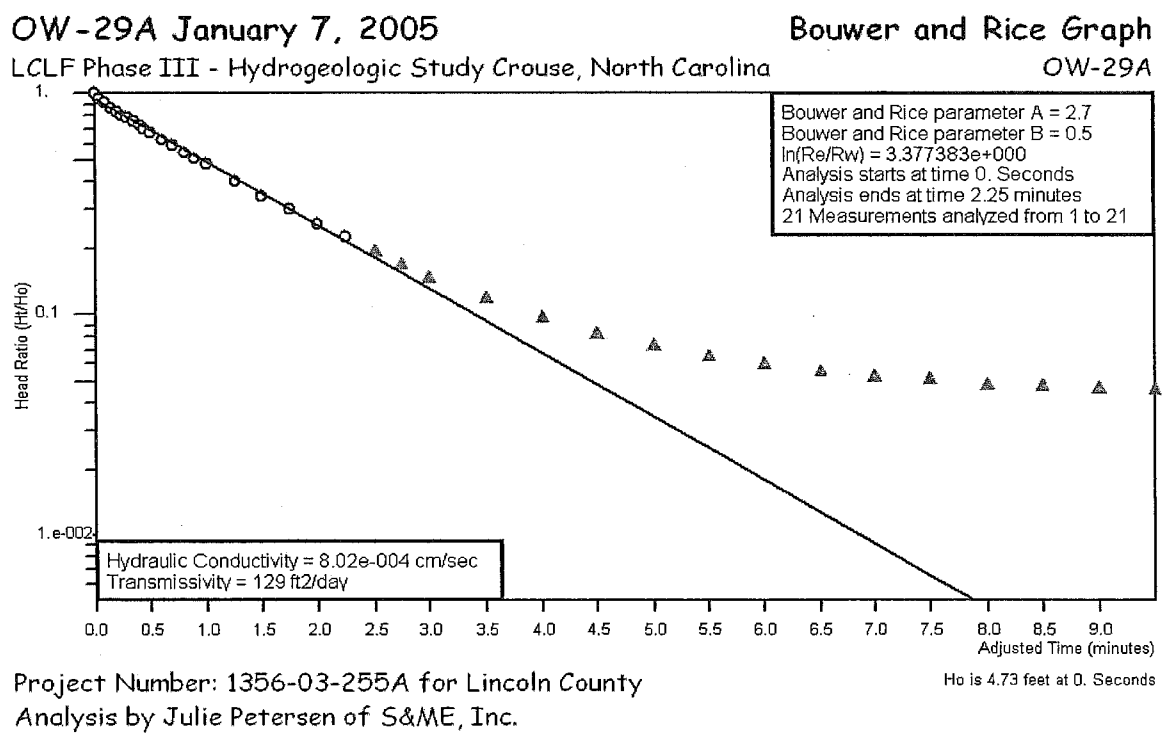
Site Name: **LCLF Phase III - Hydrogeologic Study**
Location: **Crouse, North Carolina**
Test Date: **01/07/2005**
Client: **Lincoln County**
Project Number: **1356-03-255A**

Well Label:	OW-29A
Aquifer Thickness:	56.9 feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	1.5 Inches
Static Water Level:	12.4 feet
Water Table to Screen Bottom:	51.9 feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds

Test starts with trial 0
There are 37 time and drawdown measurements
Maximum head is 4.73 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	0	0	17.1	4.73	1
2	5.00E-02	5.00E-02	16.9	4.49	0.949
3	0.1	0.1	16.7	4.3	0.908
4	0.15	0.15	16.5	4.12	0.871
5	0.2	0.2	16.3	3.96	0.837
6	0.25	0.25	16.2	3.82	0.806
7	0.3	0.3	16	3.67	0.776
8	0.35	0.35	15.9	3.54	0.748
9	0.4	0.4	15.8	3.41	0.721
10	0.45	0.45	15.7	3.29	0.695
11	0.5	0.5	15.5	3.18	0.671
12	0.6	0.6	15.3	2.96	0.625
13	0.7	0.7	15.1	2.76	0.584
14	0.8	0.8	14.9	2.58	0.545
15	0.9	0.9	14.8	2.42	0.51
16	1	1	14.6	2.26	0.477
17	1.25	1.25	14.3	1.92	0.406
18	1.5	1.5	14	1.64	0.346

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
19	1.75	1.75	13.8	1.41	0.298
20	2	2	13.6	1.21	0.256
21	2.25	2.25	13.4	1.05	0.222
22	2.5	2.5	13.3	0.918	0.194
23	2.75	2.75	13.2	0.805	0.17
24	3	3	13.1	0.705	0.149
25	3.5	3.5	12.9	0.571	0.121
26	4	4	12.8	0.466	9.84E-02
27	4.5	4.5	12.8	0.392	8.28E-02
28	5	5	12.7	0.347	7.33E-02
29	5.5	5.5	12.7	0.312	6.59E-02
30	6	6	12.6	0.284	6.00E-02
31	6.5	6.5	12.6	0.267	5.64E-02
32	7	7	12.6	0.251	5.30E-02
33	7.5	7.5	12.6	0.243	5.13E-02
34	8	8	12.6	0.232	4.90E-02
35	8.5	8.5	12.6	0.226	4.77E-02
36	9	9	12.6	0.222	4.69E-02
37	9.5	9.5	12.6	0.216	4.56E-02



Project Number: 1356-03-255A for Lincoln County
Analysis by Julie Petersen of S&ME, Inc.

MW-35

OW-31 Slug Out

Site Name: **LCLF Phase III - Hydrogeologic Study**
Location: **Crouse, North Carolina**
Test Date: **01/07/2005**
Client: **Lincoln County**
Project Number: **1356-03-255A**

Well Label:	OW-31
Aquifer Thickness:	15. feet
Screen Length:	15. feet
Casing Radius:	1. Inches
Effective Radius:	4. Inches
Gravel Pack Porosity:	30.00%
Corrected Casing Radius:	2.35 Inches
Static Water Level:	26.8 feet
Water Table to Screen Bottom:	10. feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds

Test starts with trial 0
There are 44 time and drawdown measurements
Maximum head is 2.27 feet
Minimum head is 0. feet

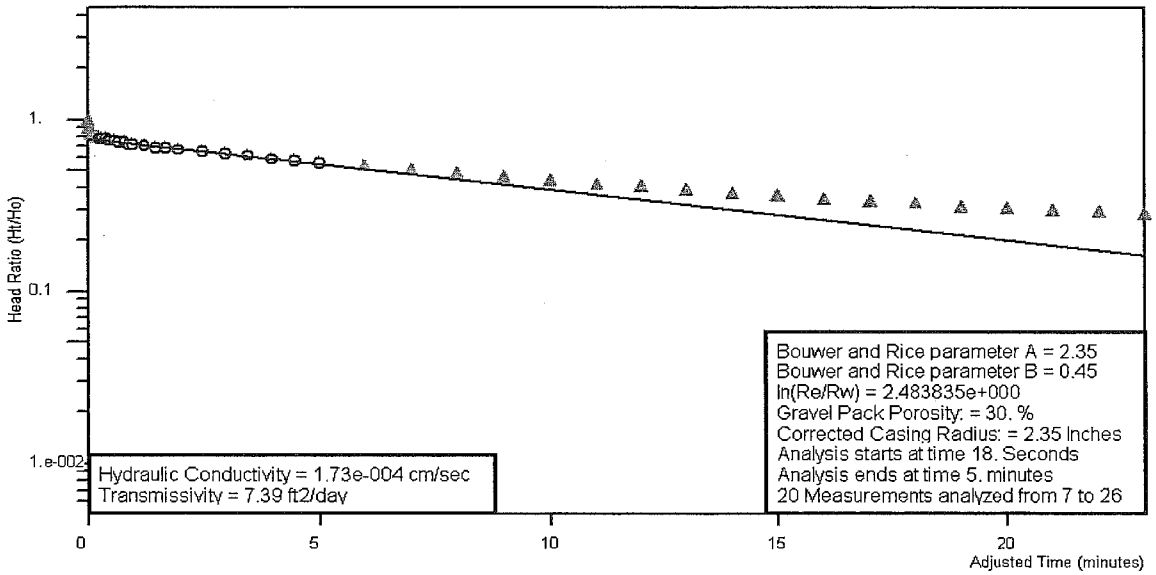
Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	0	0	29	2.27	1
2	5.00E-02	5.00E-02	28.8	2.05	0.901
3	0.1	0.1	28.7	1.9	0.837
4	0.15	0.15	28.6	1.84	0.809
5	0.2	0.2	28.6	1.81	0.798
6	0.25	0.25	28.6	1.79	0.789
7	0.3	0.3	28.5	1.78	0.781
8	0.35	0.35	28.5	1.76	0.775
9	0.4	0.4	28.5	1.75	0.77
10	0.45	0.45	28.5	1.73	0.762
11	0.5	0.5	28.5	1.71	0.754
12	0.6	0.6	28.5	1.7	0.747
13	0.7	0.7	28.4	1.68	0.739
14	0.8	0.8	28.4	1.67	0.733
15	0.9	0.9	28.4	1.65	0.725
16	1	1	28.4	1.63	0.719

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
17	1.25	1.25	28.4	1.6	0.704
18	1.5	1.5	28.3	1.57	0.689
19	1.75	1.75	28.3	1.54	0.676
20	2	2	28.3	1.51	0.665
21	2.5	2.5	28.2	1.46	0.644
22	3	3	28.2	1.42	0.626
23	3.5	3.5	28.2	1.39	0.611
24	4	4	28.1	1.35	0.595
25	4.5	4.5	28.1	1.32	0.579
26	5	5	28.1	1.28	0.565
27	6	6	28	1.23	0.54
28	7	7	27.9	1.17	0.517
29	8	8	27.9	1.12	0.495
30	9	9	27.8	1.07	0.473
31	10	10	27.8	1.03	0.452
32	11	11	27.7	0.975	0.429
33	12	12	27.7	0.932	0.41
34	13	13	27.7	0.891	0.392
35	14	14	27.6	0.856	0.377
36	15	15	27.6	0.825	0.363
37	16	16	27.6	0.796	0.35
38	17	17	27.5	0.769	0.338
39	18	18	27.5	0.745	0.328
40	19	19	27.5	0.72	0.317
41	20	20	27.5	0.699	0.308
42	21	21	27.5	0.683	0.301
43	22	22	27.4	0.667	0.294
44	23	23	27.4	0.65	0.286

MW-35

OW-31 Slug Out January 7, 2005 — Bouwer and Rice Graph

LCLF Phase III - Hydrogeologic Study Crouse, North Carolina — OW-31



Ho is 2.27 feet at 0. Seconds

Project Number: 1356-03-255A for Lincoln County
Analysis by Julie Petersen of S&ME, Inc.

MW-35A

OW-31A Slug Out

Site Name: **LCLF Phase III - Hydrogeologic Study**
Location: **Crouse, North Carolina**
Test Date: **01/07/2005**
Client: **Lincoln County**
Project Number: **1356-03-255A**

Well Label:	OW-31A
Aquifer Thickness:	45. feet
Screen Length:	5. feet
Casing Radius:	1. Inches
Effective Radius:	4. Inches
Static Water Level:	28.1 feet
Water Table to Screen Bottom:	40. feet
Anisotropy Ratio:	1
Time Adjustment:	0. Seconds

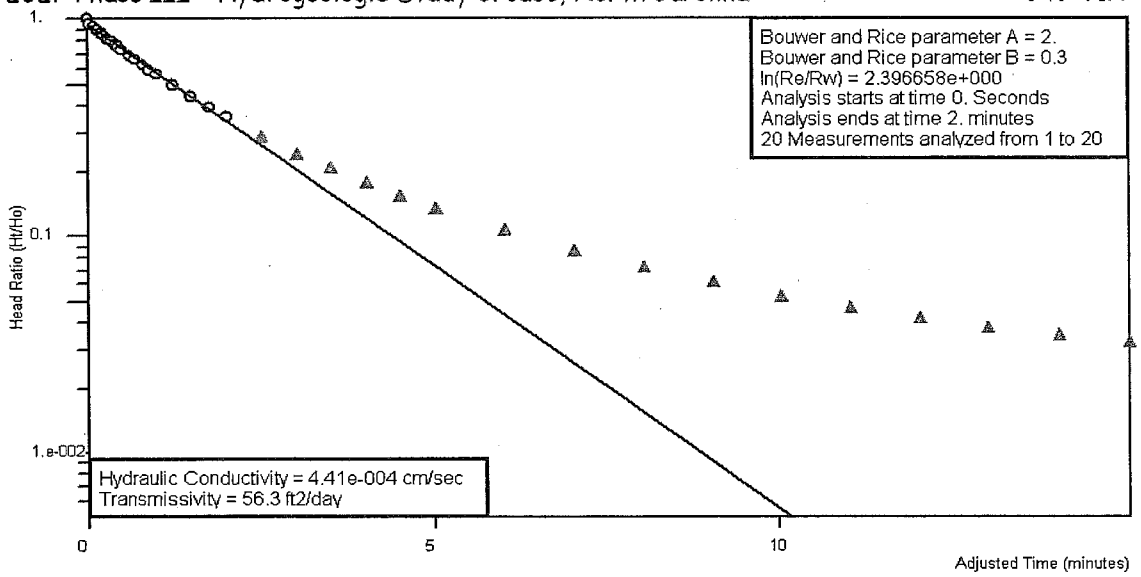
Test starts with trial 0
There are 36 time and drawdown measurements
Maximum head is 3.97 feet
Minimum head is 0. feet

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
1	0	0	32	3.97	1
2	5.00E-02	5.00E-02	31.9	3.81	0.961
3	0.1	0.1	31.7	3.68	0.929
4	0.15	0.15	31.6	3.56	0.898
5	0.2	0.2	31.5	3.45	0.871
6	0.25	0.25	31.4	3.35	0.844
7	0.3	0.3	31.3	3.25	0.819
8	0.35	0.35	31.2	3.15	0.795
9	0.4	0.4	31.1	3.06	0.772
10	0.45	0.45	31	2.97	0.749
11	0.5	0.5	30.9	2.89	0.728
12	0.6	0.6	30.8	2.73	0.688
13	0.7	0.7	30.6	2.59	0.652
14	0.8	0.8	30.5	2.45	0.619
15	0.9	0.9	30.4	2.33	0.587
16	1	1	30.3	2.21	0.558
17	1.25	1.25	30	1.96	0.495
18	1.5	1.5	29.8	1.75	0.442

Trial	Time (minutes)	Adjusted Time (minutes)	Drawdown (feet)	Head (feet)	Head Ratio
19	1.75	1.75	29.6	1.57	0.396
20	2	2	29.5	1.41	0.357
21	2.5	2.5	29.2	1.16	0.291
22	3	3	29	0.969	0.244
23	3.5	3.5	28.9	0.821	0.207
24	4	4	28.8	0.702	0.177
25	4.5	4.5	28.7	0.61	0.154
26	5	5	28.6	0.536	0.135
27	6	6	28.5	0.421	0.106
28	7	7	28.4	0.341	8.60E-02
29	8	8	28.3	0.286	7.21E-02
30	9	9	28.3	0.243	6.13E-02
31	10	10	28.3	0.208	5.24E-02
32	11	11	28.2	0.185	4.66E-02
33	12	12	28.2	0.165	4.16E-02
34	13	13	28.2	0.15	3.78E-02
35	14	14	28.2	0.138	3.48E-02
36	15	15	28.2	0.128	3.23E-02

OW-31A Slug Out January 7, 2005 Bouwer and Rice Graph

LCLF Phase III - Hydrogeologic Study Crouse, North Carolina OW-31A



Ho is 3.97 feet at 0. Seconds

Project Number: 1356-03-255A for Lincoln County

Analysis by Julie Petersen of S&ME, Inc.

SOIL LABORATORY DATA SHEETS

LABORATORY PROCEDURES

Moisture Content: The moisture content is the ratio, expressed as a percentage, of the weight of water in a given mass of soil to the weight of the solid particles. This test was conducted in accordance with ASTM Designation D 2216.

Grain Size Test with Hydrometer: Grain size tests were performed to determine the particle size and distribution of the samples tested. The grain size distribution of soils coarser than a No. 200 sieve was determined by passing the samples through a set of nested sieves. The soil particles passing the No. 200 sieve were suspended in solution and the grain size distribution determined from the rate of settlement.

Soil Plasticity Test (Atterberg Limits Test): Representative samples were selected for Atterberg Limits testing to determine the soil's plasticity characteristics. The Plasticity Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL). The Liquid Limit is the moisture content at which the soil will flow as a heavy viscous fluid. The Plastic Limit is the moisture content at which the soil begins to lose its plasticity. Although some samples had high proportion of clay and silt ECS Carolinas reported the samples were not able to roll to 1/8 in diameter and stay intact therefore reported as non-plastic (NP).

Specific Gravity: The specific gravity of the permeability test samples was determined. The specific gravity is the ratio of the weight, in air, of a given volume of soil particles to the weight in air, of an equal volume of water. This test conducted in accordance with ASTM Designation D-854-58.

Unit Weight: In the laboratory, a section of each selected undisturbed sample, still in its steel tube, was measured and weighed to determine gross weight and volume. The sample was then extruded from its steel tube and the net weight and volume of the sample determined for the calculation of the soil wet unit weight in pounds per cubic foot. The dry unit weight was then calculated from the net unit weight and the natural moisture content.

Permeability Test: The coefficient of permeability, k, of selected samples was estimated in the laboratory by testing the samples in a constant head permeameter. The sample and apparatus dimensions were carefully measured and the sample saturated prior to initiating the test. A head was then applied to the sample to provide flow, and the change in head was measured over a corresponding time interval. The coefficient of permeability was then calculated from the measured dimensions, head change and elapsed test time. This test was conducted in accordance with ASTM Designation D-5084.

August 31, 2015

Project No. 2015-724-001

Mr. Jonathan Pfohl
MESCO
PO Box 98
Garner, NC 27529

Transmittal
Laboratory Test Results
Lincoln County MSWLF, Phase 4

Please find attached the laboratory test results for the above referenced project. The tests were outlined on the Project Verification Form that was transmitted to your firm prior to the testing. The testing was performed in general accordance with the methods listed on the enclosed data sheets. The test results are believed to be representative of the samples that were submitted for testing and are indicative only of the specimens which were evaluated. We have no direct knowledge of the origin of the samples and imply no position with regard to the nature of the test results, i.e. pass/fail and no claims as to the suitability of the material for its intended use.

The test data and all associated project information provided shall be held in strict confidence and disclosed to other parties only with authorization by our Client. The test data submitted herein is considered integral with this report and is not to be reproduced except in whole and only with the authorization of the Client and Geotechnics. The remaining sample materials for this project will be retained for a minimum of 90 days as directed by the Geotechnics' Quality Program.

We are pleased to provide these testing services. Should you have any questions or if we may be of further assistance, please contact our office.

Respectively submitted,
Geotechnics, Inc.

Michael P. Smith
Regional Manager

We understand that you have a choice in your laboratory services and we thank you for choosing Geotechnics.

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PERMEABILITY TEST

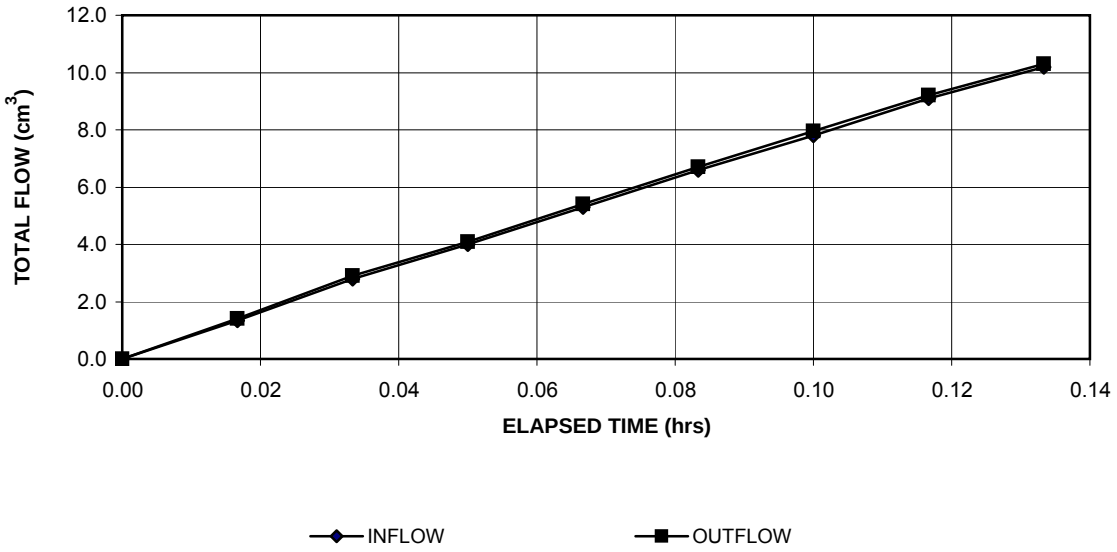
ASTM D 5084-10

geotechnics
geotechnical & geosynthetic testing

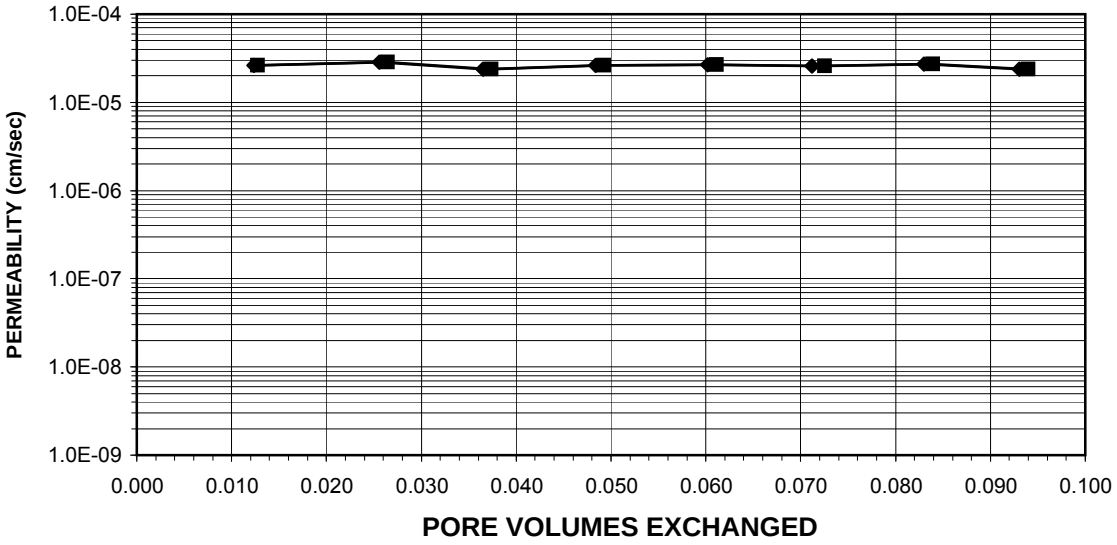
Client:	MESCO	Boring No.:	OW4-6D
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	35-37
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-001		

AVERAGE PERMEABILITY = 2.6E-05 cm/sec @ 20°C
AVERAGE PERMEABILITY = 2.6E-07 m/sec @ 20°C

TOTAL FLOW vs. ELAPSED TIME



PORE VOLUMES EXCHANGED vs. PERMEABILITY



Tested By: TRE Date: 8/20/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10

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PERMEABILITY TEST

ASTM D 5084-10

geotechnics
geotechnical & geosynthetic testing

Client:	MESCO	Boring No.:	OW4-6D
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	35-37
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-001		

Specific Gravity:	2.66	Measured
Sample Condition:		Undisturbed

Visual Description: Brown Weathered Micaceous Rock

MOISTURE CONTENT:	BEFORE TEST	AFTER TEST
Tare Number	575	888
Weight of Tare & Wet Sample (g)	208.71	861.60
Weight of Tare & Dry Sample (g)	196.22	738.30
Weight of Tare (g)	82.39	110.36
Weight of Water (g)	12.49	123.30
Weight of Dry Sample (g)	113.83	627.94
Moisture Content (%)	**11.0**	**19.6**

SPECIMEN:	BEFORE TEST	AFTER TEST
Weight of Tube & Wet Sample (g)	944.36	NA
Weight of Tube (g)	217.84	NA
Weight of Wet Sample (g)	726.52	783.24
Length 1 (in)	3.180	3.279
Length 2 (in)	3.177	3.311
Length 3 (in)	3.205	3.272
Top Diameter (in)	2.879	2.899
Middle Diameter (in)	2.882	2.900
Bottom Diameter (in)	2.882	2.900
Average Length (in)	3.19	3.29
Average Area (in^2)	6.52	6.60
Sample Volume (cm^3)	340.49	355.74
Unit Wet Weight (g/cm^3)	2.13	2.20
Unit Wet Weight (pcf)	133.2	137.4
Unit Dry Weight (pcf)	120.0	114.9
Unit Dry Weight (g/cm^3)	1.92	1.84
Void Ratio, e	0.38	0.45
Porosity, n	0.28	0.31
Pore Volume (cm^3)	94.4	109.6
Total Weight of Sample After Test (g)		751.5

Tested By: TRE Date: 8/20/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10 *permflow.xls*

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PERMEABILITY TEST

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Client:	MESCO	Boring No.:	OW4-6D
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	35-37
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-001		

Pressure Heads (Constant)		Final Sample Dimensions	
Top Cap (psi)	69.0	Sample Length (cm), L	8.35
Bottom Cap (psi)	71.0	Sample Diameter (cm)	7.37
Cell (psi)	75.0	Sample Area (cm^2), A	42.60
Total Pressure Head (cm)	140.6	Inflow Burette Area (cm^2), a-in	0.898
Hydraulic Gradient	16.84	Outflow Burette Area (cm^2), a-out	0.899
		B Parameter (%)	99

AVERAGE PERMEABILITY = 2.6E-05 cm/sec @ 20°C

AVERAGE PERMEABILITY = 2.6E-07 m/sec @ 20°C

DATE (mm/dd/yy)	TIME (hr)	TIME (min)	ELAPSED TIME t (hr)	TOTAL INFLOW (cm^3)	TOTAL OUTFLOW (cm^3)	TOTAL HEAD h (cm)	FLOW (0 flow) (1 stop)	TEMP. (°C)	INCREMENTAL PERMEABILITY @ 20°C (cm/sec)
8/21/15	8	32	0.000	0.0	0.0	163.6	0	22.0	NA
8/21/15	8	33	0.017	1.4	1.4	160.5	0	22.0	2.6E-05
8/21/15	8	34	0.033	2.8	2.9	157.2	0	22.0	2.9E-05
8/21/15	8	35	0.050	4.0	4.1	154.6	0	22.0	2.4E-05
8/21/15	8	36	0.067	5.3	5.4	151.7	0	22.0	2.6E-05
8/21/15	8	37	0.083	6.6	6.7	148.8	0	22.0	2.7E-05
8/21/15	8	38	0.100	7.8	8.0	146.1	0	22.0	2.6E-05
8/21/15	8	39	0.117	9.1	9.2	143.3	0	22.0	2.7E-05
8/21/15	8	40	0.133	10.2	10.3	140.9	1	22.0	2.4E-05

Tested By: TRE Date: 8/20/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10

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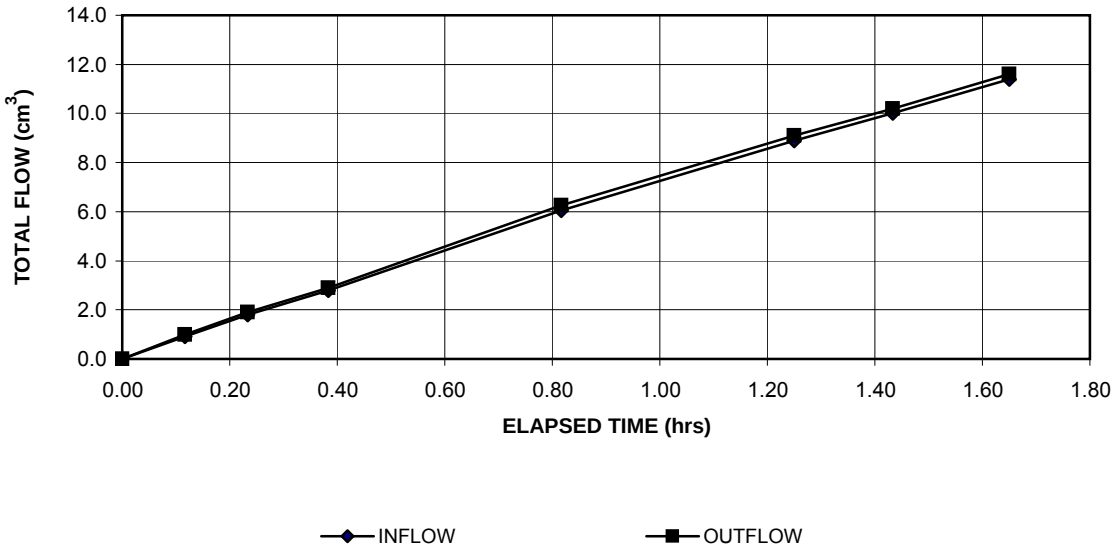
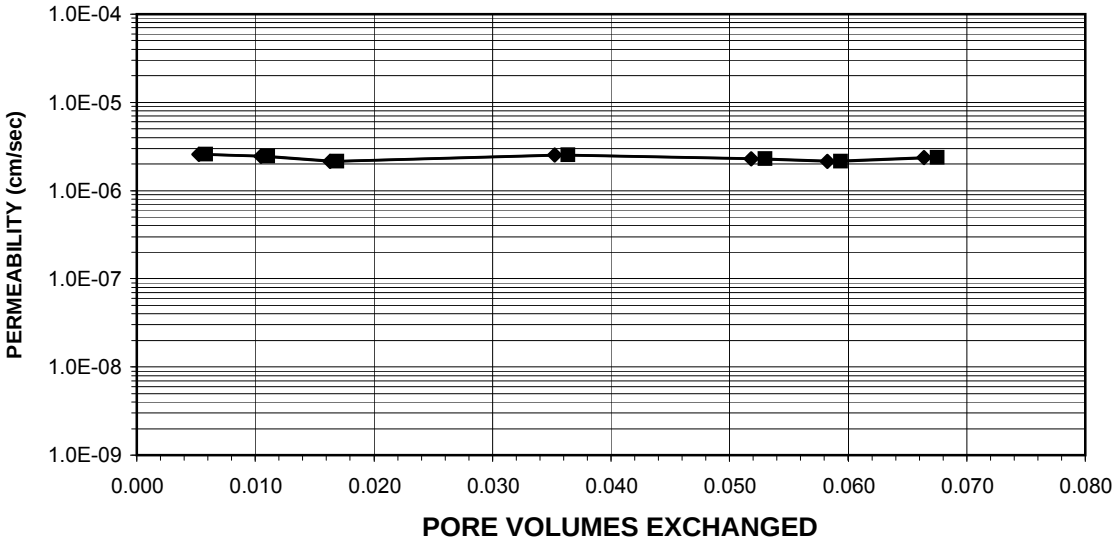
Client:	MESCO	Boring No.:	OW4-3D
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	34-36
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-002		

AVERAGE PERMEABILITY = 2.3E-06 cm/sec @ 20°C
AVERAGE PERMEABILITY = 2.3E-08 m/sec @ 20°C

TOTAL FLOW vs. ELAPSED TIME



PORE VOLUMES EXCHANGED vs. PERMEABILITY



Tested By: JAB Date: 8/24/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10

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Client:	MESCO	Boring No.:	OW4-3D
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	34-36
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-002		

Specific Gravity:	2.71	Measured
Sample Condition:		Undisturbed

Visual Description: Light Brown Sandy Silt

MOISTURE CONTENT:	BEFORE TEST	AFTER TEST
Tare Number	573	1705
Weight of Tare & Wet Sample (g)	292.71	648.95
Weight of Tare & Dry Sample (g)	231.42	478.70
Weight of Tare (g)	82.40	83.05
Weight of Water (g)	61.29	170.25
Weight of Dry Sample (g)	149.02	395.65
Moisture Content (%)	**41.1**	**43.0**

SPECIMEN:	BEFORE TEST	AFTER TEST
Weight of Tube & Wet Sample (g)	852.26	NA
Weight of Tube (g)	276.07	NA
Weight of Wet Sample (g)	576.19	583.95
Length 1 (in)	3.082	3.070
Length 2 (in)	3.045	3.160
Length 3 (in)	3.058	3.140
Top Diameter (in)	2.882	2.843
Middle Diameter (in)	2.877	2.835
Bottom Diameter (in)	2.880	2.818
Average Length (in)	3.06	3.12
Average Area (in^2)	6.51	6.30
Sample Volume (cm^3)	326.76	322.40
Unit Wet Weight (g/cm^3)	1.76	1.81
Unit Wet Weight (pcf)	110.1	113.1
Unit Dry Weight (pcf)	78.0	79.0
Unit Dry Weight (g/cm^3)	1.25	1.27
Void Ratio, e	1.17	1.14
Porosity, n	0.54	0.53
Pore Volume (cm^3)	176.1	171.7
Total Weight of Sample After Test (g)		566.1

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Client:	MESCO	Boring No.:	OW4-3D
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	34-36
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-002		

Pressure Heads (Constant)		Final Sample Dimensions	
Top Cap (psi)	69.0	Sample Length (cm), L	7.93
Bottom Cap (psi)	71.0	Sample Diameter (cm)	7.19
Cell (psi)	75.0	Sample Area (cm^2), A	40.64
Total Pressure Head (cm)	140.6	Inflow Burette Area (cm^2), a-in	0.861
Hydraulic Gradient	17.72	Outflow Burette Area (cm^2), a-out	0.861
		B Parameter (%)	96

AVERAGE PERMEABILITY = 2.3E-06 cm/sec @ 20°C

AVERAGE PERMEABILITY = 2.3E-08 m/sec @ 20°C

DATE (mm/dd/yy)	TIME (hr)	TIME (min)	ELAPSED TIME t (hr)	TOTAL INFLOW (cm^3)	TOTAL OUTFLOW (cm^3)	TOTAL HEAD h (cm)	FLOW (0 flow) (1 stop)	TEMP. (°C)	INCREMENTAL PERMEABILITY @ 20°C (cm/sec)
8/25/15	9	33	0.000	0.0	0.0	165.8	0	22.0	NA
8/25/15	9	40	0.117	0.9	1.0	163.6	0	22.0	2.6E-06
8/25/15	9	47	0.233	1.8	1.9	161.5	0	22.0	2.5E-06
8/25/15	9	56	0.383	2.8	2.9	159.2	0	22.0	2.1E-06
8/25/15	10	22	0.817	6.1	6.3	151.5	0	22.0	2.5E-06
8/25/15	10	48	1.250	8.9	9.1	144.9	0	22.0	2.3E-06
8/25/15	10	59	1.433	10.0	10.2	142.3	0	22.0	2.2E-06
8/25/15	11	12	1.650	11.4	11.6	139.1	1	22.0	2.4E-06

Tested By: JAB Date: 8/24/15 Checked By: KC Date: 9/18/15

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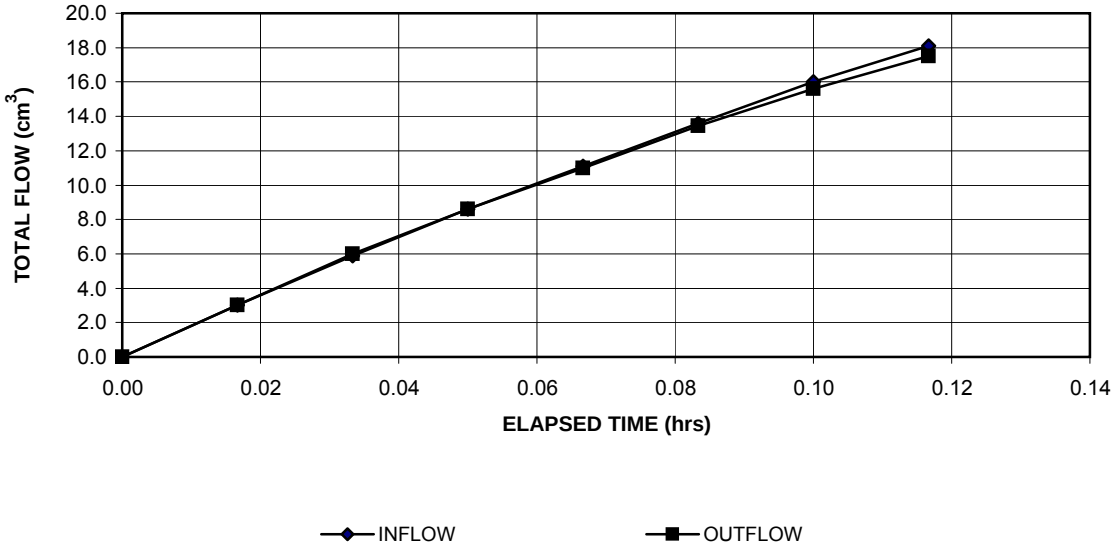
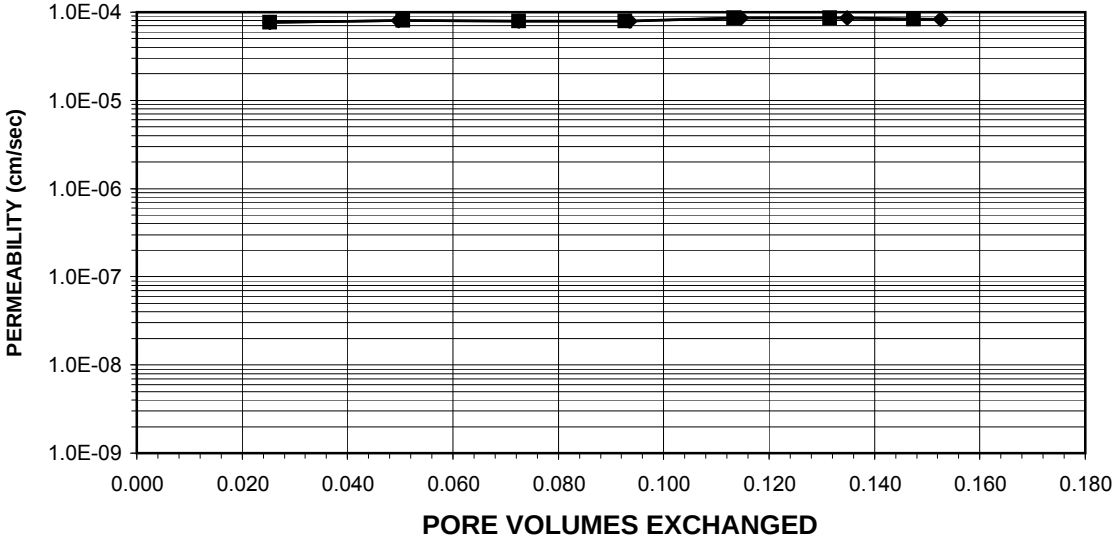
Client:	MESCO	Boring No.:	OW4-11
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	10-12
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-003		

AVERAGE PERMEABILITY = 8.4E-05 cm/sec @ 20°C
AVERAGE PERMEABILITY = 8.4E-07 m/sec @ 20°C

TOTAL FLOW vs. ELAPSED TIME



PORE VOLUMES EXCHANGED vs. PERMEABILITY



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DCN: CT-22 DATE: 4/10/13 REVISION: 10

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Client:	MESCO	Boring No.:	OW4-11
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	10-12
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-003		

Specific Gravity:	2.69	Measured
Sample Condition:		Undisturbed

Visual Description: Brown Weathered rock with Clay

MOISTURE CONTENT:	BEFORE TEST	AFTER TEST
Tare Number	607	579
Weight of Tare & Wet Sample (g)	166.95	540.12
Weight of Tare & Dry Sample (g)	153.90	434.20
Weight of Tare (g)	82.73	82.96
Weight of Water (g)	13.05	105.92
Weight of Dry Sample (g)	71.17	351.24
Moisture Content (%)	**18.3**	**30.2**

SPECIMEN:	BEFORE TEST	AFTER TEST
Weight of Tube & Wet Sample (g)	443.99	NA
Weight of Tube (g)	0.00	NA
Weight of Wet Sample (g)	443.99	488.34
Length 1 (in)	2.506	2.409
Length 2 (in)	2.554	2.410
Length 3 (in)	2.480	2.413
Top Diameter (in)	2.814	2.877
Middle Diameter (in)	2.892	2.890
Bottom Diameter (in)	2.793	2.886
Average Length (in)	2.51	2.41
Average Area (in^2)	6.30	6.53
Sample Volume (cm^3)	259.62	258.12
Unit Wet Weight (g/cm^3)	1.71	1.89
Unit Wet Weight (pcf)	106.8	118.1
Unit Dry Weight (pcf)	90.2	90.7
Unit Dry Weight (g/cm^3)	1.45	1.45
Void Ratio, e	0.86	0.85
Porosity, n	0.46	0.46
Pore Volume (cm^3)	120.1	118.6
Total Weight of Sample After Test (g)		458.2

Tested By: JAB Date: 8/26/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10 *permflow.xls*

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Client:	MESCO	Boring No.:	OW4-11
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	10-12
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-003		

Pressure Heads (Constant)		Final Sample Dimensions	
Top Cap (psi)	69.5	Sample Length (cm), L	6.12
Bottom Cap (psi)	70.5	Sample Diameter (cm)	7.33
Cell (psi)	75.0	Sample Area (cm^2), A	42.15
Total Pressure Head (cm)	70.3	Inflow Burette Area (cm^2), a-in	0.861
Hydraulic Gradient	11.48	Outflow Burette Area (cm^2), a-out	0.861
		B Parameter (%)	95

AVERAGE PERMEABILITY = 8.4E-05 cm/sec @ 20°C

AVERAGE PERMEABILITY = 8.4E-07 m/sec @ 20°C

DATE (mm/dd/yy)	TIME (hr)	TIME (min)	ELAPSED TIME t (hr)	TOTAL INFLOW (cm^3)	TOTAL OUTFLOW (cm^3)	TOTAL HEAD h (cm)	FLOW (0 flow) (1 stop)	TEMP. (°C)	INCREMENTAL PERMEABILITY @ 20°C (cm/sec)
8/28/15	9	27	0.000	0.0	0.0	95.1	0	21.8	NA
8/28/15	9	28	0.017	3.0	3.0	88.1	0	21.8	7.6E-05
8/28/15	9	29	0.033	5.9	6.0	81.2	0	21.8	8.1E-05
8/28/15	9	30	0.050	8.6	8.6	75.1	0	21.8	7.9E-05
8/28/15	9	31	0.067	11.1	11.0	69.4	0	21.8	7.9E-05
8/28/15	9	32	0.083	13.6	13.5	63.6	0	21.8	8.6E-05
8/28/15	9	33	0.100	16.0	15.6	58.3	0	21.8	8.7E-05
8/28/15	9	34	0.117	18.1	17.5	53.7	1	21.8	8.3E-05

Tested By: JAB Date: 8/26/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10

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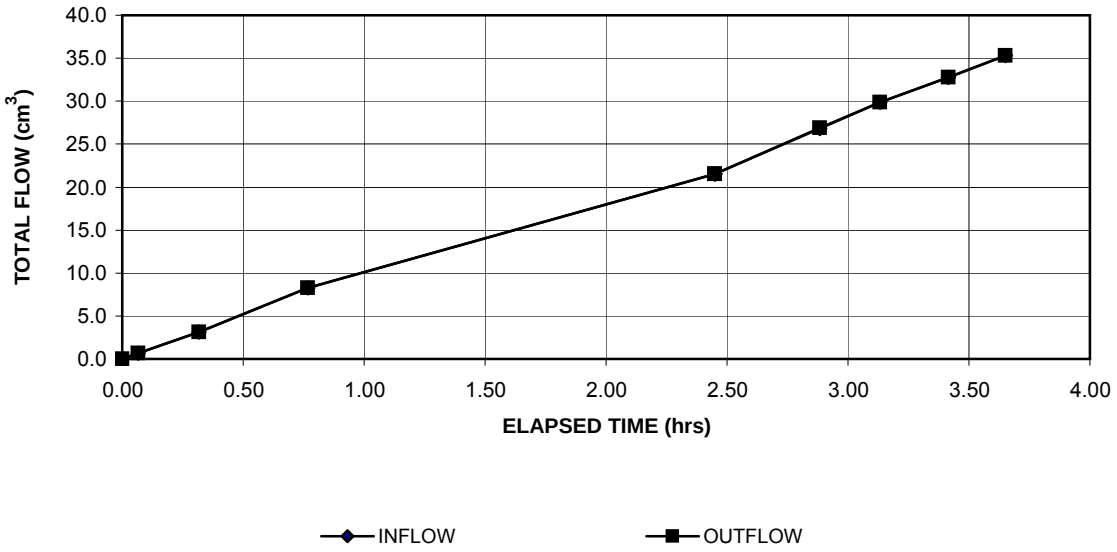
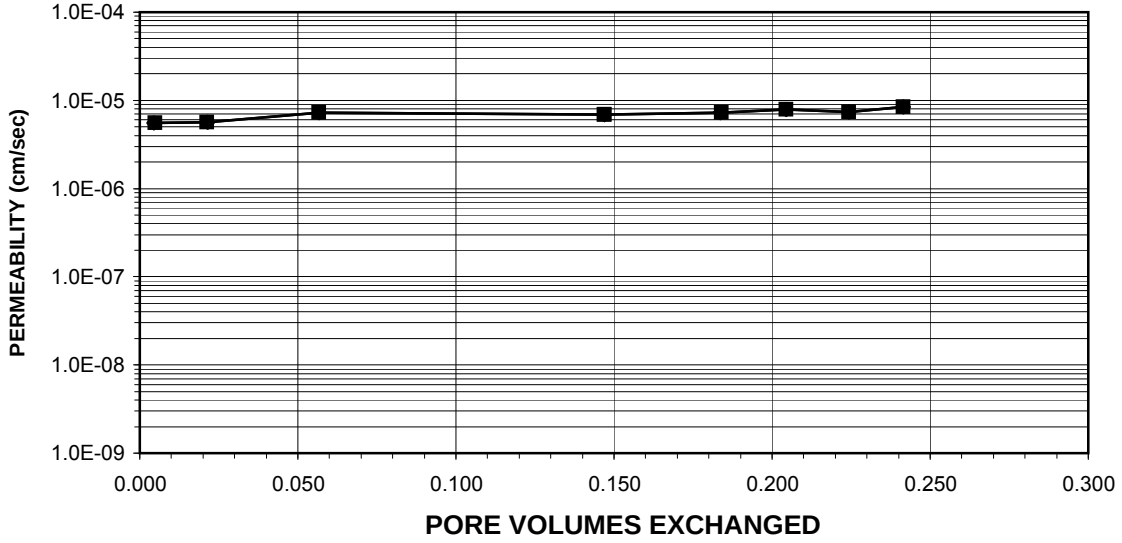
Client:	MESCO	Boring No.:	OW4-4
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	10-12
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-004		

AVERAGE PERMEABILITY = 7.7E-06 cm/sec @ 20°C
AVERAGE PERMEABILITY = 7.7E-08 m/sec @ 20°C

TOTAL FLOW vs. ELAPSED TIME



PORE VOLUMES EXCHANGED vs. PERMEABILITY



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Client:	MESCO	Boring No.:	OW4-4
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	10-12
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-004		

Specific Gravity:	2.73	Measured
Sample Condition:		Undisturbed

Visual Description: Reddish Brown Silty Sand

MOISTURE CONTENT:	BEFORE TEST	AFTER TEST
Tare Number	871	729
Weight of Tare & Wet Sample (g)	312.69	756.11
Weight of Tare & Dry Sample (g)	272.44	616.00
Weight of Tare (g)	110.43	86.24
Weight of Water (g)	40.25	140.11
Weight of Dry Sample (g)	162.01	529.76
Moisture Content (%)	**24.8**	**26.4**

SPECIMEN:	BEFORE TEST	AFTER TEST
Weight of Tube & Wet Sample (g)	864.75	NA
Weight of Tube (g)	215.30	NA
Weight of Wet Sample (g)	649.45	657.79
Length 1 (in)	3.175	3.234
Length 2 (in)	3.184	3.197
Length 3 (in)	3.179	3.179
Top Diameter (in)	2.890	2.830
Middle Diameter (in)	2.882	2.870
Bottom Diameter (in)	2.884	2.874
Average Length (in)	3.18	3.20
Average Area (in^2)	6.54	6.42
Sample Volume (cm^3)	340.66	336.76
Unit Wet Weight (g/cm^3)	1.91	1.95
Unit Wet Weight (pcf)	119.0	121.9
Unit Dry Weight (pcf)	95.3	96.4
Unit Dry Weight (g/cm^3)	1.53	1.54
Void Ratio, e	0.79	0.77
Porosity, n	0.44	0.43
Pore Volume (cm^3)	150.1	146.2
Total Weight of Sample After Test (g)		670.2

Tested By: TRE Date: 8/26/15 Checked By: KC Date: 9/18/15

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Client:	MESCO	Boring No.:	OW4-4
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	10-12
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-004		

Pressure Heads (Constant)		Final Sample Dimensions	
Top Cap (psi)	69.5	Sample Length (cm), L	8.14
Bottom Cap (psi)	70.5	Sample Diameter (cm)	7.26
Cell (psi)	75.0	Sample Area (cm^2), A	41.39
Total Pressure Head (cm)	70.3	Inflow Burette Area (cm^2), a-in	0.861
Hydraulic Gradient	8.64	Outflow Burette Area (cm^2), a-out	0.861
		B Parameter (%)	99

AVERAGE PERMEABILITY = 7.7E-06 cm/sec @ 20°C

AVERAGE PERMEABILITY = 7.7E-08 m/sec @ 20°C

DATE (mm/dd/yy)	TIME (hr)	TIME (min)	ELAPSED TIME t (hr)	TOTAL INFLOW (cm^3)	TOTAL OUTFLOW (cm^3)	TOTAL HEAD h (cm)	FLOW (0 flow) (1 stop)	TEMP. (°C)	INCREMENTAL PERMEABILITY @ 20°C (cm/sec)
8/28/15	9	30	0.000	0.0	0.0	95.9	0	21.8	NA
8/28/15	9	34	0.067	0.7	0.7	94.3	0	21.8	5.6E-06
8/28/15	9	49	0.317	3.2	3.1	88.6	0	21.8	5.6E-06
8/28/15	10	16	0.767	8.3	8.3	76.6	0	21.8	7.3E-06
8/28/15	11	57	2.450	21.5	21.5	45.9	1	21.8	6.8E-06
8/28/15	12	43	2.450	21.5	21.5	96.3	0	21.5	NA
8/28/15	13	9	2.883	26.9	26.9	83.8	0	21.5	7.3E-06
8/28/15	13	24	3.133	29.9	29.9	76.8	0	21.5	7.9E-06
8/28/15	13	41	3.417	32.8	32.8	70.1	0	21.5	7.3E-06
8/28/15	13	55	3.650	35.3	35.3	64.3	1	21.5	8.4E-06

Tested By: TRE Date: 8/26/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10

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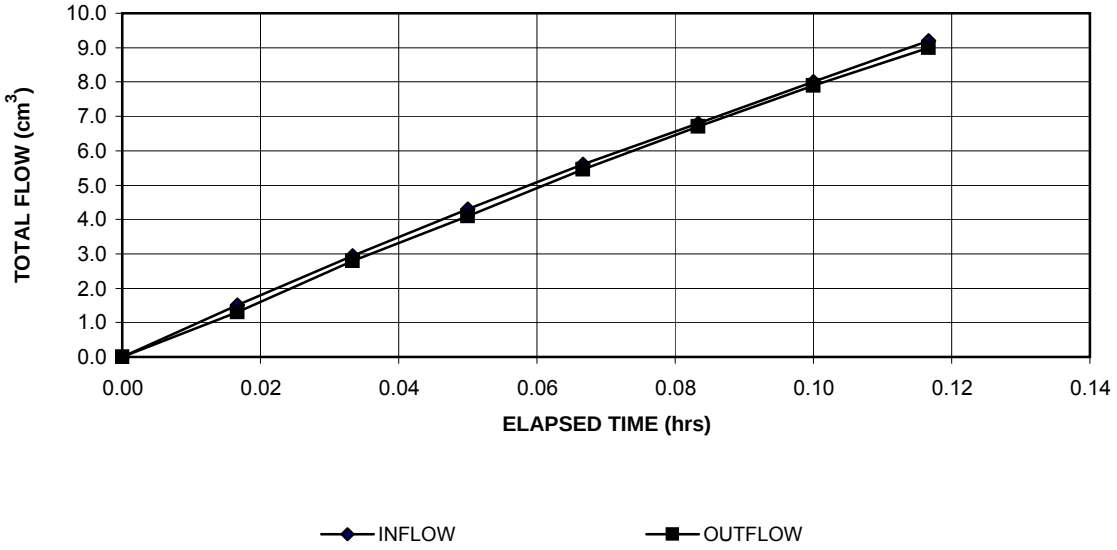
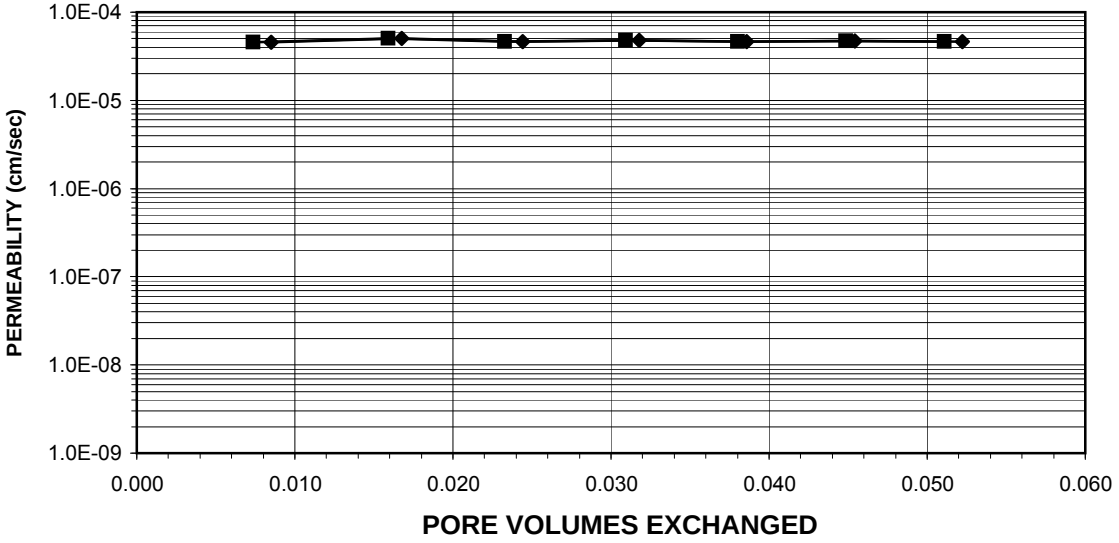
Client:	MESCO	Boring No.:	OW4-5
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	11.5-13.5
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-005		

AVERAGE PERMEABILITY = 4.7E-05 cm/sec @ 20°C
AVERAGE PERMEABILITY = 4.7E-07 m/sec @ 20°C

TOTAL FLOW vs. ELAPSED TIME



PORE VOLUMES EXCHANGED vs. PERMEABILITY



Tested By: TRE Date: 8/26/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10

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Client:	MESCO	Boring No.:	OW4-5
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	11.5-13.5
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-005		

Specific Gravity:	2.64	Measured
Sample Condition:		Undisturbed

Visual Description: Reddish Brown Sandy Silt

MOISTURE CONTENT:	BEFORE TEST	AFTER TEST
Tare Number	917	592
Weight of Tare & Wet Sample (g)	288.13	731.12
Weight of Tare & Dry Sample (g)	247.24	560.10
Weight of Tare (g)	109.80	81.34
Weight of Water (g)	40.89	171.02
Weight of Dry Sample (g)	137.44	478.76
Moisture Content (%)	**29.8**	**35.7**

SPECIMEN:	BEFORE TEST	AFTER TEST
Weight of Tube & Wet Sample (g)	619.85	NA
Weight of Tube (g)	0.00	NA
Weight of Wet Sample (g)	619.85	648.37
Length 1 (in)	3.171	3.267
Length 2 (in)	3.185	3.277
Length 3 (in)	3.191	3.327
Top Diameter (in)	2.889	2.901
Middle Diameter (in)	2.890	2.903
Bottom Diameter (in)	2.893	2.908
Average Length (in)	3.18	3.29
Average Area (in^2)	6.56	6.62
Sample Volume (cm^3)	342.24	357.13
Unit Wet Weight (g/cm^3)	1.81	1.82
Unit Wet Weight (pcf)	113.1	113.3
Unit Dry Weight (pcf)	87.1	83.5
Unit Dry Weight (g/cm^3)	1.40	1.34
Void Ratio, e	0.89	0.97
Porosity, n	0.47	0.49
Pore Volume (cm^3)	161.3	176.2
Total Weight of Sample After Test (g)		652.0

Tested By: TRE Date: 8/26/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10 *permflow.xls*

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PERMEABILITY TEST

ASTM D 5084-10

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Client:	MESCO	Boring No.:	OW4-5
Client Project:	Lincoln Co. MSWLF, Ph. 4	Depth (ft):	11.5-13.5
Project No.:	2015-724-001	Sample No.:	NA
Lab ID No.:	2015-724-001-005		

Pressure Heads (Constant)		Final Sample Dimensions	
Top Cap (psi)	69.5	Sample Length (cm), L	8.36
Bottom Cap (psi)	70.5	Sample Diameter (cm)	7.38
Cell (psi)	75.0	Sample Area (cm^2), A	42.73
Total Pressure Head (cm)	70.3	Inflow Burette Area (cm^2), a-in	0.861
Hydraulic Gradient	8.41	Outflow Burette Area (cm^2), a-out	0.861
		B Parameter (%)	98

AVERAGE PERMEABILITY = 4.7E-05 cm/sec @ 20°C

AVERAGE PERMEABILITY = 4.7E-07 m/sec @ 20°C

DATE (mm/dd/yy)	TIME (hr)	(min)	ELAPSED TIME t (hr)	TOTAL INFLOW (cm^3)	TOTAL OUTFLOW (cm^3)	TOTAL HEAD h (cm)	FLOW (0 flow) (1 stop)	TEMP. (°C)	INCREMENTAL PERMEABILITY @ 20°C (cm/sec)
8/28/15	8	43	0.000	0.0	0.0	97.0	0	21.8	NA
8/28/15	8	44	0.017	1.5	1.3	93.8	0	21.8	4.6E-05
8/28/15	8	45	0.033	3.0	2.8	90.4	0	21.8	5.0E-05
8/28/15	8	46	0.050	4.3	4.1	87.3	0	21.8	4.7E-05
8/28/15	8	47	0.067	5.6	5.5	84.2	0	21.8	4.8E-05
8/28/15	8	48	0.083	6.8	6.7	81.3	0	21.8	4.6E-05
8/28/15	8	49	0.100	8.0	7.9	78.6	0	21.8	4.7E-05
8/28/15	8	50	0.117	9.2	9.0	75.9	1	21.8	4.7E-05

Tested By: TRE Date: 8/26/15 Checked By: KC Date: 9/18/15

DCN: CT-22 DATE: 4/10/13 REVISION: 10

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ECS CAROLINAS, LLP
"Setting the Standard for Service"
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NC Registered Engineering Firm F-1078

June 3, 2015

Mr. Wayne Sullivan
Municipal Engineering Services Co. PA
PO Box 97
Garner, NC 27529

RE: Report of Laboratory Services
Lincoln MSWLF, Phase 4
Crouse, North Carolina
ECS Project No. 06:22408

Dear Mr. Sullivan:

ECS Carolinas, LLP (ECS) has completed the laboratory testing of soils delivered to the ECS laboratory from the Lincoln MSWLF, Phase 4 project as requested by Municipal Engineering Services Company, PA (MESCO). This testing includes Natural Moisture Contents, Classification Testing, Soil Specific Gravities, and Permeability testing.

Testing was assigned by Jonathan Pfohl with MECSO. Laboratory testing was performed in general accordance with ASTM standards. Not all permeability tests assigned were able to be performed due to the soil conditions when the sample was extracted from the Shelby tubes. Please see the attached soils reports for further information.

Thank you for the opportunity to work with you on this project. Should you have any questions or if we could be of further assistance, please do not hesitate to contact us.

Respectfully,
ECS CAROLINAS, LLP represented by;
Firm License Number: F-1078

Terry L. Pope
Group Manager

C. (Nathan) Nallainathan, PE
Principal Engineer
NC PE License No. 019937

NORTH CAROLINA PROFESSIONAL SEAL 19937 06/03/15 ENGINEER NALLAINATHAN

ECS Carolinas, LLP
9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911
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NATURAL MOISTURE CONTENT

PROJECT INFORMATION

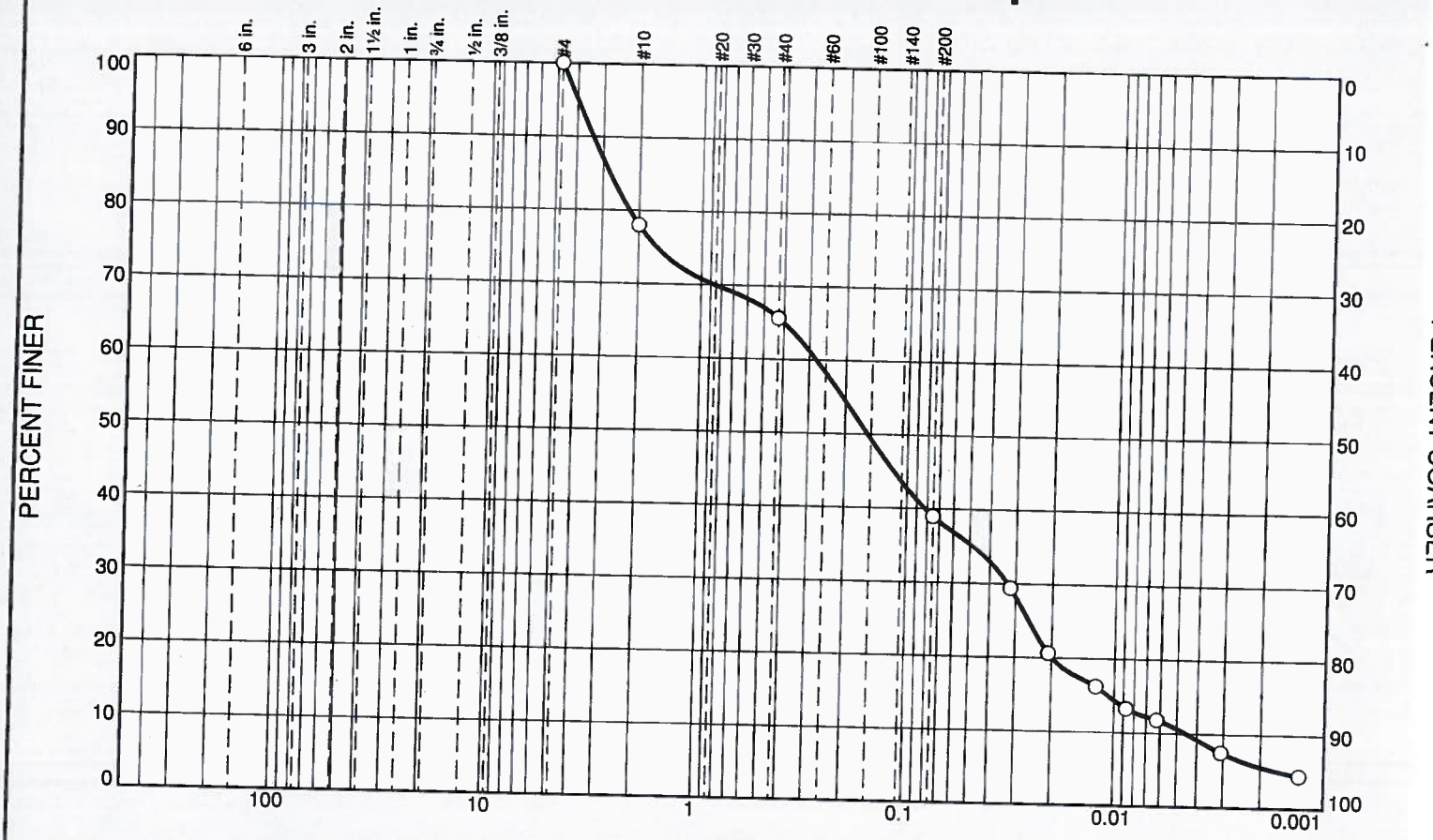
NAME: Lincoln MSWLF, Phase 4

NUMBER: 6.22408

DATE : 06/03/15

Sample	Depth (feet)	Moisture Content, %
OW4-4	10-12	26.80
OW4-5	11.5-13.5	24.10
OW4-6D	12.0-14.0	38.00
OW4-11	10.0-12.0	25.90
OW4-10	15.0-17.0	44.40
OW4-2	25.0-28.0	30.10
OW4-4	10.0-12.0	26.80
OW4-3D	34.0-36.0	26.60
OW4-6D	35.0-37.0	39.00
OW4-8	7.0-9.0	28.80
OW4-8	17.0-19.0	41.60

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	22.0	12.4	26.6	28.3	10.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	78.0		
#40	65.6		
#200	39.0		
0.0318 mm.	29.4		
0.0208 mm.	20.7		
0.0122 mm.	16.2		
0.0087 mm.	13.3		
0.0062 mm.	11.8		
0.0031 mm.	7.5		
0.0013 mm.	4.4		

* (no specification provided)

Soil Description

Pinkish Brown Silty Sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 3.3548 D_{85}= 2.7728 D_{60}= 0.2772
D_{50}= 0.1553 D_{30}= 0.0328 D_{15}= 0.0106
D_{10}= 0.0045 C_u= 61.46 C_c= 0.86

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Source of Sample: Lincoln

Sample Number: OW4-4 **Depth:** 10.00-12.00

Date:

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Phone: (919) 861-9910
Fax: (919) 861-9911

Client: Municipal Engineering Services Co. PA

Project: Lincoln MSWLF, Phase 4

Project No: 22408 **Figure**

Tested By: MB

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Pinkish Brown Silty Sand
NUMBER	22408	NUMBER	OW4-4
		DEPTH	10-12'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	680.87		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.58**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

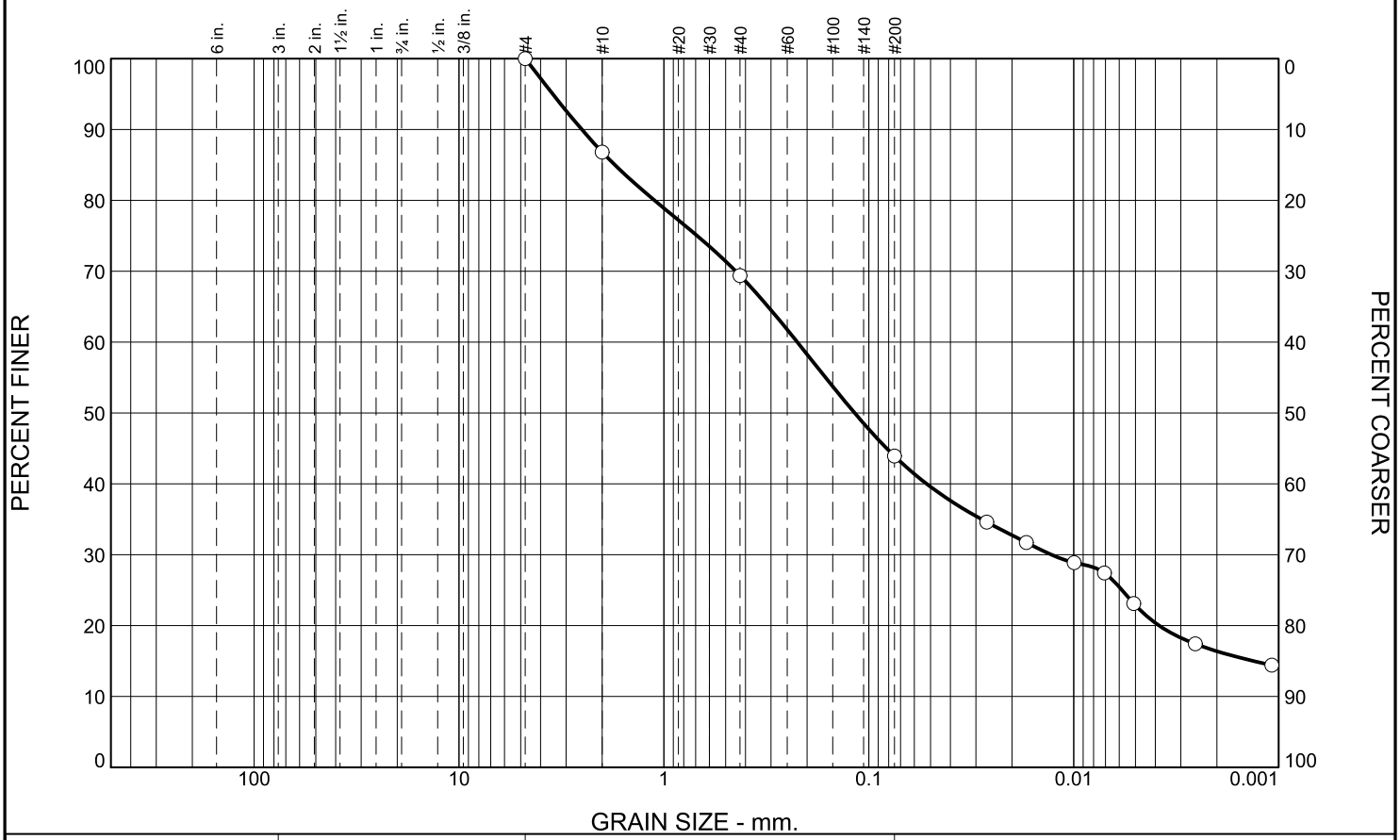
Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	27.18		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.58	**Specific Gravity**	**2.73**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	698.84		
Tempreature when Wb was determined (°C) Tx	22.00		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	13.2	17.4	25.5	21.0	22.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	86.8		
#40	69.4		
#200	43.9		
0.0266 mm.	34.6		
0.0170 mm.	31.7		
0.0099 mm.	28.9		
0.0071 mm.	27.4		
0.0051 mm.	23.1		
0.0025 mm.	17.4		
0.0011 mm.	14.4		

* (no specification provided)

Soil Description

Dark Brown & Orange Silty Sand

Atterberg Limits

PL= 41 LL= 41 PI= NP

Coefficients

D_{90}= 2.5158 D_{85}= 1.7352 D_{60}= 0.2234
D_{50}= 0.1173 D_{30}= 0.0129 D_{15}= 0.0013
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Source of Sample: Lincoln **Depth:** 11.50-13.50

Sample Number: OW4-5 **Date:**

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Phone: (919) 881-9910
Fax: (919) 881-9911

Client: Municipal Engineering Services Co. PA
Project: Lincoln MSWLF, Phase 4

Project No: 22408 **Figure**

Tested By: MB

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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Dark Brown & Orange Silty Sand
NUMBER	22408	NUMBER	OW4-5
		DEPTH	11.5-13.5'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	680.87		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.58**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

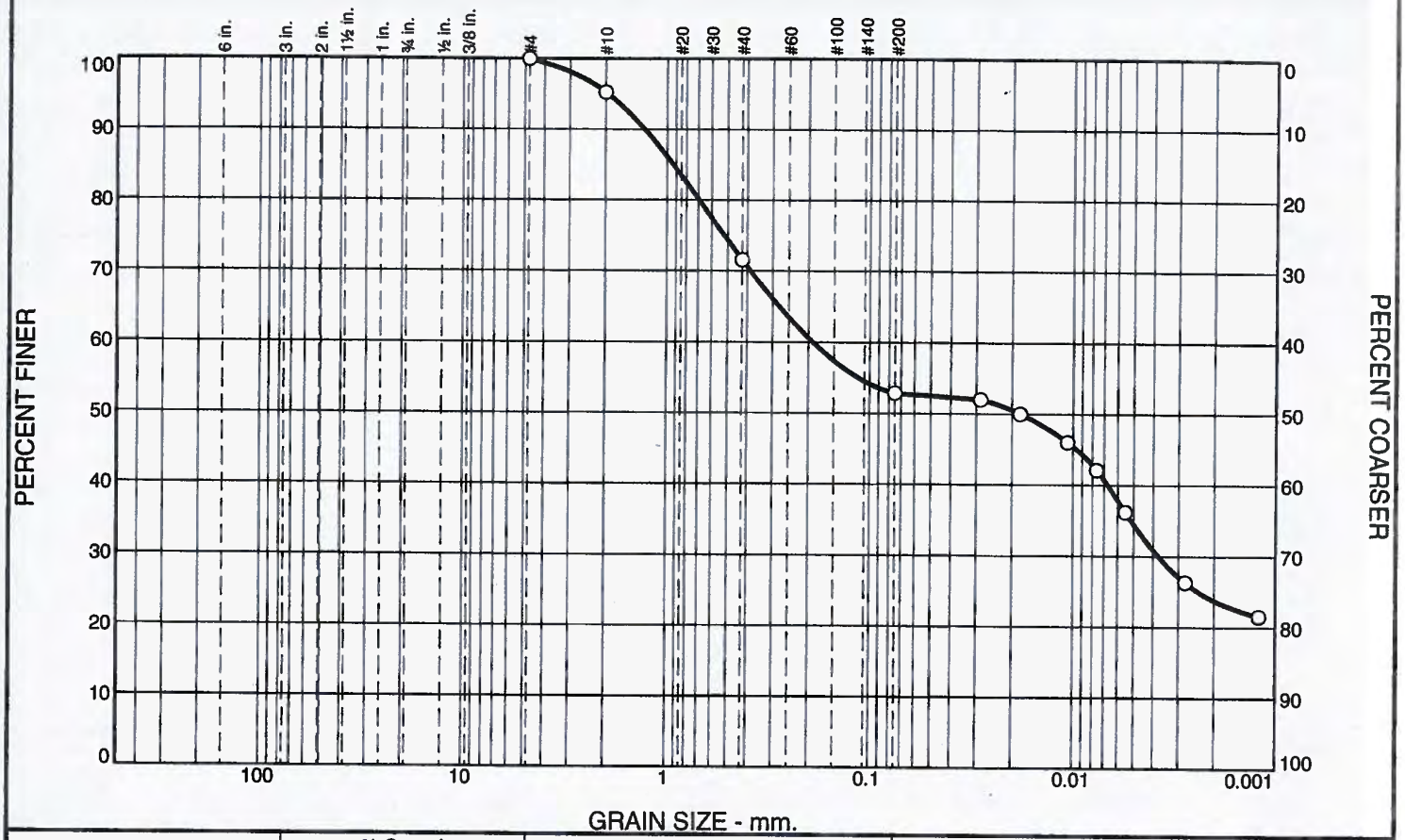
Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	26.44		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.58	**Specific Gravity**	**2.64**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	698.03		
Tempreature when Wb was determined (°C) Tx	21.90		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	4.7	23.7	18.7	18.4	34.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	95.3		
#40	71.6		
#200	52.9		
0.0286 mm.	52.0		
0.0182 mm.	50.0		
0.0107 mm.	46.1		
0.0076 mm.	42.1		
0.0055 mm.	36.2		
0.0028 mm.	26.3		
0.0012 mm.	21.5		

* (no specification provided)

Soil Description

Orangish Brown Sandy Silt

Atterberg Limits

PL= 43 LL= 51 PI= 8

Coefficients

D_{90}= 1.2884 D_{85}= 0.9318 D_{60}= 0.1907
D_{50}= 0.0182 D_{30}= 0.0038 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= MH AASHTO= A-5(4)

Remarks

Source of Sample: Lincoln **Depth:** 12.00-14.00

Sample Number: OW4-6D **Date:**

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Fax: (919) 881-9911

Client: Municipal Engineering Services Co. PA
Project: Lincoln MSWLF, Phase 4

Project No: 22408 **Figure**

Tested By: MB

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Raleigh, NC 27617
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Fax: (919) 861-9911
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Orangish Brown Sandy Silt
NUMBER	22408	NUMBER	OW4-6D
		DEPTH	12-14'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	680.87		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.58**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

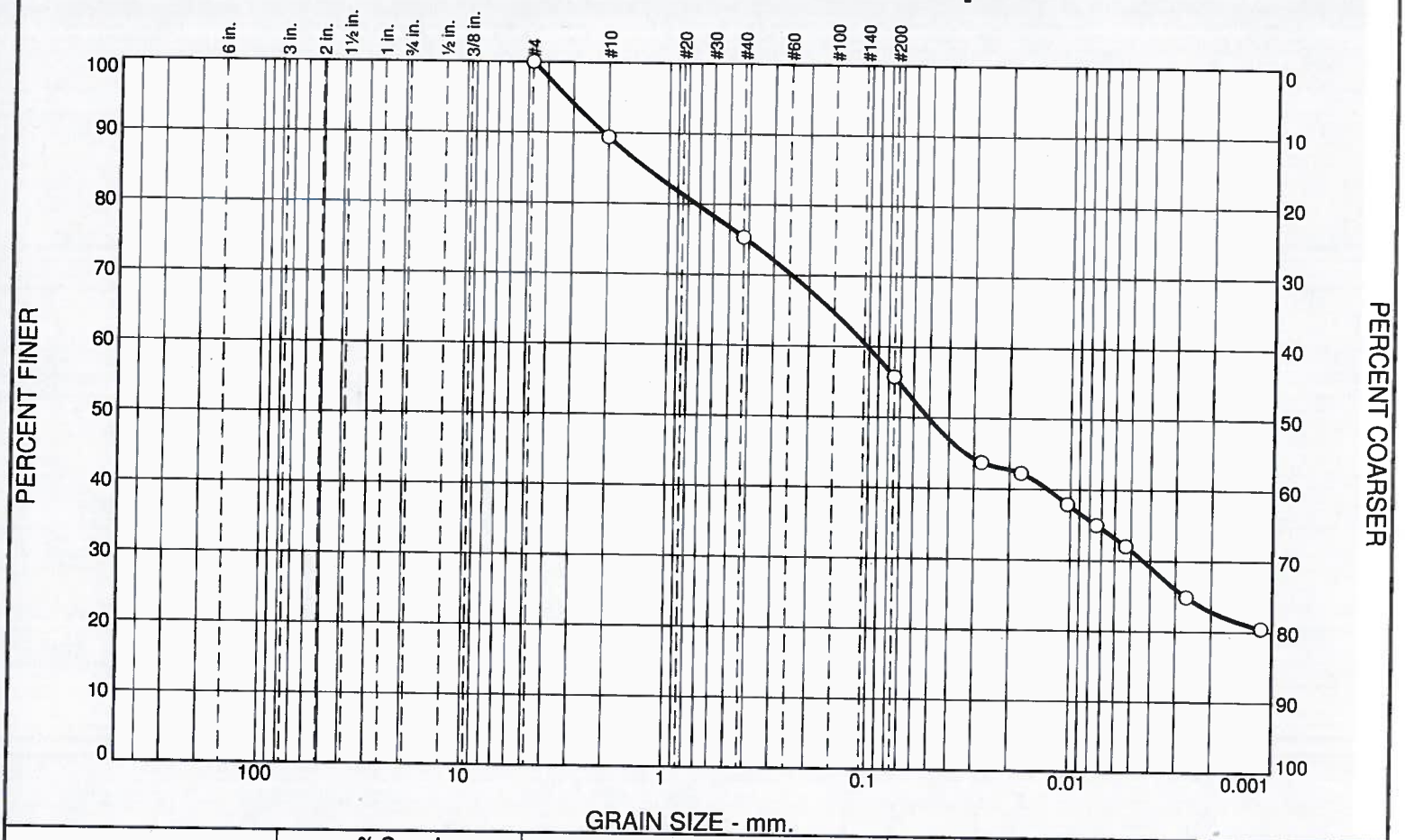
Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	26.39		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.58	**Specific Gravity**	**2.67**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	698.12		
Tempreature when Wb was determined (°C) Tx	20.30		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	10.6	14.1	19.5	24.3	31.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	89.4		
#40	75.3		
#200	55.8		
0.0275 mm.	43.8		
0.0175 mm.	42.3		
0.0103 mm.	37.9		
0.0074 mm.	35.0		
0.0053 mm.	32.1		
0.0027 mm.	24.9		
0.0011 mm.	20.5		

* (no specification provided)

Soil Description

Orangish Brown Sandy Silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 2.1163 D_{85}= 1.2951 D_{60}= 0.1021
D_{50}= 0.0504 D_{30}= 0.0043 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Source of Sample: Lincoln

Sample Number: OW4-11

Depth: 10.00-12.00

Date:

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Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911

Client: Municipal Engineering Services Co. PA

Project: Lincoln MSWLF, Phase 4

Project No: 22408

Figure

Tested By: MB

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Oragnish Brown Sandy Silt
NUMBER	22408	NUMBER	OW4-11
		DEPTH	10-12'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	680.87		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.58**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

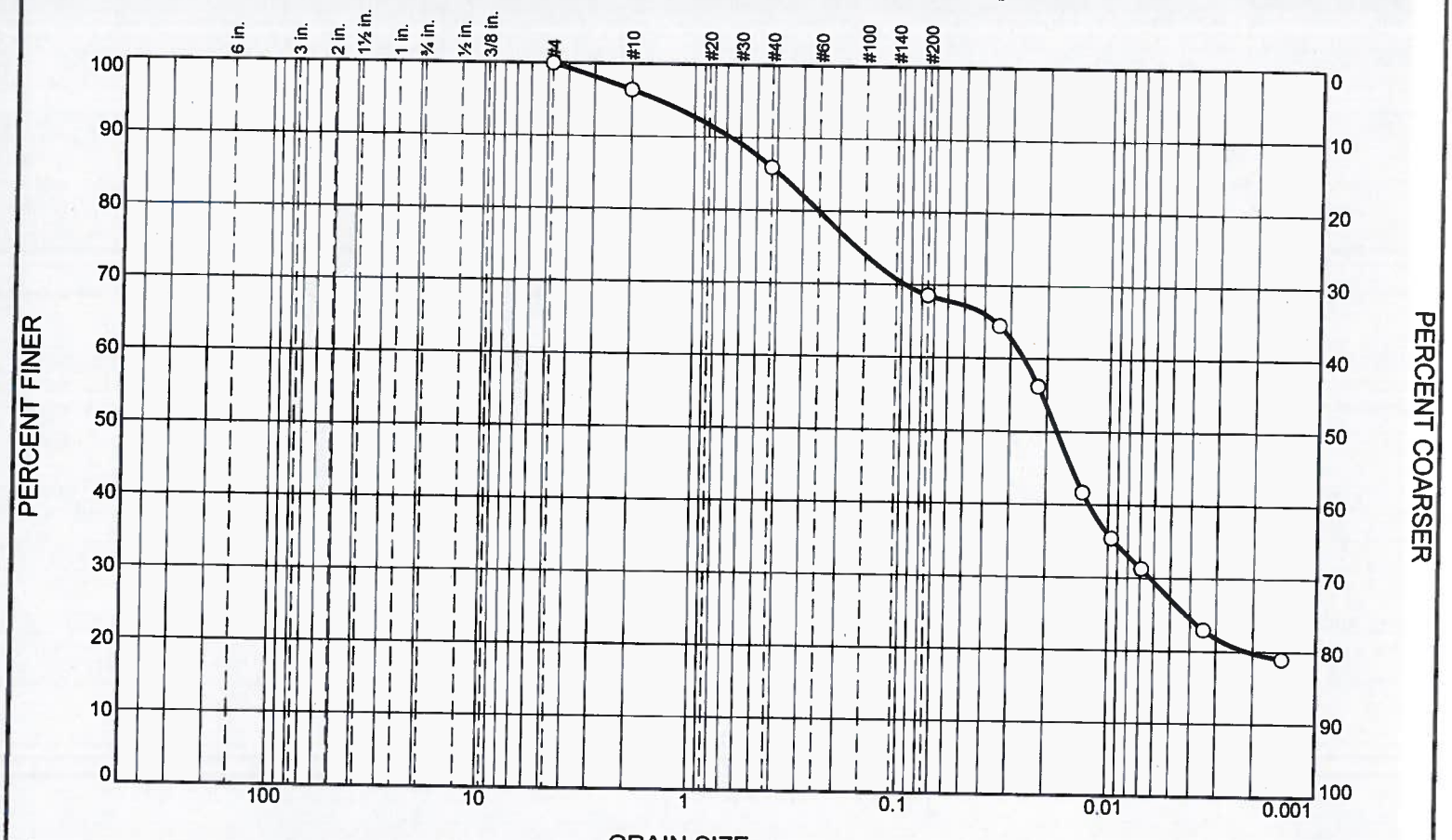
Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	25.95		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.58	**Specific Gravity**	**2.69**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	697.92		
Tempreature when Wb was determined (°C) Tx	21.40		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	3.6	10.5	17.4	41.3	27.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	96.4		
#40	85.9		
#200	68.5		
0.0340 mm.	64.5		
0.0221 mm.	56.2		
0.0134 mm.	41.7		
0.0096 mm.	35.4		
0.0069 mm.	31.3		
0.0035 mm.	23.0		
0.0015 mm.	19.0		

* (no specification provided)

Soil Description

Orangish Brown Sandy Silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.6710 D_{85}= 0.3905 D_{60}= 0.0259
D_{50}= 0.0178 D_{30}= 0.0062 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Source of Sample: Lincoln **Depth:** 15.00-17.00

Sample Number: OW4-10 **Date:**

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 881-9910
Fax: (919) 851-9911

Client: Municipal Engineering Services Co. PA
Project: Lincoln MSWLF, Phase 4
Project No: 22408 **Figure**

Tested By: MB

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Oragnish Brown Sandy Silt
NUMBER	22408	NUMBER	OW4-10
		DEPTH	15-17'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	680.87		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.58**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

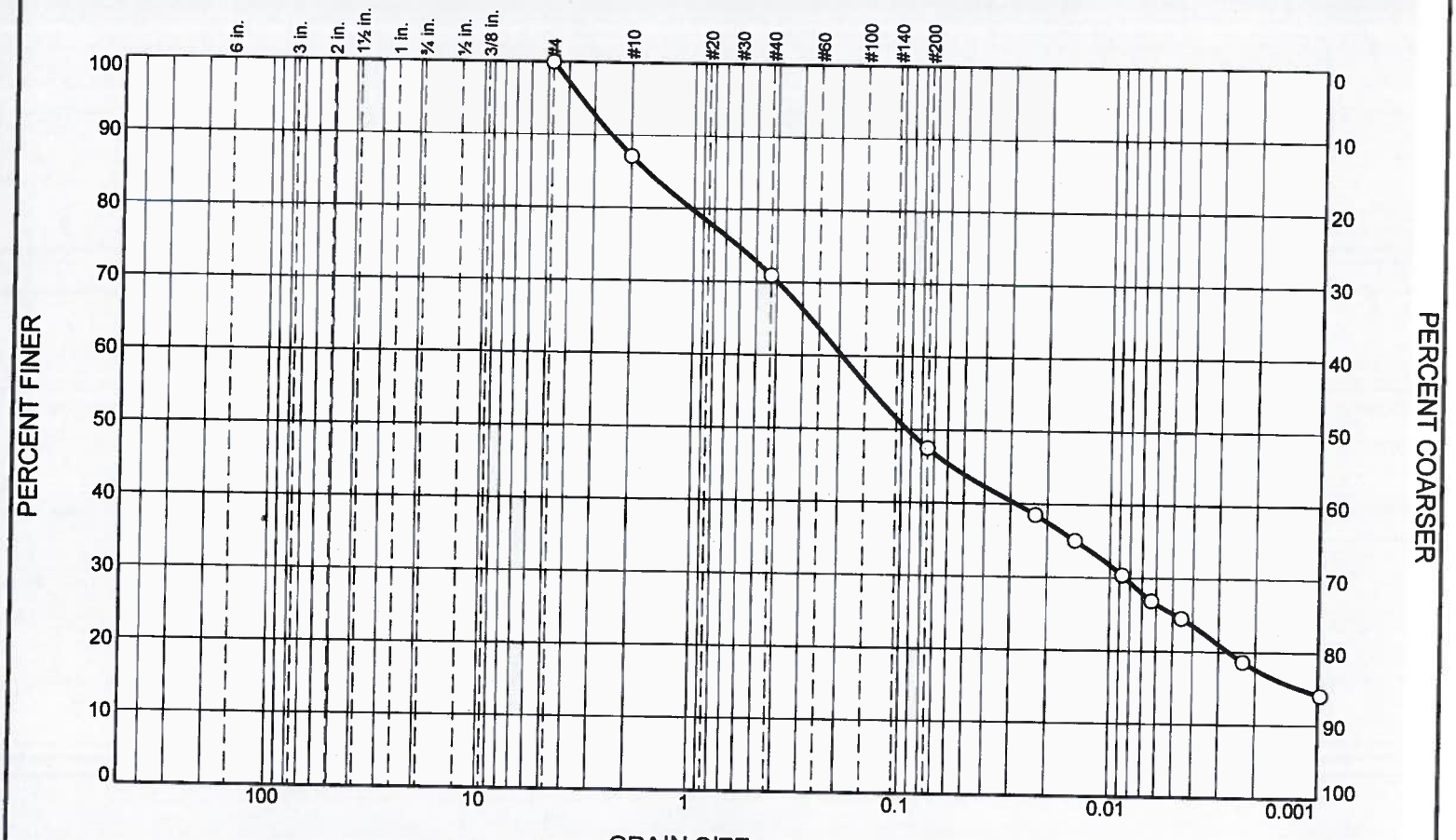
Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	19.58		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.58	**Specific Gravity**	**2.65**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	693.79		
Tempreature when Wb was determined (°C) Tx	21.10		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	12.9	16.2	23.4	22.3	25.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	87.1		
#40	70.9		
#200	47.5		
0.0228 mm.	38.5		
0.0147 mm.	35.0		
0.0088 mm.	30.4		
0.0063 mm.	26.9		
0.0045 mm.	24.5		
0.0023 mm.	18.6		
0.0010 mm.	14.1		

* (no specification provided)

Soil Description

Tan Silty Sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 2.4834 D_{85}= 1.6815 D_{60}= 0.1936
D_{50}= 0.0939 D_{30}= 0.0085 D_{15}= 0.0012
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Source of Sample: Lincoln **Depth:** 25.00-28.00

Sample Number: OW4-2 **Date:**

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911

Client: Municipal Engineering Services Co. PA
Project: Lincoln MSWLF, Phase 4

Project No: 22408 **Figure**

Tested By: MB

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Tan Silty Sand
NUMBER	22408	NUMBER	OW4-2
		DEPTH	25-28'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	680.87		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.58**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

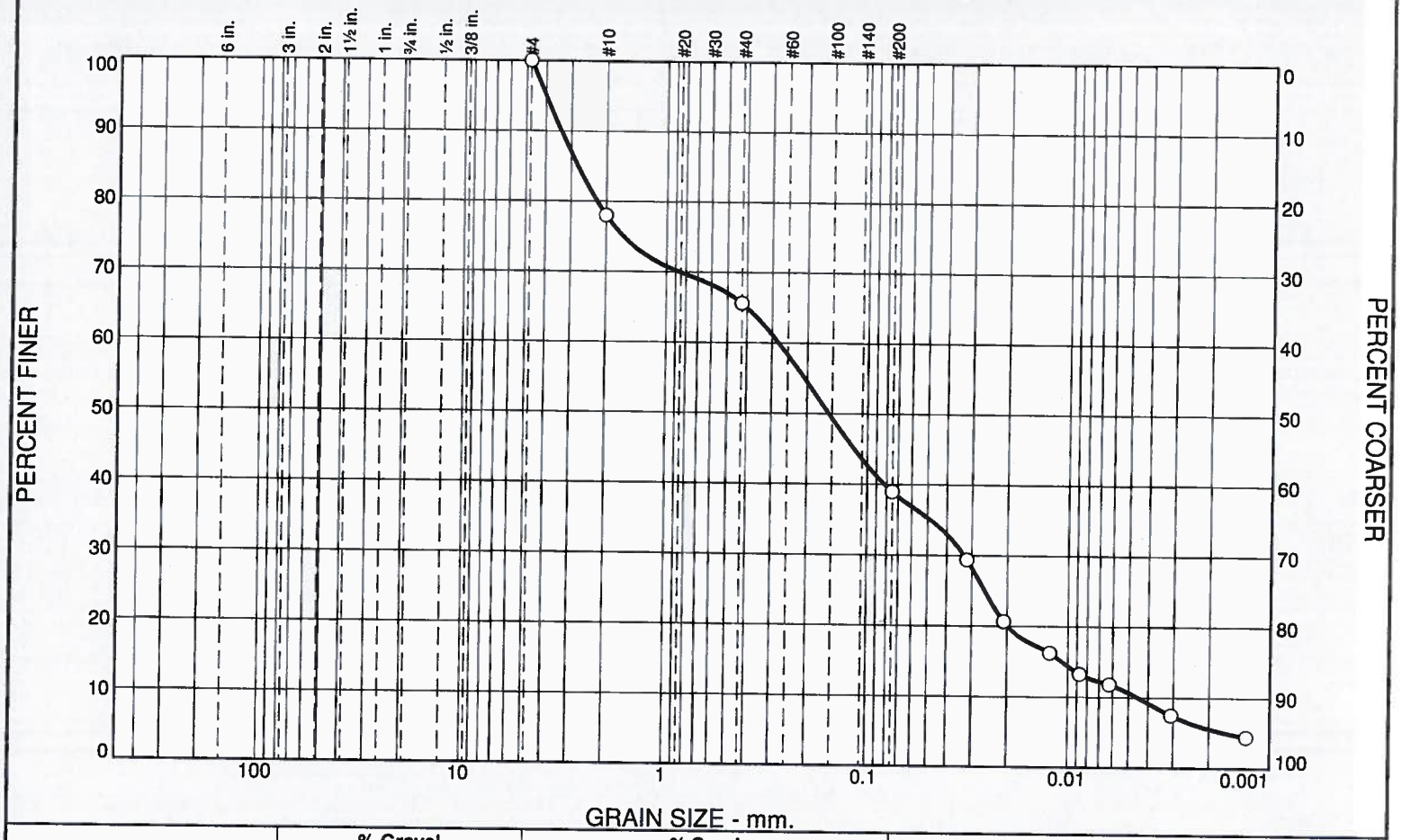
Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	27.52		
Mass of Pycnometer filled with Water at Tx (gr) Wa	680.87	**Specific Gravity**	**2.69**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	698.20		
Tempreature when Wb was determined (°C) Tx	21.10		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	22.0	12.4	26.6	28.3	10.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	78.0		
#40	65.6		
#200	39.0		
0.0318 mm.	29.4		
0.0208 mm.	20.7		
0.0122 mm.	16.2		
0.0087 mm.	13.3		
0.0062 mm.	11.8		
0.0031 mm.	7.5		
0.0013 mm.	4.4		

* (no specification provided)

Soil Description

Pinkish Brown Silty Sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 3.3548 D_{85}= 2.7728 D_{60}= 0.2772
D_{50}= 0.1553 D_{30}= 0.0328 D_{15}= 0.0106
D_{10}= 0.0045 C_u= 61.46 C_c= 0.86

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Source of Sample: Lincoln

Sample Number: OW4-4

Depth: 10.00-12.00

Date:

ECS CAROLINAS, LLP
9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911

Client: Municipal Engineering Services Co. PA

Project: Lincoln MSWLF, Phase 4

Project No: 22408

Figure

Tested By: MB

ECS Carolinas, LLP
9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Pinkish Brown Silty Sand
NUMBER	22408	NUMBER	OW4-4
		DEPTH	10-12'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	680.87		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.58**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

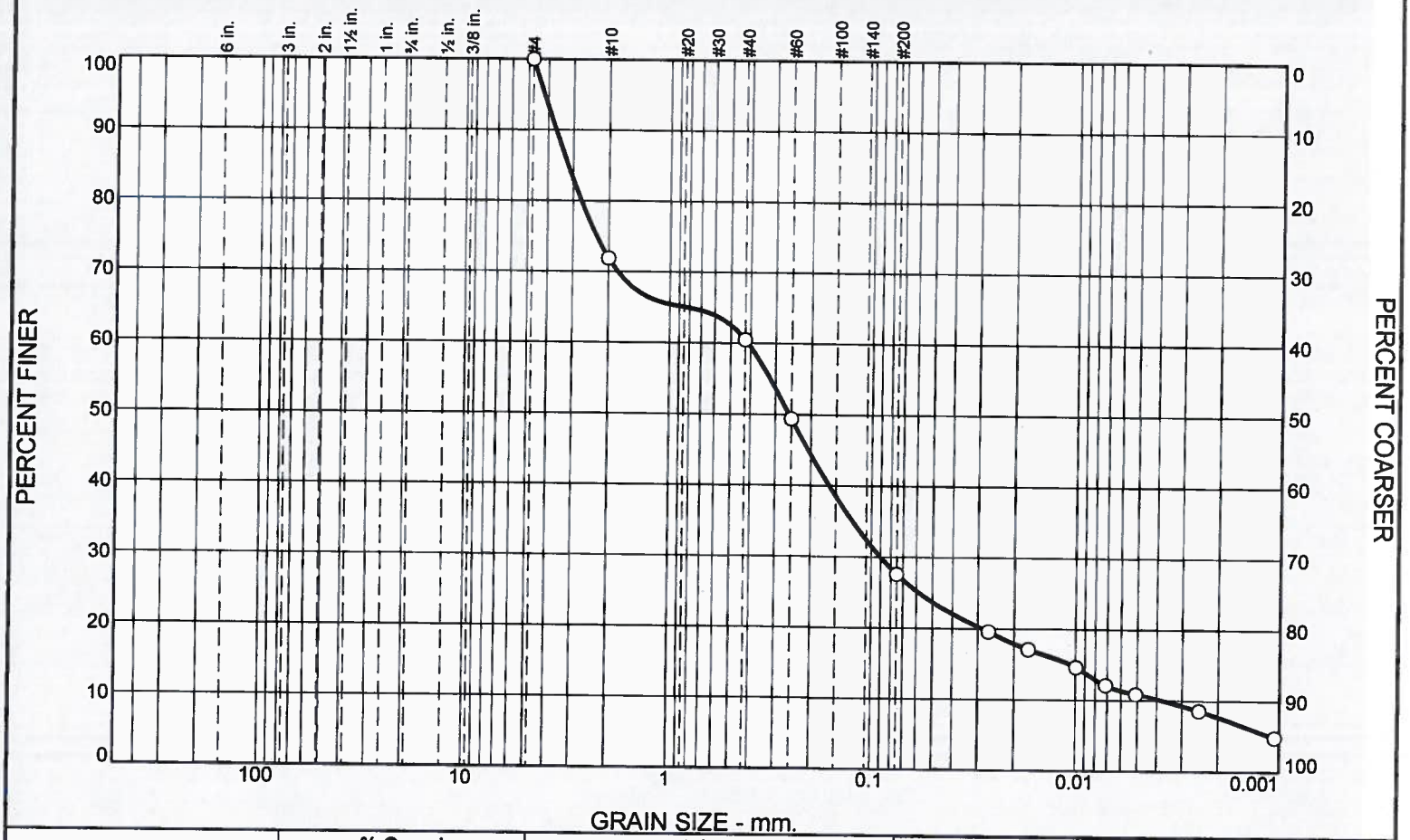
Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	27.18		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.58	**Specific Gravity**	**2.73**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	698.84		
Tempreature when Wb was determined (°C) Tx	22.00		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	28.1	11.4	32.9	16.7	10.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	71.9		
#40	60.5		
#60	49.4		
#200	27.6		
0.0267 mm.	19.6		
0.0171 mm.	17.1		
0.0100 mm.	14.6		
0.0071 mm.	12.1		
0.0051 mm.	10.9		
0.0025 mm.	8.6		
0.0011 mm.	4.8		

* (no specification provided)

Soil Description

Light Brown Silty Sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 3.6547 D_{85}= 3.1801 D_{60}= 0.4114
D_{50}= 0.2571 D_{30}= 0.0903 D_{15}= 0.0106
D_{10}= 0.0037 C_u= 110.93 C_c= 5.34

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Source of Sample: Lincoln **Depth:** 34.00-36.00

Sample Number: OW4-3D **Date:**

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 881-9910
Fax: (919) 861-9911

Client: Municipal Engineering Services Co. PA
Project: Lincoln MSWLF, Phase 4
Project No: 22408 **Figure**

Tested By: MB

ECS Carolinas, LLP
9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Light Brown Silt
NUMBER	22408	NUMBER	OW4-3D
		DEPTH	34-36'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	681.07		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.78**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

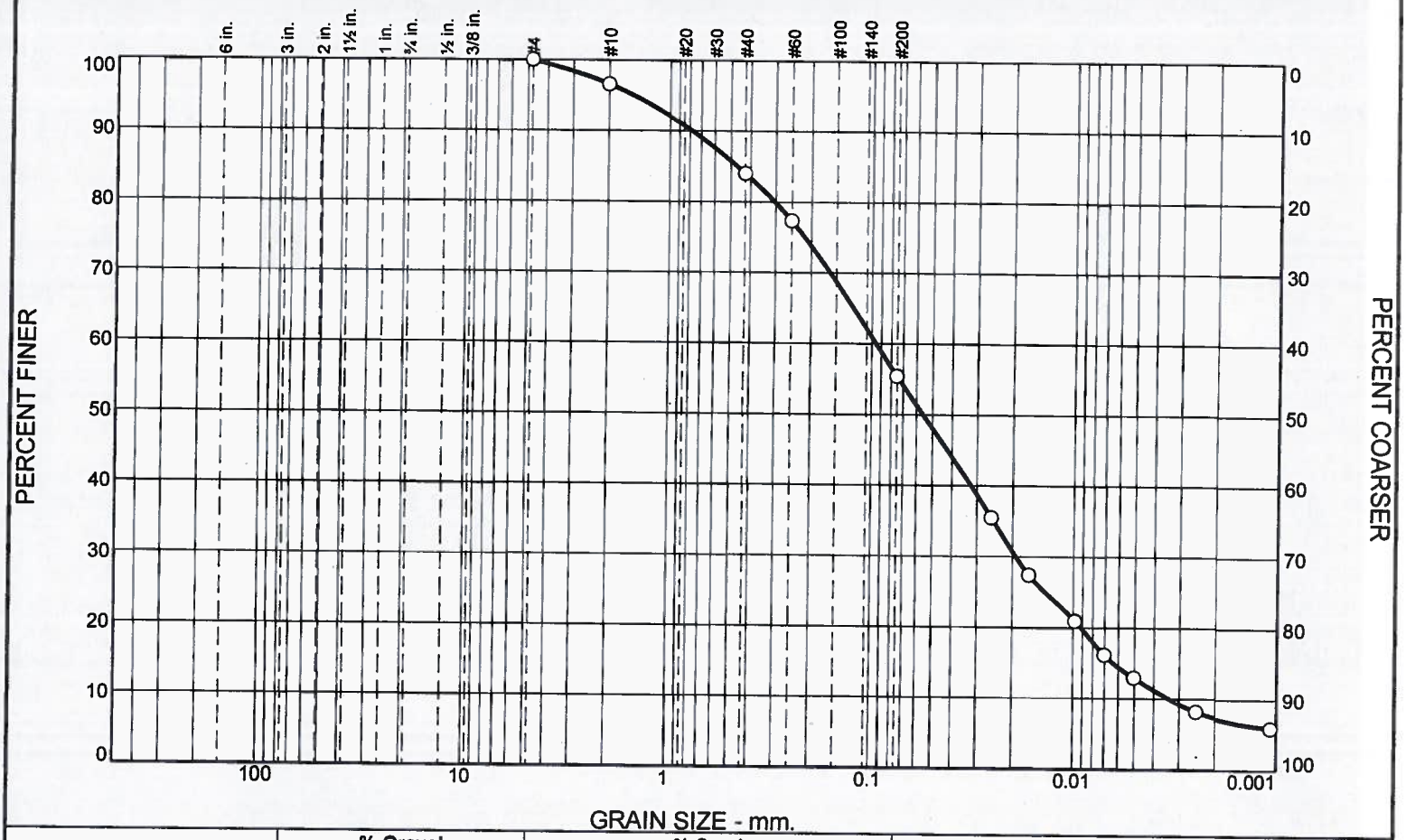
Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	20.56		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.07	**Specific Gravity**	**2.71**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	694.06		
Tempreature when Wb was determined (°C) Tx	20.20		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	3.4	12.6	28.6	42.5	12.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	96.6		
#40	84.0		
#60	77.3		
#200	55.4		
0.0255 mm.	35.5		
0.0166 mm.	27.4		
0.0098 mm.	21.0		
0.0070 mm.	16.2		
0.0050 mm.	12.9		
0.0025 mm.	8.2		
0.0011 mm.	6.0		

* (no specification provided)

Soil Description

Red Sandy Silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.7788 D_{85}= 0.4659 D_{60}= 0.0953
D_{50}= 0.0557 D_{30}= 0.0193 D_{15}= 0.0064
D_{10}= 0.0034 C_u= 28.21 C_c= 1.16

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Source of Sample: Lincoln **Depth:** 35.00-37.00

Sample Number: OW4-6D **Date:**

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Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911

Client: Municipal Engineering Services Co. PA
Project: Lincoln MSWLF, Phase 4
Project No: 22408 **Figure**

Tested By: MB

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Red Sandy Silt
NUMBER	22408	NUMBER	OW4-6D
		DEPTH	35-37'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	680.87		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.58**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

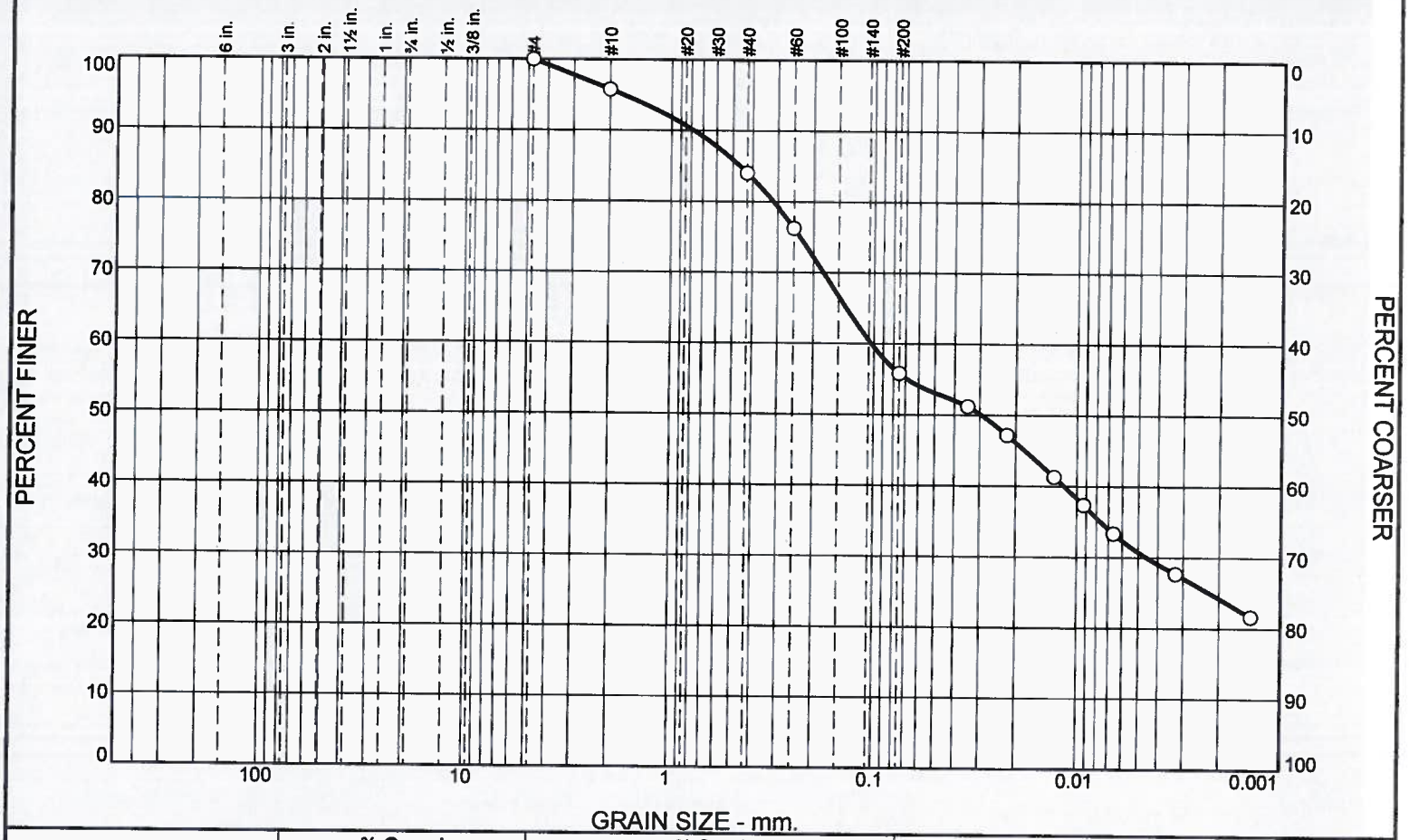
Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	21.80		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.58	**Specific Gravity**	**2.66**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	695.22		
Tempreature when Wb was determined (°C) Tx	21.60		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	4.2	11.8	28.2	25.1	30.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	95.8		
#40	84.0		
#60	76.2		
#200	55.8		
0.0344 mm.	51.2		
0.0220 mm.	47.2		
0.0129 mm.	41.3		
0.0093 mm.	37.4		
0.0066 mm.	33.4		
0.0033 mm.	27.7		
0.0014 mm.	21.6		

* (no specification provided)

Soil Description

Orangish Brown Sandy Silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.7773 D_{85}= 0.4619 D_{60}= 0.1031
D_{50}= 0.0296 D_{30}= 0.0045 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Source of Sample: Lincoln **Depth:** 7.00-9.00

Sample Number: OW4-8 **Date:**

ECS CAROLINAS, LLP
9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 881-9910
Fax: (919) 861-9911

Client: Municipal Engineering Services Co. PA
Project: Lincoln MSWLF, Phase 4
Project No: 22408 **Figure**

Tested By: MB

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
Fax: (919) 861-9911
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Orangish Brown Sandy Silt
NUMBER	22480	NUMBER	OW4-8
		DEPTH	7-9'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	681.07		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.78**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	20.72		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.78	**Specific Gravity**	**2.70**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	694.84		
Tempreature when Wb was determined (°C) Tx	20.10		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

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HYDRAULIC CONDUCTIVITY

PROJECT INFORMATION

NAME	Lincoln Co. MSWLF, Ph. 4
NUMBER	22408

SAMPLE INFORMATION

DESCRIPTION	Orangish Brown Sandy Silt
Depth	7-9'
Sample	OW4-8
PREPERATION	Undisturbed

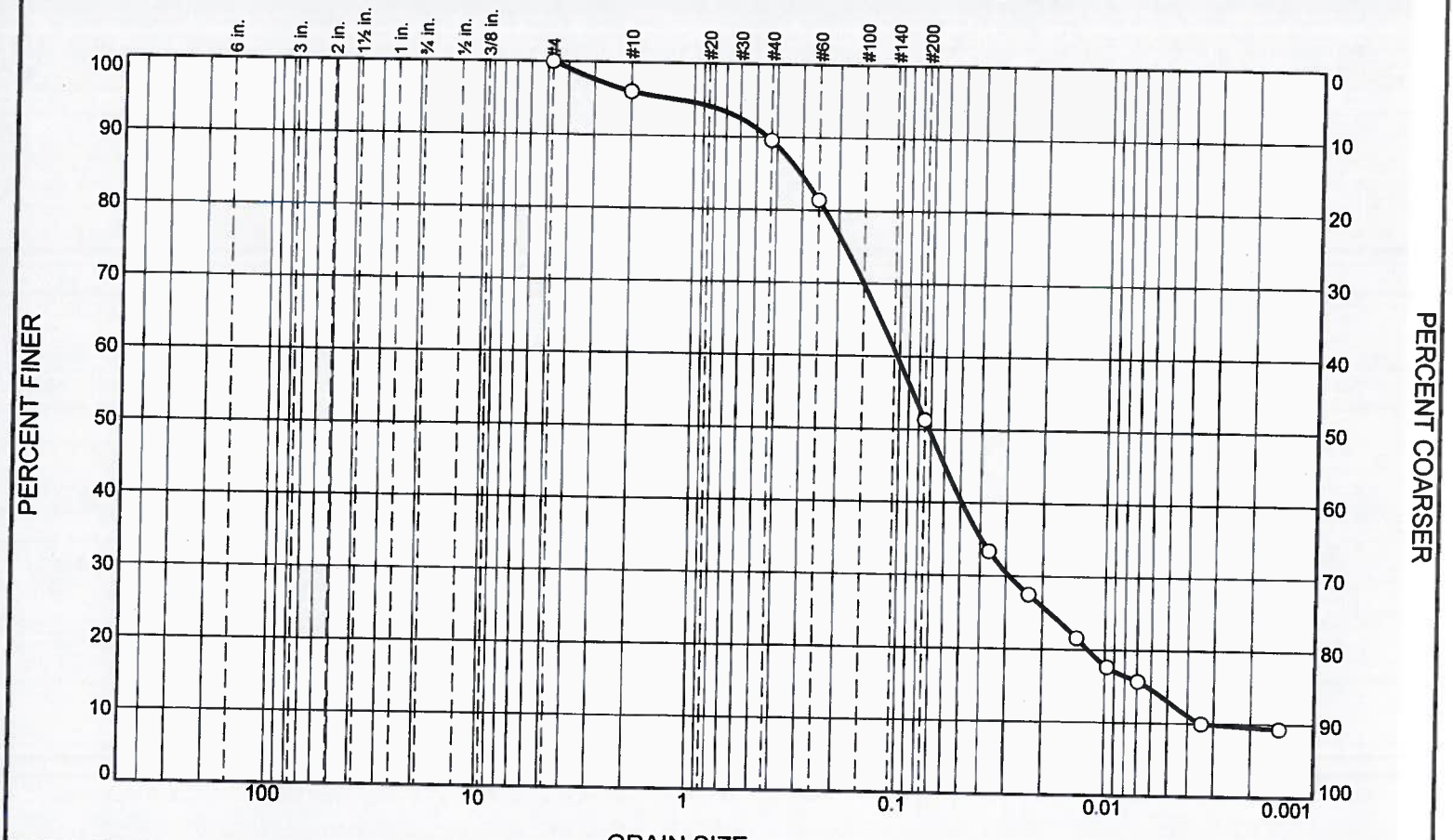
Sample Properties	**Initial**
Diameter (in)	2.836
Height (in)	5.148
Area (in²)	6.317
Volume (ft³)	0.019
Dry Unit Weight (pcf)	98.7
Void Ratio	0.67

Confining Pressure (psi)	**58**
Top Burette Pressure (psi)	**52**
Base Burette Pressure (psi)	**55**

Average Hydraulic Conductivity (cm/sec)

1.92E-07

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	4.0	6.5	38.2	38.2	13.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	96.0		
#40	89.5		
#60	81.3		
#200	51.3		
0.0362 mm.	33.4		
0.0233 mm.	27.5		
0.0137 mm.	21.6		
0.0098 mm.	17.7		
0.0069 mm.	15.7		
0.0034 mm.	10.0		
0.0015 mm.	9.4		

* (no specification provided)

Soil Description

Gray & Orange Sandy Silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.4432 D_{85}= 0.3068 D_{60}= 0.1027
D_{50}= 0.0716 D_{30}= 0.0290 D_{15}= 0.0062
D_{10}= 0.0034 C_u= 29.90 C_c= 2.38

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Source of Sample: Lincoln **Depth:** 17.00-19.00

Sample Number: OW4-8 **Date:**

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9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 881-9910
Fax: (919) 861-9911

Client: Municipal Engineering Services Co. PA

Project: Lincoln MSWLF, Phase 4

Project No: 22408 **Figure**

Tested By: MB

ECS Carolinas, LLP
9001 Glenwood Avenue
Raleigh, NC 27617
Phone: (919) 861-9910
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SOILS SPECIFIC GRAVITY

PROJECT INFORMATION		SAMPLE INFORMATION	
NAME	Lincoln Co. MSWLF, Ph. 4	DESCRIPTION	Gray & Orange Sandy Silt
NUMBER	22408	NUMBER	OW4-8
		DEPTH	17-19'

Calibration of Pycnometer

Mass of Pycnometer and Water (gr) Wa	680.87		
Mass of Pycnometer (gr) Wf	184.02	**Wa (@Tx)**	**681.58**
Observed Temperature of Water (°C) Ti	25.55		
Desired Temperaure (°C) Tx	20.00		

Wa(@ Tx) = (density of water @ Tx / density of water @ Ti) x (Wa (@Ti) - Wf) + Wf

Calculations

Mass of Sample Oven Dryed (gr) Wo	26.61		
Mass of Pycnometer filled with Water at Tx (gr) Wa	681.58	**Specific Gravity**	**2.69**
Mass of Pycnometer filled with Water & Soil at Tx (Wb	698.32		
Tempreature when Wb was determined (°C) Tx	19.20		
Factor K	0.997		

Specific Gravity, Tx/Tx = Wo /[Wo + (Wa - Wb)] x K

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Raleigh, NC 27617
Phone: (919) 861-9910
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HYDRAULIC CONDUCTIVITY

PROJECT INFORMATION

NAME	Lincoln Co. MSWLF, Ph. 4
NUMBER	22408

SAMPLE INFORMATION

DESCRIPTION	Gray & Orange Sandy Silt
Depth	17-19'
Sample	OW4-8
PREPERATION	Undisturbed

Sample Properties	**Initial**
Diameter (in)	2.836
Height (in)	5.148
Area (in²)	6.317
Volume (ft³)	0.019
Dry Unit Weight(pcf)	85.2
Void Ratio	0.94

Confining Pressure (psi)	**58**
Top Burette Pressure (psi)	**52**
Base Burette Pressure (psi)	**55**

Average Hydraulic Conductivity (cm/sec)
5.07E-06

MW-33A/OW-29A

CONSTANT HEAD PERMEABILITY

ASTM D5084

S&ME Project Number: 1356-03-255A Project Name: Lincoln County LF Ph 3 Hydro 1/18/2005

Sample Name: OW-29A

Sample Description: Brown Coarse to Fine Sandy Silty Clay

Type of Sample: UNDISTURBED

Sample Data		Molding Moisture Content		Target Molding Conditon			Additonal Data	
D (cm)	7.239	Tare No.	G-3	γ_{wet} (pcf)	0.0		Panel No	7
L (cm)	13.18	WWS+ Tare (gm)	349.08	γ_{dry} (pcf)			Cell P (psi)	83.5
A (cm^2)	41.16	WDS+Tare (gm)	306.9	w (%)			Soil P (psi)	81.0
V (cm^3)	542.45	WT of Water (gm)	42.18	Actual Molding Condition			Back P (psi)	80.0
WWS (gm)	972.7	WT of TARE (gm)	81.6	γ_{wet} (pcf)	106.8		Gs	2.66
		WT Dry Soil (gm)	225.3	γ_{dry} (pcf)	90.0		n	0.64
		w (%)	18.7	w (%)	18.7			

K = (Q x L) / (t x H x A)

Run	Temp. (°C)	Hour	Minute	Time, t (sec)	BURRETTE 1 (cc)	BURRETTE 2 (cc)	BURRETTE 3 (cc)	Q (cc)	Δ H (cm)	Temp Corr.	K(cm/sec
1		11	37		11	0.1	24.7				
	23	16	3	15960	11	3.0	21.6	3.0	70.4	0.9310	7.96E-07
2		11	26		11	0.3	24.3				
	23	17	21	21300	11	4.5	20.5	4.0	70.4	0.9310	7.96E-07
3		9	30		11	0.2	24.5				
	23	16	59	26940	11.1	5.0	19.5	4.9	70.4	0.9310	7.71E-07
4		9	43		11.1	0.3	24.5				
	23	15	13	19800	11.1	4.0	21.0	3.6	70.4	0.9310	7.70E-07
5		8	35		11.1	0.1	24.3				
	23	13	11	16560	11.1	3.0	21.3	3.0	70.4	0.9310	7.55E-07
7										AVG. K	7.73E-07
8										(Runs 2 thru 5)	
9											
10											

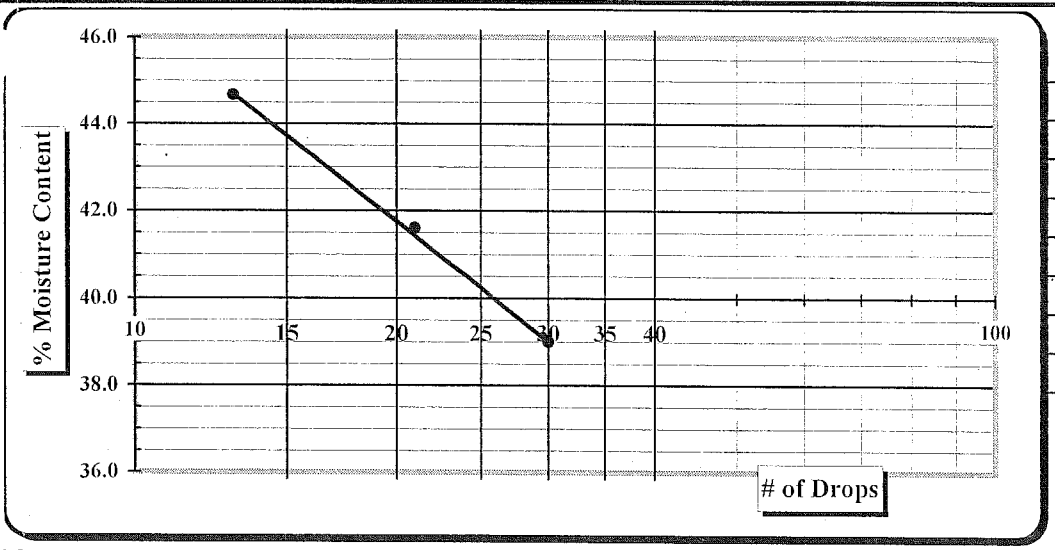
MW-31A/OW-29A

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1356-03-255A** Report Date: 1/14/05
Project Name: LINCOLN COUNTY LANDFILL PHASE III Test Date(s): 1/12-13/05
Client Name:
Client Address:
Boring #: OW-29A Sample #: UD Sample Date:
Location: Offset: Depth: 2-4'
Sample Description: BROWN COARSE TO FINE SANDY SILTY CLAY (CL)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	69	TS	2				5	9	
A	Tare Weight	15.37	15.38	15.79				**15.69**	13.92	
B	Wet Soil Weight + A	25.92	25.59	25.44				22.17	20.41	
C	Dry Soil Weight + A	22.96	22.59	22.46				21.12	19.34	
D	Water Weight (B-C)	2.96	3.00	2.98				1.05	1.07	
E	Dry Soil Weight (C-A)	7.59	7.21	6.67				5.43	5.42	
F	% Moisture Content (D/E)*100	39.0%	41.6%	44.7%				19.3%	19.7%	
N	# OF DROPS	30	21	13				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							19.5%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	40
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	20
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	20
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	CL

Technician Name: Karen Warner _____ *Certification #*

Technical Responsibility: Julie Petersen _____ *Signature* _____ *Position*

GRAIN SIZE DISTRIBUTION TEST DATA

MW-31A/OW-29A

Client:
Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY
Project Number: 03-255A

Sample Data

Source:
Sample No.: OW-29A UD
Elev. or Depth: 2-4'
Sample Length (in./cm.):
Location:
Description: BROWN COARSE TO FINE SANDY SILTY CLAY
Liquid Limit: 40
Plastic Limit: 20
USCS Classification: CL
AASHTO Classification:
Testing Remarks: TESTED BY KMW

Mechanical Analysis Data

	Initial
Dry sample and tare=	369.12
Tare =	0.00
Dry sample weight =	369.12

Sample split on number 10 sieve
Split sample data:
Sample and tare = 50.01 Tare = .00 Sample weight = 50.01
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
.375 inch	0.00	100.0
# 4	2.98	99.2
# 10	11.67	96.8
# 20	1.89	93.1
# 40	6.17	84.9
# 60	11.34	74.9
# 100	16.92	64.0
# 200	23.74	50.8

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 96.8
Weight of hydrometer sample: 50.01
Hygroscopic moisture correction:
Moist weight & tare = 26.33
Dry weight & tare = 26.16
Tare = 15.80
Hygroscopic moisture= 1.6 %
Calculated biased weight= 50.83
Automatic temperature correction
Composite correction at 20 deg C = -5

Meniscus correction only= 1
Specific gravity of solids= 2.66
Specific gravity correction factor= 0.998
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

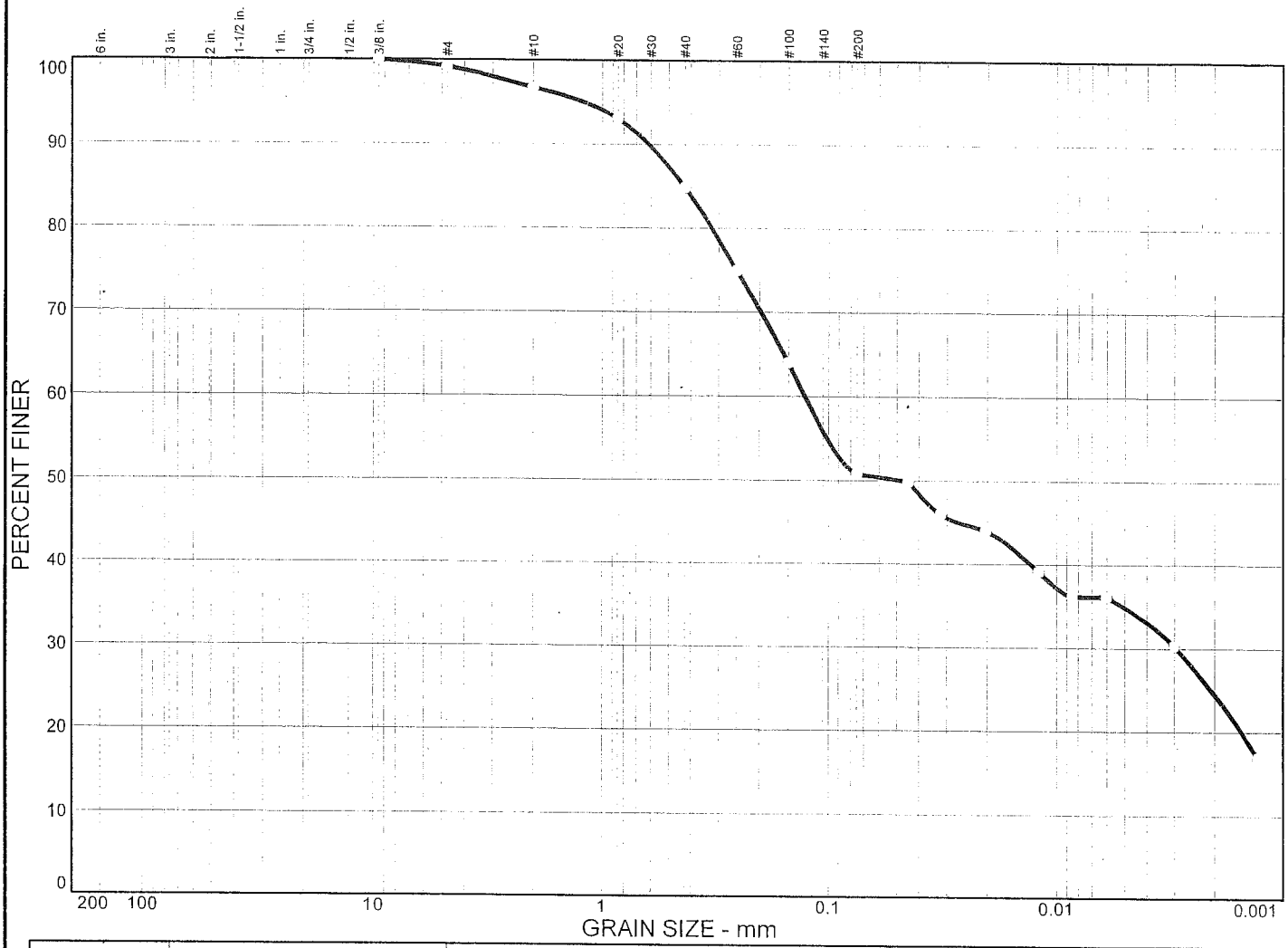
Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
1.00	22.0	30.0	25.4	0.0133	31.0	11.2	0.0444	49.9
2.00	22.0	28.0	23.4	0.0133	29.0	11.5	0.0319	46.0
5.00	22.0	27.0	22.4	0.0133	28.0	11.7	0.0203	44.0
15.00	22.0	24.5	19.9	0.0133	25.5	12.1	0.0119	39.1
30.00	22.0	23.0	18.4	0.0133	24.0	12.4	0.0085	36.1
60.00	22.0	23.0	18.4	0.0133	24.0	12.4	0.0060	36.1
250.00	22.0	20.0	15.4	0.0133	21.0	12.9	0.0030	30.3
1440.00	23.0	13.0	8.7	0.0131	14.0	14.0	0.0013	17.0

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #270
% COBBLES = % GRAVEL = 0.8 % SAND = 49.0
% SILT = 15.4 % CLAY = 34.8

D_{85}= 0.43 D_{60}= 0.13 D_{50}= 0.05
D_{30}= 0.00

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.8	49.0	15.4	34.8

LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
40	20	0.428	0.127	0.0471	0.0029				

MATERIAL DESCRIPTION	USCS	AASHTO
BROWN COARSE TO FINE SANDY SILTY CLAY	CL	

Project No. 03-255A **Client:**

Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY

Source: **Sample No.:** OW-29A UD **Elev./Depth:** 2-4'

Remarks:
TESTED BY KMW

Particle Size Distribution Report

S & ME, INC.

SAMPLE OW-29A UD

GRAIN SIZE DISTRIBUTION TEST DATA

Client:
Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY
Project Number: 03-255A

Sample Data

Source:
Sample No.: OW-29A (S-3&4)
Elev. or Depth: Sample Length (in./cm.):
Location:
Description: TAN & WHITE SLIGHTLY CLAYEY SILTY COARSE TO MEDIUM SAND
Liquid Limit: NP Plastic Limit: NP
USCS Classification: SM AASHTO Classification:
Testing Remarks: TESTED BY KMW/SB

Mechanical Analysis Data

	Initial
Dry sample and tare=	304.08
Tare =	0.00
Dry sample weight =	304.08

Sample split on number 10 sieve
Split sample data:
Sample and tare = 100.00 Tare = .00 Sample weight = 100.00
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
.375 inch	0.00	100.0
# 4	3.26	98.9
# 10	44.06	85.5
# 20	29.85	60.0
# 40	49.50	43.2
# 60	60.79	33.5
# 100	68.59	26.9
# 200	77.20	19.5

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 85.5
Weight of hydrometer sample: 100.00
Hygroscopic moisture correction:
Moist weight & tare = 25.71
Dry weight & tare = 25.66
Tare = 14.21
Hygroscopic moisture= 0.4 %
Calculated biased weight= 116.45
Automatic temperature correction
Composite correction at 20 deg C = -5

Meniscus correction only= 1
Specific gravity of solids= 2.65
Specific gravity correction factor= 1.000
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

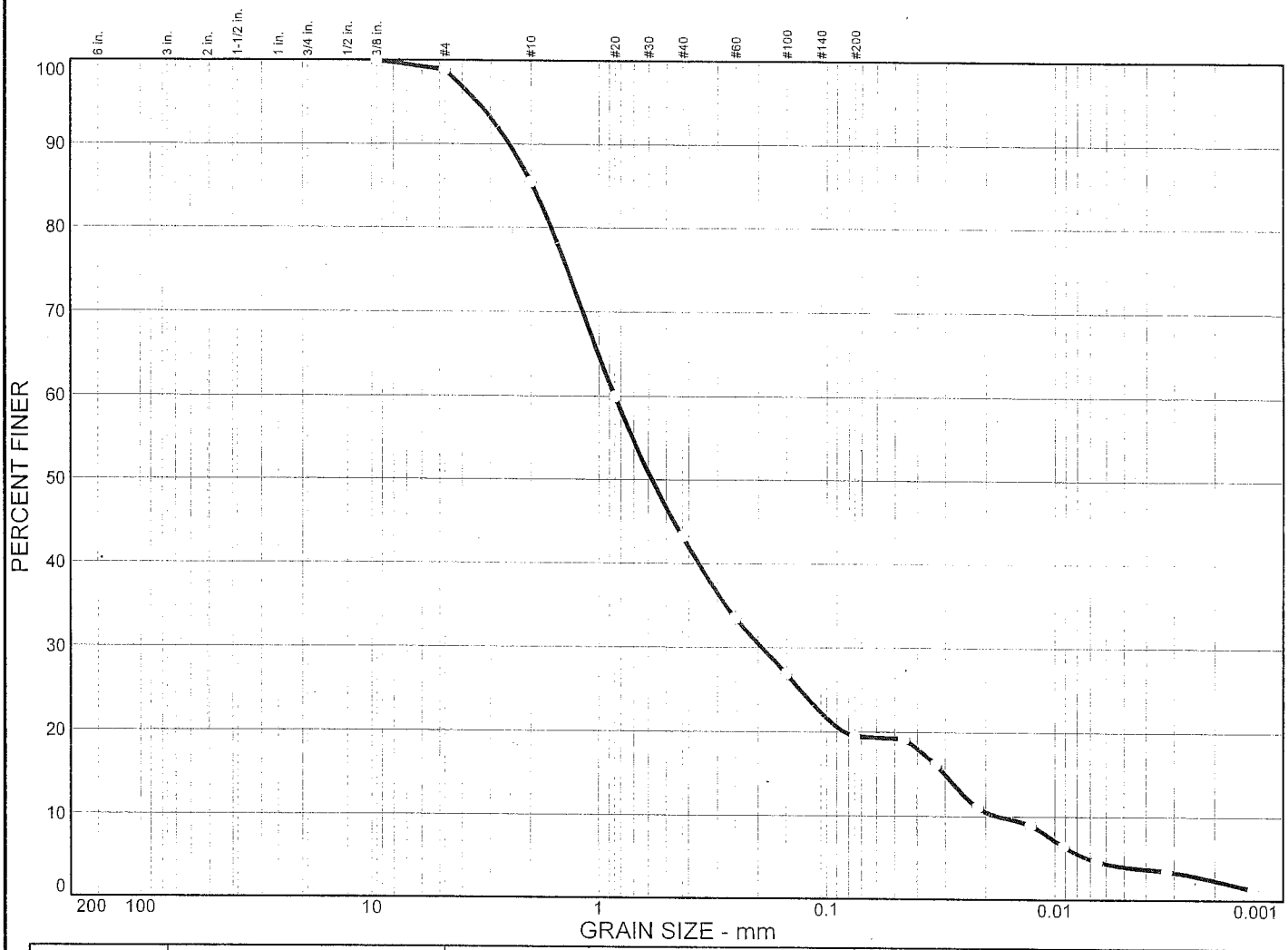
Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
1.00	22.0	27.0	22.4	0.0133	28.0	11.7	0.0455	19.2
2.00	22.0	23.5	18.9	0.0133	24.5	12.3	0.0330	16.2
5.00	22.0	17.5	12.9	0.0133	18.5	13.3	0.0217	11.1
15.00	22.0	15.0	10.4	0.0133	16.0	13.7	0.0127	8.9
30.00	22.0	12.0	7.4	0.0133	13.0	14.2	0.0091	6.4
60.00	22.0	10.0	5.4	0.0133	11.0	14.5	0.0065	4.6
250.00	22.0	8.5	3.9	0.0133	9.5	14.7	0.0032	3.4
1440.00	22.0	6.0	1.4	0.0133	7.0	15.1	0.0014	1.2

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% COBBLES = % GRAVEL = 1.1 % SAND = 79.4
% SILT = 15.6 % CLAY = 3.9

D_{85}= 1.96 D_{60}= 0.85 D_{50}= 0.58
D_{30}= 0.19 D_{15}= 0.03 D_{10}= 0.02
C_c= 2.4562 C_u= 47.8971

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.1	79.4	15.6	3.9

LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
NP	NP	1.96	0.850	0.579	0.192	0.0300	0.0177	2.46	47.90

MATERIAL DESCRIPTION	USCS	AASHTO
TAN & WHITE SLIGHTLY CLAYEY SILTY COARSE TO MEDIUM SAND	SM	

Project No. 03-255A **Client:**

Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY

Source:

Sample No.: OW-29A (S-3&4)

Remarks:

TESTED BY KMW/SB

Particle Size Distribution Report

S & ME, INC.

SAMPLE OW-29A

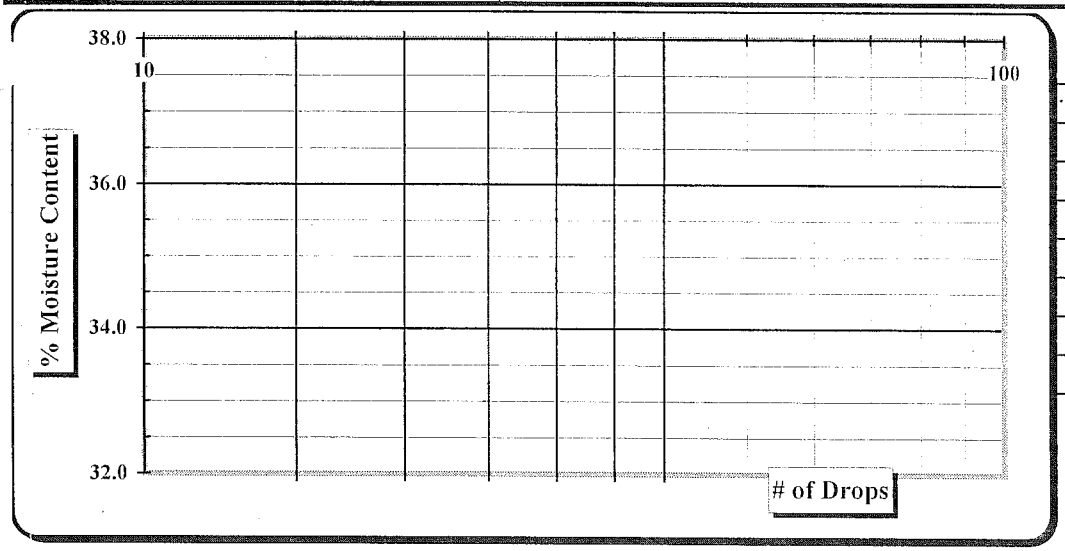
MW-31A/OW-29A

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1356-03-255A** Report Date: 2/10/05
Project Name: LINCOLN COUNTY LANDFILL PHASE III Test Date(s): 2/8-9/05
Client Name:
Client Address:
Boring #: OW-29A Sample #: SS 3&4 Sample Date:
Location: Offset: Depth:
Sample Description: TAN & WHITE SL. CLAYEY SILTY COARSE TO MEDIUM SAND

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #									
A	Tare Weight									
B	Wet Soil Weight + A									
C	Dry Soil Weight + A									
D	Water Weight (B-C)									
E	Dry Soil Weight (C-A)									
F	% Moisture Content (D/E)*100									
N	# OF DROPS							*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average									



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☒
Liquid limit Test:	Multipoint Method ☐	One-point Method ☒		Liquid Limit	
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Karen Warner

Certification #

Technical Responsibility: Julie Petersen

Signature Position

GRAIN SIZE DISTRIBUTION TEST DATA

Client:
Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY
Project Number: 03-255A

Sample Data

Source:
Sample No.: B-30 (S-5&6)
Elev. or Depth: Sample Length (in./cm.):
Location:
Description: TAN & WHITE SLIGHTLY CLAYEY SILTY COARSE TO FINE SAND
Liquid Limit: 31 Plastic Limit: 26
USCS Classification: SM AASHTO Classification:
Testing Remarks: TESTED BY KMW/SB

Mechanical Analysis Data

	Initial
Dry sample and tare=	326.63
Tare =	0.00
Dry sample weight =	326.63

Sample split on number 10 sieve
Split sample data:
Sample and tare = 100.01 Tare = .00 Sample weight = 100.01
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
.375 inch	0.00	100.0
# 4	1.79	99.5
# 10	11.89	96.4
# 20	14.08	82.8
# 40	27.22	70.2
# 60	35.97	61.7
# 100	44.77	53.2
# 200	58.81	39.7

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 96.4
Weight of hydrometer sample: 100.01
Hygroscopic moisture correction:
Moist weight & tare = 28.58
Dry weight & tare = 28.47
Tare = 16.95
Hygroscopic moisture= 1.0 %
Calculated biased weight= 102.76
Automatic temperature correction
Composite correction at 20 deg C = -5

Meniscus correction only= 1
Specific gravity of solids= 2.65
Specific gravity correction factor= 1.000
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

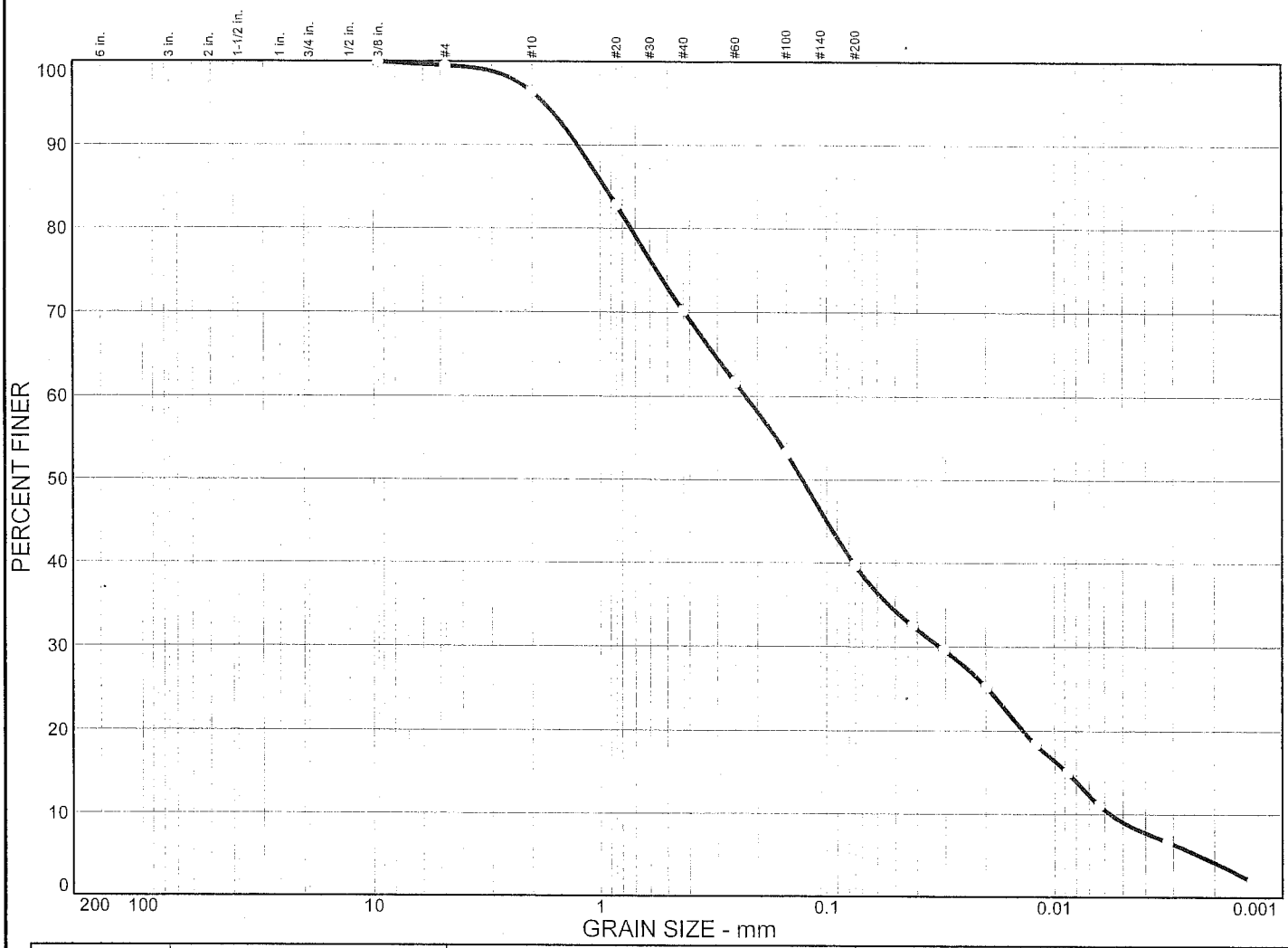
Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
1.00	22.0	38.0	33.4	0.0133	39.0	9.9	0.0419	32.5
2.00	22.0	35.0	30.4	0.0133	36.0	10.4	0.0303	29.6
5.00	22.0	30.5	25.9	0.0133	31.5	11.1	0.0199	25.2
15.00	22.0	23.5	18.9	0.0133	24.5	12.3	0.0120	18.4
30.00	22.0	20.0	15.4	0.0133	21.0	12.9	0.0087	15.0
60.00	22.0	16.0	11.4	0.0133	17.0	13.5	0.0063	11.1
250.00	22.0	11.5	6.9	0.0133	12.5	14.2	0.0032	6.7
1440.00	22.0	6.5	1.9	0.0133	7.5	15.1	0.0014	1.9

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% COBBLES = % GRAVEL = 0.5 % SAND = 59.8
% SILT = 30.6 % CLAY = 9.1

D_{85}= 0.96 D_{60}= 0.22 D_{50}= 0.13
D_{30}= 0.03 D_{15}= 0.01 D_{10}= 0.01
C_c= 0.7965 C_u= 39.7513

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.5	59.8	30.6	9.1

LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
31	26	0.955	0.224	0.127	0.0317	0.0087	0.0056	0.80	39.75

MATERIAL DESCRIPTION	USCS	AASHTO
TAN & WHITE SLIGHTLY CLAYEY SILTY COARSE TO FINE SAND	SM	

Project No. 03-255A **Client:**

Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY

Source:

Sample No.: B-30 (S-5&6)

Remarks:

TESTED BY KMW/SB

Particle Size Distribution Report

S & ME, INC.

SAMPLE B-30(S5&6)

MW-34/B-30

S&ME

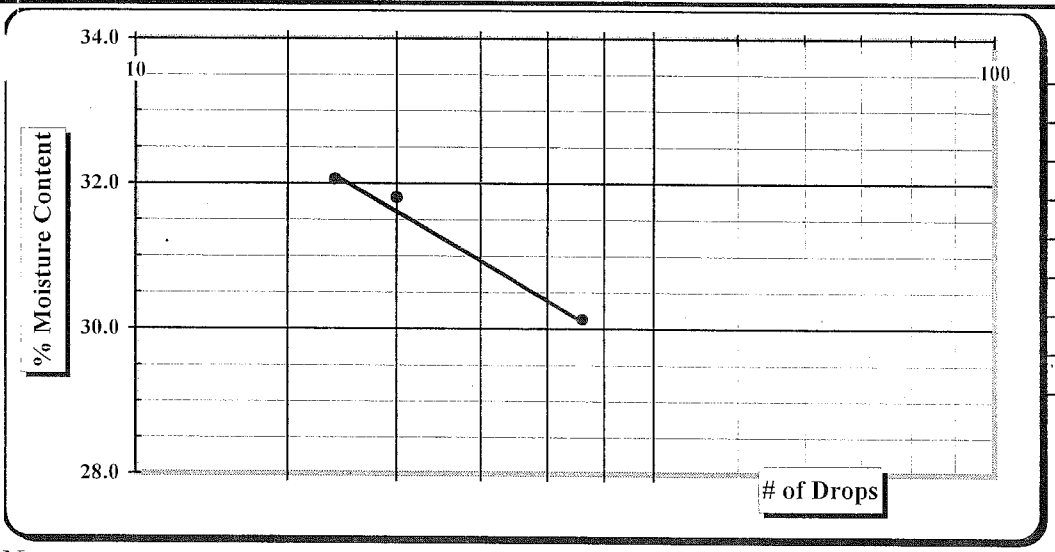
Liquid Limit, Plastic Limit, and Plastic Index

Project #: 1356-03-255A
Project Name: LINCOLN COUNTY LANDFILL PHASE III
Client Name:
Client Address:

Report Date: 2/5/05
Test Date(s): 2/2-5/05

Boring #: B-30 Sample #: SS-5&6 Sample Date:
Location: Offset: Depth:
Sample Description: TAN & WHITE SLIGHTLY CLAYEY SILTY COARSE TO FINE SAND

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	I	SMS	SSS				JORDI	HH	
A	Tare Weight	15.53	15.15	16.56				**15.94**	17.01	
B	Wet Soil Weight + A	23.39	20.91	22.78				22.18	22.45	
C	Dry Soil Weight + A	21.57	19.52	21.27				20.89	21.30	
D	Water Weight (B-C)	1.82	1.39	1.51				1.29	1.15	
E	Dry Soil Weight (C-A)	6.04	4.37	4.71				4.95	4.29	
F	% Moisture Content (D/E)*100	30.1%	31.8%	32.1%				26.1%	26.8%	
N	# OF DROPS	33	20	17				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							26.4%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	31
Classification:	ASTM D 2487 ☐	AASHTO M 145 ☐		Plastic Limit	26
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	5
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

Technician Name: Sarah Bonner
Certification #

Technical Responsibility: Julie Petersen
Signature Position

MW-35A/B-31

CONSTANT HEAD PERMEABILITY

ASTM D5084

S&ME Project Number: 1356-03-255A Project Name: Lincoln County LF Ph 3 Hydro 1/17/2005

Sample Name: B-31

Sample Description:Red Clayey Silt w/Sand

Type of Sample: UNDISTURBED

Sample Data		Molding Moisture Content		Target Molding Conditon			Additonal Data	
D (cm)	7.244	Tare No.	G-P	γ_{wet} (pcf)	0.0		Panel No	3
L (cm)	10.96	WWS+ Tare (gm)	303.81	γ_{dry} (pcf)			Cell P (psi)	83.5
A (cm^2)	41.21	WDS+Tare (gm)	250.72	w (%)			Soil P (psi)	81.0
V (cm^3)	451.71	WT of Water (gm)	53.09	**Actual Molding Condition**			Back P (psi)	80.0
WWS (gm)	824	WT of TARE (gm)	82.73	γ_{wet} (pcf)	113.9		Gs	2.75
		WT Dry Soil (gm)	167.99	γ_{dry} (pcf)	86.5		n	0.63
		w (%)	31.6	w (%)	31.6			

K = (Q x L) / (t x H x A)

Run	Temp. (^{0}C)	Hour	Minute	Time, t (sec)	BURRETTE 1 (cc)	BURRETTE 2 (cc)	BURRETTE 3 (cc)	Q (cc)	Δ H (cm)	Temp Corr.	K(cm/sec
1		13	24		11.4	0.1	24.2				
	23	13	38	840	11.4	24.3	0.0	24.2	70.4	0.9310	1.01E-04
2		13	40		11.4	0.3	24.3				
	23	13	53	780	11.5	24.5	0.2	24.2	70.4	0.9310	1.09E-04
3		14	13		11.5	0.1	24.5				
	23	14	26	780	11.5	24.4	0.1	24.4	70.4	0.9310	1.10E-04
4		14	53		11.5	0.2	24.3				
	23	15	6	780	11.5	24.2	0.1	24.1	70.4	0.9310	1.09E-04
5		15	47		11.5	0.2	24.6				
	23	16	0	780	11.5	24.1	0.6	24.0	70.4	0.9310	1.08E-04
7										AVG. K	1.09E-04
8										(Runs 2 thru 5)	
9											
10											

GRAIN SIZE DISTRIBUTION TEST DATA

Client:
Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY
Project Number: 03-255A

Sample Data

Source:
Sample No.: B-31 UD
Elev. or Depth: 2-4'
Sample Length (in./cm.):
Location:
Description: RED CLAYEY SILT W/SAND
Liquid Limit: 58
Plastic Limit: 36
USCS Classification: MH
AASHTO Classification:
Testing Remarks: TESTED BY KMW

Mechanical Analysis Data

	Initial
Dry sample and tare=	237.37
Tare =	0.00
Dry sample weight =	237.37

Sample split on number 10 sieve
Split sample data:
Sample and tare = 50.00 Tare = .00 Sample weight = 50.00
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
# 4	0.00	100.0
# 10	0.49	99.8
# 20	0.62	98.6
# 40	2.27	95.3
# 60	4.07	91.7
# 100	5.85	88.1
# 200	8.83	82.2

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 99.8
Weight of hydrometer sample: 50.00
Hygroscopic moisture correction:
Moist weight & tare = 26.80
Dry weight & tare = 26.24
Tare = 16.06
Hygroscopic moisture= 5.5 %
Calculated biased weight= 47.49
Automatic temperature correction
Composite correction at 20 deg C = -5

Meniscus correction only= 1
Specific gravity of solids= 2.75
Specific gravity correction factor= 0.978
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

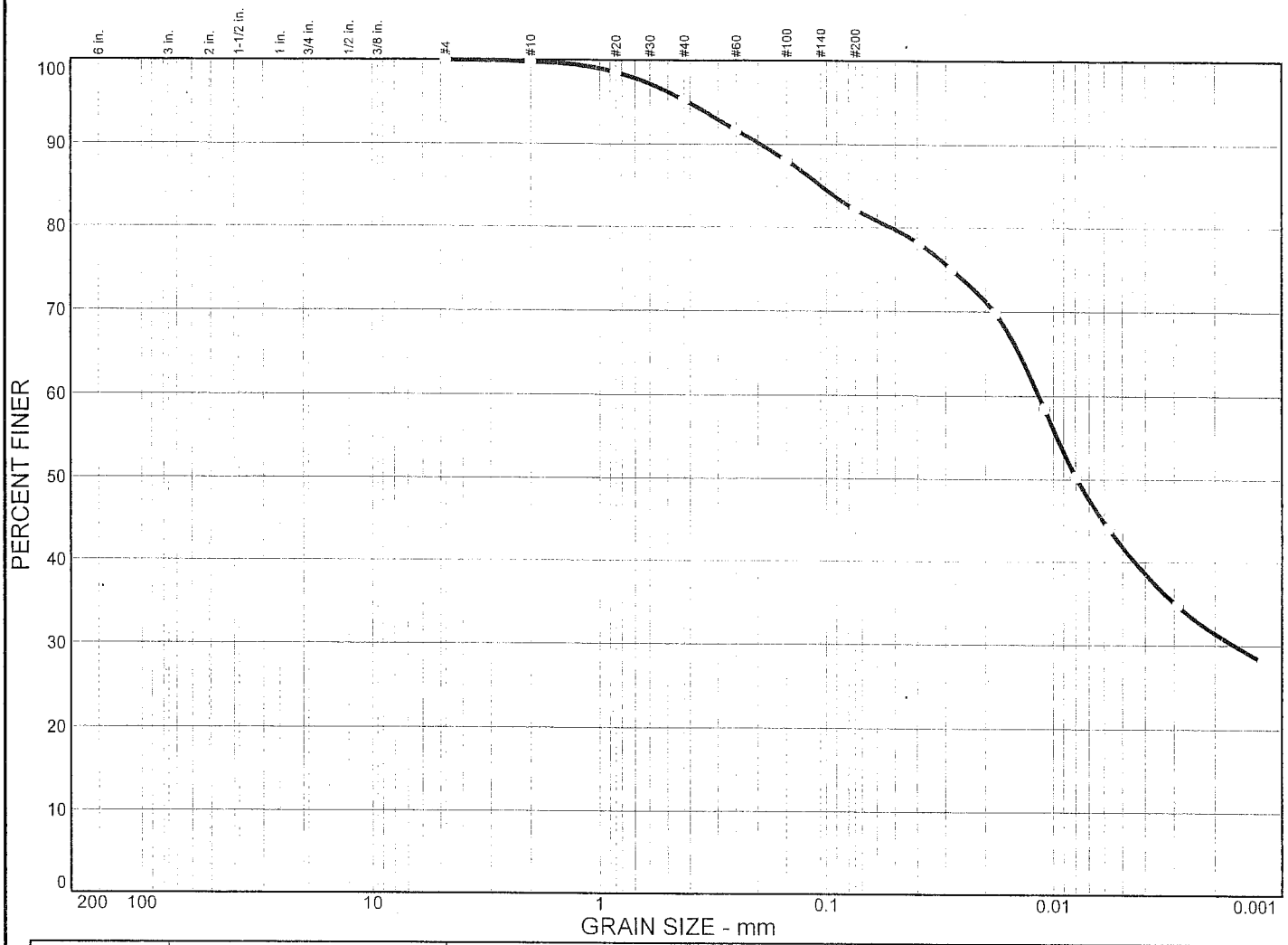
Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
1.00	22.0	42.5	37.9	0.0129	43.5	9.2	0.0391	78.1
2.00	22.0	41.0	36.4	0.0129	42.0	9.4	0.0280	75.0
5.00	22.0	38.5	33.9	0.0129	39.5	9.8	0.0181	69.8
15.00	22.0	33.0	28.4	0.0129	34.0	10.7	0.0109	58.5
30.00	22.0	29.0	24.4	0.0129	30.0	11.4	0.0080	50.3
60.00	22.0	26.0	21.4	0.0129	27.0	11.9	0.0057	44.1
250.00	22.0	21.5	16.9	0.0129	22.5	12.6	0.0029	34.8
1440.00	23.0	18.0	13.7	0.0128	19.0	13.2	0.0012	28.1

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #270
% COBBLES = % GRAVEL = % SAND = 19.9
% SILT = 38.2 % CLAY = 41.9

D_{85}= 0.11 D_{60}= 0.01 D_{50}= 0.01
D_{30}= 0.00

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	19.9	38.2	41.9

LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
58	36	0.105	0.0116	0.0079	0.0016				

MATERIAL DESCRIPTION	USCS	AASHTO
RED CLAYEY SILT W/SAND	MH	

Project No. 03-255A **Client:**

Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY

Source: **Sample No.:** B-31 UD **Elev./Depth:** 2-4'

Remarks:
TESTED BY KMW

Particle Size Distribution Report

S & ME, INC.

SAMPLE B-31 UD

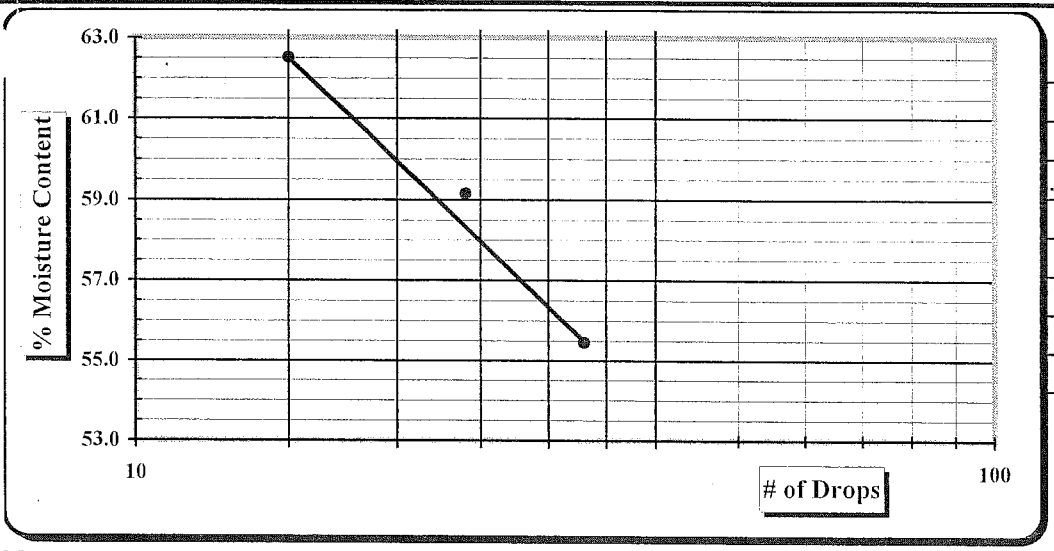
MW-35A/B-31

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1356-03-255A** Report Date: 1/14/05
Project Name: LINCOLN COUNTY LANDFILL PHASE III Test Date(s): 1/12-13/05
Client Name:
Client Address:
Boring #: B-31 Sample #: UD Sample Date:
Location: Offset: Depth: 2-4'
Sample Description: RED CLAYEY SILT W/SAND (MH)

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	36	CC	8				EE	26	
A	Tare Weight	15.68	16.86	13.94				**16.93**	13.99	
B	Wet Soil Weight + A	24.93	24.77	25.30				22.95	20.71	
C	Dry Soil Weight + A	21.63	21.83	20.93				21.35	18.92	
D	Water Weight (B-C)	3.30	2.94	4.37				1.60	1.79	
E	Dry Soil Weight (C-A)	5.95	4.97	6.99				4.42	4.93	
F	% Moisture Content (D/E)*100	55.5%	59.2%	62.5%				36.2%	36.3%	
N	# OF DROPS	33	24	15				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							36.3%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	58
Classification:	ASTM D 2487 ☐	AASHTO M 145 ☐		Plastic Limit	36
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	22
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	MH

Technician Name: Karen Warner
Certification #
Technical Responsibility: Julie Petersen
Signature Position

GRAIN SIZE DISTRIBUTION TEST DATA

Client:
Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY
oject Number: 03-255A

Sample Data

Source:
Sample No.: B-31 (S-5&6)
Elev. or Depth: Sample Length (in./cm.):
Location:
Description: RED BROWN CLAYEY MEDIUM TO FINE SANDY SILT
Liquid Limit: 43 Plastic Limit: 43
USCS Classification: ML AASHTO Classification:
Testing Remarks: TESTED BY KMW/SB

Mechanical Analysis Data

	Initial
Dry sample and tare=	173.20
Tare =	0.00
Dry sample weight =	173.20

Sample split on number 10 sieve
Split sample data:
Sample and tare = 50.01 Tare = .00 Sample weight = 50.01
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
# 4	0.00	100.0
# 10	0.00	100.0
# 20	0.52	99.0
# 40	2.98	94.0
# 60	6.15	87.7
# 100	10.88	78.2
# 200	19.76	60.5

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 100.0
Weight of hydrometer sample: 50.01
Hygroscopic moisture correction:
Moist weight & tare = 26.71
Dry weight & tare = 26.59
Tare = 16.56
Hygroscopic moisture= 1.2 %
Calculated biased weight= 49.42
Automatic temperature correction
Composite correction at 20 deg C = -5

Meniscus correction only= 1
Specific gravity of solids= 2.65
ecific gravity correction factor= 1.000
ydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

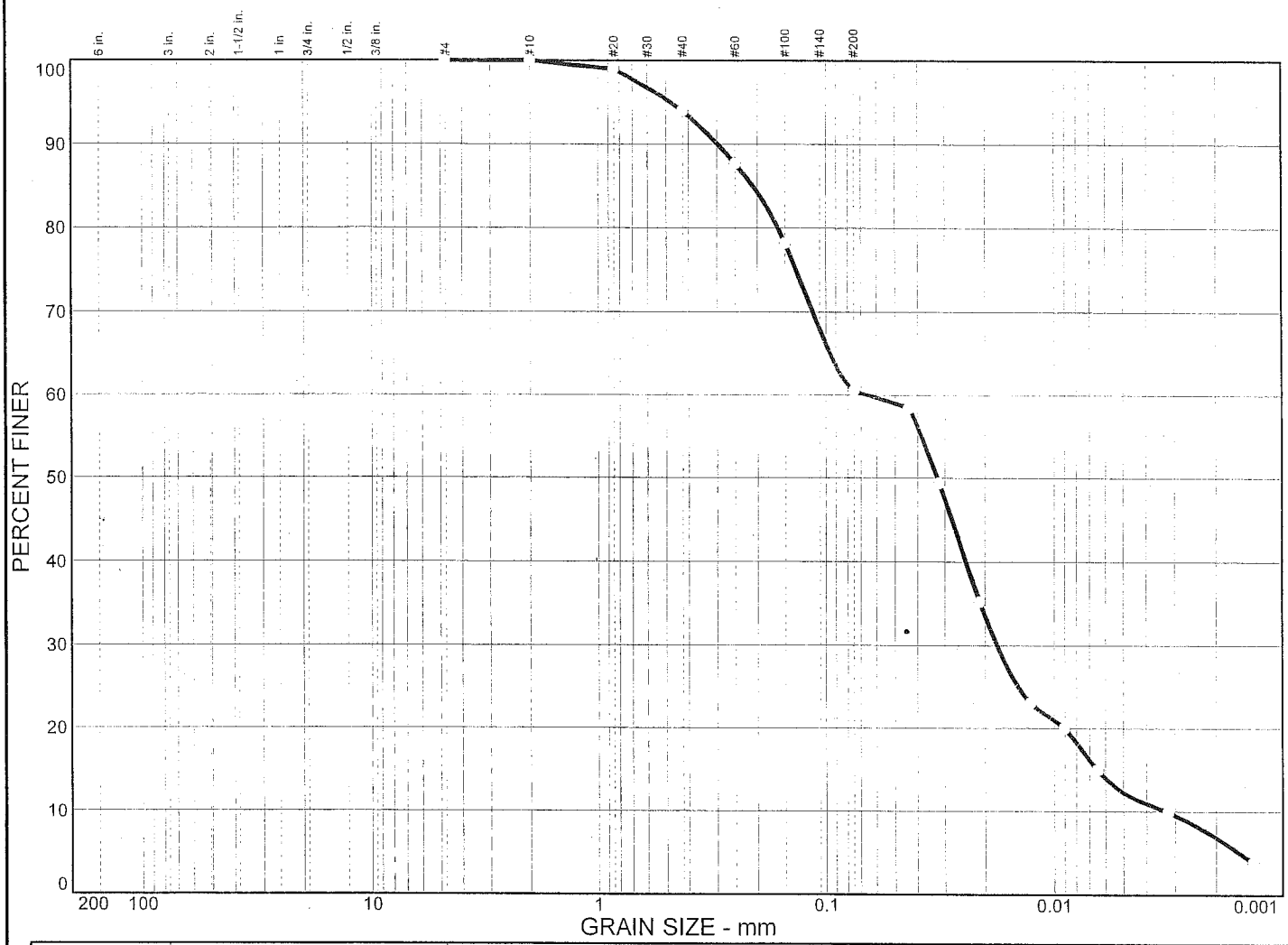
Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
1.00	22.0	33.5	28.9	0.0133	34.5	10.6	0.0434	58.5
2.00	22.0	29.0	24.4	0.0133	30.0	11.4	0.0318	49.4
5.00	22.0	22.0	17.4	0.0133	23.0	12.5	0.0211	35.2
15.00	22.0	16.0	11.4	0.0133	17.0	13.5	0.0126	23.1
30.00	22.0	14.5	9.9	0.0133	15.5	13.8	0.0090	20.0
60.00	22.0	12.0	7.4	0.0133	13.0	14.2	0.0065	15.0
250.00	22.0	9.5	4.9	0.0133	10.5	14.6	0.0032	9.9
1440.00	22.0	6.5	1.9	0.0133	7.5	15.1	0.0014	3.9

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% COBBLES = % GRAVEL = % SAND = 39.5
% SILT = 48.2 % CLAY = 12.3

D_{85}= 0.21 D_{60}= 0.07 D_{50}= 0.03
D_{30}= 0.02 D_{15}= 0.01 D_{10}= 0.00
C_c= 1.4672 C_u= 19.95

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	39.5	48.2	12.3

LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
43	43	0.209	0.0654	0.0324	0.0177	0.0065	0.0033	1.47	19.95

MATERIAL DESCRIPTION	USCS	AASHTO
RED BROWN CLAYEY MEDIUM TO FINE SANDY SILT	ML	

Project No. 03-255A **Client:**

Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY

Source: **Sample No.:** B-31 (S-5&6)

Remarks:
TESTED BY KMW/SB

Particle Size Distribution Report

S & ME, INC.

SAMPLE B-31(5&6)

MW-35A/B-31

S&ME

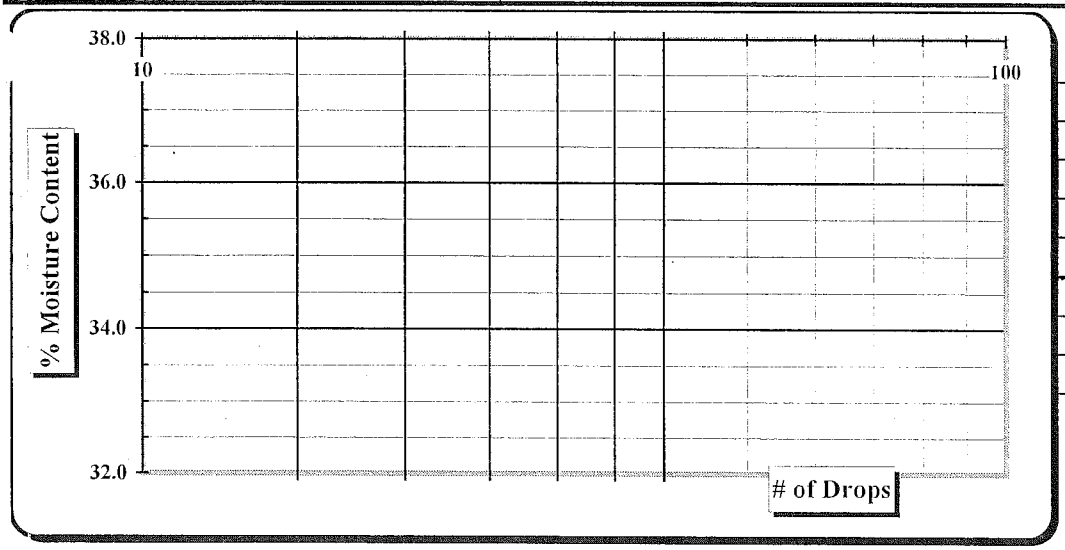
Liquid Limit, Plastic Limit, and Plastic Index

roject #: 1356-03-255A
Project Name: LINCOLN COUNTY LANDFILL PHASE III
Client Name:
Client Address:

Report Date: 2/10/05
Test Date(s): 2/8-9/05

Boring #: B-31 Sample #: SS 5&6 Sample Date:
Location: Offset: Depth:
Sample Description: RED BROWN CLAYEY MEDIUM TO FINE SANDY SILT

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	SSS						XX	I	
A	Tare Weight	16.57						**15.32**	15.52	
B	Wet Soil Weight + A	27.71						21.83	21.21	
C	Dry Soil Weight + A	24.32						19.87	19.50	
D	Water Weight (B-C)	3.39						1.96	1.71	
E	Dry Soil Weight (C-A)	7.75						4.55	3.98	
F	% Moisture Content (D/E)*100	43.7%						43.1%	43.0%	
N	# OF DROPS	21						*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR	**43.0%**								
Ave.	Average	43.0%						43.0%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☐	One-point Method ☒		Liquid Limit	43
Classification:	ASTM D 2487 ☒	AASHTO M 145 ☐		Plastic Limit	43
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	0
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	ML

Technician Name: Karen Warner
Certification #

Technical Responsibility: Julie Petersen
Signature Position

GRAIN SIZE DISTRIBUTION TEST DATA

Client:
Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY
Project Number: 03-255A

Sample Data

Source:
Sample No.: B-31 (S-13&14)
Elev. or Depth: Sample Length (in./cm.):
Location:
Description: BROWN & WHITE SLIGHTLY CLAYEY SILTY SAND W/GRAVEL
Liquid Limit: 37 Plastic Limit: 32
USCS Classification: SM AASHTO Classification:
Testing Remarks: TESTED BY KMW/SB

Mechanical Analysis Data

	Initial
Dry sample and tare=	282.23
Tare =	0.00
Dry sample weight =	282.23

Sample split on number 10 sieve
Split sample data:
Sample and tare = 100.00 Tare = .00 Sample weight = 100.00
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
.75 inch	0.00	100.0
.5 inch	24.75	91.2
.375 inch	34.39	87.8
# 4	48.45	82.8
# 10	78.06	72.3
# 20	15.98	60.7
# 40	25.61	53.8
# 60	33.69	47.9
# 100	42.56	41.5
# 200	56.37	31.5

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 72.3
Weight of hydrometer sample: 100.00
Hygroscopic moisture correction:
Moist weight & tare = 25.87
Dry weight & tare = 25.69
Tare = 15.71
Hygroscopic moisture= 1.8 %
Calculated biased weight= 135.86
Automatic temperature correction
Composite correction at 20 deg C = -5

Meniscus correction only= 1
Specific gravity of solids= 2.65
Specific gravity correction factor= 1.000

Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
1.00	22.0	43.5	38.9	0.0133	44.5	9.0	0.0399	28.6
2.00	22.0	37.0	32.4	0.0133	38.0	10.1	0.0299	23.9
5.00	22.0	31.5	26.9	0.0133	32.5	11.0	0.0197	19.8
15.00	22.0	25.0	20.4	0.0133	26.0	12.0	0.0119	15.0
30.00	22.0	20.0	15.4	0.0133	21.0	12.9	0.0087	11.3
60.00	22.0	16.0	11.4	0.0133	17.0	13.5	0.0063	8.4
250.00	22.0	12.0	7.4	0.0133	13.0	14.2	0.0032	5.5
1440.00	23.0	8.0	3.7	0.0132	9.0	14.8	0.0013	2.7

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% COBBLES = % GRAVEL = 17.2 % SAND = 51.3
% SILT = 24.4 % CLAY = 7.1

D_{85}= 6.44 D_{60}= 0.80 D_{50}= 0.30
D_{30}= 0.05 D_{15}= 0.01 D_{10}= 0.01
C_c= 0.3632 C_u= 103.9835

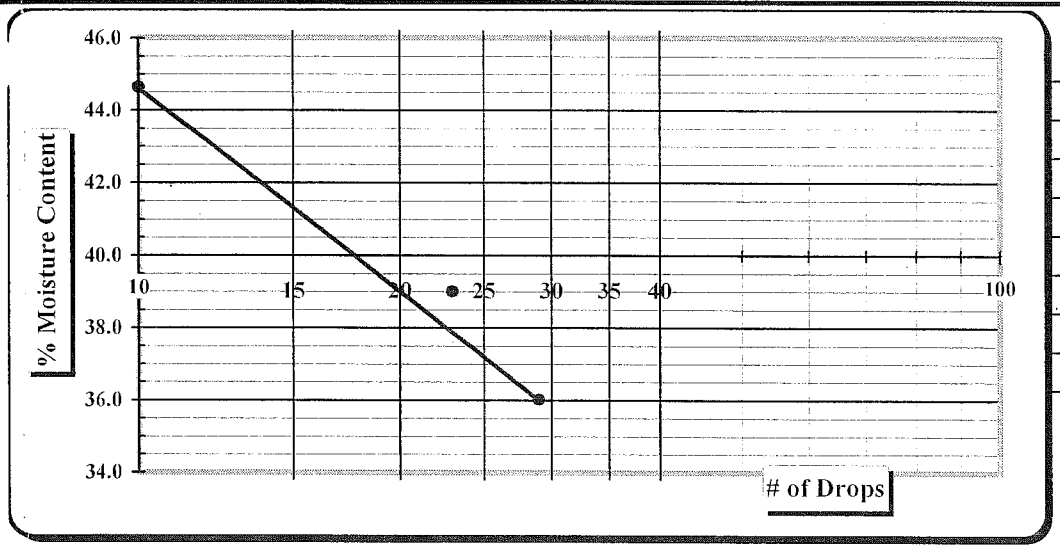
MW-35A/B-31

S&ME

Liquid Limit, Plastic Limit, and Plastic Index

Project #: **1356-03-255A** Report Date: 2/16/05
Project Name: LINCOLN COUNTY LANDFILL PHASE III Test Date(s): 2/14-15/05
Client Name:
Client Address:
Boring #: B-31 Sample #: SS-13&14 Sample Date:
Location: Offset: Depth:
Sample Description: BROWN & WHITE SLIGHTLY CLAYEY SILTY SAND W/GRAVEL

Pan #		Liquid Limit						Plastic Limit		
	Test #	1	2	3	4	5	6	1	2	3
	Tare #	NN	OO	9				32	6	
A	Tare Weight	15.31	16.23	13.94				**13.97**	14.04	
B	Wet Soil Weight + A	21.54	21.86	20.29				20.27	20.32	
C	Dry Soil Weight + A	19.89	20.28	18.33				18.74	18.81	
D	Water Weight (B-C)	1.65	1.58	1.96				1.53	1.51	
E	Dry Soil Weight (C-A)	4.58	4.05	4.39				4.77	4.77	
F	% Moisture Content (D/E)*100	36.0%	39.0%	44.6%				32.1%	31.7%	
N	# OF DROPS	29	23	10				*Moisture Contents determined by ASTM D 2216*		
LL	LL = F * FACTOR									
Ave.	Average							31.9%		



One Point Liquid Limit			
N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.990	29	1.018
24	0.995	30	1.022
25	1.000		

Notes: Estimate the % Retained on the #40 Sieve

Special Sampling Methods:

Sample Preparation:	Wet Preparation ☐	Dry Preparation ☒	Air Dried ☒	NP, Non-Plastic	☐
Liquid limit Test:	Multipoint Method ☒	One-point Method ☐		Liquid Limit	37
Classification:	ASTM D 2487 ☐	AASHTO M 145 ☐		Plastic Limit	32
Liquid limit Test:	ASTM D 4318 ☒	AASHTO T 89 ☐		Plastic Index	5
Plastic limit Test:	ASTM D 4318 ☒	AASHTO T 90 ☐		Group Symbol	SM

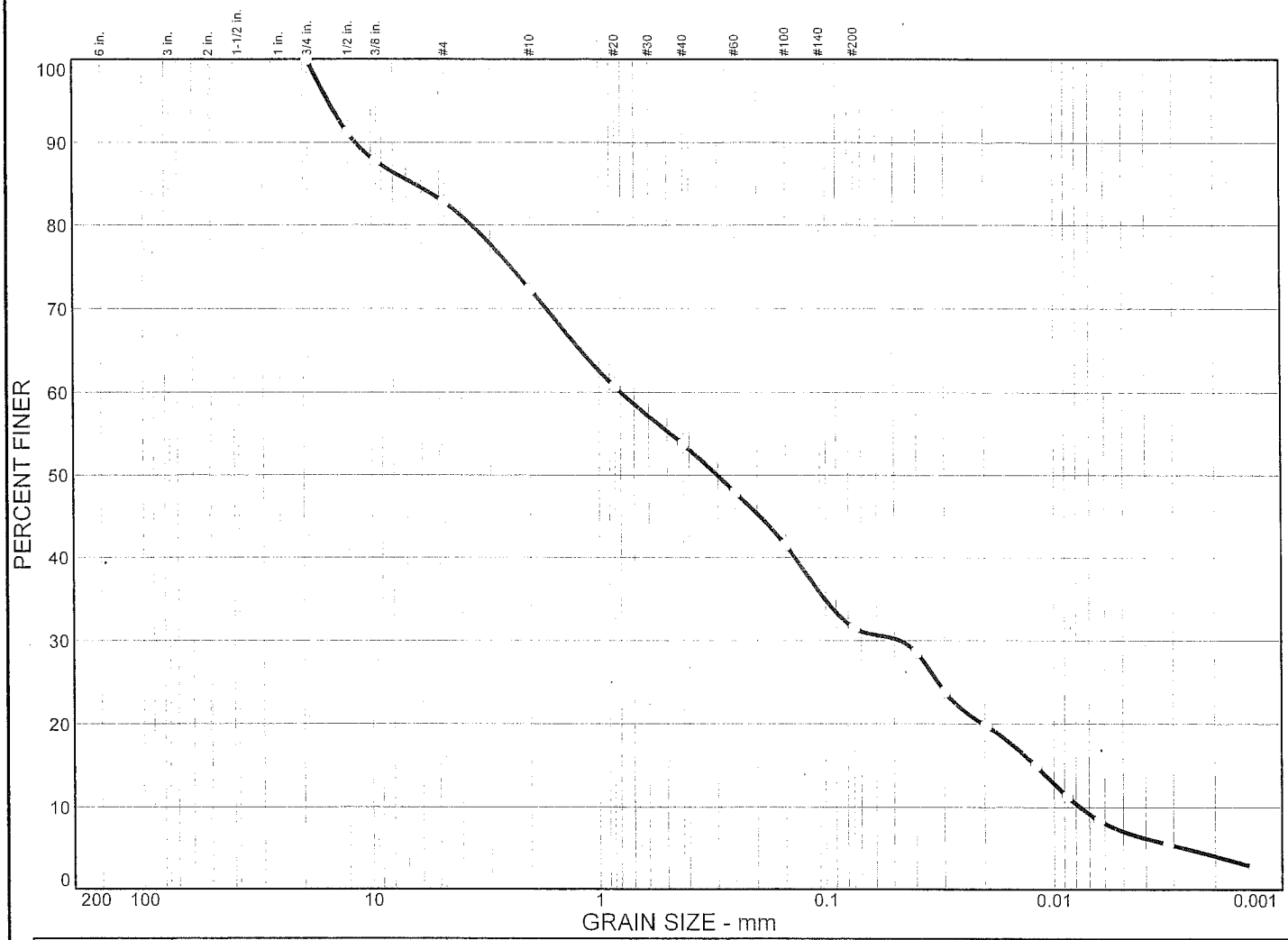
Technician Name: Sarah Bonner

Certification #

Technical Responsibility: Julie Petersen

Signature *Position*

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	17.2	51.3	24.4	7.1

LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
37	32	6.44	0.798	0.300	0.0472	0.0119	0.0077	0.36	103.98

MATERIAL DESCRIPTION	USCS	AASHTO
BROWN & WHITE SLIGHTLY CLAYEY SILTY SAND W/GRAVEL	SM	

Project No. 03-255A **Client:**

Project: LINCOLN COUNTY LANDFILL PHASE 3 - HYDRO STUDY

Source:

Sample No.: B-31 (S-13&14)

Remarks:

TESTED BY KMW/SB

Particle Size Distribution Report

S & ME, INC.

SAMPLE B-31(13&14)

APPENDIX C

CALCULATIONS

SEASONAL HIGH GROUNDWATER CALCULATIONS

ESTIMATED LONG TERM SEASONAL HIGH CALCULATIONS

JOHNSON and BEAR SOIL TEXTURE DIAGRAMS

HORIZONTAL HYDRAULIC GRADIENT CALCULATIONS

VERTICAL HYDRAULIC GRADIENT CALCULATIONS

CALCULATION OF GW FLOW DIRECTIONS (HYDRAULIC CONDUCTIVITY ELLIPSE METHOD)

SEASONAL HIGH
and
ESTIMATED LONG TERM SEASONAL HIGH
GROUNDWATER CALCULATIONS

Seasonal High and Estimated Long Term Seasonal High

					A						B	C		D	E		F	
Well ID	**Onsite Well Indexed to**	**Statistical Correlation to Onsite Index Well (%) [1]**	**Land Surface Elevation**	**Top of Casing Elevation**	**Highest Ever Recorded**		**Z Score of Highest Ever Recorded**	**Standard Normal Distribution of Highest Ever Recorded**	**05/05/15**		**Data Points &/or Years [2]**	**Mean of Spring Data Points [3]**		**STD DEV**	**Seasonal High (SH)**		**Estimated Long-Term Seasonal High (LTSH)**	
															(D+1C)*		(D+2.52C)*	
			(ft msl)	(ft msl)	(ft msl)	(ft bls)	-	%	(ft msl)	(ft bls)	#	(ft msl)	(ft bls)		(ft msl)	(ft bls)	(ft msl)	(ft bls)
MW-32R	MW-32R	-	825.89	827.25	813.43	12.46	1.77	96.16	811.96	15.29	10	812.28	13.61	0.65	**812.93**	12.96	**813.92**	11.97
MW-33	MW-33	-	816.33	819.38	808.87	7.46	2.52	99.41	806.11	13.27	11	806.58	9.75	0.91	**807.49**	8.84	**808.87**	7.46
MW-34	MW-34	-	829.82	832.77	811.42	18.40	2.00	97.77	806.20	26.57	11	806.65	23.17	2.39	**809.04**	20.78	**812.67**	17.15
MW-35	MW-35	-	836.85	839.64	815.04	21.81	2.07	98.07	809.42	30.22	11	809.95	26.90	2.46	**812.41**	24.44	**816.15**	20.70
OW4-1	MW-35	98.4	832.40	835.40	804.06	28.34			804.06	31.34	1				**807.06**	25.35	**810.94**	21.47
OW4-2	MW-35	98.6	812.43	815.43	794.93	17.50			794.93	20.50	1				**795.85**	16.58	**798.39**	14.04
OW4-3S	MW-35	98.4	824.05	827.05	789.54	34.51			789.54	37.51	1				**793.72**	30.34	**798.36**	25.69
OW4-4	MW-33	99.8	819.05	822.05	801.32	17.73			801.32	20.73	1				**805.24**	13.81	**807.40**	11.65
OW4-5	MW-33	99.1	822.57	825.57	801.89	20.68			801.89	23.68	1				**806.79**	15.77	**809.26**	13.31
OW4-6S	MW-33	98.8	814.97	817.97	796.27	18.70			796.27	21.70	1				**800.52**	14.46	**802.78**	12.19
OW4-7	MW-34	99.5	816.60	819.60	796.67	19.93			796.67	22.93	1				**798.67**	17.93	**801.80**	14.80
OW4-8	MW-33	99.5	808.81	811.81	796.79	12.02			796.79	15.02	1				**798.81**	10.01	**800.37**	8.44
OW4-9S	MW-33	99.5	819.21	822.21	800.09	19.12			800.06	22.15	1				**804.45**	14.76	**806.76**	12.45
OW4-10	MW-34	99.7	811.70	814.70	799.56	12.14			799.56	15.14	1				**799.86**	11.84	**801.93**	9.77
OW4-11	MW-34	99.5	819.97	822.97	800.38	19.59			800.38	22.59	1				**802.30**	17.67	**805.39**	14.58

Notes:

ft msl – feet mean sea level

ft bls – feet below land surface

Normal Distribution 99.41% 2.52

Normal Distribution 84.10% (Represents once every 10 years) 1.00

[1] = Statistical correlation presented on table on next page

[2] = To be conservative only the highest groundwater elevations recorded in each of the last 11 calender years was used in the calculations since using data from measurements during other times would reduce the mean thus result in a SH and LTSH that may be biased low.

* = SH made by this relationship: Depth to SH of "OW4-" wells = WT of "OW4" on 5/5/15 x (SH of associated Index well / WT at Index Well on 5/5/15)

* = LTSH made by this relationship: Depth to LTSH of "OW4-" wells = WT of "OW4" on 5/5/15 x (LTSH of associated Index well / WT at Index Well on 5/5/15)

Groundwater Fluctuation Correlation

	OW4-1	OW4-2	OW4-3S	OW4-3D	OW4-4	OW4-5	OW4-6S	OW4-6D	OW4-7	OW4-8	OW4-9S	OW4-9D	OW4-10	OW4-11	MW-33	MW-34	MW-35	MW-35A	MW-32R
OW4-1	1.0000	0.9853	0.9567	0.9573	0.9820	0.9927	0.9899	0.9951	0.9877	0.9839	0.9787	0.9941	0.9819	0.9819	0.9668	0.9828	**0.9840**	0.9998	0.9749
OW4-2	0.9853	1.0000	0.9541	0.9371	0.9525	0.9675	0.9707	0.9759	0.9633	0.9566	0.9503	0.9720	0.9627	0.9586	0.9276	0.9642	**0.9864**	0.9845	0.9618
OW4-3S	0.9567	0.9541	1.0000	0.9877	0.9179	0.9389	0.9751	0.9626	0.9126	0.9102	0.8919	0.9437	0.9018	0.9018	0.9655	0.8888	**0.9843**	0.9997	0.9782
OW4-3D	0.9573	0.9371	0.9877	1.0000	0.9471	0.9581	0.9869	0.9750	0.9335	0.9362	0.9189	0.9605	0.9242	0.9254	**0.9939**	0.9017	0.9470	0.9909	0.9923
OW4-4	0.9820	0.9525	0.9179	0.9471	1.0000	0.9975	0.9829	0.9905	0.9972	0.9990	0.9962	0.9964	0.9955	0.9967	**0.9977**	0.9852	0.9320	0.9842	0.9934
OW4-5	0.9927	0.9675	0.9389	0.9581	0.9975	1.0000	0.9910	0.9970	0.9970	0.9970	0.9928	0.9998	0.9934	0.9948	**0.9911**	0.9865	0.9541	0.9937	0.9903
OW4-6S	0.9899	0.9707	0.9751	0.9869	0.9829	0.9910	1.0000	0.9981	0.9782	0.9784	0.9682	0.9925	0.9720	0.9729	**0.9884**	0.9597	0.9594	0.9957	0.9907
OW4-6D	0.9951	0.9759	0.9626	0.9750	0.9905	0.9970	0.9981	1.0000	0.9888	0.9884	0.9810	0.9980	0.9840	0.9848	**0.9867**	0.9753	0.9624	0.9966	0.9902
OW4-7	0.9877	0.9633	0.9126	0.9335	0.9972	0.9970	0.9782	0.9888	1.0000	0.9994	0.9987	0.9963	0.9987	0.9996	0.9906	**0.9952**	0.9551	0.9941	0.9919
OW4-8	0.9839	0.9566	0.9102	0.9362	0.9990	0.9970	0.9784	0.9884	0.9994	1.0000	0.9989	0.9959	0.9983	0.9993	**0.9951**	0.9918	0.9430	0.9892	0.9934
OW4-9S	0.9787	0.9503	0.8919	0.9189	0.9962	0.9928	0.9682	0.9810	0.9987	0.9989	1.0000	0.9913	0.9984	0.9996	**0.9949**	0.9947	0.9440	0.9897	0.9927
OW4-9D	0.9941	0.9720	0.9437	0.9605	0.9964	0.9998	0.9925	0.9980	0.9963	0.9959	0.9913	1.0000	0.9929	0.9938	0.9893	0.9859	0.9578	**0.9951**	0.9912
OW4-10	0.9819	0.9627	0.9018	0.9242	0.9955	0.9934	0.9720	0.9840	0.9987	0.9983	0.9984	0.9929	1.0000	0.9995	0.9904	**0.9950**	0.9496	0.9913	0.9949
OW4-11	0.9829	0.9586	0.9018	0.9254	0.9967	0.9948	0.9729	0.9848	0.9996	0.9993	0.9996	0.9938	0.9995	1.0000	0.9925	**0.9954**	0.9497	0.9920	0.9942
MW-33	0.9668	0.9276	0.9655	0.9939	0.9977	0.9911	0.9884	0.9867	0.9906	0.9951	0.9949	0.9893	0.9904	0.9925	1.0000	0.9768	0.9058	0.9701	0.9894
MW-34	0.9828	0.9642	0.8888	0.9017	0.9852	0.9865	0.9597	0.9753	0.9952	0.9918	0.9947	0.9859	0.9950	0.9954	0.9768	1.0000	0.9753	0.9995	0.9849
MW-35	0.9840	0.9864	0.9843	0.9470	0.9320	0.9541	0.9594	0.9624	0.9551	0.9430	0.9440	0.9578	0.9496	0.9497	0.9058	0.9753	1.0000	0.9815	0.9285
MW-35A	0.9998	0.9845	0.9997	0.9909	0.9842	0.9937	0.9957	0.9966	0.9941	0.9892	0.9897	0.9951	0.9913	0.9920	0.9701	0.9995	0.9815	1.0000	0.9792
MW-32R	0.9749	0.9618	0.9782	0.9923	0.9934	0.9903	0.9907	0.9902	0.9919	0.9934	0.9927	0.9912	0.9969	0.9942	0.9894	0.9849	0.9285	0.9792	1.0000

0.9949 =Underlined and shaded = Old "Index" well (MW-) associated with new observation well (OW4-) used in seasonal high and estimated long term seasonal high calculations.

Groundwater levels measured on 3/27/15, 5/5/15, 5/28/15, 6/26/15, 7/24/15, 8/25/15.

Method: Pearson Product-Moment Correlation Coefficient

The Pearson product-moment correlation coefficient is a statistical measurement of the correlation (linear association) between two sets of values.

The Pearson product-moment correlation coefficient for two sets of values, x and y, is given by the formula :

$$r = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2 \sum(y-\bar{y})^2}}$$

where x and y are the sample means of the two arrays of values.

If the value of r is close to +1, this indicates a strong positive correlation, and if r is close to -1, this indicates a strong negative correlation.

More information on the Pearson Product-Moment Correlation Coefficient is given on Wikipedia

Monthly Precipitation

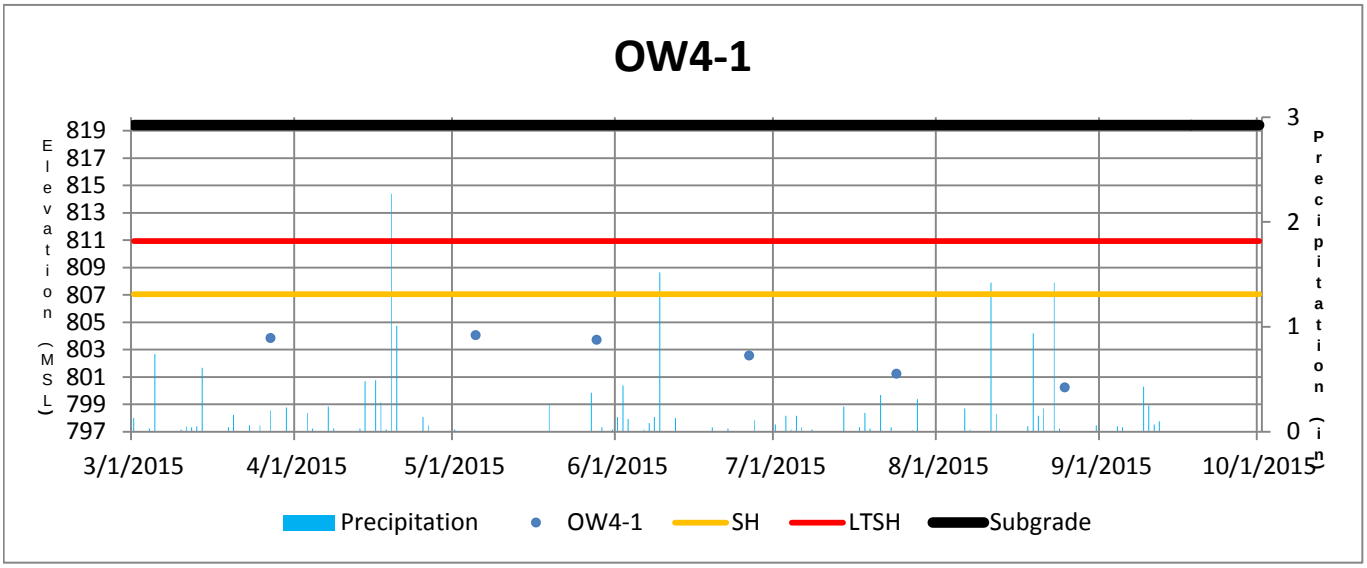
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1989	1.75	5.01	4.05	2.71	4.47	4.90	5.08	3.15	7.66	4.90	4.61	4.27	52.56
1990	4.42	6.17	4.83	3.10	6.53	1.17	3.54	2.30	0.90	12.01	2.23	3.43	50.63
1991	4.57	1.55	6.96	6.83	2.43	2.99	4.73	6.95	1.64	0.08	1.52	3.11	43.36
1992	2.82	4.53	4.84	3.84	5.66	7.04	1.53	6.73	3.66	8.45	7.55	4.00	60.65
1993	7.00	4.29	9.57	3.63	3.13	2.10	1.26	3.52	4.61	2.08	3.55	3.87	48.61
1994	5.25	2.99	6.84	2.23	2.15	6.41	5.12	9.65	1.68	4.56	2.92	2.17	51.97
1995	6.18	6.58	2.97	0.72	5.90	9.25	3.32	6.39	6.29	9.53	5.10	1.87	64.10
1996	5.65	3.18	5.11	2.95	3.98	3.16	2.42	4.72	3.54	1.78	4.39	4.52	45.40
1997	3.92	5.63	4.00	6.42	1.90	3.82	3.21	0.57	4.06	5.01	3.28	4.16	45.98
1998	8.02	6.31	4.96	5.57	3.92	2.99	5.54	5.90	2.42	0.93	2.17	3.65	52.38
1999	4.96	2.79	2.88	4.99	1.94	4.70	3.63	3.03	5.20	4.32	1.59	2.59	42.62
2000	4.28	2.22	3.97	7.40	2.60	2.71	4.46	1.99	5.74	0.00	3.53	1.84	40.74
2001	2.64	3.00	6.64	1.38	3.44	4.97	4.59	1.88	3.55	0.98	1.04	3.05	37.16
2002	4.63	1.83	4.02	0.51	2.61	1.99	3.32	4.63	3.69	4.79	5.45	7.94	45.41
2003	2.18	4.62	9.18	10.02	12.34	7.54	10.78	6.21	3.71	1.72	2.63	2.44	73.37
2004	1.09	3.78	2.11	2.90	2.57	4.48	0.29	6.80	8.87	0.99	5.33	4.84	44.05
2005	2.13	2.96	4.59	2.62	4.19	7.05	7.63	2.30	0.37	9.85	4.40	5.08	53.17
2006	3.72	1.15	1.52	3.19	1.72	3.13	2.48	9.46	4.39	6.19	3.98	2.46	43.39
2007	3.24	2.05	4.08	3.01	0.80	4.43	1.48	0.66	0.63	2.85	1.19	4.28	28.70
2008	1.22	3.18	4.13	3.21	2.77	3.27	4.82	8.73	3.60	1.59	1.69	4.23	42.44
2009	2.56	1.96	6.78	3.42	6.96	6.04	1.72	2.46	4.76	3.58	6.34	7.00	53.58
2010	6.57	4.16	4.73	2.95	6.21	0.96	3.33	4.38	4.07	2.60	1.25	2.33	43.54
2011	1.79	2.80	6.03	3.16	3.95	2.29	4.24	4.48	7.99	2.61	5.65	3.30	48.29
2012	1.96	1.58	3.24	2.76	4.75	3.95	3.45	2.30	7.11	2.89	0.46	4.48	38.93
2013	5.55	3.36	2.71	5.64	4.34	7.72	9.16	5.12	2.30	2.27	4.16	5.77	58.10
2014	3.30	2.94	4.88	5.50	3.30	2.07	1.66	5.34	6.04	1.31	4.38	2.29	43.01
2015	2.57	2.31	2.42	5.26	0.71	2.77	1.65	4.70	3.62				>26.01
Mean	3.85	3.44	4.74	3.92	3.90	4.22	3.87	4.61	4.15	3.76	3.48	3.81	48.16
STDEV	1.83	1.50	1.93	2.08	2.33	2.13	2.35	2.45	2.18				
NRMLDIST	0.24	0.22	0.11	0.74	0.09	0.25	0.17	0.52	0.40				
Z Score	-0.70	-0.76	-1.20	0.64	-1.37	-0.68	-0.94	0.04	-0.24				
% Chance >=2015	75.83	77.55	88.55	26.05	91.45	75.17	82.72	48.46	59.63				
2015 Diff from Mean	-1.28	-1.13	-2.32	1.34	-3.19	-1.45	-2.22	0.09	-0.53				

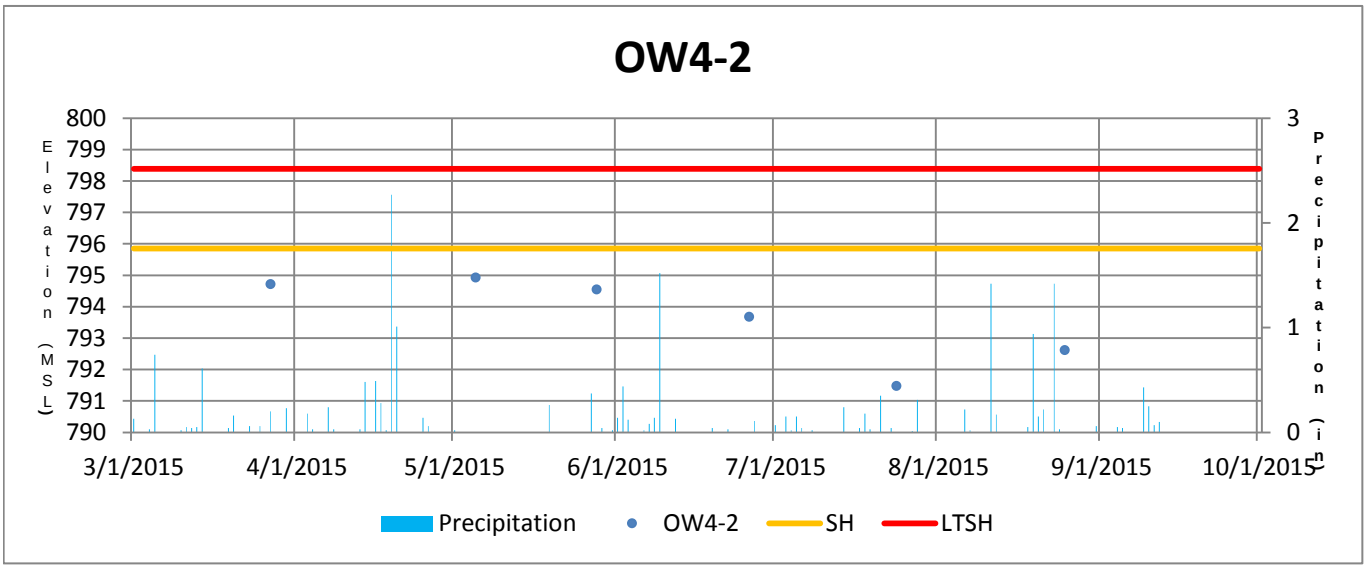
Source:

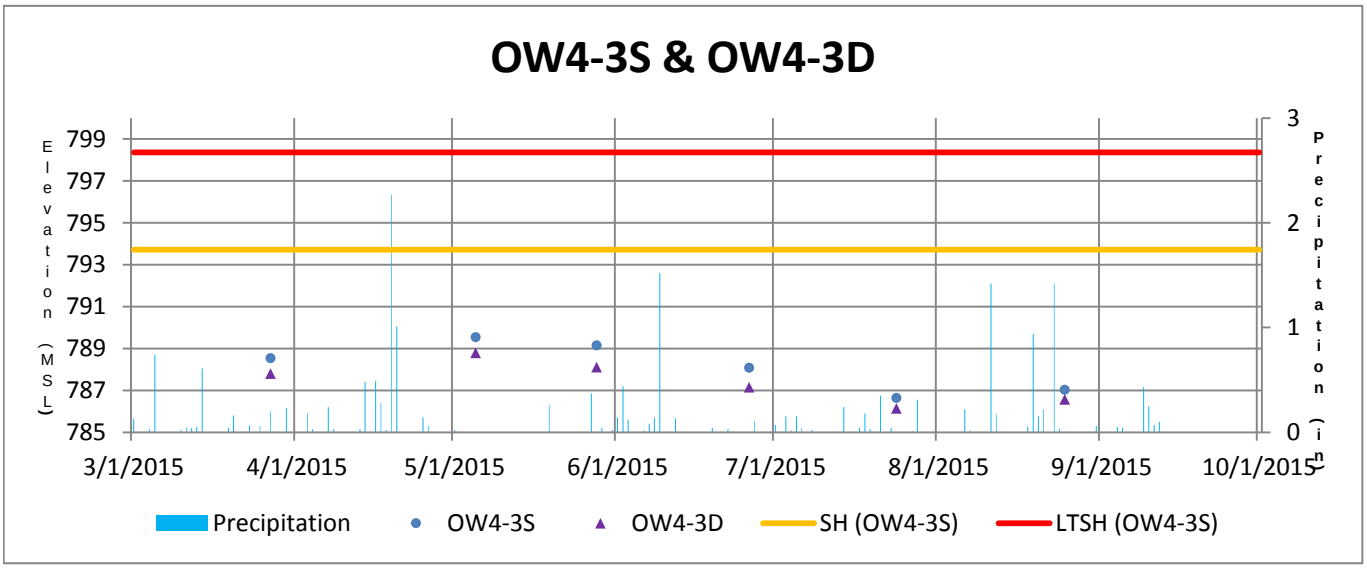
State Climate Office of North Carolina

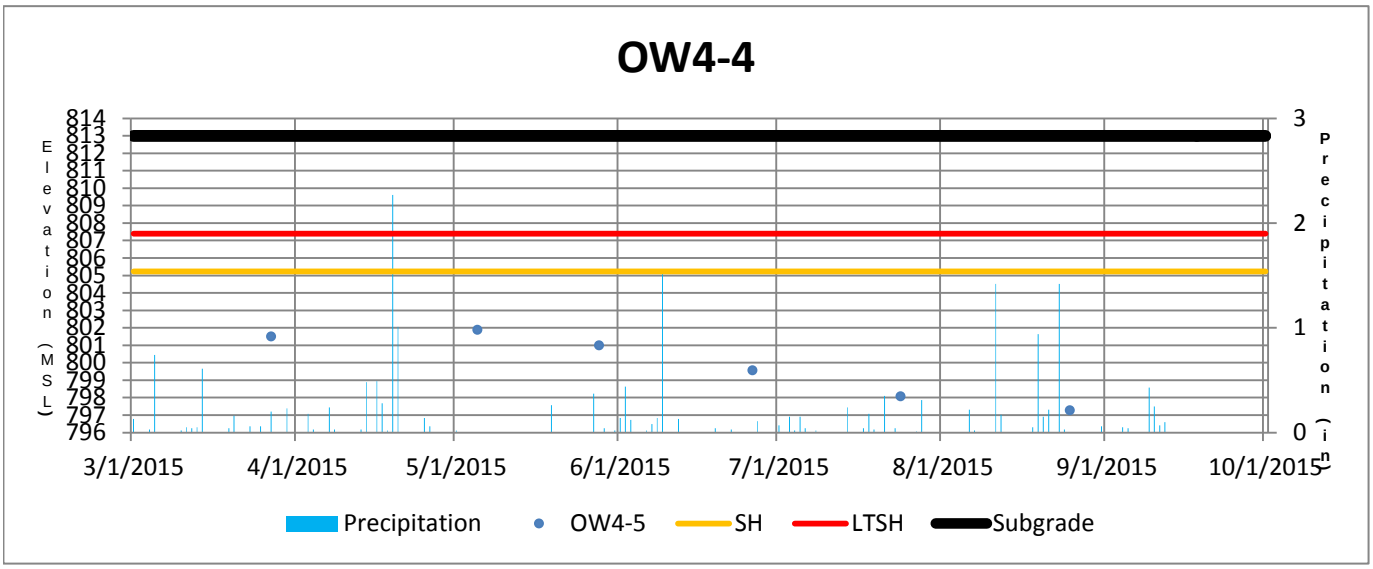
COOP Station ID: LINCOLNTON 4 W, NC (UCAN: 14187,COOP: 314996)

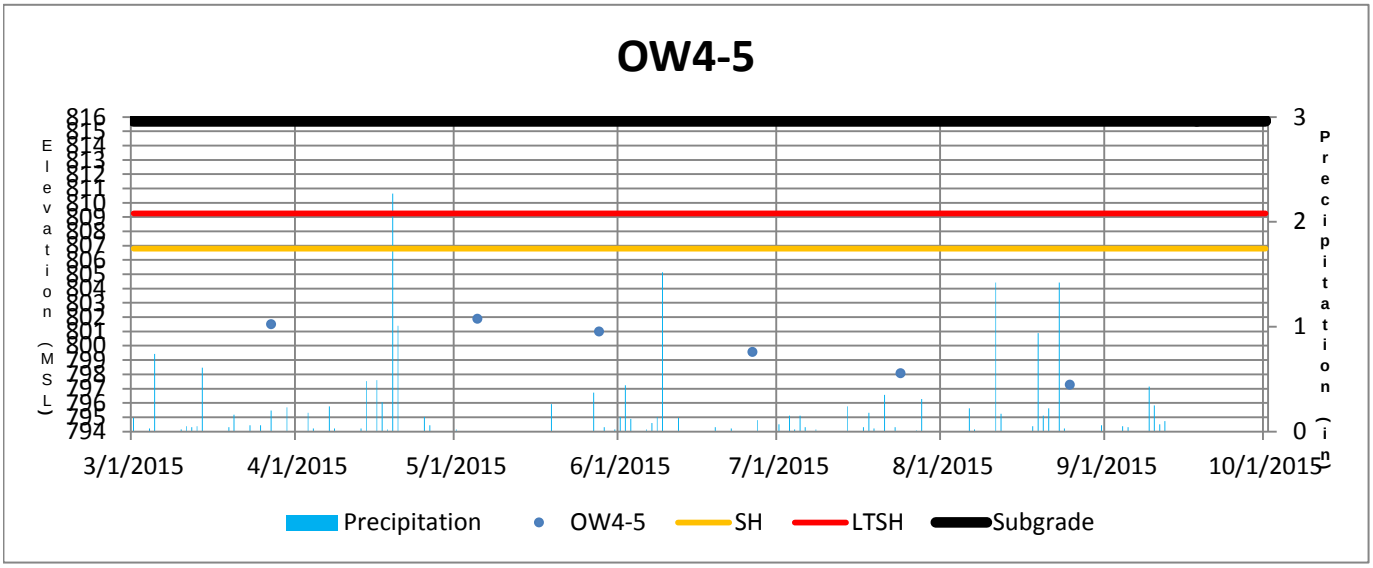
http://www.nc-climate.ncsu.edu/

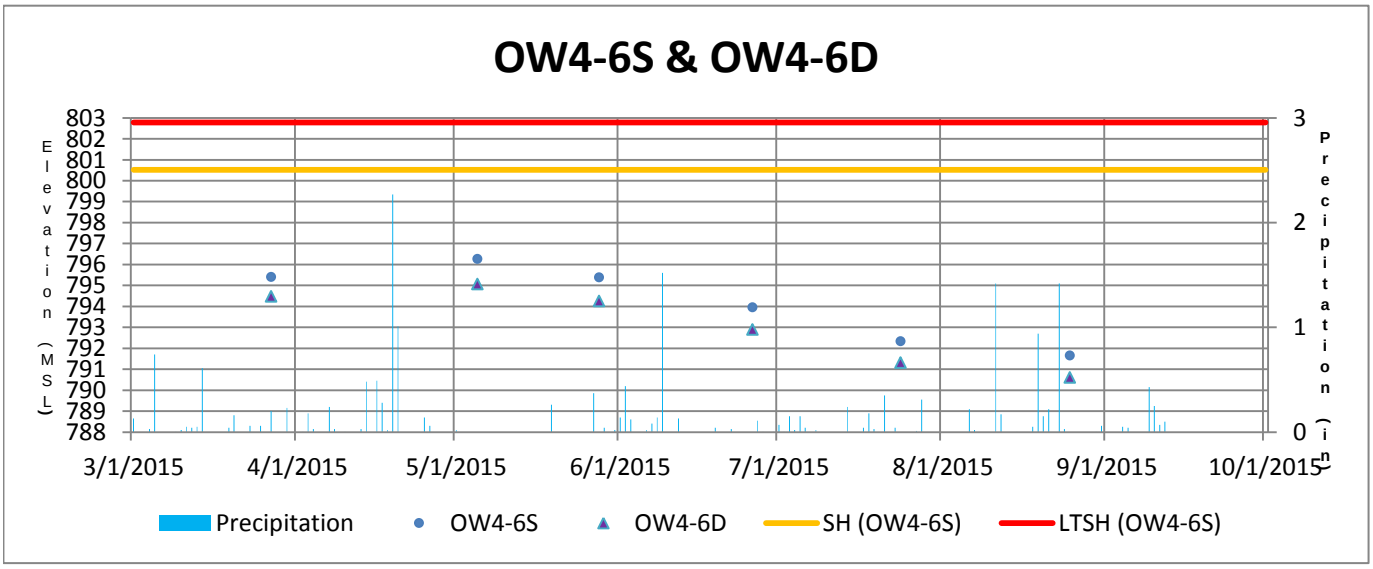

OW4-1
Elevation (MSL)
819
817
815
813
811
809
807
805
803
801
799
797
Precipitation (in)
3
2
1
0
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-1
SH
LTSH
Subgrade

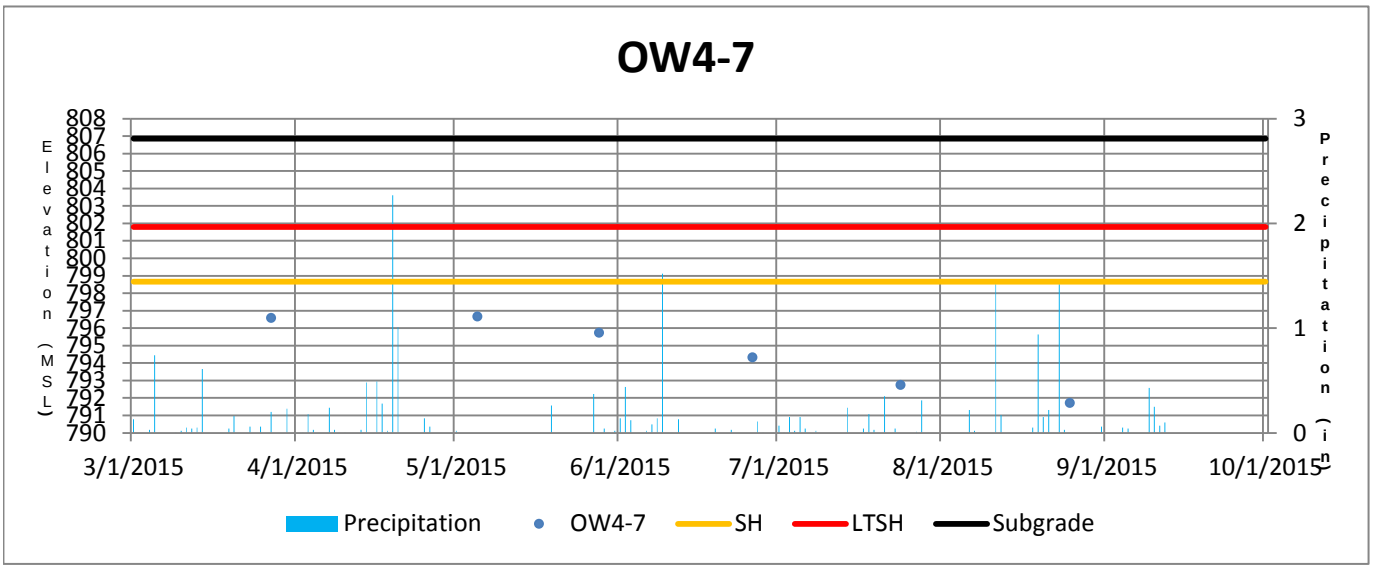

OW4-2
Elevation (MSL)
800
799
798
797
796
795
794
793
792
791
790
Precipitation (in)
3
2
1
0
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-2
SH
LTSH

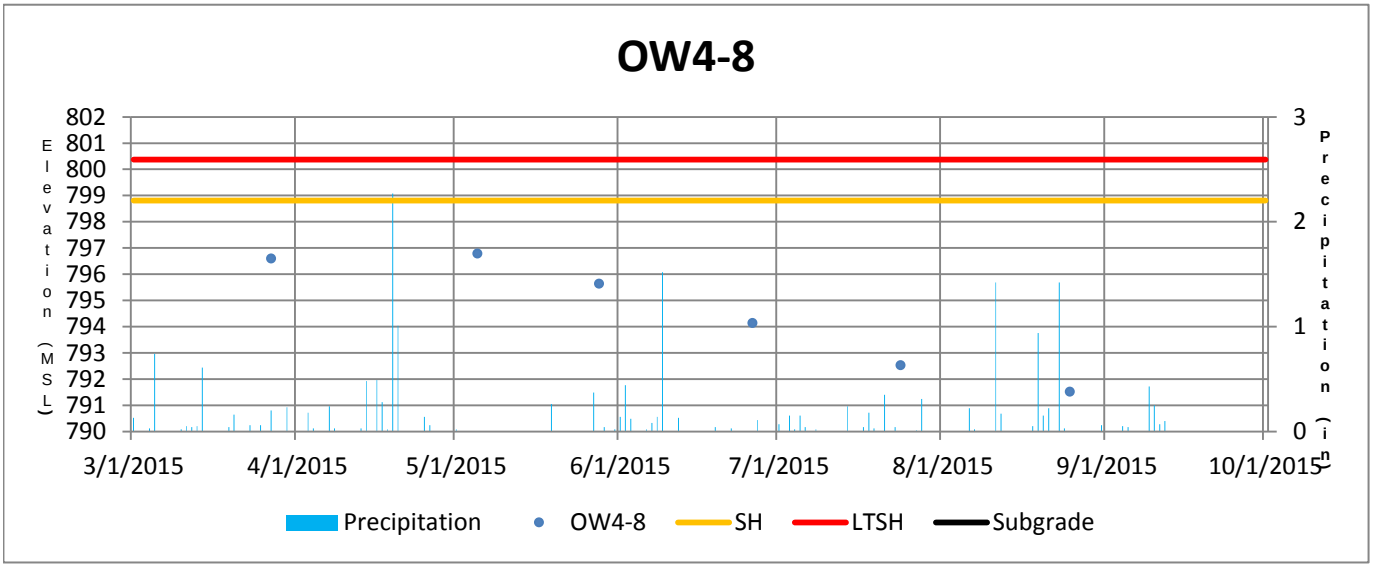

OW4-3S & OW4-3D
Elevation (MSL)
799
797
795
793
791
789
787
785
Precipitation (in)
3
2
1
0
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-3S
OW4-3D
SH (OW4-3S)
LTSH (OW4-3S)

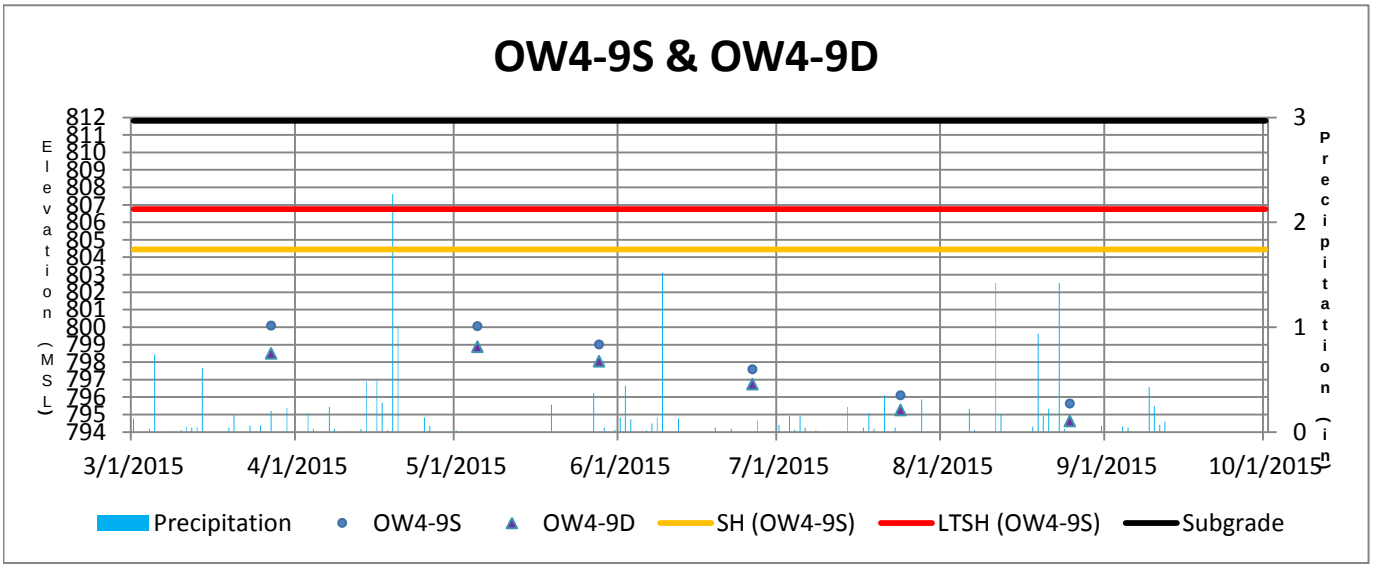

OW4-4
Elevation (MSL)
Precipitation (in)
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-5
SH
LTSH
Subgrade

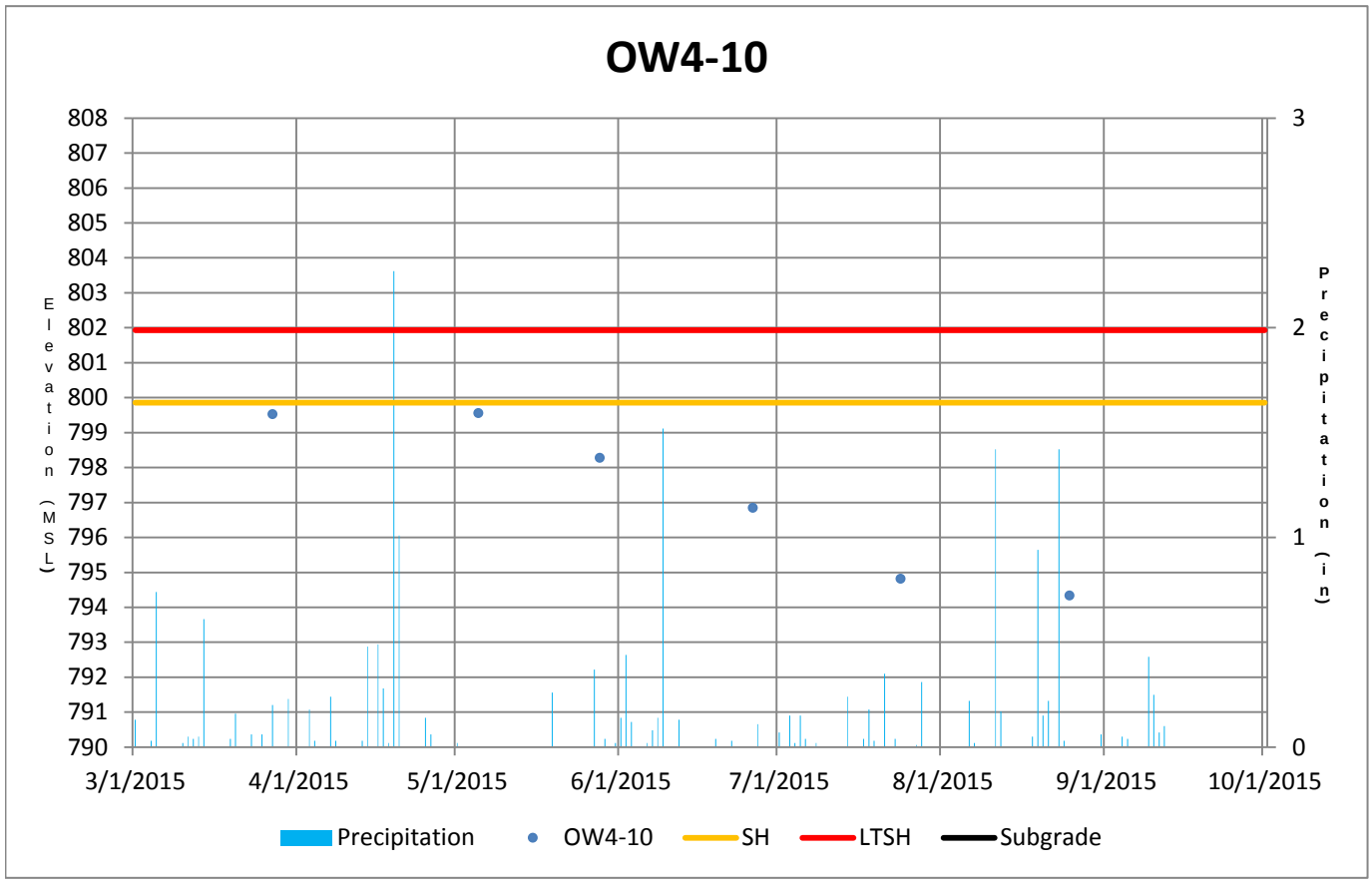

OW4-5
Elevation (MSL)
Precipitation (in)
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-5
SH
LTSH
Subgrade

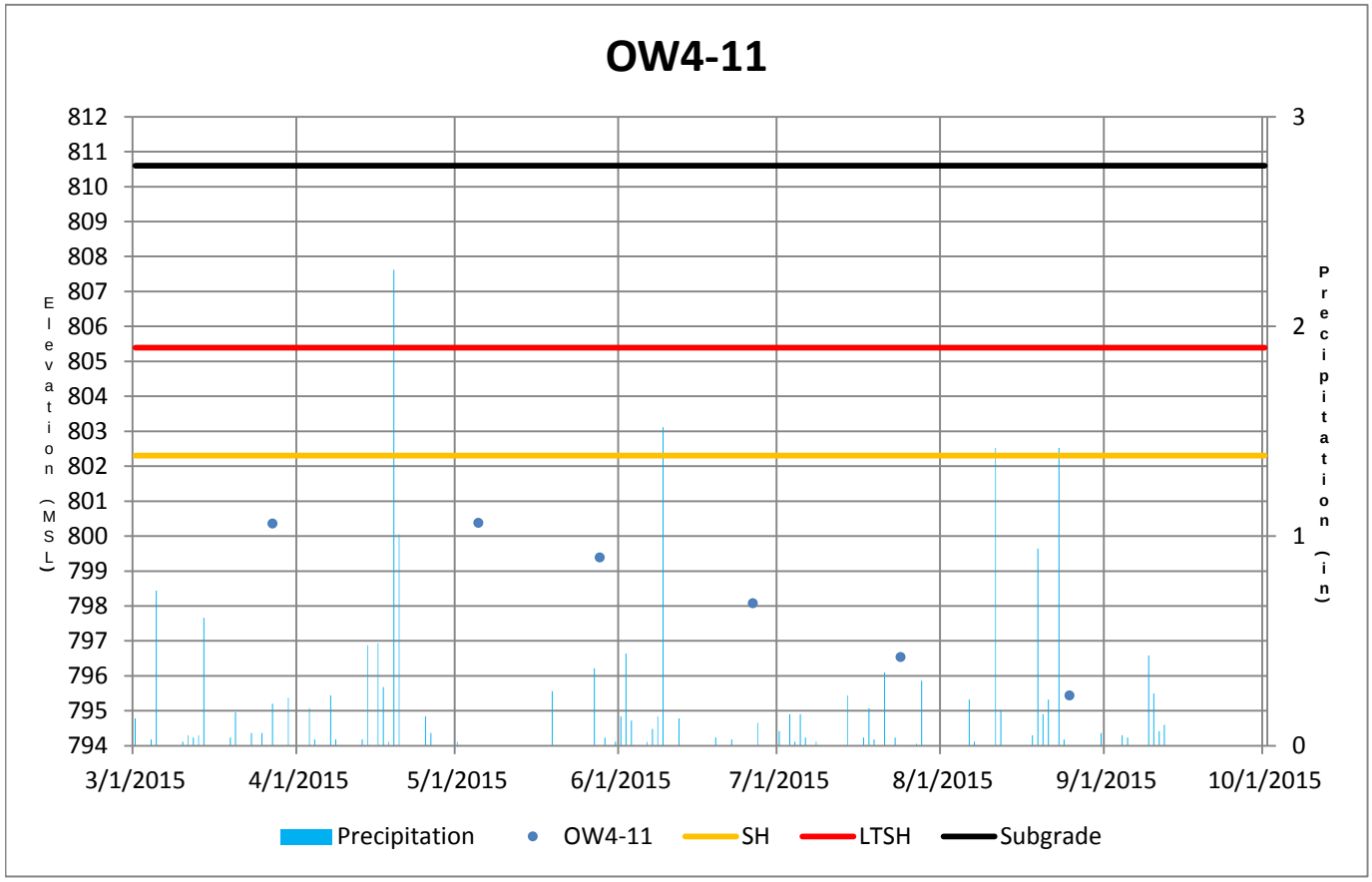

OW4-6S & OW4-6D
Elevation (MSL)
Precipitation (in)
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-6S
OW4-6D
SH (OW4-6S)
LTSH (OW4-6S)

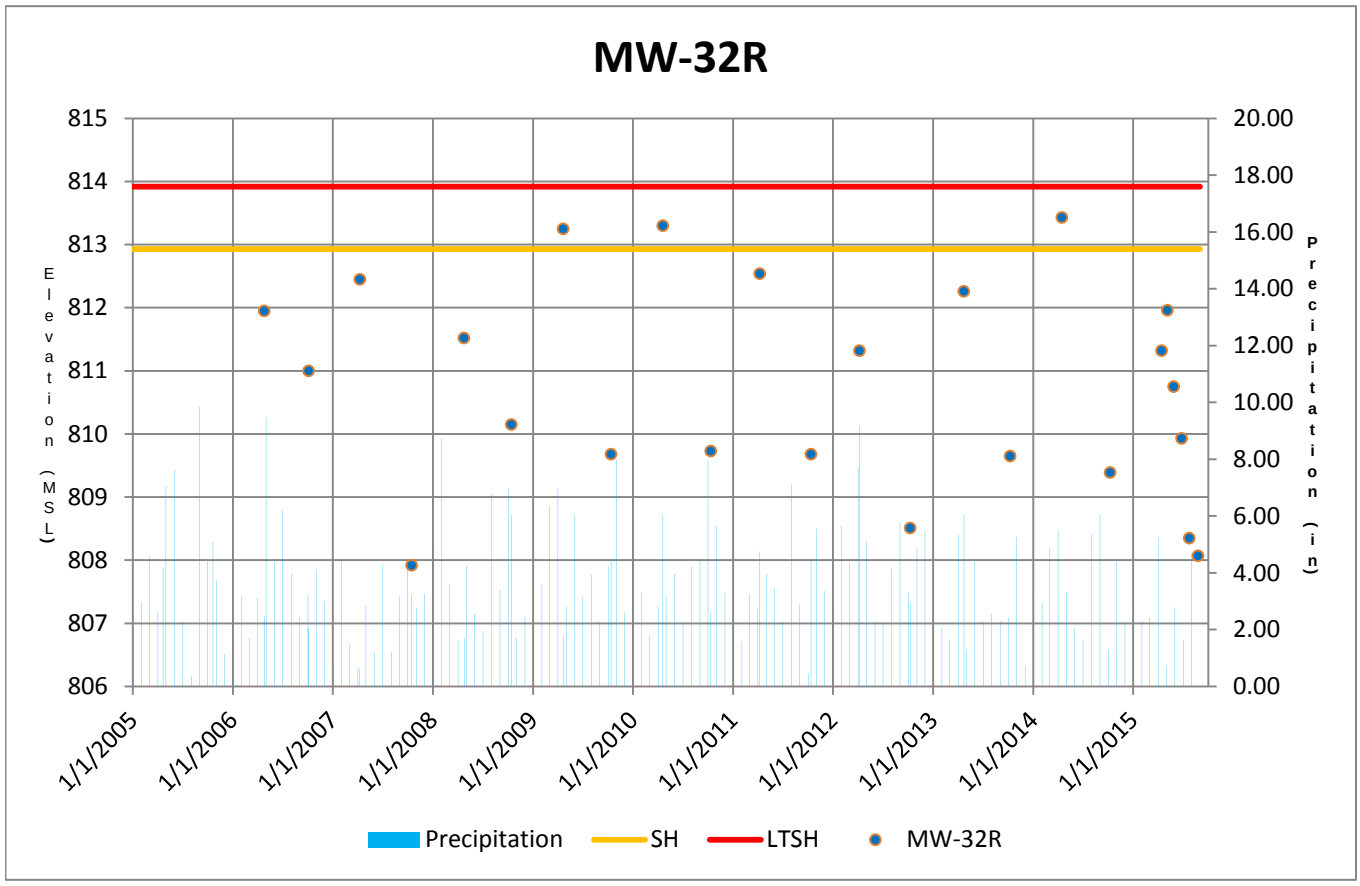

OW4-7
Elevation (MSL)
808
807
806
805
804
803
802
801
800
799
798
797
796
795
794
793
792
791
790
Precipitation (in)
3
2
1
0
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-7
SH
LTSH
Subgrade

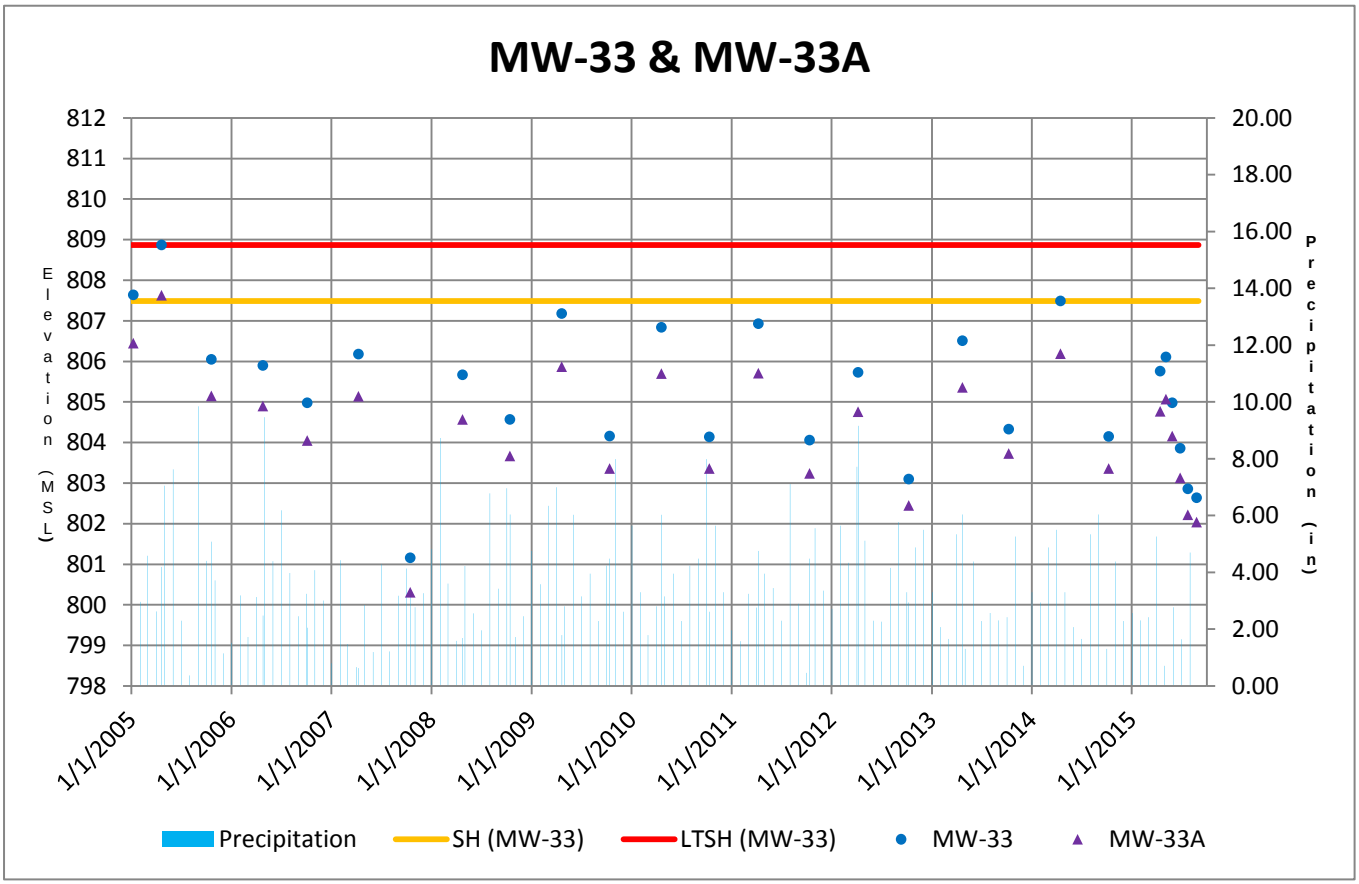

OW4-8
Elevation (MSL)
802
801
800
799
798
797
796
795
794
793
792
791
790
Precipitation (in)
3
2
1
0
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-8
SH
LTSH
Subgrade

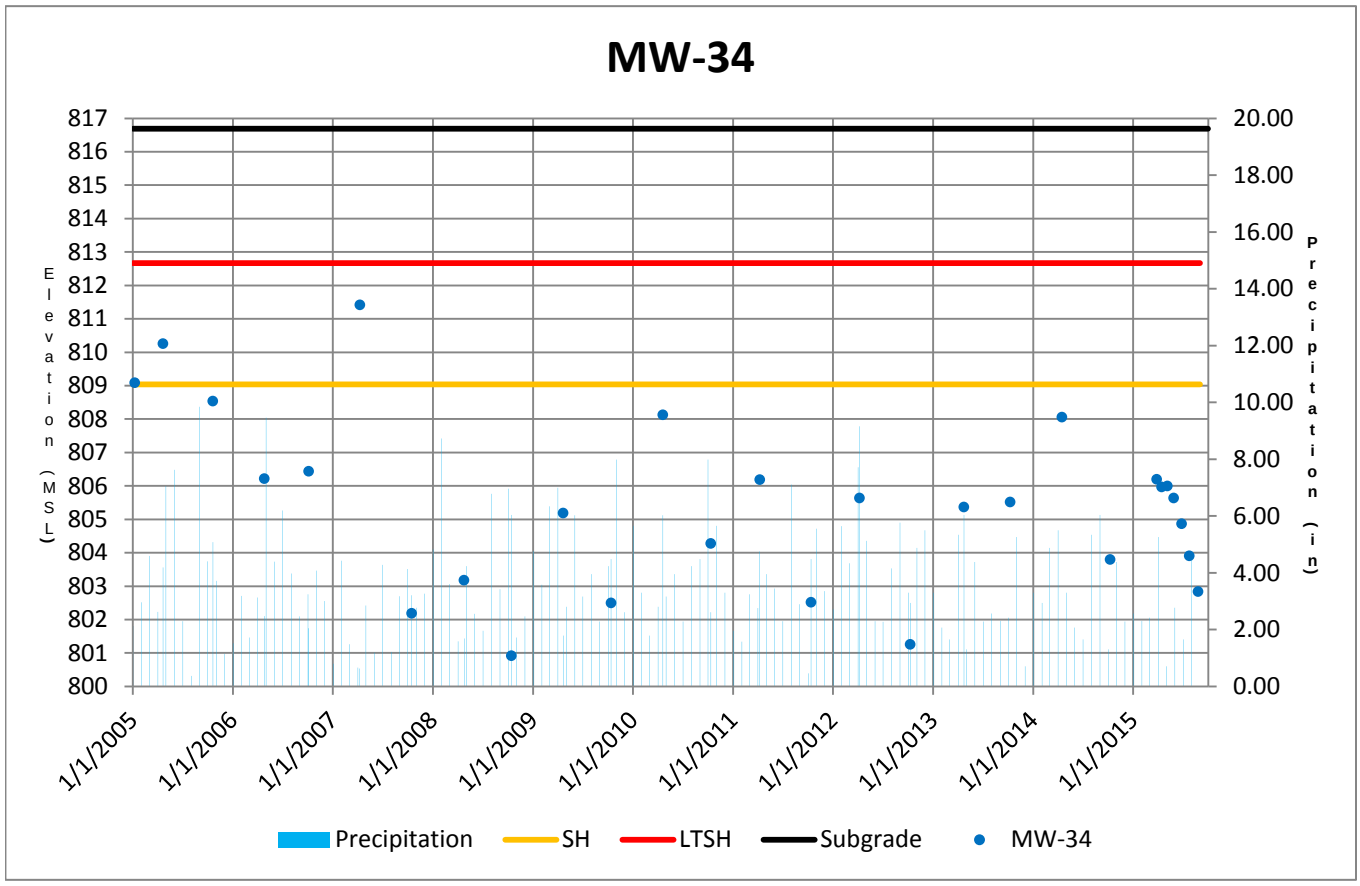

OW4-9S & OW4-9D
Elevation (MSL)
812
811
810
809
808
807
806
805
804
803
802
801
800
799
798
797
796
795
794
Precipitation (in)
3
2
1
0
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-9S
OW4-9D
SH (OW4-9S)
LTSH (OW4-9S)
Subgrade

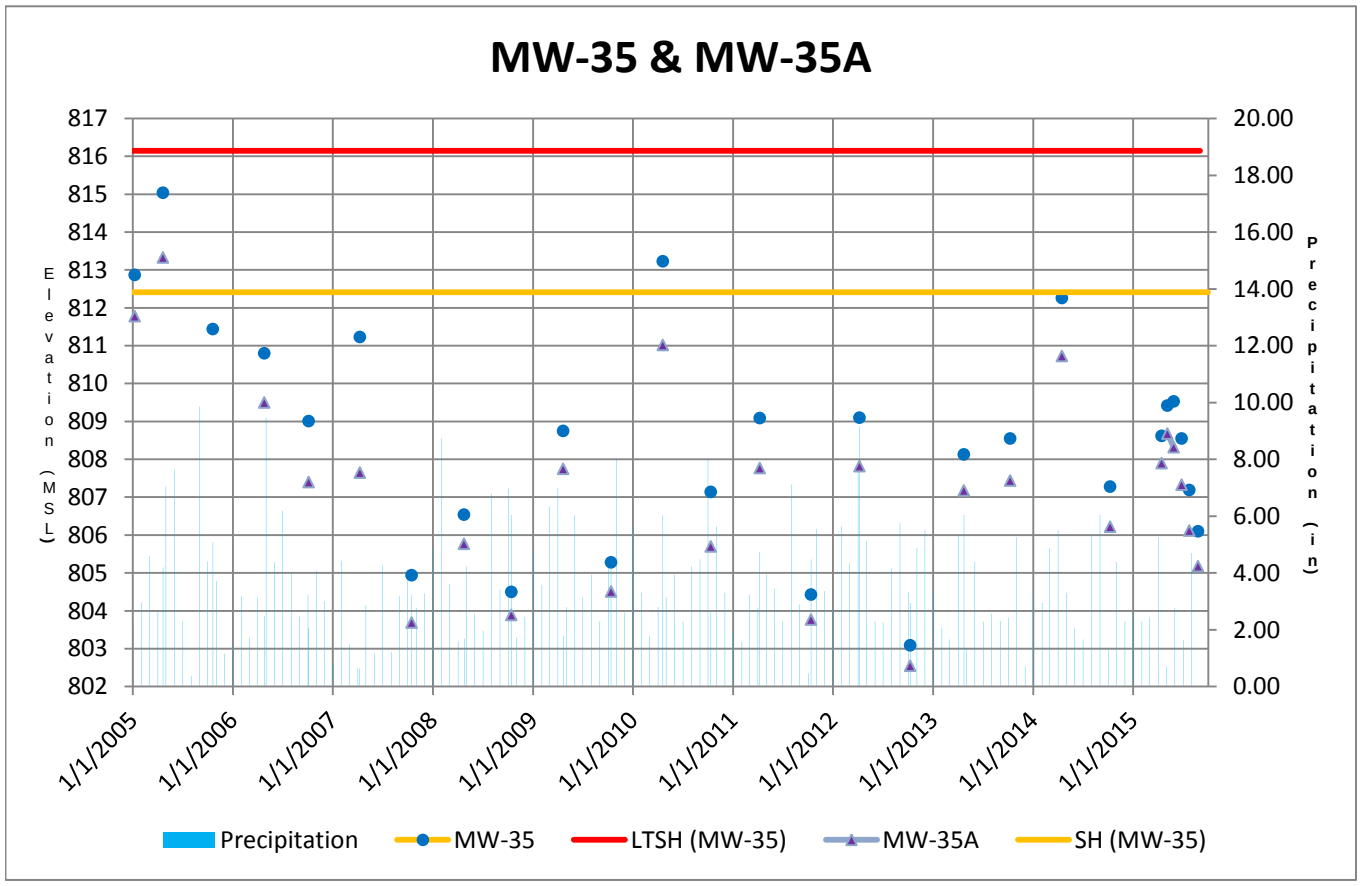

OW4-10
Elevation (MSL)
Precipitation (in)
808
807
806
805
804
803
802
801
800
799
798
797
796
795
794
793
792
791
790
3
2
1
0
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-10
SH
LTSH
Subgrade


OW4-11
Elevation (MSL)
Precipitation (in)
812
811
810
809
808
807
806
805
804
803
802
801
800
799
798
797
796
795
794
3
2
1
0
3/1/2015
4/1/2015
5/1/2015
6/1/2015
7/1/2015
8/1/2015
9/1/2015
10/1/2015
Precipitation
OW4-11
SH
LTSH
Subgrade

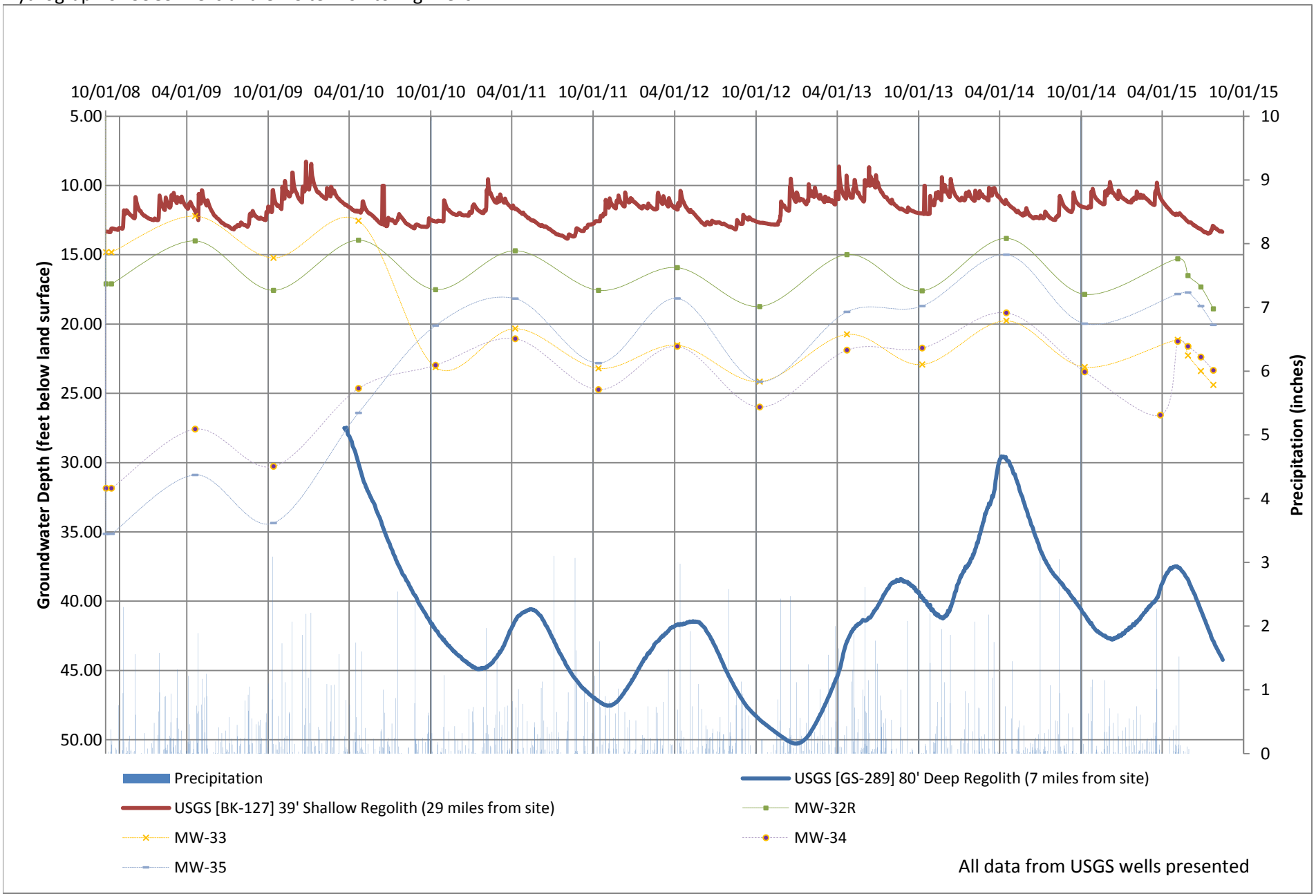

MW-32R
Elevation (MSL)
Precipitation (in)
815
814
813
812
811
810
809
808
807
806
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Precipitation
SH
LTSH
MW-32R


MW-33 & MW-33A
Elevation (MSL)
Precipitation (in)
812
811
810
809
808
807
806
805
804
803
802
801
800
799
798
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Precipitation
SH (MW-33)
LTSH (MW-33)
MW-33
MW-33A


MW-34
Elevation (MSL)
Precipitation (in)
817
816
815
814
813
812
811
810
809
808
807
806
805
804
803
802
801
800
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Precipitation
SH
LTSH
Subgrade
MW-34


MW-35 & MW-35A
Elevation (MSL)
Precipitation (in)
817
816
815
814
813
812
811
810
809
808
807
806
805
804
803
802
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
1/1/2012
1/1/2013
1/1/2014
1/1/2015
Precipitation
MW-35
LTSH (MW-35)
MW-35A
SH (MW-35)

Hydrograph of USGS Wells and On-Site Monitoring Wells



Lincoln Co. Landfill, Ph 4

HORIZONTAL HYDRAULIC GRADIENT CALCULATIONS

HORIZONTAL HYDRAULIC GRADIENTS PROCEDURES & CALCULATIONS

Formula:

Horizontal hydraulic gradients (dh/dl) are based on a change in hydraulic head (dh) over measured distance (dl).

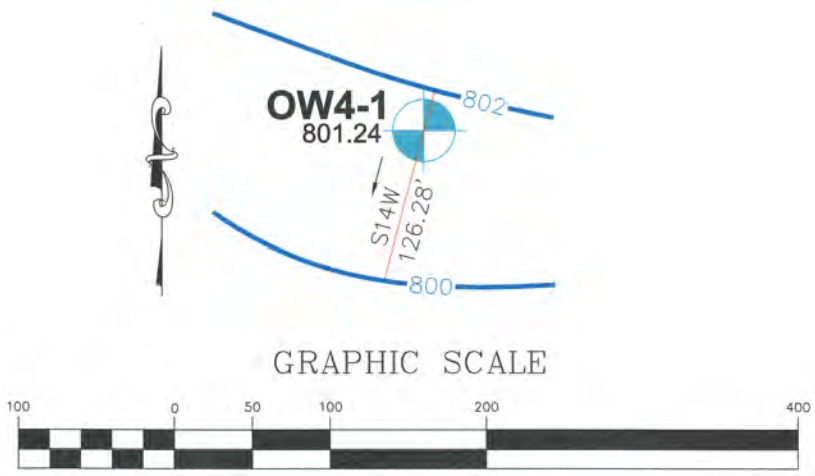
For wells located between two groundwater contours, the hydraulic gradient is calculated by taking the change in head (the difference in eleveation between the upgradient groundwater contour and the well location and dividing by the distance between them. Projected flow paths are perpendicular to the upgradient groundwater contour and bisect the well being calculated.

Calculation: OW4-1

dh = 2.00 ft

dl = 126.28 ft

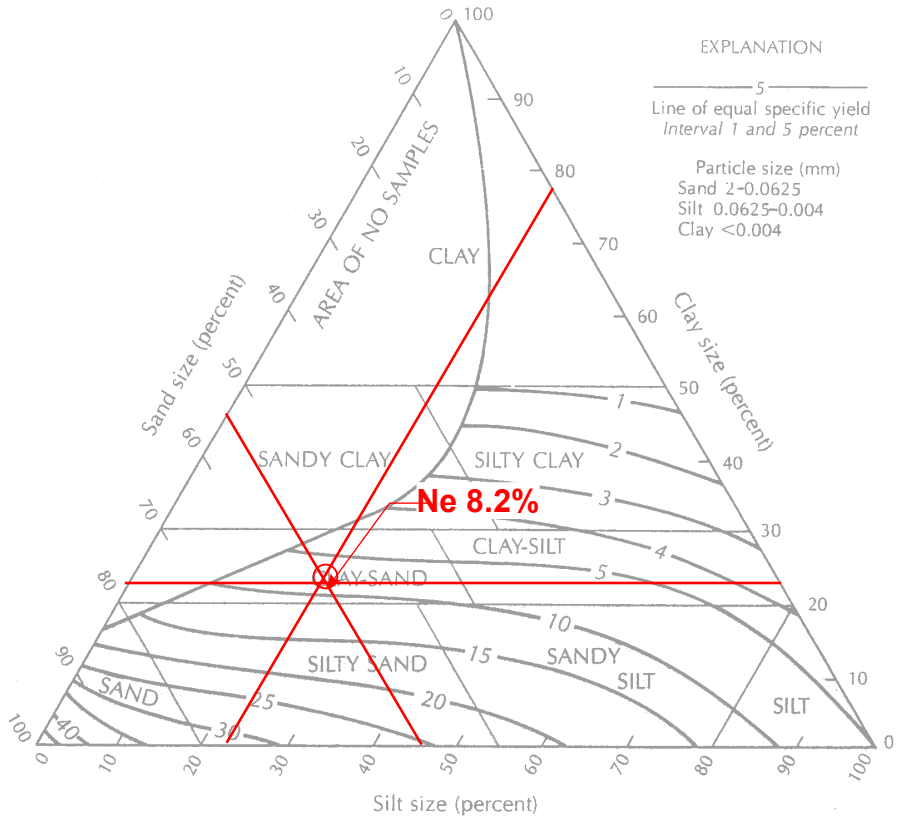
dh/dl = 0.02 ft/ft

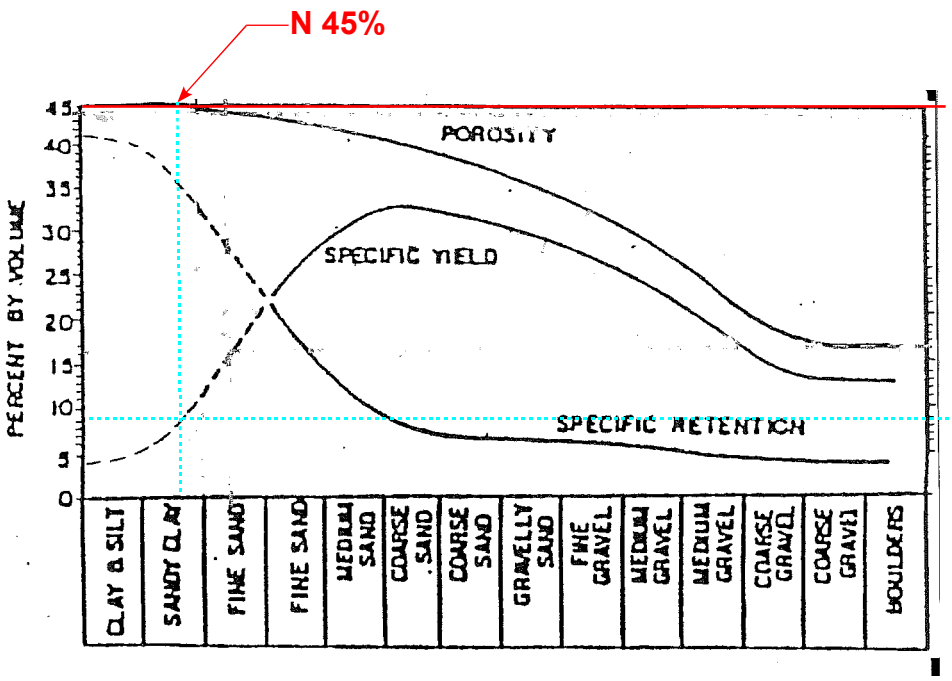


Well ID	dh (ft)	dl (ft)	dh/dl (ft/ft)
OW4-1	2.00	126.28	0.02
OW4-2	2.00	33.65	0.06
OW4-3S	1.36	35.22	0.04
OW4-4	2.00	89.71	0.02
OW4-5	2.00	63.86	0.03
OW4-6S	2.00	153.28	0.01
OW4-7	2.00	127.15	0.02
OW4-8	2.00	207.46	0.01
OW4-9S	2.00	79.57	0.03
OW4-10	2.00	154.23	0.01
OW4-11	2.00	99.72	0.02
MW-32R	2.00	90.55	0.02
MW-33	2.00	84.86	0.02
MW-34	2.00	60.15	0.03
MW-35	0.81	26.03	0.03
Min			0.01
Average			0.02
Max			0.06

JOHNSON and BEAR
SOIL TEXTURE DIGRAMS

Calculation of estimated porosity and effective porosity from re-calculated grain size distribution, OW4-2 (25'-28')





OW4-2 (25'-28')

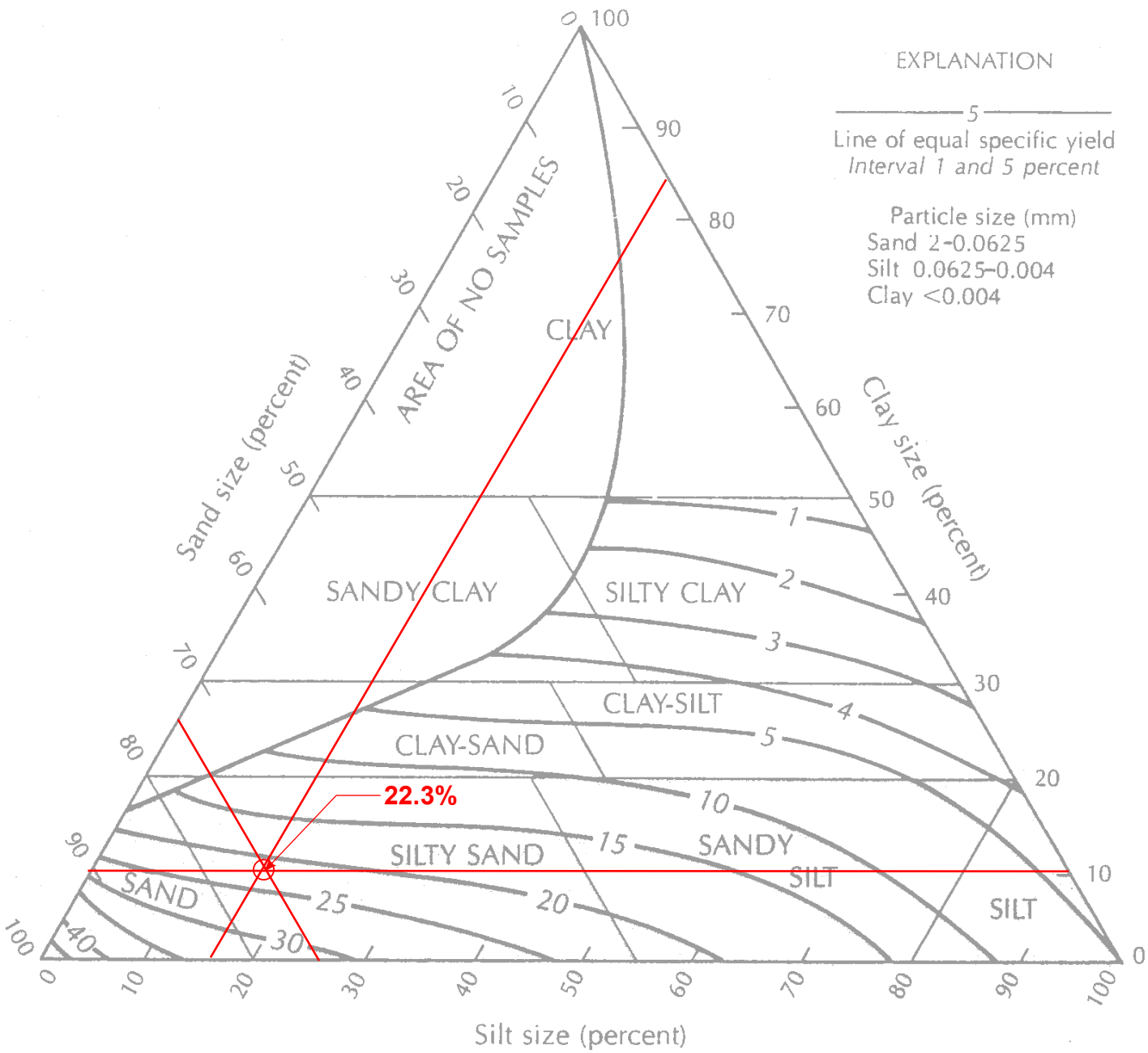
Soil Type	Proportion (%)
Sand	53.9%
Silt	23.0%
Clay	23.2%

AGU Soil Classification
Clay -Sand

Effective Porosity
N_e=8.2%

Total Porosity
N=45%

Calculation of effective porosity from re-calculated grain size distribution, OW4-3D (34'-36')



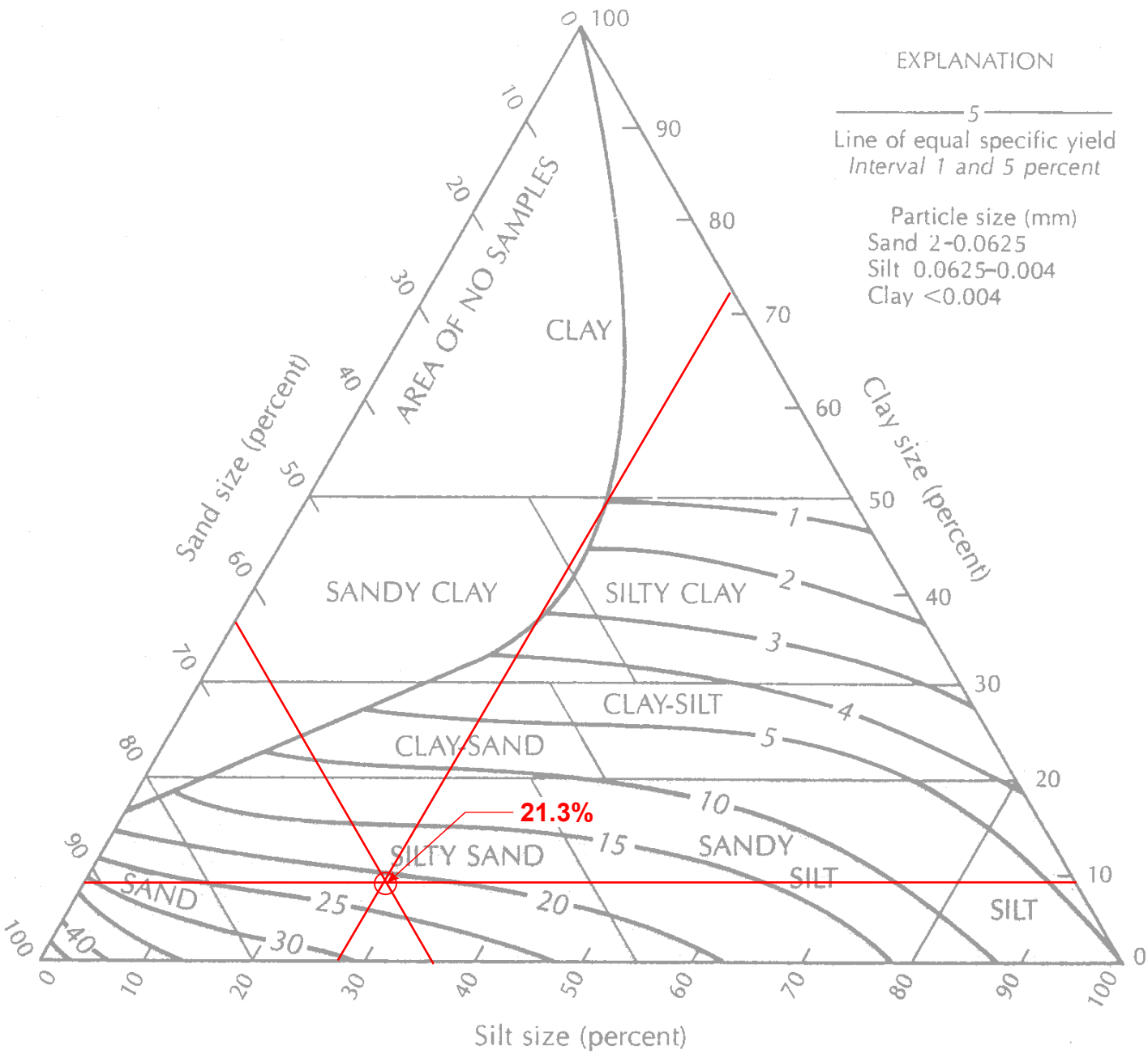
OW4-3D (34'-36')

Soil Type	Proportion (%)
Sand	73.8%
Silt	16.1%
Clay	10.1%

AGU Soil Classification
Silty Sand

Effective Porosity
N_e=22.3%

Calculation of effective porosity from re-calculated grain size distribution, OW4-4 (10'-12')



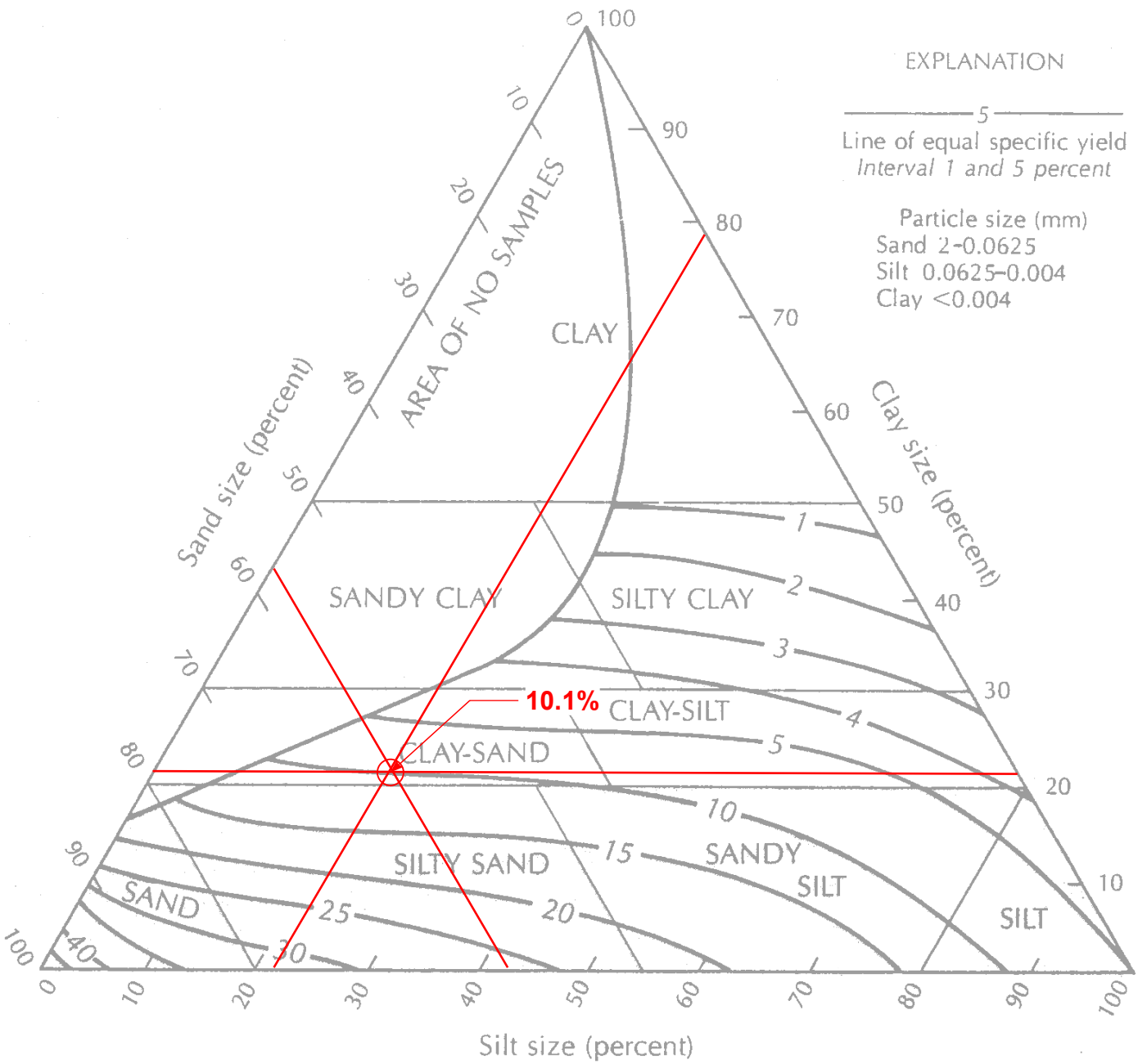
OW4-4 (10'-12')

Soil Type	Proportion (%)
Sand	63.0%
Silt	27.9%
Clay	9.1%

AGU Soil Classification
Silty Sand

Effective Porosity
N_e=21.3%

Calculation of effective porosity from re-calculated grain size distribution, OW4-5(11.5'-13.5')



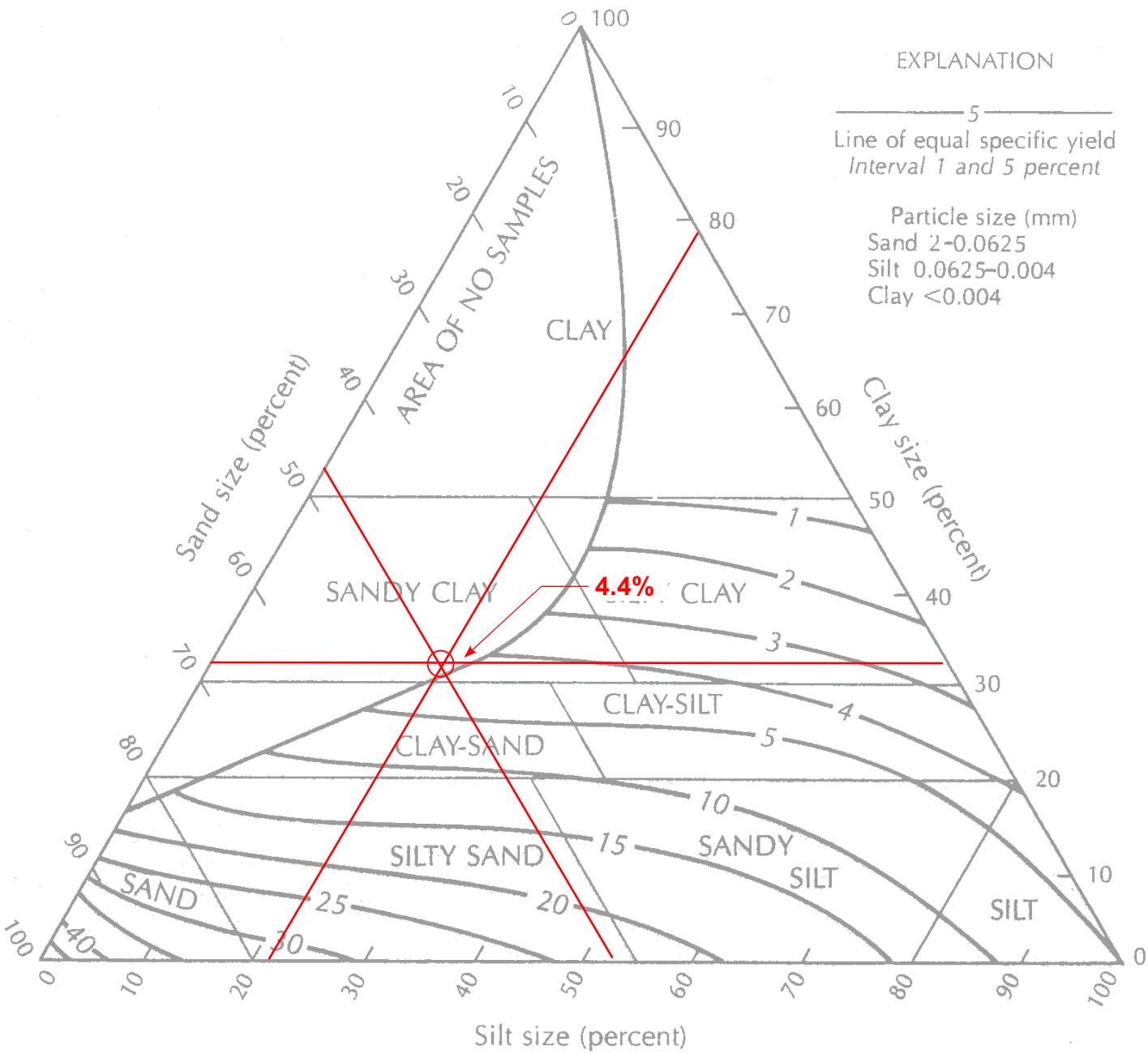
OW4-5 (11.5'-13.5')

Soil Type	Proportion (%)
Sand	57.7%
Silt	21.1%
Clay	21.2%

AGU Soil Classification
Clay-Sand

Effective Porosity
N_e=10.1%

Calculation of effective porosity from re-calculated grain size distribution, OW4-6D (12'-14')



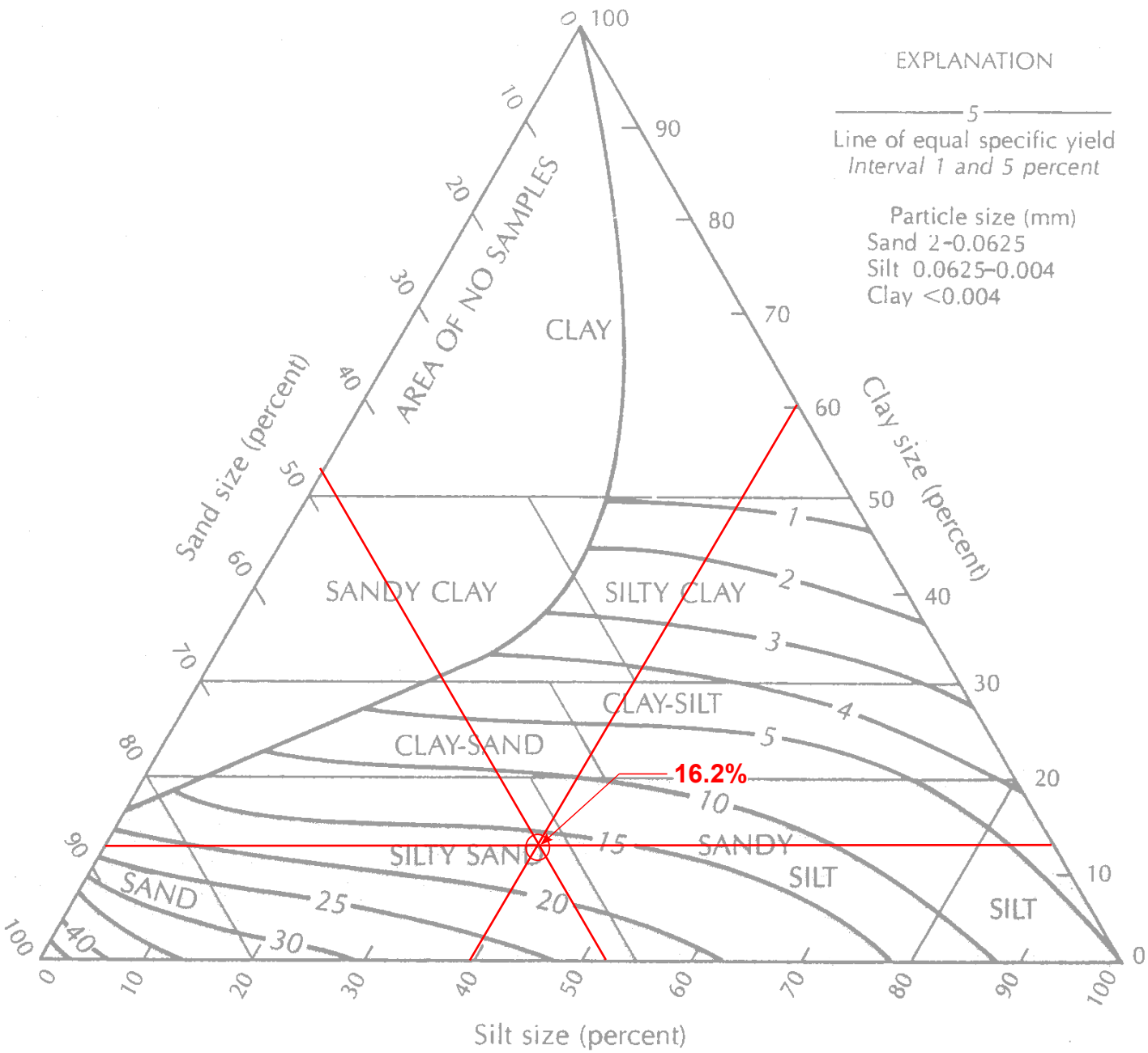
OW4-6D (12'-14')

Soil Type	Proportion (%)
Sand	46.9%
Silt	21.6%
Clay	31.5%

AGU Soil Classification
Sandy Clay

Effective Porosity
N_e=4.4%

Calculation of effective porosity from re-calculated grain size distribution, OW4-6D (35'-37')



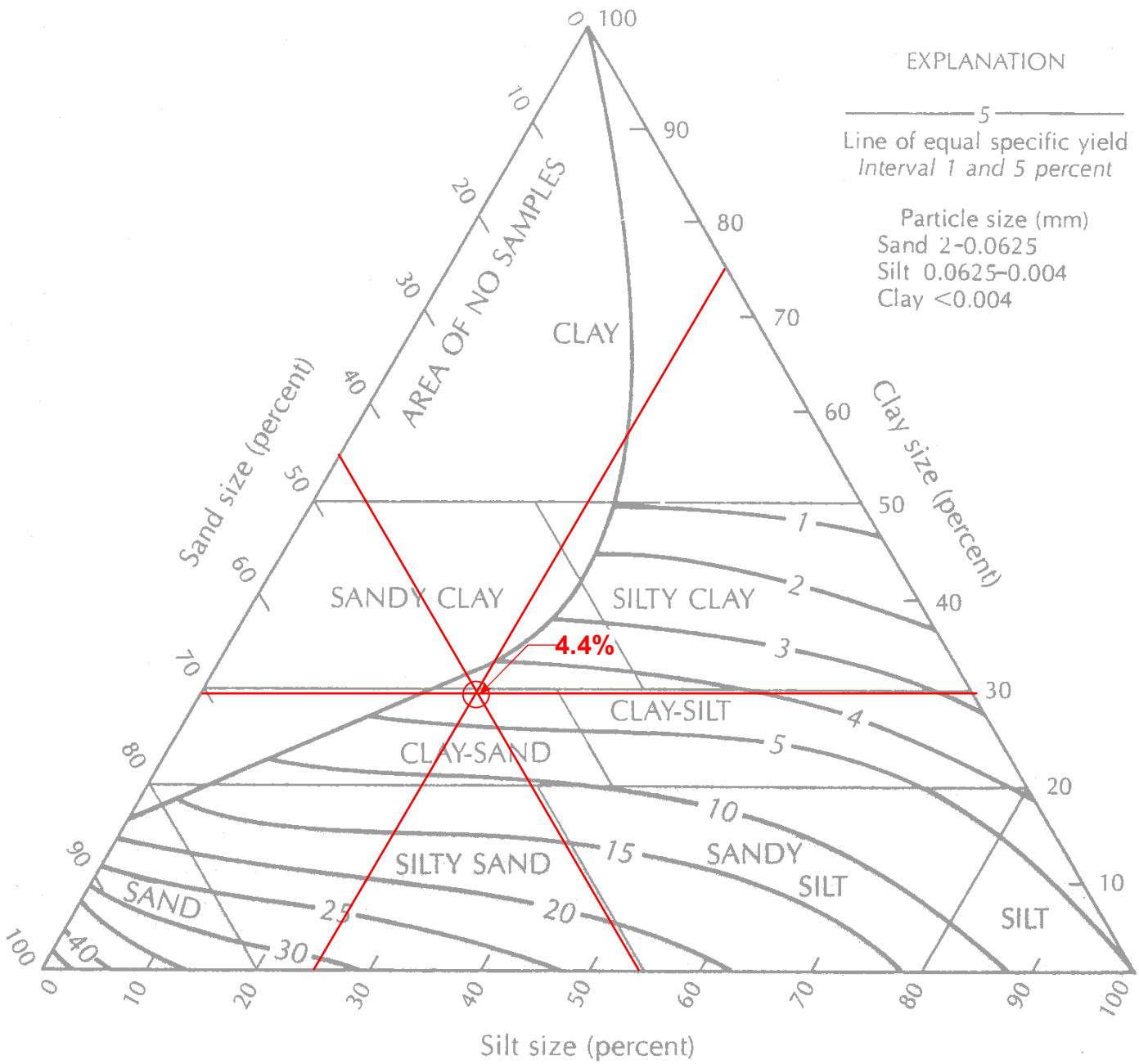
OW4-6D (35'-37')

Soil Type	Proportion (%)
Sand	48.4%
Silt	39.7%
Clay	11.9%

AGU Soil Classification
Silty Sand

Effective Porosity
N_e=16.2%

Calculation of effective porosity from re-calculated grain size distribution, OW4-8 (7'-9')



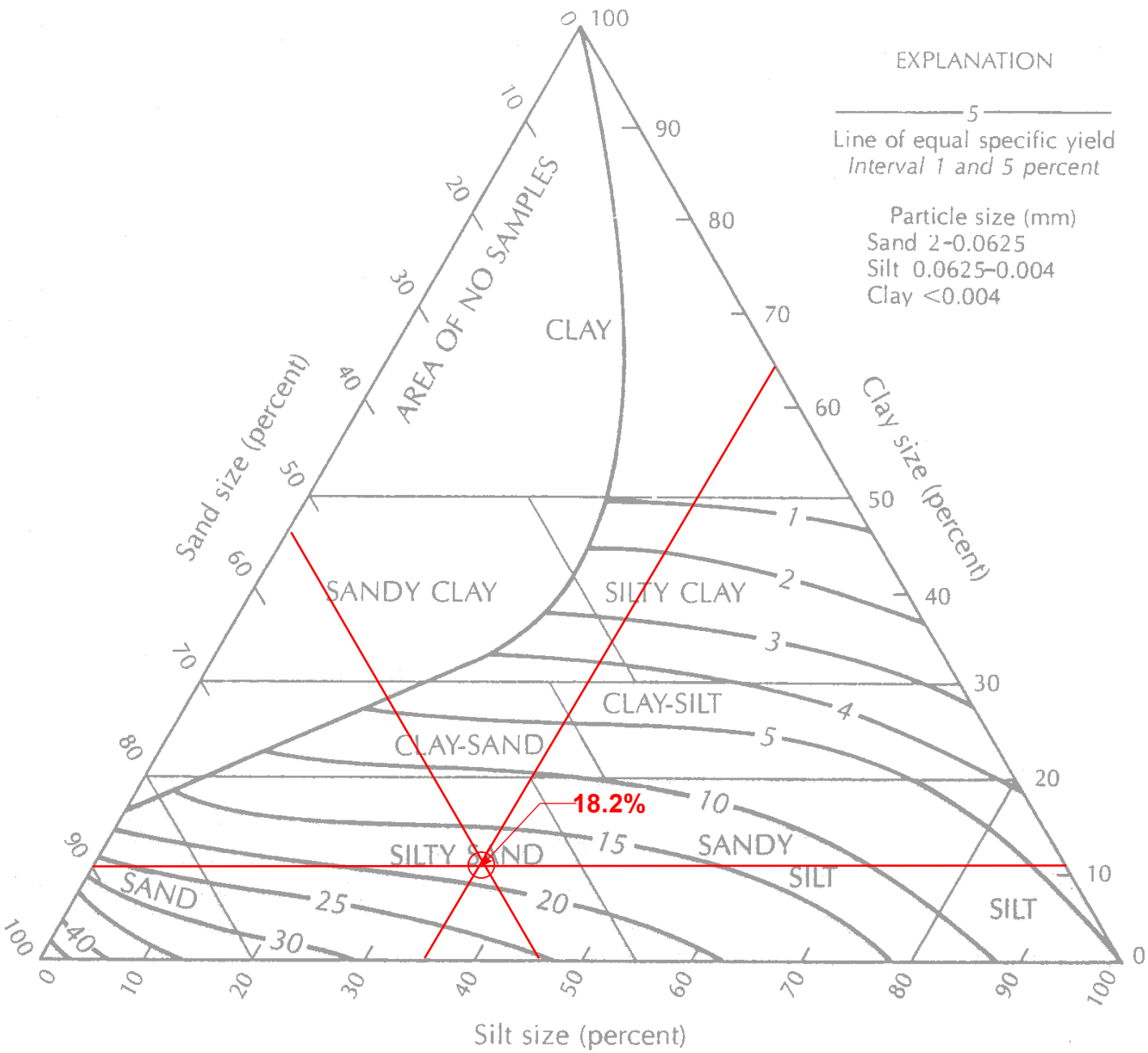
OW4-8 (7'-9')

Soil Type	Proportion (%)
Sand	45.3%
Silt	25.4%
Clay	29.3%

AGU Soil Classification
Clay-Silt

Effective Porosity
N_e=4.6%

Calculation of effective porosity from re-calculated grain size distribution, OW4-8 (17'-19')



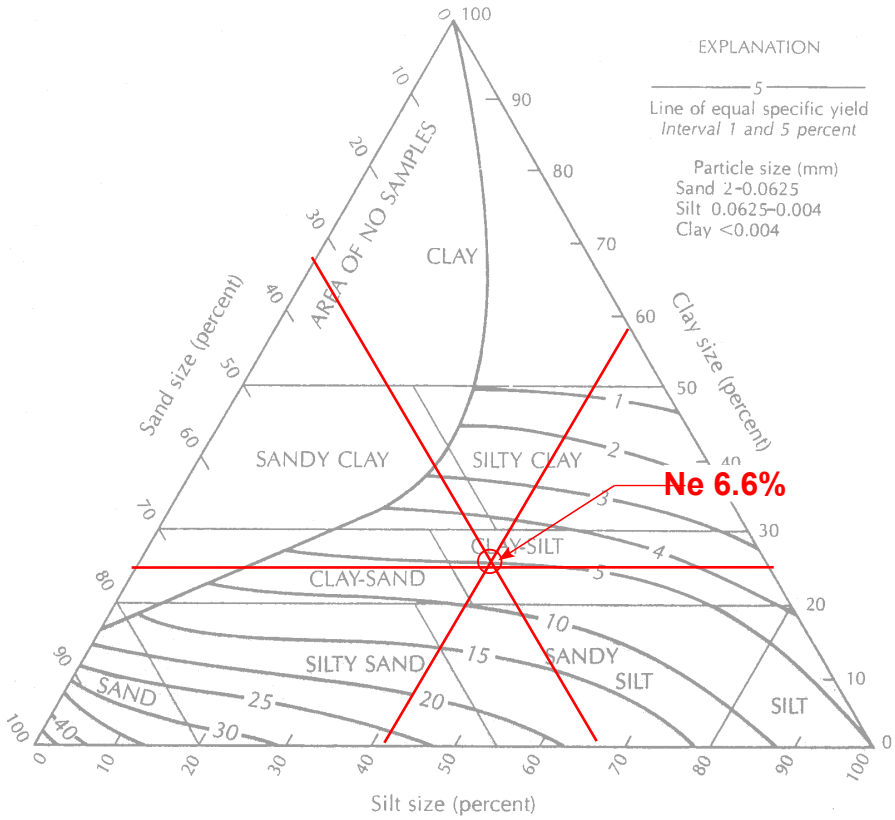
OW4-8 (17-19')

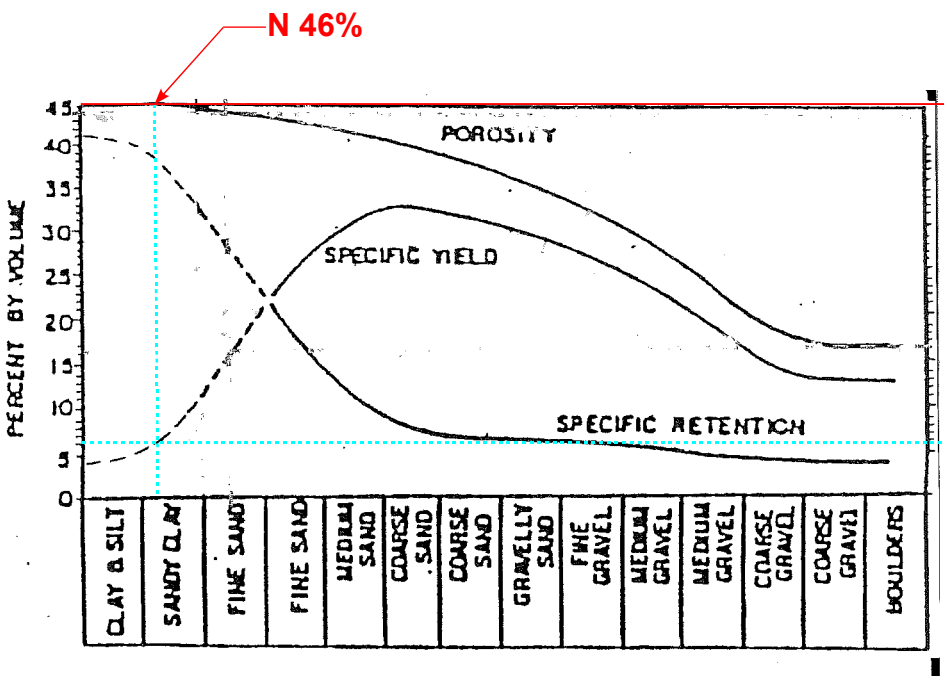
Soil Type	Proportion (%)
Sand	64.5%
Silt	29.5%
Clay	6.0%

AGU Soil Classification
Silty Sand

Effective Porosity
N_e=18.2%

Calculation of estimated porosity and effective porosity from re-calculated grain size distribution, OW4-10 (15'-17')





OW4-2 (25'-28')

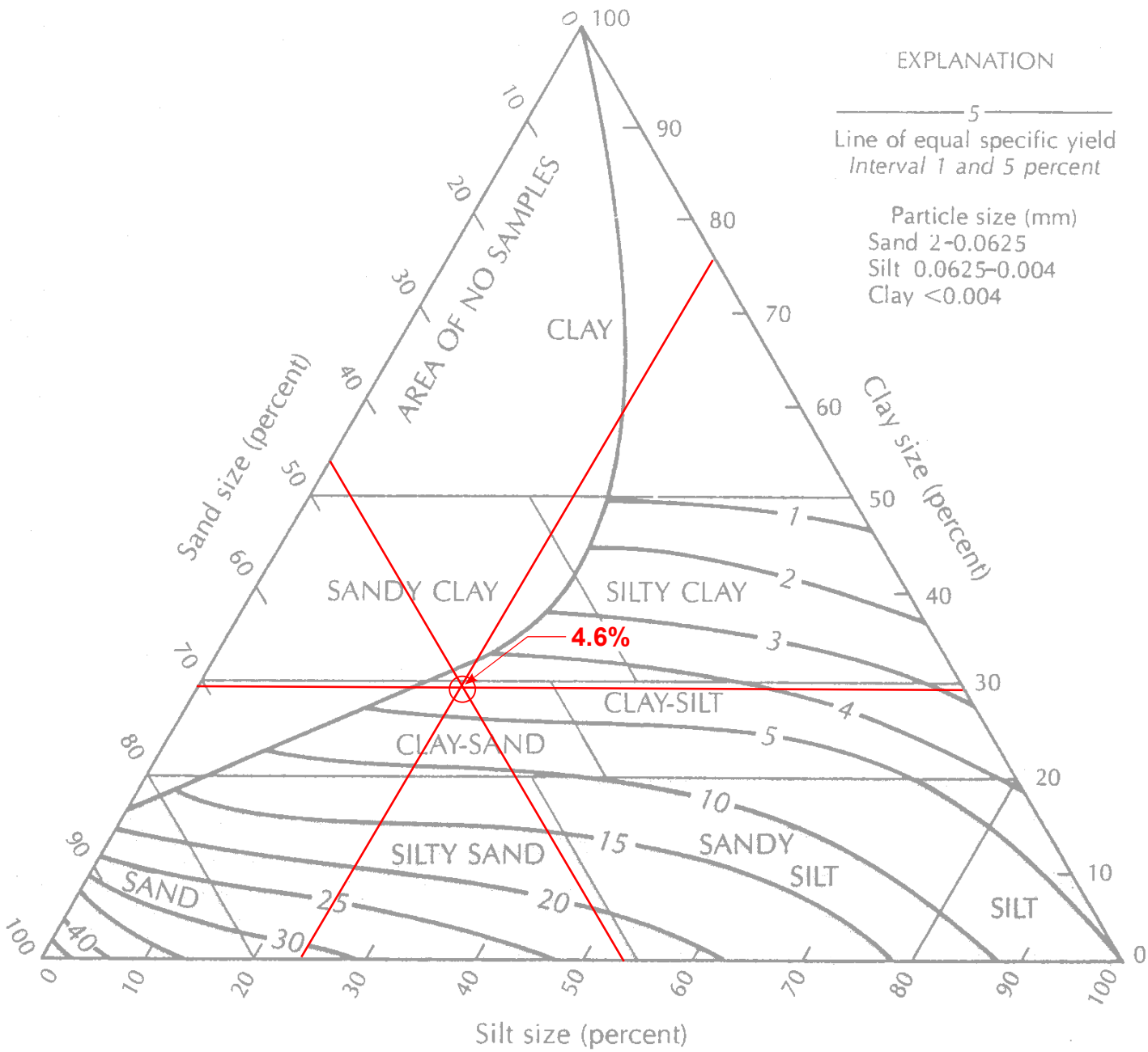
Soil Type	Proportion (%)
Sand	32.4%
Silt	42.9%
Clay	24.6%

AGU Soil Classification
Clay -Silt

Effective Porosity
N_e=6.6%

Total Porosity
N=46%

Calculation of effective porosity from re-calculated grain size distribution, OW4-11 (10'-12')



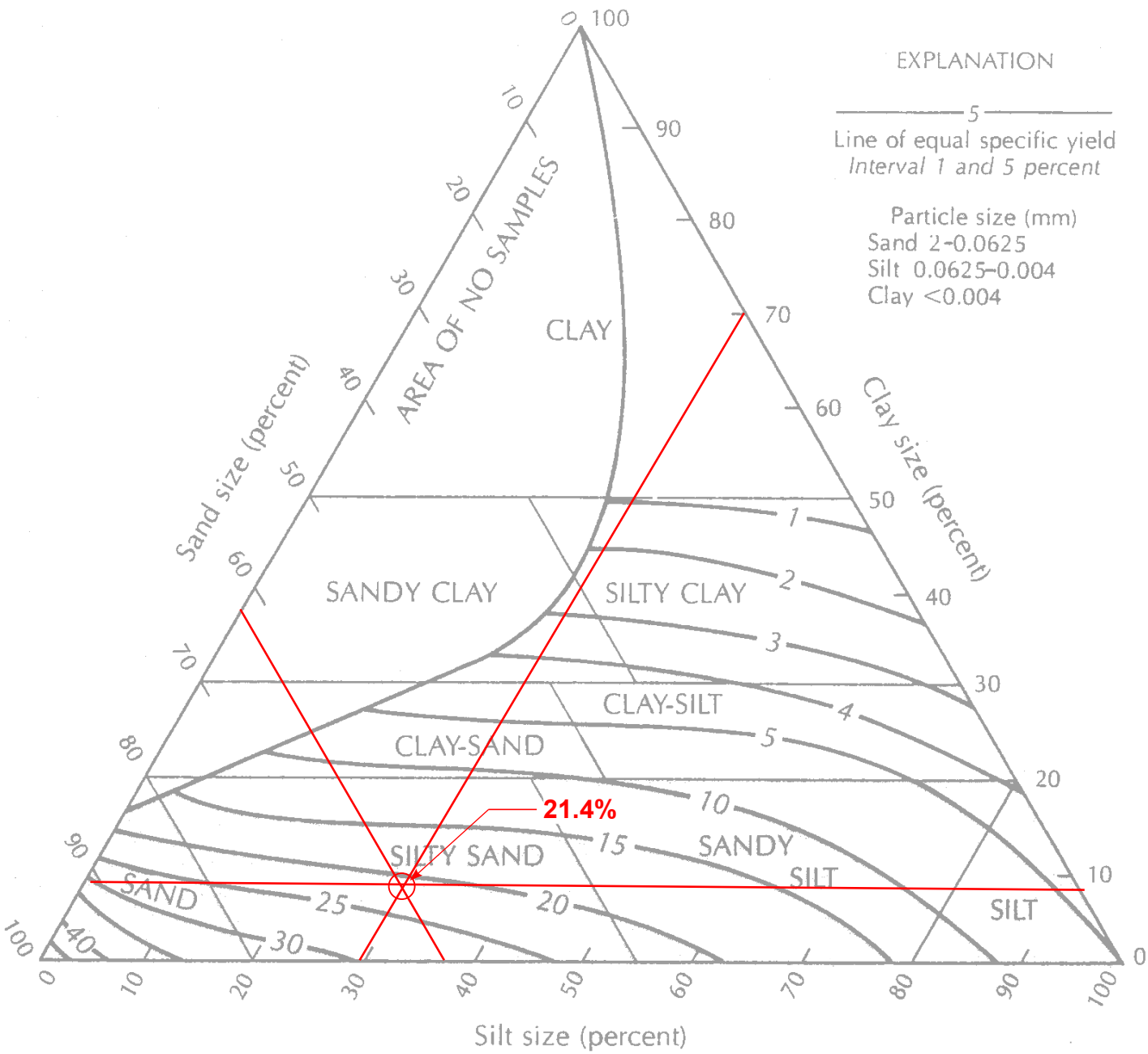
OW4-11 (10'-12')

Soil Type	Proportion (%)
Sand	44.1%
Silt	33.5%
Clay	22.4%

AGU Soil Classification
Clay-Sand

Effective Porosity
N_e=4.6%

Calculation of effective porosity from re-calculated grain size distribution, MW-34/B-30 (23.5-30')



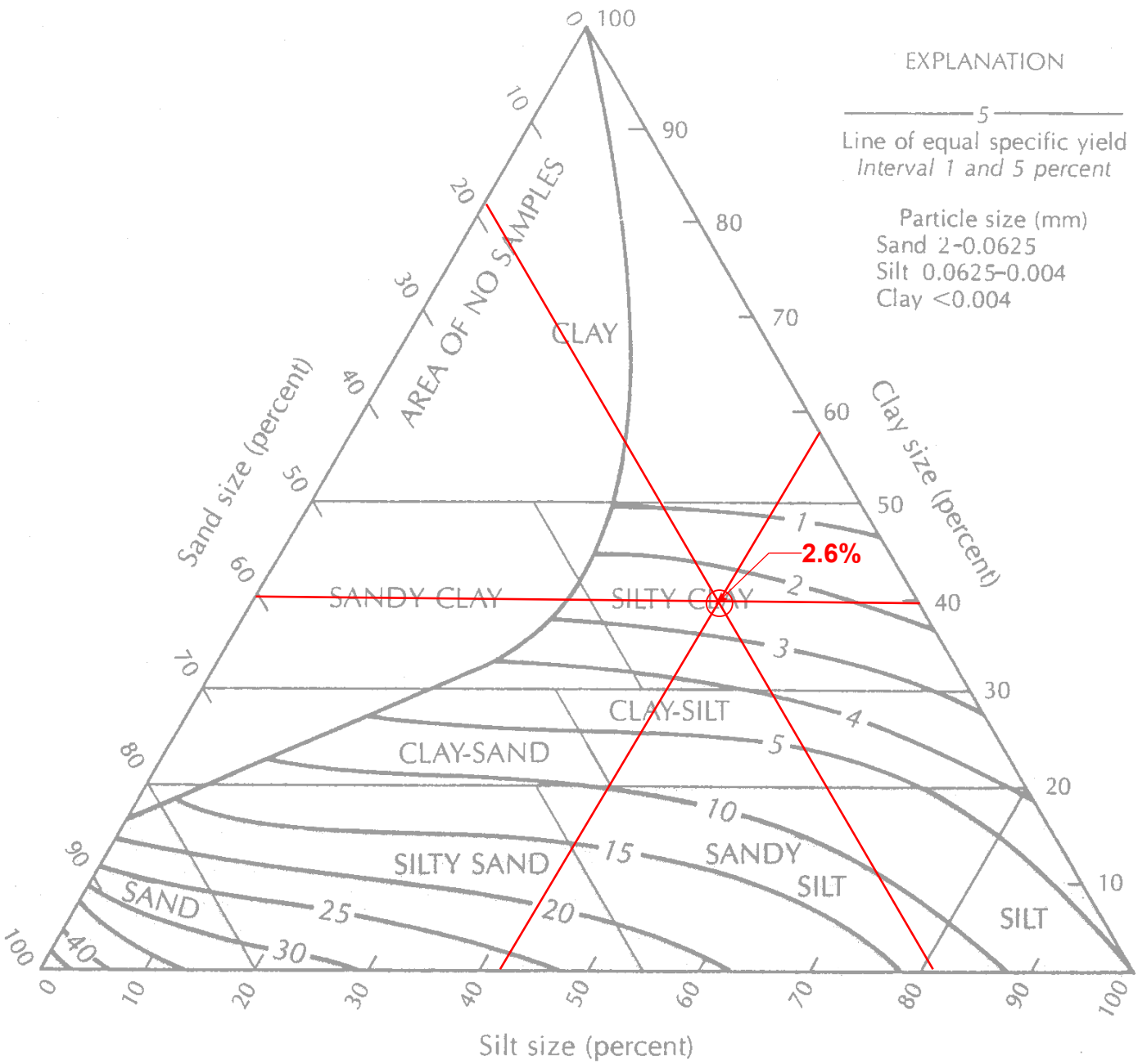
MW-34/B-30 (23.5'-30')

Soil Type	Proportion (%)
Sand	62.3%
Silt	29.5%
Clay	8.1%

AGU Soil Classification
Silty Sand

Effective Porosity
N_e=21.4%

Calculation of effective porosity from re-calculated grain size distribution, MW-35/B-31 (2'-4')



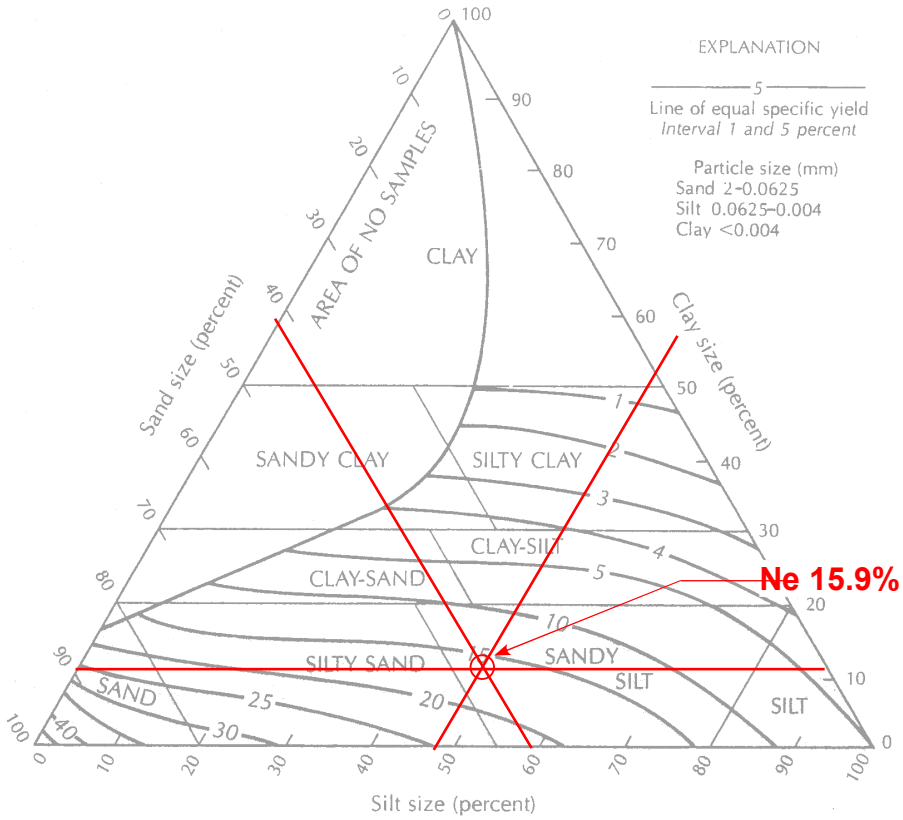
MW-35/B-31 (2'-4')

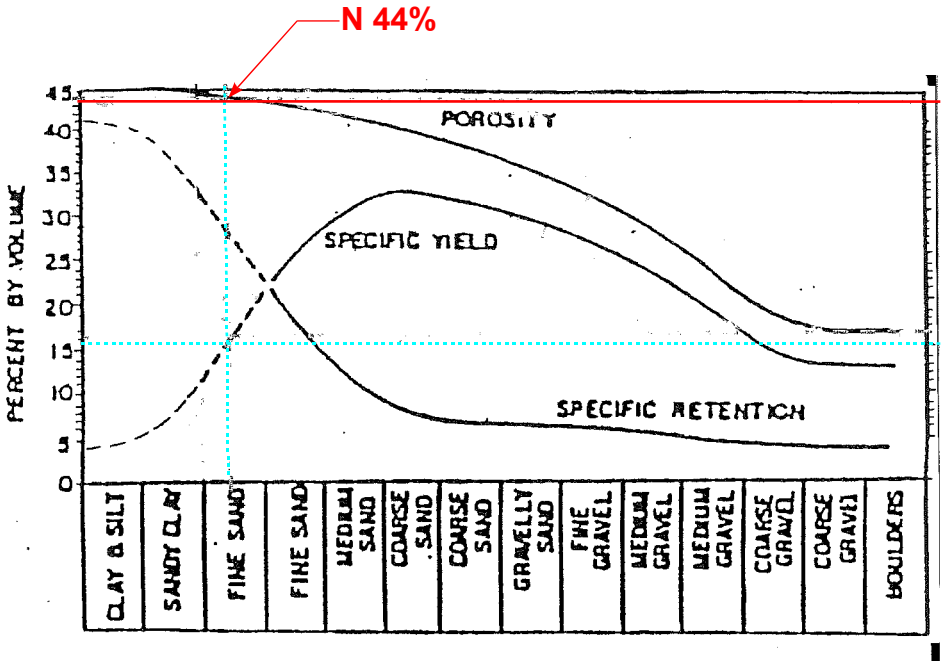
Soil Type	Proportion (%)
Sand	18.9%
Silt	41.8%
Clay	39.2%

AGU Soil Classification
Silty Clay

Effective Porosity
N_e=2.6%

Calculation of estimated porosity and effective porosity from re-calculated grain size distribution, MW-35/B-31 (23.5-30')





MW-35/B-31 (23.5-30')

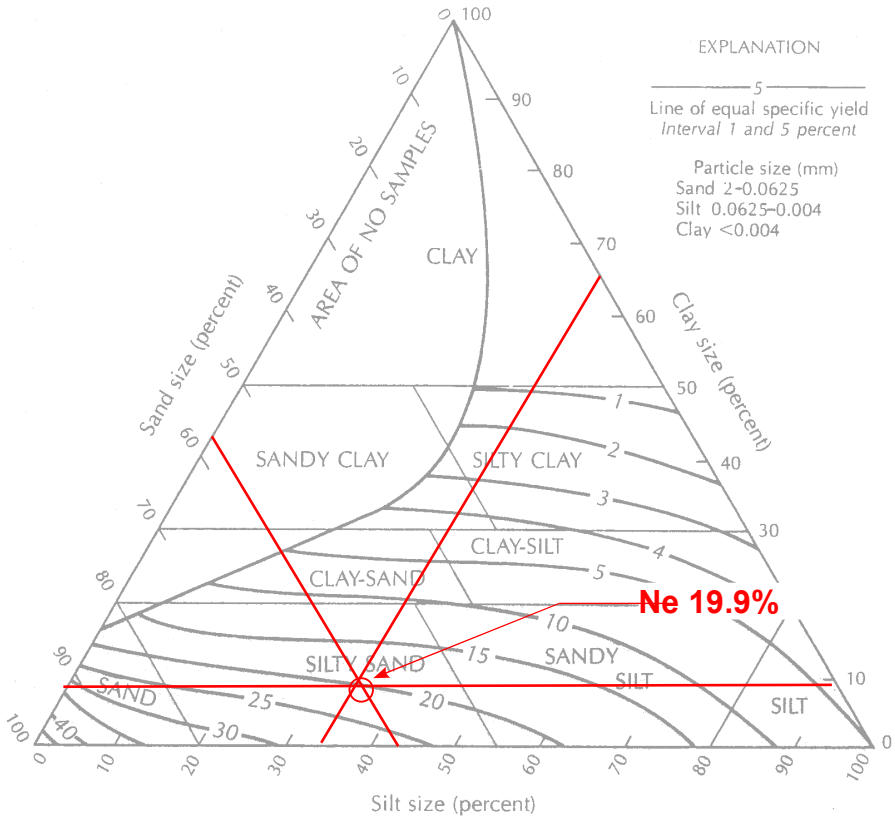
Soil Type	Proportion (%)
Sand	40.2%
Silt	48.3%
Clay	11.5%

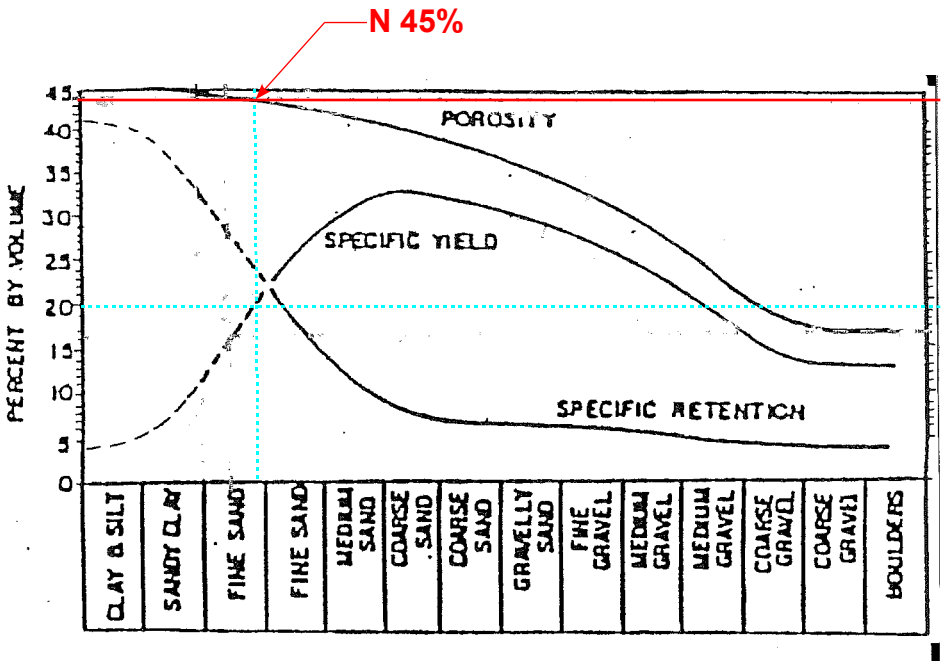
AGU Soil Classification
Sandy Silt

Effective Porosity
N_e=15.9%

Total Porosity
N=44%

Calculation of estimated porosity and effective porosity from re-calculated grain size distribution, MW-35/B-31 (63.5-70')





MW-35/B-31 (63.5-70.0')

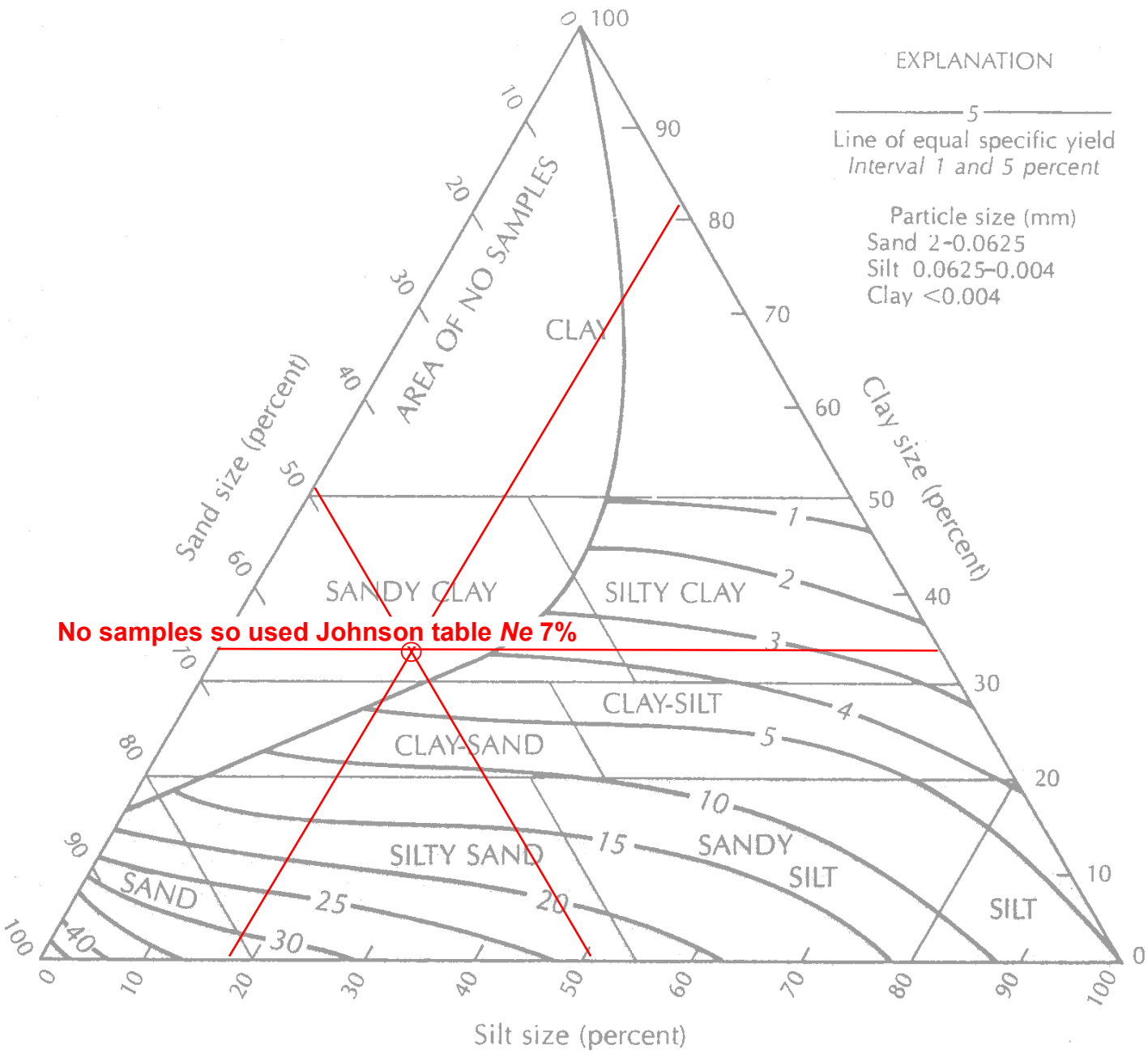
Soil Type	Proportion (%)
Sand	57.6%
Silt	33.9%
Clay	8.5%

AGU Soil Classification
Silty Sand

Effective Porosity
N_e=19.9%

Total Porosity
N=45%

Calculation of effective porosity from re-calculated grain size distribution, MW-33A/OW-29A (2-4')



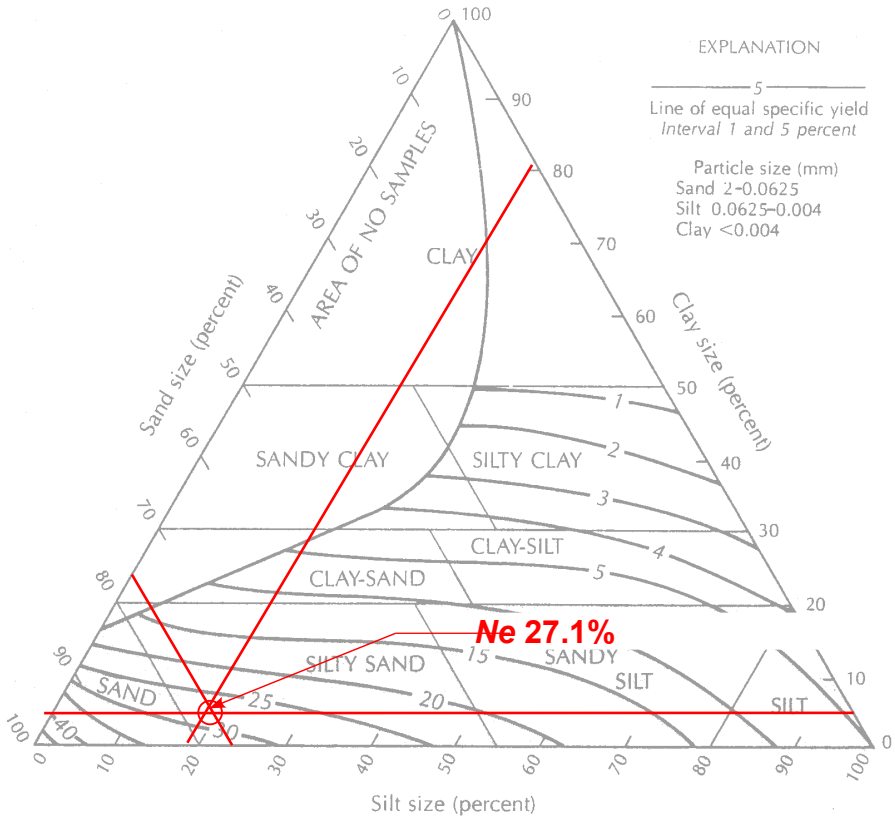
MW-33A/OW-29A (2-4')

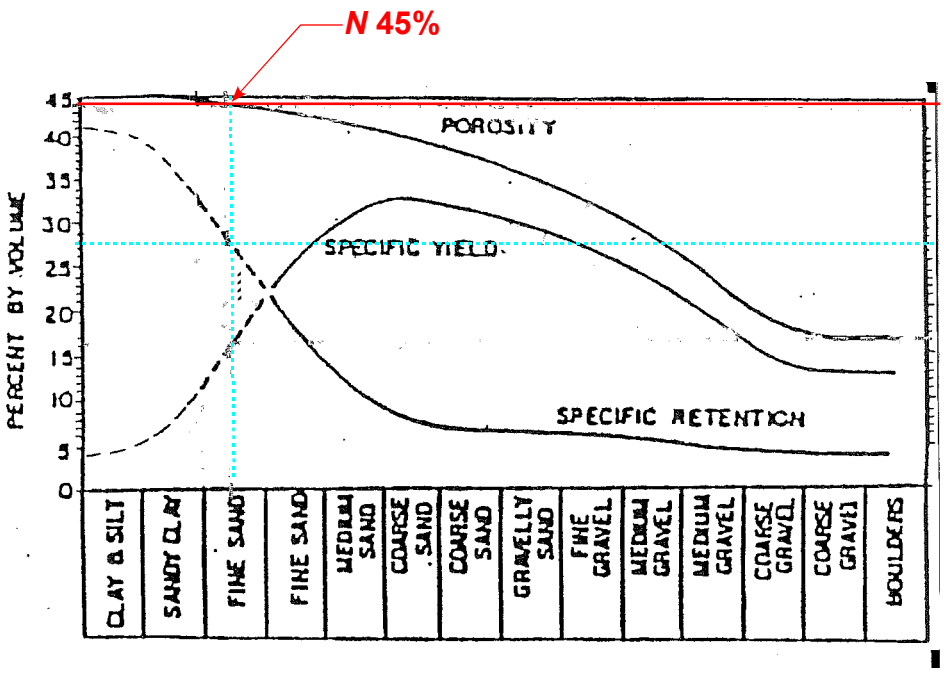
Soil Type	Proportion (%)
Sand	49.5%
Silt	17.8%
Clay	32.7%

AGU Soil Classification
Sandy Clay

Effective Porosity
N_e=7%
Since data plotted in "Area of No Samples"
Used average for Sandy Clay (Johnson 1967)

Calculation of estimated porosity and effective porosity from re-calculated grain size distribution, MW-33/OW-29A(13.5-20')





MW-33A/OW-29A (13.5-20')

Soil Type	Proportion (%)
Sand	77.3%
Silt	18.4%
Clay	4.4%

AGU Soil Classification
Silty Sand

Effective Porosity
N_e=27.1%

Total Porosity
N=45%

VERTICAL HYDRAULIC GRADIENT CALCULATIONS

Vertical Hydraulic Gradients
OW4-3S and OW3-4D

Well ID	Land Surface Elevation	Screened Interval				Date	Water Elevation	Mid-Point Elevation	Separation of			Vertical Hydraulic Gradient	Horizontal Hydraulic Gradient	Horizontal to Vertical Ratio
		Upper Depth	Upper Elevation	Lower Depth	Lower Elevation				Screened Interval	Mid-Points	Water Level			
	(ft-MSL)	(ft-bls)	(ft-MSL)	(ft-MSL)	(ft-MSL)	(m/d/y)	(ft-MSL)	(ft-MSL)	(+ overlap) (- seperate) (ft)	(+ overlap) (- seperate) (ft)	(+ down) (- Up) (ft)	(+ down) (- Up) (ft/ft)	(ft/ft)	(ft/ft)
OW4-3S	824.05	30.95	793.10	45.95	778.10	03/27/15	788.54	783.32	-6.13	-16.96	-0.75	0.044		
OW4-3D	823.62	52.08	771.54	62.08	761.54		787.80	766.36						
OW4-3S	824.05	30.95	793.10	45.95	778.10	05/15/15	789.54	783.82	-6.13	-17.46	-0.76	0.043		
OW4-3D	823.62	52.08	771.54	62.08	761.54		788.79	766.36						
OW4-3S	824.05	30.95	793.10	45.95	778.10	05/28/15	789.15	783.63	-6.13	-17.27	-1.05	0.061		
OW4-3D	823.62	52.08	771.54	62.08	761.54		788.11	766.36						
OW4-3S	824.05	30.95	793.10	45.95	778.10	06/26/15	788.08	783.09	-6.13	-16.73	-0.94	0.056		
OW4-3D	823.62	52.08	771.54	62.08	761.54		787.15	766.36						
OW4-3S	824.05	30.95	793.10	45.95	778.10	07/24/15	786.64	782.37	-6.13	-16.01	-0.51	0.032	0.040	1.27
OW4-3D	823.62	52.08	771.54	62.08	761.54		786.14	766.36						
OW4-3S	824.05	30.95	793.10	45.95	778.10	08/25/15	787.03	782.57	-6.13	-16.20	-0.46	0.028		
OW4-3D	823.62	52.08	771.54	62.08	761.54		786.57	766.36						
Average										**-16.77**	**-0.74**	**0.044**		

Vertical Hydraulic Gradients
OW4-6S and OW3-6D

Well ID	Land Surface Elevation	Screened Interval				Date	Water Elevation	Mid-Point Elevation	Separation of			Vertical Hydraulic Gradient	Horizontal Hydraulic Gradient	Horizontal to Vertical Ratio
		Upper Depth	Upper Elevation	Lower Depth	Lower Elevation				Screened Interval	Mid-Points	Water Level			
	(ft-MSL)	(ft-bls)	(ft-MSL)	(ft-MSL)	(ft-MSL)	(m/d/y)	(ft-MSL)	(ft-MSL)	(+ overlap) (- seperate) (ft)	(+ overlap) (- seperate) (ft)	(+ down) (- Up) (ft)	(+ down) (- Up) (ft/ft)	(ft/ft)	(ft/ft)
OW4-6S	815.26	17.05	798.21	32.05	783.21	03/27/15	795.41	789.31	-27.43	-38.55	-0.93	0.024		
OW4-6D	815.24	59.48	755.76	69.48	745.76		794.48	750.76						
OW4-6S	814.97	17.05	797.92	32.05	782.92	05/15/15	796.27	789.60	-27.43	-38.74	-1.20	0.031		
OW4-6D	815.34	59.48	755.86	69.48	745.86		795.07	750.86						
OW4-6S	814.97	17.05	797.92	32.05	782.92	05/28/15	795.39	789.16	-27.43	-38.30	-1.13	0.030		
OW4-6D	815.34	59.48	755.86	69.48	745.86		794.26	750.86						
OW4-6S	814.97	17.05	797.92	32.05	782.92	06/26/15	793.96	788.44	-27.43	-37.58	-1.06	0.028		
OW4-6D	815.34	59.48	755.86	69.48	745.86		792.90	750.86						
OW4-6S	814.97	17.05	797.92	32.05	782.92	07/24/15	792.34	787.63	-27.43	-36.77	-1.02	0.028	0.010	0.360
OW4-6D	815.34	59.48	755.86	69.48	745.86		791.32	750.86						
OW4-6S	814.97	17.05	797.92	32.05	782.92	08/25/15	791.66	787.29	-27.43	-36.43	-1.05	0.029		
OW4-6D	815.34	59.48	755.86	69.48	745.86		790.61	750.86						
Average										**-37.73**	**-1.06**	**0.028**		

Vertical Hydraulic Gradients
OW4-9S and OW3-9D

Well ID	Land Surface Elevation	Screened Interval				Date	Water Elevation	Mid-Point Elevation	Separation of			Vertical Hydraulic Gradient	Horizontal Hydraulic Gradient	Horizontal to Vertical Ratio
		Upper Depth	Upper Elevation	Lower Depth	Lower Elevation				Screened Interval	Mid-Points	Water Level			
	(ft-MSL)	(ft-bls)	(ft-MSL)	(ft-MSL)	(ft-MSL)	(m/d/y)	(ft-MSL)	(ft-MSL)	(+ overlap) (- seperate) (ft)	(+ overlap) (- seperate) (ft)	(+ down) (- Up) (ft)	(+ down) (- Up) (ft/ft)	(ft/ft)	(ft/ft)
OW4-9S	819.21	14.26	804.95	32.05	787.16	03/27/15	800.09	793.63	-19.53	-38.72	-1.59	0.041		
OW4-9D	819.39	51.58	767.81	69.48	749.91		798.50	754.91						
OW4-9S	819.21	14.26	804.95	32.05	787.16	05/15/15	800.06	793.61	-19.53	-38.70	-1.18	0.030		
OW4-9D	819.39	51.58	767.81	69.48	749.91		798.88	754.91						
OW4-9S	819.21	14.26	804.95	32.05	787.16	05/28/15	799.01	793.09	-19.53	-38.18	-0.96	0.025		
OW4-9D	819.39	51.58	767.81	69.48	749.91		798.05	754.91						
OW4-9S	819.21	14.26	804.95	32.05	787.16	06/26/15	797.59	792.38	-19.53	-37.47	-0.85	0.023		
OW4-9D	819.39	51.58	767.81	69.48	749.91		796.74	754.91						
OW4-9S	819.21	14.26	804.95	32.05	787.16	07/24/15	796.10	791.63	-19.53	-36.72	-0.84	0.023	0.030	1.31
OW4-9D	819.39	51.58	767.81	69.48	749.91		795.26	754.91						
OW4-9S	819.21	14.26	804.95	32.05	787.16	08/25/15	795.63	791.40	-19.53	-36.49	-1.00	0.027		
OW4-9D	819.39	51.58	767.81	69.48	749.91		794.63	754.91						
Average										**-37.71**	**-1.07**	**0.028**		

Vertical Hydraulic Gradients
MW-33 and MW-33A

Well ID	Land Surface Elevation	Screened Interval				Date	Water Elevation	Mid-Point Elevation	Separation of			Vertical Hydraulic Gradient	Horizontal Hydraulic Gradient	Horizontal to Vertical Ratio
		Upper Depth	Upper Elevation	Lower Depth	Lower Elevation				Screened Interval	Mid-Points	Water Level			
	(ft-MSL)	(ft-bls)	(ft-MSL)	(ft-MSL)	(ft-MSL)	(m/d/y)	(ft-MSL)	(ft-MSL)	(+ overlap) (- seperate) (ft)	(+ overlap) (- seperate) (ft)	(+ down) (- Up) (ft)	(+ down) (- Up) (ft/ft)	(ft/ft)	(ft/ft)
MW-33	816.33	7.00	809.33	22.38	793.95	01/07/05	807.64	800.80	-34.12	-44.32	-1.19	0.027	0.03	1.117
MW-33A	815.94	56.50	759.44	61.96	753.98		806.45	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	04/20/05	808.87	801.41	-34.12	-44.93	-1.24	0.028		
MW-33A	815.94	56.50	759.44	61.96	753.98		807.63	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	10/19/05	806.05	800.00	-34.12	-41.02	-0.90	0.022		
MW-33A	815.94	56.50	759.44	61.96	753.98		805.15	758.98						
MW-33	816.33	7.00	809.33	22.38	793.95	04/25/06	805.90	799.93	-34.12	-43.44	-1.00	0.023		
MW-33A	815.94	56.50	759.44	61.96	753.98		804.90	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	10/04/06	804.98	799.47	-34.12	-42.99	-0.93	0.022		
MW-33A	815.94	56.50	759.44	61.96	753.98		804.05	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	04/09/07	806.18	800.07	-34.12	-41.09	-1.04	0.025		
MW-33A	815.94	56.50	759.44	61.96	753.98		805.14	758.98						
MW-33	816.33	7.00	809.33	22.38	793.95	10/15/07	801.16	797.56	-34.12	-41.07	-0.85	0.021		
MW-33A	815.94	56.50	759.44	61.96	753.98		800.31	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	04/23/08	805.67	799.81	-34.12	-43.33	-1.10	0.025		
MW-33A	815.94	56.50	759.44	61.96	753.98		804.57	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	10/13/08	804.57	799.26	-34.12	-42.78	-0.90	0.021		
MW-33A	815.94	56.50	759.44	61.96	753.98		803.67	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	04/20/09	807.18	800.57	-34.12	-44.09	-1.31	0.030		
MW-33A	815.94	56.50	759.44	61.96	753.98		805.87	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	10/12/09	804.16	799.06	-34.12	-42.57	-0.80	0.019		
MW-33A	815.94	56.50	759.44	61.96	753.98		803.36	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	04/19/10	806.84	800.40	-34.12	-43.92	-1.14	0.026		
MW-33A	815.94	56.50	759.44	61.96	753.98		805.70	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	10/11/10	804.14	799.05	-34.12	-42.56	-0.78	0.018		
MW-33A	815.94	56.50	759.44	61.96	753.98		803.36	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	04/08/11	806.93	800.44	-34.12	-43.96	-1.22	0.028		
MW-33A	815.94	56.50	759.44	61.96	753.98		805.71	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	10/12/11	804.06	799.01	-34.12	-42.53	-0.82	0.019		
MW-33A	815.94	56.50	759.44	61.96	753.98		803.24	756.48						

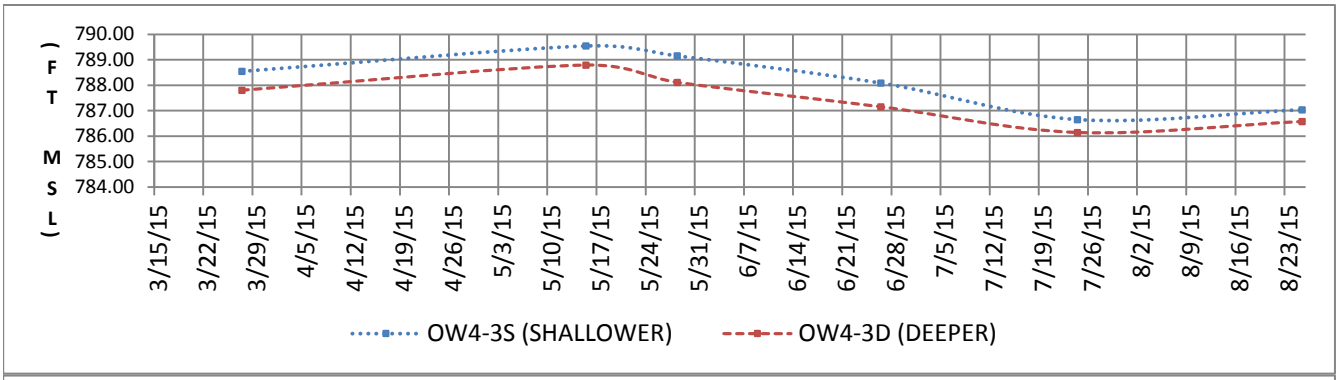
Well ID	Land Surface Elevation	Screened Interval				Date	Water Elevation	Mid-Point Elevation	Separation of			Vertical Hydraulic Gradient	Horizontal Hydraulic Gradient	Horizontal to Vertical Ratio
		Upper Depth	Upper Elevation	Lower Depth	Lower Elevation				Screened Interval	Mid-Points	Water Level			
	(ft-MSL)	(ft-bls)	(ft-MSL)	(ft-MSL)	(ft-MSL)	(m/d/y)	(ft-MSL)	(ft-MSL)	(+ overlap) (- seperate) (ft)	(+ overlap) (- seperate) (ft)	(+ down) (- Up) (ft)	(+ down) (- Up) (ft/ft)	(ft/ft)	(ft/ft)
MW-33	816.33	7.00	809.33	22.38	793.95	04/06/12	805.73	799.84	-34.12	-43.36	-0.97	0.022		
MW-33A	815.94	56.50	759.44	61.96	753.98		804.76	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	10/08/12	803.10	798.53	-34.12	-42.05	-0.65	0.015		
MW-33A	815.94	56.50	759.44	61.96	753.98		802.45	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	04/23/13	806.51	800.23	-34.12	-43.75	-1.15	0.026		
MW-33A	815.94	56.50	759.44	61.96	753.98		805.36	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	10/08/13	804.33	799.14	-34.12	-42.66	-0.60	0.014		
MW-33A	815.94	56.50	759.44	61.96	753.98		803.73	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	04/15/14	807.49	800.72	-34.12	-44.24	-1.30	0.029		
MW-33A	815.94	56.50	759.44	61.96	753.98		806.19	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	10/08/14	804.15	799.05	-34.12	-42.57	-0.79	0.019		
MW-33A	815.94	56.50	759.44	61.96	753.98		803.36	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	05/05/15	806.11	800.03	-34.12	-43.55	-1.04	0.024		
MW-33A	815.94	56.50	759.44	61.96	753.98		805.07	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	05/28/15	804.98	799.47	-34.12	-42.99	-0.82	0.019		
MW-33A	815.94	56.50	759.44	61.96	753.98		804.16	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	06/26/15	803.86	798.91	-34.12	-42.43	-0.73	0.017		
MW-33A	815.94	56.50	759.44	61.96	753.98		803.13	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	07/24/15	802.86	798.41	-34.12	-41.93	-0.64	0.015	0.020	1.31
MW-33A	815.94	56.50	759.44	61.96	753.98		802.22	756.48						
MW-33	816.33	7.00	809.33	22.38	793.95	08/25/15	802.64	798.30	-34.12	-41.82	-0.60	0.014		
MW-33A	815.94	56.50	759.44	61.96	753.98		802.04	756.48						
Average										**-42.92**	**-0.94**	**0.0219**		

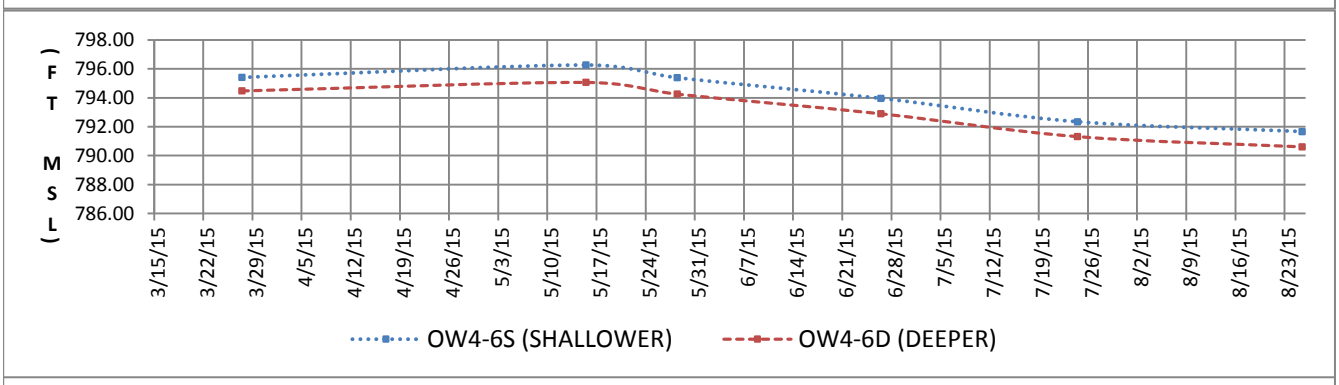
Vertical Hydraulic Gradients
MW-35 and MW-35A

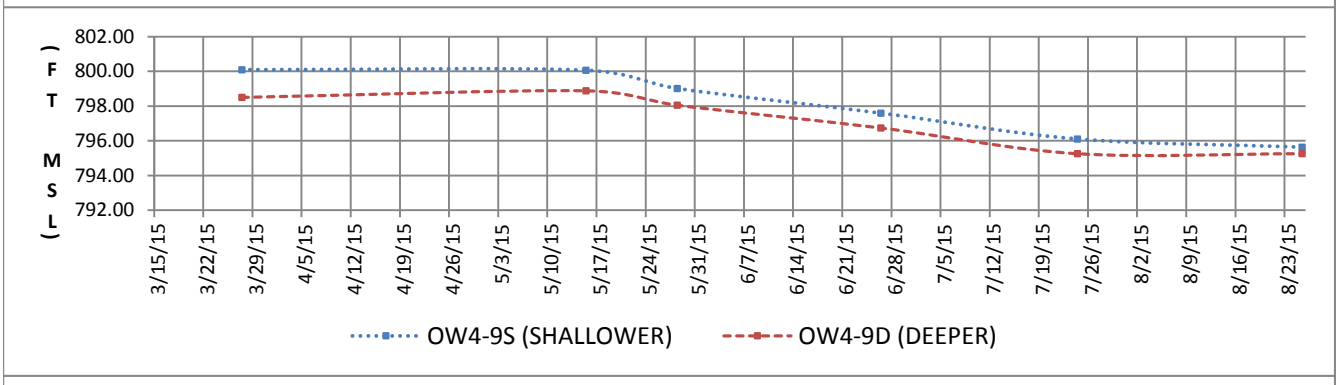
Well ID	Land Surface Elevation	Screened Interval				Date	Water Elevation	Mid-Point Elevation	Separation of			Vertical Hydraulic Gradient	Horizontal Hydraulic Gradient	Horizontal to Vertical Ratio
		Upper Depth	Upper Elevation	Lower Depth	Lower Elevation				Screened Interval	Mid-Points	Water Level			
	(ft-MSL)	(ft-bls)	(ft-MSL)	(ft-MSL)	(ft-MSL)	(m/d/y)	(ft-MSL)	(ft-MSL)	(+ overlap) (- seperate) (ft)	(+ overlap) (- seperate) (ft)	(+ down) (- Up) (ft)	(+ down) (- Up) (ft/ft)	(ft/ft)	(ft/ft)
MW-35	836.85	19.61	817.24	34.61	802.24	01/07/05	812.87	807.56	-27.06	-34.96	-1.09	0.031		
MW-35A	836.77	61.67	775.10	66.67	770.10		811.78	772.60					0.02	0.64
MW-35	836.85	19.61	817.24	34.61	802.24	04/20/05	815.04	808.64	-27.06	-36.04	-1.71	0.047		
MW-35A	836.77	61.67	775.10	66.67	770.10		813.33	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	04/25/06	810.8	806.52	-27.06	-33.92	-1.30	0.038		
MW-35A	836.77	61.67	775.10	66.67	770.10		809.50	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	10/04/06	809.01	805.63	-27.06	-33.03	-1.61	0.049		
MW-35A	836.77	61.67	775.10	66.67	770.10		807.4	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	04/09/07	811.23	806.74	-27.06	-31.64	-3.58	0.113		
MW-35A	836.77	61.67	775.10	66.67	770.10		807.65	775.10						
MW-35	836.85	19.61	817.24	34.61	802.24	10/15/07	804.94	803.59	-27.06	-30.99	-1.25	0.040		
MW-35A	836.77	61.67	775.10	66.67	770.10		803.69	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	04/23/08	806.54	804.39	-27.06	-31.79	-0.77	0.024		
MW-35A	836.77	61.67	775.10	66.67	770.10		805.77	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	10/13/08	804.5	803.37	-27.06	-30.77	-0.61	0.020		
MW-35A	836.77	61.67	775.10	66.67	770.10		803.89	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	04/20/09	808.75	805.50	-27.06	-32.90	-1.00	0.030		
MW-35A	836.77	61.67	775.10	66.67	770.10		807.75	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	10/12/09	805.28	803.76	-27.06	-31.16	-0.77	0.025		
MW-35A	836.77	61.67	775.10	66.67	770.10		804.51	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	04/19/10	813.23	807.74	-27.06	-35.14	-2.21	0.063		
MW-35A	836.77	61.67	775.10	66.67	770.10		811.02	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	10/11/10	807.14	804.69	-27.06	-32.09	-1.44	0.045		
MW-35A	836.77	61.67	775.10	66.67	770.10		805.70	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	04/08/11	809.09	805.67	-27.06	-33.06	-1.32	0.040		
MW-35A	836.77	61.67	775.10	66.67	770.10		807.77	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	10/12/11	804.43	803.34	-27.06	-30.74	-0.66	0.021		
MW-35A	836.77	61.67	775.10	66.67	770.10		803.77	772.60						

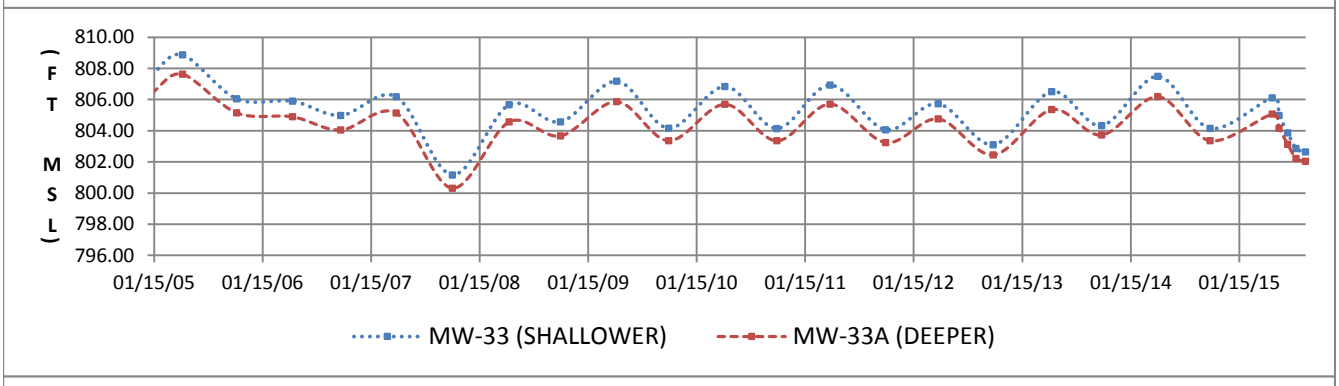
Well ID	Land Surface Elevation	Screened Interval				Date	Water Elevation	Mid-Point Elevation	Separation of			Vertical Hydraulic Gradient	Horizontal Hydraulic Gradient	Horizontal to Vertical Ratio
		Upper Depth	Upper Elevation	Lower Depth	Lower Elevation				Screened Interval	Mid-Points	Water Level			
	(ft-MSL)	(ft-bls)	(ft-MSL)	(ft-MSL)	(ft-MSL)	(m/d/y)	(ft-MSL)	(ft-MSL)	(+ overlap) (- seperate) (ft)	(+ overlap) (- seperate) (ft)	(+ down) (- Up) (ft)	(+ down) (- Up) (ft/ft)	(ft/ft)	(ft/ft)
MW-35	836.85	19.61	817.24	34.61	802.24	04/06/12	809.1	805.67	-27.06	-33.07	-1.28	0.039		
MW-35A	836.77	61.67	775.10	66.67	770.10		807.82	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	10/08/12	803.09	802.67	-27.06	-30.06	-0.54	0.018		
MW-35A	836.77	61.67	775.10	66.67	770.10		802.55	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	04/23/12	808.13	805.19	-27.06	-32.58	-0.95	0.029		
MW-35A	836.77	61.67	775.10	66.67	770.10		807.18	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	10/08/13	808.55	805.40	-27.06	-32.80	-1.11	0.034		
MW-35A	836.77	61.67	775.10	66.67	770.10		807.44	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	04/15/14	812.26	807.25	-27.06	-34.65	-1.53	0.044		
MW-35A	836.77	61.67	775.10	66.67	770.10		810.73	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	10/08/14	807.28	804.76	-27.06	-32.16	-1.06	0.033		
MW-35A	836.77	61.67	775.10	66.67	770.10		806.22	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	05/05/15	809.42	805.83	-27.06	-33.23	-0.74	0.022		
MW-35A	836.77	61.67	775.10	66.67	770.10		808.68	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	05/28/15	809.53	805.89	-27.06	-33.29	-1.21	0.036		
MW-35A	836.77	61.67	775.10	66.67	770.10		808.32	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	06/26/15	808.55	805.40	-27.06	-32.80	-1.22	0.037		
MW-35A	836.77	61.67	775.10	66.67	770.10		807.33	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	07/24/15	807.19	804.72	-27.06	-32.12	-1.07	0.033	0.030	0.900
MW-35A	836.77	61.67	775.10	66.67	770.10		806.12	772.60						
MW-35	836.85	19.61	817.24	34.61	802.24	08/25/15	806.1	804.17	-27.06	-31.57	-0.92	0.029		
MW-35A	836.77	61.67	775.10	66.67	770.10		805.18	772.60						
Average										**-32.66**	**-1.24**	**0.038**		

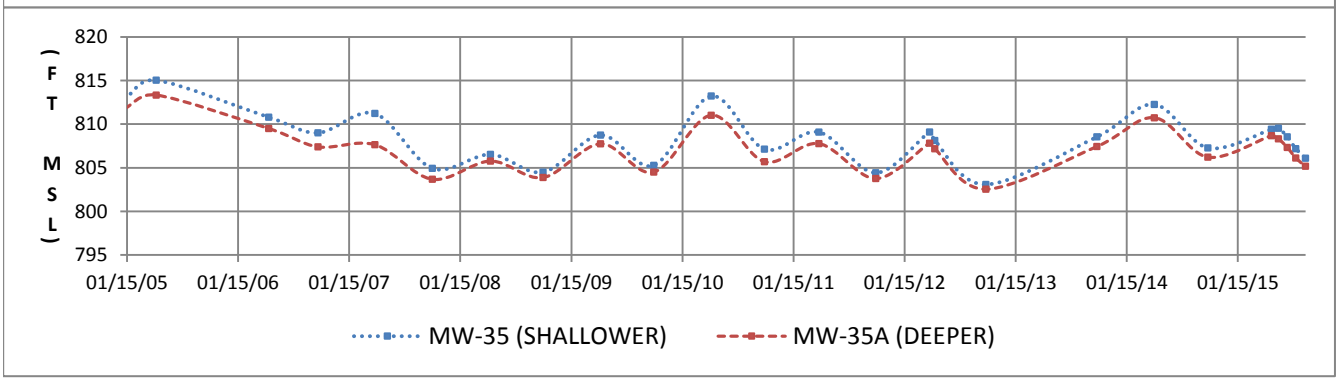
Groundwater Fluctuation of Nested Pairs





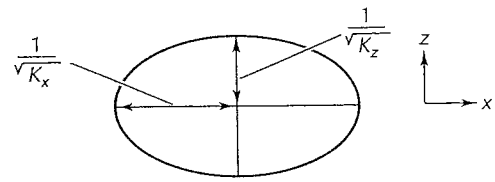




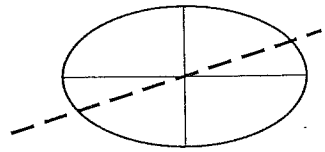


CALCULATION OF GROUNDWATER FLOW DIRECTION

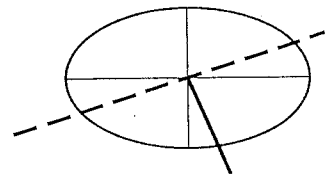
(HYDRAULIC CONDUCTITY ELLIPSE METHOD)



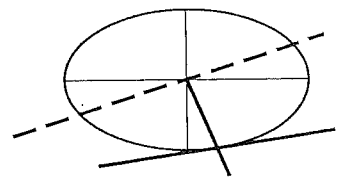
1. Construct a hydraulic-conductivity ellipse.



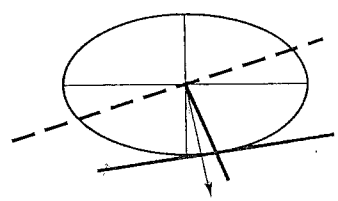
2. Draw the equipotential line as it is oriented with respect to the hydraulic-conductivity axes and passing through the origin of the ellipse.



3. Draw grad *h* perpendicular to the equipotential line and starting at the origin of the ellipse.



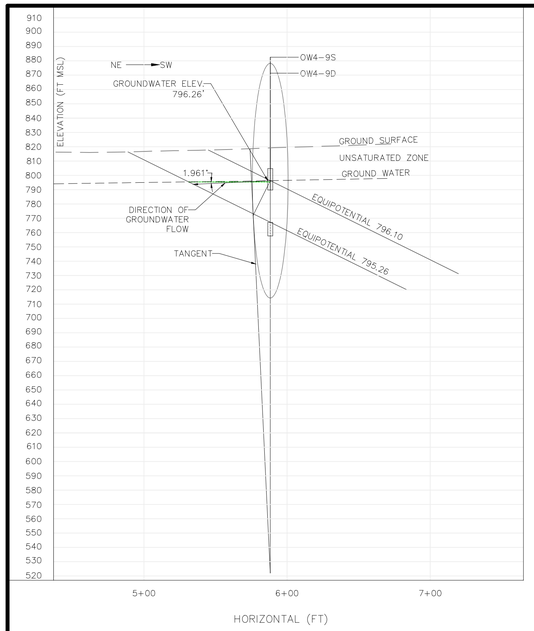
4. Draw a tangent to the ellipse at the point where grad *h* intersects the ellipse.



5. Draw a flow line so that it passes through the origin of the ellipse and is perpendicular to the tangent.

FIGURE 5.9 Steps in the determination of the direction of ground-water flow in an anisotropic medium using the hydraulic conductivity ellipse. Source: C. W. Fetter, *Ground Water Monitoring Review* 1, 1 (1981): 28–31. Copyright © 1981 Ground Water Publishing Co.

Copied From:
Fetter, C.W., 1994, *Applied Hydrogeology* 3rd ed.: Prentice-Hall Inc., New Jersey, page 154.



OW4-9S 796.10 & OW4-9D 795.26

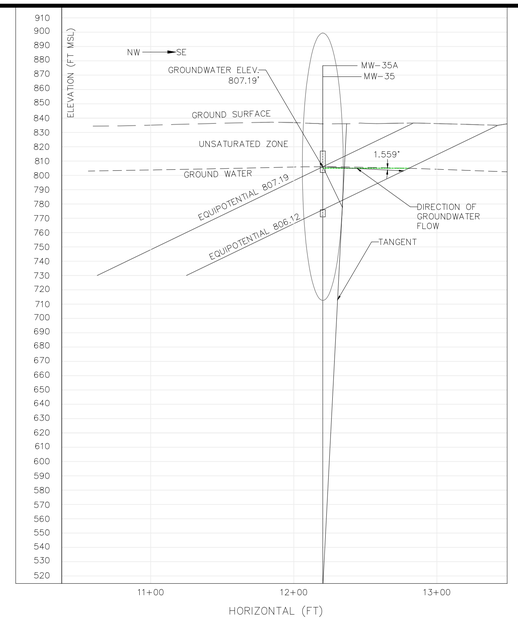
Kh = 0.64 ft/day 1/vKh = 1.25X 10 = 12.5 feet
Kv = 0.015 ft/day 1/vKh = 8.2 X 10 = 82 feet

Kv EST [Derived from geometric mean (GeoMean) of on-site (ML) soil]
GeoMean (ML) Kh = OW4-9S Kh
GeoMean (ML) Kv OW4-9S Kv EST

2.84 x 10-4cm/sec = 2.25 X 10-4 cm/sec
6.79 x 10-6cm/sec Kv EST

Kv EST = 5.38 X 10-6 cm/sec = 0.015 ft/day

Anistropy Ratio (Kh/Kv) = 43:1



MW-35 807.19 & MW-35A 806.12

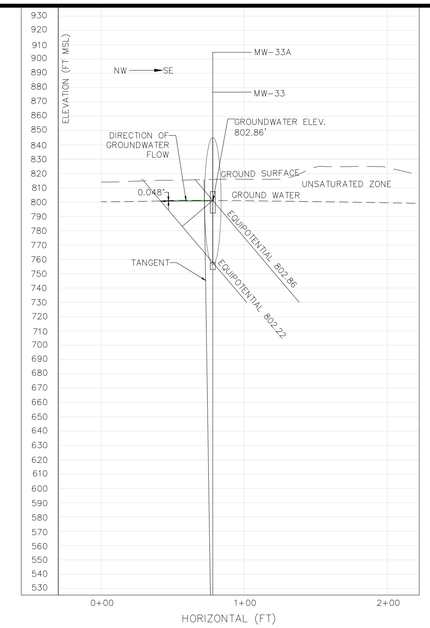
Kh = 0.49 ft/day 1/vKh = 1.43X 10 = 14.3 feet
Kv = 0.0115 ft/day 1/v Kv = 9.34 X 10 = 93.46 feet

Kv EST [Derived from geometric mean (GeoMean) of on-site (ML) soil]
GeoMean (ML) Kh = MW-35 Kh
GeoMean (ML) Kv MW-35 Kv EST

2.84 x 10-4cm/sec = 1.7 X 10-4 cm/sec
6.79 x 10-6cm/sec Kv EST

Kv EST = 4.06 X 10-6 cm/sec = 0.0115 ft/day

Anistropy Ratio (Kh/Kv) = 42:1



MW-33 802.86 & MW-33A 802.22

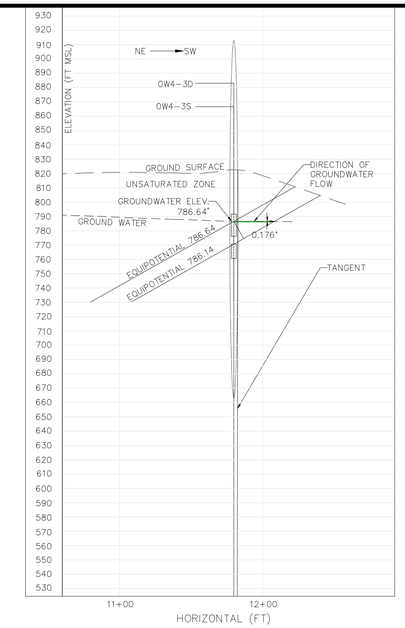
Kh = 3.0 ft/day 1/vKh = 0.58 X 10 = 5.8 feet
Kv = 0.051 ft/day 1/v Kv = 4.44 X 10 = 44.4 feet

Kv EST [Derived from geometric mean (GeoMean) of on-site (SM) soil]
GeoMean (SM) Kh = MW-33 Kh
GeoMean (SM) Kv MW-33 Kv EST

5.90 x 10-4cm/sec = 1.1 X 10-3 cm/sec
9.41x 10-6cm/sec Kv EST

Kv EST = 1.8 X 10-5 cm/sec = 0.051 ft/day

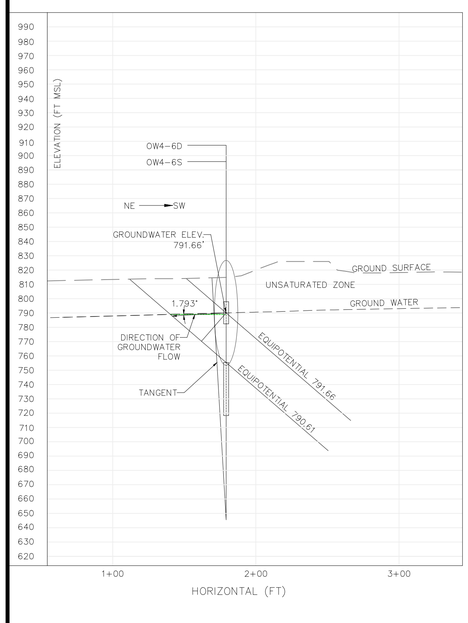
Anistropy Ratio (Kh/Kv) = 59:1



OW4-3S & OW4-3D

Kh = 12.67 ft/day 1/vKh = 0.28 X 10 = 2.8 feet
Kv = 0.0065 ft/day 1/v Kv = 12.5 X 10 = 125 feet

Anistropy Ratio (Kh/Kv) = 1,949:1



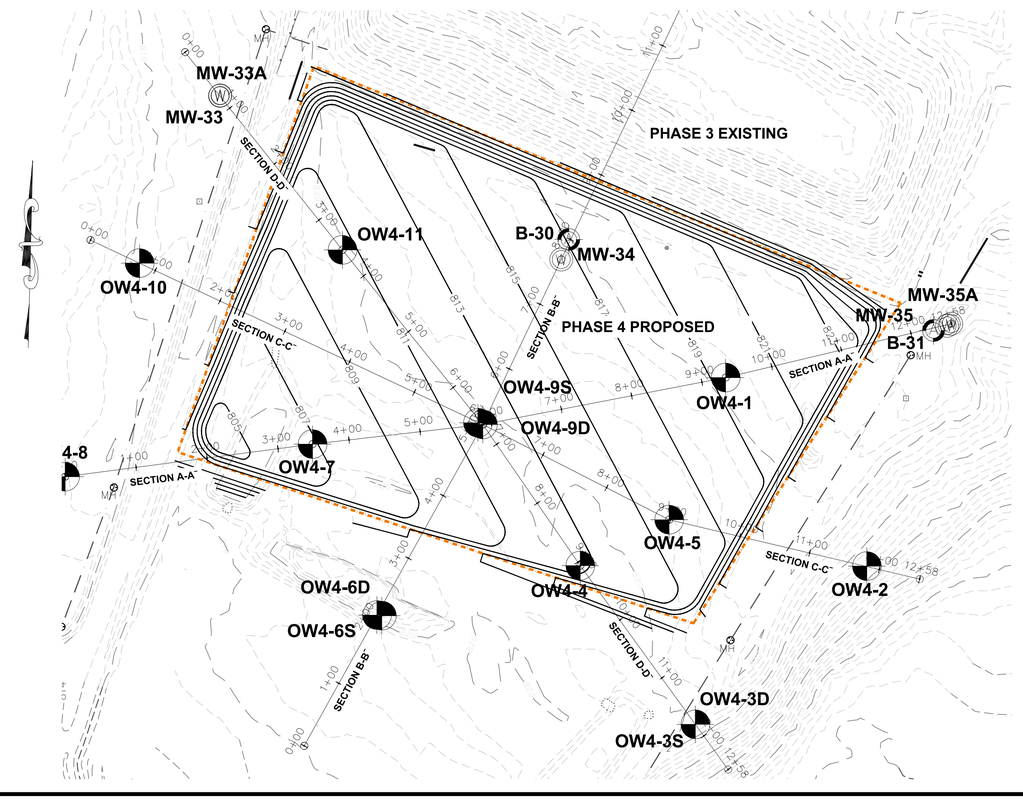
OW4-6S 791.66 & OW4-6D 790.61

Kh = 1.49 ft/day 1/vKh = 0.82 X 10 = 8.2 feet
Kv = 0.074 ft/day 1/vKv= 3.67 X 10 = 36.7 feet

Anistropy Ratio (Kh/Kv) = 20:1

0 50 100 150
HORIZONTAL

0 50 100 150
VERTICAL



Municipal Services Engineering Company, P.A.
P.O. BOX 97, GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349, BOONE, N.C. 28607 (828) 262-1767
LICENSE NUMBER: C-0281

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY
CROUSE, NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

FLOW DIRECTION CALCULATIONS

SCALE:	AS SHOWN
DATE:	9/30/2015
DRWN. BY:	R.MOSS
CHKD. BY:	S.GANDY
PROJECT NUMBER	G15041
DRAWING NO.	SHEET NO.

APPENDIX D

DRAWINGS

Sheet 1 Boring Location Plan

Sheet 2 Groundwater Surface

Sheet 3 Seasonal High Groundwater

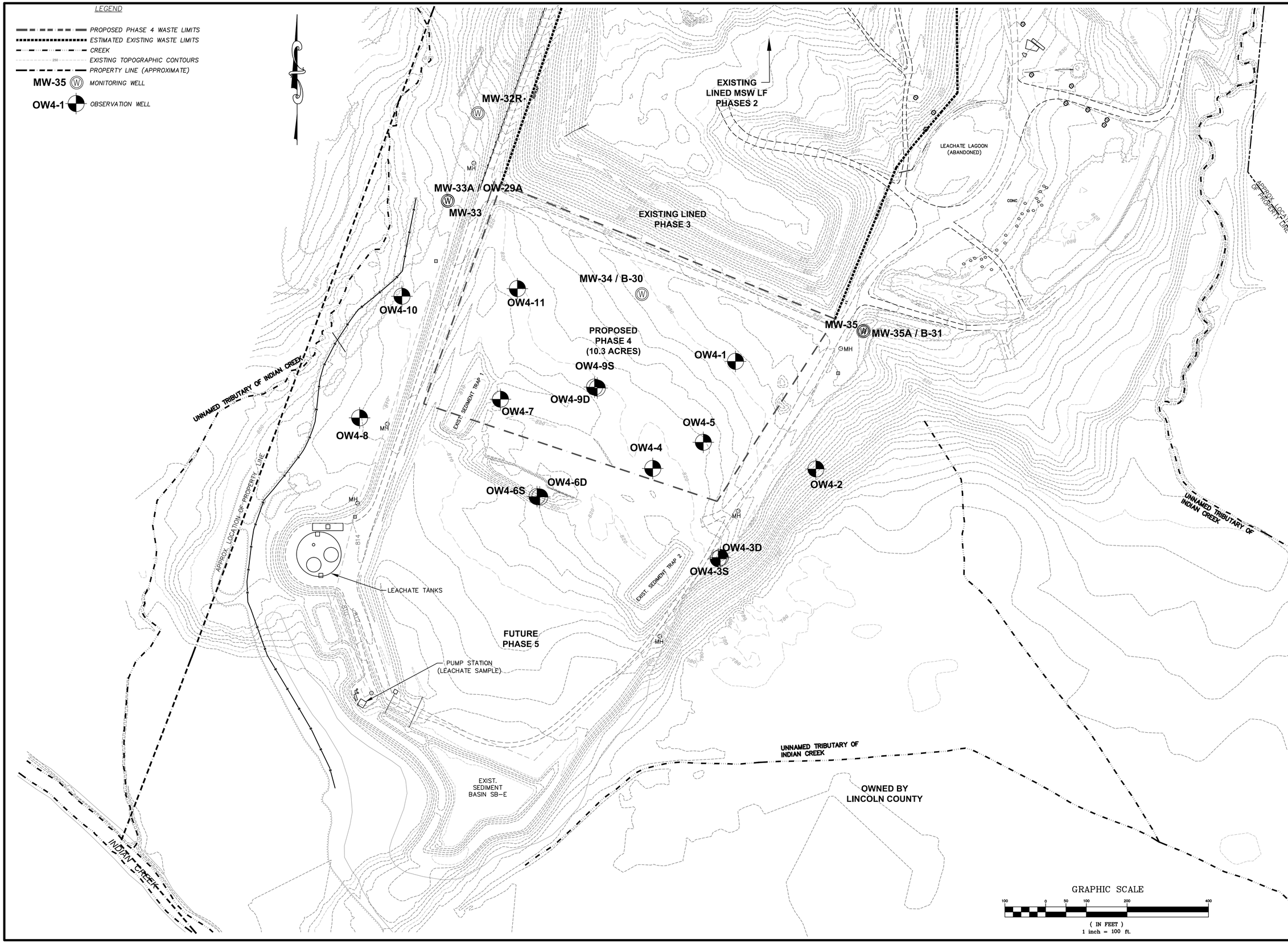
Sheet 4 Top of Bedrock

Sheet 5 Estimated Long Term Seasonal High Groundwater

Sheet 6 Hydrogeologic Cross Section (A-A¯ and B-B¯)

Sheet 7 Hydrogeologic Cross Section (C-C¯ and D-D¯)

Sheet 8 Well Abandonment



Municipal Services Engineering Company, P.A.

P.O. BOX 97, GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
LICENSE NUMBER: C-0281

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY
CROUSE, NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

BORING LOCATION PLAN

SCALE:	1" = 100'
DATE:	10-13-2015
DRWN. BY:	R.MOSS
CHKD. BY:	S.GANDY
PROJECT NUMBER	G15041
DRAWING NO.	
SHEET NO.	1

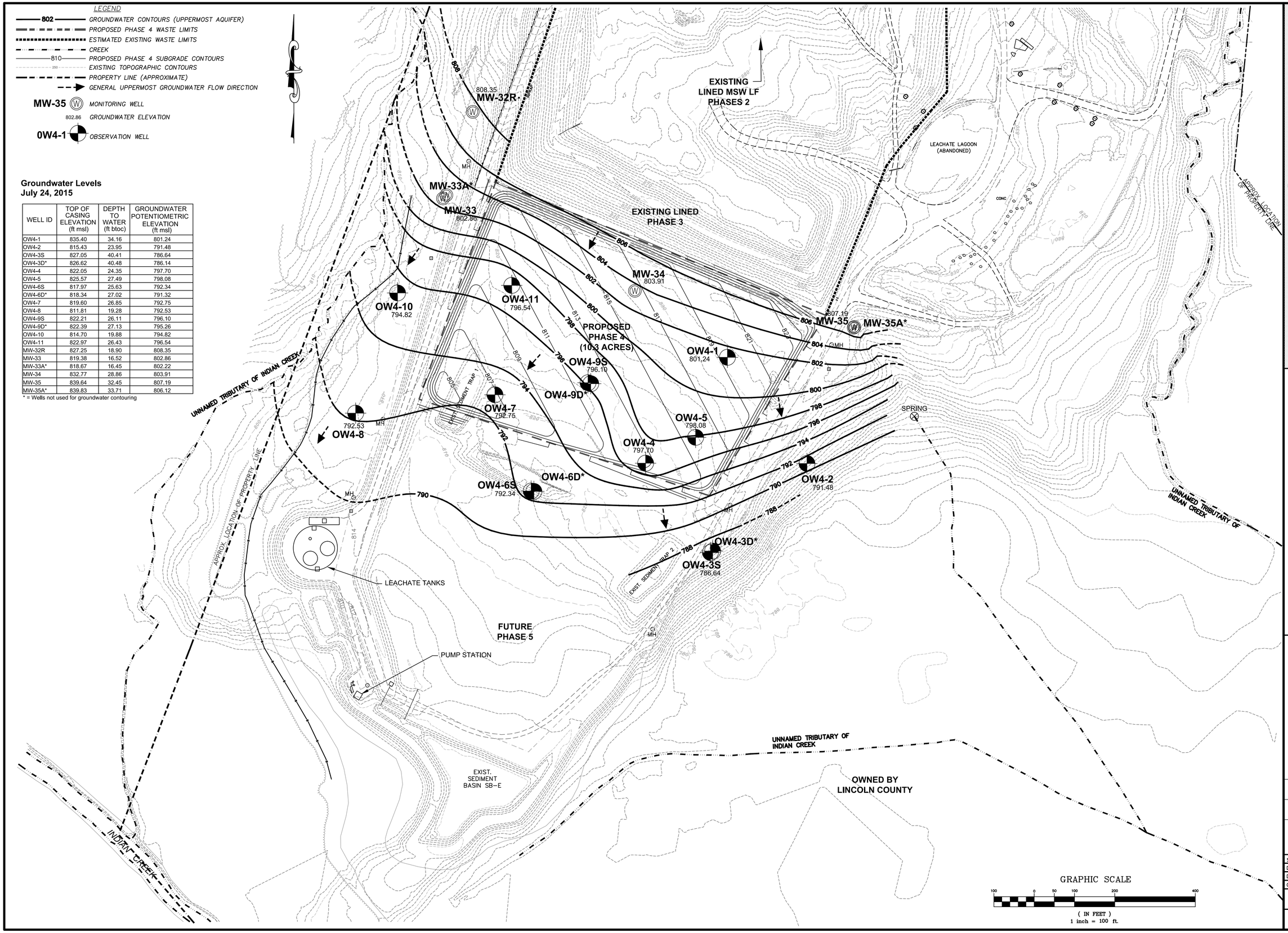
LEGEND

- 802 — GROUNDWATER CONTOURS (UPPERMOST AQUIFER)
- PROPOSED PHASE 4 WASTE LIMITS
- ESTIMATED EXISTING WASTE LIMITS
- CREEK
- 810 — PROPOSED PHASE 4 SUBGRADE CONTOURS
- 250 — EXISTING TOPOGRAPHIC CONTOURS
- PROPERTY LINE (APPROXIMATE)
- GENERAL UPPERMOST GROUNDWATER FLOW DIRECTION
- MW-35 — MONITORING WELL
- 802.86 — GROUNDWATER ELEVATION
- 0W4-1 — OBSERVATION WELL

Groundwater Levels
July 24, 2015

WELL ID	TOP OF CASING ELEVATION (ft msl)	DEPTH TO WATER (ft btoc)	GROUNDWATER POTENTIOMETRIC ELEVATION (ft msl)
OW4-1	835.40	34.16	801.24
OW4-2	815.43	23.95	791.48
OW4-3S	827.05	40.41	786.64
OW4-3D*	826.62	40.48	786.14
OW4-4	822.05	24.35	797.70
OW4-5	825.57	27.49	798.08
OW4-6S	817.97	25.63	792.34
OW4-6D*	818.34	27.02	791.32
OW4-7	819.60	26.85	792.75
OW4-8	811.81	19.28	792.53
OW4-9S	822.21	26.11	796.10
OW4-9D*	822.39	27.13	795.26
OW4-10	814.70	19.88	794.82
OW4-11	822.97	26.43	796.54
MW-32R	827.25	18.90	808.35
MW-33	819.38	16.52	802.86
MW-33A*	818.67	16.45	802.22
MW-34	832.77	28.86	803.91
MW-35	839.64	32.45	807.19
MW-35A*	839.83	33.71	806.12

* = Wells not used for groundwater contouring



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P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
LICENSE NUMBER: C-0281

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY
CROUSE, NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

GROUNDWATER SURFACE
JULY 24, 2015

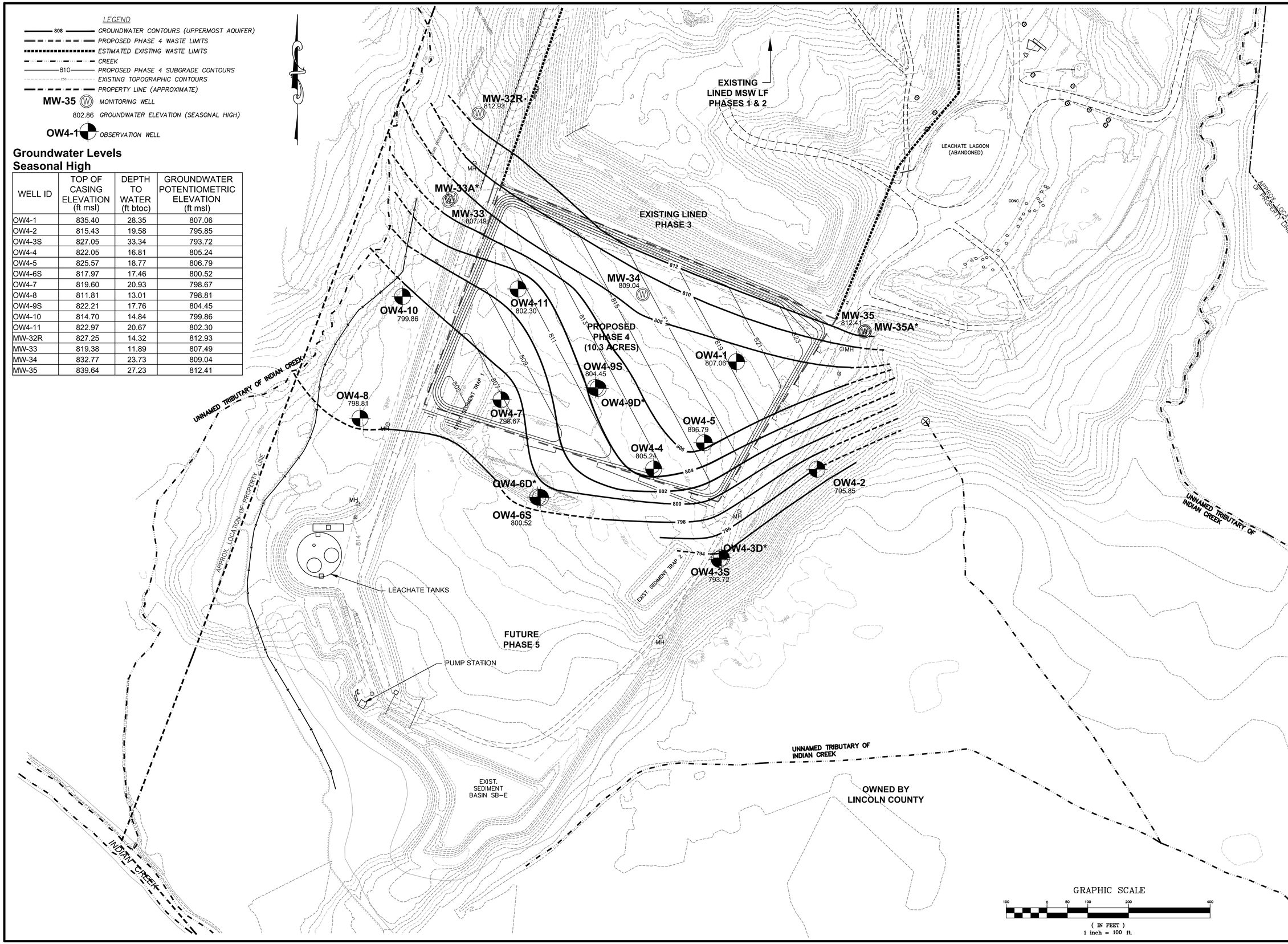
SCALE:	1" = 100'
DATE:	10-13-2015
DRWN. BY:	R.MOSS
CHKD. BY:	S.GANDY
PROJECT NUMBER	G15041
DRAWING NO.	
SHEET NO.	2

LEGEND

- 808 — GROUNDWATER CONTOURS (UPPERMOST AQUIFER)
- PROPOSED PHASE 4 WASTE LIMITS
- ESTIMATED EXISTING WASTE LIMITS
- CREEK
- 810 — PROPOSED PHASE 4 SUBGRADE CONTOURS
- 250 — EXISTING TOPOGRAPHIC CONTOURS
- PROPERTY LINE (APPROXIMATE)
- MW-35 (W) MONITORING WELL
- 802.86 GROUNDWATER ELEVATION (SEASONAL HIGH)
- OW4-1 OBSERVATION WELL

Groundwater Levels
Seasonal High

WELL ID	TOP OF CASING ELEVATION (ft msl)	DEPTH TO WATER (ft btoc)	GROUNDWATER POTENTIOMETRIC ELEVATION (ft msl)
OW4-1	835.40	28.35	807.06
OW4-2	815.43	19.58	795.85
OW4-3S	827.05	33.34	793.72
OW4-4	822.05	16.81	805.24
OW4-5	825.57	18.77	806.79
OW4-6S	817.97	17.46	800.52
OW4-7	819.60	20.93	798.67
OW4-8	811.81	13.01	798.81
OW4-9S	822.21	17.76	804.45
OW4-10	814.70	14.84	799.86
OW4-11	822.97	20.67	802.30
MW-32R	827.25	14.32	812.93
MW-33	819.38	11.89	807.49
MW-34	832.77	23.73	809.04
MW-35	839.64	27.23	812.41



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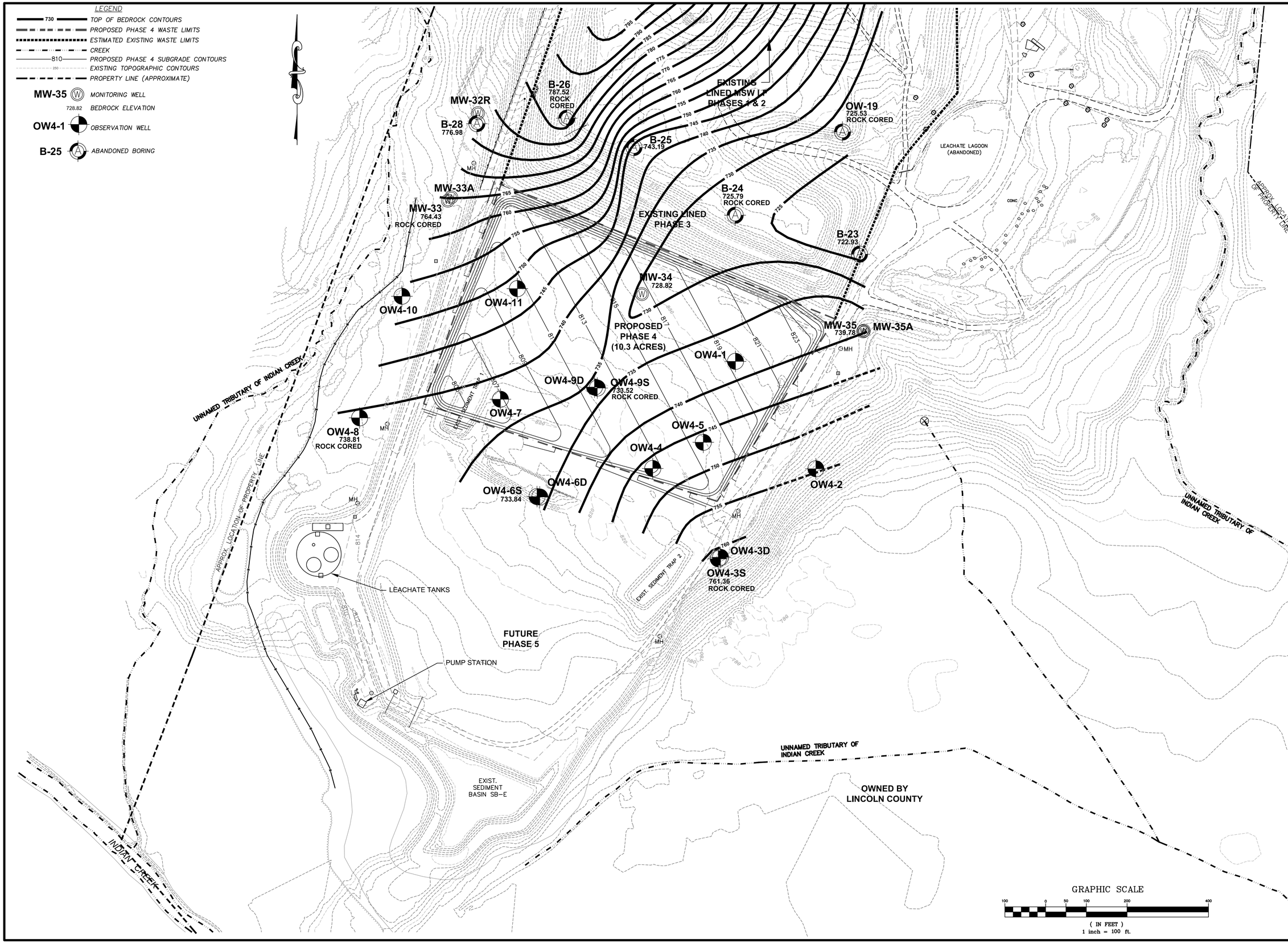
MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY
CROUSE, NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SEASONAL HIGH GROUNDWATER SURFACE

SCALE:	1" = 100'
DATE:	10-13-2015
DRWN. BY:	R.MOSS
CHKD. BY:	S.GANDY
PROJECT NUMBER	G15041
DRAWING NO.	
SHEET NO.	3



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LICENSE NUMBER: C-0281

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY CROUSE, NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

TOP OF BEDROCK

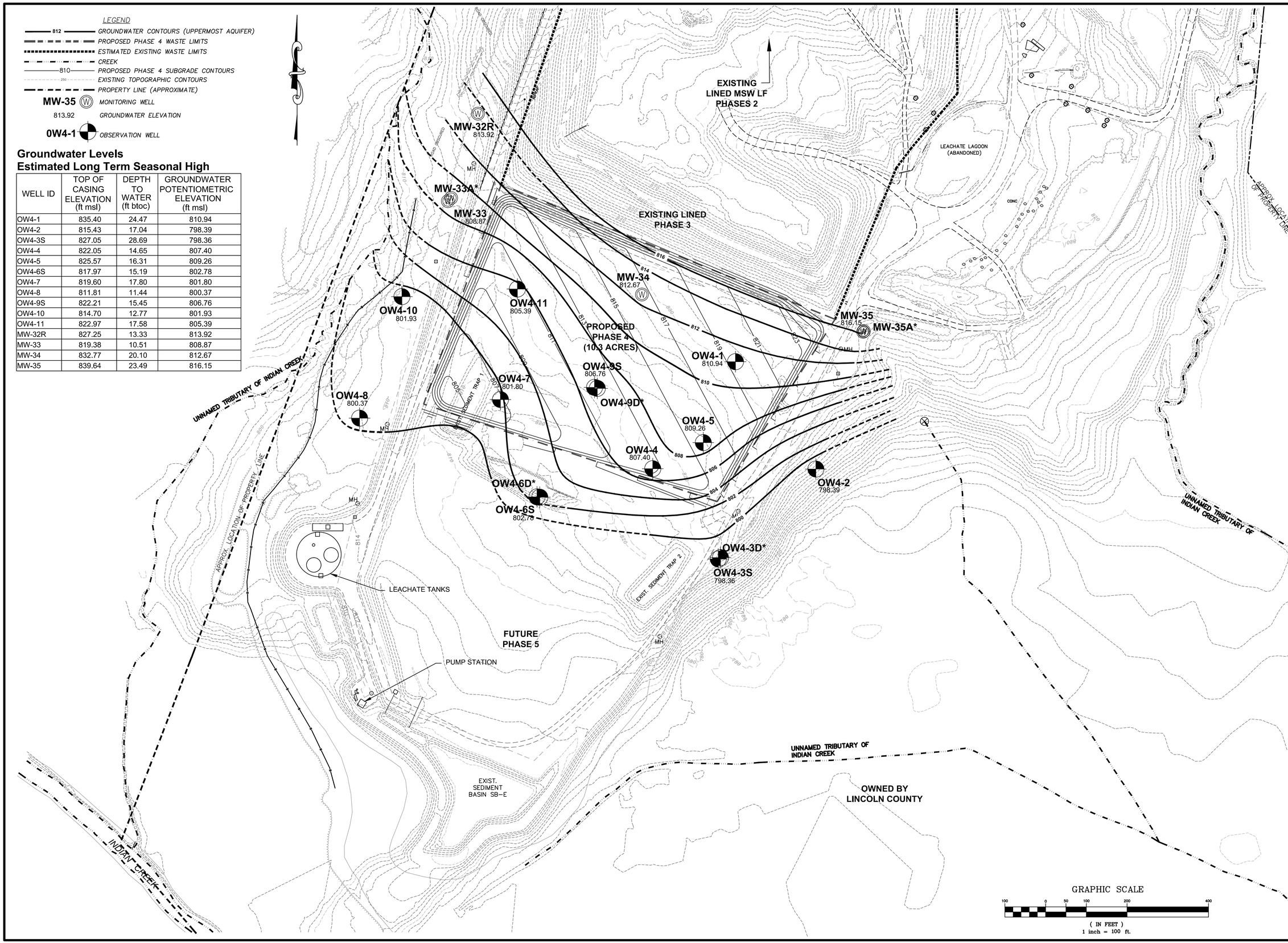
SCALE:	1" = 100'
DATE:	10-13-2015
DRWN. BY:	R.MOSS
CHKD. BY:	S.GANDY
PROJECT NUMBER	G15041
DRAWING NO.	SHEET NO. 4

LEGEND

- 812 — GROUNDWATER CONTOURS (UPPERMOST AQUIFER)
- PROPOSED PHASE 4 WASTE LIMITS
- ESTIMATED EXISTING WASTE LIMITS
- CREEK
- 810 — PROPOSED PHASE 4 SUBGRADE CONTOURS
- 250 — EXISTING TOPOGRAPHIC CONTOURS
- PROPERTY LINE (APPROXIMATE)
- MW-35 (W) MONITORING WELL
- 813.92 GROUNDWATER ELEVATION
- 0W4-1 OBSERVATION WELL

Groundwater Levels
Estimated Long Term Seasonal High

WELL ID	TOP OF CASING ELEVATION (ft msl)	DEPTH TO WATER (ft btoc)	GROUNDWATER POTENTIOMETRIC ELEVATION (ft msl)
OW4-1	835.40	24.47	810.94
OW4-2	815.43	17.04	798.39
OW4-3S	827.05	28.69	798.36
OW4-4	822.05	14.65	807.40
OW4-5	825.57	16.31	809.26
OW4-6S	817.97	15.19	802.78
OW4-7	819.60	17.80	801.80
OW4-8	811.81	11.44	800.37
OW4-9S	822.21	15.45	806.76
OW4-10	814.70	12.77	801.93
OW4-11	822.97	17.58	805.39
MW-32R	827.25	13.33	813.92
MW-33	819.38	10.51	808.87
MW-34	832.77	20.10	812.67
MW-35	839.64	23.49	816.15



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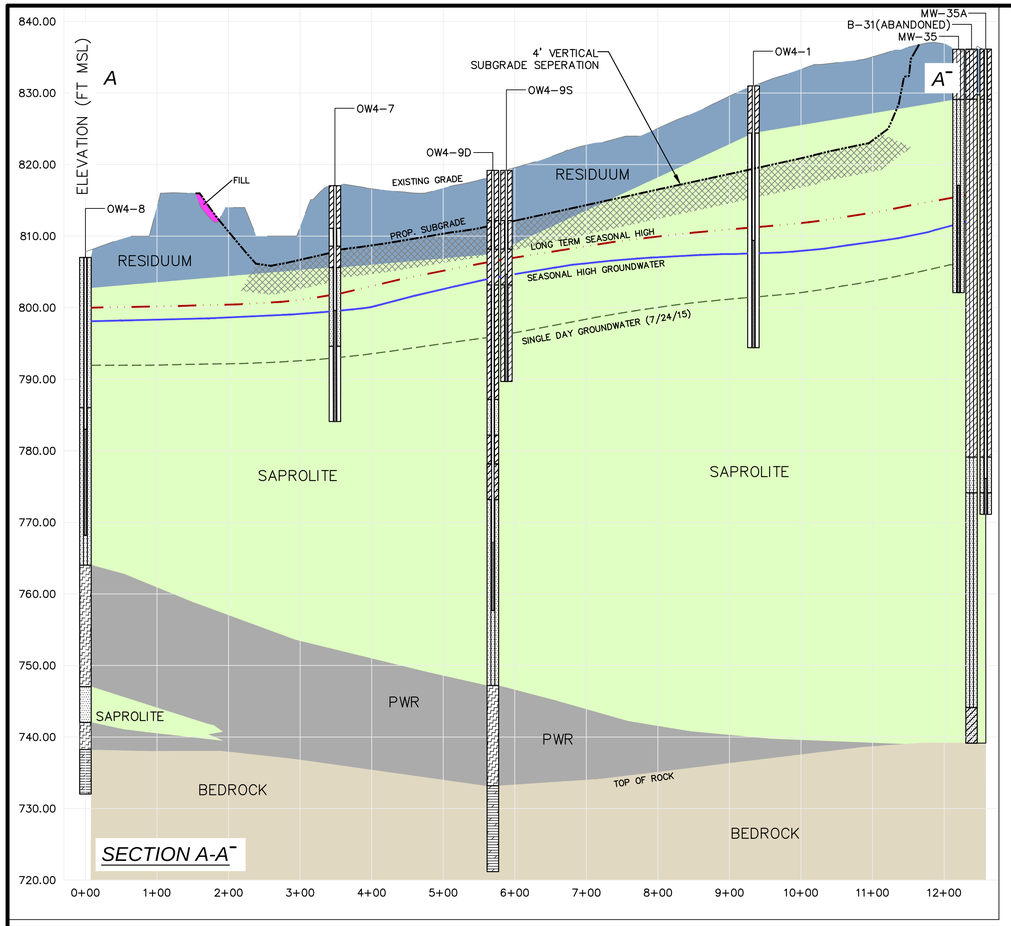
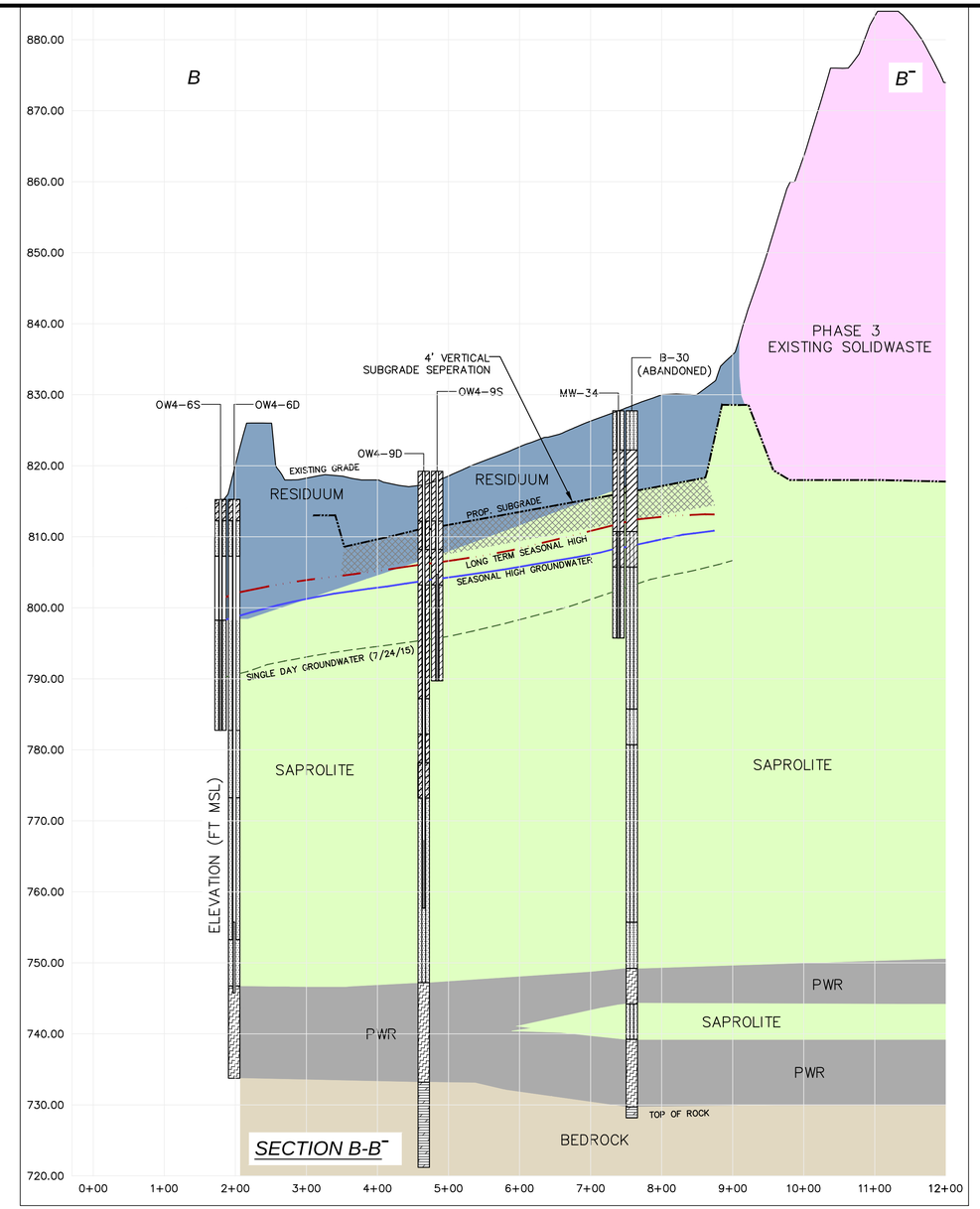
MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY CROUSE, NORTH CAROLINA

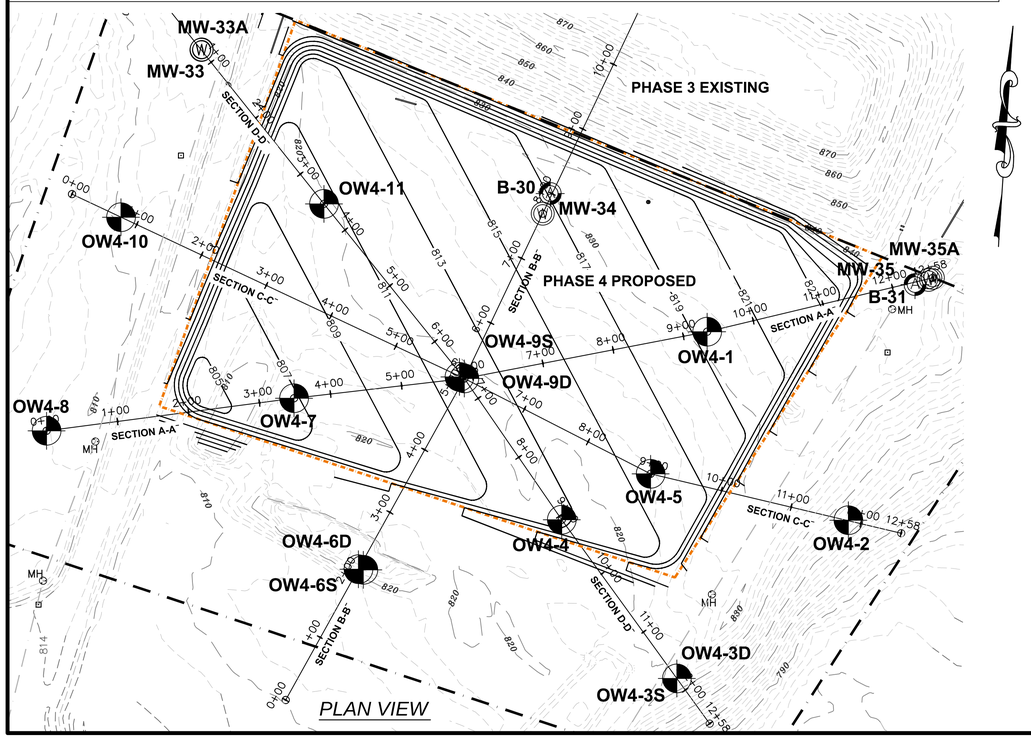
DATE	BY	REV.	DESCRIPTION

LONG TERM SEASONAL HIGH GROUNDWATER SURFACE MAP

SCALE: 1" = 100'
DATE: 10-13-2015
DRWN. BY: R.MOSS
CHKD. BY: S.GANDY
PROJECT NUMBER G15041
DRAWING NO.
SHEET NO. 5







LEGEND:

KEY TO BORING LOG

- CLAYEY SAND
- CLAYEY SILT
- SAND
- ROCK
- PARTIALLY WEATHERED ROCK
- SILTY SAND
- SANDY SILT
- SILT
- CLAY
- SILTY CLAY
- SANDY CLAY

KEY TO WELL LOG

- SCREEN

0 100 200 300
HORIZONTAL

0 10 20 30
VERTICAL

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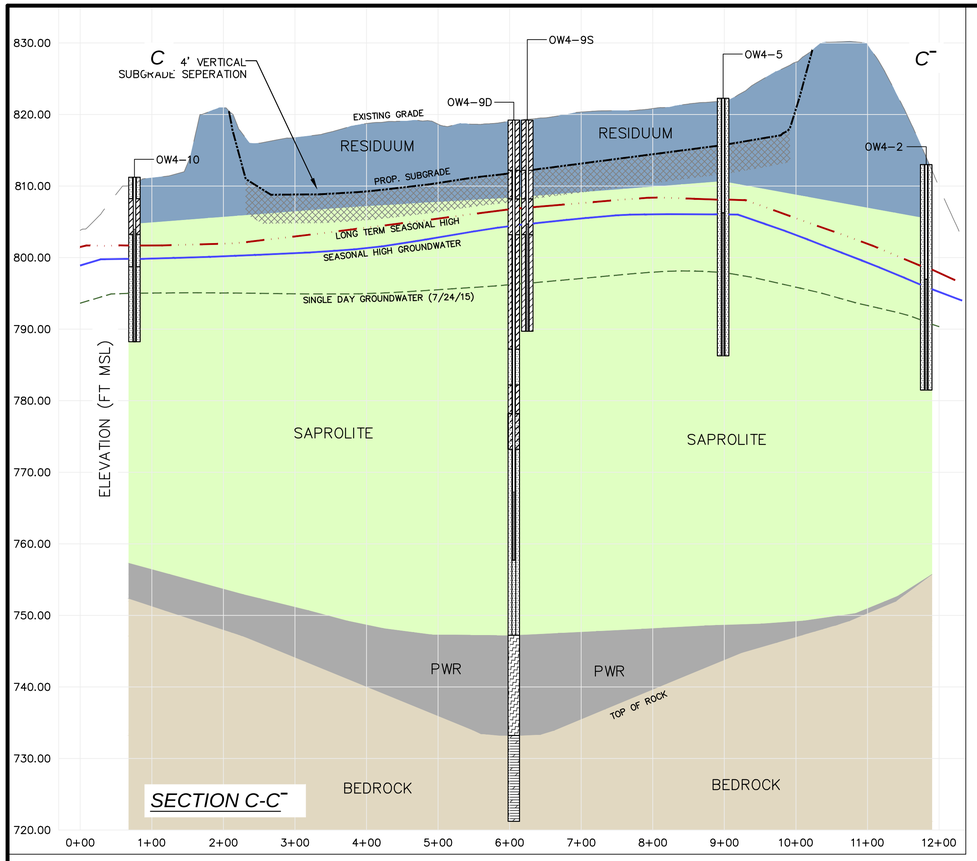
LICENSE NUMBER: C-0281

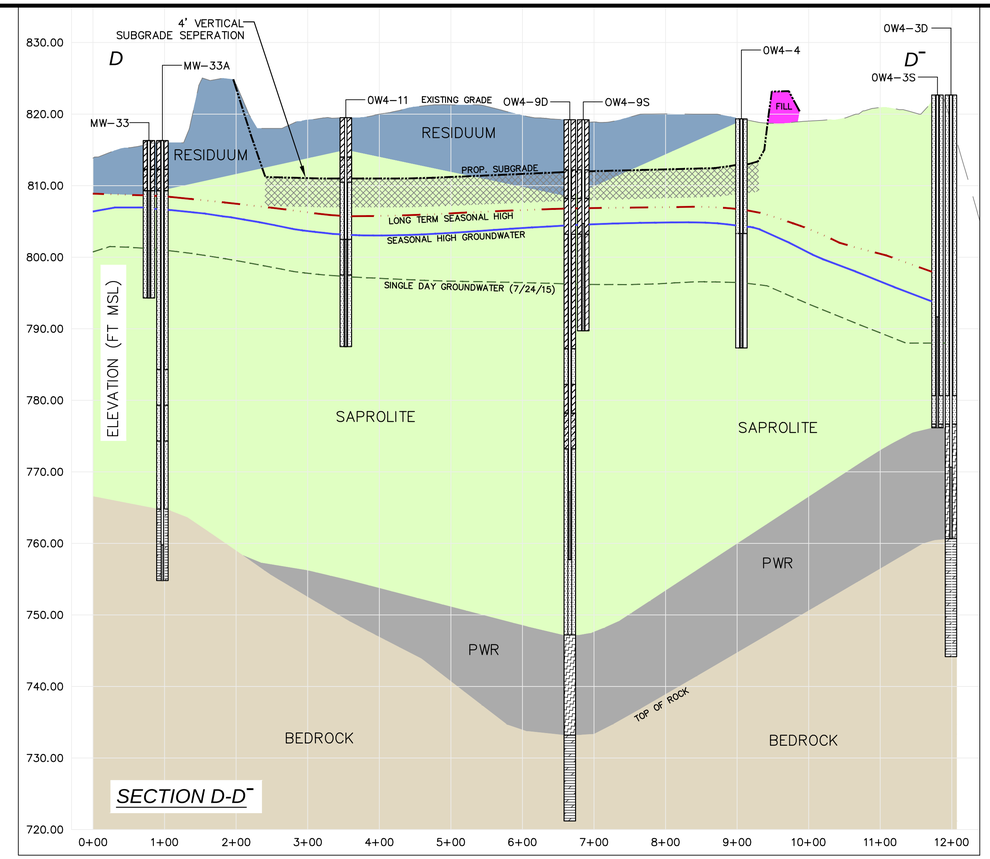
MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY
CROUSE, NORTH CAROLINA

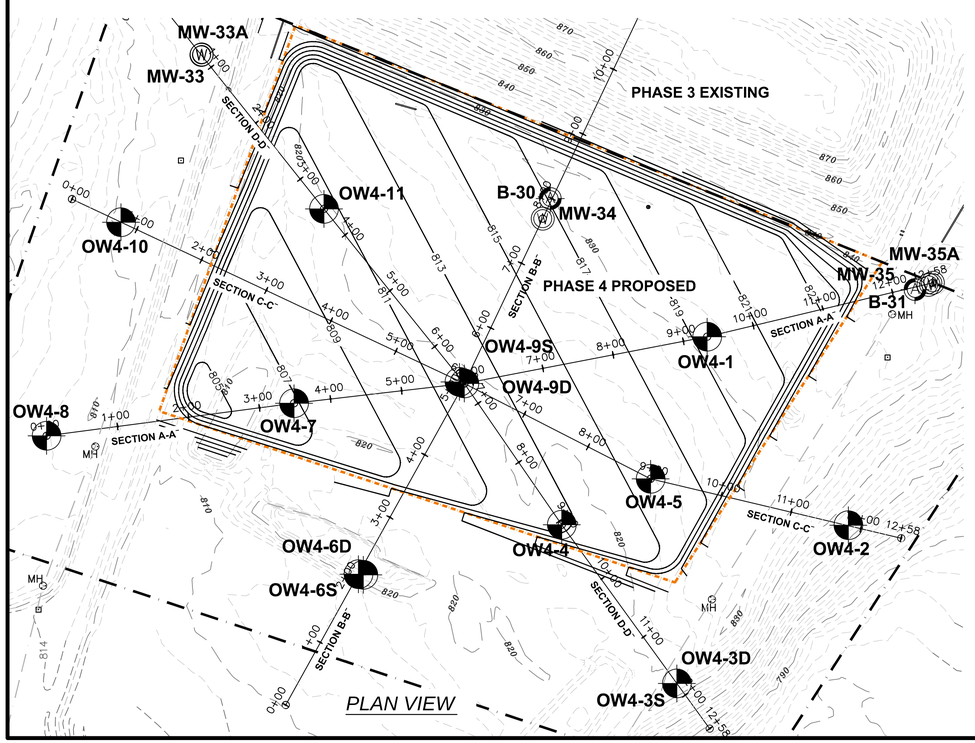
DATE	BY	REV.	DESCRIPTION

HYDROGEOLOGIC CROSS-SECTIONS (A-A' and B-B')

SCALE:	AS SHOWN
DATE:	9/30/2015
DRWN. BY:	R.MOSS
CHKD. BY:	S.GANDY
PROJECT NUMBER	G15041
DRAWING NO.	SHEET NO. 6







LEGEND:

KEY TO BORING LOG

- CLAYEY SAND
- CLAYEY SILT
- SAND
- ROCK
- PARTIALLY WEATHERED ROCK
- SILTY SAND
- SANDY SILT
- SILT
- CLAY
- SILTY CLAY
- SANDY CLAY

KEY TO WELL LOG

- SCREEN

0 100 200 300
HORIZONTAL

0 10 20 30
VERTICAL

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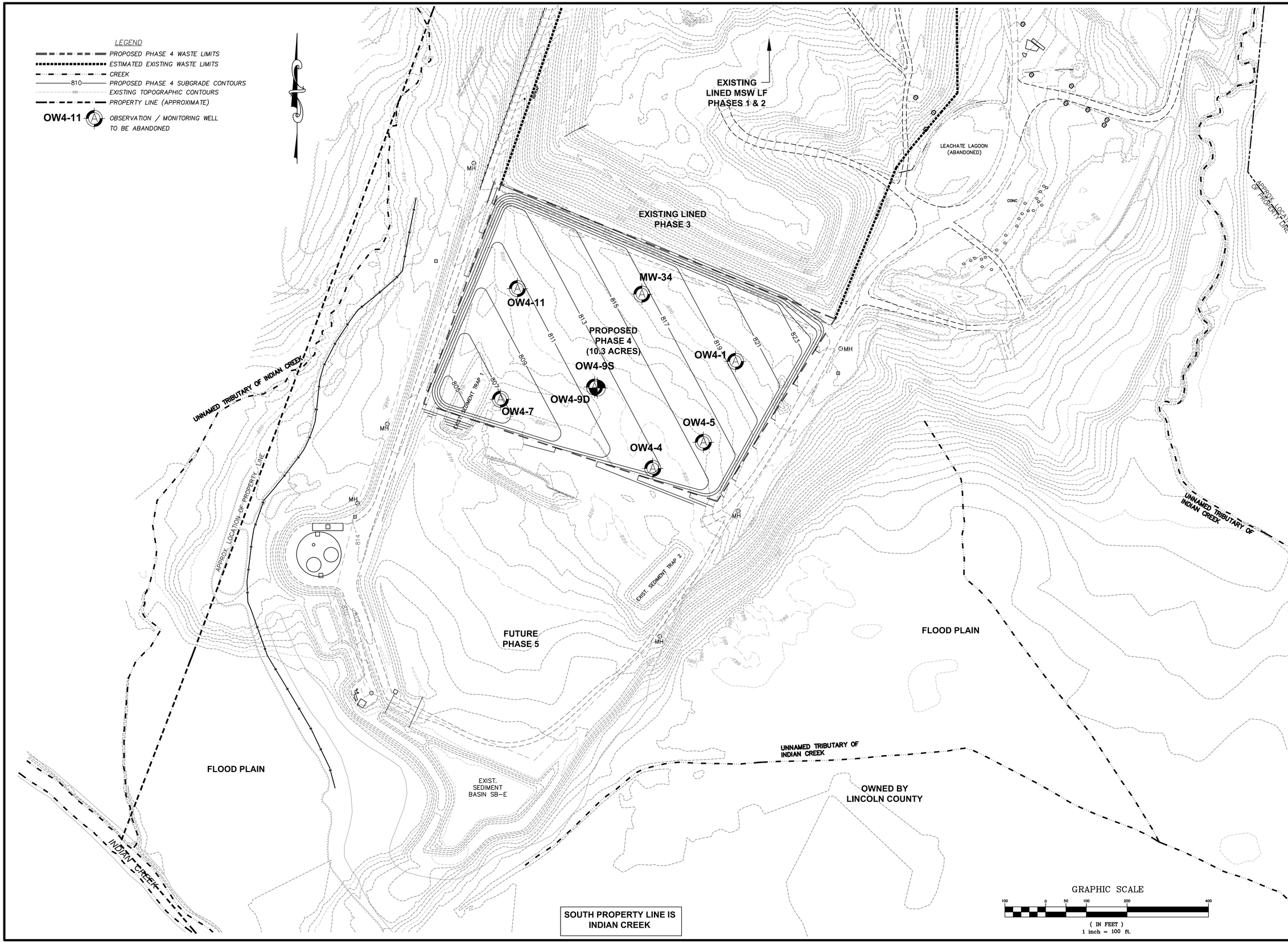
MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY
CROUSE, NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

HYDROGEOLOGIC CROSS-SECTIONS (C-C' and D-D')

SCALE:	AS SHOWN
DATE:	9/30/2015
DRWN. BY:	R.MOSS
CHKD. BY:	S.GANDY
PROJECT NUMBER	G15041
DRAWING NO.	
SHEET NO.	7



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LICENSE NUMBER: C-0281

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LINCOLN COUNTY
CROUSE, NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

WELL ABANDONMENT

SCALE:	1" = 100'
DATE:	10-13-2015
DRWN. BY:	R.MOSS
CHKD. BY:	S.GANDY
PROJECT NUMBER	G15041
DRAWING NO.	SHEET NO. 8

APPENDIX E

DATA FROM PREVIOUS STUDIES

BORING LOGS OF BORINGS FROM PHASE 3 (NORTH OF PROPOSED PH 4) THAT ENCOUNTERED BEDROCK. USED TO IMPROVE TOP OF BEDROCK MAP SHEET 4.

OW-19

B-23

B-24

B-25

B-26

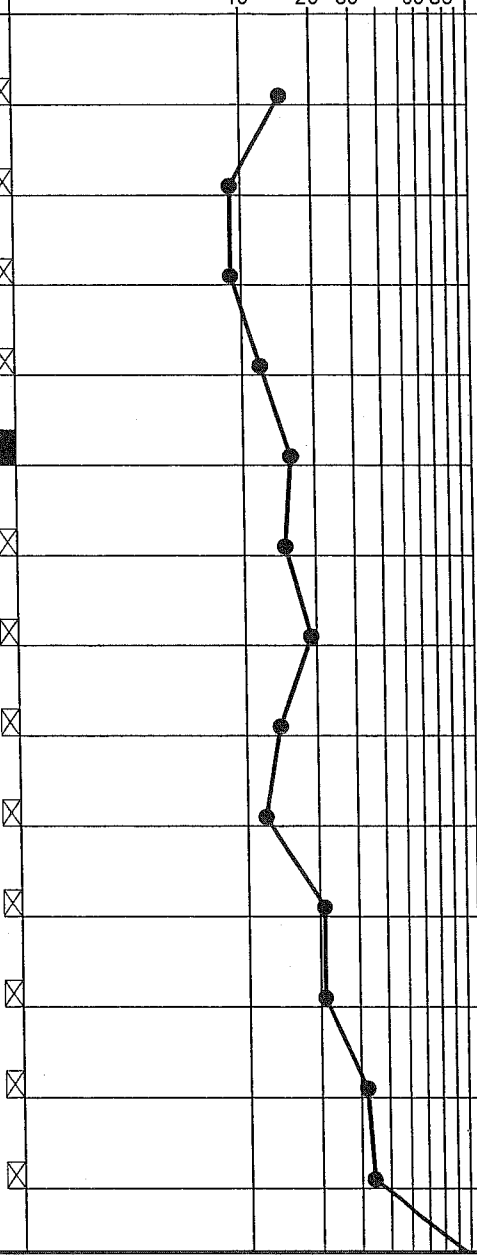
B-28

PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-23

DATE DRILLED: 6/5/03	ELEVATION: 837.9	NOTES: Abandoned geotechnical boring for OW-23 location - Phase III Hydro Study. Boring abandoned after completion by grouting.
DRILLING METHOD: 3¼" H.S.A.	BORING DEPTH: 115.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Brian Wilson, NC Cert No. 2718	DRILL RIG: Mobile B-57	

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
	RESIDUUM: Reddish Tan Micaceous Slightly Clayey Fine Sandy **SILT**			
5	RESIDUUM: Tan and White Micaceous Slightly Clayey Silty Medium to Fine **SAND (SM)**	832.9	1	15
10	SAPROLITE: Reddish Tan Slightly Sandy Clayey **SILT** with Manganese Staining	827.9	2	9
15	SAPROLITE: Tannish Red Clayey Coarse to Fine Sandy **SILT** with Manganese Staining	822.9	3	9
20	SAPROLITE: Reddish Tan Clayey Medium to Fine Sandy **SILT** with Manganese Staining **(ML)**	817.9	4	12
25	SAPROLITE: Tannish Red Clayey Coarse to Fine Sandy **SILT** with Manganese Staining **(MH)** SAPROLITE: Tannish Red Fine Sandy Clayey **SILT** with Grey and White Sand Seams	812.9	5	16
30		807.9	6	15
35	SAPROLITE: Grey and White Slightly Clayey Silty Medium to Fine **SAND**	802.9	7	19
40	SAPROLITE: Reddish Tan and Grey Laminated Fine Sandy Clayey **SILT**	797.9	8	14
45	SAPROLITE: Grey and White Micaceous Slightly Clayey Silty Medium to Fine **SAND (SM)**	792.9	9	12
50		787.9	10	21
55		782.9	11	21
60	SAPROLITE: Grey and White Micaceous Slightly Clayey Silty Coarse to Fine **SAND (SM)**	777.9	12	32
65	SAPROLITE: Reddish Brown Slightly Clayey Medium to Fine Sandy **SILT** with Large Quartz Fragments	772.9	13	34

STANDARD PENETRATION TEST DATA (blows/ft)



1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
2. *PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.*

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Charlotte, NC 28273

BORING LOG NEWLOGS.GPJ S&ME.GDT 8/14/04

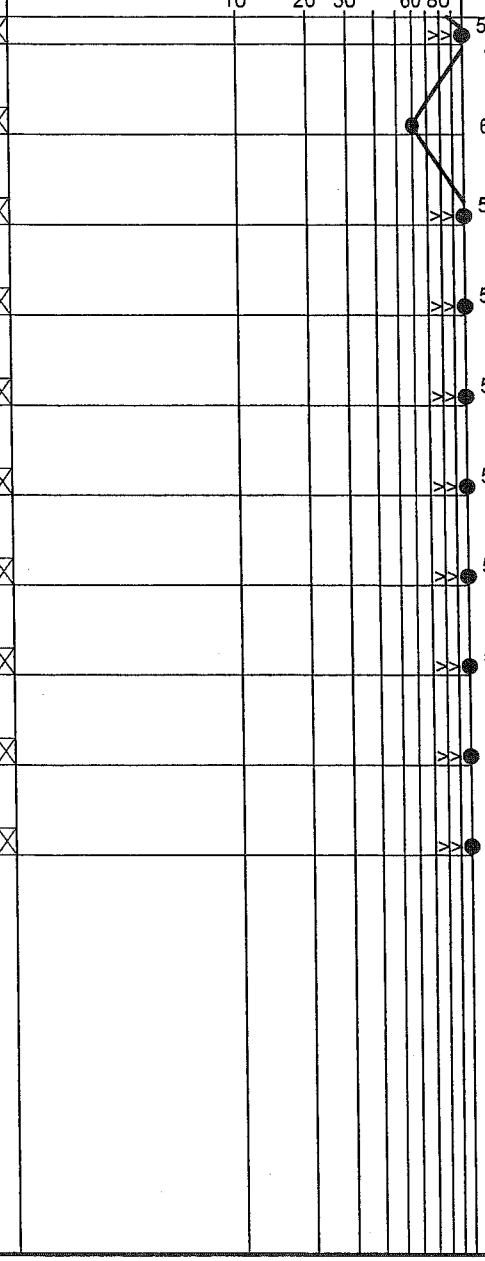
PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-23

DATE DRILLED: 6/5/03	ELEVATION: 837.9	NOTES: Abandoned geotechnical boring for OW-23 location - Phase III Hydro Study. Boring abandoned after completion by grouting.
RILLING METHOD: 3¼" H.S.A.	BORING DEPTH: 115.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Brian Wilson, NC Cert No. 2718	DRILL RIG: Mobile B-57	

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
70	PARTIALLY WEATHERED ROCK: When Sampled Becomes Grey, Green and White Micaceous Silty Coarse to Fine **SAND** with Quartz Fragments	767.9	14	50/4
75		762.9	15	60
80	PARTIALLY WEATHERED ROCK: When Sampled Becomes Green and White Silty Coarse to Fine **SAND**	757.9	16	50/4
85		752.9	17	50/4
90	PARTIALLY WEATHERED ROCK: When Sampled Becomes Brown and White Micaceous Slightly Clayey Silty Coarse to Fine **SAND** with Traces of Manganese Staining **(SM)**	747.9	18	50/4
95		742.9	19	50/3
100		737.9	20	50/4
105		732.9	21	50/3
110		727.9	22	50/1
115	PARTIALLY WEATHERED ROCK: When Sampled Becomes Brown, White and Green Slightly Clayey Silty Coarse to Fine **SAND** **AUGER REFUSAL AT 115 FT BLS**	722.9	23	50/1

WATER LEVEL

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG NEWLOGS.GPJ S&ME.GDT 8/14/04

1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
2. *PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.*

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Charlotte, NC 28273

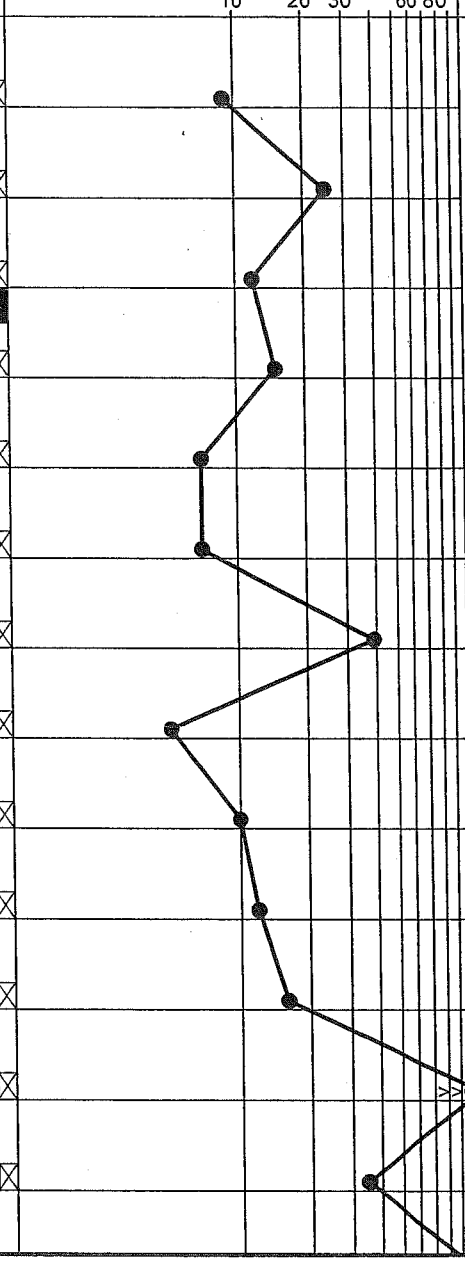
PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-24

DATE DRILLED: 6/11/03	ELEVATION: 834.8	NOTES: Abandoned geotechnical boring for OW-24/24A location - Phase III Hydro Study. Boring abandoned after completion by grouting.
RILLING METHOD: 3¼" H.S.A.	BORING DEPTH: 119.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Brian Wilson, NC Cert No. 2718	DRILL RIG: Mobile B-57	

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
	SAPROLITE: Reddish Tan Slightly Clayey Fine Sandy **SILT**			
5	SAPROLITE: White Slightly Clayey Silty Coarse to Fine **SAND** with Manganese Staining	829.8	1	9
10	SAPROLITE: Reddish Tan Micaceous Slightly Clayey Fine Sandy **SILT** with Traces of Manganese Staining	824.8	2	25
15	SAPROLITE: Reddish Tan and White Laminated Micaceous Slightly Clayey Silty Coarse to Fine **SAND** with Traces of Manganese Staining **(SM)**	819.8	3	12
20	SAPROLITE: White Silty Coarse to Fine **SAND** with Manganese Staining	814.8	4	15
25	SAPROLITE: Tannish Red to Brown Fine Sandy Clayey **SILT** with Manganese Staining	809.8	5	7
30		804.8	6	7
35	SAPROLITE: White Silty Coarse to Fine **SAND** with Manganese Staining	799.8	7	39
40	SAPROLITE: Red and Brown Laminated Micaceous Clayey Medium to Fine Sandy **SILT** with Manganese Staining **(ML)**	794.8	8	5
45		789.8	9	10
50		784.8	10	12
55		779.8	11	16
60	SAPROLITE: Brown and Greenish Tan Laminated Slightly Clayey Medium to Fine Sandy **SILT** with Manganese Staining **(MH)**	774.8	12	18
65		769.8	13	35

WATER LEVEL

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG NEWLOGS.GPJ S&ME.GDT 8/14/04

1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
2. *PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.*

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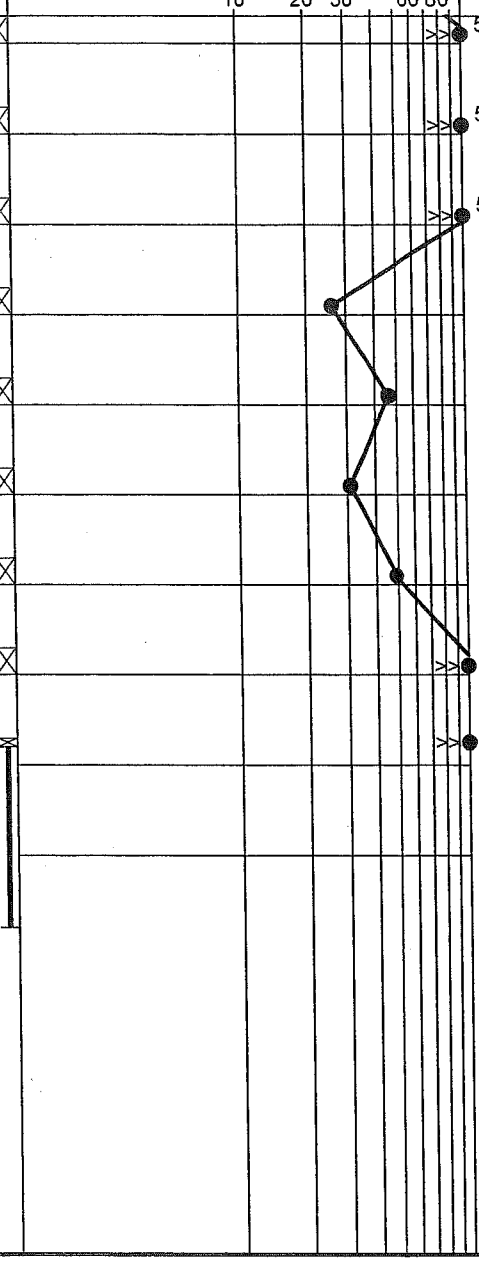
Charlotte, NC 28273

PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-24

DATE DRILLED: 6/11/03	ELEVATION: 834.8	NOTES: Abandoned geotechnical boring for OW-24/24A location - Phase III Hydro Study. Boring abandoned after completion by grouting.
DRILLING METHOD: 3¼" H.S.A.	BORING DEPTH: 119.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Brian Wilson, NC Cert No. 2718	DRILL RIG: Mobile B-57	

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
70	PARTIALLY WEATHERED ROCK: When Sampled Becomes Brown and Greenish Tan Laminated Clayey Silty Medium to Fine **SAND** with Manganese Staining	764.8	14	50/2
75	PARTIALLY WEATHERED ROCK: When Sampled Becomes White Silty Coarse to Fine **SAND** with Manganese Staining	759.8	15	50/4
80	PARTIALLY WEATHERED ROCK: When Sampled Becomes Tan and White Slightly Micaceous Slightly Clayey Silty Coarse to Fine **SAND** with Manganese Staining **(SM)**	754.8	16	50/3
85	SAPROLITE: Tan and White Slightly Micaceous Slightly Clayey Coarse to Fine Sandy **SILT** with Manganese Staining	749.8	17	26
90		744.8	18	46
95		739.8	19	31
100		734.8	20	49
105	PARTIALLY WEATHERED ROCK: When Sampled Becomes Tan and White Slightly Micaceous Silty Coarse to Fine **SAND** with Manganese Staining	729.8	21	50/5
110	**AUGER REFUSAL AT 109 FT BLS** BEDROCK: Sampled as Very Weathered Biotite Gneiss	724.8	22	50/2
115	Run #1 - 109 to 112 ft bls REC = 86%, RQD = 31% Run #2 - 112 to 114 ft bls REC = 96%, RQD = 0% Run #3 - 114 to 119 ft bls REC = 80%, RQD = 17%	719.8	REC 85% RQD 18%	

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG NEWLOGS.GPJ S&ME.GDT 8/14/04

1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
2. *PENETRATION (N-VALUE) IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.*

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ROCK CORE DETAILS

Boring ID:	Job Name and Number:	Classification:
B-24	Lincoln County Landfill Phase III, 1356-03-255A	Very Weathered Biotie Gneiss

Core Depths (ft-bls):	Total Core Length (ft):
From: 109' To: 119'	10 feet

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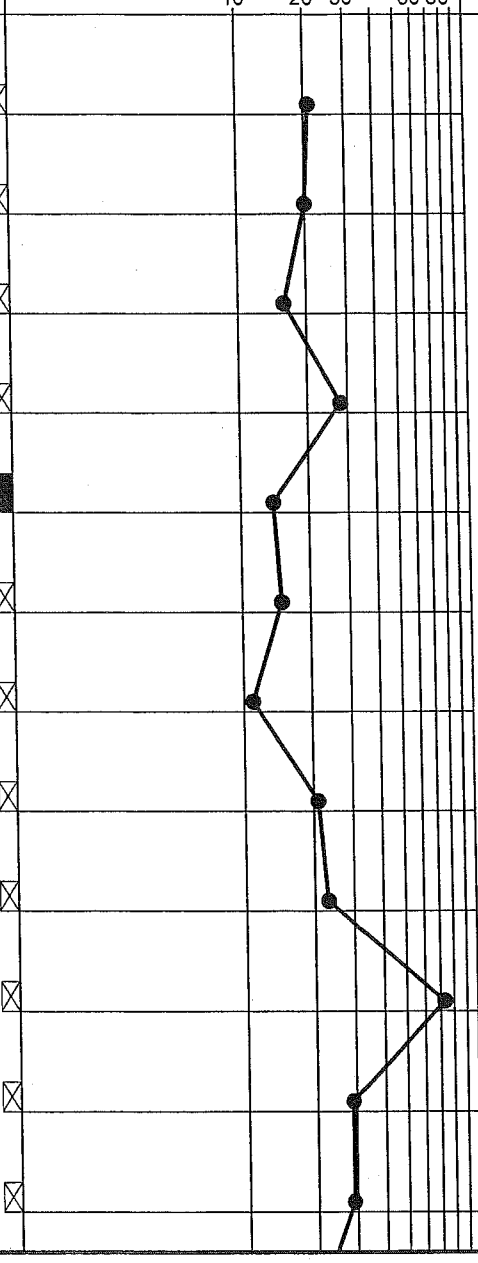
Run #1	3'	Run #2	2'	Run #3	5'	Run #	
From: 109'	To: 112'	From: 112'	To: 114'	From: 114'	To: 119'	From:	To:
Core Length:	2.58'	Core Length:	1.92'	Core Length:	4'	Core Length:	
Rec: 86%	RQD: 31%	Rec: 96%	RQD: 0%	Rec: 80%	RQD: 17%	Rec:	RQD:

PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-25

DATE DRILLED: 6/9/03	ELEVATION: 838.2	NOTES: Abandoned geotechnical boring for OW-25 location - Phase III Hydro Study. Boring abandoned after completion by grouting.
DRILLING METHOD: 3¼" H.S.A.	BORING DEPTH: 95.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Brian Wilson, NC Cert No. 2718	DRILL RIG: Mobile B-57	

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
5	RESIDUUM: Yellowish Red Slightly Sandy Silty **CLAY**	833.2	1	21
10	SAPROLITE: Red and White Laminated Fine Sandy Clayey **SILT**	828.2	2	20
15	SAPROLITE: Pinkish White Silty Coarse to Fine **SAND**	823.2	3	16
20	SAPROLITE: Brown and White Laminated Micaceous Clayey Coarse to Fine Sandy **SILT** with Traces of Manganese Staining **(ML)**	818.2	4	28
25		813.2	5	14
30	SAPROLITE: White Slightly Clayey Silty Coarse to Fine **SAND** with Traces of Manganese Staining **(SM)**	808.2	6	15
35	SAPROLITE: Brown and White Laminated Fine Sandy Clayey **SILT**	803.2	7	11
40	SAPROLITE: Brown and White Laminated Micaceous Clayey Coarse to Fine Sandy **SILT** with Manganese Staining	798.2	8	21
45	SAPROLITE: Red Micaceous Slightly Clayey Silty Coarse to Fine **SAND (SM)**	793.2	9	23
50	SAPROLITE: Brown and Tan Laminated Micaceous Slightly Clayey Silty Coarse to Fine **SAND** with Manganese Staining **(SM)**	788.2	10	73
55		783.2	11	29
60		778.2	12	29

STANDARD PENETRATION TEST DATA (blows/ft)



WATER LEVEL

GRAPHIC LOG

BORING LOG NEWLOGS.GPJ S&ME.GDT 8/14/04

1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
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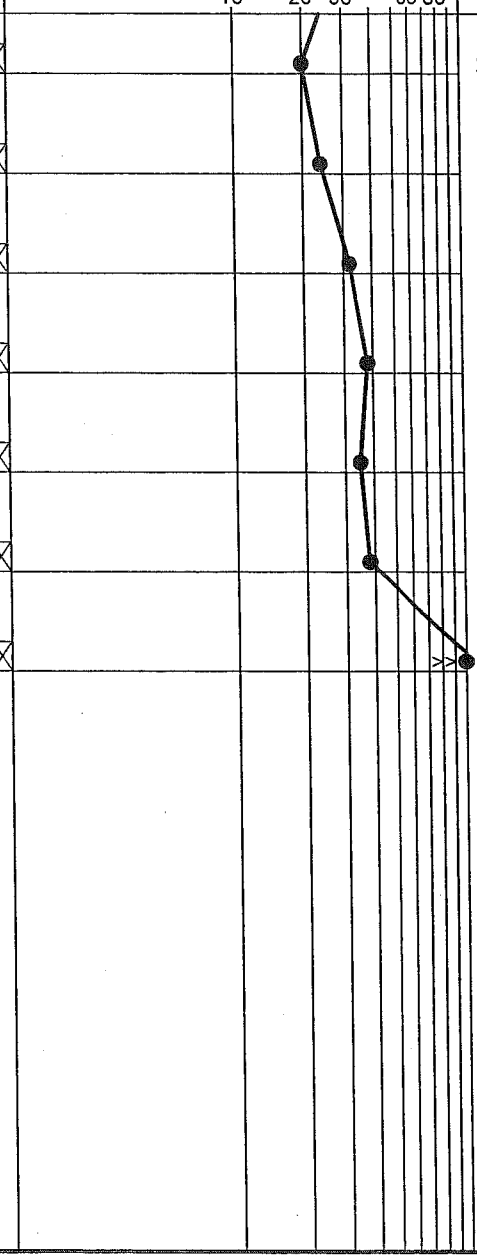
PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-25

DATE DRILLED: 6/9/03	ELEVATION: 838.2	NOTES: Abandoned geotechnical boring for OW-25 location - Phase III Hydro Study. Boring abandoned after completion by grouting.
DRILLING METHOD: 3¼" H.S.A.	BORING DEPTH: 95.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Brian Wilson, NC Cert No. 2718	DRILL RIG: Mobile B-57	

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	STANDARD PENETRATION TEST DATA (blows/ft)	N VALUE
65		SAPROLITE: Brown, Tan and White Laminated Clayey Medium to Fine Sandy **SILT** with Manganese Staining		773.2	13		20
70				768.2	14		24
75		SAPROLITE: Brown and White Micaceous Silty Coarse to Fine **SAND**		763.2	15		32
80		SAPROLITE: Brown, Tan and White Laminated Slightly Clayey Silty Coarse to Fine **SAND** with Manganese Staining **(SM)**		758.2	16		38
85				753.2	17		35
90				748.2	18		38
95		PARTIALLY WEATHERED ROCK: When Sampled Becomes Brown, Tan and White Laminated Silty Medium to Fine **SAND** with Manganese Staining **AUGER REFUSAL AT 95 FT BLS**		743.2	19		50/4



1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
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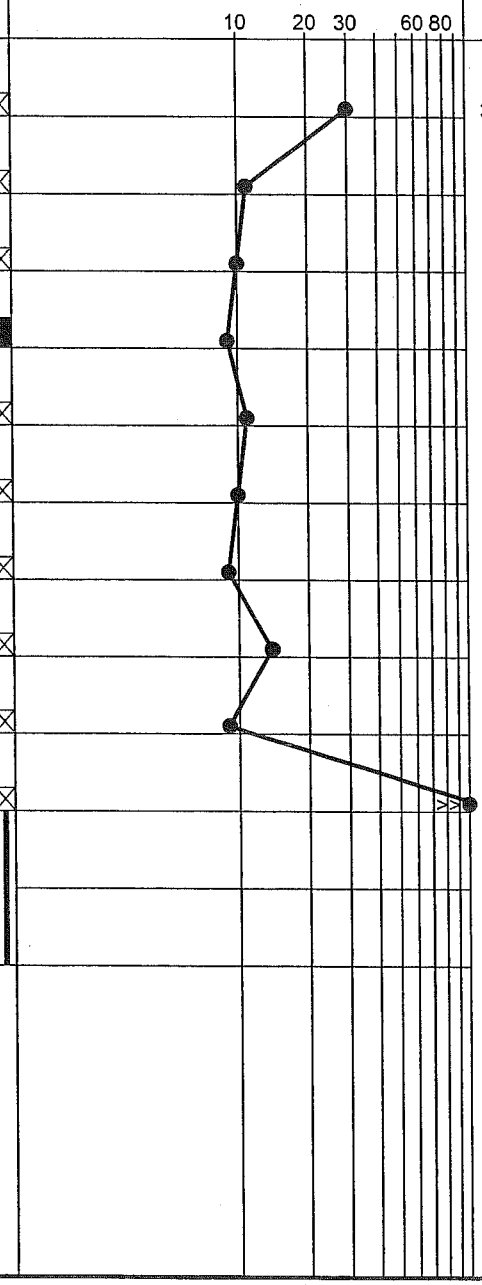
BORING LOG NEWLOGS.GPJ S&ME.GDT 8/14/04

PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A	BORING LOG B-26

DATE DRILLED: 6/17/03	ELEVATION: 837.6	NOTES: Abandoned geotechnical boring for OW-26/26A location - Phase III Hydro Study. Boring abandoned after completion by grouting.
DRILLING METHOD: 3¼" H.S.A.	BORING DEPTH: 60.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Brian Wilson, NC Cert No. 2718	DRILL RIG: Mobile B-57	

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
	RESIDUUM: Red Medium to Fine Sandy Silty **CLAY (CH)**			
5		832.6	1	30
	SAPROLITE: Reddish Yellow Clayey Medium to Fine Sandy **SILT** with Manganese Staining **(ML)**			
10		827.6	2	11
15		822.6	3	10
	SAPROLITE: Reddish Tan Clayey Medium to Fine Sandy **SILT** with Managanese Staining **(ML)**			
20		817.6	4	9
25		812.6	5	11
	SAPROLITE: Brown and Tan Slightly Clayey Silty Medium to Fine **SAND** with Manganese Staining **(SM)**			
30		807.6	6	10
35		802.6	7	9
40		797.6	8	14
45		792.6	9	9
50	PARTIALLY WEATHERED ROCK: When Sampled Becomes Brown and Tan Slightly Clayey Silty Medium to Fine **SAND** with Traces of Manganese Staining	787.6	10	50/1
55	**AUGER REFUSAL AT 50 FT BLS** BEDROCK: Sampled as Amphibolite and Biotite Gneiss with minor layers of Mica Schist	782.6	REC 98% RQD 98%	
60	Run #1 - 50 to 53.2 ft bls REC = 95%, RQD = 95% Run #2 - 53.2 to 58 ft bls REC = 100%, RQD = 100% Run #3 - 58 to 60 ft bls REC = 100%, RQD = 96%	777.6		

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG NEWLOGS.GPJ S&ME.GDT 8/14/04

1. BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.
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ROCK CORE DETAILS

Boring ID:	Job Name and Number:	Classification:
B-26	Lincoln County Landfill Phase III, 1356-03-255A	Amphibolite and Biotite Gneiss with minor layers of Mica Schist

Core Depths (ft-bls):	Total Core Length (ft):
From: 50' To: 60'	10 feet

Run #1	3.2'	Run #2	4.8'	Run #3	2'	Run #	
From: 50'	To: 53.2'	From: 53.2'	To: 58'	From: 58'	To: 60'	From:	To:
Core Length:	3.04'	Core Length:	4.8'	Core Length:	2'	Core Length:	
Rec: 95%	RQD: 95%	Rec: 100%	RQD: 100%	Rec: 100%	RQD: 96%	Rec:	RQD:

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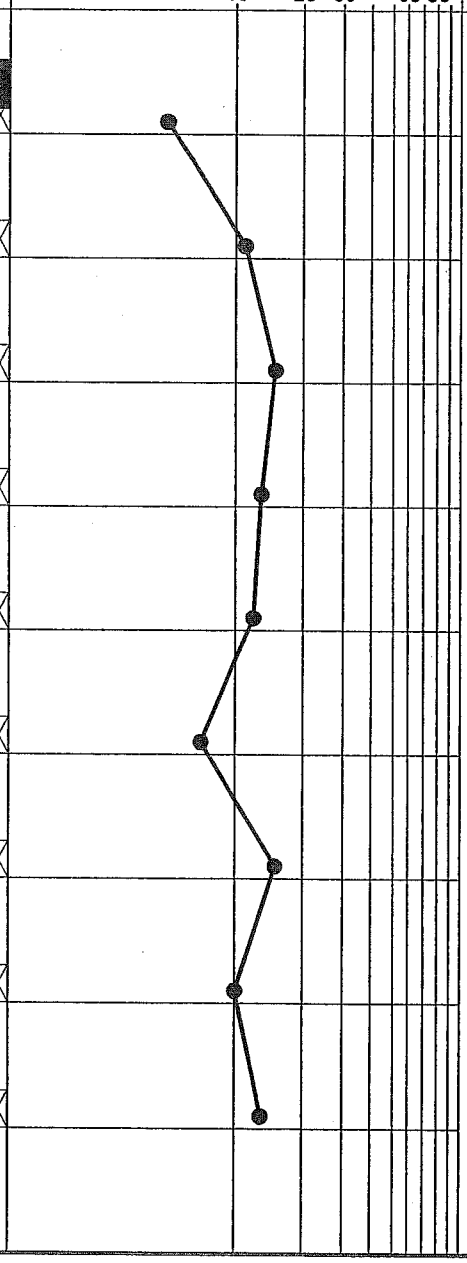
PROJECT: Lincoln County Landfill Phase III Crouse, North Carolina 1356-03-255A		BORING LOG B-28
DATE DRILLED: 12/20/04	ELEVATION: 823.0	NOTES: Abandoned geotechnical boring for OW-28 location - Phase III Hydro Study. Boring abandoned after completion by grouting.
DRILLING METHOD: 3¼" H.S.A.	BORING DEPTH: 46.0	
LOGGED BY: Julie Petersen	WATER LEVEL:	
DRILLER: Jay Little, NC Cert No. 2717	DRILL RIG: CME-45	

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet-MSL)	SAMPLE NO/TYPE	N VALUE
	RESIDUUM: Brown Silty Clayey Medium to Fine **SAND (SC)**			
5	RESIDUUM: Tan and Gray Silty Coarse to Fine Sandy **CLAY**	818.0	1	5
	SAPROLITE: Tannish White Silty Coarse to Fine **SAND**			
10		813.0	2	11
	SAPROLITE: Tannish White Slightly Clayey Silty Coarse to Medium **SAND (SM)**			
15		808.0	3	15
20	SAPROLITE: Slightly Clayey Silty Coarse to Fine **SAND**	803.0	4	13
	SAPROLITE: Red Micaceous Slightly Clayey Silty Fine **SAND** with Manganese Staining			
25		798.0	5	12
30		793.0	6	7
	SAPROLITE: Red to Res and Tan Micaceous Clayey Fine Sandy SILT with Manganese Staining.			
35	**AUGER REFUSAL AT 46 FT BLS**	788.0	7	15
40		783.0	8	10
45		778.0	9	13

WATER LEVEL

STANDARD PENETRATION TEST DATA (blows/ft)



BORING LOG NEWLOGS.GPJ S&ME.GDT 2/22/05

1. *BORING AND SAMPLING IS IN ACCORDANCE WITH ASTM D-1586.*
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PROJECT: Lincoln County Landfill
Loncoln County, North Carolina

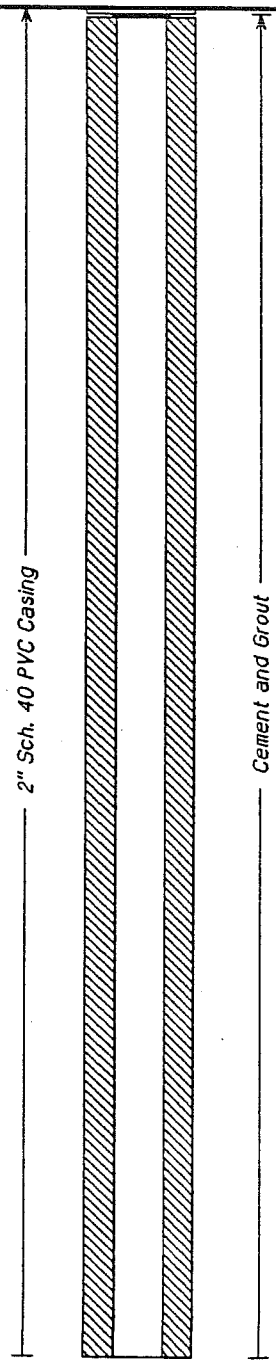
WELL LOG

OW-19

PROJECT NO.: 1356-97-285	ELEVATION: 854.53 +/- MSL	NOTES:
LOGGED BY: KJS	BORING DEPTH: 138.0 FEET	
DATE DRILLED: 01-14-98	WATER LEVEL: 35.65	
DRILLING METHOD: 4 1/4" hsa	DRILL RIG: CME 55	

DEPTH (ft)	GRAPHIC LOG	Description & Remarks	SAMPLE NUMBER	SAMPLE	OVM (ppm)	SPR	ELEV.
		TOPSOIL					
		Tan Clayey Silty **SAND**		X			
		Brown Tan White Sandy Clayey **SILT** with Mica		X		11	
5							850
				X		11	
10							845
				X		11	
15							840
		Tan Yellow Slightly Sandy Silty **CLAY**		X		12	
20							835
		Tan White Slightly Sandy Clayey **SILT** with Rock Fragments		X		9	
25							830
				X		7	
30							825
				X		9	
35							820

WELL DIAGRAM



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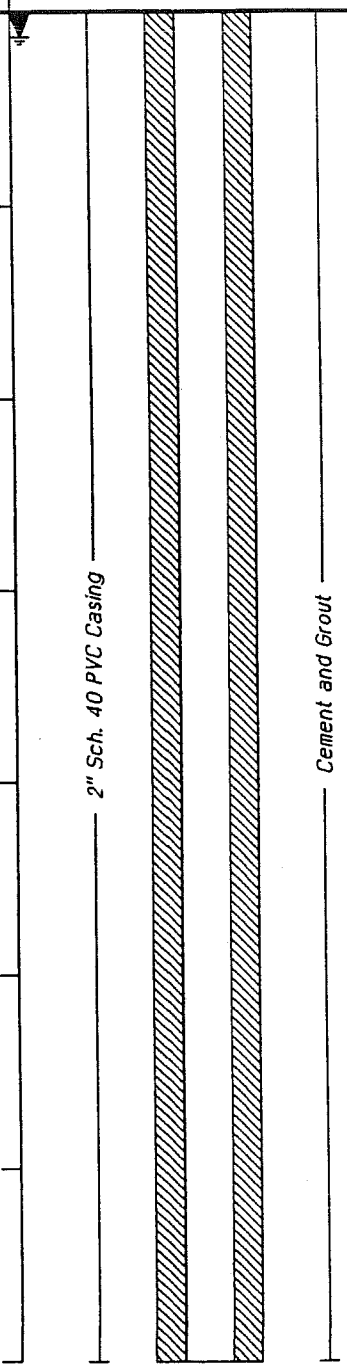
PROJECT:	Lincoln County Landfill Loncoln County, North Carolina	WELL LOG	OW-19

PROJECT NO. :	1356-97-285	ELEVATION: 854.53 +/- MSL	NOTES:
LOGGED BY:	KJS	BORING DEPTH: 138.0 FEET	
DATE DRILLED:	01-14-98	WATER LEVEL: 35.65	
DRILLING METHOD:	4 1/4" hsa	DRILL RIG: CME 55	

DEPTH (ft)	GRAPHIC LOG	Description & Remarks	SAMPLE NUMBER	SAMPLE	OVM (ppm)	SPR	ELEV.	WELL DIAGRAM
		Tan White Slightly Sandy Silty **CLAY**				9		
40							815	
						11		
45							810	
		Tan Orange Brown Slightly Sandy Silty **CLAY**				24		
50							805	
						24		
55							800	
						15		
60							795	
		Tan Brown Micaceous Sandy Clayey **SILT**				8		
65							790	
						20		
70							785	



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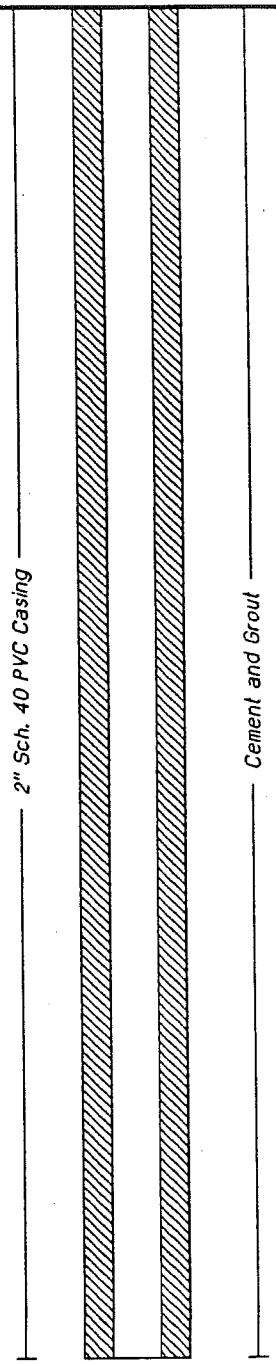
PROJECT:	Lincoln County Landfill Loncoln County, North Carolina	WELL LOG	OW-19

PROJECT NO.: 1356-97-285	ELEVATION: 854.53 +/- MSL	NOTES:	
LOGGED BY: KJS	BORING DEPTH: 138.0 FEET		
DATE DRILLED: 01-14-98	WATER LEVEL: 35.65		
DRILLING METHOD: 4 1/4" hsa	DRILL RIG: CME 55		

DEPTH (ft)	GRAPHIC LOG	Description & Remarks	SAMPLE NUMBER	SAMPLE	OVM (ppm)	SPR	ELEV.
		Orange Grey Slightly Clayey Sandy **SILT**		X		21	780
75							
		Orange Slightly Sandy Clayey **SILT**		X		20	775
80							
		Orange Brown Fine Sandy Silty **CLAY**		X		26	770
85							
		Tan Brown Slightly Clayey Sandy **SILT**		X		63	765
90							
				X		30	760
95							
		Partially Weathered Rock as Tan Brown Micaceous Sandy Clayey **SILT**		X		50/4	755
100							
				X		50/5	750
105							

WELL DIAGRAM



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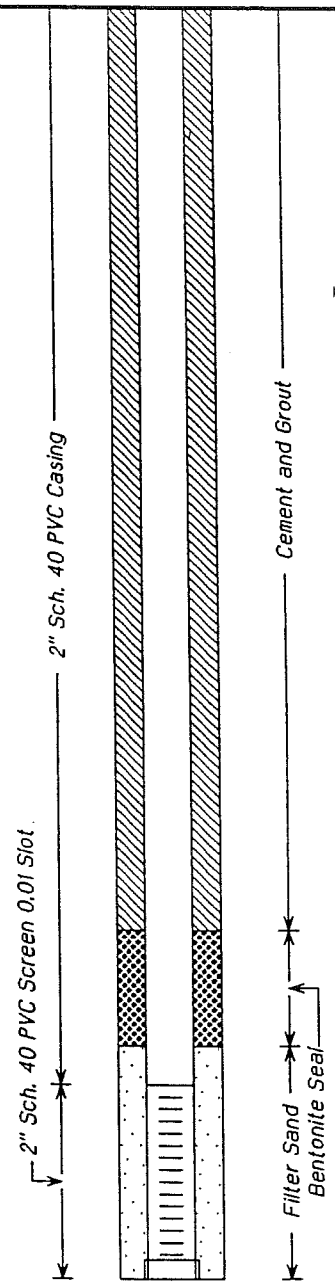
PROJECT:	Lincoln County Landfill Loncoln County, North Carolina	WELL LOG	OW-19
PROJECT NO.: 1356-97-285	ELEVATION: 854.53 +/- MSL	NOTES:	
LOGGED BY: KJS	BORING DEPTH: 138.0 FEET		
DATE DRILLED: 01-14-98	WATER LEVEL: 35.65		
DRILLING METHOD: 4 1/4" hsa	DRILL RIG: CME 55		

DEPTH (ft)	GRAPHIC LOG	Description & Remarks	SAMPLE NUMBER	SAMPLE	OVM (ppm)	SPR	ELEV.
						52	
		Tan Brown Sandy Clayey **SILT**		X			
110							745
115							740
		Tan Brown Slightly Silty Clayey **SAND**					
120							735
125							730
130		**Metamorphic Rock** Highly Weathered Amphibolite and Biotite Gneiss Run #1: 129 - 132.25 ft Recovery = 100% RQD = 0% Run #2: 132.25 - 137.25 ft Recovery = 8% RQD = 0% Run #3: 137.25 - 138 ft Recovery = 98% RQD = 0%					725
135							720
140		*Termination Of Boring At 138.0 Feet*					715

WELL DIAGRAM



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