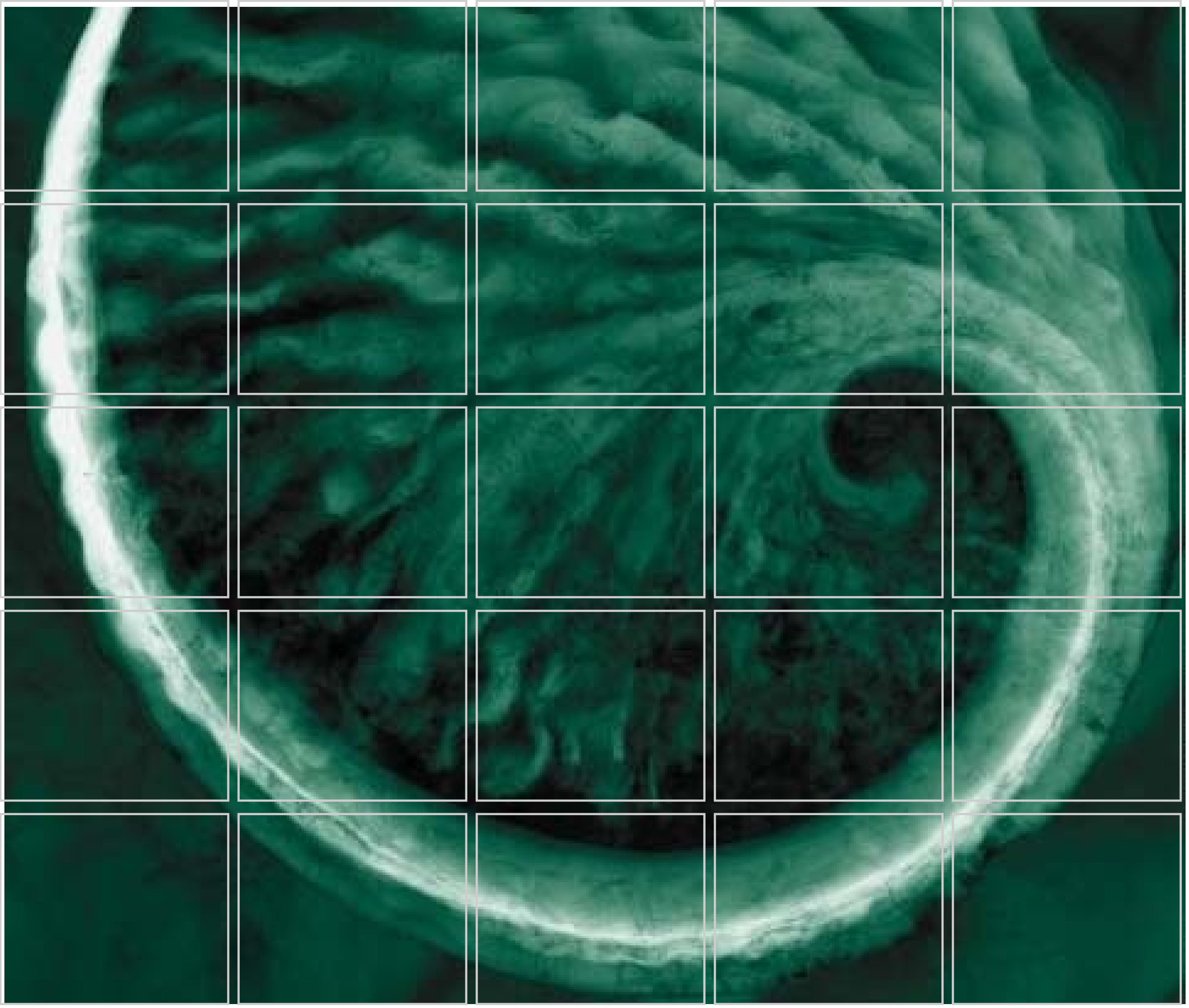

New York State Department of Environmental Conservation

Remedial Investigation Report

Metal Etching Site
Freeport, New York
NYSDEC Site No.: 1-30-110
Work Assignment No. D003970-12

January, 2007

Environmental Resources Management
520 Broad Hollow Road, Suite 210
Melville, New York 11747

REMEDIAL INVESTIGATION REPORT

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LIST OF ACRONYMS

°C	Degrees Celsius
AOC	Area of Concern
Aroclor	Commercial PCB Containing Product (Mixture)
ASC	Analytical Services Corporation
ASP	Analytical Services Protocol
AST	Above Ground Storage Tank
bgs	Below Grade Surface
BS	Blank Spike
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
BOD	Biological Oxygen Demand
CAS	Chemical Abstract Services
Cis-1,2-DCE	Cis1,2-dichloroethene
CFR	Code of Federal Regulations
CHC	Chlorinated Hydrocarbons
CLP	Contract Laboratory Program
COC	Constituent of Concern
COD	Chemical Oxygen Demand
CRDL	Contract Required Detection Limit
CRQLs	Contract Required Quantitation Limits
CSM	Conceptual Site Model
DNAPL	Dense Non-aqueous Phase Liquid
DRO	Diesel Range Organics
DUSR	Data Usability Summary Report
ECD	Electron Capture Detector
ELAP	Environmental Laboratory Accreditation Program
EM	Electromagnetic
ERM	Environmental Resources Management
FS	Feasibility Study
FSP	Field Sampling Plan
Ft	feet

LIST OF ACRONYMS

FWIA	Fish and Wildlife Impact Analysis
GC	Gas Chromatography
GIS	Geographic Information System
GPR	Ground Penetrating Radar
GWQS	Groundwater Quality Standards
HHEEA	Human Health and Environmental Exposure Assessment
ICOPC	Inorganic Constituent Of Potential Concern
ICP	Inductively Coupled Plasma Spectroscopy
ICS	Interference Check Sample
ID	Inner Diameter
IDL	Instrument Detection Limit
IRM	Interim Remedial Measure
K	Hydraulic Conductivity
LCS	Laboratory Control Sample
LNAPL	Light Non-aqueous Phase Liquid
MDLs	Method Detection Limits
mg/kg	Milligrams/kilogram (ppm)
mg/l	Milligrams per Liter (ppm)
MS	Mass Spectroscopy
MS/MSD	Matrix Spike / Matrix Spike Duplicate
MTBE	Methyl-Tertiary-Butyl Ether
NAPL	Non-Aqueous Phase Liquid
ug/kg	micrograms/kilogram (ppb)
NCDOH	Nassau County Department of Health
NTUs	Nephelometric Turbidity Units
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
ORP	Oxidation/Reduction Potential

LIST OF ACRONYMS

PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyl Compounds
PCE	tetrachloroethen
PID	Photoionization detector
Ppb	parts per billion
Ppm	parts per million
PVC	Polyvinyl chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation Recover Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROW	Right of Way
RSCOs	Recommended Soil Cleanup Objectives
SB	Soil Boring
SCGs	Standards, Criteria and Guidances
SEL	Severe Effect Level
SM	Standard Methods for the Analysis of Water and Wastewater
SOP	Standard Operating Procedure
SOW	Statement of Work
SVOCs	Semi Volatile Organic Compounds
SW	Solid Waste
TAGM	Technical and Administrative Guidance Memorandum
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon

LIST OF ACRONYMS

TGA	Tight Grid Area
TOGS	Technical and Operational Guidance Series
Trans-1,2-DCE	Trans-1,2-dichloroethene
TSDF	Transfer, Storage, and Disposal Facility
TP	Test Pit
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
UCL	Upper Confidence Level
UFPO	Underground Facilities Protection Organization
ug/l	Micrograms per Liter
µS	MicroSiemen
USACE	U.S. Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USCS	Unified Soil Classification System
USGS	United States Geological Survey
UST	Underground Storage Tank
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds
Yd^3	Cubic yards

1.0 INTRODUCTION

Environmental Resources Management (ERM) is pleased to submit this Remedial Investigation Report (RI) for the Metal Etching Site located in Freeport, New York to the New York State Department of Environmental Conservation (NYSDEC). ERM carried out RI field activities at the Metal Etching Site between May and November 2004. Supplemental RI activities were performed in August 2004 and March 2005, including an Interim Remedial Measure (IRM) in March 2005. This RI has been prepared in accordance with the specifications set forth in the 21 October 2003 NYSDEC State Superfund Standby Contract, Work Assignment No. D003970-12.

1.1 ORGANIZATION OF REPORT

The objectives of the RI were to characterize surface and subsurface materials at the former Metal Etching Co., Site, to determine whether any of the activities conducted at the Site during the period of operation by Metal Etching impacted the subsurface soils or groundwater; and lastly to determine the vertical and horizontal extent of impact in both soils and groundwater. The purpose of this RI report is to summarize the relevant history of the Site and its operations; the field activities conducted by ERM at the Site and the data collected, and present a discussion of the type(s) and distribution of the organic and inorganic compounds detected in the soils and groundwater at the Site. The report is divided into the following sections:

- <u>Introduction:</u> contains the Site description and background information, a summary of physical characteristics of the Site and a discussion of the operational and waste disposal history.

- <u>Remedial Investigation Activities:</u> describes the scope of work and field activities conducted during the RI.

- <u>Environmental and Physical Settings:</u> provides a description of physical settings of the Site including; climate, topography, geological and hydrogeological characteristics.

- <u>Site Environmental Conditions:</u> includes a discussion of the sampling program conducted during the RI, the analytical results, and applicable Standards, Criteria and Guidance values (SCGs).

- Human Health Exposure Assessment: presents potential public health exposure pathways.

- Fish and Wildlife Impact Analysis: presents the fish and wildlife resources that presently exist at and in the vicinity of the site and presents actual or potential impacts of site-related chemicals on fish and wildlife resources

- Conclusions: includes an evaluation of the source of contamination, the migration paths and the actual or potential receptors of the contaminants, This section also presents the reference documents that were used to prepare this report.

1.2 SITE DESCRIPTION

The Metal Etching site, ("Site"), is a Class 2 Site listed on the NYSDEC Registry of Inactive Hazardous Waste Sites (No. 1-30-110). The Site is located in Nassau County at 435 South Main Street, Freeport, New York, adjacent to Freeport Creek. A Site location map is presented as Figure 1-1. The Site is currently owned by Freeport Creek Associates and leased by Main Street Marine, 500 South Main Street, Freeport, New York. The Metal Etching property designation is: Section 62 Block 45 Lots 144, 145 and 158. The Site is approximately 1.05 acres; however, the area investigated in the RI was 2.06 acres. The additional 1.01 acres includes several properties: Section 62 Block 45 Lots 24, 25, 54, 155 and 157. These properties are located immediately to the south and east of the Site along Freeport Creek. The term "Site" includes these additional properties and the Site and Study Area Boundaries are depicted on Figure 1-2.

The Site is currently used as a boat dealership, marina and boat storage yard. Operations at the Site are conducted in a single 2,400-square foot building located on the northeast corner of the property. A smaller 1,200-square foot building, located on the western portion of the property, has been restored and is used for office space for the boat dealership. Minor boat restoration activities are performed within the 2,400-square foot building and include: engine rebuilds, sanding and painting/varnishing. Most areas of the Site grounds are concrete or asphalt paved. Portions of the Site adjacent to Freeport Creek are covered with gravel. Soil cover was observed on a small stretch of land on the southern property beneath a two (2)-story boat rack.

The former Metal Etching buildings at the Site were erected prior to 1954; however, the exact date of construction is unknown. These connected buildings occupied approximately 26,650 square feet of the property (approximately 60 percent of the Metal Etching portion of the property).

Except for the 2,400 square foot building, which was a portion of the Metal Etching quarters, the Metal Etching buildings were demolished during 2001, however the ground supports such as concrete slab/flooring/footings remain in the ground at the Site. A six (6) inch thick concrete slab covering an approximate area of 7,750 square feet was the foundation of the Metal Etching plating slab and is visible to the west of the 2,400 square foot building.

1.3 FACILITY HISTORY

Prior to 1966, the Site operated as Flores Manufacturing, which processed handbags. The processing included decorative plating with nickel, chromium, and cadmium. From 1966 to 1999, Metal Etching Corporation manufactured metal nameplates, instrument panels, rulers and miscellaneous plated products. All products were etched or printed. The process of etching included anodizing, chromate conversion, and chrome/nickel plating. From 1973 to 1982 Metal Etching Co. operated under the name of Plastic Associates, as a wholly owned subsidiary. From July 1982 to June 1999 Metal Etching Co., Inc. was the entity that operated the Site. In the later years of the operation of Metal Etching Co., Inc. several of the metal coating operations were discontinued; anodizing (discontinued in 1998), chromate conversion (discontinued in 1997), and chrome plating (discontinued in 1997). All operations terminated in 1999 and Metal Etching Co., Inc. abandoned the premises during September of 1999.

The facility buildings were demolished some time around 2001. During the demolition, limited decontamination and/or investigation was performed under the oversight of NYSDEC Resource Conservation and Recovery Act (RCRA) personnel. Two (2) 4,000 gallon above ground storage tanks (ASTs), which formerly contained ferric chloride, were decontaminated and removed from the Site during demolition activities.

As discussed above, the former Metal Etching Facility was used primarily for plating, etching and anodizing of metals. Operations carried out at the Site included plating, etching, anodizing, degreasing, wastewater treatment, paint/powder coating, photo processing, including ink screening and printing, and metal cutting. Table 1-1 provides a summary of the areas of concern (AOCs) identified at the Site with a description of the previous operations carried out. The locations of these buildings and AOCs are illustrated on Figure 1-3.

Historically, sanitary and industrial wastewater was disposed of through the sanitary sewer line. Locations of these features are approximated on Figure 1-3.

1.4 HISTORICAL DATA REVIEW

ERM conducted a review of: existing Metal Etching files (provided by the NYSDEC); historical aerial photographs of the Site (16 December 2003 at Al Grovers High and Dry Marina in Freeport, New York); Nassau County Department of Health (NCDOH); and, Village of Freeport Department of Public Works (30 December 2003) foils. The following observations are based on the aforementioned reviews:

- In 1956 a five (5)-inch transite pipe sewer connection was made.

- In April 1969 a twenty-six (26) foot section of the transite pipe was replaced from the main line underneath the sidewalk on East Ray Street to the building foundation. Replacement of the 26-foot section of transite pipe was necessitated due to corrosion of the pipe.

- In 1973 water usage at the Site was restricted by the Village of Freeport to 540,000 gallons per month. Wastewater discharge limits to the sanitary sewer system for 1973 are provided in Table 1-2.

- In October of 1976 a twenty-two (22) foot section of broken transite pipe was replaced. The section was also replaced from the main line located underneath the sidewalk to the building foundation. The bottom of the pipe had been again corroded away.

- In April 1990, Metal Etching requested permission from the NCDOH to remove one (1) 550-gallon underground storage (UST) tank located in western portion of the Site. Metal Etching also requested permission to abandon one (1) 1,500 gallon UST in place. This UST was located just south and west of the 2,400 square foot building. No documentation of tank closure was identified in the file review.

A review of historical Site aerial photographs from years 1954, 1972, 1983 and 1990 revealed several key features that were taken into account during the Remedial Investigation (RI) Work Plan development. These include:

1. The Site appears to have been paved between 1983 and 1990. The aerial photographs from 1954, 1972 and 1983 show the Site with dirt parking areas. Poor house keeping (i.e., spills, leaks, etc.) that may have occurred prior to 1990 would have therefore spilled directly to the soil.

2. The aerial photographs also indicate that between the years 1983 and 1990 a bulkhead was installed along the southeastern edge waters of the property. ERM contacted the U.S. Army Corps of Engineers

(USACE) and the Town of Hempstead Department of Conservation and Water Ways for permit and technical information regarding this bulkhead. These agencies did not have any record of bulkhead installation or permit applications at the property.

3. The aerial photograph from 1983 illustrates improper and haphazard storage of many 55-gallon drums. The areas in which the drums were observed on the aerial photograph are depicted on Figure 1-3, AOC F.

4. The aerial photograph from 1983 also indicates the storage of telephone poles, large timbers, and miscellaneous debris.

A review of the NYSDEC Spill Incidents Database Search indicates that three (3) oil spills have been reported at the Metal Etching Site and four (4) oils spills have been reported in the immediate vicinity of Metal Etching (in the up-gradient/cross-gradient directions). Table 1-3 details the nature and status of these spills.

1.5 TRIAD APPROACH

The Triad Approach is a dynamic approach to site investigation and cleanup that is flexible and incorporates site-specific decision and data needs. The Triad Approach was used in the RI conducted at the Site. The Triad Approach has been developed to improve confidence in the identification of contamination at a site, reduce costs and expedite site closeout. The Triad Approach focuses on management of decision uncertainty by incorporating:

- systematic Project Planning,
- dynamic Work Plan Strategies, and
- real-time measurement technologies

to accelerate site investigation and the cleanup process.

1.5.1 Systematic Project Planning

Systematic Project Planning is a deliberate and coordinated effort to identify and manage factors and issues that contribute to decision uncertainty. During Systematic Project Planning, factors and variables that impact execution of the investigation are identified so that tactics to manage these factors can be developed. Systematic Project Planning links data collection to site decisions so that the appropriate data are collected to justify decision on cleanup strategy. For example, data collected to screen soil contamination can be less rigorous than data collected to determine compliance with groundwater standards. Using a less rigorous and lower cost analytical technique to analyze screening samples can allow collection of a greater number of samples to improve representativeness.

Dynamic Planning helps determine if and how a dynamic implementation approach makes sense at a site, whether field analytical methods are applicable and establishes the framework to ensure that the data collected are sufficient for site needs. Systemic planning is a common-sense approach that identifies decision end-points and data are collected to support these decisions. A thorough planning process is therefore crucial within the Triad approach.

1.5.1.1 The Conceptual Site Model

The Conceptual Site Model (CSM) is one of the primary planning tools used in systematic project planning. The CSM organizes the information known about a site and helps identify information that needs to be collected. The systematic planning process links project goals to the investigation activities necessary to reach these goals by identifying data gaps. The CSM is used to direct the gathering of needed information and refine decision goals as more is learned about the Site. As the CSM matures and contaminant characterization is better defined, data quality objectives and decision criteria are revised.

1.5.2 Dynamic Work Plan Strategies

Dynamic work plan strategies are the second element of the Triad approach. These strategies use real-time data decision making in the field to limit the number of mobilizations necessary to fill data gaps or take remedial actions. The approach can significantly reduce project costs and shorten the project schedule. A dynamic work plan strategy is one where decisions are made and the work plans directing sampling and analysis are adjusted in response to data generated, while the field activities are still underway. Appropriate application of a dynamic strategy allows field teams to efficiently collect the data needed for decision-making and to fill data gaps with as few mobilizations as possible. A dynamic work plan strategy relies on real-time data to reach decision points and quickly identify the need for alternative action. During preparation of the RI work, a logic diagram outlining the dynamic strategy developed for the RI was prepared and used during the field work. For example, sampling density was adjusted in response to soil sampling results.

1.5.3 Real-Time Measurement Technologies

Real-time measurements are those that are produced within a rapid time frame so that that real-time decision-making and revision of the CSM can occur in real-time (i.e., when the field time is still at the site). Real-time measurement technologies include more than just on-site analytical tools. It also includes in situ detection technologies and software to manage, interpret, display and map data in real-time to make dynamic work plan strategies possible. Additionally, the term includes rapid turnaround of results from a fixed laboratory that may use either standard or screening methods. Screening methods are typically associated with field use; however, running screening methods in a traditional laboratory can be efficient both logistically and economically.

Use of non-traditional analytical strategies is key to saving time and money. When using innovative technologies to characterize a site it is prudent to use innovative and standard methods collaboratively to obtain a clearer image of the problems present at the site. For example, screening methods may be used to increase sampling density and improve accuracy of the CSM. After the analysis of the screening samples has been completed, analytical uncertainty can be managed by selecting appropriate samples for analysis using more rigorous analytical techniques. The RI at the Site incorporated use of screening analytical methods. This allowed screening data to be transmitted to ERM within 24-hours after sample collection. These data were incorporated into a geographic information system (GIS) and "real time" graphic depictions of contaminant distributions were generated and used to direct subsequent data collection.

1.6 CONCEPTUAL SITE MODEL

The Metal Etching Corporation (and predecessor companies) manufactured metal nameplates, instrument panels, rulers and miscellaneous plated products. Historically all products produced at the facility were etched, plated and/or printed. Metal finishing processes included etching, anodizing, chromate conversion, paint/powder coating, photo processing including ink screening and printing, and metal cutting. Plating processes included decorative plating with nickel/chrome, and cadmium. Degreasing was a necessary pre-finishing operation and wastewater treatment was carried out on-Site post processing.

The primary method for disposal of sanitary and industrial wastewater appears to have been through the sanitary sewer lines. However, there are two reported incidents of failure of the underground piping connecting the on-Site wastewater treatment system with the sanitary sewer system. Poor housekeeping (observed during regulatory inspections of the Site) likely resulted in incidental releases of processes wastes, spent solvents as well as losses of raw chemicals. The NYSDEC Spills Incident Database contains records of three known spills. Historic aerial photographs indicate that the Site was not paved until 1990 and also reveal the haphazard storage of 55-gallon drums, telephone poles, timbers and miscellaneous debris throughout the Site. Additionally, there is a report by a local citizen of dumping of material onto the ground at the Site.

The water table at the Site is approximately three and a half (3.5) to six (6) feet below ground surface (bgs). Therefore, any sizable amount of material spilled/released to the ground surface can easily exceed the sorbative capacity of the overburden material and rapidly reach the water table. Groundwater is, therefore, one of the principal pathways for contaminant migration at the Site. Heavy metal (chromium, cadmium and nickel) and solvent (chlorinated hydrocarbons such as tetrachloroethene (PCE) and trichlroethene (TCE) ([CHC]) contamination of soils associated with leaking of waste chemicals, spillage during operation, or improper storage and/or disposal will contribute to groundwater contamination. Once these materials reach the groundwater they can dissolve in groundwater and be transported via groundwater flow. The location of the Site, along Freeport Creek, a tidal estuary, suggests that shallow groundwater flow is, at certain periods in the tidal cycle, toward and likely discharging to the creek. Dissolved contaminants could therefore potentially migrate from a release site on the Site into Freeport Creek contaminating either sediment and/or surface water.

Potential impacts to ground- and surface water must be tempered by considering the leaching potential of heavy metals and CHCs through the unsaturated zone, and their mobility in groundwater. Movement of contaminants through the unsaturated and saturated zones depends on several factors including the sorptive capacity of Site soil, the oxidation/ reduction potential (ORP) and dissolved oxygen (DO) content of the subsurface, the Site's hydrogeological characteristics, contaminant solubility, and contaminant speciation. The environment beneath the Site consists of a thin three (3) to six (6) foot unsaturated zone underlain by saturated soil that is likely estuarine in nature. Substantial concentrations of nutrients/dissolved minerals are transported into the saturated portion of the subsurface during each tidal cycle. The high nutrient concentrations support growth of native soil bacteria, which may use the nutrient/dissolved minerals as a source of energy. As the bacterial population(s) increase, the environment beneath the Site becomes anoxic (anaerobic) and the ORP and DO will fall. Low DO concentrations and low ORPs favor reduced cationic and anionic species and promote co-metabolization of several of the CHCs used at the Site. The processes serve to attenuate and immobilize several of the potential contaminants present. Therefore, although releases from operations at the Site have been observed, migration of contaminants off-Site to Freeport Creek may be limited by environmental conditions.

Metal Etching Co. carried out chromium plating. When chromium is plated, a solution of hexavalent chromium (Cr+6) is used. Chromium in the +6 state is very mobile in groundwater, however, it is a powerful oxidant and when the ion enters the subsurface beneath Metal Etching where reducing conditions predominate, hexavalent chromium (Cr+6) is reduced to trivalent chromium (Cr+3), which is immobile. Thus at the Site, immobilization of chromium could, based on the observed ORP of the subsurface, be expected. Similarly, in a reducing environment with sulfur present (as sulfite ion), immobilization of nickel as nickel sulfide and copper, zinc and cadmium also as sulfides would be expected. In other words, the metals typically used in etching and plating operations should not migrate in high concentration or appreciable distances from the point of their release.

Degradation of PCE, TCE and cis-1,2-DCE is also enhanced in anaerobic environments. As the concentration of DO and the ORP potential decrease, subsurface conditions become favorable for the growth of anaerobes capable of degrading CHCs through reductive dechlorination. Environmental research has shown that bacterial degradation of CHCs proceeds in a stepwise process starting with PCE and ending with ethane/ethene. The degradation sequence is:

PCE → TCE → cis-1,2-Dichloroethene → vinyl chloride → ethane/ethene

Except for ethane/ethene, which have not been analyzed for, each of the species in the degradation pathway has been observed at the Site. Low DO concentrations have been observed in each of the monitoring wells installed as part of the RI and in six (6) of the ten (10) monitoring wells installed at the Site. The ORP is conducive for the reductive dechlorination of CHCs. Therefore, there is an active transformation mechanism in the subsurface at the Site that will remove/limit the migration of any PCE or TCE released during operation of the business.

The soil matrix will adsorb releases of volatile CHCs to the subsurface. The capacity to adsorb CHC is determined in part by the quantity of CHC released, the soil bulk density, porosity and chemical composition of the soil matrix. If a quantity of CHC is released that exceeds the retention capacity of the soil matrix, the CHC will migrate vertically to the water table, a portion of which will eventually dissolve and enter the groundwater. However, vertical migration of CHCs will continue below the water table if the quantity of CHC reaching the water table can exert enough hydrostatic pressure to displace water from saturated soil pores. CHCs will continue to migrate vertically until the hydrostatic pressure exerted by the CHC is balanced by pore-water pressure or the migrating CHCs encounter a low permeability layer. When the pressures are balanced, CHC will be trapped in interstitial pore spaces. CHCs behaving in the manor described above are referred to as Dense Non-Aqueous

Liquids (DNAPL). The potential presence of DNAPL at a site is typically evaluated by comparing the maximum concentrations of dissolved CHCs with a benchmark set at 1-percent of the solubility of the CHCs detected at the site. As discussed in Section 4.1.3.3 dissolved CHC concentrations are below this benchmark and DNAPL is likely not present below the Site.

Atmospheric gases, water vapor and/or liquid water normally occupy soil pores in the unsaturated zone. CHCs adsorbed or retained in soil pores in the unsaturated zone or dissolved in groundwater can volatilize and can contaminate soil gas. Contaminated soil gas can displace water and/or atmospheric gases normally present in pore spaces. Contaminated soil gas will migrate in response to pressure gradients induced by changes in atmospheric pressure or subsurface structures (i.e., foundations, utility bedding, etc) that induce a pressure gradient. Releases of CHCs at the Site resulted in contamination of soil gas. If a substantial quantity of CHCs were lost in the past, residual CHCs could remain in the unsaturated zone that would continue to act as sources of soil gas contamination. Depending on the relative pressures inside the two buildings on the Site, contaminated soil gas could diffuse into the building(s) if pressures inside the buildings were lower than the soil gas pressure. Similarly, contaminated soil gas on the Metal Etching Site could diffuse off-Site due to pressure gradients created by depressurization of utility bedding or nearby structures with respect to the pressure of contaminated soil on-Site.

2.0 REMEDIAL INVESTIGATION ACTIVITIES

The work plan was developed for the RI in accordance with the NYSDEC State Superfund Standby Contract Work Assignment No. D003970-12. The purpose of the RI was to comprehensively characterize environmental conditions at the Site utilizing the Triad Approach to streamline site assessment, improve field decisions to reduce costs and decrease the time frames of the investigation. A CSM was developed to identify potential contaminants of concern, areas of concern (AOCs) and to identify potential migratory pathways of contaminants.

A discussion of the investigation activities that were completed as part of the RI is provided below. Additional details regarding the sampling and analytical methods and procedures that were followed during the RI are presented in the Remedial Investigation/Feasibility Study Work Plan the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP), dated March 2004.

2.1 SITE SURVEY

A survey of the Site was carried out by Donald G. DeKenipp of Sayville, New York, a New York State licensed and registered land surveyor. A topographic map with one-foot contours (see Figure 2-1 Certified Site Survey Map) was prepared from the initial Site survey. This map includes the location of structures, bulk heading, shorelines, property lines, and other significant features including certified property boundaries.

A second survey was conducted at the completion of RI field activities to locate all sampling points including soil borings, piezometers, monitoring wells, soil gas and manholes (see Figure 2-2 for a Summary of Sample Locations). The elevations of monitoring well casings and soil borings were established to within plus or minus 0.01 feet established from Benchmark 22011 elevation 9.642 from the Nassau County Department of Public Works benchmark book (U.S.C. & G.S. datum). A permanent mark was placed in the interior monitoring well casings to provide a reference point for subsequent monitoring events.

2.2 UTILITY SURVEY/GEOPHYSICAL INVESTIGATION

On June 23rd and 24th, 2004, Northeast Geophysical Services of Bangor, Maine conducted a geophysical investigation of the Site. The Geophysical

Survey results were used to finalize sampling locations and guide implementation of intrusive field investigation activities.

The objective of the geophysical investigation was to locate and define any subsurface features that may have potential environmental implications and to investigate the portion of the Site covered by the former building footprint. The majority of the Site property was included in the geophysical investigation with the exception of areas occupied by boats or areas that were otherwise inaccessible. The geophysical survey focused on the footprint of the former plating building and the adjacent areas that contained paint booths and chemical storage. A geophysical survey of the building footprint was also conducted to identify additional source areas such as sumps, dry wells, or underground storage tanks (USTs).

A grid system based upon a north-south and east-west coordinate system was developed so that any identified anomalies could be accurately located relative to permanent and recoverable landmarks at the Site. Grid coordinates were designated by the number of feet north by the number of feet east from the established grid datum (e.g. 00N/00E). The corners of the grid were permanently marked with wooden or metal stakes such that they could be located in the Site survey. The following summarizes the geophysical survey activities that were completed.

2.2.1 *Electromagnetic (EM) Method*

A Geonics EM-61 metal detector was used for the electromagnetic survey. The EM-61 is designed specifically to locate medium to large buried metal objects such as drums and tanks while being relatively insensitive to above-surface metallic objects such as fences, buildings and power lines. The technique is sensitive enough to detect buried metal up to a depth of approximately twelve (12) feet.

The size and burial depth of the metal determine the strength of the EM-61 response. EM data are digitally recorded at regular intervals.

The recorded EM data were transferred to a field computer at the completion of the data collection process. The data were then contoured to identify any potential features that could represent subsurface features of concern. A summary of the findings is presented in Section 3.1.2.1 and Appendix C includes the geophysical report.

2.2.2 *Ground Penetrating Radar Method*

Ground penetrating radar (GPR) was used to better define anomalies identified by the EM survey. The GPR method is based upon the transmission of repetitive radio-frequency pulses into the subsurface. When the downward wave contacts an interface of dissimilar electrical character, it returns to the surface in the form of a reflected signal. This reflected signal is then detected by a receiver within the GPR unit and added to a data file. The GPR anomaly remains prevalent as long as the electrical contrast between media is present and constant. The system records a continuous image of the subsurface by plotting two-way travel times versus the distance traveled along the ground surface. Two-way travel time values are then converted to depths below grade surface, using known soil velocity functions.

A Geophysical Survey Systems SIR-3 System was utilized to collect the GPR data. Several traverses were collected across each anomaly to determine the areal and vertical extent of the feature and to determine if the feature could be an UST or a buried drum. Field evaluation of the GPR records were used to more fully characterize each EM anomaly. The locations of all GPR traverses were referenced to the Site survey grid coordinate system. The results of the survey are presented in Section 3.1.2.1 and the Geophysical report is presented in Appendix C.

2.3 VERTICAL PROFILE AND MICRO WELL INSTALLATION

One vertical profile boring (VP-01) was installed at the location shown on Figure 2-2. The profile boring was installed to characterize the stratigraphy beneath the Site, to determine if there has been any downward vertical migration of contaminants, and to determine if the "twenty-foot clay" that has been identified in the vicinity of the Site (approximately 50 feet bgs) is present. Based on the results of the vertical profile boring, subsequent RI activities could be modified to account for unexpected detections of compounds not considered in the CSM. Vertical profile results were therefore used primarily to establish the framework for the remainder RI activities and analyses that were completed. Vertical profile results are presented in Section 4.1.1.

Vertical profiling was carried out by collecting continuous macro core soil samples from ground surface to the water table, and at ten-foot intervals thereafter to the termination depth of approximately 41 feet bgs where the "20-foot clay" was encountered. Soil samples from the vertical profile (VP-01) were collected at the following intervals: 4 to 8 ft bgs (duplicate collected at this interval), 10 to 14 ft bgs, 20 to 24 ft bgs and 30 to 34 ft bgs.

Groundwater samples were collected utilizing the Geoprobe SP-15 sampler at ten (10)-foot intervals from the water table (approximately four (4) feet bgs) to 30 feet bgs. Groundwater samples were collected at the following intervals: 4 ft bgs, 10 ft bgs, 20 ft bgs and 30 ft bgs. Soil and groundwater samples were analyzed by Analytical Services Corporation (ASC Inc.) for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), target analyte list (TAL) metals, pesticides and polychlorinated biphenyls (PCBs).

At the completion of the vertical profile boring, a micro well (MW-01) screened from twenty-one (21) to thirty-one (31) feet bgs, was constructed within the borehole. This micro well served to monitor deep groundwater elevations in relation to shallow groundwater elevations throughout the tidal study (described in Section 2.4.1) and to measure the vertical gradient in the aquifer.

The micro well was constructed of one (1)-inch inner diameter (ID), threaded flush joint, polyvinyl chloride (PVC) casing and is equipped with a screen ten (10) feet in length, also constructed of PVC with slot openings of 0.010-inches.

2.4 PIEZOMETER INSTALLATION AND HYDRAULIC MONITORING

Eleven (11) piezometers and one (1) creek gauge were installed at the Site to evaluate groundwater elevation fluctuations (seasonal and tidal), and the direction of groundwater movement (see Figure 2-2 for piezometer locations). The piezometers were constructed of one (1) inch ID schedule 40 PVC screen and riser.

The piezometers were installed using a Geoprobe®. The drill rods, equipped with an expendable point, were driven down to the desired depth, approximately fifteen (15) feet bgs. Once the desired depth was reached, a PVC point was placed on the end of a ten-foot slotted section of Schedule 40 PVC and was placed into the drill rods. Additional five-foot sections of PVC were added to advance the slotted section to the desired depth. Once the PVC was installed within the drill rods the expendable point was knocked out of the drill rods. The drill rods were retracted leaving the PVC screen at the desired depth. The piezometers were completed at grade and a threaded cap was installed.

Hydraulic data was collected over a one-week period following the installation of the piezometers. Four (4) full rounds of synoptic water level measurements were collected. Table 2-1 provides the summary of measuring point elevations and groundwater elevation data. The synoptic water level measurement rounds were performed during low and high tides. Depth to water measurements were collected to the nearest 0.01 foot from the marked points identified on the temporary piezometers risers and the newly installed micro well. Water levels were measured using an interface probe capable of detecting a separate phase liquid; however, none was detected.

In addition to groundwater level measurements, the surface water levels (Creek Gauge water levels) in the Freeport Creek were recorded to correlate groundwater elevations to surface water elevation.

In conjunction with the water level measurements, hydraulic level loggers were placed in seven (7) piezometers and the newly installed micro well at the Site. The hydraulic monitoring and the tidal influence study were used to understand groundwater flow at the Site throughout all stages of the tidal cycle. In addition, since a portion of the Site's perimeter is bulk headed, hydraulic monitoring assisted in evaluating how, if at all, the bulkhead may be affecting groundwater movement in the subsurface.

The hydraulic information gathered during this one-week period was used to refine the Site Conceptual Model and assist in selecting the initial points for the soil boring and groundwater investigation.

2.4.1 Tidal Study

On July 26th and 27th, 2004, a tidal influence study was conducted at the Site. Since the east coast of the United States experiences diurnal tides, one of which has a greater range than the other, the planned duration of the tidal study was 25 hours. The study was conducted during an interval of fair weather when the effects of precipitation and large barometric pressure changes were minimal. To fully compensate for barometric changes a single level logger was placed on the Creek Gauge, and not submerged to directly measure the barometric pressure. Water levels, within (piezometer 4 [P4], piezometer 6 [P6], piezometer 8 [P8], piezometer 9 [P9], and piezometer 10 [P10]), MW-01 and in a piezometer that had been installed in the Freeport Creek (Creek Gauge) [to measure the actual tidal action observed throughout the study period], were measured every 5 seconds for a period of approximately 25 hours using Solinst LT level loggers (pressure sensitive transducers and data loggers). The study was actually continued an additional 1.5 hours over the planned 25 hours, at which point it was determined that two full tidal periods had been observed.

Tidally influenced groundwater regimes are characterized by the cyclical rise and fall of water levels effected by tidally influenced surface water bodies. To determine if tidal influences are present in a particular area, the cycle of the change in water levels in the piezometers must be examined. The arithmetic plot of water level versus time in a tidally influenced area resembles a sine wave. If the time between two peaks is approximately equal to the length of the tidal cycle (approximately 12 hours and 10 minutes) and the amplitude of the cycle remains constant over that period of time, then it is likely that the area is tidally influenced. Water level data was plotted against time for the measured piezometers at the Site to determine if the area was tidally influenced.

Once completed, the plots of water level versus time were examined for tidal influence, phase shifts, and barometric pressure adjustments. Phase shifts are the result of a time lag between the tidal water level highs and lows and the corresponding maximum high and low water level responses at a corresponding tidally influenced well. Under ideal conditions of a homogenous, isotropic aquifer, a trend of decreasing amplitude and increasing phase shift would be expected with increasing distance from the surface body that caused the tidal influence.

Groundwater levels within aquifer wells will typically rise in adjustment to rapid decreases in barometric pressure and fall in adjustment to increases. Water levels will then re-adjust as equilibrium between the aquifer and the atmosphere is reestablished. One millibar of pressure is approximately equal to 0.40 inches of water. Barometric pressure data was plotted against time in order to evaluate the effects, if any, of barometric pressure changes on piezometer water levels during the tidal study at the Site.

Groundwater elevations were calculated at each well for the duration of the tidal study using the groundwater level data from each well and initial groundwater elevation measurements. This data was analyzed to determine the maximum, minimum, average and range in fluctuation of groundwater levels for each piezometer during the tidal study period. Groundwater elevation data compiled for the piezometers are provided in Table 2-1. The results of the tidal influence study are presented in Section 3.1.4.1.

2.5 CONCRETE SLAB/MISCELLANEOUS CORING

To facilitate sample collection beneath the concrete slab of the former plating building and in the right of ways (ROWs), concrete coring was carried out at approximately 56 primary boring locations (i.e., the locations in the building grid) prior to initiating the soil boring program. Water was used to suppress dust and particulates from becoming airborne during the coring activities at the Site. Core holes remained sealed until soil sampling was carried out.

2.6 SOIL GAS SURVEY WITH GORE SORBERS

Soil gas samples were collected at ten (10) soil boring locations as identified on Figure 2-3 to assess the potential for migration of VOC vapor emanating from potentially impacted groundwater or from contaminated soil. The soil gas samples were collected at each location prior to the soil boring investigation. The soil gas samples were collected using Gore Sorber modules. The Gore Sorber modules were analyzed for the following compounds: methyl-tert-butyl ether (MTBE), trans-1,2-dichloroethene, 1,1-dichloroethane , cis-1,2-dichloroethene , chloroform, 1,1,1-trichloroethane, benzene, carbon tetrachloride, 1,2-dichloroethane, TCE, toluene, octane, PCE, chlorobenzene, ethylbenzene, o,m,p-xylene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, 1,4-dichlorobenzene, undecane, naphthalene, tridecane, 2-methyl naphthalene, and pentadecane. Appendix B provides the Gore Sorber sampling report.

A three (3) to four (4)-inch diameter pilot hole was drilled through the concrete slab at each soil vapor sampling location. When the coring device had broken through the bottom of the concrete, a narrow diameter hole (three-quarter inch) was drilled into the subsurface to a depth of two (2) to three (3) feet below the bottom of the concrete slab. After the pilot hole was completed, an initial VOC measurement was made using a photoionization detector (PID) instrument immediately following the removal of the bit. The initial reading was recorded in the field logbook and is presented as Table 2-2.

Once the hole was created, a length of cord was tied to the loop end of the module, and a cork was tied to the surface end of the cord. A stainless steel insertion rod was placed in the pocket at the opposite end of the module, and the unit was inserted down the hole. The insertion rod was removed and the cork tamped flush into the ground at the soil surface. The Site map was marked with the location of the soil gas modules and the serial numbers.

The following information was recorded in the field data collection form for each soil vapor sample location:

- Sampler's name;
- Date, time and initial PID reading;
- Date and time of Gore module insertion and pilot hole sealing;
- Date, time and sustained PID reading;
- Module serial number;
- Survey location number, and descriptive location of the sampling area;
- Sampling depth(s); and
- Description of the surface features (i.e., drainage, facilities, etc.), soils, any contamination observed, and trenches or any other feature that may impact the soil vapor measurement.

Following the requisite module exposure period (approximately 13 days) each module was located, identified and verified in the field using the Site map. Each module was removed and placed in a labeled and properly sealed 20 ml glass vials. Preservation was not necessary for the samples.

The sample containers were placed in a cooler and shipped via Federal Express to W.L. Gore and Associates, Inc., located in Elkton, Maryland. The results are presented in Section 4.1.6.1 and the Gore Sorber report is presented in Appendix B.

2.7 TRIAD SOIL AND GROUND WATER INVESTIGATION

The soil and groundwater investigation at the Site was performed through the installation of soil borings with groundwater sampling to determine the presence and extent of contamination. Delta Well and Pump Co., Inc. of Ronkonkoma, New York, under ERM supervision installed a total of 69 soil borings as part of the soil investigation. Geoprobe sampling techniques were utilized to collect surface and subsurface soil and groundwater samples in accordance with the program established in the RI Work Plan and Field Sampling Plan. The soil boring sampling locations are shown on Figure 2-2.

Soil and groundwater samples were collected at nodes of a grid, which spanned the entire Site. Grid spacing was established on 75-foot centers in the perimeter of the Site with the spacing reduced to 15-foot centers in the former plating and chemical storage areas. Sampling was carried out at grid nodes to:

- assess impacts the Former Plating, Wastewater Treatment, and Chemical Storage Areas (approximately 41 nodes were sampled); and

- assess the perimeter and off-Site areas, (approximately 28 borings completed). Locations were chosen based on previously identified potential sources such as former USTs, chemical storage areas, etc.

The density of soil borings installed within the grid system was selected based on the CSM (i.e., biased toward known and suspected contaminated areas).

Borings were completed using direct push methodology (Geoprobe®). Soil samples were collected continuously at each boring location using 4-foot macro-core sample units and screened in the field using a PID. Soil boring logs describing subsurface soils encountered at each of the borings were prepared by the on-Site hydrogeologist. Descriptions of soil sample texture, composition, color, consistency, moisture content, recovery, odor, PID readings and staining were documented using the Unified Soil Classification system (USC System). Boring logs are presented in Appendix A. Soil boring locations are shown on Figure 2-2. A summary of the intervals sampled and their respective analyses are provided in Table 2-3.

The water table was encountered at approximately three (3) to five (5) feet bgs. With the exception of the four locations described in the following paragraph, continuous soil sampling was carried out up to twelve (12) feet bgs. Soil samples were collected from 0.0 to 0.5 ft bgs and subsequently from 1.5 to 2.5 ft bgs, 6.0 to 7.0 feet bgs and 11.0 to 12.0 feet bgs. Samples were sent for accelerated screening analysis for target compound list (TCL) VOCs and TAL metals to Mitkem Corporation, an approved Environmental Laboratory Accreditation Program (ELAP) certified laboratory.

Soil borings SB-55 and SB-56, located in the down gradient area of the Site, were installed to a depth of 30 feet bgs to address the potential for contamination migration below the base of the bulkhead located along the southern and eastern boundaries of the perimeter property, see Figure 2-1 for bulkhead locations. Borings SB-16 and SB-24 were also advanced to 30 feet bgs to further delineate the vertical distribution of metals in soil in these areas. The deep borings were also used to verify the presence and depth of the suspected clay layer.

Following completion of soil sampling at each boring location a groundwater sample was collected. A total of 65 groundwater samples were collected and analyzed for of TCL VOCs and TAL metals. Screening of groundwater samples was conducted by the Mitkem Corporation. The methods for soil and groundwater collection are described in the 2004 Metal Etching Work Plan. Due to the presence of suspended solids, the turbidity of groundwater samples collected during the primary investigation was often greater than 50 nephelometric turbidity units (NTUs). In these instances samples for metals analyses were collected in non-preserved bottles and were allowed to settle for a period of time before running the analysis. This allowed some of the suspended solids to drop out. Groundwater samples were not collected from SB-34 due to the presence of hydrocarbon staining and SB-59 due to collapse of the borehole.

Exclusive of quality assurance/quality control (QA/QC), 273 screening soil samples and 65 screening shallow groundwater samples were collected and analyzed for VOCs and metals to characterize the Site. Table 2-3 provides a sample summary of all samples collected at the Site and the analyses carried out.

Twenty percent (20%) of the field screening samples collected were also submitted for confirmatory laboratory analysis. A total of 59 soil samples and thirteen (13) groundwater samples were analyzed for confirmatory analyses. The soil and groundwater samples were analyzed by Mitkem for TCL VOCs (OLM04.1) and TAL Metals (ILM04.1). A portion of each soil sample was collected for laboratory chemical analysis as specified in the ERM 2004 Work Plan. Confirmation soil samples were collected from soil borings at depth intervals and placed on hold with the laboratory. The criteria used to decide when to collect confirmation soil samples were based on the screening analytical results. Selection based on screening results ensured that both high and low concentration samples were analyzed and that high or low biases in the screening analysis were identified.

Following receipt of the data packages, a qualified data validator reviewed the data (see Section 2.14 through Sections 2.17 for data quality and validation results.

2.8 SEDIMENT AND SURFACE WATER SAMPLING

Eight (8) sediment and surface water samples were collected from the Freeport Creek to assess any potential Site impacts on the sediment and water quality (Figure 2-2). Six (6) sediment samples (SED-01, SED-02, SED-03, SED-04, SED-05 and SED-07) were collected from along the shores where groundwater and storm water discharge to the Freeport Creek. Six (6) surface water samples (SW-01, SW-02, SW-03, SW-04, SW-05 and SW-07) were collocated with the sediment samples. The remaining two (2) sediment and surface water samples were collected upstream from the Site discharge point (SED-06 & SW-06) and downstream from the Site discharge point (SED-08 & SW-08). Surface water and sediment sampling locations were biased towards discharge points or any identified surface features potentially related to historical potential discharges. All Freeport Creek sediment samples were analyzed for VOC, SVOC, Metals, pesticides/PCBs and total organic carbon (TOC).

Sediment samples were collected using a decontaminated ponar dredge sampler. The sampling was conducted using the following general protocol:

- The sampling location was identified and recorded in the field notebook.

- The winch line and dredge sampler was released and fell through the surface water into the sediment at the desired sample location. Any standing water that accumulated in the ponar dredge or hand auger was decanted prior to sample collection. Sediment samples collected for VOC analysis were immediately placed into a sample container upon reaching the surface. Each metals sample was placed into a properly decontaminated stainless steel mixing bowl for homogenization prior to placement in laboratory provided glassware.

- Sample homogenization for metals analysis consisted of placing the sample from the ponar dredge into the stainless steel mixing bowl. The sample was stirred with a stainless steel spoon till the sample appeared consistent throughout.
- The sample was then transferred to the appropriate sample containers.
- The sample container was identified in terms of designation, depth, date and time the sample was obtained.
- Samples were preserved in accordance with the protocols outlined in the QAPP and shipped to the laboratory via overnight courier under proper chain of custody.
- The sampling tool was decontaminated according to the decontamination procedures described in the work plan for non-aqueous sampling equipment.

Each sample was visually examined for evidence of staining. The soil sample data recorded included date and time sampled, location, depth, grain size, color etc.

2.9 SANITARY AND STORM SEWER SAMPLING

A sediment sample was collected from the manhole (MH-01) located in the roadway at the corner of East Ray Street and South Main Street. MH-01 received sanitary and wastewater discharge from the former Metal Etching Corporation. A sediment sample was also collected from the storm drain (SD-01) located at the east end of East Ray Street (adjacent to the Site) that also likely received Site runoff, see Figure 2-2 for manhole and storm drain sample locations. Sediment samples were collected from the bottom of the manhole and storm drain with a properly decontaminated hand auger. The samples were collected and analyzed for VOC, SVOC, Metals and Pesticides/PCBs.

2.10 ADDITIONAL SAMPLING HEXAVALENT CHROMIUM, TCLP & TPH/DRO

In addition to the VOC and metals analyses performed, total petroleum hydrocarbon (TPH)/diesel range organics (DRO) analyses were performed on soil sample SB-07 (6.0 to 7.0) ft. The results are presented in Section 4.1.2.1.

To assess the potential leaching of metals in soil to groundwater, RCRA metals analyses, using the toxic compound leaching procedure (TCLP) was performed on four (4) soil samples: SB-02 (1.5 to 2.5) ft, SB-07 (0.0 to 0.5) ft, SB-10 (1.5 to 2.5) ft, and SB-16 (1.5 to 2.5) ft.

As prescribed in the RI Work Plan, if chromium concentration in soil exceeded 10 times the average background concentration (approximately 20 milligrams per kilogram (mg/kg) [parts per million] {ppm}]), based on Eastern US data reported in Technical and Administrative Guidance Memorandum (TAGM) 4046, in a sample. The sample was to be further analyzed for hexavalent chromium. Hexavalent chromium analyses were carried out on sixteen (16) samples. SB-02 (1.5 to 2.5) ft, SB-03 (0.0 to 0.5) ft, SB-07 (0.0 to 0.5) ft, SB-07 (1.5 to 2.5) ft, SB-07 (6.0 to 7.0) ft, SB-10 (0.0 to 0.5) ft, SB-10 (1.5 to 2.5) ft, SB-12 (0.0 to 0.5) ft, SB-12 (6.0 to 7.0) ft, SB-16 (0.0 to 0.5) ft, SB-16 (1.5 to 2.5) ft, SB-16 (6.0 to 7.0) ft, SB-17 (0.0 to 0.5) ft, SB-21 (6.0 to 7.0) ft, SB-24 (6.0 to 7.0 ft) and SB-34 (0.0 to 0.5) ft. Section 4.1.2.1 presents the results of the additional sampling conducted at the Site.

2.11 GROUND WATER INVESTIGATION

To evaluate the quality of groundwater at the Site, a network of ten (10) monitoring wells were installed and sampled. The monitoring wells were installed in areas where soil and groundwater impacts were observed during the RI activities.

2.11.1 Monitoring Well Installation

To augment the hydrogeologic and groundwater quality, data were obtained from the soil boring/groundwater investigation, Delta Well and Pump Co., Inc., under ERM supervision, installed a total of nine (9) permanent monitoring wells. Monitoring well MW-01 was installed using a Geoprobe at the completion of the vertical profile boring earlier in the RI process. Three (3) monitoring well clusters consisting of one shallow (S) well and one deep (D) well were installed at the Site (MW-02S, MW-2D, MW-03S, MW-03D, MW-07S and MW-07D). Additionally, three single shallow monitoring wells (MW-04, MW-05 and MW-06) were installed to ensure that LNAPL if present would be detected. The well clusters were installed such that the screened interval of the shallow wells bridged the groundwater table and the screened interval of the deep well served to monitor groundwater above the top of the “20 foot clay” present at a depth of approximately thirty-one (31) feet across the Site. The locations of the newly installed wells (MW-02 through MW-07) were based on a review of the results of the geophysical investigation, field observations, and the findings of the soil boring and groundwater investigation as described in Section 2.7, and approved by the NYSDEC. The monitoring well installations for MW-02 through MW-07 were performed using a Failing F-7 rotary drilling rig equipped with 4.25-inch ID (for the single shallow wells) and 6.25-inch ID (for the well clusters) ID hollow stem augers.

To reduce the potential for "running sands" during auger drilling, a head of potable water was applied within the augers when the water table was encountered to maintain a positive hydrostatic head on subsurface material during well installation. The borehole for each well installation was drilled to a predetermined target depth, typically thirty-one (31) and thirteen (13) feet bgs for deep and shallow monitoring wells, respectively.

The monitoring wells were constructed of 10-foot long, 2-inch ID, Schedule 40 PVC well screen with 0.010-inch slots and flush jointed PVC riser pipe. The new monitoring wells were constructed at each borehole once the hollow stem augers reached the target depth. Drill cuttings from the well installations were collected in reconditioned 55-gallon New York State Department of Transportation (NYSDOT) open-top drums and staged at the Site, pending characterization sampling and analysis, for disposal. Following the screen and riser installation, a sandpack consisting of No. 1 Morie sand was installed to a height of two (2) to three (3) feet (minimum 20% of the screen length) above the top of the well screen. During sandpack installation, the augers were slowly removed allowing the sand to flow evenly into the borehole. A level of sand above the base of the lead auger was maintained during the installation process to ensure proper placement of the sandpack.

Upon completion of the placement of the sand packs, a minimum 2-foot thick bentonite pellet was seal was installed into the annular space above the sand pack. For the cluster wells where two wells were constructed within the borehole the bentonite layer was brought to a height of approximately 15 feet bgs. At this depth No. 1 Morie was installed in the borehole to insure that the shallow of the two wells could be set at an accurate depth and insure that the water table was straddled with the ten (10) foot screen. The No. 1 Morie was brought to a level of two feet above the top of the well screen and sealed with a bentonite pellet slurry to insure that rain or standing water would not enter the well from above.

Once installed, the top of the well riser was marked to establish a reference point for subsequent surveying and groundwater level measurement events. The wells were then completed with steel protective manholes. The manholes were installed flush with grade and equipped with locking caps. Adequate space was left above the top of the well riser and below the steel protective cover to allow for the installation of an expandable well cap. The wells were fitted with locks that were keyed alike. A summary of monitoring well construction details is provided in Table 2-4. Monitoring well construction logs are presented in Appendix A.

Each of the shallow wells and well clusters were completed at the surface with 6-inch diameter flush-mount roadway boxes cemented in place. The top of each well was equipped with an expansion plug and padlock. Each drilling location was restored to pre-work Site conditions.

2.11.2 *Well Development*

The newly installed monitoring wells were developed using surging and evacuation methods. During well development, turbidity was measured at a minimum frequency of once per well volume of groundwater evacuated from the well. Well development measurements are presented in Appendix E. Development was continued until the turbidity value was less than 50 NTUs.

2.11.3 *Hydraulic Monitoring*

Site monitoring wells and piezometers were located horizontally and vertically by the surveyor Donald G. Dekennip. Ground level and well casing elevations were surveyed to the nearest hundredth of a foot (0.01) vertically and to the nearest one-tenth (0.1) of a second of latitude and longitude.

The monitoring wells have a reference point that is permanently affixed on the highest point of the inner PVC casing to allow for accurate and reproducible groundwater level measurements. Depth to water measurements were collected to the nearest 0.01 foot from the surveyed points identified on the well risers. Synoptic rounds of groundwater level measurements were collected at the time of installation and prior to and immediately following the October 2004 groundwater-sampling event. Groundwater levels were measured using an interface probe that is also capable of detecting NAPL. NAPL readings were also collected to monitor for the presence of LNAPL and DNAPLs. Neither LNAPL nor DNAPL was detected in Site monitoring wells. The synoptic groundwater elevation data that resulted from the monitoring sampling event is presented in Table 2-1.

The series of synoptic rounds of groundwater level measurements were collected and plotted to better understand the hydraulic conditions and flow directions at the Site. The results of the hydraulic investigation explained in more detail in Section 3.1.4.

2.11.4 *Ground Water Sampling*

Groundwater samples were collected for analyses to confirm the results of the RI soil boring and groundwater investigation. Samples were collected from the ten (10) monitoring wells installed on-Site: (MW-01, MW-02S, MW-02D, MW-03S, MW-03D, MW-04, MW-05, MW-06, MW-07S and MW-07D). The results of the groundwater sampling are presented in Section 4.1.3.3.

The following parameters were monitored prior to the purging of the monitoring wells and resulting data were documented in field logs:

- Date, time and weather conditions;
- Well number and well permit number;
- LNAPL, measured thickness, if present;
- Total depth of well from the top of inner casing or surveyors mark if present;
- Depth from the top of inner casing to water; and
- Estimated volume of groundwater in monitoring well.

The static water level in each monitoring well was measured and the volume of standing water in the well was calculated. An interface probe was used to check the wells for the presence of NAPL. No indication of DNAPL or LNAPL was noted at any well location and wells were purged and sampled. Pumps used for purging and/or collection of groundwater samples were properly cleaned utilizing an Alconox wash and potable water rinse followed by a deionized water rinse prior to the first well and between all subsequent well locations. Pumps were outfitted with dedicated lengths of new polyethylene tubing. The pumps and dedicated tubing were lowered into the well casing, purging was initiated and the pH, specific conductance, turbidity, dissolved oxygen, temperature, salinity and oxidation-reduction potential of the pump discharge were monitored to ensure stabilization of parameters prior conclusion of the purge activity.

A low flow protocol was employed for sampling during the RI. Groundwater sampling was conducted in accordance with Environmental Protection Agency (EPA) low-flow sampling procedures (USEPA, 1998). This technique was employed to minimize the turbidity of the samples.

Once the well purge was determined to be complete based on stabilization of parameters and/or volume of water purged (depending on well depth as mentioned above), a groundwater sample was collected from the well directly from the pump discharge in accordance with low-flow sampling procedures.

The following information was measured and documented during and after the well was properly purged:

- Start and end time for purging interval;
- Purge method;
- Purge rate; and
- Total volume of groundwater purged

All groundwater samples were handled in a manner consistent with the NYSDEC-approved FSP and QAPP. Each sample was properly labeled with the well identification, parameter sampled, date, time, samplers' initials, preservative, and the Site name. The groundwater samples were analyzed for full TCL and TAL analyses. Groundwater sampling records are presented in Appendix E.

2.12 SUPPLEMENTAL ACTIVITIES

2.12.1 Preliminary On and off-Site Soil Vapor Investigation (August 2004)

Additional RI field activities were conducted to assess soil gas quality at and in the vicinity of the Site. At the request of the NYSDEC, soil gas sampling was carried out to evaluate contamination of subsurface gasses by VOCs. Samples were collected using summa canisters beneath the on-Site buildings and at off-Site locations upgradient of the Site. Soil gas samples were collected from six (6) locations shown on Figure 2-2 and identified below:

- shallow soil vapor from beneath the slab of the small 1,200 square foot building located on the northwest corner of the Site (SG-01);
- shallow soil vapor from beneath the slab of the larger 2,400 square ft building on the northeast portion of the Site (SG-02);
- shallow soil vapor from beneath the road way (East Ray Street) upgradient of the Site and north of SB-15 (SG-03);
- shallow soil vapor from beneath the road way (East Ray Street) upgradient of the Site and north of SB-13 (SG-04);
- shallow soil vapor from beneath the road way (South End Place) upgradient of the Site (SG-05); and

- shallow soil vapor from beneath the road way (South End Place) upgradient of the Site (SG-06).

Soil gas samples were collected in evacuated Summa canisters with flow regulators at a maximum flow rate of 0.1 liters per minute. The samples were shipped via overnight delivery to ASC in Lancaster, New York for VOC analysis by EPA Method TO-15. Sampling procedures for each location are summarized below.

For the samples collected from beneath the building slab, a hole was drilled into the floor to a depth of approximately three (3) to six (6) inches into the sub-slab material. A dedicated length of new ¼ inch Teflon tubing was threaded through a laboratory-grade rubber stopper, and inserted in the hole to the bottom of the borehole. Plumbers putty was applied around the hole, rubber stopper and tubing to insure a good seal. The stopper served to seal the borehole through the concrete slab. The tubing was then connected to a Teflon-lined calibrated air-sampling pump with Teflon discharge tubing. Initially, the pump was connected to the discharge tube and approximately one volume of gas from the sub-slab probe was purged from the hole at no greater than 0.1 liters per minute. Once the purging was complete, a PID measurement was taken directly from the tubing. The results of PID measurements are provided in Table 2-5. Immediately following the PID reading, a Summa canister was attached to the Teflon inlet tubing and the sampling regulator set to collect a soil vapor sample at no greater than 0.1 liters per minute. Each sample was collected over a 2-hour period. After each sample was collected, Teflon tubing and stoppers were removed and disposed of as general refuse. All penetrations of concrete/asphalt were sealed with cement patch.

Soil gas sampling was performed according to the "Soil Gas Sampling Work Plan Addendum" approved by the NYSDEC which is provided in Appendix F. The results of this work are presented in Section 4.1.6.2.

2.12.2 *Supplemental Air/Subsurface Vapor Sampling (March 2005)*

The air and subsurface vapor sampling investigation consisted of the collection of thirteen (13) air and soil vapor samples from both on and off Site locations. Indoor air, ambient outdoor air, and subsurface soil vapor samples were collected. Further details of the sample locations are provided in the paragraphs below. A discussion of the results are presented in Section 4.1.6.3. Figure 3-15 provides the sample locations and sampling results for each supplemental air and subsurface vapor sample collected at the Site.

Off-Site indoor air samples were also collected from the basement, crawl space and first floor of two (2) buildings: 4 East Ray Street and 433 South Main Street, situated on the north side of East Ray Street. The samples were collected over a 24-hour period using summa canisters equipped with timed sample acquisition regulators. Concurrently, one (1) outdoor ambient air (background) sample was collected during off-Site indoor air sampling activities between the two (2) buildings. The ambient air sample was collected over a period of 2-hours using a timed summa canister sample acquisition regulator. A total of seven (7) air samples were collected from these off-Site locations. Sub slab samples could not be collected from beneath the homes on East Ray Street due to the presence of groundwater directly beneath the building slabs.

Off-Site subsurface soil gas samples were collected on the west side of South Main Street in the grass areas of two (2) residences (4 President Street and 3 Ray Street) and on-Site toward the southern most property boundary (Section 62, Block 45, Lot 155). Subsurface soil vapor samples were collected over a 2-hour period with the AMS retract-a-tip soil vapor sampling system. A total of three (3) subsurface soil gas samples were collected.

Finally, two (2) indoor air samples were collected from the two (2) existing on-Site building structures (2,400 square foot and 1,200 square foot buildings) as well as one (1) on-Site outdoor ambient air sample. The indoor air samples were collected over a 24-hour period and the outdoor ambient air sample was collected over a 2-hour period.

The air samples were analyzed by a NYSDOH ELAP-certified laboratory using USEPA Method TO-15 for VOCs. The results of this work are presented in Section 3.1.6.3.

2.12.3 *Sub-Slab Depressurization System Installations (March 2005)*

Two sub-slab venting systems were installed. One beneath the 2,400 square foot building (large warehouse building) and the other beneath the 1,200 square foot building (Show room) at the Site. The objective of the installation of these two venting systems was to provide a temporary means of reducing the pressure beneath the building slabs to provide an alternate migration pathway for soil vapor.

2,400 Square Foot Building

Two (2) stainless steel well screens (two inches in diameter, three (3) feet long, 0.020-inch slot) were installed at an even spacing along the centerline of the building. Installation of the screens was through holes cored through the concrete floor. The auger was then used to loosen the underlying soil, prior to driving the screens to the necessary depth. The annular space between the screen and the floor was sealed to prevent soil vapor from migrating into the building. Three-inch PVC Schedule 40 piping was connected to the screens and run along the ceiling to the northeast corner of the building. To allow for flow adjustment or isolation of each point, a valve was placed downstream of the well screens. The piping was inserted through an existing hole in a window and connected to a Radon America Model GP501 in-line ventilation fan mounted in the piping on the outside of the building. A tee and valve, installed at the inlet to the fan, allowed the fan to draw ambient air to keep the fan motor cool. The three-inch outlet piping was attached to the side of the building and extends above the roofline. The exhaust point was covered with a rain cap.

1,200 Square Foot Building

The 1,200 square foot building was recently renovated and limited space is available for interior floor penetrations and piping. Therefore, the venting point consisted of ten (10) feet of stainless steel well screen (two inches in diameter with 0.020-inch slot size) driven horizontally ten (10) feet underneath the building. An area near the building exterior was excavated and the building foundation exposed to install the screens. A core drill was used to drill an approximate three-inch hole through the building foundation, at a depth of approximately 16 to 24 inches below grade. The well screen was then driven underneath the building. The annular space between the screen and the foundation was sealed.

Three-inch PVC pipe was connected to the well screen. The piping was connected to a Radon America Model GP501 in-line ventilation fan mounted in the piping on the outside of the building. As described above, a tee and inlet valve allowed the fan to draw ambient air to keep the fan motor cool. The three-inch outlet piping was attached to the side of the building and extends above the roofline. The exhaust point is covered with a rain cap. Following completion of the venting system, asphalt surfaces were restored to original condition.

2.13 DISPOSAL OF INVESTGATION DERIVED WASTE

Waste generated during the RI requiring management and disposal consisted of general trash (boxes, paper, etc.), residual soil generated during decontamination activities, polyethylene tubing used in well development and purging activities, and personal protective equipment (PPE) such as nitrile gloves.

Non-contaminated trash, debris and protective clothing were placed in a trash dumpster and disposed of by a local garbage hauler. The drill cuttings from the installation of each monitoring well were stored in reconditioned 55-gallon, NYSDOT open-top drums provided by ERM's drilling subcontractor drums in accordance with NYSDEC TAGM No.

4032. Liquids generated from equipment decontamination and permanent groundwater monitoring well development/purging were discharged to the ground at the point of generation in accordance with the protocols established in the RI Work Plan.

Accordingly, handling and disposal procedures of soil were as follows:

- Cuttings from soil borings and the tailings from the unused portion of the samples were placed in 55-gallon steel drums. The borehole was grouted by hand or with a tremie pipe. The boreholes were sealed at or near the water table with a non-shrinking impermeable material to prevent the hole from acting as a conduit for surface runoff.
- Cuttings from monitoring well installations were collected and stored in reconditioned 55-gallon, NYSDOT open-top drums provided by the ERM's drilling subcontractor.
- Liquids generated from equipment decontamination and permanent groundwater monitoring well development/purging were discharged to the ground at the point of generation.
- Drums were labeled according to the borehole/well number. The drilling subcontractor moved the drums on a daily basis at the direction of ERM's representative to the staging area.
- ERM procured waste transport and disposal subcontractor services to properly dispose of investigative derived waste (IDW) in accordance with all local, State and Federal regulations.
- Non-contaminated trash, debris and protective clothing were placed in a trash dumpster and disposed of by a local garbage hauler.

Representative samples of cuttings and spoils were analyzed to evaluate if the materials were "hazardous waste" or a "non-hazardous waste" and to allow for proper classification, treatment, and disposal. Cuttings and soils were sent off-Site for disposal as "non-hazardous waste" and transported by a hauler licensed in accordance with 6 (New York Code of Rules and Regulations) NYCRR Part 364. Appendix G provides the Investigative Derived Waste Disposal Manifest for the fieldwork.

2.14 ANALYTICAL DATA QUALITY EVALUATION

The Quality Assurance Project Plan (QAPP) details the Data Quality Objectives (DQO) and the analytical requirements for this project. Quality Assurance (QA) protocols, both NYSDEC Analytical Services Protocols (ASP) and non-ASP are provided in the QAPP. All samples gathered during this investigation were collected by the means described in the QAPP. The analytical laboratories utilized for this project maintained

NYSDOH ELAP certification in all categories of analytical testing for the duration of the project. A NYSDEC ASP Category B deliverable was provided for all samples except those analyzed by the screening method, a few additionally requested analyses and the vapor samples. The deliverable provided for those samples not receiving a full Category B deliverable, except the vapor samples (gore sorbers), contained most elements found in a Category B deliverable and was sufficient to review the data and determines its usability. The deliverable for the vapor samples was a detailed report containing data tables and plume maps. The electronic copy deliverables can be found in Appendix J. A Data Usability Summary Report (DUSR) was prepared for the soil gas (June and August 2004) samples, the confirmatory analyses, the groundwater samples and the sediment and surface water samples collected from the Freeport Creek. There are a total of four DUSR. Each DUSR can be found in Appendix I. Included with each DUSR are the validated and qualified organic and inorganic analysis data sheets (Form I) for each sample referenced by the DUSR. These validated Form I results have been transferred to each applicable analytical results summary table.

2.15 RELIABILITY OF LABORATORY ANALYTICAL DATA (SCREENING AND CONFIRMATORY ANALYSES/SOIL GAS/GORE SORBERS

Included in this section is the discussion of the analytical procedures performed for the analysis of all environmental samples of various media collected during the investigation. A discussion pertaining to the validation and qualification of the analytical results is also provided.

2.15.1 Laboratories Performing Analyses

Analytical Services Corporation (ASC) analyzed the soil gas samples and the soil and aqueous samples from the vertical profile gathered collected during the investigation. ASC was located at 4493 Walden Avenue, Lancaster, New York, 14086. ASC is a NYSDOH ELAP certified laboratory (Lab ID number 10486). ASC meets the requirements for documentation, data reduction and reporting and is certified to perform the analytical methods utilized in this investigation.

Mitkem Corporation (Mitkem), analyzed the screening and confirmatory soil and aqueous samples collected from the soil borings along with the sediment and surface water samples collected from the Freeport Creek and the aqueous samples collected from the monitoring wells. Mitkem is located at 175 Metro Center Boulevard Warwick, Rhode Island 02886-1755. Mitkem is a NYSDOH ELAP certified laboratory (Lab ID number 11522). Mitkem meets the requirements for documentation, data reduction and reporting and is certified to perform the analytical methods utilized in this investigation.

W.L. Gore & Associates, Inc. (GORE) analyzed the vapor samples collected at the Site. GORE is located at 100 Chesapeake Boulevard, Elkton, Maryland 21921.

2.15.2 Analytical Procedures

Samples collected at the Site, included vapor, soil gas, soil, groundwater, surface water, and sediment were analyzed following the methods detailed in the QAPP and the ASP. The methods, both CLP and SW-846, provide the technical and contractual background for environmental laboratories to conduct analytical methods for the preparation, detection and quantitative measurement of organic target compounds and inorganic target analytes in various matrices.

The vapor samples collected during the investigation were analyzed for Volatile Organic Compounds (VOCs) by a modified SW-846 Method 8260/8270. The soil gas samples collected during the investigation were analyzed for VOCs following USEPA Method TO-15. The soil and aqueous samples collected from the vertical profile were analyzed for Target Compound List (TCL) VOCs by SW-846 Method 8260B, TCL Semivolatile Organic Compounds (SVOCs) by SW-846 Method 8270C, TCL Pesticide Compounds (Pest) by SW-846 Method 8081A, TCL Polychlorinated Biphenyls (PCBs) by SW-846 Method 8082, and Target Analyte List (TAL) Metals by USEPA SW-846 Methods 6010B/7471A. These methods were performed following "Test Methods for Evaluation Solid Waste, USEPA SW-846, Third Edition, September 1986, with revisions." The TCL and TAL are detailed in Exhibit C of the most recent version of the Contract Laboratory Program (CLP) Statement of Work (SOW).

The screening soil and aqueous samples collected from the soil borings during the investigation were analyzed for a reduced list of TCL VOCs by a modified SW-846 Method 8260B and a reduced list of TAL Metals by a modified SW-846 Method 6010B. Table 2-6 contains the reduced lists of compounds reported by the laboratory for the screening samples.

The soil and aqueous samples for screening analysis were picked-up at the Site at mid-day each day, and delivered to the laboratory late that afternoon. Analyses and initial data review were performed over-night with final data review, data reporting, and electronic data deliverable file generation completed the following morning. The approaches utilized by the laboratory to analyze the samples for VOCs and Metals are summarized below.

Screening Approach for VOCs

- The target quantitation range for volatile organics was set at 250 – 10,000 ug/Kg.
- Samples were collected into pre-weighed VOC vials containing 5 ml of purge and trap grade methanol.
- Analyses were performed using the methanol-preserved aliquots using the medium-level approach.
- Instrument was calibrated for only a reduced list of analytes (see
- Table 2-6).
- Re-analyses were not performed for low-level samples, which did not contain detectable concentrations at the nominal reporting limit of 250 ug/kg.
- Dilutions were not performed where concentrations exceeded the upper calibration range of the instrument. The subsequent samples that may be impacted by relatively low-level carryover were identified and a determination was made if the samples required re-analysis.
- Results were reported on a wet weight basis, no percent moisture determinations were performed.
- Data qualifiers were applied accordingly.
- Each batch of up to 20 samples included an instrument tune using 4-bromoluoro-benzene (BFB) continuing calibration verification check standard, method blank, laboratory control sample and MS/MSD.

Screening Approach for Metals:

- Soil samples were prepped at half of the normal digestion weight at approximately 0.50 grams. This step reduced both the possibilities of matrix and spectral interferences resulting from high levels of target and interferent elements, as well as the likelihood of target analytes exceeding the linear range of the instrument. This approach proved successful as very few samples were found to contain analyte concentrations over the linear range of the instrument or negative peaks resulting from interferences.
- Method blanks and analytical run blanks were evaluated against project action levels rather than method specific action levels for all target metals. This reduced the need for reanalysis of samples that contained low level contamination below the levels of concern for this project.
- To provide "screening-type" results, a Continuing Calibration Verification (CCV) QC limit of +/- 15% was utilized.
- Metals spike results are qualified on the QC report for all percent recoveries that are outside of the QC limits. Metals methodology states that for sample values that are greater than four times the spike amount, no data qualification should be made. This evaluation step was not applied due to the time constraints of this project. Some spike

recoveries that meet method QC criteria were qualified on the QC reports. No modifications have been applied.
- In order to reduce analysis time and expedite data production, serial dilutions and post-digestion spikes (normally required per method quality control criteria) were not analyzed.

Twenty percent of the overall number of screening samples per matrix were collected in duplicate for confirmatory analysis. The purpose of the confirmatory analyses was to confirm the concentrations reported in the screening analyses. Refer to Appendix D-7 and Appendix D-10, which include an evaluation of the comparability of the screening results versus the confirmatory analyses. The confirmatory analyses performed included TCL VOCs following United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) Statement of Work (SOW) for Organics Analysis, Multi-Media, Multi-Concentration, OLM04.2 (latest revision) and Target Analyte List (TAL) Metals following USEPA CLP SOW Method ILM04.1.

Sediment and surface water samples collected from the Freeport Creek, the sediment samples collected from the manhole (MH-01) and storm drain (SD-01), and aqueous samples collected from the monitoring wells were analyzed for TCL VOCs, TCL SVOCS, and TCL Pest/PCB following USEPA CLP SOW OLM04.2 and TAL Metals following USEPA CLP SOW Method ILM04.1. Aqueous monitoring well samples were also analyzed for Hexavalent Chromium following SW-846 Method 7196A. Sediment samples, excluding the manhole and storm drain sediment samples, were also analyzed for Total Organic Carbon following a modified "Lloyd Kahn Method, July 27, 1988". Two aqueous monitoring well samples were also analyzed for Chloride following EPA Method 325.2. It should be noted that not all aqueous monitoring well samples were analyzed for Chloride due to limited available sample volume.

Additionally, a select number of screening samples were analyzed for Hexavalent Chromium following USEPA Method 7196A, TCLP Metals prepared in accordance with SW-846 Method 1311 and analyzed by SW-846 Method 6010B and 7470A and Diesel Range Organics (DRO) analysis by a modified USEPA Method 8015B.

A detailed summary of all samples collected and their associated analyses can be found in Table 2-3.

2.16 DATA VALIDATION

2.16.1 Objectives

Data validation is the assessment of data quality with respect to method requirements and technical performance of the analytical laboratory. The overall objective of the data validation process is to determine the degree of confidence that may be placed on the analytical results. The validation process identifies deviations from the methods, poor quality control (QC) results, matrix interference, and other analytical problems that may compromise the potential uses of the data. Analytical data packages were examined to ensure that all required laboratory components are included, all QA/QC requirements were performed, and the data use restrictions were well defined. The analytical data were qualified and appropriately flagged by the data validator. This information was taken into account during the interpretation of the data.

2.16.2 Procedures

A separate Data Usability Summary Report (DUSR) was prepared for the soil gas samples, the confirmatory soil and aqueous samples collected from the soil borings, the surface water and sediment samples collected from the Freeport Creek and the aqueous samples collected from the monitoring wells. A modified Tier I review was performed on the vertical profile samples, the screening samples and the additional analyses requested (Hexavalent Chromium, TCLP Metals, DRO, etc.). A separate report was generated to discuss the findings of these reviews. The DUSRs were prepared according to the guidelines established by Division of Environmental Remediation Quality Assurance Group and reviewed the following questions:

- Is the data package complete as defined under the requirements for the NYSDEC ASP Category B or USEPA CLP deliverables?
- Have all holding times been met?
- Do all the QC data: blanks, instrument tunings, calibration standards, calibration verifications, surrogate recoveries, spike recoveries, replicate analyses, laboratory controls and sample data fall within the protocol required limits and specifications?
- Have all of the data been generated using established and agreed upon analytical protocols?
- Does an evaluation of the raw data confirm the results provided in the data summary sheets and qualify control verification forms?
- Have the correct data qualifiers been used?

The data have been evaluated according to the protocols and quality control (QC) requirements of the analytical methods, the Analytical Services Protocols (ASP), the USEPA CLP National Functional Guidance for Organic Data Review (October 1999), the USEPA CLP National Functional Guidelines for Inorganic Data Review (July 2002), the USEPA Region 2 RCRA and CERCLA Data Validation Standard Operating Procedure (SOP) Number HW-6, Revision 12, March 2001: CLP Organics Data Review and Preliminary Review, SOP Number HW-2, Revision 11, January 1992: Evaluation of Metals Data for the CLP Program, and the reviewer's professional judgment. The order in which the aforementioned guidance documents and/or criteria were listed to be used for validation does not imply a hierarchy of reliance on a particular document. The most comprehensive reference sources of criteria will be used to perform a complete validation.

The review of data analyzed by SW-846 methods also utilizes the USEPA Region 2 Data Validation SOP Number HW-24, Revision 1, June 1999: Validating Volatile Organic Compounds by SW-846 Method 8260B, SOP Number HW-22, Revision 2, June 2001: Validating Semivolatile Organic Compounds by SW-846 Method 8270C, SOP Number HW-23B, Revision 1.0, May 2002: Validating PCB Compounds by SW-846 Method 8082 (until a Regional Data Validation SOP can be prepared for Pesticides (i.e., utilizing analytical method SW-846 Method 8081A), SOP HW-23 should be used in conjunction with the QA/QC criteria detailed in SW-846 Method 8081A, and the reviewer’s professional judgment.
The review of the soil gas samples also utilizes the USEPA Region 2 Data Validation SOP Number HW-18, Revision 0, August 1994: Validating Canisters of Volatile Organics in Ambient Air and the reviewer’s professional judgment.

A preliminary review of the data was performed to verify that all of the necessary paperwork, such as chain-of-custodies, traffic reports, analytical reports, and deliverable packages, were present. A qualified ERM chemist verified the qualitative and quantitative reliability of the data as the laboratory provided it and then performed a detailed quality assurance review.

The following items/criteria were reviewed for Organics:

- Case narrative and deliverables compliance
- Holding times both technical and procedural and sample preservation (including pH and temperature)
- System Monitoring Compound (Surrogate) recoveries and summaries
- Matrix Spike/Matrix Spike Duplicate (MS/MSD) results, recoveries and summaries
- Blank spike (BS) results, recoveries and summaries

- Method blank results and summaries
- Gas Chromatography (GC)/Mass Spectroscopy (MS) tuning and performance
- Initial and continuing calibration summaries
- Internal standard areas, retention times and summaries
- Field and Trip Blank Data when applicable
- Blind Field Duplicate sample results when applicable
- GC/Electron Capture Detector (ECD) Instrument Performance Check
- Pesticide Cleanup Checks
- Organic analysis data sheets (Form I)
- GC/MS and GC chromatograms, mass spectra and quantitation reports
- Quantitation/detection limits
- Qualitative and quantitative compound identification

The following items/criteria were reviewed for the Inorganics:

- Case narrative and deliverable requirements
- Holding times and sample preservation
- Detection limits
- Inorganic analysis data sheets (Form I)
- Initial and continuing calibration verifications
- Contract Required Detection Limit (CRDL) standard analysis
- Lab blank data
- Inductively Coupled Plasma Spectroscopy (ICP) interference check sample (ICS) analysis
- Matrix Spike analysis
- Matrix Duplicate analysis
- Laboratory control sample (LCS) results
- ICP serial dilution analysis
- Field Blank results when applicable
- Blind Field Duplicate results when applicable

Based upon the results of the data review, detailed DUSR/data validation summary reports were prepared. The DUSRs/reports consist of a section that contains an assessment of the deliverables, followed by a section that describes, on an item-by-item basis, the analytical results and any qualifications that should be considered when using the data. The qualifications were made by assessing the results submitted by the laboratory in terms of the technical requirements of the analytical methods (including quality assurance/quality control [QA/QC] criteria) and the data validation requirements. The DUSRs/reports highlight the data results that did not meet QC limits and therefore may have required data qualification. The reports also indicate the data qualification actions taken as a result of these criteria.

Based upon the data evaluation process, the qualifications of data are made by the use of qualifier codes. These qualifiers serve as an indication of the qualitative and quantitative reliability of the data. The qualifier codes utilized for this project are as follows:

- No qualifier - The analyte was positively identified at the associated numerical value, which is the concentration of the analyte in the sample.
- U – Non-detect. The compound was analyzed for, but not detected. The associated numerical value is the detection limit. The value is usable as a non-detect at the detection limit.
- J - Estimated value. The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample. The value is usable as an estimated result.
- UJ – The compound was analyzed for, but not detected. The associated numerical value is the detection limit. However, due to a QC exceedence the value is an estimated quantity. The value is usable as a non-detect at the estimated detection limit.
- R - Rejected. Quality control indicates that the data are unusable (compound may or may not be present).

2.16.3 Results

The analytical results for all samples collected as part of the investigation are valid and usable with qualifications as noted in each DUSR and modified Tier I review. Data qualifiers were taken into account during the interpretation of the analytical results. Analytical results were simplified for preparation of the analytical results summary tables which are presented in Section 4.0. Qualifier flags were limited to “U” for non-detects, “J” for estimated values based upon results of the validation, “UJ” for non-detect values that were estimated based on the validation and “R” for values that were deemed as unusable during the validation process based on quality control deficiencies. No analytical results were rejected based on the data evaluation. Overall there was no significant impact regarding the usability of the data set. The validator has determined that after thorough review of the entire data set, all samples collected during the investigation are valid and should be considered usable.

2.17 EXPOSURE ASSESSMENT

A qualitative Human Health and Environmental Exposure Assessment for the Site was completed. The objectives of the Exposure Assessment were to:

- identify potential exposure pathways for contaminants at the Site;
- identify chemicals of concern for each exposure pathway; and
- qualitatively evaluate potential human health exposures for each pathway.

The Exposure Assessment was conducted in accordance with the protocols specified in the RI Work Plan (ERM, 2004), and is presented in Section 4.0.

3.0 ENVIRONMENTAL AND PHYSICAL SETTINGS

The Site is located adjacent to Freeport Creek at an average elevation of five (5) feet above mean sea level (msl). The Site and Study area boundaries are presented as Figure 1-2. This surface water body tidally influences local hydrogeology at the Site. Consequently, groundwater beneath the Site ranges in elevation from 0 feet msl at low tide to 3.5 feet msl at high tide. The bulkhead along the shore does not appear to affect groundwater movements beneath the Site. The topography of the area generally dips gently southward towards the Atlantic Ocean. Further site environmental and physical settings are presented in the following sections.

3.1 SITE SPECIFIC CHARACTERISTICS

3.1.1 Regional Geology

The Site is located in southwestern Nassau County, Long Island. Long Island is situated within the Atlantic Coastal Plain physiographic province, which is underlain by a wedge of unconsolidated sediments that thickens and dips to the southeast toward the Atlantic Ocean. Figure 3-1 is presented to facilitate the following discussion and depicts a generalized north-south trending cross-sectional view of the sediments, which comprise Long Island.

The unconsolidated deposits, which underlie the Site study area, range in age from late Cretaceous (65 million years ago) to recent. The Pleistocene stratigraphic record in Long Island includes depositional sequences of two glaciations (Illinoian and late Wisconsinan), the last interglacial (Sangamon) and interstadial (mid Wisconsinan), and the latest postglacial interval. The oldest glacial deposits are of Illinoian age and include till, outwash and lacustrine facies. This older drift underlies younger, late Wisconsinan, glacial deposits. Its upper strata were deformed and thrusted by the advancing, late Wisconsinan ice sheet. Its undeformed surface out crops near sea level in southeastern Long Island. Erosion during the higher than present Sagamon Sea may have contributed to the drift's low-relief.

An in-place subsurface marine clay, the Gardiners Formation, was deposited during the last interglacial interval. This unit lies between 110 and 150 feet below sea level beneath the southeast coast and is about thirty (30) feet thick. It contains microflora and microfauna indicative of warm climatic conditions. It is not the equivalent of glaciolacustrine clays and thrusted masses of marine sediment known as 'Gardiners Clay'. The latter, which contain a cold-water fauna are found as clasts in the late Wisconsinan moraines in eastern Long Island. However, clasts of mid-Wisconsinan age estuarine and coastal sediment emplaced in the late Wisconsinan end moraine in western Long Island contain a pollen zonation revealing a cold-warm-cold climatic fluctuation for that interval. Mid-Wisconsinan 'warm climate' clays also occur in place off the south shore. A possible postglacial marine clay, the "20-Foot Clay", formed locally in south shore embayments. Correlations based on radiometric ages and fossil content have been made between Sangamon and mid-Wisconsinan strata of Long Island and the mid-Atlantic coastal region to the south. Sangamon, mid-Wisconsinan and late Wisconsinan pollen zonations facilitate these correlations.

The principal deposits at land surface in the vicinity of the Site are Pleistocene (glacial) in age. In the western region of Nassau County, where the Site is located, the thickness of the unconsolidated deposits ranges from approximately 400 feet on the north shore of Long Island to greater than 1,500 feet on the south shore. The approximate thickness of the unconsolidated deposits in proximity of the Site is estimated to be 1,000 feet.

The unconsolidated deposits, from land surface downward, include glacial deposits of Pleistocene age (Pleistocene deposits); the Matawan Group-Magothy Formation (Magothy), undifferentiated, of late Cretaceous age; and the Lloyd sand and clay members of the Raritan Formation, also of late Cretaceous age. Both the Upper Glacial and Magothy are principal aquifers in the region.

The unconsolidated deposits rest unconformably on crystalline bedrock, consisting of Precambrian schist and gneiss, which is considered to be the bottom of the groundwater reservoir on Long Island. The age of the bedrock beneath Long Island has been established as Precambrian. The geologic history of this region exceeds 575 million years. However, long periods of non-deposition and/or periods of large-scale erosion are responsible for limiting the rock record to the older Precambrian bedrock and younger Upper Cretaceous and Pleistocene sands, gravels and clays, which are believed to have been deposited during the last 125 million years.

3.1.2 *Site Geology*

The Site is underlain by glacial outwash deposits that generally consist of varying amounts of sand, silt, and clay. The upper three (3) to four (4) feet of material on the eastern portion of the Site is made up of a densely compacted fill material consisting mainly of gravel, debris such as brick and wood timbers. Below the fill material is a highly organic humus horizon composed of plant organics and shells. This highly organic humus and peat horizon occur between four (4) to eleven (11) feet below ground surface (bgs). The upper thirty (30) feet of sediments are mixtures of well-sorted sands and silts.

It was anticipated based on USGS records that the "20 –foot clay1" existed beneath the Site at a depth of approximately 50 feet below ground surface. During the initial RI phase the vertical profile boring encountered a stiff grayish green clay at approximately thirty-one (31) feet below ground surface. It was unclear whether this was the "20-foot clay" or rather a lense or stringer of clay. Therefore, the boring was continued an additional 11 feet to a depth of approximately 41 feet bgs, due to the stiffness of the clay the geoprobe could not penetrate further and the thickness of the clay was not determined. Based on the geologic descriptions of the clay present beneath the Site and previous studies conducted in the vicinity, it is believed that the "20-foot clay" exists below the Site at an approximate depth of 31 to 35 feet bgs.

The "20 Foot Clay" was encountered at the Site in several boring locations. In each instance the top of the clay was encountered at similar depths between 30 and 35 feet bgs. The complete thickness of the clay was not determined at the Site so as not to penetrate the clay and create a preferential pathway for migration of impacted groundwater into the unit below. Table 3-1 presents the borings that identified the top of the clay and the depth it was encountered.

The glacial outwash is underlain by the Magothy formation, also called the Magothy Aquifer. The Magothy Aquifer is made up of sand and gravel with intermittent beds of clayey sands and is considered a sole source aquifer. In many areas along the south shore of Long Island the Gardiners Clay formation lies between the Magothy and the upper glacial outwash deposits. However, it is generally understood that the upper glacial deposits are hydraulically connected to the Magothy Aquifer and most of the recharge to the aquifer is through infiltration. Water supply wells (Nassau County Water Authority Well Field) are located within a mile northwest (upgradient) of the Site.

3.1.2.1 *Geophysical Investigation Results*

Both electromagnetic (EM) and ground penetrating radar (GPR) methods were utilized to identify and characterize the subsurface features at the Site. In general, the geophysical survey identified several areas of subsurface rubble, concrete pads, and building foundations of former

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[1] Perlmutter, N.M., and Geraghty, J.J. Geology and Groundwater Conditions in Southern Nassau and Southeastern Queens Counties, Long Island, N.Y., U.S Geological Survey Water Supply Paper 1613-A1963

buildings. Some exposed features also caused metallic responses which include walls of the two (2) existing buildings, boats, boat trailers and metal fences. The less than optimal results of the geophysical investigation were due in part to the large amount of shallow sub-surface debris (i.e., metal, rubble, and trash). This material interfered with the transmission of signals that would be expected from any possible buried pipes, tanks, etc. The geophysical data report is presented in Appendix C.

The geophysical survey detected the outlines of two (2) of the former Site buildings in the central part of the survey area, and also identified a tank-like GPR reflector on the eastern wall of the 1,200 square foot office building which coincided with a moderately strong metal anomaly. Evidence of a tank in this area was not confirmed. The anomaly may have been due to an excavation northeast of the building carried out to connect a sewer line.

Finally, the geophysical report indicates an anomaly located at grid node 10, depicted on Figure 1 of the geophysical report, which can be found in Appendix C of this document. Grid node 10 is the approximate location of SB-34, which is described in further detail in Section 4.1.2.1 of this report. Figure 3-2 presents the potential UST locations identified during file reviews, field investigation and potential geophysical tank-like reflectors.

Deleted: ¶

3.1.3 Regional Hydrogeology

The Upper Glacial and Magothy, aquifers are designated as part of Long Island's sole-source aquifer system with NYSDEC Class GA designations for use as a source(s) of potable water supply. For the purpose of this investigation, only the Upper Glacial and Magothy aquifers will be discussed.

3.1.3.1 Upper Glacial Aquifer

The Pleistocene deposits contain the water table aquifer in this region of Long Island, which is referred to as the Upper Glacial aquifer. In the vicinity of the Site, depth to water ranges between three (3.0) to five (5.0) feet below land surface. Hydraulic conductivity values for the Upper Glacial aquifer range between 150 to 300 ft/day and averages about 270 ft/day. The average hydraulic gradient in the Upper Glacial aquifer within this area of Nassau County is 0.0017 ft/ft. The Upper Glacial aquifer provides groundwater recharge to the underlying Magothy aquifer.

3.1.3.2 *Magothy Aquifer*

The Magothy formation is fully saturated and, therefore, its entire thickness makes up the Magothy aquifer. Hydraulic conductivities for the Magothy aquifer average 40 and 70 ft/day and may range as high as 190 ft/day in the basal zone. The average hydraulic gradient in the Magothy aquifer within this area of Nassau County is 0.0019 ft/ft. The Magothy aquifer receives groundwater recharge from the overlying Upper Glacial aquifer.

3.1.4 Site Hydrogeology

Groundwater occurs at depths ranging from three (3) to six (6) feet below grade at the Site. Previous studies conducted in Nassau County indicate that the hydraulic conductivity of the shallow soils in the area is on the order of 250 feet/day and groundwater flow is toward the southeast under a regional gradient of 0.00125 feet/feet and local gradient of .0064 feet/feet.

3.1.4.1 *Tidal Study Results*

On July 26 and 27, 2004 , a tidal influence study was conducted at the Site using select piezomenters and the deep micro-well. Specific piezometers were selected for the tidal study to obtain representative observations of tidal influences across the Site. The results of the study confirmed that water level measurements were collected over two full tidal cycles. During the tidal cycle, the water level in the Freeport Creek fluctuated 4.59 feet. The first recorded high tide occurred at approximately 1554 hours on July 26th, almost four and half hours into the study. The initial low tide was observed at 2232 hours, eleven (11) hours after the study began. A plot of water levels versus time shows a sinusoidal effect in the water level fluctuations in all piezometers evaluated (see Figure 3-2 for results). The sine waves were similar in shape but ranged in amplitude between –0.73 and 3.66 feet of fluctuation. As previously described the time it takes high or low tide impacts to be observed in a Site piezometer is referred to as lag time. Lag time causes a phase shift in the plot of water levels versus time between high and low water levels in the Freeport Creek and those in the Site piezometers. The lag times vary between approximately three (3) minutes to three (3) hours and twenty (20) minutes behind the low and high tides in Freeport Creek.

The greatest water level fluctuation was observed in piezometer P4 at 4.14 feet. P4 is located closest to the Freeport Creek and the greatest tidal response would be expected at this location. The second highest water level fluctuation was observed in P9 with a range of 3.26 feet. It appears that the water level changes observed in P 4 are similar to those observed in the Freeport Creek at high tide, however, the low water level changes in Freeport Creek are more similar to those observed in P9.

The smallest water level fluctuation (0.42 feet) was observed in P10. P10 is located furthest away from the Freeport Creek, and therefore a very small tidal response was expected.

The observed water level fluctuations indicate that the formation at each piezometer location is in good hydraulic communication with the Freeport Creek. Table 3-2 presents a summary of the tidal study groundwater elevation data.

The plot (Figure 3-3) of hourly barometric pressure measurements (data from John F. Kennedy Airport) versus time for the tidal influence study period indicated that the atmospheric pressure dropped by slightly less than 0.2 inches of mercury. Groundwater levels within confined aquifer wells will typically rise in response to rapid decreases in barometric pressure and fall in response to increases. No effects from the relatively slow and small barometric pressure decline were observed in any of the wells during the tidal influence study.

3.1.4.2 *Ground Water Elevation and Flow*

To evaluate groundwater flow paths at the Site, groundwater elevation contour maps were constructed. The groundwater elevation contour maps were generated using data collected during the tidal study in July 2004 and prior to and immediately following the groundwater-sampling event on 7 and 8 October 2004. Collected groundwater elevation data are presented in Table 2-1. Groundwater contour maps were generated with three (3) sets of monitoring points; the first set utilizing the temporary piezometers screened at the water table (P04, P06, P08, P09 and P10) shown on Figure 3-4; the second set utilizing monitoring wells screened at the water table “shallow wells”, specifically MW-02S, MW-03S, MW-04, MW-05, MW-06 and MW-07S shown on Figures 3-5 and 3-6, and; third set utilizing monitoring wells screened on top of the 20 Foot Clay specifically MW-01, MW-02D, MW-03D and MW-07D, shown on Figures 3-7 and 3-8.

The results of the tidal study demonstrate that water levels across the Site are clearly influenced by tide changes and are highly variable. Consequently groundwater flow paths cannot be accurately depicted with one set of water level measurements. In tidally influenced groundwater regimes, average values computed from data collected over a longer period of time will provide a more accurate representation of long term groundwater hydraulic conditions. As a result, a groundwater flow map was constructed from water table elevations averaged over the period of the tidal study. Figure 3-4 represents the groundwater flow path from higher groundwater elevations to the lower groundwater elevations. The average groundwater elevation established from the averaged heads over the tidal influence study period indicates that the flow paths at the Site trend toward the south-southeast.

As depicted in Figures 3-5 through 3-8, groundwater elevation is highly variable and dependent on tidal stage. Figure 3-5 depicts the shallow groundwater elevations during the final stage of outgoing tide. Figure 3-6 also depicts shallow groundwater elevations however; low tide had just occurred and the tide on this figure is in the beginning stage of incoming toward the Site. This is evident on the east side of the Site with the higher groundwater elevation observed at MW-05. Figure 3-7 presents the final stages of outgoing tide in deep monitoring wells screened above the "20 foot clay" approximately 20 to 30 feet bgs, and Figure 3-8 presents the first stages of incoming tide toward the site in deep monitoring wells screened above the "20 foot clay".

The depth to water at the Site ranges from approximately 3.0 feet below grade to approximately 5 feet below grade. Average groundwater elevation determined by the tidal influence study and groundwater elevation data determined from synoptic water level measurements across the Site as shown on the groundwater gradient maps (Figure 3-9), illustrate a generalized flow toward the Freeport Creek (south southeast flow direction). This flow direction appears to be consistent with the local and regional topographic setting.

During the planning and development stages of the RI it was thought that the bulkhead located along the southern and eastern portions of the Site would impede the natural groundwater flow patterns at the site. The results of the tidal influence study do not indicate that the bulkhead influences groundwater flow.

3.1.5 Climate

The local climate of Long Island is considered temperate. Air masses and weather systems mostly originate in the humid continental climate of North America and are tempered by the maritime influences within the region. As a result of these influences, daily and annual temperatures have a reduced range. Precipitation is uniform but generally heavier in the winter and spring.

The major influences on the regional temperature pattern are the Atlantic Ocean to the south and east, and Long Island Sound to the north. The proximity of the ocean moderates temperatures thus reducing seasonal temperature extremes. Winter temperatures are milder than those of mainland areas at similar latitudes, while summer temperatures are cooler.

The region benefits from favorable geographic location with respect to prevailing weather systems. These systems provide Long Island with an abundant and fairly uniform supply of precipitation throughout the year, with slightly greater amounts during the winter.

Spring and summer rainfall is primarily convective whereas precipitation in autumn and winter results mostly from storms which move northeastward along, or in close proximity, to the East Coast of the United States.

Winter storms occur between October and April with an average seasonal precipitation of 31 inches. However, total snowfall varies greatly from year to year. Heavy ice storms are rare and would generally occur in the month of January.

Most precipitation in the winter months is produced by low-pressure systems that form to the south and intensify as they move northeastward. As storm systems move off the coast in the mid-Atlantic region, they occasionally stall and influence weather in the Long Island area for several days. Significant amounts of snowfall are produced when these systems are accompanied by freezing temperatures.

In the summer, precipitation is associated with the passage of fronts and convective showers. Localized heavy rainfall may result from squall lines and intense thunderstorms. Precipitation is also produced by convective thunderstorms. The localized nature of convective storms may account for local pockets of higher than normal precipitation.

The strength of the wind generally increases in the winter and decreases in the summer. This change coincides with the movement of the mid-latitude jet stream. During summer, the jet stream is well to the north of the region, resulting in slightly lower relative wind speeds with some significant gusts related to thunderstorms or squall lines. Significant gusts occur during winter.

3.1.6 Water Supply

A well search was carried out to obtain information concerning all pumping wells within a 1-mile radius of the Site. Well information was obtained from the NYSDEC and NCDOH. Freedom of information law (FOIL) access requests were submitted to the NCDOH and NYSDEC Water Division to obtain any records on potable public supply, private potable supply (domestic or private purveyor), irrigation, industrial and groundwater monitoring wells within 1-mile radius of the Site.

The results of the well search indicate that the nearest public supply well is located at a distance approximately 6,000 feet to the north (upgradient) of the Site. It appears that two (2) pumping fields exist in the upgradient direction. The supply wells associated with each field are presented below:

Northwest Field
- N-008657 greater than 6, 000 feet northwest of the Site,
- N-005695 greater than 6,000 feet northwest of the Site,
- N-00069 greater than 6,000 feet northwest of the Site,

North Field
- N-000132 approximately 6,000 feet north of the Site,
- N-000133 approximately 6,000 feet north of the Site,
- N-000134 approximately 6,000 feet north of the Site,
- N-007796 approximately 6,000 feet north of the Site, and
- N-005696 approximately 6,000 feet north of the Site.

Miscellaneous monitoring wells were located within 1-mile of the Site however, do not provide any additional groundwater informational support for the Site investigation.

4.0 RESULTS OF THE REMEDIAL INVESTIGATION

The purpose of this section is to present an analysis and interpretation of the concentrations of chemicals and impacts in soil, groundwater, surface water, sediments and air in terms of Site-specific conditions.

4.1 SUMMARY OF ENVIRONMETNAL CONDITIONS

Data were evaluated by comparing the analytical results with the standards and guidance values (criteria) presented in NYSDEC Technical and Administrative Guidance Memorandum (TAGM) #4046 "Determination of Soil Cleanup Objectives and Cleanup Levels" (January 1994) i.e., recommended soil cleanup objectives (RSCOs) [TAGM RSCOs], NYSDEC guidance "Technical Guidance for Screening Contaminated Sediments" (January 1999), and NYSDEC Technical and Operational Guidance Series (TOGS) No. 1.1.1 "Ambient Water Quality Standards and Guidance Values" (1998) (NYSDEC TOGS). Unbiased background samples were difficult to obtain due to the nature of the surrounding industrial properties. Therefore, Eastern U.S. background concentrations were used to evaluate metal concentrations when TAGM RSCOs indicated the use of Site background concentrations.

The results of the sampling and analyses carried out as part of the Metal Etching RI are presented in Appendix D-1 through D-14 and tables summarizing detections are presented in Tables 4-1 to 4-25.

4.1.1 Vertical Profile Boring Analytical Results

One vertical profile boring designated VP-01 was installed to the east of the 2,400 square foot building and its location is illustrated on Figure 2-2. The primary goal of installing the profile boring was to: (1) identify compounds not considered in the CSM to determine whether additional analyses other than VOCs and Metals should be considered throughout the RI field activities; (2) determine if there has been any downward vertical migration of VOC impacts; and (3) characterize the stratigraphy at the Site to determine if the “twenty-foot clay” which has been identified in the region at a depth of approximately 50 feet bgs, is present beneath the Site. The following sections discuss a summary of the compounds detected in soil and groundwater during the installation of the vertical profile boring above applicable criteria and identification of potential constituents of concern. A discussion of the Site stratigraphy was previously presented in Section 3.1.2.

4.1.1.1 *Soil Vertical Profile Screening Results - Soil*

A total of four (4) soil samples were collected from the vertical profile boring, VP-01. The samples were collected at 4-8 feet bgs, 10-14 feet bgs, 20-24 feet bgs and 30-34 feet bgs. Vertical profile boring VP-01 was terminated at the top of the "20-foot clay" encountered at a depth of approximately 30 ft bgs. Each of the soil samples was analyzed for VOCs, SVOCs, Metals and Pesticides/PCBs. The soil vertical profile sampling results are presented in Appendix D-2, a summary of detections for each analysis are presented in Tables 4-1 through 4-4 and are discussed below.

Volatile Organic Compounds (VOCs)

A summary of VOC detections in the vertical profile boring soils is presented in Table 4-1. Acetone was the only VOC to exceed the RSCOs in any of the four (4) sample intervals analyzed, (VP-01 (4-8) ft.). The detected concentration at this interval was 247 ug/kg and the RSCO for acetone is 200 ug/kg. The duplicate sample collected from this interval, contained an estimated concentration of 5.77 ug/kg of acetone. The elevated level of acetone in the primary sample is most likely attributable to laboratory artifact and is not considered a potential constituent of concern. No additional VOCs were detected above the RSCOs, however the following three (3) compounds were present in the sample below the applicable RSCOs: 2-butanone, isopropylbenzene, and methylcyclohexane.

Metals

The vertical profile metals analytical results are summarized in Table 4-2. Metals were detected in soil from the vertical profile boring. Background soil analyses were not carried out as part of this investigation; therefore, RSCOs based either on Eastern U.S. background concentrations, New York regional background data or risk-derived concentrations were used for comparison purposes. Comparison with these criteria revealed that arsenic, beryllium, chromium, copper, iron, mercury, nickel, and zinc were detected above RSCOs. Each vertical profile soil sample exhibited exceedences of one or more RSCOs.

Beryllium, iron and mercury exceeded RSCOs in the 4 to 8 foot interval. Only iron exceed its RSCO in the duplicate soil sample collected from this interval. Beryllium ranged in concentration in vertical profile soil sampling results from 0.0794J mg/kg to 0.92 mg/kg. Iron ranged in concentrations in the vertical profile soil analytical results from 2,240 mg/kg to 40,100 mg/kg. Mercury results in VP-01 sample intervals ranged from ND to 0.162 mg/kg.

Only iron exceeded its RSCOs in the 10 to 14 feet and 20 to 24 feet interval. No other metals were above NYSDEC RSCOs.

Eight (8) metals were detected above the RSCOs in the deepest sample 30 to 34 feet intervals, arsenic, beryllium, chromium, copper, iron, mercury, nickel, and zinc. Although the greatest numbers of metals were detected above RSCOs in the deepest interval of VP-01, it is unclear whether these metals could be attributed to Site operations since only minor exceedances were observed in the intermediate interval soil samples.

In summary, metals above RSCOs were primarily detected in the shallow interval (4-8 feet bgs) and the deepest interval (30-34 feet bgs) sample. Although it is unclear whether metal contamination were related to site activities, metals were retained as analytes.

Semivolatile Organic Compounds (SVOCs)

The SVOCs detected in the vertical profile samples can be divided into three general categories: polynuclear aromatic hydrocarbons (PAHs), dichlorobenzenes, and phthalates. A summary of detections is presented in Table 4-3. Only PAHs exceeded RSCOs. Similar to the distribution of metals, concentrations of PAHs exceed RSCOs in two out of four intervals, specifically, 4-8 feet and 30-34 feet. PAHs exceeding RSCOs include benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene and dibenz(a,h)anthracene. See Table 4-3 for a summary of detected SVOCs.

One (1) PAH detection in the upper vertical profile interval was above its RSCOs: benzo(a)pyrene. No SVOCs were detected in the two (2) intermediate intervals 10-14 feet and 20-24 feet. Six (6) PAHs were detected in the 30-34 feet interval exceeding cleanup objectives: benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene and dibenzo(a,h)anthracene.

Because SVOCs in soil were not encountered with high frequency and since compounds were predominantly detected in the deepest sampling interval, SVOC analyses were not carried out at the Site as part of the soil boring and groundwater sampling program. Consequently, SVOC constituents were not considered constituents of concern at the Site.

Pesticides and Polychlorinated Biphenyls (PCBs)

The pesticides and PCBs and a summary of detections presented in Table 4-4. Pesticides and PCBs were not detected in the soil samples collected from the vertical profile boring. Since neither pesticides nor PCBs were encountered during the vertical profiling, these analyses were not carried out during the soil boring and groundwater sampling program.

Summary of Soil Detections in the VP-01

In summary, analyses of soil samples collected from VP-01 did not reveal results that would require modification of the work plan to include SVOC or Pesticides/PCBs analyses. Although VOCs soil impacts were not observed in VP-01, the document reviews and historic aerial photos indicated poor house keeping practices, and the potential for VOC impacts, therefore, VOCs and metals analyses were carried out during the soil boring program as prescribed in the work plan.

4.1.1.2 *Ground Water Analytical Results for Vertical Profile Boring VP-01*

A total of four (4) groundwater profile samples were collected from 30 feet, 20 feet, 10 feet and 4 feet. Each of the groundwater samples was analyzed for VOCs, SVOCs, Metals and Pesticides/PCBs. Groundwater data from the vertical profile samples are presented on Appendix D-3 and summarized in Tables 4-5 through 4-9. As discussed below, results were compared to NYSDEC TOGS Class GA (6 NYCRR Part 701, §701.15 Class GA fresh groundwaters) groundwater standards. Based on the salinity of groundwater, Site groundwater may be classified as Class GSA saline groundwater. However, no standards have been established for Class GSA groundwaters, therefore exceedences must be viewed with this proviso.

Volatile Organic Compounds (VOCs)

VOCs detected in the vertical profile groundwater samples includes acetone, cis-1,2-dichloroethene, methyl-tert-butyl-ether (MTBE), PCE and TCE. A summary of VOC detections is presented on Table 4-5. MTBE was detected in each sample depth; however, it did not exceed the NYSDEC TOGS in any interval. Although there were detections of acetone and cis-1,2-dichloroethene in the groundwater in each interval sampled, neither of these constituents exceeded the regulatory criteria.

PCE and TCE exceeded Class GA standards in the groundwater sample and the duplicate sample collected from 30 feet bgs. PCE was the constituent observed at the highest concentration during groundwater profile sampling in groundwater profile sample collected from above the “20-foot clay”. The Class GA standard for both constituents is 5 ug/l. PCE and TCE concentrations in the VP-01 30 feet were 25.7 ug/l and 7.43 ug/l, respectively.

The concentrations of chlorinated VOCs in groundwater samples collected in the vertical profile-sampling results did not suggest the existence of DNAPL at the Site; however, chlorinated VOCs were identified at the Site supporting the CSM. The extent of VOCs in groundwater was unknown and further investigation was necessary.

Metals

The analytical results for inorganics (metals) in groundwater are summarized in Table 4-6. Metals were detected in all intervals sampled. Aluminum, arsenic, barium, calcium, chromium, cobalt, copper, mercury, nickel, potassium, vanadium and zinc were detected; however, detected concentrations did not exceed standards. Class GA standards were exceeded by the following constituents; iron, magnesium, manganese, selenium and sodium. Magnesium and sodium are principal dissolved substances found in sea water (see Table 4-7 for Principal Dissolved Substances in Sea Water) and exceedences of standards are expected due to the tidal nature of the Site setting and respective boring location. Iron and manganese are typical metals found in local soil and groundwater on Long Island. It should also be noted that although every attempt to minimize sample turbidity was performed in the field, samples were not filtered and therefore elevated metals results may also be attributable to suspended solids in the samples.

Semivolatile Organic Compounds(SVOCs)

The analytical results for SVOCs analyses are summarized on Table 4-8. SVOCs were observed in each of the discrete interval groundwater samples collected from VP-01. The compounds detected were benzoic acid and bis(2-ethylhexyl)phthalate. Only bis(2-ethylhexyl)phthalate exceeded the Class GA standards of 5ug/l in 4 feet sample. No other SVOC exceedences were observed.

Pesticides/PCBs

Pesticides and PCB analyses of groundwater samples are summarized in Table 4-9. Analyses of groundwater samples collected during the groundwater profile sampling did not identify any PCBs. There were several detections of pesticides in VP-01 specifically; 4,4′-DDE, 4,4′-DDT, alpha-chlordane, endrin ketone and methoxychlor. Although pesticides were observed in VP-01, none of the concentrations exceeded the NYSDEC Class GA standards. Therefore, analyses for these parameters were not included during the soil boring and groundwater sampling program.

Summary of Groundwater Detections in the VP-01

In summary groundwater discrete interval samples collected from VP-01 did not reveal results that would drive modification of the work plan to include SVOC or Pesticides/PCBs. The identification of VOCs and metals in groundwater supported the CSM, therefore, only VOCs and metals were collected from the groundwater at each of the soil boring locations as prescribed in the work plan.

4.1.2 Site Soil Characterization Screening and Confirmatory Analyses

As discussed in Section 2.7, Site soil was characterized by the installation of 69 soil borings with a total of 273 soil samples screened for VOC and metals. Approximately 20% of the screening samples, (fifty-nine (59) soil samples), were selected for confirmatory analyses using laboratory methods OLM04.2 and ILM04.1. Table 2-3 summarizes the samples collected for screening analyses and identifies those selected for confirmatory analyses. Additionally, the ERM geologist performed screening of the soil samples with a PID for the presence of VOCs and visually observed the soil samples for staining, discoloration, or other indications of contamination. These results are noted on the soil boring logs, which are presented in Appendix A. The results of the chemical screening analyses are presented in Appendix D-4 and summarized on Tables 4-10 and 4-11. The results of the confirmatory soil analyses are presented in Appendix D-6.

4.1.2.1 Soil Boring Analytical Results

Volatile Organic Compounds (VOCs)

Twenty-five (25) of the 273 soil samples contained measurable concentrations of several VOCs above the NYSDEC RSCOs. The constituents that exceed RSCOs include; benzene, toluene, ethylbenzene, xylene, MTBE, naphthalene, chlorobenzene, PCE, TCE, trans-1,2-DCE and vinyl chloride (VC). The following paragraphs describe the boring locations and intervals that are impacted with VOCs. The screening analytical results for the VOCs in soil samples are summarized on Table 4-10.

Figure 4-1 presents only those soil borings and sample intervals that exhibited VOC concentrations above the TAGM RSCOs and analytical results are posted next to each sample location. Concentrations exceeding the TAGM RSCOs criterion are shown with a bracket (i.e., [4,300]). Review of this figure indicates that a total of seventeen (17) soil boring locations exceeded the RSCOs for one or more compounds and one or more sample intervals. The figure also depicts "clusters" of contamination which are described from east to west and discussed in further detail in the paragraphs below.

The "Eastern Cluster" nearest to the Freeport Creek includes three (3) borings; SB-02, SB-52 and SB-56. Constituents that exceeded the RSCOs from the eastern cluster are; ethylbenzene, chlorobenzene and xylenes. The "Central Eastern Cluster" to the 2,400 square foot building includes nine (9) borings; SB-07, SB-10, SB-11, SB-31, SB-34, SB-36, SB-37, SB-48 and SB-65. The primary RSCO exceedences in the "Central Eastern Cluster" include; benzene, toluene, MTBE, PCE, TCE, trans-1-2-DCE and VC. The

“Central Western Cluster” is comprised of single boring, SB-41 located southeast of the 1,200 square foot building with an exceedence of TCE. The “Western Cluster” includes four (4) borings, which were located in the tank grave of a former fuel oil UST and includes; SB-43, SB-58, SB-60 and SB-63. The VOC constituents which exceeded RSCOs in the western cluster are; xylenes and naphthalene. The paragraphs below discuss the results by area in more detail.

Eastern Cluster

The eastern portion of the Site located adjacent to Freeport Creek, is covered with crushed gravel and some weeds. This area of the Site is used for year round boat storage. Past and present Site activities including boat maintenance or chemical/fuel spillage would have been discharged directly to the gravel and underlying soil; potentially impacting soil in this area. The “Eastern Cluster” consisting of soil borings SB-02, SB-52 and SB-56 appears to be three (3) separate hot spot areas, with VOCs exceeding the RSCOs at different depth intervals. Ethylbenzene, chlorobenzene and xylenes are the VOCs exceeding RSCOs. Ethylbenzene and xylenes are components of fuels and chlorobenzene is frequently a component of paints and adhesives. Given the long term storage and maintenance of boats in this area of the site, the likely sources of these VOCs is the boating activities. A summary of detections is presented in Table 4-10 and illustrated on Figure 4-1.

Ethylbenzene was detected above the TAGM RSCO of 5,500 ug/kg in only sample collected from SB-56 at a depth of 7.0 to 8.0 feet bgs. The concentration of ethylbenzene was 14,000 ug/kg.

Only one detection of chlorobenzene above the RSCO was observed in Site soil from boring SB-56 (7.0 to 8.0) feet bgs. The RSCO for chlorobenzene is 1,700 ug/kg and the detected concentration was 3,700 ug/kg.

Xylenes were detected in each of the three (3) borings from the eastern cluster above the RSCOs of 1,200 ug/kg. Xylenes ranged in concentration from ND to 15,000 at SB-56 (7.0 to 8.0) feet bgs. For a summary of xylenes detected in this cluster refer to Table 4-10.

Central Eastern Cluster

The “Central Eastern Cluster” made up of soil borings SB-10, SB-11, SB-31, SB-34, SB-36, SB-37, SB-48 and SB-65 are located generally to the south of the 2,400 square foot building, see Figure 4-1. Historically this area included AOCF, which was the former waste storage/drum storage and solvents holding areas where poor housekeeping and improper storage of drums was observed in historical aerial photographs. Additionally, an UST of unknown status is located in this area (See Figure 3-2 for potential UST locations).

In the central eastern area detections of benzene, toluene, MTBE, PCE, TCE, trans-1,2-DCE and VC were detected above the RSCOs. Cis-1,2 DCE was detected frequently in the borings comprising the Central Eastern Cluster. There is no RSCO for this compound; however, detected concentrations range from ND to 12,000 ug/kg and cis-1,2-DCE must therefore be considered a significant contaminant. MTBE and TCE were detected at the greatest frequency in this area. Concentrations of MTBE ranged from ND to 1,500 ug/kg at SB-34 and TCE ranged from ND to 10,000 ug/kg at SB-65. A complete summary of detections in the "Central Eastern Cluster" are shown on Table 4-10.

Contamination associated with the Central Eastern Cluster appears to result from two sources: (1) the former Metal Etching Chemical/Waste Storage and (2) petroleum products either stored in the suspected UST or from discharges of petroleum products from marine/boating activities. As discussed below, the identification of a NAPL in soil boring SB-34 in the area in a former or suspected UST suggests the benzene and toluene detected in the Central Eastern Cluster results from losses from this feature.

PCE and TCE were detected frequently in the soil samples collected from the borings of the Central Eastern Cluster. TCE was one of the most frequently detected VOCs in Site soil borings and concentrations ranged from ND to 10,000 ug/kg . The finds suggest that either PCE and/or TCE was used at Metal Etching and releases from the chemical /waste storage area, located in this area, are the source of the contamination. PCE ranged in concentration from ND to a maximum 4,300 ug/kg at SB-37.

Breakdown products of PCE are also present at significant concentrations in soil indicating that degradation of PCE and TCE is occurring in the subsurface in the Central Eastern Cluster vicinity. A significant concentration of cis-1,2-dichloroethene (cis-1,2-DCE) was observed in SB-37; however there is no RSCO for this compound in soil. Cis-1,2-DCE is a known biologically mediated breakdown product of PCE.

VC was also observed in the shallow soil sample collected from SB-37 (VC concentrations ranged from ND to 1,800 at SB-37). The presence of VC at high concentrations in soil is a strong indication that degradation of chlorinated solvent is occurring at the Site because very strong reducing conditions are required to transformation PCE/TCE to VC.

Finally, MTBE was frequently detected in the Central Eastern Cluster borings and concentrations ranged in soil borings from ND to 1,500 ug/kg. The site was paved after 1983, the time frame when MTBE was present in motor fuels. So it is unlikely that surface spills from vehicles and/or boat fueling is the source of the MTBE. MTBE could be present in the NAPL observed near SB-34. Therefore, the suspected UST may be the source of the MTBE.

Non-aqueous phase liquid (NAPL) was observed at the groundwater table interface in soil boring SB-34 at a depth interval of six (6) to seven (7) feet. The NAPL was localized and was bounded by SB-32, SB-46 and SB-48 (in the expected down gradient directions). The NAPL observed by the ERM hydrogeologist in SB-34 was black, with a viscous oily consistency. PID field screening indicated concentrations of greater than 1,900 ppm. Residual product in the soil was observed to a depth of approximately twelve feet below grade. SB-34 was the only location to exhibit NAPL and therefore must be considered a potential source area. As previously indicated this area (AOC F) was used by Metal Etching to store fresh chemicals and waste. Although an anomaly was not clearly evident from the results of the geophysical investigation, the likelihood of a UST in this area is high. Refusals at approximately 4 feet below grade were noted in the soil boring log from this location. Additionally, document reviews at the local and state agencies indicated that a UST was to be abandoned in this area however no further documentation of removal or closure was found.

Central Western Cluster

This area only includes one (1) soil boring, SB-41 as illustrated on Figure 4-1. TCE was the only compound to exceed the RSCO criteria in this boring is located slightly west of the former footprint of the plating building. SB-41 is also located to the southeast of the 1,200 square foot building where a potential UST anomaly was identified in the geophysical report. The TCE exceedence in SB-41 appears to be limited to the shallow soil because VOCs were not detected in the deeper interval samples. Borings to the north, i.e., SB-40, SB-25 and SB-44 also did not contain VOCs above RSCOs. This detection of TCE is likely from one time disposal of the compound onto the ground surface. See Table 4-10 for further details.

Western Cluster

The western portion of the Site surface cover is concrete. A total of ten (10) soil borings were installed on the western portion of the Site. Of the ten (10) borings, four (4) contained xylene and naphthalene above RSCOs. Initial detections of xylene and naphthalene in SB-43 prompted installation of additional delineation borings in each cardinal direction from SB-43 and include SB-58, SB-59, SB-60 and SB-61. Upon receipt of analyses from those borings further delineation was performed with the installation of soil borings SB-62, SB-63 and SB-66. Concentrations of Xylene in Site soil borings ranged from ND to 2,000 ug/kg at SB-49 and Napthalene concentrations ranged from ND to 25,000 ug/kg at SB-18. Table 4-10 provides the data from all borings in the Western Cluster.

Xylene and naphthalene were detected above RSCOs in Western Cluster borings SB-43, SB-60 and SB-63. The locations of the borings that exceeded the NYSDEC RSCOs are in the area of a former No. 2 fuel oil UST and are shown on Figure 4-1. The limits of contamination in this area were bounded by soil borings which delineated extents of fuel oil contamination and include; SB-59 located to directly to the south, SB-61 located directly to the east, SB-62 located directly to the west and SB-66, which was located directly to the north.

Total Volatile Organic Compounds (TVOCs) in Soil

Figure 4-2 depicts Total VOCs (TVOCs) in soil. Figure 4-2 was created by selecting the maximum concentration from each soil boring and contouring the TVOC concentrations (GISKey software was used as the contouring tool). The maximum concentration represented on Figure 4-2, colorimetric scale represents the highest total VOC concentration observed in any soil boring (SB-34). The lower end on the scale represents the TAGM 4040 RSCOs criterion, which states that total VOCs in soil shall be less than 10 ppm (equivalent to 10,000 ppb[ug/kg]).

As illustrated on Figure 4-2 there are four (4) areas of the Site where TVOCs exceed 10,000 ppb. On the eastern portion of the Site six (6) soil borings were identified with TVOC concentrations above 10,000 ppb, these borings include; SB-02, SB-03, SB-04, SB-52, SB-54 and SB-56. In general, methylcyclohexane is the compound present at highest contamination and accounts for the worst contaminant mass in these borings. Exceedences to specific RSCOs criterion at SB-02, SB-52 and SB-56 were also observed as described above and summarized in Table 4-10.

In the central portion of the Site five (5) soil borings contained TVOC concentrations above 10,000 ppb including; SB-07, SB-34, SB-36 and SB-37. In two (2) of the borings TVOC concentrations exceeded 100,000 ppb (equivalent to 100 ppm[mg/kg]) at SB-07 and SB-34. Similar to the eastern borings the greater part of the TVOC mass was from methyl cyclohexane.

On the western portion of the Site four (4) soil borings exceeded 10,000 ppb including; SB-43, SB-58, SB-60 and SB-63. The bulk of the TVOC mass in these borings was naphthalene, confirming the location of a former UST. Methyl cyclohexane is a gasoline constituent and is contained in paint thinners and adhesive solvents. Release of these material is more likely from marine operations at the Site, rather than processes at Metal Etching.

Inorganic Compounds (Metals)

The analytical results for screening analyses of soil samples for metals are presented in Appendix D-4, and summarized on Table 4-11. Metals detected in the soil boring samples include aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium and zinc. Background soil sampling were not carried out as part of this investigation; therefore RSCOs based on Eastern U.S. background concentrations, New York regional background were used for comparison purposes. Comparison with these criteria indicated that the concentrations of arsenic, barium, beryllium, cadmium, calcium, chromium, hexavalent chromium, cobalt, copper, iron, lead, magnesium, nickel, selenium, and zinc exceeded TAGM-4046 RSCOs criterion.

Recognizing the local geologic and hydrogeologic setting of the Site, detections of particular inorganic constituents were expected. Both calcium and magnesium are naturally occurring constituents present at high concentrations in sea water. Given the Site location, a tidally influenced groundwater environment, these metals are likely from this source and will not be discussed further. Table 4-7 provides a summary of the principal dissolved substances in sea water.

To further evaluate detected inorganics in soil and identify Inorganic Constituents of Potential Concern (ICOPCs) at the site, a histogram depicting frequency of detections above TAGM RSCOs was generated and is presented on Figure 4-3. This figure makes it clear that five (5) metals were detected at the greatest frequency, specifically; iron, zinc, copper, nickel and chromium. Although iron was detected most frequently at the site, its natural occurrence in Long Island geologic formations and in Long Island groundwater precludes it from consideration in the ICOPC list and from further discussion. The elevated detection frequencies of chromium, copper, nickel and zinc however, could be attributable to former Site operations and therefore will be further evaluated as ICOPCs. The remaining metals detected at the Site above RSCOs are arsenic, barium, beryllium, cadmium, lead, and selenium. Although these metals exceeded the RSCOs, concentrations above the RSCOs were either marginally above or detected at too low a frequency to be considered an ICOPC, these metals will therefore not be discussed in detail within this RI Report.

Figure 4-4 presents the metals analytical results. Concentration data are posted with a leader identifying each sample location that exceeded the RSCOs for each interval sampled. Concentrations exceeding the RSCOs are identified with a bracket (i.e., [390]). From this figure it is evident that ICOPC metals above RSCOs at the Site are distributed ubiquitously across the Site. Isolation of the particular ICOPCs identifies hot spot areas where localized concentrations can be assessed both horizontally and vertically.

The Site-wide distribution of each of the ICOPC metals was mapped using the surveyed boring locations and the screening sampling data. Isopleths were contoured using GISKey Software, a Krieging algorhythm, set to consider the concentration of the particular ICOPC in the 4 nearest neighboring borings. The color concentration scale (mesh color) has been standardized for all of the metal isopleths diagrams, i.e., the mesh color corresponding to the ICOPC metal detected at highest concentration (copper) is consistent on all figures.

Isopleth's for each ICOPC are presented for each of the intervals sampled during the installation of the screening borings. Because the surface elevation of the Site does not vary greatly across the Site, the Isopleth's present are accurate visualization of the vertical distribution of the ICOPC metal across the Site.

Chromium

Chromium horizontal and vertical distribution maps in soil are presented on Figure 4-5 and a summary of analytical results can be found in Table 4-11. The concentration of the chromium in soil boring analytical data exceeds the 50 mg/kg New York State background in a total of 40 out of 273 samples. Chromium concentrations in soil boring samples ranged from non-detect (ND) to 2,200 mg/kg at SB-10 1.5 to 2.5 ft bgs. Review of the chromium distribution figure indicates the presence of hot spot areas or potential release/disposal areas identified by areas of increased concentration and color gradation. In general chromium hot spot areas appear to be attributable to potential disposal areas and from the former plating area operations.

Copper

Copper was detected above the 50 mg/kg RSCO in 91 of the 273 samples collected, see Table 4-11. Copper concentrations in soil ranged from ND to 5,700 mg/kg at SB-01 at a depth of 1.5 to 2.5 ft bgs. Copper distribution in soil above the TAGM RSCOs are depicted in Figure 4-6 at each of the four (4) sample intervals. Several hot spot areas were observed in the shallowest sample interval for copper designated an ICOPC for the Site. Concentrations exceeding the RSCOs were identified in the former plating area. Each of these areas could be attributable to historic disposal areas however, it should also be noted that ablative paints, used in the boating industry on boat hulls slowly release copper for antifouling purposes. As a result, historic boat storage and marina operations activities (i.e., sanding, washing and scrubbing old ablative paint from boat hulls) may also have contributed to the elevated concentrations of copper observed in the shallow soil samples at the Site.

Nickel

Nickel exceeded the TAGM RSCO of 13 mg/kg in 52 of the 273 soil samples collected at the Site. Nickel concentrations in soil ranged from ND to 1,300 mg/kg at SB-11 1.5 to 2.5 ft bgs. Soil concentration maps depicting nickel distribution in soil intervals above the TAGM RSCOs are shown on Figure 4-7 and summarized on Table 4-11. From this figure it appears that poor house keeping, disposal events and former plating operations have contaminated shallow soil at the Site.

Zinc

The concentration of the zinc in soil boring analytical data exceeds the 20 mg/kg TAGM RSCO in 126 out of 273 samples. The concentrations of zinc ranged from ND to 3,600 mg/kg at SB-25 in the former plating area. Figure 4-8 depicts zinc distribution is soils for each of the sample intervals above the TAGM RSCOs and Table 4-11 provides a summary of detections in soil.

Additional Sampling: Hexavalent Chromium, TCLP Analyses & TPH/DRO

Soil samples were also analyzed for hexavalent chromium when total chromium concentrations exceeded approximately 10 times the average background concentration of 20 mg/kg, as per the RI Work Plan, i.e.; when a concentration of 200 mg/kg was observed in a sample, the sample was further analyzed for hexavalent chromium. Hexavalent chromium was detected in twelve (12) of the sixteen (16) samples submitted for analysis. The highest concentration of hexavalent chromium was observed in SB-12, located in the northeast corner of the former plating area, and soil impacts are likely the result of Site operations. For a summary of hexavalent chromium results refer to Table 4-12.

To assess the potential leaching of metals in soil to groundwater, RCRA metals analyses using the toxicity characteristic leaching procedure (TCLP) was performed on four (4) soil samples: SB-02 (1.5 to 2.5) ft, SB-07 (0.0 to 0.5) ft, SB-10 (1.5 to 2.5) ft, and SB-16 (1.5 to 2.5) ft. A summary of the results are presented in Table 4-13. The results indicate that no exceedences to the Federal Regulations (Title 40, Part 261, Subpart C), Maximum Concentration of Contaminants for the Toxicity Characteristic were observed.

As previously discussed in Section 2.10, a single TPH sample was collected from SB-07 at 6.0 to 7.0 bgs and the results are presented of Table 4-12.

4.1.2.2 *Confirmatory Soil Sampling Results*

Confirmatory soil samples (59 samples total) were collected from soil borings and submitted to Mitkem to be analyzed by methods OLM04.2 for VOCs and ILM04.1 for metals. A summary of the confirmatory soil analytical results is presented in Appendix D-6. Discussion of the screening and confirmatory data comparisons were presented in Section 2.17. The results of the confirmation analyses were compared to the screening results and to the TAGM 4046 RSCOs. The relative percent difference (RPD) between the screening and confirmatory samples analysis was calculated for each analyte in each sample. The results of this comparison are presented in Appendix D-7. Laboratory analytical data packages have been recorded onto a compact disk in pdf format and are presented in Attachment 1 of this document. Validated data (DUSR) packages are presented in Appendix I.

As discussed in Section 1.5, use of collaborative data is recommended when the Triad approach is used. Collaborative data at the Site included the screening sample data and confirmation analyses of splits of the same sample. Screening data were generated using a modification of SW-846 Method 6010B for metals and SW-846 Method 8260 for VOCs. Confirmatory data were generated using OLM04.2 and ILM04.2 for VOCs and metals, respectively. Relative percent differences (%D) and screening samples were computed on a wet weight basis because there was insufficient time to properly dry samples. Of the 1,140 VOC and 1,140 metals analyses carried out the %D was greater than 100 %D (the benchmark, based on validation criteria established for correlation of screening and confirmatory sample correlation) in 1.93-percent of the VOCs and 7.37-percent of the metals. Because of the low error rate, use of the metal screening data for evaluation of remedial alternatives was deemed appropriate. Note that in cases where the %D was greater than 100-percent, ERM reviewed the screening data to determine if the concentration of a compound of concern in the screening sample was higher or lower than the concentration reported in the corresponding confirmatory analysis. If the screening sample concentration was lower, the location of low biased samples was identified to assess the impact on remedial option selection.

4.1.3 Site Groundwater Characterization Screening, Confirmatory and Permanent Monitoring Well Sampling Results

As described in Sections 2.7 and 2.11, groundwater samples were collected from 65 soil borings installed at the Site and confirmatory samples were collected from a total of thirteen (13) locations. The groundwater samples were collected at the water table following completion of each soil boring. Groundwater samples were analyzed for VOCs and metals. The groundwater sampling locations (soil boring designations) are shown on Figure 2-2, and a summary of the groundwater screening detections are presented in Tables 4-14 for VOCs and 4-15 for Metals. A complete summary of analytical results is provided in Appendix D-8.

At the completion of the soil boring program a permanent groundwater monitoring well network was installed consisting of the ten (10) monitoring wells. The monitoring well network was installed based on the observed groundwater flow direction and in areas where soil and groundwater impacts were observed during the soil boring program. The network consisted of shallow (S designation) water table wells and deep (D designation) wells situated on top of the "20 foot Clay". During the groundwater sampling event, groundwater elevation, pH, temperature, specific conductivity, salinity, oxidation/reduction potential and turbidity measurements were also collected from the sampled wells. A summary of the measurements collected is presented on the Groundwater Sampling records (Appendix E). Groundwater collected from monitoring wells was analyzed for TCL VOCs, SVOCs, TCL Pesticides/PCBs and TAL metals including hexavalent chromium and cyanide. A summary of the analyses detected is presented in Tables 4-16 through 4-19 and complete summary of monitoring well sampling results is presented in Appendix D-11. The groundwater sampling results are discussed below. Based on the specific conductance, Site groundwater is best classified as Class GSA saline groundwater2. However, standards have not been established for Class GSA groundwaters. Therefore, the tables compare the sampling data to the NYSDEC Water Quality Standards and Guidance Values for Class GA groundwater (from TOGS 1.1.1 dated June 1998).

4.1.3.1 Groundwater Screening Results

<u>Volatile Organic Compounds (VOCs)</u>

Forty-seven (47) of 65 groundwater screening samples contained VOCs above the NYSDEC Class GA standards. The following constituents, in order of greatest frequency of detection exceeded its standard MTBE, benzene, cis-1,2-dichlorethene , PCE , vinyl chloride, xylene, ethylbenzene, toluene, TCE, chlorobenzene, naphthalene, 1,1-dichloroethene, 1,2-dichlorobenzene, and 1,4- dichlorobenzene. Figures 4-9 through 4-14 depict groundwater results exceeding the NYSDEC TOGS for: PCE, TCE, cis-1,2-DCE, VC, total BTEX and MTBE (in soil borings and monitoring wells). The permanent groundwater monitoring results are presented and discussed in later Section 4.1.3.3.

A uniform color grid mesh, based the highest groundwater VOC concentration observed was used on each of the figures. The same approach was used with metal contaminant maps.

PCE

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[2] Hem, John D., Study and Interpretation of the Chemical Characteristics of Natural Water. 3rd Edition. U.S. Geological Survey Water Supply Paper No. 2254. 1992. Dissolved Solids = A x Specific Conductance. A in this relationship is a constant that in natural waters assumed to be 0.59. K is specific conductance. Based on calculations using this formula and the lowest specific conductance value measured during groundwater sampling (approximately 600 umhos/cm). The dissolved solid concentration in groundwater would be greater than the GSA standard of 2,000 mg/l.

Figure 4-9 illustrates the PCE groundwater plume at the Site. A summary table of groundwater detections in soil borings is presented in Table 4-14. PCE concentrations in groundwater screening results ranged from ND to 250 ug/l, in the sample collected from SB-24. SB-24 is located in the former plating area and is likely located in the vicinity of the former degreasing area or perhaps where solvents were handled or disposed of. As indicated in the Site description, concrete flooring within the plating room was friable and in poor condition from corrosion. Therefore, spillage from product handling would likely have discharged directly to underlying material ultimately impacting groundwater at the Site.

TCE

A summary table of groundwater detections in soil borings is presented in Table 4-14. TCE concentrations in groundwater were contoured and the results are presented on Figure 4-10. As stated earlier in this report TCE observed in groundwater at the Site is present from the degradation of PCE into its daughter products. Upon review of Figure 4-10, TCE concentrations appear to mimic PCE in groundwater, although TCE was observed at lower concentrations. TCE concentrations in groundwater screening results ranged from ND to a maximum of 20 ug/l at SB-65.

Cis-1,2-DCE

Figure 4-11 illustrates cis-1,2-DCE concentrations in the groundwater. An increased number of borings relative to PCE and TCE containing elevated concentrations of cis-1,2-DCE is a strong indication that reductive dechlorination is occurring. Concentrations of Cis-1,2-DCE in groundwater screening samples ranged from ND to a maximum of 160 ug/l at SB-32. Review of the figure also indicates that cis-1,2-DCE is mobile in groundwater and is migrating with groundwater flow from the source area. A summary table of VOC detections in soil boring groundwater samples is presented in Table 4-14.

VC

Figure 4-12 illustrates the VC groundwater plume at the Site including both the soil boring and permanent groundwater monitoring well sampling results. A summary table of groundwater detections in soil borings is presented in Table 4-14. Similar to the cis-1,2 DCE figures, the figure also shows that VC is mobile and migrating with groundwater flow toward downgradient locations including the Freeport Creek. VC concentrations in groundwater screening results ranged from ND to 390 ug/l at SB-04.

BTEX

Benzene, toluene, ethylbenzene and total xylenes (BTEX) in groundwater are contoured and presented on Figure 4-13. The figure presents the summation of BTEX compounds in groundwater with the minimum concentration on the color contour scale equated to the compound with the most stringent groundwater standard, i.e., benzene. A summary table of detections in groundwater collected from the soil borings is presented in Table 4-14. As can be seen on this figure, there is widespread BTEX groundwater contamination across the site, likely reflecting the use of fuel for the boats stored on the Site.

MTBE
The soil boring and groundwater investigation results indicate the presence of MTBE at the Site above Class GA Standards. A summary table of detections in groundwater collected from the soil borings is presented in Table 4-14. Its presence at the Site is indicative of fuel spillage from current Site operations. Figure 4-14 illustrates the MTBE groundwater plume at the Site including both the soil boring and permanent groundwater monitoring well sampling results. As previously described, the greatest MTBE concentration was observed at SB-31. It should also be noted that in this area a UST may be present that was potentially identified in the geophysical survey and several drilling refusals were encountered in this area. Additionally, LNAPL was observed in soil boring SB-34 by the ERM geologist indicating a black hydrocarbon stained soil.

Metals

The analytical results for metals in soil boring groundwater samples are presented in Appendix D-8 and summarized in Table 4-15. Metals were detected in all intervals sampled. The only metals exceeding Class GA groundwater standards were arsenic, chromium, iron, magnesium, manganese and nickel.

In the screening groundwater samples it should be noted that turbidities were greater than 50 NTUs during sample collection. Although the suspended solids in samples may have had time to settle prior to laboratory analysis, the suspended content and preservation of each sample is likely the reason for the elevated concentrations.

As described in Section 4.1.2.4, monitoring well sampling results do not indicate the presence of metals as observed during the soil boring groundwater screening investigation. Monitoring wells were sampled using low flow techniques and turbidities in most instances were below 10 NTUs. For this reason metals results pertaining to the permanent monitoring well network were evaluated as the primary groundwater metals investigation at the Site. A summary of the groundwater screening results is presented below.

Even with the elevated turbidities at the Site metals constituents in groundwater do not appear to be mobile as had been initially considered in the CSM. Because of the naturally reducing groundwater environment metals are immobile and exceedences of metals like chromium, copper, nickel and zinc were minimal.

Iron concentrations in groundwater exceeded the GA Standard in 51 out of a total 65 screening groundwater samples and manganese also exceeded its standard in 51 out of 65 groundwater samples collected. Results of the soil boring screening groundwater sampling are summarized in Table 4-15. As discussed above, suspended solids likely contributed to these exceedences as well as intrusion of sea water during tidewater inflow.

Iron, magnesium and manganese concentrations, above Class GA Standards, are a common issue on Long Island. Iron, magnesium and manganese rich sands were deposited during the glacial epochs that resulted in soil and groundwater with considerable concentrations of these metals. Water percolating through soil and rock dissolves iron and manganese, and these minerals subsequently enter groundwater supplies. Surface water does not usually contain high concentrations of iron or manganese because the oxygen-rich water enables both minerals to settle out as sediments.

In deep wells, where both the oxygen content and pH tend to be low, water containing dissolved iron or manganese appears colorless. When exposed to air, the dissolved iron or manganese reacts with oxygen and is converted to a colored, solid material that settles out of the water.

4.1.3.2 *Confirmatory Ground Water Sampling Results*

Confirmatory groundwater samples were collected from thirteen (13) borings locations and submitted to Mitkem for analysis of VOCs (OLM04.2) and metals (ILM04.1). A summary of the confirmatory groundwater analytical results is presented in Appendix D-9. The results of the confirmation analyses were compared to the screening results and to the Class GA Groundwater Standards or Guidance Values (NYSDEC TOGS). The relative percent difference (RPD) was calculated for each compound in each sample. The results of this comparison are presented in Appendix D-10. Laboratory analytical data packages have been recorded onto a compact disk in pdf format and are presented in Attachment 1 of this document. Validated data (DUSR) packages are presented in Appendix H. A brief summary of the correlation results is presented below.

The comparison of the groundwater screening and confirmatory groundwater data was previously presented in Sections 2.14 through 2.17 and is summarized below. Only 3.08 percent of the %D was greater than 50 percent indicating excellent data reliability. However, because the groundwater collected from the boreholes was turbid, potentially impacting metals concentrations, evaluation of groundwater impacts was based on data collected from the permanent monitoring well network. The groundwater screening data was used to better define the extent of VOC impacts. The confirmatory data confirms the presence of the constituents of concern at the Site.

4.1.3.3 *Permanent Monitoring Well Ground Water Quality*

To complement the hydrogeologic and groundwater quality data that were obtained from the soil boring groundwater screening investigation, a total of ten (10) permanent monitoring wells were installed at the Site. Groundwater samples were collected from the monitoring well network as discussed in Section 2.11. The groundwater quality data resulting from this sampling event are discussed in the following sections. Appendix D-11 provides a summary of the analytical results and Tables 4-16 through 4-19 presents a summary of detections for each parameter analyzed in the permanent monitoring well network.

Volatile Organic Compounds

As in the groundwater samples collected from the soil borings, PCE, TCE, cis-1,2-DCE, VC, benzene and MTBE concentrations exceeded the NYSDEC TOGS Class GA groundwater standards in several on-Site monitoring wells. Figure 4-15 presents only VOCs that were detected and that exceed the standards. Analytical results are posted at each well location and concentrations exceeding the groundwater criterion are shown with a bracket (i.e., [1,600]). A summary of the VOCs detected in permanent monitoring wells is presented in Table 4-16 and a full summary of analytical results is presented in Appendix D-11.

Figures 4-9 through 4-14 illustrate contaminants in groundwater with data compiled from the soil boring groundwater investigation and the permanent monitoring well groundwater sampling event.

PCE in monitoring wells was detected at concentrations ranging from ND to 1,600 ug/l in MW-07D as shown on Figures 4-9 and 4-15. A potential release of PCE at the surface would initially impact soil then groundwater at the Site. Upon reaching the groundwater table the PCE would sink vertically through the water column. Hence, if a sufficient quantity of PCE were released, the PCE could pool on stringers or layers of soils with lower conductivities such as silts or clays. The presence of the "20 foot Clay" at 30 to 35 ft bgs at the Site would act as such a barrier to vertical movement. As a result, the installation of monitoring wells near a source/disposal area screened on top of this clay would therefore detect PCE DNAPL in groundwater, if present. The observed elevated levels of PCE concentrations in two (2) deep monitoring wells MW-02D (1,100 ug/l) and MW-07D (1,600 ug/l) indicates the presence of a dissolved PCE plume, (see Table 4-16 for a summary of detections). A commonly applied rule-of-thumb suggests that DNAPL may be present when dissolved groundwater concentrations are about 1% of the pure compound solubility. PCE has solubility of 200 milligrams per liter (mg/L). Accordingly, the concentration of PCE in MW-07D and MW-02D are not indicative of the presence of DNAPL.

TCE was also used at the Site and was detected above the NYSDEC TOGS value of 5 ug/l in MW-01, MW-02S, MW-02D, MW-04, MW-07S and MW-07D. TCE concentrations ranged from ND to a maximum of 25 ug/l in MW-07D. TCE data is summarized on Table 4-16 and depicted on Figures 4-10 and 4-15.

The next compound in the degradation sequence of PCE and TCE is cis-1,2-DCE. Cis-1,2-DCE in monitoring wells ranged from ND to 390 ug/l. Cis-1,2-DCE was observed above the Class GA standard of 5 ug/l in MW-02S, MW-02D, MW-03s and MW-07S. VC was detected above the Class GA standard in monitoring wells MW-02S, MW-03S and MW-07s. The last compound in the degredation sequence before reduction to ethane's and ethene's is VC. VC ranged in concentration from ND to 400 ug/l at MW-7s. The presence of cis-1,2-DCE and VC in groundwater is indicative that reductive dechlorination of PCE and TCE in the subsurface is occurring. Breakdown product plume maps are shown on Figures 4-11 for cis-1,2-DCE and 4-12 for VC and posted data is presented on Figure 4-15.

BTEX and MTBE plume maps are presented on Figures 4-13 and 4-14 and individual data is posted on Figure 4-15. As shown on Figure 4-13, BTEX is detected groundwater across the entire Site. Degradation of BTEX by naturally occurring soil bacteria (aerobic degradation) depletes dissolved oxygen and lowers the Eh of the groundwater. Thus, BTEX provides a source of energy for bacterial populations, resulting in a subsurface environment favorable to the anaerobes that degrade PCE to VC.

Metals

The analytical results for metals in groundwater are presented in Appendix D-11 and a summary of detections is presented in Table 4-17. Figure 4-16 presents only metals that were detected and exceed the NYSDEC TOGS criteria. Analytical results are posted at each well location and concentrations exceeding the groundwater criterion are shown with a bracket (i.e., [529]).

As previously presented in Section 4.1.3.1 metals in the soil boring groundwater screening samples were impacted by turbidity inaccurately representing elevated concentrations of some ICOPCs in groundwater. Based on that conclusion the permanent monitoring well data set for metals was used to assess groundwater quality. Utilizing low flow sampling methodologies turbidities in this data set were in most instances below 10 NTUs and well within acceptable ranges.

Metals were detected in all wells sampled. Generally, the groundwater in each of the wells sampled contained iron, magnesium, manganese and sodium above Class GA standards and guidance values.

Metal Etching Co. historically carried out chromium plating. When chromium is plated, a solution of hexavalent chromium (Cr+6) is used. Chromium in the +6 state is very mobile in groundwater, however, it is a powerful oxidant and when the ion enters the subsurface beneath the Site where reducing conditions predominate, hexavalent chromium (Cr+6) is reduced to trivalent chromium (Cr+3), which is immobile. Thus at the Site, immobilization of chromium could, based on the observed ORP of the subsurface, be expected. Similarly, in a reducing environment with sulfur present (as sulfite ion), immobilization of nickel as nickel sulfide and copper, zinc and cadmium also as sulfides would be expected. In other words, the metals typically used in etching and plating operations should not migrate in high concentration or appreciable distances from the point of their release.

Only MW-05 contained hexavalent chromium above the NYSDEC TOGS criterion. Concentrations of hexavalent chromium ranged from ND to 0.07 at MW-05. No other detections of hexavalent chromium above the NYSTOGS were observed, metals in the permanent monitoring well network are presented on Figure 4-16.

Semivolatile Organic Compounds

The analytical results for SVOCs in groundwater are presented in Appendix D-11 and a summary of detections is presented in Table 4-18. There were no exceedences to the Class GA standards by SVOCs.

Pesticides/PCBs

Analyses of groundwater samples collected from the October 2004 sampling event did not detect any PCBs. PCB analyses of groundwater samples are shown in Appendix D-11 and summarized on Table 4-19. Only one (1) detection of a pesticide (endrin ketone) was detected, in MW-07S well below the NYSDEC Class GA Standards.

4.1.4 Freeport Creek Surface Water Quality

As part of the RI, surface water samples were collected from the Freeport Creek. The Freeport Creek is a Class SC surface water body and promulgated Class SC standards are available in TOGS 1.1.1. In addition, there are also US Environmental Protection Agency (USEPA) Water Quality Criteria for the protection of human health via ingestion of fish. Class SC waters are defined as saline surface water. The best usage of Class SC waters is fishing (6 NYCRR Part 701, §701.12 Class SC saline surface waters). These waters shall be for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

Samples were collected at each of the eight (8) surface water (SW-01 through SW-08) locations for TCL VOCs, TCL SVOCs, Pesticides/PCBs and TAL Metals analysis. Surface water samples SW-06 and SW-08 were evaluated as background samples and were designated as follows: SW-06 was the upstream location and SW-08 was considered downstream. The results of the surface water sampling carried out are presented in Appendix D-12 and the standards, criteria and/or guidance values (SCGs) are presented in Table 4-20.

Volatile Organic Compounds

The analytical results for VOCs in surface water are presented in Appendix D-12, summarized in Table 4-20 and their locations are provided in Figure 2-2. The VOCs detected in the surface water were; benzene, ethylbenzene, toluene, xylenes and MTBE. Two compounds, ethylbenzene and xylene, in sample SW-08 (downstream sample) exceeded the SCGs for Class SC water. No other exceedences of surface water quality standards or guidance values were observed.

Semivolatile Organic Compounds

The analytical results for SVOCs in surface water are presented in Appendix D-12, summarized in Table 4-20 and their locations are provided in Figure 2-2. Seven (7) SVOCs were detected in surface water including; 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, di-n-butyl phthalate, di-n-octyl phthalate, fluoranthene and pyrene. Of the compounds detected in the surface water samples, only 2,4-dimethylphenol is regulated. No exceedences to this SCG were observed in the surface water samples.

Pesticides/PCBs

The analytical results for pesticides and PCBs in surface water are presented in Appendix D-12 and summarized in Table 4-20. No pesticides or PCBs were detected in the eight (8) surface water samples.

Inorganic Compounds

The analytical results for metals are presented in Appendix D-12 and the SCGs are presented in Table 4-20. Metals were detected in all surface water samples collected. Exceedences of ambient surface water quality standards occurred in two (2) of the eight (8) samples collected. In each of these samples copper exceeded the surface water SCGs for fish propagation in saline water and fish survival in saline water.

Comparison of the surface water concentrations to the upstream values and the Class SC standards is presented in Table 4-20. As shown in this table, surface water concentrations in excess of the background concentrations occur for copper at two of the Site-related sample locations, SW-04 and SW-05. These concentrations are also in excess of the surface water standard for fish propagation in saline waters. The presence of copper in surface water in the vicinity of the Study Area is curious since copper is not a ICOPC concern in the Site Study Area groundwater. The only potential source of copper in surface water from the Site that has been identified is the residual sediment present in the storm sewer discharging in the vicinity of SW-01. Previous surface water runoff when the Site was unpaved may have also been a source. Isolated exceedances of the Class SC standards for ethylbenzene and xylene was also detected at SW-08; however, these compounds are not present in Site groundwater.

Marinas line the western banks of the Freeport Creek. Many boat fittings, engine parts, such as propellers and fastenings are made from brass to resist corrosion from salt. Brass is an alloy of copper and zinc. Although brass is more resistant than iron or steel to the effects of salt water, it does in time corrode. Furthermore, marine antifouling paints now commonly include copper as a biocide. Copper concentrations in antifouling points can be as large as 50% and dissolve into water bodies over time (Johnsen and Engoy, 1999). Therefore, the presence of copper in surface water is not considered to be Site-related.

4.1.5 Freeport Creek Sediments, Sanitary Sewer and Storm Drain Sediments

Sediment samples were collected from the Freeport Creek (SED-01 through SED-08) and from two (2) manholes, sanitary manhole (MH-01) and storm drain sewer manhole (SD-01). Freeport Creek sediment samples were collocated with surface water samples collected along the perimeter of the Site where groundwater discharges to surface water. One (1) sample was collected in the upstream direction (SED-06) and one (1) in the downstream direction (SED-08) of the Site. SED-08 and SED-06 are designated as the background samples. Samples collected at each location were analyzed for VOCs, SVOCs, pesticides/PCBs and metals. In addition, total organic carbon (TOC) analysis was carried out for use in calculation of Site-specific sediment criteria. The results of the sediment sampling are presented in Appendix D-13 and the SCGs are presented in Table 4-21 and 4-22. Sediment sampling locations as well as the configuration of the storm drain sewer and outfall to the Freeport Creek are presented in Figure 2-2. MH-01 and SD-01 sampling results are presented in Appendix D-13 and detections only are summarized on Table 4-23.

The Freeport Creek sediment concentrations were first compared to the background sediment samples from SED-06 and SED-08, presented on Table 4-21. Sediment concentrations above the background levels were compared to the specific sediment screening criteria provided in NYSDEC Technical Guidance for Screening of Contaminated Sediment (NYSDEC, 1999), presented on Table 4-22.

Sediment concentrations in excess of the SED-06 and SED-08 background concentrations occur for a number of SVOCs, PCBs, pesticides/herbicides, calcium, chromium, mercury, nickel and zinc. The SVOCs, PCBs, pesticides/herbicides and mercury are not associated with the Site. Consequently these chemicals will be eliminated from consideration. Although calcium was observed above its background value, it is present at a concentration below its Effects Range-Low (ER-L) and therefore is not of concern. The remaining chemicals present above background concentrations and above their SCGs are nickel in excess of its ER-L at SED-01 and SED-04, chromium above its ER-L at SED-04 and zinc above its Effects Range-Medium (ER-M) at SED-04. A summary of the detections by analysis are presented below. Figure 4-17 illustrates the inorganic constituents of concern in sediment samples posted next to each sample location.

Volatile Organic Compounds

The analytical results summary for VOCs in sediment are presented in Appendix D-13 and the SCGs are presented in Table 4-21 and 4-22. Sediment samples collected from SD-01 and MH-01 are summarized on Table 4-23. Acetone, carbon disulfide and MTBE were detected in the sediment samples. Acetone and carbon disulfide are likely laboratory artifacts.

Metals

The analytical results for metals in sediment are presented in Appendix D-13 and SCGs are presented in Table 4-21 and 4-22. Figure 4-17 illustrates the metal constituents of concern (chromium, mercury, nickel and zinc) in sediment compared to ER-M values. Sediment samples collected from SD-01 and MH-01 are summarized on Table 4-23. Metals were detected in all sediment samples.

Semivolatile Organic Compounds

Analytical results for SVOCs in sediments are presented in Appendix D-13 and the SCGs are presented in Table 4-21 and 4-22. Sediment samples collected from SD-01 and MH-01 are summarized on Table 4-23. SVOCs were detected in all eight (8) sediment samples collected from the Freeport Creek and two (2) sediment samples collected from the sanitary sewer and storm drain sewer. Based on groundwater concentrations obtained from the Site, none of the SVOCs can be considered Site related.

Pesticides/PCBs

The analytical results for pesticides and PCBs in sediment are presented in Appendix D-13 and summarized in Table 4-21 and 4-22. Sediment samples collected from SD-01 and MH-01 are summarized on Table 4-23. Except for SED-06, SED-07 and SED-08, pesticides were detected in all sediments samples.

Aroclor 1254 was detected in six (6) of the ten (10) sediment samples. Based on the groundwater data collected from the Site, neither pesticides nor PCBs can be considered Site related.

TOC

Freeport Creek sediment samples (SED-01 through SED-08) were analyzed for total organic carbon content. Analytical results for these parameters in sediment are presented in Appendix D-13 and summarized on Table 4-24.

4.1.6 Air

To assess the potential for migration of VOCs emanating from potentially impacted groundwater or from contaminated soil, soil gas samples were collected at ten (10) soil boring locations using Gore Sorber modules (Figure 2-3). The soil gas samples were collected at each location prior to initiating the soil boring and groundwater investigation. The results are summarized below.

4.1.6.1 Gore Sorbers

The soil gas survey with Gore Sorbers is described in Section 2.6. The results of the soil gas survey indicate the presence of VOCS in the soil gas at the Site. Appendix B provides the Gore Sorber sampling report and table of results. The following VOCs were detected in the samples: MTBE, trans-1,2,-dichloroethane, TCE, toluene, octane, PCE, chlorobenzene, ethylbenzene, xylenes, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, undecane, naphthalene, tridecane, 2-methyl naphthalene, and pentadecane.

4.1.6.2 *Results of Preliminary On and Off-site Supplemental Investigation 2004*

As a result of the Gore Sorber, survey which identified in soil vapor at the Site, a soil vapor investigation was requested by the NYSDEC. Both on and off-Site soil vapor samples were collected using Summa Canisters analyzed by method TO-15 for VOCs. The analytical results are summarized below and Appendix D-14 presents a full summary of the analytical results. Table 4-25 presents a summary of detections. Figure 4-18 identifies sample locations on a recent satellite image of the Site with analytical data (detections only) posted adjacent to the sample locations. The sample collection method was described earlier in Section 2.12.

Shallow Soil Vapor (SG-01): The primary compounds detected in this sample collected from beneath the slab in the 1200 square foot building were acetone, PCE and TCE.

Shallow Soil Vapor (SG-02): The vapor sample collected from beneath the slab in the northeast building contained PCE and TCE.

Shallow Soil Vapor (SG-03): The principal constituents detected in this sample were PCE and acetone.

Shallow Soil Vapor (SG-04): The vapor sample collected from beneath the road at SG-04 contained PCE.

Shallow Soil Vapor (SG-05): The TCA primary constituents detected at this location are 1,1,1-trichloroethane and 1,1-dichloroethane at concentrations.

Shallow Soil Vapor (SG-06): 2-Propanol, acetone, dichlorodifluoromethane and propane were observed in this sample. The compound detected at highest concentration was acetone. None of these compounds are Site related.

The results of the preliminary on and off-Site supplemental air investigation revealed PCE and TCE in soil gas at elevated concentrations. The greatest concentrations were observed in the sub slab vapor sample collected from beneath the 2,400 square foot building. Off-Site impacts of PCE and TCE related to Site contaminants were also observed. In general concentrations decreased as the distance from the Site increased. Results of this investigation prompted further on-Site and off-Site soil vapor sampling as well as indoor air sampling in surrounding structures. The results of that investigation are presented below.

1,1,1-Trichloroethane (1,1,1-TCA) which is not a Site related compound, were observed in off-Site soil gas samples as well as on-Site samples. This finding prompted the NYSDEC to open a new investigation to delineate the source of the 1,1,1-TCA in soil vapor. This investigation is named South End Place Site Characterization and the Site No. is 1-30-162.

4.1.6.3 *Results of Supplemental Air/Subsurface Vapor Sampling (March 2005)*

The results of the supplemental air sampling conducted in March 2005 are summarized below by. Both on and off-Site air/soil vapor samples were collected using Summa Canisters analyzed by method TO-15 for VOCs. Figure 4-18 identifies sample locations on a recent satellite image of the Site with analytical data (detections only) posted adjacent to the sample locations. A summary of the detections only are reported on Table 4-25.

The results of this investigation determined that off-Site impacts related to the Site were limited to soil vapor. Off-Site indoor air and basement samples collected from 433 South Main Street and 4 East Ray Street did not indicate that Site related contaminants were impacting indoor air quality nor the basement or crawl space. Additionally, soil vapor samples collected from surrounding properties such as 4 President Street and 3 Ray Street did not indicate that further investigation would be necessary. Detections were below NYSDOH decision matrix values. As a result of this investigation no further investigation was warranted and mitigation was not required at any off-Site location.

4.1.6.4 *Results of sub-Slab Depressurization System Installations (March 2005)*

An evaluation of the effectiveness of two sub-slab venting systems underneath the 2,400 square foot building (large warehouse building) and the 1,200 square foot building (Show room) at the Site was performed. The objective of these two venting systems was to provide a temporary means of reducing the pressures underneath the building slabs, and providing an alternative migration pathway for soil vapor. This would thereby mitigate the elevated concentrations of soil vapor contaminants below the structures.

Upon completion of the sub-slab depressurization system installations ERM confirmed the effectiveness of the systems by monitoring the vacuum pressures with a manometer. Each vacuum point is capable of being isolated to confirm the presence of vacuum. Additionally, each depressurization system was monitored with a Flame Ionization Detector (FID) to evaluate concentrations of VOCs venting from beneath the slab through the depressurization systems. Table 4-26 presents the sub-slab depressurization systems performance with measurements of FID concentrations in the systems and measured pressures in inches of water column for both systems.

5.0 HUMAN HEALTH EXPOSURE ASSSESSMENT

On the basis of the information presented in the preceding sections, a qualitative Human Health Exposure Assessment for the Site was completed. The purpose of the Exposure Assessment is to identify potential exposure pathways for contaminants at the Site and identify how any unacceptable exposure pathways might be eliminated/mitigated.

The Exposure Assessment is divided into four sections. In the first step, potential exposure pathways at the Site are identified (Section 5.1). In the second step, chemicals of potential concern for each of the identified pathways/media are selected (Section 5.2). In the third step, a qualitative evaluation of potential human health exposures for each exposure pathway is conducted based on the identified chemicals of concern (Section 5.3). The conclusions of the Exposure Assessment are presented (Section 5.4).

5.1 IDENTIFICATION OF POTENTIAL EXPOSURE PATHWAYS

The Site occupies approximately 2 acres of developed land located adjacent to Freeport Creek in Freeport. The Site is bordered by South Main Street and Ray Street to the west, Freeport Creek to the east, and commercial properties (boatyards) to the north and south. The Site is currently used as a boat dealership, marina and boat storage yard. Boat repairs, including repainting/varnishing and engine rebuilding, are conducted in a 2,400-square foot building located on the northeast corner of the property. A smaller 1,200-square foot building, located on the western portion of the property, has been restored and is used for office space for the boat dealership. Except for the portion of the Site adjacent to Freeport Creek, which is covered with gravel, most areas of the Site grounds are paved with either concrete or asphalt. The entire Site is fenced to limit entry. The nearest residential areas are to the west of the site on the west side of South Main Street. The houses on the north side of East Ray Street are no longer inhabited.

During the RI, five media were investigated: soil, groundwater, surface water, sediment and air. Potential exposure pathways for each of these media are described below.

5.1.1 Soil

As described above, almost the entire Site is paved or covered with gravel and there are therefore very limited areas where direct contact with soil could occur. In addition, the Site is fenced to restrict access. Consequently, direct contact with soils by trespassers is not a complete exposure pathway. If future redevelopment of the Site were to occur, direct contact with Site soils by construction workers could potentially take place (incidental ingestion and dermal absorption).

The presence of VOCs in Site soil could result in inhalation exposures to Site workers and Site visitors either in indoor air (in the two on-Site buildings) or outdoor air under current and future conditions.

Chemicals in Site soil could also act as a source of groundwater contamination. Groundwater exposure pathways are discussed below.

5.1.2 Ground Water

Currently, there is no groundwater usage at or in the immediate vicinity of the Site (e.g., domestic or industrial wells), and no expected future use of groundwater. Shallow groundwater is saline and thus unsuitable for drinking water. The elevated dissolved solids concentrations also make the shallow groundwater unsuitable for industrial usage; as a result significant use of groundwater at the Site is not expected. The nearest public supply well is approximately 6,000 ft north (upgradient) of the Site, and thus is not impacted by Site conditions.

The VOCs in Site groundwater could result in inhalation exposures to Site workers and Site visitors either in indoor air (in the two on-Site buildings) or outdoor air under current and future conditions. Site groundwater flows to the southeast and discharges to Freeport Creek. Potential exposure pathways for surface water are discussed below.

5.1.3 Surface Water

Freeport Creek is designated as Class SC water. The best usage of Class SC waters is fishing and the waters are suitable for fish propagation and survival (6 NYCRR 701.12). Therefore, ingestion of fish from Freeport Creek represents a potential exposure pathway.

NYSDEC regulations also indicate that Class SC waters may be suitable for primary and secondary contact recreation, although other factors may limit these activities. Based on a review of the land usage in the Site vicinity and the nature of the creek, direct contact (incidental ingestion and dermal absorption [i.e., secondary contact]) with surface water could occur as a result of fishing and recreational boating. Primary contact recreation (i.e., swimming) is not expected to be significant. The Site is located in a highly developed, industrialized stretch of Freeport Creek with boatyards located to the north and south of the Site. Industrial properties, including a fire-training center and power plant, occupy the opposite bank of the creek. Therefore, access to the creek by residents in the vicinity of the Site is limited.

5.1.4 Sediment

Significant direct contact with Freeport Creek sediment in the Site vicinity is not expected based on the depth of the creek, the volume of boat traffic, limited access, and the presence of bulk heading. The only potential exposure pathway for Freeport Creek sediment is via ingestion of fish. Site-specific sediment criteria (SSC) were calculated for SVOCs using the procedures outlined in the NYSDEC document entitled, Technical Guidance for Screening Contaminated Sediments dated March 1998 with January 1999 revisions. SSC were derived for Human Health Bioaccumulation, Benthic Aquatic Life Acute and Chronic Toxicity, and Wildlife Bioaccumulation using the organic compound normalized sediment criteria contained in Table 1 from the Contaminated Sediments Guidance Document and an average organic carbon concentration calculated from the organic carbon concentrations of seven sediment samples collected from Freeport Creek.

SSC for each compound were compared to SVOC concentrations in each of the sediment samples and exceedences were determined. As shown on Table 5-1, Human Health Bioaccumulation impacts were identified for six (6) PAHs, including: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene and indeno(1,2,3-cd)pyrene. In addition, phenanthrene exceeded SSC for Chronic Benthic Aquatic Life Toxicity in two (2) samples.

5.1.5 Air

Land use at the site is primarily commercial/residential. Therefore, inhalation of chemicals from site soil or groundwater, which have volatilized to overlying air (indoor or outdoor) could result in inhalation exposures to Site workers or local residents.

5.2 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN FOR EACH PATHWAY

Chemicals of potential concern (COPC) for each exposure pathway/medium are identified based on exceedence of standards, criteria and/or guidance values (SCGs). Data tables presented in Section

4.0 show all sampling results as well as the relevant SCGs. These tables were reviewed to identify COPC for each pathway/medium.

5.2.1 Soil

A total of 69 soil borings were installed as part of the RI. From these, a total of 273 screening samples were collected and analyzed for TCL VOCs and TAL metals. Identification of these two analyte groups as the contaminants requiring further investigation was based on preliminary sampling conducted at the beginning of the RI. Preliminary sampling details and collection of the screening samples, including sampling locations are provided in Sections 2.0. The results are discussed below.

Volatile Organic Compounds

A total of 273 soil samples were analyzed for VOCs and the concentration of VOCs detected in the samples was compared with the NYSDEC Recommended Soil Cleanup Objectives (RSCOs) from NYSDEC TAGM 4046 (dated January 24, 1994). The results of the comparison are presented in Appendix D-4 and summarized on Table 4-10. As shown in that table, eleven (11) chemicals (benzene, toluene, ethylbenzene, xylene, MTBE, naphthalene chlorobenzene, PCE, TCE, trans-1,2-DCE and VC) were detected at concentrations in excess of the RSCOs. These chemicals are identified as COPC and are further evaluated in Section 5.3.

Inorganics

Appendix D-4 and Table 4-11 also compares the concentrations of metals detected in soil with the relevant RSCOs. As shown in Table 4-11, fifteen (15) metals were detected at concentrations in excess of the relevant RSCOs (arsenic, barium, beryllium, cadmium, calcium, trivalent chromium, hexavalent chromium, cobalt, copper, iron, lead, magnesium, nickel, selenium, and zinc). Further analysis of the frequencies of detection and potential Site usage resulted in the identification of copper, trivalent chromium, hexavalent chromium, nickel and zinc as COPC. These metals are evaluated further in Section 5.3.

5.2.2 Ground Water

Ten (10) groundwater samples were collected from Site monitoring well network. The samples were analyzed for the full suite of TCL/TAL compounds as well as hexavalent chromium. Section 2.0 provides groundwater sampling locations and sampling results are provided in Appendix D-11 and a summary of detections are presented in Tables 4-16 to 4-19 for VOCs, SVOCs, pesticides/PCBs, and inorganics. Based on the concentration of dissolved solids, Site groundwater is best classified as GSA groundwater. However, standards have not been established for this groundwater classification. Therefore, groundwater monitoring data were compared to available groundwater standards promulgated by the New York State (i.e., 6 New York Code of Rules and Regulations Part 703 for Class GA Groundwater). Class GA groundwater standards are based on usage of the groundwater for drinking water. As shown in these tables, chemicals detected in one or more samples above the Part 703 standards include six (6) VOCs; benzene, cis-1,2-DCE, MTBE, PCE, TCE, and VC and seven (7) metals; antimony, barium, hexavalent chromium, iron, magnesium, manganese, and sodium. No SVOCs or pesticides/PCBs were detected above Part 703 Standards. Therefore, these thirteen (13) chemicals are identified as COPC in groundwater and are further evaluated in Section 5.3.

5.2.3 *Surface Water*

Eight (8) surface water samples were collected from Freeport Creek. Due to the tidal nature of the creek, none of these sampling locations can be considered an unimpacted background sample. The samples were analyzed for full suite of TCL/TAL compounds. Further details of sample collection, sampling locations are presented in Sections 2.0.

Appendix D-12 provides the surface water sampling results for VOCs, SVOCs, pesticides/PCBs, and inorganics, respectively. Freeport Creek is designated as Class SC surface water. As shown in Table 4-20, chemicals detected in one (1) or more samples above Part 703 Class SC standards include two (2) VOCs; ethylbenzene and xylenes and one (1) metal; copper. No SVOCs or pesticides/PCBs were detected above Class SC Standards. Therefore, these three (3) chemicals are identified as COPC in surface water and are further evaluated in Section 5.3.

It may be noted that Class SC standards have not been established for a majority of the chemicals detected in surface water.

5.2.4 *Sediment*

Eight (8) sediment samples, collocated with the surface water samples, were collected from Freeport Creek. The samples were analyzed for full suite of TCL/TAL compounds. Sections 2.0 presents the details of sample collection and sampling locations.

Appendix D-13 provides the sediment sampling results for VOCs, SVOCs, pesticides/PCBs, and inorganics. SSC for each compound were compared to contaminant concentrations in each of the sediment samples and exceedences were determined. As discussed in Section 4.1.5, pesticides/PCBs are not believed to be Site related and these compounds were not retained as COPC. Bioaccumulation impacts were identified for six PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene and indeno(1,2,3-cd)pyrene. In addition, the concentration of phenanthrene exceeded SSC for Chronic Benthic Aquatic Life Toxicity in two (2) samples.

PAHs are not typically associated with metal finishing operations such as those carried out at the Site. However, PAHs are present in fuel oil and oil based paint products, asphalt, and in the preservatives used to treat timbers and telephone poles, etc. The RI identified hydrocarbon contamination at locations across the Site. However, PAHs are spraining soluble in water and are therefore not very mobile dissolved in groundwater. The source(s) of PAHs detected in Freeport Creek sediments cannot be determined because of potential multiple sources present on and off-Site. Therefore, SVOCs (PAHs) were eliminated from further evaluation. Additional delineation of sediment impacts is recommended during predesign to more fully characterize PAH distribution in Freeport Creek sediments and to determine if they are Site related, and if remediation required.

A total of four (4) VOCs (acetone, carbon disulfide, methylene chloride and MTBE) and fifteen (15) inorganics (aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, silver, thallium, vanadium, and zinc) were detected in sediment and could be Site related. All of the VOCs and inorganics listed above detected in sediment from Freeport Creek are retained as COPC and are further evaluated in Section 5.3.

5.2.5 *Air*

Nineteen (19) air samples were collected as part of the supplemental RI. All of the samples were analyzed for VOCs using USEPA Method TO-15. Details on sample location and collections methods are presented in Section 4.1.6. To investigate potential human health impacts, VOCs detected in subsurface, indoor and outdoor samples were evaluated by the NYSDOH to assess potential human health impacts. The NYSDOH required the installation of two sub-slab depressurization units on the on-Site buildings as part of an interim remedial measure. If additional data or sampling is required by the NYSDOH, sampling requirements will be addressed during the implementation of the FS.

5.2.6 *Summary*

Table 5-2 summarizes the COPC at the Site. Potential human exposures for these chemicals and pathways are qualitatively evaluated in Section 5.3.

5.3 QUALITIVE EXPOSURE CHARACTERIZATION

5.3.1 Soil

COPC in soil, based on exceedence of SCGs, include eleven (11) VOCs (benzene, toluene, ethylbenzene, xylene, MTBE, naphthalene, chlorobenzene, PCE, TCE, trans-1,2-DCE and vinyl chloride (VC) and fifteen (15) inorganics (arsenic, barium, beryllium, cadmium, calcium, chromium, hexavalent chromium, cobalt, copper, iron, lead, magnesium, nickel, selenium, and zinc). There are three (3) potential exposure pathways for these COPC: direct contact with soil, leaching of chemicals in soil to groundwater, and volatilization of chemicals in soil to overlying air. Each of these pathways is evaluated below. Results for organic compounds and inorganics are addressed separately.

Organic Compounds

NYSDEC TAGM-4046 presents acceptable soil levels for organic compounds for both direct contact with soil and for protection of groundwater. The lower of these two (2) values is generally the Recommended Soil Cleanup Objective, which was used in Section 4.2 to screen the chemicals. The acceptable level for direct contact exposures is based on a residential exposure scenario, with children ages one (1) to six (six) ingesting soil. The acceptable level for protection of groundwater is based on leaching of chemicals in soil to groundwater where groundwater concentrations must meet promulgated or proposed New York State groundwater (Class GA)/drinking water quality standards. Groundwater at the Site is most appropriately characterized as Class GSA based on its salinity, and is not suitable for water supply. However, to further evaluate which chemicals may pose a human health exposure via each of the above pathways, the maximum detected concentration of each of the chemicals of concern is compared to these two (2) acceptable levels (Table 5-3).

As shown in Table 5-3, the NYSDEC direct contact screening criteria for the eleven (11) VOC COPC, where available, were not exceeded in any samples. Therefore, direct contact with these chemicals in soil does not represent a significant current or future exposure pathway.

Organic chemicals present in soil at concentrations in excess of groundwater protection criteria include all eleven (11) VOC COPC (trans-1,2-DCE, benzene, chlorobenzene, ethylbenzene, MTBE, naphthalene, PCE, toluene, TCE, xylene, vinyl chloride). Of these, six (6) VOCs were not identified as COPC in groundwater (trans-1,2-DCE, chlorobenzene, ethylbenzene, naphthalene, toluene, and xylene) (see Section 5.3.2), and therefore are not evaluated further for this pathway. The presence of the remaining VOCs in soil and their impact on groundwater (benzene, MTBE, PCE, TCE, and vinyl chloride) is evaluated in Section 5.3.2.

All of the VOC COPC in Site soil can volatilize to overlying indoor and/or outdoor air. Therefore, these chemicals represent a potential significant exposure pathway. The potential for this exposure pathway is confirmed by the presence of VOCs in the soil gas samples collected at the Site.

Inorganics

A total of five inorganics were identified as COPC in soil (chromium, hexavalent chromium, copper, nickel, and zinc). These chemicals were identified based on exceedence of RSCOs without consideration of Site background data or, for those chemicals with RSCOs of "Site Background", based on exceedence of New York Region background levels as listed in TAGM 4046. TAGM 4046 does not include groundwater protection criteria and direct contact criteria for inorganics. Therefore, no pathway specific analysis can be completed for inorganics in soil using the RSCOs.

To further evaluate the inorganic chemicals of potential concern in soil, Table 5-4 compares the maximum detected concentrations of these chemicals to the RSCOs, the New York Region background concentrations (as listed in TAGM 4046), and eastern U.S. background concentrations. As shown in this table, five chemicals are present in concentrations exceeding both New York Region background and eastern U.S. background concentrations, where available. These chemicals are chromium, hexavalent chromium, copper, nickel, and zinc. Therefore, direct contact with these chemicals in soil may represent a potential exposure pathway.

To evaluate the potential for leaching to ground water of these nine chemicals, Site groundwater quality data was reviewed. As shown in Appendix D-11 and summarized in Tables 4-16 to 4-19 only one of these chemicals, hexavalent chromium, was also present in Site ground water at a concentration above its Class GA standard. The exceedence was minor and only occurred at one location. Based on this evaluation, leaching of inorganics from soil to ground water is not a significant pathway.

5.3.2 *Ground Water*

COPC in groundwater at the Site based on exceedence of the Class GA groundwater quality standards and guidance include six (6) VOCs (benzene, MTBE, PCE, TCE, cis-1,2-DCE, and VC) and seven inorganics (antimony, barium, hexavalent chromium, iron, magnesium, manganese, and sodium).

As noted in Section 5.1.2, groundwater is not currently used for drinking water or any other purposes at the Site or in the Site area. Based on the concentration of dissolved solids the groundwater is best characterized as Class GSA saline groundwater. However, there are no standards or guidance values for Class GSA waters. Potential exposure pathways for groundwater at the Site include volatilization to overlying indoor or outdoor air and discharge to Freeport Creek (Class SC), with resulting exposures via secondary contact recreation and fish ingestion. Each of these pathways is discussed below.

The COPC for the volatilization pathway are benzene, cis-1,2-DCE, MTBE, PCE, TCE, and vinyl chloride. With the exception of MW-03D, all monitoring wells (all shallow monitoring wells) had one or more detections of the COPC in excess of the Class GA standards. Although the Class GA standards are for usage of groundwater water as drinking water, volatilization of all of the COPC from shallow groundwater to indoor or outdoor air at the Site may represent a significant exposure pathway. The potential for this exposure pathway is confirmed by the presence of VOCs in the soil gas samples collected at the Site. The presence of MTBE is not believed to be due to operation of the Site as a plating facility; however MTBE concentrations appear to be elevated in the area east of SB-34, i.e., the area where boasts are stored.

Groundwater beneath the Site discharges to Freeport Creek, therefore, the COPC for secondary contact with Freeport Creek surface waters and ingestion of fish are the thirteen (13) COPC identified for Site groundwater. The chemicals were identified as COPC based on the maximum detected concentrations in on-Site groundwater; however, concentrations are expected to be significantly decreased following discharge to Freeport Creek. As shown in Section 5.2.3, none of these chemicals was identified as a COPC in surface water based on sampling of Freeport Creek. Therefore, discharge of groundwater to Freeport Creek does not represent a significant exposure pathway.

5.3.3 *Surface Water*

COPC in surface water, based on exceedence of the Class SC surface water quality SGC include two VOCs (ethylbenzene and xylenes) and one metal (copper). There are two (2) potential exposure pathways for surface water: ingestion of fish and secondary contact through fishing and recreational boating activities. Each of these pathways is addressed below.

Table 5-5 presents the maximum detected concentration of the chemicals of potential concern and the NYSDEC Class SC surface water quality standards and guidance values. The Class SC surface water quality standard can be based on either impacts to aquatic life or impacts to human health based on ingestion of fish. The standards listed in Table 5-5 are all based on impacts to aquatic life. Class SC standards have not been developed for these three chemicals for ingestion of fish. Therefore, to further evaluate these data, the USEPA Water Quality Criteria for the protection of human health via ingestion of fish is provided in Table 5-5 (EPA, 2002). As shown in this table, the maximum detected concentrations of ethylbenzene and copper are below the USEPA water quality criteria. No such criterion has been established for xylenes. However, xylenes were detected in only one of the eight surface water samples (SW-08), and that sample was collected from the middle of Freeport Creek. Xylenes were not detected in any of the seven surface water samples immediately adjacent to the Site.

Contact with Freeport Creek water can occur via secondary contact activities such as fishing and recreational boating. There are no established standards for evaluating this pathway. However, as described above, xylenes were only detected in one surface water sample (SW-08), and in none of the samples adjacent to the Site. Ethylbenzene was also detected only in SW-08. Direct contact with the remaining COPC, copper, may represent a significant exposure pathway. Review of the ground water sampling results indicates that copper is not a chemical of concern in groundwater. A possible source of copper in surface water is residual sediment in the storm sewer system discharging to the Creek. Review of the sampling results for storm sewer sample SD-01 indicates elevated concentrations of copper and other inorganics.

5.3.4 *Sediment*

COPC in sediment at the Site include all VOCs and inorganics detected in sediment from Freeport Creek (, acetone, carbon disulfide, methylene chloride and MTBE, aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, silver, thallium, vanadium, and zinc). The pathway of concern in this evaluation is impacts to human health via ingestion of fish. The VOCs listed above do not bioaccumulate to significant levels in tissue. Consumption of fish tissue exposed to these VOCs is therefore not expected to be an exposure pathway. Thus there aren't any VOC ICOPCs in the sediment. The NYSDEC sediment criteria for inorganics for the protection of human health via bioaccumulation were considered (Table 1 of the Technical Guidance for Screening Contaminated Sediments). However, no criteria have been established for any of the inorganics of potential concern. Therefore, the presence of these metals in sediment cannot be further evaluated for this pathway.

5.4 CONCLUSION – HUMAN HEALTH EXPOSURE EVALUATION

Five (5) media were evaluated for potential human health impacts: soil, groundwater, surface water, and sediment. A summary of the findings for each medium and the relevant pathways is provided below.

5.4.1 Soil Pathways

Direct Contact with Soil

The presence of VOC COPC in Site soil does not represent a significant human exposure pathway via direct contact under current or future conditions. Inorganics could not be evaluated on a pathway-specific basis using the RSCOs. However, nine (9) inorganics (cadmium, chromium, hexavalent chromium, cobalt, copper, lead, nickel, selenium, and zinc) were detected in concentrations above both New York regional background levels and eastern U.S. background levels, where available. Therefore, direct contact with these chemicals in soil may represent a potential exposure pathway.

Leaching of Chemicals in Soil to Groundwater

None of the COPC detected in Site soil result in a significant exposure pathway via leaching to groundwater and subsequent discharge to Freeport Creek.

Volatilization of Chemicals in Soil to Overlying Indoor and/or Outdoor Air

The eleven (11) VOC COPC detected in Site soil may represent a significant exposure pathway via inhalation by on-Site workers or visitors (benzene, chlorobenzene, ethylbenzene, toluene, xylene, MTBE, naphthalene, trans-1,2-DCE, PCE, TCE and VC). With the exception of chlorobenzene, VC, and naphthalene (which was not analyzed), all of the other VOC COPC were detected in the soil gas samples collected during the RI.

5.4.2 Ground Water Pathways

Volatilization of Chemicals in Soil to Overlying Indoor and/or Outdoor Air

The six (6) VOC COPC detected in Site groundwater may represent a significant exposure pathway via inhalation by on-Site workers or visitors (benzene, MTBE, PCE, TCE, cis-1,2-DCE and VC). With the exception of

VC, all of the other VOC COPC were detected in the soil gas samples collected during the RI.

Ingestion of Fish and Secondary Contact with Freeport Creek Waters Following Discharge of Groundwater to the Creek.

None of the COPC in groundwater represents a significant exposure pathway for ingestion of fish or secondary contact with Freeport Creek water.

5.4.3 *Surface Water Pathways*

Secondary Contact with Freeport Creek Water

Copper is the only COPC in surface water that may represent a significant exposure pathway via secondary contact with Freeport Creek water. As noted above, the source of copper in surface water is suspected to be residual contamination in the storm sewer system.

Ingestion of Fish From Freeport Creek

None of the COPC in surface water represents a significant exposure pathway for ingestion of fish from Freeport Creek.

5.4.4 *Sediment Pathways*

Ingestion of Fish From Freeport Creek

Twenty-one (21) inorganic COPC detected in Freeport Creek sediment may represent a significant exposure pathway via ingestion of fish (2-butanone, acetone, carbon disulfide, methylene chloride, MTBE, were detected in creek sediments, however, these VOCs do not bioaccumulate and therefore consumption of fish tissue exposed to these compounds is not an exposure pathway. Evaluation of the exposure potential of aluminum, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, silver, sodium, thallium, vanadium, and zinc) could not be carried out due to lack of appropriate criteria.

PAHs were detected in Freeport Creek sediments. PAH concentrations are greatest in sediment collected closest to the storm sewer. Freeport Creek sediment samples collected near the large motel parking lot also had elevated PAH concentrations with respect to upstream samples. It is possible that runoff from the roadways and asphalt sealer in the parking lot is a source of sediment PAHs. Additional sediment sampling will be required to determine if the PAHs in Freeport Creek sediments are Site related.

6.0 FISH AND WILDLIFE IMPACT ANALYSIS

6.1 OBJECTIVES

This section presents the Fish and Wildlife Impact Analysis (FWIA) for the Site. The FWIA was conducted in accordance with the New York State Department of Environmental Conservation (NYSDEC) Draft DER-10 Technical Guidance for Site Investigation and Remediation, Section 3.10.1, dated December 2002. This guidance is still in draft form; however, Section 3.10.1 (Part 1: Resource Characterization) is consistent with previous guidance contained in the memorandum entitled Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites (NYSDEC, 1994). According to the 1994 NYSDEC guidance, the initial phase of the FWIA involves two steps: Step I – Site Description, and Step II – Contaminant-Specific Impact Assessment. These Steps are conducted in this report as Part 1: Resource Characterization, as described in Section 3.10.1 of the 2002 draft guidance.

The objectives of Part 1 of the FWIA are to: (1) identify the fish and wildlife resources that presently exist at and in the vicinity of the site and (2) identify actual or potential impacts of site-related chemicals on fish and wildlife resources. The first step of the FWIA is to determine if fish or wildlife resources are present. If no resources are present or no migration pathway exists for site-related contaminants to impact resources, then no further analysis is required. If resources are determined to be present within a 0.5 mile radius, and a migration pathway is present (either currently or historically) to these resources, contaminants of concern are identified by comparing site-specific chemical levels with numerical criteria for the protection of biota in each media of concern. If site-related contaminants are present at concentrations exceeding criteria, then a Part 2: Ecological Impact Assessment will be recommended.

6.1.1 Site Description

A detailed Site description is provided in Section 1.2. The Site occupies 1.05 acres along Freeport Creek in Nassau County, Freeport, New York. It is a Class 2 Site listed on the NYSDEC Registry of Inactive Hazardous Waste Sites (No. 1-30-110). The Site, which is owned by Freeport Creek Associates, is leased by Main Street Marine and is currently used as a boat dealership, marina, and boat storage yard. An additional 1.01 acres located immediately south and east of the Site along Freeport Creek is also being investigated as part of the RI and the FWIA and is included in the term “Site”.

The Metal Etching buildings that formerly occupied the property, with the exception of a 2,400-square foot building located in the northeast portion of the Site, were demolished in 2001. The foundations of the original buildings (concrete slab/flooring/footings) remain in the ground. The land area on the Site consists primarily of concrete or paved areas, and portions of the Site adjacent to Freeport Creek are covered with gravel.

When in operation (1966 to 1999), the Metal Etching Corporation manufactured metal nameplates, instrument panels, rulers and other miscellaneous plated products on the Site. Operations carried out at the Site included anodizing, chromate conversion, paint/powder coating, photo processing including ink screening and printing, metal cutting, and chrome/nickel plating. Degreasing was part of the pre-finishing process. Wastewater treatment was carried out on-Site post processing.

6.2 FISH & WILDLIFE RESOURCES

A topographic map of the Site is provided as Figure 6-1. Documented fish and wildlife resources exist within a 0.5-mile radius of the Site, including the Freeport Creek to the south and east of the Site and tidal wetland areas approximately 0.4 miles east and southeast of the Site.

Figure 6-2 presents the National Wetland Inventory (NWI) map for the Site and a 0.5-mile radius of the Site. No freshwater wetlands are mapped on the Site or within a 0.5-mile radius of the Site. The NWI map indicates tidal wetlands within a 0.5-mile radius of the Site; these wetlands are classified as estuarine and marine wetlands (E2EM1P) and estuarine and marine deepwater (E1UBL and E1UBLx). The closest freshwater wetland to the Site is a freshwater pond located to the south, just outside of the 0.5-mile radius of the Site.

Figure 6-3 presents the New York State Freshwater Wetland Maps for the Site and a 0.5-mile radius of the Site (Freeport quadrangle). No state designated freshwater wetlands occur within a 0.5-mile radius of the Site.

Figure 6-4 presents the New York State Tidal Wetlands Map. These maps indicate three types of tidal wetlands within a 0.5-mile radius of the Site. Freeport Creek and adjacent canal areas are classified as the Littoral Zone (LZ). An undeveloped portion of the coastline along the eastern side of the radius, as well as an island located in Freeport Creek, are noted as High Marsh (HM) areas, with the intertidal portion of these areas labeled as Intertidal Marsh (IM).

The terrain across the Site is relatively flat with a slight downward gradient towards the Freeport Creek. The direction of surface flow is depicted on Figure 6-5. Groundwater elevation is highly variable and greatly influenced by tidal changes, but generally occurs at 3.5 to 6.0 feet below ground surface. The groundwater gradient map (Figure 3-9) shows a generalized south-southeast flow of groundwater toward Freeport Creek. Groundwater contour maps have been constructed based on a tidal study that was conducted at the Site in 2004.

The ecological communities found within a 0.5-mile radius of the Site are defined as follows based on the Ecological Communities of New York State: Second Edition (NYSDEC, 2002).

6.2.1 *Terrestrial Systems*

6.2.1.1 *Terrestrial Cultural (City of Freeport)*

This subsystem characterizes the Site and the majority of the 0.5-mile radius surrounding the Site. The six communities that are present are created and maintained by human activities or modified by human influence. These communities include:

Urban Vacant Lot: an open site in a developed, urban area. Sparsely vegetated with areas of exposed soil, rubble and other debris.

Urban Structure Exterior: exterior surface of structures in an urban area. Surfaces may provide substrate for vegetation, invertebrates, nesting or resting areas for wildlife.

Interior of Non-Agricultural Building: interior space of a building used primarily by people for work or storage space.

Paved Road/Path: a road or pathway paved with asphalt, concrete, etc.

Unpaved: a sparsely vegetated road or pathway of gravel or bare soil.

Mowed Lawn: residential, commercial, or recreational land where groundcover is dominated by clipped grasses and tree cover is less than 30 percent.

6.2.2 *Estuarine Systems*

6.2.2.1 *Estuarine Subtidal (Freeport Creek)*

Freeport Creek belongs to the estuarine subtidal subsystem, which includes areas below the lowest tide which are continuously submerged.

6.2.2.2 *Estuarine Intertidal*

Estuarine intertidal areas are areas located between the low tide level and the high tide level. The substrate is periodically exposed and flooded by semidiurnal tides (two high tides and two low tides per day). Areas within a 0.5-mile radius that fall within this category are along the eastern side of the radius area and include an undeveloped shoreline as well as portions of an island comprised of tidal wetlands.

6.2.2.3 *Estuarine Cultural*

The southern portion of the 0.5-mile radius is comprised mainly of manmade tidal channels. These areas have been channelized to allow for boat docking in residential areas.

6.3 CONTAMINANT MIGRATION PATHWAYS

The former manufacturing activities at the Site, failure of underground piping, and incidental releases due to poor housekeeping, are possible sources of contamination at the Site. During operations, the primary method for disposal of sanitary and industrial wastewater appears to have been through the sanitary sewer lines. There are two reported incidents of the failure of underground piping connecting the on-Site wastewater treatment system to the sanitary sewer. Poor housekeeping, including spillage during operations, improper storage and disposal, and leakage of waste chemicals, likely resulted in incidental releases of process wastes, spent solvents, and raw chemicals. The NYSDEC Spills Incident Database contains records of three known spills.

Contaminants from these releases include heavy metals (chromium, cadmium, and nickel) and solvents (chlorinated hydrocarbons (CHC) such as tetrachloroethene (PCE) and trichloroethene (TCE)).

There is evidence of soil contamination on the Site, but habitat for endangered, threatened, or special concern species is not present on the Site. There are no ecological habitats on the Site, and the surrounding land area is characterized as a terrestrial cultural (upland) community type.

The soil beneath the Site is characterized by an unsaturated zone underlain by saturated soil that is most likely estuarine. As the water table at the Site occurs at approximately 3.5 to 6.0 feet below grade, any sizable amount of material released on the property can rapidly reach the water table. Once these contaminants reach the water table, they can be transported via groundwater flow. Because of the Site's location adjacent to Freeport Creek, a tidal estuary, the groundwater is likely discharging into the Creek at certain periods in the tidal cycle. The potential therefore exists for contaminants to migrate from beneath the Site into Freeport Creek, contaminating sediment and/or surface water. Because of this situation, groundwater is one of the principal pathways for contaminant migration at the Site.

Although the potential for the migration of contaminants exists, environmental conditions may attenuate much of the contamination. Movement of contaminants through the unsaturated and saturated zones depends on several factors, including the sorptive capacity, the oxidation/reduction potential (ORP) and the dissolved oxygen (DO) content of the subsurface. Significant concentrations of nutrients and dissolved minerals are transported into the saturated portion of the subsurface during each tidal cycle. These nutrients lead to the growth of native bacteria in the soil, which may use the nutrients and dissolved minerals as a source of energy. The soil will become increasingly anoxic (anaerobic) as the bacteria population increases, and the ORP and DO will fall. Low ORP and DO reduce cationic and anionic species, which promotes the co-metabolization of chlorinated hydrocarbons. This process may serve to limit the migration of contaminants off-Site.

6.4 DESCRIPTION OF RESOURCES POTENTIALLY IMPACTED BY THE SITE

Because the ground water flows toward Freeport Creek, biological communities in the creek will be the focus of this FWIA. Freeport Creek borders the Site to the east and south. It is classified as a Class SC surface water body; saline surface water. The surrounding area is heavily developed with bulkheads along the shorelines of the creek.

The New York State Natural Heritage Program and the U.S. Fish and Wildlife Services have been contacted to request information concerning the occurrence of plants, wildlife and any endangered, threatened, proposed, or candidate species or their critical habitats on or in the vicinity of the Site. Responses to these inquiries have not been received, but will be forwarded upon receipt.

6.5 IDENTIFICATION OF FISH & WILDLIFE REGULATORY CRITERIA AND CONTAMINANTS OF ECOLOGICAL CONCERN

A criteria-specific analysis uses numerical criteria to assess potential ecological impacts associated with the constituents of concern. The numerical criteria are obtained from the New York State Department of Environmental Conservation Water Quality Regulations: Surface Water and Groundwater Classifications and Standards (New York State Codes, Rules and Regulations; Title 6, Chapter X Parts 700-706, Amendments through August 4, 1999) and the New York State Department of Environmental Conservation Technical Guidance for Screening Contaminated Sediments. If constituent concentrations are less than the numerical criteria, it is assumed that the constituent does not pose an unacceptable risk, and additional analysis is unnecessary. Where Site-related constituent concentrations exceed the numerical criteria, an analysis of toxic effects is required.

6.5.1 Screening of Analytical Data

As explained in Section 4.1, the surface water data results were compared to applicable standards, criteria or guidance values (SCGs) found in the Division of Water Technical and Operational Guidance Series (1.1.1) (TOGS 1.1.1); Class SC for protection of Human Consumption of Fish, Fish Propagation and Fish Survival for surface water.

To evaluate the potential for Site-related impacts to surface water, the detected concentrations of constituents in ground water were also compared against the surface water SCGs; Class SC for protection of Fish Propagation and where these are not available, Human Consumption of Fish. For the screening of ground water, the NOAA Coastal Protection and Restoration Division (CPRD) uses 10 times the applicable surface water SCGs to account for the dilution expected during migration and upon discharge to surface water. Since the Freeport Creek is a large tidally-influenced body of water, the methodology of NOAA CPRD was considered conservative for screening ground water in this analysis. Therefore, the applicable surface water SCGs were multiplied by 10 to derive a screening level for comparison to ground water data.

Sediment data results were compared to SCGs provided in the New York State Department of Environmental Conservation Technical Guidance for Screening Contaminated Sediments.

6.5.1.1 Ground Water Screening Results

Ten monitoring wells located on the Site were sampled in October 2004; MW-01, MW-02S, MW-02D, MW-03S, MW-03D, MW-04, MW-05, MW-06, MW-07S, and MW-07D (Figure 2-2). The screening of positively detected VOCs, inorganics, SVOCs and pesticides/PCBs against the Class GA SCGs are presented on Tables 4-16, 4-17, 4-18 and 4-19, respectively.

Table 6-1 presents the screening results against the surface water SCGs adjusted for dilution. There are no exceedances.

6.5.1.2 Surface Water Screening Results

Eight surface water samples were collected from Freeport Creek. As shown on Figure 2-2, SW-01, SW-02, SW-03, SW-04, SW-05 and SW-07 were collected adjacent to the Site, SW-06 was collected upstream of the Site and SW-08 was collected downstream of the Site. The locations of these samples were biased towards discharge points or any identified surface features potentially related to historical discharges. These samples were also analyzed for VOCs, SVOCs, pesticides/PCBs and metals and the screening results are presented on Table 4-20.

Two VOCs (ethylbenzene and xylene) and one metal (copper) were detected above their associated SCG. Where SCGs were available, SVOCs were not detected above them. PCBs and pesticides were not detected.

6.5.1.3 *Freeport Creek Sediment Screening Results*

Eight sediment samples were collected from Freeport Creek. These samples were collocated with the surface water samples; SED-01, SED-02, SED-03, SED-04, SED-05 and SED-07 were collected adjacent to the Site, SED-06 was collected upstream of the Site and SED-08 was collected downstream of the Site. SED-06 and SED-08 are considered background (i.e., reference) samples for the purpose of this evaluation. However, due to the tidal nature of the creek, none of these samples can be considered uncontaminated background samples. These samples were analyzed for VOCs, SVOCs, pesticides/PCBs, inorganics and total organic carbon.

As explained in Section 4.1.5, the detected sediment results were first compared to the background samples. Constituents exceeding background were subsequently compared to the ER-Ls and ER-Ms. Additionally, Site-specific sediment criteria (SSC) were derived using the sediment criteria provided on Table 1 in the Technical Guidance for Screening Contaminated Sediments and a calculated average organic carbon concentration from the Freeport Creek sediment samples. The results of this screening are presented on Table 4-21 and 4-22.

Several SVOCs, pesticides/PCBs and four inorganics (chromium, mercury, nickel and zinc) were detected above the background concentrations and the SCGs. Screening criteria were not available for the four detected VOCs.

6.5.1.4 *Sanitary Sewer and Storm Drain Sediment Screening Results*

Two sediment samples were also collected from the bottom of a sanitary manhole (MH-01) and a storm drain (SD-01) located on northern side of the Site as depicted on Figure 2-2. MH-01 received sanitary and wastewater discharge from the former Metals Etching Corporation and SD-01 likely received Site-related run-off. These samples were analyzed for VOCs, SVOCs, pesticides/PCBs and inorganics. The detected results are shown on Table 4-23.

MH-01 and SD-01 were screened against the ER-L and ER-M values provided on Table 4-21. Many SVOCs, pesticides/PCBs and metals were detected above the screening criteria (Table 6-2).

6.6 *FWIA SUMMARY AND CONCLUSIONS*

In general, groundwater does not appear to be the source of detections in the surface water and sediment results based on the results of the criteria-specific analysis.

The VOCs that were detected above their SCGs in the surface water samples are not detected in the ground water samples, and the one low detection of copper (28.3 ug/L) in an upgradient well (MW-02D) does not appear to be the source of copper in SW-04 (19.5 ug/L) and SW-05 (46.5 ug/L). Furthermore, copper is commonly found in boat propellers, fastenings and paints, indicating that other sources of copper are present in Freeport Creek (see Section 7.3.3).

With respect to the exceedances noted in Freeport Creek sediment samples, it should be noted that the SVOCs and pesticides/PCBs are not Site-related. Further, neither ground water discharge from the Site nor the storm drain/sanitary sewer appear to be the source of the inorganic exceedances in sediment samples SED-01 and SED-04. The ground water discharge pathway was discussed previously and was determined not to be of concern based on a comparison with surface water SCGs. In addition, although Site-related metals were found in the storm drain/sanitary sewer sediment samples, sediment transport from this feature to Freeport Creek does not appear to be a concern based on the following observations:

The averaged results of SED-01 and a duplicate sample collected at the storm drain outfall (Figure 2-2) indicate that the only SCG excedances were for mercury and nickel. Mercury is not Site-related, and the reported nickel concentration from SED-01 is consistent with background results.

SED-04 is located along the southern side of the Site. As indicated above, SED-01 is located in the vicinity of the storm drain outfall, and samples SED-02, SED-03, SED-07 are located south of the outfall between SED-01 and SED-04. There were no inorganic SCG exceedances at these intermediate sample locations.

The sediment samples in the storm drain and sanitary sewer may potentially pose a risk to ecological receptors utilizing these areas based on the reported exceedances of SCGs. However, SVOCs and pesticides/PCBs are not associated with the Site. The remaining constituents in storm drain and sanitary sewer samples, chromium, copper, nickel and zinc, were identified as ICOPCs in Site soils and, therefore, the Site may have historically been a potential source of these constituents to the storm drain and sanitary sewer.

Based upon the fish and wildlife resources and exposure pathways identified in this assessment, and the results of the screening analysis, no Site-related adverse impacts to fish and wildlife resources have occurred or are expected to occur on, adjacent to, or within a 0.5-mile radius of the Former Metal Etching Site, with the possible exception of the storm drain, sanitary sewer and sediments in the vicinity of SED-04.

7.0 SUMMARY AND CONCLUSIONS

Between May and November 2004, ERM carried out RI field activities at the Metal Etching Site. Supplemental RI activities were performed in August 2004 and March 2005, including an Interim Remedial Measure (IRM) in March 2005.

The RI utilized the Triad Approach, a dynamic approach to site investigation and cleanup that is flexible and incorporates site-specific decision to improve data collection . The Triad Approach was developed to improve confidence in the identification of contamination at a site, reduce costs and expedite site closeout. The Triad Approach focused on management of decision uncertainty by incorporating:

- systematic Project Planning,
- dynamic Work Plan Strategies, and
- real-time measurement technologies

to accelerate site investigation and the cleanup process.

The RI included:

- site survey;
- utility survey/geophysical investigation;
- on-site soil gas survey;
- soil and groundwater investigation;
- sediment and surface water sampling;
- off-site soil gas survey;
- indoor air sampling; and
- sub-slab depressurization system installation.

7.1 POTENTIAL SOURCES OF CONTAMINATION

Prior to 1966, the Site operated as Flores Manufacturing, which processed handbags. The processing included decorative plating with nickel, chromium, and cadmium. From 1966 to 1999, Metal Etching Corporation manufactured metal nameplates, instrument panels, rulers and miscellaneous plated products. All products were etched or printed. The process of etching included anodizing, chromate conversion, and chrome/nickel plating. From 1973 to 1982 Metal Etching Co. operated under the name of Plastic Associates, as a wholly owned subsidiary. From July 1982 to June 1999 Metal Etching Co., Inc. was the entity that operated the Site. In the later years of the operation of Metal Etching Co., Inc.

several of the metal coating operations were discontinued; anodizing (discontinued in 1998), chromate conversion (discontinued in 1997), and chrome plating (discontinued in 1997). All operations terminated in 1999 and Metal Etching Co., Inc. abandoned the premises during September of 1999.

The facility buildings were demolished some time around 2001. During the demolition, limited decontamination and investigations were performed under the oversight of NYSDEC Resource Conservation and Recovery Act (RCRA) personnel. Two (2)-4,000 gallon ASTs, which formerly contained ferric chloride, were decontaminated and removed from the Site during demolition activities.

ERM conducted a review of the existing Metal Etching documents (provided by the NYSDEC), a review of historical aerial photographs of the Site, a file review at the Nassau County Department of Health (NCDOH) , and a file review at the Village of Freeport Department of Public Works. The following observations are based on these reviews:

- In 1956 a five (5)-inch diameter transite pipe sewer connection was made.
- In April of 1969 a twenty-six (26) foot section of the transite pipe was replaced from the main line underneath the sidewalk to the building foundation. Replacement of the 26-foot section of transite pipe was necessary because the bottom of the pipe had corroded away.
- In 1973 water usage at the Site was restricted by the Village of Freeport to 540,000 gallons per month.
- In October of 1976 a twenty-two (22) foot section of broken transite pipe was again replaced. The section was replaced from the main line located underneath the sidewalk to the building foundation. The bottom of the pipe had been again eaten away.
- In April 1990, Metal Etching requested permission to the Nassau County Department of Health to remove one (1) 550-gallon underground storage (UST) tank located in western portion of the Site. Additionally Metal Etching also requested permission to abandon one (1) 1,500 gallon UST in place. This UST was located just south and west of the 2,400 square foot building. No further documentation of tank closure reports was identified in the file review.

A review of historical aerial photographs for years 1954, 1972, 1983 and 1990 for the Site revealed several key features that were taken into account during the Remedial Investigation (RI) Work Plan development. These include:

- The Site does not appear paved until the 1990 aerial photograph. The aerial photographs from 1954, 1972 and 1983 show the Site with dirt parking areas. Poor house keeping (i.e., spills, leaks, etc.) that may have occurred prior to 1990 would have likely spilled directly to the soil.

- The aerial photograph from 1983 illustrates improper and haphazard storage of many 55-gallon drums on the facility (Section 62, Block 45 Lots 144, 145, and 158.
- The aerial photograph from 1983 also indicates the storage of telephone poles, large timbers, and miscellaneous debris off the facility property (Section 62, Block 45 Lots 54, 155 and 157.
- The aerial photographs indicate that between the years 1983 and 1990 a bulkhead was installed along the southeastern edge waters of the Site off the facility property (Section 62, Block 45, Lots 54, 155 and 157). ERM contacted the US Army Corps of Engineers and the Town of Hempstead Department of Conservation and Water Ways for permit and technical information regarding this bulkhead. However, these agencies did not have any record of bulkhead installation or permit applications at the property.
- Historically, the primary method for disposal of sanitary and industrial wastewater was through the sanitary sewer lines

  A review of the NYSDEC Spill Incidents Database Search indicates that three (3) spill cases have been reported at the Metal Etching Site and four (4) spills have been reported in the immediate vicinity of Metal Etching (in the up-gradient/cross-gradient).

  Based on the information presented above, the potential sources of contamination at the Metal Etching Site include the following:

- Plating of metals, etching, anodizing, degreasing with chlorinated VOCs, wastewater treatment, paint/powder coating, photo processing, including ink screening and printing, and metal cutting;
- Acidic/corrosive wastewater discharge to sanitary lines substantiated by several replacements of transite pipe sections due to corrosion of the pipe invert;
- Poor house keeping and improper storage of fresh chemicals and waste chemicals, resulting in spillage to ground and contamination of soil and water at the Site.

7.2 *SUMMARY OF FINDINGS*

A summary of the RI findings is presented below.

7.2.1 *Ground Water Usage*

There are currently no groundwater uses at the Site or in the immediate vicinity (e.g., domestic or industrial wells), and no expected future use of groundwater at the Site. Shallow groundwater at the Site is saline as a result of the proximity to Freeport Creek, and thus is unsuitable for drinking water. Based on the dissolved solids concentrations and the depth to the affected groundwater, significant use of groundwater is not expected. The nearest public supply well is approximately 6,000 ft north (upgradient) of the Site, and thus is not impacted by Site conditions.

7.2.2 *Geophysical Results*

A geophysical survey utilizing ground penetrating radar (GPR) and electromagnetics techniques (EM-61) was conducted to finalize sampling locations and guide implementation of intrusive field investigation activities. The geophysical survey identified two potential underground storage tanks (USTs) at the Site (see Figure 3-1).

7.2.3 *Hydrogeology*

The Site is underlain by glacial outwash deposits that generally consist of varying amounts of sand, silt, and clay. The upper three (3) to four (4) feet of material on the eastern portion of the Site is made up of a densely compacted fill material consisting mainly of gravel, debris such as brick and wood timbers. Below the fill material is a highly organic humus horizon composed of plant organics and shells. This highly organic humus and peat horizon occur between four (4) to eleven (11) feet below ground surface (bgs). From eleven (11) to thirty (30) feet bgs soil mixtures of well-sorted sands and silts are present. The "20 Foot Clay" was encountered at the Site in several boring locations. In each instance the top of the clay was encountered at similar depths between 30 and 35 feet bgs. The complete thickness of the clay was not determined at the Site; however United States Geological Survey (USGS) records that the "20 – foot clay[3]" is on the order of 20 feet thick in this area. Table 3-1 presents the borings that identified the top of the clay and the depth it was encountered.

7.2.4 *Groundwater*

The depth to water at the Site ranges from approximately 3.0 feet below grade to approximately 5.0 feet below grade. Average groundwater elevation determined by the tidal influence study and groundwater

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[3] Perlmutter, N.M., and Geraghty, J.J. Geology and Groundwater Conditions in Southern Nassau and Southeastern Queens Counties, Long Island, N.Y., U.S Geological Survey Water Supply Paper 1613-A1963

elevation data determined from synoptic water level measurements across the Site illustrate a generalized flow toward the Freeport Creek and that the Site is tidally influenced. Previous studies conducted in Nassau County indicate that the hydraulic conductivity of the shallow soils in the area is on the order of 250 feet/day and groundwater flow is toward the south southeast under a regional gradient of 0.00125 feet/feet and local gradient of 0.0064 feet/feet.

7.3 IMPACTS OBSERVED

The five (5) media investigated at the Site were soil, groundwater, surface water, sediment and soil gas. The impacts to each of these media are described below.

7.3.1 Soil

Site soil was characterized by the installation of 69 soil borings. A summary of findings is presented below.

Metals

Metals (inorganics) in soil are found ubiquitously across the Site at concentrations that exceed the RSCOs listed in TAGM 4046 as presented on Figure 4-4. The presence of metals in the surface and subsurface soil is likely the result of the historical operational and disposal activities, airborne pollution from the facility and from natural sources.

Based on the frequency of detections above TAGM RSCOs, (chromium, copper, nickel and zinc) were identified as ICOPCs.

Evaluation of Ispleth maps for the individual metal ICOPCs (chromium, copper, nickel and zinc are represented on Figures 4-5 through 4-8) reveal hot spot areas. In general the hot spot areas are observed at greater frequency in the upper zero to seven (7) feet bgs intervals. Concentrations decrease in frequency of detection with depth. The concentrations of ICOPC at the interval from eleven (11) to twelve (12) feet bgs become minimal.

The findings of the Human Health and Environmental Exposure Assessment do not indicate that direct contact with soil nor leaching of chemicals in soil to groundwater present a complete exposure pathway.

VOCs

Soil samples contained measurable concentrations of several VOCs above the NYSDEC RSCOs. The constituents that exceed RSCOs, including: benzene, toluene, ethylbenzene, xylene, MTBE, naphthalene, chlorobenzene, PCE, TCE, trans-1,2-DCE and vinyl chloride (VC). The distribution of VOCs in soil exceeding the TAGM RSCOs indicates that

VOC contamination is present at four (4) areas across the Site depicted on Figure 4-1.

Contamination at the eastern portion of the Site "Eastern Cluster" is most likely attributable to fuel spillage and boat maintenance activities attributable to current Site operations. On the western portion of the Site "Western Cluster" fuel oil contaminants were observed in soil borings installed in the tank grave of the former 550 gallon UST abandoned sometime around year 1990.

A third area "Central Western Cluster" located southeast of the 1,200 square foot building revealed TCE above the RSCO. The geophysical survey also indicated that an anomaly was present along the eastern wall of the 1,200 square foot building. The TCE source in soil is likely from disposal of spent solvent or spillage during product handling.

The fourth area where soil impacts were observed is located at the center of Site "Central Eastern Cluster". This area contained benzene, toluene, MTBE, PCE, TCE, trans-1,2-DCE and VC above the RSCOs. Waste handling and spillage from the former waste/product storage area that may have occurred in this area would have directly impacted soil cover.

LNAPL was observed in a boring near an abandoned 1,500-gallon UST located in the Central eastern portion of the Site. No documentation recording the status of the tank abandonment was identified during the file review.

7.3.2 Groundwater

Groundwater samples were collected from soil borings and a permanent groundwater monitoring well network consisting of the ten (10) monitoring wells. The monitoring well network was installed based on the determination of groundwater flow direction in areas where soil and groundwater impacts were observed during the soil boring program. The network consisted of shallow (S designation) water table wells and deep (D designation) wells situated on top of the "20 foot Clay".

VOCs

VOCs above the NYSDEC Part 203 Class GA ground water standards were observed in borings and monitoring wells including: (in order of highest frequency of detection): MTBE, benzene, cis-1,2-dichlorethene , PCE , vinyl chloride, xylene, ethylbenzene, toluene, TCE, chlorobenzene, naphthalene, 1,1-dichloroethene, 1,2-dichlorobenzene, and 1,4-dichlorobenzene.

PCE was observed at the highest concentration in monitoring wells and PCE appears to be migrating toward the Freeport Creek. VOCs in groundwater are attributed to former Metal Etching Co., Inc. operations and poor housekeeping which impacted soil and ultimately groundwater at the Site. The greatest VOC concentrations were observed in the Central Eastern portion of the Site. The presence of breakdown products from PCE such as TCE, cis-1,2-DCE and VC indicates that reductive dechlorination is naturally occurring in subsurface.
Degradation of PCE, TCE and cis-1,2-DCE occurs in anaerobic environments. Low DO concentrations have been observed in each of the monitoring wells installed as part of the RI. The ORP is conducive for the reductive dechlorination of CHCs. The low ORP is likely due to degradation of BTEX present in soil and ground water beneath the Site. As BTEX is metabolized by native bacteria DO and ORP fall and condition become conducive for degradation of PCE. Therefore, there is an active transformation mechanism in the subsurface at the Site that will remove/limit the migration of any PCE or TCE released during operation of the business.

<u>Metals</u>

Metals above the class GA ground water standards included inorganics: antimony, barium, hexavalent chromium, iron, magnesium, manganese, and sodium, see Figure 4-16.

Metal Etching Co., Inc. facility represents the likely source of many of these metals. Elevated concentrations of sodium, iron, magnesium and manganese were observed and appear to be related to the local naturally occurring geochemistry and the tidally influenced groundwater regime at the Site. A significant metals dissolved plume was not observed in Site monitoring wells likely due to the reducing conditions present in the subsurface, which results in sulfide precipitation of reduced metal species. Therefore metals in groundwater do not appear to be of concern at this time.

7.3.3 Surface Water

Chemicals of potential concern in surface water include ethylbenzene, xylenes and copper. The ethylbenzene and xylenes are likely from petroleum fuels lost from boat engines.

Marinas line the western banks of the Freeport Creek. Many boat fittings, engine parts, such as propellers and fastenings are made from brass to resist corrosion from salt. Brass is an alloy of copper and zinc. Although brass is more resistant than iron or steel to the effects of salt water, it does in time corrode. Furthermore, marine antifouling paints now commonly include copper as a biocide. Therefore, the presence of copper in surface water is not considered to be Site-related.

7.3.4 *Sediment*

Sediment in Freeport Creek is impacted by both organic contaminants and metals. The organic contaminants (principally PAHs, pesticides and PCBs) are not Site related because groundwater and/or storm water discharging to the Creek are not contaminated by those substances. Metal contamination of Freeport Creek sediments is potentially related to storm water discharge, either from the storm sewer or from non-point sources. Hydrogeochemical conditions limit the movement of metals in groundwater and metals are not transported to Freeport Creek by groundwater discharge.

7.3.5 *Soil Gas*

Soil gas contamination, from contaminated groundwater or from soil contaminants, by VOCs was detected. The soil gas contaminants are related to degreasing solvents used at the Site (and degradation products thereof) and petroleum hydrocarbons (plus oxygenates). Soil gas contamination is present beneath the on-Site buildings and extends beneath East Ray and South End Place Streets. However, impacts to air quality within residential structures adjacent to the Site have not been directly observed.

Two sub-slab depressurization systems have been installed beneath the two (2) on-Site structures. The objective of installing these two venting systems was to provide a temporary means of reducing the pressures underneath the building slabs, and providing an alternative migration pathway for soil vapor. Thereby mitigating the elevated concentrations of soil vapor contaminants beneath the structures. Venting systems are currently in operation at the Site.

7.4 *RECOMMENDATIONS*

The recommendations for supplemental remedial investigation activities at the Metal Etching Site are:

- LNAPL was discovered in the soil at SB-34. Document reviews revealed that a 1,500-gallon UST was to be abandoned in place in this area, it is recommended that excavation and investigation of this area be conducted to determine the source of LNAPL.

- Potential UST-like signature identified during the geophysical survey along the eastern wall of the 1,200 square foot building should be investigated further to confirm its presence. This could be accomplished with a small three to four foot deep test pit located in that general area.
- Five (5) additional monitoring well clusters (shallow and deep) should be installed. ERM recommends the installation of one (1) cluster well in the downgradient direction of MW-07S and D to identify the extent of deep groundwater impacts identified at the Site. ERM also recommends the installation of one (1) cluster well up gradient of MW-02S and D to serve as upgradient monitoring points. The investigation would also benefit from a third cluster well located between MW-04 and MW-03S and D to monitor the lateral extents of impacted groundwater. The fourth cluster well should be located downgradient of the MW-03S and D adjacent to the Freeport Creek bulkhead to close a data gap in that area. The final well cluster should be located in the upper northwest corner of the property near the corner of East Ray Street and South Main Street to monitor groundwater entering the Site.

8.0 REFERENCES

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APPENDIX A

Soil Boring Logs and Monitoring Well Construction Logs (CD-ROM)