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DRAFT
DATA REPORT

SITE INVESTIGATION FORMER NIKE BATTERY BU-51/52

HAMBURG, NEW YORK

Volume I

VOLUME I

DRAFT REPORT

for

SITE INVESTIGATION
FORMER NIKE BATTERY BU-51/52
HAMBURG, NEW YORK

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TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 4
2.1 Project Objectives 4
2.2 Site Location and Physiography 4
2.3 Ownership and Prior Land Use 5

3.0 SITE INVESTIGATION 5
3.1 Soil Borings 5
3.2 Monitoring Well Installation 6
3.2.1 Monitoring Well Development and Purging 7
3.2.2 Water Levels and Water Table Contour Map 7
3.2.3 Geologic Cross Sections 8
3.3 Environmental Sampling 8
3.3.1 Soil Sample Collection 8
3.3.2 Groundwater Sample Collection 8

4.0 ANALYTICAL RESULTS 9
4.1 Introduction 9
4.2 Review of Existing Data 9
4.3 Standard and Guidance Values 10
4.4 Analytical Methods 11
4.5 Quality Assurance/Quality Control 12
4.6 Groundwater Results 12
4.7 Soil Results 13
4.8 Investigation Derived Waste 14

5.0 CONCLUSIONS AND RECOMMENDATIONS 14

6.0 REFERENCES 16

TABLES

TABLE 1: SUMMARY OF SAMPLES COLLECTED AND ASSOCIATED CHEMICAL ANALYSES
TABLE 2: SUMMARY OF DETECTIONS – GROUNDWATER.
TABLE 3: SUMMARY OF LOW LEVEL PAHS – GROUNDWATER.
TABLE 4: SUMMARY OF DETECTIONS – SOILS

FIGURES

FIGURE 3-1: BOREHOLE LOCATIONS AT FORMER NIKE LAUNCH SITE, TOWN OF HAMBURG, NEW YORK
FIGURE 3-2: GROUNDWATER ELEVATIONS (FT AMSL) AT FORMER NIKE LAUNCH SITE, TOWN OF HAMBURG, NEW YORK
FIGURE 3-3: CROSS SECTION LOCATIONS AT FORMER NIKE LAUNCH SITE, TOWN OF HAMBURG, NEW YORK
FIGURE 3-4: CROSS SECTION A–A' AT FORMER NIKE LAUNCH SITE, TOWN OF HAMBURG, NEW YORK
FIGURE 3-5: CROSS SECTION I–A AT FORMER NIKE LAUNCH SITE, TOWN OF HAMBURG, NEW YORK
FIGURE 3-6: CROSS SECTION 1-2 AT FORMER NIKE LAUNCH SITE, TOWN OF HAMBURGT, NEW YORK

VOLUME II -APPENDICES

Appendix I: Boring Logs
Appendix II: Monitoring Well As-Built Diagrams
Appendix III: Water Quality Field Measurements - Groundwater
Appendix IV: Soil Analytical Results
Appendix V: Groundwater Analytical Results
Appendix VI: Soil TPH – Extractable GC/FID Chromatograms

1.0 EXECUTIVE SUMMARY

This report describes a soil and groundwater environmental quality investigation performed in an area on and adjacent to the former U.S. Army Nike Base in Hamburg, New York. The property is currently owned and operated by the Town of Hamburg and used by the Department of Public Works (DPW). The work described in this report focused on determining (1) the presence and magnitude of subsurface contamination in soil and groundwater at selected sampling locations on and adjacent to the area of the Nike Missile Silos (referred to in this report as the Launch Site), and (2) if there was evidence for any migration of contaminants from the Launch Site, southward toward residential properties located along Lakeview Road. This investigation complements a recent study that was performed by GZA GeoEnvironmental, Inc. for the Town of Hamburg. The GZA study focused on determining environmental conditions across the Town of Hamburg property.

This investigation consisted of collecting samples from existing groundwater monitoring wells within the Launch Site and one GZA well located on residential property south of the Site. Three new soil borings at the Launch Site perimeter and four new groundwater monitoring wells on residential property south of the Site were installed as part of this investigation. The new soil borings and monitoring wells were positioned at points that are between the former Launch Site and the residential dwellings. In this manner, any migrating contamination would be detected along its migration route between any possible sources of contamination on the Launch Site property and the residences. Soils and waters collected from these locations were analyzed for a list of New York State Department of Conservation (NYSDEC) target analytes. Analytical results were compared to available NYSDEC criteria. Also as part of this investigation, groundwater levels were measured in the four existing and four newly installed monitoring wells. These water level data were used to construct a potentiometric surface map to determine the groundwater flow direction.

Site Stratigraphy and Hydrogeology

The site stratigraphy consists of clay-rich soils (till and weathered bedrock) overlaying weathered shale, which in turn overlays competent shale bedrock. The site is very poorly drained because of the low permeability of surficial soils and the lithology of the underlying weathered shale and shale bedrock. The depth to groundwater at the site is very shallow, sometimes as low as a few tenths of a foot below ground surface. Groundwater flows southward across the area. Both surface water and groundwater discharge to Eighteen-Mile Creek, which is located about 150 yards south of Lakeview Road.

Because the site is enriched in clay and shale, it is very poorly drained. As a result, the site may often drain via overland runoff as well as from infiltration and groundwater discharge. In the subsurface, fractures present in both the overburden (clay and weathered shale) and bedrock shale play a role in groundwater flow. Both overland and fracture flow may also influence contaminant transport and the distribution of contaminants across the site.

Soil and Groundwater Results

The soil and groundwater samples collected in this investigation were analyzed for trace metals and organic chemicals of concern. Three metals in groundwater—(barium, manganese and sodium)—exceeded NYSDEC criteria; the source of these particular inorganic constituents is likely attributable to DPW storage of road salt on the site. This finding is consistent with recent measurements made by GZA (1999). All metals analyzed (except Cd and Se) were detected in all subsurface soils collected. Slightly higher levels were detected in subsurface soils collected from the borings located on the perimeter of the Launch Site. Although a number of metals exceeded NYSDEC recommended soil clean-up objectives (RSCOs) (As, Al, Ca, Cr, Cu, Fe, Pb, Mn, Mg, Ni, K, and Zn), most were detected at levels generally comparable to the New York State Department of Health (NYSDOH) regional background levels for surface soil samples. Most exceedences occurred in subsurface soils collected from the Launch Site perimeter, rather than from residential properties. In addition, with the exception of Cr and Be in one of the Launch Site soil boring, trace metal concentrations were within a factor of two of the NYSDOH background level for surface soils. This suggests that the subsurface soil levels are representative of background, especially on the residential property.

Volatile organic compounds (VOCs including petroleum-derived compounds such as benzene, toluene, ethylbenzene and xylenes [BTEX], as well as selected chlorinated solvents) were measured in groundwater and subsurface soil samples. No VOCs were detected in soils (except Acetone, a common laboratory contaminant). BTEX were detected in the four new wells (MW-1 through MW-4) and the one existing well (GZA-4) located on the residential properties just south of the Launch Site. The highest concentrations of BTEX detected during this study were in GZA–4 and MW-4, where benzene, toluene and total xylenes all exceeded NYSDEC Class GA criteria. These results support the findings reported by GZA in their recent investigation.

Polynuclear aromatic hydrocarbons (PAHs) were also detected in groundwater samples collected from wells on both the Launch Site and the residential properties. Only two PAH compounds (chrysene and benzo(b)flouranthene) — etected at low levels just above the method-reporting limit — slightly exceeded NYSDEC criteria. However, these two compounds were also detected in the rinsate blank quality control sample at similar levels as found in the samples.

Two types of Total Petroleum Hydrocarbon (TPH) measurements were performed: Purgeable Hydrocarbons, which represent the volatile hydrocarbons (*e.g.* gasoline range) and Extractable Hydrocarbons, representing the less-to-non-volatile components (*e.g.*, diesel fuel, home heating oil, fuel oil, or naturally occurring hydrocarbons). Low levels of purgeable TPH were measured at levels near the detection limits in two of the monitoring wells located on residential property, MW-4 and GZA-4, with slightly higher levels found in MW-4. Extractable TPH were only detected in groundwater from one well, located on the Launch Site (ME-2).

Extractable TPH were detected in all soils collected. Further review of the chromatographic pattern revealed that the material detected in subsurface soils was similar at both the Launch Site perimeter boring locations and monitoring well locations and was generally consistent with a moderately weathered heavy fuel oil (similar to an industrial heating fuel oil #6 or 'bunker C' type fuel). However, the extractable material in most soils also exhibited features typical of

naturally occurring hydrocarbons, *e.g.*, hydrocarbons derived from modern or fossil plant debris that may occur in the area's clays/shales. Thus, the concentration reported as "TPH" may also contain a significant amount of naturally occurring hydrocarbons.

Hydrazine was detected at low levels in soils collected from borings at the perimeter of the Launch Site; this chemical was not detected in any residential soil boring locations. In contrast, GZA reported similar hydrazine levels in soil collected on and adjacent to the Launch Site and in surface and subsurface soils collected at the Control Area (located about one half mile East of the site). Hydrazine is used in rocket fuels, chemical manufacturing and to prevent corrosion in boilers and was a component of the starting fuel used for missiles found at the Nike Site. It is highly volatile in air and soluble in water and tends to break down into less harmful compounds within days to weeks of release (ATSDR 2000). Small amounts of hydrazine also occur naturally in plants.

Conclusions

The primary organic chemical constituents found in both soil and groundwater samples collected during this study appear to arise from petroleum. In groundwater from wells placed on residential properties south of the Launch Site, the presence of benzene, toluene, ethylbenzene and total xylenes (chemicals that comprise a substantial portion of purgeable TPH) are suggestive of a gasoline source. While there is no evidence for free phase gasoline or other petroleum product in the wells, the relative concentrations of the BTEX chemicals are consistent with a water-soluble fraction of gasoline. Petroleum product storage tanks in the vicinity of these wells are a possible source. Both purgeable and extractable total petroleum hydrocarbons (TPH) were detected in subsurface soils from the perimeter of the Launch Site and from residential property just south of the site. The levels and composition of the petroleum-related material were similar at both locations. Review of the TPH chromatograms revealed the presence of a naturally occurring, plant-derived hydrocarbon signature. These naturally occurring hydrocarbons could well account for a significant portion of the TPH concentration reported.

Recommendations

The current and historical data appear to show that the human health risk from the groundwater and subsurface soil contamination is low. While a number of constituents in groundwater exceed the NYSDEC SCGs for Class GA water, these standards are only applicable to the protection of groundwater used as a source of drinking water. The means of evaluating the risk to human health would be to perform a Human Health Risk Assessment (HHRA). This type of evaluation is based on identifying potential pathways through which humans may be exposed to contaminants in the groundwater and the soil and to address those pathways by evaluating potential health risks to people living near these areas.

The HHRA considers potential pathways through which residents would be exposed to contaminants in groundwater and soil including ingestion, skin contact and inhalation. To assure

that no unacceptable risk is presented to the residents living along Lakeview Road from the analytes detected in subsurface soil and groundwater on their property, it is recommended that a screening level risk analyses be performed with currently-available information. Although this and previous studies were designed primarily to identify and characterize the presence or absence of contaminants, the existing data are appropriate for conducting a conservative screening level assessment of risks to human health.

2.0 INTRODUCTION

2.1 Project Objectives

The objectives of this investigation were to determine (1) the presence and magnitude of subsurface contamination in soil and groundwater at the Nike Launch Site and (2) if there was evidence for any migration of contaminants from the Launch Site southward toward residential properties located along Lakeview Road. This work was accomplished through the following specific tasks performed during this investigation.

1) Drill and sample three shallow borings to the top of bedrock. Use a hollow stem auger and a split spoon sampler to advance each borehole and collect soil samples.

2) Drill and sample four borings into bedrock extending 25 feet below ground surface. Convert each boring into a new monitoring well.

3) Purge and sample four existing monitoring wells.

4) Submit all soil and groundwater samples, along with accompanying QC samples to a certified lab for analysis of NYSDEC target chemicals.

5) Survey each newly drilled location for coordinates and ground surface and/or top of casing elevation.

6) Measure water levels in the new and previously installed wells. Construct a groundwater table contour map to determine the direction of groundwater flow.

7) Manage, evaluate, and dispose of investigation-derived wastes (IDW).

All work was performed in accordance with all applicable Federal, State, and local laws and regulations.

2.2 Site Location and Physiography

The Nike site is located in the Town of Hamburg, New York, approximately 15 miles southwest of Buffalo. Access to the site is via Route 20 to Lakeview Road. The Nike battery is located in a flat, rural portion of Erie County, approximately 5 miles south of Lake Erie.

2.3 Ownership and Prior Land Use

The Nike Launch Site consists of approximately 300 acres, including the 57 acre Nike battery. The Town of Hamburg (NY) presently owns the site. The site was conveyed to the Town of Hamburg in 1968 following the termination of the Nike Missile Program. The Federal Government (U.S Army), which had held ownership and occupied the property from December 1955 to 1968, used it for the Nike Missile Program. GZA Environmental of New York (August, 1999) reports that records were not available to identify who held the property prior the Federal Government. However, based on their interviews and aerial photo reviews, GZA states that prior to hosting the Nike battery, the land was thought to either be unused or used for agriculture. The site is currently being used as the storage yard and offices for the Hamburg Department of Public Works (DPW). A landfill north of the site was developed and operated by the Town starting in 1970, until it was closed in 1984.

3.0 SITE INVESTIGATION

Three soil borings and four monitoring wells were drilled on and adjacent to the former Nike Site as part of this investigation. Soil profiles were also evaluated during the monitoring well installations. Sections 3.1 through 3.3 summarize the soil boring and monitoring well installation and sampling activities. Table 1 summarizes all environmental samples collected as part of this investigation. Figure 3-1 shows the locations of the new soil borings (SB-1 through SB-3) and monitoring wells (MW-1 through MW-4) along with the locations of previously existing monitoring wells that were sampled as part of this investigation.

3.1 Soil Borings

Hollow stem augering was performed to advance soil borings at the three new locations. The three borings were performed at locations near the fence line of the active Hamburg DPW yard, along the southern perimeter of the former Nike Launch Site (Fig. 3-1). These locations were selected because they are positioned between any potential sources at the Nike Launch Site and the residences along Lakeview Road. Thus, these borings allowed for an evaluation of the soil conditions between the Launch Site and the residences.

At each soil boring location, continuous soil sampling was conducted using a 3-in diameter by 2 ft long split spoon sampler. Blow counts were counted and recorded for each 6-in interval as the split spoon was advanced. N-values were also logged. Split spoon sampling continued until split spoon refusal was reached at each location. Given that the underlying shale was highly weathered, at some of the locations additional unlithified zones were encountered below the depth of split spoon and auger refusal. The boring logs for the three new borings are presented in Appendix 1 of this report.

Upon opening each split spoon, the soil core was scanned with a photoionization detector (PID) and then quickly measured with a tape measure to determine the amount of soil recovery from the two foot sampling interval. Following the preliminary PID scan and percent recovery measurements, sections of each soil core were placed either in glass jars or in Ziplock bags to

perform headspace gas analyses. These headspace PID analyses were made in an effort to determine if lower levels of volatile organic compounds (VOCs) were present within the soil.

Once a soil core was scanned, a decision was made by the field geologist as to where to collect soil samples for laboratory analyses. The soil intervals exhibiting the highest levels of the soil scan and/or headspace PID readings were selected for laboratory analyses. If there was a lack of positive PID readings, the most clay-rich interval close to the top of bedrock was selected for laboratory analysis.

3.2 Monitoring Well Installation

As mentioned in Section 3.1, four monitoring wells were also installed during this assessment. These wells were located closer to the homes along Lakeview Road (Figure 3-1).

There were three types of geologic material encountered as each of the wells. The uppermost material consists of a clay soil overburden. Below the clay there is a zone of weathered shale and finally, below the weathered shale there is competent (unweathered) shale which is considered to be the local bedrock. The shales (both weathered and unweathered) encountered in the course of installing these wells were evaluated in the same manner as the soil borings described in Section 3.1. However, in the shale zones it was necessary to employ rock coring instead of split spoon sampling. As the rock cores were brought to the surface, a PID scan was made for each core to check for the presence of VOCs. Percent recovery and rock quality designation (RQD) were measured by the site geologist. Finally, a verbal lithologic description of the core was also noted in the boring log. Boring logs for and the four new monitoring wells are presented in Appendix I. As-built well construction diagrams for the installed monitoring wells are presented in Appendix II.

The monitoring wells were installed to evaluate groundwater quality on the residential land. The wells were cored to 25ft total depth and then completed so that the screen interval in each well straddled what appeared to be the shallowest and most permeable portion of the aquifer. The field geologist chose the screen depth for each well based on what was observed in the cores during drilling. Given that the overburden clay and bedrock shale underlies the study area, the weathered shale may be the most porous and permeable strata of the near-surface aquifer. However, it is also likely that the underlying competent shale may be transmitting groundwater in fractures located at or near the top bedrock. As a result, the wells were completed with a portion of the screen set in the weathered shale and a portion set in the underlying competent bedrock.

While in the field it was determined that the GZA-MW-4 well, which was completed at a greater depth below ground surface (total depth - 31 ft), was screened completely within the competent bedrock shale. This well is very low yielding, is slow to recover after it is pumped, and has an abnormally low groundwater level. This implies that competent shale bedrock (at least at this location) may not possess enough primary or secondary porosity to effectively transmit groundwater. The performance of this bedrock well supports the premise that most groundwater is being transmitted at or above the weathered shale/bedrock shale interface.

3.2.1 Monitoring Well Development and Purging

Cement grout in all four of the newly installed monitoring wells was allowed to cure for at least 48 hours prior to well development. There were a total of eight wells sampled during this site assessment effort, including four existing wells and the four newly installed monitor wells. During development, each of the four newly installed monitor wells was purged and pumped to remove fine suspended particles and to develop the filter pack. The purpose of well development is to assure the removal of fine particles from the well to assure a good hydraulic connection between the well screen, filter pack and formation. The ultimate goal of both well development and purging is to make certain that the groundwater samples collected from each monitoring well are representative of the actual groundwater within the aquifer. Each well was deemed ready for sample collection only after the water quality parameters had stabilized.

To minimize the amount of water lifted from each well, each of the newly installed monitor wells were sampled immediately after development, when water quality parameters had stabilized. Existing monitoring wells were purged until water quality parameters stabilized and then they were sampled. Total volumes of water lifted from the newly installed monitor wells ranged from 20 to 80 gallons.

A 2-in diameter stainless steel Redi-Flow submersible pump and Teflon-lined polyethylene tubing was used for well development and purging. The tubing was linked to a flow-through cell and a Huerba Water Quality Meter that continuously monitored the pumped groundwater for the following parameters: turbidity, temperature, pH, conductivity, oxidation-reduction potential (ORP), and dissolved oxygen (DO). (The results of these measurements are listed in Appendix III).

3.2.2 Water Levels and Water Table Contour Map

During the field effort, Battelle delayed collecting a set of synoptic water levels until all new monitoring wells had been developed, purged, and sampled. Water levels were measured at each well during the sample collection process, but since the sampling effort took several days to complete, these water levels were collected over too great of a time period to be considered synoptic. As the sampling program was ending, the site sustained three days of very heavy rains that prevented collecting water levels at the time. Synoptic water levels were eventually measured on January 17, 2000. These levels were used with the survey data and a site base map to construct a water table contour map (Figure 3-2). Depth to groundwater at this time was very low, less than one-tenth of a foot in some of the new monitoring wells. As Figure 3-2 illustrates, groundwater generally flows south from the Nike Site area across the residential properties and toward Lakeview Road.

Because the soil beneath the Site is rich in very fine-grained soil and rock (*i.e.*, clay and shale) it is very poorly drained. As a result, the site may often drain via overland runoff as well as from infiltration and groundwater discharge. In the subsurface, fractures present within both the overburden (clay and weathered shale) and bedrock (competent shale) play a role in groundwater flow. Both overland and fracture flow may also influence contaminant transport and the distribution of contaminants across the site.

3.2.3 Geologic Cross Sections

The lithologic data, survey data, and water level data were utilized to construct a set of cross sections that depict subsurface conditions across the study area. These cross-sections show the three lithologic units recognized across the site, namely overburden clay, weathered shale, and bedrock shale. Figure 3-3 shows the orientations of three cross sections that are shown in Figures 3-4, 3-5 and 3-6. Also depicted on these cross sections are the screened intervals for each of the area's monitoring wells and the groundwater elevation (as measured on Jan. 17, 2000).

3.3 Environmental Sampling

Table 1 is a summary of all samples collected on the site during the current study and the associated chemical analyses performed.

3.3.1 Soil Sample Collection

There were two general types of soil samples collected in the field for laboratory analysis. The first consisted of discreet samples collected using Encore® sampling devices for volatile organic compound (VOC) analysis. The second type of sample was a composite of soil collected from longer intervals at each boring. The composite samples were selected based on lithology, field PID readings, and estimated groundwater depth. The Encore samples were collected from a core interval thought to contain elevated levels of VOC contamination. This sample was collected in a special core-accepting container that eliminated any headspace. This lack of headspace assured that there was no loss of VOC mass due to volatilization, so that the actual concentrations present within the soil could be measured. Encore samples were collected immediately after the initial PID scan to minimize any loss of contaminant concentration resulting from exposure to open air. Composite samples were collected for semi-volatiles compounds (SVOCs), metals, cyanide, hydrazine and nitrate/nitrites (Table 1). All samples were stored at approximately 4°C, under chain of custody, until receipt at the laboratory.

3.3.2 Groundwater Sample Collection

Groundwater samples were collected from a total of eight wells, including each of the four new monitoring wells drilled and installed by Battelle and from four existing on-site wells (GZA-MW-2; GZA-MW-4; ME-MW-2; ME-MW-3). The volume of groundwater recovered from the GZA-MW-4 during sampling was insufficient to enable a full suite of analyses. During the field effort Battelle learned that the GZA-MW-4 is screened entirely in competent shale bedrock (Fig. 3-6). Because of this, GZA-MW-4 yielded very low volumes of groundwater and recovered too slowly to collect large sample volumes within a reasonable time. Therefore, only selected parameters were measured from this location. All samples were stored at approximately 4°C, under chain of custody, until receipt at the laboratory.

4.0 ANALYTICAL RESULTS

4.1 Introduction

Soil and groundwater samples were analyzed by Quanterra in their North Canton, OH laboratory. Groundwater was also analyzed for low-level PAHs by Battelle in their Duxbury, MA laboratory. The following includes a brief review of the pre-existing data from the site, a description of the methods used in the current study, and summary tables of any detected analytes from the current study.

Results from all analyses, along with associated quality control results, are presented in Appendices IV and V. Copies of the Gas Chromatography/Flame Ionization (GC/FID) chromatograms for Extractable Total Petroleum Hydrocarbons (TPH) are provided in Appendix VI.

4.2 Review of Existing Data

A number of studies have been completed over the past decade to address potential contamination on or emanating from the former Nike facility. The results discussed below only include those results that involve samples taken on or in the vicinity of the Launch Site. Figure 1 shows the location of the sites discussed below.

- In 1989, Metcalf and Eddy, Inc. (M&E) completed a report for the USACOE that focused on the Launch Area of the Nike Base and included groundwater, surface water and soil sampling for VOCs and metals analyses. Of the four wells installed on the site, only MW-3 (ME-3) contained levels of VOCs (toluene and total xylenes) that exceeded the Class GA criteria. In addition, the following metals exceeded Class GA criteria: arsenic (ME-2, ME-3, ME4), barium (ME-2, ME-3), cadmium (ME-2 and ME-4), chromium (ME-2) and lead (ME-2, M-3 and ME-4). Surface water was collected from five of the former missile silos on site. Methylene chloride exceeded Class GA criterion in one sample and cadmium, chromium, lead and mercury exceeded the Class GA criterion in at least one sample. Five surface soils were collected at various locations on the site; only arsenic and chromium exceeded the TAGH #4046 RSCOs in one sample each. No definitive conclusion as to the source(s) of contamination was determined. However, M&E suspected that both former DOD, as well as current Hamburg Town Highway activities, had contributed to the concentrations measured.

- In February 1999, the State of New York Department of Health (DOH) sampled sumps and well points at four residential properties along Lakeview Road. Water collected was analyzed for VOCs and metals. No VOCs were detected in any of the sumps. Low levels of toluene, ethylbenzene, xylenes and 1,2,4 trimethylbenzene (< 5 ug/L – ppb) were detected in two of the four well points sampled. The DOH determined from comparison of these results to the available NYSDEC standards that the presence of these substances in the ground water do not present a health concern as the well water is not used for household purposes and thus there is no route of exposure.

- In March 1999, a soil vapor study was conducted for the purposes of delineating the diesel contaminant plume presumably emanating from a former underground storage tank (UST) on the Site. The excavated 8,000-gallon UST was originally used to store diesel fuel. Surrounding soils were analyzed for the presence of VOCs and subsurface soils were collected to a depth of 8 feet and analyzed for both volatile and semivolatile hydrocarbons. Detectable VOC readings were found only at depth. Comparison of VOC and SVOC concentrations to NYSDEC STARS Memo No. 1 TCLP Alternative Guidance Values indicated that all values were within acceptable limits.

- In the spring of 1999, GZA GeoEnvironmental of New York (GZA) completed a study of current conditions at the Nike Base. Sampling included collection of surface and subsurface soils, surface water, sediment and groundwater at locations on the DPW property including the Nike "Site" as well as other DPW properties in the vicinity. On the former Nike Base property, GZA installed four monitoring wells and sampled subsurface soils from a number of GeoProbe locations (see Figure 1). Samples were analyzed for VOCs, SVOCs, hydrazine and metals. Benzene, toluene, ethylbenzene, and o-xylene concentrations in one well (GZA-4) and m-, p-xylene concentrations in another well (GZA-3) exceeded Class GA criterion. Subsurface soils from locations around the Launch Site did not exceed TAGM 4046 RSCOs for VOCs; however, a number of VOCs were detected in some of the borings. Metals, including arsenic, copper, nickel and selenium, exceeded RSCOs and/or soil background levels in one or more borings. A number of polynuclear aromatic hydrocarbons (PAHs) were detected in one or more soil samples; however, PAH levels were well below RSCOs. Hydrazine was also found in two soil samples from the "Launch Site" as well as from subsurface soils and sediments collected at off-site locations.

4.3 Standard and Guidance Values

The analytical data generated by the current and previous studies were evaluated by comparing the results to available New York State Department of Environmental Conservation (NYSDEC) standards, criteria and guidance (SCG) values. These include SCGs for protection of groundwater (Class GA waters) and recommended soil clean-up levels (RSCOs) and regional background concentrations for soil. The NYSDEC SCGs used to evaluate groundwater pertain to its use as a drinking water source. Since groundwater from this shallow aquifer is not used as drinking water it may not be appropriate to use these SCGs for evaluation purposes. Below is a summary of the SCGs referenced in this report.

NYSDEC Standards/Guidance Values	Abbreviations/Media Evaluated
Division of Water Technical and Operational Guidance Series (TOGS) (1.1.1) NYSDEC Class GA Groundwater Criteria –Source of Drinking Water (groundwater)	Class GA Criteria- Ambient and Groundwater Effluent Limitations Media Evaluated: • groundwater
NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 Recommended Soil Clean-up Objectives (RSCO) – dated January 24th, 1994	TAGM #40446 RSCOs Media Evaluated: • subsurface soil
NYSDOH Area Background Metal Concentrations	Background Media Evaluated: • subsurface soil

4.4 Analytical Methods

All chemical analyses were performed by Quanterra of North Canton, OH with the exception of the low-level PAHs in groundwater, which were analyzed by Battelle in Duxbury, MA. The analytical methods performed as part of the current study are summarized below.

Parameter	Matrix	Method
VOC	Soil/ Groundwater	SW846 5035/8021B SW846 5030B/8260B
SVOC	Soil/ Groundwater	SW846 3540C/8270C SW846 3520C/8270C
PAHs – Low Level	Groundwater	SW846 3520C/8270mod (SIM)
Chlorinated Pesticides	Soil	SW846 3540C/8081A
TPH Purgeable(GRO)/Extractable (DRO)	Soil/ Groundwater	SW846 5030B/3540C/8015B SW846 5030B/3520C/8015B
Hydrazine	Soil/Groundwater	ASTM 1385
NO_2/NO_3	Soil/Groundwater	MCAWW353.2
TAL Metals	Soil/Groundwater	SW846 6010B
Mercury	Soil/Groundwater	SW846 7471A
CN	Soil/Groundwater	SW846 9012A
Alkalinity	Groundwater	MCAWW310.1
Percent Solids	Soil	MCAWW 160.3mod

4.5 Quality Assurance/Quality Control

The quality of the data generated during this study was evaluated through analysis of a number of quality control samples (QC) including matrix spikes, field duplicates, trip and rinseate blanks as well as laboratory quality control samples, such as procedural blanks, blank spikes and/or laboratory control samples (Results provided in Appendix IV and V). Reporting Limits (RLs) for all analytes, except Li and Be in soils, met the detection limit goals of the project. These goals were based on achieving detection limits sufficient for evaluating the data against the NYSDEC water and soil standards described in Section 4.3. For the most part, results of QC samples were within the control limits specified for the methods performed. Based on review of these data, the quality of the data was found to be acceptable and all data points generated were used in the preparation of this report.

4.6 Groundwater Results

A summary of all compounds detected in groundwater samples is provided in Table 2. Also included are the available NYSDEC standard and guidance values associated with those analytes. Table 3 includes the results of the low-level polynuclear aromatic hydrocarbon (PAH) analyses. Below is a brief discussion of levels detected in groundwater collected as part of this study and comparison to available criteria.

Metals – Groundwater samples were analyzed for twenty-three metals. Of the fifteen metals detected above the reporting limit (RL), only barium (Ba), manganese (Mn) and sodium (Na) exceeded the NYSDEC Class GA criteria in all three existing wells sampled (GZA-4 was not sampled for metals) and in at least three of the four new wells installed. Thallium (Tl) exceeded the criteria in two of the existing wells (ME-2 and ME-3). Thallium concentrations detected in the samples were just above the RL and less than five times the amount found in the associated method blank, therefore, thallium detections were flagged as suspect since they may be indicative of false positives. Barium and sodium are most likely a result of stockpiles of roadsalt currently stored on DPW property (BaCl).

Volatile Organics – A number of volatile organic compounds (VOCs) were detected in groundwater samples. Only benzene, toluene and xylenes exceeded Class GA criteria in three wells (GZA-4, MW-1 and MW-4). Highest concentrations of these compounds were detected in GZA–4 and MW-4.

Semivolatile Organics – No semivolatile organic compounds (SVOCs) were detected in groundwater samples above reporting limits (RLs) in samples analyzed according to the standard EPA Method 8270C. A modified version of EPA Method 8270C, using selected ion monitoring (SIM), was performed to achieve low detection limits, which allowed comparison of the NYSDEC criteria for a number of PAHs. PAHs were detected in all groundwater samples at concentrations ranging from 0.002 to 2.0 parts per billion (ppb). The lowest concentrations were found in groundwater from the existing wells (GZA-2, ME-2 and ME-3; again, GZA-4 was not sampled for SVOCs due to low yield/volume of water). The highest PAH concentrations were detected in the recently installed wells (MW-1, MW-2, MW-3 and MS-4). Chrysene concentrations exceeded Class GA criteria in most of the wells and benzo(b)flouranthene exceeded criteria in one well (ME-2). However, the criteria for both of these PAH compounds

are at the detectable level of the method (2.0 ppb) and both chrysene and benzo(b)flouranthene concentrations were found at similar levels in the rinseate blank. Therefore, detection of these two compounds in the samples are suspect.

Total Petroleum Hydrocarbon – Two types of Total Petroleum Hydrocarbon (TPH) measurements were performed: Purgeable Hydrocarbons, which represent the volatile fraction of petroleum related hydrocarbons (*e.g.*, gasoline range) and Extractable Hydrocarbons, representing the semi-volatile to non-volatile components (*e.g.*, diesel fuel #2, home heating oil, as well as any naturally occurring, plant-derived hydrocarbons). Purgeable hydrocarbons were detected at levels near the detection limits in two monitoring wells, namely MW-4 and GZA-4, with slightly higher levels found in MW-4. Extractable TPH were only detected in groundwater from one well, ME-2.

4.7 Soil Results

Table 4 summarizes the compounds detected in subsurface soils.

Metals - All metals analyzed (except Cd and Se) were detected in all subsurface soils collected. Slightly higher levels were detected in subsurface soils collected from the borings located on the perimeter of the Launch Site. Although a number of metals exceeded RSCOs (As, Al, Ca, Cr, Cu, Fe, Pb, Mn, Mg, Ni, K, and Zn), most were detected at levels generally comparable to the NYSDOH area background levels for surface soil samples. Most exceedences occurred in subsurface soils collected from the Launch Site perimeter, rather than from the residential properties. For example, slightly elevated levels of lead and chromium in soils from borings SB-1, SB-2 and SB-3 collected near the silos may be a result of previous metal plating activities and are consistent with results reported by Metcalf and Eddy (1989). In addition, with the exception of Cr from SB-01 and Be (detected below reporting limits in all samples), trace metal concentrations measured were generally within a factor of two of the regional background level for surface soils reported by the NYSDOH (Ca, Mg, and Mn values were somewhat higher than this factor, however, the levels of these crustal elements vary considerably depending on the geology of the area). This suggests that the subsurface soil levels are representative of background, especially those occurring on the residential properties.

Volatile Organics - The only VOC detected in soils above RLs was acetone. Concentrations did not exceed RSCOs. In addition, acetone is a common laboratory contaminant.

Semivolatile Organics - The only SVOCs found in subsurface soils were a number of PAH compounds that were detected at concentrations below RLs and bis(2-ethylhexyl)phthalate, also detected below the RL. No SVOC compounds exceeded RSCOs. Hydrazine was detected in two soil borings (SB-1 and SB-2) at levels just below RLs.

TPH - Purgeable and extractable TPH analyses were performed on subsurface soils. Purgeable TPH were detected in MW-1 and MW-2. Extractable TPH were detected in all soils collected. The lowest concentrations (44-93 ppm) were found in the soil borings (SB-1 through SB-3) and higher concentrations (230 to 450 ppm) were found in the soils collected during monitoring well installation (MW-1 through MW-4). A review of the chromatographic 'fingerprint' pattern revealed that the extractable material was similar at both the boring and monitoring well

locations. The material contained hydrocarbons ranging from approximately C8 through C40 and was generally consistent with a moderately weathered heavy fuel oil (similar to an industrial heating fuel oil #6 or 'bunker C' type fuel). However, the extractable material in most of the soils tested also exhibited features typical of naturally occurring hydrocarbons, *e.g.*, hydrocarbons derived from modern or fossil plant debris that may occur in the area's clays/shales. The presence of this material was clearly indicated by a predominance of odd-numbered n-alkanes in the C25-C33 range, a feature characteristic of plant waxes. Additional features within the 'fingerprints' further support the contention that natural 'petroleum' may exist in the area's soils/shales. In fact, there may be little or no heavy fuel oil present in the soil samples studied. (Only additional analyses could help resolve this.) Thus, the concentrations of extractable hydrocarbons reported as total "*petroleum*" hydrocarbon (TPH) may be largely misleading since they may be naturally occurring hydrocarbons and have nothing to do with contamination.

4.8 Investigation Derived Waste

During and following drilling operations, soil and rock cuttings were shoveled into 55-gallon drums at each site. Each drum was sealed. At the request of the landowner, cuttings at MW-1 were used as fill at the drill site. Development and purge water was also containerized and retained in 55-gallon drums pending the results from the analysis of groundwater samples collected from each well. Separate drums of development and purge water were collected for each well. All drums containing IDW, both soil and rock cuttings, and groundwater were marked with the respective well or boring name and the collection date and moved to a holding area on town property located north of the residential land but south of the fenced area, *i.e.*, northwest of the location of SB-2.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Overall, the level of contamination of the subsurface soil and groundwater at the perimeter of the Nike Launch Site and at the residential properties just south of the site is quite low. Certain metals in groundwater — (barium, manganese and sodium) — exceeded NYSDEC criteria; the source of these particular inorganic constituents is likely attributable to the Town's DPW storage of road salt on the site. This finding is consistent with recent measurements made by GZA. In general, the levels of metals detected in subsurface soils, particularly those on the residential properties, are comparable to the New York State Department of Health (NYSDOH) area background levels for surface soil samples.

Hydrazine was detected at low levels in soils collected from borings at the perimeter of the Launch Site; this chemical was not detected in any residential soil boring locations. In contrast, GZA reported similar hydrazine levels in soil collected on and adjacent to the Launch Site and in surface and subsurface soils collected at the Control Area (located about one half mile East of the site). Hydrazine is used in rocket fuels, chemical manufacturing and to prevent corrosion in boilers and was a component of the starting fuel used for missiles found at the Nike Site. Small amounts of hydrazine also occur naturally in plants. It is highly volatile in air and soluble in water and tends to break down into less harmful compounds within days to weeks of release (ATSDR 2000).

The primary organic chemical constituents found in both soil and groundwater samples collected during this study appear to arise from petroleum. In groundwater from wells placed on residential properties south of the Launch Site, the presence of benzene, toluene, ethylbenzene and total xylenes (chemicals that comprise a substantial portion of purgeable TPH) are suggestive of a gasoline source, presumably at some upgradient location(s). While there is certainly no evidence for any free phase gasoline (or other petroleum product) in any the wells, the relative concentrations of the VOC's in groundwater are generally consistent with a water-soluble fraction of gasoline (*i.e.*, they're enriched in BTEX compounds). The presence petroleum storage tanks in the vicinity of the wells may be possible sources.

Both purgeable and extractable total petroleum hydrocarbons (TPH) were detected in subsurface soils from the perimeter of the Launch Site and from residential properties just south of the site. The concentrations and composition of the hydrocarbon material(s) were similar at both locations. Concentrations were generally low and were slightly higher in the soils from the residential properties. Review of the TPH chromatographic 'fingerprints' revealed the presence of naturally occurring, plant-derived hydrocarbons. It is believed that these natural hydrocarbons could account for a significant portion of the TPH concentrations reported. The presence of naturally occurring hydrocarbons would not be inconsistent with the area's soil and rock types, *e.g.*, shales often contain hydrocarbons derived from fossil plant debris contained within the shale. Groundwater in contact with the weathered shale and bedrock shale may dissolve some portion of these natural hydrocarbons. Thus, even the source of some of the groundwater contamination may be naturally occurring.

Recommendations

The current and historical data appear to show that the human health risk from the groundwater and subsurface soil contamination is low. While a number of constituents in groundwater (BTEX, Chrysene) exceed the NYSDEC SCGs for Class GA water these standards are only applicable to the protection of groundwater used as a source of drinking water. The means of evaluating the risk to human health would be to perform a Human Health Risk Assessment (HHRA). This type of evaluation is based on identifying potential pathways through which humans may be exposed to contaminants in the groundwater and the soil and to address those pathways by evaluating potential health risks to people living near these areas.

The HHRA considers potential pathways through which residents would be exposed to contaminants in groundwater and soil including ingestion, skin contact and inhalation. To assure that no unacceptable risk is presented to the residents living along Lakeview Road from the analytes detected in subsurface soil and groundwater on their property, it is recommended that a screening level risk analyses be performed with currently-available information. Although this and previous studies were designed primarily to identify and characterize the presence or absence of contaminants, the existing data are appropriate for conducting a conservative screening level assessment of risks to human health.

6.0 REFERENCES

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New York State Department of Environmental Conservation Technical and Administrative Guidance Memorandum, HWR-9404046 (TAGM 4046). Revised TAGM – Determination of Soil Cleanup Objectives and Cleanup Levels." NYSDEC Division of Hazardous Waste Remediation: January 24, 1994.

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TABLES

Table 1. Summary of Samples Collected and Associated Chemical Analyses.

Soil Borings		**VOC**	**SVOC**	**TPH**	**TAL Metals/CN**	**Nitrate+ Nitrite**	**Pesticides**	**Hydrazine**	**Acidity/ Alkalinity**
Method	**Date Collected**	**5035/ 8021B**	**3540C/ 8270C**	**3540C/8015B (5030 GRO/ 3540C DRO)**	**6010B/ 7471A (Hg)/ 9012A (CN)**	**353.2**	**3540C/ 8081**	**ASTM 1385**	**NA**
S0001- 3.5-5’	10/19/99	X	X	X	X	X	X	X	NA
S0002- 2.3-3’	11/2/99	X	X	X	X	X	X	X	NA
S0003- 2-3.5’	10/19/99	X	X	X	X	X	X	X	NA
MWS0001-4.8’ + Dup*	11/1/99	X	X	X	X	X	X	X	NA
MWS0002-11’*	10/22/99	X	X	X	X	X	X	X	NA
MWS0003-7.3’*	10/28/99	X	X	X	X	X	X	X	NA
MWS004- 11’* MWS004- 4’	10/19/99 10/19/99	X X	X	X	X	X	X	X	NA
Trip Blank -1	10/19/99	X	NA	NA(2)	NA	NA	NA	NA	NA
Monitoring Wells		**VOC**	**SVOC**	**TPH**	**TAL Metals/CN**	**Nitrate+ Nitrite**	**Pesticides**	**Hydrazine**	**Acidity/ Alkalinity**
Method	**Date Collected**	**5030B/ 8260B**	**3520C/ 8270C/ modified 8270C-SIM****	**3520C/ 8015B (5030B GRO/ 3540C DRO)**	**6010B/ 7471A (Hg)/ 9012A (CN)**	**353.2**	**NA**	**ASTM 1385**	**305.1/310.1**
Existing MW ME-2-102699	10/26/99	X	X	X	X	X	NA	X	X
Existing MW ME-3-102699	10/26/99	X	X	X	X	X	NA	X	X
Existing MW GZA-2-102799	10/27/99	X	X	X	X	X	NA	X	X
Existing MW GZA-4-102899	10/28/99	X	(1)	X (3)	(1)	(1)	NA	X	(1)
New MW MW1-110499	11/4/99	X	X	X	X	X	NA	X	X
New MW MW2-110199	11/1/99	X	X	X	X	X	NA	X	X
MW3-110299	11/2/99	X	X	X	X	X	NA	X	X
New MW MW4-110199+ Dup	11/1/99	X	X	X	X	X	NA	X	X
Rinseate Blank WRB-102699	10/28/99	X	X	NA(2)	X	NA	NA	NA	NA
Trip Blank-2	10/26/99	X	NA	NA(2)	NA	NA	NA	NA	NA

NA = Not applicable
TAL = Target analyte list
* Completed as monitoring wells
**Groundwater samples forsemivolatiles were analyzed by Method 8270 both full scan and in SIM (selected ionmonitoring) mode. The GC/MS SIM method was performed at BattelleDuxbury Operations for selectedsemivolatile compounds to achieve requiredRLs. Modifications include SIM and PFTBA tuning.
(1) Limited volumes precluded analyses of these parameters.
(2) Sample not collected.
(3) Only Extractable TPH collected.

Table 2. Summary of Detections – Groundwater.

																	DUPLICATE
	NYSDEC	NYSDEC				SAMPLE ID	WRB-102699	TRIP BLANK	GZA2-102799	GZA4-102899	ME2-102699	ME3-102699	MW1-110499	MW2-110199	MW3-110299	MW4-110199	MW4-110199
	GW Effluent/Class GA	Ambient/Class GA				SITE	Water Rinseate Blank		Monitoring Well GZA-2	Monitoring Well GZA-4	Monitoring Well ME-2	Monitoring Well ME-3	MW-1	MW-2	MW-3	MW-4	MW-4
	TOGS 1.1.1	TOGS 1.1.1				DATE COLLECTED	10/26/1999	10/26/1999	10/27/1999	10/28/1999	10/26/1999	10/26/1999	11/04/1999	11/01/1999	11/02/1999	11/01/1999	11/01/1999
	Max. Allowable Conc.	Standard/Guidance				QUANTERRA LOT NO.	A9J270184	A9J270184	A9J290162	A9J300165	A9J270184	A9J270184	A9KO80133	A9K020153	A9K040104	A9K020153	A9K020153
PARAMETER			REPORTING LIMIT	UNITS		ANALYTICAL METHOD											
Metals																	
Thallium	0.0005	0.0005	0.01	mg/L	SW846	6010B	ND	ND	ND	NA	0.022 S	0.014 S	ND	ND	ND	ND	ND
Aluminum	NSG	NSG	0.2	mg/L	SW846	6010B	ND	ND	ND	NA	1.5	2.4	ND	ND	ND	ND	0.093 B
Barium	2	1	0.2	mg/L	SW846	6010B	0.086B	ND	0.14B	NA	0.12 B	0.092 B	0.30	0.3	0.58	2.1	2.1
Beryllium	0.003	0.003	0.005	mg/L	SW847	6010B	ND	ND	ND	NA	ND	0.0018 B	ND	ND	ND	ND	ND
calcium	NSG	NSG	5	mg/L	SW846	6010B	65.9	ND	85.7	NA	442	97.3	540	137	192	590	592
Cobalt	NSG	NSG	0.05	mg/L	SW847	6010B	ND	ND	ND	NA	ND	0.013 B	ND	ND	ND	ND	ND
Copper	1	0.2	0.025	mg/L	SW846	6010B	ND	ND	ND	NA	0.036	0.28	ND	ND	ND	0.022 B	0.021 B
Iron	0.6	0.3	0.1	mg/L	SW846	6010B	ND	ND	9.2	NA	21.8	34.1	16.00	1.2	0.15	4.2	4.2
Lead	0.05	0.025	0.003	mg/L	SW847	6010B	ND	ND	ND	NA	0.011	0.0045	ND	ND	ND	ND	ND
Magnesium	35	35	5	mg/L	SW846	6010B	12.5	ND	16.3	NA	80	17.3	128	29	37.8	113	113
Manganese	0.6	0.3	0.015	mg/L	SW846	6010B	2.5 B	ND	1	NA	5.5	1.6	6.80	0.6	0.47	3.2	3.2
Nickel	0.2	0.1	0.04	mg/L	SW847	6010B	ND	ND	ND	NA	0.028 B	0.043	ND	ND	ND	ND	ND
Potassium	NSG	NSG	5	mg/L	SW846	6010B	ND	ND	13	NA	46.8	25.1	8.20	4.7 B	3.2 B	21	21
Sodium	NSG	20	50	mg/L	SW846	601 OB	24.3	ND	980	NA	7370	2250	153	41.6	18.2	1660	1670
Zinc	5	2 (guidance)	0.02	mg/L	SW846	6010B	0.05	ND	0.032	NA	0.2	0.53	ND	0.015 B	0.023	0.023	0.019 B
Total Petroleum Hydrocarbons																	
Purgeable			100	ug/L	SW846	8015 MOD	ND	ND	ND	190	ND	ND	ND	ND	ND	280	290
Extractable			100	ug/L	SW846	8015 MOD	ND	ND	ND	NA	160	ND	ND	ND	ND	ND	ND
Semivolatile Organics																	
bis(2-Ethylhexyl)	5	5	10	ug/L	SW846	8270C	ND	ND	ND	NA	ND	ND	ND	ND	4.4 J	ND	6.0.J
Benzo(a)pyrene	ND	ND	10	ug/L	SW847	8270C	ND	ND	ND	NA	ND	2.8 J	ND	ND	ND	ND	ND
Indeno(*1,2,3-cd)pyrene	0.002	0.002 (guidance)	10	ug/L	SW848	8270C	ND	ND	ND	NA	ND	2.9 J	ND	ND	ND	ND	ND
Volatile Organics																	
Chloroethane	5	5	3.3	ug/L	SW846	8260B	ND	ND	ND	0.30 J	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	5	5	1 - 1.7	ug/L	SW846	8260B	0.31 JB	0.43 JB	0.34 J	0.64 J,B	0.35 JB	0.26 JB	2.10	0.32 J	ND	ND	ND
Carbon disulfide	NSG	NSG	1	ug/L	SW846	8260B	ND	ND	ND	ND	ND	ND	ND	0.12 J	ND	0.14 J	ND
Acetone	50	50 (guidance)	1.7	ug/L	SW846	8260B	6.3 J	3.3 J	ND	120	ND	4.8 J	ND	ND	ND	ND	ND
Chloroform	7	7	1 - 1.7	ug/L	SW846	8260B	ND	ND	ND	0.33 J	0.85 J	ND	0.19 J	0.37 J	0.25 J	0.20 J	0.21 J
Benzene	1	1	1 - 1.7	ug/L	SW846	8260B	ND	ND	ND	12	ND	ND	1.40	0.85 J	0.60 J	4.9	5
Trichloroethene	5	5	1	ug/L	SW847	8260B	0.078 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	5	5	1	ug/L	SW848	8260B	0.13 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	5	5	1 - 1.7	ug/L	SW846	8260B	0.094 J	ND	ND	12	0.05 J	ND	3.10	1.9	1.9	8.5	8.6
Ethylbenzene	5	5	1 - 1.7	ug/L	SW846	8260B	ND	ND	ND	0.90 J	ND	ND	0.991 J	0.63 J	0.75 J	3.5	3.6
Xylenes (total)	5 (individual)	5 (individual)	1 - 1.7	ug/L	SW846	8260B	ND	ND	ND	4.20	ND	ND	5.00	3.4	3.6	16	16
General Chemistry																	
Nitrate/Nitrite	20	10	0.1	mg/L	MCAWW	353.2	ND	ND	0.05 B	NA	0.9	ND	ND	ND?	ND	ND	ND
Total Alkalinity	NA	NA	5	mg/L	MCAWW	310.1	ND	ND	78	NA	78	22	100	150	190	200	220
Cyanide, Total (CN)	0.4	0.2	0.01	mg/L	SW846	9012A	ND	ND	ND	NA	0.02	ND	ND	ND	ND	ND	ND

NA = Not Analyzed
ND = Not Detected
J = Organics: Detected below the reporting limit.
B = Metals: Detected below the reporting limit
S = Results Suspect; values <5 X procedural blank concentration

Table 3. Summary of Low Level PAHs – Groundwater.

																					DUPLICATE	
BATTELLE ID			**XG79PB**		**X2677**		**X2680**		**X2676**		**X2678**		**X2758**		**X2698**		**X2757**		**X2696**		**X2697**	
FIELD ID	**NYSDEC**	**NYSDEC**			**WRB-102699**		**GZA2-102799**		**ME2-102699**		**ME3-102699**		**MW1-110499**		**MW2-110199**		**MW3-110299**		**MW4-110199**		**MW4-110199 DUP**	
SAMPLE DESCRIPTION	**GW Effluent/ Class GA**	**Ambient/ Class GA**	**Procedural Blank**		**Rinseate Blank**		**Monitoring Well GZA2**		**Monitoring Well ME2**		**Monitoring Well ME3**		**Monitoring Well MW1**		**Monitoring Well MW2**		**Monitoring Well MW3**		**Monitoring Well MW4**		**Monitoring Well MW4**	
BATCH ID	**TOGS 1.1.1**	**TOGS 1.1.1**	**99-630**		**99-630**		**99-630**		**99-630**		**99-630**		**99-630**		**99-630**		**99-630**		**99-630**		**99-630**	
EXTRACTION DATE	**Max. Allowable Conc.**	**Standard/Guidance**	**11/08/99**		**11/02/99**		**11/02/99**		**11/02/99**		**11/02/99**		**11/08/99**		**11/02/99**		**11/08/99**		**11/02/99**		**11/02/99**	
ANALYSIS DATE			**11/21/99**		**11/20/99**		**11/20/99**		**11/20/99**		**11/20/99**		**11/21/99**		**11/21/99**		**11/21/99**		**11/20/99**		**11/20/99**	
UNITS			**ng/l**		**ng/l**		**ng/l**		**ng/l**		**ng/l**		**ng/l**		**ng/l**		**ng/l**		**ng/l**		**ng/l**	
Naphthalene	10,000	10,000 (guidance)	5.53		25.40	B	24.63	B	30.73	B	39.69	B	120.40		136.73		91.42		259.14		234.64	
2-Methylnaphthalene	50,000	50,000 (guidance)	1.51	J	8.72	B	11.46	B	22.53	B	26.03	B	343.53		801.75		304.50		555.82		508.64	
1-Methylnaphthalene		NSG	2.00	U	5.27	B	8.75	B	29.65		30.44		310.29		613.56		232.78		500.49		464.97	
2,6-Dimethylnaphthalene		NSG	2.00	U	1.29	J	4.59		30.58		30.44		401.15		1221.72		513.19		346.05		331.09	
2,3,5-Trimethylnaphthalene		NSG	2.00	U	2.00	U	3.41		32.94		14.14		127.42		379.40		291.10		105.31		101.48	
Biphenyl		NSG	1.16	J	1.70	J	1.69	J	5.95		6.15		72.55		86.62		76.07		89.30		85.17	
2-chloronaphthalene	10,000	NSG	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Acenaphthylene	20,000	NSG	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Acenaphthene	20,000	NSG	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	55.97		2.00	U	5.70		5.53	
Dibenzofuran		5000	2.00	U	1.75	J	1.27	J	2.00	U	1.96	J	51.58		68.38		89.64		45.79		44.97	
Fluorene	50,000	50,000 (guidance)	2.00	U	1.82	J	1.45	J	7.05		4.79		102.49		170.97		169.73		90.91		89.00	
Phenanthrene	50,000	50,000 (guidance)	1.16	J	6.79		11.74		26.92		12.29		486.66		1056.05		2011.25		408.01		419.75	
Anthracene	50,000	50,000 (guidance)	2.00	U	2.00	U	0.82	J	4.53		0.96	J	9.60		18.13		41.45		8.57		9.44	
1-Methylphenanthrene		NSG	2.00	U	2.00	U	4.86		30.21		5.01		133.30		425.86		879.75		114.89		118.93	
Fluoranthene	50,000	50,000 (guidance)	2.00	U	7.39		23.06		2.59		1.10	J	6.76		27.06		50.43		6.82		8.30	
Pyrene	50,000	50,000 (guidance)	2.00	U	6.25		104.30		5.65		1.75	J	7.12		20.25		41.94		8.22		9.18	
Benzo(a)anthracene	2	2 (guidance)	2.00	U	1.90	J	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Chrysene	2	2 (guidance)	2.00	U	3.37		1.36	J	19.63		0.96	J	2.75		7.52		6.92		5.60		5.65	
Benzo(b)fluoranthene	2	2 (guidance)	2.00	U	2.24		2.00	U	2.49		2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	1.46	J
Benzo(k)fluoranthene	2	2 (guidance)	2.00	U	2.32		2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Benzo(e)pyrene	NSG	NSG	2.00	U	2.05		2.17		6.50		2.00	U	2.00	U	1.67	J	2.00	U	1.68	J	2.45	
Benzo(a)pyrene	ND	ND	2.00	U	1.99	J	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Perylene	NSG	NSG	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Indeno(1,2,3-c,d)pyrene	2	2 (guidance)	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Dibenz(a,h)anthracene	50,000	50,000 (guidance)	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Benzo(g,h,i)perylene	NSG	5000	2.00	U	2.00	U	5.93		2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U	2.00	U
Surrogate Recoveries (%)																						
Naphthalene-d8			76		68		54		76		70		74		67		70		65		56	
Phenanthrene-d10			79		75		70		68		74		77		84		74		76		72	
Chrysene-d12			93		89		72		76		92		95		85		87		85		82	

J = Detected but below the reporting limit (RL).
B = Not Blank corrected, Procedural Blank>=5*MDL.
U = The RL is reported. Value is not detected at or above the MDL.
& = QC value outside the accuracy or precision data quality objective.

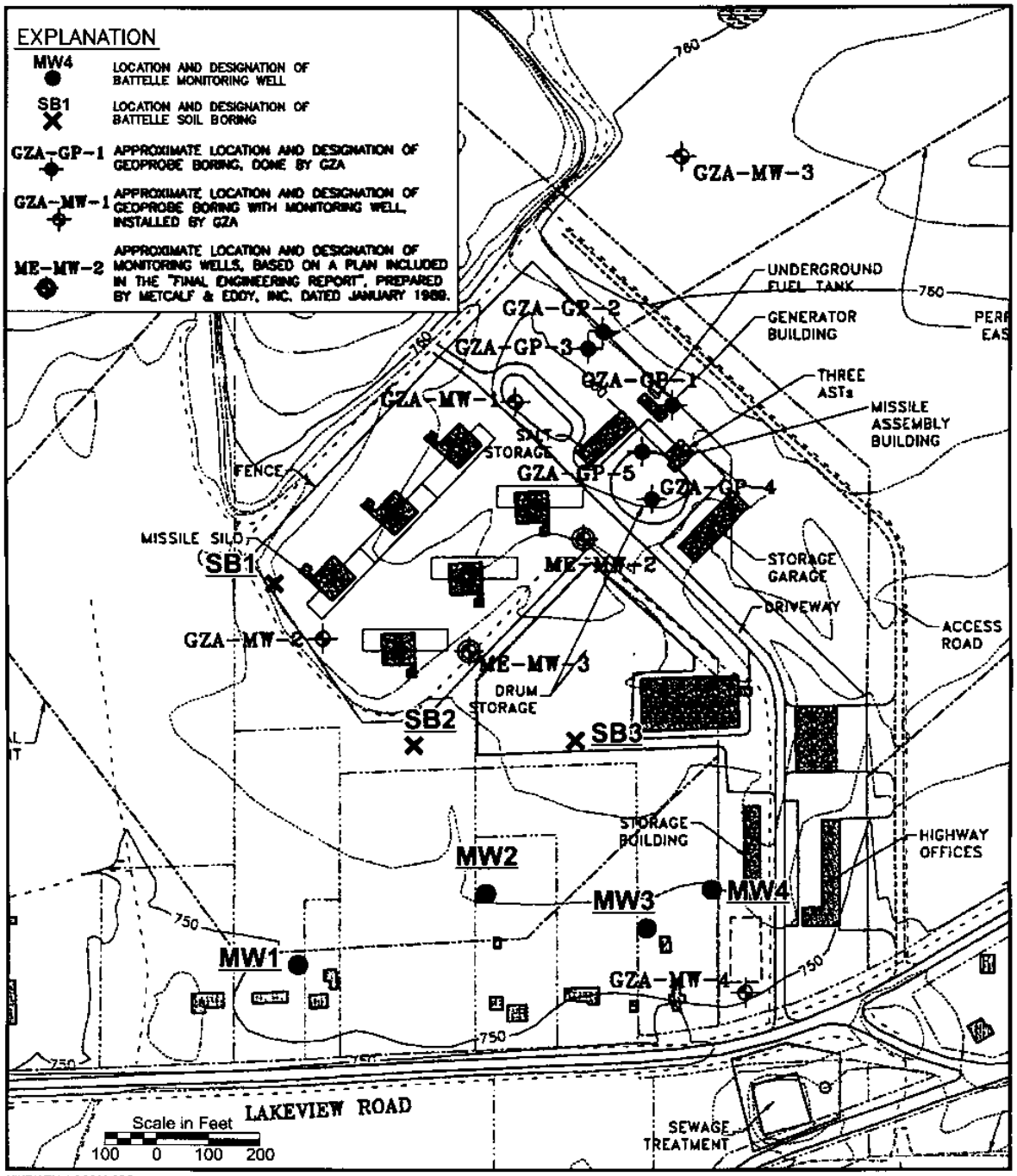
Table 4. Summary of Detections – Soils

										DUPLICATE			
					SAMPLE ID	S0001-3.5-5'	S0002-2.3-3'	S0003- 3.5-5'	MWS0001-4.8'	MWS0001-4.8'	MWS0002-11'	MWS0003-7.3'	MWS0004-11'
					SITE	SB01	SB02	SB03	MW-1	MW-1	MW-2	MW-3	MW4
					DEPTH	3.5-5'	2.3-3'	3.5-5'	4.8'	4.8'	11'	7.3'	11'
					DATE COLLECTED	10/19/1999	11/02/1999	10/19/1999	11/01/1999	11/01/1999	10/22/1999	10/28/1999	10/19/1999
					QUANTERRA LOT NO.	A9J250146	A9K040104	A9J250146	A9K020153	A9K020153	A9J260155	A9J290275	A9J250146
PARAMETER	NYSDEC TAGM 4046 RSCO	REPORTING LIMIT (range)	UNITS	ANALYTICAL METHOD									
Metals													
Mercury	0.1	0.11 - 0.12	mg/kg	SW846	7471A	0.032 B	0.11 B	0.057 B	0.038 B	0.025 B	0.014 B	0.013 B	0.011 B
Arsenic	7.5 or 9.5 (SB)	1.10 - 1.2	mg/kg	SW846	6010B	8.40	11.70	11.30	7.60	7.30	7.00	7.60	9.50
Aluminum	9343 (SB)	22.00 - 24.7	mg/kg	SW846	6010B	10400	10400	11400	2760	5300	4120	3520	5430
Barium	300 or 51.2 (SB)	22.00 - 24.7	mg/kg	SW846	6010B	49.50	58.50	56.00	34.00	82.30	36.00	26.80	54.00
Beryllium	0.16 (1)	0.55 - 0.62	mg/kg	SW846	6010B	0.48 B	0.47 B	0.63	0.20 B	0.35 B	0.25 B	0.20 B	0.39 B
Cadmium	1 or 1.7 (SB)	0.54	mg/kg	SW846	6010B	ND	ND	ND	ND	0.68	ND	0.34 B	ND
calcium	638 (SB)	550 - 616	mg/kg	SW846	6010B	33500	545 B	4970	2050	2780	8660	17500	24800
Chromium	10 or 13.1 (SB)	1.10 - 1.2	mg/kg	SW846	6010B	33.90	12.90	14.00	5.10	9.10	8.90	6.40	11.00
Cobalt	30 or 6.0 (SB)	5.50 - 6.2	mg/kg	SW846	6010B	7.10	4.1 B	4.7 B	6.40	8.90	6.90	6.40	8.80
Copper	25 or 22.7 (SB)	2.70 - 3.1	mg/kg	SW846	6010B	26.50	27.80	27.20	20.10	27.60	26.20	27.10	33.50
Iron	2000 or 23,300 (SB)	11.00 - 12.3	mg/kg	SW846	6010B	21500 MBB	26100	27900 MBB	12300 MBB	17700 MBB	15000	14300	19300 MBB
Lead	26.9 (SB) (2)	0.33 - 0.37	mg/kg	SW846	6010B	26.00	14.90	45.60	7.70	9.30	8.70	9.20	12.90
magnesium	1443 (SB)	550 - 616	mg/kg	SW846	6010B	7510	2110	2550	1790	3030	2810	4460	5150
Manganese	204 (SB)	1.60 - 1.8	mg/kg	SW846	6010B	502	74.40	133	74.1 MBB	115 MBB	130	140	196
Nickel	13 or 24 (SB)	4.40 - 4.9	mg/kg	SW846	6010B	28.60	32.60	28.30	30.50	47.90	33.50	31.20	44.40
Potassium	938 (SB)	550 - 616	mg/kg	SW846	6010B	1750	1500 MBB	1880	710	1450	1010	963	1270
Selenium	2 or 3.9 (SB)	0.56	mg/kg	SW846	6010B	ND	1.40	ND	0.84	0.72	1.20	1.30	
Sodium	ND	550 - 616	mg/kg	SW846	6010B	302 B	698	156 B	121 B	153 B	118 B	140 B	156 B
Thallium	ND	1.10 - 1.2	mg/kg	SW846	6010B	2.60	2.00	1.90	1.30	2.00	0.99 B	1.60	2.90
Vanadium	150 or 26.5 (SB)	5.50 - 6.2	mg/kg	SW846	6010B	21.50	20.30	20.90	7.10	12.80	9.90	10.70	13.10
Zinc	20 or 106 (SB)	2.20 - 2.5	mg/kg	SW846	6010B	91.8 MBB	149 MBB	150 MBB	115	74.90	41.20	71.00	122 MBB
Total Petroleum Hydrocarbons													
Purgeable	NSG	110	ng/kg	SW846	8015 MOD	ND	ND	ND	170	530	140	ND	170
Extractable	NSG	12 - 62	mg/kg	SW846	8015 MOD	44	24	93	230	360	250	240	450
Volatiles Organics													
Acetone	200	8.60 - 10	ug/kg	SW846	8021B	32	ND	ND	ND	ND	22	19	15
Semivolatile Organics													
2-Methylnaphthalene	36,400	360 - 410	ug/kg	SW846	8270C	ND	ND	ND	44 J	96 J	ND	ND	ND
Phenanthrene	50,000	360 - 410	ug/kg	SW846	8270C	ND	ND	ND	120 J	180 J	ND	ND	ND
Chrysene	400	360 - 410	ug/kg	SW846	8270C	ND	ND	ND	150 J	210 J	130 J	160 J	160 J
Fluoranthene	50,000	360 - 410	ug/kg	SW846	8270C	ND	ND	77 J	ND	ND	ND	ND	ND
Pyrene	50,000	360 - 410	ug/kg	SW846	8270C	ND	ND	58 J	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	50,000	360 - 410	ug/kg	SW846	8270C	ND	ND	54 J	160J	93 J	ND	ND	52 J
4,4--DDD	2,900	2.1	ug/kg	SW846	8081A	0.68 J	ND	ND	ND	ND	ND	ND	ND
Hydrazine	NSG	236 - 243	ug/kg	ASTM	D1385	96.5 B	197 B	ND	ND	ND	ND	ND	ND
General Chemistry													
DI Leachable NO_2/NO_3	NSG	1.10 - 1.2	mg/kg	MCAWW	353.20	3.90	4.90	4.90	2.80	3.00	2.10	2.00	3.00
Percent Solids	NSG	0.10	%	MCAWW	160.3 MOD	82.30	84.7	81.10	91.00	89.40	89.60	92.50	90.90

NA = Not Analyzed
ND = Not Detected
B = Metals: Detected below the reporting limit
J = Organics: Detected below the reporting limit
MBB = Detected in method blank@<5% of sample amount

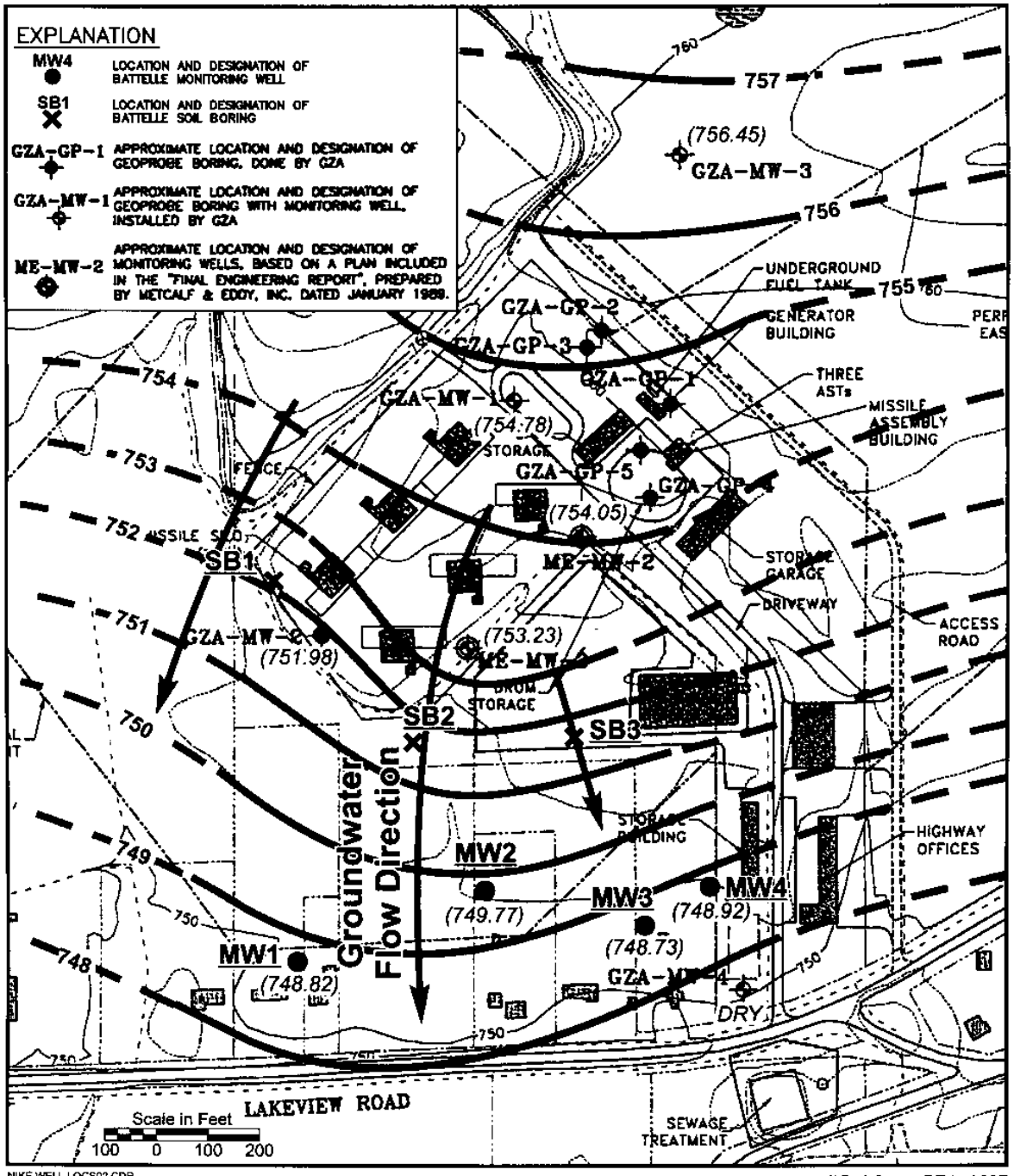
SB = Soil Background
NSG = No standard or guidance values
(1) HEAST = USEPA Health Effects Assessment Tables, Current through Dec. 1990
(2) Background levels for lead vary widely. Ave. rural = 4-61 ppm. Ave. suburban = 200-5--ppm

FIGURES



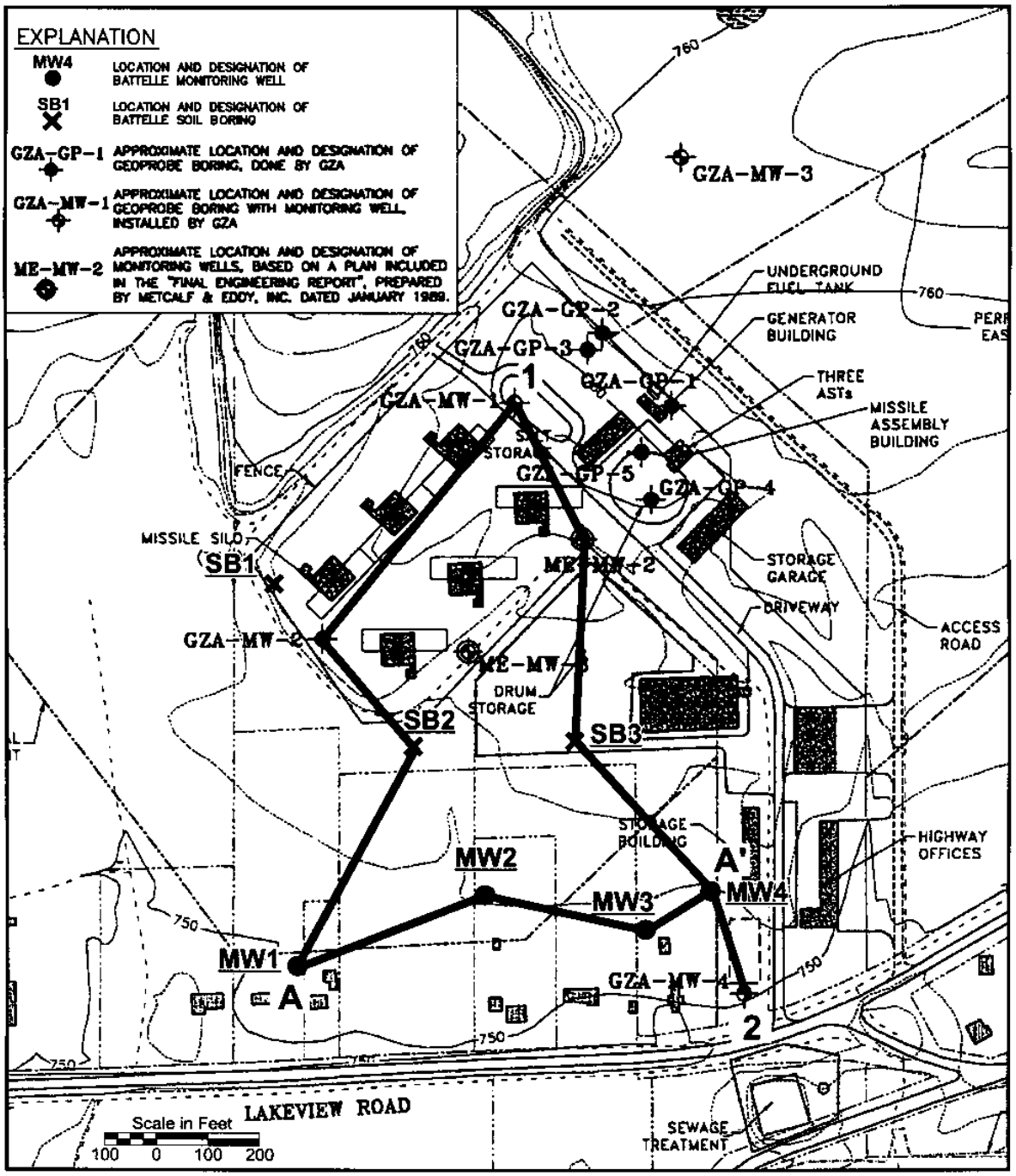
Modified from: GZA, 1997.

Figure 3-1: Borehold Locations at Former Nike Launch Site, Town of Hamburg, New York



Modified from: GZA, 1997.

Figure 3-2. Groundwater Elevations (ft amsi) at Former Nike Launch Site, Town of Hamburg, New York.



Modified from: GZA, 1997.

Figure 3-3: Cross Section Locations at Former Nike Launch Site, Town of Hamburg, New York

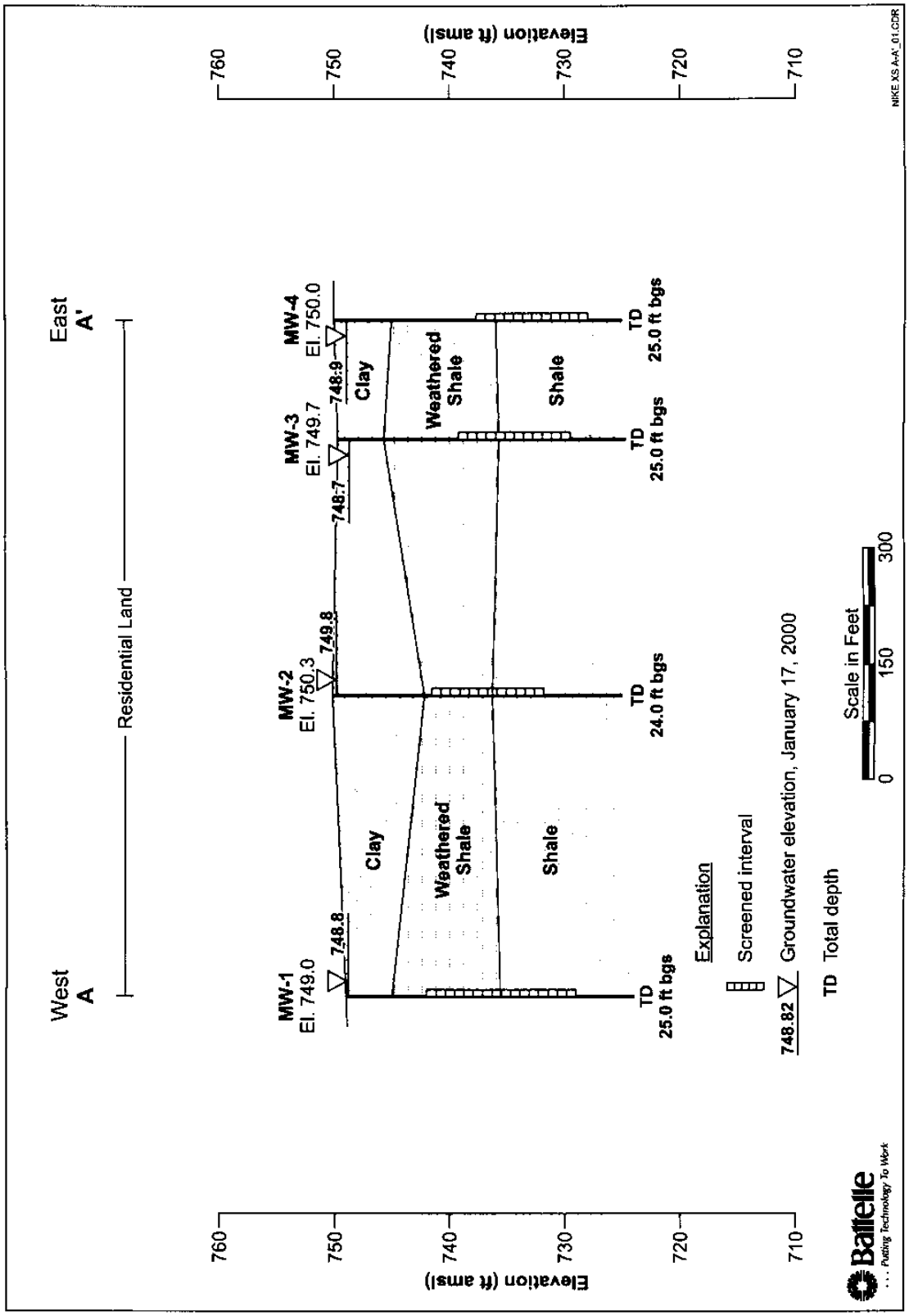


Figure 3-4: Cross Section A-A' at Former Nike Launch Site, Town of Hamburg, New York

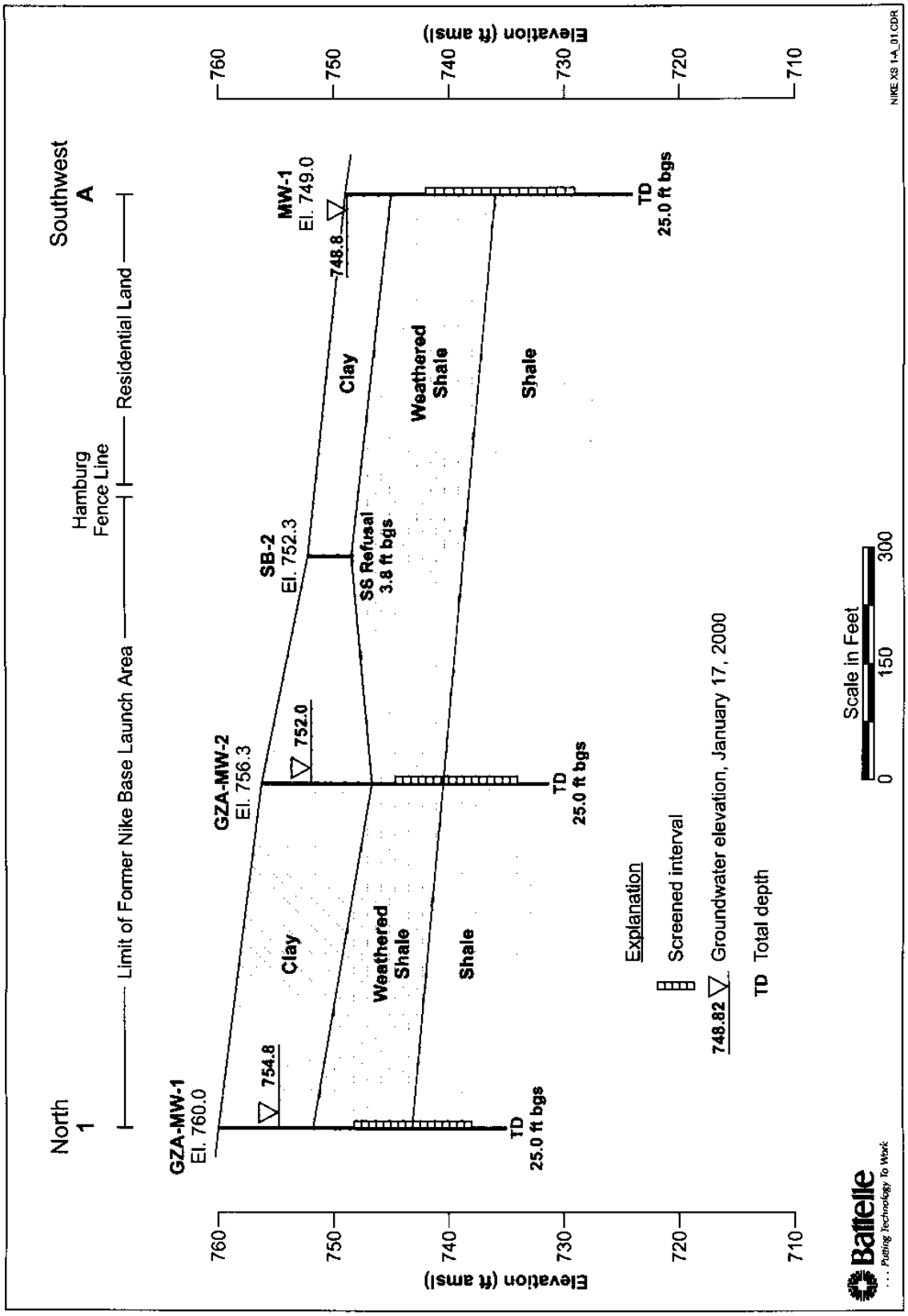


Figure 3-5: Cross Section I-A at Former Nike Launch Site, Town of Hamburg, New York

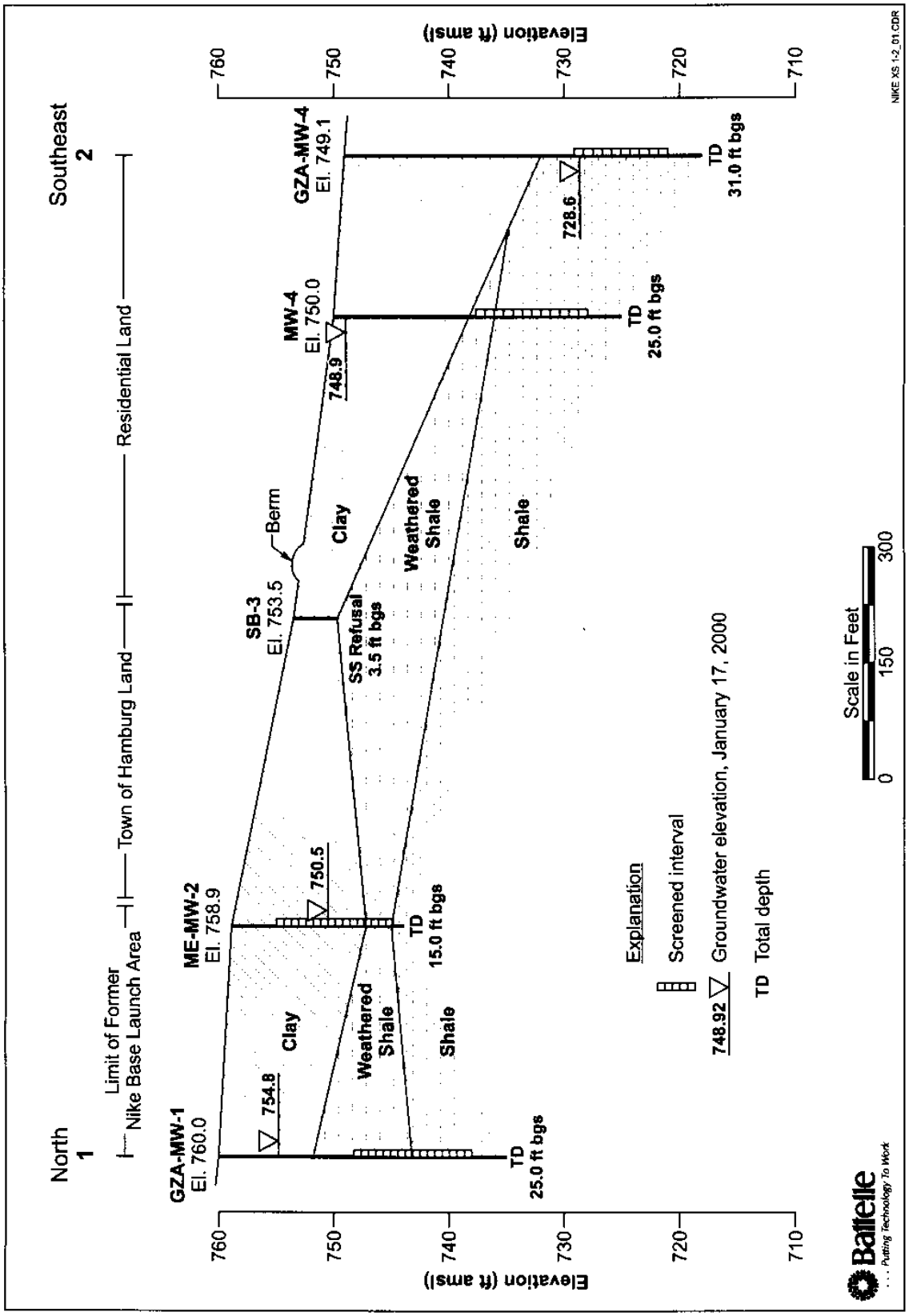


Figure 3-6: Cross Section I-2 at Former Nike Launch Site, Town of Hamburg, New York

VOLUME II

APPENDICES

for

SITE INVESTIGATION
FORMER NIKE BATTERY BU-51/52
HAMBURG, NEW YORK

Submitted to

Department of the Army
U.S. Army Corps of Engineers
North Atlantic Division
New England District

Contract No. DACW33-96-D-0005
Delivery Order No. 35

February 25, 2000

Prepared by

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APPENDIX I

Boring Logs

APPENDIX II

Monitoring Well As-Built Diagrams

APPENDIX III

Water Quality Field Measurements - Groundwater

Well ID	Ground Surface Elevation	Top of Casing Elevation	Top of Bedrock Elevation	Groundwater Elevation	Total Well Depth (ft)	Total Well Depth Screened (ft bgs)	Water Levels	Water Quality Parameters				DO (mg/L)	Turbidity (NTU)	Salinity	
								Temp (^{o}C)	Specific Conductivity (µS/cm)	pH	ORP (mV)				
ME-MW-2	757.4	759.1	745.1	752.75	13	6.9 to 11.9	4.65	13.8	3.6	5.87	156	0.7	0	2.3	22
ME-MW-3	753.44	757.98	731.14	74.09	22	10 to 22	4.35	15.3	1.3	4.45	175	1.1	63	0.8	8
GZA-MW-2	757.93	759.1	741.93	751.21	25	11 to 21	6.72	13.8	0.64	6.67	111	1	30	0.3	4
GZA-MW-4	749.4	751.82	731.4	NA	31	20 to 29	22.8	10.8	0.8	6.75	232	9.7	180	0.4	5
MW-1	749.4	749.96	737.4	749.22	25	11 to 21	0.18	12.7	1.5	7.1	95	0.3	-10	0.3	0.9
MW-2	750.7	750.79	740.7	750.17	24	8.8 to 18.8	0.53	14.6	0.11	7.12	-70	0.3	-10	0	0.7
MW-3	750.1	750.12	735.1	749.13	25	10.3 to 20.3	0.97	14.7	0.14	7.29	158	0.4	7	0.1	0.9
MW-4	750.4	750.54	736.4	749.32	25	12 to 22	2.08	13.9	1.2	6.85	180	0.3	150	0.7	8

APPENDIX IV

Soil Analytical Results

APPENDIX V

Groundwater Analytical Results

APPENDIX VI

TPH Extractable GC/FID Chromatograms