MONITORING AND MAINTENANCE PLAN FOR TYPE 5 RISK REDUCTION STANDARDS

NORTHSIDE DRIVE LANDFILL
Atlanta, Georgia

December 2003
(Revised July 2005)

TABLE OF CONTENTS

Attachment
As-built drawings

TABLE

Northside Drive Landfill
Monitoring and Maintenance Plan
December 2003 (Revised July 2005)

1.0 INTRODUCTION

The Northside Drive Landfill (NDL) site is listed on the State of Georgia's Hazardous Site Inventory pursuant to the Georgia Hazardous Site Response Act, Official Code of Georgia Annotated (O.C.G.A.) § 12-8-90 and associated Rules for Hazardous Site Response, Chapter 391-3-19. The landfill portion of the NDL site (landfill) was remediated using engineering and institutional controls. The engineering controls involved the installation of a soil-bentonite slurry wall and an engineered control cap as illustrated in the approved As-Built Drawings dated October 2003 and supporting documents. A second engineering control was developed which consisted of a concrete cap placed adjacent to and running parallel with Northside Drive. The concrete cap was designed to address contaminated soils that persisted at the property boundary along Northside Drive (former Tax Parcel 14-82-6-3-0). The institutional controls implemented were a deed notice and conservation easement that includes this Monitoring and Maintenance (M&M) Plan.

A notification was submitted to the Georgia Environmental Protection Division (GA EPD) on March 7, 2005 regarding the change in use of the landfill. The use of the landfill effective July 1, 2005 will be that of a surface parking lot.

This M&M plan contains six sections, 3 appendices, and an attachment. Section 2.0 describes the current landfill monitoring and control systems. Section 3.0 presents the groundwater-monitoring plan. Section 4.0 contains the landfill maintenance and inspection plan. Section 5.0 describes land use of the landfill portion of the NDL site. References are presented in Section 6.0. The appendices are as follows: Appendix A contains descriptions of potential statistical data evaluation methods; Appendix B contains a figure; and Appendix C contains forms. As-built drawings of the landfill portion of the NDL site are presented in the Attachment.

2.0 LANDFILL MONITORING AND CONTROL SYSTEMS

2.1 LANDFILL ENGINEERING CONTROLS

The engineering controls consist of a three foot wide soil-bentonite slurry wall which extends from the surface to bedrock around the landfill wastes and covered with an engineered control cap consisting of a geosynthetic clay liner, LLDPE liner, geocomposite drainage layer with two feet of select fill.

The following nine (9) groundwater monitoring wells and a dewatering well are located in and around the landfill as show in Figure 1, Appendix B:

- MWC-1 A, MWC-1B, and MWC-1 C, (located on the southeastern corner of Tax Parcel No. 14-82-68 at the corner of John and Gray Streets)
- MWC-3B, MM-02, and MWC-3C (located on the southwestern corner of Tax Parcel No. 14-82-6-8 at the corner of John Street and Northside Drive)
- Dewatering well (located within the limits of the engineering controls of the landfill at the northwest corner of the landfill)
- MM-03 (located midway along John Street)
- MM-01 (located midway along Northside Drive between Western Avenue and John Street)
- MM-04 which is the upgradient, background groundwater monitoring well (located near the corner of Western Avenue and Gray Street)

These wells are used to identify and/or evaluate the following conditions:

- Release of regulated substances from the landfill above background and/or the risk reduction standards of Section 391-3-19-.07 of the Rules
- Migration and/or expansion of regulated substances located outside of the landfill
- Measure groundwater levels inside and outside the slurry wall

2.2 CONCRETE CAP

Additional engineering controls consist of an 8-foot wide, 8-inch deep concrete cap, which extends from the property boundary adjacent to and running parallel with Northside Drive (see Figure 2, Appendix B). A portion of the concrete cap will be covered with a 2-inch layer of asphalt per Georgia Department of Transportation specifications. The concrete cap is shown in C1.1, CM1.1, and CM1.2 of the construction plans (collectively referred to as Figure 2).

3.0 GROUNDWATER-MONITORING PLAN

This section summarizes the regulated substances to be measured, sampling and analysis requirements including the sampling and analysis plan, data evaluation (statistical methods), and reporting requirements. No natural surface water drainage features are present; therefore, a plan to monitor surface water is not included in this M&M Plan.

3.1 GROUNDWATER STANDARDS

The Georgia Type 1 risk reduction standards (Section 391-3-19-.07 of the Rules) forregulated substances will be used as the groundwater standards for the groundwater-monitoring plan.

3.1.1 Regulated Substances

The regulated substances for the NDL site include polynuclear aromatic hydrocarbons (PAH) and metals. Table 1 lists the regulated substances, the frequency at which they will be monitored, the Type 1 risk reduction standards (RRS), and the analytical methods that will be used. The selected analytical method must have detection limits at or below the Type 1 RRS listed in Table 1. Detection limit is the practical quantitation limit (PQL), defined in the Rules as the lowest concentration, for an approved analytical test method and for a given sample matrix, at which the quantity of a regulated substance can be measured with a stated degree of confidence under routine laboratory operating conditions. Monitoring for regulated substances at the frequencies given in Table 1 must be conducted for all monitoring wells including the background-monitoring well (See 3.1.2 for more detail). In addition, field parameters must be recorded at the same frequencies, as part of the monitoring plan. Field parameters include water level, pH, specific conductance, temperature, and turbidity. Section 3.2.2 (Sample Collection) gives a detailed explanation of the procedures to accurately evaluate and record field parameters.

3.1.2 Monitoring Frequency

Upon notification by the Georgia Environmental Protection Division (EPD) to initiate the groundwater-monitoring plan, groundwater-monitoring sampling shall be initiated within sixty (60) days of receipt of notification. The groundwater-monitoring plan will consist of the following activities:

- Measurements of field parameters (total depth of the well, water level, pH, specific conductance, temperature, and turbidity) for all groundwater monitoring wells and the dewatering well; and
- Sampling for the regulated substances included in Table 1 from all of the groundwater-monitoring wells.

The frequency of monitoring is provided in Table 1. The quarterly sampling will be based on calendar quarters ending March 31, June 30, September 30 and December 31. Reports must be submitted to EPD within forty-five (45) days of the end of the calendar quarter for which the sampling was performed. The quarterly sampling will be performed for two years to establish existing conditions and background data that could be used for statistical analysis, if warranted. After two years of quarterly sampling and unless notified otherwise by EPD, the frequency of groundwater sampling will be reduced to once annually with the annual report due to EPD within forty-five (45) days of the end of the quarter for which the sampling was performed. An M&M review report must be submitted to EPD within sixty (60) days from the close of every fifth year that summarizes and evaluates groundwater trends discerned through that time period and make recommendations as appropriate.

Table 1
Regulated Substances for Groundwater
Northside Drive Landfill

Regulated Substance	Frequency of Groundwater Monitoring*	Type 1 RRS (mg/L)	Analytical Method
Organics			
Acena hthene	Quarterly for 2 years, then annually	2	SW846 8310
Acena hth lene	Quarterly for 2 years, then annually	PQL[a]: 0.023	SW846 8310
Anthracene	Quarterly for 2 years, then annually	PQL[a]: 0.0066	SW846 8310
Benzo(a)anthracene	Quarterly for 2 years, then annually	0.0001	SW846 8310
Benzo(k)fluoranthene	Quarterly for 2 years, then annually	PQL[a]: 0.00017	SW846 8310
Benzo(b)fluoranthene	Quarterly for 2 years, then annually	0.0002	SW846 8310
Benzo(g,h,i)perylene	Quarterly for 2 years, then annually	PQL[a]: 0.00076	SW846 8310
Benzo(a)pyrene	Quarterly for 2 years, then annually	0.0002	SW846 8310
Chrysene	Quarterly for 2 years, then annually	0.0002[b]	SW846 8310
Dibenz(a,h)anhracene	Quarterly for 2 years, then annually	0.0003	SW846 8310
Fluoranthene	Quarterly for 2 years, then annually	1	SW846 8310
Fluorene	Quarterly for 2 years, then annually	1	SW846 8310
Indeno(1,2,3-cd)pyrene	Quarterly for 2 years, then annually	0.0004	SW846 8310
Naphthalene	Quarterly for 2 years, then annually	0.02	SW846 8310
Phenanthrene	Quarterly for 2 years, then annually	PQL[a]: 0.0064	SW846 8310
Pyrene	Quarterly for 2 years, then annually	1	SW846 8310
Metals			
Beryllium	Quarterly for 2 years, then annually	0.004	SW846 6010B
Lead	Quarterly for 2 years, then annually	0.015	SW846 6010B
Mercury	Quarterly for 2 years, then annually	0.002	SW846 7470A

Notes:

* Frequency of groundwater monitoring may be modified only upon receipt of EPD's approval.

a The PQL presented is the value provided in SW846 Method 8310 for a typical groundwater matrix in the absence of interference. Interference may cause the PQL value to increase. As such, this PQL value is provided for guidance and may not always be achieved.

b The health based drinking water criterion for this substance/analyte is lower than the lowest c currently achievable and available detection limit. According to Rule 391-3-19.07(4)(e), the detection limit or background must be the Type I groundwater concentration criterion for this s substance/analyte.

mg/L Milligrams per liter
PQL Practical quantitation limit
SW 846 U.S. EPA. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. Including updates I, 11, IIA, IIB, III, and IIIA to the Third Edition. September 1986 through 1998.

3.2 SAMPLING AND ANALYSIS PLAN

This section provides the methodology for groundwater sampling and analysis of both background and detection monitoring wells.

The regulated substances to be measured and the frequency at which samples must be collected appear in Table 1. Field parameters include total depth of the well, water level, specific conductance, pH, temperature, and turbidity. Regulated substances and field parameters must be monitored quarterly for the first 2 years and then annually thereafter unless notified otherwise by EPD. An M&M review report must be submitted to EPD within sixty (60) days from the close of every fifth year that summarizes and evaluates groundwater trends discerned through that time period and make recommendations as appropriate.

Water levels must be measured on a quarterly basis from the monitoring wells and the dewatering well to record the fluctuations of the water table due to seasonal effects. High water table conditions typically occur during the winter and spring, due to precipitation. Low water table conditions predominate in the summer and fall due to lower relative precipitation. Water level, other field parameter measurements and first-year quarterly sampling events must be timed so that two quarterly events are conducted during high water table conditions and two quarterly events are conducted during low water table conditions.

The following sections describe procedures for measuring water levels and field parameters and collecting groundwater samples. Water level measurements for a well must be completed before presample purging of the well is conducted. Water level measurement and sample collection must be conducted at the background well first, followed by detection wells and finally the dewatering well. Powderless latex gloves must be worn during water level measurements and groundwater sampling and must be changed between wells. The water level indicator must be decontaminated between wells. All information collected in association with water level measurement, other field parameters and groundwater sampling must be recorded on the groundwater sampling data sheets (Appendix C) and in

a logbook. All activities associated with measurements of water levels and field parameters and collection of groundwater samples must be performed in accordance with the most recent edition of the EPA's Environmental Investigation Standard Operating Procedures and Quality Assurance Manual (EISOPQAM).

3.2.1 Water Level Measurement

The equipment required for water level measurement includes:

- Electric water level indicator (probe)
- Logbook
- Well keys
- Decontamination equipment (tubs or buckets, brushes, phosphate-free laboratory-grade detergent, distilled, deionized water, wastewater container)
- Photoionization detector (PID)
- Powderless surgical gloves

After removing the protective cap and casing cap, the breathing zone must be checked for organic vapors using the PID. If elevated breathing zone vapors are encountered, the sampling team must leave the well and don the appropriate level of personal protective equipment (PPE) before continuing. Action levels and appropriate PPE must be specified in the site-specific health and safety plan. The PID must also be used to survey vapors inside the top opening of the well casing.

To measure the water level in the casing, the probe must be lowered into the casing until the light or sound alarm is activated, indicating that the probe has touched the water surface. Before the water level is measured, the probe and its cable must be physically checked against a measuring tape to verify that the water level indicator has not been cut or altered and to confirm that the indicator's reading is accurate. The static water level must be read directly from the indicator cable by holding the cable to the permanent mark at the top of the well casing and reading off the depth to the nearest 0.01 foot. The probe must be raised and lowered two more times in order to obtain two more measurements; the three readings must then be averaged and recorded in the logbook. Next, the probe must be lowered until it encounters resistance, indicating it has reached the bottom of the well casing. This depth must be read off the cable and recorded in the logbook.

The probe and cable must be washed with a phosphate-free laboratory-grade detergent after they are retrieved from the well, and rinsed in distilled, deionized water. Wash and rinse water must be contained in a wastewater container before proceeding to the next well.

PID readings, as well as general observations of the appearance and condition of the well casing and protective outer casing, must be recorded in a logbook and on the groundwater sampling data sheets.

3.2.2 Sample Collection

In addition to the equipment listed above for water level measurement, sample collection must require the following equipment:

- Sample containers and labels
- Calibrated bucket (example: 5-gallon bucket)

- Coolers, and ice
- Permanent marker
- Low-flow sampling pump (for example, bladder, variable speed, peristaltic)
- Groundwater sampling data sheets
- Instruments for measuring field parameters

All instruments used for measuring field parameters must be calibrated at the beginning of each day of sampling. The instruments response to a calibration standard must be recorded in the logbook and on the groundwater sampling data sheets for all instruments, including those not typically calibrated in the field (such as a specific conductivity meter). The makes, models, serial number, and dates of last calibration of all instruments used must be recorded in the logbook. The sources, lot numbers, and expiration dates of the standards solutions used for calibration must also be recorded in the logbook.

After measuring the water level and bottom of well casing, the water volume within the well casing must be calculated. The volume of water inside the well casing is determined by subtracting from the total depth of well casing the depth to groundwater, and multiplying the height of water in the casing by 0.163 gallons per linear foot (for a 2-inch inner diameter well).

Wells must be purged a minimum of three casing volumes and sampled with a low flow pump. Water must be discharged from the pump to a calibrated bucket that has volumes marked in increments of gallons or fractions of gallons. A sample of purge water must be discharged into a beaker or other container after each casing volume is removed from the well, for measurement of field parameters. The purge water must be contained in a wastewater container (such as a 55-gallon drum). If stability of the field parameters is not achieved within purging of 3 well volumes, the sampling team leader must make the determination whether to sample the well.

Field parameters must be measured and recorded on the groundwater sampling data sheets and in a logbook along with the associated cumulative purge volume. Observations of purge water appearance must also be entered on the groundwater sampling data sheet and in a logbook. The well must be purged until field parameters are stable between three consecutive measurements. To be considered stable, field parameters must change by no more than the following tolerance levels: pH measurements remain constant within 0.1 Standard Unit, specific conductance varies no more than 10 percent, and temperature is constant for three consecutive readings. Turbidity must also be measured and recorded. Stability is achieved when pH, specific conductance, and temperature have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTU) (EISOPQAM).

Water levels must be periodically monitored with a water level indicator while purging. The purging rate must be adjusted to avoid purging the well dry.

All preservatives must be added to containers prior to sampling. Samples collected in pre-preserved containers must not be overfilled. The order of sample collection is as follows:

1. PAHs
2. Metals

This sample order is determined largely by the volatility of the sampled constituent, with the most volatile being sampled first. Sample containers must be labeled and placed in a cooler with ice

immediately after the containers are filled. Before delivery to the analytical laboratory, all samples must be containerized and packaged to maintain sample integrity and chain of custody.

Any equipment (such as a water level indicator) that will be used to sample in more than one well must be decontaminated using a phosphate-free detergent and rinsed with distilled and deionized water. Decontamination procedures should be noted in the logbook. Any purge water and solid wastes such as PPE, etc. generated during the groundwater monitoring and sampling events must be disposed of properly within thirty (30) days of completion of the event. At no time shall empty containers be stock piled and/or stored on the NDL site.

3.2.3 Sample Labeling and Documentation

Samples must be labeled immediately after collection. At a minimum, sample labels must include sample identification (ID) number, date of collection, time of collection, preservative used, required analyses, and sampler names. The name of the well must be used as the ID number (for example, MW-1). The ID number must also be included in the logbook, chain-of-custody forms, and other records documenting sampling activities. The label must be covered with clear plastic tape to prevent damage after it is filled out.

In addition to sample labels, field-sampling activities require other forms of documentation. This additional documentation is necessary to provide an accurate record of sampling events and field observations. This information must be recorded in logbooks, groundwater sampling data sheets, and chain-of-custody forms. Example forms are provided in the Appendices.

Documentation must be completed legibly in ink. Errors must be crossed out with a single line, dated, and initialed by the sampling team member recording the information. Unused portions of logbook pages must be crossed out, and each page must be signed and dated by the sampling team member who made the entry.

3.2.4 Sample Shipment and Chain of Custody

After samples are collected, labeled, and sealed with custody seals, they must be placed in iced coolers. Inert packing materials (such as vermiculite) must be placed around sample containers to prevent breakage. Coolers must be stored in a secured location until they are shipped to the analytical laboratory. Chain-of-custody (COC) forms must be completed for all samples. Before shipment, the field sample custodian and the courier receiving the samples must sign the COC form. A copy of the COC form must be retained for the project files. After the COC form has been completed and signed, it must be inserted in a sealed plastic bag and taped inside the lid of the cooler. The cooler must be sealed with a minimum of two seals (signed and dated by the field sample custodian), so that the seals must be broken to remove the samples. The field chain of custody terminates when the laboratory receives the samples. At that time, the laboratory assumes responsibility for custody. Upon receipt at the laboratory, a laboratory representative must inspect the contents of the cooler, sign the COC form, and list the date and time.

3.2.5 Quality Control Samples

The quality assurance and quality control (QA/QC) guidance outlined in the EISOPQAM must be followed. QA/QC field samples must be collected to evaluate whether data quality has been affected by field activities or other outside events. QA/QC field samples include field duplicates, equipment blanks, and trip blanks. Additional sample volumes must also be collected for matrix spike and matrix spike duplicate (MS/MSD) samples.

Field duplicate samples are used to assess the reproducibility and representativeness of results. Field duplicate samples are collected in a manner identical to the real sample, but are submitted blind to the analytical laboratory. The well the field duplicate sample was collected from must be recorded in the logbook and on the groundwater sampling form. Field duplicate samples must be collected once for every 10 wells sampled (one every sampling event).

Equipment blanks are collected to assess the quality of decontamination procedures used on nondisposable sampling equipment (equipment used in more than one well). Equipment blanks are obtained by flushing the sampling equipment with deionized water after it has been decontaminated and air-dried. The flush water must then be containerized and analyzed for the same constituents as the groundwater samples. Equipment blanks must be collected at a frequency of one per sampling event.

Trip blanks are used to determine sample handling variability resulting in positive bias in contaminant concentration if samples were contaminated during storage and/ or transportation back to the laboratory. The sample is prepared prior to the sampling event in the actual container and is stored with the investigative samples throughout the sampling event. They are then packaged for shipment with the other samples and submitted for analysis. At no time after preparation are the sample containers to be opened before they reach the laboratory. Trip blanks must be provided at a frequency of one per sample shipment, but not for each cooler.

MS/MSD samples gauge the accuracy and precision of the data derived from sample analysis. Although spiking is an internal laboratory procedure, the laboratory typically requires that a triple volume be collected for MS/MSD samples. A triple volume of a sample chosen at the discretion of the sampling team must be collected, and each container must be labeled with the same ID number. Under the remarks or comments on the chain-of-custody form, the triple volume must be noted as collected for MS/MSD. MS/MSDs must be collected at a frequency of 1 per 20 wells sampled or at least once during every sampling event, whichever is more frequent.

3.2.6 Laboratory Analysis

A laboratory that complies with the O.C.G.A. 12-2-26, Georgia Commercial Analytical Laboratory Act and associated Rules must analyze the groundwater samples. Samples must be analyzed using the methods presented in Table 1. The analytical laboratory is required to have a QA/QC plan to assure the reliability of analytical results. Any report that submits analytical results to EPD must include a certification that complies with Chapter 391-3-26 of the Rules for Commercial Environmental Laboratories.

3.3 DATA EVALUATION

Analytical results and field parameters must be evaluated to determine if a release has occurred from the landfill to groundwater or if groundwater is infiltrating the slurry wall or engineered control cap. This data validation and evaluation process consists of data review, tabulation of qualified data, review and handling of outlying data, statistical analysis, and professional judgment screening. Analytical results from the background well and detection monitoring wells must be tabulated and evaluated separately before making any statistical comparison. Inferential statistical tests can be performed only on regulated substances detected in monitoring well samples after a year of quarterly sampling (4 sampling events).

Regulated substances not detected in background well samples, but detected in one or more detection monitoring well samples, must be evaluated using professional judgment as discussed in Section 3.3.4 to determine if the detection represents a release from the landfill or has some other plausible cause.

Professional judgment must be applied throughout the data evaluation process, but is essential for two areas in particular: data quality and statistical interpretation. Professional judgment is required for: determining that results are representative of aquifer conditions, the handling of outliers, and determining if the statistical tests were failed (reject the null hypothesis, H_o, that there is no significant difference between the data sample means for the background and detection monitoring wells) as a result of a release from the landfill.

3.3.1 Analytical Data Validation and Tabulation

To evaluate data quality, all data received from the laboratory must be subjected to the EPA's EISOPQAM data validation process. The data quality review must include a report on data quality, which must discuss among other things, detections of any regulated substances in blanks and other QA/QC results. The data must be examined for any other errors, such as those made during transcription. Any data quality issues that may affect the outcome of statistical tests must be noted. The representativeness of the results must also be reviewed and noted.

Qualified data must be tabulated in a format presenting all ID numbers, dates of sampling, and results for all analyses. Separate tables must be generated for detection monitoring well data and background well data. Data evaluation may include summary statistics tables, graphs, and concentration plots. Results from each detection monitoring well must be independently compared to background.

3.3.2 Outlier Evaluation

An unavoidable problem in the statistical analysis of environmental data is the presence of outliers. Outliers are extreme (high or low) values that are widely divergent from the main body of data (Gad and Weil 1989). Outliers may arise from mistakes such as transcription, data-coding errors, instrument breakdowns, calibration problems, and power failures. Additionally, they may arise due to the inherent spatial or temporal variability of the regulated substance (Gad and Weil 1989). Outliers disproportionately affect the statistical descriptors of the data set, biasing the mean and standard deviation toward the outlying observation. Therefore, it is important to identify and investigate outliers in the data and treat them appropriately.

Outliers can be identified by visual inspection of data, use of a scattergram (or other graph), or by a large increase in the standard deviation (if the data set is small enough, as is the case with this monitoring plan) (Gad and Well 1989). Professional judgment must be used with the above techniques to determine the presence of suspect outliers. If not obvious, a test for a single outlier, such as that described by Dixon (1953), may be applied. However, because one outlier may mask another, such tests may not identify an outlier (Gilbert 1987).

Once identified, outliers must be corrected, discarded, or retained. Outliers that are obvious mistakes must be corrected, when possible. Outliers that are not obvious mistakes must be reviewed to determine the cause. The outlier must be discarded if a cause is identified (that is not a result of geochemical variation of the landfill). Causes that might warrant discarding an outlier might include field or laboratory contamination, matrix interference, or calibration problems. If the outlier can neither be corrected nor discarded, the outlier may be retained in the data set for statistical testing. Statistical testing may be conducted with the outlier both present and absent from the data set to determine the effect on the statistical test outcome.

3.3.3 Statistical Tests

Statistical tests consistent with those required in the *Guidance for Data Quality Assessment, Practical Methods for Data Analysis* (EPA QA/G-9 QA00 Update) must be used for the data evaluation. Statistical comparisons and tests must be calculated only for regulated substances that are detected in samples collected from both background and detection monitoring wells. When a regulated substance is detected only in samples from detection monitoring wells and not in samples from background wells, it must be evaluated using professional judgment prior to verification sampling for confirming a release from the landfill.

The minimum sample size necessary for meaningful inferential statistical tests is four. This sample size must be achieved after one year of quarterly sampling. The inferential test that must be performed is determined by the distribution of data (parametric or nonparametric) and the frequency of detection. The data must first be tested to determine whether the data distribution is normal or random. If the data are normally distributed, a parametric test (for instance the Cochran's t-test) may be used to compare data sample means between detection wells and the background well. If the data are randomly distributed, a nonparametric test (for instance, a Wilcoxon Rank Sum [WRS] test) must be performed to compare data sample means between detection monitoring wells and the background well. A parametric test must be performed if data are normally distributed and regulated substances are detected at a frequency of 80 percent or greater. A nonparametric test must be used for data that are randomly distributed or are detected at a frequency of less than 80 percent. Appendix A describes normality testing, handling of non-detections, and the Cochran's Nest and the WRS test. All inferential statistical tests must be performed at a level of significance (p-value) of 0.05 (0.95 confidence level).

3.3.4 Professional Judgment

No statistical test or comparison alone can identify a release with absolute confidence. Identifying a release requires a combination of more than one statistical test and professional judgment. The identification of any regulated substance as differing from background concentrations (rejection of H_o) is subject to professional judgment. Professional judgment must be applied to prevent reporting of statistically significant evidence of a release that is at the landfill (a false positive). Professional

judgment must always be accompanied by a plausible explanation. Factors that may cause a regulated substance to be identified as statistically different from background, though not as a result of a release, include the effect of non-detects in the statistical test, Type I error rates, spatial and temporal distribution of constituents, and off-site releases. This step is similar to that taken when data are initially reviewed for influences such as field or laboratory contamination. Professional judgment must also be applied to detections in detection monitoring wells when the regulated substance is not detected in a background well.

3.3.5 Verification Procedure for Suspected Releases

Verification sampling must be conducted if statistically significant or other evidence of a release is not rejected by professional judgment. Only those detection monitoring wells in which a suspected release was detected must be resampled; however, if the next sampling event takes place prior to identifying a suspected release, this newly collected data might be used. Results from resampling must be compared to existing background data for a regulated substance that may have been released. A discrete retest (using only the newly-collected detection monitoring well data) must be performed.

3.4 REPORTING

A groundwater monitoring report including data evaluation, along with a cover letter, must be submitted to EPD.

The groundwater monitoring report must be submitted within forty-five (45) days of the end of the calendar quarter in which the sampling event occurred. The report must include tabulation of qualified analytical results and a narrative summary of the results. The report must include analysis of water level data and groundwater flow direction and gradient. The report must discuss any deviations from the M&M plan. The report must also provide the data validation report and the results of QA/QC sampling and analysis. The report should provide photographic documentation of the site including each component of the landfill system along with anything that warrants documentation such as damage to site features (i.e. monitoring wells). Each photo should include at a minimum the site name, date, photographer's name and title, and a description of the photo.

An annual groundwater monitoring report must include a narrative summarizing all the data collected within a year's monitoring events and a statistical evaluation of the data.

The groundwater monitoring report must include the following signed certifications:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate that information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief true and accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Authorized Signature

I certify that I am a qualified groundwater scientist who has received a baccalaureate or postgraduate degree in the natural sciences or engineering, and have sufficient training and experience in groundwater hydrology and related fields, as demonstrated by state registration and completion of accredited university courses, that enable me to make sound professional judgments regarding groundwater monitoring and contaminant fate and transport. I further certify that this report was prepared by myself or by a subordinate working under my direction.

Georgia Registered Professional
Geologist or Engineer

An M&M review report must be submitted to EPD within sixty (60) days from the close of every fifth year that summarizes and evaluates groundwater trends discerned through that time period and make recommendations as appropriate. EPD will review, comment, respond and/or approve these reports as appropriate.

4.0 LANDFILL MAINTENANCE AND INSPECTION PLANS

This section of the M&M plan describes the methods, procedures, and processes that must be used to inspect and maintain the engineering controls of the landfill (Section 2.1) and concrete cap (Section 2.2). These components include final cover and grading; drainage system; and groundwater monitoring network. Use of the property must not disturb the integrity of the soil cap and liner system of the landfill, the concrete cap, or any other components of the containment system, or the function of the monitoring systems. Maintenance and inspection of the landfill must be performed by person(s) experienced in the maintenance and inspection of the engineering controls at the landfill through both professional training and educational experience sufficient to evaluate the condition of the landfill as it relates to the requirements set forth below. Minimum experience requires the inspector be a Georgia certified Professional Engineer with experience in the design and/or evaluation of landfills.

Maintenance and inspection activity documentation includes the M&M Inspection Log form and Maintenance Record form. Inspection logs include the date of the inspection, name of the inspector(s), component inspected, weather conditions, condition of the item inspected, notation of any damages requiring attention and indicate if the noted damage would be classified as major damage. EPD should be notified within 24 hours for each incidence of damage determined to be major damage. All damage must be addressed by contractor personnel who meet the requirements specified in the "Construction Specifications, Landfill Cap and Slurry Wall, Northside Drive Landfill, Atlanta, Fulton County, Georgia" (Construction Specifications). A copy of the M&M Inspection Log form is in Appendix C. Maintenance records include the dates repairs were initiated and completed, and the name of the person recording the information. Comments describing the severity of the damage (i.e.: major) must also be noted on the maintenance record along with a description of the repairs. A copy of the Maintenance Record form is in Appendix C.

4.1 FINAL COVER AND GRADING

It is necessary to maintain the integrity and effectiveness of the final cover (i.e. soil cap and vegetative cover, asphalt parking lot, and concrete cap), including making repairs as necessary to correct the effects of settling, subsidence, erosion, or other events, and preventing run-on and run-off from causing erosion or other damage to the final cover. The final cover must be inspected every calendar quarter. The inspection must evaluate the final cover to ensure adequate quantity and quality of the final cover and to ensure prevention of erosion and ponding. The results of the inspection must be recorded on the M&M Inspection Log form in Appendix C.

4.1.1 Soil Cap and Vegetative Cover

In those areas where vegetation is present, a satisfactory stand of grass plants will be considered a minimum of 10 grass plants per square foot and total bare spots less than two percent (2%) of the total area. The cover will be mowed a minimum of each calendar quarter during the growing season and once at the end of the growing season. More frequent mowing is required if it is determined additional mowing is required to maintain a satisfactory stand of grass plants and/or grass height exceeds eight inches (8"). During mowing, clippings must be removed if clippings will result in thatching that inhibits growth of desires grass plants. Maintenance of the cover shall include eradication of weeds, removal of trees or other woody plants, removal of trash, and fertilization if necessary.

All erosion rills must be noted during the quarterly inspection. Erosion rills must be filled with topsoil, seeded with similar grasses, mulched to prevent loss of seed, irrigated sufficiently to establish and maintain growth if needed, and if necessary, surface erosion control blankets must be installed. All areas of ponding must be noted during the quarterly inspection. Ponding areas must be regraded, seeded, mulched, irrigated sufficiently to establish and maintain growth if needed, and if necessary, surface erosion control blankets installed to provide for drainage off of and away from the cover. All maintenance of the cover must be documented in a logbook and on Maintenance Record forms.

4.1.2 Major Damage – Soil Cap and Vegetative Cover

The following conditions are considered major damage to the Soil Cap and Vegetative Cover:

- Any rill greater than one foot (1') wide and/or depth greater than three inches (3")
- An area of ponding with standing water forty-eight (48) hours after a rain event
- Holes, greater than 6 inches in diameter and 2 inches in depth, in the vegetative cover caused by digging or posting during staging events.
- Any damage to landfill liner system or slurry wall

If major damage is noted, EPD must be notified within 24 hours, and repairs must be completed within seven (7) days of discovery. Any major damage not repaired within seven (7) days must be reported in writing to EPD within nine (9) days of discovery. All other items requiring repair must be completed within thirty (30) days of discovery. Repairs must be made in accordance with the Construction Specifications and must be conducted by qualified contractors with personnel who meet the requirements specified in the Construction Specifications.

4.1.3 Asphalt Parking Lot

Upon completion of the asphalt parking lot, it will be necessary to inspect the integrity of the asphalt layer, including making repairs to the asphalt cover, to correct the effects of weather, excessive use by the public, as well as staging during events. The inspection must evaluate the asphalt cover to ensure adequate quantity and quality of the asphalt and to ensure prevention of any breach of the asphalt, including punctures, into the soil cap and cover. Cracks in the asphalt layer need to be addressed to prevent erosion to the components of the final cover. Positive drainage of stormwater must be maintained across the asphalt parking lot to prevent ponding. The results of the inspection must be recorded on the M&M Inspection Log form in Appendix C. All maintenance of the asphalt parking lot must be documented in a logbook and on Maintenance Record forms.

4.1.4 Major Damage – Asphalt Parking Lot

The following conditions are considered major damage to the Asphalt Parking Lot:

- Cracks or potholes through the depth of the asphalt parking lot that cause erosion of the underlying soil cap
- Any damage to landfill liner system or slurry wall
- Settling of asphalt parking lot more than 3 inches in depth in any 12 inch area

If major damage is noted, EPD must be notified within 24 hours, and repairs must be completed within seven (7) days of discovery. Any major damage not repaired within seven (7) days must be reported in writing to EPD within nine (9) days of discovery. All other items requiring repair must be completed within thirty (30) days of discovery. Repairs must be made in accordance with the Construction Specifications and must be conducted by qualified contractors with personnel who meet the requirements specified in the Construction Specifications.

4.1.5 Concrete Cap

It is necessary to maintain the integrity and effectiveness of the concrete cap adjacent to and running along Northside Drive, including making repairs as necessary to correct the effects of settling, cracks, weather, construction along Northside Drive or other events, and preventing infiltration of surface water run-on and run-off from causing leaching of contaminated soils to the groundwater. The concrete cap must be inspected every calendar quarter. The inspection must evaluate the concrete cap to ensure adequate quantity and quality of the concrete cap to ensure prevention of surface water infiltration. Positive drainage must be maintained across the concrete cap to prevent ponding. The results of the inspection must be recorded on the M&M Inspection Log form in Appendix C. All maintenance of the concrete cap must be documented in a logbook and on maintenance Record forms.

4.1.6 Major Damage – Concrete Cap

The following conditions are considered major damage to the Concrete Cap:

- Cracks extending through the depth of the concrete cap
- Any gross damage (i.e, cracks, breakage, removal of concrete structures)
- Failure of epoxy seal such that surface water comes in contact with contaminated soil

- Any occurrence causing leaching of contaminated soil to the groundwater

If major damage is noted, EPD must be notified within 24 hours, and repairs must be completed within seven (7) days of discovery. Any major damage not repaired within seven (7) days must be reported in writing to EPD within nine (9) days of discovery. All other items requiring repair must be completed within thirty (30) days of discovery. Repairs must be made in accordance with the Construction Specifications and must be conducted by qualified contractors with personnel who meet the requirements specified in the Construction Specifications.

4.1.7 Granite Markers

The conservation easement mandates that the NDL Site be fitted with markers identifying the Site as a "restricted area". Granite markers were placed on each corner of the property boundary with additional markers installed across the NDL Site. The structural integrity of the markers must be maintained. The granite markers are to be inspected every calendar quarter. The results of the inspection must be recorded on the M&M Inspection Log form in Appendix C. All maintenance of the granite markers must be documented in a logbook and on Maintenance Record forms.

4.1.8 Major Damage – Granite Markers

The following conditions are considered major damage to the Granite Markers:

- Crushed, broken, or defaced markers making markers unreadable
- Markers removed from any corner of the property boundary
- Damage to concrete pad, such that the marker can be removed

If major damage is noted, EPD must be notified within 24 hours, and repairs must be completed within seven (7) days of discovery. Any major damage not repaired within seven (7) days must be reported in writing to EPD within nine (9) days of discovery. All other items requiring repair must be completed within thirty (30) days of discovery. Repairs must be made in accordance with the Construction Specifications and must be conducted by qualified contractors with personnel who meet the requirements specified in the Construction Specifications.

4.2 DRAINAGE SYSTEM

4.2.1 Drainage System

The drainage system is designed to prevent run-on and run-off from compromising the integrity of the cover. Debris and vegetation may build up and block passages for drainage from the landfill. Blockage in drainage areas could increase drainage in other areas and cause erosion. All drain structures (drop inlets, check dams, berms, and drainage swales) around the site must be inspected quarterly for debris or other obstructions that may prevent proper drainage. If any debris is found, it must be removed. Debris cleaned from the structures must be properly disposed off-site. Once a year, one of the quarterly inspections must be performed during a significant rain event so that the drainage system can be evaluated.

Drainage swales must be mowed/weed whacked a minimum of each calendar quarter. Clippings must be removed if clippings will result in thatching or obstruct drainage structures. All trash must be removed.

All erosion rills must be noted during the quarterly inspection. Erosion rills must be filled with topsoil, seeded with DOT approved similar grasses, mulched to prevent loss of seed, irrigated sufficiently to establish and maintain growth if needed, and if necessary, surface erosion control blankets must be installed.

All areas of ponding must be noted during the quarterly inspection. Ponding areas must be regraded, seeded, mulched, and if necessary, surface erosion control blankets installed to provide for drainage off of and away from the cover. Check dams must be checked for excess silt or buildup of debris. Excess silt/debris must be removed. Berms must be checked for erosion or slumping. If slumping or erosion is noted, the berm must be regraded, seeded, mulched, and if necessary, surface erosion control blankets installed. All maintenance of the drainage system must be documented in a logbook and on Maintenance Record forms.

4.2.2 Major Damage – Drainage System

The following conditions are considered major damage to the Drainage System:

- Any rill greater than one foot (1') wide and/or depth greater than six inches (6")
- An area of ponding with standing water forty-eight (48) hours after a rain event is considered
- Any check dam or berm that is breached

If major damage is noted, EPD must be notified within 24 hours, and repairs must be completed within seven (7) days of discovery. Any major damage not repaired within seven (7) days must be reported in writing to EPD within nine (9) days of discovery. All other items requiring repair must be completed within thirty (30) days of discovery. Repairs must be made in accordance with the Construction Specifications and must be conducted by qualified contractors with personnel who meet the requirements specified in the Construction Specifications.

4.3 GROUNDWATER MONITORING NETWORK AND DEWATERING WELL

4.3.1 Groundwater Monitoring Network and Dewatering Well

The groundwater-monitoring network and the dewatering well at the site must be maintained and inspected quarterly. Damage to the locks, wells, and well labels could result from vandalism or weathering. Any damage of the groundwater-monitoring network must be repaired. If locks have rusted and do not function properly, they must be replaced. All wells must remain securely locked.

Wells must be observed for accumulations of silt and sand by measuring the total depth during sampling and comparing these depths to previous and original depths. If an accumulation of silt or sand is noted, the well must be redeveloped. The wells must be visually inspected for signs of grout or concrete stress or failure, and the watertight locking caps must be inspected for cracked or torn rubber seals. It is required these wells be maintained and inspected to ensure the well integrity in accordance with the EPA's Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM). All maintenance of the monitoring well system and the dewatering well must be documented in a logbook and on Maintenance Record forms.

4.3.2 Major Damage – Groundwater Monitoring Network and Dewatering Well

The following conditions are considered major damage:

- Damaged well cap
- Damaged well casing inside well
- Erosion undermining concrete pad around well
- Damage or cracking of concrete pad around well
- Damage to the manhole cover, such that the manhole cover no longer functions properly or protects underlying well from damage

If major damage is noted, EPD must be notified within 24 hours, and repairs must be completed within seven (7) days of discovery. Any major damage not repaired within seven (7) days must be reported in writing to EPD within nine (9) days of discovery. All other items requiring repair must be completed within thirty (30) days of discovery. Repairs must be made in accordance with the Construction Specifications and must be conducted by qualified contractors with personnel who meet the requirements specified in the Construction Specifications.

4.4 REPORTING

A landfill maintenance and inspection report that includes each inspection event, along with a cover letter, must be submitted to EPD with the groundwater monitoring report. Annually in the cover letter for the landfill maintenance and inspection report, the name, mailing address, telephone number and facsimile number of the person EPD should contact regarding the closure requirements associated with the landfill must be provided to EPD.

The landfill maintenance and inspection report must include the following signed certifications:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate that information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief true and accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.
>
> _____
> Authorized Signature
>
> I certify that I am a qualified engineer who has received a baccalaureate or post-graduate degree in engineering, and have sufficient training and experience in designing and/or evaluating landfills, as demonstrated by State registration and completion of accredited university courses, that enable me to make sound professional judgment regarding the effectiveness of engineering controls at this site. I also certify that this report meets the requirements set forth in the Monitoring and Maintenance Plan for the site. I further certify that this report was prepared by myself or by a subordinate working under my direction.

PE Signature and Seal

An M&M review report must be submitted to EPD within sixty (60) days from the close of every fifth year that summarizes and evaluates maintenance of the cover, drainage system and wells through that time period and make recommendations as appropriate. EPD will review, comment, respond and/or approve these reports as appropriate.

5.0 PLANNED USES OF PROPERTY

Any use of the landfill must preserve the integrity and effectiveness of final cover of the landfill. The landfill's initial use was that of vacant contoured ground with a vegetative cover. A notification was submitted to GA EPD on March 7, 2005 regarding the change in use of the landfill. The use of the landfill as of July 1, 2005 will be that of a surface parking lot. Any future changes in use of the landfill/ parking lot must be approved by EPD and address the continuation of repairs to the engineering controls as necessary to correct the effects of settling, subsidence, erosion, or other events, and preventing run-on and run-off from causing erosion or otherwise damage to final cover. The M&M Plan must be reviewed and revised as appropriate. If it is determined the M&M Plan must be revised, the revised M&M Plan be submitted to EPD for review and approval within sixty (60) days of the change in use.

The landfill liner system is designed to support a H20 live load with a minimum of three feet of soil and road base cover. The total load (static and dynamic) placed on the landfill liner system (geomembrane and GCL layers) shall not be more than 8.3 pounds per square inch (psi). In addition, areas where high loads may be applied over the soil-bentonite slurry wall (entrance roads, heavy truck parking areas, etc) shall be structural reinforcement or bridged during installation of the roadway or parking lot using concrete, geogrid, geotextiles, etc. to prevent significant deformation of the landfill cover over the slurry wall. The concrete cap is designed to have a minimum of eight (8) inches of concrete cover. The concrete cap shall prevent the infiltration of surface water into the contaminated soils that remain adjacent to Northside Drive. As the parking lot may on occasion act as a staging area for events, at no time will the staging activities penetrate the asphalt cover, the engineered control cap, the soil bentonite slurry wall, or concrete cap.

5.1 NON-RESIDENTIAL USE

The landfill must be inspected annually with regard to the use of the landfill. Use of the landfill must remain non-residential use.

- The inspection must verify the use of the landfill by owners, tenants, and other occupants to be consistent with non-residential use.
- All contract and lease agreements, and informal agreement must be reviewed to insure it is consistent with the non-residential use.
- The conservation easement must be reviewed annually to ensure it is in place and the uses of the property must conform to the restrictions placed on the property.

The results of the inspection must be summarized in a landfill use statement.

5.2 REPORTING

A landfill use statement regarding compliance with the non-residential use must be submitted to EPD annually with the annual groundwater monitoring report.

The landfill use statement must include the following signed certification:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate that information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief true and accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

_____
Authorized Signature

6.0 REFERENCES

Bouwer, H and R.C. Rice. 1989. The Bouwer and Rice Slug Test - An Update. Ground Water. Vol. 27. No. 3. May-June. Pages 304-309.

Cressler, C. W., C. J. Thurmond, and W. G. Hester. 1983. Ground Water in the Greater Atlanta Region Georgia. Information Circular 63. Georgia Geologic Survey.

Dixon, W.J. 1953. Processing Data for Outliers. Biometrics. 9:74-89.

Gad, S.C. and C.S. Weil. 1989. Statistics for Toxicologists In Principles and Methods for Toxicology. Second Edition (Ed: A. Wallace Hayes). Raven Press Ltd. New York.

GA EPD. 1999. "Chapter 391-3-19: HAZARDOUS SITE RESPONSE." November.

Gilbert. R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold. New York.

Tetra Tech. 2001. "Construction Specifications, Landfill Cap and Slurry Wall, Northside Drive Landfill, Atlanta, Fulton County, Georgia." Prepared for GA EPD. Atlanta, Georgia.

APPENDIX A

STATISTICAL DATA EVALUATION

A.1 Normality Testing

Determining whether the distribution of data is normal, lognormal, or that there is no underlying distribution is necessary in selecting the appropriate statistical test. Normal or lognormal distributions are usually evaluated with parametric statistical tests. Nonparametric tests are usually applied to data with no underlying distribution. This section presents the W test; however, other tests for normality or graphical evaluations may be used to determine the data distribution.

The W test, developed by Shapiro and Wilk (1965), can be used to determine whether the data distribution is normal, lognormal, or random. This test is appropriate for sample populations of less than 25. The null hypothesis (H_o) to be tested is that the population has a normal distribution. The alternative hypothesis (H_a) is the population does not have a normal distribution. The W test, as presented in Gilbert (1987), is conducted as follows:

1. Compute the denominator d of the W test statistic, using the n data.

$$d = \sum_{i=1}^{n} (x_i - \bar{x})^2 = \sum_{i=1}^{n} x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)^2$$

2. Order the n data from smallest to largest to obtain the sample order statistics.

$$x_{[1]} \# x_{[2]} \# \ldots \# x_{[n]},$$

3. Compute k, where

$$k = \frac{n}{2} \quad \text{if n is even}$$

$$k = \frac{n-1}{2} \quad \text{if n is odd}$$

4. Use Table A6 of Gilbert (1987) and for the observed n find the coefficients $a_1, a_2, \ldots, a_k$.

5. Then compute

$$W = \frac{1}{d}\left|\sum_{i=1}^{k} a_i \left(X_{[n-i+1]} - x_{[i]}\right)\right|^2$$

6. Reject H_o at the α significance level if W is less than the quantile given in Table A7 of Gilbert (1987).

If H_o is accepted, the data are normally distributed. If H_o is rejected, the data must be transformed to the log of the data. Then, the W test must be completed on the log of the data. If H_o is then accepted, the data are distributed lognormally. If H_o is rejected while performing this test on the data and the log data, the data are considered to have no underlying distribution (nonparametric).

A.2 Handling Nondetections

Many environmental data sets contain analytes that are not positively detected in each sample collected and analyzed. Instead, the data set must generally contain some samples with positive results for a particular chemical and others with nondetected results. The nondetected, or censored, results are usually reported as sample quantitation limits (SQLs). An SQL indicates that the chemical could not be detected above a particular concentration, which may vary from sample to sample. The chemical may be present at a concentration below the reported quantitation limit, or it may not be present in the sample at all. During evaluation of detection monitoring and background groundwater data, one-half the SQL must be used in statistical testing as a starting point. EPA guidance (1989) recommends using one-half the SQL. A value of zero (not detected) must be used in place of the SQL if one-half the SQL is greater than any of the detections. The effect of the SQL on statistical tests must be taken into account during the application of professional judgment.

A.3 Cochran's t-Test

The Cochran's t-test is a modified Student's t-test that is appropriate for use when the data sets have heterogeneous variances and unequal sample sizes. The criteria of normality, independence of data, complete frequency of detection, and appropriate sample size must also be met for this test to be used. However, a frequency of detection of 80 percent is being allowed.

The observed test statistic for the Cochran's t-test is calculated using the equation:

$$t_{obs} = (\bar{x}_1 - \bar{x}_2)/(W_1 + W_2)^{0.5}$$

where:

$\bar{x}_1$ = the mean of the first data set
$\bar{x}_2$ = the mean of the second data set
W_1 = the variance of the first data set divided by the sample size of the first data set
W_2 = the variance of the second data set divided by the sample size of the second data set

The t_{obs} value is compared to the expected t value (t_{exp}), which is calculated using the equation:

$$t_{exp} = (t_1 W_1 + t_2 W_2)/(W_1 + W_2)$$

where:

t_1 = t-value for the first data set taken from the t distribution table at the appropriate degree of freedom and level of significance
t_2 = t-value for the second data set taken from the t-distribution table at the appropriate degree of freedom and level of significance

The t_{obs} value is compared to the t_{exp} value; if the absolute value of t_{obs} is lower than t_{exp}, then there is no statistical difference between the two groups. The data indicate a release if t_{obs} is greater than t_{exp} and the mean of the site data is greater than the mean of the background data.

A.4 Wilcoxon Rank Sum Test

The Wilcoxon Rank Sum (WRS) test is a nonparametric version of the t-tests. The results of this test indicate when the measurements of one population are consistently higher or lower than measurements of a second population. Sample sizes need not be equal for the application of this test. However, the WRS test is somewhat sensitive to nondetect data. This test can handle a moderate number of nondetects by treating them as ties (equal in rank) (Gilbert 1987). However, if different SQLs are given for nondetects, this test may be weakened.

The WRS test is conducted by first ranking the combined site and background data from smallest to largest. Ranks are then assigned to each data point, starting with one for the lowest value and continuing until all data points have been assigned a corresponding rank. The ranks of the site data are then summed and compared to an acceptance range corresponding to a particular level of significance (0.05), the sample size of the site, and background data sets. If the sum of the ranks falls within the acceptance region, then the null hypothesis (that the site and background data are similar) is not rejected. If the rank sum exceeds the range, then the site concentrations are statistically greater than the background concentrations (Gilbert 1987, 1993). Tables found in Remington and Schork (1985) present the critical values for this test.

This approach can be used even when some data points are tied (equal in rank). In that case, the tied values are each given the mean value of the tied ranks. For example, if three data points were equal, and corresponded to the ranks of 3, 4, and 5, each of the data points would be ranked as 4 (Gilbert 1987, 1993). The next largest data point would have the rank of 6. If the number of tied ranks becomes large, however, the WRS test may not provide accurate results.

A.5 References

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York.

Gilbert, R.O. 1993. Letter Report to Beverly Ramsey, Battelle, July 30.

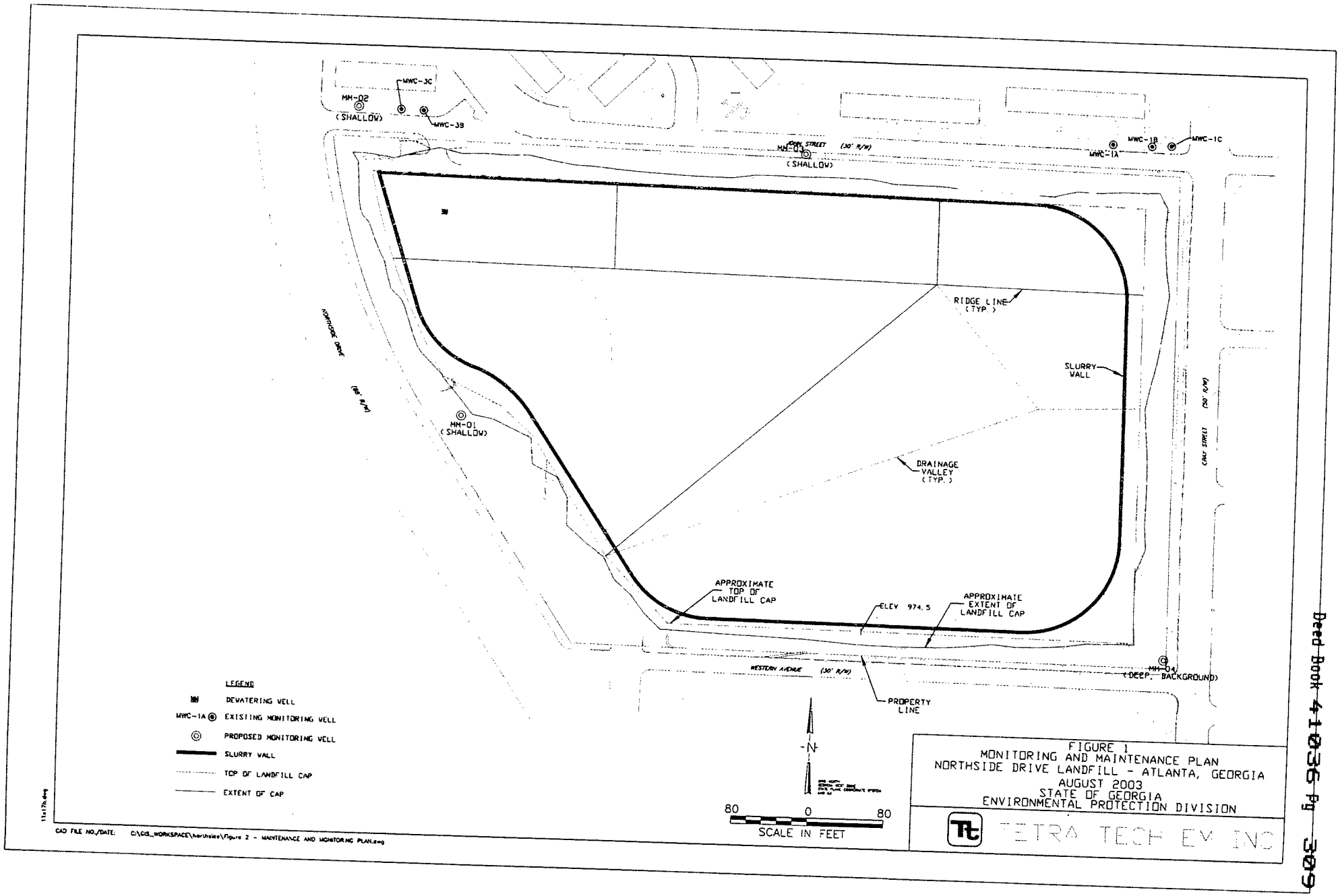
Remington, R.D. and M.A. Schork. 1985. Statistics With Applications to the Biological and Health Sciences. Second edition. Prentice Hall, New Jersey.

Shapiro, S.S. and M.B. Wilk. 1965. An Analysis of Variance Test for Normality. Journal of the American Statistical Association. 67: pp. 215-216.

U.S. Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A), Interim Final. EPA/5401/1-89/002. Office of Emergency and Remedial Response. December.

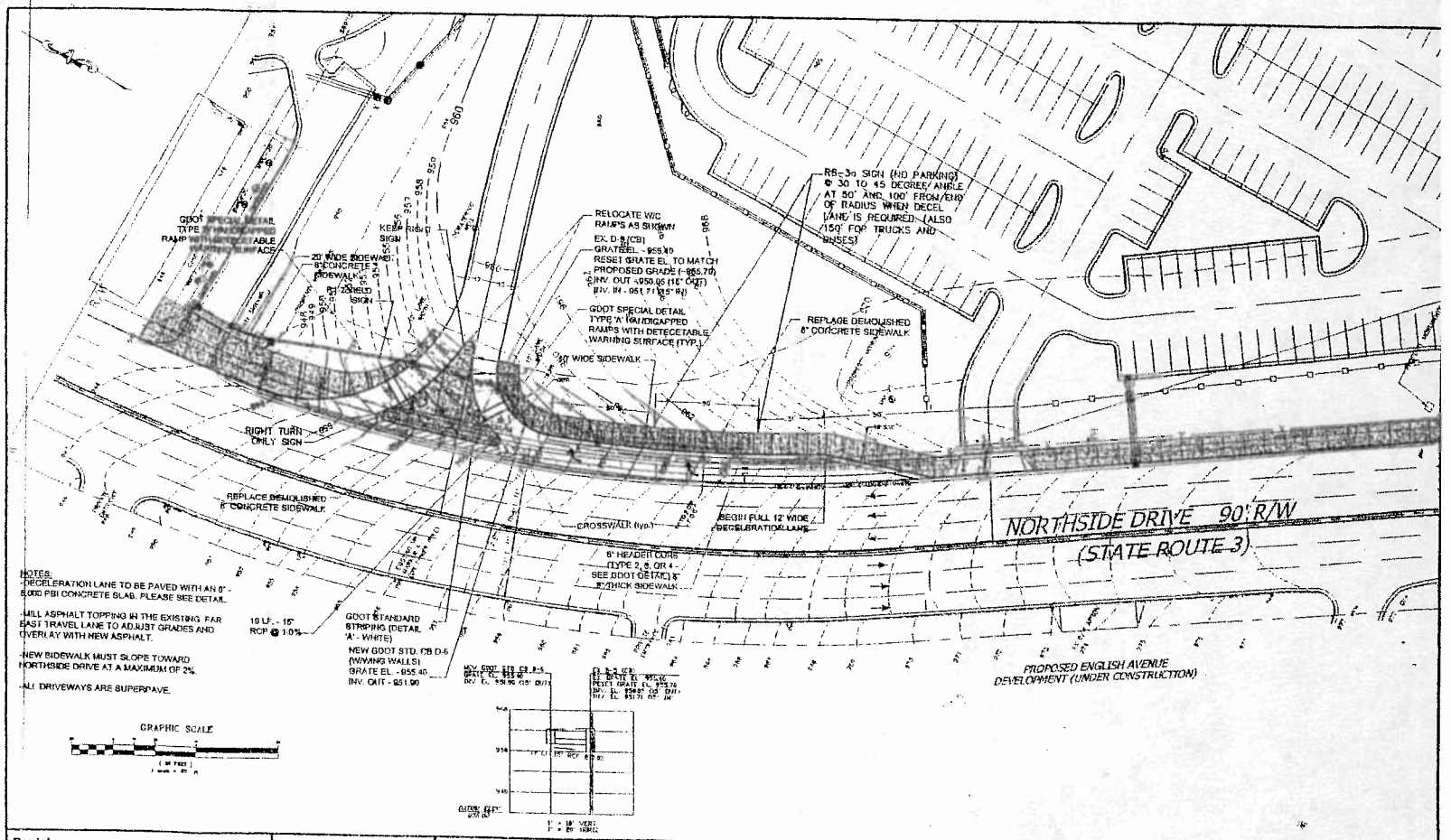
APPENDIX B

MONITORING WELL AND PIEZOMETER LOCATIONS



Deed Book 41036 Pg 309

Deed Book 41036 Pg 310



Revisions:

No.	Date

ALTAMIRA

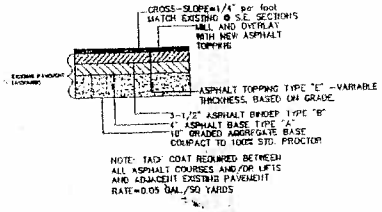
Williams-Russell & Johnson, Inc.
ENGINEERS-PLANNERS-ARCHITECTS
771 SPRING STREET, N.W.
ATLANTA, GEORGIA 30308
OFFICE: (404) 853-6800
FAX: (404) 607 8890

GEORGIA WORLD CONGRESS CENTER

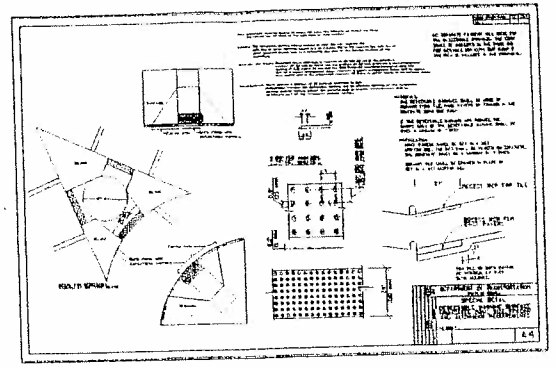
JONES AVENUE PARKING, PHASE II

CONSTRUCTION PLAN

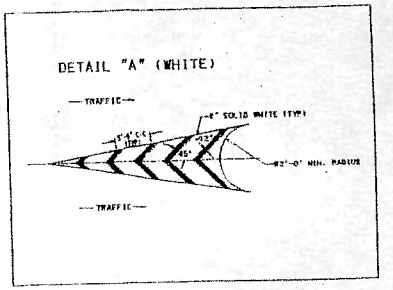
C1.1



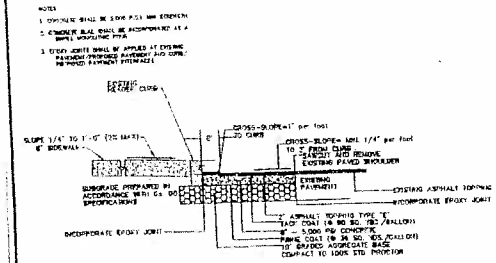
PAVEMENT SECTION (FOR OVERLAY)
NOT TO SCALE



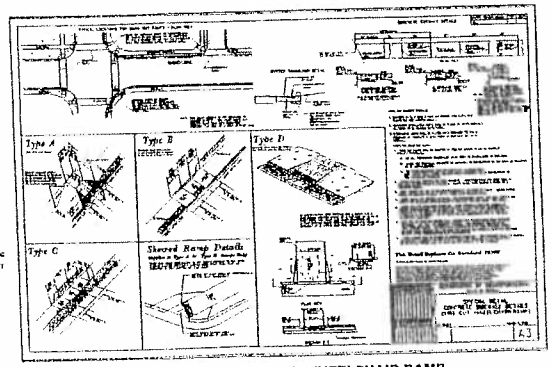
DETECTABLE WARNING SURFACE
NOT TO SCALE



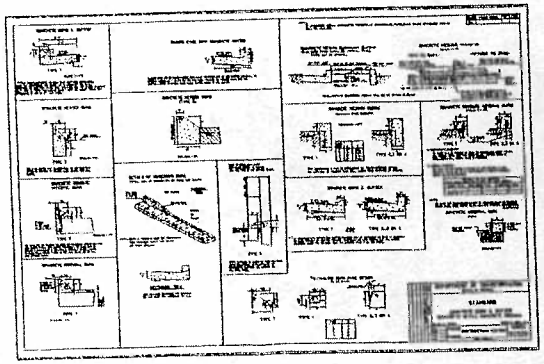
GORE DETAIL
NOT TO SCALE



PAVEMENT SECTION W/8" - 5,000 PSI CONCRETE
NOT TO SCALE



GDOT SPECIAL DETAIL WHEELCHAIR RAMP
NOT TO SCALE



GDOT HEADER CURB DETAIL
NOT TO SCALE

Revisions:

No	Date

ALTAMIRA
DESIGN AND CONSULTING SERVICES, INC.

Williams-Russell & Johnson, Inc.
ENGINEERS-PLANNERS-ARCHITECTS
771 SPRING STREET, N.W.
ATLANTA, GEORGIA 30308
OFFICE: (404) 853-6800
FAX: (404) 607-8890

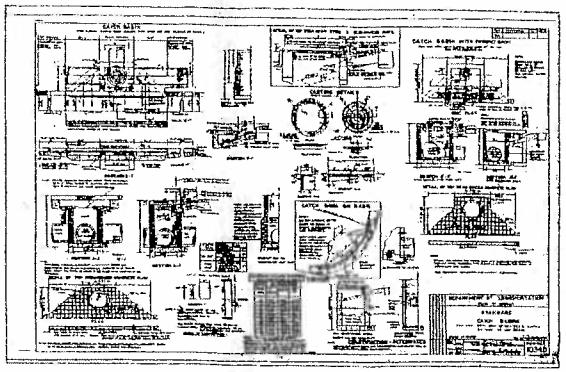
GEORGIA WORLD CONGRESS CENTER

JONES AVENUE
PARKING, PHASE II

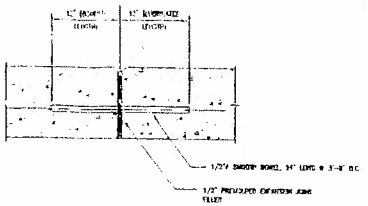
Project No.: 4278
Designed By: JHJR
Drawn By: JHJR
Checked By: JHJR
Issue Date: 4/27/2005
Drawing Scale: AS SHOWN

Drawing Title: CIVIL DETAILS

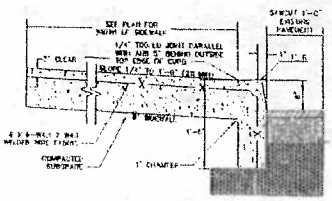
Drawing No.: CM1.1



GDOT STANDARD CATCHBASIN (W/WING WALLS)



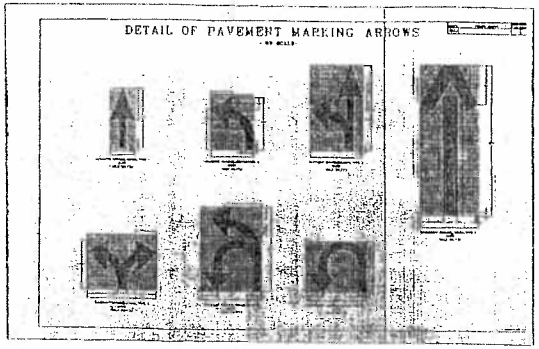
TYPICAL EXPANSION JOINT



8" MONOLITHIC SIDEWALK AND CURB

NOTES:

1. SIDEWALK SHALL BE SCORED WITH TRAVERSE CONTROL JOINTS IN SQUARES EQUAL TO SIDEWALK WIDTH, BUT NOT TO EXCEED 10 FEET. 1" X 1-1/2" CONTROL JOINT TO BE MADE WITHIN 12 HOURS OF CONCRETE POUR.
2. CONCRETE SHALL BE TYPE "A" 3,000 P.S.I. MIN. STRENGTH.
3. EXPANSION JOINTS SHALL EXTEND ACROSS THE FULL WIDTH OF THE SIDEWALK. CONTROL JOINTS SHALL BE LOCATED ON EACH SIDE OF A DRIVEWAY AND NOT MORE THAN 100 FEET APART.
4. PREFORMED BITUMINOUS MATERIAL SHALL BE PLACED BETWEEN ALL FIXED OBJECTS AND THE NEW CONCRETE SIDEWALK.
5. ALL CONCRETE WORK SHALL BE PER CITY OF ATLANTA STANDARD SPECIFICATIONS FOR CONSTRUCTION.
6. 1/2-INCH TOOLED JOINT BETWEEN CURB AND SIDEWALK.



PAVEMENT MARKINGS DETAIL

24" x 30"

R8-3a SIGN (NO PARKING)

30" x 30" x 36"

R8-3a SIGN (NO PARKING)

18" x 24"

KEEP RIGHT SIGN

18" x 24"

RIGHT TURN ONLY SIGN

NOTE: ALL TRAFFIC SIGNS MUST MEET MUTCD CODE.

Revisions:

No.	Date

ALTAMIRA
SOCIAL AND COMMUNITY SERVICE, INC.

Williams-Russell & Johnson, Inc.
ENGINEERS-PLANNERS-ARCHITECTS
771 SPRING STREET, N.W.
ATLANTA, GEORGIA 30308
OFFICE: (404) 853-6800
FAX: (404) 607-8800

Seal

GEORGIA WORLD CONGRESS CENTER

JONES AVENUE PARKING, PHASE II

Project No.: 4276
Designed By: JWH
Drawn By: JWH
Checked By: JWH
Issue Date: 08/29/2005
Drawing Scale: AS SHOWN

Drawing Title: CIVIL DETAILS

Drawing No.: CM1.2

APPENDIX C

FORMS

NORTHSIDE DRIVE LANDFILL
ATLANTA, GEORGIA
M&M INSPECTION LOG

DATE: _____ WEATHER: _____

INSPECTOR(S): _____

Component Inspected	Condition of Component	Check if Major Damage

Comments:

NORTHSIDE DRIVE LANDFILL
ATLANTA, GEORGIA
MAINTENANCE RECORD FORM

DATE: _____

WEATHER: _____

INSPECTOR(S): _____

Component Inspected	Repair Dates		Inspector	Description of Repairs	Check if Major Damage
	Initiated	Completed			

Deed Book 41036 Pg 315

GROUNDWATER SAMPLING DATA SHEET

SITE INFORMATION

Site Name: _____ Municipality: _____

Project Number: _____ County: _____

Personnel: _____ State: _____

Date: _____ Street or Map Location: _____

(If Off-Site): _____

WEATHER CONDITIONS AND EQUIPMENT

Temperature Range: _____ Equipment Name: _____

Precipitation: _____ Equipment Number: _____

Barometric Pressure: _____ Latest Calibration Date: _____

Tidally-Influenced [ ] Yes [ ] No

Well Number and Sample ID	Date/Time	Measurement made at top of: (PVC, casing?)	Water Level Indicator Reading (Feet)*	LNAPL or DNAPL present? (yes/no)	NAPL Description/ Thickness*

MONITORING AND MAINTENANCE PLAN FOR TYPE 5 RISK REDUCTION STANDARDS

NORTHSIDE DRIVE LANDFILL
Atlanta, Georgia

December 2003

TABLE OF CONTENTS

1.0 INTRODUCTION

The Northside Drive Landfill (NDL) site is listed on the State of Georgia's Hazardous Site Inventory pursuant to the Georgia Hazardous Site Response Act, Official Code of Georgia Annotated (O.C.G.A.) §12-8-90 and associated Rules for Hazardous Site Response, Chapter 391-3-19. The landfill portion of the NDL site (landfill) was remediated using engineering and institutional controls. The engineering controls involved the installation of a soil-bentonite slurry wall and an engineered control cap as illustrated in the approved As-Built Drawings dated August 2003 and supporting documents. The institutional controls implemented were a deed notice and conservation easement that includes this Monitoring and Maintenance (M&M) Plan.

This M&M plan contains six sections, 3 appendices, and an attachment. Section 2.0 describes the current landfill monitoring and control systems. Section 3.0 presents the groundwater-monitoring plan. Section 4.0 contains the landfill maintenance and inspection plan. Section 5.0 describes land use of the landfill portion of the NDL site. References are presented in Section 6.0. The appendices are as follows: Appendix A contains descriptions of potential statistical data evaluation methods; Appendix B contains a figure; and Appendix C contains forms. As-built drawings of the landfill portion of the NDL site are presented in the Attachment.

2.0 CURRENT LANDFILL MONITORING AND CONTROL SYSTEMS

The engineering controls consist of a three foot wide soil-bentonite slurry wall which extends from the surface to bedrock around the landfill wastes and covered with an engineered control cap consisting of a geosynthetic clay liner, LLDPE liner, geocomposite drainage layer with two feet of select fill.

The following nine (9) groundwater monitoring wells and a dewatering well are located in and around the landfill as show in Figure 1, Appendix B:

- MWC-1A, MWC-1B, and MWC-1C, (located on the southeastern corner of Tax Parcel No. 14-82-6-8 at the corner of John and Gray Streets)
- MWC-3B, MM-02, and MWC-3C (located on the southwestern corner of Tax Parcel No. 14-82-6-8 at the corner of John Street and Northside Drive)
- Dewatering well (located within the limits of the engineering controls of the landfill at the northwest corner of the landfill)
- MM-03 (located midway along John Street)
- MM-01 (located midway along Northside Drive between Western Avenue and John Street)
- MM-04 which is the upgradient, background groundwater monitoring well (located near the corner of Western Avenue and Gray Street)

These wells are used to identify and/or evaluate the following conditions:

- Release of regulated substances from the landfill above background and/or the risk reduction standards of Section 391-3-19-.07 of the Rules
- Migration and/or expansion of regulated substances located outside of the landfill
- Measure groundwater levels inside and outside the slurry wall

3.0 GROUNDWATER-MONITORING PLAN

This section summarizes the regulated substances to be measured, sampling and analysis requirements including the sampling and analysis plan, data evaluation (statistical methods), and reporting requirements.

No natural surface water drainage features are present; therefore, a plan to monitor surface water is not included in this M&M Plan.

3.1 GROUNDWATER STANDARDS

The Georgia Type 1 risk reduction standards (Section 391-3-19-.07 of the Rules) for regulated substances will be used as the groundwater standards for the groundwater-monitoring plan.

3.1.1 Regulated Substances

The regulated substances for the NDL site include polynuclear aromatic hydrocarbons (PAH) and metals. Table 1 lists the regulated substances, the frequency at which they will be monitored, the Type 1 risk reduction standards (RRS), and the analytical methods that will be used. The selected analytical method must have detection limits at or below the Type 1 RRS listed in Table 1. Detection limit is the practical quantitation limit (PQL), defined in the Rules as the lowest concentration, for an approved analytical test method and for a given sample matrix, at which the quantity of a regulated substance can be measured with a stated degree of confidence under routine laboratory operating conditions. Monitoring for regulated substances at the frequencies given in Table 1 must be conducted for all monitoring wells including the background-monitoring well (See 3.1.2 for more detail). In addition, field parameters must be recorded at the same frequencies, as part of the monitoring plan. Field parameters include water level, pH, specific conductance, temperature, and turbidity. Section 3.2.2 (Sample Collection) gives a detailed explanation of the procedures to accurately evaluate and record field parameters.

3.1.2 Monitoring Frequency

Upon notification by the Georgia Environmental Protection Division (EPD) to initiate the groundwater-monitoring plan, groundwater-monitoring sampling shall be initiated within sixty (60) days of receipt of notification. The groundwater-monitoring plan will consist of the following activities:

- Measurements of field parameters (total depth of the well, water level, pH, specific conductance, temperature, and turbidity) for all groundwater monitoring wells and the dewatering well; and
- Sampling for the regulated substances included in Table 1 from all of the groundwater-monitoring wells.

The frequency of monitoring is provided in Table 1. The quarterly sampling will be based on calendar quarters ending March 31, June 30, September 30 and December 31. Reports must be submitted to EPD within thirty (30) days of the end of the calendar quarter for which the sampling was performed. The quarterly sampling will be performed for two years to establish existing conditions and background data that could be used for statistical analysis, if warranted. After two years of quarterly sampling and unless notified otherwise by EPD, the frequency of groundwater sampling will be reduced to once annually with the annual report due to EPD within thirty (30) days of the end of the quarter for which the sampling was performed. An M&M review report must be submitted to EPD within sixty (60) days from the close of every fifth year that summarizes and evaluates groundwater trends discerned through that time period and make recommendations as appropriate.

Table 1
Regulated Substances for Groundwater
Northside Drive Landfill

Regulated Substance	Frequency of Groundwater Monitoring*	Type 1 RRS (mg/L)	Analytical Method
Organics			
Acenaphthene	Quarterly for 2 years, then annually	2	SW846 8310
Acenaphthylene	Quarterly for 2 years, then annually	PQL[a]: 0.023	SW846 8310
Anthracene	Quarterly for 2 years, then annually	PQL[a]: 0.0066	SW846 8310
Benzo(a)anthracene	Quarterly for 2 years, then annually	0.0001	SW846 8310
Benzo(k)fluoranthene	Quarterly for 2 years, then annually	PQL[a]: 0.00017	SW846 8310
Benzo(b)fluoranthene	Quarterly for 2 years, then annually	0.0002	SW846 8310
Benzo(g,h,i)perylene	Quarterly for 2 years, then annually	PQL[a]: 0.00076	SW846 8310
Benzo(a)pyrene	Quarterly for 2 years, then annually	0.0002	SW846 8310
Chrysene	Quarterly for 2 years, then annually	0.0002[b]	SW846 8310
Dibenz(a,h)anthracene	Quarterly for 2 years, then annually	0.0003	SW846 8310
Fluoranthene	Quarterly for 2 years, then annually	1	SW846 8310
Fluorene	Quarterly for 2 years, then annually	1	SW846 8310
Indeno(1,2,3-cd)pyrene	Quarterly for 2 years, then annually	0.0004	SW846 8310
Naphthalene	Quarterly for 2 years, then annually	0.02	SW846 8310
Phenanthrene	Quarterly for 2 years, then annually	PQL[a]: 0.0064	SW846 8310
Pyrene	Quarterly for 2 years, then annually	1	SW846 8310
Metals			
Beryllium	Quarterly for 2 years, then annually	0.004	SW846 6010B
Lead	Quarterly for 2 years, then annually	0.015	SW846 6010B
Mercury	Quarterly for 2 years, then annually	0.002	SW846 7470A

Notes:

* Frequency of groundwater monitoring may be modified only upon receipt of EPD's approval.

a The PQL presented is the value provided in SW846 Method 8310 for a typical groundwater matrix in the absence of interference. Interference may cause the PQL value to increase. As such, this PQL value is provided for guidance and may not always be achieved.

b The health based drinking water criterion for this substance/analyte is lower than the lowest currently achievable and available detection limit. According to Rule 391-3-19.07(4)(e), the detection limit or background must be the Type I groundwater concentration criterion for this substance/analyte.

mg/L Milligrams per liter
PQL Practical quantitation limit
SW 846 U.S. EPA. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. Including updates I, II, IIA, IIB, III, and IIIA to the Third Edition. September 1986 through 1998.

3.2 SAMPLING AND ANALYSIS PLAN

This section provides the methodology for groundwater sampling and analysis of both background and detection monitoring wells.

The regulated substances to be measured and the frequency at which samples must be collected appear in Table 1. Field parameters include total depth of the well, water level, specific conductance, pH, temperature, and turbidity. Regulated substances and field parameters must be monitored quarterly for the first 2 years and then annually thereafter unless notified otherwise by EPD. An M&M review report must be submitted to EPD within sixty (60) days from the close of every fifth year that summarizes and evaluates groundwater trends discerned through that time period and make recommendations as appropriate.

Water levels must be measured on a quarterly basis from the monitoring wells and the dewatering well to record the fluctuations of the water table due to seasonal effects. High water table conditions typically occur during the winter and spring, due to precipitation. Low water table conditions predominate in the summer and fall due to lower relative precipitation. Water level, other field parameter measurements and first-year quarterly sampling events must be timed so that two quarterly events are conducted during high water table conditions and two quarterly events are conducted during low water table conditions.

The following sections describe procedures for measuring water levels and field parameters and collecting groundwater samples. Water level measurements for a well must be completed before presample purging of the well is conducted. Water level measurement and sample collection must be conducted at the background well first, followed by detection wells and finally the dewatering well. Powderless latex gloves must be worn during water level measurements and groundwater sampling and must be changed between wells. The water level indicator must be decontaminated between wells. All information collected in association with water level measurement, other field parameters and groundwater sampling must be recorded on the groundwater sampling data sheets (Appendix C) and in a logbook. All activities associated with measurements of water levels and field parameters and collection of groundwater samples must be performed in accordance with the most recent edition of the EPA's Environmental Investigation Standard Operating Procedures and Quality Assurance Manual (EISOPQAM).

3.2.1 Water Level Measurement

The equipment required for water level measurement includes:

- Electric water level indicator (probe)
- Logbook
- Well keys
- Decontamination equipment (tubs or buckets, brushes, phosphate-free laboratory-grade detergent, distilled, deionized water, wastewater container)
- Photoionization detector (PID)
- Powderless surgical gloves

After removing the protective cap and casing cap, the breathing zone must be checked for organic vapors using the PID. If elevated breathing zone vapors are encountered, the sampling team must leave the well and don the appropriate level of personal protective equipment (PPE) before continuing. Action levels and appropriate PPE must be specified in the site-specific health and safety plan. The PID must also be used to survey vapors inside the top opening of the well casing.

To measure the water level in the casing, the probe must be lowered into the casing until the light or sound alarm is activated, indicating that the probe has touched the water surface. Before the water level is measured, the probe and its cable must be physically checked against a measuring tape to verify that the water level indicator has not been cut or altered and to confirm that the indicator's reading is accurate. The static water level must be read directly from the indicator cable by holding the cable to the permanent mark at the top of the well casing and reading off the depth to the nearest 0.01 foot. The probe must be raised and lowered two more times in order to obtain two more measurements; the three readings must then be averaged and recorded in the logbook. Next, the probe must be lowered until it encounters resistance, indicating it has reached the bottom of the well casing. This depth must be read off the cable and recorded in the logbook.

The probe and cable must be washed with a phosphate-free laboratory-grade detergent after they are retrieved from the well, and rinsed in distilled, deionized water. Wash and rinse water must be contained in a wastewater container before proceeding to the next well.

PID readings, as well as general observations of the appearance and condition of the well casing and protective outer casing, must be recorded in a logbook and on the groundwater sampling data sheets.

3.2.2 Sample Collection

In addition to the equipment listed above for water level measurement, sample collection must require the following equipment:

- Sample containers and labels
- Calibrated bucket (example: 5-gallon bucket)
- Coolers, and ice
- Permanent marker
- Low-flow sampling pump (for example, bladder, variable speed, peristaltic)
- Groundwater sampling data sheets
- Instruments for measuring field parameters

All instruments used for measuring field parameters must be calibrated at the beginning of each day of sampling. The instruments response to a calibration standard must be recorded in the logbook and on the groundwater sampling data sheets for all instruments, including those not typically calibrated in the field (such as a specific conductivity meter). The makes, models, serial number, and dates of last calibration of all instruments used must be recorded in the logbook. The sources, lot numbers, and expiration dates of the standards solutions used for calibration must also be recorded in the logbook.

After measuring the water level and bottom of well casing, the water volume within the well casing must be calculated. The volume of water inside the well casing is determined by subtracting from the total depth of well casing the depth to groundwater, and multiplying the height of water in the casing by 0.163 gallons per linear foot (for a 2-inch inner diameter well).

Wells must be purged a minimum of three casing volumes and sampled with a low flow pump. Water must be discharged from the pump to a calibrated bucket that has volumes marked in increments of gallons or fractions of gallons. A sample of purge water must be discharged into a beaker or other container after each casing volume is removed from the well, for measurement of field parameters. The purge water must be contained in a wastewater container (such as a 55-gallon drum). If stability of the field parameters is not

achieved within purging of 3 well volumes, the sampling team leader must make the determination whether to sample the well.

Field parameters must be measured and recorded on the groundwater sampling data sheets and in a logbook along with the associated cumulative purge volume. Observations of purge water appearance must also be entered on the groundwater sampling data sheet and in a logbook. The well must be purged until field parameters are stable between three consecutive measurements. To be considered stable, field parameters must change by no more than the following tolerance levels: pH measurements remain constant within 0.1 Standard Unit, specific conductance varies no more than 10 percent, and temperature is constant for three consecutive readings. Turbidity must also be measured and recorded. Stability is achieved when pH, specific conductance, and temperature have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTU) (EISOPQAM).

Water levels must be periodically monitored with a water level indicator while purging. The purging rate must be adjusted to avoid purging the well dry.

All preservatives must be added to containers prior to sampling. Samples collected in pre-preserved containers must not be overfilled. The order of sample collection is as follows:

1. PAHs
2. Metals

This sample order is determined largely by the volatility of the sampled constituent, with the most volatile being sampled first. Sample containers must be labeled and placed in a cooler with ice immediately after the containers are filled. Before delivery to the analytical laboratory, all samples must be containerized and packaged to maintain sample integrity and chain of custody.

Any equipment (such as a water level indicator) that will be used to sample in more than one well must be decontaminated using a phosphate-free detergent and rinsed with distilled and deionized water. Any purge water and solid wastes such as PPE, etc. generated during the groundwater monitoring and sampling events must be disposed of properly within thirty (30) days of completion of the event. At no time shall empty containers be stock piled and/or stored on the NDL site.

3.2.3 Sample Labeling and Documentation

Samples must be labeled immediately after collection. At a minimum, sample labels must include sample identification (ID) number, date of collection, time of collection, preservative used, required analyses, and sampler names. The name of the well must be used as the ID number (for example, MW-1). The ID number must also be included in the logbook, chain-of-custody forms, and other records documenting sampling activities. The label must be covered with clear plastic tape to prevent damage after it is filled out.

In addition to sample labels, field-sampling activities require other forms of documentation. This additional documentation is necessary to provide an accurate record of sampling events and field observations. This information must be recorded in logbooks, groundwater sampling data sheets, and chain-of-custody forms. Example forms are provided in the Appendices.

Documentation must be completed legibly in ink. Errors must be crossed out with a single line, dated, and initialed by the sampling team member recording the information. Unused portions of logbook pages must be crossed out, and each page must be signed and dated by the sampling team member who made the entry.

3.2.4 Sample Shipment and Chain of Custody

After samples are collected, labeled, and sealed with custody seals, they must be placed in iced coolers. Inert packing materials (such as vermiculite) must be placed around sample containers to prevent breakage. Coolers must be stored in a secured location until they are shipped to the analytical laboratory. Chain-of-custody (COC) forms must be completed for all samples. Before shipment, the field sample custodian and the courier receiving the samples must sign the COC form. A copy of the COC form must be retained for the project files. After the COC form has been completed and signed, it must be inserted in a sealed plastic bag and taped inside the lid of the cooler. The cooler must be sealed with a minimum of two seals (signed and dated by the field sample custodian), so that the seals must be broken to remove the samples. The field chain of custody terminates when the laboratory receives the samples. At that time, the laboratory assumes responsibility for custody. Upon receipt at the laboratory, a laboratory representative must inspect the contents of the cooler, sign the COC form, and list the date and time.

3.2.5 Quality Control Samples

The quality assurance and quality control (QA/QC) guidance outlined in the EISOPQAM must be followed. QA/QC field samples must be collected to evaluate whether data quality has been affected by field activities or other outside events. QA/QC field samples include field duplicates and equipment blanks. Additional sample volumes must also be collected for matrix spike and matrix spike duplicate (MS/MSD) samples.

Field duplicate samples are used to assess the reproducibility and representativeness of results. Field duplicate samples are collected in a manner identical to the real sample, but are submitted blind to the analytical laboratory. The well the field duplicate sample was collected from must be recorded in the logbook and on the groundwater sampling form. Field duplicate samples must be collected once for every 10 wells sampled (one every sampling event).

Equipment blanks are collected to assess the quality of decontamination procedures used on nondisposable sampling equipment (equipment used in more than one well). Equipment blanks are obtained by flushing the sampling equipment with deionized water after it has been decontaminated and air-dried. The flush water must then be containerized and analyzed for the same constituents as the groundwater samples. Field duplicate must be collected at a frequency of one per sampling event.

MS/MSD samples gauge the accuracy and precision of the data derived from sample analysis. Although spiking is an internal laboratory procedure, the laboratory typically requires that a triple volume be collected for MS/MSD samples. A triple volume of a sample chosen at the discretion of the sampling team must be collected, and each container must be labeled with the same ID number. Under the remarks or comments on the chain-of-custody form, the triple volume must be noted as collected for MS/MSD. MS/MSDs must be collected at a frequency of 1 per 20 wells sampled or at least once during every sampling event, whichever is more frequent.

3.2.6 Laboratory Analysis

A laboratory that complies with the O.C.G.A. 12-2-26, Georgia Commercial Analytical Laboratory Act and associated Rules must analyze the groundwater samples. Samples must be analyzed using the methods presented in Table 1. The analytical laboratory is required to have a QA/QC plan to assure the reliability of analytical results. Any report that submits analytical results to EPD must include a certification that complies with Chapter 391-3-26 of the Rules for Commercial Environmental Laboratories.

3.3 DATA EVALUATION

Analytical results and field parameters must be evaluated to determine if a release has occurred from the landfill to groundwater or if groundwater is infiltrating the slurry wall or engineered control cap. This data validation and evaluation process consists of data review, tabulation of qualified data, review and handling of outlying data, statistical analysis, and professional judgment screening. Analytical results from the background well and detection monitoring wells must be tabulated and evaluated separately before making any statistical comparison. Inferential statistical tests can be performed only on regulated substances detected in monitoring well samples after a year of quarterly sampling (4 sampling events).

Regulated substances not detected in background well samples, but detected in one or more detection monitoring well samples, must be evaluated using professional judgment as discussed in Section 3.3.4 to determine if the detection represents a release from the landfill or has some other plausible cause.

Professional judgment must be applied throughout the data evaluation process, but is essential for two areas in particular: data quality and statistical interpretation. Professional judgment is required for: determining that results are representative of aquifer conditions, the handling of outliers, and determining if the statistical tests were failed (reject the null hypothesis, H_o, that there is no significant difference between the data sample means for the background and detection monitoring wells) as a result of a release from the landfill.

3.3.1 Analytical Data Validation and Tabulation

To evaluate data quality, all data received from the laboratory must be subjected to the EPA's EISOPQAM data validation process. The data quality review must include a report on data quality, which must discuss among other things, detections of any regulated substances in blanks and other QA/QC results. The data must be examined for any other errors, such as those made during transcription. Any data quality issues that may affect the outcome of statistical tests must be noted. The representativeness of the results must also be reviewed and noted.

Qualified data must be tabulated in a format presenting all ID numbers, dates of sampling, and results for all analyses. Separate tables must be generated for detection monitoring well data and background well data. Data evaluation may include summary statistics tables, graphs, and concentration plots. Results from each detection monitoring well must be independently compared to background.

3.3.2 Outlier Evaluation

An unavoidable problem in the statistical analysis of environmental data is the presence of outliers. Outliers are extreme (high or low) values that are widely divergent from the main body of data (Gad and Weil 1989). Outliers may arise from mistakes such as transcription, data-coding errors, instrument breakdowns, calibration problems, and power failures. Additionally, they may arise due to the inherent spatial or temporal variability of the regulated substance (Gad and Weil 1989). Outliers disproportionately affect the statistical descriptors of the data set, biasing the mean and standard deviation toward the outlying observation. Therefore, it is important to identify and investigate outliers in the data and treat them appropriately.

Outliers can be identified by visual inspection of data, use of a scattergram (or other graph), or by a large increase in the standard deviation (if the data set is small enough, as is the case with this monitoring plan) (Gad and Weil 1989). Professional judgment must be used with the above techniques to determine the presence of suspect outliers. If not obvious, a test for a single outlier, such as that described by Dixon (1953), may be applied. However, because one outlier may mask another, such tests may not identify an outlier (Gilbert 1987).

Once identified, outliers must be corrected, discarded, or retained. Outliers that are obvious mistakes must be corrected, when possible. Outliers that are not obvious mistakes must be reviewed to determine the cause. The outlier must be discarded if a cause is identified (that is not a result of geochemical variation of the landfill). Causes that might warrant discarding an outlier might include field or laboratory contamination, matrix interference, or calibration problems. If the outlier can neither be corrected nor discarded, the outlier may be retained in the data set for statistical testing. Statistical testing may be conducted with the outlier both present and absent from the data set to determine the effect on the statistical test outcome.

3.3.3 Statistical Tests

Statistical tests consistent with those required in the *Guidance for Data Quality Assessment, Practical Methods for Data Analysis* (EPA QA/G-9 QA00 Update) must be used for the data evaluation. Statistical comparisons and tests must be calculated only for regulated substances that are detected in samples collected from both background and detection monitoring wells. When a regulated substance is detected only in samples from detection monitoring wells and not in samples from background wells, it must be evaluated using professional judgment prior to verification sampling for confirming a release from the landfill.

The minimum sample size necessary for meaningful inferential statistical tests is four. This sample size must be achieved after one year of quarterly sampling. The inferential test that must be performed is determined by the distribution of data (parametric or nonparametric) and the frequency of detection. The data must first be tested to determine whether the data distribution is normal or random. If the data are normally distributed, a parametric test (for instance the Cochran's t-test) may be used to compare data sample means between detection wells and the background well. If the data are randomly distributed, a nonparametric test (for instance, a Wilcoxon Rank Sum [WRS] test) must be performed to compare data sample means between detection monitoring wells and the background well. A parametric test must be performed if data are normally distributed and regulated substances are detected at a frequency of 80 percent or greater. A nonparametric test must be used for data that are randomly distributed or are detected at a frequency of less than 80 percent. Appendix A describes normality testing, handling of non-detections, and the Cochran's t-test and the WRS test. All inferential statistical tests must be performed at a level of significance (p-value) of 0.05 (0.95 confidence level).

3.3.4 Professional Judgment

No statistical test or comparison alone can identify a release with absolute confidence. Identifying a release requires a combination of more than one statistical test and professional judgment. The identification of any regulated substance as differing from background concentrations (rejection of H_o) is subject to professional judgment. Professional judgment must be applied to prevent reporting of statistically significant evidence of a release that is at the landfill (a false positive). Professional judgment must always be accompanied by a plausible explanation. Factors that may cause a regulated substance to be identified as statistically different from background, though not as a result of a release, include the effect of non-detects in the statistical test, Type I error rates, spatial and temporal distribution of constituents, and off-site releases. This step is similar to that taken when data are initially reviewed for influences such as field or laboratory contamination. Professional judgment must also be applied to detections in detection monitoring wells when the regulated substance is not detected in a background well.

3.3.5 Verification Procedure for Suspected Releases

Verification sampling must be conducted if statistically significant or other evidence of a release is not rejected by professional judgment. Only those detection monitoring wells in which a suspected release was

detected must be resampled; however, if the next sampling event takes place prior to identifying a suspected release, this newly collected data might be used. Results from resampling must be compared to existing background data for a regulated substance that may have been released. A discrete retest (using only the newly-collected detection monitoring well data) must be performed.

3.4 REPORTING

A groundwater monitoring report including data evaluation, along with a cover letter, must be submitted to EPD.

The groundwater monitoring report must be submitted within thirty (30) days of the end of the calendar quarter in which the sampling event occurred. The report must include tabulation of qualified analytical results and a narrative summary of the results. The report must include analysis of water level data and groundwater flow direction and gradient. The report must discuss any deviations from the M&M plan. The report must also provide the data validation report and the results of QA/QC sampling and analysis.

An annual groundwater monitoring report must include a narrative summarizing all the data collected within a year's monitoring events and a statistical evaluation of the data.

The groundwater monitoring report must include the following signed certifications:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate that information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief true and accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.
>
> _____
> Authorized Signature
>
> I certify that I am a qualified groundwater scientist who has received a baccalaureate or post-graduate degree in the natural sciences or engineering, and have sufficient training and experience in groundwater hydrology and related fields, as demonstrated by state registration and completion of accredited university courses, that enable me to make sound professional judgments regarding groundwater monitoring and contaminant fate and transport. I further certify that this report was prepared by myself or by a subordinate working under my direction.
>
> _____
> Georgia Registered Professional
> Geologist or Engineer

An M&M review report must be submitted to EPD within sixty (60) days from the close of every fifth year that summarizes and evaluates groundwater trends discerned through that time period and make recommendations as appropriate. EPD will review, comment, respond and/or approve these reports as appropriate.

4.0 LANDFILL MAINTENANCE AND INSPECTION PLANS

This section of the M&M plan describes the methods, procedures, and processes that must be used to inspect and maintain the engineering controls of the landfill. These components include final cover and grading; drainage system; and groundwater monitoring network. Use of the property must not disturb the integrity of the soil cap and liner system of the landfill or any other components of the containment system, or the function of the monitoring systems. Maintenance and inspection of the landfill must be performed by person(s) experienced in the maintenance and inspection of the engineering controls at the landfill through both professional training and educational experience sufficient to evaluate the condition of the landfill as it relates to the requirements set forth below. Minimum experience requires the inspector be a Georgia certified Professional Engineer with experience in the design and/or evaluation of landfills.

Maintenance and inspection activity documentation includes the M&M Inspection Log form and Maintenance Record form. Inspection logs include the date of the inspection, name of the inspector(s), component inspected, weather conditions, condition of the item inspected, notation of any damages requiring attention and indicate if the noted damage would be classified as major damage. A copy of the M&M Inspection Log form is in Appendix C. Maintenance records include the dates repairs were initiated and completed, and the name of the person recording the information. Comments describing the severity of the damage (i.e.: major) must also be noted on the maintenance record along with a description of the repairs. A copy of the Maintenance Record form is in Appendix C.

4.1 FINAL COVER AND GRADING

It is necessary to maintain the integrity and effectiveness of the soil cap and vegetative cover, including making repairs to the cover as necessary to correct the effects of settling, subsidence, erosion, or other events, and preventing run-on and run-off from causing erosion or other damage to the soil cap and vegetative cover. The cover must be inspected every calendar quarter. The inspection must evaluate the vegetative cover to ensure adequate quantity and quality of the vegetative cover, and the soil cap to ensure prevention of erosion and ponding. The results of the inspection must be recorded on the M&M Inspection Log form in Appendix C.

A satisfactory stand of grass plants will be considered a minimum of 10 grass plants per square foot and total bare spots less than two percent (2%) of the total area. The cover will be mowed a minimum of each calendar quarter during the growing season and once at the end of the growing season. More frequent mowing is required if it is determined additional mowing is required to maintain a satisfactory stand of grass plants and/or grass height exceeds eight inches (8"). During mowing, clippings must be removed if clippings will result in thatching that inhibits growth of desires grass plants. Maintenance of the cover shall include eradication of weeds, removal of trees or other woody plants, removal of trash, and fertilization if necessary.

All erosion rills must be noted during the quarterly inspection. Erosion rills must be filled with topsoil, seeded with similar grasses, mulched to prevent loss of seed, irrigated sufficiently to establish and maintain growth if needed, and if necessary, surface erosion control blankets must be installed. Any rill greater than one foot (1') wide and/or depth greater than three inches (3") is considered major damage. All areas of ponding must be noted during the quarterly inspection. Ponding areas must be regraded, seeded, mulched, irrigated sufficiently to establish and maintain growth if needed, and if necessary, surface erosion control blankets installed to provide for drainage off of and away from the cover. An area of ponding with standing water forty-eight (48) hours after a rain event is considered major damage. All maintenance of the cover must be documented in a logbook and on Maintenance Record forms.

If major damage is noted, repairs must be completed within seven (7) days of discovery. Any major damage not repaired within seven (7) day must be reported in writing to EPD within nine (9) days of discovery. All other items requiring repair must be completed within thirty (30) days of discovery.

4.2 DRAINAGE SYSTEM

The drainage system is designed to prevent run-on and run-off from compromising the integrity of the cover. Debris and vegetation may build up and block passages for drainage from the landfill. Blockage in drainage areas could increase drainage in other areas and cause erosion. All drain structures (drop inlets, check dams, berms, and drainage swales) around the site must be inspected quarterly for debris or other obstructions that may prevent proper drainage. If any debris is found, it must be removed. Debris cleaned from the structures must be properly disposed off-site. Once a year, one of the quarterly inspections must be performed during a significant rain event so that the drainage system can be evaluated.

Drainage swales must be mowed/weed whacked a minimum of each calendar quarter. Clippings must be removed if clippings will result in thatching or obstruct drainage structures. All trash must be removed. All erosion rills must be noted during the quarterly inspection. Erosion rills must be filled with topsoil, seeded with DOT approved similar grasses, mulched to prevent loss of seed, irrigated sufficiently to establish and maintain growth if needed, and if necessary, surface erosion control blankets must be installed. Any rill greater than one foot (1') wide and/or depth greater than six inches (6") is considered major damage. All areas of ponding must be noted during the quarterly inspection. Ponding areas must be regraded, seeded, mulched, and if necessary, surface erosion control blankets installed to provide for drainage off of and away from the cover. An area of ponding with standing water forty-eight (48) hours after a rain event is considered major damage. Check dams must be checked for excess silt or buildup of debris. Excess silt/debris must be removed. Berms must be checked for erosion or slumping. If slumping or erosion is noted, the berm must be regraded, seeded, mulched, and if necessary, surface erosion control blankets installed. Any check dam or berm that is breached is considered major damage. All maintenance of the drainage system must be documented in a logbook and on Maintenance Record forms.

If major damage is noted, repairs must be completed within seven (7) days of discovery. Any major damage not repaired within seven (7) day must be reported in writing to EPD within nine (9) days of discovery. All other items requiring repair must be completed within thirty (30) days of discovery.

4.3 GROUNDWATER MONITORING NETWORK AND DEWATERING WELL

The groundwater-monitoring network and the dewatering well at the site must be maintained and inspected quarterly. Damage to the locks, wells, and well labels could result from vandalism or weathering. Any damage of the groundwater-monitoring network must be repaired. If locks have rusted and do not function properly, they must be replaced. All wells must remain securely locked.

Wells must be observed for accumulations of silt and sand by measuring the total depth during sampling and comparing these depths to previous and original depths. If an accumulation of silt or sand is noted, the well must be redeveloped. The wells must be visually inspected for signs of grout or concrete stress or failure, and the watertight locking caps must be inspected for cracked or torn rubber seals. It is required these wells be maintained and inspected to ensure the well integrity in accordance with the EPA's Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM). All maintenance of the monitoring well system and the dewatering well must be documented in a logbook and on Maintenance Record forms.

The following conditions are considered major damage:

- Damaged manhole cover
- Damaged well cap
- Damaged well casing inside well
- Erosion undermining concrete pad around well
- Damage or cracking of concrete pad around well

If major damage is noted, repairs must be completed within seven (7) days of discovery. Any major damage not repaired within seven (7) day must be reported in writing to EPD within nine (9) days of discovery. All other items requiring repair must be completed within thirty (30) days of discovery.

4.4 REPORTING

A landfill maintenance and inspection report that includes each inspection event, along with a cover letter, must be submitted to EPD with the groundwater monitoring report. Annually in the cover letter for the landfill maintenance and inspection report, the name, mailing address, telephone number and facsimile number of the person EPD should contact regarding the closure requirements associated with the landfill must be provided to EPD.

The landfill maintenance and inspection report must include the following signed certifications:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate that information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief true and accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.
>
> _____
> Authorized Signature
>
> I certify that I am a qualified engineer who has received a baccalaureate or post-graduate degree in engineering, and have sufficient training and experience in designing and/or evaluating landfills, as demonstrated by State registration and completion of accredited university courses, that enable me to make sound professional judgment regarding the effectiveness of engineering controls at this site. I also certify that this report meets the requirements set forth in the Monitoring and Maintenance Plan for the site. I further certify that this report was prepared by myself or by a subordinate working under my direction.
>
> _____
> PE Signature and Seal

An M&M review report must be submitted to EPD within sixty (60) days from the close of every fifth year that summarizes and evaluates maintenance of the cover, drainage system and wells through that time period and make recommendations as appropriate. EPD will review, comment, respond and/or approve these reports as appropriate.

5.0 PLANNED USES OF PROPERTY

Any use of the landfill must preserve the integrity and effectiveness of the soil cap and liner system of the landfill. The landfill's current use is that of vacant contoured ground with a vegetative cover. All changes in use of the landfill must be approved by EPD and address the continuation of repairs to the engineering controls as necessary to correct the effects of settling, subsidence, erosion, or other events, and preventing run-on and run-off from causing erosion or otherwise damage to the soil cap and liner system. The M&M Plan must be reviewed and revised as appropriate. If it is determined the M&M Plan must be revised, the revised M&M Plan be submitted to EPD for review and approval within sixty (60) days of the change in use.

The landfill liner system is designed to support a H20 live load with a minimum of three feet of soil and road base cover. The total load (static and dynamic) placed on the landfill liner system (geomembrane and GCL layers) shall not be more than 8.3 pounds per square inch (psi). In addition, areas where high loads may be applied over the soil-bentonite slurry wall (entrance roads, heavy truck parking areas, etc) shall be structural reinforcement or bridged during installation of the roadway or parking lot using concrete, geogrid, geotextiles, etc. to prevent significant deformation of the landfill cover over the slurry wall.

5.1 NON-RESIDENTIAL USE

The landfill must be inspected annually with regard to the use of the landfill. Use of the landfill must remain non-residential use.

- The inspection must verify the use of the landfill by owners, tenants, and other occupants to be consistent with non-residential use.
- All contract and lease agreements, and informal agreement must be reviewed to insure it is consistent with the non-residential use.
- The conservation easement must be reviewed annually to ensure it is in place and the uses of the property must conform to the restrictions placed on the property.

The results of the inspection must be summarized in a landfill use statement.

5.2 REPORTING

A landfill use statement regarding compliance with the non-residential use must be submitted to EPD annually with the annual groundwater monitoring report.

The landfill use statement must include the following signed certification:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate that information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief true and accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.
>
> _____
> Authorized Signature

6.0 REFERENCES

Bouwer, H and R.C. Rice. 1989. The Bouwer and Rice Slug Test - An Update. Ground Water, Vol. 27, No. 3. May-June. Pages 304-309.

Cressler, C. W., C. J. Thurmond, and W. G. Hester. 1983. Ground Water in the Greater Atlanta Region Georgia. Information Circular 63. Georgia Geologic Survey.

Dixon, W.J. 1953. Processing Data for Outliers. Biometrics. 9:74-89.

Gad, S.C. and C.S. Weil. 1989. Statistics for Toxicologists In Principles and Methods for Toxicology, Second Edition (Ed: A. Wallace Hayes). Raven Press Ltd. New York.

GA EPD. 1999. "Chapter 391-3-19: HAZARDOUS SITE RESPONSE." November.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York.

Tetra Tech. 2001. "Construction Specifications, Landfill Cap and Slurry Wall, Herndon Homes Housing Project, Atlanta, Fulton County, Georgia." Prepared for GA EPD. Atlanta, Georgia.

APPENDIX A

STATISTICAL DATA EVALUATION

A.1 Normality Testing

Determining whether the distribution of data is normal, lognormal, or that there is no underlying distribution is necessary in selecting the appropriate statistical test. Normal or lognormal distributions are usually evaluated with parametric statistical tests. Nonparametric tests are usually applied to data with no underlying distribution. This section presents the W test; however, other tests for normality or graphical evaluations may be used to determine the data distribution.

The W test, developed by Shapiro and Wilk (1965), can be used to determine whether the data distribution is normal, lognormal, or random. This test is appropriate for sample populations of less than 25. The null hypothesis (H_o) to be tested is that the population has a normal distribution. The alternative hypothesis (H_a) is the population does not have a normal distribution. The W test, as presented in Gilbert (1987), is conducted as follows:

1. Compute the denominator d of the W test statistic, using the n data.

$$d = \sum_{i=1}^{n} (x_i - \bar{x})^2 = \sum_{i=1}^{n} x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i \right)^2$$

2. Order the n data from smallest to largest to obtain the sample order statistics.

$$x_{*1*} \# x_{*2*} \# \ldots \# x_{*n*}.$$

3. Compute k, where

$$k = \frac{n}{2} \quad \text{if n is even}$$

$$k = \frac{n-1}{2} \quad \text{if n is odd}$$

4. Use Table A6 of Gilbert (1987) and for the observed n find the coefficients $a_1, a_2, \ldots, a_k$.

5. Then compute

$$W = \frac{1}{d}\left| \sum_{i=1}^{k} a_i \left(X_{|n-i+1|} - x_{|i|} \right) \right|^2$$

6. Reject H_o at the α significance level if W is less than the quantile given in Table A7 of Gilbert (1987).

If H_o is accepted, the data are normally distributed. If H_o is rejected, the data must be transformed to the log of the data. Then, the W test must be completed on the log of the data. If H_o is then accepted, the data are distributed lognormally. If H_o is rejected while performing this test on the data and the log data, the data are considered to have no underlying distribution (nonparametric).

A.2 Handling Nondetections

Many environmental data sets contain analytes that are not positively detected in each sample collected and analyzed. Instead, the data set must generally contain some samples with positive results for a particular chemical and others with nondetected results. The nondetected, or censored, results are usually reported as sample quantitation limits (SQLs). An SQL indicates that the chemical could not be detected above a particular concentration, which may vary from sample to sample. The chemical may be present at a concentration below the reported quantitation limit, or it may not be present in the sample at all.
During evaluation of detection monitoring and background groundwater data, one-half the SQL must be used in statistical testing as a starting point. EPA guidance (1989) recommends using one-half the SQL. A value of zero (not detected) must be used in place of the SQL if one-half the SQL is greater than any of the detections. The effect of the SQL on statistical tests must be taken into account during the application of professional judgment.

A.3 Cochran's t-Test

The Cochran's t-test is a modified Student's t-test that is appropriate for use when the data sets have heterogeneous variances and unequal sample sizes. The criteria of normality, independence of data, complete frequency of detection, and appropriate sample size must also be met for this test to be used. However, a frequency of detection of 80 percent is being allowed.

The observed test statistic for the Cochran's t-test is calculated using the equation:

$$t_{obs} = (\bar{x}_1 - \bar{x}_2)/(W_1 + W_2)^{0.5}$$

where:

$\bar{x}_1$ = the mean of the first data set
$\bar{x}_2$ = the mean of the second data set
W_1 = the variance of the first data set divided by the sample size of the first data set
W_2 = the variance of the second data set divided by the sample size of the second data set

The t_{obs} value is compared to the expected t value (t_{exp}), which is calculated using the equation:

$$t_{exp} = (t_1' W_1 + t_2' W_2)/(W_1 + W_2)$$

where:

t_1' = t-value for the first data set taken from the t distribution table at the appropriate degree of freedom and level of significance
t_2' = t-value for the second data set taken from the t-distribution table at the appropriate degree of freedom and level of significance

The t_{obs} value is compared to the t_{exp} value; if the absolute value of t_{obs} is lower than t_{exp}, then there is no statistical difference between the two groups. The data indicate a release if t_{obs} is greater than t_{exp} and the mean of the site data is greater than the mean of the background data.

A.4 Wilcoxon Rank Sum Test

The Wilcoxon Rank Sum (WRS) test is a nonparametric version of the t-tests. The results of this test indicate when the measurements of one population are consistently higher or lower than measurements of a second population. Sample sizes need not be equal for the application of this test. However, the WRS test is somewhat sensitive to nondetect data. This test can handle a moderate number of nondetects by treating them as ties (equal in rank) (Gilbert 1987). However, if different SQLs are given for nondetects, this test may be weakened.

The WRS test is conducted by first ranking the combined site and background data from smallest to largest. Ranks are then assigned to each data point, starting with one for the lowest value and continuing until all data points have been assigned a corresponding rank. The ranks of the site data are then summed and compared to an acceptance range corresponding to a particular level of significance (0.05), the sample size of the site, and background data sets. If the sum of the ranks falls within the acceptance region, then the null hypothesis (that the site and background data are similar) is not rejected. If the rank sum exceeds the range, then the site concentrations are statistically greater than the background concentrations (Gilbert 1987, 1993). Tables found in Remington and Schork (1985) present the critical values for this test.

This approach can be used even when some data points are tied (equal in rank). In that case, the tied values are each given the mean value of the tied ranks. For example, if three data points were equal, and corresponded to the ranks of 3, 4, and 5, each of the data points would be ranked as 4 (Gilbert 1987, 1993). The next largest data point would have the rank of 6. If the number of tied ranks becomes large, however, the WRS test may not provide accurate results.

A.5 References

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York.

Gilbert, R.O. 1993. Letter Report to Beverly Ramsey. Battelle. July 30.

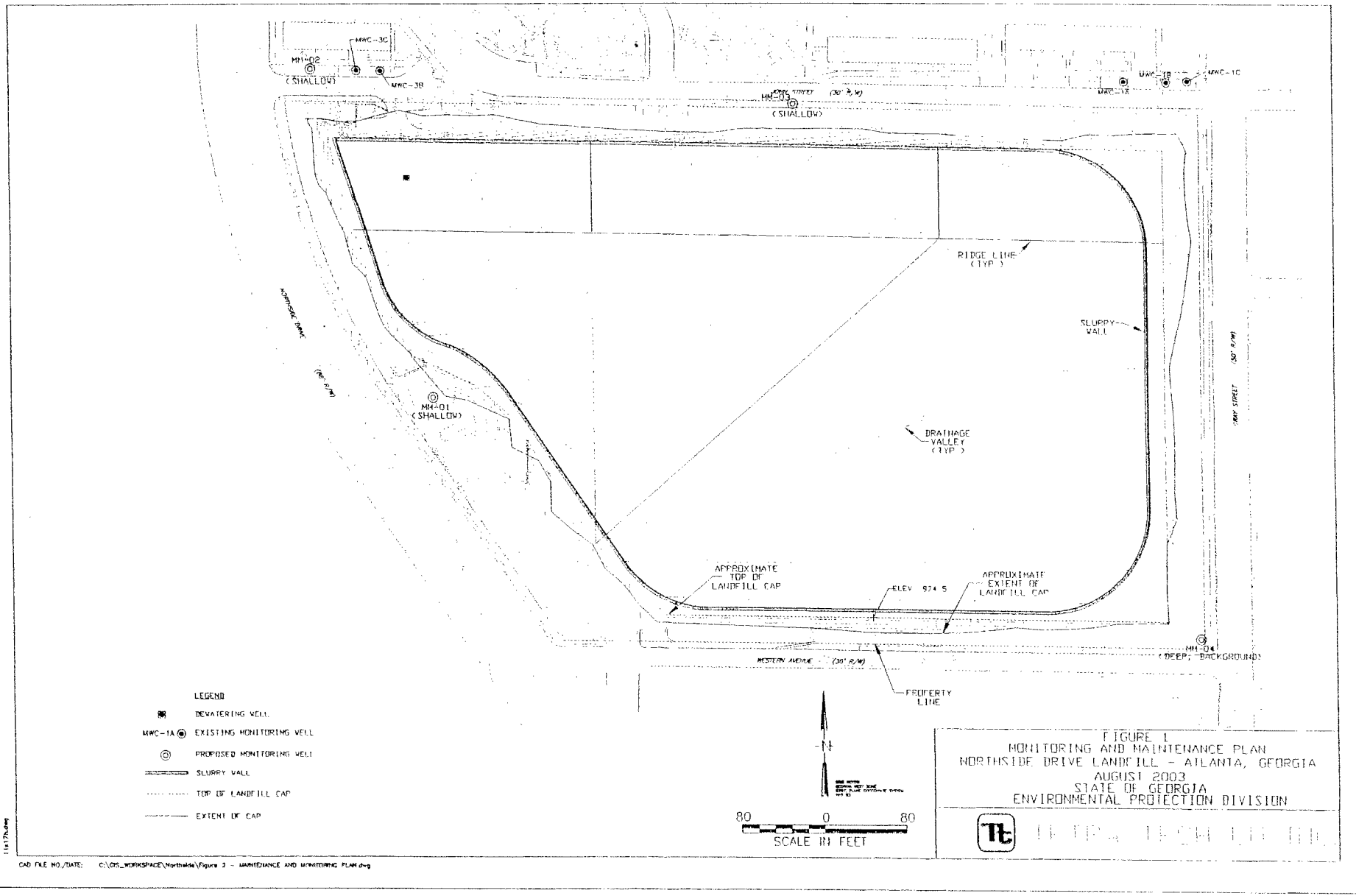
Remington, R.D. and M.A. Schork. 1985. Statistics With Applications to the Biological and Health Sciences. Second edition. Prentice Hall, New Jersey.

Shapiro, S.S. and M.B. Wilk. 1965. An Analysis of Variance Test for Normality. Journal of the American Statistical Association. **67**: pp. 215-216.

U.S. Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A), Interim Final. EPA/5401/1-89/002. Office of Emergency and Remedial Response. December.

APPENDIX B

FIGURE



CAD FILE NO./DATE: C:\GIS_WORKSPACE\Northside\Figure 3 - MAINTENANCE AND MONITORING PLAN.dwg

APPENDIX C

FORMS

NORTHSIDE DRIVE LANDFILL
ATLANTA, GEORGIA
M&M INSPECTION LOG

DATE: _____ WEATHER: _____

INSPECTOR(S): _____

Component Inspected	Condition of Component	Check if Major Damage

Comments:

NORTHSIDE DRIVE LANDFILL
ATLANTA, GEORGIA
MAINTENANCE RECORD FORM

DATE: _____ WEATHER: _____

INSPECTOR(S): _____

Component Inspected	Repair Dates		Inspector	Description of Repairs	Check if Major Damage
	Initiated	Completed			

GROUNDWATER SAMPLING DATA SHEET

SITE INFORMATION

Site Name: _____ Municipality: _____

Project Number: _____ County: _____

Personnel: _____ State: _____

Date: _____ Street or Map Location: _____

(If Off-Site): _____

WEATHER CONDITIONS AND EQUIPMENT

Temperature Range: _____ Equipment Name: _____

Precipitation: _____ Equipment Number: _____

Barometric Pressure: _____ Latest Calibration Date: _____

Tidally-Influenced [ ] Yes [ ] No

Well Number and Sample ID	Date/Time	Measurement made at top of: (PVC, casing?)	Water Level Indicator Reading (Feet)*	LNAPL or DNAPL present? (yes/no)	NAPL Description/ Thickness*

EXHIBIT C

[See 1 attached page]

RESTRICTED AREA

SUBJECT TO CONSERVATION EASEMENT
HSI #10222
CALL THE GEORGIA WORLD CONGRESS CENTER AUTHORITY
OR
THE GEORGIA ENVIRONMENTAL PROTECTION DIVISION PRIOR TO DIGGING OR COMMENCING ANY OTHER LAND DISTURBING ACTIVITY.