BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

WATER QUALITY MONITORING PLAN

CLOSED FRANCIS FARM LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

PERMIT NUMBER 44-03

PREPARED FOR:

HAYWOOD COUNTY SOLID WASTE MANAGEMENT DEPARTMENT
CLYDE, NORTH CAROLINA

PREPARED BY:

BUNNELL-LAMMONS ENGINEERING, INC.
GREENVILLE, SOUTH CAROLINA
ASHEVILLE, NORTH CAROLINA

NOVEMBER 24, 2015

BLE NORTH CAROLINA BUSINESS LICENSE C-1538

BLE PROJECT NUMBER J15-1957-52

BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

November 24, 2015

Haywood County Solid Waste Management Department
C/O Office of the County Manager
215 N. Main Street
Waynesville, NC 28786

Attention: Mr. David B. Francis
Solid Waste and Tax Administrator

Subject: **Water Quality Monitoring Plan**
Closed Francis Farm Landfill
Haywood County, North Carolina
BLE Project Number J15-1957-52
Permit Number 44-03

Dear Mr. Francis:

Bunnell-Lammons Engineering, Inc. (BLE) is pleased to present this Water Quality Monitoring Plan (WQMP) for the Francis Farm Landfill located in Haywood County, North Carolina. This Plan is being submitted in general accordance with North Carolina Rules for Solid Waste Management, 15A NCAC 13B .0601, and .1630 through .1637 (groundwater), 15A NCAC 13B .0602 (surface water), and 15A NCAC 13B .1624(12)(c) (leachate). The Plan contained herein includes procedures performed at the facility in the past and incorporates the future work required for post-closure care.

We appreciate the opportunity to serve as your geological consultant on this project and look forward to continue working with you at the Francis Farm Landfill. If you have any questions, please contact us at (864) 288-1265.

Sincerely,
BUNNELL-LAMMONS ENGINEERING, INC.

Andrew W. Alexander, P.G., RSM
Senior Hydrogeologist
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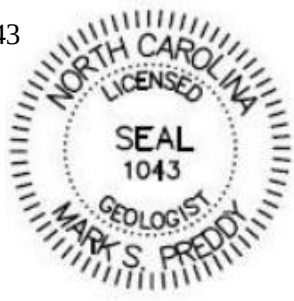

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1.0 INTRODUCTION

The following project information was obtained from documents provided by Haywood County and from site data (in BLE's project records) from our current services with Haywood County.

Haywood County owns and maintains the Francis Farm Landfill which is currently closed (**Figure 1**). The facility was operational prior to the promulgation of the Subtitle D rules. The facility includes eight (8) parcels with approximate total acreage of 75.76. This total includes three (3) properties (44.09 acres) acquired by Haywood County in 2015 to expand the facility boundary. The Haywood County Consolidated School District operates an office and bus garage (2.86 acre parcel) on the property and utilizes additional areas of the facility for bus parking.

The landfill requires semi-annual groundwater and surface water monitoring and reporting as part of post closure care. The facility has 30 groundwater monitoring wells (MW-1A, MW-2A, MW-3A, MW-4 through MW-14, MW-14D, MW-15, MW-16, MW-16D, MW-17, MW-18, MW-19, MW-19D, MW-20, MW-20D, MW-21, MW-23D and MW-22 through MW-25) and 4 surface water monitoring points (US-1, DS-1, DS-2, & DS-3) which are sampled every February and August (**Figure 2**).

McGill Associates, P.A. (McGill) has been retained by Haywood County to provide engineering services related to the post-closure care of the landfill. BLE has been retained by Haywood County (since 2007) to provide semi-annual statistical analysis and reporting services for groundwater and surface water sampling conducted by others. The facility is currently in assessment monitoring and an assessment of corrective measures (ACM) is in progress.

Ongoing maintenance of the existing soil cap is currently in progress and permanent improvements are scheduled for 2016. Several of the existing groundwater monitoring wells will be abandoned as part of the improvements. BLE submitted a conceptual well abandonment and installation plan to the North Carolina Solid Waste Section (SWS) as part of the project on March 30, 2015. The SWS granted preliminary approval of the conceptual plan on March 31, 2015.

A new Water Quality Monitoring Plan (WQMP) will be required to document proposed changes to the facility's monitoring infrastructure. Final approval will be issued by the SWS upon submittal and review of this WQMP. Haywood County has requested that BLE prepare a WQMP for submittal to SWS in accordance with the SWS directives. This new WQMP will also be part of an application for permit modifications which will be prepared by McGill.

The objective of this project is to prepare a WQMP which will include procedures and locations for groundwater, surface water, and leachate monitoring as required by the following North Carolina Department of Environmental Quality (DEQ) Solid Waste Management Rules (Rules):

- Groundwater – *North Carolina Rules for Solid Waste Management, 15A NCAC 13B Rules .0601, and .1630 through .1637.*
- Surface Water – *North Carolina Rules for Solid Waste Management, 15A NCAC 13B Rule .0602.*
- Lechate – *North Carolina Rules for Solid Waste Management, 15A NCAC 13B Rule .1626(12)(c).*

The locations of the groundwater, surface water, and leachate monitoring points are indicated on the attached **Figure 2** titled *Water Quality Environmental Monitoring System.*

2.0 GEOLOGIC CONDITIONS

The subject site is located within the Blue Ridge geologic belt. The geology of the Blue Ridge Belt consists of metamorphic Precambrian basement rock overlain with unconformable younger Precambrian metamorphosed sedimentary and igneous rocks. The Blue Ridge belt is bordered to the southeast by the Brevard belt and to the northwest by the Valley and Ridge. The Precambrian basement has undergone several episodes of uplift, deformation, faulting, intrusion, metamorphism and erosion.

Locally, the site is geologically underlain by the lower portion of the Middle/Late Proterozoic Coweeta Group known as the Persimmon Creek Gneiss, which overlies the Tallulah Falls Formation (*Hatcher, 1979; Rhodes and Conrad, 1985; Horton and Zullo, 1991*). The Persimmon Creek Gneiss consists of migmatitic feldspar-quartz-biotite gneiss interlayered and gradational with biotite-garnet gneiss and amphibolite. The original protolith of the gneiss bedrock is most likely highly metamorphosed clastic sediments.

The typical residual soil profile consists of clayey and silty soils near the surface, where soil weathering is more advanced, underlain by micaceous sandy silts and silty sands. Residual soil zones develop by the *in situ* chemical weathering of bedrock, and are commonly referred to as "saprolite." Saprolite usually consists of micaceous sand with large rock fragments and lesser amounts of clay and silt. The boundary between soil and rock is not sharply defined.

A transitional zone of partially weathered rock (PWR) is normally found overlying the parent bedrock. Partially weathered rock is defined, for engineering purposes, as residual material with standard penetration resistance (ASTM D 1586) in excess of 100 blows per foot (bpf). Fractures, joints, and the presence of less resistant rock types facilitate weathering. Consequently, the profile of the partially weathered rock and hard rock is quite irregular and erratic, even over short horizontal distances. Also, it is not unusual to find lenses and boulders of hard rock and zones of partially weathered rock within the soil mantle, well above the general bedrock level.

3.0 WATER QUALITY MONITORING PLAN

This Water Quality Monitoring Plan (WQMP) will serve as a guidance document for collecting and analyzing groundwater, surface water, and leachate samples, evaluating the associated analytical results, and for monitoring existing and potential releases from the Francis Farm Landfill.

This WQMP complies with Title 15A, Subchapter 13B Rules .0601, and .1630 through .1637 pertaining to groundwater monitoring, Rule .0602 for surface water monitoring, and Rule .1626 for leachate monitoring.

3.1 Groundwater Monitoring

3.1.1 Monitoring Well Network

The existing groundwater monitoring network at Francis Farm Landfill (**Table 1**) consists of one (1) upgradient (background) well (MW-12) and twenty-nine (29) downgradient (compliance) wells (MW-1A, MW-2A, MW-3A, MW-4 through MW-11, MW-13, MW-14, MW-14D, MW-15, MW-16, MW-16D, MW-17, MW-18, MW-19, MW-19D, MW-20, MW-20D, MW-21, MW-23D and MW-22 through MW-25). Monitoring well MW-1 is also present on the facility but is not used for compliance because it was installed (by others) above the elevation of groundwater and is dry. The location of each well is indicated on the *Water Quality Environmental Monitoring System* (**Figure 2**). A description of each groundwater monitoring point in the network and the proposed sequence of abandonment is provided below.

Monitoring Location	Well Location and Classification
MW-12 (background)	Existing upgradient (background) monitoring well installed south of the limits of waste. See **Table 1** and **Appendix A** for additional information. This well was installed in 2010 and was established as the facility's sole background well in 2014.
MW-5 through MW-11, MW-15, MW-16, MW-16D, MW-17, MW-18, MW-19, MW-19D, MW-20, MW-20D, MW-21, MW-23D and MW-22 through MW-25 (compliance)	Existing downgradient (compliance) monitoring well locations set to intercept groundwater from the waste unit. These wells are set in varying strata including shallow saprolite, deep saprolite, bedrock, and alluvial soils. See **Table 1** and **Appendix A** for additional information.
MW-1 **(abandonment)**	Existing dry well location proposed for abandonment prior to the permanent landfill cap improvements scheduled for 2016. See **Table 1** for additional information.

Monitoring Location	Well Location and Classification
MW-1A, MW-2A, MW-3A, MW-4, MW-13, MW-14, and MW-14D **(abandonment)**	Existing downgradient (compliance) monitoring well locations proposed for abandonment prior to the permanent landfill cap improvements scheduled for 2016. See **Table 1** and **Appendix A** for additional information. These wells will continue to be used as compliance points until they are abandoned.

The existing well locations are selected to yield groundwater samples representative of the conditions in the aquifers underlying the facility, and to monitor for potential releases from the landfill unit. Well placement, well construction methods, well development, well maintenance, and well abandonment procedures are discussed in the following sections. Groundwater monitoring wells shall be sampled during the post-closure period in accordance with 15A NCAC 13B Rule .1630 of the Rules.

3.1.2 Changes in Groundwater Elevations

After each sampling event, groundwater surface elevations will be evaluated to determine whether the monitoring system remains adequate, and to determine the rate and direction of groundwater flow.

The direction of groundwater flow will be determined semiannually by comparing the groundwater surface elevations among the monitoring wells, and constructing a groundwater surface elevation contour map. The groundwater flow rate shall be determined using the following modified Darcy equation:

$$V = \frac{Ki}{n_e}$$

where V = the groundwater flow rate (feet/day)
K = the hydraulic conductivity (feet/day)
i = the hydraulic gradient, $\Delta h/\Delta l$ (foot/foot)
n_e = the effective porosity of the host medium (unitless)
Δh = the change in groundwater elevation between two wells or groundwater contours (feet)
Δl = the distance between the same two wells or groundwater contours (feet)

If the evaluation shows that the groundwater monitoring system does not satisfy the requirements of the Rules, the monitoring system will be modified accordingly. These modifications may include a change in the number, location, and/or depth of the monitoring wells.

3.1.3 Monitoring Well Construction

The well completion information for the existing groundwater monitoring wells are included on **Table 1**. Completed boring and well construction logs which are present in the facility records are included in **Appendix A**.

The installation of additional monitoring wells at the site is not anticipated. If additional monitoring wells are required in the future, drilling and installation will be performed in accordance with the specifications outlined in 15A NCAC Subchapter 2C, Section .0100. Further guidance is provided in the *Draft North Carolina Water Quality Monitoring Guidance Document for Solid Waste Facilities; Solid Waste Section, Division of Solid Waste Management; Department of Environment, and Natural Resources* (March 1995). Boring logs/well construction records for new monitoring wells will be submitted to the Solid Waste Section (SWS) following installation.

Each groundwater monitoring well will consist of 2-inch diameter polyvinyl chloride (PVC, Schedule 40 ASTM 480, NSF-rated) casing with flush-threaded joints installed in a 6.0-inch (or larger) nominal augered diameter borehole in soil or bedrock. The bottom 5- to 15-foot section of each well will be a manufactured well screen with 0.010-inch wide machined slots with a 0.20-foot long sediment trap threaded onto the bottom of the screen section. The screen section of each well will be set to intersect the water table in the residual soil or the water-producing fractures in the bedrock. Silica filter sand will be placed around the outside of the pipe up to approximately 2-feet above the top of the well screen. A hydrated bentonite seal will be installed on top of the filter sand backfill to seal the monitoring well at the desired level. The borehole will then be grouted with a bentonite-cement grout mixture up to the ground surface. The surface completion of each well will consist of a PVC cap and a lockable 4" x 4" x 5' standup protective steel cover, with a 3-foot by 3-foot concrete pad at the base of the steel cover. Each well will be constructed with a vent hole in the PVC casing near the top of the well and a weep hole near the base of the outer protective steel cover. An identification plate will be fastened to the protective steel cover that specifies the well identification number, drilling contractor, date installed, total depth, and construction details. Flush mount covers and air-tight well caps will be required for any well installed in a roadway or parking area. Actual well construction will be dictated by geology encountered, groundwater elevation, available water column, and unsaturated zone length. A typical groundwater monitoring well construction detail is attached as **Figure 3**.

A geologist or engineer will oversee drilling activities and prepare boring and well construction logs for each newly installed well. As-built locations of new wells will be located by a surveyor licensed in North Carolina to within $\pm$0.1 foot on the horizontal plane and $\pm$0.01 foot vertically in reference to existing survey points. A boring log, well construction log, groundwater monitoring network map, and well installation certification will be submitted to the SWS upon completion.

3.1.4 Monitoring Well Development

Newly constructed wells will be developed to remove particulates that are present in the well due to construction activities, and to interconnect the well with the aquifer. Development of new monitoring wells will be performed no sooner than 24 hours after well construction. Wells may be developed with disposable bailers, a mechanical well developer, or other approved method. A surge block may be used as a means of assessing the integrity of the well screen and riser. In the event a pump is employed, the design of the pump will be such that any groundwater that has come into

contact with air is not allowed to drain back into the well. Each well will be developed until sediment-free water with stabilized field parameters (i.e., temperature, pH, and specific conductance) is obtained.

Well development equipment (bailers, pumps, surge blocks) and any additional equipment that contacts subsurface formations will be decontaminated prior to on-site use, between consecutive on-site uses, and/or between consecutive well installations.

The purge water will be disposed on the ground surface at least 10 feet downgradient of the monitoring well being purged, unless field characteristics suggest the water will need to be otherwise disposed. If field characteristics suggest, the purge water will be containerized and disposed in the facility's leachate collection system, or by other approved disposal means.

Samples withdrawn from the facility's monitoring wells should be clay- and silt-free; therefore, existing wells may require redevelopment from time to time based upon observed turbidity levels during sampling activities. If redevelopment of an existing monitoring well is required, it will be performed in a manner similar to that used for a new well.

3.1.5 Maintenance and Recordkeeping

The existing monitoring wells will be used and maintained in accordance with design specifications throughout the life of the monitoring program. Routine well maintenance will include inspection and correction/repair, as necessary, of identification labels, concrete aprons, locking caps and locks, and access to the wells. Should it be determined that background or compliance monitoring wells no longer provide samples representative of the quality of groundwater passing the relevant point of compliance, the SWS will be notified. The owner will re-evaluate the monitoring network, and provide recommendations to the SWS for modifying, rehabilitating, abandoning, or installing replacement or additional monitoring wells, as appropriate.

Laboratory analytical results will be submitted to the SWS semiannually, along with sample collection field logs, statistical analyses (if used), groundwater flow rate and direction calculations, and groundwater contour map(s) as described in the following sections. Analytical data, calculations, and other relevant groundwater monitoring records will be kept throughout the active life of the facility and the post-closure care period, including notices and reports of any groundwater quality standards (15A NCAC 2L, .0202) exceedances, re-sampling notifications, and re-sampling results.

3.1.6 Monitoring Well Abandonment

Piezometers and wells will be properly abandoned in accordance with the procedures for permanent abandonment, as described in 15A NCAC 2C Rule .0113(b). The piezometers and wells will be progressively abandoned as necessary to complete construction activities. Wells which have been scheduled for abandonment are highlighted on **Tables 1 and 2** and **Figure 2**. Piezometers and wells that will potentially interfere with landfill clearing and construction activities will be abandoned without over-drilling by attempting to pull the casing and screen and then grouting the well in place with a cement-bentonite grout. If the well casing and screen cannot be pulled it will grouted in place. Additionally, surface features such as concrete aprons, protective casings, and stickups will be removed. In each case, the bentonite content of the cement-bentonite grout shall be approximately

5%, and a tremie pipe will be used to ensure that grout is continuously placed from the bottom of the borehole/monitoring well upward.

If a monitoring well becomes unusable during the monitoring period of the landfill, the well will be abandoned in accordance with the procedures described above. Approval from the SWS will be obtained prior to abandoning any monitoring well.

For each monitoring well abandoned, the following information will be provided to the SWS in a report sealed by a licensed geologist in accordance with 15A NCAC 13B Rule .1623 of the Rules: the monitoring well name, a description of the procedure by which the monitoring well was abandoned, the date when the monitoring well was considered to be taken out of service, and the date when the monitoring well was abandoned.

3.1.7 Detection Monitoring Program

If the facility is in detection monitoring, groundwater samples will be obtained and analyzed semiannually for the NC Appendix I list of constituents (**Appendix B**), as defined in the Detection Monitoring Program (15A NCAC 13B .1633), during the life of the facility and the post-closure care period.

The SWS has issued four (4) memoranda concerning guidelines for electronic submittal of monitoring data and environmental reporting limits and standards for constituents. Those memoranda include: 1) ***New Guidelines for Electronic Submittal of Environmental Monitoring Data*** (dated October 27, 2006), 2) ***Addendum to the October 27, 2006 North Carolina Solid Waste Section Memorandum Regarding New Guidelines for Electronic Submittal of Environmental Data*** (dated February 23, 2007), 3) ***Environmental Monitoring Data for North Carolina Solid Waste Facilities*** (dated October 16, 2007), and 4) ***Groundwater, Surface Water, Soil, Sediment, and Landfill Gas Electronic Document Submittal*** (dated November 5, 2014). The SWS has also issued a ***Solid Waste Environmental Monitoring Reporting Limits and Standards – Constituent List*** (dated June 13, 2011) which consolidates reporting standards and limits for each required constituent. Copies of the memoranda and constituent list are included in **Appendix C**.

The results of the groundwater data (and statistical analysis, if the owner so chooses to perform) will be submitted to the SWS semiannually in accordance with the documents in **Appendix C**. Sampling reports will be submitted on a CD-ROM with analytical data submitted in the required format, and will be accompanied by the required Environmental Monitoring Form, which will be signed and sealed by a licensed geologist in the State of North Carolina. A copy of this form is also included in **Appendix D** for reference.

3.1.7.1 Sampling Frequency

Groundwater samples will be collected semiannually and analyzed for NC Appendix I Detection Monitoring constituents (**Appendix B**) plus required field parameters, including but not limited to, pH, conductivity, and temperature while the site is in detection monitoring. New monitoring wells will be sampled four times during the first semiannual sampling period, and then one time during each semiannual period thereafter. If the facility's groundwater monitoring program must progress to Assessment Monitoring, notification and sampling will be conducted according to the schedule specified in 15A NCAC 13B Rule .1634.

3.1.7.2 Establishment of Background Data

Background conditions have been established at the facility which is currently closed. If background conditions change as the result of facility re-development and/or change in operational status, a minimum of four independent pre-waste groundwater samples will be collected within the first semiannual sampling period from any newly installed monitoring wells as specified in the Permit to Construct, once issued. Samples collected from these wells will be analyzed for the NC Appendix I constituents (or alternate SWS approved sampling matrix). The intent of background sampling is to collect data to more accurately reflect the natural fluctuations that may occur with these constituents. The data will be submitted to the SWS after completing the fourth background sampling event.

3.1.7.3 Evaluation of Detection Monitoring Data

If the owner or operator determines that there is an exceedance of the groundwater protection standards (15A NCAC 2L, .0202) for one or more of the constituents in the NC Appendix I list of constituents (**Appendix B**) at any monitoring well at the relevant point of compliance, the following procedures will be performed:

1) Notify SWS within 14 days of the finding and place a notice in the site operating record indicating which constituents have exceeded groundwater protection standards.

2) Within 90 days, establish an Assessment Monitoring Program meeting the requirements of 15A NCAC 13B Rule .1634, except as discussed below.

The data may be re-evaluated within 90 days to determine that a source other than a landfill unit caused the exceedance, or the exceedance resulted from an error in sampling, analysis, or natural variation in groundwater quality. If it can be demonstrated that one of these factors occurred, a report (Alternate Source Demonstration) certified by a North Carolina licensed geologist or engineer will be submitted to the SWS within 90 days. A copy of this report will be placed in the operating record. If the SWS approves the demonstration, the Detection Monitoring Program will be resumed with the required semiannual sampling and analysis. If the SWS does not accept the demonstration within 90 days, the Assessment Monitoring Program will be initiated.

3.1.8 Assessment Monitoring Program

The subject facility initiated a groundwater assessment and entered into an assessment monitoring program in 2010. The groundwater assessment was conducted from 2010 through 2014 and included the installation of several new groundwater monitoring wells both on- and off-site. The final assessment report was titled *Report of Groundwater Assessment: Monitoring Well MW-23D* dated June 30, 2014 (BLE Project No. J13-1957-39). In summary, the results of the assessment indicated that the nature and extent of the release had been significantly defined as required in NCAC Title 15A 13B .1634 (g)(1)(A).

The SWS reviewed the report and approved the assessment on August 5, 2014 (**Appendix E**). The letter also approved the proposed sampling matrix (**Table 2**) and required that Haywood County initiate and submit an Assessment of Corrective Measures (ACM) report in accordance with NCAC Title 15A 13B .1635. The ACM is currently in progress.

The following text discusses the general requirements for assessment monitoring for incorporation into this WQMP. Assessment Monitoring (15A NCAC 13B .1634) is required whenever a violation of the groundwater quality standards (15A NCAC 2L, .0202) has occurred, and no source of error, alternate source, or naturally occurring condition can be identified.

Within 90 days of triggering the Assessment Monitoring Program, and annually thereafter, groundwater will be sampled for analysis of the NC Appendix II list of constituents (**Appendix B**). A minimum of one groundwater sample will be collected from each well and submitted for analysis during each Assessment Monitoring sampling event. However, the Rules allow for petitions to the SWS for an appropriate subset of wells or a reduction in the NC Appendix II sampling list.

If any NC Appendix II constituents are detected in groundwater from the downgradient wells, a minimum of four independent samples will be collected from each background and downgradient well to establish background concentrations for the detected Appendix II constituents.

Within 14 days after receipt of the initial or subsequent sampling analytical data, a report identifying the detected NC Appendix II constituents will be submitted to the SWS, and a notice will be placed in the operating record. Background concentrations of any detected NC Appendix II constituents will be established and reported to the SWS.

Within 90 days, and on at least a semiannual basis thereafter, the wells will be sampled and analyzed for the NC Appendix I list plus any additional detected Appendix II constituents. An analytical results report of each sampling event will be submitted to the SWS and placed in the facility operational record.

The SWS will determine whether Groundwater Protection Standards must be established for the facility (15 NCAC 13B .1634(g) and (h)), and may specify a more appropriate alternate sampling frequency for repeated sampling and analysis for the full set of NC Appendix II constituents. Groundwater monitoring will continue in one of two ways, based on the results of the water quality analyses:

1) If the NC Appendix II constituent concentrations are equal to or less than the approved Groundwater Protection Standards for two consecutive sampling events, the facility may resume Detection Monitoring with the approval of SWS.

2) If one or more NC Appendix II constituents are detected in excess of the approved Groundwater Protection Standards, and no source of error can be identified, within 14 days the SWS will be notified, a notice will be placed in the operating record, and appropriate local government officials will be notified. The facility operator will proceed to characterize the nature and extent of the release (15A NCAC 13B .1634(f)(1)). Next, the operator will initiate an assessment of corrective measures and corrective action plan, and proceed according to 15A NCAC 13B .1635 through.1637. If the facility proceeds to corrective action, a revised WQMP will be submitted to the SWS with the Corrective Action Plan.

The results of the groundwater data will be submitted to the SWS semiannually in accordance with the documents in **Appendix C**. Reports will be submitted on a CD-ROM with analytical data submitted in the required format, and be accompanied by the required Environmental Monitoring

Form, which will be signed and sealed by a licensed geologist or engineer in the State of North Carolina. A copy of this form is also included in **Appendix D**.

3.1.9 Groundwater Sampling Methodology

Groundwater samples will be collected in general accordance with Solid Waste Management Rules 15A NCAC 13B Rule .1632 and guidance provided in the *Solid Waste Section Guidelines for Groundwater, Soil, and Surface Water Sampling* (April 2008). Procedures for well purging, sample withdrawal, and decontamination methods as well as chain-of-custody procedures are outlined below. Field parameter measurements will be submitted electronically to the SWS in accordance with the documents in **Appendix C**.

3.1.9.1 Sample Collection

The procedures for collecting groundwater samples are presented below. The background well (MW-12) will be sampled first, followed by the downgradient compliance wells (MW-1A, MW-2A, MW-3A, MW-4 through MW-11, MW-13, MW-14, MW-14D, MW-15, MW-16, MW-16D, MW-17, MW-18, MW-19, MW-19D, MW-20, MW-20D, MW-21, MW-23D and MW-22 through MW-25). The downgradient wells will be sampled so that the most contaminated well, if one is identified from the previous sampling event, is sampled last. An alternative sampling order may be implemented in conjunction with disposable equipment and appropriate decontamination procedures to prevent cross contamination.

3.1.9.1.1 Sampling Frequency

The above-mentioned samples will be collected on a semiannual basis during the Detection and/or Assessment Monitoring programs.

3.1.9.1.2 Static Water Elevations

The static water level and total well depth will be measured with an electronic water level indicator, to the nearest 0.01 foot, in each well prior to sampling. Static water elevations will be calculated from water depth measurements and top of casing elevations. A reference point will be marked on the top of casing of each well to ensure the same measuring point is used each time static water levels are measured.

If a monitoring well contains a dedicated pump, the depth to water shall be measured without removing the pump. Depth to bottom measurements should be taken from the well construction data and updated when pumps are removed for maintenance.

3.1.9.1.3 Well Evacuation

The preferred well evacuation and sampling procedure for the site is conventional bailed well technology (standard evacuation) which is presented below.

3.1.9.1.3.1 Standard Evacuation Procedures

Monitoring wells will be evacuated with a laboratory cleaned bailer, disposable bailer, or submersible pump. If a pump or bailer is used for multiple wells, it and any other non-dedicated equipment will be decontaminated before use and between each well.
A low-yield well (one that yields less than 0.5 gallon per minute) will be purged so that water is removed from the bottom of the screened interval. Low-yield wells will be evacuated to dryness once. However, at no time will a well be evacuated to dryness if the recharge rate causes the formation water to vigorously cascade down the sides of the screen and cause an accelerated loss of volatiles. Upon recharging of the well and no longer than a time period of 24 hours, the first sample will be field-tested for pH, temperature, and specific conductivity. Samples will then be collected and containerized in the order of the volatilization sensitivity of the target constituents.

A high-yield well (one that yields 0.5 gallon per minute or more) will be purged so that water is drawn down from above the screen in the uppermost part of the water column to ensure that fresh water from the formation will move upward in the screen. If a pump is used for purging, a high-yield well should be purged at less than 4 gallons per minute to prevent further well development.

A minimum of three casing volumes will be evacuated from each well prior to sampling. An alternative purge will be considered complete if the monitoring well goes dry before removing the calculated minimum purge volume. The well casing volume for a 2-inch well will be calculated using the following formula:

$$V_c \text{ (gallons)} = 0.163 \times h_w$$

where:

V_c = volume in the well casing = $(d_c^2/4) \times 3.14 \times h_w \times 7.48$ gallons/cubic foot)
d_c = casing diameter in feet ($d_c = 0.167$)
h_w = height of the water column (i.e., well depth minus depth to water)

The purge water will be disposed by pouring on the ground surface at least 10 feet downgradient of the monitoring well being purged, unless field characteristics suggest the purge water may be contaminated. In that case, the purged water will be containerized and disposed in the facility's leachate collection system (or by other approved disposal means).

The monitoring wells will be sampled using laboratory cleaned or disposable bailers within 24 hours of completing the purge. The bailers will be equipped with a check valve and bottom-emptying device. The bailer will be lowered gently into the well to minimize the possibility of degassing the water.

Field measurements of temperature, pH, specific conductance, and turbidity will be made before and after sample collection as a check on the stability of the groundwater sampled over time. The direct-reading equipment used at each well will be calibrated in the field according to the manufacturer's specifications prior to each day's use. Calibration information should be documented in the instrument's calibration logbook and the field book.

3.1.9.1.3.2 Low-Flow Procedures

Under normal conditions, monitoring wells will be purged and sampled using the Standard Evacuation Procedures specified above. However, at the discretion of the owner/operator a low-flow sampling method in accordance with the United States Environmental Protection Agency's (EPA) *Low-Flow (Minimal Drawdown) Sampling Procedures* (EPA, April 1996), may be implemented as allowed under the Rules. A summary of these procedures is listed below, and a copy of the procedures is presented in **Appendix F**.

Depth-to-water measurements will be obtained using an electronic water level indicator capable of recording the depth to an accuracy of 0.01 foot. A determination of whether or not the water table is located within the screened interval of the well will be made. If the water table is not within the screened interval, the amount of drawdown that can be achieved before the screen is intersected will be calculated. If the water table is within the screened interval, total drawdown should not exceed 1 foot so as to minimize the amount of aeration and turbidity. If the water table is above the top of the screened interval, the amount of drawdown should be minimized to keep the screen from being exposed.

If the purging equipment is non-dedicated, the equipment will be lowered into the well, taking care to minimize the disturbance to the water column. If conditions (i.e., water column height and well yield) allow, the pump will be placed in the uppermost portion of the water column (minimum of 18 inches of pump submergence is recommended).

The minimum volume/time period for obtaining independent Water Quality Parameter Measurements (WQPM) will be determined. The minimum volume/time period is determined based on the stabilized flow rate and the amount of volume in the pump and the discharge tubing (alternatively, the volume of the flow cell can be used, provided it is greater than the volume of the pump and discharge tubing). Volume of the bladder pump should be obtained from the manufacturer. Volume of the discharge tubing is as follows:

3/8-inch inside diameter tubing:	20 milliliters per foot
1/4-inch inside diameter tubing:	10 milliliters per foot
3/16-inch inside diameter tubing:	5 milliliters per foot

Once the volume of the flow-cell or the pump and the discharge tubing has been calculated, the well purge will begin. The flow rate should be based on historical data for that well (if available) and should not exceed 500 milliliters per minute. The initial round of WQPM should be recorded and the flow rate adjusted until drawdown in the well stabilizes. Water levels should be measured periodically to maintain a stabilized water level. The water level should not fall within 1 foot of the top of the well screen. If the purge rate has been reduced to 100 milliliters or less and the head level in the well continues to decline, the required water samples should be collected following stabilization of the WQPM, based on the criteria presented below.

If neither the head level nor the WQPM stabilize, a passive sample should be collected. Passive sampling is defined as sampling before WQPM have stabilized if the well yield is low enough that the well will purge dry at the lowest possible purge rate (generally 100 milliliters per minute or less).

WQPM stabilization is defined as follows:

- pH (+/- 0.2 S.U.);
- conductance (+/- 5% of reading);
- temperature (+/- 10% of reading or 0.2 C);
- dissolved oxygen [+/- 10% of reading or 0.2 mg/L (whichever is greater)]; and
- oxidation reduction potential (ORP) may also be measured and ideally should also fall within +/- 10% of reading; however, this is not a required field parameter.

Stabilization of the WQPM should occur in most wells within five to six rounds of measurements. If stabilization does not occur following the removal of a purge volume equal to three well volumes, a passive sample will be collected.

At a minimum, turbidity measurements should also be recorded at the beginning of purging, following the stabilization of the WQPM, and following the collection of the samples. The optimal turbidity range for micropurging is 25 NTU or less. Turbidity measurements above 25 NTU are generally indicative of an excessive purge rate or natural conditions related to excessive fines in the aquifer matrix.

The direct-reading equipment used at each well will be calibrated in the field according to the manufacturer's specifications prior to each day's use and checked at a minimum at the end of each sampling day. Calibration information should be documented in the instrument's calibration logbook and the field book.

Each well is to be sampled immediately following stabilization of the WQPM. The sampling flow rate must be maintained at a rate that is less than or equal to the purging rate. For volatile organic compounds, lower sampling rates (100 - 200 milliliters/minute) should be used. Final field parameter readings should be recorded prior to and after sampling.

3.1.9.1.4 Sample Collection

Samples will be collected and containerized in the order described below.

- Volatile Organic Compounds (SW- 846 Method 8260);
- Semi-Volatile Organic Compounds (SW- 846 Method 8270);
- Herbicides (SW-846 Method 8151);
- Pesticides (SW- 846 Method 8081);
- Polychlorinated Biphenyls (PCBs; SW-846 Method 8082);
- Cyanide and Sulfide; and
- Total Metals.

Total metals samples may be collected out of sequence if the turbidity increases during sample collection. Samples will be transferred directly from field sampling equipment into pre-preserved, laboratory-supplied containers. Containers for volatile organic analyses will be filled in such a manner that no headspace remains after filling.

3.1.9.1.5 Decontamination

Non-dedicated field equipment that is used for purging or sample collection shall be cleaned with a phosphate-free detergent, and triple-rinsed with distilled water. Any disposable polyethylene tubing

used with non-dedicated pumps should be discarded after use at each well. Clean, chemical-resistant nitrile gloves will be worn by sampling personnel during well evacuation and sample collection. Measures will be taken to prevent surface soils, which could introduce contaminants into the well being sampled, from coming in contact with the purging and sampling equipment.

3.1.9.2 Sample Preservation and Handling

Upon containerizing the water samples, the samples will be packed into pre-chilled, ice-filled coolers and either hand-delivered or shipped overnight by a commercial carrier to the laboratory for analysis. Sample preservation methods will be used to retard biological action and hydrolysis, as well as to reduce sorption effects. These methods will include chemical preservation, cooling/refrigeration at 4º C, and protection from light. The type of sample container, minimum volume, chemical preservative, and holding times for each analysis type are provided in **Table 3**.

3.1.9.3 Chain-of-Custody Program

The chain-of-custody program will allow for tracing sample possession and handling from the time of field collection through laboratory analysis. The chain-of-custody program includes sample labels, sample seal, field logbook, and chain-of-custody record.

3.1.9.3.1 Sample Labels

Legible labels sufficiently durable to remain legible when wet will contain the following information:

- Site identification;
- Monitoring well number or other location;
- Date and time of collection;
- Name of collector;
- Parameters to be analyzed; and
- Preservative, if applicable.

3.1.9.3.2 Sample Seal

The shipping container will be sealed to ensure that the samples have not been disturbed during transport to the laboratory. The tape used to seal the shipping container will be labeled with instructions to notify the shipper if the seal is broken prior to receipt at the laboratory. Custody seals are not required on shipping containers if sampling is performed by the analytical laboratory and sample containers never left possession of the laboratory staff.

3.1.9.3.3 Field Logbook

The field logbook will contain sheets documenting the following information:

- Identification of the well;
- Well depth;
- Field meter calibration information;
- Static water level depth and measurement technique;

- Purge volume (given in gallons);
- Time well was purged;
- Date and time of collection;
- Well sampling sequence;
- Types of sample containers used and sample identification numbers;
- Preservative used;
- Field analysis data and methods;
- Field observations on sampling event;
- Name of collector(s); and
- Climatic conditions including air temperatures and precipitation.

3.1.9.3.4 Chain-of-Custody Record

The chain-of-custody record is required for tracing sample possession from time of collection to time of receipt at the laboratory. A chain-of-custody record will accompany each individual shipment. The record will contain the following information:

- Sample destination and transporter;
- Sample identification numbers;
- Signature of collector;
- Date and time of collection;
- Sample type;
- Identification of well;
- Number of sample containers in shipping container;
- Parameters requested for analysis;
- Signature of person(s) involved in the chain of possession;
- Inclusive dates of possession; and
- Internal temperature of shipping container upon opening in laboratory (noted by the laboratory).

A copy of the completed chain-of-custody form will accompany the shipment and will be returned to the shipper after the shipping container reaches its destination. The chain-of-custody record will also be used as the analysis request sheet.

3.1.9.4 Analytical Procedures

A laboratory certified by the North Carolina Department of Environmental Quality (DEQ) will be utilized for analysis of groundwater and surface water samples from the facility. Analyses will be performed in accordance with U.S. EPA SW-846 methods in accordance with the EPA guidance document (EPA, June 1997). For Detection Monitoring, method numbers and reporting limits to be used will be those listed in accordance with the documents in **Appendix C**. Alternate SW-846 methods may be used if they have the same or lower reporting limit. The laboratory must report any detection of any constituent even if it is detected below the solid waste section limit (**Appendix C**).

The laboratory certificates-of-analyses shall, at a minimum, include the following information:

- Narrative: Must include a brief description of the sample group (number and type of samples, field and associated lab sample identification numbers, preparation and analytical methods used). The data reviewer shall also include a statement that all holding times and Quality Control (QC) criteria were met, samples were received intact and properly preserved, with a brief discussion of any deviations potentially affecting data usability. This includes, but is not limited to, test method deviation(s), holding time violations, out-of-control incidents occurring during the processing of QC or field samples and corrective actions taken, and repeated analyses and reasons for the reanalyses (including, for example, contamination, failing surrogate recoveries, matrix effects, or dilutions). The narrative shall be signed by the laboratory director or authorized laboratory representative, signifying that all statements are true to the best of the reviewer's knowledge, and that the data meet the data quality objectives as described in this plan (except as noted). One narrative is required for each sample group.

- Original Chain-of Custody Form.

- Target Analyte List (TAL)/Target Compound List (TCL): The laboratory shall list all compounds for which the samples were analyzed. The TAL/TCL is typically included as part of the analytical reporting forms.

- Dilution factors with a narrative of the sample results, including the reasons for the dilution (if any).

- Blank Data: For organic analyses, the laboratory shall report the results of any method blanks, reagent blanks, trip blanks, field blanks, and any other blanks associated with the sample group. For inorganic analyses, the laboratory shall provide the results of any preparation or initial calibration blanks associated with the sample group.

- QC Summary: The laboratory will provide summary forms detailing laboratory QC sample results, which include individual recoveries and relative percent differences (if appropriate) for the following Quality Assurance (QA)/QC criteria: surrogates, MS analyses, MSD analyses, LCS, and sample duplicate analyses. QC control limits shall also be reported; if any QC limits are exceeded, a flag or footnote shall be placed to indicate the affected samples.

Additional QA data and/or other pertinent data may be reported as requested by the owner/operator of the facility.

3.1.9.5 Quality Assurance and Quality Control Program

Trip and field blanks will be collected and analyzed during each monitoring event to verify that the sample collection and handling process has not affected the quality of the samples. The trip blank will be prepared in the laboratory each time a group of bottles is prepared for use in the field. The appropriate number of bottles for VOA analysis will be filled with Type II reagent grade water, transported to the site, handled like the samples, and shipped to the laboratory for analysis. The field blank will be prepared in the field and exposed to the sampling environment. As with all other

samples, the time of the blank exposure will be recorded so that the sampling sequence is documented. The field blank will be analyzed for the same list of constituents as the groundwater samples. The trip blank will be analyzed for volatile organic compounds only.

The assessment of blank analysis results will be in general accordance with EPA guidance documents (EPA, 1993 and 1994). No positive sample results will be relied upon unless the concentration of the compound in the sample exceeds 10 times the amount in any blank for common laboratory contaminants (see next paragraph), or five times the amount for other compounds. If necessary, resampling will be performed as necessary to confirm or refute suspect data; such resampling will occur within the individual compliance monitoring period.

Concentrations of any contaminants found in the blanks will be used to qualify the groundwater data. Any compound (other than those listed below) detected in the sample, which was also detected in any associated blank, will be qualified "B" when the sample concentration is less than five times the blank concentration. For common laboratory contaminants (methylene chloride, acetone, 2-butanone, and common phthalate esters), the results will be qualified "B" when the reported sample concentration is less than 10 times the blank concentration. The "B" qualifier designates that the reported detection is considered to represent cross-contamination and that the reported constituent is not considered to be present in the sample at the reported concentration.

3.1.10 Statistical Methods (Optional)

If the landfill owner or operator chooses, groundwater monitoring data for landfill compliance wells screened in the uppermost aquifer may be evaluated using statistical procedures. However as specified in the Rules, this is optional (not required) under 15A NCAC 13B .1632(g). The statistical test used to evaluate the groundwater monitoring data will be the prediction interval procedure unless the test is inappropriate with the data collected. If statistical evaluation of groundwater monitoring data is selected, it will be performed in compliance with 15A NCAC 13B Rule .1632 (g), (h), and (i) and the USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, Office of Solid Waste, Waste Management Division, US EPA*, dated March 2009.

3.2 Surface Water Monitoring

3.2.1 Sampling Locations

In accordance with 15A NCAC 13B Rule .0602 of the Rules, four (4) surface water monitoring locations have been established for the facility to monitor water quality surrounding the facility (**Table 4**). The surface water locations consist of one (1) upstream (background) point (US-1) and three (3) downstream (compliance) points (DS-1, DS-2, and DS-3). The location of each surface water sampling point is indicated on the *Water Quality Environmental Monitoring System* (**Figure 2**).

3.2.2 Monitoring Frequency

The surface water sampling locations will be sampled semiannually. The site is currently in assessment monitoring and surface water is analyzed for the NC Appendix I constituents, a subset of the Appendix II constituents, and for water quality field parameters (pH, specific conductivity,

temperature, and turbidity) (**Table 2**). Surface water sampling will continue as specified herein until the site returns to detection monitoring or an alternate sampling matrix is approved by the SWS. The results of the analysis of the surface water data will be submitted to the SWS semiannually in conjunction with the groundwater data.

3.2.3 Surface Water Sampling Methodology

The surface water samples should be collected using the Dipper Method or the Direct Method described below. In surface water sampling, extreme care must be used to obtain a representative sample. The greatest potential source of inadvertent sample contamination is incorrect handling by field personnel. Therefore, extreme care should be used during sample collection to minimize the potential for inadvertent contamination.

3.2.3.1 Sample Collection

Surface water samples will be obtained from areas of minimal turbulence and aeration. Samples will only be collected if flowing water is observed during the sampling event.

3.2.3.1.1 Dipper Method

A dip sampler is useful for situations where a sample is to be recovered from an outfall pipe or where direct access is limited. The long handle on such a device allows sample collection from a discrete location. Sampling procedures are as follows:

1. Assemble the dip sampler device in accordance with the manufacturer's instructions.
2. Extend the device to the sample location and collect the sample.
3. Retrieve the sampler and transfer the sample to the appropriate sample container.

3.2.3.1.2 Direct Method

The sampler should face upstream and collect the sample without disturbing the sediment. The collector submerses the closed sample container, opens the bottle to collect the sample and then caps the bottle while sub-surface. The collection bottle may be rinsed two times by the sample water. Collect the sample under the water surface avoiding surface debris. When using the direct method, pre-preserved sample bottles should not be used because the collection method may dilute the concentration of preservative necessary for proper sample preservation. Samples will be collected using dedicated, clean, laboratory-provided bottles, and then the samples are carefully transferred into the pre-preserved bottles for transport to the laboratory.

3.2.3.1.3 Decontamination

Non-dedicated field equipment that is used for sample collection shall be cleaned with a phosphate-free detergent, and triple-rinsed with distilled water. Clean, chemical-resistant nitrile gloves will be worn by sampling personnel during sample collection. Measures will be taken to prevent surface soils, which could introduce contaminants into the location being sampled, from coming in contact with the sampling equipment.

3.2.3.2 Sample Preservation and Handling

Upon containerizing the water samples, the samples will be packed into pre-chilled, ice-filled coolers and either hand-delivered or shipped overnight by a commercial carrier to the laboratory for analysis. Sample preservation methods will be used to retard biological action and hydrolysis, as well as to reduce sorption effects. These methods will include chemical preservation, cooling/refrigeration at 4º C, and protection from light. The type of sample container, minimum volume, chemical preservative, and holding times for each analysis type are provided in **Table 3**.

3.2.3.3 Chain-of-Custody Program

The chain-of-custody program will allow for tracing sample possession and handling from the time of field collection through laboratory analysis. The chain-of-custody program includes sample labels, sample seal, field logbook, and chain-of-custody record.

3.2.3.3.1 Sample Labels

Legible labels sufficiently durable to remain legible when wet will contain the following information:

- Site identification;
- Sampling location identifier;
- Date and time of collection;
- Name of collector;
- Parameters to be analyzed; and
- Preservative, if applicable.

3.2.3.3.2 Sample Seal

The shipping container will be sealed to ensure that the samples have not been disturbed during transport to the laboratory. The tape used to seal the shipping container will be labeled with instructions to notify the shipper if the seal is broken prior to receipt at the laboratory.

3.2.3.3.3 Field Logbook

The field logbook will contain sheets documenting the following information:

- Sampling location identifier;
- Flow conditions observations;
- Field meter calibration information;
- Date and time of collection;
- Sequence of sampling locations;
- Types of sample containers used and sample identification numbers;
- Preservative used;
- Field analysis data and methods;
- Field observations on sampling event;
- Name of collector(s); and
- Climatic conditions including air temperatures and precipitation.

3.2.3.3.4 Chain-of-Custody Record

The chain-of-custody record is required for tracing sample possession from time of collection to time of receipt at the laboratory. A chain-of-custody record will accompany each individual shipment. The record will contain the following information:

- Sample destination and transporter;
- Sample identification numbers;
- Signature of collector;
- Date and time of collection;
- Sample type;
- Number of sample containers in shipping container;
- Parameters requested for analysis;
- Signature of person(s) involved in the chain of possession;
- Inclusive dates of possession; and
- Internal temperature of shipping container upon opening in laboratory (noted by the laboratory).

A copy of the completed chain-of-custody form will accompany the shipment and will be returned to the shipper after the shipping container reaches its destination. The chain-of-custody record will also be used as the analysis request sheet.

3.2.3.4 Analytical Procedures

A laboratory certified by the DENR will be utilized for analysis of groundwater and surface water samples from the facility. Analyses will be performed in accordance with U.S. EPA SW-846 methods in accordance with the EPA guidance document (EPA, 1997). For Detection Monitoring, method numbers and reporting limits to be used will be those listed in accordance with the documents in **Appendix C**. The monitoring parameters are also included in **Appendix C**, along with the proposed analytical methods and reporting limits. Alternate SW-846 methods may be used if they

have the same or lower reporting limit. The laboratory must report any detection of any constituent even if it is detected below the solid waste reporting limit (**Appendix C**).

The laboratory certificates-of-analyses shall, at a minimum, include the following information:

- Narrative: Must include a brief description of the sample group (number and type of samples, field and associated lab sample identification numbers, preparation and analytical methods used). The data reviewer shall also include a statement that all holding times and Quality Control (QC) criteria were met, samples were received intact and properly preserved, with a brief discussion of any deviations potentially affecting data usability. This includes, but is not limited to, test method deviation(s), holding time violations, out-of-control incidents occurring during the processing of QC or field samples and corrective actions taken, and repeated analyses and reasons for the reanalyzes (including, for example, contamination, failing surrogate recoveries, matrix effects, or dilutions). The narrative shall be signed by the laboratory director or authorized laboratory representative, signifying that all statements are true to the best of the reviewer's knowledge, and that the data meet the data quality objectives as described in this plan (except as noted). One narrative is required for each sample group.

- Original Chain-of Custody Form.

- Target Analyte List (TAL)/Target Compound List (TCL): The laboratory shall list all compounds for which the samples were analyzed. The TAL/TCL is typically included as part of the analytical reporting forms.

- Dilution factors with a narrative of the sample results, including the reasons for the dilution (if any).

- Blank Data: For organic analyses, the laboratory shall report the results of any method blanks, reagent blanks, trip blanks, field blanks, and any other blanks associated with the sample group. For inorganic analyses, the laboratory shall provide the results of any preparation or initial calibration blanks associated with the sample group.

- QC Summary: The laboratory will provide summary forms detailing laboratory QC sample results, which include individual recoveries and relative percent differences (if appropriate) for the following Quality Assurance (QA)/QC criteria: surrogates, MS analyses, MSD analyses, LCS, and sample duplicate analyses. QC control limits shall also be reported; if any QC limits are exceeded, a flag or footnote shall be placed to indicate the affected samples.

Additional QA data and/or other pertinent data may be reported as requested by the owner/operator of the facility.

3.2.3.5 Quality Assurance and Quality Control Program

Trip and field blanks will be collected and analyzed during each monitoring event to verify that the sample collection and handling process has not affected the quality of the samples. The trip blank will be prepared in the laboratory each time a group of bottles is prepared for use in the field. The

appropriate number of bottles for VOA analysis will be filled with Type II reagent grade water, transported to the site, handled like the samples, and shipped to the laboratory for analysis. The field blank will be prepared in the field and exposed to the sampling environment. As with all other samples, the time of the blank exposure will be recorded so that the sampling sequence is documented. The field blank will be analyzed for the same list of constituents as the groundwater samples. The trip blank will be analyzed for volatile organic compounds only.

The assessment of blank analysis results will be in general accordance with EPA guidance documents (EPA, 1993 and 1994). No positive sample results will be relied upon unless the concentration of the compound in the sample exceeds 10 times the amount in any blank for common laboratory contaminants (see next paragraph), or five times the amount for other compounds. If necessary, resampling will be performed as necessary to confirm or refute suspect data; such resampling will occur within the individual compliance monitoring period.

Concentrations of any contaminants found in the blanks will be used to qualify the groundwater data. Any compound (other than those listed below) detected in the sample, which was also detected in any associated blank, will be qualified "B" when the sample concentration is less than five times the blank concentration. For common laboratory contaminants (methylene chloride, acetone, 2-butanone, and common phthalate esters), the results will be qualified "B" when the reported sample concentration is less than 10 times the blank concentration. The "B" qualifier designates that the reported detection is considered to represent cross-contamination and that the reported constituent is not considered to be present in the sample at the reported concentration.

3.3 Leachate Monitoring

3.3.1 Leachate Collection System and Sampling Location

A leachate collection system was not installed nor in operation when the landfill was active. Combination leachate/landfill gas extraction wells were installed at the facility by McGill in 2010 as part of construction of a landfill gas to energy system (**Figure 2 – EW-1 through EW-21**). On June 22, 2010 the Town of Waynesville submitted a *Flow Tracking/Acceptance for a Sewer Extension Permit Application* (**Appendix G**) to the NCDWQ for Haywood County to discharge leachate to the town's wastewater treatment plant (WWTP Facility Permit No. NC0025321). Samples of leachate were collected from three extraction wells and a single composite sample was analyzed for parameters selected by the wastewater treatment plant in February 2011. Based on the results of the sampling and analysis the Town agreed to accept the leachate without pre-treatment. On July 1, 2011 McGill submitted an application for permit to construct a wastewater collection system extension (leachate collection system) to the NCDWQ on behalf of Haywood County. The permit (No. WQ0035486) was issued by the NCDWQ on July 29, 2011 (**Appendix G**). The leachate collection system was constructed and a leachate pump station / wet well is the designated leachate sampling location, if required. The leachate wet well location is shown on the attached **Figure 2** titled *Water Quality Environmental Monitoring System*.

3.3.2 Monitoring Frequency

Since the leachate collection system was not constructed until after landfill closure, the SWS has verbally informed BLE that sampling of the leachate is not required by Rule (15A NCAC 13B .1626(12)(c). However, the SWS has specified that leachate sampling should be performed if required by discharge permit, operational plan, or agreement with the POTW. Upon review of the leachate collection system facility documents provided by McGill and Haywood County and from our discussions with Haywood County, it appears that leachate sampling is not required by permit, plan, or by agreement (**Table 2**). The SWS has specified that leachate sampling can be performed at any time by voluntary action of Haywood County. Please note that if is leachate sampling is performed the results should be submitted to the SWS semiannually in conjunction with the groundwater and surface water data.

3.3.3 Leachate Sampling Methodology

The leachate sampling methodology (if performed) including sample collection, sample preservation and handling, chain-of-custody program, and quality assurance and quality control program will be in general accordance with those specified herein for surface water. The NC required leachate parameters include the Appendix I list of constituents plus the following required additional parameters: 1) biological oxygen demand (BOD), 2) chemical oxygen demand (COD), 3) phosphate, 4) nitrate, 5) sulfate, and 6) pH. Actual leachate sampling parameters may be modified from those specified above based on POTW operational requirements or on other project objectives.

3.4 Reporting

3.4.1 Monitoring Well Installation and Abandonment Reports

Groundwater monitoring well installation and abandonment reports will be prepared upon completion of well installation or abandonment. The monitoring well installation reports will include documentation of boring logs, well diagrams, development results, and field procedures. The abandonment reports will include documentation of abandonment logs and field procedures. Monitoring well installation and abandonment reports will be submitted in electronic format in accordance with the procedures in **Appendix C** and if physical copies are required to the SWS at the following mailing address:

North Carolina Department of Environmental Quality
Division of Waste Management -- Solid Waste Section
1646 Mail Service Center
Raleigh, North Carolina 27699-1646

Additionally, copies of all installation and abandonment reports will be kept at the landfill as part of the facility's operating record.

3.4.2 Water Quality Reports

Copies of all laboratory analytical data will be forwarded to the SWS within 120 calendar days of the sampling event. The analytical data submitted will specify the date of sample collection, the sampling point identification and include a map of sampling locations. Should a significant concentration of contaminants be detected in ground and surface water, as defined in North Carolina Solid Waste Management Rules, Groundwater Quality Standards, or Surface Water Quality Standards, the owner/operator of the landfill shall notify the SWS and will place a notice in the landfill records as to which constituents were detected. All monitoring reports will be submitted with the following:

1. An evaluation of potentiometric surface;
2. Analytical laboratory reports and summary tables;
3. A *Solid Waste Environmental Monitoring Data Form* (included in **Appendix D**); and
4. Laboratory Data submitted in accordance with the Electronic Data Deliverable Template.

Monitoring reports will be submitted electronically by e-mail, CD, or FTP and in paper copy form if requested. Copies of all laboratory results and water quality reports for the Haywood County Solid Waste Department office as part of the facility's operating record. Reports summarizing all groundwater quality results and data evaluation will be submitted in electronic form in accordance with the procedures in **Appendix C** and if physical copies are required to the SWS at the following mailing address:

North Carolina Department of Environmental Quality
Division of Waste Management -- Solid Waste Section
1646 Mail Service Center
Raleigh, North Carolina 27699-1646

4.0 REFERENCES

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TABLES

Table 1
Groundwater Monitoring Well Data
Closed Francis Farm Landfill
Haywood County, North Carolina
Permit Number 44-03
BLE Project No. J15-1957-52

Well	Well Location	Northing (feet)	Easting (feet)	Lat. North (dd)	Long. West (dd)	Meas. Pt. Elevation	Gnd. Surface Elevation	Total Borehole Depth (bgs)	Screen Depth (bgs)	Screen Elevation	Well Type	Well Monitors	Top of Rock Depth (bgs)	Top of Rock Elev.
MW-1	On-Site	662,529.13	822,317.14	35.505892476	82.958166600	2,666.59	2,663.72	UK	UK - UK	UK - UK	UK	UK	UK	UK
MW-1A	On-Site	662,590.73	822,083.15	35.506035959	82.958960455	2,690.88	2,687.97	UK	UK - UK	UK - UK	UK	UK	UK	UK
MW-2A	On-Site	662,347.08	822,814.69	35.505447169	82.956471743	2,643.78	2,640.98	27.0	12.0 - 27.0	2,629.0 - 2,614.0	II	PWR/BR	18.0	2,623.0
MW-3A	On-Site	661,921.62	823,026.22	35.504302294	82.955704601	2,674.29	2,671.59	UK	UK - UK	UK - UK	UK	UK	UK	UK
MW-4	On-Site	661,420.29	822,245.39	35.502840483	82.958258973	2,789.47	2,786.88	UK	UK - UK	UK - UK	UK	UK	UK	UK
MW-5	On-Site	661,286.31	822,167.91	35.502464177	82.958501150	2,797.08	2,797.37	94.0	73.1 - 88.1	2,724.3 - 2,709.3	II	PWR	89.0	2,708.4
Groundwater Monitoring Wells MW-6 through MW-25 Installed by BLE														
MW-6	Off-Site	662,941.12	822,167.78	35.507007166	82.958723254	2,612.63	2,613.03	12.5	2.3 - 12.3	2,610.7 - 2,600.7	II	Res/Collv	12.5	2,600.5
MW-7	Off-Site	662,800.72	822,584.39	35.506667347	82.957305699	2,621.33	2,621.48	24.0	4.0 - 19.0	2,617.5 - 2,602.5	II	Collv/Allv	NE	NE
MW-8	Off-Site	662,619.60	822,989.68	35.506214483	82.955920712	2,620.05	2,620.25	19.0	3.0 - 13.0	2,617.3 - 2,607.3	II	Alluvial	NE	NE
MW-9	Off-Site	662,309.84	823,295.25	35.505397531	82.954853325	2,618.67	2,619.19	19.0	2.0 - 12.0	2,617.2 - 2,607.2	II	Alluvial	NE	NE
MW-10	Off-Site	661,947.33	823,365.59	35.504410017	82.954568656	2,623.60	2,623.96	15.0	2.0 - 12.0	2,622.0 - 2,612.0	II	Alluvial	NE	NE
MW-11	On-Site	661,509.39	822,572.73	35.503120939	82.957171928	2,756.22	2,756.46	100.0	70.8 - 85.8	2,685.7 - 2,670.7	II	BR	71.0	2,685.5
MW-12	Off-Site	661,078.94	822,142.39	35.501892082	82.958559051	2,803.11	2,800.28	90.0	64.8 - 79.8	2,735.5 - 2,720.5	II	BR	64.0	2,736.3
MW-13	On-Site	661,377.43	821,791.88	35.502673138	82.959775795	2,799.14	2,799.51	127.0	74.0 - 89.0	2,725.5 - 2,710.5	II	PWR/BR	81.0	2,718.5
MW-14	On-Site	661,894.81	821,755.37	35.504089518	82.959967696	2,770.34	2,770.64	120.0	93.8 - 108.8	2,676.8 - 2,661.8	II	BR	33.0	2,737.6
MW-14D	On-Site	661,878.59	821,754.85	35.504044931	82.959967268	2,771.63	2,772.05	250.5	202.0 - 212.0	2,570.0 - 2,560.0	II	BR	41.0	2,731.0
MW-15	On-Site	662,338.59	821,896.86	35.505323343	82.959552125	2,719.57	2,716.89	163.0	75.8 - 90.8	2,641.1 - 2,626.1	II	BR	19.0	2,697.9
MW-16	Off-Site	661,203.62	821,457.75	35.502159358	82.960874268	2,716.16	2,716.29	70.0	54.8 - 69.8	2,661.5 - 2,646.5	II	PWR/BR	63.0	2,653.3
MW-16D	Off-Site	661,192.49	821,467.73	35.502129896	82.960839270	2,716.28	2,716.57	150.0	116.0 - 126.0	2,600.6 - 2,590.6	II	BR	81.0	2,635.6
MW-17	Off-Site	661,739.15	821,178.09	35.503598911	82.961884951	2,664.77	2,665.07	73.0	49.8 - 64.8	2,615.3 - 2,600.3	II	PWR/BR	63.0	2,602.1
MW-18	Off-Site	662,150.91	821,256.31	35.504737902	82.961677540	2,620.91	2,620.93	41.0	25.8 - 40.8	2,595.1 - 2,580.1	II	BR	22.0	2,598.9
MW-19	Off-Site	662,965.29	822,624.55	35.507123544	82.957192901	2,615.08	2,615.29	21.0	5.5 - 20.5	2,609.8 - 2,594.8	II	Allv/Res	NE	NE
MW-19D	Off-Site	662,952.84	822,617.92	35.507088639	82.957213494	2,615.33	2,615.62	59.0	53.9 - 58.9	2,561.7 - 2,556.7	II	PWR	NE	NE
MW-20	Off-Site	661,973.29	823,503.41	35.504496365	82.954109418	2,621.94	2,622.13	15.5	5.3 - 15.3	2,616.8 - 2,606.8	II	Alluvial	NE	NE
MW-20D	Off-Site	661,973.43	823,494.68	35.504495795	82.954138746	2,621.94	2,622.12	69.0	60.0 - 65.0	2,562.1 - 2,557.1	II	PWR	NE	NE
MW-21	Off-Site	661,424.40	823,203.28	35.502956636	82.955043604	2,658.37	2,658.72	36.0	18.8 - 33.8	2,639.9 - 2,624.9	II	Residuum	NE	NE
MW-22	Off-Site	661,046.30	820,724.07	35.501647029	82.963316321	2,599.86	2,600.00	25.0	4.0 - 24.0	2,596.0 - 2,576.0	II	Alluvial	NE	NE
MW-23	Off-Site	663,169.77	822,719.36	35.507695290	82.956901959	2,611.43	2,611.63	24.0	3.8 - 23.8	2,607.8 - 2,587.8	II	Alluvial	NE	NE
MW-23D	Off-Site	663,182.53	822,725.71	35.507731029	82.956882336	2,611.52	2,611.75	62.0	53.0 - 58.0	2,558.8 - 2,553.8	III	BR	37.0	2,574.8
MW-24	Off-Site	662,019.81	823,641.42	35.504639177	82.953652291	2,625.80	2,626.04	35.0	7.5 - 27.5	2,618.5 - 2,598.5	II	Collv/PWR/BR	15.0	2,611.0
MW-25	Off-Site	661,488.76	822,382.32	35.503043453	82.957808429	2,756.31	2,756.67	259.5	249.3 - 259.3	2,507.4 - 2,497.4	II	BR	62.0	2,694.7

Notes:
All survey data provided by McGill Associates, all units in feet.
All values shown to the nearest 0.1-ft have been rounded.
MW-1, -1A, -2A, -3A, -4, -5 installed by others. MW-6 through MW-25 installed by BLE.
Wells proposed for abandonment in late 2015 or early 2016 as part of cap improvements.

BR & PWR = Bedrock & Partially Weathered Rock
Res = Residuum
Collv = Colluvium
Allv = Alluvium

Prepared by: AWA
Checked by: IAI

Table 2
Sampling Matrix
Closed Francis Farm Landfill
Haywood County, North Carolina
Permit Number 44-03
BLE Project No. J15-1957-52

		February & August						
	Station ID	App II VOCs EPA 8260	App I Total Metals EPA 6010	Pesticides EPA 8081	Cyanide SM 4500-CN-E	pH Field	Sp. Cond. Field	Temp. Field
Background Well	MW-12	X	X			X	X	X
Compliance Wells	MW-1							
	MW-1A	X	X		X	X	X	X
	MW-2A	X	X	X	X	X	X	X
	MW-3A	X	X		X	X	X	X
	MW-4	X	X	X		X	X	X
	MW-5	X	X		X	X	X	X
	MW-6	X	X		X	X	X	X
	MW-7	X	X	X	X	X	X	X
	MW-8	X	X		X	X	X	X
	MW-9	X	X	X		X	X	X
	MW-10	X	X			X	X	X
	MW-11	X	X	X	X	X	X	X
	MW-13	X	X	X	X	X	X	X
	MW-14	X	X	X	X	X	X	X
	MW-14D	X	X			X	X	X
	MW-15	X	X		X	X	X	X
	MW-16	X	X			X	X	X
	MW-16D	X	X			X	X	X
	MW-17	X	X			X	X	X
	MW-18	X	X			X	X	X
	MW-19	X	X	X		X	X	X
	MW-19D	X	X	X		X	X	X
	MW-20	X	X			X	X	X
	MW-20D	X	X			X	X	X
	MW-21	X	X			X	X	X
	MW-22	X	X			X	X	X
	MW-23	X	X			X	X	X
	MW-23D	X	X			X	X	X
	MW-24	X	X			X	X	X
	MW-25	X	X	X		X	X	X
Surface Water	US-1	X	X	X	X	X	X	X
	DS-1	X	X	X	X	X	X	X
	DS-2	X	X	X	X	X	X	X
	DS-3	X	X	X	X	X	X	X
Leachate	Leachate*	Not Required Per Solid Waste Rules						

Notes:

* A leachate collection system was not installed at the facility while the landfill was in operation.
* Landfill gas / leachate extraction wells were installed in 2011 as part of a landfill gas to energy system.
* Landfill leacahte is extracted on a intermitant basis and discharged to the POTW under permit.
* Landfill leacahte samples will only be collected if required by the POTW or if desired by the landfill operator.

Wells proposed for abandonment prior to 2016 landfill cap improvements

Prepared by: AWA
Checked by: MSP

Table 3
Sampling and Preservation Procedures
Closed Francis Farm Landfill
Haywood County, North Carolina
Permit Number 44-03
BLE Project No. J15-1957-52

Parameter	Container & Volume	Preservative	Maximum Holding Time
Cyanide	P,G; 500 mL	4°C NaOH to pH>12, add Sodium Arsenite	14 days
Sulfide	P,G; 500 mL	4°C, add Zinc Acetate	7 days
Mercury (total)	P; 500 mL	HNO3 to pH<2	28 days
Metals (total) except mercury	P; 500 mL	HNO3 to pH<2	6 months
Base Neutrals & Acids	G, Teflon-lined cap; 1000 mL	4°C	7 days to extraction, 40 days after extraction
Chlorinated Pesticides/PCBs	G, Teflon-lined cap; 1000 mL	4°C	7 days to extraction, 40 days after extraction
Chlorinated Acids	G, Teflon-lined cap; 1000 mL	4°C	7 days to extraction, 40 days after extraction
Purgeables (VOCs)	2-40 mL VOA w/G, Teflon-lined septum	4°C; HCl to pH<2	14 days
BOD	P; 1000 mL	6°C	48 hours
COD	P; 250 mL	6°C, H2SO4 to pH<2	28 days
Sulfate	P; 250 mL	4°C	28 days
Nitrate	P; 250 mL	4°C	48 hours
ortho-Phosphate	P; 250 mL	4°C	48 hours

Notes: P - Plastic, G - Glass, T - Fluorocarbon Resin (PTFE, Teflon®, FEP, etc.)

No headspace should be allowed in the volatile organic compound containers.

Prepared by: AWA
Checked by: MSP/MPH

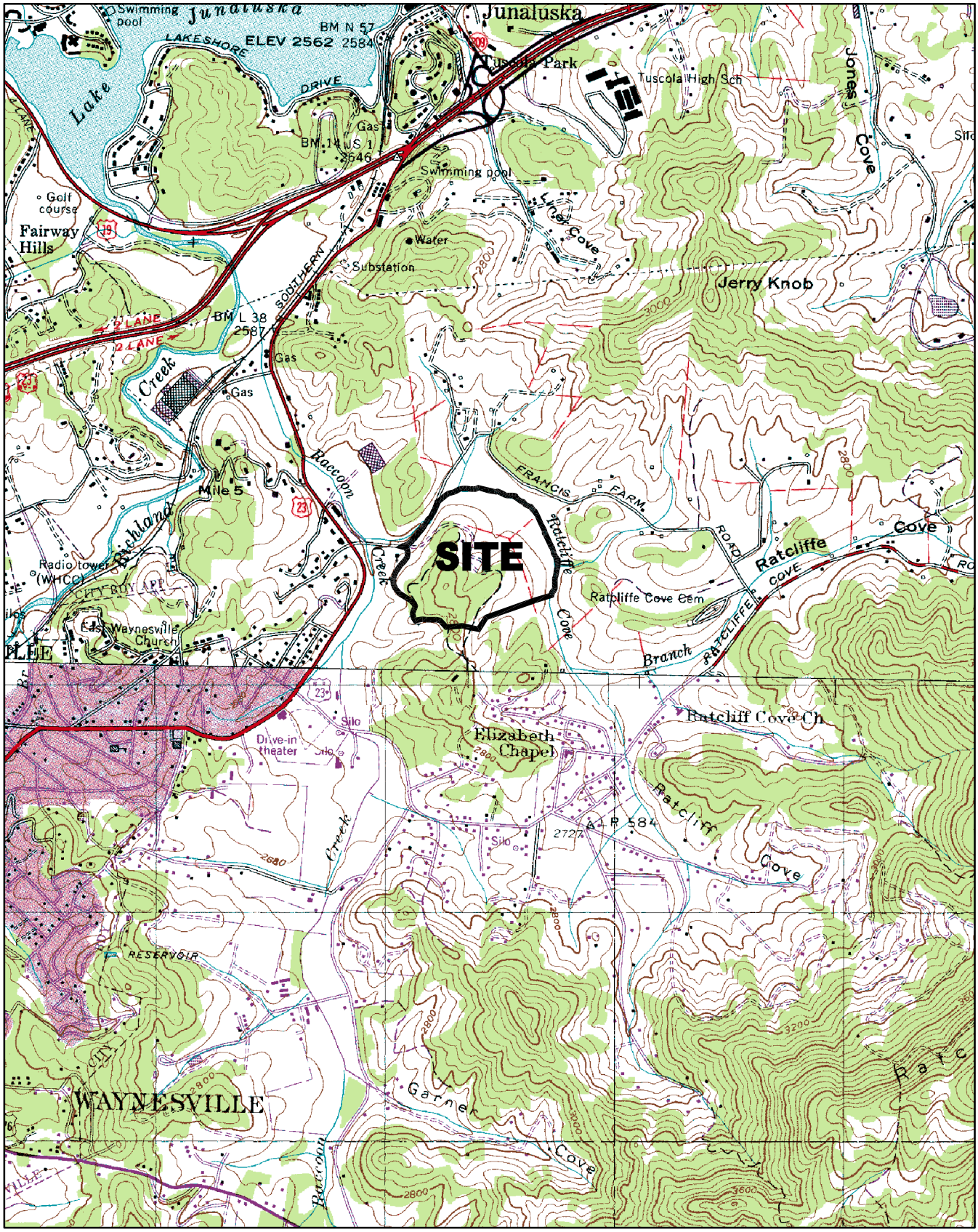
Table 4
Surface Water Sampling Point Data
Closed Francis Farm Landfill
Haywood County, North Carolina
Permit Number 44-03
BLE Project No. J15-1957-52

Monitoring Point	Water Body Monitored	Status/Purpose	Northing	Easting	Latitud (dd)[1]	Longitude (dd)[1]
US-1	Ratcliffe Cove Branch	Upstream	UK	UK	35.50145	82.95387
DS-1	Ratcliffe Cove Branch	Downstream	UK	UK	35.50449	82.95406
DS-2	Ratcliffe Cove Branch	Downstream	UK	UK	35.50726	82.95746
DS-3	Ratcliffe Cove Branch	Downstream	UK	UK	35.50513	82.96319

[1] - GPS coordinates measured by BLE via hand-held GPS receiver on January 16, 2014

Prepared by: AWA
Checked by: MSP

FIGURES



REFERENCE:
USGS TOPOGRAPHIC MAP, 7.5 MINUTE SERIES, CLYDE AND WAYNESVILLE, N.C. QUADRANGLES, 1978 AND PHOTOREVISED 1979.

DRAWN: ACE	DATE: 09-08-15	BLE INC. BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288-1265 FAX: (864)288-4430	FIGURE 1
CHECKED: AWA	CAD: FIG 1 FFLF-52 SLM		
APPROVED:	JOB NO: J15-1957-52		

SITE LOCATION MAP
HAYWOOD COUNTY LANDFILL
CLOSED FRANCIS FARM LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

MONITORING LOCATION LEGEND

MW-13	GROUNDWATER MONITORING WELL
DS-2	SURFACE WATER MONITORING LOCATION
MM-5	LANDFILL GAS MONITORING WELL
SM-1a	LANDFILL GAS MONITORING LOCATION IN STRUCTURE
MM-19	PROPOSED LANDFILL GAS MONITORING WELL
MW-2A	WELL TO BE ABANDONED IN 2015/2016
	LEACHATE PUMP STATION/WET WELL
EW-1	LANDFILL GAS EXTRACTION WELL

TOPOGRAPHIC & GEOLOGIC LEGEND

	FACILITY PROPERTY BOUNDARY
	APPROXIMATE WASTE LIMITS
	SURFACE WATER
2610	GROUNDWATER ELEVATION CONTOUR, (FEBRUARY 19, 2014) CONTOUR INTERVAL = 10 FEET
	GENERALIZED GROUNDWATER FLOW PATH

SURVEY CONTROL NOTES:
1. SURVEY BASED ON NAD83 (NSRS 2007).
2. ELEVATIONS BASED ON NAVD88.
3. AS-BUILT SURVEYS CONDUCTED BY McGILL IN SEPTEMBER, OCTOBER, NOVEMBER 2010, OCTOBER/NOVEMBER 2011, JANUARY 2012, AND NOVEMBER 2013.

NOTES:
1. PROPERTY LINES SHOWN ARE FROM HAYWOOD COUNTY G.I.S. DEPARTMENT, AND ARE APPROXIMATE ONLY.
2. CONTOURS ON FRANCIS FARM LANDFILL PROPERTY SOUTH AND WEST OF PAVED ACCESS ROAD ARE FROM GROUND SURVEY PERFORMED BY McGILL ASSOCIATES, OCTOBER 15, 2009. REMAINING CONTOURS ARE LIDAR CONTOURS PROVIDED BY HAYWOOD COUNTY.
3. SURVEY CONTROL INFORMATION BASED ON NAVD 88 AND NAD83 (NSRS 2007).
4. WASTE LIMITS SHOWN ARE A COMPILATION OF EXISTING DOCUMENTATION AND FIELD INVESTIGATION NOVEMBER 2010, AND ARE APPROXIMATE ONLY.
5. UNDERGROUND UTILITIES SHOWN ARE APPROXIMATE ONLY!

GENERAL MAP REFERENCE

200 100 0 200 400
APPROXIMATE SCALE IN FEET

REFERENCES
1. McGILL DRAWING TITLED "FFLF CONCEPT LFG MONITORING PLAN 3-24-15" DATED 3-24-2015.

NORTH CAROLINA LICENSED LANDSCAPE ARCHITECT 1475 GEOLOGIST ANDREW W. ALEXANDER

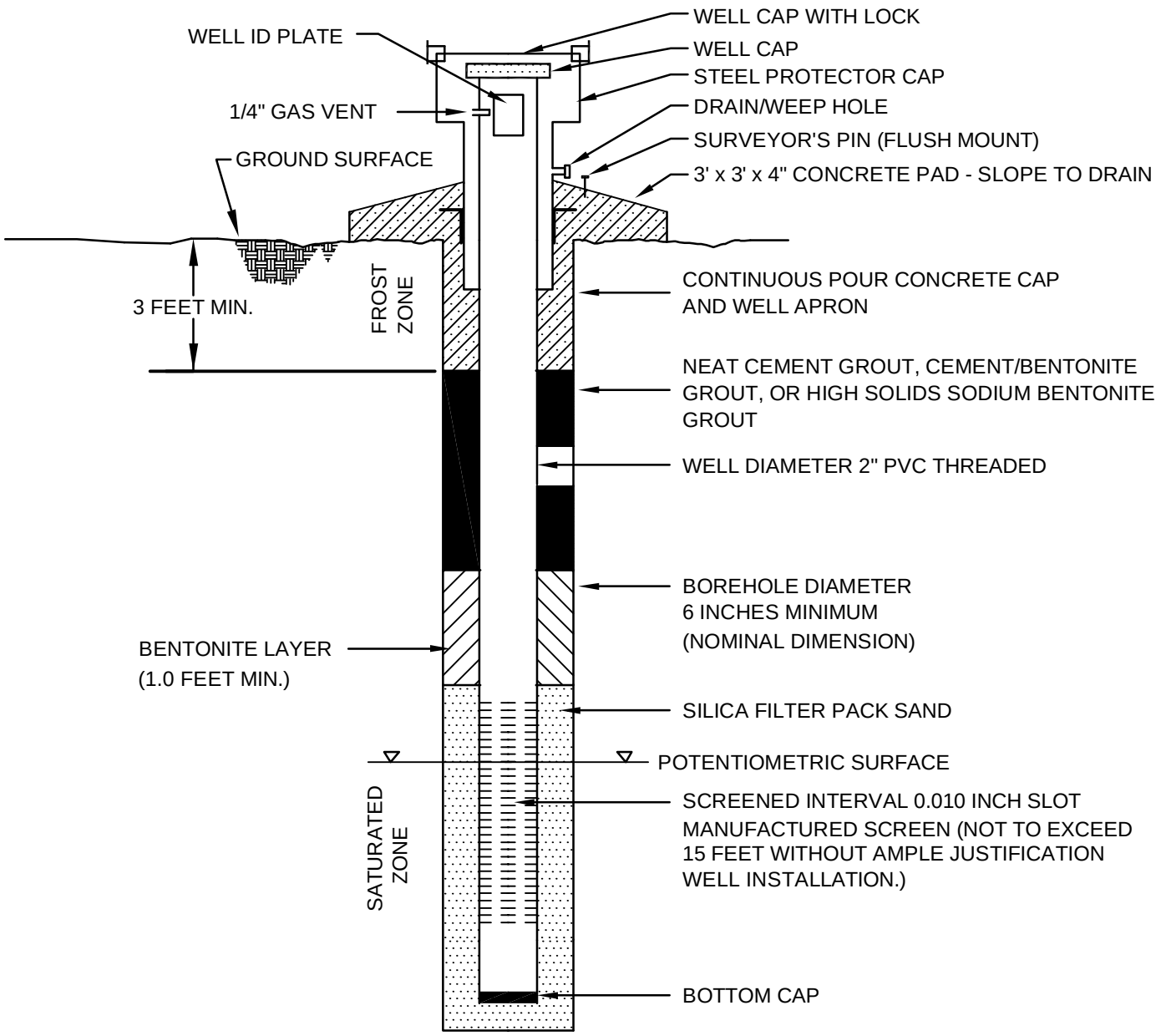
REVISIONS		
No.	DESCRIPTION	BY

DRAWN:	ACE
CHECKED:	AWA
APPROVED:	
DATE:	09-30-15
CAD FILE:	WQEMP 1957-52
JOB NO:	J15-1957-52

BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
8004 FOWLERS COURT
GREENVILLE, SOUTH CAROLINA 29615
PHONE: (864)288-1265 FAX: (864)288-4480

WATER QUALITY ENVIRONMENTAL MONITORING SYSTEM
CLOSED FRANCIS FARM LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

FIGURE NO. 2



NOTES:

1. IF THE WELL IS SET IN SOIL, THE SCREEN WILL BE SET TO BRACKET THE 24-HOUR WATER LEVEL WITH APPROXIMATELY 12-FT OF WATER IN THE WELL. IF THE WELL IS SET INTO BEDROCK, THE SCREEN WILL BE SET TO ENCOUNTER WATER-PRODUCING FRACTURES.
2. PLACE PEA GRAVEL IN ANNULAR SPACE BETWEEN PVC STICK UP AND STEEL PROTECTIVE CASING.

GROUNDWATER MONITORING WELL (TYP.)

JOB NO.: J15-1957-52 DATE: 09-08-15 SCALE: NOT TO SCALE	BUNNELL-LAMMONS ENGINEERING, INC. 6004 PONDERS COURT GREENVILLE, SOUTH CAROLINA 29615 PHONE: (864)288-1265 FAX: (864)288-4430	GROUNDWATER MONITORING WELL DETAIL HAYWOOD COUNTY LANDFILL CLOSED FRANCIS FARM LANDFILL HAYWOOD COUNTY, NORTH CAROLINA	FIGURE 3

APPENDICES

APPENDIX A

MONITORING WELL CONSTRUCTION RECORDS

LOG OF BORING: MW-2A

Francis Farms Closed Landfill — **Project No. G00027.0**

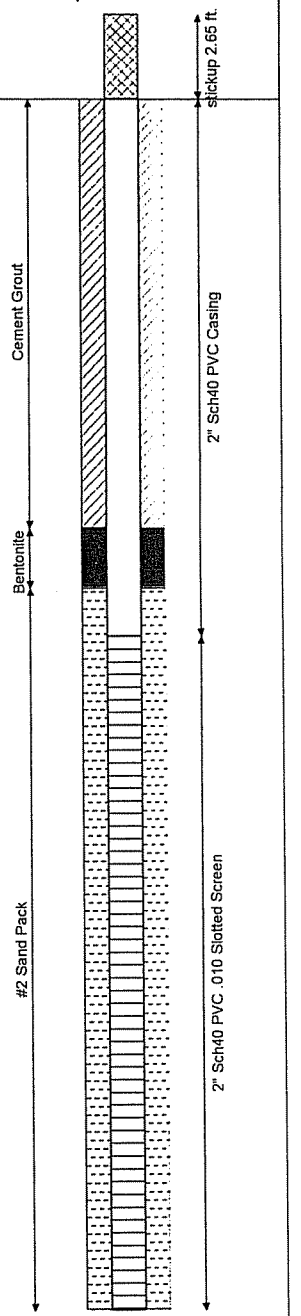
Drilling contractor: Alpha Environmental
Drill rig & method: 6" O.D HSA & 6" O.D DTH
Logged by: Jonathan Pfohl

Date started: 2/6/01
Date ended: 2/9/01
Completion depth: 27.0 ft
Stickup height: 2.65 ft

Surface elevation: 2502.99 ft (MSL)
Top of pipe elevation: 2505.64 ft (MSL)
Depth to water (TOB):
Depth to water (24hrs):

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
5	13			Silty Clay; Red, medium dense, micaceous, very cohesive, white soft crystalline parting at 4.18 ft. no relict fractures, dry.
10	12			Partially weathered rock; Dark olive gray saprolite, medium dense, some large angular weathered rock fragments, slightly micaceous, slightly moist.
15	69			Partially weathered rock; Dark olive gray saprolite, very dense, same as above except more dense and less PWR fragments.
				- 14.5' Auger refusal with Alpha's Simco drill rig.
20				- 18' Rock encountered.
25				Boring terminated at 27.0 feet
30				

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: MW-5

Francis Farms Closed Landfill — **Project No. G00027.0**

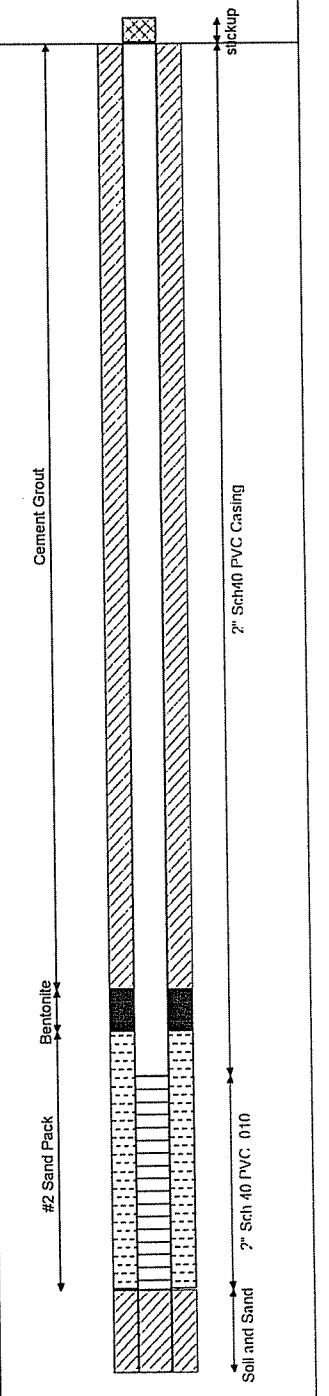
Drilling contractor: Alpha Environmental
Drill rig & method: 6" O.D DTH
Logged by: Jonathan Pfohl

Date started: 2/9/01
Date ended: 2/9/01
Completion depth: 94.0 ft
Stickup height: 1.87 ft

Surface elevation: 2659.38 ft (MSL)
Top of pipe elevation: 2661.25 ft (MSL)
Depth to water (TOB):
Depth to water (24hrs):

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
5				
10				CLAYEY SILT; Red (0-20.09')
15				
20				
25				SILT; Brown (20.09-30')
30				
35				SILT: Light brown (20.09-30')
40				
45				SILT; Very light tan (40.59-56.59')
50				
55				
60				Boulder (56.59-59.59)
65				
70				PARTIALLY WEATHERED ROCK; Gray (59.59-89.01)
75				
80				
85				
90				ROCK; Gray (89.01-94')
95				Boring terminated at 94.0 feet

Well Diagram



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BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-6

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 8-12-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2613.03

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 75; 4-inch ID augers

DEPTH TO - WATER> INITIAL: dry AFTER 96 HOURS: 7.49 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2610 / 0	2-inches of TOPSOIL Brown, slightly micaceous, fine to medium sandy SILT - (collumvium)			ND ND	Neat cement, 0 to 0.5 feet Bentonite seal, 0.5 to 2.0 feet. Filter pack, sand 2.0 to 12.5 feet
2605 / 5	Light brown, micaceous, fine to medium sandy SILT - (residuum)			ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.3 to 12.3 feet
2600 / 10	Dark brown, micaceous, fine to medium sandy SILT - (residuum)			ND ND	Pipe cap Total well depth, 12.5 feet
2595 / 15	Auger refusal at 12.5 feet. No groundwater encountered at time of drilling, but was encountered at 7.49 feet after 96 hours.				SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel, bolted manhole cover 1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively
2590 / 20					Ground surface elev. = 2,613.03 feet Top of PVC casing elev. = 2,612.63 feet
2585 / 25					Northing = 662,941.12' Easting = 822,167.78'
2580 / 30					
2575 / 35					

ENV_WELL_ONLY_PID 1957-14.GPJ 12/15/10

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-7

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 8-12-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2621.48

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 75; 4-inch ID augers

DEPTH TO - WATER> INITIAL: 10.2 AFTER 24 HOURS: 9.50 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2620 / 0	2-inches of TOPSOIL Brown, slightly micaceous, fine to medium sandy SILT - (collumvium)			ND	Neat cement, 0 to 0.5 feet Bentonite seal, 0.5 to 2.0 feet. Filter pack, sand 2.0 to 24.0 feet
5 / 2615				ND	
				ND	
10 / 2610				ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 4.0 to 19.0 feet
				ND	
	COBBLE LAYER - (alluvium)				
15 / 2605	Dark gray, micaceous, fine to medium sandy SILT - (alluvium)			ND	
				ND	Pipe cap
20 / 2600				ND	Total well depth, 19.2 feet SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel, bolted manhole cover
	Brown, micaceous, fine to medium sandy SILT - (alluvium)			ND	
				ND	1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively
25 / 2595	Boring terminated at 24 feet. Groundwater encountered at 10.2 feet at time of drilling and at 9.50 feet after 24 hours.				Ground surface elev. = 2,621.48 feet
					Top of PVC casing elev. = 2,621.33 feet
30 / 2590					Northing = 662,800.72'
					Easting = 822,584.39'
35 / 2585					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-8

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 8-12-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2620.25

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 75; 4-inch ID augers

DEPTH TO - WATER> INITIAL: 7.50 AFTER 24 HOURS: 6.79 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2620 / 0	2-inches of TOPSOIL Dark brown, fine to medium sandy SILT - (colluvium)			ND	Neat cement, 0 to 0.5 feet Bentonite seal, 0.5 to 2.0 feet. Filter pack, sand 2.0 to 19.0 feet
2615 / 5	Very moist COBBLE LAYER - (alluvium)			ND	
	Brown, very moist, micaceous, silty, fine to medium SAND with some cobbles - (alluvium)			ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 3.0 to 13.0 feet
2610 / 10				ND	
				ND	Pipe cap Total well depth, 13.2 feet
2605 / 15				ND	SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel, bolted manhole cover
				ND	1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively
2600 / 20	Boring terminated at 19 feet. Groundwater encountered at 7.50 feet at time of drilling and at 6.79 feet after 24 hours.				Ground surface elev. = 2,620.25 feet Top of PVC casing elev. = 2,620.05 feet
2595 / 25					Northing = 662,619.60' Easting = 822,989.68'
2590 / 30					
2585 / 35					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-9

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 8-12-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2619.19

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 75; 4-inch ID augers

DEPTH TO - WATER> INITIAL: ▽ 4.2 AFTER 8 HOURS: ▼ 3.5 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2615 / 5	2-inches of TOPSOIL Dark brown, fine to medium sandy SILT - (colluvium)				Neat cement, 0 to 0.5 feet Bentonite seal, 0.5 to 1.5 feet Filter pack, sand 1.5 to 19.0 feet
	COBBLE LAYER - (alluvium)				
	Tan and brown, very moist, micaceous, fine to medium sandy SILT - (alluvium)			ND	
2610 / 10				ND	
				ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.0 to 12.0 feet
				ND	
2605 / 15				ND	Pipe cap Total well depth, 12.2 feet
				ND	SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel, bolted manhole cover
2600 / 20	Boring terminated at 19 feet. Groundwater encountered at 4.2 feet at time of drilling and at 3.5 feet after 8 hours.			ND	1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively
2595 / 25					Ground surface elev. = 2,619.19 feet Top of PVC casing elev. = 2,618.87 feet
					Northing = 662,309.84' Easting = 823,295.25'
2590 / 30					
2585 / 35					
2580					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-10

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 8-11-10 END: 8-18-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2623.96

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 75; 4-inch ID augers

DEPTH TO - WATER> INITIAL: ▽ 2.5 AFTER 16 HOURS: ▼ 2.5 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2620 / 0	2-inches of TOPSOIL Brown, fine to medium sandy SILT - (colluvium)				Neat cement, 0 to 0.5 feet Bentonite seal, 0.5 to 1.5 feet Filter pack, sand 1.5 to 15.0 feet
2620 / 5	Small COBBLE layer - (alluvium) Tan and brown, very moist, micaceous, fine to medium sandy SILT - (alluvium)			ND ND	
2615 / 10				ND ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 2.0 to 12.0 feet Pipe cap Total well depth, 12.2 feet
2610 / 15				ND ND	
2605 / 20	Boring terminated at 15 feet. Groundwater encountered at 2.5 feet at time of drilling and at 2.5 feet after 16 hours.				SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel, bolted manhole cover 1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively Ground surface elev. = 2,623.96 feet Top of PVC casing elev. = 2,623.60 feet Northing = 661,947.33' Easting = 823,365.59'
2600 / 25					
2595 / 30					
2590 / 35					
2585					

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-11

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-29-10 END: 8-4-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2756.46

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 96 HOURS: ▼ 78.0 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2755 / 0	2-inches of TOPSOIL Reddish-brown, micaceous, silty, fine to medium SAND - (fill)				Neat cement, 0 to 64.0 feet
2750 / 5				ND	
2745 / 10					
2740 / 15				ND	
2735 / 20	Brown, micaceous, silty, fine to medium SAND - (residuum)				
2730 / 25				ND	
2725 / 30					
2720 / 35				ND	

ENV_WELL_ONLY_PID 1957-14.GPJ 12/15/10

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-11

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-29-10 END: 8-4-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2756.46

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 96 HOURS: ▼ 78.0 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2715 / 45	Brown, micaceous, silty, fine to medium SAND - (residuum)			ND	
2710 / 50					Neat cement, 0 to 64.0 feet
2705 / 55					
2700 / 60	PARTIALLY WEATHERED ROCK which sampled as tan to brown, micaceous, silty, fine to medium SAND			ND	
2695 / 65					Bentonite seal, 64.0 to 68.4 feet
2690 / 70				ND	Filter pack, sand 68.4 to 100.0 feet
2685 / 75	ROCK which sampled as tan and gray, micaceous, silty, fine to medium SAND				
2680	▼ ROCK which sampled as gray, micaceous, silty, fine to medium SAND			ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 70.8 to 85.8 feet

ENV_WELL_ONLY_PID 1957-14.GPJ 12/15/10

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-11

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-29-10 END: 8-4-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2756.46

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 96 HOURS: ▼ 78.0 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2675 / 85	ROCK which sampled as gray, micaceous, silty, fine to medium SAND			ND	Pipe cap Total well depth, 86.0 feet SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel, bolted manhole cover 1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively
2670 / 90					
2665 / 95	Fracture at 95 feet			ND	Ground surface elev. = 2,756.46 feet Top of PVC casing elev. = 2,756.22 feet Northing = 661,509.39' Easting = 822,572.73'
2660 / 100	Boring terminated at 100 feet. No groundwater encountered at time of drilling, but was encountered at 78.0 feet after 96 hours.				
2655 / 105					
2650 / 110					
2645 / 115					
2640					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-12

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 8-11-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2800.28

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 21 HOURS: ▼ 77.2 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2800	2-inches of TOPSOIL or GRAVEL Brown, micaceous, silty, fine to medium SAND - (residuum)				Neat cement, 0 to 57.0 feet
2795 (5)				ND	
2790 (10)					
2785 (15)				ND	
2780 (20)					
2775 (25)				ND	
2770 (30)					
2765 (35)				ND	

ENV_WELL_ONLY_PID 1957-14.GPJ 12/15/10

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-12

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 8-11-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2800.28

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 21 HOURS: ▼ 77.2 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2760	Brown, micaceous, silty, fine to medium SAND - (residuum)				
2755 — 45	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND with rock fragments			ND	
2750 — 50					Neat cement, 0 to 57.0 feet
2745 — 55				ND	
					Bentonite seal, 57.0 to 61.0 feet
	Brown, micaceous, silty, fine to medium SAND - (soil)				
2740 — 60					Filter pack, sand 61.0 to 90.0 feet
	PARTIALLY WEATHERED ROCK which sampled as tan and brown, micaceous, silty, fine to medium SAND				
2735 — 65	ROCK which sampled as gray and brown, micaceous, silty, fine to medium SAND Fractures at 65 and 66.5 feet			ND	
2730 — 70	PARTIALLY WEATHERED ROCK which sampled as tan and brown, micaceous, silty, fine to medium SAND				2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 64.8 to 79.8 feet
2725 — 75	ROCK which sampled as light gray and tan, micaceous, silty, fine to medium SAND			ND	
	▼ Fracture at 77 feet				

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-12

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 8-11-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2800.28

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 21 HOURS: ▼ 77.2 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2720	ROCK which sampled as light gray and tan, micaceous, silty, fine to medium SAND Fracture at 81 feet				Pipe cap Total well depth, 80.0 feet SURFACE COMPLETION 2.83-foot stick-up with 4" x 4" x 5' long steel protective cover installed in a 3' x 3' x 4" thick concrete pad 1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively Ground surface elev. = 2,800.28 feet Top of PVC casing elev. = 2,803.11 feet Northing = 661,078.94' Easting = 822,142.39'
2715 — 85				ND	
2710 — 90	Boring terminated at 90 feet. No groundwater encountered at time of drilling, but was encountered at 77.2 feet after 21 hours.				
2705 — 95					
2700 — 100					
2695 — 105					
2690 — 110					
2685 — 115					

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-13

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-27-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2799.51

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 360 HOURS: ▼ 83.5 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2795 / 5	4-inches of GRAVEL Brown, micaceous, silty, fine to medium SAND - (residuum)			ND	Neat cement, 0 to 67.0 feet
2790 / 10					
2785 / 15				ND	
2780 / 20					
2775 / 25				ND	
2770 / 30					
2765 / 35				ND	
2760					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-13

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-27-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2799.51

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 360 HOURS: ▼ 83.5 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2755 / 45	**Brown, micaceous, silty, fine to medium SAND - (residuum)**			ND	
2750 / 50					Neat cement, 0 to 67.0 feet
2745 / 55				ND	
2740 / 60					
2735 / 65	**PARTIALLY WEATHERED ROCK which sampled as tan and brown, micaceous, silty, fine to medium SAND**			ND	Bentonite seal, 67.0 to 71.0 feet
2730 / 70					Filter pack, sand 71.0 to 127.0 feet
2725 / 75				ND	
2720					2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 74.0 to 89.0 feet

ENV_WELL_ONLY_PID 1957-14.GPJ 12/15/10

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-13

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-27-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2799.51

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 360 HOURS: ▼ 83.5 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2715 / 85	PARTIALLY WEATHERED ROCK which sampled as tan and brown, micaceous, silty, fine to medium SAND				
	ROCK which sampled as light tan to brown, micaceous, silty, fine to medium SAND			ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 74.0 to 89.0 feet
2710 / 90					Pipe cap Total well depth, 89.2 feet SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel, bolted manhole cover
	ROCK which sampled as tan and gray, micaceous, silty, fine to medium SAND				
2705 / 95				ND	1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively
	Tan to brown, micaceous, silty, fine to medium SAND - (fracture)				
	ROCK which sampled as gray, micaceous, silty, fine to medium SAND				
2700 / 100					Ground surface elev. = 2,799.51 feet Top of PVC casing elev. = 2,799.14 feet Northing = 661,377.43' Easting = 821,791.88'
2695 / 105					
	Fracture at 108 feet				
2690 / 110					
	Fractures at 114 and 116 feet				
2685 / 115					
2680					

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-13

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-27-10 END: 8-19-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2799.51

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 360 HOURS: ▼ 83.5 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2675 / 125	**ROCK which sampled as gray, micaceous, silty, fine to medium SAND**				Filter pack, sand 71.0 to 127.0 feet
2670 / 130	**Boring terminated at 127.0 feet. No groundwater encountered at time of drilling but was encountered at 83.5 feet after 360 hours.**				
2665 / 135					
2660 / 140					
2655 / 145					
2650 / 150					
2645 / 155					
2640					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-28-10 END: 8-14-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2770.64

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 120 HOURS: ▼ 101.2 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2770	No topsoil Brown, micaceous, silty, fine to medium SAND with cobbles - (fill)				Neat cement, 0 to 54.7 feet
2765 (5)	Brown, micaceous, silty, fine to medium SAND - (residuum)			ND	
2760 (10)					
2755 (15)				ND	
2750 (20)					
2745 (25)				ND	
	PARTIALLY WEATHERED ROCK which sampled as tan and brown, micaceous, silty, fine to medium SAND				
2740 (30)	ROCK which sampled as tan and gray, micaceous, silty, fine to medium SAND				
	Brown, micaceous, silty, fine to medium SAND - (fracture/soil seam)				
2735 (35)	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-28-10 END: 8-14-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2770.64

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 120 HOURS: ▼ 101.2 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2730	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND				Neat cement, 0 to 54.7 feet
45 / 2725				ND	
50 / 2720					
55 / 2715				ND	Bentonite seal, 54.7 to 59.3 feet
60 / 2710	Fracture at 62 feet				Filter pack, sand 59.3 to 120.0 feet
65 / 2705				ND	
70 / 2700					
75 / 2695				ND	

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14
CLIENT: Haywood County — START: 7-28-10 END: 8-14-10
LOCATION: Haywood County, North Carolina — ELEVATION: 2770.64
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ dry AFTER 120 HOURS: ▼ 101.2 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2690	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND				Filter pack, sand 59.3 to 120.0 feet
85 / 2685				ND	
90 / 2680					
95 / 2675				ND	
	Fracture at 97 feet				
100 / 2670 ▼					2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 93.8 to 108.8 feet
	Fracture at 104 feet				
105 / 2665				ND	
					Pipe cap
110 / 2660					Total well depth, 109.0 feet
					SURFACE COMPLETION: Flush-mount below ground surface secured with an 8-inch diameter steel, bolted manhole cover
115 / 2655				ND	1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively
	Fracture at 116 feet				
					Ground surface elev. = 2,770.64 feet
					Top of PVC casing elev. =

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GROUNDWATER MONITORING WELL NO. MW-14

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-28-10 END: 8-14-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2770.64

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 120 HOURS: ▼ 101.2 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2650 / 125 / 2645 / 130 / 2640 / 135 / 2635 / 140 / 2630 / 145 / 2625 / 150 / 2620 / 155 / 2615	**Boring terminated at 120.0 feet. No groundwater encountered at time of drilling, but was encountered at 101.2 feet after 120 hours.**				**2,770.34 feet** **Northing = 661,894.81'** **Easting = 821,755.37'**

ENV_WELL_ONLY_PID 1957-14.GPJ 12/15/10

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14D

PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34

CLIENT: Haywood County | START: 12-4-12 END: 12-18-12

LOCATION: Waynesville, North Carolina | ELEVATION: 2772.05

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 245 AFTER 24 HOURS: ▼ 163 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2770 / 0	6-inches of GRAVEL Brown, micaceous, silty, fine to medium SAND - (residuum)				SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad Ground surface elev. = 2,772.05 feet Top of PVC casing elev. = 2,771.63 feet Northing = 661,878.59' Easting = 821,754.85'
2765 / 5					
2760 / 10					
2755 / 15	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND				
2750 / 20					Neat cement, 0 to 197.0 feet
2745 / 25					
2740 / 30					
2735 / 35	ROCK which sampled as light brown, micaceous, silty, fine to medium SAND				

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14D

PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34
CLIENT: Haywood County | START: 12-4-12 END: 12-18-12
LOCATION: Waynesville, North Carolina | ELEVATION: 2772.05
DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: 245 AFTER 24 HOURS: 163 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2730 / 45	ROCK which sampled as light brown, micaceous, silty, fine to medium SAND			ND	
	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND				
2725 / 50					
2720 / 55					
2715 / 60					Neat cement, 0 to 197.0 feet
2710 / 65					
2705 / 70					
2700 / 75					
2695					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14D

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34
CLIENT: Haywood County — START: 12-4-12 END: 12-18-12
LOCATION: Waynesville, North Carolina — ELEVATION: 2772.05
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ 245 AFTER 24 HOURS: ▼ 163 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2690 / 85	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	
2685 / 90					
2680 / 95					
2675 / 100	Small fracture with water at 100 feet				Neat cement, 0 to 197.0 feet
2670 / 105					
2665 / 110					
2660 / 115					
2655					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14D

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34
CLIENT: Haywood County — START: 12-4-12 END: 12-18-12
LOCATION: Waynesville, North Carolina — ELEVATION: 2772.05
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ 245 AFTER 24 HOURS: ▼ 163 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2650 / 125	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	
2645 / 130					
2640 / 135					
2635 / 140					Neat cement, 0 to 197.0 feet
2630 / 145					
2625 / 150	Small fracture at 150 feet				
2620 / 155					
2615					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14D

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34
CLIENT: Haywood County — START: 12-4-12 END: 12-18-12
LOCATION: Waynesville, North Carolina — ELEVATION: 2772.05
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: 245 AFTER 24 HOURS: 163 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2610 / 165	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	
2605 / 170					
2600 / 175					
2595 / 180	Fracture from 179 to 180 feet				Neat cement, 0 to 197.0 feet
2590 / 185					
2585 / 190					
2580 / 195					Bentonite seal, 197.0 to 199.0 feet
2575					Filter pack, sand 199.0 to 250.5 feet

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14D

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34
CLIENT: Haywood County — START: 12-4-12 END: 12-18-12
LOCATION: Waynesville, North Carolina — ELEVATION: 2772.05
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ 245 AFTER 24 HOURS: ▼ 163 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2570 / 205	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	
2565 / 210	Fracture with water at 207 feet				2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 202.0 to 212.0 feet
2560 / 215	Small fracture at 215 feet				Pipe cap Total well depth, 212.2 feet
2555 / 220					
2550 / 225					
2545 / 230	Small fracture at 230 feet				
2540 / 235					
2535					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-14D

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34

CLIENT: Haywood County — START: 12-4-12 END: 12-18-12

LOCATION: Waynesville, North Carolina — ELEVATION: 2772.05

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 245 AFTER 24 HOURS: ▼ 163 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2530 / 245 ▽	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	Filter pack, sand 199.0 to 250.5 feet
2525 / 250				ND	
2520 / 255	Boring terminated at 250.5 feet. Groundwater encountered at 245 feet 1 hour after drilling, at 221 feet after 7.5 hours and at 163 feet after 24 hours.				
2515 / 260					
2510 / 265					
2505 / 270					
2500 / 275					
2495					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-15

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-28-10 END: 8-4-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2716.89

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 120 HOURS: ▼ 83 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2715	4-inches of TOPSOIL Brown, micaceous, silty, fine to medium SAND - (residuum)				Neat cement, 0 to 67.8 feet
5				ND	
2710	PARTIALLY WEATHERED ROCK which sampled as tan and brown, micaceous, silty, fine to medium SAND				
10					
2705					
15				ND	
2700					
20	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND				
2695	Fracture at 22 feet				
25				ND	
2690					
	Fracture at 28 feet				
30	Fracture/soil seam at 30 feet				
2685					
35				ND	
2680					

ENV_WELL_ONLY_PID 1957-14.GPJ 12/15/10

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-15

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-28-10 END: 8-4-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2716.89

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 120 HOURS: ▼ 83 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2675 / 45	**ROCK which sampled as light gray, micaceous, silty, fine to medium SAND** **Fracture at 43 feet**			ND	Neat cement, 0 to 67.8 feet
2670 / 50					
2665 / 55				ND	
2660 / 60					
2655 / 65					
2650 / 70				ND	Bentonite seal, 67.8 to 73.3 feet
2645 / 75					Filter pack, sand 73.3 to 163.0 feet
2640				ND	

ENV_WELL_ONLY_PID 1957-14.GPJ 12/15/10

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-15

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-28-10 END: 8-4-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2716.89

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 120 HOURS: ▼ 83 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2635	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND				Filter pack, sand 73.3 to 163.0 feet
85				ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 75.8 to 90.8 feet
2630					
90					Pipe cap
2625					Total well depth, 91.0 feet
					SURFACE COMPLETION
95				ND	2.68-foot stick-up with 4" x 4" x 5' long steel protective cover installed in a 3' x 3' x 4" thick concrete pad
2620					1/4-inch vent and weep holes installed in the PVC casing and the protective cover, respectively
100					Ground surface elev. = 2,716.89 feet
2615					Top of PVC casing elev. = 2,719.57 feet
					Northing = 662,338.59'
105				ND	Easting = 821,896.86'
2610					
110					
2605					
115				ND	
2600					

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BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-15

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14
CLIENT: Haywood County — START: 7-28-10 END: 8-4-10
LOCATION: Haywood County, North Carolina — ELEVATION: 2716.89
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ dry AFTER 120 HOURS: ▼ 83 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2595 / 125	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	Filter pack, sand 73.3 to 163.0 feet
2590 / 130					
2585 / 135	Fracture at 134 feet			ND	
2580 / 140	Fracture at 137 feet				
2575 / 145				ND	
2570 / 150					
2565 / 155	Fracture at 151 feet Fracture at 154 feet			ND	
2560	Fracture at 159 feet				

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-15

PROJECT: Haywood County Francis Farm Landfill — PROJECT NO.: J10-1957-14

CLIENT: Haywood County — START: 7-28-10 END: 8-4-10

LOCATION: Haywood County, North Carolina — ELEVATION: 2716.89

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ dry AFTER 120 HOURS: ▼ 83 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2555 / 160	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND				Filter pack, sand 73.3 to 163.0 feet
165	Boring terminated at 163.0 feet. No groundwater encountered at time of drilling, but was encountered at 83.0 feet after 120 hours.				
2550 / 170					
2545 / 175					
2540 / 180					
2535 / 185					
2530 / 190					
2525 / 195					
2520					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-16

PROJECT: Francis Farm Landfill — PROJECT NO.: J11-1957-25

CLIENT: Haywood County — START: 10-17-11 END: 10-18-11

LOCATION: Waynesville, North Carolina — ELEVATION: 2716.29

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 68 AFTER 24 HOURS: ▼ 58.70 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2715 / 0	3.5-inches of ASPHALT 4-inches of ABC STONE Reddish-brown, micaceous, fine to medium sandy SILT - (residuum)				**SURFACE COMPLETION** Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad Ground surface elev. = 2,716.29 feet Top of PVC casing elev. = 2,716.16 feet Northing = 661,203.62' Easting = 821,457.75'
2710 / 5					
2705 / 10				ND	
2700 / 15					
2695 / 20	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND			ND	Neat cement, 0 to 46.5 feet
2690 / 25					
2685 / 30				ND	
2680 / 35					

ENV_WELL_ONLY_PID 1957-25.GPJ 8/23/12

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BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-16

PROJECT: Francis Farm Landfill | PROJECT NO.: J11-1957-25
CLIENT: Haywood County | START: 10-17-11 END: 10-18-11
LOCATION: Waynesville, North Carolina | ELEVATION: 2716.29
DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: 68 AFTER 24 HOURS: 58.70 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2675	**PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND**			ND	Neat cement, 0 to 46.5 feet
45					
2670					Bentonite seal, 46.5 to 52 feet
50				ND	
2665					Filter pack, sand 52 to 70 feet
55					
2660					
60				ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 54.8 to 69.8 feet
2655					
	ROCK which sampled as grayish-brown, micaceous, silty, fine to medium SAND **Fracture encountered at 63.5 feet**				
65					
2650					
70				ND	Pipe cap
	Boring terminated at 70 feet. Groundwater encountered at 68 feet at time of drilling and at 58.70 feet after 24 hours.				Total well depth, 70 feet
2645					
75					
2640					

ENV_WELL_ONLY_PID 1957-25.GPJ 8/23/12

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-16D

PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34

CLIENT: Haywood County | START: 12-06-12 END: 12-19-12

LOCATION: Waynesville, North Carolina | ELEVATION: 2716.57

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ 78.1 CAVING> _____

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2715 / 0	4-inches of GRAVEL				**SURFACE COMPLETION** Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 2' x 2' x 4" thick concrete pad
	Brown, micaceous, silty, fine to medium SAND - (residuum)				Ground surface elev. = 2,716.57 feet
5					Top of PVC casing elev. = 2,716.28 feet
2710					Northing = 661,192.49'
					Easting = 821,467.73'
10					
2705					
15					
2700					
20				ND	Neat cement, 0 to 109.0 feet
2695					
25					
2690					
30					
2685					
35					
2680					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-16D

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34
CLIENT: Haywood County — START: 12-06-12 END: 12-19-12
LOCATION: Waynesville, North Carolina — ELEVATION: 2716.57
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ 78.1 CAVING> _____

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2675 / 45	Brown, micaceous, silty, fine to medium SAND - (residuum)			ND	
2670 / 50					
2665 / 55					
2660 / 60	PARTIALLY WEATHERED ROCK which sampled as light brown, micaceous, silty, fine to medium SAND			ND	Neat cement, 0 to 109.0 feet
2655 / 65					
2650 / 70					
2645 / 75					
2640	▼				

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-16D

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34

CLIENT: Haywood County — START: 12-06-12 END: 12-19-12

LOCATION: Waynesville, North Carolina — ELEVATION: 2716.57

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ 78.1 CAVING> _____

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2635	**PARTIALLY WEATHERED ROCK which sampled as light brown, micaceous, silty, fine to medium SAND**			ND	
	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND				
85 / 2630					
90 / 2625					
95 / 2620					
100 / 2615				ND	Neat cement, 0 to 109.0 feet
105 / 2610					
110 / 2605					Bentonite seal, 109.0 to 112.0 feet
					Filter pack, sand 112.0 to 150.0 feet
115 / 2600					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-16D

PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34
CLIENT: Haywood County | START: 12-06-12 END: 12-19-12
LOCATION: Waynesville, North Carolina | ELEVATION: 2716.57
DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ 78.1 CAVING> _____

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2595 / 120	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND Small fracture at 121 feet			ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 116.00 to 126.0 feet
2590 / 125					Pipe cap Total well depth, 126.2 feet
2585 / 130					
2580 / 135					
2575 / 140				ND	
2570 / 145					
2565 / 150				ND	
2560 / 155	Boring terminated at 150 feet. Groundwater was encountered at 78.1 feet after 24 hours.				

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-17

PROJECT: Francis Farm Landfill | PROJECT NO.: J11-1957-25

CLIENT: Haywood County | START: 10-17-11 END: 10-18-11

LOCATION: Waynesville, North Carolina | ELEVATION: 2665.07

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 72 AFTER 24 HOURS: ▼ 52.40 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
	3.5-inches of ASPHALT				SURFACE COMPLETION: Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad
	4-inches of ABC STONE				
	Brown, micaceous, fine to medium sandy SILT - (residuum)				Ground surface elev. = 2,665.07 feet
2660 — 5					Top of PVC casing elev. = 2,664.77 feet
					Northing = 661,739.15'
					Easting = 821,178.09'
2655 — 10				ND	
2650 — 15					
2645 — 20	PARTIALLY WEATHERED ROCK which sampled as light brown, micaceous, silty, fine to medium SAND			ND	Neat cement, 0 to 40 feet
2640 — 25	Dark brown, micaceous, silty, fine to medium SAND - (soil seam)				
	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND				
2635 — 30				ND	
2630 — 35					

ENV_WELL_ONLY_PID 1957-25.GPJ 8/23/12

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-17

PROJECT: Francis Farm Landfill | PROJECT NO.: J11-1957-25

CLIENT: Haywood County | START: 10-17-11 END: 10-18-11

LOCATION: Waynesville, North Carolina | ELEVATION: 2665.07

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 72 AFTER 24 HOURS: ▼ 52.40 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2620 — 45	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND			ND	Bentonite seal, 40 to 45.5 feet
					Filter pack, sand 45.5 to 73 feet
2615 — 50				ND	
2610 — 55					2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 49.8 to 64.8 feet
	Dark brown, micaceous, silty, fine to medium SAND - (soil seam)				
2605 — 60	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND			ND	
	ROCK which sampled as grayish-brown, micaceous, silty, fine to medium SAND				
2600 — 65					Pipe cap
					Total well depth, 65 feet
2595 — 70				ND	
2590 — 75	Boring terminated at 73 feet. Groundwater encountered at 72 feet at time of drilling and at 52.40 feet after 24 hours.				

ENV_WELL_ONLY_PID 1957-25.GPJ 8/23/12

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-18

PROJECT: Francis Farm Landfill | PROJECT NO.: J11-1957-25

CLIENT: Haywood County | START: 10-17-11 END: 10-20-11

LOCATION: Waynesville, North Carolina | ELEVATION: 2620.93

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: 28.5 AFTER 24 HOURS: 26.7 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2620	3.5-inches of ASPHALT 4-inches of ABC STONE Reddish-brown, micaceous, fine to medium sandy SILT - (residuum)				SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad Ground surface elev. = 2,620.93 feet Top of PVC casing elev. = 2,620.91 feet Northing = 662,150.91' Easting = 821,256.31'
5					
2615					
10				ND	
2610					Neat cement, 0 to 22 feet
15					
2605					
	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND				
20				ND	
2600					
	ROCK that sampled as grayish-brown, micaceous, silty, fine to medium SAND				Bentonite seal, 22 to 23.8 feet Filter pack, sand 23.8 to 41 feet
25					
2595					
30	Fracture encountered at 30 feet			ND	
2590					2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 25.8 to 40.8 feet
35	Water bearing fracture encountered at 35 feet				
2585					

ENV_WELL_ONLY_PID 1957-25.GPJ 8/23/12

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-18

PROJECT: Francis Farm Landfill | PROJECT NO.: J11-1957-25

CLIENT: Haywood County | START: 10-17-11 END: 10-20-11

LOCATION: Waynesville, North Carolina | ELEVATION: 2620.93

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 28.5 AFTER 24 HOURS: ▼ 26.7 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2580	ROCK that sampled as grayish-brown, micaceous, silty, fine to medium SAND Boring terminated at 41 feet. Groundwater encountered at 28.5 feet at time of drilling and at 26.7 feet after 24 hours.			ND	Pipe cap Total well depth, 41 feet
45 / 2575					
50 / 2570					
55 / 2565					
60 / 2560					
65 / 2555					
70 / 2550					
75 / 2545					

ENV_WELL_ONLY_PID 1957-25.GPJ 8/23/12

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GROUNDWATER MONITORING WELL NO. MW-19

PROJECT: Francis Farm Landfill | PROJECT NO.: J11-1957-25

CLIENT: Haywood County | START: 10-13-11 END: 10-20-11

LOCATION: Waynesville, North Carolina | ELEVATION: 2615.29

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750; 8-inch hollow stem auger

DEPTH TO - WATER> INITIAL: 14 AFTER 24 HOURS: 7.42 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2615	4-inches of GRASS and TOPSOIL				Neat cement, 0 to 1 foot
	Brown, micaceous, silty, fine to medium SAND - (colluvium/farm soil)				Bentonite seal, 1 to 3 feet
					Filter pack, sand 3 to 21 feet
2610 (5)	Brownish-gray, very moist, micaceous, silty, fine to medium SAND - (alluvium)			ND	
	COBBLE layer (very wet) - (alluvium)				
	Light brownish-gray, wet, micaceous, silty, fine to medium SAND - (alluvium)				
2605 (10)				ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 5.5 to 20.5 feet
2600 (15)				ND	
	Light brown, wet, micaceous, silty, fine to medium SAND - (residuum)				
2595 (20)				ND	Pipe cap
	Boring terminated at 21 feet. Groundwater encountered at 14 feet at time of drilling and at 7.42 feet after 24 hours.				Total well depth, 21 feet
					SURFACE COMPLETION: Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad
2590 (25)					Ground surface elev. = 2,615.29 feet
					Top of PVC casing elev. = 2,615.08 feet
2585 (30)					Northing = 662,965.29'
					Easting = 822,624.55'
2580 (35)					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-19D

PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34

CLIENT: Haywood County | START: 12-11-12 END: 12-18-12

LOCATION: Waynesville, North Carolina | ELEVATION: 2615.62

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750; 3-3/4 inch ID hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 18 HOURS: ▼ 8.2 CAVING> _____

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2615	4-inches of TOPSOIL/GRASS				SURFACE COMPLETION: Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad
	Brown, micaceous, silty, fine to medium SAND - (colluvium/farm fill)				Ground surface elev. = 2,615.62 feet
2610 (5)					Top of PVC casing elev. = 2,615.33 feet
	COBBLE layer - (alluvium)				Northing = 662,952.84'
	Light brown to gray, wet, micaceous, silty, fine to medium SAND - (alluvium)				Easting = 822,617.92'
2605 (10)				ND	
2600 (15)	Brown, moist, micaceous, silty, fine to medium SAND - (residuum)				
2595 (20)				ND	Neat cement, 0 to 49.3 feet
2590 (25)					
2585 (30)				ND	
2580 (35)					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-19D

PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34
CLIENT: Haywood County | START: 12-11-12 END: 12-18-12
LOCATION: Waynesville, North Carolina | ELEVATION: 2615.62
DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth
DRILLING METHOD: CME 750; 3-3/4 inch ID hollow stem auger
DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 18 HOURS: ▼ 8.2 CAVING> _____

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2575	PARTIALLY WEATHERED ROCK which sampled as brown, wet, micaceous, silty, fine to medium SAND			ND	
45					
2570					
50				ND	Bentonite seal, 49.3 to 52.1 feet
2565					Filter pack, sand 52.1 to 59.0 feet
55					
2560					2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 53.8 to 58.8 feet
				ND	
					Pipe cap
60	Boring terminated at 59 feet. Groundwater was encountered at 8.2 feet after 18 hours.				Total well depth, 59.0 feet
2555					
65					
2550					
70					
2545					
75					
2540					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-20

PROJECT: Francis Farm Landfill | PROJECT NO.: J11-1957-25

CLIENT: Haywood County | START: 10-12-11 END: 10-20-11

LOCATION: Waynesville, North Carolina | ELEVATION: 2622.13

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750; 8-inch hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ 3 AFTER 24 HOURS: ▼ 2.60 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2620 / 0	4-inches of GRASS and TOPSOIL Dark brown, moist, micaceous, silty, fine to medium SAND - (alluvium)				Neat cement, 0 to 1 foot Bentonite seal, 1 to 3 feet Filter pack, sand 3 to 15.5 feet
2615 / 5	Cobbles at 3.5 feet Brown, wet, micaceous, silty, fine to medium SAND - (alluvium)			ND	
2610 / 10				ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 5.3 to 15.3 feet
2605 / 15				ND	Pipe cap
2600 / 20	Boring terminated at 15.5 feet. Groundwater encountered at 3 feet at time of drilling and at 2.60 feet after 24 hours.				Total well depth, 15.5 feet SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad Ground surface elev. = 2,622.13 feet Top of PVC casing elev. = 2,621.94 feet Northing = 661,973.29' Easting = 823,503.41'
2595 / 25					
2590 / 30					
2585 / 35					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-20D

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34
CLIENT: Haywood County — START: 12-12-12 END: 12-18-12
LOCATION: Waynesville, North Carolina — ELEVATION: 2622.12
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: CME 750; 3-3/4 inch ID hollow stem auger
DEPTH TO - WATER> INITIAL: 8 AFTER 1 HOURS: 5 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2620	4-inches of TOPSOIL/GRASS Brown, moist, micaceous, silty, fine to medium SAND - (alluvium)				SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad Ground surface elev. = 2,622.12 feet Top of PVC casing elev. = 2,621.94 feet Northing = 661,973.43' Easting = 823,494.68'
5	COBBLE layer with water - (alluvium)				
2615	Brown, very moist, micaceous, silty, fine to medium SAND				
10				ND	
2610					
15					
2605					
20				ND	Neat cement, 0 to 54.0 feet
2600					
25					
2595					
30				ND	
2590					
35					
2585	Brown, very moist, micaceous, fine to medium sandy SILT				

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-20D

PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34

CLIENT: Haywood County | START: 12-12-12 END: 12-18-12

LOCATION: Waynesville, North Carolina | ELEVATION: 2622.12

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750; 3-3/4 inch ID hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ 8 AFTER 1 HOURS: ▼ 5 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2580	Brown, very moist, micaceous, fine to medium sandy SILT			ND	
	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND				
	ROCK seam				
45	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND				
2575					
50				ND	
2570					
55					Bentonite seal, 54.0 to 57.0 feet
2565					Filter pack, sand 57.0 to 69.0 feet
60				ND	
2560					2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 60.0 to 65.0 feet
65					Pipe cap
2555					Total well depth, 65.1 feet
				ND	
70	Boring terminated at 69 feet. Groundwater encountered at 8 feet at time of drilling and at 5 feet after 1 hour.				
2550					
75					
2545					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-21

PROJECT: Francis Farm Landfill — PROJECT NO.: J11-1957-25

CLIENT: Haywood County — START: 10-12-11 END: 10-20-11

LOCATION: Waynesville, North Carolina — ELEVATION: 2658.72

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750; 8-inch hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ 36 AFTER 24 HOURS: ▼ 24.12 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
	3-inches of GRASS and TOPSOIL				SURFACE COMPLETION: Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad
	Brown, micaceous, fine to medium sandy SILT - (residuum)				
2655	Light brown, micaceous, fine to medium sandy SILT with some rock				Ground surface elev. = 2,658.72 feet
5				ND	Top of PVC casing elev. = 2,658.37 feet
					Northing = 661,424.40'
					Easting = 823,203.28'
2650					Neat cement, 0 to 15 feet
10				ND	
2645					
15				ND	Bentonite seal, 15 to 17 feet
	Dark brown, moist, micaceous, fine to medium sandy SILT				Filter pack, sand 17 to 36 feet
2640					
20				ND	
	Dark brown, moist to very moist, micaceous, fine to medium sandy SILT				
2635	▼				2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 18.8 to 33.8 feet
25				ND	
2630					
30				ND	
2625					Pipe cap
35	▽			ND	Total well depth, 34 feet
	Boring terminated at 36 feet. Groundwater encountered at 36 feet at time of drilling and at 24.12 feet after 24 hours.				
2620					

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GROUNDWATER MONITORING WELL NO. MW-22

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34

CLIENT: Haywood County — START: 12-11-12 END: 12-14-12

LOCATION: Waynesville, North Carolina — ELEVATION: 2600.00

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750; 3-3/4 inch ID hollow stem auger

DEPTH TO - WATER> INITIAL: ▽ 5 AFTER 24 HOURS: ▼ 2.3 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
	6-inches of TOPSOIL				Neat cement, 0 to 0.5 feet
	Brown, moist, micaceous, silty, fine to medium SAND - (alluvium)				Bentonite seal, 0.5 to 2.0 feet
					Filter pack, sand 2.0 to 25.0 feet
2595 — 5	COBBLE layer			ND	
	Gray, moist, micaceous, silty, fine to medium SAND				
2590 — 10				ND	
	Brown, moist, micaceous, fine to medium sandy SILT				
2585 — 15				ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 4.0 to 24.0 feet
2580 — 20				ND	
					Pipe cap
2575 — 25				ND	Total well depth, 24.2 feet
	Boring terminated at 25 feet. Groundwater encountered at 5 feet at time of drilling and at 2.3 feet after 24 hours.				SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad
2570 — 30					Ground surface elev. = 2,600.00 feet
					Top of PVC casing elev. = 2,599.86 feet
					Northing = 661,046.30'
2565 — 35					Easting = 820,724.07'

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-23

PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34

CLIENT: Haywood County | START: 12-11-12 END: 12-14-12

LOCATION: Waynesville, North Carolina | ELEVATION: 2611.63

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750; 3-3/4 inch ID hollow stem auger

DEPTH TO - WATER> INITIAL: 5 AFTER 24 HOURS: 1.7 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2610 / 0	4-inches of GRASS/TOPSOIL				Neat cement, 0 to 0.5 feet
	Brown, micaceous, silty, fine to medium SAND - (alluvium)				Bentonite seal, 0.5 to 2.0 feet
					Filter pack, sand 2.0 to 24.0 feet
2605 / 5	Very moist COBBLE layer			ND	
	Brown, moist, micaceous, silty, fine to medium SAND				
2600 / 10				ND	
2595 / 15				ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 3.8 to 23.8 feet
2590 / 20				ND	
				ND	
2585 / 25	Boring terminated at 24 feet. Groundwater encountered at 5 feet at time of drilling and at 1.7 feet after 24 hours.				Pipe cap
					Total well depth, 24.0 feet
2580 / 30					SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad
					Ground surface elev. = 2,611.63 feet
					Top of PVC casing elev. = 2,611.43 feet
2575 / 35					Northing = 663,169.77'
					Easting = 822,719.36'

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GROUNDWATER MONITORING WELL NO. MW-23D

PROJECT: Francis Farm Landfill — PROJECT NO.: J13-1957-39

CLIENT: Haywood County — START: 9-30-13 END: 10-1-13

LOCATION: Waynesville, North Carolina — ELEVATION: 2611.75

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750; 8-inch OD hollow stem auger, Schramm T450S; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ 2.8 CAVING> _____

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2610 / 0	4-inches of TOPSOIL/GRASS Brown, micaceous, silty, fine to medium SAND - (alluvium)				SURFACE COMPLETION Flush-mount secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" concrete pad Top of PVC casing elev. = 2,611.52 feet Ground surface elev. = 2,611.75 feet Northing = 663,182.5348' Easting = 822,725.7136'
2605 / 5	Very moist COBBLE layer - (alluvium)				
	Gray-brown, moist, very micaceous, silty, fine to medium SAND - (alluvium)				
2600 / 10				ND	
	Brown, moist, micaceous, silty, fine to medium SAND - (alluvium)				
2595 / 15					6-inch outer casing set to 37.0 feet
2590 / 20				ND	Grout, 0 to 46.7 feet
2585 / 25					
2580 / 30				ND	
2575 / 35	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND				Borehole diameter 0 to 37 feet, 8-inches
	ROCK which sampled as grayish-brown, micaceous, silty, fine to medium SAND				

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-23D

PROJECT: Francis Farm Landfill | PROJECT NO.: J13-1957-39

CLIENT: Haywood County | START: 9-30-13 END: 10-1-13

LOCATION: Waynesville, North Carolina | ELEVATION: 2611.75

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: CME 750; 8-inch OD hollow stem auger, Schramm T450S; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ _____ AFTER 24 HOURS: ▼ 2.8 CAVING> _____

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2570 / 45	**ROCK which sampled as grayish-brown, micaceous, silty, fine to medium SAND**				Grout, 0 to 46.7 feet
2565					Bentonite seal, 46.7 to 50.5 feet
50					Filter pack, sand 50.5 to 62.0 feet
2560					
55	**Water bearing fracture at 55 feet**				2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 53.0 to 58.0 feet
2555					Pipe cap
	Water bearing fracture at 59 feet				Total well depth, 58.2 feet
60					Borehole diameter 37 to 62 feet, 6-inches
2550	**Boring terminated at 62.0 feet. Groundwater encountered at 2.8 feet after 24 hours.**				
65					
2545					
70					
2540					
75					
2535					

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-24

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34
CLIENT: Haywood County — START: 12-05-12 END: 12-07-12
LOCATION: Waynesville, North Carolina — ELEVATION: 2626.04
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ dry AFTER 24 HOURS: ▼ 5 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2625	4-inches of GRASS/TOPSOIL Brown, micaceous, silty, fine to medium SAND - (colluvium)				Neat cement, 0 to 1.0 foot Bentonite seal, 1.0 to 5.0 feet
2620 (5)				ND	Filter pack, sand 5.0 to 35.0 feet
2615 (10)				ND	
	PARTIALLY WEATHERED ROCK which sampled as light brown, micaceous, silty, fine to medium SAND				
2610 (15)	ROCK which sampled as grayish-brown, micaceous, silty, fine to medium SAND - (residuum)			ND	2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 7.5 to 27.5 feet
2605 (20)	ROCK and PARTIALLY WEATHERED ROCK which sampled as grayish-brown, micaceous, silty, fine to medium SAND Fracture with water at 20 feet			ND	
2600 (25)				ND	Pipe cap Total well depth, 27.7 feet
2595 (30)				ND	SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad
2590 (35)	Boring terminated at 35 feet. No groundwater encountered at time of drilling, but was encountered at 5 feet after 24 hours.			ND	Ground surface elev. = 2,626.04 feet Top of PVC casing elev. = 2,625.80 feet Northing = 662,019.81' Easting = 823,641.42'

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-25

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34

CLIENT: Haywood County — START: 12-05-12 END: 12-20-12

LOCATION: Waynesville, North Carolina — ELEVATION: 2756.67

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 219 AFTER 13 HOURS: ▼ 209 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2755 / 0	3-inches of GRASS/TOPSOIL Brown, micaceous, silty, fine to medium SAND - (residuum)				SURFACE COMPLETION Flush-mount below ground surface secured with an 8-inch diameter steel bolted manhole cover in a 3' x 3' x 4" thick concrete pad Ground surface elev. = 2,756.67 feet Top of PVC casing elev. = 2,756.31 feet Northing = 661,488.76' Easting = 822,382.32'
2750 / 5					
2745 / 10	PARTIALLY WEATHERED ROCK which sampled as brown, micaceous, silty, fine to medium SAND				
2740 / 15					
2735 / 20					Neat cement, 0 to 235.0 feet
2730 / 25					
2725 / 30					
2720 / 35	ROCK with layers of PARTIALLY WEATHERED ROCK which sampled as light brown, micaceous, silty, fine to medium SAND				

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DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 219 AFTER 13 HOURS: ▼ 209 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2715	ROCK with layers of PARTIALLY WEATHERED ROCK which sampled as light brown, micaceous, silty, fine to medium SAND			ND	
45 / 2710	ROCK with layers of PARTIALLY WEATHERED ROCK which sampled as gray, micaceous, silty, fine to medium SAND				
50 / 2705					
55 / 2700					
60 / 2695					Neat cement, 0 to 235.0 feet
	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND				
65 / 2690					
70 / 2685					
75 / 2680					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

GROUNDWATER MONITORING WELL NO. MW-25

PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34

CLIENT: Haywood County | START: 12-05-12 END: 12-20-12

LOCATION: Waynesville, North Carolina | ELEVATION: 2756.67

DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 219 AFTER 13 HOURS: ▼ 209 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2675 / 85	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	
2670 / 90					
2665 / 95					
2660 / 100					Neat cement, 0 to 235.0 feet
2655 / 105					
2650 / 110					
2645 / 115					
2640					

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GROUNDWATER MONITORING WELL NO. MW-25

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CLIENT: Haywood County — START: 12-05-12 END: 12-20-12
LOCATION: Waynesville, North Carolina — ELEVATION: 2756.67
DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ 219 AFTER 13 HOURS: ▼ 209 CAVING>

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2635 / 125	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	
2630 / 130					
2625 / 135					
2620 / 140					Neat cement, 0 to 235.0 feet
2615 / 145					
2610 / 150	Fracture at 150 feet				
2605 / 155					
2600					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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PROJECT: Francis Farm Landfill | PROJECT NO.: J12-1957-34
CLIENT: Haywood County | START: 12-05-12 END: 12-20-12
LOCATION: Waynesville, North Carolina | ELEVATION: 2756.67
DRILLER: Landprobe, M. King | LOGGED BY: B. Nisbeth
DRILLING METHOD: Schramm T450WS; 6-inch air hammer
DEPTH TO - WATER> INITIAL: ▽ 219 AFTER 13 HOURS: ▼ 209 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2595 / 165	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	
2590 / 170					
2585 / 175					
2580 / 180					Neat cement, 0 to 235.0 feet
2575 / 185					
2570 / 190	Fracture at 190 feet				
2565 / 195					
2560					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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GROUNDWATER MONITORING WELL NO. MW-25

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34

CLIENT: Haywood County — START: 12-05-12 END: 12-20-12

LOCATION: Waynesville, North Carolina — ELEVATION: 2756.67

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 219 AFTER 13 HOURS: ▼ 209 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2555 / 0	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	
205					
2550					
210					
2545					
215					
2540					
220					Neat cement, 0 to 235.0 feet
2535	Fracture at 223 feet				
225					
2530					
230					
2525					
235					Bentonite seal, 235.0 to 243.8 feet
2520					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

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GROUNDWATER MONITORING WELL NO. MW-25

PROJECT: Francis Farm Landfill — PROJECT NO.: J12-1957-34

CLIENT: Haywood County — START: 12-05-12 END: 12-20-12

LOCATION: Waynesville, North Carolina — ELEVATION: 2756.67

DRILLER: Landprobe, M. King — LOGGED BY: B. Nisbeth

DRILLING METHOD: Schramm T450WS; 6-inch air hammer

DEPTH TO - WATER> INITIAL: ▽ 219 AFTER 13 HOURS: ▼ 209 CAVING> ▨

ELEVATION/ DEPTH (FT)	DESCRIPTION	SOIL TYPE	SAMPLES	PID (ppm) READING	MONITOR WELL INSTALLATION DETAILS
2515 / 245	ROCK which sampled as light gray, micaceous, silty, fine to medium SAND			ND	
2510 / 250					Filter pack, sand 243.8 to 262.0 feet
2505 / 255	Fracture with some water at 254 feet				2-inch diameter, 0.010-inch slotted Schedule 40 PVC well screen, 249.3 to 259.3 feet
2500 / 260					Pipe cap
2495				ND	Total well depth, 259.5 feet
2490 / 265	Boring terminated at 262 feet. Groundwater encountered at 219 feet at time of drilling and at 209 feet after 13 days.				
2485 / 270					
2480 / 275					

ENV_WELL_ONLY_PID 1957-34.GPJ 6/27/13

KEY TO SOIL CLASSIFICATIONS AND CONSISTENCY DESCRIPTIONS

BUNNELL-LAMMONS ENGINEERING, INC.
GREENVILLE, SOUTH CAROLINA

Penetration Resistance* Blows per Foot	Relative Density
SANDS	
0 to 4	Very Loose
5 to 10	Loose
11 to 20	Firm
21 to 30	Very Firm
31 to 50	Dense
over 50	Very Dense

Penetration Resistance* Blows per Foot	Consistency
SILTS and CLAYS	
0 to 2	Very Soft
3 to 4	Soft
5 to 8	Firm
9 to 15	Stiff
16 to 30	Very Stiff
31 to 50	Hard
over 50	Very Hard

*ASTM D 1586

Particle Size Identification

Boulder: Greater than 300 mm
Cobble: 75 to 300 mm
Gravel:
Coarse - 19 to 75 mm
Fine - 4.75 to 19 mm
Sand:
Coarse - 2 to 4.75 mm
Medium - 0.425 to 2 mm
Fine - 0.075 to 0.425 mm
Silt & Clay: Less than 0.075 mm

KEY TO DRILLING SYMBOLS


Grab Sample


Split Spoon Sample


Undisturbed Sample

NR = No reaction to HCL

NA = Not applicable

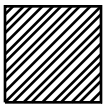
NS = No sample

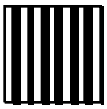

Groundwater Table at Time of Drilling

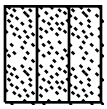

Groundwater Table 24 Hours after Completion of Drilling

KEY TO SOIL CLASSIFICATIONS

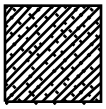

Well-graded Gravel
GW


Low Plasticity Clay
CL

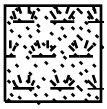

Clayey Silt
MH


Silty Sand
SM

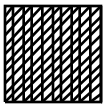

Poorly-graded Gravel
GP

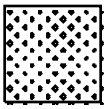

Sandy Clay
CLS


Sandy Silt
MLS


Topsoil
TOPSOIL

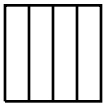

Partially Weathered Rock
BLDRCBBL

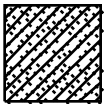

Silty Clay
CL-ML

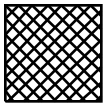

Sand
SW

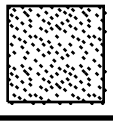

Trash
MUCKPEAT

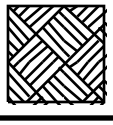

High Plasticity Clay
CH

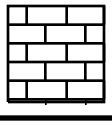

Silt
ML


Clayey Sand
SC


Fill
FILL


Poorly Graded Sand
SP


Bedrock
BEDROCK


Limestone
LIMESTONE

APPENDIX B

NORTH CAROLINA APPENDIX I AND APPENDIX II CONSTITUENT LISTS

Constituents for Detection Monitoring
(40 CFR 258, Appendix I)

Common name	CAS RN
Antimony	(Total)
Arsenic	(Total)
Barium	(Total)
Beryllium	(Total)
Cadmium	(Total)
Chromium	(Total)
Cobalt	(Total)
Copper	(Total)
Lead	(Total)
Nickel	(Total)
Selenium	(Total)
Silver	(Total)
Thallium	(Total)
Vanadium	(Total)
Zinc	(Total)
Acetone	67-64-1
Acrylonitrile	107-13-1
Benzene	71-43-2
Bromochloromethane	74-97-5
Bromodichloromethane	75-27-4
Bromoform; Tribromomethane	75-25-2
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroethane; Ethyl chloride	75-00-3
Chloroform; Trichloromethane	67-66-3
Dibromochloromethane; Chlorodibromomethane	124-48-1
1,2-Dibromo-3-chlorpropane; DBCP	96-12-8
1,2-Dibromoethane; Ethylene dibromide; EDB	106-93-4
o-Dichlorobenzene; 1,2-Dichlorobenzene	95-50-1
p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7
trans-1,4-Dichloro-2-butene	110-57-6
1,1-Dichloroethane; Ethylidene chloride	75-34-3
1,2-Dichloroethane; Ethlyene dichloride	107-06-2
1,1-Dichloroethylene; 1-1-Dichloroethene; Vinylidene chloride	75-35-4
cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	156-59-2
trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene	156-60-5
1,2-Dichlorpropane; Propylene dichloride	78-87-5
cis-1,3-Dichlorpropene	10061-01-5
trans-1,3-Dichlorpropene	10061-02-6
Ethylbenzene	100-41-4
2-hexanone; Methyl butyl ketone	591-78-6
Methyl bromide; Bromomethane	74-83-9
Methyl chloride; Chloromethane	74-87-3
Methylene bromide Dibromomethane	74-95-3
Methylene chloride; Dichloromethane	75-09-2
Methyl ethyl ketone; MEK; 2-Butanone	78-93-3
Methyl iodide; Iodomethane	74-88-4
4-Methyl-2-pentanone; Methyl isobutyl isobutyl ketone	108-10-1
Styrene	100-42-5
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethylene; Tetracholorethene; Perchloroethylene	127-18-4
Toluene	108-88-3
1,1,1-Trochlorethane; Methylchloroform	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethylene; Trichlorethene	79-01-6
Trichlorofluoromethane; CFC-11	75-69-4
1,2,3-Trichloropropane	96-18-4
Vinyl acetate	108-05-4
Vinyl chloride	75-01-4
Xylenes	1330-20-7

Constituents for Assessment Monitoring
(40 CFR 258, Appendix II)

Common Name	CAS RN
Acenaphthene	83-32-9
Acenaphthylene	208-96-8
Acetone	67-64-1
Acetonitrile; Methyl cyanide	75-05-8
Acetophenone	98-86-2
2-Acetylaminofluorene; 2-AAF	53-96-3
Acrolein	107-02-8
Acrylonitrile	107-13-1
Aldrin	309-00-2
Allyl chloride	107-05-1
4-Aminobiphenyl	92-67-1
Anthracene	120-12-7
Antimony	(Total)
Arsenic	(Total)
Barium	(Total)
Benzene	71-43-2
Benzo[a]anthracene; Benzanthracene	56-55-3
Benzo[b]fluoranthene	205-99-2
Benzo[k]fluoranthene	207-08-9
Benzo[ghi]perylene	191-24-2
Benzo[a]pyrene	50-32-8
Benyl alcohol	100-51-5
Beryllium	(Total)
alpha-BHC	319-84-6
beta-BHC	319-85-7
delta-BHC	319-86-8
gamma-BHC; Lindane	58-89-9
Bis(2-chloroethoxy)methane	111-91-1
Bis(2-chloroethyl)ether; Dichloroethyl ether	111-44-4
Bis-(2-chlor-1-methyl) ether; 2, 2-Dichloro-diisopropyl ether; DCIP, See note 6	108-60-1
Bis(2-ethylhexyl) phthalate	117-81-7
Bromochloromethane; Chlorobromomethane	74-97-5
Bromodichloromethane; Dibromochloromethane	75-27-4
Bromoform; Tribromomethane	75-25-2
4-Bromophenyl phenyl ether	101-55-3
Butyl benzyl phthalate; Benzyl butyl phthalate	85-68-7
Cadmium	(Total)
Carbon disulfide	75-15-0
Carbon tetrachloride	56-23-5
Chlordane	See NOTE 1
p-Chloroaniline	106-47-8
Chlorobenzene	108-90-7
Chlorobenzilate	510-15-6
p-Chloro-m-cresol; 4-Chloro-3-methylphenol	59-50-7

Chloroethane; Ethyl chloride	75-00-3
Chloroform; Trichloromethane	67-66-3
2-Chloronaphthalene	91-58-7
2-Chlorophenol	95-57-8
4-Chlorophenyl phenyl ether	7005-72-3
Chloroprene	126-99-8
Chromium	(Total)
Chrysene	218-01-9
Cobalt	218-01-9
Copper	(Total)
m-Cresol; 3-methylphenol	108-39-4
o-Cresol; 2-methlphenol	95-48-7
p-Cresol; 4-methylphenol	106-44-5
Cyanide	57-12-5
2,4-D; 2,4-Dichlorophenoxyacetic acid	94-75-7
4,4-DDD	72-54-8
4,4-DDE	72-55-9
4,4-DDT	50-29-3
Diallate	2303-16-4
aDibenz[a,h]anthracene	53-70-3
Dibenzofuran	132-64-9
Dibromochloromethane; Chlorodibromomethane	124-48-1
1,2-Dibromo-30chloropropane; DBCP	96-12-8
1,2-Dibromoethane; Ethylene dibromide; EDB	106-93-4
Di-n-butyl phthalate	84-74-2
o-Dichlorobenzene; 1,2-Dichlorobenzene	95-50-1
m-Dichlorobenzene; 1,3-Dichlorobenzene	541-73-1
p-Dichlorobenzene; 1,4-Dichlorobenzene	106-46-7
3,3-Dichlorobenzidine	91-94-1
trans-1,4-Dichloro-2-butene	110-57-6
Dichlorodifluoromethane; CFC 12;	75-71-8
1,1-Dichloroethane chloride	75-34-3
1,2-Dichloroethane; Ethylene dichloride	107-06-2
1,1-Dichloroethylene; 1,1-Dichloroethane; Vinylidene	75-35-4
chloride	(Total)
cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene	156-59-2
trans-1,2-Dichloroethylene trans-1,2-Dichloroethene	156-60-5
2,4-Dichlorophenol	120-83-2
2,6-Dichlorophenol	87-65-0
1,2-Dichloropropane; Propylene dichloride	78-87-5
1,3-Dichloropropane; Trimethylene dichloride	142-28-9
2,2-Dichloropropane; Isopropylidene chloride	594-20-7
1,1-Dichloropropene	563-58-6
cis-1,3-Dichloropropene	10061-01-5
trans-1,3-Dichloropropene	10061-02-6
Dieldrin	60-57-1
Diethyl phthalate	84-66-2

0,0-Diethyl 0-2-pyrazinyl phosphorothioate; thionazin	297-97-2
Dimethoate	60-51-5
p-(Dimethylamino)azobenzene	60-11-7
7,12-Dimethylbenxz[a]anthracene	57-97-6
3,3-Dimethylbenzidine	119-93-7
2,4-Dimethlphenol; m-Xylenol	105-67-9
Dimethyl phthalate	131-11-3
m-Dinitrobenzene	99-65-0
4,6-Dinitro-o-cresol 4,6-Dinitro-2-methylphenol	534-52-1
2,4-Dinitrophenol	51-28-5
2,4-Dinitrotoluene	121-14-2
2,6-Dinitrotoluene	606-20-2
Dinoseb; DNBP; 2-sec-Butyl-4,6-dinitrophenol	88-85-7
Di-n-octyl phthalate	117-84-0
Diphenylamine	122-39-4
Disulfoton	298-04-4
Endosulfan I	959-98-8
Endosulfan II	33213-65-9
Endodulfan sulfate	1031-07-8
Endrin	72-20-8
Endrin aldehyde	7421-93-4
Ethylbenzene	100-41-4
Ethyl methacrylate	97-63-2
Ethyl methanesulfonate	62-50-0
Famphur	52-85-7
Fluoranthene	206-44-0
Fluorene	86-73-7
Heptachlor	76-44-8
Heptachlor epoxide	1024-57-3
Hexachlorobenzene	118-74-1
Hexachlorobutadiene	87-68-3
Hexachlorocyclopentadiene	77-47-4
Hexachloroethane	67-72-1
Hexachloropropene	188-71-7
2-Hexanone; Methyl butyl ketone	591-78-6
Indenol(1,2,3-cd)pyrene	193-39-5
Isopbutyl alcohol	78-83-1
Isodrin	465-73-6
Isophorone	78-59-1
Isosafrole	120-58-1
Kepone	143-50-0
Lead	(Total)
Mercury	(Total)
Methacrylonitrile	126-98-7
Methapyrilene	91-80-5
Methoxychlor	72-43-5
Methyl bromide; Bromomethane	74-83-9
Methyl chloride; Chloromethane	74-87-3
3-Methylcholanthrene	56-49-5
Methyl ethyl ketone; MEK; 2-Butanone	78-93-3
Methyl iodide; lodomethane	74-88-4

Methyl methacrylate	80-62-6
Methyl methanesulfonate	66-27-3
2-Methylnaphthalene	91-57-6
Methyl parathion; Parathion methyl	298-00-0
4-Methyl-2-pentanone; Methyl isobutyl ketone	108-10-1
Methylene bromide; Dibromomethane	74-95-3
Methylene chloride; Dichloromethane	75-09-2
Naphthalene	91-20-3
1,4-Naphthoquinone	130-15-4
1-Naphthylamine	134-32-7
2-Naphthylamine	91-59-8
Nickel	(Total)
o-Nitroaniline; 2-Nitroaniline	88-74-4
m-Nitroaniline; 3-Nitroanile	99-09-2
p-Nitroaniline; 4-Nitroaniline	100-01-6
Nitrobenzene	98-95-3
o-Nitrophenol; 2-Nitrophenol	88-75-5
p-Nitrophenol; 4-Nitrophenol	100-02-7
N-Nitrosodi-n-butylamine	924-16-3
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
N-Nitrosodiphenylamine, N-Nitroso-N-Di-n-propylnitrosamine	86-30-6
N-Nitrosodipropylamine; dipropylamine;	621-64-7
N-Nitrosomethylethalamine	10595-95-6
N-Nitrosopiperidine	100-75-4
N-Nitrosopyrrolidine	930-55-2
5-Nitro-o-toluidine	99-55-8
Parathion	56-38-2
Pentachlorobenzene	608-93-5
Pentachloronitrobenzene	82-68-8
Pentachlorophenol	87-86-5
Phenacetin	62-44-2
Phenanthrene	85-01-8
Phenol	108-95-2
p-Phenylenediamine	106-50-3
Phorate	298-02-2
Polychlorinated biphenyls (PCBs); Aroclors	see NOTE 2
Pronamide	23950-58-5
Propionitrile; Ethyl cyanide	107-12-0
Pyrene	129-00-0
Safrole	94-59-7
Selenium	(Total)
Silver	(Total)
Silvex; 2,4,5-TP	93-72-1
Styrene	100-42-5
Sulfide	18496-25-8
2,4,5-T; 2,4,5-Trichlorophenoxyacetic acid	93-76-5
1,2,4,5-Tetrachlorobenzene	95-94-3
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5

Tetrachloroethylene; Tetrachloroethene; Perchloroethylene	127-18-4
2,3,4,6-Tetrachlorophenol	58-90-2
Thallium	(Total)
Tin	(Total)
Toluene	108-88-3
o-Toluidine	95-53-4
Toxaphene	See NOTE 3
1,2,4-Trichlorobenzene	120-82-1
1,1,1-Trichloroethane; Methylchloroform	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethylene; Trichloroethene	79-01-6
Trichlorrofluoromethane; CFC-11	75-69-4
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
1,2,3-Trichloropropane	96-18-4
0,0,0-Triethyl phosphorothioate	126-68-1
sym-Trinitrobenzene	99-35-4
Vanadium	(Total)
Vinyl acetate	108-05-4
Vinyl chloride; Chloroethene	75-01-4
Xylene (total)	See NOTE 4
Zinc	(Total)

1. Chlordane: This entry includes alpha-chlordane (CAS RN 5103-71-9), beta-chlordane (CAS RN 5103-74-2), gamma-chlordane (CAS RN 5566-34-7), and constituents of chlordane (CAS RN 57-74-9 and CAS RN 12789-03-6)
2. Polychlorinated biphenyls (CAS RN 1336-36-3); this category contains congener chemicals, including constituents of Aroclor-1016 (CAS RN 12674-11-2), Aroclor-1221 (CAS RN 11104-28-2), Aroclor-1232 (CAS RN 11141-16-5), Aroclor-1242 (CAS RN 53469-21-9), Aroclor-1248 (CAS RN 12672-29-6), Aroclor-1254 (CAS RN 11097-69-1), and Aroclor-1260 (CAS RN 11096-82-5)
3. Toxaphene: This entry includes congener chemicals contained in technical toxaphene (CAS RN 8001-35-2), ie, chlorinated camphene
4. Xylene (total): This entry includes o-xylene (CAS RN 96-47-6), m- xylene (CAS RN 108-38-3), p-xylene (CAS RN 106-42-3), and unspecified xylenes (dimethylbenzenes) (CAS RN 1330-20-7)

APPENDIX C

NCDENR MEMORANDA AND REPORTING LIMITS AND STANDARDS

North Carolina Department of Environment and Natural Resources
Dexter R. Matthews, Director Division of Waste Management Michael F. Easley, Governor
William G. Ross Jr., Secretary

October 27, 2006

To: SW Director/County Manager/Consultant/Laboratory

From: NC DENR-DWM, Solid Waste Section

Re: New Guidelines for Electronic Submittal of Environmental Monitoring Data

The Solid Waste Section receives and reviews a wide variety of environmental monitoring data from permitted solid waste management facilities, including the results from groundwater and surface water analyses, leachate samples, methane gas readings, potentiometric measurements, and corrective action data. We are in the process of developing a database to capture the large volume of data submitted by facilities.

To maintain the integrity of the database, it is critical that facilities, consultants, and laboratories work with the Solid Waste Section to ensure that environmental samples are collected and analyzed properly with the resulting data transferred to the Solid Waste Section in an accurate manner.

In order to better serve the public and to expedite our review process, the Solid Waste Section is requesting specific formatting for environmental monitoring data submittals for all solid waste management facilities.

Effective, December 1, 2006, please submit a Solid Waste Environmental Monitoring Data Form in addition to your environmental monitoring data report. This form will be sent in lieu of your current cover letter to the Solid Waste Section. The Solid Waste Environmental Monitoring Data Form must be filled out completely, signed, and stamped with a Board Certified North Carolina Geologist License Seal.

The solid waste environmental monitoring data form will include the following:

1. Contact Information
2. Facility Name
3. Facility Permit Number
4. Facility Address
5. Monitoring Event Date (MM/DD/YYYY)
6. Water Quality Status: Monitoring, Detection Monitoring, or Assessment Monitoring
7. Type of Data Submitted: Groundwater Monitoring Wells, Groundwater Potable Wells, Leachate, Methane Gas, or Corrective Action Data
8. Notification of Exceedance of Groundwater, Surface Water, or Methane Gas (in table form)
9. Signature
10. North Carolina Geologist Seal

1646 Mail Service Center, Raleigh, North Carolina 27699-1646
Phone: 919-508-8400 \ FAX: 919-733-4810 \ Internet http://wastenotnc.org

Most of these criteria are already being included or can be added with little effort. The Solid Waste Environmental Monitoring Data Form can be downloaded from our website: http://www.wastenotnc.org/swhome/enviro_monitoring.asp.

The Solid Waste Section is also requesting a new format for monitoring wells, potable wells, surface water sampling locations, and methane probes. This format is essential in the development and maintenance of the database. The Solid Waste Section is requesting that each sampling location at all North Carolina solid waste management facilities have its own unique identification number. We are simply asking for the permit number to be placed directly in front of the sampling location number (example: 9901-MW1 = Permit Number 99-01 and Monitoring Well MW-1). No changes will need to be made to the well tags, etc. This unique identification system will enable us to accurately report data not only to NCDENR, but to the public as well. We understand that this new identification system will take some time to implement, but we feel that this will be beneficial to everyone involved in the long term.

Additionally, effective December 1, 2006, the Practical Quantitation Limits (PQLs) established in 1994 will change. The Solid Waste Section is requiring that all solid waste management facilities use the new Solid Waste Reporting Limits (SWRL) for all groundwater analyses by a North Carolina Certified Laboratory. Laboratories must also report any detection of a constituent even it is detected below the new SWRL (e.g., J values where the constituent was detected above the detection limit, but below the quantitation limit).

PQLs are technology-based analytical levels that are considered achievable using the referenced analytical method. The PQL is considered the lowest concentration of a contaminant that the lab can accurately detect and quantify. PQLs provided consistency and available numbers that were achievable by the given analytical method. However, PQLs are not health-based, and analytical instruments have improved over the years resulting in lower achievable PQLs for many of the constituents. As a result, the Solid Waste Section has established the SWRLs as the new reporting limits eliminating the use of the PQLs.

We would also like to take this opportunity to encourage electronic submittal of the reports. This option is intended to save resources for both the public and private sectors. The Solid Waste Section will accept the entire report including narrative text, figures, tables, and maps on CD-ROM. The CD-ROM submittal shall contain a CD-ROM case and both CD-ROM and the case shall be labeled with the site name, site address, permit number, and the monitoring event date (MM/DD/YYYY). The files may be a .pdf, .txt, .csv, .xls, or .doc type. Also, analytical lab data should be reported in an .xls file. We have a template for analytical lab data available on the web at the address listed above.

If you have any questions or concerns, please call (919) 508-8400. Thank you for your anticipated cooperation in this matter.

North Carolina Department of Environment and Natural Resources

Dexter R. Matthews, Director | Division of Waste Management | Michael F. Easley, Governor
William G. Ross Jr., Secretary

February 23, 2007

MEMORANDUM

To: Solid Waste Directors, Landfill Operators, North Carolina Certified Laboratories, and Consultants

From: North Carolina Division of Waste Management, Solid Waste Section

Re: Addendum to October 27, 2006, North Carolina Solid Waste Section Memorandum Regarding New Guidelines for Electronic Submittal of Environmental Data.

The purpose of this addendum memorandum is to provide further clarification to the October 27, 2006, North Carolina Solid Waste Section memo titled, "New Guidelines for Electronic Submittal of Environmental Data."

The updated guidelines is in large part due to questions and concerns from laboratories, consultants, and the regulated community regarding the detection of constituents in groundwater at levels below the previous practical quantitation limits (PQLs). The North Carolina Solid Waste Section solicited feedback from the regulated community, and, in conjunction with the regulated community, developed new limits. The primary purpose of these changes was to improve the protection of public health and the environment. The North Carolina Solid Waste Section is concerned about analytical data at these low levels because the earliest possible detection of toxic or potentially carcinogenic chemicals in the environment is paramount in the North Carolina Solid Waste Section's mission to protect human health and the environment. Low level analytical data are critical for making the correct choices when designing site remediation strategies, alerting the public to health threats, and protecting the environment from toxic contaminants. The revised limits were updated based on readily available laboratory analytical methodology and current health-based groundwater protection standards.

Definitions

Many definitions relating to detection limits and quantitation limits are used in the literature and by government agencies, and commonly accepted procedures for calculating these limits exist. Except for the Solid Waste Section Limit and the North Carolina 2L Standards, the definitions listed below are referenced from the Environmental Protection Agency (EPA). The definitions are also an attempt to clarify the meaning of these terms as used by the North Carolina Solid Waste Section.

Method Detection Limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

Method Reporting Limit or Method Quantitation Limit (MRL or MQL) is the minimum concentration of a target analyte that can be accurately determined by the referenced method.

Practical Quantitation Limit (PQL) is a quantitation limit that represents a practical and routinely achievable quantitation limit with a high degree of certainty (>99.9% confidence) in the results. Per EPA Publication Number SW-846, the PQL is the lowest concentration that can be reliably measured within specified limits of precision and accuracy for a specific laboratory analytical method during routine laboratory operating conditions in accordance with "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. The PQL appears in older NCDENR literature; however, it is no longer being used by the North Carolina Solid Waste Section.

Solid Waste Section Limit (SWSL) is the lowest amount of analyte in a sample that can be quantitatively determined with suitable precision and accuracy. The SWSL is the concentration below which reported analytical results must be qualified as estimated. *The SWSL is the updated version of the PQL that appears in older North Carolina Solid Waste Section literature. The SWSL is the limit established by the laboratory survey conducted by the North Carolina Solid Waste Section. The nomenclature of the SWRL described in the October 27, 2006, memorandum has changed to the SWSL.*

North Carolina 2L Standards (2L) are water quality standards for the protection of groundwaters of North Carolina as specified in 15A NCAC 2L .0200, Classifications and Water Quality Standards Applicable to the Groundwaters of North Carolina.

Method Detection Limits (MDLs)

Clarification of detection limits referenced in the October 27, 2006, memorandum needed to be addressed because of concerns raised by the regulated community. The North Carolina Solid Waste Section is now requiring laboratories to report to the method detection limit.

Method detection limits are statistically determined values that define the concentration at which measurements of a substance by a specific analytical protocol can be distinguished from measurements of a blank (background noise). Method detection limits are matrix-specific and require a well defined analytical method. In the course of routine operations, laboratories generally report the highest method detection limit for all the instruments used for a specific method.

In many instances, the North Carolina Solid Waste Section gathers data from many sources prior to evaluating the data or making a compliance decision. Standardization in data reporting significantly enhances the ability to interpret and review data because the reporting formats are comparable. Reporting a method detection limit alerts data users of the known uncertainties and limitations associated with using the data. Data users must understand these limitations in order to minimize the risk of making poor environmental decisions. Censoring data below unspecified or non-statistical reporting limits severely biases data sets and restricts their usefulness.

Solid Waste Section Limits (SWSLs)

Due to comments from the regulated community, the North Carolina Solid Waste Section has changed the nomenclature of the new limits referenced on Page 2 of the October 27, 2006, memorandum, from the North Carolina Solid Waste Reporting Limits (SWRL) to the Solid Waste Section Limits (SWSL). Data must be reported to the laboratory specific method detection limits and must be quantifiable at or below the SWSL. The SWSLs must be used for both groundwater and surface water data reported to the North Carolina Solid Waste Section. The PQLs will no longer be used.

The North Carolina Solid Waste Section has considered further feedback from laboratories and the regulated community and has made some additional changes to the values of the SWSLs. These changes may be viewed on our webpage:
http://www.wastenotnc.org/sw/swenvmonitoringlist.asp

Analytical Data Reporting Requirements

The strategy for implementing the new analytical data reporting requirements involves reporting the actual laboratory method detection limit with all analytical laboratory results along with the following requirements:

1) Any analyte detected at a concentration greater than the MDL but less than the SWSL is known to be present, but the uncertainty in the value is higher than a value reported above the SWSL. As a result, the actual concentration is estimated. The estimated concentration is reported along with a qualifier ("J" flag) to alert data users that the result is between the MDL and the SWSL. Any analytical data below quantifiable levels should be examined closely to evaluate whether the analytical data should be included in any statistical analysis. A statistician should make this determination. If an analyte is detected below the North Carolina 2L Standards, even if it is a quantifiable concentration, compliance action may not be taken unless it is statistically significant increase over background.

These analytical results may require additional confirmation.

2) Any analyte detected at a concentration greater than the SWSL is present, and the quantitated value can be reported with a high degree of confidence. These analytes are reported without estimated qualification. The laboratory's MDL and SWSL must be included in the analytical laboratory report. Any reported concentration of an organic or inorganic constituent at or above the North Carolina 2L Standards will be used for compliance purposes, unless the inorganic constituent is not statistically significant). Exceedance of the North Carolina 2L Standards or a statistically significant increase over background concentrations define when a violation has occurred. Any reported concentration of an organic or inorganic constituent at or above the SWSL that is not above an North Carolina 2L Standard will be used as a tool to assess the integrity of the landfill system and predict the possibility that a constituent concentration may exceed the North Carolina 2L Standards in the future.

These analytical results may be used for compliance without further confirmation.

Failure to comply with the requirements described in the October 27, 2006, memorandum and this addendum to the October 27, 2006, memorandum will constitute a violation of 15A NCAC 13B .0601, .0602, or .1632(b), and the analytical data will be returned and deemed unacceptable. Submittal of unacceptable data may lead to enforcement action.

Electronic Data Deliverable (EDD) Submittal

The North Carolina Solid Waste Section would also like to take this opportunity to encourage electronic submittal of the reports in addition to the analytical laboratory data. This option is intended to save resources for both the public and private sectors.

The North Carolina Solid Waste Section will accept the entire report including narrative text, figures, tables, and maps on CD-ROM. Please separate the figures and tables from the report when saving in order to keep the

size of the files smaller. The CD-ROM submittal shall contain a CD-ROM case and both CD-ROM and the case shall be labeled with the site name, site address, permit number, and the monitoring event date (MM/DD/YYYY). The reporting files may be submitted as a .pdf, .txt, .csv, .xls,. or .doc type.

Also, analytical lab data and field data should be reported in .xls files. The North Carolina Solid Waste Section has a template for analytical lab data and field data. This template is available on our webpage: http://www.wastenotnc.org/swhome/enviro_monitoring.asp. Methane monitoring data may also be submitted electronically in this format.

Pursuant to the October 27, 2006, memorandum, please remember to submit a Solid Waste Section Environmental Monitoring Reporting Form in addition to your environmental monitoring data report. This form should be sealed by a geologist or engineer licensed in North Carolina if hydrogeologic or geologic calculations, maps, or interpretations are included with the report. Otherwise, any representative that the facility owner chooses may sign and submit the form. Also, if the concentration of methane generated by the facility exceeds 100% of the lower explosive limits (LEL) at the property boundary or exceeds 25% of the LEL in facility structures (excluding gas control or recovery system components), include the exceedance(s) on the North Carolina Solid Waste Section Environmental Monitoring Reporting Form.

If you have any questions or concerns, please feel free to contact Jaclynne Drummond (919-508-8500) or Ervin Lane (919-508-8520).

Thank you for your continued cooperation with this matter.

North Carolina Department of Environment and Natural Resources

Dexter R. Matthews, Director | Division of Waste Management | Michael F. Easley, Governor
William G. Ross Jr., Secretary

October 16, 2007

MEMORANDUM

To: Solid Waste Directors, Landfill Operators, North Carolina Certified Laboratories, and Consultants

From: North Carolina Division of Waste Management, Solid Waste Section

Re: Environmental Monitoring Data for North Carolina Solid Waste Management Facilities

The purpose of this memorandum is to provide a reiteration of the use of the Solid Waste Section Limits (SWSLs), provide new information on the Groundwater Protection Standards, and provide a reminder of formats for environmental monitoring data submittals.

The updated guidelines are in large part due to questions and concerns from laboratories, consultants, and the regulated community regarding the detection of constituents in groundwater at levels below the previous Practical Quantitation Limits (PQLs). The North Carolina Solid Waste Section solicited feedback from the regulated community, and, in conjunction with the regulated community, developed new limits. The primary purpose of these changes was to improve the protection of public health and the environment.

Data must be reported to the laboratory specific method detection limits and must be quantifiable at or below the SWSLs. The SWSLs must be used for both groundwater and surface water data reported to the North Carolina Solid Waste Section. The PQLs will no longer be used.

In June 2007, we received new information regarding changes to the Groundwater Protection Standards. If a North Carolina 2L Groundwater Standard does not exist, then a designated Groundwater Protection Standard is used pursuant to 15A NCAC 13B .1634. Toxicologists with the North Carolina Department of Health and Human Services calculated these new Groundwater Protection Standards. Questions regarding how the standards were calculated can be directed to the North Carolina Department of Health and Human Services.

We have reviewed the new results from the North Carolina Department of Public Health and have updated our webpage accordingly. The list of Groundwater Protection Standards, North Carolina 2L Standards and SWSLs are subject to change and will be reviewed every year or sooner if new scientific and toxicological data become available. Please review our website periodically for any changes to the 2L NC Standards, Groundwater Protection Standards, or SWSLs. Specific updates will be noted on our website.

http://www.wastenotnc.org/sw/swenvmonitoringlist.asp

In addition, the following should be included with environmental monitoring data submittals:

1. Environmental Monitoring Data Form as a cover sheet:
http://www.wastenotnc.org/swhome/EnvMonitoring/NCEnvMonRptForm.pdf
2. Copy of original laboratory results.
3. Table of detections and discussion of 2L exceedances.
4. Electronic files on CD or sent by email. These files should include the written report as a Portable Document Format (PDF) file and the laboratory data as an excel file following the format of the updated Electronic Data Deliverable (EDD) template on our website:
http://www.wastenotnc.org/swhome/enviro_monitoring.asp

If you have any questions or concerns, please feel free to contact Donald Herndon (919-508-8502), Ervin Lane (919-508-8520) or Jaclynne Drummond (919-508-8500).

Thank you for your continued cooperation with these matters.

North Carolina Department of Environment and Natural Resources
Division of Waste Management

Pat McCrory
Governor

John E. Skvarla, III
Secretary

November 5, 2014

MEMORANDUM

To: Solid Waste Directors, Public Works Directors, Landfill Operators, and Landfill Owners

From: Solid Waste Section

Re: Groundwater, Surface Water, Soil, Sediment, and Landfill Gas Electronic Document Submittal

The Solid Waste Section is continuing its efforts to improve efficiencies in document management. All groundwater, surface water, soil, sediment, and landfill gas documents submitted to the Solid Waste Section are stored electronically and are made readily available for the public to view on our webpage. Please remember that hard copies/paper copies are not required, and should not be submitted. The submittal of these electronic documents following a consistent electronic document protocol will also assist us in our review. Please follow these procedures when submitting all groundwater, surface water, soil, sediment, and landfill gas documents to the Solid Waste Section.

Submittal Method and Formatting

- All files must be in portable document format (pdf) except for Electronic Data Deliverables (EDDs) unless otherwise specified by the Solid Waste Section. All pdf files should meet these requirements:
  - Optical Characteristic Recognition (OCR) applied;
  - Minimum of 300 dpi;
  - Free of password protections and/or encryptions (applies to EDDs as well);
  - Optimized to reduce file size; and
  - Please begin using the following naming convention when submitting all electronic files: Permit Number (00-00)_Date of Document (YYYYMMDD). For example: 00-00_20140101.
- Please submit all files via email or by file transfer protocol (FTP) via email to the appropriate Hydrogeologist unless otherwise specified by the Solid Waste Section. If the electronic file is greater than 20 MB, please submit the file via FTP or on a CD. If submitting a CD, please mail the CD to the appropriate Hydrogeologist. The CD should be labeled with the facility name, permit number, county, name of document, date of monitoring event (if applicable), and the date of document.
- Please be sure a signed Environmental Monitoring Data Form is submitted as part of the electronic file for all water quality and landfill gas documents (monitoring, alternate source demonstration, assessment, investigation, corrective action). This completed form should be the first page of the document before the cover/title page and should not be submitted as an individual file. Blank forms can be downloaded at http://www.wastenotnc.org/swhome/EnvMonitoring/NCEnvMonRptForm.pdf

Monitoring Data

Monitoring data documents may include any or all of the following: 1) groundwater and surface water monitoring; 2) soil and sediment, and 3) landfill gas monitoring. In addition to the above procedures, at a minimum, please include the following:

Groundwater and Surface Water Monitoring

- A copy of the laboratory report(s).
- A copy of the sampling log(s).
- A separate table of detections and exceedances for each monitoring location.

1646 Mail Service Center, Raleigh, North Carolina 27699-1646
Phone: 919-707-8200

2090 US Highway 70, Swannanoa, North Carolina 28778-82111
Phone: 828-296-4500

http://portal.ncdenr.org/web/wm/

    - All analytical results should be reported in micrograms per liter (ug/L) except for field parameters and specific Monitored Natural Attenuation (MNA) parameters.
    - Please also include the laboratory's method detection limit (MDL) in ug/L, the Solid Waste Section Limit (SWSL) in ug/L, the appropriate NC regulatory standard in ug/L (2L, 2B, GWPS, IMAC), and the Federal Maximum Contaminant Level (MCL) in ug/L.
    - Please **BOLD** each exceedance result.
- A separate table of field parameters for each monitoring location.
- An Electronic Data Deliverable (EDD) spreadsheet for each monitoring event submitted in the correct format. All analytical results should be reported in micrograms per liter (ug/L) except for field parameters and specific Monitored Natural Attenuation (MNA) parameters. The blank EDD template can be downloaded at http://www.wastenotnc.org/swhome/enviro_monitoring.asp. Please pay attention to the formats within the spreadsheet. Any EDD received that is not formatted correctly will be emailed back to be resubmitted via email within five (5) days.
- A separate groundwater monitoring well construction table.
    - Please also include the date the well was drilled, well diameter, total well depth, depth to top of screened interval (in feet), screened interval (in feet), geology of screened interval, TOC elevation, ground elevation, groundwater elevation, GPS coordinates (latitude and longitude), and depth to water (in feet).
- A separate groundwater table with groundwater flow rate(s).
- A recent facility figure that includes labeled groundwater and surface water monitoring locations.
- A groundwater flow map with an arrow(s) indicating flow direction(s), including date the measurements were taken.

Soil and Sediment Sampling

- A copy of the laboratory report(s).
- A copy of the sampling log(s).
- A separate table of detections and exceedances for each sampling location.
    - Please also include the results in micrograms per liter (ug/L), the laboratory's method detection limit (MDL) in ug/L, and the appropriate NC regulatory standard (PSRG) in ug/L.
    - Please **BOLD** each exceedance result.
- A separate table of soil and/or sediment characteristics.
- A recent facility figure that includes labeled sampling locations.

Landfill Gas Monitoring

- A blank Landfill Gas Monitoring Data Form can be found within the *Landfill Gas Monitoring Guidance* document and can be downloaded at http://portal.ncdenr.org/c/document_library/get_file?uuid=da699f7e-8c13-4249-9012-16af8aefdc7b&groupId=38361.
- A separate table of landfill gas detections and exceedances for each monitoring location. Please **BOLD** each exceedance result.
- A recent facility figure that includes labeled landfill gas monitoring locations (both permanent and temporary).

If you have any questions or concerns regarding electronic submittals, please feel free to contact the Hydrogeologist overseeing your facility. The Solid Waste Section greatly appreciates your assistance on this matter. Working together, we can continue to provide excellent customer service to you and to the public.

- Jackie Drummond, Asheville Regional Office, 828-296-4706, jaclynne.drummond@ncdenr.gov
- Ervin Lane, Raleigh Central Office, 919-707-8288, ervin.lane@ncdenr.gov
- Elizabeth Werner, Raleigh Central Office, 919-707-8253, elizabeth.werner@ncdenr.gov
- Christine Ritter, Raleigh Central Office, 919-707-8254, christine.ritter@ncdenr.gov
- Perry Sugg, Raleigh Central Office, 919-707-8258, perry.sugg@ncdenr.gov

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Phone: 828-296-4500
http://portal.ncdenr.org/web/wm/

NC Department of Environment and Natural Resources

Waste Management - Constituent List

Solid Waste Environmental Monitoring Reporting Limits and Standards

All units are in (ug/L) unless noted.
NE = Not Established
CAS numbers that begin with "SW" are not real CAS numbers, instead this represents the Solid Waste Section's ID number.

CAS Number	Name	Other Names	2L Std.	GWP* Std.	SWSL**	SW ID	App I
630-20-6	1,1,1,2-Tetrachloroethane	Ethane, 1,1,1,2-tetrachloro-	NE	1	5	190	I
71-55-6	1,1,1-Trichloroethane;	Ethane, 1,1,1-trichloro-	200	--	1	200	I
79-34-5	1,1,2,2-Tetrachloroethane	Ethane, 1,1,2,2-tetrachloro-	0.2	0.18	3	191	I
79-00-5	1,1,2-Trichloroethane	Ethane, 1,1,2-trichloro-	NE	0.6	1	202	I
76-13-1	1,1,2-Trichlorotrifluoroethane	CFC-113	200000	NE	NE	398	
92-52-4	1,1-biphenyl	1,1-biphenyl	400	--	10	421	
75-34-3	1,1-Dichloroethane; Ethyldidene	Ethane, 1,1-dichloro-	6	--	5	75	I
75-35-4	1,1-Dichloroethylene; 1,1-	Ethene, 1,1-dichloro-	7	--	5	77	I
563-58-6	1,1-Dichloropropene	1-Propene, 1,1-dichloro-	NE	NE	5	85	
96-18-4	1,2,3-Trichloropropane	Propane, 1,2,3-trichloro-	0.005	--	1	206	I
95-94-3	1,2,4,5-Tetrachlorobenzene	Benzene, 1,2,4,5-tetrachloro-	NE	2	10	189	
120-82-1	1,2,4-Trichlorobenzene	Benzene, 1,2,4-trichloro-	70	70	10	199	
95-63-6	1,2,4-Trimethylbenzene	Pseudocumene	400	NE	NE	372	
226-36-8	1,2,5,6-Dibenzacridine		NE	NE	NE	385	
96-12-8	1,2-Dibromo-3-chloropropane; DBCP	Propane, 1,2-dibromo-3-chloro-	0.04	--	13	67	I
106-93-4	1,2-Dibromoethane; Ethylene dibromide;	Ethane, 1,2-dibromo-	0.02	--	1	68	I
107-06-2	1,2-Dichloroethane; Ethylene	Ethane, 1,2-dichloro-	0.4	--	1	76	I
540-59-0	1,2-Dichloroethylene mixed isomers	Mixed Isomers	NE	60	NE	481	
78-87-5	1,2-Dichloropropane	Propane, 1,2-dichloro-	0.6	--	1	82	I
122-66-7	1,2-Diphenylhydrazine		NE	NE	NE	394	
108-67-8	1,3,5-Trimethylbenzene)	Mesitylene	400	NE	NE	373	
142-28-9	1,3-Dichloropropane; Trimethylene	Propane, 1,3-dichloro-	NE	NE	1	83	
106-37-6	1,4-Dibromobenzene	p-Dibromobenzene, p-Bromobenzene		70		471	
123-91-1	1,4-dioxane	1,4-dioxane	3	--	10	422	
130-15-4	1,4-Naphthoquinone	1,4-Naphthalenedione	NE	NE	10	149	
87-61-6	1-2-3-Trichlorobenzene		NE	NE	NE	371	
90-12-0	1-Methylnaphthalene	α-methylnaphthalene	NE	1	NE	503	
134-32-7	1-Naphthylamine	1-Naphthalenamine	NE	NE	10	150	
120-36-5	2-(2-4-dichlorophenoxy)propionic		NE	NE	NE	352	

594-20-7	2,2-Dichloropropane; Isopropylidene	Propane, 2,2-dichloro-	NE	NE	15	84	
58-90-2	2,3,4,6-Tetrachlorophenol	Phenol, 2,3,4,6-tetrachloro-	200	--	10	193	
93-76-5	2,4,5-T; 2,4,5-Trichlorophenoxyacetic	Acetic acid, (2,4,5-trichlorophenoxy)-	NE	NE	2	188	
93-72-1	2,4,5-TP Acid	Silvex	50	NE	NE	452	
95-95-4	2,4,5-Trichlorophenol	Phenol, 2,4,5-trichloro-	NE	63	10	204	
88-06-2	2,4,6-Trichlorophenol	Phenol, 2,4,6-trichloro-	NE	4	10	205	
94-75-7	2,4-D; 2,4-Dichlorophenoxyacetic	Acetic acid, (2,4-dichlorophenoxy)-	70	--	2	59	
120-83-2	2,4-Dichlorophenol	Phenol, 2,4-dichloro-	NE	0.98	10	80	
105-67-9	2,4-Dimethylphenol; m-Xylenol	Phenol, 2,4-dimethyl-	100	--	10	95	
51-28-5	2,4-Dinitrophenol	Phenol, 2,4-dinitro-	NE	NE	50	99	
121-14-2	2,4-Dinitrotoluene	Benzene, 1-methyl-2,4-dinitro-	NE	0.1	10	100	
87-65-0	2,6-Dichlorophenol	Phenol, 2,6-dichloro-	NE	NE	10	81	
606-20-2	2,6-Dinitrotoluene	Benzene, 2-methyl-1,3-dinitro-	NE	NE	10	101	
94-82-6	2-4 DB		NE	NE	NE	350	
53-96-3	2-Acetylaminofluorene; 2-AAF	Acetamide, N-9H-fluoren-2-yl-	NE	NE	20	6	
110-75-8	2-Chloroethylvinyl ether		NE	NE	NE	358	
91-58-7	2-Chloronaphthalene	Naphthalene, 2-chloro-	NE	NE	10	47	
95-57-8	2-Chlorophenol	Phenol, 2-chloro-	0.4	--	10	48	
591-78-6	2-Hexanone; Methyl butyl ketone	2-Hexanone	NE	40	50	124	I
91-57-6	2-Methylnaphthalene	Naphthalene, 2-methyl-	30	--	10	145	
91-59-8	2-Naphthylamine	2-Naphthalenamine	NE	NE	10	151	
109-06-8	2-Picoline		NE	NE	NE	390	
91-94-1	3,3'-Dichlorobenzidine	[1,1'-Biphenyl]-4,4'-diamine,3,3'-	NE	NE	20	72	
119-93-7	3,3'-Dimethylbenzidine	[1,1'-Biphenyl]-4,4'-diamine,3,3'-	NE	NE	10	94	
56-49-5	3-Methylcholanthrene	Benz[j]aceanthrylene,1,2-dihydro-3-	NE	NE	10	138	
72-54-8	4,4'-DDD	Benzene 1,1'-(2,2-	0.1	--	0.1	60	
72-55-9	4,4'-DDE	Benzene, 1,1'-	NE	NE	0.1	61	
50-29-3	4,4'-DDT	Benzene, 1,1'-(2,2,2-	0.1	--	0.1	62	
534-52-1	4,6-Dinitro-o-cresol; 4,6-Dinitro-2-	Phenol, 2-methyl-4,6-dinitro-	NE	NE	50	98	
92-67-1	4-Aminobiphenyl	[1,1'-Biphenyl]-4-amine	NE	NE	20	11	
460-00-4	4-Bromofluorobenzene		NE	NE	NE	463	
101-55-3	4-Bromophenyl phenyl ether	Benzene, 1-bromo-4-phenoxy-	NE	NE	10	31	
7005-72-3	4-Chlorophenyl phenyl ether	Benzene, 1-chloro-4-phenoxy-	NE	NE	10	49	
108-10-1	4-Methyl-2-pentanone; Methyl isobutyl	2-Pentanone, 4-methyl-	NE	560	100	147	I
56-57-5	4-nitroquinoline-1-oxide		NE	NE	NE	388	
99-55-8	5-Nitro-o-toluidine	Benzenamine, 2-methyl-5-nitro-	NE	NE	10	157	
57-97-6	7,12-Dimethylbenz[a]anthracene	Benz[a]anthracene, 7,12-dimethyl-	NE	NE	10	93	
83-32-9	Acenaphthene	Acenaphthylene, 1,2-dihydro-	80	--	10	1	
208-96-8	Acenaphthylene	Acenaphthylene	200	--	10	2	
SW416	Acetic Acid	Acetic Acid	NE	NE	NE	416	
34256-82-1	Acetochlor			100		490	

187022-11-3	Acetochlor ESA			1000		491	
184992-44-4	Acetochlor OXA			1000		492	
67-64-1	Acetone	2-Propanone	6000	--	100	3	I
75-05-8	Acetonitrile; Methyl cyanide	Acetonitrile	NE	42	55	4	
98-86-2	Acetophenone	Ethanone, 1-phenyl-	NE	700	10	5	
50594-66-6	Acifluorofen	Acifluorofen				453	
107-02-8	Acrolein	2-Propenal	NE	4	53	7	
79-06-1	Acrylamide	Acrylamide	0.008	--	NE	429	
107-13-1	Acrylonitrile	2-Propenenitrile	NE	NE	200	8	I
15972-60-8	Alachlor			0.4		469	
309-00-2	Aldrin	1,4:5,8-	NE	0.002	0.05	9	
SW337	Alkalinity		NE	NE	NE	337	
107-05-1	Allyl chloride	1-Propene, 3-chloro-	NE	NE	10	10	
319-84-6	alpha-BHC	Cyclohexane,1,2,3,4,5,6-hexachloro-	NE	0.006	0.05	24	
319-84-6	alpha-Hexachlorocyclohexane	α-Benzenehexachloride	NE	0.006	NE	501	
--	Aluminum	Aluminum	NE	3500	NE	454	
7429-90-5	Aluminum		NE	3500	NE	438	
7664-41-7	Ammonia	Ammonia	NE	1500	NE	435	
62-53-3	Aniline		NE	NE	NE	381	
120-12-7	Anthracene	Anthracene	2000	--	10	12	
7440-36-0	Antimony	Antimony	NE	1	6	13	I
140-57-8	Aramite		NE	NE	NE	382	
12674-11-2	Aroclor 1016	congener of PCB; see (1336-36-3)	NE	NE	NE	401	
11104-28-2	Aroclor 1221	congener of PCB; see (1336-36-3)	NE	NE	NE	402	
11141-16-5	Aroclor 1232	congener of PCB; see (1336-36-3)	NE	NE	NE	403	
53469-21-9	Aroclor 1242	congener of PCB; see (1336-36-3)	NE	NE	NE	404	
12672-29-6	Aroclor 1248	congener of PCB; see (1336-36-3)	NE	NE	NE	405	
11097-69-1	Aroclor 1254	congener of PCB; see (1336-36-3)	NE	NE	NE	406	
11096-82-5	Aroclor 1260	congener of PCB; see (1336-36-3)	NE	NE	NE	407	
7440-38-2	Arsenic	Arsenic	10	--	10	14	I
7440-39-3	Barium	Barium	700	--	100	15	I
25057-89-0	Bentazon		NE	NE	NE	462	
100-52-7	Benzaldehyde	Phenylmethanal,	NE	700	NE	496	
71-43-2	Benzene	Benzene	1	--	1	16	I
122-09-8	Benzeneethanamine, alpha,alpha-		NE	NE	NE	386	
92-87-5	Benzidine		NE	NE	NE	383	
56-55-3	Benzo[a]anthracene;	Benz[a]anthracene	0.05	--	10	17	
50-32-8	Benzo[a]pyrene	Benzo[a]pyrene	0.005	--	10	21	
205-99-2	Benzo[b]fluoranthene	Benz[e]acephenanthrylene	0.05	--	10	18	
191-24-2	Benzo[ghi]perylene	Benzo[ghi]perylene	200	--	10	20	

207-08-9	Benzo[k]fluoranthene	Benzo[k]fluoranthene	0.5	--	10	19	
65-85-0	Benzoic Acid		30000	28000	NE	395	
100-51-6	Benzyl alcohol	Benzenemethanol	NE	700	20	22	
7440-41-7	Beryllium	Beryllium	NE	4	1	23	I
319-85-7	beta-BHC	Cyclohexane,1,2,3,4,5,6-hexachloro-	NE	0.019	0.05	25	
319-85-7	beta-Hexachlorocyclohexane	ß-Benzenehexachloride	NE	0.02	NE	502	
SW347	Bicarbonate (as CaCO3)		NE	NE	NE	347	
SW316	Biological Oxygen Demand	BOD	NE	NE	NE	316	
101-84-8	biphenyl ether	biphenyl ether	NE	NE	10	423	
108-60-1	Bis(2-chloro-1-methylethyl) ether; 2,2'-	Propane, 2,2'-oxybis[1-chloro-	NE	NE	10	46	
111-91-1	Bis(2-chloroethoxy)methane	Ethane, 1,1'-[methylenebis(oxy)]bis [2-	NE	NE	10	42	
111-44-4	Bis(2-chloroethyl)ether; Dichloroethyl	Ethane, 1,1'-oxybis[2-chloro-	NE	0.031	10	43	
39638-32-9	Bis(2-chloroisopropyl) ether		0.03	NE	NE	384	
117-81-7	Bis(2-ethylhexyl) phthalate	1,2-Benzenedicarboxylic acid, bis(2-	3	NE	15	111	
7440-42-8	Boron	Boron	700	--	NE	428	
108-86-1	Bromobenzene		NE	NE	NE	360	
74-97-5	Bromochloromethane;	Methane, bromochloro-	NE	0.6	3	28	I
75-27-4	Bromodichloromethane;	Methane, bromodichloro-	0.6	--	1	29	I
75-25-2	Bromoform; Tribromomethane	Methane, tribromo-	4	--	3	30	I
71-36-3	Butanol n	n-Butyl Alcohol	NE	700		470	
78-92-2	Butanol sec	sec-Butyl Alcohol	NE	10000		483	
85-68-7	Butyl benzyl phthalate; Benzyl butyl	1,2-Benzenedicarboxylicacid, butyl	1000	--	10	32	
SW418	Butyric Acid	Butyric Acid	NE	NE	NE	418	
7440-43-9	Cadmium	Cadmium	2	--	1	34	I
7440-70-2	Calcium		NE	NE	NE	375	
471-34-1	Calcium carbonate		NE	NE	NE	464	
105-60-2	Caprolactam		4000	NE	NE	440	
86-74-8	Carbazole	dibenzopyrrole, diphenylenimine,	NE	2	NE	497	
1563-66-2	Carbofuran	Carbofuran	40	NE	NE	430	
124-38-9	Carbon Dioxide		NE	NE	NE	459	
SW413	Carbon Dioxide (CO2)	CO2 Gas	NE	NE	NE	413	
75-15-0	Carbon disulfide	Carbon disulfide	700	--	100	35	I
56-23-5	Carbon tetrachloride	Methane, tetrachloro-	0.3	--	1	36	I
SW348	Carbonate (as CaCO3)		NE	NE	NE	348	
7440-44-0	Charcoal		NE	NE	NE	466	
SW317	Chemical Oxygen Demand	COD	NE	NE	NE	317	
57-74-9	Chlordane	4,7-Methano-1H-indene,1,2,4,5,6,7,8,8-	0.1	--	0.5	339	
12789-03-6	Chlordane (constituents)		NE	NE	NE	400	
5103-71-9	Chlordane, alpha	cis-Chlordane	NE	NE	NE	379	
5103-74-2	Chlordane, beta	trans-Chlordane	NE	NE	NE	378	
5566-34-7	Chlordane, gamma		NE	NE	NE	399	

16887-00-6	Chloride	Chloride				455	
SW301	Chloride		250000	--	NE	301	
108-90-7	Chlorobenzene	Benzene, chloro-	50	--	3	39	I
510-15-6	Chlorobenzilate	Benzeneacetic acid, 4-chloro-(4-	NE	NE	10	40	
75-00-3	Chloroethane; Ethyl chloride	Ethane, chloro-	3000	--	10	41	I
67-66-3	Chloroform; Trichloromethane	Methane, trichloro-	70	--	5	44	I
126-99-8	Chloroprene	1,3-Butadiene, 2-chloro-	NE	NE	20	50	
7440-47-3	Chromium	Chromium	10	--	10	51	I
218-01-9	Chrysene	Chrysene	5	--	10	52	
156-59-2	cis-1,2-Dichloroethylene; cis-1,2-	Ethene, 1,2-dichloro-,(Z)-	70	--	5	78	I
10061-01-5	cis-1,3-Dichloropropene	1-Propene, 1,3-dichloro-, (Z)-	0.4	--	1	86	I
7440-48-4	Cobalt	Cobalt	NE	1	10	53	I
SW309	Coliform (total)		1	NE	NE	309	
SW310	Color (color units)		15	NE	NE	310	
7440-50-8	Copper	Copper	1000	--	10	54	I
57-12-5	Cyanide	Cyanide	70	--	10	58	
75-99-0	Dalapon		NE	200	NE	355	
3424-82-6	DDE	o,p-DDE		0.1		472	
319-86-8	delta-BHC	Cyclohexane,1,2,3,4,5,6-hexachloro-	NE	0.019	0.05	26	
SW318	Depth To Water (ft)	DTW	NE	NE	NE	318	
117-81-7	Di(2-ethylhexyl)phthalate	Di(2-ethylhexyl)phthalate, DEHP	2.5	--	NE	431	
2303-16-4	Diallate	Carbamothioic acid,bis(1-methylethyl)-,	NE	NE	10	63	
53-70-3	Dibenz[a,h]anthracene	Dibenz[a,h]anthracene	0.005	--	10	64	
132-64-9	Dibenzofuran	Dibenzofuran	NE	28	10	65	
124-48-1	Dibromochloromethane;	Methane, dibromochloro-	0.4	0.41	3	66	I
1918-00-9	Dicamba		NE	NE	NE	353	
79-43-6	Dichloroacetic Acid		NE	0.7	NE	480	
75-71-8	Dichlorodifluoromethane; CFC 12	Methane,dichlorodifluoro-	1000	--	5	74	
60-57-1	Dieldrin	2,7:3,6-Dimethanonaphth[2,3-	0.002	--	0.075	88	
84-66-2	Diethyl phthalate	1,2-Benzenedicarboxylicacid, diethyl	6000	--	10	90	
60-51-5	Dimethoate	Phosphorodithioic acid,O,O-dimethyl S-	NE	NE	20	91	
131-11-3	Dimethyl phthalate	1,2-Benzenedicarboxylicacid, dimethyl	NE	NE	10	96	
84-74-2	Di-n-butyl phthalate	1,2-Benzenedicarboxylic acid, dibutyl	700	--	10	33	
117-84-0	Di-n-octyl phthalate	1,2-Benzenedicarboxylicacid, dioctyl	100	--	10	168	
88-85-7	Dinoseb; DNBP; 2-sec-Butyl-4,6-	Phenol, 2-(1-methylpropyl)-4,6-dinitro-	NE	7	1	102	
1746-01-6	Dioxin	2,3,7,8-TCDD	0.2	NE	NE	441	
101-84-8	Diphenyl ether	Diphenyl oxide; 1,1'-Oxybisbenzene;	NE	100	NE	498	
122-39-4	Diphenylamine	Benzenamine, N-phenyl-	NE	NE	10	103	
85-00-7	Diquat			20		473	
74-82-8	Dissolved Methane	Dissolved Methane				456	

7782-44-7	Dissolved Oxygen		NE	NE	NE	356	
298-04-4	Disulfoton	Phosphorodithioic acid,O,O-diethyl S-[2-	0.3	--	10	104	
3648-20-2	Diundecyl phthalate	Santicizer 711	100	NE	NE	442	
959-98-8	Endosulfan I	6,9-Methano-2,4,3-benzodiox-	40	NE	0.1	105	
33213-65-9	Endosulfan II	6,9-Methano-2,4,3-	--	42	0.1	106	
1031-07-8	Endosulfan sulfate	6,9-Methano-2,4,3-	NE	40	0.1	107	
145-73-3	Endothall			100		474	
72-20-8	Endrin	2,7:3,6-Dimethanonaphth[2,3-b]oxirene,	2	--	0.1	108	
7421-93-4	Endrin aldehyde	1,2,4-Methenocyclo-penta[cd]pentalene-	2	--	0.1	109	
106-89-8	Epichlorohydrin		4	NE	NE	443	
74-84-0	Ethane- Dissolved		NE	NE	NE	331	
64-17-5	Ethanol	Ethyl alcohol, Ethyl hydrate,	NE	4000	NE	499	
74-85-1	Ethene- Dissolved		NE	NE	NE	332	
141-78-6	Ethyl acetate		3000	NE	NE	444	
97-63-2	Ethyl methacrylate	2-Propenoic acid, 2-methyl-, ethyl	NE	NE	10	112	
62-50-0	Ethyl methanesulfonate	Methanesulfonic acid,ethyl ester	NE	NE	20	113	
637-92-3	Ethyl tert-butyl ether	ETBE, Ethyl tertiary butyl ether	NE	47	NE	500	
100-41-4	Ethylbenzene	Benzene, ethyl-	600	--	1	110	I
107-21-1	ethylene glycol	ethylene glycol	10000	--	10,000	424	
52-85-7	Famphur	Phosphorothioic acid, O-[4-	NE	NE	20	114	
SW334	Ferrous Iron- Dissolved		NE	NE	NE	334	
206-44-0	Fluoranthene	Fluoranthene	300	--	10	115	
86-73-7	Fluorene	9H-Fluorene	300	--	10	116	
16984-48-8	Fluoride		2000	--	2000	312	
SW313	Foaming Agents		500	--	NE	313	
50-00-0	Formaldehyde		600	NE	NE	445	
59-89-9	gamma-BHC (Lindane)	gamma-BHC (Lindane)				457	
58-89-9	gamma-BHC; Lindane	Cyclohexane,1,2,3,4,5,6-hexachloro-	0.03	--	0.05	27	
SW314	Gross Alpha		15	NE	NE	314	
SW427	Groundwater Elevation (feet)	GW Elevation (feet)	NE	NE	NE	427	
SW319	Head (ft mean sea level)		NE	NE	NE	319	
76-44-8	Heptachlor	4,7-Methano-1H-indene,1,4,5,6,7,8,8-	0.008	--	0.05	117	
1024-57-3	Heptachlor epoxide	2,5-Methano-2H-indeno[1,2-	0.004	--	0.075	118	
142-82-5	Heptane	Heptane	400	--	NE	432	
118-74-1	Hexachlorobenzene	Benzene, hexachloro-	0.02	--	10	119	
87-68-3	Hexachlorobutadiene	1,3-Butadiene,1,1,2,3,4,4-hexachloro-	0.4	0.44	10	120	
608-73-1	Hexachlorocyclohexane isomers		0.02	NE	NE	446	
77-47-4	Hexachlorocyclopentadiene	1,3-Cyclopentadiene,1,2,3,4,5,5-	NE	50	10	121	
67-72-1	Hexachloroethane	Ethane, hexachloro-	NE	2.5	10	122	
70-30-4	Hexachlorophene		NE	NE	NE	387	
1888-71-7	Hexachloropropene	1-Propene, 1,1,2,3,3,3-hexachloro-	NE	NE	10	123	

142-62-1	Hexanoic Acid		NE	NE	NE	485	
133-74-0	Hydrogen Gas	Dissolved Hydrogen Gas	NE	NE	NE	420	
SW338	Hydrogen Sulfide		NE	NE	NE	338	
646-07-1	i-Hexonic Acid		NE	NE	NE	486	
193-39-5	Indeno(1,2,3-cd)pyrene	Indeno[1,2,3-cd]pyrene	0.05	--	10	125	
503-74-2	i-Pentanoic Acid		NE	NE	NE	488	
7439-89-6	Iron		300	--	300	340	
78-83-1	Isobutyl alcohol	1-Propanol, 2-methyl-	NE	NE	100	126	
465-73-6	Isodrin	1,4,5,8-Dimethanonaphthalene,1,2,3,4,1	NE	NE	20	127	
78-59-1	Isophorone	2-Cyclohexen-1-one,3,5,5-trimethyl-	40	--	10	128	
108-20-3	Isopropyl ether		70	--	NE	366	
98-82-8	Isopropylbenzene		70	--	NE	367	
120-58-1	Isosafrole	1,3-Benzodioxole, 5-(1-propenyl)-	NE	NE	10	129	
143-50-0	Kepone	1,3,4-Metheno-2H-cyclobuta-	NE	NE	20	130	
SW415	Lactic Acid	Lactic Acid	NE	NE	NE	415	
SW329	Landfill Gas	LFG	NE	NE	NE	329	
7439-92-1	Lead	Lead	15	--	10	131	I
SW374	m-&p-Cresol (combined)		NE	NE	NE	374	
SW359	m-&p-Xylene (combined)		NE	NE	NE	359	
7439-95-4	Magnesium		NE	NE	NE	376	
7439-96-5	Manganese		50	--	50	342	
SW335	Manganese- Dissolved		50	--	50	335	
94-74-6	MCPA		NE	NE	NE	351	
108-39-4	m-Cresol; 3-Methylphenol	Phenol, 3-methyl-	400	--	10	345	
541-73-1	m-Dichlorobenzene; 1,3-	Benzene, 1,3-dichloro-	200	--	5	70	
99-65-0	m-Dinitrobenzene	Benzene, 1,3-dinitro-	NE	NE	20	97	
93-65-2	Mecopop, MCPP		NE	NE	NE	354	
7439-97-6	Mercury	Mercury	1	--	0.2	132	
126-98-7	Methacrylonitrile	2-Propenenitrile, 2-methyl-	NE	NE	100	133	
SW333	Methane- Dissolved		NE	NE	NE	333	
67-56-1	Methanol		4000	NE	NE	448	
91-80-5	Methapyrilene	1,2,Ethanediamine, N,N-dimethyl-N'-2-	NE	NE	100	134	
72-43-5	Methoxychlor	Benzene, 1,1'-	40	--	1	135	
72-43-5	Methoxychlor		40	NE	NE	449	
74-83-9	Methyl bromide; Bromomethane	Methane, bromo-	NE	10	10	136	I
74-87-3	Methyl chloride; Chloromethane	Methane, chloro-	3	--	1	137	I
78-93-3	Methyl ethyl ketone; MEK; 2-	2-Butanone	4000	--	100	141	I
74-88-4	Methyl iodide; Iodomethane	Methane, iodo-	NE	NE	10	142	I
108-10-1	Methyl Isobutyl Ketone			100		493	
80-62-6	Methyl methacrylate	2-Propenoic acid, 2-methyl-, methyl	NE	25	30	143	
66-27-3	Methyl methanesulfonate	Methanesulfonic acid,methyl ester	NE	NE	10	144	

298-00-0	Methyl parathion; Parathion methyl	Phosphorothioic acid,O,O-dimethyl	NE	NE	10	146	
2037-26-5	Methylbenzene		NE	NE	NE	461	
74-95-3	Methylene bromide;	Methane, dibromo-	NE	70	10	139	I
75-09-2	Methylene chloride;	Methane, dichloro-	5	--	1	140	I
1634-04-4	Methyl-tert-butyl ether (MTBE)		20	--	NE	369	
99-09-2	m-Nitroaniline; 3-Nitroaniline	Benzenamine, 3-nitro-	NE	NE	50	153	
7439-98-7	Molybdenum		NE	NE	NE	397	
108-38-3	m-Xylene		NE	NE	NE	409	
91-20-3	Naphthalene	Naphthalene	6	--	10	148	
104-51-8	n-Butylbenzene		70	--	NE	361	
110-54-3	n-Hexane		400	NE	NE	447	
7440-02-0	Nickel	Nickel	100	--	50	152	I
14797-55-8	Nitrate (as N)		10000	--	10000	303	
14797-65-0	Nitrite (as N)		1000	--	1000	304	
98-95-3	Nitrobenzene	Benzene, nitro-	NE	NE	10	156	
7727-37-9	Nitrogen		NE	NE	NE	467	
55-18-5	N-Nitrosodiethylamine	Ethanamine, N-ethyl-N-nitroso-	NE	NE	20	160	
62-75-9	N-Nitrosodimethylamine	Methanamine, N-methyl-N-nitroso-	0.0007	--	10	161	
924-16-3	N-Nitrosodi-n-butylamine	1-Butanamine, N-butyl-N-nitroso-	NE	NE	10	162	
86-30-6	N-Nitrosodiphenylamine	Benzenamine, N-nitroso-N-phenyl-	NE	NE	10	163	
SW426	N-	N-	NE	NE	10	426	
SW439	N-		NE	NE	NE	439	
621-64-7	N-Nitrosodipropylamine; N-Nitroso-N-	1-Propanamine, N-nitroso-N-propyl-	NE	NE	10	164	
10595-95-6	N-Nitrosomethylethalamine	Ethanamine, N-methyl-N-nitroso-	NE	NE	10	165	
59-89-2	N-Nitrosomorpholine		NE	NE	NE	389	
100-75-4	N-Nitrosopiperidine	Piperidine, 1-nitroso-	NE	NE	20	166	
930-55-2	N-Nitrosopyrrolidine	Pyrrolidine, 1-nitroso-	NE	NE	10	167	
SW419	No2/No3 (nitrate & nitrite reported	NOX	NE	NE	NE	419	
103-65-1	n-Propylbenzene		70	NE	NE	370	
126-68-1	O,O,O-Triethyl phosphorothioate	Phosphorothioic acid,O,O,O-triethyl	NE	NE	10	207	
297-97-2	O,O-Diethyl O-2-pyrazinyl	Phosphorothioic acid,O,O-diethyl O-	NE	NE	20	89	
136777-61-2	o,p-Xylene		NE	NE	NE	460	
95-49-8	o-Chlorotoluene	2-chlorotoluene	100	NE	NE	364	
95-48-7	o-Cresol; 2-Methylphenol	Phenol, 2-methyl-	NE	400	10	56	
95-50-1	o-Dichlorobenzene; 1,2-	Benzene, 1,2-dichloro-	20	--	5	69	I
88-74-4	o-Nitroaniline; 2-Nitroaniline	Benzenamine, 2-nitro-	NE	NE	50	154	
88-75-5	o-Nitrophenol; 2-Nitrophenol	Phenol, 2-nitro-	NE	NE	10	158	
SW437	Orthophosphate Phosphorus		NE	NE	NE	437	
95-53-4	o-Toluidine	Benzenamine, 2-methyl-	NE	NE	10	197	
23135-22-0	Oxamyl		200	NE	NE	450	

SW336	Oxygen Reduction Potential (mV)	ORP	NE	NE	NE	336	
96-47-6	o-Xylene		NE	NE	NE	408	
60-11-7	p-(Dimethylamino)azobenzene	Benzenamine, N,N-dimethyl-4-	NE	NE	10	92	
56-38-2	Parathion	Phosphorothioic acid,O,O-diethyl-O-(4-	NE	NE	10	169	
106-47-8	p-Chloroaniline	Benzenamine, 4-chloro-	NE	NE	20	38	
59-50-7	p-Chloro-m-cresol; 4-Chloro-3-	Phenol, 4-chloro-3-methyl-	NE	NE	20	45	
106-43-4	p-Chlorotoluene		NE	24	NE	365	
106-44-5	p-Cresol; 4-Methylphenol	Phenol, 4-methyl-	40	NE--	10	344	
99-87-6	p-Cymene		NE	25	NE	368	
106-46-7	p-Dichlorobenzene; 1,4-	Benzene, 1,4-dichloro-	6	--	1	71	I
608-93-5	Pentachlorobenzene	Benzene, pentachloro-	NE	NE	10	171	
76-01-7	Pentachloroethane		NE	NE	NE	380	
82-68-8	Pentachloronitrobenzene	Benzene,pentachloronitro-	NE	NE	20	172	
87-86-5	Pentachlorophenol	Phenol, pentachloro-	0.3	--	25	173	
109-52-4	Pentanoic Acid		NE	NE	NE	487	
7790-98-9	Perchlorate and Perchlorate Salts			2		494	
335-67-1	Perfluorooctanoic acid	PFOA, C8		2		484	
SW307	petroleum aliphatic carbon fraction class		10000	--	NE	307	
SW305	petroleum aliphatic carbon fraction class		400	--	NE	305	
SW306	petroleum aliphatic carbon fraction class		700	--	NE	306	
SW308	petroleum aromatics carbon fraction		200	--	NE	308	
SW320	pH (field)		NE	NE	NE	320	
SW321	pH (lab)		NE	NE	NE	321	
62-44-2	Phenacetin	Acetamide, N-(4-ethoxyphenyl)	NE	NE	20	174	
85-01-8	Phenanthrene	Phenanthrene	200	--	10	175	
108-95-2	Phenol	Phenol	30	--	10	177	
298-02-2	Phorate	Phosphorodithioic acid,O,O-diethyl S-	1	--	10	178	
96-91-3	Picramic Acid	2-amino-4,6-dinitiphenol	NE	0.7	NE	482	
100-01-6	p-Nitroaniline; 4-Nitroaniline	Benzenamine, 4-nitro-	NE	NE	20	155	
100-02-7	p-Nitrophenol; 4-Nitrophenol	Phenol, 4-nitro-	NE	NE	50	159	
1336-36-3	Polychlorinated biphenyls; PCBs	1,1'-Biphenyl,chloro derivatives Method	NE	0.09	2	434	
7440-09-7	Potassium		NE	NE	NE	377	
106-50-3	p-Phenylenediamine	1,4-Benzenediamine	NE	NE	10	176	
23950-58-5	Pronamide	Benzamide, 3,5-dichloro-N-(1,1-	NE	NE	10	179	
SW417	Propionic Acid	Propionic Acid	NE	NE	NE	417	
107-12-0	Propionitrile; Ethyl cyanide	Propanenitrile	NE	NE	150	180	
57-55-6	Propylene Glycol		NE	140,000	NE	507	
106-42-3	p-Xylene		NE	NE	NE	410	
129-00-0	Pyrene	Pyrene	200	--	10	181	
110-86-1	Pyridine		NE	7	NE	391	

SW414	Pyruvic Acid	Pyruvic Acid	NE	NE	NE	414	
94-59-7	Safrole	1,3-Benzodioxole, 5-(2-propenyl)-	NE	NE	10	182	
135-98-8	sec-Butylbenzene		70	--	NE	362	
7782-49-2	Selenium	Selenium	20	--	10	183	I
7440-22-4	Silver	Silver	20	--	10	184	I
93-72-1	Silvex; 2,4,5-TP	Propanoic acid, 2-(2,4,5-	50	--	2	185	
122-34-9	Simazine		4	NE	NE	451	
7440-23-5	Sodium		NE	20000	NE	322	
SW323	SpecCond (field)		NE	NE	NE	323	
SW324	SpecCond (lab)		NE	NE	NE	324	
7440-24-6	Strontium		NE	NE	NE	465	
100-42-5	Styrene	Benzene, ethenyl-	70	--	1	186	I
14808-79-8	Sulfate		250000	--	250000	315	
18496-25-8	Sulfide	Sulfide	NE	NE	1000	187	
3689-24-5	Sulfotep		NE	NE	NE	392	
99-35-4	sym-Trinitrobenzene	Benzene, 1,3,5-trinitro-	NE	NE	10	208	
SW325	Temp (oC)		NE	NE	NE	325	
994-05-8	tert-Amyl methyl ether	TAME, 2-methoxy-2-methylbutane	NE	128	NE	504	
98-06-6	tert-Butylbenzene		70	--	NE	363	
75-65-0	Tertiary Butyl Alcohol	tert-butanol	NE	10	NE	505	
127-18-4	Tetrachloroethylene; Tetrachloroethene;	Ethene, tetrachloro-	0.7	--	1	192	I
109-99-9	Tetrahydrofuran		NE	NE	NE	458	
7440-28-0	Thallium	Thallium	NE	0.28	5.5	194	I
7440-31-5	Tin	Tin	NE	2000	100	195	
108-88-3	Toluene	Benzene, methyl-	600	--	1	196	I
SW328	Top Of Casing (ft mean sea level)	TOC	NE	NE	NE	328	
SW425	Total BHC		NE	0.019	NE	425	
SW311	Total Dissolved Solids	TDS	500000	--	NE	311	
SW436	Total Fatty Acids	Total Fatty Acids	NE	NE	NE	436	
E-10195	Total Organic Carbon		NE	NE	NE	357	
SW396	Total Organic Halides		NE	NE	NE	396	
7723-14-0	Total Phosphorus	Total Phosphorus	NE	NE	NE	412	
SW343	Total Suspended Solids		NE	NE	NE	343	
SW411	Total Well Depth (ft)	TD	NE	NE	NE	411	
8001-35-2	Toxaphene	Toxaphene	0.03	--	1.5	198	
156-60-5	trans-1,2-Dichloroethylene; trans-1,2-	Ethene, 1,2-dichloro-,(E)-	100	--	5	79	I
10061-02-6	trans-1,3-Dichloropropene	1-Propene, 1,3-dichloro-, (E)-	0.4	--	1	87	I
110-57-6	trans-1,4-Dichloro-2-butene	2-Butene, 1,4-dichloro-, (E)-	NE	NE	100	73	I
79-01-6	Trichloroethylene; Trichloroethene	Ethene, trichloro-	3	--	1	201	I
75-69-4	Trichlorofluoromethane; CFC-11	Methane,trichlorofluoro-	2000	--	1	203	I
SW330	Turbidity		NE	NE	NE	330	

7440-62-2	Vanadium	Vanadium	NE	0.3	25	209	I
108-05-4	Vinyl acetate	Acetic acid, ethenylester	NE	88	50	210	I
75-01-4	Vinyl chloride; Chloroethene	Ethene, chloro-	0.03	--	1	211	I
1330-20-7	Xylene (total)	(o-,m-,and p-, Benzene, dimethyl	500	--	5	346	I
7440-66-6	Zinc	Zinc	1000	--	10	213	I

* GWP = Groundwater Protection Last updated: 6/13/2011 8:19:15 AM

** SWSL = Solid Waste

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N.C. Department of Environment and Natural Resources
1601 Mail Service Center, Raleigh, NC 27699-1601
Headquarters (Environment and Natural Resources Building): 217 W. Jones St.
Archdale Building: 512 N. Salisbury St.
Toll Free: (877) 623-6748

APPENDIX D

ENVIRONMENTAL MONITORING REPORTING FORM

DENR USE ONLY: ☐ Paper Report ☐ Electronic Data - Email CD (data loaded: Yes / No) Doc/Event #:

NC DENR
Division of Waste Management - Solid Waste

Environmental Monitoring Reporting Form

Notice: This form and any information attached to it are "Public Records" as defined in NC General Statute 132-1. As such, these documents are available for inspection and examination by any person upon request (NC General Statute 132-6).

Instructions:

- **Prepare one form for each individually monitored unit.**
- **Please type or print legibly.**
- Attach a notification table with values that attain or exceed NC 2L groundwater standards or NC 2B surface water standards. The notification must include a preliminary analysis of the cause and significance of each value. (e.g. naturally occurring, off-site source, pre-existing condition, etc.).
- Attach a notification table of any groundwater or surface water values that equal or exceed the reporting limits.
- Attach a notification table of any methane gas values that attain or exceed explosive gas levels. This includes any structures on or nearby the facility (NCAC 13B .1629 (4)(a)(i).
- Send the original signed and sealed form, any tables, and Electronic Data Deliverable to: Compliance Unit, NCDENR-DWM, Solid Waste Section, 1646 Mail Service Center, Raleigh, NC 27699-1646.

Solid Waste Monitoring Data Submittal Information

Name of entity submitting data (laboratory, consultant, facility owner):

Contact for questions about data formatting. Include data preparer's name, telephone number and E-mail address:

Name: _____ Phone: _____

E-mail: _____

Facility name:	Facility Address:	Facility Permit #	NC Landfill Rule: (.0500 or .1600)	Actual sampling dates (e.g., October 20-24, 2006)

Environmental Status: (Check all that apply)

☐ Initial/Background Monitoring ☐ Detection Monitoring ☐ Assessment Monitoring ☐ Corrective Action

Type of data submitted: (Check all that apply)

☐ Groundwater monitoring data from monitoring wells
☐ Groundwater monitoring data from private water supply wells
☐ Leachate monitoring data
☐ Surface water monitoring data
☐ Methane gas monitoring data
☐ Corrective action data (specify) _____
☐ Other(specify) _____

Notification attached?

☐ No. No groundwater or surface water standards were exceeded.
☐ Yes, a notification of values exceeding a groundwater or surface water standard is attached. It includes a list of groundwater and surface water monitoring points, dates, analytical values, NC 2L groundwater standard, NC 2B surface water standard or NC Solid Waste GWPS and preliminary analysis of the cause and significance of any concentration.
☐ Yes, a notification of values exceeding an explosive methane gas limit is attached. It includes the methane monitoring points, dates, sample values and explosive methane gas limits.

Certification

To the best of my knowledge, the information reported and statements made on this data submittal and attachments are true and correct. Furthermore, I have attached complete notification of any sampling values meeting or exceeding groundwater standards or explosive gas levels, and a preliminary analysis of the cause and significance of concentrations exceeding groundwater standards. I am aware that there are significant penalties for making any false statement, representation, or certification including the possibility of a fine and imprisonment.

Facility Representative Name (Print) Title (Area Code) Telephone Number

Affix NC Licensed/ Professional Geologist Seal

Signature Date

Facility Representative Address

NC PE Firm License Number (if applicable effective May 1, 2009)

Revised 6/2009

APPENDIX E

GROUNDWATER ASSESSMENT SWS APPROVAL LETTER

North Carolina Department of Environment and Natural Resources

Pat McCrory
Governor

John E. Skvarla, III
Secretary

August 5, 2014

Sent Via Email – idove@haywoodnc.net

Mr. Ira Dove
Haywood County Manager
215 North Main Street
Waynesville, NC 28786

Re: MW-23D Groundwater Assessment Report Review and Approval
Haywood County Closed Landfill – Francis Farm
Permit No. 44-03
Doc ID No. 21525

Dear Mr. Dove:

The Solid Waste Section (Section) has reviewed the *Report of Groundwater Assessment: Monitoring Well MW-23D* (DIN 21463) submitted on your behalf by Bunnell-Lammons Engineering, Inc. on June 30, 2014. The Section approves the proposed alternant sampling matrix for the August 2014 semi-annual sampling event. The proposed sampling matrix includes the elimination of mercury analysis for all groundwater monitoring wells and surface water monitoring locations. In addition, pesticides analysis is proposed to be removed from 20 monitoring wells and cyanide analysis removed from 19 monitoring wells. Details of the newly proposed sampling matrix are displayed in Table 5A and Table 5B in the above mentioned document.

Based on results from the *Groundwater Assessment Monitoring Plan* (August 11, 2004) and all subsequent assessment reports and work plans, the Section agrees that the delineation of the contaminant plume is now complete. The next step is to initiate and submit a report of the Assessment of Corrective Measures (ACM) in accordance with NCAC 15A 13B .1635.

If you have questions or concerns, please don't hesitate to contact me via email elizabeth.werner@ncdenr.gov or phone at (919) 707-8253.

Sincerely,

Elizabeth S. Werner
Permtting Hydrogeologist
Solid Waste Section

Cc: Stephen King - Haywood Co SW Director
Andrew Alexander, PG - BLE, Inc.
Mark Cathey, PE – McGill Associates
Allen Gaither, PE – SWS, Permitting Engineer
Andrea Keller – SWS, Environmental Specialist
Jason Watkins – SWS, Field Operations Branch Head

APPENDIX F

LOW-FLOW GROUNDWATER PURGING AND SAMPLING GUIDANCE

United States Environmental Protection Agency | Office of Research and Development | Office of Solid Waste and Emergency Response | EPA/540/S-95/504 April 1996

Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

For further information contact: Robert Puls, 405-436-8543, Subsurface Remediation and Protection Division, NRMRL, Ada, Oklahoma.

I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

[1]National Risk Management Research Laboratory, U.S. EPA
[2]University of Michigan

Superfund Technology Support Center for Ground Water

National Risk Management Research Laboratory
Subsurface Protection and Remediation Division
Robert S. Kerr Environmental Research Center
Ada, Oklahoma

Technology Innovation Office
Office of Solid Waste and Emergency Response, US EPA, Washington, DC

Walter W. Kovalick, Jr., Ph.D.
Director

chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling

objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

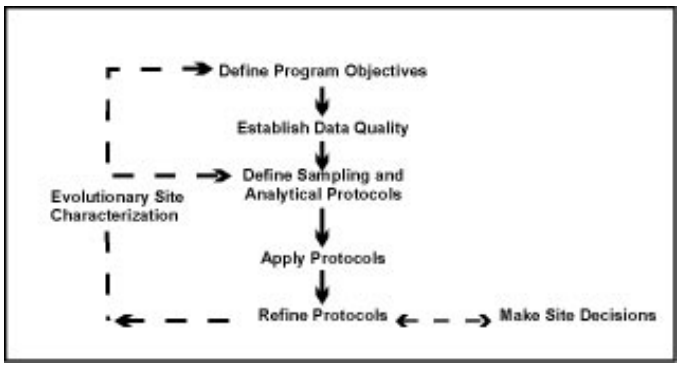

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-

flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action*.

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g. , pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:

- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality

indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of

the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

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Figure 2. **Ground Water Sampling Log**

Project _____ **Site** _____ **Well No.** _____ **Date** _____
Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____
Sampling Device _____ **Tubing type** _____ **Water Level** _____
Measuring Point _____ **Other Infor** _____

_____

Sampling Personnel _____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc			Notes

Type of Samples Collected

_____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Figure 3. **Ground Water Sampling Log** (with automatic data logging for most water quality parameters)

Project _____ **Site** _____ **Well No.** _____ **Date** _____
Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____
Sampling Device _____ **Tubing type** _____ **Water Level** _____
Measuring Point _____ **Other Infor** _____

_____

Sampling Personnel _____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

Type of Samples Collected

_____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

APPENDIX G

SEWER EXTENSION PERMIT APPLICATION AND LEACHATE COLLECTION SYSTEM PERMIT

State of North Carolina
Department of Environment and Natural Resources
Division of Water Quality

Flow Tracking/Acceptance for Sewer Extension Permit Applications
(FTSE –10/07)

Project Applicant Name: Haywood County

Project Name for which flow is being requested: Francis Farm Landfill

More than one FTSE-10/07 may be required for a single project if the owner of the WWTP is not responsible for all pump stations along the route of the proposed wastewater flow.

I. Complete this section only if you are the owner of the wastewater treatment plant.

a. WWTP Facility Name: Town of Waynesville

b. WWTP Facility Permit #: NC 0025321

	All flows are in MGD
c. WWTP facility's permitted flow	6.0
d. Estimated obligated flow not yet tributary to the WWTP	0.008
e. WWTP facility's actual avg. flow	2.899
f. Total flow for this specific request	0.015
g. Total actual and obligated flows to the facility	2.922
h. Percent of permitted flow used	48.7%

II. Complete this section for each pump station you are responsible for along the route of this proposed wastewater flow.

List pump stations located between the project connection point and the WWTP

Pump Station Name	Approx. Capacity, MGD (Firm/Design)	Approx. Current Avg. Daily Flow, MGD

III. Certification Statement:

I, Frederick L. Baker, certify that, to the best of my knowledge, the addition of the volume of wastewater to be permitted in this project has been evaluated along the route to the receiving wastewater treatment facility and that the flow from this project is not anticipated to cause any capacity related sanitary sewer overflows or overburden any downstream pump station en route to the receiving treatment plant under normal circumstances. This analysis has been performed in accordance with local established policies and procedures using the best available data. This certification applies to those items listed above in Sections I and II for which I am the responsible party. Signature of this form indicates acceptance of this wastewater flow.

Frederick L. Baker Dir Pub Wks 6/22/10

Signing Official Signature *Date*

North Carolina Department of Environment and Natural Resources
Division of Water Quality

Beverly Eaves Perdue
Governor

Coleen H. Sullins
Director

Dee Freeman
Secretary

July 29, 2011

Marty Stamey, County Manager
Haywood County, North Carolina
215 N. Main Street
Waynesville, NC 28786

Subject: Permit No. WQ0035486
Haywood County
Francis Farm Leachate Pump Station
Wastewater Collection System

Dear Mr.Stamey:

In accordance with your application received July 1, 2011, we are forwarding herewith Permit No. WQ0035486, dated July 29, 2011, to Haywood County for the construction and operation of the subject wastewater collection system extension. This permit shall be effective from the date of issuance until rescinded, and shall be subject to the conditions and limitations as specified therein. This cover letter shall be considered a part of this permit and is incorporated therein by reference. Please send Jeff Menzel or Don Price a copy of the "notice to proceed" issued to your contractor for this collection system extension.

Please pay particular attention to Permit Condition 3 which requires that the wastewater collection facilities be properly operated and maintained in accordance with 15A NCAC 2T .0403 or any individual system-wide collection system permit issued to the Permittee.

Permitting of this project does not constitute an acceptance of any part of the project that does not meet 15A NCAC 2T; the Division of Water Quality's (Division) Gravity Sewer Minimum Design Criteria adopted February 12, 1996 as applicable; and the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains adopted June 1, 2000 as applicable, unless specifically mentioned herein. Division approval is based on acceptance of the certification provided by the North Carolina-licensed Professional Engineer named in the application. It shall be the Permittee's responsibility to ensure that the as-constructed project meets the appropriate design criteria and rules. Failure to comply may result in penalties in accordance with North Carolina General Statute §143-215.6A through §143-215.6C, construction of additional or replacement wastewater collection facilities, and/or referral of the North Carolina-licensed Professional Engineer to the licensing board.

In accordance with the provisions of Article 21 of Chapter 143, General Statutes of North Carolina as amended, and other applicable Laws, Rules, and Regulations, permission is hereby granted to Haywood County for the construction and operation of approximately 1,212 linear feet of 2-inch force main and pump station with duplex pumps with on-site audible and visual high water alarms, as part of the Francis Farm Leachate Pump Station project, and the discharge of collected landfill leachate wastewater into the Town of Waynesville existing sewerage system, pursuant to the application received July 1, 2011 and in conformity with 15A NCAC 2T; the Division's Gravity Sewer Minimum Design Criteria adopted February 12, 1996 as applicable; the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains adopted June 1, 2000 as applicable; and other supporting data subsequently filed and approved by the Department of Environment and Natural Resources and considered a part of this permit;

The sewage and wastewater collected by this system shall be treated in the Town of Waynesville Wastewater Treatment Facility (Permit No. NC0025321) prior to being discharged into the receiving stream.

This permit shall become voidable unless the agreement between Haywood County and Town of Waynesville for the collection and final treatment of wastewater is in full force and effect.

If any parts, requirements, or limitations contained in this permit are unacceptable, you have the right to request an adjudicatory hearing upon written request within 30 days following receipt of this permit. This request must be in the form of a written petition, conforming to Chapter 150B of North Carolina General Statutes, and filed with the Office of Administrative Hearings, 6714 Mail Service Center, Raleigh, NC 27699-6714. Unless such demands are made, this permit shall be final and binding.

If you need additional information concerning this matter, please contact Jeff Menzel or Don Price at (828) 296-4500.

Sincerely,

Roger C. Edwards

for Coleen H. Sullins, Director
Division of Water Quality

cc: Town of Waynesville WWTP NC0025321
William Sperry, Project Manager/McGill Associated
Surface Water Protection Section Central Files
PERCS Files

S:\SWP\Haywood\Collection Systems\Waynesville Collection System\WQ0035486 Francis Farm Landfill 07-29-2011.doc

NORTH CAROLINA

ENVIRONMENTAL MANAGEMENT COMMISSION

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

RALEIGH

WASTEWATER COLLECTION SYSTEM EXTENSION PERMIT

This permit shall be effective from the date of issuance until rescinded and shall be subject to the following specified conditions and limitations:

1. This permit shall become voidable unless the wastewater collection facilities are constructed in accordance with the conditions of this permit; 15A NCAC .0200; the Division of Water Quality's (Division) Gravity Sewer Minimum Design Criteria adopted February 12, 1996 as applicable; the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains adopted June 1, 2000 as applicable; and other supporting materials unless specifically mentioned herein.

2. This permit shall be effective only with respect to the nature and volume of wastes described in the application and other supporting data.

3. The wastewater collection facilities shall be properly maintained and operated at all times. The Permittee shall maintain compliance with an individual system-wide collection system permit for the operation and maintenance of these facilities as required by 15A NCAC 2T .0403. If an individual permit is not required, the following performance criteria shall be met as provided in 15A NCAC 2T .0403:

   a. The sewer system shall be effectively maintained and operated at all times to prevent discharge to land or surface waters, and any contravention of the groundwater standards in 15A NCAC 2L .0200 or the surface water standards in 15A NCAC 2B .0200.

   b. A map of the sewer system shall be developed and shall be actively maintained.

   c. An operation and maintenance plan shall be developed and implemented.

   d. Pump stations that are not connected to a telemetry system shall be inspected every day (i.e. 365 days per year). Pump stations that are connected to a telemetry system shall be inspected at least once per week.

   e. High-priority sewer lines shall be inspected at least once per every six-month period of time.

   f. A general observation of the entire sewer system shall be conducted at least once per year.

   g. Inspection and maintenance records shall be maintained for a period of at least three years.

   h. Overflows and bypasses shall be reported to the appropriate Division regional office in accordance with 15A NCAC 2B .0506(a), and public notice shall be provided as required by North Carolina General Statute §143-215.1C.

4. **This permit shall not be transferable.** In the event there is a desire for the wastewater collection facilities to change ownership, or there is a name change of the Permittee, a formal permit request shall be submitted to the Division accompanied by documentation from the parties involved, and other supporting materials as may be appropriate. The approval of this request shall be considered on its merits and may or may not be approved.

5. Construction of the gravity sewers, pump stations, and force mains shall be scheduled so as not to interrupt service by the existing utilities nor result in an overflow or bypass discharge of wastewater to the surface waters of the State.

6. Upon completion of construction and prior to operation of these permitted facilities, a certification, a copy of the construction record drawings, as well as supporting design calculations for any pump stations permitted as part of this project shall be received from a North Carolina-licensed Professional Engineer certifying that the facilities have been installed in accordance with this permit; 15A NCAC 2T; the Division's Gravity Sewer Design Criteria adopted February 12, 1996 as applicable; the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Station and Force Main adopted June 1, 2000 as applicable; and other supporting materials. If this project is to be completed in phases and partially certified, you shall retain the responsibility to track further construction approved under the same permit, and shall provide a final certificate of completion once the entire project has been completed. A copy of the construction record drawings, indicating the facilities constructed in the phase being certified, shall be submitted with each partial certification. Mail the Engineer's Certification, one copy of the "Construction Record Drawings," and one copy of the supporting design calculations to the Non-Discharge Permitting Unit, 1617 Mail Service Center, Raleigh, NC 27699-1617.

7. A copy of the construction record drawings shall be maintained on file by the Permittee for the life of the wastewater collection facilities.

8. Failure to abide by the conditions and limitations contained in this permit; 15A NCAC 2T.; the Division's Gravity Sewer Design Criteria adopted February 12, 1996 as applicable; the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Station and Force Mains adopted June 1, 2000 as applicable; and other supporting materials may subject the Permittee to an enforcement action by the Division, in accordance with North Carolina General Statutes §143-215.6A through §143-215.6C.

9. In the event that the wastewater collection facilities fail to perform satisfactorily, including the creation of nuisance conditions, the Permittee shall take immediate corrective action, including those as may be required by this Division, such as the construction of additional or replacement facilities.

10. The issuance of this permit shall not exempt the Permittee from complying with any and all statutes, rules, regulations, or ordinances that may be imposed by other government agencies (local, state and federal) which have jurisdiction, including but not limited to applicable river buffer rules in 15A NCAC 2B .0200, erosion and sedimentation control requirements in 15A NCAC Ch. 4 and under the Division's General Permit NCG010000, and any requirements pertaining to wetlands under 15A NCAC 2B .0200 and 15A NCAC 2H .0500.

11. **Noncompliance Notification:**

The Permittee shall report by telephone to a water quality staff member at the Asheville Regional Office, telephone number (828) 296-4500, as soon as possible, but in no case more than 24 hours or on the next working day, following the occurrence or first knowledge of the occurrence of either of the following:

a. Any process unit failure, due to known or unknown reasons, that renders the facility incapable of adequate wastewater transport, such as mechanical or electrical failures of pumps, line blockage or breakage, etc.; or

b. Any failure of a pumping station or sewer line resulting in a by-pass directly to receiving waters without treatment of all or any portion of the influent to such station or facility.

Voice mail messages or faxed information is permissible but this shall not be considered as the initial verbal report. Overflows and spills occurring outside normal business hours may also be reported to the Division of Emergency Management at telephone number (800) 858-0368 or (919) 733-3300. Persons reporting any of the above occurrences shall file a spill report by completing Part I of Form CS-SSO (or the most current Division approved form), within five days following first knowledge of the occurrence. This report shall outline the actions taken or proposed to ensure that the problem does not recur. Per Condition I(2), Part II of Form CS-SSO (or the most current Division approved form) can also be completed to show that the SSO was beyond control.

Permit issued this the 29th day of July, 2011

NORTH CAROLINA ENVIRONMENTAL MANAGEMENT COMMISSION

Roger C. Edwards

for Coleen H. Sullins, Director
Division of Water Quality
By Authority of the Environmental Management Commission

Permit Number WQ0035486

ENGINEERING CERTIFICATION – POST CONSTRUCTION

System Description:

permission is hereby granted to Haywood County for the construction and operation of approximately 1,212 linear feet of 2-inch force main and pump station with duplex pumps with on-site audible and visual high water alarms, as part of the Francis Farm Leachate Pump Station project, and the discharge of collected landfill leachate wastewater into the Town of Waynesville existing sewerage system.

Complete and submit this form to the Asheville regional office with the following:

- One copy of the project record drawings (plan & profile views of sewer lines) of the wastewater collection system extension
- supporting design calculations (selected pumps, system curve, operating point, available storage if portable generator(s) or storage greater than longest past three year outage reliability option selected) for any pump stations permitted as part of this project
- Changes to the project should be clearly identified on the record drawings or in written summary form. Permit modifications are required for any changes resulting in non-compliance with this permit, regulations or minimum design criteria.

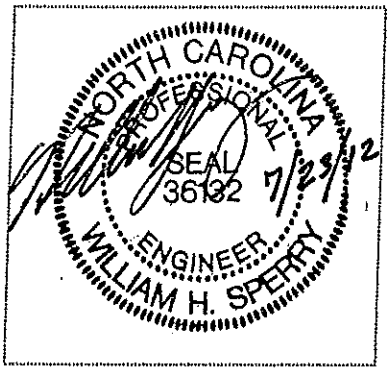
This project shall not be considered complete nor allowed to operate until this Engineer's Certification and all required supporting documentation have been received by the Division. **Therefore, it is highly recommended that this certification be sent in a manner that provides proof of receipt by the Division.**

ENGINEER'S CERTIFICATION

☐ Partial ☒ Final

I, William H. Sperry, as a duly registered Professional Engineer in the State of North Carolina, having been authorized to observe (☒ periodically, ☐ weekly, ☐ full time) the construction of the above referenced project for the Permittee hereby state that, to the best of my abilities, due care and diligence was used in the observation of the construction such that the construction was observed to be built within substantial compliance of this permit; 15A NCAC 2T; the Division of Water Quality's (Division) Gravity Sewer Minimum Design Criteria adopted February 12, 1996 as applicable; the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains adopted June 1, 2000 as applicable; and other supporting materials.

North Carolina Professional Engineer's seal, signature, and date:



SEND THIS FORM & SUPPORTING DOCUMENTATION WITH REQUIRED ATTACHMENTS TO THE FOLLOWING ADDRESS

ROGER C. EDWARDS
SURFACE WATER PROTECTION SUPERVISOR
ASHEVILLE REGIONAL OFFICE
2090 US HIGHWAY 70
SWANNANOA, NC 28778

The Permittee is responsible for tracking all partial certifications up until a final certification is received. Any wastewater flow made tributary to the wastewater collection system extension prior to completion of this Engineer's Certification shall be considered a violation of the permit and shall subject the Permittee to appropriate enforcement actions.

Francis Farm Landfill
Haywood County, North Carolina

Permit No. WQ0035486

The Francis Farm Landfill pump station is a packaged unit with dual pumps specified to operate at 30 gpm at 23 feet TDH. The pumps as installed operate at ±32 gpm at ±23 feet TDH or ±30 gpm at ±25.8 feet TDH. A copy of the applicable pump curve is attached to this project description. Also attached is data on the pumps. The pumps are controlled to operate as alternating pumps under normal conditions. If needed to handle the flow the pumps will operate as "lead on" then "lag on". The pump station is equipped with an auto-dialer and both audible and visual alarm systems should the pumps fail to operate and the level of liquid in the wet well continues to rise.

The package pump station receives its flow from six (6) down-hole variable speed piston pumps specifically designed to remove leachate from water logged landfill gas wells. The pumps utilized on this project are capable of varying the pump rate from a low of approximately 1/2 gallon per minute to a maximum of approximately 3.3 gallons per minute. During the initial week of operation the pumps will be set at the maximum pump rate to remove the accumulated water in the wells and the surrounding waste mass. After approximately a week of operation the pump rate will be dialed back to approximately 1/2 to 1 gallon per minute as the recharge rate for solid waste is generally very slow. The intent is to keep the wells relatively clear of liquid to enhance the flow of methane gas to the collection and combustion system. Once the initial liquid is removed the anticipated flow rate to the pump station should be in the range of 3 – 6 gallons per minute. A knockout pot for collection condensate from the landfill gas collection lines also discharges into the package pump station. The pump in this tank is also a down-hole variable speed piston pump with the same capacity and operating characteristics as the aforementioned pumps except that it is operated with liquid level transducers to control when it runs.

The pump station, the knockout pot pump and the down-hole variable speed piston pumps operate off the same single electrical feed from Haywood EMC. The electrical power comes into the main disconnect located on a power control panel rack located in the vicinity of the pump station. From the main disconnect the power runs through a double-throw switch panel to allow the use of stand-by generator power should the need arise. From there the pump station, the down-hole piston pumps and the flare system feed through designated control panels. A unique feature of this system is that in the event of a system power failure at the site then all systems go down simultaneously and the flow to the pump station ceases except for the flow left in the pipes at the time the power ceased. When the power is restored, the pumping systems will restart automatically. Should the need arise, the entire system is equipped with a power connect feed for a standby generator. Operators are on site daily to monitor the operation of the flare system, the engine/generator system and the operation of the pump station.

The pump station is a 48" diameter unit that is 12'-6" in total vertical height with a capacity of approximately 94 gallons of liquid per vertical foot. Basically this package pump station has storage capacity in excess of approximately 640 gallons to 752 gallons that could be utilized in the case of an emergency or power outage.

McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT: Francis Farm Landfill, Haywood Cty.
PROJECT NO.: 09.00721
DESCRIPTION: Permit No. WQ0035486
CALCULATED BY: WHS CHECKED BY:
DATE: 1/30/12 SHEET NO. 1 OF 1

Pisgah Pump Station - 48" Diameter - *94 gallons / vertical foot.

Controlling Elevation for the liquid Level would be the elevation of the electrical coupling @ elevation 2693.0 (21"-30" below Top of pump station) → See Copy of cut-sheet from pump station submittal.

Lowest approximate elevation of Liquid retained in the pump station will be elevation 2685.0 (pump-off elevation) The highest normal level of Liquid in the pump station should be approximately elevation 2686.2 when the lead pump should switch on.

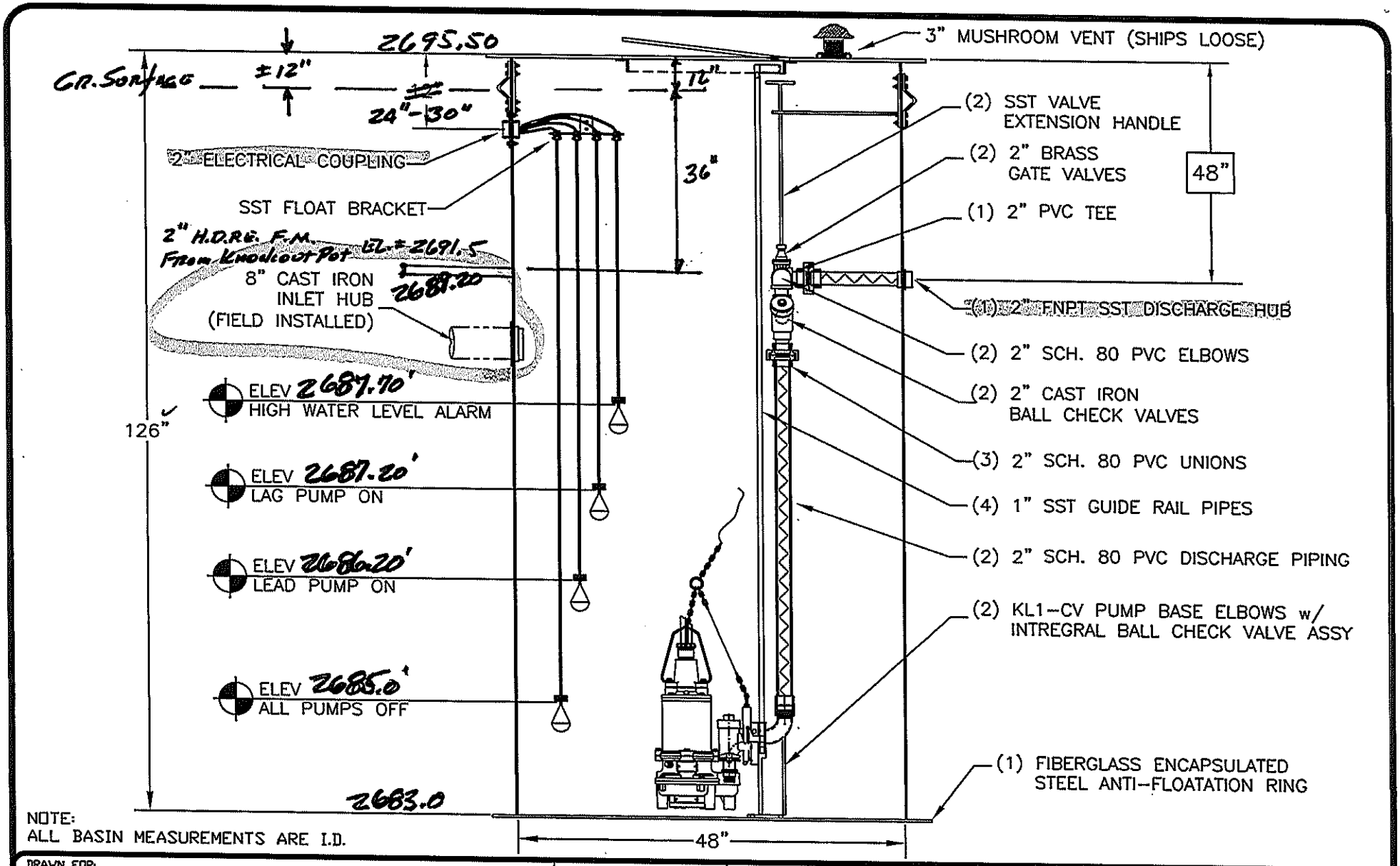
Storage available between the electrical coupling (elevation 2693.0) and the Lead pump on elevation (elevation 2686.2) is 639.2 gallons.

Elev. Electrical Coupling: 2693.0
Elev. Lead pump on: 2686.2
6.8 V.F @ 94 gal./V.F = *639.2 gal

Storage available between the electrical coupling (elev. 2693.0) and the pump off elevation (elev. 2685.0) is

Elev. Electrical Coupling: 2693.0
Elev. Pump Off: 2685.0
8.0 V.F @ 94 gal/V.F = ± 752.0 gal.

Therefore the volume of storage capacity could vary between approximately ±640 gallons to ±752 gallons depending on the Level of the liquid at the time the power to the system went down.



NOTE:
ALL BASIN MEASUREMENTS ARE I.D.

DRAWN FOR: FRANCIS FARM LANDFILL – PHASE 2B	PO# --- QUOTE # ---	DISCONNECTS: KEEN KL1-CV PUMPS: KEEN KG2-23	SHEET 1 OF 2	Revision 0
JOB REFERENCE / Notes: PACKAGE LEACHATE GRINDER PUMP STATION	BASIN DESCRIPTION: 48" X 126" DUPLEX FIBERGLASS BASIN COVER DESCRIPTION: 1/4" ALUMINUM DIAMOND-PLATED COVER	DRAWN BY: SMH / DATE: 6/06/2011 CHECKED BY: SMH / DATE CHECKED: 7/22/2011	CAROLINA PUMPWORKS Engineered Pumping & Process Equipment phone: 828-692-4511 - fax: 828-692-4501 www.cpwllc.com	

CPW
CAROLINA PUMPWORKS, LLC

172 Highlands Square Dr, Suite 313
Hendersonville, NC 28792
Cell: (803) 917-9798
Phone: (828) 692-4511
Fax: (828) 692-4501
E-mail: shale@cpwllc.com

July 23, 2011

To: Payne, McGinn & Cummins, Inc. **From:** Scott Hale

Attn: Rick Galway, P.E. **Re:** Package Submersible Leachate Pumping Station for Francis Farm Landfill – Phase 2B – Haywood County

PACKAGE SUBMERSIBLE LEACHATE PUMP STATION

2 ea Keen Pump Model KG2-23 Submersible Solids Handling Sewage Grinder Pump Of Heavy-Duty Cast Iron Construction, Direct Coupled To A Totally Encapsulated, Submersible Motor To Include the Following Items of Construction:

- 2-HP, 3450 RPM, 460-Volt, 3-Phase, Class F, High Torque Submersible Motor
- Double Mechanical Shaft Seals – Silicon Carbide Upper & Lower Seal Faces
- Motor Winding Over-Temperature Sensors
- Two-Probe Seal Fail Sensors Detects Moisture Intrusion Inside Motor Housing
- Stainless Steel Pump Lifting Bail Assembly
- 30-ft Dual Power & Control Cables

1 ea **48" Diameter X 126" Deep** Duplex Factory-Built Fiberglass Wet-Well System to Arrive Onsite with the Following Components Pre-Plumbed and Factory Installed:

- 2" NPT Cast Iron Base Elbows for Pump Lift-Out Guide Rail System
- Cast Iron Pump Sealing Flanges w/ Rail Guide Plates & Integral Ball Check Valve Assemblies
- 2" Sch. 80 PVC Discharge Piping, Elbows & Unions As Required
- 2" Brass Isolation Gate Valves w/ Stainless Steel Valve Extension Handles
- 2" FNPT Stainless Steel Discharge Hub – Located 48" Down From Top of Basin
- 1" Stainless Steel Guide Rails
- 3/16" Stainless Steel Lifting Chain Assemblies for Removing Pumps
- Stainless Steel Float Switch Mounting Bracket
- Aluminium Skid-Proof Cover w/ Hinged Access Door, Hold-Open Arm, & Lockable Latch
- 8" Cast Iron Inlet Hub *(inlet hub ships loose for field installation by contractor)*

1 ea Duplex 2-HP Pump Control Panel for **460-Volt, 3-Phase** Incoming Power To Include the Following:

- NEMA 4X Fiberglass Enclosure w/ Aluminium Dead Front Inner Door & Lockable Latch
- UL 508 Listed & Labeled
- Lightning Arrestor
- Power Distribution, Neutral & Grounding Blocks
- Phase & Voltage Monitor
- 460V/120V Control Power Transformer, 2kVA with Primary & Secondary Fusing
- Individual Pump Circuit Breakers
- Control Power Circuit Breaker
- IEC Rated Motor Starters w/ Adjustable Overloads
- Hand-Off-Auto Switches
- Pump Run Indicator Lights
- Elapsed Time Meters *(non-resettable type)*
- Duplex Float Switch Relay Logic *(pump off, lead pump, lag pump, & high water alarm)*
- Seal Failure & Motor Over-Temperature Alarms w/ Indicator Lights
- Flashing Alarm Light
- Audible Alarm Horn w/ Silence Pushbutton
- Auxiliary Contacts for Telephone Alarm Dialer

CONTINUED

CPW
CAROLINA PUMPWORKS, LLC

172 Highlands Square Dr, Suite 313
Hendersonville, NC 28792
Cell: (803) 917-9798
Phone: (828) 692-4511
Fax: (828) 692-4501
E-mail: shale@cpwllc.com

1 ea 4-Channel Automatic Telephone Alarm Dialer w/ 12-Volt Battery Back-Up To Be Mounted, Wired and Tested Inside Pump Control Panel. *(Telephone line and connection services provided by others)*

4 ea Liquid Level Float Switches, Internally Weighted & 30-ft. Control Cables

1 ea Flomotion Systems Isomag Model MS2500-T50-A6A4B - 2" Flanged Electromagnetic Flow Meter and Shall Include the Following Items of Construction:
- 304SS, PTFE Lined Flow Tube
- 150# ANSI Flanges
- Hastelloy C Flow and Grounding Electrodes

1 ea Flomotion Systems Isomag Model ML110-B0B1B1A0 Converter / Transmitter and Shall Include the Following Items of Construction:
- Two Line Alphanumeric Display
- Internal 3 Position Keypad
- Programmable 4-20mA & (2) Selectable Frequency, Scaled Pulse or Alarm Outputs
- Bi-Directional Flow Capability
- 90-265 VAC Power Input
- Corrosion Resistant Non-Metallic NEMA 4X Enclosure w/ Remote Sensor Mount

1 ea 100-ft. – Electrode and Coil Interconnect Cable

2 ea Sets of Recommended Spare Parts Provided for Each Submersible Grinder Pump

1 ea Day Start-Up Service, Equipment Testing & Operator Training – 1-Day, 1-Trip

1 ea Prepaid Freight to Jobsite – Equipment Off-Loading By Others

NOTES:

1. Our proposal only includes the components quoted herein.
2. Taxes are not included and any applicable taxes will be added to the final invoice.
3. The above pricing includes pre-paid freight to the jobsite via a commercial LTL freight carrier.
4. Equipment off-loading and/or installation services are provided by others.
5. Piping, valves, and/or any miscellaneous fittings external to the fiberglass basin provided by others.
6. Flow meter vault, access cover, piping, valves, fittings, wiring, and/or installation of meter by others.
7. Generator, transfer switch, generator receptacle, and/or generator plug are provided by others.
8. Main service disconnect, meter base, area lighting, and/or signage are provided by others.
9. Conduit, miscellaneous fittings, Kellum grips, and/or field wiring connections provided by others.
10. Flow meter vault, access cover, piping, valves, fittings, wiring, and/or installation by others.
11. Equipment delivered in **4 weeks** after receiving approved submittals.

All prices are F.O.B. factory, full freight allowed to jobsite where accessible by commercial carrier. Prices do not include any applicable taxes. Warranty and sales conditions are per manufacturers and Carolina Pumpworks standard terms and conditions. Payment terms are Net 30 days. A 1.5% per month finance charge will be applied to any past due invoices. Partial billing will be made on partial shipments. Payment terms are independent of and not contingent upon third party contracts or commitments, unless Carolina Pumpworks specifically agrees to terms in writing.

We thank you for your interest in our equipment and look forward to being of service to you in the near future.

Features and Benefits

1.Triple Sealed Cable Entrance
Stainless steel strain relief cord grip with compression grommet protects outer cord jacket. Epoxy filled inner cord cap with individually soldered wires provide anti-wicking moisture protection to the motor even if power cable is cut or damaged.

2. Modular Pump Design
Commonality of parts across the Keen product line minimizes the amount of parts required for servicing. Heavy duty ASTM A48, Class 30 cast iron components.

3. Strong Motor
Powerful high torque motor for reliable pump operation.
208 / 230 volt, 1-phase
208 / 230 / 460 volt, 3-phase
Pressed stator securely holds motor and efficiently transfers heat. Class F insulation with overload protection in oil filled chamber for cool operation and long motor life.

4. 3- Bearing Support
Motor / Pump shaft securely held with upper and lower ball bearing plus addition sleeve bearing in lower seal chamber. Long 50,000 hour B-10 bearing life.

5. Double Mechanical Seal Protection
Dual silicon carbide mechanical shaft seals provide twice the moisture protection for the motor. Dual seals are housed in a secondary oil filled seal chamber. Tougher silicon carbide seals better handles sand, grit and abrasive materials.

6. Moisture Detection
Seal leak probe signals alarm in control panel for scheduled maintenance.

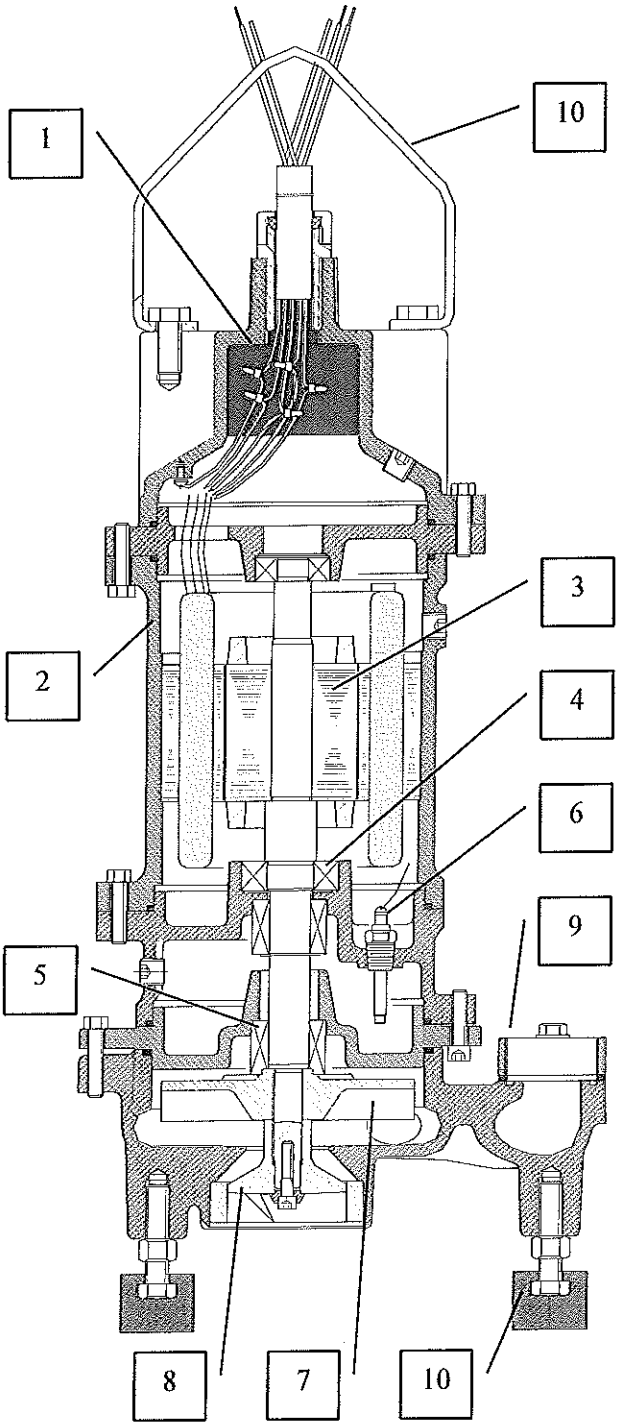
7. Non-Overloading Hydraulic Design
The recessed centrifugal impeller allows 100% performance curve operation from shut-off to maximum flow without damage to the pump or system. The recessed vortex impeller is out of the passageway of fluid flow, eliminating concerns of blockage or wear.

8. Proven Grinder Assembly
Hardened (Rockwell 56-60) stainless steel grinder assembly has 30+ years proven field experience. The reversible grinder ring and grinder impeller effectively reduces solids into a fine slurry, easily passable in a piping system without concerns of clogging. Highly efficient 16,600 cuts per second.

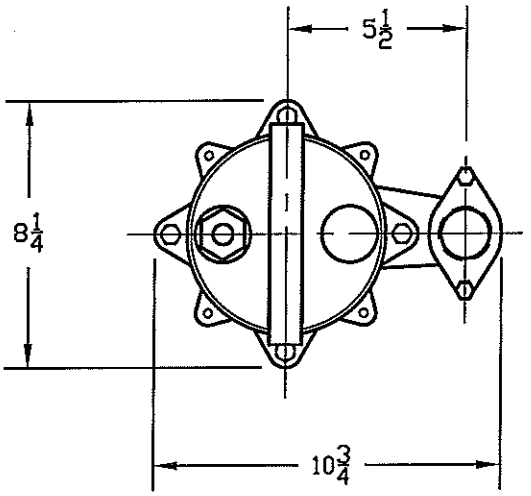
9. Easy Piping Connection
Removable 1-1/4" NPT connection flange for simple and easy connection to discharge piping.

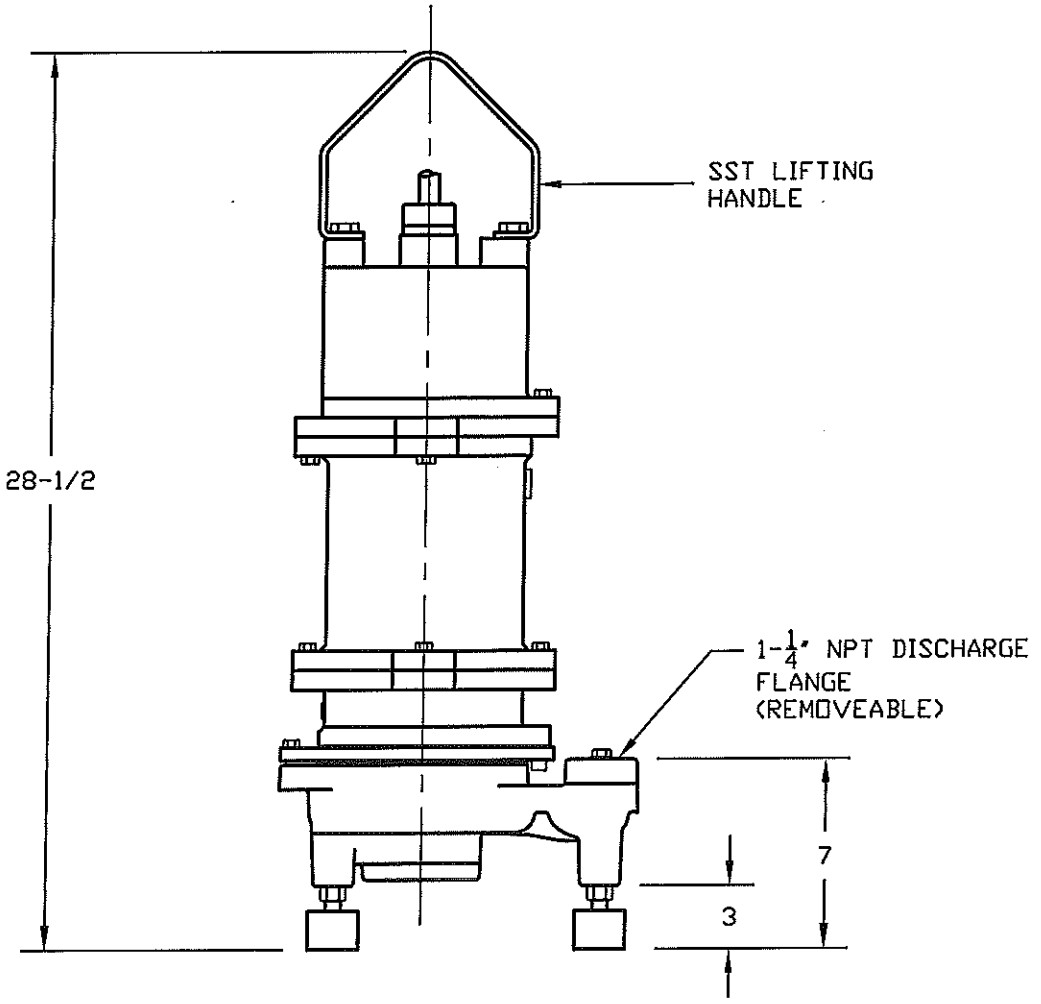
10. Accessories Included
Stainless steel lifting handle and anti-vibration rubber mounting feet are included with the pump.

2 HP Grinder Pump
Dual Seal
KG2-21 & 23



ISO 9001
CERTIFIED PUMP





KEEN PUMP COMPANY
KEEN PUMP CO.
471 EAST STATE ROUTE 250 E.
ASHLAND, OHIO 44805
PHONE: 419-207-9400
FAX: 419-207-8031

TITLE			
KG2 2HP GRINDER PUMP OUTLINE			
SCALE: NTS		DWG. #: KN-16	REV.: -
DWG. BY: F. YUHASZ	DATE: 9/25/08		

Keen Pump

2 HP Grinder Pumps KG2-21 & 23

Performance Specifications

Pump Model – Pump shall be of the centrifugal type, KG2-21 & 23, with an integrally built-in grinder unit and submersible type motor. The grinder unit shall be capable of macerating all material in normal domestic and commercial sewage, including reasonable amounts of foreign objects such as sanitary napkins, disposable diapers, thin rubber, small wood, plastic and the like to a fine slurry that will easily pass through the pump and 1-1/4" NPT discharge.

Operating Conditions – The pump shall have a capacity of 30 GPM at a total head of 23 feet, and shall use a motor rated at 2 HP and 3450 RPM.

Pump Impeller – Ductile Iron threaded on a stainless steel shaft. The impeller shall be of the recessed vortex type to provide an unobstructed passage through the volute for the ground solids.

Grinder Construction – Both grinder impeller and shredding ring shall be of 440C stainless steel hardened to 56-60 Rockwell C. The grinder assembly shall consist of a grinder impeller and shredding ring mounted directly below the volute passage. The grinder impeller is threaded to a stainless steel shaft, locked with a screw and washer. The shredding ring shall be pressed into the cast iron volute for easy removal. All grinding of solids shall be from the action of the grinder impeller against the shredding ring. There shall be 16,600 cuts / second.

Seals – Type 21, dual mechanical seal construction mounted in tandem, shall protect the motor. Primary seal shall be silicon / carbide. Secondary seal shall be silicon / carbide. The seal face shall be lapped to a flatness of one light band. An electrode shall be mounted in the seal chamber to detect water entering the chamber through the lower seal. Water in the chamber shall cause a red light to turn on at the control box. This signal shall not stop the motor, but shall act as a warning only, indicating service is required.

Motor – The pump motor shall be of the submersible type, rated 2 HP, 3450 RPM. The motor shall be for 60 Hz, either 208,230, 460 volt, single or three phase operation. Single-phase motors shall be capacitor start, capacitor run type for high starting torque. Start & run capacitors, and electronic relay for operating the motor will be found in the control box. Major motor operating temperature must not exceed Class B ratings.

The stator winding shall be of the open type with Class F insulation. Winding housing shall be filled with clean, high dielectric oil that lubricates bearings and seals, transferring heat from windings and rotor to the outer cast housing. Air-filled motors, which do not have the superior heat dissipating capabilities of oil-filled motors, shall not be considered equal.

The motor shall have two heavy-duty ball bearings and one sleeve bearing to support the pump shaft, taking radial and thrust loadings. Ball bearings shall be designed for a minimum 50,000 hours B-10 life. The stator shall be pressed into the motor housing. The common motor pump and grinder shaft shall be of 416 SST, threaded to take the pump and grinder impeller.

Single-phase motors shall have automatic reset overload protection attached to the top end of the motor windings to stop the motor if the motor winding temperature reaches 130 degrees C. The high temperature shut-off will cause the pump to cease operation, should a control failure cause the pump to run in a dry wet well. The overload shall automatically reset when the motor cools to a safe operating temperature. Three phase motors contain temperature sensors with (2) wires for attachment to the control panel.

Power Cord – The motor power cord shall be 12 Ga. SOW/SJOWA or SOOW. The cable jacket shall be sealed at the motor entrance by means of a rubber compression washer and compression nut. An epoxy filled cord cap shall seal the outer cable jacket and individual leads to prevent water from entering the motor housing. Individual conductor strands shall be soldered within.

PUMP SPECIFICATIONS

DISCHARGE..... 1-1/4" NPT, Vertical
LIQUID TEMPERATURE..... 120 degrees F (Continuous)
140 degrees F. (Intermittent)

MOTOR HOUSING..... Cast Iron, ASTM A-48, Class 30
CORD CAP..... Cast Iron, ASTM A-48, Class 30
VOLUTE..... Cast Iron, ASTM A-48, Class 30
SEAL PLATE.....Cast Iron, ASTM A-48, Class 30

IMPELLER..... Ductile Iron, ASTM A-48, Class 35B
12 vane, Vortex with Pump-out Vanes, Dynamically Balanced

SHREDDING RING..... Hardened 440C Stainless Steel
56-60 Rockwell C
GRINDER IMPELLER..... Hardened 440C Stainless Steel
56-60 Rockwell C

SHAFT..... 416 Stainless Steel

SHAFT SEAL..... Mechanical

	Main (Motor)	Secondary(Pump)
	Carbide – Rotating Face	Carbide – Rotating Face
	Silicon– Stationary Face	Silicon – Stationary Face

Buna-N - Elastomer
300 Series Stainless Steel - Hardware

BEARING (UPPER)..... Single Row, Ball, Oil Lubricated
BEARING (LOWER)..... Single Row, Ball, Oil Lubricated

HARDWARE..... 300 Series Stainless Steel
O-RINGS..... Buna-N

CORD..... 12 AWG, Type SJOW or SOOW
30' Length Standard. Other Lengths Available.

CORD ENTRY..... Triple Sealed Design
Compression Grommet – Outer Jacket Seal
Epoxy Potted – Inner Conductor Seal
Butt Connector – Inner Wire Strand Wicking Blockage

MOTOR (SINGLE PHASE)..... 2 HP, 3450 RPM, 60 Hz
Dual voltage, 200 / 230 volts
Includes Overload Protection in the Motor.
Oil Filled, Class F
Capacitor Start / Capacitor Run

	Start Capacitor	Run Capacitor
KG2-115 K(H)G2-21C	..... 200 mfd, 125 VAC	70 mfd, 250 VAC
K(H)G2-21	.... 150 mfd, 250 VAC	30 mfd, 370 VAC
KHHG2(H)-21	.... 300 mfd, 250 VAC	30 mfd, 370 VAC

MOTOR (THREE PHASE)..... 2 HP, 3450 RPM, 60 Hz
Tri-voltage, 200 / 230 / 460 volts
On-Winding temperature sensor, requires temperature sensor circuitry in control panel
Oil Filled, Class F

OPTIONAL EQUIPMENT..... Seal Materials
Additional Cable Lengths
Impeller Trims

Pump Data Sheet - Keen Pump

Company: Carolina Pumpworks, LLC
Name: Scott M. Hale
Date: 7/23/2011

KEEN PUMP

Pump:

Size: KG2-21, KG2-23

Type: Grinder
Synch speed: 3600 rpm

Speed: 3450 rpm
Dia: 3.75 in

Curve:

Impeller:

Specific Speeds:

Ns: ---
Nss: ---

Dimensions:

Suction: ---
Discharge: 1.25 in

Pump Limits:

Temperature: ---
Pressure: ---
Sphere size: ---

Power: ---
Eye area: ---

Search Criteria:

Flow: 30 US gpm

Head: 23 ft

Fluid:

Water
Density: 62.25 lb/ft³
Viscosity: 1.105 cP

Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

NPSHa: ---

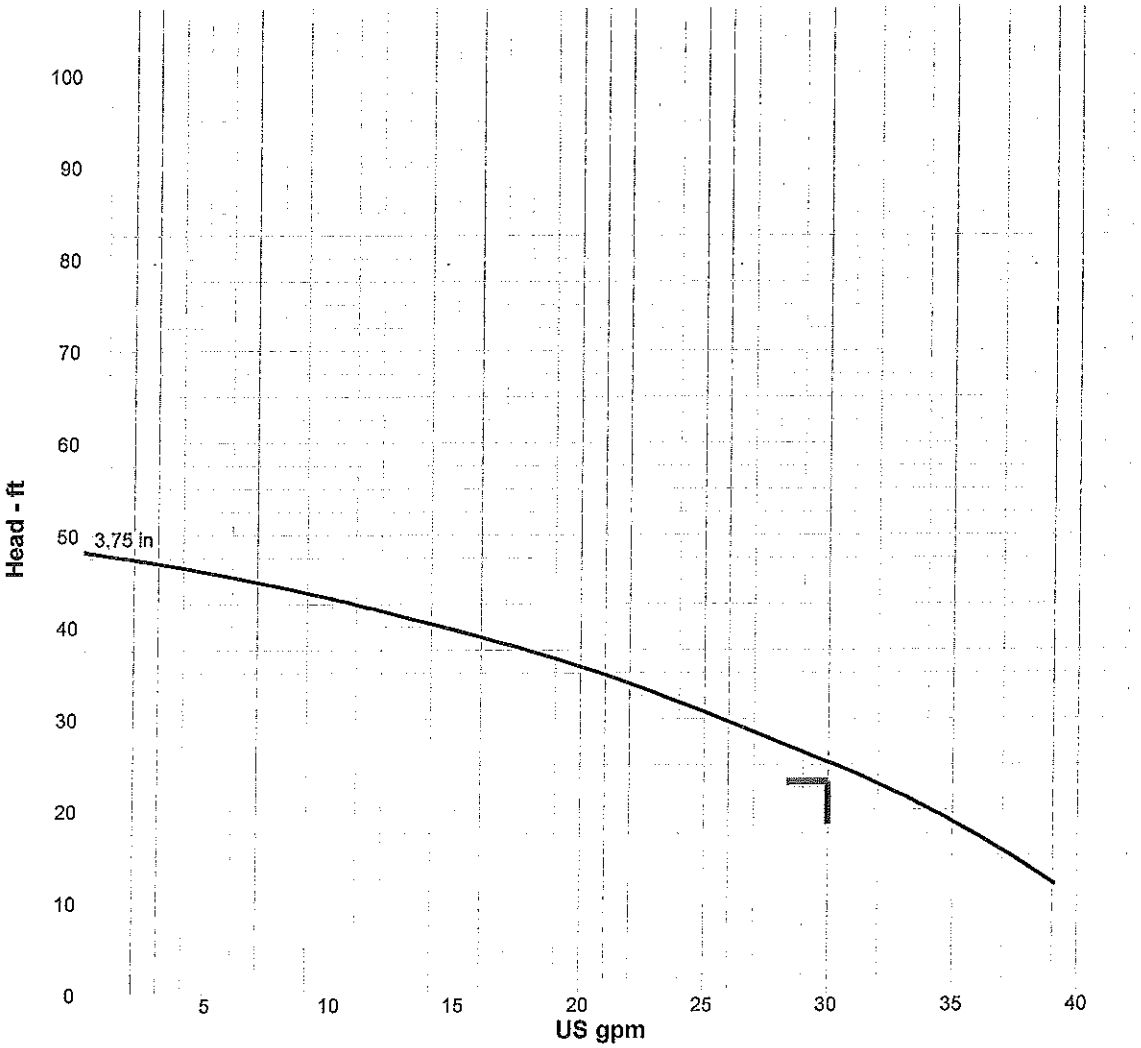
Motor:

Standard: NEMA
Enclosure: TEFC

Size: 2 hp
Speed: 3600
Frame: 145T

Sizing criteria: Max Power on Design Curve

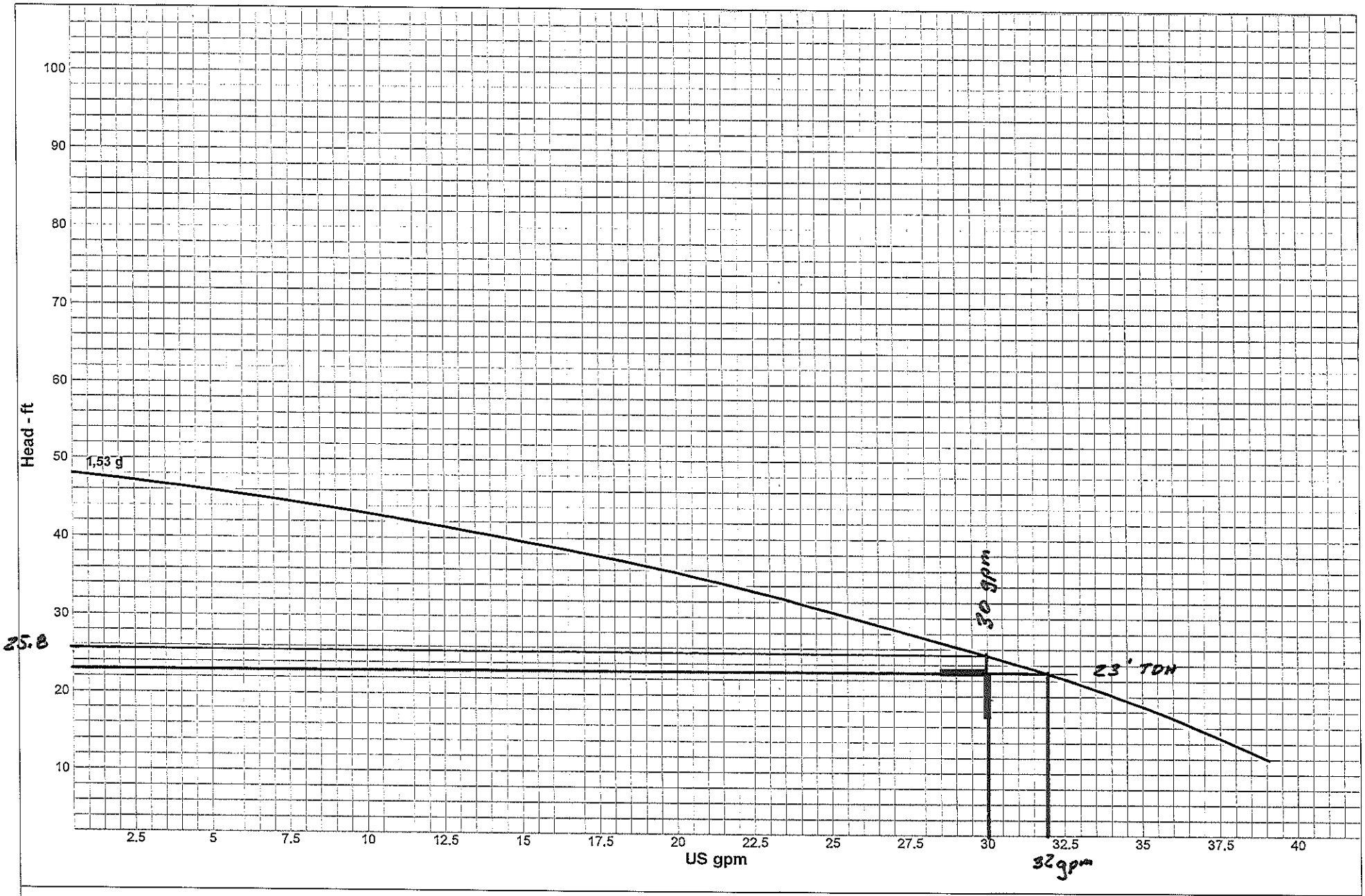
---- Data Point ----	
Flow:	30 US gpm
Head:	25.1 ft
Eff:	n/a
Power:	2 hp
NPSHr:	n/a
---- Design Curve ----	
Shutoff head:	48.2 ft
Shutoff dP:	20.8 psi
Min flow:	---
BEP:	--- %
NOL power:	2 hp @ 2.5 US gpm
-- Max Curve --	
Max power:	2 hp @ 2.5 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
36	3450	17	---	2	---
30	3450	25.1	---	2	---
24	3450	31.6	---	2	---
18	3450	37.1	---	2	---
12	3450	41.7	---	2	---

Selected from catalog: Keen.60, Vers Nov 2009



Company: Carolina Pumpworks, LLC
Name: Scott M. Hale
7/23/2011

Keen Pump Company
Catalog: Keen.60, Vers Nov 2009
Grinder - 3600
Design Point: 30 US gpm, 23 ft

Size: KG2-21, KG2- 23
Speed: 3450 rpm
Dia: 3.75 in

KEEN PUMP