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DATE 9-27-'09 BY Z. Barbee

Corrective Action Plan

Prepared for

Lenoir County Landfill - Permit #54-03
La Grange, Lenoir County, North Carolina

MESCO Project Number: G07062.0

Completed on 2/13/2009
Revised on 4/30/2009

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

OPERATION/CONSTRUCTION MANAGERS

Municipal Services

CIVIL/SANITARY ENGINEERS

Engineering Company, P.A.

September 30, 2009

RECEIVED
SEP 30 2009
SOLID WASTE SECTION

Mr. Zinith Barbee, Permitting Branch
Solid Waste Section
Division of Waste Management
North Carolina Department of Environmental and Natural Resources
401 Oberlin Road, Suite 150
Raleigh, NC 27605

Re: Revised Corrective Action Plan
Lenoir County C&D Permit #54-03

Dear Mr. Barbee:

Please find enclosed one hard copy and one electronic copy of the approved Corrective Action Plan (CAP) report for the Lenoir County C&D Landfill, permit #54-03. Please do not hesitate to contact me should you have any questions regarding either the CAP report or any other aspect of this project.

Sincerely yours,
MUNICIPAL ENGINEERING SERVICES, P.A.

Sean K. Patrick, P.G.
Project Hydrogeologist

attachments

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1 INTRODUCTION

1.1 Site Background

The Lenoir County Sanitary landfill is located on Hodges Farm Road (SR 1524), La Grange, Lenoir County, North Carolina. Lenoir County landfill operates under permit #54-03. Prior to operation as a C&D landfill the site operated as a Municipal Solid Waste (MSW) unlined sanitary landfill. A small area of the MSW, located in the southern portion of the facility stopped receiving waste prior to October 1994 and was closed with a 24 inch soil cover. The remainder of the sanitary landfill was closed prior to October 1998. This unit was closed with an 18-inch cohesive soil cap with a permeability of 1 x 10^{-5} cm/sec, and 18 inches of erosive layer, as part of the *Lenoir Conuty Transition Plan*.[4] The C&D landfill was constructed and is operating on top of the MSW unit. In 1980 S&ME completed a geotechnical investigation of the soils per the City of Kinston's request. Adjacent to the C&D landfill and utilizing the same scale house is the existing Subtitle D MSW landfill, which also operates under permit #54-09. The site is monitored under 15A NCAC 13B.1630. A topographic map showing the location of the site is included as **Plate 1**. A site map showing the layout of the permitted facility is included as **Plate 2**.

1.2 Aquifer Characteristics

The site lies within the Atlantic Coastal Plain physiographic province [2], a region that is characterized by flat or gently undulating topography dissected by drainage features with narrow to moderately sloped sides. Surface drainage flows northwest towards Fredricks Branch*, which flows northeast into Falling Creek and subsequently into the Neuse River. The site is generally bounded by NCSR 1524 on the west, Falling Creek on the east and Fredricks Branch on the north. The existing Subtitle D MSW landfill is adjacent to C&D area.

The lithology below the site consists of a unit of unnamed surficial sediments overlying the Cretaceous-age Peedee Formation. The surficial deposits consist of clayey sand, sandy clay, silty sand, and sand. The Peedee Formation consists of an overlying confining unit of clay, silty clay, and sandy clay approximately 25 feet thick, underlain by a unit of fine to medium sand interbedded with clay and silt. The estimated depth of the Peedee confining layer at the site is 36 feet below ground surface (bgs), based upon boring logs from previous subsurface investigations. Monitoring well MW-11 was completed on top of the Peedee confining layer at an approximate elevation of 39.4 feet above mean sea level (amsl). Assuming a slight dip of the confining layer, monitoring wells MW-9 and MW-12 were also completed close to the confining layer.

---

* The name of the creek was referenced as Fredricks Branch in the *Transition Plan*. The creek is not named on USGS topographic quadrangle maps.

Regionally, Lenoir County is located in the Coastal Plain groundwater region of the United States.[3] The unconfined aquifer at the site consists of unconsolidated silty and clayey sands that are underlain by the Peedee Confining Unit. Groundwater typically occurs at depths of <10 to over 20 feet (bgs), with the shallowest depths occurring in draws and near drainage features. Groundwater depths in the monitoring wells have been generally consistent over time, and have been reported in the following approximate depth ranges:

- ≤ 10 ft. bgs: *MW-3, MW-4, MW-6, MW-9*
- 10 to 20 ft. bgs: *MW-1, MW-6, MW-8, MW-10, MW-11, MW-12*
- > 20 ft. bgs: *MW-8, MW-10*

Historical groundwater elevations are provided in **Table 2**. Groundwater flow dynamics are primarily controlled by the topographical high and local drainage features of Fredricks Branch and Falling Creek. Groundwater flow at the site is in a general east-northeasterly direction. A single-day potentiometric map depicting groundwater flow conditions on July 15, 2008 is provided as **Plate 4**.

Hydraulic conductivity (K) values are summarized in **Table 3**. K values, as determined from slug testing, ranged from 6.55 x 10^{-6} cm/sec (MW-12) to 5.40 x 10^{-4} cm/sec (MW-4), with a geometric mean of 1.32 x 10^{-4} cm/sec. Hydraulic gradient in the area of the closed landfill is relatively and shallow and consistent, with a typical value of 0.009 ft/ft. Average linear groundwater velocities (v_x), also known as *seepage velocities*, were calculated in the *Assessment of Corrective Measures* (ACM) report using the following equation:

$$v_x = \frac{K * i}{n_e}$$

where

v_x is the average linear groundwater velocity ([length/time]

K is the hydraulic conductivity [length/time]

n_e is the effective porosity [unitless]

i is the horizontal hydraulic gradient in the direction of groundwater flow, taken as the difference in head elevation between two points divided by the distance between those points [unitless, or length/length]

The calculated average linear groundwater velocities were found to have a median value of 13.7 ft/yr. [5]

1.3 Contaminant Distribution

Groundwater contamination at the site consists of dissolved-phase volatile organic compounds (VOCs) and inorganic compounds in concentrations exceeding established 15A NCAC 2L groundwater standards (2L Standards). Groundwater contaminants-of-concern (COCs), as identified in the *ACM* and subsequent semi-annual groundwater monitoring reports are 1,1-dichloroethane (1,1-DCA; a VOC), mercury (a toxic heavy metal), and cobalt (a naturally-occurring metal). Historic organic and inorganic results of detected constituents are shown in **Tables 4A & 4B**, respectively. The extent of VOCs at the site is depicted in **Plate 6**. VOC concentrations are greatest in the area near monitoring wells MW-8 and MW-10. Groundwater impact is limited to the unconfined aquifer.

1.4 Site Conceptual Models

Site conceptual and analytical models were developed in the *ACM*. The models consisted of conceptual cross sections and analytical modeling using MODFLOW with MT3D[96]. The conceptual cross sections from the *ACM* are provided as **Plate 5**.

Physical Process

As dissolved-phase constituents in groundwater, all COCs are subject to the physical processes of advection and dispersion. The primary physical mechanism of plume movement is through advection. Advective flow with applied sorption (retardation) typically slows plume migration. The retardation coefficient (R) used to calculate the expected migration rates for the constituents can be calculated from the following equation [7]:

$$R = 1 + \frac{\rho_d}{n} K_d$$

where

- R is the retardation coefficient
- ρ_d is the dry bulk density of the soil (g/cm^3)
- n is the porosity (unitless)
- K_d is the distribution coefficient (mL/g)

The average dry bulk density (ρ_d) presented in the *ACM* report, as calculated from laboratory dry weights determined during the *Phase 1 Design Hydrogeological Study*, was reported as 1.78 g/cm^3. The distribution coefficient (K_d) can be estimated as the constituent-specific soil–water partitioning coefficient (K_{oc}) times the fraction of organic carbon (f_{oc}) in the soil.[1] A conservative value of 1% (0.01) was chosen for soil organic carbon, based on boring logs and field observations An average total porosity value of 37% (0.37) was used based upon the range of 32%-43% determined for laboratory soil samples that was reported in the *ACM* report. Values for the three COCs are presented in the following table.

Table of Retardation Coefficients		
Constituent of Concern	**Distribution Coefficient (K_d)**	**Retardation Coefficient (R)**
1,1-Dichloroethane (1,1-DCA)	0.40 (K_{oc} = 40) [7]	2.92
Mercury	6,310 [8]	30,400
Cobalt	126 [8]	601
Note - values have been re-calculated for this CAP report.		

Since contaminant velocity in groundwater (v_c) is equal to the seepage velocity divided by the retardation coefficient[7], the above table of retardation coefficients suggests that 1,1-DCA has the potential to travel at approximately one-third that of the seepage velocities calculated in the *ACM*. Cobalt is expected to be less mobile, with a travel rate approximately 1/600th that of the calculated seepage velocities. Mercury is expected to be relatively immobile in groundwater.

Chemical/Biochemical Process

The identified COCs consist of chlorinated aliphatic hydrocarbons and metals dissolved in groundwater. Natural bidegradation of chlorinated solvents such as 1,1-DCA occurs primarily through the biochemical process of reductive dechlorination.[7] Reductive dechlorination occurs as the result of microbial activity which progressively removes chlorine atoms from chlorinated hydrocarbons through various oxidation-reduction reactions. Under anaerobic conditions, reductive dechlorination occurs through electron acceptor reactions, with the chlorinated hydrocarbons acting as electron donors rather than as a carbon source for microbial activity. Under aerobic and some anaerobic conditions, reductive dechlorination can occur as a result of electron donor reactions, during which chlorinated hydrocarbons act as both carbon and energy sources for microbial actitivity.

1.5 Regulatory Status

The Lenoir County Landfill operates as a C&D landfill over a MSWLF landfill under permit #54-03. Assessment monitoring is currently performed on a semi-annual basis at the site.

2 CONTAMINANT CHARACTERIZATION

2.1 Contaminants of Concern

The following chemical compounds were identified in the *ACM* as being COCs:

- 1,1-dichloroethane (1,1-DCA) – *chlorinated aliphatic hydrocarbon*
- mercury – *toxic metal*
- cobalt –*heavy metal*

Additionally, the naturally-occurring metal cobalt has been detected in concentrations up to and exceeding the established NCDENR Solid Waste Section Limit (SWSL) of 10 µg/L. Increases in cobalt concentrations were identified as statistically significant during the semi-annual groundwater monitoring events conducted in July 2002, January 2003, July 2003, and January 2004. At the request of the NCDENR Solid Waste Section (SWS), cobalt has been added to the list of COCs.

2.2 Contaminant Source Confirmation

The groundwater contaminant source appears to be the former MSW landfill cell. The mechanism for the presence of this contamination is precipitation that has percolated through the landfill waste, allowing VOCs to partition from solid/liquid phases into a dissolved phase, and that has subsequently migrated downwards to mix with groundwater. To limit water percolation, the MSW unit was closed with an 18 inch cohesive soil cap with a permeability of 1×10^{-5} cm/sec, and 18 inches of erosive layer.

2.3 Source Control Measures

The first unit of the landfill stopped receiving MSW by October 1994 and was closed with a 24-inch thick final soil cover. The second unit was closed with an 18-inch cohesive soil cap with a permeability of 1×10^{-5} cm/sec, and 18 inches of erosive layer. Lenoir County owns and controls an extensive buffer around the waste limit. Northeast of the waste is a borrow site and the facility transfer station. North of the waste limit is a flood plain consisting of unused property owned by Lenoir County. East of the property is the borrow site for the Subtitle D landfill. South of the property, across Hodges Road and upgradient, is private property that is being used for the storage of construction trailers.

A passive gas venting system for methane extraction/collection was installed as part of the *Transition Plan*. The permanent probes were installed in October 1994 and are monitored quarterly. Since landfill gas is a potential contaminant transport mechanism. The existing methane extraction system will continue to be used to passively vent vapor-phase hydrocarbons from the subsurface. Information regarding the methane extraction system, as presented in the *Transition Plan*, is presented in **Appendix C**.

Several institutional control measures have been implemented to restrict and control access to the site and possible contact with contamination. Public access to the site is limited during operation hours. A chain link fence controls vehicle access off Hodges Farm Road. Heavy vegetation and the floodplain limit access from other areas. Access to groundwater at the facility is controlled by locked monitoring wells. Lenoir County owns the majority of the property surrounding the facility.

A receptor survey performed as part of the *Transition Plan* identified three (3) potable water supply wells and one (1) non-potable water supply well located within 2,000 feet of the facility. An updated receptor survey was performed in 2007. Lenoir County has since purchased two of those properties. Connections to the potable water supply wells located on those properties have been removed, and the properties have been demolished or are in the process of being demolished. Municipal water is available to the surrounding area.

The non-potable water supply well is located at the facility, and is used for equipment washing. The well is constructed of 1-inch dia. PVC encased in 3-inch PVC. The depth of the well was reported to be 155 feet bgs with a screened interval from 75-100 feet bgs. These construction details indicate that the on-site non-potable water supply well is screened below the Peedee confining layer, and is cased off from the surficial aquifer. This fact, combined with the low flow rates achievable from wells of this type, indicate that the on-site water supply well would be unable to significantly affect downward migration of groundwater contaminants. There is, therefore, no need to abandon this well as part of any corrective action at the facility.

2.4 Risk Assessment

Risk assessment was performed as part of the *ACM* and assumed direct contact with the identified contamination. Risk assessments were performed assuming children would consume 1 liter of water each day with an exposure duration of 8 years. Dermal exposure risks assumed contact through bathing based on one 15 minute bath per day. Inhalation exposure assumed 12 cubic meters of air per day. Risk assessment is based on worst-case scenario, where exposure is to the maximum observed concentrations and the current concentrations for the COCs. Exposure tables from the *ACM* report are presented as **Tables 7A – 7C**.

2.5 Contaminant Concentrations

2.5.1 Background Concentrations

Groundwater sampling and monitoring has been conducted at the site since 1994. Background water quality data has historically been collected from monitoring well MW-1. Background sampling has detected concentrations of arsenic, beryllium, chromium, cobalt, manganese, lead, and zinc, with only manganese and

lead exceeding 2L Standards. A 2L Standard for cobalt has not been established, although the Solid Waste Section has adopted a Groundwater Protection Standard (GWP) of 70 µg/L in lieu of a 2L Standard. The presence of metals occurring in the background samples, surface water samples, Subtitle D landfill samples, and NURE sediment samples[5, 9] indicate that these metals are naturally occurring and may not represent contamination associated with the landfill. Historical results are shown in **Tables 4A, 4B, & 5**. Current groundwater results (July 2008) are shown in **Table 6**.

2.5.2 Exceedances of Groundwater Quality Standards

Groundwater contaminants that have been found to exceed 2L Standards are 1,1-DCA, 1,2-dichloropropane, benzene, vinyl chloride (chloroethene), *cis*-1,2-dichloroethene, ethylene dichloride, methylene chloride, *p*-dichlorobenzene, tetrachloroethene, and trichloroethene. Mercury was detected in monitoring wells MW-3, MW-4, MW-5, MW-8, MW-10 and MW-12 from the period of 1995 through 2007. Since the presence of mercury cannot be attributed to either natural sources or laboratory error, its presence in groundwater is likely due to the waste stored in the closed landfill. Manganese and lead concentrations in some samples were also found to exceed 2L Standards, and were identified in the *ACM* as occurring naturally. Cobalt has been found to exceed the currently accepted SWSL.

2.5.3 Exceedances of Surfacewater Quality Standards

Laboratory analysis of surfacewater samples have not detected contaminant concentrations in excess of established NCAC 2B surfacewater quality standards (2B Standards). Appendix I VOCs and metal concentrations were not detected above method detection limits during the July 2008 semi-annual sampling event.

2.6 Media of Concern

Groundwater is the primary media of concern at the site since it acts as the primary mechanism of transport for environmental contaminants emanating from the landfill. Dissolved-phase contaminants can potentially be transported via groundwater and discharged to surfacewater.

Landfill gas is a secondary media of concern since it can transport VOCs that have partitioned into the vapor phase, allowing them to re-partition into the dissolved phase into groundwater. A passive horizontal gas venting system for methane extraction/collection was installed as part of the *Transition Plan*.

3 SELECTED AND APPROVED REMEDY / TECHNICAL APPROACH

A number of factors influenced selection of remediation alternatives.

- Groundwater contamination exists within the surficial (unconfined) aquifer.
- Groundwater contamination exists within the relevant zone of compliance.
- Groundwater contamination exists at relatively low levels (ppb range).
- Groundwater contamination is below risk exposure levels.
- Mercury, one identified COC, was determined in the *ACM* to be relatively immobile in groundwater.
- No active potable wells have been identified within 2,000 feet of the waste limit.
- The on-site non-potable water supply well is screened below the Peedee confining layer and cased off from the surficial aquifer.

The relatively low levels of groundwater contamination, the biodegradability of 1,1-DCA, and the relative immobility of mercury and cobalt indicate that aggressive remedial technologies discussed in the *ACM* (e.g. air sparging, vapor extraction, pump-and-treat), although effective for VOC remediation, are ineffective for metals remediation, and would therefore be unsuitable for implementation.

3.1 Technical Approach – Monitored Natural Attenuation

Groundwater contamination exists within the unconfined, shallow aquifer. Natural attenuation mechanisms are actively controlling groundwater contaminant movement in this area. Since contaminant modeling results indicate limited plume movement over a 50-year period, monitored natural attenuation (MNA) has been chosen as a cost-effective remedial strategy. Modeling results from the *ACM* report are presented in **Appendix A**.

Groundwater sampling will continue to be performed semi-annually on all monitoring wells currently included in the sampling schedule. Additionally, baseline sampling for the full suite of MNA performance parameters listed in **Section 4** and **Appendix B** shall be performed for two years following initiation of the remedial strategy. Monitoring of stream quality in the adjacent surface waters will be achieved through sampling at sampling points SW-1 and SW-2 (see **Plate 3**, and **Appendix B, Plate B**). Surfacewater sampling parameters will include Appendix I VOCs and metals.

4 GROUNDWATER AND SURFACEWATER MONITORING PLAN

4.1 Groundwater Sampling and Monitoring

Data with which to monitor and evaluate the performance of remediation shall be obtained through a groundwater sampling and monitoring program. Semi-annual groundwater sampling will continue to be performed on the following wells: MW-1, MW-3, MW-4, MW-6, MW-9, MW-11, and MW-12. All groundwater samples collected from the monitoring wells will be analyzed for Appendix I VOC concentrations by EPA method 8260, and EPA method 6010 (or 7040) for mercury, and compared with the existing 2L Standards. Additionally, the following MNA performance parameters will be analyzed for an initial two-year period for following initiation of corrective action:

MNA Performance Parameters		
Parameter	**Analysis Type**	**Analytical Method**
Dissolved Oxygen (DO)	Field Reading	Multi-parameter Field Instrument w/ flow-through cell
pH	Field Reading	
Oxidation-Reduction Potential (ORP)	Field Reading	
Turbidity	Field Reading	
Conductivity	Field Reading	
Temperature	Field Reading	
Dissolved CO_2	Field Reading	Field Instrument / Hach Kit
Alkalinity (Total as $CaCO_3$)*	Laboratory/Field*	EPA 310.2
Chloride*	Laboratory/Field*	SM 4500-CLB
Iron	Laboratory	SM3111B
Nitrate*	Laboratory/Field*	EPA 353.2 / SM 2320B
Sulfate*	Laboratory/Field*	EPA 375.4 / SM 4500-SO4E
Sulfide*	Laboratory/Field*	EPA 376.1 or SM 4500SE
TOC/BOD/COD	Laboratory	EPA 415.1 / EPA 405.1 / EPA 410.1
Methane	Laboratory	RSK 175
Ethane, Ethene	Laboratory	RSK 175
Hydrogen	Laboratory	AM19GA
Volatile Fatty Acids	Laboratory	AM23G
*For budgetary considerations these analyses may be performed in the field using Hach® brand color wheel test kits. Historical iron concentrations have exceeded Hach kit quantitation limits.		

4.2 Surfacewater Sampling and Monitoring

Surfacewater sampling will be conducted to monitor COC concentrations in the adjacent stream areas. To date (January 2009) COC concentrations have been below NCAC 2B standards. Surfacewater sampling point locations are depicted in **Plate 2**. Surfacewater sampling point SW-1 is located downstream of the landfill, and sampling point SW-2 is located upstream of the landfill, along Fredericks Branch. All surfacewater samples will be analyzed for Appendix I VOC and metals concentrations by EPA methods 8260 and 6010, respectively, and compared with the existing 2B Standards. The complete *Ground and Surfacewater Sampling and Analysis Plan* is presented as **Appendix B**.

5 EVALUATION OF EFFECTIVENESS AND REPORT SUBMITTALS

5.1 Evaluation of Effectiveness

As remediation progresses at the site certain changes in the physical and chemical characteristics of the contaminant plumes should occur. In all areas contaminant concentrations are expected to decrease over the period of remediation, thus resulting in a decrease in the physical extent of the plume. The various methods for evaluating the effectiveness are discussed in the sections below.

5.1.1 Qualitative and Quantitative Evaluation

Qualitative Evaluation

Qualitative methods include graphical analysis of groundwater analytical data over time to visualize changing trends in groundwater chemistry that are expected to occur over time as a result of the various remedial mechanisms/processes occurring at the site (e.g. biodegradation, phytoremediation, HRC injection, etc.). Examples of graphical analyses that will be used include, but are not be limited to, time-series graphs of contaminant concentrations and groundwater levels, distance-concentration graphs of analytical data, and mapping of the contaminant plumes over time. Specific biodegradation plume parameters (e.g. point attenuation rate, bulk attenuation rate, biodegradation rate) will be determined for the individual plume areas.

Quantitative Evaluation

Quantitative evaluation will be conducted through revised MODFLOW modeling and through analysis of groundwater analytical data using statistical tests for significance. Statistical significance tests can be grouped into two types, *inter-well* and *intra-well*. *Inter-well* methods determine statistical significance by examining trends in contaminant concentrations from performance wells with respect to those from background wells, which are used as a control group. As remediation progresses, the performance well data is expected to exhibit decreases in contaminant concentrations, while contaminant concentrations in the background wells are

expected to remain relatively stable. Background wells are selected on the basis of location (typically upgradient) and analytical history (non-impacted wells are best). *Intra-well* methods determine statistical significance within individual performance wells by examining historical analytical results (time series) for a given well, thus indicating if changing contaminant concentrations at a given well location result from either remedial activity or natural fluctuation. Comparisons of background well data with sentinel and compliance well data will also be performed to monitor groundwater contaminant movement over time.

Various types of significance tests have been developed to analyze differing types of data populations based upon characteristics such as distribution type (normal vs. non-normal), trend type (changing vs. non-changing), percentage of "non-detect" results for a given population, and the sample population size. This allows for the selection of particular methods that are appropriate for a given situation. For the remedial activity at the subject facility the following statistical tests are proposed for use, although others may be used as the course of remediation progresses:

- Wilcoxon Rank-Sum (Inter-well) - *normal or non-normal data, invariant trends, < 90% non-detects, >3 samples/per well.*
- Parametric Prediction Limit (Inter-well) – *normal data, varying trends,< 15% non-detects.*
- Parametric Prediction Limit (Intra-well) – *normal data, varying trends,≥ 4 samples/well, < 15% non-detects.*
- Non-Parametric Prediction Limit (Inter-Well & Intra-Well) – *normal or non-normal data, can tolerate high percentage of non-detects, compares recent to historical data.*

As indicated by the above list, it is important to note that prior to conducting any test of statistical significance a baseline of analytical data must first be established. For the MNA parameters listed in **Section 4.0** this baseline will consist of the four (4) semi-annual sampling events mentioned previously. *Since some plume areas do not have upgradient wells that are suitable for use as background wells, non-impacted compliance wells may be used if necessary for inter-well statistical analyses.*

5.1.2 Evaluation of MNA

Monitoring well MW-1 will continue to be used as a background well for inter-well statistical analysis of MNA data. The remaining monitoring wells will be used as performance and compliance wells.

5.2 Refining the Site Conceptual Model

Over the course of corrective action the site conceptual model may be refined, if necessary, in order to determine the appropriate course of remediation. New and/or additional information on groundwater chemistry, site lithology, plume characteristics, etc. will be used to further improve understanding of

contaminant fate and transport at the site, and to determine any changes to the approved remedial measures if necessary.

5.3 Report Submittals

Remediation Status Reports will be submitted on a semi-annual basis, within 30 days of receiving all complete laboratory analytical reports. An *Initial Status Report* will be submitted upon implementation of the selected remedial approach, and will detail all activities performed to initiate corrective action. All reports submitted shall include complete laboratory analytical reports, data tables, contaminant concentration trend graphs, groundwater flow maps, contaminant plume maps, and cross-sections, as per NCDENR-SWS guidelines.

6 CONTINGENCY PLAN

6.1 Contingency Plan

Should the selected remedial approach not perform as expected and/or the constituent concentrations do not decrease, a contingency plan will be needed. One remedial technology that could potentially supplement MNA of VOC and metals concentrations is phytoremediation. Phytoremediation occurs through several processes including the release of enzymes from the root system that break down hydrocarbons (phytodegradation), increasing evapotranspiration to limit plume migration (phytostabilization), and uptake of hydrocarbons and metals (phytoextraction). To accelerate the natural evapotranspiration process and to allow for hydraulic containment (plume control), the proposed area would be planted with hybrid willows of the genus *Salix*. Hybrid willows have been recognized as being phreatophytic (water-loving) trees with root systems that can extend up to 40 feet bgs. Available literature (e.g. Schnoor, 1997 [6]) indicates an initial planting density of 1,000-2,000 trees/acre (~43 ft^2/tree). As the trees become established over time (1-2 years) competition between plants will reduce this density to ~600-800 trees/acre. The plume area over which phytoremediation would be implemented comprises approximately 1.4 acres. At the aforementioned planting density a minimum of 1,400 hybrid willow seedlings would need to be planted at the onset of corrective action. Planting of seedlings would likely be performed by mechanical methods to reduce installation costs, and would occur during the spring. Protective fencing to prevent damage to the seedlings by wildlife (e.g. deer) would be constructed around the area of planting. *It must be noted that the proposed contingency plan is subject to change depending on future site and environmental conditions. The proposed phytoremediation area would be determined after the decision to implement the contingency plan is made, and would roughly correspond to the footprint of the dissolved-phase plume as determined through subsequent groundwater sampling and monitoring events.*

6.2 Safeguard Measures and Site Security

Exposure pathways are limited to onsite contact with groundwater. Monitoring wells are cased and secured with locking well caps. Access to the site is limited during operational hours. Heavy vegetation limits access from other areas. Lenoir County owns the majority of the property surrounding the facility. Public water is available to the surrounding area. A passive horizontal gas venting system for methane extraction/collection was installed as part of the *Transition Plan*. [4]

Prior to the facility becoming a C&D landfill, the western unit of the sanitary landfill was closed with a 24-inch cohesive soil cap and vegetative cover. The vegetative cover acts as an erosion control measure and also aides in the evapotranspiration process to reduce infiltration. As with the western unit, side slopes of the eastern unit were closed with a 24 inch soil cap and vegetative cover. The top of the eastern unit was closed with an 18-inch thick cohesive soil cap with a permeability of 1×10^{-5} cm/sec, and 18 inches of erosive layer. Surfacewater is diverted from the landfill and is not impounded on the landfill property.

6.3 Revisions

Requests for modification of the approved corrective action and implementation schedule will be submitted in writing to the Solid Waste Section. No actions regarding modification will be implemented until written approval is received from the Division of Waste Management.

7 SCHEDULE AND MAINTENANCE

7.1 Operations & Maintenance

Apart from semi-annual sampling, monitoring, and reporting, the implementation of MNA will not require additional operation or maintenance procedures. Lenoir County landfill personnel will continue to oversee the operation, maintenance, and monitoring of the gas extraction and collection system. The Lenoir Department of Solid Waste can be contacted at (252) 566-4194 regarding daily activities.

7.2 Timeline

Implementation of corrective action will begin within 30 days of CAP approval. The MNA performance parameter baseline will be established during the July 2009 semi-annual sampling event. A timeline estimate for sampling events and performance evaluation is presented in **Table 8**.

8 FINANCIAL ASSURANCE REQUIREMENTS

In general accordance with 15A NCAC 13B .0546, demonstration of financial assurance was achieved through the local government financial test. Semi-annual sampling and monitoring activities, analysis, data interpretation, and semi-annual compliance reporting will be performed by MESCO. A breakdown of estimated costs for the implementation of MNA over a 5-year period, is as follows:

Laboratory Analyses –
Est. cost of MNA groundwater sample = $750/sample
Total annual est. MNA sample costs = 14 (7 monitoring wells sampled twice yearly) = $10,500/year
Est. cost of surfacewater sample = $230/sample
Total annual surfacewater sample costs = 4 (2 sampling points sampled twice yearly) = $920/year

Labor-
Est. cost per semi-annual event = $2,000
Total annual est. cost of labor = $4,000/year

Compliance Reporting-
Est. semi-annual monitoring report preparation & review - $2,500
Total annual est. cost of reporting = $5,000/year

Estimated Annual Costs - $20,420
Estimated Total Costs (5 years) – $102,100

9 COMPLETENESS OF CORRECTIVE ACTION

Results indicate that reduction of the low level contamination can be achieved through monitored natural attenuation. There is no indication that the contamination would reach the relative point of compliance within a reasonable time period. Institutional controls limit access to the site. The source area has been capped to limit infiltration. There is no need to abandon the on-site non-potable water supply well as part of any corrective action at the facility. In order to determine if the observed cobalt, lead and other metals exceedances in groundwater are the result of source material leaching or are naturally-occurring, an Alternate Source Demonstration may be necessary.

Respectfully submitted,

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

NORTH CAROLINA LICENSED SEAL 1711 GEOLOGIST STATE OF NORTH CAROLINA

Mark Brown, PG
Senior Geologist

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TABLES

Table 1: Well Construction Details

Monitoring Well	Date Installed	Ground Elevation	Top-of-Casing Elevation	Northing	Easting	Well Diameter	Boring Diameter	Screen Interval	Confining Layer	Status
MW-1	10/07/1980	100.17	98.34	563561.0457	2384799.9038	2"	8"	?-39.29	-	Sampling Plan
MW-2	10/08/1980	-	-	-	-	2"	8"	?-39	-	Not Sampled
MW-3	09/26/1991	60.71	63.87	565738.7089	2385774.3624	2"	8"	2-12	-	Sampling Plan
MW-4	09/25/1991	65.86	68.03	565054.2711	2385971.0500	2"	8"	5-15	-	Sampling Plan
MW-5	05/27/1992	83.97	86.15	564380.6554	2383976.4624	2"	8"	7-17	-	Abandoned
MW-6	Unknown	84.93	85.56	564443.4953	2383917.3666	2"	8"	-	-	Sampling Plan
MW-8	08/24/1994	85.39	88.29	565306.5563	2384693.6083	2"	8"	16.5-31.5	-	Not Sampled
MW-9	08/24/1994	56.55	62.40	566503.8677	2385215.4900	2"	8"	4.8-19.8	-	Sampling Plan
MW-10	08/24/1994	84.04	87.15	565578.3870	2384939.7968	2"	8"	16.5-31.5	-	Not Sampled
MW-11	03/31/1999	75.36	78.26	565406.8257	2384608.2924	2"	8"	26-36	-	Sampling Plan
MW-12	03/31/1999	74.65	77.46	565826.7160	2384981.6568	2"	8"	25-35	36.4	Sampling Plan

NOTE:
1. Ground and datum elevations in of feet below ground surface
2. Well and boring diameter in inches.

Table 2: Historical Groundwater Elevation Data

WELL	9/9/1994	10/28/1994	1/6/1995	2/24/1995	7/17/1995	1/23/1996	7/25/1996	1/14/1997	7/11/1997	1/21/1998	7/27/1998	1/6/1999
MW-1	80.10	79.34	78.29	79.59	83.86	81.42	81.83	85.79	83.72	81.15	84.35	81.46
MW-3	57.34	57.56	58.12	59.35	58.25	59.20	58.97	59.24	57.51	59.91	57.50	59.58
MW-4	61.50	62.00	62.22	63.92	62.77	63.72	63.30	64.00	61.21	64.63	61.17	64.33
MW-5	-	74.56	73.77	75.21	78.72	76.51	77.00	79.71	77.55	76.84	-	-
MW-6	-	-	-	-	-	-	-	-	-	-	76.04	75.30
MW-8	69.17	68.96	68.44	70.09	70.24	68.36	68.70	69.23	68.40	68.54	68.78	68.43
MW-9	56.11	56.44	56.58	57.05	56.69	56.87	56.84	57.03	56.35	57.29	56.67	57.11
MW-10	65.49	65.39	64.73	66.51	68.51	65.46	66.28	66.16	64.88	64.54	65.39	64.20
MW-11	-	-	-	-	-	-	-	-	-	-	-	-
MW-12	-	-	-	-	-	-	-	-	-	-	-	-

WELL	6/29/1999	1/27/2000	2/23/2000	7/17/2000	1/24/2001	7/11/2001	1/10/2002	7/8/2002	1/22/2003	7/7/2003	1/22/2004	7/12/2004
MW-1	83.63	84.95	-	83.84	82.57	83.46	80.54	81.19	79.91	85.34	84.66	84.91
MW-3	58.29	59.89	-	57.22	58.53	57.55	58.87	56.72	58.32	58.95	58.72	58.99
MW-4	62.81	64.38	-	61.52	62.08	61.56	63.68	59.63	62.21	63.31	62.55	63.44
MW-5	-	-	-	-	-	-	-	-	-	-	-	-
MW-6	75.95	77.10	-	75.28	73.97	76.13	73.34	73.22	72.46	77.65	77.01	77.84
MW-8	68.39	68.70	-	68.29	67.84	68.02	66.96	-	-	-	-	-
MW-9	56.86	57.29	-	56.60	57.25	57.40	57.47	56.40	57.32	57.62	57.30	57.41
MW-10	64.47	65.01	-	64.50	64.05	64.15	64.15	-	-	-	-	-
MW-11	-	-	67.08	65.75	65.56	65.70	64.95	64.55	65.05	66.37	65.96	66.99
MW-12	-	-	62.89	61.52	61.58	61.74	61.12	60.50	61.16	62.66	61.18	62.75

WELL	1/26/2005	7/14/2005	1/25/2006	7/13/2006	1/17/2007	7/31/2007	1/23/2008	7/15/2008	Observed High	Observed Low	Difference	Average
MW-1	82.31	82.01	82.21	81.34	84.78	82.11	79.32	82.21	85.79	78.29	7.50	82.45
MW-3	58.92	56.80	60.08	54.44	59.05	57.76	58.85	55.93	60.08	54.44	5.64	58.35
MW-4	62.93	60.76	64.58	58.53	63.25	62.16	62.78	59.05	64.63	58.53	6.10	62.57
MW-5	-	-	-	-	-	-	-	-	79.71	73.77	5.94	76.65
MW-6	75.18	73.91	74.99	71.73	76.78	74.38	72.27	72.29	77.84	71.73	6.11	75.21
MW-8	-	-	-	-	-	-	-	-	70.24	66.96	3.28	68.64
MW-9	57.24	56.57	57.45	53.79	57.45	56.95	57.07	55.61	57.62	53.79	3.83	56.87
MW-10	-	-	-	-	-	-	-	-	68.51	64.05	4.46	65.22
MW-11	65.85	65.09	66.47	62.23	66.68	64.90	64.70	64.15	67.08	62.23	4.85	65.62
MW-12	61.88	61.09	62.49	58.23	62.93	61.85	61.03	60.21	67.08	58.23	8.85	64.31

Table 3: Summary of Slug Test Results

Well	Screen Interval (BGS)	Initial DTW (BTOC)	Initial Head Change	K (cm/sec)	Lithology
MW-1*	Unknown	18.87	18.87	4.30E-04	Silty Sand
MW-3*	2-12	7.49	4.49	1.30E-04	Silty Sand
MW-4*	5-15	8.79	8.79	5.40E-04	Silty Sand
MW-5*	7-17	11.27	8.27	5.30E-04	Silty Sand
MW-8*	16.5-31.5	19.25	9.25	2.20E-04	Sandy Clay
MW-9*	4.8-19.8	7.56	7.56	3.80E-04	Sandy Clay
MW-10*	16.5-31.5	22.15	7.15	6.90E-05	Clayey Sand
MW-11#	26-36	12.02	3.38	2.07E-05	Sand
MW-12#	25-35	15.46	2.84	6.55E-06	Sand

Summary Statistics			
Geometric Mean (GM)	1.32E-04	Maximum	5.40E-04
Geo. Std. Deviation (σ_{GSD})	4.78	Minimum	6.55E-06
GM / GSD ($-1\sigma_{GSD}$)	2.77E-05	Median	2.20E-04
GM * GSD ($+1\sigma_{GSD}$)	6.33E-04	Count	9

Notes: BGS = Below Ground Surface
BTOC = Below Top-of-Casing

* Information obtained from GAI Consultants, Inc, 1996, Responses to Review Comments Lenoir County Landfill Permit #54-03 LaGrange, North Carolina

Information provided to NCDENR from MESCO on June 25, 1999.

Table 4A: Historical Organic Groundwater Results

Well ID	Parameter Name [1]	Sample Date	Result	Unit	PQL [2]	NCGW2L [3]	Exceedance
MW-10	**1,1-Dichloroethane**	**09/09/1994**	**103**	**ug/l**	**5**	**70**	**33**
MW-10	**1,1-Dichloroethane**	**10/28/1994**	**77**	**ug/l**	**5**	**70**	**7**
MW-10	**1,1-Dichloroethane**	**01/06/1995**	**94**	**ug/l**	**5**	**70**	**24**
MW-10	**1,1-Dichloroethane**	**02/24/1995**	**90**	**ug/l**	**5**	**70**	**20**
MW-10	**1,1-Dichloroethane**	**07/17/1995**	**106**	**ug/l**	**5**	**70**	**36**
MW-10	**1,1-Dichloroethane**	**01/23/1996**	**96**	**ug/l**	**5**	**70**	**26**
MW-10	1,1-Dichloroethane	07/25/1996	69	ug/l	5	70	
MW-10	**1,1-Dichloroethane**	**01/14/1997**	**96**	**ug/l**	**5**	**70**	**26**
MW-10	**1,1-Dichloroethane**	**08/22/1997**	**76**	**ug/l**	**5**	**70**	**6**
MW-10	1,1-Dichloroethane	07/27/1998	18	ug/l	5	70	
MW-10	1,1-Dichloroethane	01/06/1999	19	ug/l	5	70	
MW-10	1,1-Dichloroethane	06/29/1999	19	ug/l	5	70	
MW-10	1,1-Dichloroethane	07/17/2000	23	ug/l	5	70	
MW-10	1,1-Dichloroethane	01/24/2001	28	ug/l	5	70	
MW-10	1,1-Dichloroethane	07/11/2001	44	ug/l	5	70	
MW-10	1,1-Dichloroethane	01/10/2002	31	ug/l	5	70	
MW-3	1,1-Dichloroethane	08/22/1997	6	ug/l	5	70	
MW-3	1,1-Dichloroethane	07/11/2001	12	ug/l	5	70	
MW-3	1,1-Dichloroethane	01/10/2002	9.1	ug/l	5	70	
MW-3	1,1-Dichloroethane	07/14/2005	8.7	ug/l	5	70	
MW-3	1,1-Dichloroethane	07/13/2006	6.8	ug/l	5	70	
MW-4	1,1-Dichloroethane	01/21/1998	6.2	ug/l	5	70	
MW-4	1,1-Dichloroethane	07/17/2000	7.3	ug/l	5	70	
MW-5	1,1-Dichloroethane	01/06/1995	10	ug/l	5	70	
MW-5	1,1-Dichloroethane	07/17/1995	18	ug/l	5	70	
MW-5	1,1-Dichloroethane	01/23/1996	6	ug/l	5	70	
MW-5	1,1-Dichloroethane	01/14/1997	6	ug/l	5	70	
MW-7	1,1-Dichloroethane	01/23/1996	5	ug/l	5	70	
MW-7	1,1-Dichloroethane	08/22/1997	12	ug/l	5	70	
MW-8	**1,1-Dichloroethane**	**09/09/1994**	**107**	**ug/l**	**5**	**70**	**37**
MW-8	**1,1-Dichloroethane**	**10/28/1994**	**73**	**ug/l**	**5**	**70**	**3**
MW-8	**1,1-Dichloroethane**	**01/06/1995**	**73**	**ug/l**	**5**	**70**	**3**
MW-8	**1,1-Dichloroethane**	**02/24/1995**	**89**	**ug/l**	**5**	**70**	**19**
MW-8	1,1-Dichloroethane	07/17/1995	41	ug/l	5	70	
MW-8	1,1-Dichloroethane	01/23/1996	59	ug/l	5	70	
MW-8	1,1-Dichloroethane	07/25/1996	50	ug/l	5	70	
MW-8	1,1-Dichloroethane	01/14/1997	47	ug/l	5	70	
MW-8	1,1-Dichloroethane	08/22/1997	54	ug/l	5	70	
MW-8	1,1-Dichloroethane	01/21/1998	52	ug/l	5	70	
MW-8	1,1-Dichloroethane	07/27/1998	25	ug/l	5	70	
MW-8	1,1-Dichloroethane	01/06/1999	26	ug/l	5	70	
MW-8	1,1-Dichloroethane	06/29/1999	20	ug/l	5	70	
MW-8	1,1-Dichloroethane	01/27/2000	9.6	ug/l	5	70	
MW-8	1,1-Dichloroethane	07/17/2000	12	ug/l	5	70	
MW-8	1,1-Dichloroethane	01/24/2001	9.2	ug/l	5	70	
MW-8	1,1-Dichloroethane	07/11/2001	14	ug/l	5	70	

Table 4A: Historical Organic Groundwater Results

Well ID	Parameter Name [1]	Sample Date	Result	Unit	PQL [2]	NCGW2L [3]	Exceedance
MW-8	1,1-Dichloroethane	01/10/2002	13	ug/l	5	70	
MW-10	1,1,2-Trichloroethane	07/17/1995	12	ug/l	5		
MW-8	1,1,2,2-Tetrachloroethane	01/27/2000	18	ug/l	5		
MW-8	**1,2-Dichloropropane**	**01/23/1996**	**5**	**ug/l**	**5**	**0.51**	**4.49**
MW-10	1,3-Dichlorobenzene	06/29/1999	5.1	ug/l	5	170	
MW-8	1,3-Dichlorobenzene	06/29/1999	14	ug/l	5	170	
MW-10	**Benzene**	**01/06/1995**	**7**	**ug/l**	**5**	**1**	**6**
MW-10	**Benzene**	**02/24/1995**	**6**	**ug/l**	**5**	**1**	**5**
MW-10	**Benzene**	**07/17/1995**	**65**	**ug/l**	**5**	**1**	**64**
MW-10	**Benzene**	**01/23/1996**	**6**	**ug/l**	**5**	**1**	**5**
MW-10	**Benzene**	**07/25/1996**	**6**	**ug/l**	**5**	**1**	**5**
MW-10	**Benzene**	**01/14/1997**	**6**	**ug/l**	**5**	**1**	**5**
MW-10	**Benzene**	**08/22/1997**	**8**	**ug/l**	**5**	**1**	**7**
MW-10	**Benzene**	**01/21/1998**	**6.1**	**ug/l**	**5**	**1**	**5.1**
MW-10	**Benzene**	**06/29/1999**	**5.8**	**ug/l**	**5**	**1**	**4.8**
MW-10	**Benzene**	**07/17/2000**	**5.9**	**ug/l**	**5**	**1**	**4.9**
MW-10	**Benzene**	**01/24/2001**	**6**	**ug/l**	**5**	**1**	**5**
MW-10	**Benzene**	**07/11/2001**	**6.6**	**ug/l**	**5**	**1**	**5.6**
MW-10	**Benzene**	**01/10/2002**	**6.2**	**ug/l**	**5**	**1**	**5.2**
MW-8	**Benzene**	**09/09/1994**	**10**	**ug/l**	**5**	**1**	**9**
MW-8	**Benzene**	**01/06/1995**	**6**	**ug/l**	**5**	**1**	**5**
MW-8	**Benzene**	**02/24/1995**	**6**	**ug/l**	**5**	**1**	**5**
MW-8	**Benzene**	**07/25/1996**	**6**	**ug/l**	**5**	**1**	**5**
MW-8	**Benzene**	**01/14/1997**	**8**	**ug/l**	**5**	**1**	**7**
MW-8	**Benzene**	**08/22/1997**	**10**	**ug/l**	**5**	**1**	**9**
MW-8	**Benzene**	**01/21/1998**	**10**	**ug/l**	**5**	**1**	**9**
MW-8	**Benzene**	**07/27/1998**	**6.9**	**ug/l**	**5**	**1**	**5.9**
MW-8	**Benzene**	**01/06/1999**	**8.9**	**ug/l**	**5**	**1**	**7.9**
MW-8	**Benzene**	**06/29/1999**	**10.3**	**ug/l**	**5**	**1**	**9.3**
MW-8	**Benzene**	**01/27/2000**	**8.8**	**ug/l**	**5**	**1**	**7.8**
MW-8	**Benzene**	**07/17/2000**	**7.4**	**ug/l**	**5**	**1**	**6.4**
MW-8	**Benzene**	**01/24/2001**	**6.1**	**ug/l**	**5**	**1**	**5.1**
MW-8	**Benzene**	**07/11/2001**	**8.1**	**ug/l**	**5**	**1**	**7.1**
MW-8	**Benzene**	**01/10/2002**	**7.6**	**ug/l**	**5**	**1**	**6.6**
MW-1	Bis(2-ethylhexyl)phthalate	07/11/2001	43	ug/l	20		
MW-12	Bis(2-ethylhexyl)phthalate	07/17/2000	36	ug/l	20		
MW-8	Chlorobenzene	09/09/1994	15	ug/l	5	50	
MW-8	Chlorobenzene	02/24/1995	8	ug/l	5	50	
MW-8	Chlorobenzene	01/23/1996	13	ug/l	5	50	
MW-8	Chlorobenzene	01/14/1997	23	ug/l	5	50	
MW-8	Chlorobenzene	08/22/1997	25	ug/l	5	50	
MW-8	Chlorobenzene	01/21/1998	28	ug/l	5	50	
MW-8	Chlorobenzene	07/27/1998	20	ug/l	5	50	
MW-8	Chlorobenzene	01/06/1999	19	ug/l	5	50	
MW-8	Chlorobenzene	06/29/1999	23	ug/l	5	50	
MW-8	Chlorobenzene	07/17/2000	17	ug/l	5	50	

Table 4A: Historical Organic Groundwater Results

Well ID	Parameter Name [1]	Sample Date	Result	Unit	PQL [2]	NCGW2L [3]	Exceedance
MW-8	Chlorobenzene	01/24/2001	19	ug/l	5	50	
MW-8	Chlorobenzene	07/11/2001	15	ug/l	5	50	
MW-8	Chlorobenzene	01/10/2002	8.4	ug/l	5	50	
MW-10	Chloroethane	09/09/1994	18	ug/l	10		
MW-10	Chloroethane	10/28/1994	16	ug/l	10		
MW-10	Chloroethane	01/06/1995	18	ug/l	10		
MW-10	Chloroethane	02/24/1995	12	ug/l	10		
MW-10	Chloroethane	07/17/1995	11	ug/l	10		
MW-10	Chloroethane	01/23/1996	13	ug/l	10		
MW-10	Chloroethane	07/25/1996	10	ug/l	10		
MW-10	Chloroethane	01/14/1997	13	ug/l	10		
MW-8	Chloroethane	09/09/1994	14	ug/l	10		
MW-8	Chloroethane	10/28/1994	11	ug/l	10		
MW-8	Chloroethane	01/06/1995	10	ug/l	10		
MW-8	Chloroethane	07/25/1996	10	ug/l	10		
MW-10	**Chloroethene**	**09/09/1994**	**24**	**ug/l**	**10**	**0.015**	**23.985**
MW-10	**Chloroethene**	**10/28/1994**	**28**	**ug/l**	**10**	**0.015**	**27.985**
MW-10	**Chloroethene**	**07/17/1995**	**28**	**ug/l**	**10**	**0.015**	**27.985**
MW-10	**Chloroethene**	**01/23/1996**	**57**	**ug/l**	**10**	**0.015**	**56.985**
MW-10	**Chloroethene**	**07/25/1996**	**36**	**ug/l**	**10**	**0.015**	**35.985**
MW-10	**Chloroethene**	**01/14/1997**	**57**	**ug/l**	**10**	**0.015**	**56.985**
MW-10	**Chloroethene**	**08/22/1997**	**37**	**ug/l**	**10**	**0.015**	**36.985**
MW-10	**Chloroethene**	**01/21/1998**	**43**	**ug/l**	**10**	**0.015**	**42.985**
MW-10	**Chloroethene**	**07/27/1998**	**23**	**ug/l**	**10**	**0.015**	**22.985**
MW-10	**Chloroethene**	**01/06/1999**	**25**	**ug/l**	**10**	**0.015**	**24.985**
MW-10	**Chloroethene**	**06/29/1999**	**30**	**ug/l**	**10**	**0.015**	**29.985**
MW-10	**Chloroethene**	**07/17/2000**	**48**	**ug/l**	**10**	**0.015**	**47.985**
MW-10	**Chloroethene**	**01/24/2001**	**44**	**ug/l**	**10**	**0.015**	**43.985**
MW-10	**Chloroethene**	**07/11/2001**	**38**	**ug/l**	**10**	**0.015**	**37.985**
MW-10	**Chloroethene**	**01/10/2002**	**40**	**ug/l**	**10**	**0.015**	**39.985**
MW-5	**Chloroethene**	**07/17/1995**	**27**	**ug/l**	**10**	**0.015**	**26.985**
MW-5	**Chloroethene**	**01/23/1996**	**33**	**ug/l**	**10**	**0.015**	**32.985**
MW-5	**Chloroethene**	**07/25/1996**	**16**	**ug/l**	**10**	**0.015**	**15.985**
MW-5	**Chloroethene**	**01/14/1997**	**21**	**ug/l**	**10**	**0.015**	**20.985**
MW-5	**Chloroethene**	**01/21/1998**	**10.3**	**ug/l**	**10**	**0.015**	**10.285**
MW-7	**Chloroethene**	**01/23/1996**	**10**	**ug/l**	**10**	**0.015**	**9.985**
MW-7	**Chloroethene**	**08/22/1997**	**26**	**ug/l**	**10**	**0.015**	**25.985**
MW-8	**Chloroethene**	**09/09/1994**	**44**	**ug/l**	**10**	**0.015**	**43.985**
MW-8	**Chloroethene**	**10/28/1994**	**46**	**ug/l**	**10**	**0.015**	**45.985**
MW-8	**Chloroethene**	**01/23/1996**	**21**	**ug/l**	**10**	**0.015**	**20.985**
MW-8	**Chloroethene**	**07/25/1996**	**11**	**ug/l**	**10**	**0.015**	**10.985**
MW-8	**Chloroethene**	**01/21/1998**	**16**	**ug/l**	**10**	**0.015**	**15.985**
MW-8	**Chloroethene**	**01/06/1999**	**12**	**ug/l**	**10**	**0.015**	**11.985**
MW-8	**Chloroethene**	**06/29/1999**	**18**	**ug/l**	**10**	**0.015**	**17.985**
MW-8	**Chloroethene**	**07/17/2000**	**31**	**ug/l**	**10**	**0.015**	**30.985**
MW-8	**Chloroethene**	**01/24/2001**	**22**	**ug/l**	**10**	**0.015**	**21.985**

Table 4A: Historical Organic Groundwater Results

Well ID	Parameter Name [1]	Sample Date	Result	Unit	PQL [2]	NCGW2L [3]	Exceedance
MW-8	**Chloroethene**	**07/11/2001**	**21**	**ug/l**	**10**	**0.015**	**20.985**
MW-8	**Chloroethene**	**01/10/2002**	**22**	**ug/l**	**10**	**0.015**	**21.985**
MW-10	cis-1,2-Dichloroethylene	09/09/1994	13	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	01/06/1995	12	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	02/24/1995	11	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	07/17/1995	27	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	01/23/1996	24	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	07/25/1996	29	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	01/14/1997	24	ug/l	5	70	
MW-10	**cis-1,2-Dichloroethylene**	**08/22/1997**	**79**	**ug/l**	**5**	**70**	**9**
MW-10	cis-1,2-Dichloroethylene	01/21/1998	41	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	07/27/1998	27	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	01/06/1999	41	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	06/29/1999	36	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	01/24/2001	50	ug/l	5	70	
MW-10	cis-1,2-Dichloroethylene	07/11/2001	67	ug/l	5	70	
MW-10	**cis-1,2-Dichloroethylene**	**01/10/2002**	**74**	**ug/l**	**5**	**70**	**4**
MW-5	cis-1,2-Dichloroethylene	01/06/1995	15	ug/l	5	70	
MW-5	cis-1,2-Dichloroethylene	02/24/1995	5	ug/l	5	70	
MW-5	cis-1,2-Dichloroethylene	07/17/1995	36	ug/l	5	70	
MW-5	cis-1,2-Dichloroethylene	01/23/1996	9	ug/l	5	70	
MW-5	cis-1,2-Dichloroethylene	01/14/1997	15	ug/l	5	70	
MW-5	cis-1,2-Dichloroethylene	01/21/1998	5	ug/l	5	70	
MW-7	cis-1,2-Dichloroethylene	08/22/1997	13	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	09/09/1994	44	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	10/28/1994	25	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	01/06/1995	20	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	02/24/1995	24	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	07/17/1995	32	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	01/23/1996	44	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	07/25/1996	55	ug/l	5	70	
MW-8	**cis-1,2-Dichloroethylene**	**01/14/1997**	**72**	**ug/l**	**5**	**70**	**2**
MW-8	**cis-1,2-Dichloroethylene**	**08/22/1997**	**99**	**ug/l**	**5**	**70**	**29**
MW-8	**cis-1,2-Dichloroethylene**	**01/21/1998**	**105**	**ug/l**	**5**	**70**	**35**
MW-8	cis-1,2-Dichloroethylene	07/27/1998	67	ug/l	5	70	
MW-8	**cis-1,2-Dichloroethylene**	**01/06/1999**	**71**	**ug/l**	**5**	**70**	**1**
MW-8	**cis-1,2-Dichloroethylene**	**06/29/1999**	**71**	**ug/l**	**5**	**70**	**1**
MW-8	cis-1,2-Dichloroethylene	01/27/2000	30	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	07/17/2000	46	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	01/24/2001	32	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	07/11/2001	29	ug/l	5	70	
MW-8	cis-1,2-Dichloroethylene	01/10/2002	23	ug/l	5	70	
MW-3	Dichlorodifluoromethane	07/27/1998	33	ug/l	5	1400	
MW-3	Dichlorodifluoromethane	07/08/2002	14.3	ug/l	5	1400	
MW-4	Dichlorodifluoromethane	07/17/2000	34	ug/l	5	1400	
MW-8	Dichlorodifluoromethane	06/29/1999	17	ug/l	5	1400	

Table 4A: Historical Organic Groundwater Results

Well ID	Parameter Name [1]	Sample Date	Result	Unit	PQL [2]	NCGW2L [3]	Exceedance
MW-8	Dichlorodifluoromethane	01/24/2001	8.8	ug/l	5	1400	
MW-8	Dichlorodifluoromethane	01/10/2002	5.2	ug/l	5	1400	
MW-10	Ethylbenzene	01/06/1995	6	ug/l	5	550	
MW-10	**Ethylene dichloride**	**02/24/1995**	**31**	**ug/l**	**5**	**0.38**	**30.62**
MW-5	**Ethylene dichloride**	**01/06/1995**	**17**	**ug/l**	**5**	**0.38**	**16.62**
MW-8	**Ethylene dichloride**	**01/06/1995**	**47**	**ug/l**	**5**	**0.38**	**46.62**
MW-8	**Ethylene dichloride**	**02/24/1995**	**34**	**ug/l**	**5**	**0.38**	**33.62**
MW-8	**Ethylene dichloride**	**01/23/1996**	**6**	**ug/l**	**5**	**0.38**	**5.62**
MW-4	Methyl chloroform	01/21/1998	52	ug/l	5	200	
MW-10	Methylbenzene	07/17/1995	6	ug/l	5	1000	
MW-3	Methylbenzene	08/22/1997	8	ug/l	5	1000	
MW-3	Methylbenzene	07/27/1998	6.4	ug/l	5	1000	
MW-10	**Methylene chloride**	**09/09/1994**	**110**	**ug/l**	**10**	**4.6**	**105.4**
MW-10	**Methylene chloride**	**10/28/1994**	**76**	**ug/l**	**10**	**4.6**	**71.4**
MW-10	**Methylene chloride**	**01/06/1995**	**83**	**ug/l**	**10**	**4.6**	**78.4**
MW-10	**Methylene chloride**	**02/24/1995**	**93**	**ug/l**	**10**	**4.6**	**88.4**
MW-10	**Methylene chloride**	**07/17/1995**	**48**	**ug/l**	**10**	**4.6**	**43.4**
MW-10	**Methylene chloride**	**07/25/1996**	**10**	**ug/l**	**10**	**4.6**	**5.4**
MW-10	**Methylene chloride**	**08/22/1997**	**18**	**ug/l**	**10**	**4.6**	**13.4**
MW-3	**Methylene chloride**	**09/09/1994**	**25**	**ug/l**	**10**	**4.6**	**20.4**
MW-3	**Methylene chloride**	**10/28/1994**	**20**	**ug/l**	**10**	**4.6**	**15.4**
MW-8	**Methylene chloride**	**09/09/1994**	**34**	**ug/l**	**10**	**4.6**	**29.4**
MW-8	**Methylene chloride**	**10/28/1994**	**31**	**ug/l**	**10**	**4.6**	**26.4**
MW-8	**Methylene chloride**	**01/06/1995**	**35**	**ug/l**	**10**	**4.6**	**30.4**
MW-8	**Methylene chloride**	**02/24/1995**	**23**	**ug/l**	**10**	**4.6**	**18.4**
MW-8	**Methylene chloride**	**07/17/1995**	**12**	**ug/l**	**10**	**4.6**	**7.4**
MW-10	**p-Dichlorobenzene**	**09/09/1994**	**10**	**ug/l**	**5**	**1.4**	**8.6**
MW-10	**p-Dichlorobenzene**	**01/06/1995**	**7**	**ug/l**	**5**	**1.4**	**5.6**
MW-10	**p-Dichlorobenzene**	**02/24/1995**	**5**	**ug/l**	**5**	**1.4**	**3.6**
MW-10	**p-Dichlorobenzene**	**08/22/1997**	**12**	**ug/l**	**5**	**1.4**	**10.6**
MW-10	**p-Dichlorobenzene**	**01/21/1998**	**6.6**	**ug/l**	**5**	**1.4**	**5.2**
MW-10	**p-Dichlorobenzene**	**07/27/1998**	**5**	**ug/l**	**5**	**1.4**	**3.6**
MW-10	**p-Dichlorobenzene**	**07/17/2000**	**5.1**	**ug/l**	**5**	**1.4**	**3.7**
MW-10	**p-Dichlorobenzene**	**01/24/2001**	**11**	**ug/l**	**5**	**1.4**	**9.6**
MW-10	**p-Dichlorobenzene**	**07/11/2001**	**7.4**	**ug/l**	**5**	**1.4**	**6**
MW-10	**p-Dichlorobenzene**	**01/10/2002**	**6.8**	**ug/l**	**5**	**1.4**	**5.4**
MW-8	**p-Dichlorobenzene**	**08/22/1997**	**12**	**ug/l**	**5**	**1.4**	**10.6**
MW-8	**p-Dichlorobenzene**	**01/21/1998**	**14**	**ug/l**	**5**	**1.4**	**12.6**
MW-8	**p-Dichlorobenzene**	**07/27/1998**	**12**	**ug/l**	**5**	**1.4**	**10.6**
MW-8	**p-Dichlorobenzene**	**01/06/1999**	**12**	**ug/l**	**5**	**1.4**	**10.6**
MW-8	**p-Dichlorobenzene**	**01/27/2000**	**10**	**ug/l**	**5**	**1.4**	**8.6**
MW-8	**p-Dichlorobenzene**	**07/17/2000**	**10**	**ug/l**	**5**	**1.4**	**8.6**
MW-8	**p-Dichlorobenzene**	**01/24/2001**	**14**	**ug/l**	**5**	**1.4**	**12.6**
MW-8	**p-Dichlorobenzene**	**07/11/2001**	**9.2**	**ug/l**	**5**	**1.4**	**7.8**
MW-8	**p-Dichlorobenzene**	**01/10/2002**	**7.9**	**ug/l**	**5**	**1.4**	**6.5**
MW-10	**Tetrachloroethene**	**09/09/1994**	**14**	**ug/l**	**5**	**0.7**	**13.3**

Table 4A: Historical Organic Groundwater Results

Well ID	Parameter Name [1]	Sample Date	Result	Unit	PQL [2]	NCGW2L [3]	Exceedance
MW-10	**Tetrachloroethene**	**01/06/1995**	**7**	**ug/l**	**5**	**0.7**	**6.3**
MW-10	**Tetrachloroethene**	**02/24/1995**	**7**	**ug/l**	**5**	**0.7**	**6.3**
MW-10	**Tetrachloroethene**	**01/23/1996**	**10**	**ug/l**	**5**	**0.7**	**9.3**
MW-10	**Tetrachloroethene**	**07/25/1996**	**11**	**ug/l**	**5**	**0.7**	**10.3**
MW-10	**Tetrachloroethene**	**01/14/1997**	**10**	**ug/l**	**5**	**0.7**	**9.3**
MW-10	**Tetrachloroethene**	**08/22/1997**	**7**	**ug/l**	**5**	**0.7**	**6.3**
MW-5	**Tetrachloroethene**	**07/17/1995**	**6**	**ug/l**	**5**	**0.7**	**5.3**
MW-10	trans-1,2-Dichloroethylene	01/21/1998	44	ug/l	5	100	
MW-10	**Trichloroethene**	**09/09/1994**	**16**	**ug/l**	**5**	**2.8**	**13.2**
MW-10	**Trichloroethene**	**10/28/1994**	**11**	**ug/l**	**5**	**2.8**	**8.2**
MW-10	**Trichloroethene**	**01/06/1995**	**13**	**ug/l**	**5**	**2.8**	**10.2**
MW-10	**Trichloroethene**	**02/24/1995**	**12**	**ug/l**	**5**	**2.8**	**9.2**
MW-10	**Trichloroethene**	**07/17/1995**	**16**	**ug/l**	**5**	**2.8**	**13.2**
MW-10	**Trichloroethene**	**01/23/1996**	**13**	**ug/l**	**5**	**2.8**	**10.2**
MW-10	**Trichloroethene**	**07/25/1996**	**15**	**ug/l**	**5**	**2.8**	**12.2**
MW-10	**Trichloroethene**	**01/14/1997**	**13**	**ug/l**	**5**	**2.8**	**10.2**
MW-10	**Trichloroethene**	**08/22/1997**	**19**	**ug/l**	**5**	**2.8**	**16.2**
MW-10	**Trichloroethene**	**01/21/1998**	**9.3**	**ug/l**	**5**	**2.8**	**6.5**
MW-10	**Trichloroethene**	**07/11/2001**	**8.6**	**ug/l**	**5**	**2.8**	**5.8**
MW-10	**Trichloroethene**	**01/10/2002**	**5.9**	**ug/l**	**5**	**2.8**	**3.1**
MW-8	**Trichloroethene**	**01/06/1995**	**7**	**ug/l**	**5**	**2.8**	**4.2**
MW-8	**Trichloroethene**	**02/24/1995**	**8**	**ug/l**	**5**	**2.8**	**5.2**
MW-8	**Trichloroethene**	**07/25/1996**	**5**	**ug/l**	**5**	**2.8**	**2.2**
MW-10	Xylenes	09/09/1994	13	ug/l	5	530	
MW-10	Xylenes	02/24/1995	6	ug/l	5	530	
MW-10	Xylenes	01/23/1996	9	ug/l	5	530	
MW-10	Xylenes	01/14/1997	9	ug/l	5	530	
MW-10	Xylenes	08/22/1997	8	ug/l	5	530	
MW-8	Xylenes	02/24/1995	5	ug/l	5	530	
MW-8	Xylenes	01/21/1998	6.8	ug/l	5	530	

[1] Table only contains detected constituents.
[2] PQL = Practical Quantitation Limit
[3] NCGW2L = North Carolina Ground Water 2L Standard

Table 4B: Historical Inorganic Groundwater Results

Well ID	Parameter Name[1]	Sample Date	Result	Unit	PQL[2]	NCGW2L[3]	Exceedance
MW-3	Arsenic	07/08/2002	0.013	mg/l	0.01	0.05	
MW-3	Arsenic	01/22/2003	0.012	mg/l	0.01	0.05	
MW-3	Arsenic	07/07/2003	0.021	mg/l	0.01	0.05	
MW-4	Arsenic	07/27/1998	0.014	mg/l	0.01	0.05	
MW-4	Arsenic	07/17/2000	0.01	mg/l	0.01	0.05	
MW-4	Arsenic	07/08/2002	0.013	mg/l	0.01	0.05	
MW-4	Arsenic	01/22/2003	0.017	mg/l	0.01	0.05	
MW-4	Arsenic	07/07/2003	0.015	mg/l	0.01	0.05	
MW-9	Arsenic	09/09/1994	0.013	mg/l	0.01	0.05	
MW-9	Arsenic	07/08/2002	0.013	mg/l	0.01	0.05	
MW-9	Arsenic	01/22/2003	0.014	mg/l	0.01	0.05	
MW-9	Arsenic	01/22/2004	0.014	mg/l	0.01	0.05	
MW-9	Arsenic	01/26/2005	0.028	mg/l	0.01	0.05	
MW-3	Beryllium, total	07/17/1995	0.002	mg/l	0.002		
MW-4	Beryllium, total	07/17/1995	0.002	mg/l	0.002		
MW-4	Beryllium, total	07/17/2000	0.004	mg/l	0.002		
MW-8	Beryllium, total	01/06/1995	0.002	mg/l	0.002		
MW-8	Beryllium, total	07/17/1995	0.002	mg/l	0.002		
MW-9	Beryllium, total	09/09/1994	0.003	mg/l	0.002		
MW-9	Beryllium, total	07/17/1995	0.004	mg/l	0.002		
MW-9	Beryllium, total	07/25/1996	0.002	mg/l	0.002		
MW-9	Beryllium, total	07/17/2000	0.003	mg/l	0.002		
MW-3	Cadmium, total	01/26/2005	0.001	mg/l	0.001	0.0018	
MW-8	**Cadmium, total**	**01/24/2001**	**0.002**	**mg/l**	**0.001**	**0.0018**	**0.0003**
MW-9	Cadmium, total	01/14/1997	0.001	mg/l	0.001	0.0018	
MW-1	Chromium, total	01/06/1999	0.014	mg/l	0.01	0.05	
MW-1	Chromium, total	01/27/2000	0.011	mg/l	0.01	0.05	
MW-1	Chromium, total	01/10/2002	0.012	mg/l	0.01	0.05	
MW-10	Chromium, total	09/09/1994	0.033	mg/l	0.01	0.05	
MW-10	Chromium, total	07/17/1995	0.013	mg/l	0.01	0.05	
MW-10	Chromium, total	07/17/1997	0.017	mg/l	0.01	0.05	
MW-10	Chromium, total	01/21/1998	0.012	mg/l	0.01	0.05	
MW-10	Chromium, total	01/06/1999	0.013	mg/l	0.01	0.05	
MW-10	Chromium, total	06/29/1999	0.026	mg/l	0.01	0.05	
MW-10	Chromium, total	01/27/2000	0.022	mg/l	0.01	0.05	
MW-10	Chromium, total	07/17/2000	0.013	mg/l	0.01	0.05	
MW-10	**Chromium, total**	**07/11/2001**	**0.055**	**mg/l**	**0.01**	**0.05**	**0.005**
MW-11	Chromium, total	07/17/2000	0.023	mg/l	0.01	0.05	
MW-12	Chromium, total	07/17/2000	0.027	mg/l	0.01	0.05	
MW-12	Chromium, total	07/11/2001	0.019	mg/l	0.01	0.05	
MW-12	Chromium, total	07/08/2002	0.016	mg/l	0.01	0.05	
MW-3	Chromium, total	01/06/1995	0.022	mg/l	0.01	0.05	
MW-3	Chromium, total	07/17/1995	0.02	mg/l	0.01	0.05	
MW-3	Chromium, total	07/27/1998	0.016	mg/l	0.01	0.05	
MW-3	Chromium, total	06/29/1999	0.027	mg/l	0.01	0.05	
MW-3	Chromium, total	01/27/2000	0.015	mg/l	0.01	0.05	
MW-3	Chromium, total	07/17/2000	0.024	mg/l	0.01	0.05	
MW-3	Chromium, total	07/11/2001	0.041	mg/l	0.01	0.05	
MW-3	Chromium, total	01/10/2002	0.028	mg/l	0.01	0.05	
MW-3	**Chromium, total**	**07/08/2002**	**0.054**	**mg/l**	**0.01**	**0.05**	**0.004**
MW-3	Chromium, total	01/22/2003	0.046	mg/l	0.01	0.05	
MW-3	**Chromium, total**	**07/07/2003**	**0.14**	**mg/l**	**0.01**	**0.05**	**0.09**

Table 4B: Historical Inorganic Groundwater Results

Well ID	Parameter Name[1]	Sample Date	Result	Unit	PQL[2]	NCGW2L[3]	Exceedance
MW-3	Chromium, total	01/22/2004	0.016	mg/l	0.01	0.05	
MW-3	Chromium, total	07/12/2004	0.014	mg/l	0.01	0.05	
MW-4	Chromium, total	09/09/1994	0.01	mg/l	0.01	0.05	
MW-4	Chromium, total	07/17/1995	0.042	mg/l	0.01	0.05	
MW-4	Chromium, total	07/25/1996	0.046	mg/l	0.01	0.05	
MW-4	Chromium, total	07/11/1997	0.029	mg/l	0.01	0.05	
MW-4	Chromium, total	01/21/1998	0.023	mg/l	0.01	0.05	
MW-4	Chromium, total	07/27/1998	0.039	mg/l	0.01	0.05	
MW-4	Chromium, total	01/06/1999	0.033	mg/l	0.01	0.05	
MW-4	Chromium, total	06/29/1999	0.04	mg/l	0.01	0.05	
MW-4	Chromium, total	01/27/2000	0.038	mg/l	0.01	0.05	
MW-4	**Chromium, total**	**07/17/2000**	**0.139**	**mg/l**	**0.01**	**0.05**	**0.089**
MW-4	**Chromium, total**	**01/24/2001**	**0.105**	**mg/l**	**0.01**	**0.05**	**0.055**
MW-4	Chromium, total	07/11/2001	0.049	mg/l	0.01	0.05	
MW-4	Chromium, total	01/10/2002	0.02	mg/l	0.01	0.05	
MW-4	**Chromium, total**	**07/08/2002**	**0.126**	**mg/l**	**0.01**	**0.05**	**0.076**
MW-4	Chromium, total	01/22/2003	0.049	mg/l	0.01	0.05	
MW-4	**Chromium, total**	**07/07/2003**	**0.078**	**mg/l**	**0.01**	**0.05**	**0.028**
MW-4	Chromium, total	01/22/2004	0.019	mg/l	0.01	0.05	
MW-4	Chromium, total	01/26/2005	0.012	mg/l	0.01	0.05	
MW-6	Chromium, total	01/06/1999	0.034	mg/l	0.01	0.05	
MW-6	Chromium, total	01/27/2000	0.024	mg/l	0.01	0.05	
MW-6	Chromium, total	07/17/2000	0.023	mg/l	0.01	0.05	
MW-6	Chromium, total	01/22/2003	0.012	mg/l	0.01	0.05	
MW-6	Chromium, total	01/22/2004	0.027	mg/l	0.01	0.05	
MW-7	Chromium, total	07/11/1997	0.038	mg/l	0.01	0.05	
MW-8	Chromium, total	02/24/1995	0.012	mg/l	0.01	0.05	
MW-8	Chromium, total	07/17/1995	0.039	mg/l	0.01	0.05	
MW-8	Chromium, total	07/11/1997	0.029	mg/l	0.01	0.05	
MW-8	Chromium, total	07/27/1998	0.018	mg/l	0.01	0.05	
MW-8	Chromium, total	06/29/1999	0.021	mg/l	0.01	0.05	
MW-8	Chromium, total	01/27/2000	0.015	mg/l	0.01	0.05	
MW-8	Chromium, total	01/24/2001	0.024	mg/l	0.01	0.05	
MW-8	**Chromium, total**	**07/11/2001**	**0.055**	**mg/l**	**0.01**	**0.05**	**0.005**
MW-8	**Chromium, total**	**01/10/2002**	**0.118**	**mg/l**	**0.01**	**0.05**	**0.068**
MW-9	Chromium, total	09/09/1994	0.021	mg/l	0.01	0.05	
MW-9	Chromium, total	07/17/1995	0.033	mg/l	0.01	0.05	
MW-9	Chromium, total	07/25/1996	0.023	mg/l	0.01	0.05	
MW-9	Chromium, total	01/14/1997	0.015	mg/l	0.01	0.05	
MW-9	Chromium, total	07/17/1997	0.014	mg/l	0.01	0.05	
MW-9	Chromium, total	01/21/1998	0.013	mg/l	0.01	0.05	
MW-9	Chromium, total	07/27/1998	0.018	mg/l	0.01	0.05	
MW-9	Chromium, total	01/06/1999	0.015	mg/l	0.01	0.05	
MW-9	Chromium, total	06/29/1999	0.017	mg/l	0.01	0.05	
MW-9	Chromium, total	01/27/2000	0.011	mg/l	0.01	0.05	
MW-9	**Chromium, total**	**07/17/2000**	**0.063**	**mg/l**	**0.01**	**0.05**	**0.013**
MW-9	Chromium, total	01/24/2001	0.034	mg/l	0.01	0.05	
MW-9	Chromium, total	07/11/2001	0.04	mg/l	0.01	0.05	
MW-9	Chromium, total	07/08/2002	0.016	mg/l	0.01	0.05	
MW-9	Chromium, total	01/22/2003	0.015	mg/l	0.01	0.05	
MW-9	Chromium, total	07/07/2003	0.012	mg/l	0.01	0.05	
MW-9	Chromium, total	01/22/2004	0.011	mg/l	0.01	0.05	

Table 4B: Historical Inorganic Groundwater Results

Well ID	Parameter Name[1]	Sample Date	Result	Unit	PQL[2]	NCGW2L[3]	Exceedance
MW-4	Cobalt, total	07/17/2000	0.01	mg/l	0.01		
MW-4	Cobalt, total	01/24/2001	0.011	mg/l	0.01		
MW-9	Cobalt, total	09/09/1994	0.019	mg/l	0.01		
MW-9	Cobalt, total	07/17/1995	0.017	mg/l	0.01		
MW-9	Cobalt, total	07/25/1996	0.012	mg/l	0.01		
MW-9	Cobalt, total	01/14/1997	0.012	mg/l	0.01		
MW-9	Cobalt, total	01/27/2000	0.017	mg/l	0.01		
MW-9	Cobalt, total	07/17/2000	0.013	mg/l	0.01		
MW-9	Cobalt, total	01/24/2001	0.043	mg/l	0.01		
MW-9	Cobalt, total	07/08/2002	0.049	mg/l	0.01		
MW-9	Cobalt, total	01/22/2003	0.043	mg/l	0.01		
MW-9	Cobalt, total	07/07/2003	0.057	mg/l	0.01		
MW-9	Cobalt, total	01/22/2004	0.065	mg/l	0.01		
MW-9	Cobalt, total	01/26/2005	0.033	mg/l	0.01		
MW-9	Cobalt, total	07/14/2005	0.015	mg/l	0.01		
MW-9	Cobalt, total	01/25/2006	0.016	mg/l	0.01		
MW-10	Lead, total	01/23/1996	0.01	mg/l	0.01	0.015	
MW-3	**Lead, total**	**10/28/1994**	**0.092**	**mg/l**	**0.01**	**0.015**	**0.077**
MW-3	Lead, total	01/06/1995	0.01	mg/l	0.01	0.015	
MW-3	Lead, total	07/17/1995	0.011	mg/l	0.01	0.015	
MW-3	Lead, total	07/17/2000	0.013	mg/l	0.01	0.015	
MW-3	Lead, total	07/08/2002	0.012	mg/l	0.01	0.015	
MW-3	Lead, total	01/22/2003	0.011	mg/l	0.01	0.015	
MW-3	**Lead, total**	**07/07/2003**	**0.033**	**mg/l**	**0.01**	**0.015**	**0.018**
MW-4	**Lead, total**	**09/09/1994**	**0.054**	**mg/l**	**0.01**	**0.015**	**0.039**
MW-4	**Lead, total**	**07/17/1995**	**0.019**	**mg/l**	**0.01**	**0.015**	**0.004**
MW-4	**Lead, total**	**07/25/1996**	**0.021**	**mg/l**	**0.01**	**0.015**	**0.006**
MW-4	**Lead, total**	**07/11/1997**	**0.017**	**mg/l**	**0.01**	**0.015**	**0.002**
MW-4	**Lead, total**	**01/21/1998**	**0.016**	**mg/l**	**0.01**	**0.015**	**0.001**
MW-4	**Lead, total**	**07/27/1998**	**0.022**	**mg/l**	**0.01**	**0.015**	**0.007**
MW-4	**Lead, total**	**06/29/1999**	**0.016**	**mg/l**	**0.01**	**0.015**	**0.001**
MW-4	Lead, total	01/27/2000	0.011	mg/l	0.01	0.015	
MW-4	**Lead, total**	**07/17/2000**	**0.022**	**mg/l**	**0.01**	**0.015**	**0.007**
MW-4	**Lead, total**	**01/24/2001**	**0.025**	**mg/l**	**0.01**	**0.015**	**0.01**
MW-4	Lead, total	07/11/2001	0.011	mg/l	0.01	0.015	
MW-4	**Lead, total**	**07/08/2002**	**0.039**	**mg/l**	**0.01**	**0.015**	**0.024**
MW-4	**Lead, total**	**01/22/2003**	**0.022**	**mg/l**	**0.01**	**0.015**	**0.007**
MW-4	**Lead, total**	**07/07/2003**	**0.036**	**mg/l**	**0.01**	**0.015**	**0.021**
MW-5	Lead, total	10/28/1994	0.013	mg/l	0.01	0.015	
MW-5	Lead, total	07/25/1996	0.012	mg/l	0.01	0.015	
MW-5	Lead, total	07/11/1997	0.01	mg/l	0.01	0.015	
MW-5	**Lead, total**	**01/21/1998**	**0.024**	**mg/l**	**0.01**	**0.015**	**0.009**
MW-6	Lead, total	01/27/2000	0.01	mg/l	0.01	0.015	
MW-6	Lead, total	07/17/2000	0.014	mg/l	0.01	0.015	
MW-6	Lead, total	01/22/2004	0.011	mg/l	0.01	0.015	
MW-7	**Lead, total**	**07/11/1997**	**0.028**	**mg/l**	**0.01**	**0.015**	**0.013**
MW-8	**Lead, total**	**09/09/1994**	**0.027**	**mg/l**	**0.01**	**0.015**	**0.012**
MW-8	Lead, total	07/11/1997	0.011	mg/l	0.01	0.015	
MW-8	Lead, total	01/10/2002	0.012	mg/l	0.01	0.015	
MW-9	Lead, total	09/09/1994	0.01	mg/l	0.01	0.015	
MW-9	Lead, total	07/17/1995	0.015	mg/l	0.01	0.015	
MW-9	Lead, total	07/25/1996	0.012	mg/l	0.01	0.015	

Table 4B: Historical Inorganic Groundwater Results

Well ID	Parameter Name[1]	Sample Date	Result	Unit	PQL[2]	NCGW2L[3]	Exceedance
MW-9	Lead, total	01/14/1997	0.011	mg/l	0.01	0.015	
MW-9	Lead, total	01/21/1998	0.01	mg/l	0.01	0.015	
MW-9	**Lead, total**	**07/17/2000**	**0.016**	**mg/l**	**0.01**	**0.015**	**0.001**
MW-9	Lead, total	01/24/2001	0.013	mg/l	0.01	0.015	
MW-9	Lead, total	01/22/2003	0.013	mg/l	0.01	0.015	
MW-9	Lead, total	07/07/2003	0.011	mg/l	0.01	0.015	
MW-11	Manganese	01/17/2007	13	ug/l	10	50	
MW-3	Manganese	01/17/2007	22	ug/l	10	50	
MW-4	**Manganese**	**01/17/2007**	**56**	**ug/l**	**10**	**50**	**6**
MW-6	Manganese	01/17/2007	46	ug/l	10	50	
MW-9	**Manganese**	**01/17/2007**	**287**	**ug/l**	**10**	**50**	**237**
MW-10	Mercury	07/17/1995	0.0006	mg/l	0.0005	0.0011	
MW-10	Mercury	01/23/1996	0.0007	mg/l	0.0005	0.0011	
MW-10	Mercury	01/14/1997	0.0007	mg/l	0.0005	0.0011	
MW-12	Mercury	01/17/2007	0.2	ug/l	0.2	1.1	
MW-3	**Mercury**	**07/07/2003**	**0.0012**	**mg/l**	**0.0005**	**0.0011**	**0.0001**
MW-4	Mercury	01/24/2001	0.0005	mg/l	0.0005	0.0011	
MW-5	**Mercury**	**01/23/1996**	**0.002**	**mg/l**	**0.0005**	**0.0011**	**0.0009**
MW-5	**Mercury**	**01/14/1997**	**0.002**	**mg/l**	**0.0005**	**0.0011**	**0.0009**
MW-5	Mercury	01/21/1998	0.0006	mg/l	0.0005	0.0011	
MW-8	**Mercury**	**07/17/1995**	**0.0013**	**mg/l**	**0.0005**	**0.0011**	**0.0002**
MW-8	**Mercury**	**01/23/1996**	**0.0017**	**mg/l**	**0.0005**	**0.0011**	**0.0006**
MW-8	**Mercury**	**07/25/1996**	**0.0023**	**mg/l**	**0.0005**	**0.0011**	**0.0012**
MW-8	**Mercury**	**01/14/1997**	**0.0017**	**mg/l**	**0.0005**	**0.0011**	**0.0006**
MW-8	**Mercury**	**01/21/1998**	**0.0012**	**mg/l**	**0.0005**	**0.0011**	**0.0001**
MW-8	Mercury	07/27/1998	0.0011	mg/l	0.0005	0.0011	
MW-8	Mercury	06/29/1999	0.0011	mg/l	0.0005	0.0011	
MW-8	Mercury	01/27/2000	0.0006	mg/l	0.0005	0.0011	
MW-8	**Mercury**	**01/24/2001**	**0.0024**	**mg/l**	**0.0005**	**0.0011**	**0.0013**
MW-8	**Mercury**	**07/11/2001**	**0.0032**	**mg/l**	**0.0005**	**0.0011**	**0.0021**
MW-8	**Mercury**	**01/10/2002**	**0.0061**	**mg/l**	**0.0005**	**0.0011**	**0.005**
MW-1	Nickel, total	01/21/1998	0.011	mg/l	0.01	0.1	
MW-10	Nickel, total	01/21/1998	0.044	mg/l	0.01	0.1	
MW-2	Nickel, total	01/21/1998	0.035	mg/l	0.01	0.1	
MW-3	Nickel, total	01/21/1998	0.034	mg/l	0.01	0.1	
MW-4	Nickel, total	01/21/1998	0.027	mg/l	0.01	0.1	
MW-5	Nickel, total	01/21/1998	0.033	mg/l	0.01	0.1	
MW-8	Nickel, total	01/21/1998	0.031	mg/l	0.01	0.1	
MW-9	Nickel, total	07/17/1995	0.051	mg/l	0.05	0.1	
MW-9	Nickel, total	01/21/1998	0.029	mg/l	0.01	0.1	
MW-9	Nickel, total	07/11/2001	0.079	mg/l	0.05	0.1	
MW-9	Selenium, total	01/27/2000	0.02	mg/l	0.02	0.05	
MW-10	Tin, total	07/11/2001	0.122	mg/l	0.1		
MW-3	Tin, total	07/11/2001	0.166	mg/l	0.1		
MW-8	Tin, total	07/11/2001	0.125	mg/l	0.1		
MW-9	Tin, total	07/11/2001	0.198	mg/l	0.1		
MW-10	Vanadium	01/27/2000	0.046	mg/l	0.04		
MW-10	Vanadium	07/11/2001	0.1	mg/l	0.04		
MW-12	Vanadium	07/17/2000	0.061	mg/l	0.05		
MW-3	Vanadium	07/17/1995	0.052	mg/l	0.04		
MW-3	Vanadium	07/11/2001	0.086	mg/l	0.04		
MW-3	Vanadium	01/10/2002	0.06	mg/l	0.04		

Table 4B: Historical Inorganic Groundwater Results

Well ID	Parameter Name[1]	Sample Date	Result	Unit	PQL[2]	NCGW2L[3]	Exceedance
MW-3	Vanadium	07/08/2002	0.09	mg/l	0.04		
MW-3	Vanadium	01/22/2003	0.094	mg/l	0.04		
MW-3	Vanadium	07/07/2003	0.26	mg/l	0.04		
MW-4	Vanadium	07/17/1995	0.093	mg/l	0.04		
MW-4	Vanadium	07/11/1997	0.074	mg/l	0.04		
MW-4	Vanadium	01/06/1999	0.063	mg/l	0.04		
MW-4	Vanadium	01/27/2000	0.062	mg/l	0.04		
MW-4	Vanadium	07/17/2000	0.278	mg/l	0.05		
MW-4	Vanadium	01/24/2001	0.173	mg/l	0.04		
MW-4	Vanadium	07/11/2001	0.08	mg/l	0.04		
MW-4	Vanadium	07/08/2002	0.201	mg/l	0.04		
MW-4	Vanadium	01/22/2003	0.095	mg/l	0.04		
MW-4	Vanadium	07/07/2003	0.15	mg/l	0.04		
MW-6	Vanadium	07/27/1998	0.101	mg/l	0.04		
MW-6	Vanadium	01/06/1999	0.062	mg/l	0.04		
MW-7	Vanadium	07/11/1997	0.065	mg/l	0.04		
MW-8	Vanadium	07/17/1995	0.045	mg/l	0.04		
MW-8	Vanadium	01/24/2001	0.044	mg/l	0.04		
MW-8	Vanadium	07/11/2001	0.085	mg/l	0.04		
MW-8	Vanadium	01/10/2002	0.233	mg/l	0.04		
MW-9	Vanadium	07/17/1995	0.096	mg/l	0.04		
MW-9	Vanadium	01/21/1998	0.049	mg/l	0.04		
MW-9	Vanadium	07/27/1998	0.059	mg/l	0.04		
MW-9	Vanadium	01/06/1999	0.049	mg/l	0.04		
MW-9	Vanadium	07/17/2000	0.154	mg/l	0.05		
MW-9	Vanadium	01/24/2001	0.09	mg/l	0.04		
MW-10	Zinc	09/09/1994	0.04	mg/l	0.05	1.05	
MW-11	Zinc	07/11/2001	0.054	mg/l	0.05	1.05	
MW-3	Zinc	07/27/1998	0.179	mg/l	0.05	1.05	
MW-3	Zinc	01/06/1999	0.347	mg/l	0.05	1.05	
MW-3	Zinc	06/29/1999	0.662	mg/l	0.05	1.05	
MW-3	Zinc	01/27/2000	0.75	mg/l	0.05	1.05	
MW-3	Zinc	01/24/2001	0.324	mg/l	0.05	1.05	
MW-3	Zinc	07/11/2001	0.572	mg/l	0.05	1.05	
MW-3	Zinc	01/10/2002	0.225	mg/l	0.05	1.05	
MW-3	Zinc	07/08/2002	0.431	mg/l	0.05	1.05	
MW-3	Zinc	01/22/2003	0.28	mg/l	0.05	1.05	
MW-3	**Zinc**	**07/07/2003**	**1.101**	**mg/l**	**0.05**	**1.05**	**0.051**
MW-3	Zinc	01/22/2004	0.208	mg/l	0.05	1.05	
MW-3	Zinc	07/12/2004	0.126	mg/l	0.05	1.05	
MW-3	Zinc	01/26/2005	0.087	mg/l	0.05	1.05	
MW-3	Zinc	07/14/2005	0.159	mg/l	0.05	1.05	
MW-3	Zinc	01/25/2006	0.057	mg/l	0.05	1.05	
MW-3	Zinc	01/17/2007	89	ug/l	10	1050	
MW-4	Zinc	06/29/1999	0.055	mg/l	0.05	1.05	
MW-4	Zinc	01/27/2000	0.05	mg/l	0.05	1.05	
MW-4	**Zinc**	**07/17/2000**	**1.122**	**mg/l**	**0.05**	**1.05**	**0.072**
MW-4	Zinc	01/24/2001	0.115	mg/l	0.05	1.05	
MW-4	Zinc	07/08/2002	0.123	mg/l	0.05	1.05	
MW-4	Zinc	01/22/2003	0.063	mg/l	0.05	1.05	
MW-4	Zinc	07/07/2003	0.074	mg/l	0.05	1.05	
MW-5	Zinc	10/28/1994	0.125	mg/l	0.05	1.05	

Table 4B: Historical Inorganic Groundwater Results

Well ID	Parameter Name[1]	Sample Date	Result	Unit	PQL[2]	NCGW2L[3]	Exceedance
MW-6	Zinc	01/27/2000	0.059	mg/l	0.05	1.05	
MW-6	Zinc	07/17/2000	0.056	mg/l	0.05	1.05	
MW-6	Zinc	07/07/2003	0.051	mg/l	0.05	1.05	
MW-6	Zinc	01/17/2007	13	ug/l	10	1050	
MW-8	Zinc	09/09/1994	0.142	mg/l	0.05	1.05	
MW-8	Zinc	01/10/2002	0.081	mg/l	0.05	1.05	
MW-9	Zinc	09/09/1994	0.06	mg/l	0.05	1.05	
MW-9	Zinc	07/17/1995	0.069	mg/l	0.05	1.05	
MW-9	Zinc	01/14/1997	0.053	mg/l	0.05	1.05	
MW-9	Zinc	07/17/2000	0.071	mg/l	0.05	1.05	
MW-9	Zinc	07/11/2001	0.088	mg/l	0.05	1.05	

[1] Table only contains detected constituents.
[2] PQL = Practical Quantitation Limit
[3] NCGW2L = North Carolina Ground Water 2L Standard

Table 5: Historical Inorganic Surface Water Results

Well ID	Parameter Name [1]	Sample Date	Result	Unit	PQL [2]	SWSTD [3]	Exceedance
SW-1	Cadmium, total	07/12/2004	0.001	mg/l	0.001	0.002	
SW-1	Chromium, total	06/29/1999	0.026	mg/l	0.01	0.05	
SW-1	Chromium, total	01/26/2005	0.013	mg/l	0.01	0.05	
SW-2	Chromium, total	01/27/2000	0.034	mg/l	0.01	0.05	
SW-2	Chromium, total	07/17/2000	0.036	mg/l	0.01	0.05	
SW-2	Chromium, total	01/22/2003	0.011	mg/l	0.01	0.05	
SW-2	Chromium, total	07/14/2005	0.013	mg/l	0.01	0.05	
SW-2	Chromium, total	01/25/2006	0.01	mg/l	0.01	0.05	
SW-2	Chromium, total	01/17/2007	12	ug/l	10	50	
SW-2	Lead, total	07/14/2005	0.021	mg/l	0.01	0.025	
SW-2	Lead, total	01/17/2007	11	ug/l	10	25	
SW-1	Nickel, total	01/21/1998	0.013	mg/l	0.01	0.025	
SW-2	Nickel, total	01/21/1998	0.021	mg/l	0.01	0.025	
SW-2	**Nickel, total**	**07/17/2000**	**0.094**	**mg/l**	**0.05**	**0.025**	**0.069**
SW-1	**Selenium, total**	**07/17/2000**	**0.02**	**mg/l**	**0.02**	**0.005**	**0.015**
SW-2	Vanadium	01/27/2000	0.057	mg/l	0.04		
SW-1	**Zinc**	**07/17/2000**	**0.09**	**mg/l**	**0.05**	**0.05**	**0.04**
SW-2	**Zinc**	**01/14/1997**	**0.071**	**mg/l**	**0.05**	**0.05**	**0.021**
SW-2	**Zinc**	**07/17/1997**	**0.071**	**mg/l**	**0.05**	**0.05**	**0.021**
SW-2	Zinc	07/17/2000	0.016	mg/l	0.05	0.05	
SW-2	Zinc	01/17/2007	18	ug/l	10	50	

[1] Table only contains detected constituents.

[2] PQL = Practical Quantitation Limit

[3] SWSTD = North Carolina Surface Water Standard Class C or Class IV as applicable

Table 6: Summary of Current Groundwater Results

Well ID	Parameter Name [1]	Sample Date	Result	Unit	MDL [4]	SWSL [2]	NCGW2L [3]	GWP[5]	Exceedance
MW-1	Chloride	7/15/08	39	ug/l	5.0	5	250000		
MW-1	**Iron**	**7/15/08**	**635**	**ug/l**	**14.0**	**300**	**300**		**335**
MW-1	TDS	7/15/08	43	ug/l	1.0	1	500000		
MW-3	1,1-Dichloroethane	7/15/08	10	ug/l	0.16	5	70		
MW-3	**1,2-Dichloroethane**	**7/15/08**	**1**	**ug/l**	**0.12**	1	**0.38**		**0.62**
MW-3	**Benzene**	**7/15/08**	**2.1**	**ug/l**	**0.16**	1	**1**		**1.1**
MW-3	Chloride	7/15/08	55	ug/l	5.0	5	250000		
MW-3	Cis-1,2-Dichloroethe	7/15/08	9.4	ug/l	0.14	5	70		
MW-3	**Iron**	**7/15/08**	**69550**	**ug/l**	**14.0**	**300**	**300**		**69250**
MW-3	TDS	7/15/08	200	ug/l	1.0	1	500000		
MW-3	**Tetrachloroethene**	**7/15/08**	**1.5**	**ug/l**	**0.16**	**1**	**0.7**		**0.8**
MW-3	Total Alkalinity	7/15/08	101	ug/l	1.0	1		NE	
MW-3	Trichloroethene	7/15/08	2.5	ug/l	0.13	1	2.8		
MW-3	**Vinyl Chloride**	**7/15/08**	**11.3**	**ug/l**	**0.34**	**1**	**0.015**		**11.285**
MW-3	Zinc	7/15/08	23	ug/l	1.86	10	1050		
MW-4	1,4-Dichlorobenzene	7/15/08	1	ug/l	0.21	1	1.4		
MW-4	**Benzene**	**7/15/08**	**1.9**	**ug/l**	**0.16**	**1**	**1**		**0.9**
MW-4	Chloride	7/15/08	16	ug/l	5.0	5	250000		
MW-4	Chlorobenzene	7/15/08	6.3	ug/l	0.13	3	50		
MW-4	**Iron**	**7/15/08**	**42925**	**ug/l**	**14.0**	**300**	**300**		**42625**
MW-4	TDS	7/15/08	186	ug/l	1.0	1	500000		
MW-4	Total Alkalinity	7/15/08	121	ug/l	1.0	1		NE	
MW-4	**Vinyl Chloride**	**7/15/08**	**0.6**	**ug/l**	**0.34**	**1**	**0.015**		**0.585**
MW-6	Chloride	7/15/08	7	ug/l	5.0	5	250000		
MW-6	**Iron**	**7/15/08**	**397**	**ug/l**	**14.0**	**300**	**300**		**97**
MW-6	**Manganese**	**7/15/08**	**51**	**ug/l**	**0.50**	**50**	**50**		**1**
MW-6	TDS	7/15/08	56	ug/l	1.0	1	500000		
MW-6	Zinc	7/15/08	15	ug/l	1.86	10	1050		
MW-9	Chloride	7/15/08	9	ug/l	5.0	5	250000		
MW-9	**Iron**	**7/15/08**	**2050**	**ug/l**	**14.0**	**300**	**300**		**1750**
MW-9	**Manganese**	**7/15/08**	**476**	**ug/l**	**0.50**	**50**	**50**		**426**
MW-9	TDS	7/15/08	65	ug/l	1.0	1	500000		
MW-9	Total Alkalinity	7/15/08	5	ug/l	1.0	1		NE	
MW-11	Chloride	7/15/08	43	ug/l	5.0	5	250000		
MW-11	**Iron**	**7/15/08**	**1333**	**ug/l**	**14.0**	**300**	**300**		**1033**
MW-11	TDS	7/15/08	41	ug/l	1.0	1	500000		
MW-12	Barium	7/15/08	182	ug/l	0.11	100	2000		
MW-12	Chloride	7/15/08	34	ug/l	5.0	5	250000		
MW-12	Mercury	7/15/08	0.49	ug/l	0.13	0.2	1.1		
MW-12	TDS	7/15/08	115	ug/l	1.0	1	500000		
MW-12	**Vinyl Chloride**	**7/15/08**	**0.8**	**ug/l**	**0.34**	**1**	**0.015**		**0.785**

[1] Table only contains detected constituents

[2] SWSL = Solid Waste Section Reporting Limit (Current as of Sampling Event)

[3] NCGW2L = North Carolina Ground Water 2L Standard (Current as of Sampling Event)

[4] MDL = Method Detection Limit

[4] GWP = Groundwater Protection Standard (Current as of Sampling Event)

LFG = Landfill Gas

Table 7A: Non-Carcinogenic Toxicity Values for Dermal Exposure

Contaminant	Well	Reference Dose	Maximum Concentration (ug/L)	LADD Maximum		Concentration 7/13/2006 (ug/L)	LADD 7/13/2006		HI Risk Maximum		HI Risk 7/13/2006	
		Oral RfD (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)	Adult	Child	Adult	Child
1,1 dichloroethane	MW-3	100	12.0	7.62E-04	2.36E-04	6.8	4.32E-04	1.34E-04	7.62E-06	2.36E-06	4.32E-06	1.34E-06
	MW-4	100	7.3	4.63E-04	1.44E-04	-	-	-	4.63E-06	1.44E-06	-	-
	MW-5	100	18.0	1.14E-03	3.54E-04	-	-	-	1.14E-05	3.54E-06	-	-
	MW-7	100	12.0	7.62E-04	2.36E-04	-	-	-	7.62E-06	2.36E-06	-	-
	MW-8	100	107.0	6.79E-03	2.10E-03	-	-	-	6.79E-05	2.10E-05	-	-
	MW-10	100	106.0	6.73E-03	2.08E-03	-	-	-	6.73E-05	2.08E-05	-	-
Mercury	MW-3	0.3	1.2	7.62E-05	2.36E-05	-	-	-	2.54E-04	7.86E-05	-	-
	MW-4	0.3	0.5	3.17E-05	9.83E-06	-	-	-	1.06E-04	3.28E-05	-	-
	MW-5	0.3	2.0	1.27E-04	3.93E-05	-	-	-	4.23E-04	1.31E-04	-	-
	MW-8	0.3	6.1	3.87E-04	1.20E-04	-	-	-	1.29E-03	4.00E-04	-	-
	MW-10	0.3	0.6	3.81E-05	1.18E-05	-	-	-	1.27E-04	3.93E-05	-	-
	MW-12	0.3	0.2	1.27E-05	3.93E-06	0.2	1.27E-05	3.93E-06	4.23E-05	1.31E-05	4.23E-05	1.31E-05

NOTE:
1. LADD is lifetime average daily dose from dermal contact with contaminated groundwater at the specified concentration
2. RfD values taken from the Region 9 Risk Based Concentration Table. These values represent a daily exposure level that is not harmful to human health, over a lifetime.
3. During 7/13/2006 sampling "-" designates none of this constituent was detected.
4. Dermal Values used the same RfD values as those used for Oral.
5. HI is the Hazard Index Risk = LADD/RfD
6. Formula used for calculations:

LADD = (C*K*EV*ED*EF*SA)/(BW*AT)

C = constituent concentration (ug/L)	
K = permeability coefficient (cm/day)	contaminant dependent
EV = event frequency	15 min/day
ED = Exposure Duration (years)	30 years for an adult, 8 years for a child
EF = Exposure Frequency (days/year)	365 days per year
SA = skin surface area (cm^2)	20,000cm^2 for adults and 9360 cm^2 for children
BW = Body weight (kg)	70 kg was used for adults, 28.2 kg for children
AT = Average Time (days)	30 years for adults and 8 for children

Table 7B: Non-Carcinogenic Toxicity Values for Oral Ingestion Exposure

Contaminant	Well	Reference Dose	Maximum Concentration (ug/L)	LADD Maximum		Concentration 7/13/2006 (ug/L)	LADD 7/13/2006		HI Risk Maximum		HI Risk 7/13/2006	
		Oral RfD (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)	Adult	Child	Adult	Child
1,1 dichloroethane	MW-3	100	12.0	0.34	0.43	6.8	0.19	0.24	3.43E-03	4.26E-03	1.94E-03	2.41E-03
	MW-4	100	7.3	0.21	0.26	-	-	-	2.09E-03	2.59E-03	-	-
	MW-5	100	18.0	0.51	0.64	-	-	-	5.14E-03	6.38E-03	-	-
	MW-7	100	12.0	0.34	0.43	-	-	-	3.43E-03	4.26E-03	-	-
	MW-8	100	107.0	3.06	3.79	-	-	-	3.06E-02	3.79E-02	-	-
	MW-10	100	106.0	3.03	3.76	-	-	-	3.03E-02	3.76E-02	-	-
Mercury	MW-3	0.3	1.2	0.03	0.04	-	-	-	0.11	0.14	-	-
	MW-4	0.3	0.5	0.01	0.02	-	-	-	0.05	0.06	-	-
	MW-5	0.3	2.0	0.06	0.07	-	-	-	0.19	0.24	-	-
	MW-8	0.3	6.1	0.17	0.22	-	-	-	0.58	0.72	-	-
	MW-10	0.3	0.6	0.02	0.02	-	-	-	0.06	0.07	-	-
	MW-12	0.3	0.2	0.01	0.01	0.2	0.01	0.01	0.02	0.02	0.02	0.02

NOTE:
1. LADD is lifetime average daily dose from ingested groundwater at the specified concentration.
2. RfD values taken from the Region 9 Risk Based Concentration Table. These values represent a daily exposure level that is not harmful to human health, over a lifetime.
3. During 7/13/2006 sampling "-" designates none of this constituent was detected.
4. HI is the Hazard Index Risk = LADD/RfD
5. Formula used for calculations:

LADD = (C*IR*ED)/(BW*AT)

C = Constituent Concentration (ug/L)

IR = Ingestion Rate (L/day)	An ingestion rate of 2L/day was used for adults 1L/day for children
ED = Exposure Duration (days)	An exposure duration of 30 years was used for adults, 8 for children
BW = Body Weight (kg)	An average weight of 70 kg was used for adults, 28.2 kg for children
AT = Average Time (days)	Times of 30 years for adults and 8 for children were used

Table 7C: Non-Carcinogenic Toxicity Values for Inhalation Exposure

Contaminant	Well	Reference Dose	Maximum Concentration (ug/L)	LADD Maximum		Concentration 7/13/2006 (ug/L)	LADD 7/13/2006		HI Risk Maximum		HI Risk 2/13/2006	
		Inhalation RfD (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)		Adult (ug/kg-day)	Child (ug/kg-day)	Adult	Child	Adult	Child
1,1 dichloroethane	MW-3	140	12	1.71	2.55	6.8	9.71E-01	1.45E+00	0.01	0.02	6.94E-03	1.03E-02
	MW-4	140	7	1.04	1.55	-	-	-	0.01	0.01	-	-
	MW-5	140	18	2.57	3.83	-	-	-	0.02	0.03	-	-
	MW-7	140	12	1.71	2.55	-	-	-	0.01	0.02	-	-
	MW-8	140	107	15.29	22.77	-	-	-	0.11	0.16	-	-
	MW-10	140	106	15.14	22.55	-	-	-	0.11	0.16	-	-
Mercury	MW-3	0.86	12	1.71	2.55	-	-	-	1.99	2.97	-	-
	MW-4	0.86	0.5	0.07	0.11	-	-	-	0.08	0.12	-	-
	MW-5	0.86	2	0.29	0.43	-	-	-	0.33	0.49	-	-
	MW-8	0.86	6	0.87	1.30	-	-	-	1.01	1.51	-	-
	MW-10	0.86	7	1.00	1.49	-	-	-	1.16	1.73	-	-
	MW-12	0.86	0.2	0.03	0.04	0.2	2.86E-02	4.26E-02	0.03	0.05	0.03	0.05

NOTE:
1. LADD is lifetime average daily dose from inhaled at the specified concentration.
2. RfD values taken from the Region 9 Risk Based Concentration Table. These values represent a daily exposure level that is not harmful to human health, over a lifetime.
3. During 7/13/2006 sampling "-" designates none of this constituent was detected.
4. HI is the Hazard Index Risk = LADD/RfD
5. Formula used for calculations:

LADD = (C*IR*ED*K)/(BW*AT)

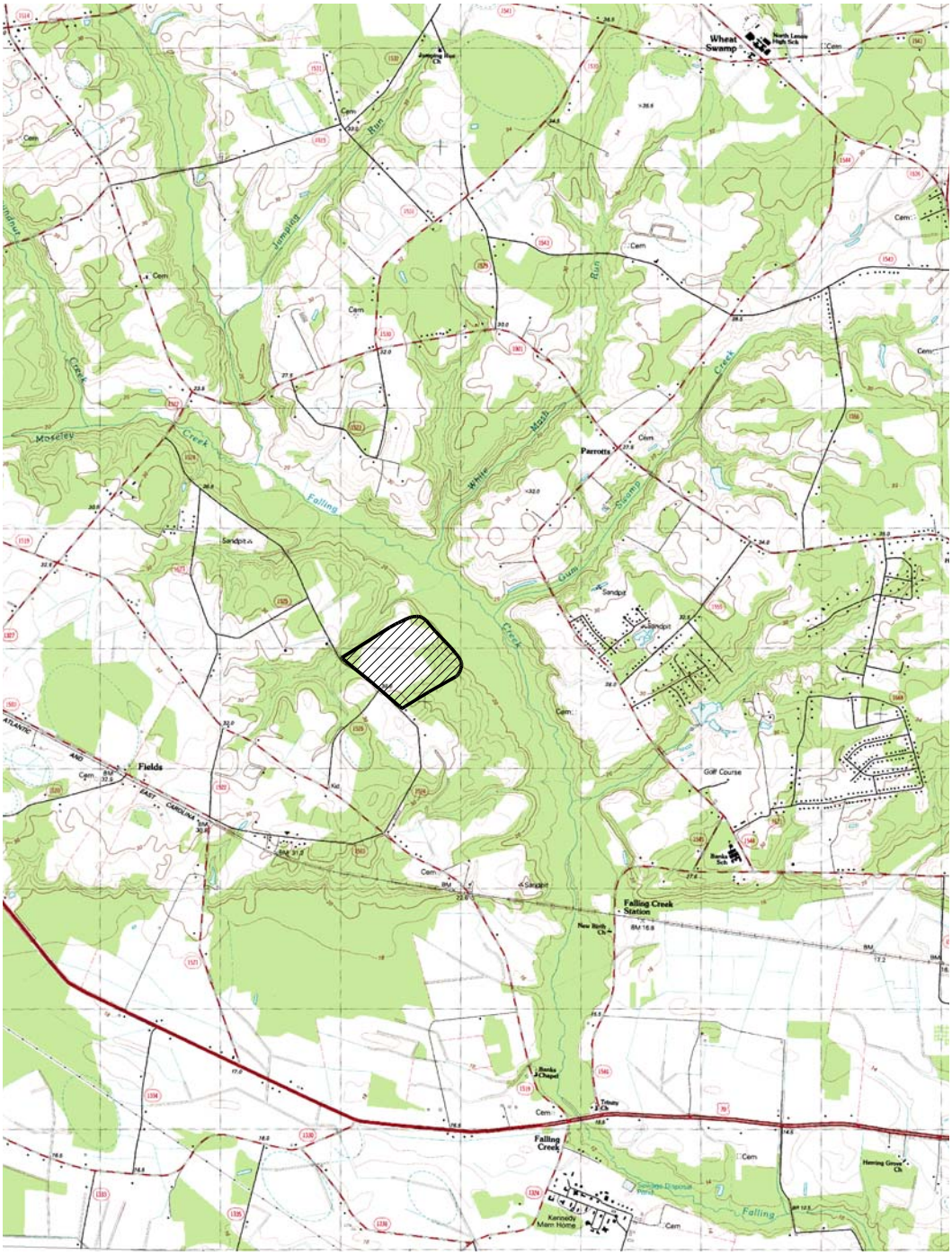
C = Constituent Concentration (ug/L)	
K = Volatilization Factor	A volatilization factor of 0.5L/m^3 was used based on EPA published values
IR = Inhalation Rate (m^3/day)	20 m^3/day was used for adults and 12m^3/day was used for children
ED = Exposure Duration (days)	An exposure duration of 30 years was used for adults, 8 for children
BW = Body Weight (kg)	An average weight of 70 kg was used for adults, 28.2 kg for children
AT = Average Time (days)	Times of 30 years for adults and 8 for children were used

PLATES

Topographic Map with Site Location

Corrective Action Plan

PLATE 1 Lenoir County Sanitary Landfill



QUADRANGLE LEGEND

ROAD CLASSIFICATION

Primary highway, hard surface

Light-duty road, hard or improved surface

Secondary highway, hard surface

Unimproved road

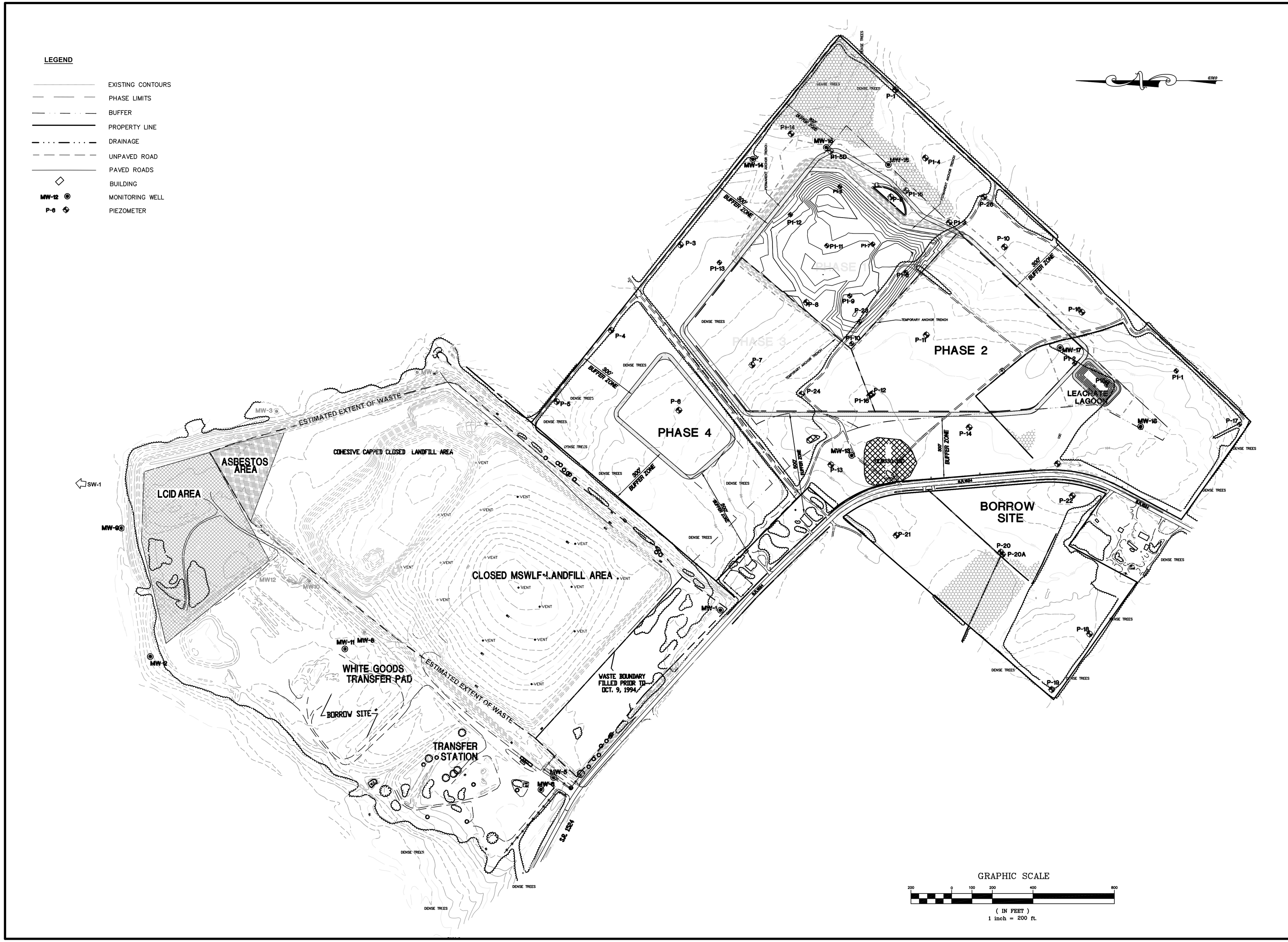
Interstate Route

U. S. Route

State Route

Date Completed	5/31/2007
Created By	M. German
Project Name	Corrective Action Plan
Site Name	Lenoir County Sanitary Landfill
Project Number	G07062.0

Municipal Engineering Services Company, PA



Municipal Services Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 628 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SITE MAP

SCALE:	1" = 200'
DATE:	2/12/09
DRWN. BY:	K. BUSSIE
CHKD. BY:	S. PATRICK
PROJECT NUMBER	G07062.0
DRAWING NO.	PLATE 2
SHEET NO.	1 OF 1

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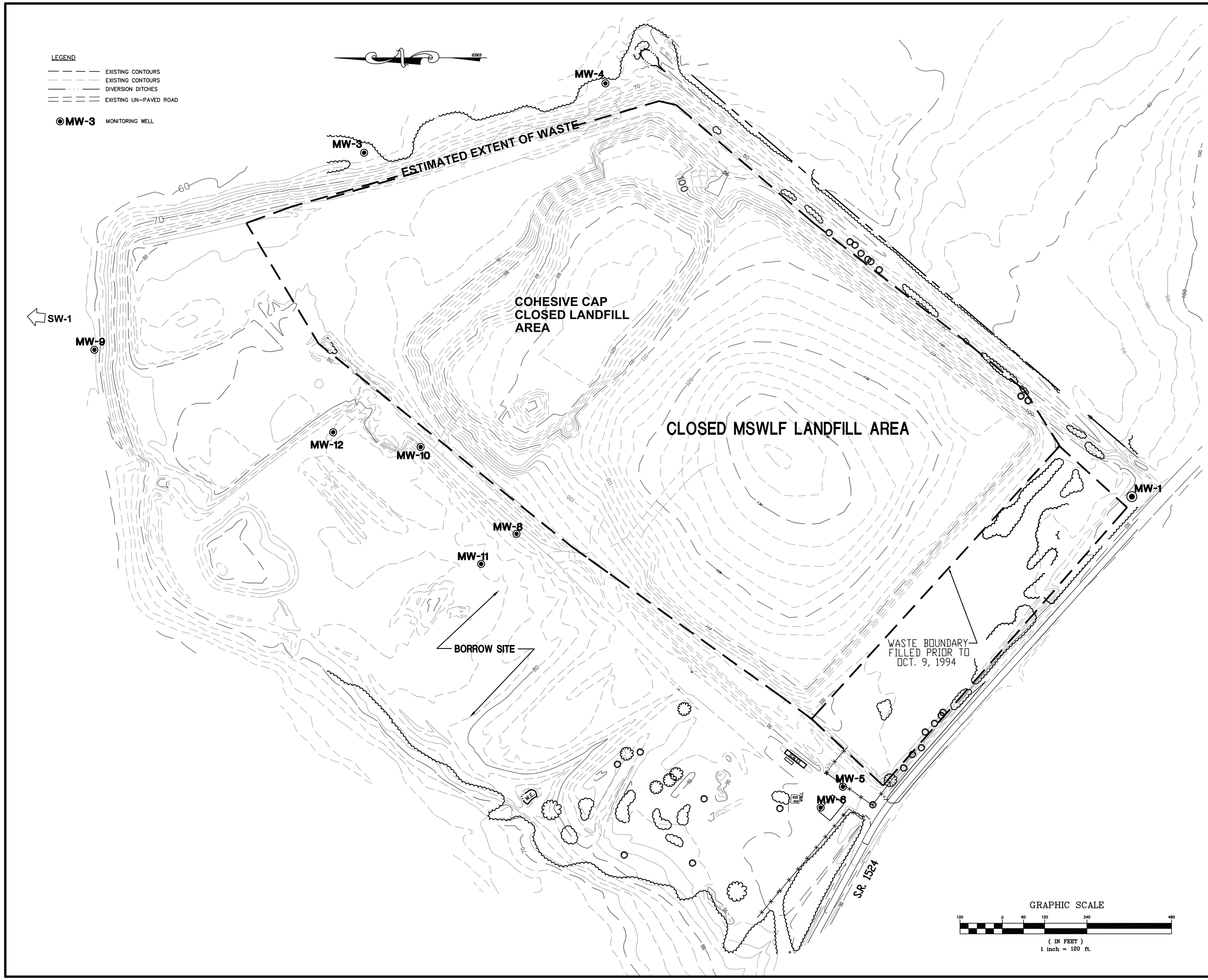

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P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 628 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SITE MAP
WITH SAMPLING LOCATIONS

SCALE:	1" = 120'
DATE:	2/10/09
DRWN. BY:	K. BUSSIE
CHKD. BY:	S. PATRICK
PROJECT NUMBER	G07062.0
DRAWING NO.	PLATE 3
SHEET NO.	1 OF 1

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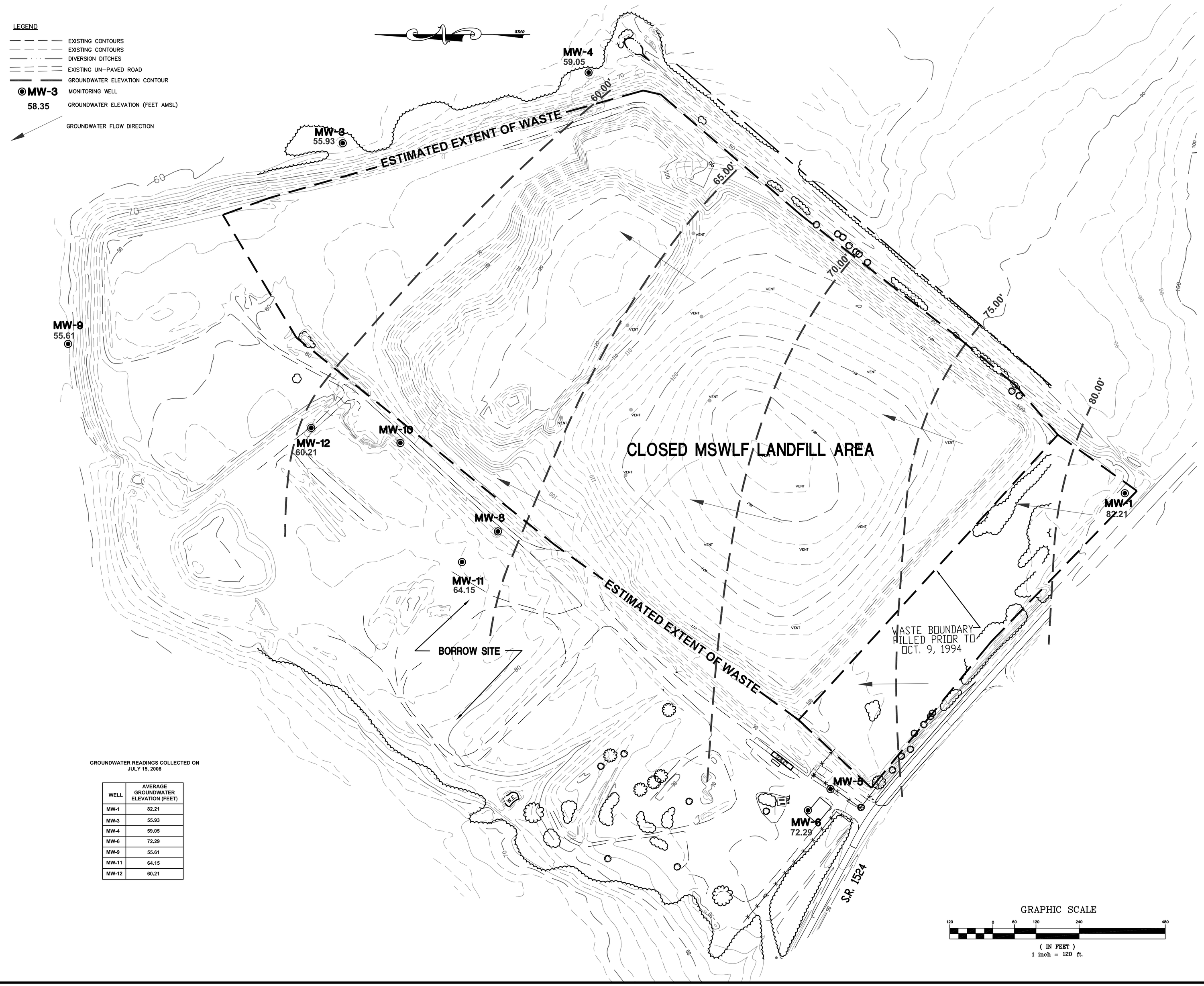

GROUNDWATER READINGS COLLECTED ON JULY 15, 2008

WELL	AVERAGE GROUNDWATER ELEVATION (FEET)
MW-1	82.21
MW-3	55.93
MW-4	59.05
MW-6	72.29
MW-9	55.61
MW-11	64.15
MW-12	60.21

Municipal Services Engineering Company, P.A.
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P.O. BOX 628 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SINGLE-DAY POTENTIOMETRIC SURFACE MAP

SCALE: 1" = 120'
DATE: 2/11/2009
DRWN. BY: S. PATRICK
CHKD. BY: S. PATRICK
PROJECT NUMBER G07062.0
DRAWING NO. PLATE 4
SHEET NO. 1 OF 1

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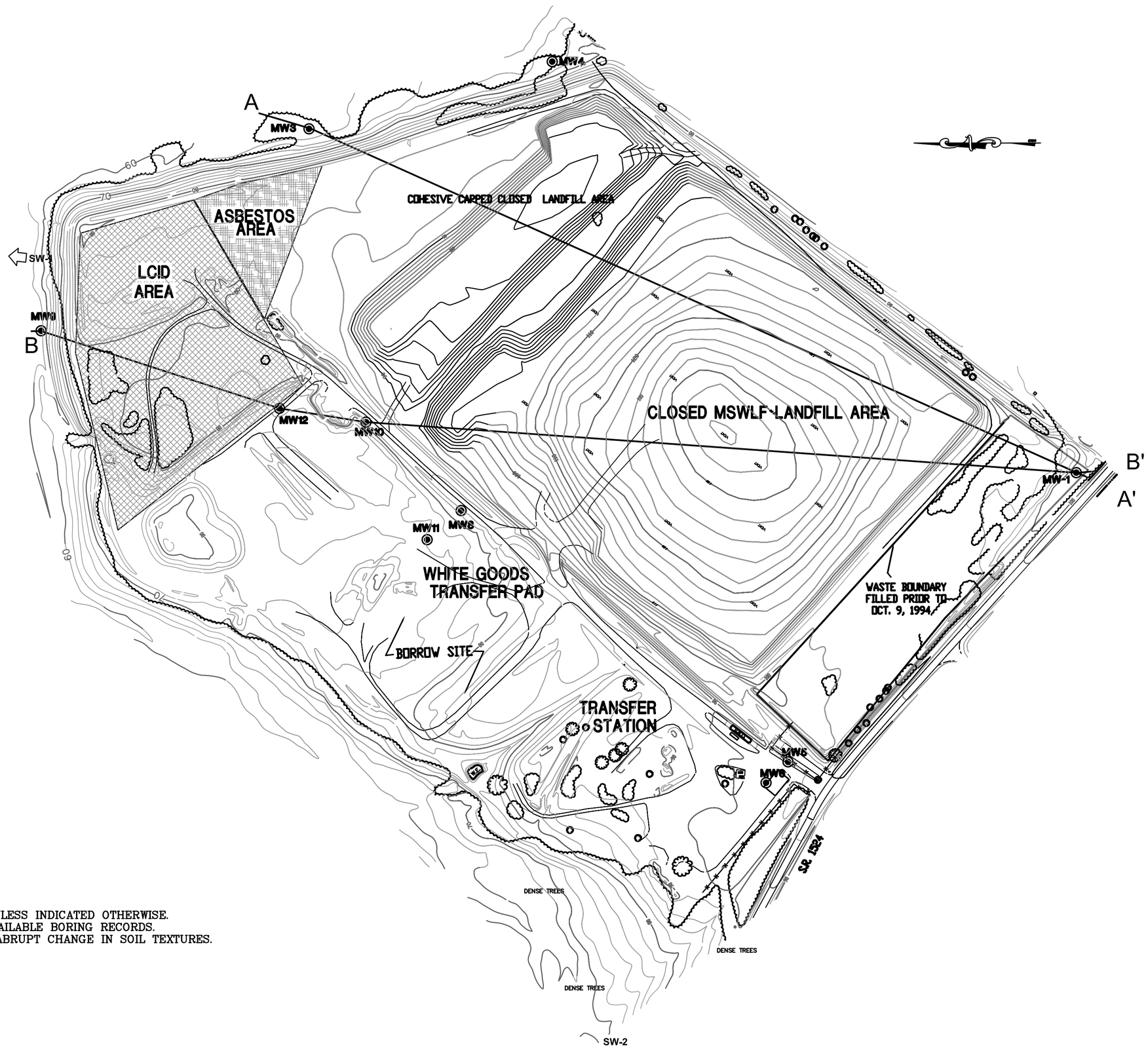
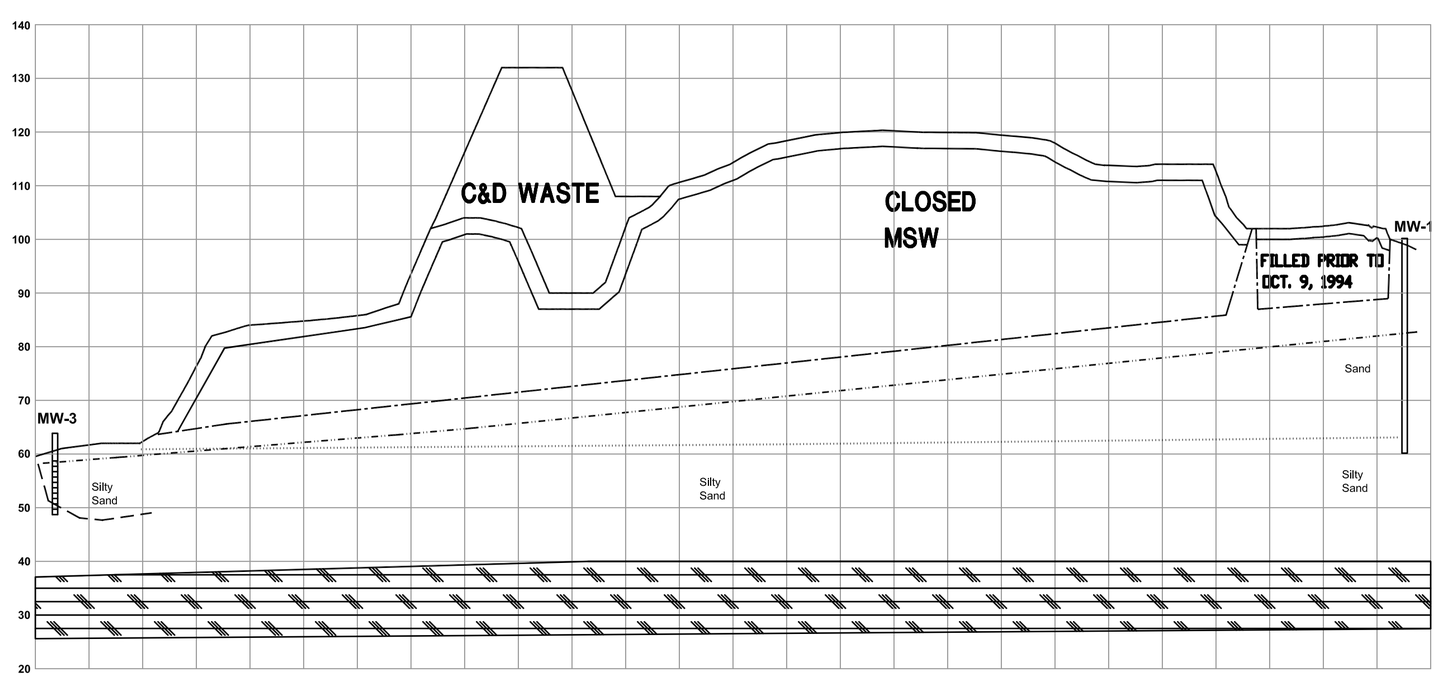
LEGEND

- EXISTING COUNTOURS
- PHASE LIMITS
- BUFFER
- PROPERTY LINE
- DRAINAGE
- UNPAVED ROAD
- PAVED ROADS
- BUILDING
- MW12 MONITORING WELL
- P-6 PIEZOMETER



NOTE:
- NUMBERS SHOWN IN THIS PLATE ARE IN UNITS OF FEET UNLESS INDICATED OTHERWISE.
- SOIL PROFILES SHOWN HEREIN ARE INTERPOLATED FROM AVAILABLE BORING RECORDS.
- SOIL PROFILE BOUNDARIES DO NOT NECESSARILY INDICATE ABRUPT CHANGE IN SOIL TEXTURES.



SECTION A-A'

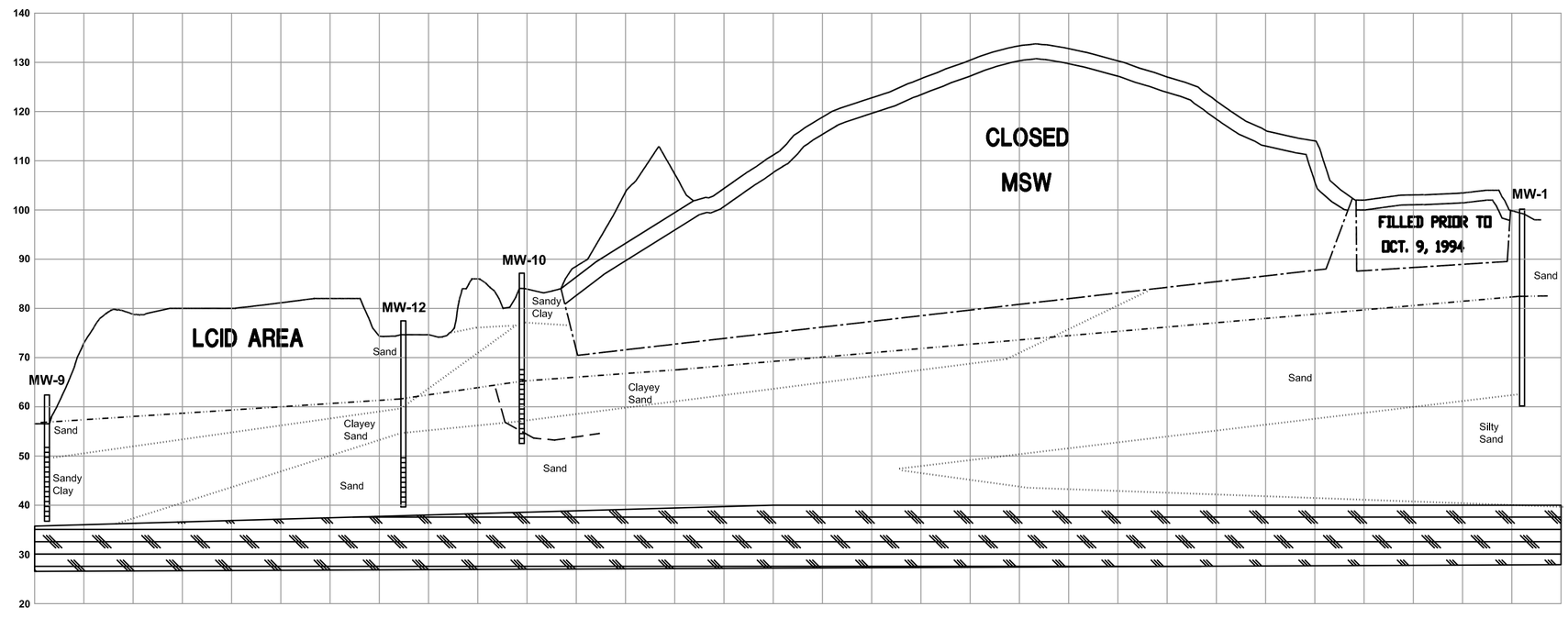
APPROX. SCALE HORIZ. 1" = 200'
VERT. 1" = 20'

LEGEND:

- NEW C&D WASTE
- TOP OF MSW WITH COVER
- ESTIMATED BASE OF MSW
- AVERAGE GROUNDWATER
- ESTIMATED STRATIGRAPHIC CONTENT
- ESTIMATED PEEDEE CONFINING LAYER
- ESTIMATED EXTENT OF VOC CONTAMINATION (JANUARY 10, 2002)

MW-12 MONITORING WELL

SCREENED SECTION



SECTION B-B'

APPROX SCALE HORIZ. 1" = 200'
VERT. 1" = 20'

DATE	BY	REV.	DESCRIPTION

SCALE: AS SHOWN
DATE: 8/28/07
DRWN. BY: M. CLEMENT
CHKD. BY: E. CALDWELL
PROJECT NUMBER G07062.0
DRAWING NO. PLATE 5
SHEET NO. 1 OF 1

CROSS SECTIONS

LENOIR COUNTY CONSTRUCTION & DEMOLITION LANDFILL FACILITY NORTH CAROLINA

Municipal Services Engineering Company, P.A.
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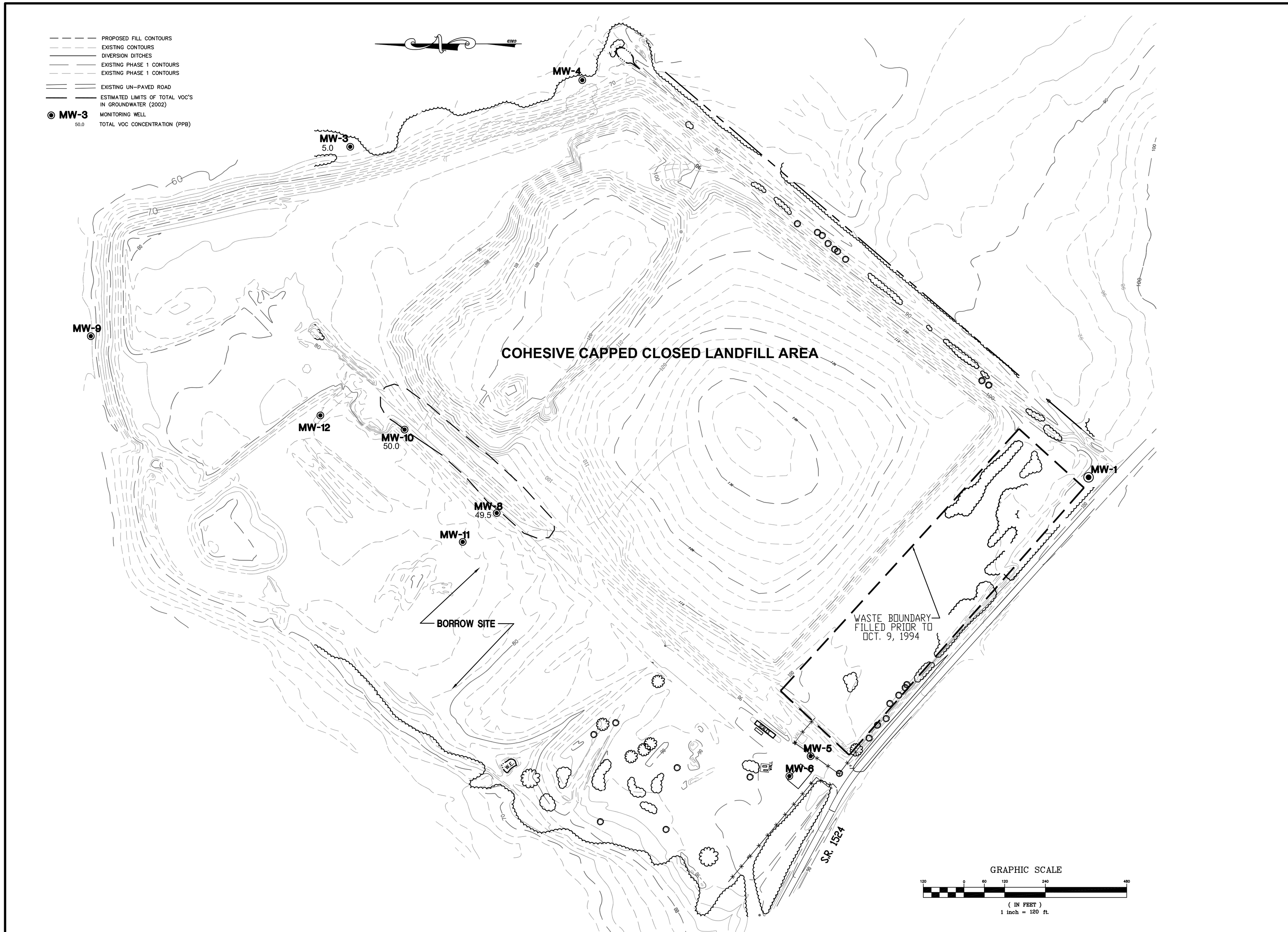
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

H:\C&D CAD\graphics\PLate 5 - x-section.dwg 2/12/2008 11:41:33 AM SYE SKP



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MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

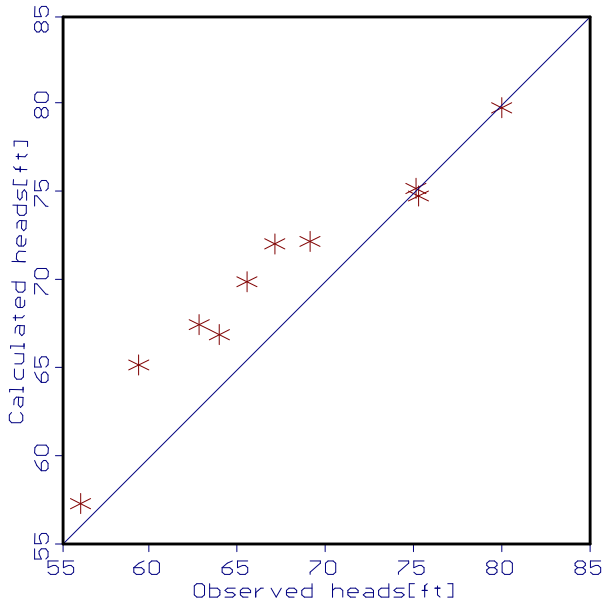
TOTAL VOC CONCENTRATION MAP

SCALE:	1" = 120'
DATE:	2/11/09
DRWN. BY:	K. BUSSIE
CHKD. BY:	S. PATRICK
PROJECT NUMBER	G07062.0
DRAWING NO.	PLATE 6
SHEET NO.	1 OF 1

H:\C&D CAP\Lenoir\CAD\Plate 6 - VOCs.dwg, 2/11/2009 3:51:30 PM, SKP,SKP

APPENDIX A

APPENDIX C
FROM
ASSESSMENT OF CORRECTIVE MEASURES REPORT
AUGUST 30, 2007



Period: 1

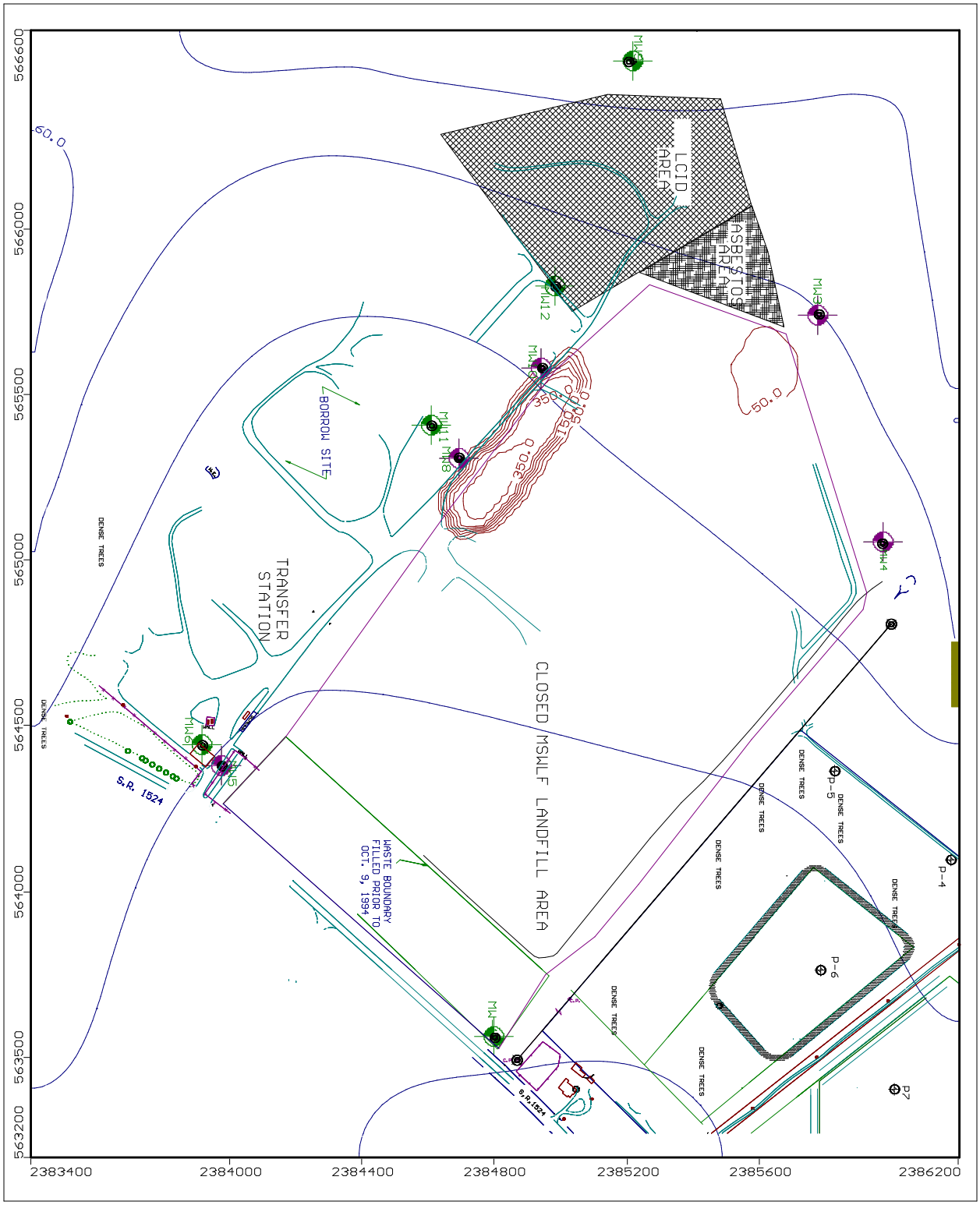
Step: 1

Mean error: 2.55808

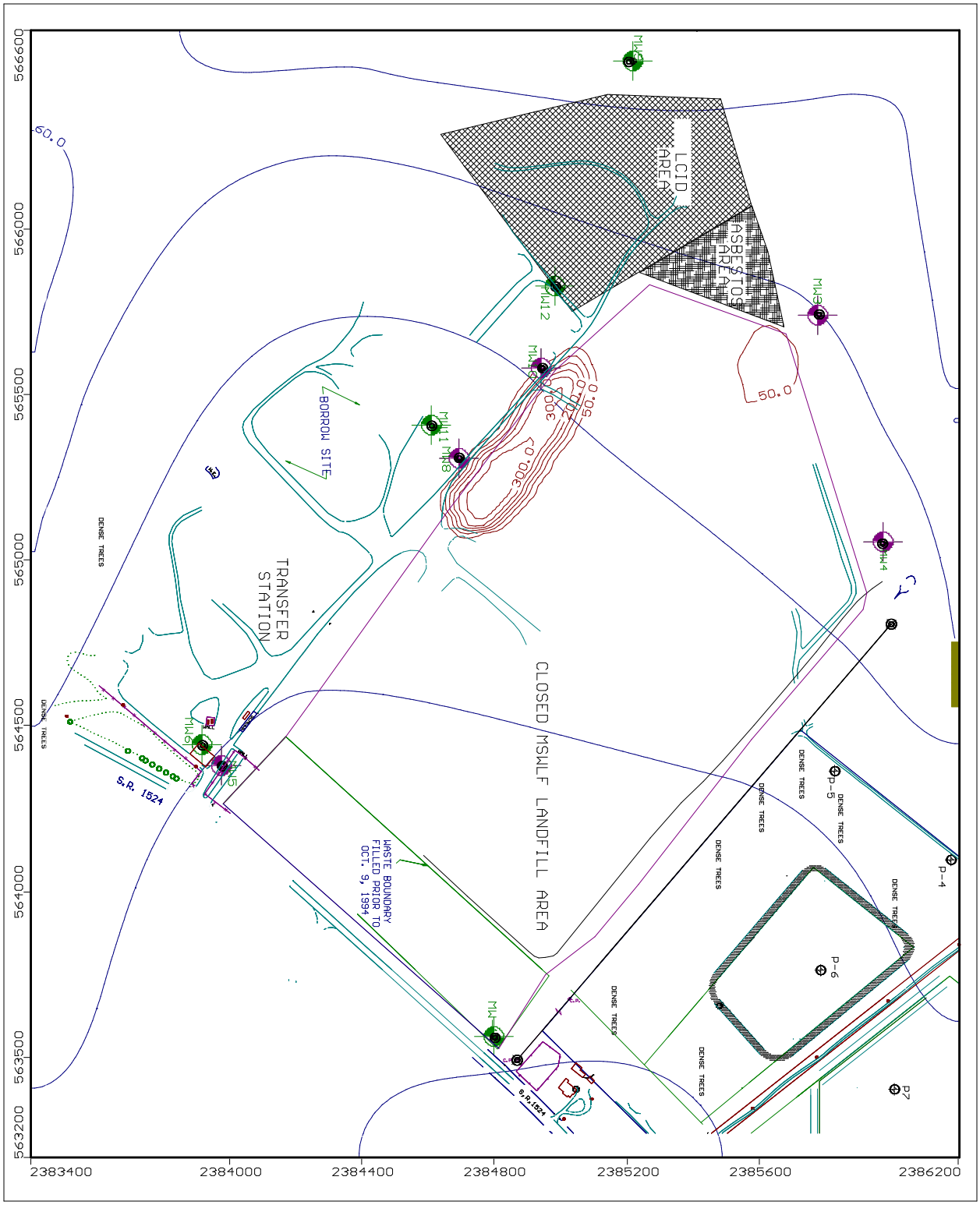
Mean abs. err: 2.74533

RMS error: 3.39692

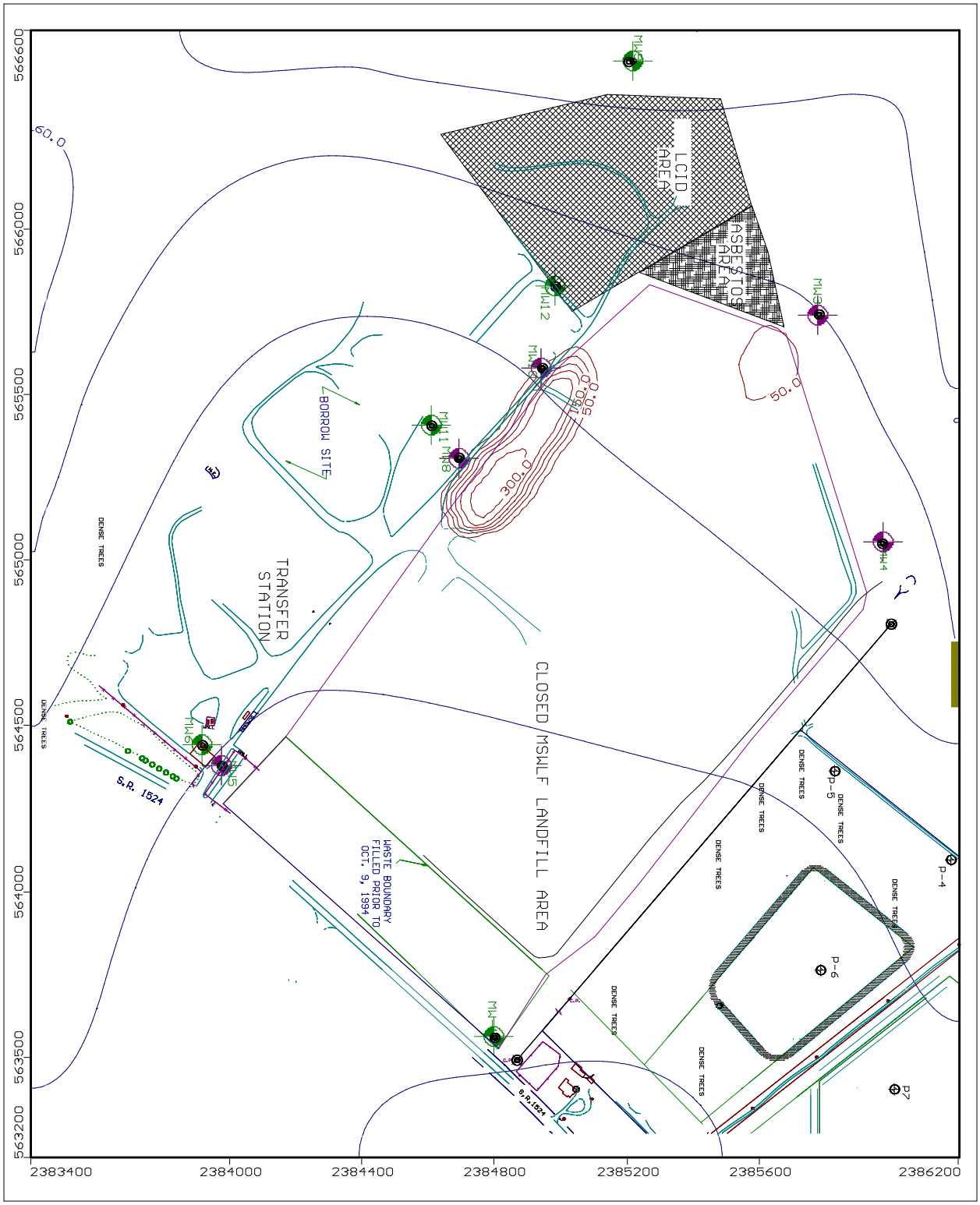
Scaled RMS: 14.1597



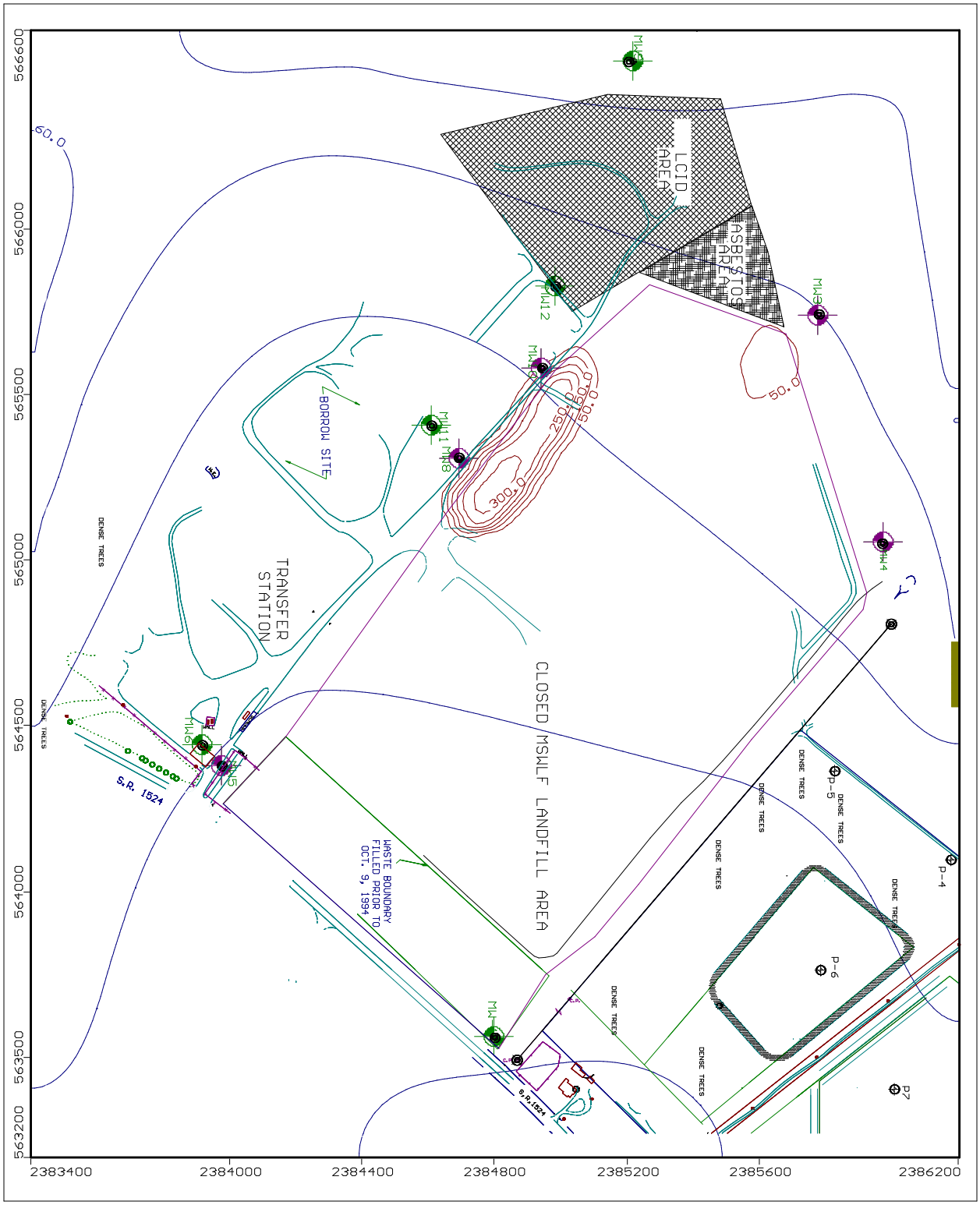
MODFLOW 5 Year Simulation
1995 VOC Concentration



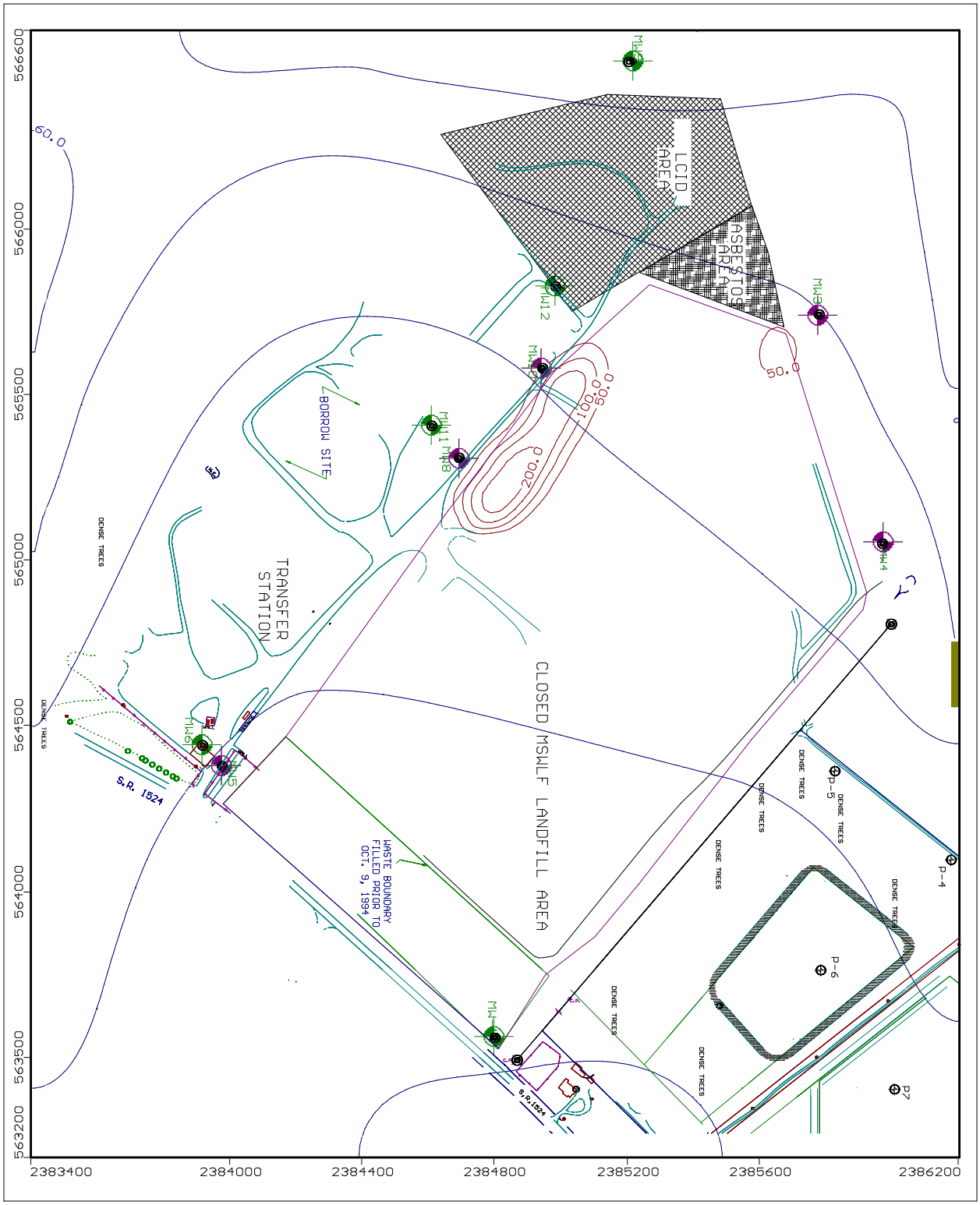
MODFLOW 10 Year Simulation
2000 VOC Concentration



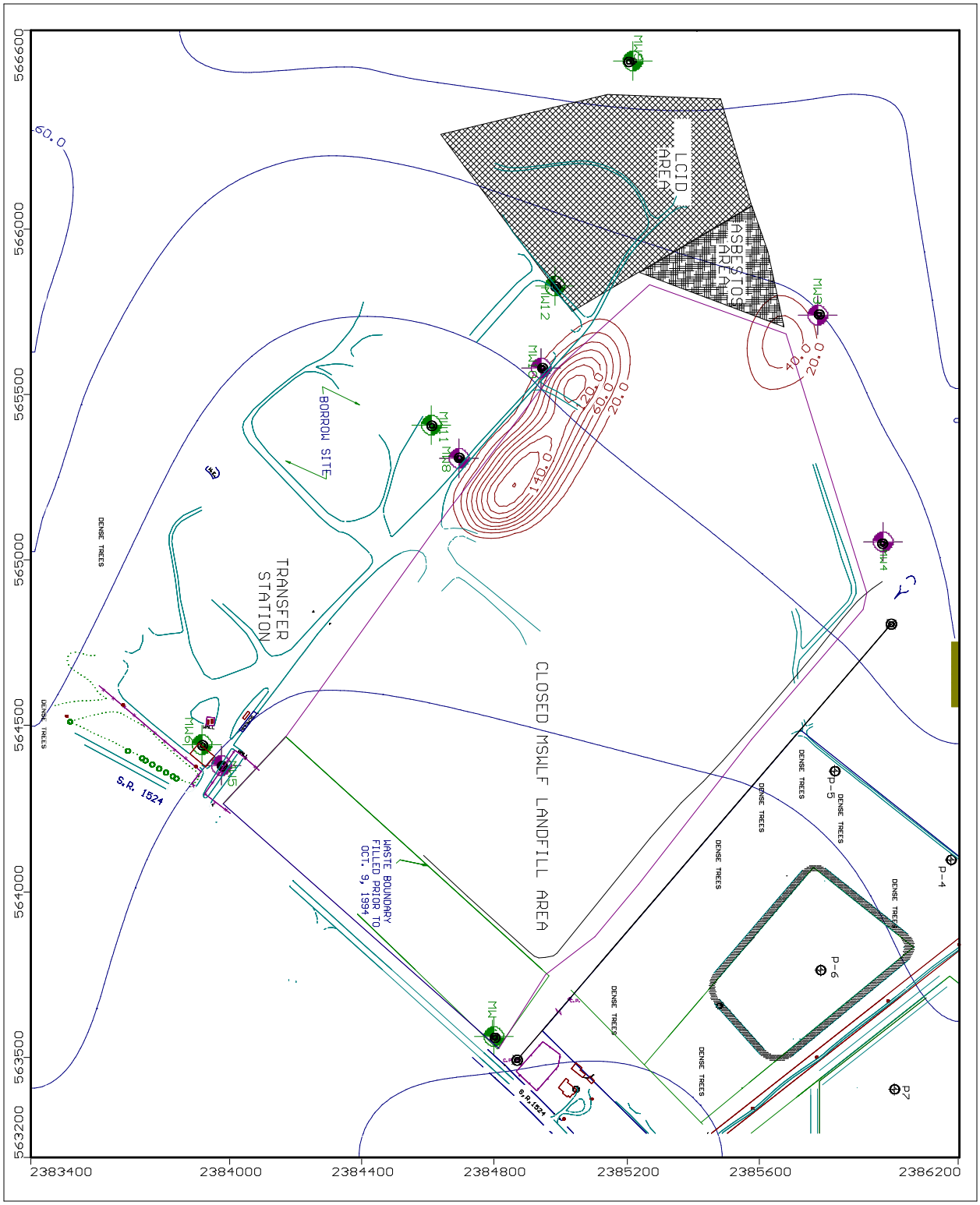
MODFLOW 11 Year Simulation
2001 VOC Concentration



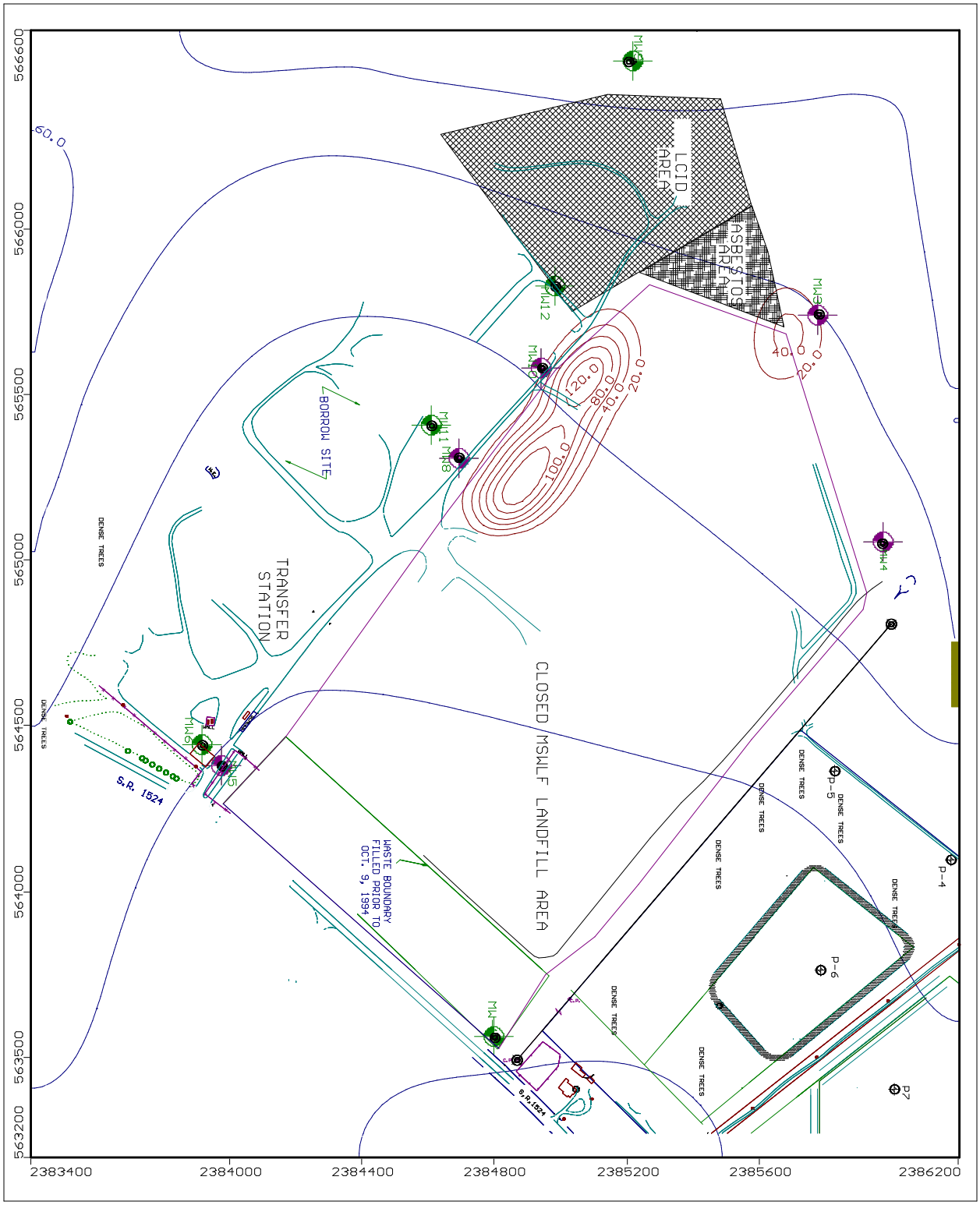
MODFLOW 12 Year Simulation
2002 VOC Concentration



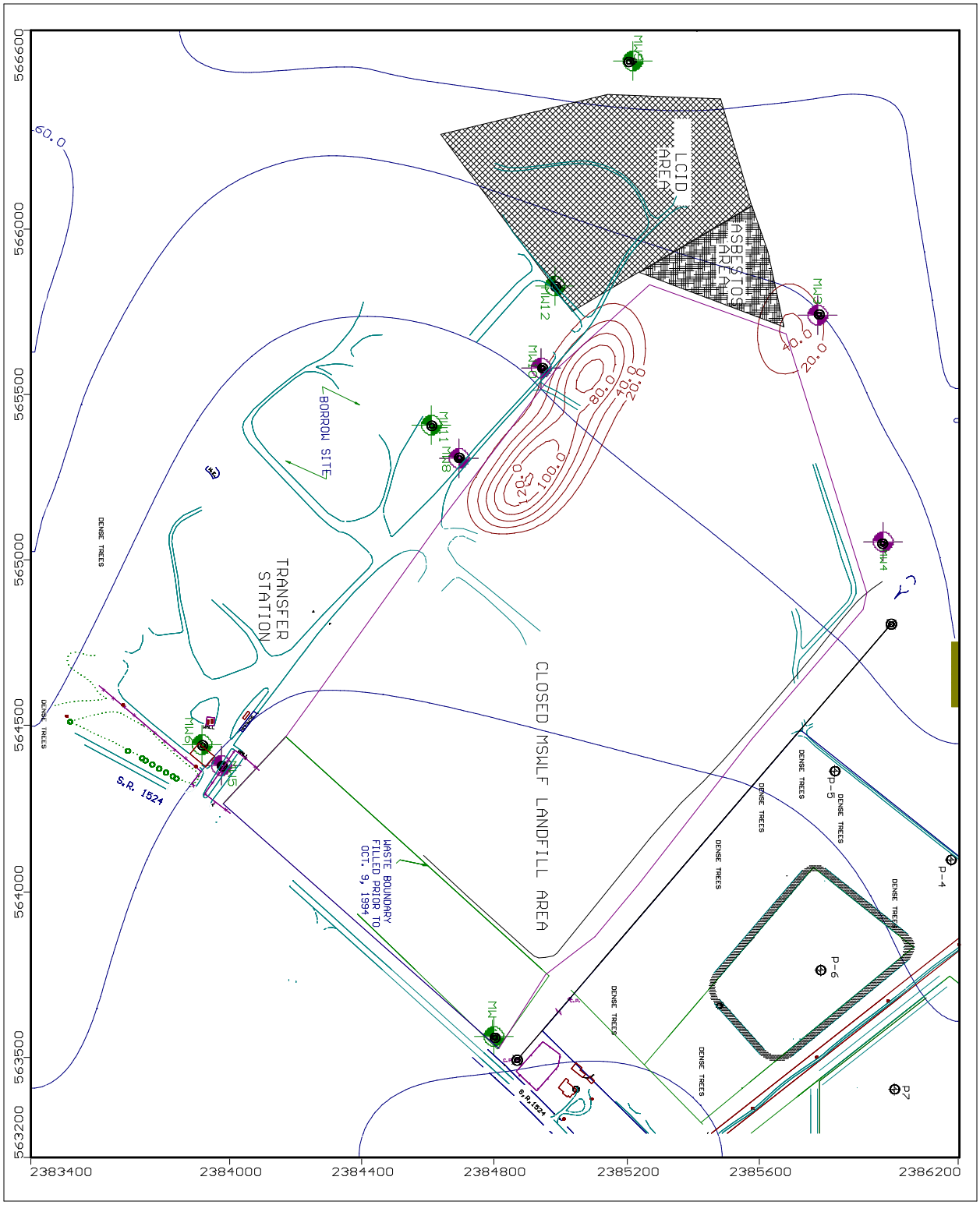
MODFLOW 25 Year Simulation
2015 VOC Contamination



MODFLOW 35 Year Simulation
2025 VOC Contamination



MODFLOW 45 Year Simulation
2035 VOC Contamination



MODFLOW 50 Year Simulation
2040 VOC Contamination

APPENDIX B

Ground and Surfacewater Sampling and Analysis Plan

Prepared for

Lenoir County C&D Landfill
La Grange, North Carolina

MESCO Project Number: G07062.0

This report is included as Appendix B the
Corrective Action Plan completed for Lenoir County.

Completed on 2/13/2009
Revised on 4/30/2009

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

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ATTACHMENTS

Attachment 1 ..... NCDENR Solid Waste Section Sampling & Monitoring Guidance

1 INTRODUCTION

1.1 Objective

The objective of the Ground and Surfacewater Sampling and Analysis Plan (SAP) is to provide clear guidelines and procedures for field and laboratory personnel when obtaining and testing ground and surface water samples. This plan is an update, and supersedes the November 1995 SAP for the Lenoir County C&D landfill on top of MSW landfill. The sampling procedures outlined in this analysis plan are guidelines by which sampling will be performed. Deviation from the procedures may be warranted depending on facility conditions or unforeseen sampling variables. Alternative sampling procedures must conform to the N.C. Water Quality Monitoring Guidance Document for Solid Waste Facilities (Guidance Document). Copies of the NCDENR Solid Waste Section technical guidelines for sampling and monitoring are presented in the **Attachments**.

All groundwater and surfacewater monitoring points shall be sampled semi-annually for the constituents listed in Appendix I plus mercury. In addition to the Appendix I constituents, the monitoring wells will be sampled for the following suite of Monitored Natural Attenuation (MNA) parameters as per SWS guidelines:

MNA Performance Parameters		
Parameter	**Analysis Type**	**Analytical Method**
Dissolved Oxygen (DO)	Field Reading	Multi-parameter Field Instrument w/ flow-through cell
pH	Field Reading	
Oxidation-Reduction Potential (ORP)	Field Reading	
Turbidity	Field Reading	
Conductivity	Field Reading	
Temperature	Field Reading	
Dissolved CO_2	Field Reading	Field Instrument / Hach Kit
Alkalinity (Total as $CaCO_3$)*	Laboratory/Field*	EPA 310.2
Chloride*	Laboratory/Field*	SM 4500-CLB
Iron	Laboratory	SM3111B
Nitrate*	Laboratory/Field*	EPA 353.2 / SM 2320B
Sulfate*	Laboratory/Field*	EPA 375.4 / SM 4500-SO4E
Sulfide*	Laboratory/Field*	EPA 376.1 or SM 4500SE
TOC/BOD/COD	Laboratory	EPA 415.1 / EPA 405.1 / EPA 410.1
Methane	Laboratory	RSK 175
Ethane, Ethene	Laboratory	RSK 175
Hydrogen	Laboratory	AM19GA
Volatile Fatty Acids	Laboratory	AM23G
*For budgetary considerations these analyses may be performed in the field using Hach® brand color wheel test kits. Historical iron concentrations have exceeded Hach kit quantitation limits.		

1.2 Water Quality Monitoring Summary

The monitoring plan consists of seven (7) monitoring wells (MW-1, MW-3, MW-4, MW-6, MW-9, MW-11, and MW-12), and two (2) surfacewater monitoring points (SW-1 and SW-2). Monitoring points included in this plan are summarized in **Table E-1**. A topographic map is provided as **Plate A**. Locations of monitoring points are shown on **Plate B**.

Monitoring well MW-1 is the background well located upgradient of the MSW Landfill. MW-3 is a downgradient monitoring well located at the northeastern tip of the facility, designed to intersect groundwater flow coming from the center of the facility. MW-4 is a downgradient monitoring well on the eastern side of the sanitary unit. MW-6 is a downgradient well located near the scale house in the south western portion of the landfill, detecting contamination flowing in a more northern direction. MW-8 is a downgradient well located north of the landfill along the unpaved road, monitoring the center of the landfill as well as the property north of center. MW-9 is the northernmost downgradient monitoring well positioned to detect an unexpected release from the northeastern portion of the landfill, prior to reaching Fredricks Branch. MW-10 is a downgradient monitoring well designed to intersect the northern groundwater flow from the southwest/south portion of the landfill based on transport by advection. MW-11 is a downgradient monitoring well for the southern portion. MW-12 is a downgradient well designed to intersect the northern groundwater flow from the southwest/south portion of the landfill.

Surfacewater sampling point SW-1 is located downstream of the landfill, and sampling point SW-2 is located upstream of the landfill, along Fredericks Branch. Surfacewater sampling locations are shown in **Plate B**.

Monitoring wells MW-3 and MW-4 were installed in September 1991, and MW-5 was installed in May 1992. It is unclear when monitoring well MW-6 was installed. There is no information on MW-7. Verbal communication with field personnel implied that MW-7 was not installed. Boring logs and/or well construction records for MW-6 and MW-7 could not be located.

Detection Monitoring

Detection monitoring will be performed on all monitoring locations. Detection monitoring will consist of collection of groundwater for analysis for the complete list of Appendix I constituents plus mercury. Additionally, field parameters including dissolved oxygen (DO), oxidation reduction potential (ORP), pH, temperature, turbidity, and conductivity will also be collected.

1.3 Sampling Equipment

Groundwater purging and sampling will be performed using a submersible pump and disposable polyethylene bailers. A new bailer will be used to sample each individual well. *Under no circumstance will a disposable bailer used to sample a given well be used to sample any remaining well.* The following procedure will be used to decontaminate the submersible pump:

1. Phosphate-free detergent & de-ionized or distilled water rinse.
2. De-ionized or distilled water rinse.
3. Isopropyl alcohol (isopropanol) rinse.
4. De-ionized or distilled water rinse.

At least one (1) equipment blank will be collected during pump decontamination procedures to ensure that cross-contamination has not occurred as a result of the decontamination process. The standard equipment necessary to conduct sampling for each well consists of sample containers (including trip blanks and equipment blanks), one wide-mouth container, at least one 100-ft spool of nylon twine, at least one box of disposable latex/nitrile gloves, temperature/pH/ORP/conductivity indicator, water level indicator, storage coolers, and ice. All equipment subject to damage and contamination will be transported in sealed, plastic bags or storage containers. The water level indicator will be decontaminated in accordance with Steps 2 and 3 described above prior to placement in a clean plastic bag or storage container.

1.4 Sampling Containers

Ground and surfacewater monitoring will include organic (volatile organic compounds- VOCs) and inorganic (metals) analyses. Samples will be collected for the various analyses in laboratory supplied containers.

1. Each sample container will be clearly labeled providing the following information: site name, county location, sample identification number, parameters to be analyzed, preservative added, date and time of sampling, and initials of the sampler.
2. Samples to be analyzed for VOC concentrations will be collected first in three 40-ml glass vials with Teflon septa caps. The sample vials will be completely filled to create zero headspace in the vials.
3. Samples to be analyzed for inorganic contamination will be collected second in a quart/1-liter polyethylene container.

All sample containers will be obtained from an independent laboratory in a sterilized condition and with the appropriate, method-specific preservative. Care will be taken by the field technician to not allow the preservative to wash out of the sample containers during sampling.

Appendix I Sampling Containers

Samples to be analyzed for VOC concentrations will be collected into three 40-ml glass vials with Teflon septa caps. The sample vials will be completely filled with zero headspace in the vials. Samples to be analyzed for inorganic compound concentrations will be collected into 1-liter polyethylene containers, with ½ inch space for air permitted. All sample containers will be obtained from an independent laboratory in a sterilized condition. Some of the containers will have a pre-measured amount of preservative in them as necessary. In this event, care will be taken not to rinse the container or to allow the preservative to wash out during sampling.

MNA Sampling Containers

Groundwater samples to be analyzed for MNA performance parameters will be collected into the container types listed in the table below.

MNA Parameter	Volume	Bottle Type	Preservative
Alkalinity	250 mL	Plastic	none; cool to 4°C
Chloride	125 mL	Plastic	none; cool to 4°C
TOC/COD	250 mL	Glass	Sulfuric acid (H_2SO_4)
BOD	500 mL	Polyethylene	none; cool to 4°C
Iron	125 mL	Plastic	Nitric acid (HNO_3)
Nitrate	125 mL	Plastic	Sulfuric acid (H_2SO_4)
Sulfate	125 mL	Plastic	none; cool to 4°C
Sulfide	250 mL	Glass	Sodium hydroxide (NaOH)
Methane/Ethane/Ethene	125 mL	Plastic	none; cool to 4°C
Hydrogen	-	-	proprietary lab sampler
Volatile Fatty Acids	40 mL	Glass	Hydrochloric Acid (HC1)

2 SAMPLING

Wells will be sampled from upgradient to downgradient; or when previous analytical data is available, from least to greatest contamination. This procedure is required to limit the potential of cross contamination between sampling points.

2.1 Set-Up

A clean sheet of plastic will be placed around the well to provide a clean surface for sampling equipment. The total well depth read from the well tag and the measured depth to water, determined using the water level

indicator, will be used to compute the depth of water in the well. The total well depth will be measured and compared to the depth indicated on the well tag as a check for silt buildup or blockage at depth.

All meters used to monitor purge parameters will be calibrated immediately prior to purging and sampling, and those readings recorded in a field logbook. Entries will always include pre- and post- calibration readings as well as the model and serial number of the equipment and the date, time, and person performing the calibration(s). Two standards, which bracket the average or suspected measurements for pH and specific conductance, will be used at the site. Since natural waters (including those impacted by environmental contaminants) tend to have pH values less than 7.0, pH buffers of 4.0 and 7.0 will typically be used for instrument calibration.

Disposable nitrile gloves will be worn by the field technician during sampling to minimize the risk of personal exposure to potentially harmful chemical substances and to minimize the risk of sample cross-contamination. Fresh pairs of nitrile gloves will be worn during each purge and sampling event. The groundwater samples will be transferred from the bailers into method-specific and appropriately preserved containers and placed into a clean cooler containing ice to chill the samples to a temperature of approximately 4°C.

Indicator parameters such as pH, temperature and specific conductance will be measured during purging as an indication that groundwater representative of the formation surrounding a given well is being sampled. Purging is considered complete when at least three well volumes have been purged and indicator parameters have stabilized such that three successive readings vary by no more than 10%. Purging may need to be continued beyond five well volumes if indicator parameters have not stabilized. All information will be recorded on a field data sheet or in a field logbook with copies submitted to the Division of Waste Management with the analytical results.

2.2 Purging

Each well will be purged of approximately three (3) to five (5) volumes of standing water and allowed to settle prior to collection of groundwater samples. If the well should go dry and not recharge before the requisite well volumes are removed, the well will be allowed to recharge and a sample will be collected within 24 hours of the initial purging. The amount of standing water will be calculated by first subtracting the depth-to-water from total well depth. The amount of water in the well (in gallons) will then be determined by using the chart on **Plate C**. For example, a two-inch well that is 29 feet deep and contains 19 feet of standing water will have a well volume of ~3.3 gallons.

After determination of the amount of water to be purged from a given well, the equipment necessary for purging will be assembled at the well. The disposable bailer will be maintained in a stable, upright position while the upper portion of the plastic wrapping will be pulled away to expose only the eyelet used for securing twine to the bailer. After the twine has been secured to the bailer with gloved hands, the bailer will be suspended as the remaining plastic is removed. The bailer will be lowered slowly into the well until the bailer contacts groundwater. The bailer twine will then be cut to an adequate length and secured to prevent loss of the bailer in the well. At no time during purging will the bailer twine be allowed to touch the ground. In order to not allow the twine to touch the ground during purging, the twine will be collected when raising the bailer either by loops gathered in one hand or by alternating hand-to-hand as the bailer is pulled from the well. When purging deep wells (in excess of 40 feet), the ground and the well head may be covered with a clean plastic bag or sheet of plastic with a slit cut to allow the plastic to slide over the well head. This will be a separate sheet of plastic from the one used for the sampling equipment.

2.3 Groundwater Sample Collection

The bailer will be lowered slowly into the well to avoid volatilization of any dissolved-phase compounds that may be present in the groundwater. Once full, the bailer will be retrieved and containers filled by emptying the water through the hole at the bottom of the bailer. Glass 40-mL vials for VOC analyses will be filled in such a manner as to produce zero headspace in the vials. Polyethylene containers for metals analyses will be filled and sealed with the cap, leaving about ½-inch of airspace at the top. In addition to collecting the samples, water will be collected in the wide-mouth container for pH, temperature, and conductivity measurements. Upon completion of sampling, all groundwater samples, including equipment and trip blanks, will be placed in labeled and sealed plastic bags and stored in ice-filled coolers to chill the samples to 4°C pending transport to a NCDENR-certified analytical laboratory. Contaminated nitrile gloves and twine will be discarded.

2.4 Surfacewater Sample Collection

Surfacewater sampling will be taken with given consideration to minimize turbulence and aeration. As during groundwater sampling, surfacewater samples will be collected by a field technician wearing disposable gloves. Containers will be dipped at sampling location points by gently dipping the sample container into surfacewater and allowing surfacewater to flow over the mouth of the container so as not to displace any preservative within the sample container. If there is little current movement, the container will be moved slowly through the water laterally. During times of low water, if the water is not deep enough to allow filling of sample containers, an appropriately decontaminated sampling cup will be used to retrieve the sample. All containers will be treated in the same manner as the groundwater samples. The samples will be sealed in labeled, plastic bags, and stored

in an ice-filled cooler to chill the samples to 4°C pending transport to a NCDENR-certified analytical laboratory.

2.5 Chain of Custody

Chain-of-custody forms will be used to document the handling of all samples collected and listing all individuals who have taken possession of a given set of samples, including field personnel, laboratory couriers, and laboratory personnel. Trip blanks, equipment blanks, and sample containers will all travel and be stored together. Trip blanks will remain in the condition they are received from the laboratory and will not be opened or tampered with during the sampling. A chain-of-custody record will be completed for each day's samples, indicating the date and time, sample location, sample matrix (soil, water, etc.), and laboratory analyses to be conducted.

3 ANALYSIS

When the water samples reach the laboratory, they will be transferred to a sample custodian who will sign the chain of custody documentation as receipt of the samples. Internal control of the water samples in the laboratory will be in accordance with QA/QC procedures for the laboratory. Copies of QA/QC manuals for approved laboratories are on file at the Division of Solid Waste.

Groundwater and surface water samples will be analyzed for the Appendix I list of constituents; QA/QC procedures utilized during the testing will be in conformance with the laboratory QA/QC manual. Monitoring wells MW-1, MW-3, MW-4, MW-6, MW-9, MW-11, and MW-12 will be sampled for the Appendix I list and the aforementioned MNA performance parameters.

4 CONCLUSION

This report is included as part of the Corrective Action Plan for the Lenoir County C&D Landfill. The ground and surfacewater monitoring plan is designed to be effective in the early detection of any possible release of hazardous constituents to the unconfined surficial and upper bedrock aquifers, and to provide indicator parameters of the natural degradation, HRC injection, and phytoremediation processes.

MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.

Sean K. Patrick, P.G.

Professional Geologist

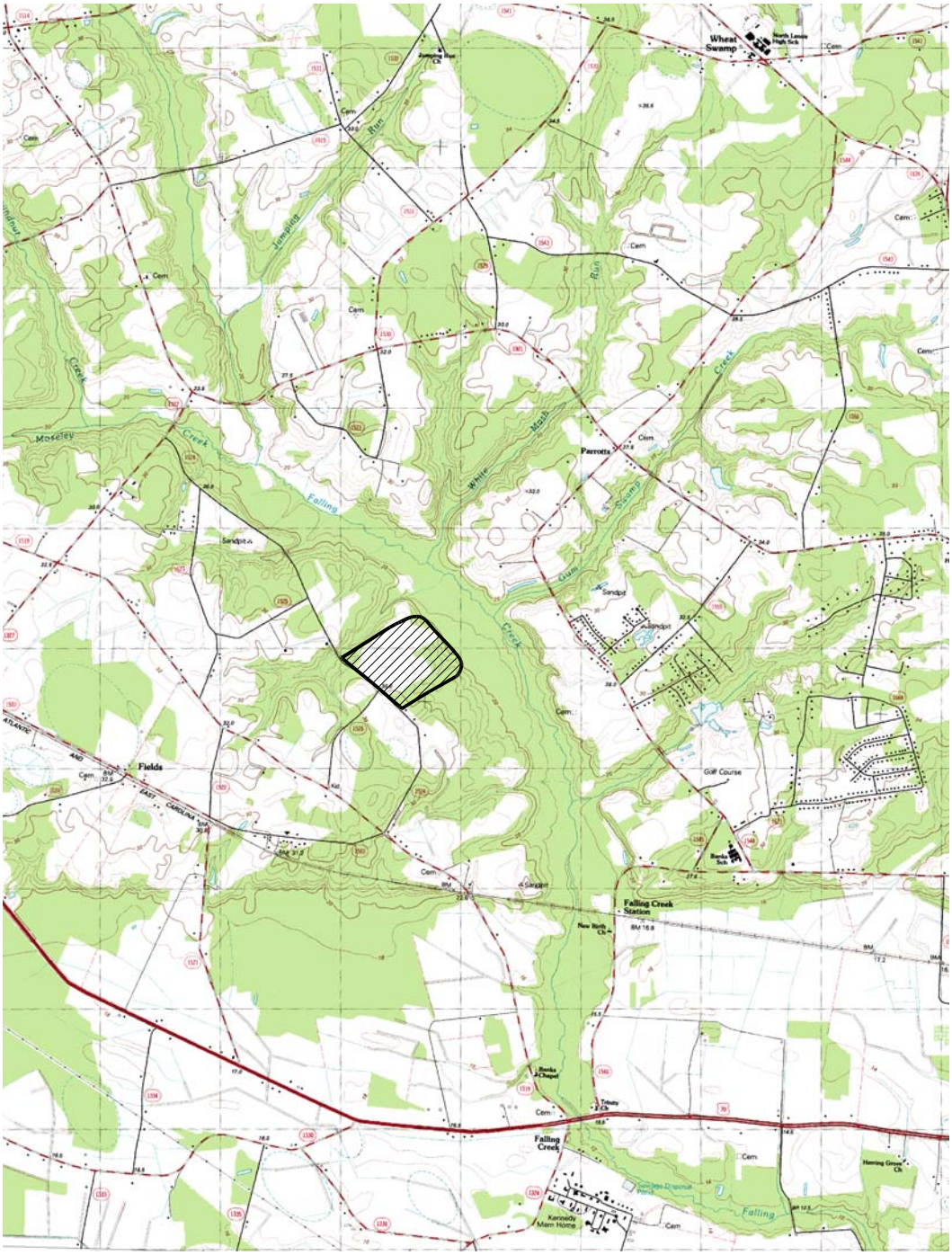
Table E-1. Summary of Ground and Surfacewater Monitoring Points

Sampling Point	Type	Gradient	Total Depth (ft)	Designation
MW-1	Monitoring Well	Upgradient	39.3	Background Well
MW-3	Monitoring Well	Downgradient	12.5	Monitoring Well
MW-4	Monitoring Well	Downgradient	15.5	Monitoring Well
MW-6	Monitoring Well	Crossgradient	19	Monitoring Well
MW-9	Monitoring Well	Downgradient	20.8	Monitoring Well
MW-11	Monitoring Well	Downgradient	36	Monitoring Well
MW-12	Monitoring Well	Down	36.4	Monitoring Well
SW-1	Surface Water	Downstream	-	Tributary
SW-2	Surface Water	Upstream	-	Tributary

Topographic Map with Site Location

Corrective Action Plan

PLATE A Lenoir County Sanitary Landfill



QUADRANGLE LEGEND

ROAD CLASSIFICATION

Primary highway, hard surface

Light-duty road, hard or improved surface

Secondary highway, hard surface

Unimproved road

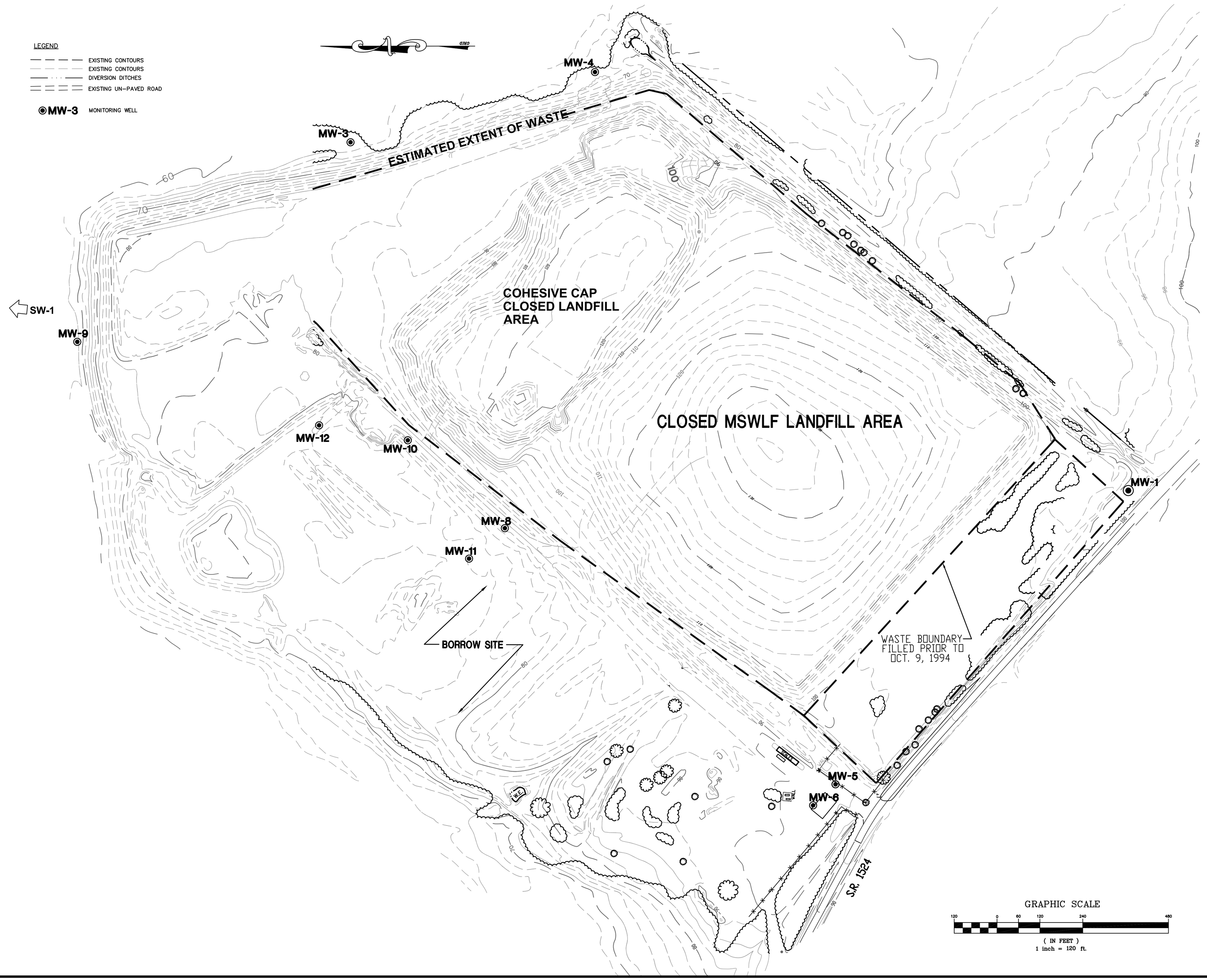
Interstate Route

U. S. Route

State Route

Date Completed	5/31/2007
Created By	M. German
Project Name	Corrective Action Plan
Site Name	Lenoir County Sanitary Landfill
Project Number	G07062.0

Municipal Engineering Services Company, PA



Municipal Services Engineering Company, P.A.

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

P.O. BOX 628 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
LENOIR COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION

SITE MAP
WITH SAMPLING LOCATIONS

SCALE:	1" = 120'
DATE:	2/10/09
DRWN. BY:	K. BUSSIE
CHKD. BY:	S. PATRICK
PROJECT NUMBER	G07062.0
DRAWING NO.	PLATE B
SHEET NO.	1 OF 1

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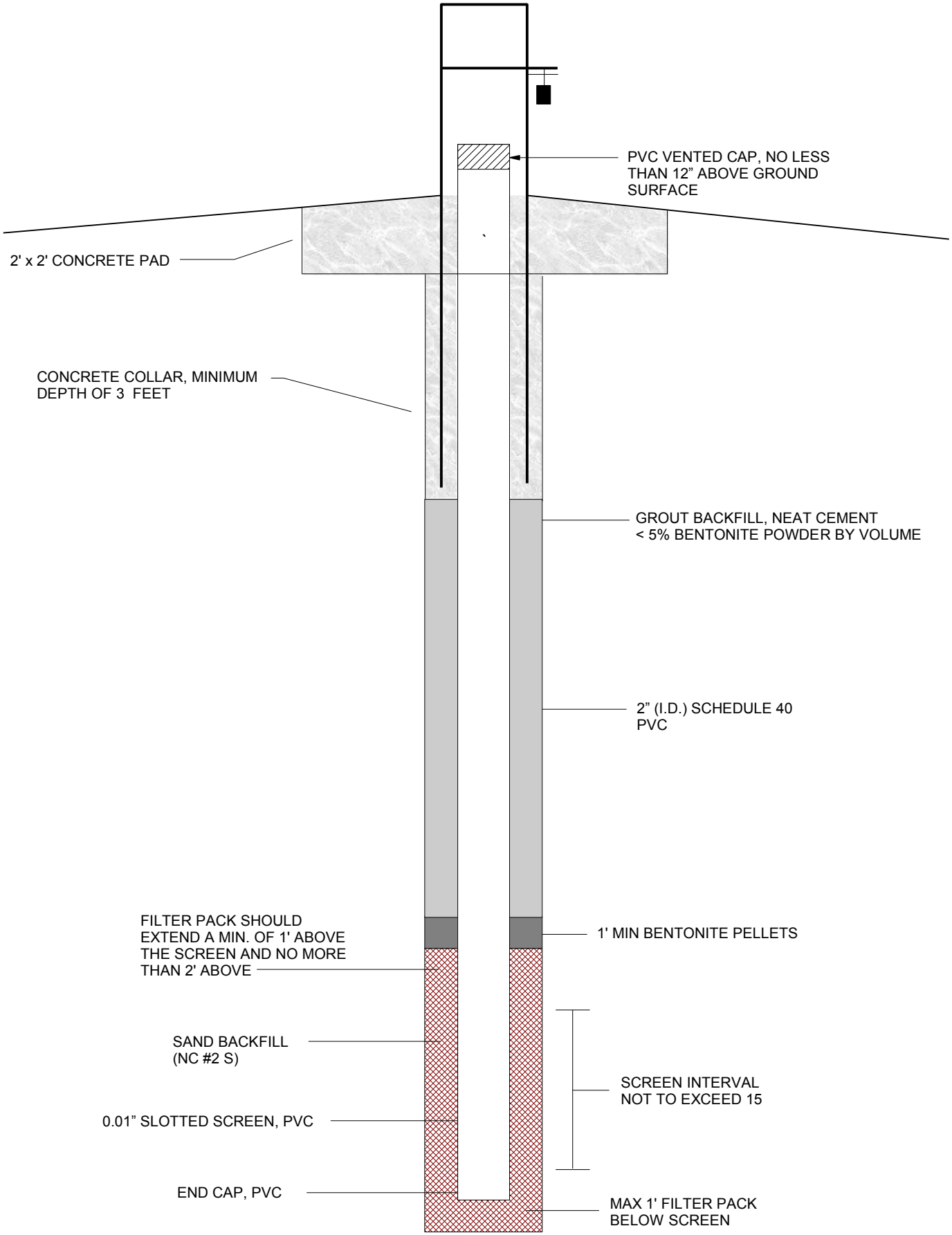
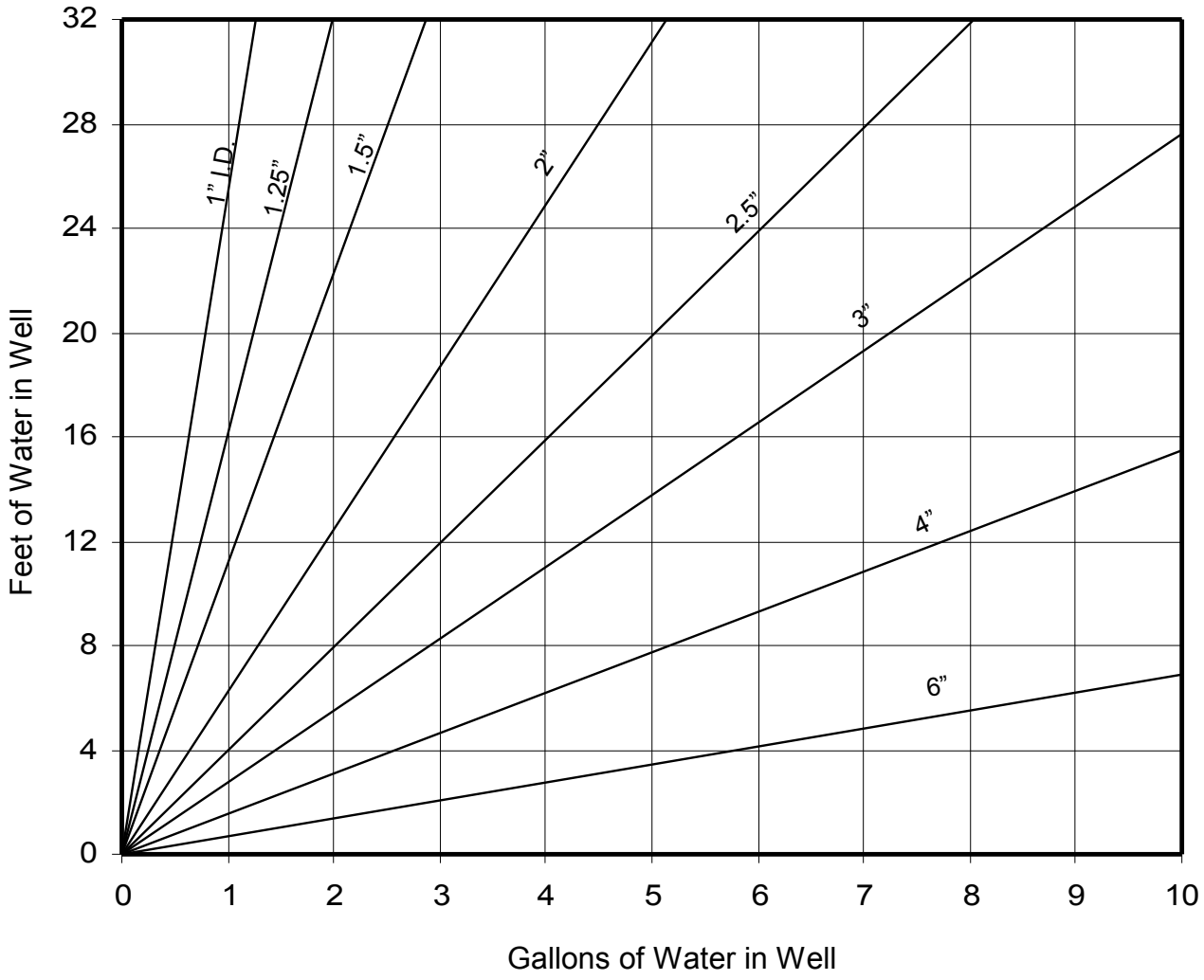


NOTE: SHALLOW WELLS REQUIRE A MINIMUM OF 5' COMBINED THICKNESS OF GROUT AND BENTONITE.

TYPICAL MONITORING WELL

PLATE C



GRAPHICAL PLOT OF STANDING VOLUMES OF WATER

PLATE D

Solid Waste Section
Guidelines for Groundwater, Soil, and Surface Water Sampling

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION

General Sampling Procedures

The following guidance is provided to insure a consistent sampling approach so that sample collection activities at solid waste management facilities provide reliable data. Sampling must begin with an evaluation of facility information, historical environmental data and site geologic and hydrogeologic conditions. General sampling procedures are described in this document.

Planning

Begin sampling activities with planning and coordination. The party contracting with the laboratory is responsible for effectively communicating reporting requirements and evaluating data reliability as it relates to specific monitoring activities.

Sample Collection

<u>Contamination Prevention</u>

a.) Take special effort to prevent cross contamination or environmental contamination when collecting samples.
    1. If possible, collect samples from the least contaminated sampling location (or background sampling location, if applicable) to the most contaminated sampling location.
    2. Collect the ambient or background samples first, and store them in separate ice chests or separate shipping containers within the same ice chest (e.g. untreated plastic bags).
    3. Collect samples in flowing water at designated locations from upstream to downstream.

b.) Do not store or ship highly contaminated samples (concentrated wastes, free product, etc.) or samples suspect of containing high concentrations of contaminants in the same ice chest or shipping containers with other environmental samples.
    1. Isolate these sample containers by sealing them in separate, untreated plastic bags immediately after collecting, preserving, labeling, etc.
    2. Use a clean, untreated plastic bag to line the ice chest or shipping container.

c.) All sampling equipment should be thoroughly decontaminated and transported in a manner that does not allow it to become contaminated. Arrangements should be made ahead of time to decontaminate any sampling or measuring equipment that will be reused when taking samples from more than one well. Field decontamination of

sampling equipment will be necessary before sampling each well to minimize the risk of cross contamination. Decontamination procedures should be included in reports as necessary. Certified pre-cleaned sampling equipment and containers may be used. When collecting aqueous samples, rinse the sample collection equipment with a portion of the sample water before taking the actual sample. Sample containers do not need to be rinsed. In the case of petroleum hydrocarbons, oil and grease, or containers with pre-measured preservatives, the sample containers cannot be rinsed.

d.) Place all fuel-powered equipment away from, and downwind of, any site activities (e.g., purging, sampling, decontamination).

1. If field conditions preclude such placement (i.e., the wind is from the upstream direction in a boat), place the fuel source(s) as far away as possible from the sampling activities and describe the conditions in the field notes.
2. Handle fuel (i.e., filling vehicles and equipment) prior to the sampling day. If such activities must be performed during sampling, the personnel must wear disposable gloves.
3. Dispense all fuels downwind. Dispose of gloves well away from the sampling activities.

<u>Filling Out Sample Labels</u>

Fill out label, adhere to vial and collect sample. Print legibly with indelible ink. At a minimum, the label or tag should identify the sample with the following information:

1. Sample location and/or well number
2. Sample identification number
3. Date and time of collection
4. Analysis required/requested
5. Sampler's initials
6. Preservative(s) used, if any [i.e., HCl, $Na_2S_2O_3$, NO_3, ice, etc.]
7. Any other pertinent information for sample identification

<u>Sample Collection Order</u>

Unless field conditions justify other sampling regimens, collect samples in the following order:

1. Volatile Organics and Volatile Inorganics
2. Extractable Organics, Petroleum Hydrocarbons, Aggregate Organics and Oil and Grease
3. Total Metals
4. Inorganic Nonmetallics, Physical and Aggregate Properties, and Biologicals
5. Microbiological

NOTE: *If the pump used to collect groundwater samples cannot be used to collect volatile or extractable organics then collect all other parameters and withdraw the pump and tubing. Then collect the volatile and extractable organics.*

Health and Safety

Implement all local, state, and federal requirements relating to health and safety. Follow all local, state and federal requirements pertaining to the storage and disposal of any hazardous or investigation derived wastes.

a.) The Solid Waste Section recommends wearing protective gloves when conducting all sampling activities.

1. Gloves serve to protect the sample collector from potential exposure to sample constituents, minimize accidental contamination of samples by the collector, and preserve accurate tare weights on preweighed sample containers.
2. Do not let gloves come into contact with the sample or with the interior or lip of the sample container. Use clean, new, unpowdered and disposable gloves. Various types of gloves may be used as long as the construction materials do not contaminate the sample or if internal safety protocols require greater protection.
3. Note that certain materials that may potentially be present in concentrated effluent can pass through certain glove types and be absorbed in the skin. Many vendor catalogs provide information about the permeability of different gloves and the circumstances under which the glove material might be applicable. The powder in powdered gloves can contribute significant contamination. Powdered gloves are not recommended unless it can be demonstrated that the powder does not interfere with the sample analysis.
4. Change gloves after preliminary activities, after collecting all the samples at a single sampling point, if torn or used to handle extremely dirty or highly contaminated surfaces. Properly dispose of all used gloves as investigation derived wastes.

b.) Properly manage all investigation derived waste (IDW).

5. To prevent contamination into previously uncontaminated areas, properly manage all IDW. This includes all water, soil, drilling mud, decontamination wastes, discarded personal protective equipment (PPE), etc. from site investigations, exploratory borings, piezometer and monitoring well installation, refurbishment, abandonment, and other investigative activities. Manage all IDW that is determined to be RCRA-regulated hazardous waste according to the local, state and federal requirements.
6. Properly dispose of IDW that is not a RCRA-regulated hazardous waste but is contaminated above the Department's Soil Cleanup Target Levels or the state standards and/or minimum criteria for ground water quality. If the drill cuttings/mud orpurged well water is contaminated with hazardous waste, contact the DWM Hazardous Waste Section (919-508-8400) for disposal options. Maintain all containers holding IDW in good condition. Periodically inspect the containers for damage and ensure that all required labeling (DOT, RCRA, etc.) are clearly visible.

Sample Storage and Transport

Store samples for transport carefully. Pack samples to prevent from breaking and to maintain a temperature of approximately 4 degrees Celsius (°C), adding ice if necessary. Transport samples to a North Carolina-certified laboratory as soon as possible. Avoid unnecessary handling of sample containers. Avoid heating (room temperature or above, including exposure to sunlight) or freezing of the sample containers. Reduce the time between sample collection and delivery to a laboratory whenever possible and be sure that the analytical holding times of your samples can be met by the laboratory.

a.) A complete chain-of-custody (COC) form must be maintained to document all transfers and receipts of the samples. Be sure that the sample containers are labeled with the sample location and/or well number, sample identification, the date and time of collection, the analysis to be performed, the preservative added (if any), the sampler's initials, and any other pertinent information for sample identification. The labels should contain a unique identifier (i.e., unique well numbers) that can be traced to the COC form. The details of sample collection must be documented on the COC. The COC must include the following:

1. Description of each sample (including QA/QC samples) and the number of containers (sample location and identification)
2. Signature of the sampler
3. Date and time of sample collection
4. Analytical method to be performed
5. Sample type (i.e., water or soil)
6. Regulatory agency (i.e., NCDENR/DWM – SW Section)
7. Signatures of all persons relinquishing and receiving custody of the samples
8. Dates and times of custody transfers

b.) Pack samples so that they are segregated by site, sampling location or by sample analysis type. When COC samples are involved, segregate samples in coolers by site. If samples from multiple sites will fit in one cooler, they may be packed in the same cooler with the associated field sheets and a single COC form for all. Coolers should not exceed a maximum weight of 50 lbs. Use additional coolers as necessary. All sample containers should be placed in plastic bags (segregated by analysis and location) and completely surrounded by ice.

1. Prepare and place trip blanks in an ice filled cooler before leaving for the field.
2. Segregate samples by analysis and place in sealable plastic bags.
3. Pack samples carefully in the cooler placing ice around the samples.
4. Review the COC. The COC form must accompany the samples to the laboratory. The trip blank(s) must also be recorded on the COC form.
5. Place completed COC form in a waterproof bag, sealed and taped under the lid of the cooler.
6. Secure shipping containers with strapping tape to avoid accidental opening.
7. For COC samples, a tamper-proof seal may also be placed over the cooler lid or over a bag or container containing the samples inside the shipping cooler.

8. "COC" or "EMERG" should be written in indelible ink on the cooler seal to alert sample receipt technicians to priority or special handling samples.
9. The date and sample handler's signature must also be written on the COC seal.
10. Deliver the samples to the laboratory or ship by commercial courier.
    NOTE*: If transport time to the laboratory is not long enough to allow samples to be cooled to 4° C, a temperature reading of the sample source must be documented as the field temperature on the COC form. A downward trend in temperature will be adequate even if cooling to 4° C is not achieved. The field temperature should always be documented if there is any question as to whether samples will have time to cool to 4° C during shipment. Thermometers must be calibrated annually against an NIST traceable thermometer and documentation must be retained.*

Appendix A - Decontamination of Field Equipment

Decontamination of personnel, sampling equipment, and containers - before and after sampling - must be used to ensure collection of representative samples and to prevent the potential spread of contamination. Decontamination of personnel prevents ingestion and absorption of contaminants. It must be done with a soap and water wash and deionized or distilled water rinse. Certified pre-cleaned sampling equipment and containers may also be used.

All previously used sampling equipment must be properly decontaminated before sampling and between sampling locations. This prevents the introduction of contamination into uncontaminated samples and avoids cross-contamination of samples. Cross-contamination can be a significant problem when attempting to characterize extremely low concentrations of organic compounds or when working with soils that are highly contaminated.

Clean, solvent-resistant gloves and appropriate protective equipment must be worn by persons decontaminating tools and equipment.

Cleaning Reagents

Recommendations for the types and grades of various cleaning supplies are outlined below. The recommended reagent types or grades were selected to ensure that the cleaned equipment is free from any detectable contamination.

a.) Detergents: Use Liqui-Nox (or a non-phosphate equivalent) or Alconox (or equivalent). Liqui-Nox (or equivalent) is recommended by EPA, although Alconox (or equivalent) may be substituted if the sampling equipment will not be used to collect phosphorus or phosphorus containing compounds.

b.) Solvents: Use pesticide grade isopropanol as the rinse solvent in routine equipment cleaning procedures. This grade of alcohol must be purchased from a laboratory supply vendor. Rubbing alcohol or other commonly available sources of isopropanol **are not acceptable**. Other solvents, such as acetone or methanol, may be used as the final rinse solvent if they are pesticide grade. However, methanol is more toxic to the environment and acetone may be an analyte of interest for volatile organics.

1. **Do not** use acetone if volatile organics are of interest
2. Containerize all methanol wastes (including rinses) and dispose as a hazardous waste.

Pre-clean equipment that is heavily contaminated with organic analytes. Use reagent grade acetone and hexane or other suitable solvents. Use pesticide grade methylene chloride when cleaning sample containers. Store all solvents away from potential sources of contamination.

c.) Analyte-Free Water Sources: Analyte-free water is water in which all analytes of interest and all interferences are below method detection limits. Maintain documentation (such as results from equipment blanks) to demonstrate the reliability and purity of analyte-free water source(s). The source of the water must meet the requirements of the analytical method and must be free from the analytes of interest. In general, the following water types are associated with specific analyte groups:

1. *Milli-Q (or equivalent polished water)*: suitable for all analyses.

2. *Organic-free*: suitable for volatile and extractable organics.
3. *Deionized water*: may not be suitable for volatile and extractable organics.
4. *Distilled water*: not suitable for volatile and extractable organics, metals or ultratrace metals.

Use analyte-free water for blank preparation and the final decontamination water rinse. In order to minimize long-term storage and potential leaching problems, obtain or purchase analyte-free water just prior to the sampling event. If obtained from a source (such as a laboratory), fill the transport containers and use the contents for a single sampling event. Empty the transport container(s) at the end of the sampling event. Discard any analyte-free water that is transferred to a dispensing container (such as a wash bottle or pump sprayer) at the end of each sampling day.

d.) Acids:

1. *Reagent Grade Nitric Acid*: 10 - 15% (one volume concentrated nitric acid and five volumes deionized water). Use for the acid rinse unless nitrogen components (e.g., nitrate, nitrite, etc.) are to be sampled. If sampling for ultra-trace levels of metals, use an ultra-pure grade acid.
2. *Reagent Grade Hydrochloric Acid*: 10% hydrochloric acid (one volume concentrated hydrochloric and three volumes deionized water). Use when nitrogen components are to be sampled.
3. If samples for both metals and the nitrogen-containing components are collected with the equipment, use the hydrochloric acid rinse, or thoroughly rinse with hydrochloric acid after a nitric acid rinse. If sampling for ultra trace levels of metals, use an ultra-pure grade acid.
4. Freshly prepared acid solutions may be recycled during the sampling event or cleaning process. Dispose of any unused acids according to local ordinances.

Reagent Storage Containers

The contents of all containers must be clearly marked.

a.) Detergents:

1. Store in the original container or in a HDPE or PP container.

b.) Solvents:

1. Store solvents to be used for cleaning or decontamination in the original container until use in the field. If transferred to another container for field use, use either a glass or Teflon container.
2. Use dispensing containers constructed of glass, Teflon or stainless steel. Note: If stainless steel sprayers are used, any gaskets that contact the solvents must be constructed of inert materials.

c.) Analyte-Free Water:

1. Transport in containers appropriate for the type of water stored. If the water is commercially purchased (e.g., grocery store), use the original containers when transporting the water to the field. Containers made of glass, Teflon, polypropylene or HDPE are acceptable.
2. Use glass or Teflon to transport organic-free sources of water on-site. Polypropylene or HDPE may be used, but are not recommended.

3. Dispense water from containers made of glass, Teflon, HDPE or polypropylene.
4. Do not store water in transport containers for more than three days before beginning a sampling event.
5. If working on a project that has oversight from EPA Region 4, use glass containers for the transport and storage of all water.
6. Store and dispense acids using containers made of glass, Teflon or plastic.

General Requirements

a.) Prior to use, clean/decontaminate all sampling equipment (pumps, tubing, lanyards, split spoons, etc.) that will be exposed to the sample.

b.) Before installing, clean (or obtain as certified pre-cleaned) all equipment that is dedicated to a single sampling point and remains in contact with the sample medium (e.g., permanently installed groundwater pump). If you use certified pre-cleaned equipment no cleaning is necessary.

1. Clean this equipment any time it is removed for maintenance or repair.
2. Replace dedicated tubing if discolored or damaged.

c.) Clean all equipment in a designated area having a controlled environment (house, laboratory, or base of field operations) and transport it to the field, pre-cleaned and ready to use, unless otherwise justified.

d.) Rinse all equipment with water after use, even if it is to be field-cleaned for other sites. Rinse equipment used at contaminated sites or used to collect in-process (e.g., untreated or partially treated wastewater) samples immediately with water.

e.) Whenever possible, transport sufficient clean equipment to the field so that an entire sampling event can be conducted without the need for cleaning equipment in the field.

f.) Segregate equipment that is only used once (i.e., not cleaned in the field) from clean equipment and return to the in-house cleaning facility to be cleaned in a controlled environment.

g.) Protect decontaminated field equipment from environmental contamination by securely wrapping and sealing with one of the following:

1. Aluminum foil (commercial grade is acceptable)
2. Untreated butcher paper
3. Clean, untreated, disposable plastic bags. Plastic bags may be used for all analyte groups except volatile and extractable organics. Plastic bags may be used for volatile and extractable organics, if the equipment is first wrapped in foil or butcher paper, or if the equipment is completely dry.

Cleaning Sample Collection Equipment

a.) <u>On-Site/In-Field Cleaning</u> – Cleaning equipment on-site is not recommended because environmental conditions cannot be controlled and wastes (solvents and acids) must be containerized for proper disposal.

1. Ambient temperature water may be substituted in the hot, sudsy water bath and hot water rinses.

NOTE: Properly dispose of all solvents and acids.

2. Rinse all equipment with water after use, even if it is to be field-cleaned for other sites.
3. Immediately rinse equipment used at contaminated sites or used to collect in-process (e.g., untreated or partially treated wastewater) samples with water.

b.) Heavily Contaminated Equipment - In order to avoid contaminating other samples, isolate heavily contaminated equipment from other equipment and thoroughly decontaminate the equipment before further use. Equipment is considered heavily contaminated if it:

1. Has been used to collect samples from a source known to contain significantly higher levels than background.
2. Has been used to collect free product.
3. Has been used to collect industrial products (e.g., pesticides or solvents) or their byproducts.

NOTE: *Cleaning heavily contaminated equipment in the field is not recommended.*

c.) On-Site Procedures:

1. Protect all other equipment, personnel and samples from exposure by isolating the equipment immediately after use.
2. At a minimum, place the equipment in a tightly sealed, untreated, plastic bag.
3. Do not store or ship the contaminated equipment next to clean, decontaminated equipment, unused sample containers, or filled sample containers.
4. Transport the equipment back to the base of operations for thorough decontamination.
5. If cleaning must occur in the field, document the effectiveness of the procedure, collect and analyze blanks on the cleaned equipment.

d.) Cleaning Procedures:

1. If organic contamination cannot be readily removed with scrubbing and a detergent solution, pre-rinse equipment by thoroughly rinsing or soaking the equipment in acetone.
2. Use hexane only if preceded and followed by acetone.
3. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with routine cleaning procedures.
4. After the solvent rinses (and/or steam cleaning), use the appropriate cleaning procedure. Scrub, rather than soak, all equipment with sudsy water. If high levels of metals are suspected and the equipment cannot be cleaned without acid rinsing, soak the equipment in the appropriate acid. Since stainless steel equipment should not be exposed to acid rinses, do not use stainless steel equipment when heavy metal contamination is suspected or present.
5. If the field equipment cannot be cleaned utilizing these procedures, discard unless further cleaning with stronger solvents and/or oxidizing solutions is effective as evidenced by visual observation and blanks.
6. Clearly mark or disable all discarded equipment to discourage use.

e.) General Cleaning - Follow these procedures when cleaning equipment under controlled conditions. Check manufacturer's instructions for cleaning restrictions and/or recommendations.

1. *Procedure for Teflon, stainless steel and glass sampling equipment*: This procedure must be used when sampling for ALL analyte groups. (Extractable organics, metals, nutrients, etc. or if a single decontamination protocol is desired to clean all Teflon, stainless steel and glass equipment.) Rinse equipment with hot tap water. Soak equipment in a hot, sudsy water solution (Liqui-Nox or equivalent). If necessary, use a brush to remove particulate matter or surface film. Rinse thoroughly with hot tap water. If samples for trace metals or inorganic analytes will be collected with the equipment that is not stainless steel, thoroughly rinse (wet all surfaces) with the appropriate acid solution. Rinse thoroughly with analyte-free water. Make sure that all equipment surfaces are thoroughly flushed with water. If samples for volatile or extractable organics will be collected, rinse with isopropanol. Wet equipment surfaces thoroughly with free-flowing solvent. Rinse thoroughly with analyte-free water. Allow to air dry. Wrap and seal as soon as the equipment has air-dried. If isopropanol is used, the equipment may be air-dried without the final analyte-free water rinse; however, the equipment must be completely dry before wrapping or use. Wrap clean sampling equipment according to the procedure described above.
2. *General Cleaning Procedure for Plastic Sampling Equipment*: Rinse equipment with hot tap water. Soak equipment in a hot, sudsy water solution (Liqui-Nox or equivalent). If necessary, use a brush to remove particulate matter or surface film. Rinse thoroughly with hot tap water. Thoroughly rinse (wet all surfaces) with the appropriate acid solution. Check manufacturer's instructions for cleaning restrictions and/or recommendations. Rinse thoroughly with analyte-free water. Be sure that all equipment surfaces are thoroughly flushed. Allow to air dry as long as possible. Wrap clean sampling equipment according to the procedure described above.

Appendix B - Collecting Soil Samples

Soil samples are collected for a variety of purposes. A methodical sampling approach must be used to assure that sample collection activities provide reliable data. Sampling must begin with an evaluation of background information, historical data and site conditions.

Soil Field Screening Procedures

Field screening is the use of portable devices capable of detecting petroleum contaminants on a real-time basis or by a rapid field analytical technique. Field screening should be used to help assess locations where contamination is most likely to be present.

When possible, field-screening samples should be collected directly from the excavation or from the excavation equipment's bucket. If field screening is conducted only from the equipment's bucket, then a minimum of one field screening sample should be collected from each 10 cubic yards of excavated soil. If instruments or other observations indicate contamination, soil should be separated into stockpiles based on apparent degrees of contamination. At a minimum, soil suspected of contamination must be segregated from soil observed to be free of contamination.

a.) Field screening devices – Many field screen instruments are available for detecting contaminants in the field on a rapid or real-time basis. Acceptable field screening instruments must be suitable for the contaminant being screened. The procdedure for field screening using photoionization detectors (PIDs) and flame ionization detectors (FIDs) is described below. If other instruments are used, a description of the instrument or method and its intended use must be provided to the Solid Waste Section. Whichever field screening method is chosen, its accuracy must be verified throughout the sampling process. Use appropriate standards that match the use intended for the data. Unless the Solid Waste Section indicates otherwise, wherever field screening is recommended in this document, instrumental or analytical methods of detection must be used, not olfactory or visual screening methods.

b.) Headspace analytical screening procedure for filed screening (semi-quantitative field screening) - The most commonly used field instruments for Solid Waste Section site assessments are FIDs and PIDs. When using FIDs and PIDs, use the following headspace screening procedure to obtain and analyze field-screening samples:

1. Partially fill (one-third to one-half) a clean jar or clean ziplock bag with the sample to be analyzed. The total capacity of the jar or bag may not be less than eight ounces (app. 250 ml), but the container should not be so large as to allow vapor diffusion and stratification effects to significantly affect the sample.
2. If the sample is collected from a spilt-spoon, it must be transferred to the jar or bag for headspace analysis immediately after opening the split-spoon. If the sample is collected from an excavation or soil pile, it must be collected from freshly uncovered soil.

3. If a jar is used, it must be quickly covered with clean aluminum foil or a jar lid; screw tops or thick rubber bands must be used to tightly seal the jar. If a zip lock bag is used, it must be quickly sealed shut.
4. Headspace vapors must be allowed to develop in the container for at least 10 minutes but no longer than one hour. Containers must be shaken or agitated for 15 seconds at the beginning and the end of the headspace development period to assist volatilization. Temperatures of the headspace must be warmed to at least 5° C (approximately 40° F) with instruments calibrated for the temperature used.
5. After headspace development, the instrument sampling probe must be inserted to a point about one-half the headspace depth. The container opening must be minimized and care must be taken to avoid the uptake of water droplets and soil particulates.
6. After probe insertion, the highest meter reading must be taken and recorded. This will normally occur between two and five seconds after probe insertion. If erratic meter response occurs at high organic vapor concentrations or conditions of elevated headspace moisture, a note to that effect must accompany the headspace data.
7. All field screening results must be documented in the field record or log book.

Soil Sample Collection Procedures for Laboratory Samples

The number and type of laboratory samples collected depends on the purpose of the sampling activity. Samples analyzed with field screening devices may not be substituted for required laboratory samples.

a.) General Sample Collection - When collecting samples from potentially contaminated soil, care should be taken to reduce contact with skin or other parts of the body. Disposable gloves should be worn by the sample collector and should be changed between samples to avoid cross-contamination. Soil samples should be collected in a manner that causes the least disturbance to the internal structure of the sample and reduces its exposure to heat, sunlight and open air. Likewise, care should be taken to keep the samples from being contaminated by other materials or other samples collected at the site. When sampling is to occur over an extended period of time, it is necessary to insure that the samples are collected in a comparable manner. All samples must be collected with disposable or clean tools that have been decontaminated. Disposable gloves must be worn and changed between sample collections. Sample containers must be filled quickly. Soil samples must be placed in containers in the order of volatility, for example, volatile organic aromatic samples must be taken first, organics next, then heavier range organics, and finally soil classification samples. Containers must be quickly and adequately sealed, and rims must be cleaned before tightening lids. Tape may be used only if known not to affect sample analysis. Sample containers must be clearly labeled. Containers must immediately be preserved according to procedures in this Section. Unless specified

otherwise, at a minimum, the samples must be immediately cooled to 4 ± 2°C and this temperature must be maintained throughout delivery to the laboratory.

b.) Surface Soil Sampling - Surface soil is generally classified as soil between the ground surface and 6-12 inches below ground surface. Remove leaves, grass and surface debris from the area to be sampled. Select an appropriate, pre-cleaned sampling device and collect the sample. Transfer the sample to the appropriate sample container. Clean the outside of the sample container to remove excess soil. Label the sample container, place on wet ice to preserve at 4°C, and complete the field notes.

c.) Subsurface Soil Sampling – The interval begins at approximately 12 inches below ground surface. Collect samples for volatile organic analyses. For other analyses, select an appropriate, pre-cleaned sampling device and collect the sample. Transfer the sample to the appropriate sample container. Clean the outside of the sample container to remove excess soil. Label the sample container, place on wet ice to preserve at 4°C, and complete field notes.

d.) Equipment for Reaching the Appropriate Soil Sampling Depth - Samples may be collected using a hollow stem soil auger, direct push, Shelby tube, split-spoon sampler, or core barrel. These sampling devices may be used as long as an effort is made to reduce the loss of contaminants through volatilization. In these situations, obtain a sufficient volume of so the samples can be collected without volatilization and disturbance to the internal structure of the samples. Samples should be collected from cores of the soil. Non-disposable sampling equipment must be decontaminated between each sample location. **NOTE:** *If a confining layer has been breached during sampling, grout the hole to land.*

e.) Equipment to Collect Soil Samples - Equipment and materials that may be used to collect soil samples include disposable plastic syringes and other "industry-standard" equipment and materials that are contaminant-free. Non-disposable sampling equipment must be decontaminated between each sample location.

Appendix C - Collecting Groundwater Samples

Groundwater samples are collected to identify, investigate, assess and monitor the concentration of dissolved contaminant constituents. To properly assess groundwater contamination, first install sampling points (monitoring wells, etc.) to collect groundwater samples and then perform specific laboratory analyses. All monitoring wells should be constructed in accordance with 15A NCAC 2C .0100 and sampled as outlined in this section. Groundwater monitoring is conducted using one of two methods:

1. Portable Monitoring: Monitoring that is conducted using sampling equipment that is discarded between sampling locations. Equipment used to collect a groundwater sample from a well such as bailers, tubing, gloves, and etc. are disposed of after sample collection. A new set of sampling equipment is used to collect a groundwater sample at the next monitor well.

2. Dedicated Monitoring: Monitoring that utilizes permanently affixed down-well and well head components that are capped after initial set-up. Most dedicated monitoring systems are comprised of an in-well submersible bladder pump, with air supply and sample discharge tubing, and an above-ground driver/controller for regulation of flow rates and volumes. The pump and all tubing housed within the well should be composed of Teflon or stainless steel components. This includes seals inside the pump, the pump body, and fittings used to connect tubing to the pump. Because ground water will not be in contact with incompatible constituents and because the well is sealed from the surface, virtually no contamination is possible from intrinsic sources during sampling and between sampling intervals. All dedicated monitoring systems must be approved by the Solid Waste Section before installation.

Groundwater samples may be collected from a number of different configurations. Each configuration is associated with a unique set of sampling equipment requirements and techniques:

1. Wells without Plumbing: These wells require equipment to be brought to the well to purge and sample unless dedicated equipment is placed in the well.

2. Wells with In-Place Plumbing: Wells with in-place plumbing do not require equipment to be brought to the well to purge and sample. In-place plumbing is generally considered permanent equipment routinely used for purposes other than purging and sampling, such as for water supply.

3. Air Strippers or Remedial Systems: These types of systems are installed as remediation devices.

Groundwater Sample Preparation

The type of sample containers used depends on the type of analysis performed. First, determine the type(s) of contaminants expected and the proper analytical method(s). Be sure to consult your selected laboratory for its specific needs and requirements prior to sampling.

Next, prepare the storage and transport containers (ice chest, etc.) before taking any samples so that each sample can be placed in a chilled environment immediately after collection.

Use groundwater purging and sampling equipment constructed of only non-reactive, non-leachable materials that are compatible with the environment and the selected analytes. In selecting groundwater purging and sampling equipment, give consideration to the depth of the well, the depth to groundwater, the volume of water to be evacuated, the sampling and purging technique, and the analytes of interest. Additional supplies, such as reagents and preservatives, may be necessary.

All sampling equipment (bailers, tubing, containers, etc.) must be selected based on its chemical compatibility with the source being sampled (e.g., water supply well, monitoring well) and the contaminants potentially present.

a.) Pumps - All pumps or pump tubing must be lowered and retrieved from the well slowly and carefully to minimize disturbance to the formation water. This is especially critical at the air/water interface.

1. *Above-Ground Pumps*
   - Variable Speed Peristaltic Pump: Use a variable speed peristaltic pump to purge groundwater from wells when the static water level in the well is no greater than 20- 25 feet below land surface (BLS). If the water levels are deeper than 18-20 feet BLS, the pumping velocity will decrease. A variable speed peristaltic pump can be used for normal purging and sampling, and sampling low permeability aquifers or formations. Most analyte groups can be sampled with a peristaltic pump if the tubing and pump configurations are appropriate.
   - Variable Speed Centrifugal Pump: A variable speed centrifugal pump can be used to purge groundwater from 2-inch and larger internal diameter wells. **Do not use** this type of pump to collect groundwater samples. When purging is complete, do not allow the water that remains in the tubing to fall back into the well. Install a check valve at the end of the purge tubing.
2. *Submersible Pumps*
   - Variable Speed Electric Submersible Pump: A variable speed submersible pump can be used to purge and sample groundwater from 2-inch and larger internal diameter wells. A variable speed submersible pump can be used for normal purging and sampling, and sampling low permeability aquifers or formations. The pump housing, fittings, check valves and associated hardware must be constructed of stainless steel. All other materials must be

compatible with the analytes of interest. Install a check valve at the output side of the pump to prevent backflow. If purging **and** sampling for organics, the entire length of the delivery tube must be Teflon, polyethylene or polypropylene (PP) tubing; the electrical cord must be sealed in Teflon, polyethylene or PP and any cabling must be sealed in Teflon, polyethylene or PP, or be constructed of stainless steel; and all interior components that contact the sample water (impeller, seals, gaskets, etc.) must be constructed of stainless steel or Teflon.

3. *Variable Speed Bladder Pump*: A variable speed, positive displacement, bladder pump can be used to purge and sample groundwater from 3/4-inch and larger internal diameter wells.
    - A variable speed bladder pump can be used for normal purging and sampling, and sampling low permeability aquifers or formations.
    - The bladder pump system is composed of the pump, the compressed air tubing, the water discharge tubing, the controller and a compressor, or a compressed gas supply.
    - The pump consists of a bladder and an exterior casing or pump body that surrounds the bladder and two (2) check valves. These parts can be composed of various materials, usually combinations of polyvinyl chloride (PVC), Teflon, polyethylene, PP and stainless steel. Other materials must be compatible with the analytes of interest.
    - If purging and sampling for organics, the pump body must be constructed of stainless steel. The valves and bladder must be Teflon, polyethylene or PP; the entire length of the delivery tube must be Teflon, polyethylene or PP; and any cabling must be sealed in Teflon, polyethylene or PP, or be constructed of stainless steel.
    - Permanently installed pumps may have a PVC pump body as long as the pump remains in contact with the water in the well.

b.) <u>Bailers</u>

1. *Purging*: Bailers must be used with caution because improper bailing can cause changes in the chemistry of the water due to aeration and loosening particulate matter in the space around the well screen. Use a bailer if there is non-aqueous phase liquid (free product) in the well or if non-aqueous phase liquid is suspected to be in the well.
2. *Sampling*: Bailers must be used with caution.
3. *Construction and Type*: Bailers must be constructed of materials compatible with the analytes of interest. Stainless steel, Teflon, rigid medical grade PVC, polyethylene and PP bailers may be used to sample all analytes. Use disposable bailers when sampling grossly contaminated sample sources. NCDENR recommends using dual check valve bailers when collecting samples. Use bailers with a controlled flow bottom to collect volatile organic samples.

4. *Contamination Prevention*: Keep the bailer wrapped (foil, butcher paper, etc.) until just before use. Use protective gloves to handle the bailer once it is removed from its wrapping. Handle the bailer by the lanyard to minimize contact with the bailer surface.

c.) Lanyards

1. Lanyards must be made of non-reactive, non-leachable material. They may be cotton twine, nylon, stainless steel, or may be coated with Teflon, polyethylene or PP.
2. Discard cotton twine, nylon, and non-stainless steel braided lanyards after sampling each monitoring well.
3. Decontaminate stainless steel, coated Teflon, polyethylene and PP lanyards between monitoring wells. They do not need to be decontaminated between purging and sampling operations.

Water Level and Purge Volume Determination

The amount of water that must be purged from a well is determined by the volume of water and/or field parameter stabilization.

a.) General Equipment Considerations - Selection of appropriate purging equipment depends on the analytes of interest, the well diameter, transmissivity of the aquifer, the depth to groundwater, and other site conditions.

1. Use of a pump to purge the well is recommended unless no other equipment can be used or there is non-aqueous phase liquid in the well, or non-aqueous phase liquid is suspected to be in the well.
2. Bailers must be used with caution because improper bailing:
    - Introduces atmospheric oxygen, which may precipitate metals (i.e., iron) or cause other changes in the chemistry of the water in the sample (i.e., pH).
    - Agitates groundwater, which may bias volatile and semi-volatile organic analyses due to volatilization.
    - Agitates the water in the aquifer and resuspends fine particulate matter.
    - Surges the well, loosening particulate matter in the annular space around the well screen.
    - May introduce dirt into the water column if the sides of the casing wall are scraped.

NOTE: *It is critical for bailers to be slowly and gently immersed into the top of the water column, particularly during the final stages of purging. This minimizes turbidity and disturbance of volatile organic constituents.*

b.) Initial Inspection

1. Remove the well cover and remove all standing water around the top of the well casing (manhole) before opening the well.
2. Inspect the exterior protective casing of the monitoring well for damage. Document the results of the inspection if there is a problem.
3. It is recommended that you place a protective covering around the well head. Replace the covering if it becomes soiled or ripped.

4. Inspect the well lock and determine whether the cap fits tightly. Replace the cap if necessary.

c.) Water Level Measurements - Use an electronic probe or chalked tape to determine the water level. Decontaminate all equipment before use. Measure the depth to groundwater from the top of the well casing to the nearest 0.01 foot. Always measure from the same reference point or survey mark on the well casing. Record the measurement.

1. *Electronic Probe*: Decontaminate all equipment before use. Follow the manufacturer's instructions for use. Record the measurement.
2. *Chalked Line Method*: Decontaminate all equipment before use. Lower chalked tape into the well until the lower end is in the water. This is usually determined by the sound of the weight hitting the water. Record the length of the tape relative to the reference point. Remove the tape and note the length of the wetted portion. Record the length. Determine the depth to water by subtracting the length of the wetted portion from the total length. Record the result.

d.) Water Column Determination - To determine the length of the water column, subtract the depth to the top of the water column from the total well depth (or gauged well depth if silting has occurred). The total well depth depends on the well construction. If gauged well depth is used due to silting, report total well depth also. Some wells may be drilled in areas of sinkhole, karst formations or rock leaving an open borehole. Attempt to find the total borehole depth in cases where there is an open borehole below the cased portion.

e.) Well Water Volume - Calculate the total volume of water, in gallons, in the well using the following equation:

$$V = (0.041)d \times d \times h$$

Where:

V = volume in gallons
d = well diameter in inches
h = height of the water column in feet

The total volume of water in the well may also be determined with the following equation by using a casing volume per foot factor (Gallons per Foot of Water) for the appropriate diameter well:

$$V = [\text{Gallons per Foot of Water}] \times h$$

Where:

V = volume in gallons
h = height of the water column in feet

Record all measurements and calculations in the field records.

f.) Purging Equipment Volume - Calculate the total volume of the pump, associated tubing and flow cell (if used), using the following equation:

$$V = p + ((0.041)d \times d \times l) + fc$$

Where:

V = volume in gallons
p = volume of pump in gallons
d = tubing diameter in inches
l = length of tubing in feet

fc = volume of flow cell in gallons

g.) If the groundwater elevation data are to be used to construct groundwater elevation contour maps, all water level measurements must be taken within the same 24 hour time interval when collecting samples from multiple wells on a site, unless a shorter time period is required. If the site is tidally influenced, complete the water level measurements within the time frame of an incoming or outgoing tide.

Well Purging Techniques

The selection of the purging technique and equipment is dependent on the hydrogeologic properties of the aquifer, especially depth to groundwater and hydraulic conductivity.

a.) Measuring the Purge Volume - The volume of water that is removed during purging must be recorded. Therefore, you must measure the volume during the purging operation.

1. Collect the water in a graduated container and multiply the number of times the container was emptied by the volume of the container, OR
2. Estimate the volume based on pumping rate. This technique may be used only if the pumping rate is constant. Determine the pumping rate by measuring the amount of water that is pumped for a fixed period of time, or use a flow meter.
    - Calculate the amount of water that is discharged per minute: D = Measured Amount/Total Time In Minutes
    - Calculate the time needed to purge one (1) well volume or one (1) purging equipment volume: Time = V/D
      Where: V = well volume or purging equipment volume
      D = discharge rate
    - Make new measurements each time the pumping rate is changed.
3. Use a totalizing flow meter.
    - Record the reading on the totalizer prior to purging.
    - Record the reading on the totalizer at the end of purging.
    - To obtain the volume purged, subtract the reading on the totalizer prior to purging from the reading on the totalizer at the end of purging.
    - Record the times that purging begins and ends in the field records.

b.) Purging Measurement Frequency - When purging a well that has the well screen fully submerged and the pump or intake tubing is placed within the well casing above the well screen or open hole, purge a minimum of one (1) well volume prior to collecting measurements of the field parameters. Allow at least one quarter (1/4) well volume to purge between subsequent measurements. When purging a well that has the pump or intake tubing placed within a fully submerged well screen or open hole, purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) volume of the pump, associated tubing and flow cell (if used) prior to collecting measurements of the field parameters. Take measurements of the field parameters no sooner than two (2) to three (3) minutes apart. Purge at least

three (3) volumes of the pump, associated tubing and flow cell, if used, prior to collecting a sample. When purging a well that has a partially submerged well screen, purge a minimum of one (1) well volume prior to collecting measurements of the field parameters. Take measurements of the field parameters no sooner than two (2) to three (3) minutes apart.

c.) Purging Completion - Wells must be adequately purged prior to sample collection to ensure representation of the aquifer formation water, rather than stagnant well water. This may be achieved by purging three volumes from the well or by satisfying any one of the following three purge completion criteria:

1.) Three (3) consecutive measurements in which the three (3) parameters listed below are within the stated limits, dissolved oxygen is no greater than 20 percent of saturation at the field measured temperature, and turbidity is no greater than 20 Nephelometric Turbidity Units (NTUs).

- Temperature: + 0.2° C
- pH: + 0.2 Standard Units
- Specific Conductance: + 5.0% of reading

Document and report the following, as applicable. The last four items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

2.) If it is impossible to get dissolved oxygen at or below 20 percent of saturation at the field measured temperature or turbidity at or below 20 NTUs, then three (3) consecutive measurements of temperature, pH, specific conductance and the parameter(s) dissolved oxygen and/or turbidity that do not meet the requirements above must be within the limits below. The measurements are:

- Temperature: + 0.2° C
- pH: + 0.2 Standard Units
- Specific Conductance: + 5.0% of reading
- Dissolved Oxygen: + 0.2 mg/L or 10%, whichever is greater
- Turbidity: + 5 NTUs or 10%, whichever is greater

Additionally, document and report the following, as applicable, except that the last four(4) items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- A description of conditions at the site that may cause the dissolved oxygen to be high and/or dissolved oxygen measurements made within the screened or open hole portion of the well with a downhole dissolved oxygen probe.

- A description of conditions at the site that may cause the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

3.) If after five (5) well volumes, three (3) consecutive measurements of the field parameters temperature, pH, specific conductance, dissolved oxygen, and turbidity are not within the limits stated above, check the instrument condition and calibration, purging flow rate and all tubing connections to determine if they might be affecting the ability to achieve stable measurements. It is at the discretion of the consultant/contractor whether or not to collect a sample or to continue purging. Further, the report in which the data are submitted must include the following, as applicable. The last four (4) items only need to be submitted once.

- Purging rate.
- Drawdown in the well, if any.
- A description of conditions at the site that may cause the Dissolved Oxygen to be high and/or Dissolved Oxygen measurements made within the screened or open hole portion of the well with a downhole dissolved oxygen probe.
- A description of conditions at the site that may cause the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

If wells have previously and consistently purged dry, and the current depth to groundwater indicates that the well will purge dry during the current sampling event, minimize the amount of water removed from the well by using the same pump to purge and collect the sample:

- Place the pump or tubing intake within the well screened interval.
- Use very small diameter Teflon, polyethylene or PP tubing and the smallest possible pump chamber volume. This will minimize the total volume of water pumped from the well and reduce drawdown.
- Select tubing that is thick enough to minimize oxygen transfer through the tubing walls while pumping.

- Pump at the lowest possible rate (100 mL/minute or less) to reduce drawdown to a minimum.
- Purge at least two (2) volumes of the pumping system (pump, tubing and flow cell, if used).
- Measure pH, specific conductance, temperature, dissolved oxygen and turbidity, then begin to collect the samples.

Collect samples immediately after purging is complete. The time period between completing the purge and sampling cannot exceed six hours. If sample collection does not occur within one hour of purging completion, re-measure the five field parameters: temperature, pH, specific conductance, dissolved oxygen and turbidity, just prior to collecting the sample. If the measured values are not within 10 percent of the previous measurements, re-purge the well. The exception is "dry" wells.

d.) Lanyards

1. Securely fasten lanyards, if used, to any downhole equipment (bailers, pumps, etc.).
2. Use bailer lanyards in such a way that they do not touch the ground surface.

Wells Without Plumbing

a.) Tubing/Pump Placement

1. If attempting to minimize the volume of purge water, position the intake hose or pump at the midpoint of the screened or open hole interval.
2. If monitoring well conditions do not allow minimizing of the purge water volume, position the pump or intake hose near the top of the water column. This will ensure that all stagnant water in the casing is removed.
3. If the well screen or borehole is partially submerged, and the pump will be used for both purging and sampling, position the pump midway between the measured water level and the bottom of the screen. Otherwise, position the pump or intake hose near the top of the water column.

b.) Non-dedicated (portable) pumps

1. *Variable Speed Peristaltic Pump*
    - Wear sampling gloves to position the decontaminated pump and tubing.
    - Attach a short section of tubing to the discharge side of the pump and into a graduated container.
    - Attach one end of a length of new or precleaned tubing to the pump head flexible hose.
    - Place the tubing as described in one of the options listed above.
    - Change gloves before beginning to purge.
    - Measure the depth to groundwater at frequent intervals.
    - Record these measurements.
    - Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

- If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
- If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that water is removed from the top of the water column.
- Record the purging rate each time the rate changes.
- Measure the purge volume.
- Record this measurement.
- Decontaminate the pump and tubing between wells (see Appendix C) or if precleaned tubing is used for each well, only the pump.

2. *Variable Speed Centrifugal Pump*
    - Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
    - Wear sampling gloves to position the decontaminated pump and tubing.
    - Place the decontaminated suction hose so that water is always pumped from the top of the water column.
    - Change gloves before beginning to purge.
    - Equip the suction hose with a foot valve to prevent purge water from re-entering the well.
    - Measure the depth to groundwater at frequent intervals.
    - Record these measurements.
    - To minimize drawdown, adjust the purging rate so that it is equivalent to the well recovery rate.
    - If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
    - If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that the water is removed from the top of the water column.
    - Record the purging rate each time the rate changes.
    - Measure the purge volume.
    - Record this measurement.
    - Decontaminate the pump and tubing between wells or if precleaned tubing is used for each well, only the pump.
3. *Variable Speed Electric Submersible Pump*
    - Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
    - Wear sampling gloves to position the decontaminated pump and tubing.
    - Carefully position the decontaminated pump.

- Change gloves before beginning to purge.
- Measure the depth to groundwater at frequent intervals.
- Record these measurements.
- To minimize drawdown, adjust the purging rate so that it is equivalent to the well recovery rate.
- If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
- If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that water is removed from the top of the water column.
- Record the purging rate each time the rate changes.
- Measure the purge volume.
- Record this measurement.
- Decontaminate the pump and tubing between wells or only the pump if precleaned tubing is used for each well.

4. *Variable Speed Bladder Pump*
    - Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
    - Wear sampling gloves to position the decontaminated pump and tubing.
    - Attach the tubing and carefully position the pump.
    - Change gloves before beginning purging.
    - Measure the depth to groundwater at frequent intervals.
    - Record these measurements.
    - To minimize drawdown, adjust the purging rate so that it is equivalent to the well recovery rate.
    - If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
    - If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that water is removed from the top of the water column.
    - Record the purging rate each time the rate changes.
    - Measure the purge volume.
    - Record this measurement.
    - Decontaminate the pump and tubing between wells or if precleaned tubing is used for each well, only the pump.

c.) <u>Dedicated Portable Pumps</u>

1. *Variable Speed Electric Submersible Pump*
    - Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
    - Wear sampling gloves.

- Measure the depth to groundwater at frequent intervals.
- Record these measurements.
- Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
- If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdraw with the recharge rate.
- Record the purging rate each time the rate changes.
- Measure the purge volume.
- Record this measurement.

2. *Variable Speed Bladder Pump*
    - Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
    - Wear sampling gloves.
    - Measure the depth to groundwater at frequent intervals.
    - Record these measurements.
    - Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
    - If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdraw with the recharge rate.
    - Record the purging rate each time the rate changes.
    - Measure the purge volume.
    - Record this measurement.
3. *Bailers* - Using bailers for purging is not recommended unless care is taken to use proper bailing technique, or if free product is present in the well or suspected to be in the well.
    - Minimize handling the bailer as much as possible.
    - Wear sampling gloves.
    - Remove the bailer from its protective wrapping just before use.
    - Attach a lanyard of appropriate material.
    - Use the lanyard to move and position the bailer.
    - Lower and retrieve the bailer slowly and smoothly.
    - Lower the bailer carefully into the well to a depth approximately a foot above the water column.
    - When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached.
    - Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column.
    - Allow time for the bailer to fill with aquifer water as it descends into the water column.

- Carefully raise the bailer. Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.
- Measure the purge volume.
- Record the volume of the bailer.
- Continue to carefully lower and retrieve the bailer as described above until the purging is considered complete, based on either the removal of 3 well volumes.
- Remove at least one (1) well volume before collecting measurements of the field parameters. Take each subsequent set of measurements after removing at least one quarter (1/4) well volume between measurements.

Groundwater Sampling Techniques

a.) Purge wells.

b.) Replace protective covering around the well if it is soiled or torn after completing purging operations.

c.) Equipment Considerations

1. The following pumps are approved to collect volatile organic samples:
    - Stainless steel and Teflon variable speed submersible pumps
    - Stainless steel and Teflon or polyethylene variable speed bladder pumps
    - Permanently installed PVC bodied pumps (As long as the pump remains in contact with the water in the well at all times)
2. Collect sample from the sampling device and store in sample container. Do not use intermediate containers.
3. To avoid contamination or loss of analytes from the sample, handle sampling equipment as little as possible and minimize equipment exposure to the sample.
4. To reduce chances of cross-contamination, use dedicated equipment whenever possible. "Dedicated" is defined as equipment that is to be used solely for one location for the life of that equipment (e.g., permanently mounted pump). Purchase dedicated equipment with the most sensitive analyte of interest in mind.
    - Clean or make sure dedicated pumps are clean before installation. They do not need to be cleaned prior to each use, but must be cleaned if they are withdrawn for repair or servicing.
    - Clean or make sure any permanently mounted tubing is clean before installation.
    - Change or clean tubing when the pump is withdrawn for servicing.
    - Clean any replaceable or temporary parts.

- Collect equipment blanks on dedicated pumping systems when the tubing is cleaned or replaced.
- Clean or make sure dedicated bailers are clean before placing them into the well.
- Collect an equipment blank on dedicated bailers before introducing them into the water column.
- Suspend dedicated bailers above the water column if they are stored in the well.

Sampling Wells Without Plumbing

a.) Sampling with Pumps – The following pumps may be used to sample for organics:

- Peristaltic pumps
- Stainless steel, Teflon or polyethylene bladder pumps
- Variable speed stainless steel and Tefloṇ submersible pumps

1. *Peristaltic Pump*

- Volatile Organics: One of three methods may be used.
  - Remove the drop tubing from the inlet side of the pump; submerge the drop tubing into the water column; prevent the water in the tubing from flowing back into the well; remove the drop tubing from the well; carefully allow the groundwater to drain into the sample vials; avoid turbulence; do not aerate the sample; repeat steps until enough vials are filled. OR
  - Use the pump to fill the drop tubing; quickly remove the tubing from the pump; prevent the water in the tubing from flowing back into the well; remove the drop tubing from the well; carefully allow the groundwater to drain into the sample vials; avoid turbulence; do not aerate the sample; repeat steps until enough vials are filled. OR
  - Use the pump to fill the drop tubing; withdraw the tubing from the well; reverse the flow on the peristaltic pumps to deliver the sample into the vials at a slow, steady rate; repeat steps until enough vials are filled.
- Extractable Organics: If delivery tubing is not polyethylene or PP, or is not Teflon lined, use pump and vacuum trap method. Connect the outflow tubing from the container to the influent side of the peristaltic pump. Turn pump on and reduce flow until smooth and even. Discard a

small portion of the sample to allow for air space. Preserve (if required), label, and complete field notes.

- Inorganic samples: These samples may be collected from the effluent tubing. If samples are collected from the pump, decontaminate all tubing (including the tubing in the head) or change it between wells. Preserve (if required), label, and complete field notes.

2. *Variable Speed Bladder Pump*
    - If sampling for organics, the pump body must be constructed of stainless steel and the valves and bladder must be Teflon. All tubing must be Teflon, polyethylene, or PP and any cabling must be sealed in Teflon, polyethylene or PP, or made of stainless steel.
    - After purging to a smooth even flow, reduce the flow rate.
    - When sampling for volatile organic compounds, reduce the flow rate to 100-200mL/minute, if possible.
3. *Variable Speed Submersible Pump*
    - The housing must be stainless steel.
    - If sampling for organics, the internal impellers, seals and gaskets must be constructed of stainless steel, Teflon, polyethylene or PP. The delivery tubing must be Teflon, polyethylene or PP; the electrical cord must be sealed in Teflon; any cabling must be sealed in Teflon or constructed of stainless steel.
    - After purging to a smooth even flow, reduce the flow rate.
    - When sampling for volatile organic compounds, reduce the flow rate to 100-200mL/minute, if possible.

b.) Sampling with Bailers - A high degree of skill and coordination are necessary to collect representative samples with a bailer.

1. *General Considerations*
    - Minimize handling of bailer as much as possible.
    - Wear sampling gloves.
    - Remove bailer from protective wrapping just before use.
    - Attach a lanyard of appropriate material.
    - Use the lanyard to move and position the bailers.
    - Do not allow bailer or lanyard to touch the ground.
    - If bailer is certified precleaned, no rinsing is necessary.
    - If both a pump and a bailer are to be used to collect samples, rinse the exterior and interior of the bailer with sample water from the pump before removing the pump.
    - If the purge pump is not appropriate for collecting samples (e.g., non-inert components), rinse the bailer by collecting a single bailer of the groundwater to be sampled.
    - Discard the water appropriately.

- Do not rinse the bailer if Oil and Grease samples are to be collected.

2. *Bailing Technique*
    - Collect all samples that are required to be collected with a pump before collecting samples with the bailer.
    - Raise and lower the bailer gently to minimize stirring up particulate matter in the well and the water column, which can increase sample turbidity.
    - Lower the bailer carefully into the well to a depth approximately a foot above the water column. When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached.
    - Do not lower the top of the bailer more than one foot below the top of the water table, so that water is removed from the top of the water column.
    - Allow time for the bailer to fill with aquifer water as it descends into the water column.
    - Do not allow the bailer to touch the bottom of the well or particulate matter will be incorporated into the sample. Carefully raise the bailer. Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.
    - Lower the bailer to approximately the same depth each time.
    - Collect the sample. Install a device to control the flow from the bottom of the bailer and discard the first few inches of water. Fill the appropriate sample containers by allowing the sample to slowly flow down the side of the container. Discard the last few inches of water in the bailer.
    - Repeat steps for additional samples.
    - As a final step measure the DO, pH, temperature, turbidity and specific conductance after the final sample has been collected. Record all measurements and note the time that sampling was completed.

c.) <u>Sampling Low Permeability Aquifers or Wells that have Purged Dry</u>

1. Collect the sample(s) after the well has been purged. Minimize the amount of water removed from the well by using the same pump to purge and collect the sample. If the well has purged dry, collect samples as soon as sufficient sample water is available.
2. Measure the five field parameters temperature, pH, specific conductance, dissolved oxygen and turbidity at the time of sample collection.
3. Advise the analytical laboratory and the client that the usual amount of sample for analysis may not be available.

Appendix D - Collecting Samples from Wells with Plumbing in Place

In-place plumbing is generally considered permanent equipment routinely used for purposes other than purging and sampling, such as for water supply.

a.) Air Strippers or Remedial Systems - These types of systems are installed as remediation devices. Collect influent and effluent samples from air stripping units as described below.

1. Remove any tubing from the sampling port and flush for one to two minutes.
2. Remove all hoses, aerators and filters (if possible).
3. Open the spigot and purge sufficient volume to flush the spigot and lines and until the purging completion criteria have been met.
4. Reduce the flow rate to approximately 500 mL/minute (a 1/8" stream) or approximately 0.1 gal/minute before collecting samples.
5. Follow procedures for collecting samples from water supply wells as outlined below.

b.) Water Supply Wells – Water supply wells with in-place plumbing do not require equipment to be brought to the well to purge and sample. Water supply wells at UST facilities must be sampled for volatile organic compounds (VOCs) and semivolatile compounds (SVOCs).

1. *Procedures for Sampling Water Supply Wells*
   - Label sample containers prior to sample collection.
   - Prepare the storage and transport containers (ice chest, etc.) before taking any samples so each collected sample can be placed in a chilled environment immediately after collection.
   - You must choose the tap closest to the well, preferably at the wellhead. The tap must be before any holding or pressurization tank, water softener, ion exchange, disinfection process or before the water line enters the residence, office or building. If no tap fits the above conditions, a new tap that does must be installed.
   - The well pump must not be lubricated with oil, as that may contaminate the samples.
   - The sampling tap must be protected from exterior contamination associated with being too close to a sink bottom or to the ground. If the tap is too close to the ground for direct collection into the appropriate container, it is acceptable to use a smaller (clean) container to transfer the sample to a larger container.
   - Leaking taps that allow water to discharge from around the valve stem handle and down the outside of the faucet, or taps in which water tends to run up on the outside of the lip, are to be avoided as sampling locations.

- Disconnect any hoses, filters, or aerators attached to the tap before sampling.
- Do not sample from a tap close to a gas pump. The gas fumes could contaminate the sample.

2. *Collecting Volatile Organic Samples*
    - Equipment Needed: VOC sample vials [40 milliliters, glass, may contain 3 to 4 drops of hydrochloric acid (HCl) as preservative]; Disposable gloves and protective goggles; Ice chest/cooler; Ice; Packing materials (sealable plastic bags, bubble wrap, etc.); and Lab forms.
    - Sampling Procedure: Run water from the well for at least 15 minutes. If the well is deep, run water longer (purging three well volumes is best). If tap or spigot is located directly before a holding tank, open a tap after the holding tank to prevent any backflow into the tap where you will take your sample. This will ensure that the water you collect is "fresh" from the well and not from the holding tank. After running the water for at least 15 minutes, reduce the flow of water. The flow should be reduced to a trickle but not so slow that it begins to drip. A smooth flow of water will make collection easier and more accurate. Remove the cap of a VOC vial and hold the vial under the stream of water to fill it. Be careful not to spill any acid that is in the vial. For best results use a low flow of water and angle the vial slightly so that the water runs down the inside of the vial. This will help keep the sample from being agitated, aerated or splashed out of the vial. It will also increase the accuracy of the sample. As the vial fills and is almost full, turn the vial until it is straight up and down so the water won't spill out. Fill the vial until the water is just about to spill over the lip of the vial. The surface of the water sample should become mounded. It is a good idea not to overfill the vial, especially if an acid preservative is present in the vial. Carefully replace and screw the cap onto the vial. Some water may overflow as the cap is put on. After the cap is secure, turn the vial upside down and gently tap the vial to see if any bubbles are present. If bubbles are present in the vial, remove the cap, add more water and check again to see if bubbles are present. Repeat as necessary. After two samples without bubbles have been collected, the samples should be labeled and prepared for shipment. Store samples at 4° C.

3. *Collecting Extractable Organic and/or Metals Samples*

- Equipment Needed: SVOC sample bottle [1 liter, amber glass] and/or Metals sample bottle [0.5 liter, polyethylene or glass, 5 milliliters of nitric acid (HNO3) preservative]; Disposable gloves and protective goggles; Ice Chest/Cooler; Ice; Packing materials (sealable plastic bags, bubble wrap, etc.); and Lab forms.
- Sampling Procedure: Run water from the well for at least 15 minutes. If the well is deep, run the water longer (purging three well volumes is best). If tap or spigot is located directly before a holding tank, open a tap after the holding tank to prevent any backflow into the tap where you will take your sample. This will ensure that the water you collect is "fresh" from the well and not from the holding tank. After running the water for at least 15 minutes, reduce the flow. Low water flow makes collection easier and more accurate. Remove the cap of a SVOC or metals bottle and hold it under the stream of water to fill it. The bottle does not have to be completely filled (i.e., you can leave an inch or so of headspace in the bottle). After filling, screw on the cap, label the bottle and prepare for shipment. Store samples at 4° C.

Appendix E - Collecting Surface Water Samples

The following topics include 1.) acceptable equipment selection and equipment construction materials and 2.) standard grab, depth-specific and depth-composited surface water sampling techniques.

Facilities which contain or border small rivers, streams or branches should include surface water sampling as part of the monitoring program for each sampling event. A simple procedure for selecting surface water monitoring sites is to locate a point on a stream where drainage leaves the site. This provides detection of contamination through, and possibly downstream of, site via discharge of surface waters. The sampling points selected should be downstream from any waste areas. An upstream sample should be obtained in order to determine water quality upstream of the influence of the site.

a.) General Cautions
    1. When using watercraft take samples near the bow away and upwind from any gasoline outboard engine. Orient watercraft so that bow is positioned in the upstream direction.
    2. When wading, collect samples upstream from the body. Avoid disturbing sediments in the immediate area of sample collection.
    3. Collect water samples prior to taking sediment samples when obtaining both from the same area (site).
    4. Unless dictated by permit, program or order, sampling at or near man-made structures (e.g., dams, weirs or bridges) may not provide representative data because of unnatural flow patterns.
    5. Collect surface water samples from downstream towards upstream.

b.) Equipment and Supplies - Select equipment based on the analytes of interest, specific use, and availability.

c.) Surface Water Sampling Techniques - Adhere to all general protocols applicable to aqueous sampling when following the surface water sampling procedures addressed below.
    1. *Manual Sampling*: Use manual sampling for collecting grab samples for immediate in-situ field analyses. Use manual sampling in lieu of automatic equipment over extended periods of time for composite sampling, especially when it is necessary to observe and/or note unusual conditions.
        - Surface Grab Samples - Do not use sample containers containing premeasured amounts of preservatives to collect grab samples. If the sample matrix is homogeneous, then the grab method is a simple and effective technique for collection purposes. If homogeneity is not apparent, based on flow or vertical variations (and should never be assumed), then use other collection protocols. Where practical, use the actual sample container submitted to the laboratory for collecting samples to be analyzed for oil and grease, volatile organic compounds (VOCs), and microbiological samples. This procedure eliminates the possibility of contaminating the sample with an intermediate collection container. The use of

unpreserved sample containers as direct grab samplers is encouraged since the same container can be submitted for laboratory analysis after appropriate preservation. This procedure reduces sample handling and eliminates potential contamination from other sources (e.g., additional sampling equipment, environment, etc.).

1. Grab directly into sample container.
2. Slowly submerge the container, opening neck first, into the water.
3. Invert the bottle so the neck is upright and pointing towards the direction of water flow (if applicable). Allow water to run slowly into the container until filled.
4. Return the filled container quickly to the surface.
5. Pour out a few mL of sample away from and downstream of the sampling location. This procedure allows for the addition of preservatives and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
6. Add preservatives, securely cap container, label, and complete field notes. If sample containers are attached to a pole via a clamp, submerge the container and follow steps 3 – 5 but omit steps 1 and 2.

- Sampling with an Intermediate Vessel or Container: If the sample cannot be collected directly into the sample container to be submitted to the laboratory, or if the laboratory provides prepreserved sample containers, use an unpreserved sample container or an intermediate vessel (e.g., beakers, buckets or dippers) to obtain the sample. These vessels must be constructed appropriately, including any poles or extension arms used to access the sample location.
    1. Rinse the intermediate vessel with ample amounts of site water prior to collecting the first sample.
    2. Collect the sample as outlined above using the intermediate vessel.
    3. Use pole mounted containers of appropriate construction to sample at distances away from shore, boat, etc. Follow the protocols above to collect samples.
- Peristaltic Pump and Tubing: The most portable pump for this technique is a 12 volt peristaltic pump. Use appropriately precleaned, silastic tubing in the pump head and attach polyethylene, Tygon, etc. tubing to the pump. This technique is not acceptable for Oil and Grease, EPH, VPH or VOCs. Extractable organics can be collected through the pump if flexible interior-wall Teflon, polyethylene or PP tubing is used in the pump head or if used with the organic trap setup.

1. Lower appropriately precleaned tubing to a depth of 6 – 12 inches below water surface, where possible.
2. Pump 3 – 5 tube volumes through the system to acclimate the tubing before collecting the first sample.
3. Fill individual sample bottles via the discharge tubing. Be careful not to remove the inlet tubing from the water.
4. Add preservatives, securely cap container, label, and complete field notes.

- Mid-Depth Grab Samples: Mid-depth samples or samples taken at a specific depth can approximate the conditions throughout the entire water column. The equipment that may be used for this type of sampling consists of the following depth-specific sampling devices: Kemmerer, Niskin, Van Dorn type, etc. You may also use pumps with tubing or double check-valve bailers. Certain construction material details may preclude its use for certain analytes. Many Kemmerer samplers are constructed of plastic and rubber that preclude their use for all volatile and extractable organic sampling. Some newer devices are constructed of stainless steel or are all Teflon or Teflon-coated. These are acceptable for all analyte groups without restriction.
    1. Measure the water column to determine maximum depth and sampling depth prior to lowering the sampling device.
    2. Mark the line attached to the sampler with depth increments so that the sampling depth can be accurately recorded.
    3. Lower the sampler slowly to the appropriate sampling depth, taking care not to disturb the sediments.
    4. At the desired depth, send the messenger weight down to trip the closure mechanism.
    5. Retrieve the sampler slowly.
    6. Rinse the sampling device with ample amounts of site water prior to collecting the first sample. Discard rinsate away from and downstream of the sampling location.
    7. Fill the individual sample bottles via the discharge tube.
- Double Check-Valve Bailers: Collect samples using double check-valve bailers if the data requirements do not necessitate a sample from a strictly discrete interval of the water column. Bailers with an upper and lower check-valve can be lowered through the water column. Water will continually be displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved. Sampling with this type of bailer must follow the same protocols outlined above, except that a messenger weight is not applicable. Although not designed specifically for this kind of sampling, a bailer is acceptable when a mid-depth sample is required

1. As the bailer is dropped through the water column, water is displaced through the body of the bailer. The degree of displacement depends upon the check-valve ball movement to allow water to flow freely through the bailer body.
2. Slowly lower the bailer to the appropriate depth. Upon retrieval, the two check valves seat, preventing water from escaping or entering the bailer.
3. Rinse the sampling device with ample amounts of site water prior to collecting the first sample.
4. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described above.

- Peristaltic Pump and Tubing: The most portable pump for this technique is a 12 volt peristaltic pump. Use appropriately precleaned, silastic tubing in the pump head and attach HDPE, Tygon, etc. tubing to the pump. This technique is not acceptable for Oil and Grease, EPH, VPH or VOCs. Extractable organics can be collected through the pump if flexible interior-wall Teflon, polyethylene or PP tubing is used in the pump head, or if used with an organic trap setup.
    1. Measure the water column to determine the maximum depth and the sampling depth.
    2. Tubing will need to be tied to a stiff pole or be weighted down so the tubing placement will be secure. Do not use a lead weight. Any dense, non-contaminating, non-interfering material will work (brick, stainless steel weight, etc.). Tie the weight with a lanyard (braided or monofilament nylon, etc.) so that it is located below the inlet of the tubing.
    3. Turn the pump on and allow several tubing volumes of water to be discharged before collecting the first sample.
    4. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described above.

Leachate Sampling and Analysis

To maintain sample quality, leachate samples are to be taken as close to the sump as possible. Because of dubious results, pond and storage tank samples should be avoided. The leachate data is to be submitted with the semi-annual monitoring report. Leachate is to be analyzed for 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. Based upon sample results, compliance history and waste screening practices, additional parameters may be required.

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SaveWaterNC.org NC SWAP Info Source Water Protection nc ONE map Geographic State Data

Electronic Data need to be in the following format such that they can be uploaded into the Solid Waste Section database.
Please see the "Data Format Explanation" tab at the bottom of this sheet for an explanation of each column.

FACILITY PERMIT	WELL ID	CAS Number	SWS ID	PARAMETER	RESULT	UNITS	QUALIFIER	METHOD	MDL	SWSL	DILUTION FACTOR	COLLECT DATE	EXTRACTION DATE	ANALYSIS DATE
12-34	1234-MW3A	74-87-3	137	Chloromethane	BQL	ug/L	U	SW846 8260B	0.18	1	1	07/23/2007	07/24/2007	7/27/2007
12-34	1234-MW3A		325	Temperature	19.1	oC						07/23/2007		
12-34	1234-MW5	74-83-9	136	Bromomethane	35	ug/L		SW846 8260B	0.26	10	1	07/23/2007	07/24/2007	7/27/2007
12-34	1234-MW5	7440-39-3	15	Barium	50	ug/L	J	SW846 6020	0.04	100	1	07/23/2007		7/27/2007
12-34	1234-MW5		411	Total Well Depth	54.3	ft						07/23/2007		

ALL DATA SHOULD INCLUDE THE PERMIT NUMBER. If unsure, contact the operator/owner of the facility.
The unit of concentration should be ug/L for ALL constituents.

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.

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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
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

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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.

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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.

APPENDIX C

Methane Extraction System Information
(from the *Lenoir County Transition Plan*)

APPENDIX III

EXPLOSIVE GAS CONTROL PLAN FOR - LENOIR COUNTY

Quarterly the County of Lenoir landfill will monitor the explosive gas at the landfill structures and at or near the landfill boundary. The monitoring system will consist of two phases. Temporary probes (phase 1) will be placed in the ground as depicted in the operation drawings. The probes are holes that are two - three feet deep either poked in the ground or hand excavated. The top of the hole is then plugged by some means such as a plastic soft drink bottle. The second phase (permanent probes) will consist of a plastic stand pipe similar to a pieziometer used for groundwater detection. A typical permanent methane probe is detailed in the operation drawings. The permanent probe will be constructed at a depth of six (6) feet. A 6" diameter hole will contain a one (1) inch slotted PVC pipe. The bottom two (2) feet will be backfilled with non-carbonate pea gravel with a bentonite seal one (1) foot thick above it. The remaining three (3) feet will be backfilled with in-situ soils. The one (1) inch PVC pipe will be approximately three (3) feet above the existing grade. The PVC pipe will be capped with a one (1) inch PVC cap, one quarter (1/4) inch NPT hose barb, and 1" tubing, plugged or capped. The permanent probes will be installed by October 9, 1994.

The location and spacing of the methane monitoring probes is somewhat arbitrary. The locations were determined by the relationship of solid waste with property lines and landfill structures. The spacing of the methane probes varies due to the proximity of the property boundary with the solid waste. On the north end of the landfill the property boundary is several hundred feet away from the creek. The west side boundary is also the creek which is six to seven hundred feet away from solid waste. The probes on these sides are arbitrarily placed near the solid waste to detect any horizontal movement of methane gas. The boundary line is nearest to solid waste at the south end of the right-of-way and at the very southeast corner. These methane probes 1,12, and 13 were placed where nest to solid waste which was buried below ground and net filled above ground. On the east side, Lenoir County owns the land for several hundred feet east of methane probes 1 and 3. A boundary line begins at methane probe 3 and continues northerly past methane probe 5. The migration of methane gas is induced by pressure gradients. The methane will move from areas of high pressure to those of low pressure following the path of least resistance. The methane will migrate vertically until it reaches the landfill cap, where it will begin to flow horizontally. This occurs until it finds a pathway out, either by the installed methane collection trenches or migration through the permeable in-situ soils. Since methane is lighter than air, it wants to escape into the atmosphere. It has been our experience that whenever gas is migrating no matter what the spacing or depth of the monitoring probes, the gas will fill the void created by the monitoring point and an explosive meter will monitor the level. The six foot depth of the monitoring probes is to ensure a stable monitoring point. The only time a shallow monitoring point has not worked is in a very heavy, impermeable clay layer that acts as a seal to the migration of

the gas. If a clay layer is encountered during the construction of the monitoring points, it will either be moved beyond the clay or excavated to a depth that is in the conductive zone below the clay.

The permanent probes surround the existing fill area. The plan has been modified. This is to check if methane is migrating toward the present landfill boundary.

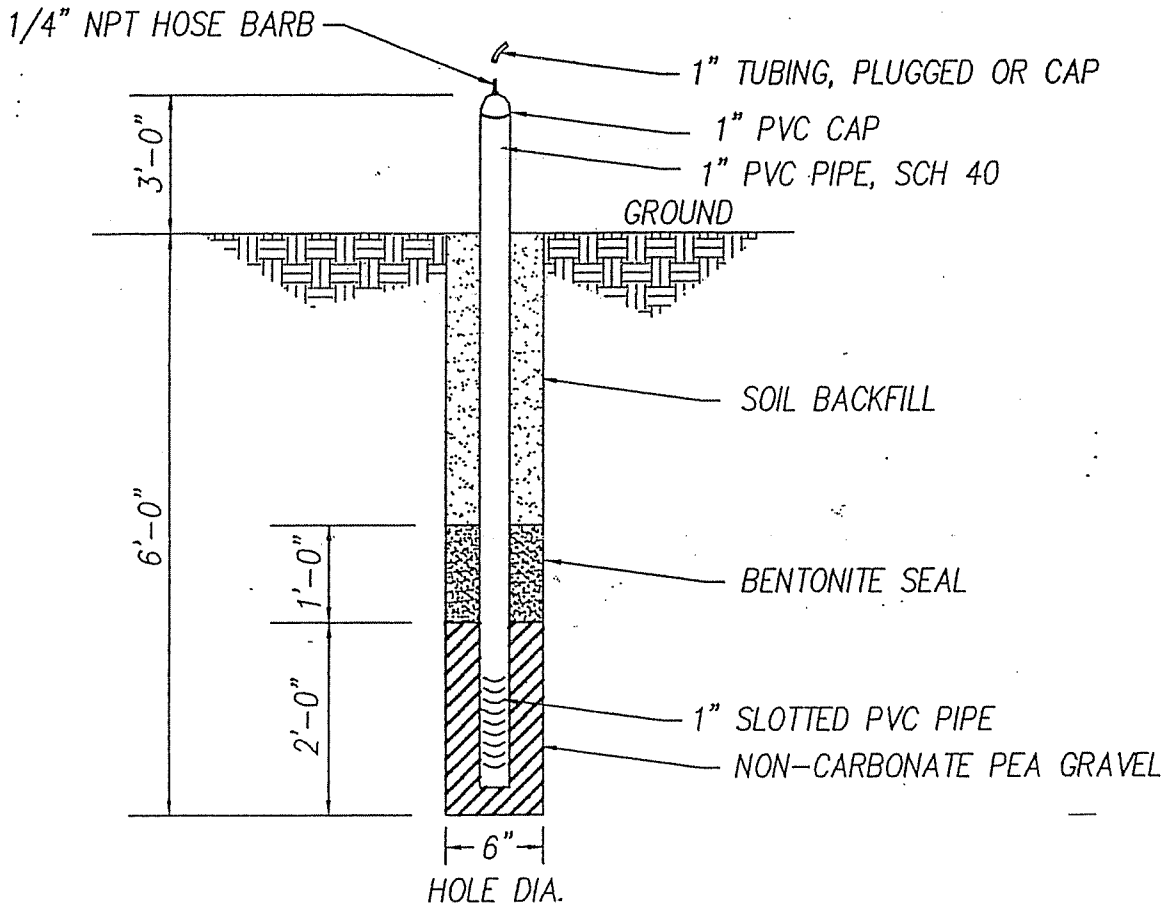
The gas can be detected by use of an instrument that reports the percent of lower explosive limit. An instrument that can be used is the Gas Tech GP 204 which can be purchased from Safety Supply America of Lexington, NC at 704-956-2131. The operation and calibration instructions are included in this appendix.

Quarterly, a County employee will visit each monitoring point either the temporary or permanent. The monitoring points consist of all methane probes. Using the detection instrument, he will determine if methane gas has filled the probes. If the probe is near the property line and methane gas is detected at or beyond the lower explosive limit (100% LEL), it must then be determined if the gas is migrating across the landfill boundary. If the probe is on the boundary or methane gas has migrated beyond the boundary, a remediation plan must be completed by Lenoir County.

Other points of monitoring will be the landfill structures. Each structure will be monitored for methane using the following methods:

1. All crawl spaces will be monitored;
2. All corners in the structure will be monitored;
3. Any holes, cracks and pipes through the foundation will be monitored

If methane gas is detected beyond 25% of its lower explosive limit in any structure, then a remediation plan is stated in the operational requirements.



METHANE GAS MONITORING PROBE

N.T.S.