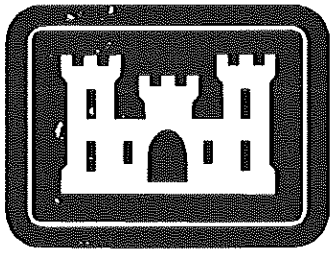
FINAL
SITE INVESTIGATION WORK PLAN
MCA BARRACKS SITE
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

Prepared for



U.S. Army Corps of Engineers
Savannah District

Contract No. DACA45-03-D-0029
Delivery Order 001

September 2005

HydroGeoLogic, Inc

DOCUMENT 8

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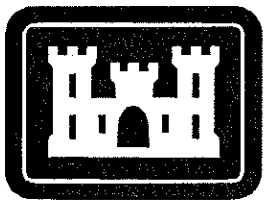

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

ABC®	Anaerobic Biochem®
bgs	below ground surface
CAP	Corrective Action Plan
cis-1,2-DCE	*cis*-1,2-dichloroethene
CSR	Compliance Status Report
DPT	direct-push technology
EM	Engineering Manual
ERD	enhanced reductive dechlorination
FSP	Field Sampling Plan
GEPD	Georgia Environmental Protection Division
HAAF	Hunter Army Airfield
HGL	HydroGeoLogic, Inc.
HSI	Hazardous Site Inventory
HSRA	Hazardous Site Response Act
IWTP	Industrial Waste Treatment Plant
MCL	maximum contaminant level
MNA	monitored natural attenuation
µg/L	micrograms per liter
PCE	tetrachloroethene
RCRA	Resource Conservation and Recovery Act
RIP	Remedy in Place
SAIC	Science Applications International Corporation
SI	site investigation
SOF	Special Operations Facility
SVOC	semivolatile organic compound
TCE	trichloroethene
USACE	U.S. Army Corps of Engineers
UST	underground storage tank

VC	vinyl chloride
VOC	volatile organic compound
WP	Work Plan

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1.0 INTRODUCTION

In November 2004, HydroGeoLogic, Inc. (HGL) was retained by the U.S. Army Corps of Engineers (USACE), Savannah District to provide environmental restoration services at the MCA Barracks site ("the Site"), located within the Hunter Army Airfield (HAAF) near Savannah, Georgia. This work is being conducted under Contract Number DACA45-03-D-0029, Delivery Order 0001. The primary objective of this project is to implement a groundwater corrective action to remediate contaminated groundwater underlying the Site. Ultimately, the goal is to reduce contaminant concentrations in groundwater to levels that will allow site closure under the State of Georgia's Hazardous Site Response Act (HSRA) program. This Work Plan (WP) and supporting documents included as Attachments A, B and C, describe the field and laboratory procedures that will be used to conduct site investigation (SI) and pilot testing activities that are proposed at the site.

The MCA Barracks site was identified as an area of concern in 1998, when the USACE Savannah District conducted an environmental assessment in the area where new barracks were slated for construction. This environmental assessment and subsequent investigations identified the presence of volatile organic compounds (VOC) in groundwater underlying the site. Several VOCs were reported at levels exceeding the Federal maximum contaminant level (MCL) and the Georgia Department of Natural Resources, Environmental Protection Division (GEPD) Target Concentration levels as defined under the HSRA including: trichloroethene (TCE), tetrachloroethene (PCE), and vinyl chloride (VC). The GEPD target levels for groundwater are 5.0 micrograms per liter (μg/L) for TCE, 5 μg/L for PCE, and 2 μg/L for VC. For compounds not listed in Table 1 of Appendix III (Section 391-3-19-.07 (6) (b) in HSRA rules, the criteria will be the background concentration or analyte detection limit, as appropriate. Isopropylbenzene and *cis*-1,2-DCE had detectable concentrations but their target levels were not detailed in Table 1 of Appendix III. The target level for isopropylbenzene, not listed in Table 1, is the detection limit (21.88 μg/L). The compound *cis*-1,2-DCE will have Type 1/Type 3 groundwater RRS equivalent to the Federal MCL (70 μg/L).

Because of this groundwater contamination, the MCA Barracks site was listed on the GEPD Hazardous Site Inventory (HSI), and therefore falls under the regulatory authority of the GEPD HSRA program. Because the MCA Barracks site is a HSRA site, HGL's technical approach for executing the site work is based on HSRA requirements.

The overall goal of the MCA Barracks site project is to conduct the necessary environmental restoration work to successfully implement a corrective action and achieve Remedy in Place

(RIP). The RIP designation indicates that the selected remedy is in place and performing as designed. HGL anticipates that the RIP designation will be obtained no later than April 30, 2007, as required by the base contract. Also under the base contract, performance monitoring will be conducted to ensure that the remedy is performing as expected and to provide data to support a long-term monitoring optimization study.

Before implementing a corrective action at the MCA Barracks site, additional site characterization and pilot testing will be conducted to satisfy the requirements of the HSRA program and to eliminate critical data gaps. Data collected as part of the SI will be used in conjunction with historical data, to complete a Compliance Status Report (CSR) as required by HSRA. A pilot study will be conducted to evaluate the effectiveness of the proposed remedy, which is interpreted to be enhanced reductive dechlorination (ERD) with monitored natural attenuation (MNA). The data collected during the pilot study also will be used to design a Corrective Action focused on remediating the VOC plume. The pilot study results will ultimately be used to support the development of a Corrective Action Plan (CAP) for the site.

This WP and supplementary documents describe the field activities and procedures related to conducting an SI and pilot study at the MCA Barracks site. This HGL prepared WP is based on guidance presented in Engineering Manual (EM) 200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 1998); and other applicable regulations and guidance documents.

This general WP document is intended to describe overall project tasks and objectives. Detailed procedures and investigation specific information are contained in Attachment A, the Field Sampling Plan (FSP); Attachment B, the Quality Assurance Project Plan; and Attachment C, the Investigation Derived Waste Management Plan. The following related project documents have been submitted under separate cover and are incorporated by reference into this WP:

- Project Management Plan (HGL, 2005a); and
- Site Safety and Health Plan (HGL, 2005b).

2.0 SITE HISTORY AND SETTING

2.1 SITE BACKGROUND

The HAAF is an active military base located along the western edge of the City of Savannah, Georgia, as shown in Figure 2.1. The complex encompasses 5,370 acres. The MCA Barracks site, identified by GEPD as HSI #10521, is located along the northern portion of the HAAF and encompasses about 75 acres (Figure 2.2). The site contains a 10 acre man-made pond and is roughly bound by Lightning Road on the south, Mitchell Boulevard on the east, Griffen Street on the west, and Cook Boulevard on the north. The land use of the site and surrounding area is industrial/commercial. The site is not on property currently scheduled for transfer to the private sector.

HAAF operated as the Savannah Municipal/Hunter Municipal Airfield from 1928 to 1940 (USACE, 2004). In 1940, the facility was converted to the Hunter Army Air Base for use during World War II. After the war, the airfield was returned to the City of Savannah by the War Assets Administration. In 1950, the City of Savannah and Air Force reached an agreement in which the facility was returned to the Government. The Air Force expanded the facility in order to use it as a Strategic Air Command base. In 1964, the Government announced the closure of Hunter Air Force Base and developed plans to excess most of the property by 1967. However, the property was not transferred to the public. In 1973, the facility was transferred to the Army for use in helicopter pilot training. In 1974, HAAF was transitioned to serve as a support facility for Fort Stewart, which was a training and maneuver area for Army and National Guard units.

HAAF continues to provide support to Fort Stewart, which is now home of to the 3rd Infantry Division (Mechanized). Currently there are approximately 5,000 soldiers stationed at HAAF. The major divisional units stationed at HAAF include the 3rd Aviation Brigade and 603d Aviation Support Battalion. Additionally, there are a number of non-divisional units assigned to HAAF that make up the major tenant units. These non-divisional units include: the 26th and 559th Quartermaster Battalions; the 1st Battalion, 75th Ranger Regiment; 3d Battalion, 160th Special Operations Aviation Regiment (Airborne); and the 224th Military Intelligence Battalion (Aerial Exploitation).

The Coast Guard Air Station Savannah is also located on HAAF. It is the largest helicopter unit in the Coast Guard and provides Savannah and Coastal Georgia with round-the-clock search and rescue coverage of the area.

2.2 PHYSIOGRAPHIC AND HYDROGEOLOGIC SETTING

HAAF is situated within the Coastal Plain Physiographic Province of Georgia. The region is characterized by Cretaceous and Cenozoic sedimentary rocks and sediments. These strata dip toward the southeast and are younger nearer the coast. HAAF is located on the northern end of the Barrier Island Sequence in Chatham and Bryan counties. This sedimentary sequence is characterized by the presence of marine terraces. The topographic relief across the installation ranges from 2 to 42 to feet above mean sea level.

The hydrogeology in the vicinity of HAAF consists of two aquifers separated by a thick confining unit. The two aquifers are referred to as the Surficial and Floridan Aquifers. In the area of HAAF, the Surficial Aquifer consists of sands intermixed with thin clay beds. Beneath the MCA Barracks site, the Surficial Aquifer primarily consists of silty sand with some thin clay beds that do not appear to be laterally extensive. The Surficial Aquifer is the primary aquifer of interest at the MCA Barracks site. It is approximately 50 feet thick in the vicinity of the MCA Barracks site.

A confining unit separates the Surficial Aquifer from the underlying Floridan Aquifer. The confining unit is composed of phosphatic clay of the Miocene-age Hawthorn Group. In the area of HAAF, the confining unit is approximately 160 feet thick, and it serves as a confining unit that restricts the vertical movement of water and contaminants originating in the Surficial Aquifer.

The Floridan Aquifer is a regionally extensive aquifer that is approximately 800 feet thick in the vicinity of the site. In the vicinity of the HAAF, the top of the Floridan Aquifer is approximately 200 feet below ground surface (bgs). It is composed primarily of Oligocene- and Eocene-age limestone formations including: the Suwannee Limestone, Ocala Group, Avon Park Formation, and the Oldsmar Formation. The Floridan Aquifer is the principal aquifer in the vicinity of Savannah and throughout large portions of Georgia and most of Florida. Due to the thick confining unit that separates the Surficial Aquifer from the underlying Floridan Aquifer, there is little potential for shallow groundwater contamination to impact groundwater quality in the underlying Floridan Aquifer.

The observed depth to groundwater ranges from 2 feet to 15 feet across the site. At the MCA Barracks site, groundwater flow within the Surficial Aquifer exists under unconfined conditions and is predominantly to the northwest. Based on water-level contour maps developed by Science Applications International Corporation (SAIC, 2004) and hydraulic conductivity data obtained from surrounding hazardous waste sites (i.e., the Old Property Disposal Yard, Building 710 Area, and former Building 728), the groundwater flow velocity is approximately 280 feet/year. The thickness of the Surficial Aquifer is thought to be approximately 50 feet in the MCA Barracks site.

3.0 SUMMARY OF SITE DATA

Several SI's have been conducted to characterize the vertical and spatial extent of contamination at the MCA Barracks site. The results of investigations conducted after the beginning of calendar year 2000 are summarized in the *Report of Findings for the MCA Barracks Site (HAA-15)*, (SAIC, 2004). The results of investigations conducted before calendar year 2000 are summarized in letters to the GEPD prepared by the Department of Army. Based on the groundwater data collected during previous SI's, only a few constituents have been detected above their HSRA target levels, and except for TCE and *cis*-1,2-DCE, these exceedances have occurred at few locations. Contaminants have not been detected in soil samples. A detailed discussion of the past SI's at the MCA Barracks site is provided in the following sections.

The VOC contamination that underlies the MCA Barracks site was first discovered in 1996, when the USACE collected soil and groundwater samples at the proposed Special Operations Facility (SOF), located north of Lightning Road. This sampling was conducted as part of the clearance process initiated before construction activities at the site. Initially, the SOF was treated as a separate site from the MCA Barracks site; however, the sites were subsequently combined into one unit (HSI #10521, MCA Barracks site), because the groundwater contamination underlying the two sites most likely represents one contiguous plume.

During the 1996 study, the USACE sampled groundwater and soil. Samples were collected from temporary wells and analyzed for VOCs; semivolatile organic compounds (SVOC); total petroleum hydrocarbons; diesel range organics; and Resource Conservation and Recovery Act (RCRA) metals. The sampling results indicated that TCE, PCE, lead, and chromium were present in groundwater samples at levels exceeding their respective primary drinking water standards. *Cis*-1,2-DCE also was detected in two groundwater samples. The elevated levels of lead and chromium were thought to be caused by highly turbid groundwater samples. Subsequent low-flow groundwater sampling conducted at the SOF verified this hypothesis. Lead and chromium were detected at background levels in samples collected using a low flow sampling technique. No contamination was detected in soil samples.

In April 1998, USACE completed another pre-construction site assessment in the area of the proposed MCA Barracks project. As part of this investigation, 7 composite soil samples (6 samples and 1 duplicate) and 13 groundwater samples (12 samples and one duplicate) were collected (Figure 3.1). The groundwater samples were collected from temporary wells at a screened depth of 3 to 4 meters and analyzed for VOCs and SVOCs. The results of the groundwater sampling indicated the presence of TCE at three locations, naphthalene at one location, and acetone at one location. Only TCE was detected at concentrations exceeding the GEPD groundwater target concentration. Methylene chloride was the only contaminant detected in the composite soil samples. This was determined to be a laboratory contaminant.

USACE conducted another SI in May 1998 to determine the extent of contamination in the area of the proposed barracks construction project. As part of this investigation, 39 groundwater samples (35 samples and 4 duplicates) were collected from temporary wells

screened across the water table. The samples were collected on a grid (Figure 3.1) and analyzed for VOCs. TCE was detected at five locations at concentrations ranging from 5.9 µg/L to 160 µg/L, all of which exceeded the GEPD groundwater target concentration of 5 µg/L. *Cis*-1,2-DCE, a common degradation product of TCE, was detected at low levels in two groundwater samples. Several constituents generally associated with petroleum hydrocarbons also were detected in two isolated groundwater sampling locations: These constituents include: benzene; toluene; ethybenzene; isopropylbenzene; n-propylbenzene; 1,3,5-trimethylbenzene; 1,2,4-trimethylbenzene; sec-butylbenzene; p-isopropyltoluene; n-butylbenzene; naphthalene; acetone; 2-butanone, and xylene. The isolated nature of the petroleum hydrocarbon compounds suggest that there is not a significant petroleum hydrocarbon plume underlying the MCA Barracks site.

In September 1999, Metcalf and Eddy installed four shallow monitoring wells (<20 feet) at the SOF and sampled groundwater from the wells for VOCs, SVOCs, and metals (SAIC, 2004). The wells were installed at the same locations as the temporary sampling points that were used to sample groundwater in 1996 (Figure 3.1). The primary purpose of the permanent wells was to determine whether the high lead and chromium concentrations detected in 1996 were a result of turbidity or were indicative of a contaminant release. The sampling results confirmed that the metals were naturally occurring and not related to a release. The sampling results also confirmed the presence of organic contaminants that were detected in 1996 including TCE, *cis*-1,2-DCE, PCE, 1,1-dichoroethane, 1,1-dichloroethene, bis (2-ethylhexyl) phthalate, and chloroform. TCE and bis (2-ethylhexyl) phthalate were the only constituents detected above the GEPD target concentration.

SAIC conducted subsequent investigations in 1999, 2000, and 2001 (SAIC, 2004). Over the course of these investigations, SAIC conducted vertical profiling of groundwater at 26 locations in an effort to characterize the vertical and horizontal extent of VOC contamination (Figure 3.1). As part of these efforts, vertical contaminant profiling was conducted by collecting groundwater samples using direct push technology (DPT). Borings XX-01 through XX-15 were sampled every 5 feet from the water table to a depth of 45 to 50 bgs and the samples were submitted for laboratory analysis. For vertical-profile borings XX-16 through XX-26, groundwater samples were collected at 5-foot intervals from the water table to a total depth of 36 to 45 feet bgs, but only selected samples were submitted for laboratory analysis (approximately three at each location). The selection of the samples for laboratory analysis was based on soil conductivity data. Several VOCs were detected in groundwater samples with TCE exceeding the GEPD HSRA groundwater target concentration in numerous samples. *Cis*-1,2-DCE was also detected at levels that exceed the MCL. Twenty-three of the 26 vertical profile locations were converted to monitoring wells. To date, these wells have not been sampled.

In 2002 and 2003, USACE conducted additional groundwater profiling to delineate the boundary of the chlorinated solvent plume (Figure 3.1). As part of these SI's, USACE installed 13 vertical-profile borings (SAIC, 2004). Groundwater was sampled every 5 feet to a total depth of approximately 45 feet and analyzed for VOCs. Approximately eight samples were collected from each boring. As with the vertical profile sampling conducted by SAIC, several VOCs were detected in the groundwater samples; however, only TCE, and VC

exceeded their respective GEPD groundwater target concentrations. Concentrations of *cis*-1,2-DCE was reported at levels above the MCL.

Based on the groundwater profiling data collected at the MCA Barracks site, HGL mapped the distribution of the chlorinated solvents TCE, *cis*-1,2-DCE, PCE and VC at three different depth intervals (less than 21 feet bgs; between 21 and 32 feet bgs; and greater than 32 feet bgs). These maps were prepared using the maximum constituent concentrations detected at each interval. An analysis of the plume maps indicates that TCE is the most widely distributed VOC in groundwater. Figures 3.2, 3.3, and 3.4 illustrate the spatial distribution of TCE in the shallow, intermediate, and deeper portions of the Surficial Aquifer, respectively. These depth intervals do not represent any type of geologic differentiation in the subsurface but were selected to illustrate that VOCs are present at different concentrations at various depths in the Surficial Aquifer. Throughout a large portion of the MCA Barracks site, TCE is detected in groundwater at concentrations exceeding the GEPD target level. The highest TCE concentrations are consistently detected between a depth of 20 to 40 feet bgs; TCE is not detected above the GEPD target concentration below a depth of 45 feet bgs.

The spatial distribution of *cis*-1,2-DCE is similar to the TCE distribution. Concentrations exceed the MCL of 70 μg/L throughout a large portion of the MCA Barracks site. The maximum concentration of 969 μg/L was detected in the deep zone at boring MVP-3, which is in proximity to one of the potential contaminant source areas (the industrial waste treatment plant [IWTP]). In general, *cis*-1,2-DCE is more prevalent in the deeper portions of the aquifer (25 to 40 feet bgs) where conditions tend to be more anaerobic and therefore more conducive to TCE degradation.

Minimal PCE contamination was observed at the MCA Barracks site. Only two samples had concentrations above the GEPD target level of 5 μg/L: a concentration of 7.9 μg/L was detected in boring XX-4 and a concentration of 32.5 μg/L was observed in boring XX-14. Well XX-04 is in the Old Property Disposal site, which is not considered part of the MCA Barracks site. The PCE detected in boring XX-14 was not detected in other nearby borings and is thought to reflect a small and localized PCE release.

VC, a common degradation product of TCE and *cis*-1,2-DCE, is not widely distributed across the site. VC was detected in four borings across the site, and it was found to slightly exceed the GEPD target level in only two borings (i.e., XX-14 and XX-15). Its presence is thought to reflect the natural anaerobic degradation of *cis*-1,2-DCE.

In addition to the chlorinated solvents discussed above, the following VOCs also were detected in groundwater during the vertical groundwater profiling investigations:

- 1,1,1-trichloroethane (detected twice, max = 1.4 J μg/L, target level = 200 μg/L);
- 1,1-dichloroethane (three detections, all < 1 μg/L, target level = 4,000 μg/L);
- carbon disulfide (max = 3.8 μg/L, target level = 4,000 μg/L);
- chloroform (detected twice, max = 0.7 J μg/L, target level of total trihalomethanes = 100 μg/L);
- ethylbenzene (max = 8.7 μg/L, target level = 700 μg/L);

- methylene chloride (max = 9 J µg/L, target level = 5 µg/L);
- toluene (max = 2.2 µg/L, target level = 1,000 µg/L);
- xylenes (max = 23.6 µg/L, target con = 10,000 µg/L);
- 2-butanone (max = 11.6 µg/L, target level = 2,000 µg/L);
- benzene (max = 17.6 µg/L, target level = 5 µg/L);
- acetone (max = 102 µg/L, target level = 4,000 µg/L);
- styrene (max = 0.26 µg/L, target level = 100 µg/L);
- 1,1,2-trichloroethane (detected once at 0.2 J µg/L, target level = 5 µg/L);
- 4-methyl-2-pentanone (detected once at 1.6 J µg/L, target level not provided);
- chloromethane (detected twice, max = 0.6 J µg/L, target total THMs = 100 µg/L);
- 1,3,5-trimethylbenzene (detected once at 16.1 µg/L, target level not provided);
- isopropylbenzene (detected twice, max = 66 µg/L, target level not provided);
- n-propylbenzene (detected twice, max = 2.5 µg/L, target level not provided);
- sec-butylbenzene (detected once at 1.1 J µg/L, target level not provided); and
- tert-butylbenzene (detected once at 0.7 µg/L, target level not provided).

Of the chemicals listed above, benzene and methylene chloride exceeded GEPD groundwater target levels. The results of the SAIC/USACE groundwater sampling are consistent with the historical groundwater sampling conducted in 1996 and 1998. The data indicate that the dominant contaminants are the chlorinated ethenes, but that petroleum hydrocarbons are found in isolated areas at low concentrations. Minor quantities of other chlorinated solvents are also present in isolated areas. With the exception of *cis*-1,2-DCE and TCE, all constituents are delineated across the site to non-detectable concentrations. Additional groundwater sampling will be required to delineate the extent of *cis*-1,2-DCE and TCE along the southern and southwestern boundary of the plume.

As discussed above, 23 of the vertical groundwater profiling sampling locations were converted to groundwater monitoring wells. To date, the existing monitoring wells have not been sampled. The locations of these wells are shown on Figure 3.5. The existing monitoring wells provide a good distribution of wells that can be used to evaluate trends in contaminant concentrations, determine whether the chlorinated solvent plume is expanding, and evaluate the performance of the proposed remedy. It is anticipated that additional monitoring wells will be required to monitor the center of the plume and to monitor for plume expansion directly north of the site.

4.0 POTENTIAL CONTAMINANT SOURCE AREAS

Consistent with its history as a military facility, the site has been used for a number of industrial activities. The *Archive Search Report* (USACE, 2004) identified the following areas that had the potential to result in contamination in the vicinity of the MCA Barracks site; however, several of the potential contaminant source areas are located hydraulically downgradient of the existing MCA Barracks plume and are highly unlikely contributors to the site's VOC plume. These sites are illustrated on Figure 4.1. A discussion of these sites is provided below:

- Railroad Spur: Two railroad spurs were identified on HAAF. One appears to have been removed sometime after 1993; the other is still present. A map from 1955 showed six underground storage tanks (UST) along the remaining railroad spur. These USTs were labeled as containing diesel fuel, 72/74 octane, cleaning solvent, (likely non-chlorinated Stoddard solvent) and 80 octane. The railroad spurs are located downgradient of the chlorinated solvent plume and are not considered a source of groundwater contamination. Additionally, the railroad spur area is associated with the Building 728 site that was investigated under the Georgia UST program as GUST Facility 9-025049.

- Old Hospital Area: This area was a multi-building complex from World War II. A number of potential source sites are identified within the Old Hospital Area. One of the buildings (Bldg 725) was leased by a dry-cleaning company for equipment repair and a 1955 map shows two USTs associated with this building. The USTs identified in the 1955 map are labeled as 500 gallon diesel fuel tanks, and located north of the immediate MCA Barracks site. These USTs are unlikely contributors to the site's VOC plume. At another part of the site a boiler room was constructed in 1941 to provide steam heat for the Old Hospital. Initially, the boilers used coal but were later converted to burn oil. At a third site, historical aerial photographs show the presence of debris at two locations east of the complex, suggesting that portions of the area may have been used for disposal. The entire hospital complex was razed and the location is currently an open area with trees. There is no historical evidence that TCE was used within the Old Hospital Area. In addition, the old hospital area is located near the front portion (downgradient end) of the plume and is not considered a likely source of the VOC groundwater contamination.

- Water Tank/Wells: A 100,000-gallon water storage tank and pump house from the 1940s are still present. Above ground storage tanks near the water tank were shown on a 1941 aerial photograph. The storage tanks most likely contained diesel fuel used to fuel back-up generators and not chlorinated solvents. Moreover, the site is located downgradient of the chlorinated solvent plume.

- Power Sub-Stations: A 1941 aerial photograph shows a power sub-station servicing the municipal airport. The building suspected of housing the sub-station was identified in a 1968 inventory as Special Fuel Storage. The building may have been present as late as

1977. Other sub-stations were likely constructed and removed over the years; however, the power sub-stations are located downgradient of the chlorinated solvent plume and are not considered a source of groundwater contamination.

- Motor Repair Shop: The Motor Repair Shop was built in 1941 and consisted of three buildings, one of which was removed in 1996. The remaining buildings currently operate as a motor repair facility. The following chemicals were associated with this facility: Stoddard solvent; kerosene; engine oil; diesel fuel; paint remover (methylene chloride); petroleum oils and lubricants; anti-freeze (ethylene glycol); lead; and sulfur. Stoddard solvent (also referred to as dry-cleaning solvent) is a petroleum distillate of linear and branched alkanes, cycloalkanes, aromatics, and does not contain chlorinated hydrocarbons. Although degreasers, such as TCE, may have been used at the Motor Repair Shop; the repair shop is located downgradient of the chlorinated solvent plume and is not considered a source of groundwater contamination at the MCA Barracks site.

- New Motor Pool: Based on maps from 1960 and 1974, no buildings were constructed in this area. Anecdotal evidence indicates that this area was used for minor automotive maintenance and repairs. However, the lack of support structures indicates that the area was not used extensively. The New Motor Pool is currently used for recreational vehicle storage; and does not support on-going maintenance operations. The motor pool is located within the footprint of the chlorinated solvent plume; however, chlorinated solvents are detected in groundwater at least 1,000 feet upgradient of the New Motor Pool. Consequently, the new motor pool is not a likely source of the chlorinated solvent plume.

- Personally Owned Vehicle Wash Rack: This feature was identified on two historical maps, but no surface expression of this wash rack currently exists. The chlorinated solvent plume does not underlie the Wash Rack. The wash rack is not considered to be a source of chlorinated solvent contamination.

- Georgia Air Guard Motor Pool: This area consists of a fenced-in parking area and two buildings that appear to date from between 1968 and 1984. No documentation was obtained concerning the specific activities performed at this location. Other buildings were identified as used for motor pools or vehicle maintenance. One of the other buildings was listed as having been used for painting; however, the "painting" building is building 1262 and is located over ½ mile southwest of the MCA Barracks site. Minimal documentation concerning the history and use of these buildings is available. The Georgia Air Guard Motor Pool does not overlie the chlorinated solvent plume and therefore it is not thought to be a source of contamination at the MCA Barracks site.

Based on their potential for historical TCE usage, and their location relative to the TCE plume, the following sites were identified as the most likely source areas for VOC contamination impacting groundwater at the MCA Barracks site:

- Aircraft Hangar Buildings T-811 and T-813;

- Aircraft Wash Rack; and
- IWTP.

- Aircraft Hangars: The Aircraft Hangars date to the 1940s and consist of two buildings, T-811 and T-813. The hangars were used for aircraft maintenance and repair. There are three 20,000-gallon USTs located between the two hangars that were used to fuel the boiler that heated the hangars. The following chemicals were identified as being used at the hangars: dry-cleaning solvents (Stoddard solvent); TCE; naphtha; carbon tetrachloride; 1,1,1-trichloroethane; cleaning compound (which consisted of Stoddard solvent, methylene chloride, and PCE); cresol-type carbon removal compound; sodium/potassium chromate; and chromic acid. TCE dip vats for degreasing and chromic acid dip vats for re-painting were used at this facility. Based on their location and documented use of TCE, the T-811 and T-813 aircraft hangars are a likely source area for the TCE contamination in groundwater. A visual inspection of Buildings 811 and 813 was conducted by HGL, USACE, and base personnel during a site visit on March 15, 2005. Building 811 contained a former degreasing room located in the northeast corner of the building. Equipment used during the degreasing procedure remain in place including the fume hood and a sink that may be a replacement for the original sink. A four inch floor drain is present near the sink and appears to lead to an outside storm sewer. The degreasing room drain was the only potential contaminant pathway that was found in Building 811. Inspection of Building 813 revealed no obvious or apparent potential contaminant pathways.

- Aircraft Wash Rack: This facility was not explicitly mentioned in the *Archive Search Report*. Based on the observed groundwater plume configuration and the nature of historical operations conducted at the facility, the aircraft wash rack is a likely contaminant source; however, groundwater sampling in the vicinity of the wash rack suggests that the wash rack is no longer a continuing source of contamination.

- IWTP: This facility was not explicitly mentioned in the *Archive Search Report*. Based on the observed groundwater plume configuration and the nature of historical operations conducted at the facility, the IWTP is a potential contaminant source; however, groundwater sampling suggests that the IWTP is no longer a continuing source of contamination.

Although the Aircraft Hangars, Aircraft Wash Rack, and IWTP facilities are the likely original source areas for the VOC contamination currently observed in groundwater, the geometry of the VOC plume suggests that these areas no longer contribute to contamination observed in groundwater. The portion of the VOC plume that is associated with the highest concentrations does not extend to these likely source areas. Consequently, it is presumed that these source areas are no longer contributing contamination to groundwater and that normal groundwater flow has diluted and/or eliminated contaminants from the original source area. Elimination of a continuing release from the source area(s) has likely allowed the plume beneath the MCA Barracks area to achieve static equilibrium within the aquifer. This assumption will be verified through additional groundwater and soil sampling that will be conducted as part of the

upcoming SI. The other areas (Old Hospital Area and Georgia Air Guard Motor Pool) will be investigated via soil sampling to determine what, if any, possible contamination was contributed to the MCA Barrack's VOC plume. Potential source areas, however unlikely, that are located outside of the MCA Barracks area, will only be investigated if the VOC plume is found to extend into the particular potential source area.

5.0 SITE INVESTIGATION FIELD ACTIVITIES

The objective of the proposed field work described in this WP is to fill data gaps remaining from previous SI's and to collect data needed to design and implement a Corrective Action. A summary of the proposed SI activities is discussed below. Specific information related to sampling locations and field procedures is contained in the FSP (Attachment A).

As described in Section 3, previous field investigations provided extensive data to identify the contaminants of concern at the MCA Barracks site; delineate the general extent of contamination in both the horizontal and vertical direction; define groundwater flow directions; and identify likely source areas. In addition, water-level data collected from monitoring wells constructed within the MCA Barracks site and surrounding hazardous waste sites (Old Property Disposal Yard, Building 710 Area, former Building 728) have been used to determine the groundwater flow directions in both the upper and lower portion of the Surficial Aquifer (SAIC, 2004). Finally, the *Archive Search Report*, prepared by the USACE provides an extensive historical evaluation of potential contaminant source areas within the MCA Barracks site and throughout the HAAF. HGL evaluated the historical research presented in the *Archive Search Report* as well as the observed spatial distribution of VOC contamination and water-level maps and identified the probable sources of chlorinated solvent contamination in groundwater, as related to the MCA Barracks area plume.

Although considerable data have been collected within the MCA Barracks site, there are data gaps that must be addressed before completing a CSR for the site (GEPD, 2003). To address the data gaps, the following tasks will be implemented during the field activities and are described in sections 5.1, 5.2, 5.3, 5.4 and 5.5.

- Delineate the VOC plume to non-detectable concentrations;
- Collect geologic data to better define the hydrostratigraphy within the Surficial Aquifer;
- Collect water-level data to more thoroughly define vertical and horizontal hydraulic gradients;
- Determine site-specific hydraulic conductivity values;
- Conduct a complete round of baseline VOC sampling in existing groundwater monitoring wells;
- Investigate potential source area(s); and
- Collect surface water and sediment samples to determine if groundwater contamination has impacted surface water.

As discussed in Section 1 of this WP, HGL proposes to implement ERD with MNA to remediate contaminated groundwater underlying the MCA Barracks site. This technology was selected because: 1) TCE degradation compounds (*cis*-1,2-DCE and VC) have been detected in groundwater indicating that reductive dechlorination is occurring; 2) the Surficial Aquifer is anaerobic at depth which is conducive to reductive dechlorination; and 3) the technology can easily be implemented around ongoing construction activities that are occurring at the MCA Barracks site. To test the effectiveness of the proposed ERD remedy, HGL will implement a

pilot test, consisting of the injection of the Anaerobic Biochem (ABC®) substrate into the contaminant plume. The pilot test findings will be evaluated to determine the most effective application rate and procedure necessary to remediate the site's VOC plume.

Project objectives will be addressed by the following principal tasks.

- Groundwater Plume Delineation. The primary purpose of the proposed groundwater delineation fieldwork is to define the plume boundary to non-detectable concentrations;

- Source Characterization. Soil samples will be collected to determine whether contamination remains within potential source areas.

- ERD Pilot Study. A pilot study will be conducted to evaluate the effectiveness of ERD in reducing VOC concentrations in groundwater.

- Monitoring Well Installation, Sampling and Testing. Monitoring well installation, aquifer testing and groundwater sampling will provide data necessary to characterize aquifer conditions, the performance of the ERD substrate during the Pilot Study, and monitor groundwater quality during the subsequent Corrective Action.

- Surface Water Sampling. Surface water and associated sediment samples will be collected from the man-made pond to determine if groundwater contamination has impacted surface water.

These tasks are summarized in more detail below. All regulated compounds as defined by the GA EPD will be reported from analytical results obtained during this SI. More specific information related to the analytical sampling and all field tasks is included in the FSP (Attachment A).

5.1 GROUNDWATER PLUME DELINEATION

The primary purpose of the proposed groundwater plume delineation fieldwork is to define the plume boundary to non-detectable concentrations. Plume delineation will be performed per HSRA guidance and GA EPD regulatory requirements. Using DPT, groundwater samples will be collected from multiple depth intervals and multiple locations around the plume. Using existing data, the initial phase of this investigation will start near the known extent of the VOC plume. If VOCs are detected at these initial locations, HGL will collect additional groundwater samples at locations that are offset downgradient or upgradient (depending on location) from the previous boring. This process will be continued until the VOC plume is delineated to non-detectable concentrations. The exact number and locations of DPT sampling points is unknown but will be driven by the analytical results as sampling will continue until the plume is defined by a non-detect (below detection limit) boundary. Samples collected from the DPT locations will be analyzed for target VOCs using a fixed laboratory. In addition, continuous soil sampling will be performed at select locations for lithologic logging. Lithologic samples will be collected from borings designated for permanent monitoring well

installation. The lithologic samples will be collected during hollow-stem augering using standard split spoon sampling protocol. Lithologic information will be used to construct a geologic cross-section of the site and will support both the pilot study and the CAP. Information from the plume delineation sampling event will be used to determine the locations and screened intervals of new monitoring wells that will be emplaced to monitor the plume boundary and conduct performance monitoring following ERD implementation.

An additional DPT groundwater sample will be collected in the vicinity of boring MVP-5 to confirm TCE detection (6.83 μg/L) in the deep portion (45 feet) of the surficial aquifer. This groundwater sample will be analyzed by VOCS 8260B. A permanent monitoring well will be installed at this location if no VOCs are detected. If VOCs are detected, additional characterization will be performed until the non-detect boundary is established.

5.2 SOURCE CHARACTERIZATION

The primary purpose of this task is to determine if one of the potential source areas discussed in Section 4.0 is a likely source of the groundwater contamination in the Surficial Aquifer and to determine if that source is a continuing source of contamination. Based on their potential for historical TCE usage, along with their location relative to the geometry of the VOC plume, the following sites were identified as the most probable sources of VOC contamination impacting groundwater at the MCA Barracks site:

- Aircraft Hangar Buildings T-811 and T-813;
- Aircraft Wash Rack; and
- IWTP.

The source characterization will also evaluate other potential source areas that are unlikely contributors to the known VOC groundwater contamination at the MCA Barracks site, but are within the footprint of the MCA Barracks site plume. Other potential source area sites include:

- Old Hospital Area (Boiler Room and Disposal Areas)
- Georgia Air Guard Motor Pool

In addition, if the VOC plume extends north of Cook Blvd., the following sites will be sampled as potential secondary source areas.

- Motor Repair Shop
- Building 725

Soil samples will be collected from ground surface to the water table from the potential source areas using a DPT rig. The initial phase of this investigation will start at Buildings 811 and 813 and from the locations of the former Aircraft Wash Rack and the former IWTP. The second phase will then take place at the Old Hospital Area (Boiler Room and Disposal Areas) and Georgia Air Guard Motor Pool Area. Soil samples will be submitted from the depth

intervals most likely impacted by contamination. Soil samples will be analyzed by various analyses including VOCs, SVOCs and RCRA metals, as presented in Table 3.4 of the FSP. If the analytical results indicate detections in the soil collected at these locations, HGL will step out from those points and collect additional soil samples. This process will continue until the analytical soil samples come back as non-detect for all analytical tests performed. Soil collected from each DPT boring will be field screened with a photoionization detector. Additional soil samples, beyond the soil samples submitted from intervals most likely impacted by contamination, may be collected if field screening indicates that VOC contamination is present.

Specific soil sampling locations at IWTP will account for underground piping to and from this facility from other buildings. Locations will be based on historical documents or remote sensing techniques, as required. Groundwater samples will be collected from these areas as well.

5.3 ERD PILOT STUDY

HGL plans to use the ERD substrate ABC®, a product of Redox Tech LLC, to perform the remediation at the MCA Barracks site. Before implementing the full-scale remedy, HGL will perform a pilot study to determine the volume of substrate that is required to remediate the VOC plume, verify the spacing of injection points, and to determine whether other aquifer amendments such as bacteria are required. The treatment will consist of injecting ABC® through a line of three temporary injection points spaced approximately 40 feet apart. The performance will be monitored using an upgradient well cluster and three downgradient monitoring well clusters and two sidegradient clusters. Performance monitoring samples will be collected prior to injection, and again at 3 months, 6 months, and 9 months after injection. In addition to natural attenuation parameters and target VOCs, the samples will be analyzed for deoxyribonucleic acid to verify that the microbes required for complete reductive dechlorination of TCE are present.

5.4 MONITORING WELL INSTALLATION, SAMPLING AND TESTING

New monitoring wells will be installed to establish baseline conditions throughout the plume area, monitor changes in the contaminant plume over time, and provide groundwater elevation data and to help characterize groundwater flow patterns. Figure 3.5 shows the locations of existing monitoring wells. The proposed locations for new wells are documented in the FSP (Attachment A). In addition to the new wells, existing wells will be incorporated into the site wide monitoring well network to provide horizontal and vertical control of the plume configuration and data on aquifer conditions. All wells will be sampled for target VOCs to establish an accurate baseline plume configuration. Slug testing will be performed on selected monitoring wells to provide accurate hydraulic conductivity information. This information will be used to design the site's Corrective Action.

5.5 POND SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment samples will be collected from the pond that is located in the

western portion of the MCA Barracks site. USACE's Performance Work Statement indicates that the surface water in the pond has not been impacted by VOC groundwater contamination. However, documentation of previous sampling of the pond is not available. Consequently, surface water and sediment samples will be collected at six selected locations to confirm that contamination has not impacted the pond.

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6.0 REPORTING

HGL will integrate the results of the groundwater plume delineation fieldwork and baseline monitoring well sampling with the results of previous sampling efforts to generate the CSR. HGL will document the results of the Pilot Study in the CAP, which will be submitted upon approval of the CSR.

The CSR will include the necessary elements to fully meet the requirements of Section 6 (Corrective Action), Sub-section 3 (CSR) of Chapter 391-3-19 (Hazardous Site Response) of the Rules of GEPD. The CSR will include the following information:

1) Introduction – Including a description of the purpose, authority and objectives of the project;

2) Site Background – Including an overall discussion of the history of the site and its environs, and a discussion of previous investigations, including sampling activities and findings;

3) Field Activities – A complete description of the field work performed by HGL;

4) Source Description(s) – Including a complete description of verified and/or potential sources;

5) Groundwater Contamination – A detailed description of the nature and extent of groundwater contamination, including plume configuration maps, cross sections, and aquifer characterization;

6) Risk Evaluation – Including a description of any human or environmental receptors; and

7) Recommendations – A presentation of the overall findings, conclusions and a summary of the proposed corrective action.

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7.0 REFERENCES

Georgia Environmental Protection Division, 2003. *Hazardous Site Response*, Chapter 391-3-19.

HydroGeoLogic, Inc. (HGL), 2005a. *Final Project Management Plan, MCA Barracks Site, Hunter Army Airfield, Savannah, Georgia*, prepared for USACE-Savannah and Omaha Districts, March, 2005.

HGL, 2005b. *Draft Site Safety and Health Plan*, Hunter Army Airfield, Savannah, Georgia, prepared for USACE-Savannah District, March, 2005.

Science Applications International Corporation, 2004. *Report of* Findings *for the MCA Barracks Site (HAA-15)*, Hunter Army Airfield, Georgia, USACE-Savannah District, July, 2004.

U.S. Army Corps of Engineers (USACE), 1998. *Requirements for the Preparation of Sampling and Analysis Plans*, EM200-1-3.

USACE, 2004. *Archive Search Report for MCA Barracks Site (HAA-15)*, prepared by the USACE-St. Louis District for Fort Stewart, Directorate of Public Works.

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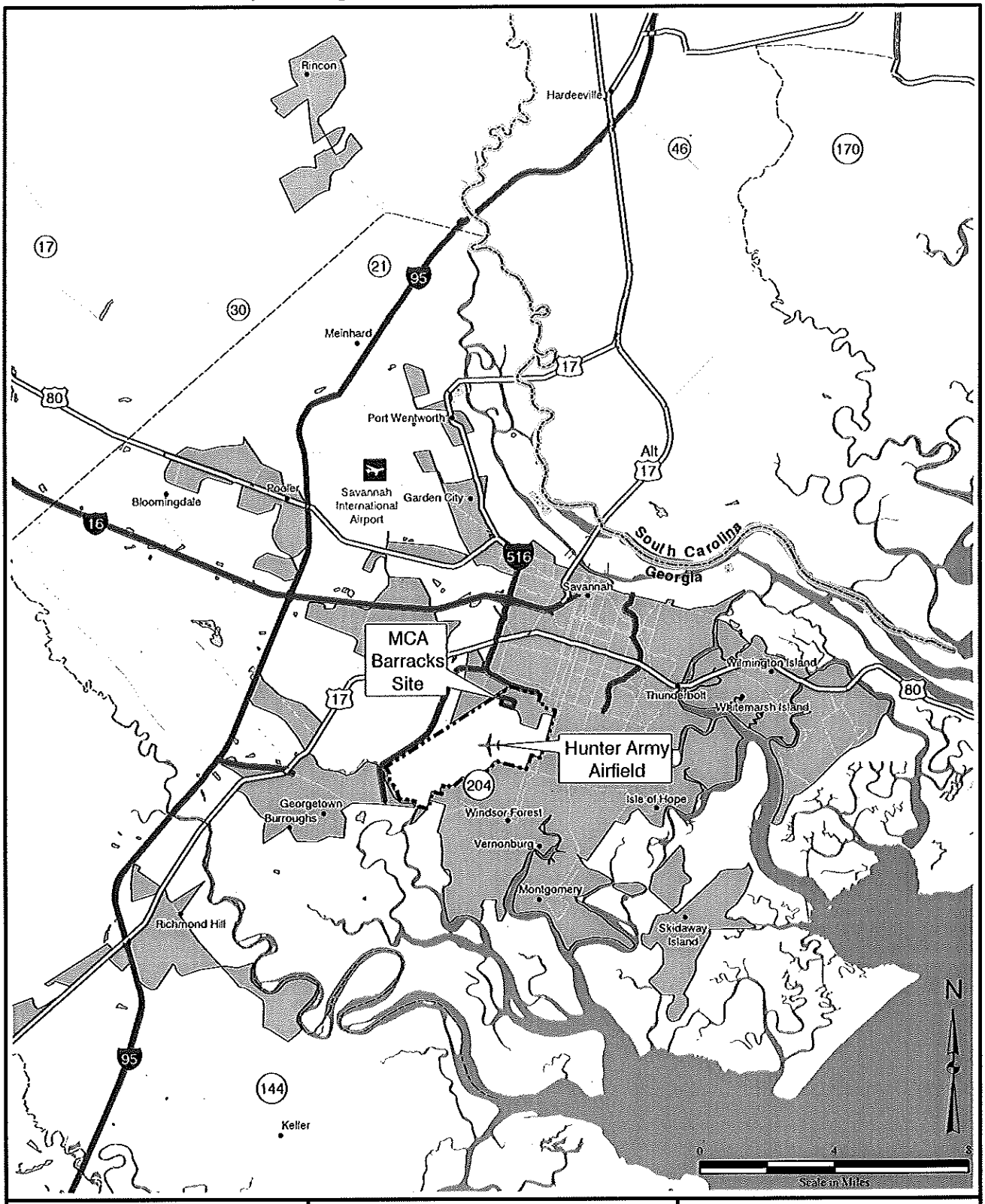
FIGURES



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Revised: 02 02 05 TB
Map Source: HydroGeoLogic GIS Database 2005

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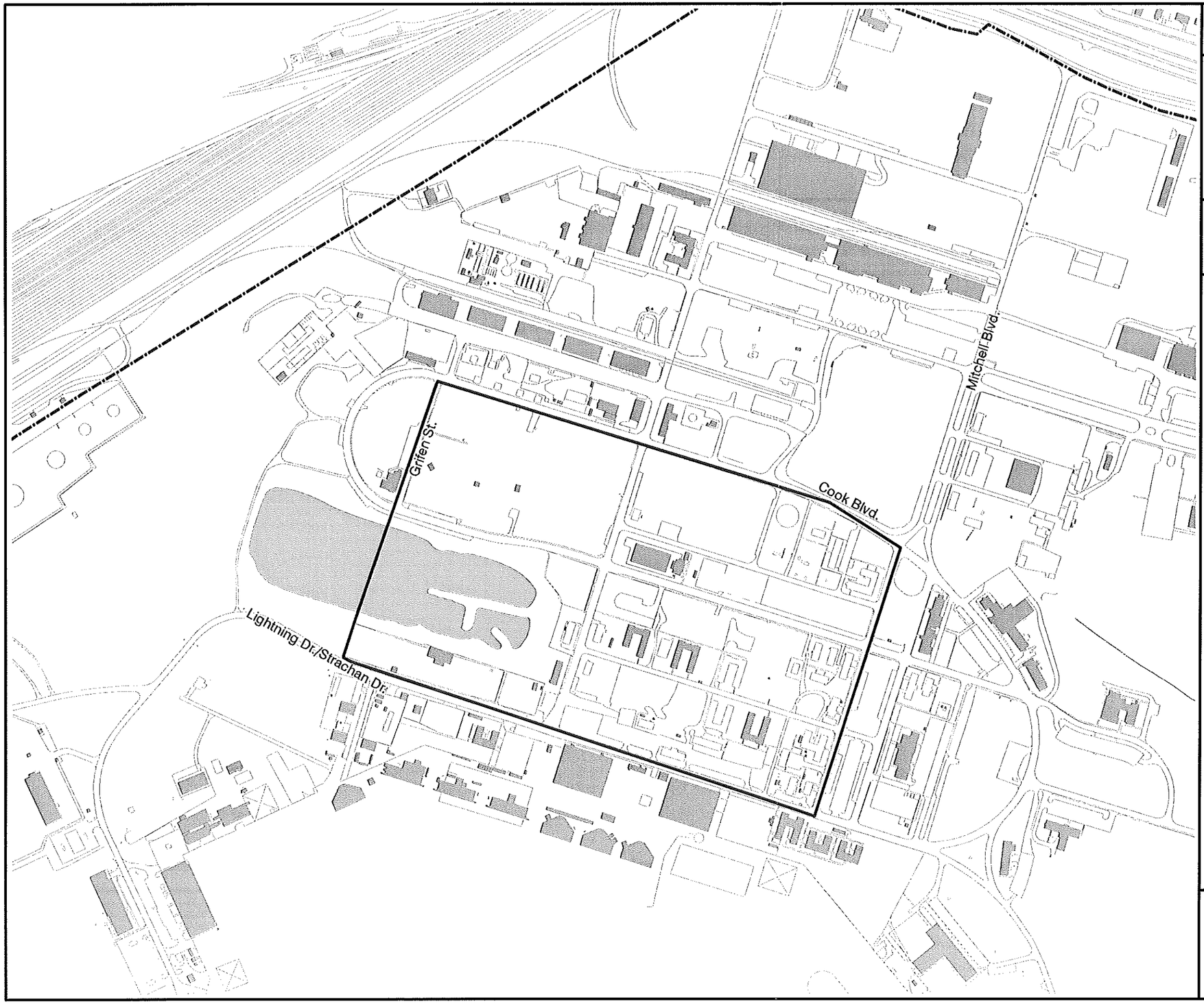
Figure 2.1
Site Location Map

Figure 2.2
Location Map
MCA Barracks Site

US Army Corps of Engineers
Savannah District



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- Location of MCA Barracks Area
- Hunter Army Airfield Property Boundary

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Revised: 02/03/05 TB
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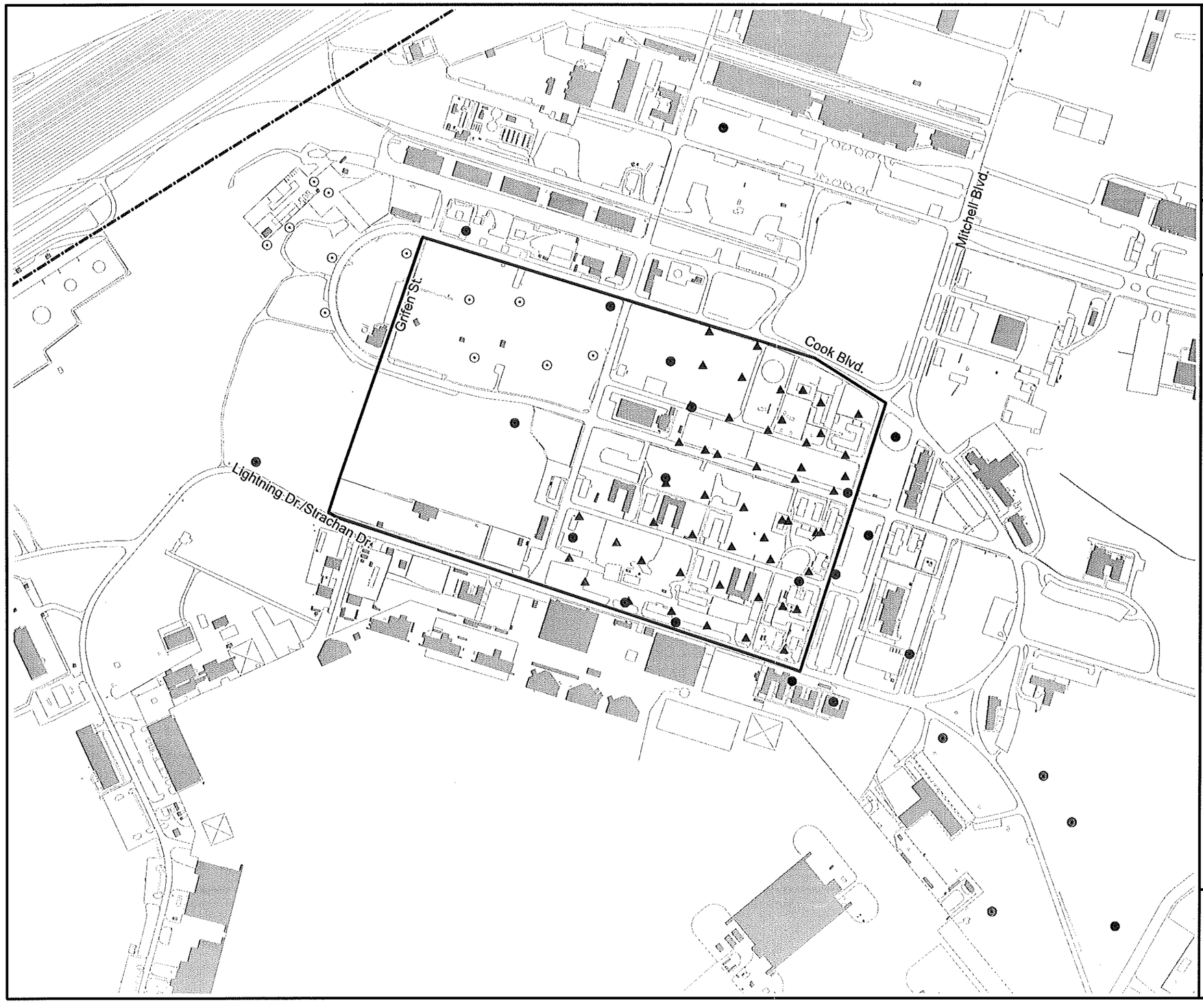
HYDRO GeoLogic Inc

Figure 3.1
Historical Groundwater Sampling Locations

US Army Corps of Engineers
Savannah District



Legend

- Location of MCA Barracks Area
- Hunter Army Airfield Property Boundary

Groundwater Sampling Locations

- Discrete Interval Sample (USACE, Apr 1998)
- Discrete Interval Sample (USACE, May 1998)
- Discrete Interval Sample (M&E, Sep 1999)
- Vertical Groundwater Profile (SAIC, Sep 1999)
- Vertical Groundwater Profile (SAIC, Feb 2000)
- Vertical Groundwater Profile (SAIC, Dec 2001)
- Vertical Groundwater Profile (USACE, Dec 2002)
- Vertical Groundwater Profile (USACE, Jun/Jul/Sep 2003)

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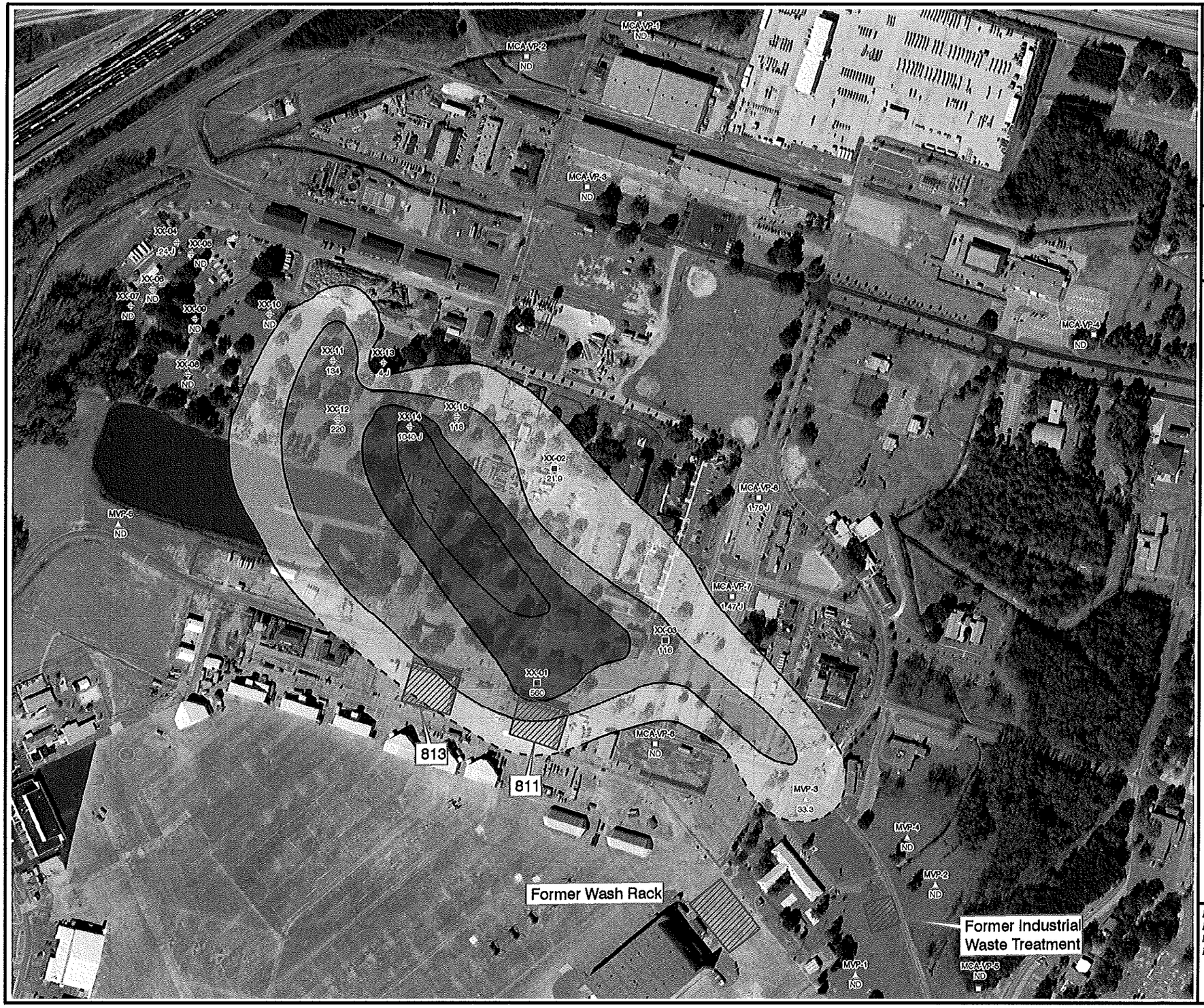
HYDRO GeoLogic Inc.

Figure 3.2
TCE Shallow Plume Map

US Army Corps of Engineers
Savannah District



Legend

- Vertical-Profile/Monitoring Well Location (2000,2001)
- Vertical-Profile Only Location (1999)
- Estimated Vertical-Profile Location (2002)
- Estimated Vertical-Profile Location (2003)
- Potential Source
- Hunter Army Airfield Property Boundary

TCE Concentrations (µg/L)

- 5 - 100
- 100 - 500
- 500 - 1000
- > 1000

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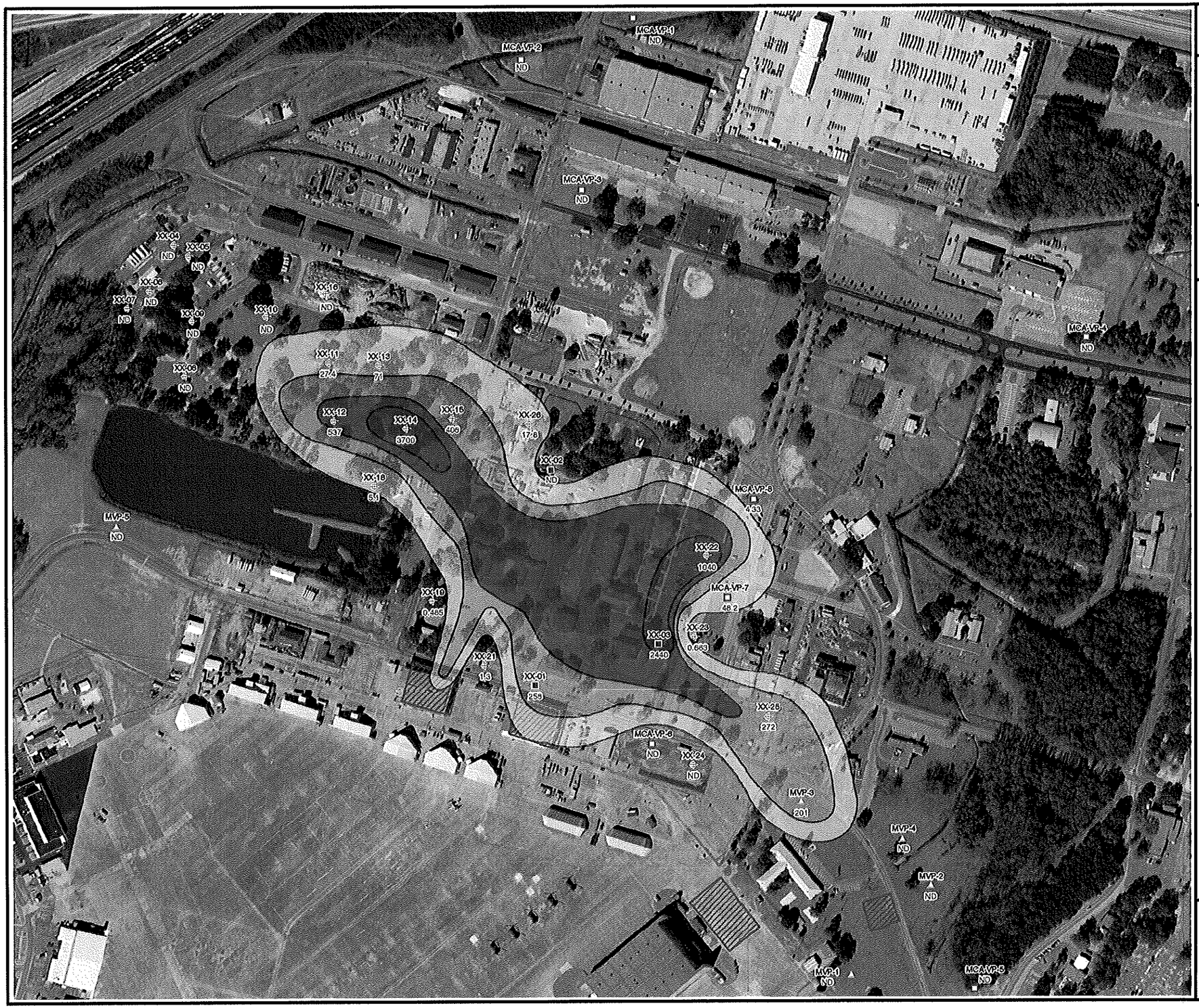
HYDRO GeoLogic

Figure 3.3
TCE Intermediate Plume Map

US Army Corps of Engineers
Savannah District



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- Vertical-Profile Only Location (1999)
- Estimated Vertical-Profile Location (2002)
- Estimated Vertical-Profile Location (2003)
- Potential Source
- Hunter Army Airfield Property Boundary

TCE Concentrations (µg/L)

- 5 - 100
- 100 - 500
- 500 - 1000
- > 1000

N

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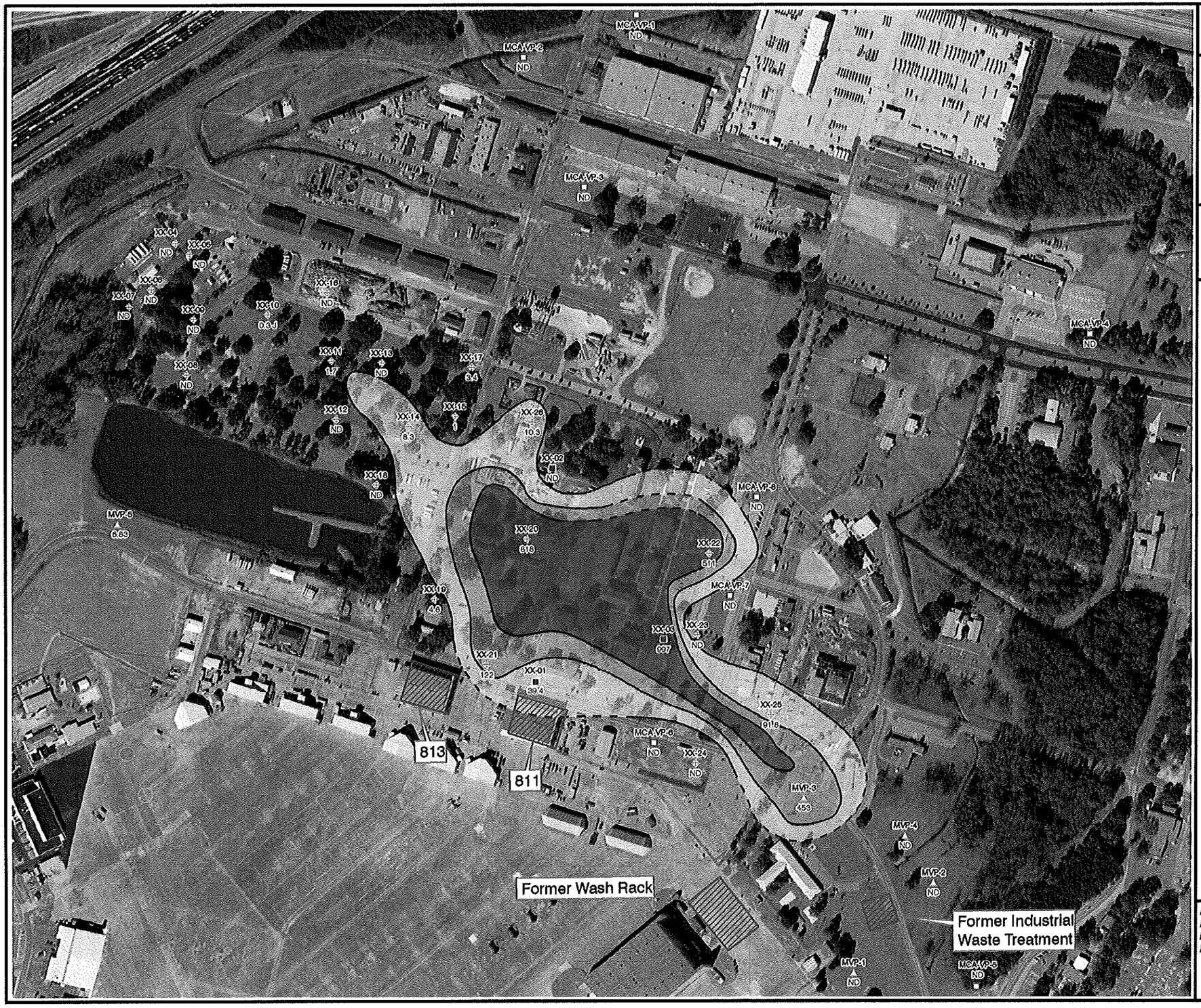
HydroGeoLogic Inc

Figure 3.4
TCE Deep
Plume Map

US Army Corps of Engineers
Savannah District



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- Vertical-Profile/Monitoring Well Location (2000,2001)
- Vertical-Profile Only Location (1999)
- Estimated Vertical-Profile Location (2002)
- Estimated Vertical-Profile Location (2003)
- Potential Source
- Hunter Army Airfield Property Boundary

TCE Concentrations (µg/L)

- 5 - 100
- 100 - 500
- 500 - 1000

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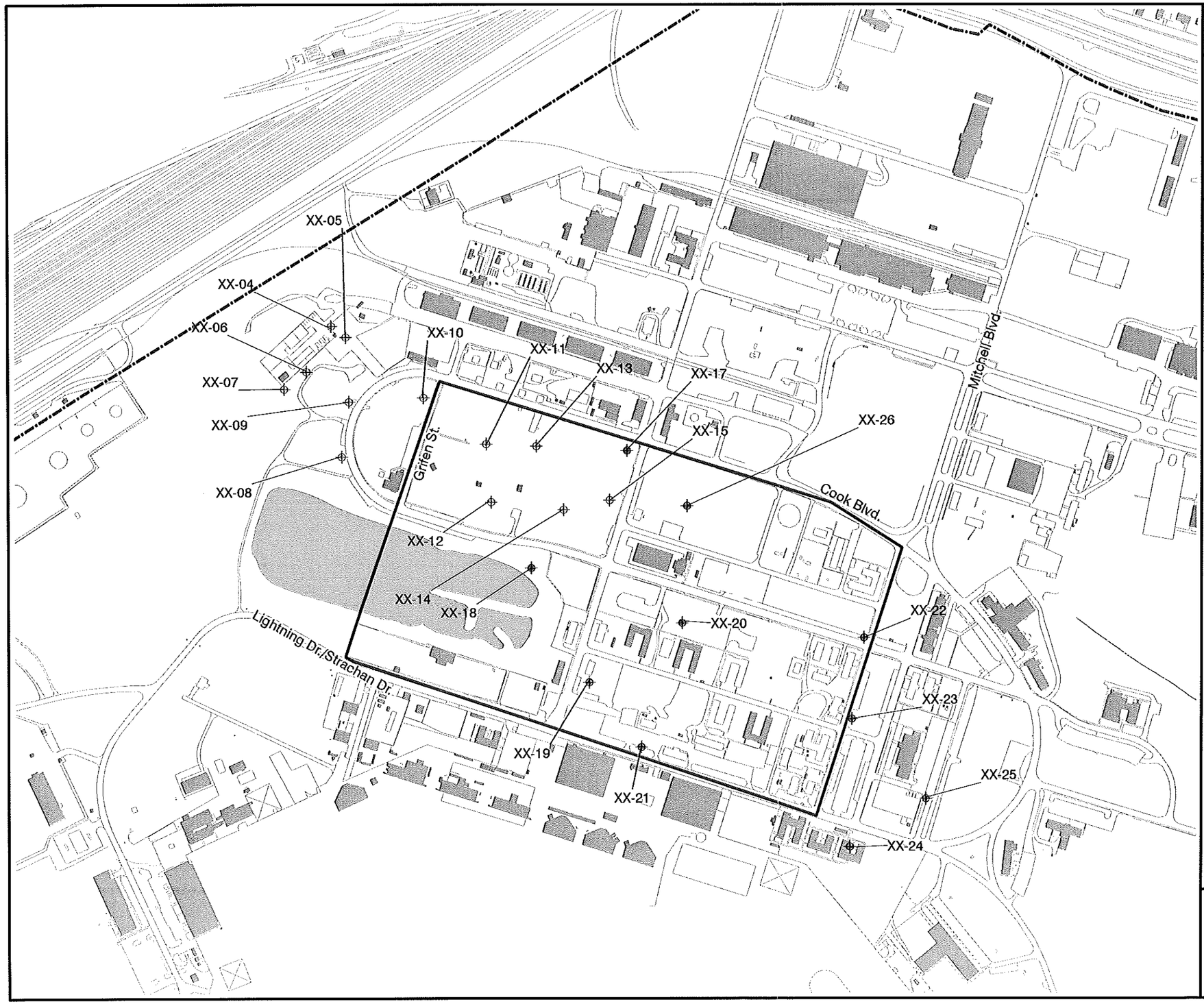
Revised: 03-02-05 TB
Photo Date: 1999

HYDRO GeoLogic

HydroGeoLogic, Inc.—Work Plan
Hunter Army Airfield, Georgia

Figure 3.5
Locations of Existing Groundwater Monitoring Wells

US Army Corps of Engineers
Savannah District



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- Location of MCA Barracks Area
- Hunter Army Airfield Property Boundary
- Monitoring Well (Feb 2000)
- Monitoring Well (Dec 2001)

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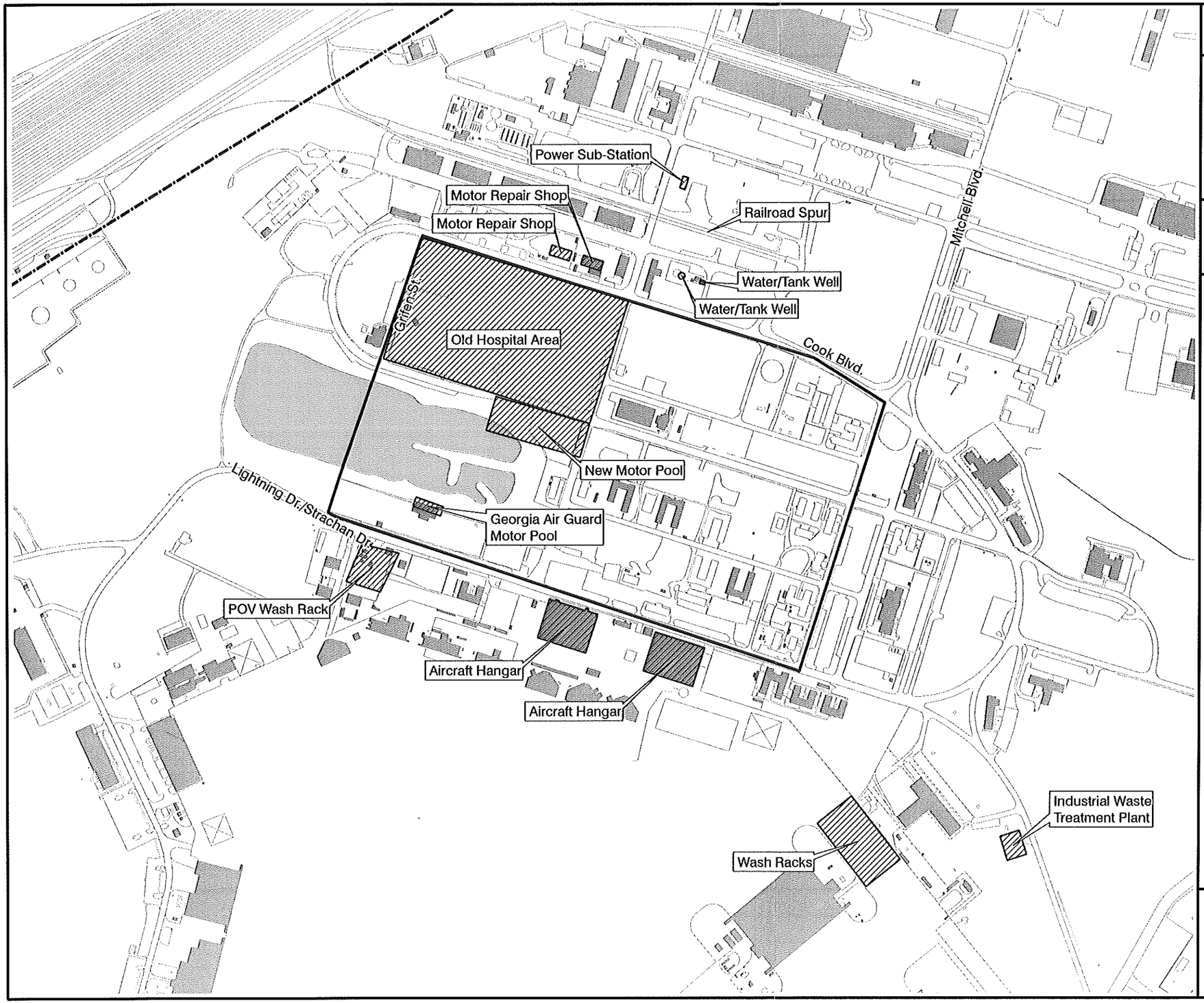
HydroGeoLogic

Figure 4.1
Potential
Source Areas

US Army Corps of Engineers
Savannah District



Legend

- Location of MCA Barracks Area
- Hunter Army Airfield Property Boundary
- Potential Source Area
- Pond

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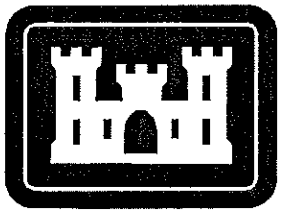
HYDRO GeoLogic Inc.

ATTACHMENT A

FIELD SAMPLING PLAN

FINAL
FIELD SAMPLING PLAN
MCA BARRACKS SITE, HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

Prepared for



U.S. Army Corps of Engineers
Savannah District

Contract No. DACA4500-03-D-0029
Delivery Order 0001

September 2005

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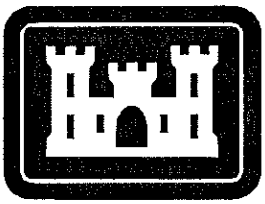
FINAL
FIELD SAMPLING PLAN
MCA BARRACKS SITE, HUNTER army AIRFIELD
SAVANNAH, GEORGIA



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Prepared by

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September 2005

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TABLE OF CONTENTS

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AHA	Activity Hazard Analysis
ASTM	American Society for Testing and Materials
ABC®	Anaerobic Biochem®
bgs	below ground surface
°C	degree Celcius
CAP	Corrective Action Plan
cis-1,2-DCE	*cis*-1,2-dichloroethene
COC	contaminant of concern
CSR	Compliance Status Report
DNA	deoxyribonucleic acid
DO	dissolved oxygen
DQCR	Daily Quality Control Report
DPT	direct push technology
EM	engineering manual
ERD	enhanced reductive dechlorination
FSP	Field Sampling Plan
ft	foot
ft/day	feet per day
GA EPD	Georgia Environmental Protection Division
HAAF	Hunter Army Airfield
HGL	HydroGeoLogic, Inc.
HSA	hollow stem auger
ID	inside diameter
IDW	investigation derived waste
IWTP	Industrial Waste Treatment Plant
L/min	liters per minute
LTM	long-term monitoring
MCA	Military Construction Account
MNA	monitored natural attenuation
NTU	nephelometric turbidity units
ORP	oxidation-reduction potential

PID	photoionization detector
PM	Project Manager
PPE	personal protection equipment
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
QAPP	Quality Assurance Project Plan
ROI	Radius of influence
SAIC	Science Application International Corporation
SHO	Safety and Health Officer
SI	Site Investigation
SOP	Standard Operating Procedure
SS	Site Supervisor
SSHP	Site Safety and Health Plan
TCE	trichloroethene
TOC	total organic compounds
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound

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FINAL
FIELD SAMPLING PLAN
MCA BARRACKS SITE, HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

1.0 INTRODUCTION

This Field Sampling Plan (FSP) was prepared by HydroGeoLogic, Inc. (HGL) to detail the requirements and procedures for field operations in performance of the Site Investigation (SI) and Pilot Study activities required to characterize groundwater and evaluate the proposed remedy at the Hunter Army Airfield (HAAF) Military Construction Account (MCA) Barracks site in Savannah, Georgia. The FSP is a key planning document that provides a detailed framework to allow for collecting the analytical data and other information required to achieve project objectives. All work identified in this FSP will be performed by HGL and its designated subcontractors under Contract Number DACA45-03-D-0029, which is administered through the U.S. Army Corps of Engineers (USACE)-Savannah City District.

This project-specific FSP was prepared to ensure that (1) the data quality objectives specified for this project are met, (2) the field sampling and Pilot Study protocols are implemented, documented and reviewed in a consistent manner, and (3) the data collected are scientifically valid and defensible. This project-specific FSP and the basewide Quality Assurance Project Plan (QAPP) constitute, by definition, the Sampling and Analysis Plan.

Guidelines followed in the preparation of this plan are set out in USACE Engineering Manual (EM) *EM200-1-2, Technical Project Planning Guidance for HTRW Data Quality Design* (USACE, 1995); *EM 200-1-3, Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 1994); *EM 1110-1-4000 Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE, 1998); *and U.S. Environmental Protection Agency (USEPA) Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (USEPA, 2001).*

This FSP is required reading for all staff participating in the work effort. The FSP shall be in the possession of the field staff during all field activities. HGL and its subcontractors are required to comply with the procedures documented in this FSP in order to maintain comparability and representativeness of the collected and generated data.

This FSP is organized as follows:

- Section 1.0 provides the introduction and an overview of the MCA Barracks site history, and previous environmental investigations;
- Section 2.0 presents an overview of key project personnel and their responsibilities relative to the project organization;

- Section 3.0 presents the proposed field activities and environmental sampling requirements for the MCA Barracks Site;
- Section 4.0 provides specific sampling methodology and techniques to be used for the proposed soil, surface water and groundwater sampling. This section also discusses the Pilot Study procedures and associated Pilot Study performance monitoring; and
- Section 5.0 lists the references used in developing the FSP.

Any future field activities that may be required as part of the MCA Barracks SI or Pilot Study, that are not detailed in this FSP, will be addressed in an FSP addendum.

1.1 SITE DESCRIPTION AND REGULATORY FRAMEWORK

HAAF is located along the western edge of the City of Savannah, Georgia and encompasses 5,370 acres (Figure 2.1 of the Work Plan). In 1967, the U.S. Air Force acquired HAAF to support flight training for military actions during the Vietnam Conflict. HAAF is a sub-installation of Fort Stewart and features an 11,375-ft. runway that can accommodate any size aircraft. Aviation training at the HAAF facility was phased out in 1973 when all aviation training was consolidated at another military facility. Currently, HAAF provides support facilities, training, and mobilization and deployment of the 3rd Infantry Division (Mechanized). The MCA Barracks site is located north of Lightning Road, west of Mitchell Boulevard, east of Griffin Street and south of Cook Boulevard (Figure 2.2 of the Work Plan). The site consists of approximately 75 acres.

The MCA Barracks site falls under the regulatory authority of the Georgia Department of Natural Resources, Environmental Protection Division (GA EPD) Hazardous Site Response Act and its Hazard Site Inventory number is 10521.

1.2 PAST INVESTIGATIONS

Since 1996, several investigations have been conducted at the MCA Barracks Site in an effort to identify the source of the trichloroethene (TCE) contaminant plume that underlies the site, and determine the horizontal and vertical extent of the plume. Past investigations are discussed in detail in the Work Plan and are summarized below.

- In 1996, USACE sampled groundwater and soil at four locations at the proposed Special Operations Facility located at the southern portion of the MCA Barracks site.
- In April 1998, USACE completed another pre-construction site assessment in the area of the proposed MCA Barracks project. As part of this investigation, 7 composite soil samples (6 samples and 1 duplicate) and 13 groundwater samples (12 samples and one duplicate) were collected
- In May 1998, USACE conducted another SI to determine the extent of contamination in the area of the proposed barracks construction project. As part of this investigation,

39 groundwater samples (35 samples and 4 duplicates) were collected from temporary wells screened across the water table.

- In September 1999, Metcalf and Eddy installed four shallow monitoring wells (<20 feet) at the SOF and sampled groundwater from the wells for volatile organic compounds (VOC), semi-volatile organic compounds, and metals. The wells were installed at the same locations as the temporary sampling points used to sample groundwater in 1996.

- In 1999, 2000, and 2001, Science Applications International Corporation (SAIC) conducted subsequent investigations (SAIC, 2004). Over the course of these investigations, SAIC conducted vertical profiling of groundwater at 26 locations in an effort to characterize the vertical and horizontal extent of VOC contamination.

- In 2002 and 2003, USACE conducted additional groundwater profiling to delineate the boundary of the chlorinated solvent plume. As part of these SIs, USACE installed 13 vertical-profile borings (SAIC, 2004). Groundwater was sampled every 5 feet to a total depth of approximately 45 feet and analyzed for VOCs.

1.3 EVALUATION OF EXISTING SITE CONDITIONS

The Surficial Aquifer is approximately 50 feet thick at the MCA Barracks site and extends from the water table to a depth of approximated 55 to 60 feet below ground surface (bgs). The Surficial Aquifer predominantly consists of fine and silty sand with some laterally discontinuous clay and gravel beds. Groundwater flow within the Surficial Aquifer occurs under unconfined conditions and is predominantly northwest. However, along the eastern edge of the site, groundwater flow appears to be primarily toward the north. The Surficial Aquifer is hydraulically isolated from the deeper Floridan Aquifer system by a 160-ft.-thick clay confining unit known as the Hawthorn Formation.

Groundwater within the Surficial Aquifer is contaminated with TCE and *cis*-1-2-dichloroethene (*cis*-1,2-DCE) at levels exceeding GA EPD groundwater target levels. Contamination is most widespread at depths ranging from 15 to 35 feet. Benzene, methylene chloride, vinyl chloride (VC), and tetrachloroethene also exceed GA EPD groundwater target levels; however, these constituents are found in isolated areas at low concentrations. With the exception of *cis*-1,2-DCE and TCE, all constituents are delineated across the site to non-detectable concentrations. Vertical profile data indicate that relatively low VOC concentrations occur near the likely source areas and higher concentrations are observed away from the source. This suggests that the source areas no longer contribute contamination to groundwater. Contaminants have not been detected in soil samples collected during the previous characterization efforts.

HGL evaluated historical information and existing groundwater data from previous investigations and determined that the Aircraft Hangars (Buildings T-811 and T-813), Aircraft Wash Rack, and Industrial Waste Treatment Plant (IWTP) are the probable sources of the chlorinated solvent contamination at the MCA Barracks site. Although these facilities are

thought to have contributed to the VOC contamination currently observed in groundwater, the geometry of the VOC plumes suggests that these areas no longer contribute to contamination observed in groundwater. The groundwater plume beneath the MCA Barracks site is likely the result of a previous release and has since migrated down and cross gradient from the original release point(s).

2.0 PROJECT ORGANIZATION

This section discusses the role of key personnel and their primary responsibilities. The Project Management Plan, submitted under a separate cover, provides additional information on the project organization and the role of key project personnel in meeting performance objectives. Key project personnel and their respective telephone numbers are listed in Table 2.1 and are summarized in the following subsections.

2.1 PROGRAM MANAGER

HGL's Program Manager, Mr. Don Jones, P.E., is responsible for the overall execution of this project. The Program Manager has overall corporate responsibility and authority for the project, including but not limited to, scheduling, cost controls, and technical quality. He has the authority to commit the necessary corporate personnel and equipment resources to assure that project objectives are met.

2.2 PROJECT MANAGER

HGL's Project Manager (PM), Mr. Eric Evans, P.G., is the prime point-of-contact for response actions at the MCA Barracks site. The PM coordinates the work of all HGL staff and subcontractors in the successful accomplishment of this Delivery Order, and is the primary point-of-contact with USACE technical staff. The PM also is responsible for assuring that all policies and procedures required by the Fixed-Price Remediation with Insurance contract are followed during the execution of all project work.

The PM reviews all documents, reports and technical memoranda prepared by HGL and its subcontractors that are relevant to completing the remediation goals of the MCA Barracks site. The PM also is responsible for establishing and maintaining the project schedule and budget, and coordinating the preparation of all project deliverables. Along with regulatory agencies, the PM certifies and approves project milestones, deliverables, and invoices. The PM also interfaces directly with the public, as requested by USACE, which has primary responsibility for community relations and public outreach.

2.3 QUALITY ASSURANCE/QUALITY CONTROL MANAGER

The Quality Assurance/Quality Control (QA/QC) manager, Mr. Kirk Switzer, reviews, evaluates, and approves all planning documents in accordance with HGL's corporate guidelines and procedures. He also serves as the point of contact for all Quality Assurance matters for this project and verifies that appropriate corrective actions are taken for all identified instances of nonconformance.

In addition, it is the QA/QC manager's responsibility to ensure that QC procedures are comprehensive, complete, and rigorously adhered to by HGL. The QA/QC manager reviews and revises Quality Assurance manuals, guidelines, and instructions used by HGL.

2.4 CORPORATE HEALTH AND SAFETY OFFICER

The Corporate Safety and Health Officer (SHO), Ms. Mary Ann Heaney, is responsible for program-level implementation of the Site Safety and Health Plan (SSHP).

2.5 PROJECT CHEMIST

The Project Chemist, Mr. Ken Rapuano, is responsible for oversight of all QC operations for the field sampling and laboratory analysis activities for this project. The Project Chemist interfaces directly with project staff, providing direction and support for project sampling and analysis activities. He is responsible for the verification of conformance with quality standards and implementation of appropriate corrective actions when data reviews identify deficiencies.

The Project Chemist is also responsible for the management of project tasks associated with sampling and analysis. These duties and responsibilities extend to the following:

- Coordinating analytical laboratory readiness to implement project-specific requirements,
- Reviewing analytical data as it becomes available to ensure conformance with quality standards,
- Executing corrective actions when data reviews uncover deficiencies, and
- Serving as the project point-of-contact for all environmental chemistry related issues.

The Project Chemist is responsible for preparing all data validation reports and/or reviewing all data validation reports prepared by HGL personnel and/or subcontractors for accuracy.

2.6 SITE SUPERVISOR/SITE SAFETY AND HEALTH OFFICER

The Site Supervisor (SS)/Site Safety and Health Officer, Mr. Mike Jackson, P.G., reports to the PM and is responsible for field enforcement of the SSHP. The SS will serve as the Site Safety and Health Officer for this project. The SS will inform the Corporate SHO and PM of any changes to the work plan before implementation, so that any safety and health issues introduced by those changes can be addressed properly.

In addition to field enforcement of the SSHP, the SS is responsible for coordinating all site activities with the PM, laboratory, and on-site subcontractors. The SS will provide the necessary orientation, training, direction, and supervision to all field personnel. The SS ensures the use of calibrated measurement and equipment, as well as manages all field documentation. All sampling operations will be monitored by the SS to ensure the sampling team members adhere to the FSP.

Other responsibilities of the SS include:

- Assuring that all field personnel on the project read and sign the SSHP,
- Contacting the Corporate SHO if changes to an Activity Hazard Analysis (AHA), or developing a new AHA as needed,
- Assuming the duties of the Corporate SHO if directed to do so by the Corporate SHO,
- Overseeing technical execution of field sampling activities,
- Providing all required supplies, equipment, and tools before initiation of each task,
- Ensuring employees maintain required training and medical monitoring throughout the project, and
- Monitoring that the equipment is properly calibrated and used, and that the results are properly recorded and filed in accordance with SSHP requirements.

2.7 SUBCONTRACTORS

All subcontractors will be required to follow the procedures of the Work Plan, FSP, and QAPP. The HGL SSHP will be provided to each subcontractor for informational purposes; however, each subcontractor will be required to develop and enforce its own SSHP for the subcontractor's site employees. If a procedural conflict between the HGL SSHP and a subcontractor SSHP is discovered, the corporate Health and Safety Officers of each company will resolve this conflict before the affected tasks continue. Periodic QC inspections of each subcontractor may be performed as specified in Section 9 of the QAPP, and Section 2.3 of the SSHP. These inspections will be performed by the QA\QC Manager, or his designee, as unannounced audits to confirm adherence to the procedures and guidance outlined in the aforementioned documents. Such inspections may relate to health and safety, QAPP requirements, or field standard operating procedures (SOP).

Subcontractors will be used primarily for laboratory analyses of samples, drilling services, and pilot study tasks. All subcontractors performing work at the MCA Barracks site must have the applicable Occupational Safety and Health Administration certifications to perform work at a hazardous waste site. Per the GA EPD, laboratory data submitted to the GA EPD must be analyzed by an approved laboratory, in accordance with the Georgia Rules for Commercial Environmental Laboratories (391-3-26). According to the State of Georgia Code 12-2-9, "all commercial analytical laboratories submitting data for regulatory purposes shall be accredited or approved as specified in the Environmental Protection Division's rules and regulations" (GA EPD, 2003). The subcontracted laboratory must also maintain validation by USACE. HGL will ensure that subcontractors performing work or providing services under this work plan meet all relevant GA EPD standards.

Table 2.1
Key Project Personnel

Name	Title	Organization	Telephone
Don Jones, P.E.	Program Manager	HGL	(916) 614-8770
Eric Evans, P.G.	Project Manager	HGL	(518) 877-0390
Kirk Switzer	QA/QC Manager	HGL	(916) 614-8770
Mary Ann Heaney, CIH	Corporate Safety and Health Officer	HGL	(303) 665-8528
Ken Rapuano	Project Chemist	HGL	(703) 736-4546
Mike Jackson, P.G.	Site Supervisor/Site Safety Health Officer	HGL	(518) 877-0390
Ana Del R. Vergara	Contracting Officer Representative	USACE	(912) 652-5835
Zsolt Haverland, P.G.	Technical Manager	USACE	(912) 652-5815
Tressa Rutland	Chief Environmental Branch Directorate of Public Works	HAAF/Ft. Stewart	(912) 767-7919
Algeana Stevenson	Environmental Specialist	HAAF/Ft. Stewart	(912) 767-2281

3.0 FIELD ACTIVITIES

The various field activities that will be conducted during the groundwater characterization and Pilot Study include the following:

- Advancing soil borings with direct-push and possibly other drilling techniques (e.g., hollow stem auger drilling technology);
- Collecting soil samples from select soil boring locations;
- Collecting groundwater samples from direct-push technology (DPT) borings;
- Installing and developing permanent monitoring wells;
- Installing and abandoning injection monitoring wells;
- Measuring water levels;
- Conducting slug testing of select new monitoring wells;
- Collecting groundwater samples from new and existing monitoring wells;
- Injecting enhanced reductive dechlorination (ERD) compound through temporary DPT borings;
- Collecting groundwater samples from temporary pilot study performance monitoring wells;
- Collecting surface water samples from the on-site pond;
- Managing investigation derived waste (IDW); and
- Surveying and utility clearing.

Tables 3.1 through 3.4 summarize the various components of the SI and include the sampling procedures and rationale, the proposed number of samples, and the required analyses. Specific methodology used to perform the field activities are presented in Section 4 of this FSP. Sampling QA/QC procedures and documentation are detailed in Sections 5 and 6 of the QAPP.

3.1 GROUNDWATER PLUME DELINEATION

As the first phase of the groundwater plume delineation/source confirmation task, a DPT rig will be used to collect groundwater samples from approximately 26 locations (Figure 3.1). For groundwater plume delineation, a groundwater sample will be taken from three separate zones, a shallow zone (from the water table to approximately 15 feet bgs), an intermediate zone from (15 to 30 feet bgs) and a deeper zone (from 30 to 50 feet bgs). Locations for the DPT sampling points were selected based on analysis of existing groundwater data, though sampling locations may be adjusted based on access restrictions. Depth intervals may be adjusted based on field screening results obtained from photoionization detector (PID) reading taken during the DPT investigation.

Groundwater data collected from these sampling points will help further characterize the horizontal and vertical extent of the TCE plume that underlies the site and provide additional source delineation data. If data collected during the first phase is insufficient to establish the plume boundary to non-detect or background concentration levels and confirm suspected source area(s), additional DPT points will be installed and groundwater samples will be collected. If a second phase is necessary, it will take place as soon as logistically possible following the first mobilization. The DPT methodology is detailed in Section 4.2 of this FSP. Soil samples will be collected for laboratory analysis if field screening results show that VOCs are present, as indicated by a PID reading of 10 parts per million above background.

3.2 PERMANENT MONITORING WELL INSTALLATION

Permanent wells will be installed for plume characterization and for eventual use in long-term monitoring. Proposed locations of 18 plume characterization wells, as shown in Figure 3.2, are based on the locations of the existing wells (installed during previous SIs) also shown in Figure 3.2, and analysis of groundwater data collected during previous SIs. Fourteen of these new wells will be nested with both a shallow and deep screened interval contained within one borehole. Each well will be constructed with 10 feet of well screen; the shallower wells will be screened from 15-25 feet, bgs and the screened interval in the deeper well will range from 30-40 feet, bgs. These screened intervals were selected based on the results of the historical vertical contaminant data. Construction of the wells with the proposed screened intervals will allow adequate characterization of the vertical distribution of contamination. Vertical contaminant profiles indicate that few VOC contaminants are present outside of these ranges.

The exact field locations and screened intervals of the monitoring wells will be refined based on the analysis of groundwater data obtained during DPT groundwater sampling. All permanent monitoring wells installed at the MCA Barracks site during the SI will be installed using hollow stem auger (HSA) well installation methods according to Section 4.3 of this FSP. If HSA cannot be used or is determined to be inappropriate based on encountered site conditions, an alternate form of drilling will be used. One likely alternative method is Rotosonic drilling which is discussed in Section 4.4 of the FSP. All three methods are "dry" methods and do not require drilling fluids to be used during monitoring well installation. Soil cores will be taken from selected borings for the purpose of lithologic logging and will be collected and described per Section 4.1 of this FSP.

Groundwater samples will be collected after installation and development of the permanent monitoring wells. This sampling event will include a total of 35 wells (18 newly installed and 17 existing). The monitoring wells will be sampled using low-flow purging and sampling techniques according to Section 4.7.1 of this FSP. If insufficient water is produced from any well then a bailer stainless steel or Teflon® will be used to collect the sample from the deficient well according to Section 4.7.2 of this FSP. Purge water will be contained either in 55-gallon drums or bulked into a holding tank. The IDW Management Plan is included as Attachment C. Samples will be analyzed for the analytical parameters identified on Table 4.2 of the IDW Management Plan. Groundwater purge stabilization parameters will be measured and recorded during the monitoring well sampling. The stabilization parameters and the

required stabilization limits are identified in Section 4.7.1.3 of this FSP. Analysis of all samples will follow the procedures outlined in Table 4.1 of the QAPP.

3.3 SOURCE INVESTIGATION

The primary purpose of this task is to determine the potential source area responsible for the groundwater contamination in the Surficial Aquifer and assess if that source is a continuing source of groundwater contamination. Based on their potential for historical TCE usage, along with their location relative to the extent of the TCE contamination, the following sites were identified as the most probable sources of VOC contamination impacting groundwater at the MCA Barracks site:

- Aircraft Hangar Buildings T-811 and T-813;
- Aircraft Wash Rack; and
- IWTP.

In addition, the following sites will be investigated as potential secondary source areas located within the immediate MCA Barracks area:

- Old Hospital Area (Former Boiler Room and Disposal Areas)
- Georgia Air Guard Motor Pool

If the VOC plume is delineated north of Cook Blvd., the following locations will be investigated as potential secondary source areas:

- Motor Repair Shop
- Building 725

Soil samples will be collected from ground surface to the water table from the potential source areas using a DPT rig. The initial phase of this investigation will begin at Buildings 811 and 813 continue at the former Aircraft Wash Rack and the former IWTP and end at the Old Hospital Area and the Georgia Air Guard Motor Pool. A total of 16 locations have been selected for soil sample collection, (Figure 3.3). If any regulated contaminants are detected in the data collected during the first phase, HGL will step out from those points and collect additional soil samples. This process will continue until the concentrations of regulated compounds are below detection limits or background levels. Soil samples will be submitted from depths where the highest contaminant concentrations are likely to occur (Section 4.2.1).

Specific soil sampling locations at the IWTP will include locations where underground piping was formerly located or abandoned. The location of former underground piping will be derived from historical documents or remote sensing techniques, if needed.

3.4 SURVEYING

All new monitoring wells, select existing monitoring wells, DPT sample locations, soil sample locations, and selected site items (i.e. building corners, roads, etc.) will be surveyed according

to Section 4.16 of this FSP. This survey will be conducted after all monitoring wells are installed.

3.5 SLUG TESTING

Hydraulic conductivity testing (slug tests) will be performed on eight of the newly installed monitoring wells. The slug testing will occur after the monitoring wells have been properly developed and sampled. The hydraulic conductivity analysis will be performed according to Section 4.11 of this FSP. The specific wells to be analyzed will be determined after the wells are installed.

3.6 PILOT STUDY

A pilot study will be conducted to determine the optimal ERD compound injection procedures, and to monitor the effectiveness of the ERD remedy. During the pilot study, the selected Anaerobic Biochem™ (ABC®) ERD compound will be injected into the subsurface through three temporary injection points. Groundwater will be monitored at locations upgradient, downgradient, and sidegradient from the injection area to determine the effectiveness of the ERD compound in enhancing microbial degradation of the dissolved-phase plume. The location of the proposed pilot study is shown on Figure 3.4.

Results of the pilot study analytical sampling will be used to design a full scale injection of the ERD compound within the MCA barracks site. Details of the pilot study and the associated analytical requirements are discussed in detail in Section 4.17 of this FSP.

3.7 POND WATER AND SEDIMENT SAMPLING

Surface water and sediment samples will be collected from six selected locations from the on-site pond to determine if the surface water and/or sediment are impacted by groundwater contamination (see Figure 3.5). The sampling locations were selected based on the direction of groundwater flow in the vicinity of the pond and the observed extent of VOC contamination in groundwater. Groundwater in the Surficial Aquifer appears to flow to the northwest. Surface water samples will be collected near the shore from the eastern side of the pond. Sediment samples will be collected from a point beneath each surface water location.

Table 3.1
Proposed Well Information and Installation Rationale

Reference Figure Number	Sampling and Installation Rationale	Well Information		
		Number of Proposed Borings to be Installed	Boring Depth	Proposed Depth of Borings
See Figure 3.1 for Proposed Groundwater Sampling Locations	A total of up to 64 DPT groundwater samples are proposed for the areas within and around the plume at the site. The purpose of the sampling is to delineate the VOC plume to non-detectable concentrations and to verify the nature and location of the VOC sources.	26 sampling locations and up to 64 groundwater samples.	Up to 50 feet	Borings may be as deep as 50 feet.
See Figure 3.4 for Pilot Study Location Map	A total of up to 11 monitoring wells are proposed. These wells will be sampled for VOCs, monitored natural attenuation (MNA) parameters, volatile fatty acids, hydrogen and deoxyribonucleic acid (DNA). These wells will monitor the performance of the ERD in the Pilot Study.	11 single-cased DPT wells (5 shallow and 6 deep)	Up to 50 feet	Wells may be as deep as 50 feet. Target screen intervals are 15-25 feet bgs and 30-40 feet bgs.
See Figure 3.4 for Pilot Study Location Map	A total of 3 Pilot Study injection points will be installed to be used solely for the purpose of injecting the ERD into the target areas.	3 injection points	Up to 50 feet	Injection points may be as deep as 50 feet. ERD will be injected through the entire saturated zone.
See Figure 3.2 for Proposed Monitoring Well Locations	A total of up to 18 monitoring wells are proposed at the site. The purpose of the wells is to either monitor the downgradient portion of the plume, monitor suspected source area(s), or to evaluate the performance of the proposed corrective action. See Table 4.2 for specific rationale.	Up to 18 monitoring wells. Seven well locations will contain two wells (one screened from 15-25 feet bgs and the other screened from 30-40 feet bgs). Two wells will be single wells screened at 15-25 feet bgs. One well will be screened from 35 to 45 feet near former MVP-5 and a deep well (>45') installed near XX-20.	Up to 50 feet	Monitoring wells may be as deep as 50 feet. Target screen intervals are 15-25 feet bgs, 30-40 feet bgs, and 40-50 feet bgs. Continuous soil sampling will be performed at select well locations.

DNA = monitored natural attenuation
MNA = deoxyribonucleic acid

Table 3.2
Summary of Rationale for Placement of New Permanent Groundwater Wells

Proposed Well Number	Selection Rationale	Screened Interval (feet bgs)	Boring Depth (feet bgs)
HGL 1B & HGL 1C	The western leading edge of the intermediate contaminant plume requires monitoring. Existing wells in that area are only screened from 2-10 feet. A nested well cluster will provide data from 15-40 feet. XX-08 will be used to provide shallow groundwater data in that location.	B=15-25 C=30-40	Up to 50 feet
HGL 2B & HGL 2C	The northwest corner of plume requires monitoring. A previously existing well (XX-16) was lost during construction activities in the area. Wells 2 B & C will be a nested well cluster and provide groundwater data from 15-40 feet. bgs. A nearby temporary DPT monitoring well will provide shallow groundwater data.	B=15-25 C=30-40	Up to 50 feet
HGL 3B	Data is needed on the north edge of the plume. The location of 3B will monitor the perimeter of the plume. Temporary DPT wells will provide shallow groundwater data. Existing well XX-017 will monitor 40-45 feet bgs.	B= 15-25	Up to 50 feet
HGL 4B & HGL 4C	There are no wells north and northeast of the plume. This well cluster will monitor the perimeter of the plume. Temporary DPT wells will provide shallow groundwater data.	B=15-25 C=30-40	Up to 50 feet
HGL 5B & HGL 5C	This nested well pair will provide groundwater data on the southeast edge of plume and is located downgradient of two of the suspected source areas.	B=15-25 C=30-40	Up to 50 feet
HGL 9B & HGL 9C (optional)	This optional well pair will be placed downgradient of suspected source area(s) if DPT data shows continuing release of regulated compounds from those areas.	B=15-25 C=30-40	Up to 50 feet
HGL 6 B & HGL 6C HGL 7 B HGL 8 B & HGL 8C	These wells will provide data on the plume interior.	B=15-25 C=30-40	Up to 50 feet
HGL 10C	Installed near well XX-20 to define extent of vertical contamination within the portion of the plume interior	C-40-50	Up to 50 feet
HGL 11C	This well will be placed in the vicinity of former plume delineation point MVP-5 to provide groundwater delineation data from the southwestern portion of the site.	C=35-45	Up to 50 feet

Table 3.3
Summary of Groundwater and Surface Water Sampling Rationale

Sampling Rationale	Proposed Investigations				
	Sample Type	Number of Locations to be Sampled	Number of Sampling Events	Sample Depths	Analyses
Collect groundwater samples using a DPT rig to delineate the vertical and horizontal extent of VOC contamination to nondetectable concentrations and to verify the nature and location of VOC sources. Up to 64 samples will be collected from 26 initial locations.	Groundwater	26 locations (64 samples)	1	Sample depths will range from 5 to 50 feet	VOCs
Three post-injection rounds of sampling will be conducted to evaluate the performance of the ABC® substrate during the Pilot Study. The wells will be sampled using low-flow purging and sampling techniques. If the water level is insufficient, a Teflon or stainless steel bailer will be used to collect the sample.	Groundwater	11 newly installed DPT monitoring wells	3	Sample depths will range from 15 to 50 feet	VOCs, metals, alkalinity, sulfate, nitrate/nitrite, and O-phosphate, methane, ethane, ethene, total organic compounds (TOC), DNA, volatile fatty acids
One round of groundwater sampling associated with the SI will occur after all new monitoring wells are installed. This sampling will include a total of up to 35 wells (18 newly installed and 17 existing). The purpose of the sampling is to establish baseline conditions in support of the Compliance Status Report (CSR) and subsequent corrective action. The wells will be sampled using low-flow purging and sampling techniques.	Groundwater	35 monitoring wells, (18 newly installed and 17 existing)	1	Sample depths will range from 2 to 46 feet	VOCs, metals, alkalinity, sulfate, nitrate/nitrite, and O-phosphate, methane, ethane, ethene, TOC
One round of surface water and sediment sampling. Six locations in the eastern area of the pond will be sampled for surface water and sediment.	Surface Water/Sediment	6	1	Sample depths will vary.	VOCs

CSR = Compliance Status Report
TOC = total organic compounds

Table 3.4
Summary of Soil Sampling Rationale

Sampling Location/Rationale	Proposed Investigations				
	Sample Type	Number of Locations to be Sampled	Number of Sampling Events	Sample Depths	Analyses
Aircraft Hangars. Samples will be collected near likely source areas. Two outside perimeter sampling locations per hangar will be analyzed. One sampling location from a degreaser room drain will be submitted for analysis (Building 811).	Soil	5	1	Sample depths will range from grade to water table. Submit soil sample for analysis from depth where contamination is likely to occur.	VOCs , RCRA Metals
Wash Rack. Samples will be collected near likely source areas. The selected locations will target locations corresponding to former drain lines.	Soil	3	1	Sample depths will range from grade to water table. Submit soil sample for analysis from depth where contamination is likely to occur.	VOCs
Industrial Waste Treatment Plant (IWTP). The selected locations correspond to the physical footprint of the former IWTP and associated underground piping.	Soil	4	1	Sample depths will range from grade to water table. Submit soil sample for analysis from depth where contamination is likely to occur	VOCS

Table 3.4
Summary of Soil Sampling Rationale (continued)

Sampling Location/Rationale	Proposed Investigations				
	Sample Type	Number of Locations to be Sampled	Number of Sampling Events	Sample Depths	Analyses
Old Hospital Area (Former Boiler Room and Disposal Areas). One sample collected for the former boiler room area and one sample collected from each of the two disposal areas.	Soil	3	1	Sample depths will range from grade to water table. Submit soil sample for analysis from depth where contamination is likely to occur	SVOCS and RCRA Metals
Georgia Air Guard Motor Pool. One sample collected from the footprint of the motor pool area.	Soil	1	1	Sample depths will range from grade to water table. Submit soil sample for analysis from depth where contamination is likely to occur.	VOCs , RCRA Metals

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4.0 FIELD METHODOLOGY

4.1 SUBSURFACE LITHOLOGIC LOGGING

Before commencing any invasive, subsurface field activities, utilities will be cleared per Georgia Code Section 25-9-6 (Georgia one-call, 1-800-282-7411) and through local coordination with Algeana Stevenson of the HAAF Environmental Division at least 14 days before the start of field activities. The subsurface investigation includes lithologic split-spoon logging of soils collected during the installation of selected borings. Direct push borehole locations will be sampled continuously at 4-ft. intervals in clear plastic liners (e.g., PVC Lexan®) using a soil sampling rod. It is unlikely that borings advanced using DPT methods can provide usable lithologic data beyond approximately the first 8 feet of depth. HSA techniques or rotosonic drilling techniques will be used to collect lithologic samples from deeper borings.

All pertinent borehole drilling information will be recorded in the field log and transcribed onto a logging form for inclusion in the CSR. A copy of the field boring log is included in Appendix A of this FSP. Borings will be logged according to the general procedures described in USACE EM 1110-1-4000 (1998) and will include the following:

- A qualified experienced geologist or geotechnical engineer will prepare boring logs in the field, as borings are drilled. Each log will be signed by the preparer.
- All log entries will be printed. Photo reproductions will be clear and legible. Copies will be submitted to the appropriate parties identified in the QAPP.
- Borehole depth information will be from direct measurements accurate to 0.10 ft..
- Logs will be prepared on the drilling log form.
- All information blanks in the log heading will be completed.
- Log scale will be 1 inch=1 ft..
- Each and every material type encountered will be described in the log form.
- Unconsolidated materials will be described as follows:
  - Descriptive Unified Soil Classification System classification;
  - Consistency of cohesive materials or apparent density of noncohesive materials;
  - Moisture content assessment (e.g., moist, wet, saturated, etc.);
  - Color;
  - Other descriptive features (e.g., bedding characteristics, organic materials, etc.); and
  - Depositional type (e.g., alluvium, till, loess, etc.).

- Stratigraphic/lithologic changes will be identified by a solid horizontal line at the appropriate scale depth on the log that corresponds to measured borehole depths at which changes occur, measured, and recorded to the nearest 0.1 ft.. Gradational transitions, changes identified from cuttings or methods other than direct observation and measurement will be identified by a horizontal dashed line at the appropriate depth based upon the best judgment of the logger.
- Logs will clearly show the depth intervals from which all samples are retained.
- Logs will clearly identify the depth at which water is first encountered, the depth to water at the completion of drilling, and the stabilized depth to water. The absence of water in borings will also be indicated. Stabilized water level data will include time allowed for levels to stabilize.
- Logs will show borehole and sample diameters and depths at which drilling or sampling methods or equipment change.
- Logs will show total depth of penetration and sampling. The bottom of the borehole will be so identified on the log by solid double lines from margin to margin with the notation "bottom of hole".
- Logs will identify any drilling fluid losses, including depths at which they occur, rate of loss, and total volume lost.
- Logs will show drilling fluids used, including as appropriate:
  - Source of makeup water,
  - Drill fluid additives by brand and product name, and mixture proportions; and
  - Type of filter for compressed air.
- Logs will show depths and types of any temporary casing used.
- Logs will identify any intervals of hole instability.
- Any special drilling or sampling problems will be recorded on logs, including descriptions of problem resolutions.
- Logs will include all other information relevant to a particular investigation, including but not limited to:
  - Odors,
  - Organic vapor meter measurements, and
  - Any observed evidence of contamination in samples, cuttings or drilling fluids.

Not all of the logging information described above will be applicable to the type of drilling proposed at the MCA Barracks site; however, it was included in this section to provide accurate and complete information should the actual drilling and/or soil sample collection procedures require modification from the proposed approach. Any changes to drilling procedures as identified in this FSP will be addressed in an addendum to this FSP.

4.2 DIRECT PUSH METHODOLOGY

The direct push methodology utilizes sampling tools that are driven into the ground using a percussion hammer mounted on a hydraulic ram. This equipment is typically mounted on a truck, van, all-terrain-vehicle, or small skid steer vehicle (i.e., Bobcat). Direct push technologies will be used at MCA Barracks site to achieve the following objectives:

- Collect ground water samples over multiple depths from approximately 26 DPT sampling locations;
- Perform Pilot Study injection of the ERD compound, and
- Gather soil samples from shallow boreholes for lithologic descriptions (detailed above); and from approximately 16 locations for soil analytical analysis.

4.2.1 Direct Push Soil Sampling

Soil samples for lithologic logging and analysis will be collected using direct push technology by driving a soil-sampling device from the ground surface to the desired depth, but not greater than that of the length of the sampling device. The soil sampling tool will be constructed of a steel tube, including a cutting shoe and a drive head, and lined with a plastic insert (liner) into which the soil is collected. Common liner material includes polyvinyl chloride (PVC), Lexan®, polyethylene terephthalate glycol, and Teflon®. After driving the sampler to the required depth, it will be retracted from the ground. The plastic liner will then be removed from the tube and cut longitudinally to expose the soil core for sampling and logging by the site geologist. Prior to description the soil core will be screened using a PID and those readings will be recorded on the field log. For soil samples collected to investigate suspected source areas, the portion of the core that receives the highest PID readings will be collected for analysis. If no VOCs are detected through field screening, the sample interval above the groundwater table where contamination is most likely to be found will be submitted for analysis. Examples of likely contamination intervals include an interval exhibiting unusual discoloration, the interval directly beneath a floor slab, an interval containing former or existing piping, or an interval containing an organic rich layer versus clean sand. The process is repeated until the desire borehole depth is achieved.

In the event that the borehole does not remain open between sample runs, a closed-piston tip assembly will be inserted into the cutting shoe of the soil sampler. The tip will keep soil material out of the soil sampler until the desired depth of sample collection is achieved. To collect soil samples in this manner, a soil sampling tube and liner with a closed-piston top is inserted in the cutting shoe. The soil sampling tube/probe rod assembly will then be driven to the desired depth. Using an extension rod lowered through the inside of the probe rods, the closed-piston tip is released and the sampler driven to depth as described above. The sampler is removed from the borehole, the soil core is retrieved, and the process is repeated until the desired borehole depth is achieved.

4.2.2 Direct Push Groundwater Sampling

Groundwater sampling using direct push methods can be achieved by several different means:

- DPT rods can be driven directly to a desired sample internal and a groundwater sample extracted from a screened DPT drive rod;
- A sampling tool can be lowered into an open soil sampling borehole; or
- A small diameter monitoring well can be employed using probe rods or constructed within the open borehole to collect groundwater samples.

Each method provides a means from which a groundwater sample can be retrieved. At the MCA Barracks site, the first option is proposed for the DPT groundwater collection task discussed in Section 3.1.

Groundwater sampling tools include slotted probe rods and sampling screens with retractable drive sheaths. A slotted probe rod is installed by driving it to a desired depth within the saturated zone and collecting a groundwater sample from within the rod. Alternately, a groundwater sampling screen with a retractable sheath is driven to the desired depth within the saturated zone. Once placed, the drill rod is pulled up to retract the sheath and expose the groundwater sampling screen. Following sampling rod placement, a bladder pump or bailer is used to retrieve a groundwater sample. These methods only allow one-time sampling at a specific point as groundwater samples can only be collected when the drill rod is in the ground. Conversely, pre-packed well screens with risers can be installed through direct push rods and sampled at a later time.

Pre-packed monitoring well screens are installed by driving probe rods fitted with an expendable anchor point to a depth desired for well construction. When the final well depth is reached, a prepackaged well screen and riser pipe are lowered through the probe rods and fastened to the expendable anchor point. As the probe rods are retracted from the hole, the expendable point and well screen/riser assembly remain in place. The remaining annulus is backfilled with a bentonite sealing material and grout, incrementally, as the probe rods are removed from the boring. An alternative method to pre-packed screen placement is to place a prefabricated well screen and riser pipe assembly into an open borehole, and subsequently backfill the hole with bentonite seal, and grout, as required. These small-diameters monitoring wells will be sampled using low-flow methods: collecting the sample with a bladder pump. Mini-bailers may be used if the water column is insufficient for low purge sampling techniques. Due to their generally temporary nature, prepacked wells will only be used for pilot test monitoring and not installed as LTM or permanent plume delineation wells.

After the newly installed wells are completed, up to five well volumes will be removed, or the well purged to dry. After water quality parameters indicate that the well is stabilized, it will be purged using a bladder pump or bailer (section 4.7.1.2 and 4.7.2.2). Well purging will be accomplished prior to sample collection to allow inflow of undisturbed formation water. After each volume is purged, the purge water will be tested for pH, temperature, conductivity, and

turbidity and these field measurements recorded on sample collection field forms. Appendix A of this FSP contains field forms that will be used to record data collected in the field.

The sample for VOC analyses will be collected first, followed by the sample portion required for additional analysis. If a bailer is used to purge the well, bailing will be performed at a slow rate to minimize volatilization and sample turbidity. All groundwater grab samples will immediately be placed in a cooler with ice and properly preserved prior to sample shipment.

After the DPT borings and/or wells are no longer needed, they will be abandoned per accepted GA EPD standards such as those identified in Rule 391-3-6-.13, which requires plugging of the boring with a bentonite or cement grout. Each borehole will be plugged from the bottom of the boring to within 3 feet of the surface using high solid bentonite slurry. The remaining 3 feet will be backfilled to grade with native soil if the borehole is completed in a grassy area, otherwise the top six inches of the boring will be completed with a matching surface completion material (asphalt, concrete, etc.)

4.2.3 Direct Push Injection Procedures (Pilot Study)

The pilot study injection of ERD compound will be accomplished using direct push methods. The pilot study is discussed in detail in Section 4.15. The ERD compound is a low viscosity fluid that easily flows into most formations. The injection of ERD compound at each Pilot Study injection point will follow the general procedures below:

- The drive rod assembly is fitted with an expendable tip and advanced to the desired maximum depth;
- The expendable tip is dropped from the drive rod;
- The ERD compound is poured into a pump hopper, use the mixing and recirculation features on the pump to create a uniform consistency;
- The delivery hose from the pump hopper is connected to the pump outlet;
- The pre-determined volume of ERD compound (Table 4.1) is injected into the aquifer while slowly withdrawing the drive rods. ERD will be injected across a predetermined interval and will cease when the top of the interval is reached. Generally, the top of the interval will correspond to the top of the saturated zone.
- An appropriate seal, such as bentonite, is installed above the ERD material through the entire vadose zone. This assures that the ERD compound remains properly placed and prevents contaminants from the surface from migrating to the subsurface. If the ERD compound seeps through the seal, an oversized drive tip or wood plug/stake can be used to plug the hole until the aquifer equilibrates and the bentonite seals; and
- The borehole will have a surface completion matching that of the surrounding area.

4.3 HOLLOW STEM AUGER METHODOLOGY

HSA drilling methods can be used in relatively shallow to moderate depths (< 100 feet) in a variety of soil conditions and borehole diameters. The method uses rotating auger flights, typically in 5-ft. sections, with a cutting bit attached to the lead flight. The flights consist of a hollow pipe and outer spiral plate, which when rotated; forces soil cuttings upward along the borehole wall to the surface. The auger string is advanced by rotation and rig-exerted down force.

A retractable plug with a pilot bit may be placed at the bottom of the auger string to prevent cuttings from entering the hollow stem. When the plug is retracted, a split-spoon sampler can be sent through the hollow center to sample soil at the bottom of the borehole without requiring auger removal. The recovered core may be used for laboratory analysis, field screening of the soil with a PID, or generating detailed lithologic logs of the borehole. Lithologic logging can be performed continuously using various split-spoon sampler lengths (typically 24-inches or 5 feet).

The use of water during drilling may be necessary if drilling is performed in sediments that may be prone to flowing sands. Although unlikely at shallower depths, if lithostatic pressure exceeds hydrostatic pressure, flowing sand could result. Examination of existing boring logs from the MCA Barracks site contain no mention of flowing sands, therefore the use of water to equalize lithostatic pressure is not anticipated. However, if unexpected conditions are encountered and use of water becomes necessary during drilling, clean, potable water will be used from the local water supply. This same water will be used to install the sand pack and for mixing grout. HGL will obtain a source sample from this water supply before the use of the raw water in the drilling program. The samples will be analyzed for all COCs. If water is used during the drilling of any of the monitoring wells, three times the amount used will be removed during the development of the permanent wells. Information regarding the source of water used and any impact on analytical results will be included in the CSR.

All drilling and sampling equipment will be decontaminated between each borehole location. Decontamination will be performed according to the procedures outlined in Section 4.14 of this report.

4.4 ROTOSONIC DRILLING METHODOLOGY

The rotosonic drilling method uses a combination of rotary power, hydraulic pull down pressure, and mechanically generated oscillations to advance a dual line of drilling pipe. The top mounted hydraulically powered drill head transmits the rotary power, hydraulic down pressure and vibratory power directly to the dual line of pipe. The inner drill pipe, variable from 3 inches to 9 inches inside diameter (ID) contains a core bit and represents the core barrel sampler. The outer pipe measuring 4 inches to 12 inches is used to prevent the collapse of the borehole and is therefore used in the construction of monitoring wells from 1 inch to 8 inches in diameter.

The combination of vibratory, rotary, and down-force pressures advances the inner core barrel sampler through typically difficult unconsolidated deposits and some consolidated formations without the use of mud, or air.

Continuous cores that can be collected are up to 10-ft. length. This corresponds to the length of each drill stem used when advancing a boring. Samples can range from 3 inches to 9 inches in diameter, depending on the diameter of the boring required.

Once the inner drilling pipe is set, the outer drilling pipe is advanced down over the inner drilling pipe to hold the boring open. The inner drilling pipe is mechanically lifted by the drilling head to the surface for core sample recovery. The core sample is vibrated out of the inner drilling pipe into a plastic sheath or a stainless steel sample tray. The core sample can also be collected in a split stainless steel or a Lexan® core barrel liner. The inner drilling pipe is then advanced to the next sample interval. These steps are repeated until the desired depth is reached.

Wells are installed within the annulus left by the outer drilling pipe, which will be removed as the well materials are installed. This will keep the borehole walls from collapsing and insure that an adequate sand pack is maintained.

4.5 PERMANENT MONITORING WELL INSTALLATION METHODOLOGY

Standard monitoring wells will be installed by HSA according to the general procedures described in USACE EM 1110-1-4000 (1998) and Section 4.3 of the FSP. The wells will be completed according to the procedures outlined in the following subsections as developed from the USEPA's *Handbook of Suggested Practices for Design and Installation of Groundwater Monitoring Wells* (USEPA, 1990). Figure 3.2 presents the proposed permanent monitoring well locations.

4.5.1 Well Construction Materials

All permanent monitoring wells will be constructed with PVC materials. Riser material will consist of new, 2-inch ID (standard well), threaded, flush-joint PVC pipe. The riser pipe will conform to American Society of Testing and Materials (ASTM) D 1785 standards for Schedule 40 pipe. Well screens will consist of new, commercially fabricated, threaded, flush-joint, factory slotted (0.010-inch) PVC screen. Several screen slot sizes and filter pack gradations will be available to ensure compatibility with the aquifer. The appropriate slot size and filter pack will be determined in the field; however, for planning purposes, 0.010-inch slot size and #1 filter sand is assumed.

4.5.2 Screen Location

The nested wells will consist of a shallow well screened at 15 to 25 feet bgs, and a deep well screened at 30 to 40 feet bgs. These screen intervals were selected based on the results of historical groundwater profiling at the HAAF MCA Barracks site and may vary based on field conditions and after reviewing DPT sampling results. All well screens are anticipated to be a

maximum of 10 feet in length, unless conditions warrant longer screen intervals. For the single interval wells, the final screen interval will be determined by field screening results.

4.5.3 Filter Pack

A sand filter pack will be installed in the annular space between the boring and well screen. A filter pack will be selected following the methods prescribed in ASTM D 5092-90 and USEPA's *Handbook of Suggested Practices for Design and Installation of Groundwater Monitoring Wells* (USEPA, 1990). In addition, Table 1 in ASTM 5092 furnishes "Recommended (Achievable) Filter Pack Characteristics for Common Screen Slot Sizes". The screen size selected will retain at least 90 percent of the filter pack. Based on historical well logs, the common filter pack used at the MCA Barracks site during previous well installations is #1 filter sand. The filter pack will consist of clean, chemically inert, noncarbonated, well-sorted silica sand. The sand filter pack will be placed from the bottom of the borehole to approximately 3 to 5 feet above the top of the well screen unless specified otherwise due to well nesting. Care will be taken to prevent bridging by continuously probing and measuring the thickness of the filter pack as it is emplaced. The final depth to the top of filter pack will be measured directly using a steel tape, a rod, or a tremie pipe and recorded.

4.5.4 Bentonite Seal

A thin layer (1-ft. thick minimum) of fine sand will be placed between the bentonite seal and the filter sand pack. A bentonite pellet or granular bentonite seal will be installed in the annular space above the thin layer of fine sand. If the bentonite seal will be above the water table, the seal will consist of granular bentonite. Bentonite pellets will not be used as they do not hydrate properly if not continuously submerged. The seal will be 3 to 5 feet thick as measured immediately after placement without allowance for swelling. In wells where the screen is close to the ground surface, a minimum of 1 ft. of bentonite must be placed. Bentonite will be installed in 6-inch lifts. The bentonite will be tamped to prevent bridging and hydrated with water between lifts from the approved water source if placed above the water table. The bentonite seal will be allowed to hydrate, then a bentonite grout collar will be placed around the well. Bentonite grout will be placed above the bentonite seal to fill the remaining annulus. The preferred method for installing the bentonite seal is using a high yield strength bentonite, designed for monitoring well sealing, (such as Pure Gold™ or equivalent).

4.5.5 Grout Seal

A cement bentonite grout mixture will be placed in the annular space from the top of the bentonite seal to 3 feet bgs, where possible, to prevent possible damage to the well by frost heaving. Concrete will be added in the remaining annular space at the same time that the protection casing and concrete pad are installed. The bentonite grout will be mixed with a grout mixer in accordance with the instructions from the manufacturer. This cement bentonite grout will contain a minimum of 5 percent bentonite mixture within a Portland cement matrix.

A side-discharging tremie pipe will be used to place the grout mixture into the annular space until undiluted grout is at the required depth (i.e., 3 feet bgs).

4.5.6 Plumbness and Alignment

All risers and screens will be set round, plumb, and true to line. For non-DPT wells, the well assembly will be hung in the borehole prior to placement of the filter pack and not allowed to rest on the bottom of the hole so as to keep the well assembly straight and plumb. Centralizers will be considered in all wells greater than 20 feet in depth. Centralizers will be PVC or stainless steel and attached to the well casing by stainless-steel fasteners or strapping. Centralizers will not be attached to the well screen or the part of the well casing exposed to the granular filter or bentonite seal.

4.5.7 Well Completion Details

The monitoring wells will be completed as flush mount wells. The flush-mount completion will consist of a protective housing set flush to the ground surface surrounded by a 2-ft. by 2-ft. concrete pad with a slightly conical-shaped bottom. The inner casing will be a few inches bgs, and capped with a watertight locking cap. For each well, padlocks with a 2-inch steel shank and brass body will be provided. All wells will be keyed alike.

If above-ground protective well completion is requested by USACE, the steel protective casing will be placed within a cement concrete pad. A weep hole will be drilled in the base of the protective casing, just above the concrete pad, and a vented PVC well cap will be placed on the inner casing. Three steel protective posts set 4 feet from the well and 2 to 3 feet bgs in concrete will be installed equidistant around the locking protective casing outside the concrete drainage pad. These protective posts will be filled with concrete. The steel casing and steel protective posts will be painted with rust-inhibiting paint.

4.5.8 Well Identification

A metal identification tag will also be mounted on each well casing or in the concrete pad, if flush-mounted, indicating the well identification number, well depth, and date of installation. This information will be engraved into the tag. The tags will be labeled with an inscription pen and attached with rivets or bolts to the well casings or manhole caps.

4.5.9 Well Development

The purpose of well development is to reverse the damage done to the borehole wall due to drilling activities. Well development is designed to ultimately reach the objective of obtaining a groundwater sample, which has a turbidity value of 50 nephelometric turbidity units (NTU) or less. In order to attain this objective, each new permanent monitoring well will be developed no sooner than 48 hours and no later 14 days after grout placement. Development will be performed using either a bailer, surge block, or submersible pump as conditions allow, until the turbidity of the discharge is 50 NTUs or less. In addition to NTU, HGL will measure and record the pH, temperature, and conductivity. Development will be performed according to the procedures described below.

Equipment and supplies:

- Water level indicator,
- pH, temperature, conductivity, and turbidity meters,
- Precleaned, stainless-steel or Teflon® bailer,
- Surge block,
- Submersible pump, and
- 55-gallon drums (if determined necessary to containerize the development water [see Attachment C, IDW Management Plan]).

A Horiba U-22 Water Analyzer multi-meter can be used to measure pH, oxidation-reduction potential (ORP), dissolved oxygen, conductivity, turbidity, and temperature.

Development Procedures:

- Measure static water level,
- Measure total depth of well,
- Alternately pump and surge (or bail) until the turbidity is less than 50 NTUs, and a minimum of three times the volume of water lost to the subsurface during drilling and the well installation is removed. If the 50 NTU objective has not been reached upon 6 hours of continuous well development, the PM will be notified of the problem and a decision will be made on the appropriate action to be taken. If the well is purged dry during development, development will cease and the well will be allowed to recharge.
- The development record will include the following:
  - Physical characteristics of the development water (i.e., pH, temperature, conductivity, turbidity, color, odor, particulate matter) recorded at 5 to 10 minute intervals;
  - Total quantity of water removed;
  - Static water level before and after development;
  - A digital photograph documenting the final development water in a clear glass jar; and
  - Management of development water as described in Section 4.13.

Well development data will be recorded on the well development field form and in the field logbook. Well development field forms are shown in Appendix A.

4.6 PILOT STUDY INJECTION MONITORING WELL INSTALLATION METHODOLOGY

The pilot study injection monitoring well sets will be installed using DPT methods. The

individual wells will be constructed of ¾ inch or 1-inch, schedule 40 PVC and contain 10 feet of 0.010-inch slotted screen. The wells will be installed with pre-packed screens. The annular space will have a seal hydrated in placed above the pre-packed filter pack and a cement/bentonite grout will be place from the top of the seal to the ground surface. Flush mount surface completions will be placed over these wells as described in Section 4.5 of this FSP.

4.7 GROUNDWATER SAMPLING OF MONITORING WELLS

Low-flow groundwater sampling procedures will be used to collect groundwater samples; however, if low-flow sampling cannot be performed, a bailer will be used to collect the samples. Groundwater samples will not be collected from the permanent monitoring wells until at least 2 days have elapsed since the completion of well development. All groundwater samples will be sent to an off-site laboratory for analysis. In addition to laboratory analyses, field measurements will be collected at the wells during the sampling activities and recorded on field forms, as shown in Appendix A of this FSP.

4.7.1 Low-Flow Groundwater Sampling Procedures

Low-flow purging/sampling using a variable speed submersible bladder will be used to obtain groundwater samples from permanent wells installed during the investigation. The objectives and methods for this procedure are included in USEPA's Guidance document titled *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (USEPA, 1996). The goal of installing and sampling monitoring wells is to provide groundwater quality data that is representative of actual aquifer conditions with minimal alteration caused by inappropriate or variable sampling techniques. Groundwater purging/sampling will be performed a minimum of 2 days after the development of the newly installed wells. Typically, flow rates of 0.1 to 0.5 liters per minute (L/min) are used; however, this is dependent on site-specific hydrogeology (USEPA, 1996). The equipment and procedure for performing low-flow groundwater sampling of the permanent wells are identified below.

4.7.1.1 Low-Flow Groundwater Sampling Equipment and Supplies

- Variable speed submersible bladder pump and Teflon®-lined groundwater tubing;
- Water level indicator;
- Dissolved oxygen (DO), pH conductivity, and temperature probes (within a single unit); turbidity meter; and associated calibration solutions;
- Pre-cleaned glass containers, equipped with Teflon®-lined lids or septa and certified "clean" per Office of Solid Waste and Emergency Response Directive 9240.9-05

- Sample preservation solutions; and
- Cooler with ice to cool all samples to 4 degrees Celsius (°C).

4.7.1.2 Low-Flow Groundwater Sample Collection Procedure

- Purging/sampling will be performed using a variable speed submersible bladder pump. This equipment will be used for both purging and sampling.
- Measure depth to water table measurement and total depth of well will be taken with a water level indicator.
- The submersible bladder pump intake will be located in the middle or slightly above the middle screened interval so most of the water pumped out will be directly from the formation.
- Flow rates of 0.1 to 0.5 L/min will be used for purging. The well should be pumped at a rate where minimal drawdown during purging does not exceed 0.3 feet. Water quality measurements will be used as the basis for establishing the stabilization of the well water. These well stabilization parameters will include pH, specific conductivity, temperature, and turbidity. These parameters will be measured every 3 to 5 minutes until stabilization of all parameters is achieved. Stablization occurs when pH measurements remain constant within 0.1 standard unit, specific conductance varies no more than 10 percent, and the temperature is constant for at least three consecutive readings. An adequate purge is achieved when the pH, specific conductance, and temperature of the groundwater have stabilized and the turbidity has either stabilized or is below 10 NTUs (twice the primary standard of 5 NTUs). All measurements will be tabulated for comparison on the Field Sampling Report (Appendix A). Final measurements will be recorded in the sampling log book.
- If the water level drops more that 0.3 feet during purging, water level stability has not been established. In this case the well will be purged until it either goes dry or until 3 to no more than 5 well volumes are removed. If the well is purged dry, it will be allowed to recharge up to 24 hours, before which time the well will be sampled using the bailing procedures as described in Section 4.6.2. If 3 to 5 well volumes can be removed sample collection will continue as described below.
- Groundwater samples will be collected after the well has been purged. The VOC portion of the sample will be collected first. The sampling flow rate will be maintained the same as during the purging process to maintain equilibrium between the well and the formation.
- The collected samples will be preserved based on the required analysis (Table 4.1 of the QAPP).
- All samples will be labeled as described in Section 4.9.1.

- The samples will be placed immediately in a cooler with ice in order to maintain the sample temperature of 4 °C.

4.7.1.3 Field Measurement Procedures (Low-Flow)

DO, pH, temperature, ORP and conductivity will be measured using an in-line electronic multifunction meter. This unit automatically corrects for salinity at low DO reading by estimating salinity from temperature and conductivity measurements and then internally adjusting the DO reading.

Before use, field instruments will be checked for calibration. Calibration procedures for complex or sensitive instruments such as the PID or multifunction meter will be performed in accordance with the procedures recommended by the equipment manufacturer. These procedures will be performed on a daily basis unless the manufacturer's recommended interval is more frequent or experience dictates a shorter interval. The instruments will be rinsed with clean deionized water between each calibration. Used calibration solution will be discarded. Calibration, maintenance, and equipment usage will be recorded on the Instrument Calibration Form (Appendix A).

After calibration, the probe is fitted into the flow-through cell provided with the instrument, using the included mounting hardware. The line from the in-well submersible or bailer pump is attached to one of the barbed hose fittings on the flow-through cell. A drain line is attached to the other fitting, with the effluent directed to a bucket. Pumping is then started. The maximum flow rate will not exceed 0.5 L/min. All field measurements will be recorded and tabulated on the Groundwater Sampling Form (Appendix A). Final stabilization values will be entered in the logbook. The probes and flow-through chamber will be thoroughly rinsed with clean deionized water after use.

The turbidity meter, depending on the multi-function meter available, may be a separate meter. If a separate meter is used, the turbidity meter will be calibrated according to the procedures presented above. Samples for turbidity will be collected from the sample tubing effluent. The turbidity meter will be rinsed with clean deionized water between each calibration.

4.7.2 Bailer Sampling Procedures

Generally, low-flow groundwater sampling procedures will be used as previously described in Section 4.7.1. However, bailing procedures will be used in the event that a monitoring well is purged dry during a low-flow groundwater sampling attempt or is otherwise not conducive to low-flow sampling, such as when sampling a small diameter well. The equipment and procedure for performing bailer sampling of the wells are identified below.

4.7.2.1 Bailer Groundwater Sampling Equipment and Supplies

- Stainless steel or Teflon® bailers
- Nylon rope,

- Water level indicator,
- pH, conductivity, and temperature probes (within a single unit); turbidity meter; and associated calibration solutions,
- Pre-cleaned glass containers, equipped with Teflon®-lined lids or septa and certified "clean" per Office of Solid Waste and Emergency Response Directive 9240.9-05,
- Plastic sealable bags,
- Sample preservation solutions, and
- Cooler with packing material and ice to cool all samples to 4 °C.

4.7.2.2 Bailer Groundwater Sample Collection Procedure

Purging and sampling of monitoring wells will be performed using a bailer. If possible, the same bailer will be used for both purging and sampling. The procedure for purging and sampling a monitoring well using a bailer follows:

- Measure depth to water table and total depth of well with a water level indicator;
- Calculate the volume of water in the well to estimate required purge volume (minimum of three well volumes), (The volume per linear foot for the necessary well sizes should be provided in the Work Plan.);
- Lower the bailer into the water slowly to minimize disturbance to the groundwater;
- Measure water quality to be used as the basis for establishing the stabilization of the well water; however, at least three well volumes of water will be removed before purging is complete. These well stabilization parameters will include pH, specific conductivity, temperature, and turbidity. These parameters will be measured every half well volume of water until stabilization of all parameters is achieved. The purging will be considered complete after the field parameters have stabilized for three successive readings. The readings should be within approximately ± 0.1 for pH, ± 10 percent for specific conductivity and turbidity. All measurements will be tabulated for comparison on the sample collection field sheet (Appendix A). Final measurements will be recorded in the sampling log book.
- Collect groundwater sample following the well purging. The VOC portion of the sample will be collected first;
- Properly preserve the sample(s) as necessary;
- Label each sample as described in Section 4.9.1; and
- Immediately place sample(s) in a cooler with ice, and maintain sample temperature at 4 °C.

4.7.2.3 Field Measurement Procedures (Bailer)

The parameters pH, temperature, and conductivity will be measured using an in-line electronic multifunction meter. Before use, field instruments will be checked for calibration. Calibration procedures will be performed in accordance with the procedures recommended by the equipment manufacturer, and will be performed on a daily basis unless the manufacturer's recommended interval is more frequent or experience dictates a shorter interval. The instruments will be rinsed with clean deionized water between each calibration. Used calibration solution will be discarded. Calibration, maintenance, and equipment usage will be recorded on the Instrument Calibration Form (Appendix A).

The turbidity meter may be a separate meter or combined with the pH, temperature, and conductivity meter. Before use, the turbidity meter will be calibrated according to the manufacturer's specifications. The turbidity meter will be rinsed with clean water between each calibration.

All field measurements will be taken at the surface. Groundwater will be poured from the bailer into a suitable container capable of accommodating the measurement probes. All field measurements will be recorded and tabulated. The probes and associated cups will be thoroughly rinsed with clean water after use.

4.8 SURFACE WATER/SEDIMENT SAMPLING

Surface water samples will be collected from the MCA Barracks area pond. Discreet grab samples will be collected near the shore. Samples will be collected as close to the bottom as possible without allowing bottom sediment to enter the sampling chamber. Discreet (grab) sampling methodology is preferred over composite samples because compositing can mask the presence of contaminants by diluting isolated concentrations of analytes that may be present in the sample. Sampling procedures as described in USACE EM200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans*, 1994; and USEPA, Region 4, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, November 2001 will be followed.

A standard Kemmerer sampler will be used to collect the surface water samples. The Kemmerer sampler is a brass cylinder with rubber stoppers that leaves the ends of the sampler open while being lowered in a vertical position. It is a messenger-activated water sampling device that, in the open position, allows water to flow easily through the device. Once the device is lowered to the desired depth, the messenger is dropped down the sample line tripping the release mechanism and closing the container. In the closed position, the bottle is sealed at the top and bottom, isolating the sample during retrieval. The recovered sample will be transferred to the sample bottle by lifting the top stopper and pouring the contents into the sample bottles. If sampling can not be accomplished from the sampler standing on the shore, a small boat may be employed for this sampling effort. Sediment samples will be collected using a gravity corer as described in USACE EM 1110-1-18-04, section 10-5.

4.9 SAMPLE LABELING, PACKAGING, AND CUSTODY

The following subsections discuss the procedures that must be followed to properly identify samples and their associated analysis and the quality assurance of sample handling and temperature preservation of the samples.

4.9.1 Sample Labeling

All samples will be assigned a unique sample identifier. Field personnel will generate a label for each sample container that will contain the sample identifier, date of sample collection, the sampler's initials, analytical parameters, and type of preservation used. The sampler will initial any change in the label information prior to the sample collection.

A sample numbering system will be used to identify each sample collected and submitted for analysis. The purpose of the numbering system is to assist in the tracking of samples and to facilitate retrieval of analytical results. The sampling number will be used on sample labels, sample tracking forms, chain-of-custody forms (Appendix A), field log books, and for other applicable documentation. The field sample numbering system will follow the general format outlined below:

MCA-AABBB-(C-C)-DDDD

Where the characters represent the following:

MCA	=	Abbreviated Site Name
AA	=	Media Type
SO	=	surface soil
SS	=	subsurface soil
GW	=	groundwater
A	=	air
SW	=	surface water
SD	=	sediment
BBB	=	Sample number (all duplicate samples will be a 100 series number)
(C-C	=	Depth interval in feet of collected sample, if applicable (i.e. 8-10)
DDDD	=	Month and year of sampling event (i.e., August 2004 = 0804)

An example of a groundwater sample collected at 10-20 feet during May 2005 would be:
MCA-GW001-(10-20)-0505

4.9.2 Sample Packaging

Preservation reagents will be added to sample containers before or immediately after collection of the sample, as indicated in Table 4.1 of the QAPP. The samples will be labeled and immediately placed on ice and then maintained at 4°C during transport to the laboratory.

Sample containers will be placed inside sealed plastic bags as a precaution against cross-contamination caused by leakage or breakage. Bagged sample containers will be placed in coolers supplied by the laboratory in such a manner as to eliminate the chance of breakage during shipment. Ice in plastic bags will be placed in the coolers to keep the samples at 4°C throughout shipment.

Sample shipment will be performed in strict accordance with all applicable U.S. Department of Transportation regulations. The samples will be shipped to the laboratory by an overnight courier service. Arrangements will be made between HGL and the contract laboratory point-of-contact for samples that are to be delivered to a laboratory on a weekend so that holding times and cooler temperatures are not compromised.

4.9.3 Sample Custody

Sample custody will be maintained in accordance with the procedures specified in Section 6.0 of the QAPP. A sample is considered to be in custody under the following situations:

- The sample is directly in your possession;
- The sample is clearly in your view;
- The sample is placed in a locked location; or
- The sample is in a designated secure area.

In order to demonstrate that the samples and coolers have not been tampered with during shipment, adhesive custody seals will be used. The custody seals will be placed across the cooler lids in such a manner that they will be visibly disturbed upon opening of the cooler. The seals will be initialed and dated by field personnel when affixed to the container and cooler.

Documentation of the chain-of-custody of the samples is necessary to demonstrate that the integrity of the samples has not been compromised between collection and delivery to the laboratory. A chain-of-custody record to document the transfer of custody from the field to the laboratory will accompany each sample cooler. All information requested in the chain-of-custody record will be completed. In addition, the air bill number assigned by the overnight courier will be listed on the chain-of-custody record or the general logbook. One copy of the custody form will be retained by the samplers and placed in the project records file. The remaining pages will be sealed in a plastic bag and placed inside of the cooler. Upon receipt at the laboratory, the chain-of-custody forms will be completed and a cooler receipt form will be completed (Appendix A). It is the responsibility of the laboratory to document the condition of custody seals and sample integrity upon receipt.

4.10 FIELD DATA MANAGEMENT

HGL's management procedures for field and analytical data are described in the QAPP. The field team leader will be responsible for tracking samples during the field sampling program.

The field data includes the field measurements and other sampling notes. This information should be documented in the field logbook and/or sampling record sheets (Appendix A). Sample substitutions or modifications to a predetermined sampling scheme must be fully documented. The field team leader will generate weekly sample summary reports to document samples collected and any field modifications (Appendix A). Field survey coordinates will be provided after the field program and matched to the sample locations in the project database (Section 4.16).

Standard paper chain of custody forms will be used to communicate sample identifications and analytical requirements to the laboratory. Analytical results from the laboratory will be provided in both a hard copy and electronic file format. Data validation will be performed on all samples analyzed and appropriate qualifiers will be added to the electronic file. HGL will input the data derived from the field work and reports into a database that can be matched to the analytical data.

4.11 SLUG TESTING

To estimate hydraulic conductivity, slug tests will be conducted at select wells installed during the investigations at the MCA Barracks site. Both slug in (falling head) and slug out (rising head) tests will be performed unless the screen extends above the water table in which case only slug out tests will be conducted. Data will be recorded in the field using self contained data transducers. A laptop computer will download the transducer data in the field to check that the data was properly recorded. Computer software, such as AQTESOLV®, will be used to estimate the hydraulic conductivity. The Bouwer and Rice (1976) solution for an unconfined aquifer, available in AQTESOLV®, will be used to calculate hydraulic conductivity. The procedure for slug tests is as follows:

- A sand-filled and capped section of appropriate diameter of PVC casing will be used as a slug to be submerged in the well. The depth to water will be measured before testing. This depth will be used along with the well depth to determine which slug size is appropriate. The largest width and length of slug practicable should be used to obtain the maximum displacement of the water. A rope or cable will be sized so that the slug is submerged but will not hit the transducer probe. Water level, total depth, screen interval, slug size, and time of test start and finish will be recorded on data sheets for each well;
- A self contained data transducer will be used to monitor water level recovery. Prior to test initiation, the transducer will be placed near the bottom of the well or a few feet below the depth the slug will reach; and
- The slug will be lowered quickly into the well, and the transducer will record changes in water levels until 90 percent of the original static elevation has been achieved. After groundwater elevations have returned to static conditions, the slug will then be rapidly pulled from the well and readings will be collected with the data transducer again until the groundwater elevation recovers to 90 percent of the original static elevation. Water level elevations will be recorded

using linear readings timed at a 1 second measurement interval. The slug and transducers will be properly decontaminated between wells.

4.12 WATER LEVEL MEASUREMENTS

HGL will perform groundwater level measurements at the time of sampling. Additional water level measurements will be collected at the PM's discretion. Water level measurements will be collected on the north side of the riser pipe and will be accurate to the nearest 0.01 ft.. The total depth in each well will only be measured and recorded during the initial round of sampling. The water level probe end and tape will be decontaminated between each well. Decontamination will be performed by rinsing the probe end and tape with deionized water and wiping with a clean paper towel. If a nonaquaeous phase liquid is encountered, the probe and/or tape will be decontaminated by rinsing with a methanol solution followed by a deionized water rinse.

4.13 FIELD DOCUMENTATION

4.13.1 Field Log Books

During all site activities, field log books will be maintained to record information related to site activities, health and safety, level of protection worn and any upgrades, visitors to the site, sampling activities and locations and observations. Field log books will be bound volumes with sequentially numbered pages. No pages will be removed from the logbooks for any reason. If corrections are necessary, they will be made by drawing a single line through the original entry (so that original entry can still be read) and writing the corrected entry alongside it. The correction will be initialed and dated. Information to be recorded, if appropriate, will include, but is not limited to the following:

- Project name and number,
- Arrival and departure times,
- Personnel on-site and their affiliation,
- Date and time,
- Tasks for the day,
- Weather conditions,
- Site activities,
- Health and safety meetings and issues,
- Names and affiliations of visitors,
- Sample location (including field sketches, if appropriate),
- Sample number,
- Sample depth,
- Sample time,
- Number of aliquots,
- Media type,
- Air monitoring readings,
- Sampling personnel present,

- Personal Protection Equipment (PPE) level, clothing and equipment used,
- Analyses requested,
- Sample preservation,
- Associated QC samples,
- Decontamination procedures,
- Field observations,
- Photographic records, and
- Other project specific information.

All entries will be in ink with any corrections crossed out with a single line, initialed and dated. Each page of the logbook will be signed and dated at the bottom by each individual making an entry. The log books will be marked with the project number and the sequential number of the log book (i.e., Logbook #1, #2, etc.) using indelible, waterproof ink. At the completion of field activities, the log books will be maintained in the permanent project files.

4.13.2 Field Sample Collection Sheets

Field Sample Collection Sheets will be maintained by sampling personnel to supplement the field log book. An example of the field sheets to be used is provided in Appendix A. Copies of the sample collection field sheets will be hand delivered to the PM for review and distribution at the completion of each sampling event and will be maintained in the permanent project files.

4.13.3 Daily Quality Control Reports

Field data and pertinent QA/QC information will be recorded in Daily Quality Control Reports (DQCRs) during all field activities. A sample DQCR form is provided in Appendix A. DQCRs will be prepared, signed and dated by the field team leader. Copies of the DQCR sheets will be attached to the monitoring reports. If problems are encountered, HGL's PM will be notified by telephone and a copy of the relevant DQCR faxed as soon as possible for transmission to USACE's Technical Manager.

4.13.4 Photographic Documentation

A photographic record of all sampling locations will be prepared by the field team. New photographs will be obtained during subsequent long-term monitoring events only if site conditions change or new sample locations added. If film cameras are used, photographs and rolls of film will be numbered and recorded as appropriate in the field logbooks and on DQCR documentation, including identification of the subject of and area photographed. Digital images will be downloaded from the digital media to the digital project files (Section 4.11.5).

4.13.5 Project File

Project files will be maintained by HGL's PM and, after completion of field and analytical work will include the following project records, as a minimum:

- Project plans and specifications, if any,
- Field logbooks and data records,
- Photographs, maps and drawings,
- Sample identification documents,
- chain-of-custody records (copies),
- Analytical data package from the laboratory, including QC documentation,
- Data review notes,
- References and literature,
- Report notes and calculations,
- Progress and technical reports
- Correspondence and other pertinent information, and
- Authorizations (e.g., property access, well installation forms, etc.).

4.14 EQUIPMENT DECONTAMINATION

Decontamination of drilling and subsurface sampling equipment will be performed before and after each boring location. HGL will make arrangements with HAAF personnel to use an on-site decontamination pad, if one is available. Otherwise, the drilling subcontractor will construct a decontamination pad that will include a high-pressure steam cleaner and a wastewater collection system. Specific attention will be given to the drilling assembly and augers. Equipment or supplies that cannot be effectively decontaminated (e.g., sample tubing or rope) will be disposed of after sampling. Investigation/sampling equipment will be cleaned at the site before use, between sampling locations, and before transport off site. Decontamination of field equipment will be noted in the project logbook. If it is necessary to make decontamination procedural changes in the field, the changes will be noted in the logbook. Otherwise, a notation will be made each day that decontamination was conducted as specified in the project documents. Procedures for decontaminating investigation/sampling equipment that may be used at the MCA Barracks site as follows:

Drilling Rig and Equipment:

- High-pressure steam cleaning,
- Scrubbing with brushes if soil remains on equipment, and
- Steam rinsing.

All drilling equipment (i.e., split-spoon samplers, rods and HSAs) will be decontaminated before and after drilling each location. Once clean, no sampling equipment may touch the ground before use. Equipment must be stored on the drill rig, or on plastic sheeting.

Sampling Equipment will be decontaminated using the following procedure:

- Steam clean (drilling equipment only) or clean water rinse immediately after use;
- Detergent scrub with brushes (Alconox, Liquinox or equivalent detergent will be used);

- Clean water rinse (with a steam cleaner for drilling equipment);
- Double deionized water rinse;
- Air dry; and
- Cover (if not to be used immediately).

Teflon® implements used in the collection of samples for metals analysis will require the following decontamination procedure:

- Clean water rinse immediately after use;
- Detergent scrub with brushes (Alconox, Liquinox or equivalent detergent will be used);
- Clean water rinse (with a steam cleaner for drilling equipment);
- Double deionized water rinse;
- Air dry; and
- Cover (if not to be used immediately).

Submersible pumps and interior and exterior surfaces of pump hoses for all pumps used to purge groundwater wells will be decontaminated using the following procedure:

- Clean water rinse immediately after use;
- Detergent and tap water wash and flush
- Clean water rinse and flush;
- Deionized water rinse and flush; and
- Air drying.

Equipment that cannot be adequately cleaned will be discarded.

4.15 DISPOSAL OF INVESTIGATION DERIVED WASTE

IDW includes disposable equipment and PPE, purge and development waters, drilling fluids, soil cuttings, and decontamination fluids. All IDW will be handled in a manner consistent with USACE and USEPA guidance for managing IDW for site inspections (USEPA, 1991). IDW will be tracked, handled, stored, and disposed of in accordance with the IDW Management Plan included as Attachment C of the Work Plan.

4.16 SITE SURVEY

Select data points will be surveyed to aid map generation. New monitoring well and boring locations will be surveyed. All survey activities will be conducted by a certified land surveyor. The surveyed locations will be accurate to 0.1 ft. and elevations will be accurate to within 0.01 ft.. New monitoring wells will be measured for both top of casing elevation and ground surface elevation. Preferred coordinate system used will be State Plane NAD 1983 Feet. If another coordinate system is used it must be approved in advance by the SS.

4.17 PILOT STUDY

4.17.1 Design and Implementation

The primary objective for the pilot study is to determine the effectiveness and optimal implementation of the ERD remediation approach selected to provide a remedy for the site's TCE plume. The ERD substrate selected for injection at the site is designed to promote the anaerobic biodegradation of chlorinated solvents in groundwater to remediate the site's chemicals of concern (chlorinated hydrocarbons). The pilot study will utilize a proprietary substrate developed by Redox Tech, LLC, as the pilot study ERD substrate. The pilot study will provide the necessary data to design the full-scale implementation of the selected remedy.

A primary objective of the pilot study is the determination of an optimal substrate distribution and application spacing. Under-application of the ERD substrate may result in incomplete degradation of the chlorinated ethenes while, conversely, over-application of the ERD substrate will lead to an inefficient remedial design. Ultimately, for the full-scale implementation of ERD at the site, the locations of the lines of injection points, injection monitoring well spacing and substrate application quantities will be determined based on the results of the pilot study and associated groundwater characterization.

4.17.2 Site Conceptual Model and Pilot Study Assumptions

HGL's technical approach for performing the Pilot Study was based on the following key conceptual model elements:

- The Surficial Aquifer is approximately 50 feet deep at the HAAF site and predominantly consists of fine sand and silty sand with some laterally discontinuous clay and gravel beds.
- The depth to groundwater is approximately 5 feet at the proposed location of the pilot study area. Groundwater flow within the Surficial Aquifer exists under unconfined conditions and is dominantly to the northwest, although along the eastern edge of the site, groundwater flow appears to be primarily to the north.
- The hydraulic conductivity of the Surficial Aquifer ranges from 1 to 80 feet per day, with an average hydraulic conductivity of 10 feet per day. The hydraulic conductivity appears to be lower in the deeper portion of the aquifer.
- The average groundwater velocity at the HAAF site is approximately 280 feet per year.
- DO measurements indicate that the Surficial Aquifer is moderately aerobic at shallow depths (generally < 5 feet bgs) and becomes increasingly anaerobic with depth.
- Groundwater underlying the site is acidic, characterized by pHs typically below 6.0.

- TCE and its degradation products *cis*-1,2-DCE and VC occur throughout the much of the entire saturated thickness of the aquifer. *Cis*-1,2-DCE and VC concentrations increase with depth; the presence of these TCE degradation products indicate that anaerobic degradation is occurring.
- There is no evidence of dense nonaquaeous phase liquid.
- There is no evidence of soil contamination at the HAAF site and contaminant desorption from soil was not factored into calculating the ERD substrate requirement.

4.17.3 Enhanced Biodegradation Compound

The ERD substrate that will be injected into the subsurface for this Pilot Study is the compound ABC®. ABC® is a mixture of lactates, fatty acids, and a phosphate buffer. The ABC® solution contains soluble lactic acid as well as slow- and long-term releasing components (ethyl lactate and soybean oil). The phosphate buffer provides phosphates, which are a micronutrient for bioremediation. In addition, the buffer helps to maintain the pH in a range that is suited for microbial growth. The buffering agent is especially critical at the HAAF site, where the groundwater is acidic, and the pH is outside the range that is considered to be ideal for microbes that are active in the dechlorination process.

The injection program is designed so that the ABC® is consumed prior to reaching any surface water. The potential impact of ABC® on surface water would be elevated biochemical oxygen demand in the surface water and the subsequent effect on dissolved oxygen. However, the ABC® is readily metabolized (i.e. consumed) and it is diluted when it is injected. It would also be substantially diluted when it reaches the surface water, as long as the injection point is at least 50 feet from the surface water body. Based on the current pilot study configuration, the nearest surface water body is at least 300 feet from the pilot study area.

4.17.4 Pilot Study Injection

To stimulate reductive dechlorination at the pilot study site, ABC® will be injected through three temporary injection points placed perpendicular to groundwater flow. This will establish a pH-balanced anaerobic zone within the aquifer system that contains the required nutrients to promote anaerobic degradation. The spacing between injection points along an individual injection line will be approximately 40 feet. The 40-ft. spacing assumes a 20-ft. radius of influence (ROI).

The ABC® solution is mixed on site in a 500-gallon mixing tank that is mounted on an injection trailer. If lesser quantities of solution are required, 55-gallon drums will be used. Potable water from an on site source will be used to mix the chemical components. A Model 5410 Geoprobe® is used to advance casing and a proprietary 360-degree injection tool to depth. Once the target depth is reached (approximately 40 feet bgs), the injection nozzle is exposed by retracting the outer casing. After the nozzle is exposed, the substrate is injected via an air-operated diaphragm pump that is mounted on the injection trailer. Without stopping the injection, the injector is raised throughout the target injection zone.

In the case of HAAF, the target zone encompasses the entire saturated thickness of the aquifer within the pilot study area. The ABC® solution will be distributed evenly across the target injection zone and no preferential (targeted) injection will be performed. Based upon calculations assuming a 20-ft. ROI and 35 feet of saturated aquifer thickness, approximately 1560 gallons of substrate will be injected at each point. The injection quantities are provided on Table 4.1. The location of the pilot test and injection layout is illustrated on Figure 4.1. The injection point installation and injection methodology is discussed in Section 4.2.3. The injection pressure should range between 25 to 75 pounds per square inch. The injection flow rate will average approximately 8 gallons per minute during the injection process. The flow rate will be decreased if the ABC® solution begins to flow out of the borehole and accumulate at the surface. All components of ABC® are non-hazardous from an environmental viewpoint. Any material that reaches surface will be adsorbed.

4.17.5 Data Needs and Proposed Sampling

The performance of each treatment zone will be monitored using seven temporary shallow and seven deep performance monitoring wells. The treatment area will have an upgradient performance monitoring well cluster, three downgradient clusters, and two sidegradient clusters. The upgradient well cluster will be installed 60 feet upgradient of the centerline of the injection points. The upgradient placement is outside of the expected injection ROI and should provide representative influent groundwater data. The downgradient well clusters will be installed at 20, 60, and 90 feet downgradient of the respective injection point centerline. An existing well, XX-14, will comprise the shallow well of the well pair located 20 feet downgradient from the injection points. The sidegradient monitoring points will be placed at 10 and 15 ft. intervals from the northernmost injection point. These monitoring wells will be used solely to assist in determining the radius of influence by measuring changes in conductivity during the injection event. The downgradient spacing of the monitoring wells extends beyond the initial projected injection ROI, but within range of advective groundwater velocity travel time for the first post-injection monitoring event scheduled for approximately one month following the pilot study injection. Treated groundwater should reach the 60-ft. well cluster within six months of injection.

The well clusters will be constructed with shallow and deep wells screened at depths of 15 to 25 feet bgs and 30 to 40 feet bgs, respectively. These intervals were selected based on the results of historical groundwater profiling at the HAAF site. The well clusters used to evaluate the Pilot Study will be installed using direct push technology. The individual wells construction methodology is presented in Section 4.6 of this FSP.

Groundwater samples will be collected using low-flow sampling techniques (Section 4.6.1) and the groundwater will be analyzed for VOCs, electron acceptors (e.g., iron-field, manganese, nitrate, and sulfate), aquifer gases (ethane, ethane, and methane), alkalinity, and total organic carbons (TOC). Field parameters will also be collected including pH, DO, and ORP. Before implementing the ERD remedy, one round of sampling will be conducted to establish baseline conditions within the plume. Samples will be collected before injection, and then three months, six months, and nine months after injection. In addition to natural attenuation parameters and target VOCs, the samples will be analyzed for DNA to verify the presence of

the microbes required for complete reductive dechlorination of TCE. The analytical results will be incorporated into a Pilot Study summary and included in a Corrective Action Plan (CAP). The Pilot Study summary will contain an analysis of the injection effectiveness and include a discussion of optimal ABC® application rates and provide a recommendation on implementing the full-scale remediation.

4.17.6 Pilot Study Data Evaluation and Validation

All analytical data collected in conjunction with the pilot study will undergo an extensive data reduction, review, and reporting process (as described in the QAPP). Pilot study data validation will include a thorough review of all data documentation from the raw data to the reported results. The following types of data will be reviewed to verify that they are complete and support the reported values:

- Case narrative,
- Sample IDs,
- Sample receipt,
- General organic and inorganic reporting,
- Internal quality control reporting,
- Laboratory blanks (method and instrument blanks),
- Surrogate spike samples,
- Matrix spike samples,
- Laboratory duplicates and/or matrix spike duplicate pairs,
- Laboratory control samples, and
- Field replicates and field blanks.

Following completion of this review the project chemist will prepare a narrative report describing the data validation process and its results. Data qualifiers will be added to the analytical results report in accordance with USACE's Evaluation Guidance or USEPA's Functional Guidelines if the subcontractor laboratory did not already flag them. If data reported by the subcontractor laboratory are rejected, HGL will consult with USACE's Technical manager regarding appropriate corrective actions.

HGL will prepare a Quality Control Summary Report for the laboratory data after validation and prior to incorporation of the pilot test data into the Draft CAP. The Quality Control Summary Report includes a description of the laboratory's QC procedures and a data evaluation summary for each method performed.

Table 4.1
Pilot Study Injection Quantities

Parameter	Injection Parameters
Number of Injection Points	3
Radius of Influence (assumed)	20 feet
Treatment Interval	5 to 40 feet
Pounds of ABC® per Injection Point	3,348
Gallons of ABC® per Injection Point [1]	401
Weight % of ABC®- Water Mixture	25
Gallons of ABC®-Water Mixture per Injection Point	1560

[1] Specific Gravity of ABC® is 8.35 lbs per gallon.
Note: calculated volume of aquifer material per boring is approximately 43,982 ft^3 (20' ROI and 35' saturated thickness)

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5.0 REFERENCES

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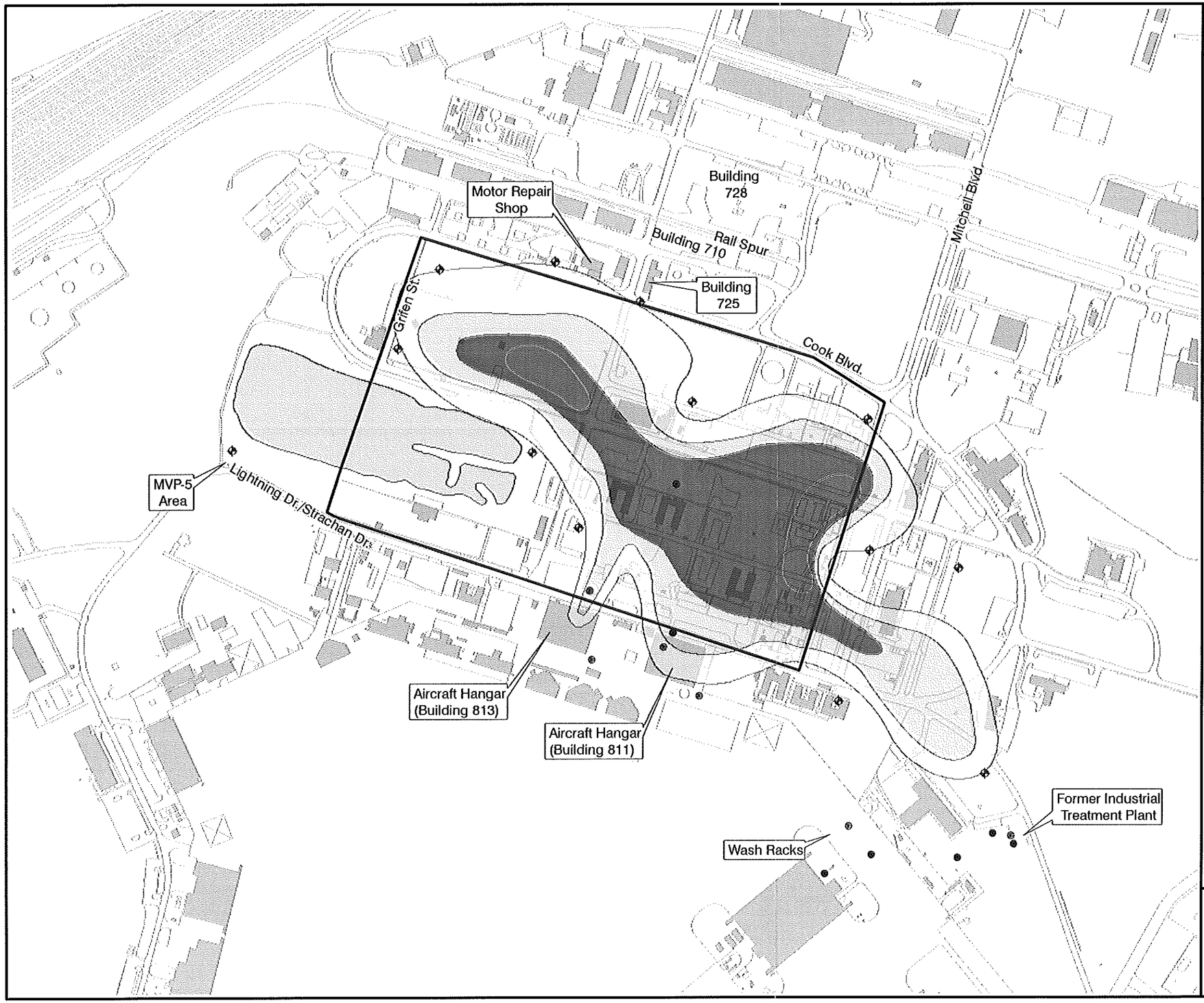
FIGURES

Figure 3.1
Proposed DPT Groundwater Sampling Locations

US Army Corps of Engineers
Savannah District



Legend

- Location of MCA Barracks Area
- Hunter Army Airfield Property Boundary
- Potential Source Area
- Pond
- Proposed DPT Groundwater Sampling Location (Source Assessment)
- Proposed DPT Groundwater Sampling Location (Source Assessment) (Single Sample)
- Proposed DPT Groundwater Sampling Location (Plume Delineation)

TCE Concentrations (µg/L)
(from 21-32 ft. bgs)

- 5 - 100
- 100 - 500
- 500 - 1000
- > 1000

N

0 200 400 800
SCALE IN FEET

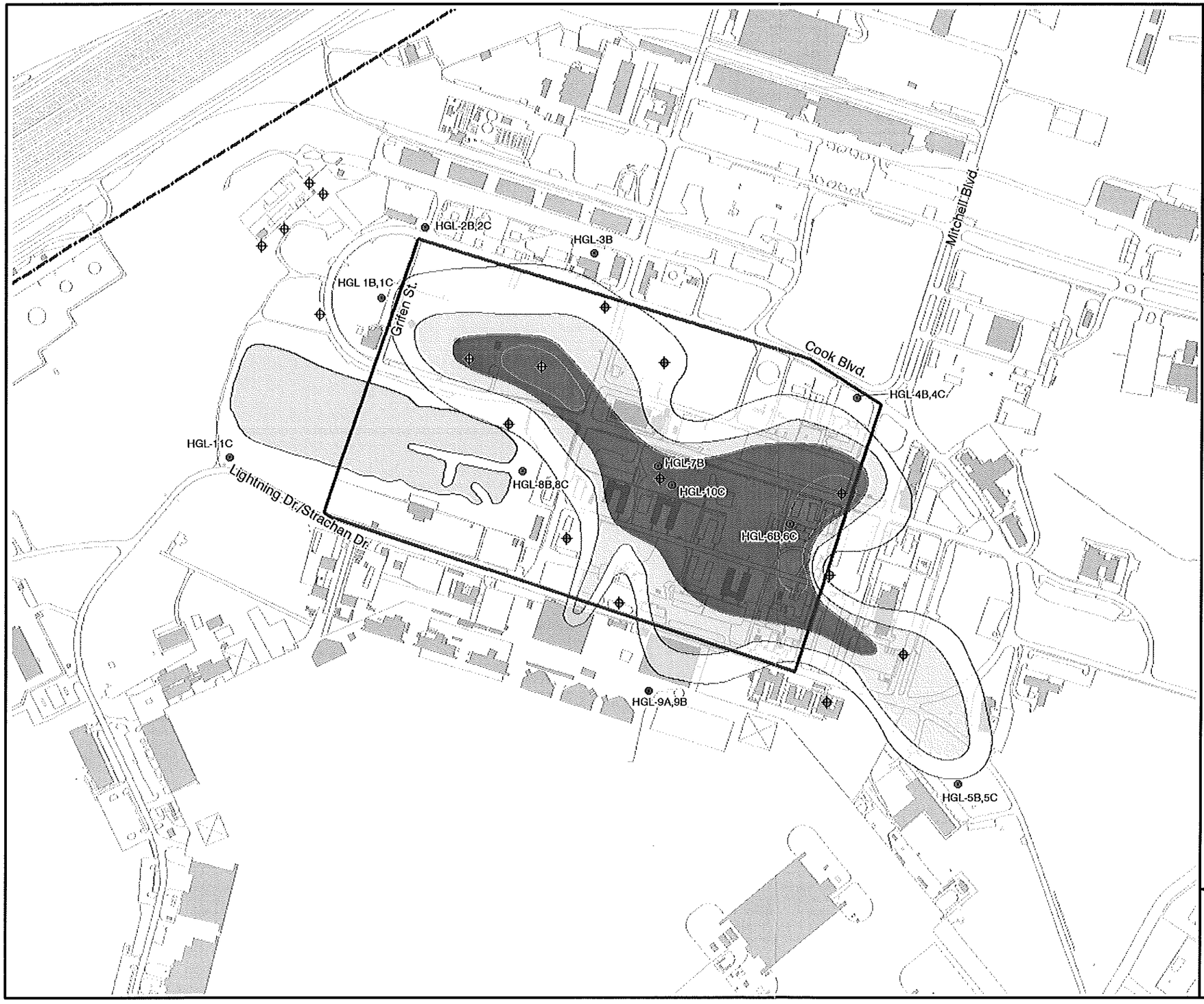
Filename: X:/OMA009/Hunter_AAF/Maps/Field_Samp_Plan/Prop_DPT_Locs.mxd
Project: OMA009-001-02-01-01
Revised: 09/26/05 ASC
Map Source: SAIC, USACE, Dec 2002-Sept 2003

HYDRO GeoLogic

HydroGeoLogic, Inc.—Field Sampling Plan
Hunter Army Airfield, Georgia

Figure 3.2
Proposed Groundwater Monitoring Wells

US Army Corps of Engineers
Savannah District



Legend

- Location of MCA Barracks Area
- Hunter Army Airfield Property Boundary
- Pond
- Existing Monitoring Well (Feb 2000)
- Existing Monitoring Well (Dec 2001)
- Proposed Monitoring Well Pair
- Proposed Monitoring Well Pair (optional)

TCE Concentrations (µg/L)
(from 21-32 ft. bgs)

- 5 - 100
- 100 - 500
- 500 - 1000
- > 1000

N

0 200 400 800
SCALE IN FEET

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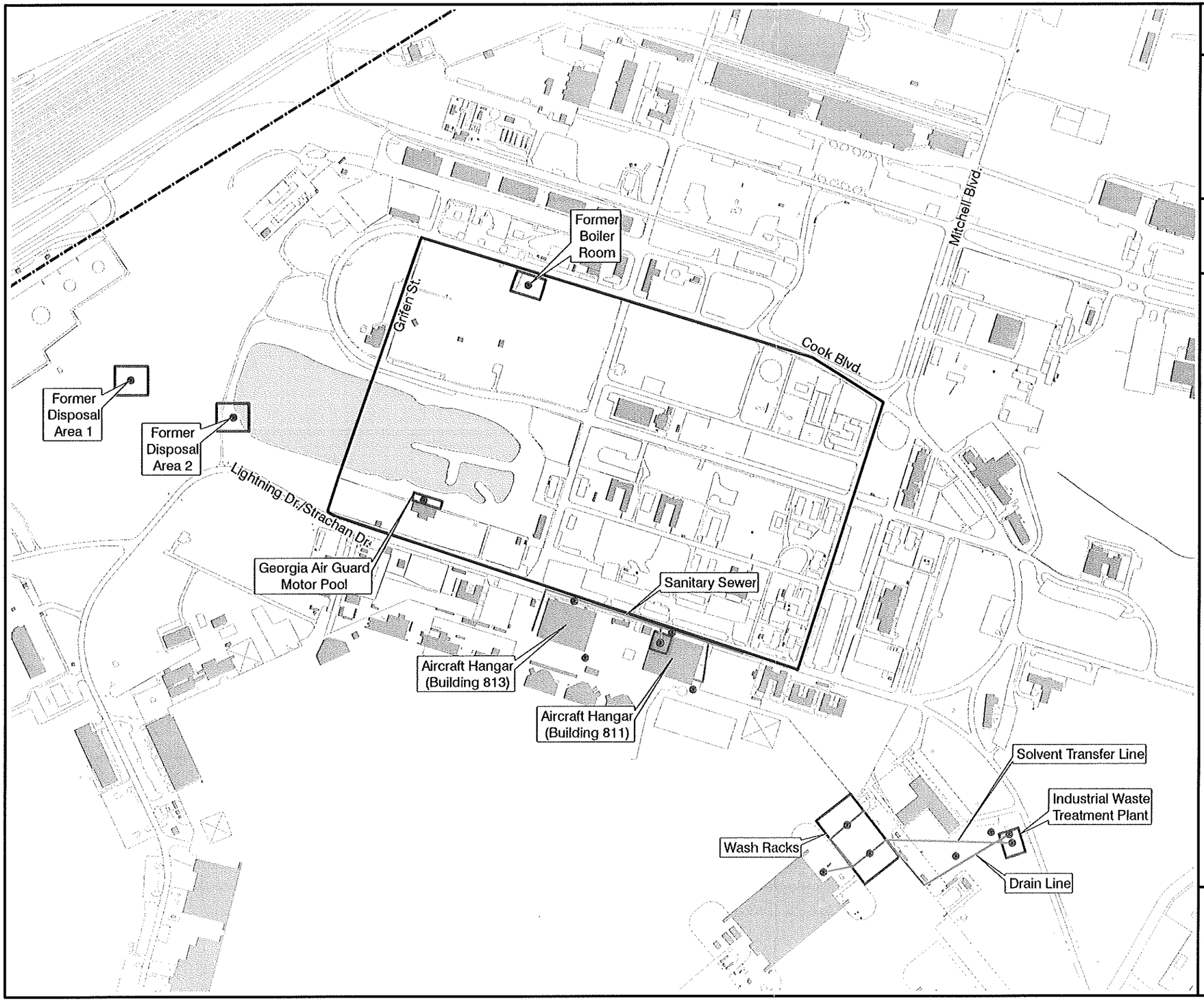
Project: OMA009-001-02-01-02
Revised: 09/26/05 ASC
Map Source: SAIC, USACE, Dec 2002-Sept 2003

HYDRO GeoLogic, Inc.

HydroGeoLogic, Inc.—Field Sampling Plan
Hunter Army Airfield, Georgia

Figure 3.3
Proposed Soil Sampling Locations

US Army Corps of Engineers
Savannah District



Legend

- Location of MCA Barracks Area
- Hunter Army Airfield Property Boundary
- Potential Source Area
- Pond
- Proposed Soil Sampling Point

N

0 200 400 800
SCALE IN FEET

Filename: X:/OMA009/Hunter_AAF/Maps/Field_Samp_Plan/Prop_Soil_Samp_Locs.mxd
Project: OMA009-001-02-01-01
Revised: 09/06/05 ASC
Map Source: SAIC, USACE, Dec 2002-Sept 2003

HYDRO GeoLogic Inc

HydroGeoLogic, Inc.—Field Sampling Plan
Hunter Army Airfield, Georgia

Figure 3.4
Pilot Study
Location Map

US Army Corps of Engineers
Savannah District

Legend

- Location of MCA Barracks Area
- Hunter Army Airfield Property Boundary
- Pilot Study Area
- Groundwater Flow Direction
- Monitoring Well (Feb 2000)
- Monitoring Well (Dec 2001)

TCE Concentrations (µg/L)
(from 21-32 ft. bgs)

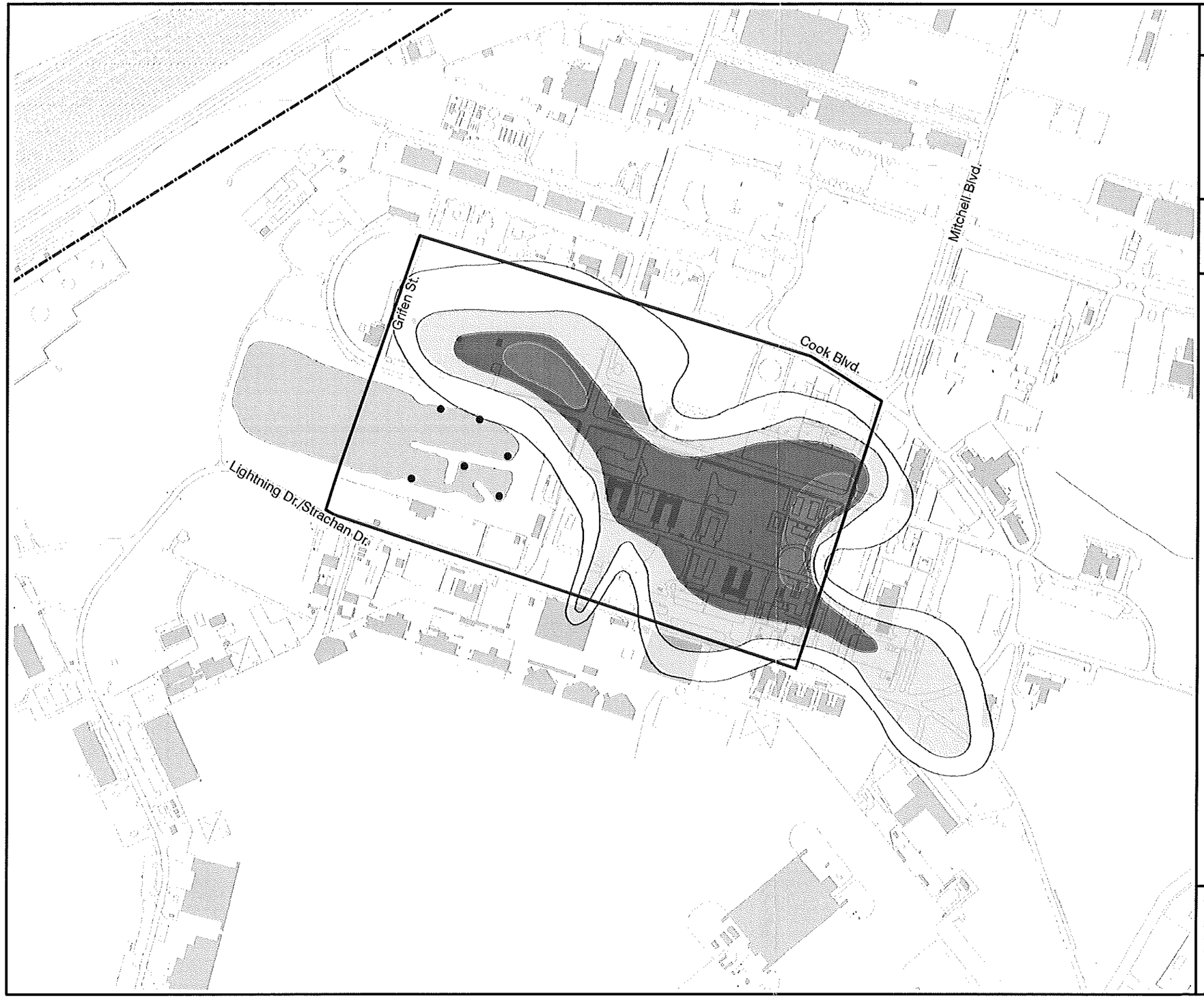
- 5 - 100
- 100 - 500
- 500 - 1000
- > 1000

N

0 125 250 500
SCALE IN FEET

Filename: X:/OMA009/Hunter_AAF/Maps/
Field_Samp_Plan/Pilot_Study_Loc.mxd
Project: OMA009-001-02-01-02
Revised: 09/08/05 ASC
Map Source: SAIC, USACE, Dec 2002-Sept 2003

HYDRO GeoLogic Inc



HydroGeoLogic, Inc.—Field Sampling Plan
Hunter Army Airfield, Georgia

Figure 3.5
Proposed Pond
Sampling Locations

US Army Corps of Engineers
Savannah District

Legend

- Location of MCA Barracks Area
- Hunter Army Airfield Property Boundary
- Pond
- Proposed Water and Sediment Sampling Location
- TCE Concentrations (µg/L) (from 21-32 ft. bgs)
  - 5 - 100
  - 100 - 500
  - 500 - 1000
  - > 1000

N

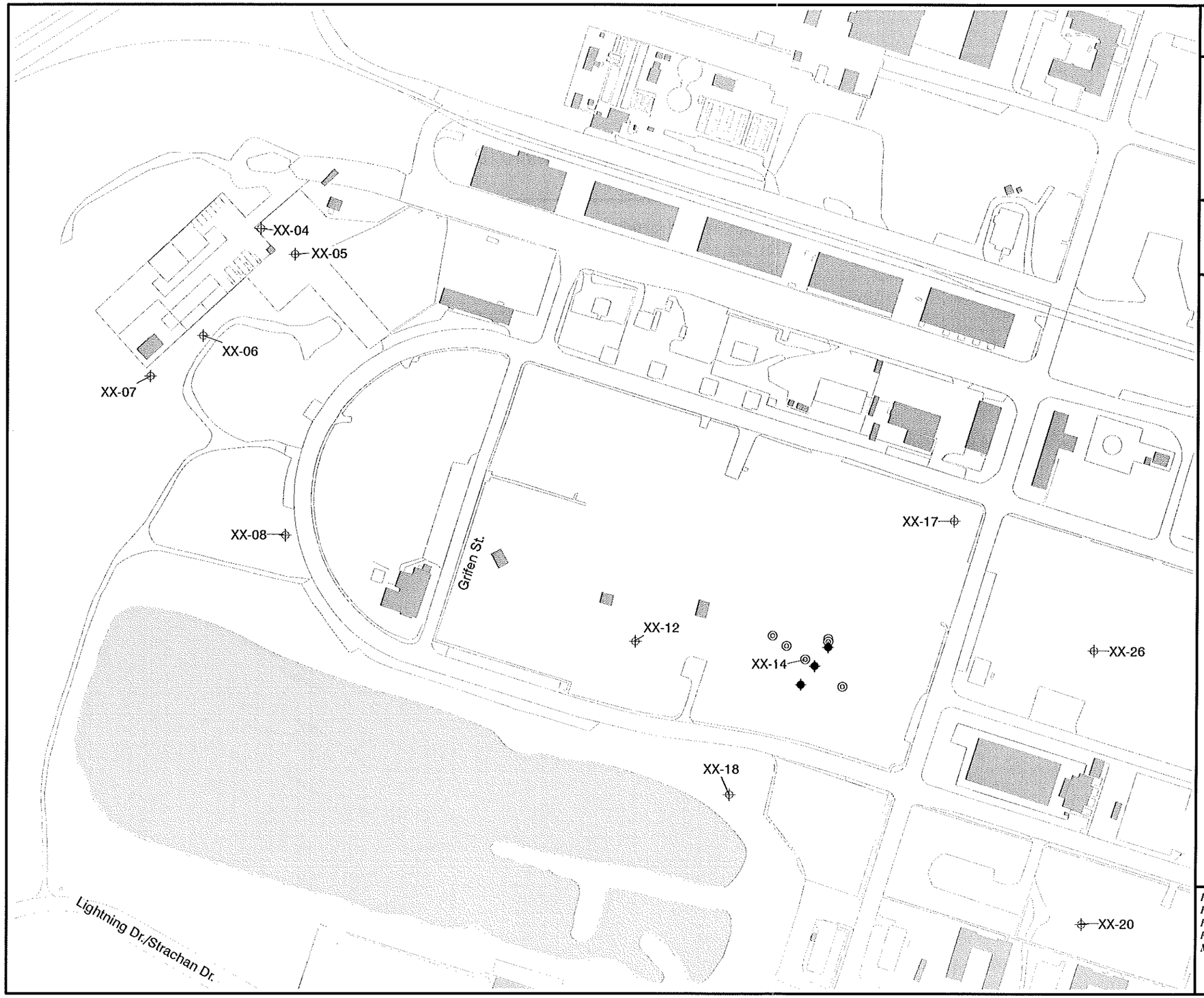
0 200 400 800
SCALE IN FEET

Filename: X:/OMA009/Hunter_AAF/Maps/Field_Samp_Plan/Prop_SS_Locs.mxd
Project: OMA009-001-02-01-01
Revised: 08/30/05 TB
Map Source: SAIC, USACE, Dec 2002-Sept 2003

HYDRO GeoLogic Inc

Figure 4.1
Pilot Test Injection and Monitoring Well Layout

US Army Corps of Engineers
Savannah District



Legend

- Existing Wells
- Proposed Pilot Study Injection Well
- Proposed Pilot Study Monitoring Well

N

0 85 170 340
SCALE IN FEET

Filename: X:/OMA009/Hunter_AAF/Maps/Field_Samp_Plan/Pilot-Test_MW_Layout.mxd
Project: OMA009-001-02-01-01
Revised: 09/19/05 ASC
Map Source: SAIC, USACE, Dec 2002-Sept 2003

HydroGeoLogic

APPENDIX A

FIELD FORMS

HYDRO GeoLogic INC.
Latham, NY
Voice: (518) 782-3435
Fax: (518) 782-3461

COOLER / SAMPLE RECEIPT FORM

Date cooler opened:_____ By:_____ HydroGeoLogic File No.:_____

Date entered into LIMS: _____ By:_____ HydroGeoLogic Order No.: _____

Cooler Identification: CAS cooler #: _____ / Client's Cooler / Box / Letter / Hand Delivered
Other: _____

Cooler Size: Small / Medium / Large / NA

Delivered By: UPS / FedX / AirBrn / Pny Exp / Field S / Mail / Walk-in / Other _____
Air Bill No.: _____

Custody Seal: Present (intact or broken) Absent Seal No.:_____
Seal matches Chain of Custody: Yes / No / NA

Type of Packing Material: Bluelce / Ice / Bubble / Foam / Paper / Peanuts / Vermiculite / NA

Cooler Temperature: (°C) 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 _____

Temp. By: Surface_____ Temp. Blank _____ Thermo. ID No.: _____

Sample Receipt Discrepancies: ☐ No ☐ Yes (See detail below)

☐ Chain of Custody not present

☐ Information obtained from:

Purchase Order / Letter received with samples

☐ Container label absent

☐ Chain of Custody incomplete

☐ Chain of Custody missing time sampled

☐ Time sampled obtained from container label

☐ Chain of Custody missing date sampled

☐ Date sampled obtained from container label

☐ Sample excluded from Chain of Custody:_____

☐ Broken or leaking containers: _____

☐ Sample listed on Chain of Custody not received:

☐ Sample description on container label different from Chain of Custody: _____

☐ Air bubbles in VOA vials:_____

Detailed description/comments:_____

Did Project manager contact client regarding cooler/sample receipt conditions: Yes / No
Who was contacted: _____ Remarks: _____

Reviewed by Project Manager: _____ Date: _____

CHAIN OF CUSTODY RECORD

HYDRO GeoLogic INC.
33 Century Hill Drive
Latham, NY 12110

Client:

Project Name/No.:

Project Manager:

Sampler:

Phone: (518) 782-3135 Fax: (518) 782-3461

SAMPLE IDENTIFICATION	DATE COLL.	TIME COLL.	GRAB	COMPOSITE	MATRIX: SOIL	MATRIX: WATER	MATRIX: OTHER	TOTAL NO. OF CONTAINERS	ANALYSIS REQUIRED	REMARKS OR SAMPLE LOCATION

APPLICABLE REGULATION
- RCRA
- ECRA
- CERCLA
- NPDES
- CWA
- SDWA
- OTHER

Special Instructions

Possible Hazard Identification
- Non Hazard - Flammable - Skin Irritant - Poison B - Unknown

Sample Disposal
- Return to Client - Disposal by Lab - Archive for _____ Months

Turn Around Time Required
- Normal - Rush

QC Level
- I - II - III

Project Specific (specify)

1. Relinquished by	Date	Time	1. Received by	Date	Time
2. Relinquished by	Date	Time	2. Received by	Date	Time
3. Relinquished by	Date	Time	3. Received by	Date	Time

Comments

FIELD CHANGE CONTROL LOG

PROJECT NAME SHEET ___ OF ___

PCR NO	DATE INITIATED	STATUS	WORK PLAN SECTION AFFECTED	REQUESTOR	DATE PCR APPROVED

FIELD SAMPLING REPORT

LOCATION: _____ PROJECT : _____

SITE: _____

SAMPLE INFORMATION

MATRIX _____ SAMPLE ID: _____

SAMPLING METHOD _____ DUP./REP. OF : _____

BEGINNING DEPTH _____ MATRIX SPIKE/MATRIX SPIKE DUPLICATE
YES ( ) NO ( )

END DEPTH _____

GRAB ( ) COMPOSITE ( ) DATE: _____ TIME: _____

CONTAINER		PRESERVATIVE/	EXTRACTION	ANALYTICAL	ANALYSIS
SIZE/TYPE	#	PREPARATION	METHOD	METHOD	

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR:	
2nd	ODOR:	
	OTHER:	

pH _____ Temperature _____ Dissolved oxygen _____ Specific Conductivity_____

GENERAL INFORMATION

WEATHER: SUN/CLEAR _____ OVERCAST/RAIN _____ WIND DRIECTION _____ AMBIENT TEMP _____

SHIPMENT VIA: FED-X _____ HAND DELIVER _____ COURIER _____ OTHER _____

SHIPPED TO: _____

COMMENTS: _____

SAMPLER: _____ OBSERVER: _____

MATRIX TYPE CODES

DC=DRILL CUTTINGS
WG=GROUND WATER
LH=HAZARDOUS LIQUID WASTE
SH=HAZARDOUS SOLID WASTE
SE=SEDIMENT
SL=SLUDGE
SO=SOIL
GS=SOIL GAS
WS=SURFACE WATER
SW=SWAB/WIPE

SAMPLING METHOD CODES

B=BAILER
BR=BRASS RING
CS=COMPOSITE SAMPLE
C=CONTINUOUS FLIGHT AUGER
DT=DRIVEN TUBE
W=SWAB/WIPE
G=GRAB
HA=HAND AUGER
H=HOLLOW STEM AUGER
HP=HYDRO PUNCH
SS=SPLIT SPOON
SP=SUBMERSIBLE PUMP

HYDRO GeoLogic

GROUNDWATER FIELD SAMPLING DATA SHEET

Well Name.:	Project Name:	LOCID:
Sampler(s):	Project No.:	
Well Depth:	Date:	Time:
DTW (ft TOC):	Screen Interval:	
Well Diameter (in):	Placement of Pump (ft TOC):	
Type of Pump:		

Field Parameters

Time	Depth to Water (ft)	Flow Rate (gpm)	Total Volume (gal)	pH	Temp. (C)	Cond. (umhos/cm)	ORP	D.O. (mg/L)	Turb. (N.T.U.)	Description

Observations

Notes:

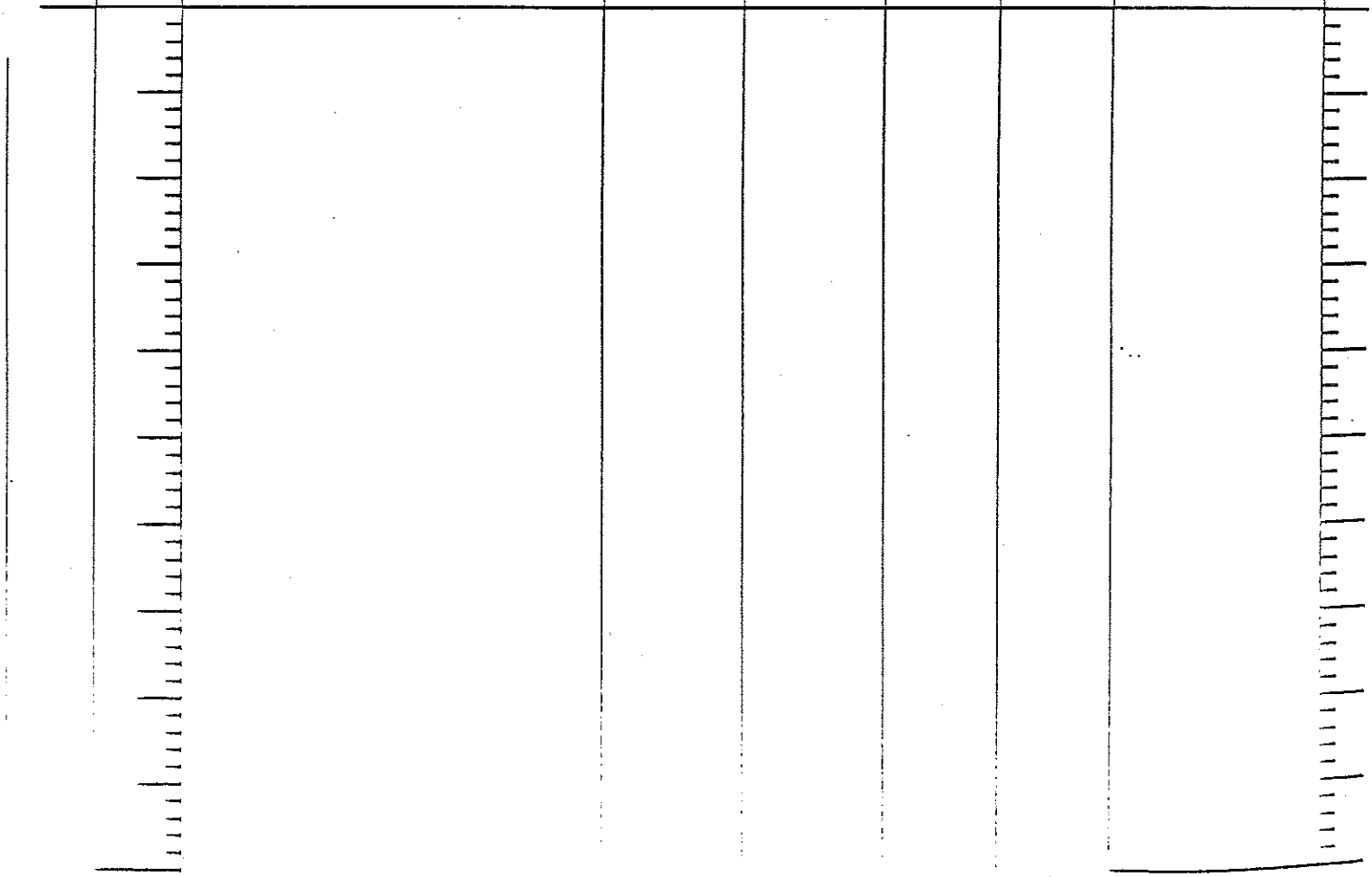
Signed: Sampler(s):

HTW DRILLING LOG

HOLE NO.		
1 COMPANY NAME	2. DRILLING SUBCONTRACTOR	SHEET 1 OF SHEETS
PROJECT	4. LOCATION	
5 NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
7 SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION	
	10. DATE STARTED	11. DATE COMPLETED
12 OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13 DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14 TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18 GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES			
20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR		

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h



PROJECT HOLE NO.

FORM
MRK JUN 89 55

HTW DRILLING LOG (CONT.)

PROJECT	INSPECTOR	HOLE NO.
		SHEET OF SHEETS

'LEV. a	DEPTH. b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h

HYDRO GeoLogic

BORING LOG

Borehole ID: _____
Sheet ____ of ___

AFIID		LOCID		
Project Name	Project Number	LTCCODE	Site ID	LPRCODE (IRPIMS)
Drilling Company ORL Code	Driller	Ground Elevation	Total Drilled Depth	EXCODE
Drilling Equipment	Drill/Excav Method / Borehole Diameter	Date/Time Drilling Started	Date/Time Total Depth Reached	
Type of Sampling Device		Water Level (bgs) First/Final	Site Name	
Sample Hammer Type / Driving Wt. / Drop		Hydrogeologist	Checked by/Date	SITEXREF

Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, mineralogy, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

HYDRO GeoLogic

BORING LOG (cont'd)

Borehole ID: _____
Sheet ____ of ____

Project Name	Project Number	Location

Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, mineralogy, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

HYDRO GeoLogic

MONITOR WELL PURGING FORM

PROJECT : _____ DATE: _____

LOCATION: _____ EXPLOSIMETER BOREHOLE READING _____

WELL ID: _____ PURGE VOLUME
(3 WELLBORE VOLUMES): _____ (L)

WELL DEPTH: _____

Time	Depth to Water (ft)	Flow Meter Reading	Volume Purged (L)	Temp. (°C)	pH	Electrical Conductivity (mmho)	Turbidity N.T.U	Comments

Note: Condition of the well: _____

pH - Calibrate at start and before last reading.

Sampler _____ Observer _____

HYDRO GeoLogic

MONITOR WELL STATIC WATER LEVEL FORM

PROJECT NAME: _____ DATE: _____

PROJECT NO.: _____

WATER LEVEL INDICATOR ID NO.: _____ FIELD BOOK NO.: _____

LOCATION: _____ PAGE NO.: _____

Monitor Well Name	LOCID	Time	Depth to Static Water Level (from T.O.C.)	Total Well Depth (ft)	Explosimeter Reading (above background)	PID Reading (above background)

Note: Total well depth to be measured at time of gauging.

Comments: _____

_____

_____

Sampler _____ Observer _____

WELL CONSTRUCTION (FLUSHMOUNT) DETAILS FORM

FIELD REPRESENTATIVE: _____

DRILLING CONTRACTOR: _____

DRILLING TECHNIQUE: _____
AUGER SIZE AND TYPE: _____

BOREHOLE IDENTIFICATION: _____
BOREHOLE DIAMETER: _____
WELL IDENTIFICATION: _____

WELL CONSTRUCTION START DATE: _____
WELL CONSTRUCTION COMPLETE DATE: _____

SCREEN MATERIAL: _____
SCREEN DIAMETER: _____
STRATUM-SCREENED INTERVAL (FT): _____

CASING MATERIAL: _____
CASING DIAMETER: _____

TYPE OF FILTER PACK: _____
GRADIATION: _____
AMOUNT OF FILTER PACK USED: _____

TYPE OF BENTONITE SEAL: _____
QUANTITY USED: _____

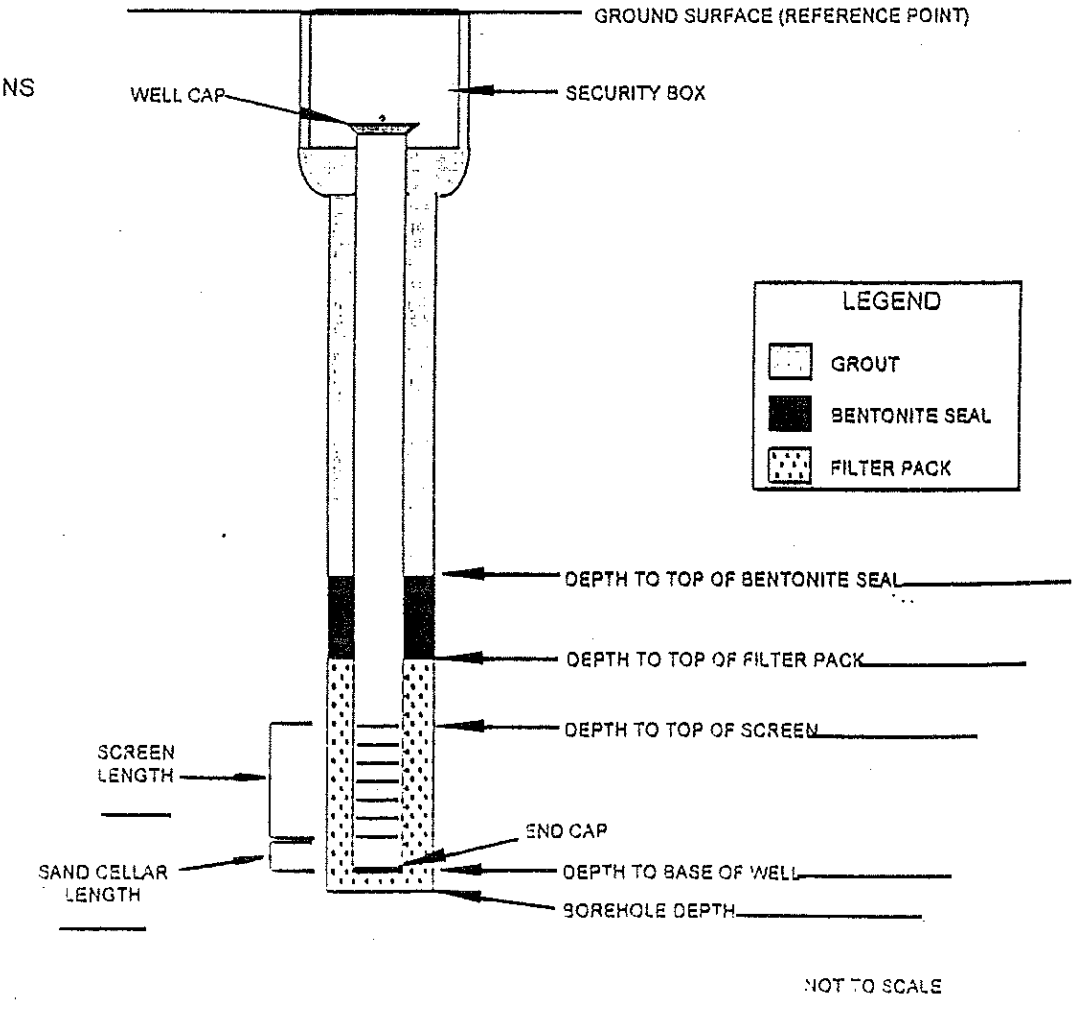
TYPE OF GROUT: _____
AMOUNT CEMENT USED: _____

DIMENSIONS OF SECURITY BOX: _____

TYPE OF WELL CAP: _____
TYPE OF END CAP: _____

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



INSTALLED BY: _____ INSTALLATION OBSERVED BY: _____

DISCREPANCIES: _____

WELL CONSTRUCTION (STANDARD) DETAILS FORM

FIELD REPRESENTATIVE: _____

DRILLING CONTRACTOR: _____

DRILLING TECHNIQUE: _____
AUGER SIZE AND TYPE: _____

BOREHOLE IDENTIFICATION: _____
BOREHOLE DIAMETER: _____
WELL IDENTIFICATION: _____

WELL CONSTRUCTION START DATE: _____
WELL CONSTRUCTION COMPLETE DATE: _____

SCREEN MATERIAL: _____
SCREEN DIAMETER: _____
STRATUM-SCREENED INTERVAL (FT): _____

CASING MATERIAL: _____
CASING DIAMETER: _____

TYPE OF FILTER PACK: _____
GRADIATION: _____
AMOUNT OF FILTER PACK USED: _____

TYPE OF BENTONITE SEAL: _____
QUANTITY USED: _____

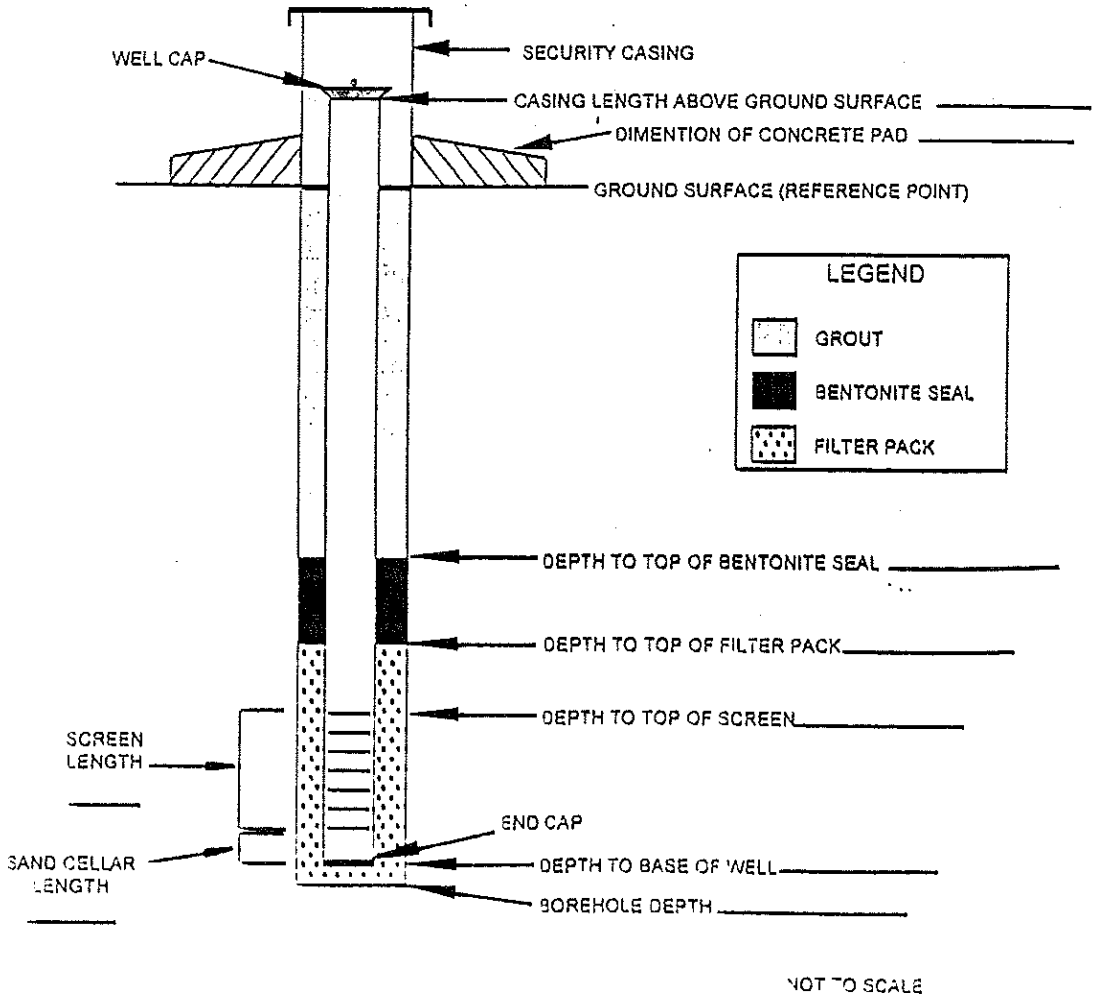
TYPE OF GROUT: _____
AMOUNT GROUT USED: _____

DIMENSIONS OF SECURITY CASING: _____

TYPE OF WELL CAP: _____
TYPE OF END CAP: _____

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: _____ INSTALLATION OBSERVED BY: _____

DISCREPANCIES: _____

HYDRO Geologic

WASTE INVENTORY TRACKING FORM

LOCATION : _____

PROJECT NAME: _____

ACTIVITIES: _____

Date Waste Generated	Activity Generating Waste (borehole # / well #)	Description of Waste	Field Evidence of Contamination	Estimated Volume	Type of Container (storage ID#)	Location of Container	Waste Characterization	Comments

Note: Describe whether soil or water samples have been collected for waste characterization, include date, if known.

Signature: _____

Well Development Log

Project: _____ Well No: _____

Project No: _____ Date: _____

Well Measurements

Casing I.D.: _____ inches

Well depth: _____ feet BTOC (before development) Borehole water volume: _____ gallons

Well depth: _____ feet BTOC (after development) Five (5) borehole volumes: _____ gallons

Depth to water: _____ feet BTOC

Casing Volume Information

Casing ID (inch)	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	10.0
Casing vol. (gal/ft)	0.04	0.09	0.16	0.37	0.65	1.0	1.5	2.0	2.6	4.08

Sampling Measurements

Date	Time	Water Level (feet BTOC)	Volume Removed (gallons)	pH	Sp. Cond. (µS/cm)	Temp. (celsius)	D.O. (mg/l)	ORP (mV)	Turbidity (NTU)	Comments (e.g. color, odor)

Development Method: _____

Notes: _____

_____

Equipment Identification Numbers

Water Level Indicator:

Water Quality Instrument:

DAILY QUALITY CONTROL REPORT

Date_____

	S	M	T	W	Th	F	S
Weather							
Temp							
Wind							
Humidity							

USACE PROJECT MANAGER:
PROJECT:

CONTRACT NUMBER:

Equipment Onsite:

Work Performed:

Signature:

Date_____

PROJECT:

CONTRACT NUMBER:

Quality Control Activities (including field calibrations):
Health and Safety Level Activities:
Problems Encountered/Corrective Action Taken:
Special Notes
Signature: Title:

HYDRO GeoLogic INC

STATIC GROUNDWATER ELEVATION LOG

Project Name: _____

Project No.: _____

Water Level Indicator ID#: _____ **PID Meter ID#:** _____

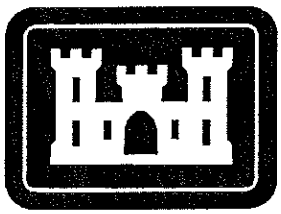
Well Identification	Date	Time	Static Depth to Water (from TOC)	Depth to Product (from TOC)	PID Reading	Comments

ATTACHMENT B

QUALITY ASSURANCE PROJECT PLAN

FINAL
QUALITY ASSURANCE PROJECT PLAN
MCA BARRACKS SITE
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

Prepared for



U.S. Army Corps of Engineers
Savannah District

Contract No. DACA45-03-D-0029
Delivery Order 001

September 2005

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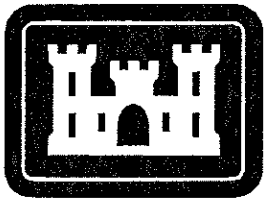
FINAL
QUALITY ASSURANCE PROJECT PLAN
MCA BARRACKS SITE
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA



Prepared for

U.S. Army Corps of Engineers
Savannah District
100 W. Oglethorpe Ave.
Savannah, GA 31401

Prepared by

HydroGeoLogic, Inc.
Northway 10 Executive Park
313 Ushers Road
Ballston Lake, NY 12019

September 2005

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS (continued)

Page

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AES	atomic emission spectroscopy
ASTM	American Society for Testing and Materials
AHA	Activity Hazard Analysis
BS	blank spike
BFB	Bromofluorobenzene
bgs	below ground surface
°C	degrees Celsius
CA	Corrective Action
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CH_4	converted to methane
CIH	Certified Industrial Hygenist
cis-1,2-DCE	*cis*-1,2-dichloroethene
CLP	Contract Laboratory Program
CO_2	carbon dioxide
COC	contaminant of concern
CSR	Compliance Status Report
DCE	dichloroethene
DO	dissolved oxygen
DoD	Department of Defense
DQCR	Daily Quality Control Report
DQO	data quality objectives
eV	electron volt
EM	Engineering Manual
ERD	enhanced reductive dechlorination
FE^{+2}	ferrous iron
FPRI	Fixed-Price Remediation with Insurance
FSP	Field Sampling Plan
GC/FID	gas chromatography/flame ionization detector
GC/MS	gas chromatography/mass spectrometry
GEPD	Georgia Environmental Protection Division
HAAF	Hunter Army Airfield
HCl	hydrochloric acid
HDPE	high density polyethylene

HNO_3	nitric acid
HGL	HydroGeoLogic, Inc.
HSR	Hazardous Site Response
HSRA	Hazardous Site Response Act
H_2SO_4	sulfuric acid
ICB	initial calibration blank
ICS	interelement check standard
ICP	inductively-coupled plasma
ICV	initial calibration verification
IDW	investigation derived waste
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LD	laboratory duplicate
LIMS	laboratory information management system
LQAM	Laboratory Quality Assurance Manual
LTM	long term monitoring
LTO	long term operations
MCL	maximum contaminant level
MDL	method detection limit
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
mL	milliliter
MNA	monitored natural attenuation
MS/MSD	matrix spike/matrix spike duplicate
MV	millivolts
NA	not analyzed
OCGA	Official Code of Georgia, Annotated
ORP	oxidation-reduction potential
%D	percent difference
%R	percent recovery
%RSD	percent relative standard deviation
PA	Program Administrator
PARCCS	precision, accuracy, representativeness, completeness, comparability and sensitivity
PCE	tetrachloroethene
PGM	Program Manager
PID	photoionization detector

PM	Project Manager
PMP	Project Management Plan
PPM	parts per million
PQL	practical quantitation limit
PRG	Preliminary Remediation Goal
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QCSR	Quality Control Summary Report
QSM	Department of Defense Quality System Manual for Analytical Laboratories
RIP	remedy in place
RL	reporting limit
RPD	relative percent difference
RRF	Relative Response Factor
RSK	Robert S. Kerr Environment Research Laboratory Method
SDG	sample delivery group
SHO	Safety and Health Officer
SOP	standard operating procedures
SPCC	system performance check compound
SS	Site Supervisor
SSHP	Site Safety and Health Plan
SSHO	Site Safety and Health Officer
TCE	trichloroethene
TOC	total organic carbon
TPP	technical project planning
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VC	vinyl chloride
VOA	volatile organic analysis
VOC	volatile organic compound

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FINAL
QUALITY ASSURANCE PROJECT PLAN
MCA BARRACKS SITE
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) is designed to provide specific guidance and quality assurance/quality control (QA/QC) requirements and evaluation criteria for the generation of environmental data of known quality for use in making site-specific decisions. HydroGeoLogic, Inc. (HGL) prepared this QAPP for the U.S. Army Corps of Engineers (USACE), Savannah District, under Contract Number DACA45-03-D-0029, Delivery Order 0001, in response to "Hunter Army Airfield (HAAF) Performance Work Statement Version 1.0 - 17 August 2004." This QAPP is intended to comply with Engineering Manual (EM) 200-1-2, Technical Project Planning (TPP) Process (USACE, 1998); EM200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 2001); and other applicable regulations and guidance documents.

The objectives of the work to be supported by this QAPP are characterized as the following:

- Suspected soil source areas;
- Establish baseline groundwater quality;
- Delineate the volatile organic compound (VOC) contamination in the groundwater at the MCA Barracks site ("the site");
- Determine the impact of groundwater contamination on a nearby surface water body;
- Complete the Compliance Status Report (CSR); and
- Implement the Corrective Action using a combination of enhanced reductive dechlorination (ERD) and monitored natural attenuation (MNA), in order to achieve a remedy in place (RIP) determination.

Once the RIP has been initiated, the remedy will be optimized by long-term operations (LTO)/long-term monitoring (LTM). The RIP will be performed in accordance with the requirements of the Georgia Department of Natural Resources, Environmental Protection Division (GEPD), Hazardous Site Response (HSR) Rules (Chapter 319-3-19), which were developed in compliance with the Hazardous Site Response Act (HSRA) promulgated in 1992 in the Official Code of Georgia, Annotated (OCGA), Section 12-8-90, et seq., as amended. This project will be performed as a Fixed-Price Remediation with Insurance (FPRI). A full

description of the site setting, background information, and investigation, and monitoring activities are presented in the Work Plan.

This QAPP is a dynamic document that may be updated as activities at the MCA Barracks site progress toward completion of the Corrective Action (CA) and evolve into LTO/LTM. This QAPP establishes the basic QC methodology to be applied during site activities and presents the task-specific information necessary to conduct the Site Investigation (SI), Corrective Action, and LTO/LTM. If any future phases of work require task-specific data quality objectives (DQO) and QC information, these will be incorporated into this QAPP by addendum.

2.0 DATA QUALITY OBJECTIVES

DQOs were developed to optimize and describe the data collection objectives for the SI, CA, and LTO/LTM activities at the MCA Barracks site. The DQO process, as described in the U.S. Environmental Protection Agency (USEPA) document *Guidance for the Data Quality Objectives Process* (USEPA, 2000), is subdivided into seven steps:

- State the problem;
- Identify the decisions;
- Identify inputs to the decisions;
- Define study boundaries;
- Develop decision rules;
- Specify limits on decision errors; and
- Optimize study design.

Each of the above steps is discussed in detail in the following sections. Due to the nature of the problem to be studied, some of the statistical components of the USEPA guidance document have been reduced or eliminated.

2.1 PROBLEM STATEMENT

Tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (*cis*-1,2 DCE), and vinyl chloride (VC) contamination has been found in groundwater (Surficial Aquifer) at the MCA Barracks site. The highest concentrations have generally been for TCE, which along with *cis*-1,2-DCE, are the primary contaminants of concern at the site. TCE concentrations have been detected at levels up to 3,700 micrograms per liter (μg/L). Subsequent environmental investigations performed at the site partially determined the lateral and vertical extent of contamination, but the extent of TCE and *cis*-1,2-DCE contamination has not been fully delineated. Although there is evidence that natural attenuation of TCE is occurring, the TCE concentrations are too high for MNA alone to be an effective response. The current problem has the following components:

- Investigate potential contaminant source areas;
- Fully define the extent of TCE and *cis*-1,2-DCE contamination in the shallow aquifer under the site (to non-detectable concentrations);
- Determine whether groundwater contamination has had an impact on a nearby surface water feature (man-made pond);
- Complete a Corrective Action to reduce the concentration of TCE and other chlorinated ethenes using a combination of ERD (TCE concentrations above 100 μg/L) and MNA (TCE concentrations of 100 μg/L or below);
- Conduct a Pilot Study to determine the optimal ERD substrate injection rate and injection point spacing; and
- Monitor the performance of the Corrective Action.

The following steps of the DQO process are presented under the assumption that the problem components will be addressed in the manner described in the project Work Plan with only minimal adjustment for field conditions. If the implementation of the Work Plan encounters unforeseen issues that will require significant deviations, future phases of work may require formulation of additional DQOs.

2.2 IDENTIFY THE DECISIONS

Decisions necessary to achieve the objectives of this project are related to assessing site conditions. These objectives include determining the source(s), configuration, and impact of the contaminant groundwater plume, determining hydrogeologic conditions at the site, and determining the effectiveness of the Corrective Action. Specifically, the project must address the following questions:

- What are the source(s) of the contamination at the site?
- Is there a continuing source of contamination?
- What is the vertical and lateral extent of chlorinated ethene contamination in the Surficial Aquifer under the site?
- Has the contamination in the Surficial Aquifer had an impact on a nearby man-made pond?
- What are the groundwater and aquifer conditions relative to the stability of the contaminant plume and what trends and temporal changes in concentrations are taking place?
- Are the groundwater contaminants degrading?

2.3 IDENTIFY INPUTS TO THE DECISIONS

The analytical chemistry data are the most critical inputs to all site decisions listed above. Analytical results from subsurface soil, groundwater, and surface water samples will be used in the formulation of every decision. If additional wells are installed, soil sample results from the installation process will also be included in the project data set.

An understanding of the geologic, hydrologic, and lithologic characteristics of the study area is essential for interpreting the results of the groundwater monitoring and water level data. While some data (from previous investigative activities at the site) are available, additional geologic, lithologic, hydrologic, and ERD Pilot Study data will be obtained prior to implementing the Corrective Action. These data will support most site decisions listed above.

2.4 DEFINE STUDY BOUNDARIES

The VOC contamination that is the focus of this project originated from past activities within the MCA Barracks site (discussed in the Work Plan). TCE is the contaminant that has been detected at the highest concentrations and across the greatest extent of the aquifer. TCE and *cis*-1,2-DCE are the primary contaminants of concern (COC) at the site. The plume

"footprint" that will be used to define the lateral boundaries of groundwater contamination will be the contour of those COC concentrations that exceed the compound-specific Target Concentrations presented in Appendix III, Table 1 of the HSR Rule or exceed the additive values exceeding the concentration allowable under Section 391-3-19-.07(6)(b) of the HSR Rule.[1]

The COC contamination has been identified only in the Surficial Aquifer at the site. This shallow aquifer ranges from approximately 2 to 50 feet below ground surface (bgs). Below the Surficial Aquifer is the Miocene age Hawthorn Group, which consists of an approximately 160 foot thick layer of phosphatic clay. The Hawthorn Group serves as a confining layer and restricts the movement of water and contaminants from the Surficial Aquifer to the Floridan Aquifer, which underlies the Hawthorn Group. The vertical distribution of COCs is bounded by the Hawthorn Group confining unit.

2.5 DEVELOP DECISION RULES

There are four rules regarding the application of data in reaching decisions:

1. Only analytical data that have been reviewed or validated and identified as acceptable, in accordance with this QAPP, may be used to support a decision. *Rationale*: Data of unacceptable quality may have biases or more serious issues (false positive or false negative results) that could contribute to decision errors. Project completeness goals (see Section 4.4.3) have been developed in order to ensure that the overall data set will be of sufficient quality to support project decisions.
2. Whenever duplicate samples are collected, the maximum concentration found in the duplicate pair will be the value used in supporting a decision. *Rationale*: Using the higher concentration to support a decision is a conservative approach; any error or bias that results from this approach will result in decisions that are more protective or will over-estimate risk to the public and the environment.
3. When multiple samples are collected from a well (as in vertical interval sampling), the maximum concentration will be the value used in supporting a decision relating to lateral extent of contamination. *Rationale*: This decision rule supports the same conservative approach as Decision Rule 2.
4. Non-detected analytes will be reported with the associated practical quantitation limit (PQL). *Rationale*: This approach is consistent with the approach presented in the HSR Rule and with the USEPA Region IV *Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services* (USEPA Region IV, 1999).

[1] The HSR Rule does not present a Target Concentration for *cis*-1,2-DCE, and the Federally established Maximum Contaminant Level (MCL) of 70 µg/L (from the Clean Water Act) will be used as the Target Concentration for that compound.

Specific decisions will be based on the following rules:

1. *Where are the source area(s) for the COC contamination? Is there a continuing source of contamination?* Contamination source(s) will be identified by evaluating the concentrations determined by the analytical results of the subsurface soil samples.
2. *What is the vertical and lateral extent of COC contamination?* The presence of TCE or other COCs at a concentration greater than the applicable Target Concentration (or additive value) will define the extent of contamination.
3. *Has the plume of COC contamination had an impact on the nearby pond?* The contaminant plume will be considered to have had an impact on the nearby pond if any of the samples collected from that pond show detections of any COC.
4. *What are the groundwater and aquifer conditions relative to the stability of the contaminant plume and what trends and temporal changes in COC concentrations are taking place?* Historic and current sampling results will be used to identify and define temporal changes and trends in groundwater quality. Likewise, measured water levels will be examined to identify temporal changes or trends in the saturated thickness of the aquifer. Where sufficient data exists, statistical analysis may be applied to quantify the uncertainty surrounding the decision. Decisions based on statistical analysis of water quality or water level data will be compared against the predicted impact(s) of lithologic and biodegradation/attenuation characteristics to ensure consistency.
5. *Are the groundwater contaminants degrading?* The presence and concentrations of TCE degradation products (*cis*-1,2-DCE, VC, and ethene/ethane/methane), natural attenuation indicators (e.g., total organic carbon [TOC], anions, dissolved metals), and volatile fatty acids will be used as indicators for degradation (both by ERD and natural attenuation) of TCE (and PCE, to a lesser extent) in the groundwater.

2.6 SPECIFY LIMITS ON DECISION ERRORS

The statements below describe the null hypotheses for this project.

- Insufficient information exists to determine the source(s) of the COC plume, or data indicating that contaminants have been depleted from the historical source area(s).
- Concentrations of VOCs in groundwater exceed the Target Concentrations.
- TCE concentrations are above 100 μg/L.
- Surface water has been impacted by the contaminant plume.
- The remedy is not decreasing COC concentrations at the site.

Decision errors may occur through two scenarios.

- A false acceptance decision error would be to conclude that the null hypothesis is true, when in fact, it is not. The consequences of this decision error would be to incur unnecessary expense to study, monitor, and remediate contamination that does not exist or would be better addressed by MNA. In the case of a false acceptance of the hypothesis that TCE is not degrading, additional unnecessary expense would be incurred in optimizing the remedy when it is in fact performing satisfactorily.
- The second type of decision error is a false rejection error. In that case, the error would be to assume that a measured concentration is not above the relevant level (the Target Concentration for COCs or the 100 μg/L of TCE which is the action level for ERD) when, in fact, it is. The consequences of this decision error would be to not study, monitor, or remediate the full extent of contamination.

Both types of errors are limited by the decision rules. Decisions are not based on a single data point, but rather on the entire body of data available. Consequently, a large number of data errors would have to occur across several locations to bias the decision towards a false acceptance or false rejection conclusion. A decision error is possible at individual data points for a specific sampling event; however, the probability of simultaneous occurrences of error at a large number of measuring points and over an extended period is very low. The requirement that decisions be based only on data that have been accepted through the data review and validation process also serves to limit the occurrence of decision errors. Based on the approach to accepting and incorporating data, there is a low probability that overall project objectives will be individual decision errors.

2.7 OPTIMIZE THE STUDY DESIGN

Previous site investigations have provided evidence that natural attenuation is already occurring at the site. The planned ERD remediation will be performed only in those areas where the TCE concentration is above 100 μg/L. This will ensure that the most contaminated portions of the plume are addressed while allowing more cost-effective MNA to be employed in those areas of lower contamination. Before performing full-scale injections of ERD substrate, HGL will perform a pilot study to optimize the delivery system, quantity, and composition of the ERD substrate, which will ultimately be injected into the Surficial Aquifer.

Data from each phase of work at the site, including the LTM events, will be evaluated to determine whether changes in the sampling or analytical methodology are warranted. If it is decided that changes are warranted, the changes will be incorporated into this QAPP by addendum, as appropriate.

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3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

3.1 RESPONSIBILITIES OF KEY PERSONNEL

The organizational structure and responsibilities defined below are designed to ensure adequate project control and proper QA for investigation, remediation, and monitoring activities at the site. The contact information and necessary communication channels are discussed in full detail in Section 5.0 of the Project Management Plan (PMP). The project organizational chart is presented as Figure 5.3 of the PMP. Key project personnel include:

- Don Jones, P.E., V.P., Program Manager (PGM)
- Eric Evans, P.G., Project Manager (PM)
- Kirk Switzer, Program QA/QC Manager
- Ken Rapuano, Kimberly Evers, Jie Lou, Chemical Data Management Team
- Mary Ann Heaney, Corporate Safety and Health Officer (SHO)
- Mike Jackson, P.G., Site Supervisor (SS)/Site Safety and Health Officer (SSHO)
- Project Staff

3.1.1 Program Manager

HGL's PGM, Mr. Don Jones, is responsible for the overall execution of this project. The PGM has overall corporate responsibility and authority for the project, including but not limited to scheduling, cost controls, and technical quality. He has the authority to commit the necessary corporate personnel and equipment resources to assure that project objectives are met.

3.1.2 Project Manager

HGL's PM, Mr. Eric Evans, is the prime point of contact for response actions at the MCA Barracks site. The PM coordinates the work of all HGL staff and subcontractors in the successful accomplishment of this Delivery Order, and is the single point of contact with USACE technical staff. The PM also is responsible for assuring that all policies and procedures required by the FPRI contract are followed during the execution of all project work.

The PM reviews all documents, reports and technical memoranda prepared by HGL and its subcontractors that are relevant to completing the remediation goals of the MCA Barracks site. The PM also is responsible for establishing and maintaining the project schedule and budget, and coordinating the preparation of all project deliverables. Along with regulatory agencies, the PM certifies and approves project milestones, deliverables, and invoices. The PM also interfaces directly with the public, as requested by USACE, which has primary responsibility for community relations and public outreach.

3.1.3 Program QA/QC Manager

The QA/QC manager, Mr. Kirk Switzer, reviews, evaluates, and approves all planning documents in accordance with HGL's corporate guidelines and procedures. He also serves as the point of contact for all QA matters for this project and verifies that appropriate corrective actions are taken for all identified instances of nonconformance.

In addition, it is the QA/QC manager's responsibility to ensure that the QC procedures are comprehensive, complete, and rigorously adhered to by HGL. The QA/QC manager reviews and revises QA manuals, guidelines, and instructions used by HGL.

3.1.4 Chemical Data Management Team

The project chemical data management team will consist of the Project QC Chemist (Mr. Ken Rapuano), Assistant Chemist (Ms. Kimberly Evers), and the Database Manager (Ms. Jie Lou). The Project QC Chemist will have overall responsibility for implementing the requirements of this QAPP and for ensuring that all data obtained from project activities are capable of supporting the DQOs. The Project QC Chemist will serve as the chief point of contact for all issues relating to laboratory performance and will coordinate with the laboratory Project Manager to ensure that the laboratory is performing all work in accordance with the QAPP. The Project QC Chemist will also provide overall technical guidance to the chemical data management team on an as-needed basis, will perform senior reviews of all data validation reports. Following the completion of data validation and data qualification in the database, the Project Chemist will produce technical evaluations of the chemical quality associated with each sampling event for inclusion in the sampling event data report. The Assistant Chemist will perform data validation and data qualification. The Database Manager will create and maintain the project database, and will ensure that the database is organized in a fashion that can be queried to support project data reporting needs. The Assistant Chemist will assist the Database Manager in ensuring that all data included in the project database are accurate, match the laboratory hardcopy data reports, and are correctly qualified.

3.1.5 Corporate Health and Safety Officer

The Corporate SHO, Ms. Mary Ann Heaney, is responsible for program-level implementation of the Site Safety and Health Plan (SSHP).

3.1.6 Site Supervisor/Site Safety and Health Officer

The SS/SSHO, Mr. Mike Jackson, P.G., reports to the PM and is responsible for field enforcement of the SSHP. The SS will serve as the SSHO for this project. The SS will inform the Corporate SHO and PM of any changes to the work plan before implementation, so that any safety and health issues introduced by those changes can be addressed properly.

In addition to field enforcement of the SSHP, the SS is responsible for coordinating all site activities with the PM, laboratory, and on-site subcontractors. The SS will provide the necessary orientation, training, direction, and supervision to all field personnel. The SS

ensures the use of calibrated measurement and equipment, as well as manages all field documentation. All sampling operations will be monitored by the SS to ensure the sampling team members adhere to the Field Sampling Plan (FSP).

Other responsibilities of the SS include:

- Assuring that all field personnel on the project read and sign the SSHP;
- Contacting the Corporate SHO if changes to an Activity Hazard Analysis (AHA), or developing a new AHA as needed;
- Assuming the duties of the SHO if directed to do so by the SHO;
- Overseeing technical execution of field sampling activities;
- Providing all required supplies, equipment, and tools before initiation of each task;
- Ensuring employees maintain required training and medical monitoring throughout the project; and
- Monitoring that the equipment is properly calibrated and used, and that the results are properly recorded and filed in accordance with SSHP requirements.

Other responsibilities include:

- Requiring that the SSHP is read and signed by all field personnel on the project, including subcontractors;
- Contacting the Certified Industrial Hygenist (CIH) if changes to an AHA, or developing a new AHA as needed;
- Assuming the duties of the SHO if directed by the SHO;
- Overseeing technical execution of field sampling activities;
- Providing all required supplies, equipment, and tools prior to initiation of each task;
- Ensuring employees maintain required training and medical monitoring throughout the project; and
- Monitoring that the equipment is properly calibrated and used, and that the results are properly recorded and filed.

3.1.7 Project Staff

Each project staff member will report to the PM and inform the PM of completed project activities. Members of the project staff are responsible for understanding and implementing the QA/QC Program, as it applies to their assigned project activities.

3.2 QUALIFICATIONS OF PERSONNEL

All personnel assigned to the project, including employees and consultants, will be qualified to perform the task to which they are assigned.

Appraisal of the qualifications of technical personnel assigned to the project will be made by the PM. The appraisal will include the comparison of the requirements of the job assignment with the relevant experience and training of the prospective assignee; it will also include a determination whether further training is required and, if required, by what method. On-the-job training is an acceptable method, provided such training is provided by a person qualified to perform the trainee's assignment and the results of that training are documented.

All documents concerning qualification appraisal will be stored in the project files.

3.3 PROJECT LABORATORIES

The primary point of contact at project laboratories will be the laboratory PM. The laboratory PM will coordinate the functions of the various laboratory sections, including sample receiving, analytical groups, report preparation, database management, and QA/QC to ensure that the analytical data delivered to HGL meet the project quality objectives and meet HGL's expectations for timeliness, completeness, and cost-effectiveness. Should issues arise that cannot be resolved by the Laboratory Manager, the laboratory Operations Manager and QA Manager will be responsible for assisting the laboratory PM.

4.0 QUALITY CONTROL OBJECTIVES

The overall QC objective for this project is to develop and implement procedures for sample collection; laboratory analyses, field measurement, and reporting that will provide data of a degree of quality consistent with its intended use. The sample set, chemical analysis results, and interpretations must be based on data that meet or exceed QC objectives established for the project. QC objectives for the field measurement systems are also an important aspect of the site investigations. The following sections discuss field and laboratory analytical measurements associated with the project analytical methods presented in Table 4.1.

4.1 FIELD QA/QC SAMPLES

The following paragraphs describe the QA/QC samples that will be associated with environmental sampling activities at the MCA Barracks site.

4.1.1 Blanks

Two types of field blanks, equipment (rinsate) blanks and trip blanks, will be collected in association with sampling at the site.

Rinsate blanks are prepared by pouring distilled/deionized water over or through the sample preparation/collection apparatus following decontamination procedures. The collection of rinsate blanks is not required for sampling methods using dedicated or disposable sampling devices. Rinsate blank results will be used to determine the potential for cross-contamination attributable to the sampling process. Such information can be used to estimate measurement error associated with the field sample preparation, containers, field environment, decontamination procedures, cross-contamination, and laboratory analysis. Rinsate samples will be collected at a rate of 1 per 10 (with a maximum of one per day per matrix sampled) environmental samples collected at the site and will be collected only for those sampling methods for which they are appropriate.

Trip blanks accompany samples collected for VOC analysis. Trip blanks are volatile organic analysis (VOA) vials filled with American Society for Testing and Materials (ASTM) Type II water at the laboratory. Trip blanks will be shipped to the sampling site, stored on-site for use, and sent back to the laboratory with field samples; they will not be opened in the field. One set of trip blanks will accompany each cooler containing VOC samples. Trip blank results can be used to identify contamination associated with sample storage, shipment, and laboratory analysis.

4.1.2 Duplicates

Field duplicate samples are co-located (soil) or sequentially collected (water) samples collected and submitted for analysis in conjunction with the field samples. Field duplicates will be sampled such that co-located samples will be obtained from the sampling device in a manner that minimizes loss due to volatilization (i.e., both sets of VOC samples will be collected first). Field duplicate samples will be submitted to the laboratory as blind QC samples (with

unique sample identifiers) to ensure that they are analyzed in the same manner as all other environmental samples. Field duplicate results will provide an estimate of overall precision of sample collection, field sample preparation, and laboratory analysis (total measurement of sample variability). Field duplicate samples will be collected at a rate of 1 per 10 environmental samples collected at the site. QA split samples, which are duplicate samples sent to two different laboratories as a check on laboratory precision, will not be collected.

4.1.3 Matrix Spike/Matrix Spike Duplicate Samples

Field samples will be submitted for matrix spike and matrix spike duplicate (MS/MSD) analyses. MS/MSD results will be used to assess the potential for matrix interferences to affect reported sample concentrations.

Extra sample quantity for MS/MSD analysis will be collected for VOCs and carbon TOC (water samples) and for VOCs (soil samples) at a rate of 1 per 20 environmental samples collected at the site. For other analyses, the standard sample size will be sufficient to allow aliquots to be selected at the laboratory for MS/MSD analyses. MS/MSD analyses will only be requested for those matrices and analyses for which they are appropriate.

MS samples will be analyzed on a batch-specific basis for metals, alkalinity, and anions. Instead of an MSD, MSs performed for these analyses will be associated with a laboratory duplicate (LD) to assess precision (see Section 4.2.4).

In addition to project-specific MS/MSD or MS/LD analyses, the analytical methods require the analysis of these analyses on the basis of each preparation batch (not to exceed 20 samples). For those preparation batches that do not contain a project-specific MS/MSD or MS/LD, the laboratory may report these results for non-project samples in order to fulfill batch QC requirements.

4.2 LABORATORY QA/QC SAMPLES

4.2.1 Method (Preparation) Blank

A method blank consists of analyte-free deionized water for groundwater samples and Ottawa sand for soil samples. Method blanks are carried through each step of the analytical method. The method blank data will be used to evaluate the contamination attributable to laboratory operations during the sample preparation and analysis processes.

4.2.2 Surrogate Spikes

Surrogates are generally specified for organic analytical methods and are usually brominated, fluorinated, or isotopically labeled compounds that are not expected to be detected in environmental media. Surrogate spikes are compounds added to every blank, sample, MS, MSD, and standard when specified in the analytical method. Surrogate results are used to evaluate the accuracy of the analytical measurement on a sample-specific basis. Surrogate

results are expressed as percent recovery (%R) of the surrogate spike. Outlying spike recoveries may indicate matrix interference or extraction anomalies.

4.2.3 Laboratory Control Samples

Laboratory control samples (LCS) are well-characterized, laboratory-generated samples that are used to monitor the laboratory's day-to-day performance of analytical methods. LCSs may also be referred to as laboratory blank spike (BS) analyses. LCSs will be used to monitor the precision and accuracy of the analytical process independent of matrix effects. The results of LCSs will be compared to well-defined evaluation criteria to determine whether extraction and analysis processes were performed properly on a batch-specific basis. Controlling laboratory operations with LCSs (rather than surrogates or MS/MSD) offers the advantage of being able to differentiate outlying recoveries due to systematic errors from those due to matrix or sample-specific effects. LCS duplicates (LCSD) will be analyzed in association with each VOC LCS. LCSDs will be evaluated in the same manner as LCSs, and will also be used to evaluate batch precision (see Section 4.3.1).

4.2.4 Laboratory Duplicate Samples

The performance of LD analyses provides an estimate of laboratory precision and isolates the measurement of overall precision from variability caused by field conditions and sampling methodology. LD analyses will be performed in a manner and at a rate consistent with the specific analytical method being performed.

4.3 QUANTITATIVE QA/QC MEASUREMENTS

QC objectives usually are expressed in terms of precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS). The target ranges for these objectives are presented in Table 4.2. Variances from the QC objectives will result in the implementation of appropriate corrective measures and an assessment of the impact of corrective measures on the usability of the data in the decision-making process. Of the PARCCS parameters, precision, accuracy, completeness, and sensitivity can be quantitatively measured and assessed. The parameters of comparability and representativeness are primarily qualitative in nature and are discussed in Section 4.4.

4.3.1 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Precision can be assessed by replicate measurements of known laboratory standards and by analysis of duplicate environmental samples (spiked or unspiked). Precision will be determined as relative percent difference (RPD) between duplicate sample results. The RPD is calculated by dividing the absolute value of the difference of the two results by the average of the two results and multiplying by 100.

Replicate measurements of known standard (LCS/LCSD pairs), spiked sample (MS/MSD pairs), and LD analyses are routinely monitored by the laboratory by comparing the RPD with established control limits. As indicated in Table 4.2, method-specific precision criteria for

LCS/LCSD, MS/MSD, and LD pairs for the methods to be performed are based on statistical evaluation of actual laboratory results and are updated at regular intervals by the laboratory. Therefore, the control limits for these analyses are not presented in this document and will be provided by project laboratories prior to beginning analytical services for this project.

The RPD for field duplicate samples will be calculated during the independent data review and validation process (see Sections 9.3 and 9.4). Precision criteria for field duplicate samples will be evaluated against a uniform criterion of 25 RPD for aqueous samples and 35 RPD for soil samples. For low-level detections (either member of the duplicate pair is a detection less than five times the associated PQL), the precision criterion will be that the two values are within the value of the PQL from each other (water) or two times the PQL from each other (soil). In those cases where one duplicate result is a non-detection and the other result of the pair is a detection, the low level rules apply, using the PQL as the nominal value for the non-detected result.

4.3.2 Accuracy

Accuracy is the degree of agreement of a measurement to an accepted reference or true value. An evaluation of the accuracy of a measurement system provides an estimate of measurement bias. The %R achieved by analyzing known concentrations of spiking compounds will be used to evaluate analytical accuracy. The %R is calculated on an analyte-specific basis by dividing the observed value by the true value and multiplying by 100.

Overall analytical accuracy is assessed on a batch-specific basis by evaluating the %R for each analyte in the LCS and LCSD against the QC limits. One known reference standard or LCS is analyzed for every batch (maximum of 20 samples). The accuracy of specific sample analyses is assessed by evaluating the %R of the surrogate spike compounds. The %R QC criteria for MS/MSDs will be used to assess the potential for matrix interferences. Table 4.2 presents the accuracy requirements project LCSs, LCSDs, and surrogates, as established in *Department of Defense (DoD) Quality Systems Manual for Analytical Laboratories* (QSM) (DoD Environmental Data Quality Workgroup, 2002). Table 4.2 also indicates those methods for which the QSM does not specify accuracy criteria and the laboratory's internal QC limits will be employed for evaluation of the data. These limits are based on statistical evaluation of actual laboratory results and are updated at regular intervals by the laboratory. Therefore, the control limits for these analyses are not presented in this document.

The QSM does not specify %R criteria for MS and MSD analyses and the laboratory's internal QC limits will be employed for evaluation of these data. These limits are based on statistical evaluation of actual laboratory results and are updated at regular intervals by the laboratory. Therefore, the control limits for these analytes are not presented in this document. Acceptable measurement accuracy is also dependent on the sample matrix.

The accuracy of field measurements will be assessed through the performance of pre-measurement calibrations and calibration verifications.

4.3.3 Completeness

Sampling completeness is defined as the percentage of analytical results obtained compared with the projected number of analytical results that would be obtained from all planned sample locations. Analytical completeness is defined as the percentage of valid (non-rejected) analytical results obtained from measurement systems compared with the total number of analytical results requested. The overall completeness for this project is defined as the sampling completeness multiplied by the laboratory completeness.

Although the ideal of 100 percent data completeness may not be achieved, it may still be possible to make site-specific decisions. The impact of rejected or missing data on project decisions will be evaluated on a case-by-case basis. Furthermore, the auditing procedures that are in place will help in the selection of subcontract laboratories which demonstrate good quality practices. During assessment of the data, an evaluation of samples needed to make decisions with respect to project objectives will be made. An overall completeness goal of 95 percent is established for each matrix to be sampled for this project.

4.3.4 Sensitivity

Sensitivity is defined as the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. Analyte-specific method detection limit (MDL) are defined as the minimum concentration of a substance that can be identified, measured and reported with a 99 percent confidence that the analyte concentration is greater than zero, and is determined for analysis of a sample in a given matrix containing the analyte. MDLs are specific to an individual MDL study performed at an individual laboratory. Typical laboratory PQLs are 3 to 5 times higher than the laboratory MDLs and are established by the low point of the calibration curve for each analyte. Target project PQLs are presented in Table 4.3. The laboratory will report all concentrations detected above the MDL. Values above the MDL and less then the PQL will be qualified as estimated.

The actual project laboratory PQLs may vary from those cited in Table 4.3 on a sample-specific basis. Sample-specific factors that can affect PQLs (and MDLs) for that sample include variations in subsample size, percent moisture, matrix interference, and dilutions. Most of these factors will decrease sample-specific sensitivity. Achievement of sensitivity requirements will be assessed during the data review process by comparing the analyte PQLs to matrix-specific GEPD target concentrations in Table 4.3.

4.4 QUALITATIVE QA/QC MEASUREMENTS

4.4.1 Representativeness

Representativeness is the degree to which data accurately and precisely expresses a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Although representativeness is a qualitative measurement, it is evaluated through a multistep process beginning with a quantitative check of precision and accuracy data, as

described in Section 4.3. Project design is one of the critical inputs that determine if the data collected are representative of the population sampled. The site is partially characterized, and environmental sampling conducted prior to RIP activities will complete the characterization of the site. Consequently, the DQOs for this sampling effort require that project design will use a sampling scheme biased toward selected locations that will provide delineation information on the TCE plume rather than a statistical sampling scheme that would be more appropriate for an uncharacterized site with little pre-existing information. Although the overall sampling scheme is biased, the samples from each individual point will be collected and analyzed using those protocols necessary to ensure that the data from each sampling location is representative of that location.

Sample representativeness will also be controlled by collection in accordance with matrix-appropriate Standard Operating Procedures (SOP). The sample containers and preservation methods presented in Table 4.1 will be used to ensure that samples arriving at the laboratory retain the appropriate degree of representativeness. The holding times presented in Table 4.1 have been established to ensure that samples retain representativeness at the time of extraction and analysis. Satisfactory representativeness will also be assessed by evaluating RPDs for field duplicate samples against the criteria listed in Section 4.3.1. Results for analytes not meeting these criteria will be evaluated in light of project objectives and, if professional judgment warrants, qualified as estimated in both the original and duplicate samples during the review process.

Representativeness will also be assessed using field and laboratory blank samples. A method blank will be analyzed with every analytical batch to determine potential contamination introduced during routine laboratory procedures. Trip blank and rinsate blank samples will be collected to assess potential contamination due to field conditions. The assessment of blank samples will determine if compounds detected in the environmental samples are site-related or introduced through shipping, storage, field procedures, or laboratory procedures.

4.4.2 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability also involves a multistep evaluation and can be related to accuracy and precision as these quantities are measures of data reliability. Data are comparable if siting considerations, collection techniques, and measurement procedures, methods, and reporting limits (RL) are equivalent for the samples within a sample set. A qualitative assessment of data comparability will be made for applicable data sets.

4.5 DATA QUALITY CATEGORIES

The two general categories of data that will be generated for use for project decision-making are: (1) screening data and (2) definitive data.

Screening data are generated by rapid methods of analysis with less rigorous sample preparation, calibration and/or QC requirements than are necessary to produce definitive data. Sample preparation steps may be restricted to simple procedures such as dilution with a

solvent, instead of elaborate extraction/digestion and cleanup. Screening data may provide analyte identification and quantitation, although the quantitation may be relatively imprecise. Physical test methods (e.g., dissolved oxygen, temperature, pH, oxidation-reduction potential [ORP], moisture content, turbidity, and conductance) have been designated by definition as screening methods. Screening methods will be confirmed, as required in the FSP, by analyses that generate definitive data. Confirmation samples will be selected to include both detected and non-detected results from each screening method. Note that some screening methods have no corresponding definitive method, and results from these methods will not require confirmation.

Definitive data are generated using rigorous analytical methods, such as approved USEPA reference methods. The data can be generated in a mobile or fixed-base laboratory. Definitive data are analyte-specific, and both identification and quantitation are confirmed. These methods have standardized QC and documentation requirements. In order for data to be classified as definitive, the data must undergo a review after the results are reported in order to verify that the appropriate QC measures were taken and were in control. Definitive data are not restricted in their use unless quality problems identified in the review process require data qualification. Note that some methods that routinely produce definitive data can also produce screening level data if the data validation process is not performed or is reduced. This screening level data can meet project end use requirements if the end data use does not require the data to be definitive, and only an minimum of data review will be performed to verify that such data have been generated in accordance with contractual requirements and good technical practices. The data review requirements presented in Section 9 is specific to the data sources and end uses for this project.

Table 4.1
Sample Containers, Preservation Requirements, and Holding Times

Parameter	Analytical Method	Sample Container	Preservation	Holding Time
Aqueous Samples				
Volatile Organic Compounds	SW8260B	3 × 40 mL VOA vials	4°C, HCl to pH <2	14 Days
Total Organic Carbon	E415.1 or SW9060A	4 × 40 mL VOA vials	4°C, HCl to pH <2	28 Days
Metals	SW6010B	1 × 1 L HDPE	4°C, HNO_3 to pH <2 (see note for dissolved metals)	6 Months
Dissolved Gases	RSK-175	3 × 40 mL VOA vials	4°C, HCl to pH <2	14 Days
Orthophosphate	E300.1 or SW9056	1 × 250 mL HDPE	4°C, H_2SO_4 to pH <2	48 Hours
Sulfate and Nitrate/Nitrite (total)	E300.1 or SW9056	1 × 250 mL HDPE	4°C	28 Days
Alkalinity	E310.1	1 × 500 mL HDPE	4°C	14 Days
Volatile Fatty Acids	AM-20 GAX (In-house method)	2 × 40 mL VOA vials	4°C	14 Days
Hydrogen	SG-43 (In-house method)	15 Ml Vessel	Under Vacuum	30 Days
DNA	BDC-4 (In-house method)	1 × 1 L HDPE	4°C	NA
Ferrous Iron	NA	NA (field test kit)	NA	Analyze immediately (field test)
ORP	ASTM D1498	Glass or HDPE	NA	Analyze immediately (field test)
Temperature	E170.1	Glass or HDPE	NA	Analyze immediately (field test)
Turbidity	E180.1	Glass or HDPE	NA	Analyze immediately (field test)
Dissolved Oxygen	E360.1	Glass or HDPE	NA	Analyze immediately (field test)
pH	SW9040B	Glass or HDPE	NA	Analyze immediately (field test)
Conductance	SW9050A	Glass or HDPE	NA	Analyze immediately (field test)

Table 4.1 (continued)
Sample Containers, Preservation Requirements, and Holding Times

Parameter	Analytical Method	Sample Container	Preservation	Holding Time
Soil Samples				
Volatile Organic Compounds	SW8260B	3 × EnCore® 5 g samplers	4°C	48 Hours; 14 days if frozen to –10°C within 48 hours of collection
Moisture	SW-846	4 ounces; glass jar	4°C	7 Days
Investigation Derived Waste (IDW)				
See Table 2.2 of the IDW plan	--	--	--	--

Note on metals preservation: If total metals analysis is required, the samples will be preserved in the field. If dissolved metals analysis is required, then the samples will be filtered in the field prior to preservation, or will be shipped to the laboratory unpreserved with instructions that the laboratory will filter and preserve the samples within 48 hours of collection.

°C - Degrees Celsius
HDPE – High Density Polyethylene
HCl - Hydrochloric Acid
mL - Milliliter
NA - Not analyzed
HNO_3 - Nitric Acid
H_2SO_4 - Sulfuric Acid

Table 4.2
Accuracy and Precision Requirements (Aqueous and Soil)

Analyte	Aqueous		Soil	
	Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Volatile Organic Compounds (SW8260B)				
Vinyl Chloride	50-145	Lab	60-125	Lab
cis-1,2-Dichloroethene	70-125	Lab	65-125	Lab
Trichloroethene	70-125	Lab	75-125	Lab
Tetrachloroethene	45-150	Lab	65-140	Lab
Surrogates:				
1,2-Dichloroethane-*d4*	70-120	NA	Lab	NA
4-Bromofluorobenzene	75-120	NA	80-120	NA
Dibromofluoromethane	85-115	NA	Lab	NA
Toluene-*d8*	85-120	NA	85-115	NA
Metals (SW6010B)				
Iron	80-120 (LCS) 75-125 (MS)	Lab	NA	NA
Manganese	80-120 (LCS) 75-125 (MS)	Lab	NA	NA
Dissolved Gases (RSK-175)				
Methane	Lab	Lab	NA	NA
Ethane	Lab	Lab	NA	NA
Ethene	Lab	Lab	NA	NA
Anions (E300.1 or SW9056)				
Orthophosphate	Lab	Lab	NA	NA
Sulfate	Lab	Lab	NA	NA
Nitrate/nitrite (total)	Lab	Lab	NA	NA
Volatile Fatty Acids (Laboratory SOP)				
Pyruvic Acid	TBD	TBD	NA	NA
Lactic Acid	TBD	TBD	NA	NA
Acetic Acid	TBD	TBD	NA	NA
Propionic Acid	TBD	TBD	NA	NA
Butyric Acid	TBD	TBD	NA	NA

Note: The following single-component tests will be required to meet laboratory generated accuracy and precision criteria: TOC (E415.1 or SW9060A), alkalinity (E310.1), hydrogen (SG-43, laboratory in-house method), DNA (BDC-4, laboratory in-house method), and moisture (SW-846). No soil analyses will be performed for these parameters, with the exception of moisture, which is analyzed for soil only. QC acceptance requirements for field instruments used for measurement of ORP, temperature, turbidity, dissolved oxygen, pH, conductance, and ferrous iron are discussed in Sections 7.1.2 and 7.1.3.

Key:
%R - Percent Recovery
RPD - Relative Percent Difference
Lab - Control limits are not established by the DoD QSM and the laboratory's internally derived control limits will be acceptable

Table 4.3
Method Sensitivity Requirements (Aqueous and Soil)

Analyte	Project Aqueous PQL (µg/L)	GEPD Target Concentration (µg/L)	Project Soil PQL (µg/kg)	GEPD Target Concentration (µg/kg)
Vinyl Chloride	1.0	2.0	5.0	40
cis-1,2-Dichloroethene	1.0	70	5.0	530
Trichloroethene	1.0	5.0	5.0	130
Tetrachloroethene	1.0	5.0	5.0	180

Note: The project PQLs for all other methods will be the laboratory routine PQLs for each analyte. Field measurement method sensitivity requirements will be based on the instrument-specific sensitivity.

Key:
- - No value has been promulgated
* - RSK and Preliminary Remediation Goal (PRG) values shown are for all isomers
µg/kg - micrograms per kilogram
µg/L - micrograms per Liter
NA - Not analyzed
PQL - Practical Quantitation Limit

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5.0 SAMPLING AND FIELD PROCEDURES

The attainment of high quality data that are legally defensible and from which sound decisions can be made involves many critical steps. The first of these steps is sample collection. Proper sampling activities provide representative samples upon which subsequent evaluations and decisions may be based. Therefore, the proper performance of sampling procedures, including proper QC procedures, is critical to the achievement of project objectives.

5.1 QUALIFICATIONS OF SAMPLING PERSONNEL

The personnel responsible for sampling and other field activities will have adequate experience to perform the tasks assigned to them. All field personnel will read and familiarize themselves with all pertinent documents, including this QAPP. Field personnel will be cognizant of the importance and level of QC that must be maintained in order to produce the most representative samples. Loss of volatiles is of particular concern for this project and particular care will be employed during sampling for VOCs analyses. The generation of acceptable data hinges on the proper collection of samples; therefore, sampling activities will be appropriately monitored by the Site Supervisor throughout the site investigation activities.

5.2 SAMPLE COLLECTION

Collection of all samples will follow standard USEPA and USACE protocols. Detailed procedures for the collection of samples are provided in Section 2 of the FSP.

5.2.1 Collection of Quality Control Samples

Field operations performed at the MCA Barracks site will include the collection of several types of QC samples. These samples will include field duplicate samples, MS/MSD samples, and rinsate blanks.

Wherever historical results are available, field duplicate samples will be collected at locations where reportable concentrations of analytes are expected. In order to minimize the effects of high analyte concentrations, MS/MSD samples will be collected from locations that are expected to exhibit low to non-detect concentrations of analytes. For field duplicate samples, fractions for the same analytical parameters will always be collected consecutively. The field duplicate samples will be submitted as laboratory blind samples by assigning a unique sample identifier. Duplicate and MS/MSD samples will be used to assess accuracy and precision as discussed in Section 4.2.

Rinsate blanks will be collected when the sampling equipment is decontaminated and reused in the field. Analyte-free water will be poured over or pumped through the equipment and the water will be collected in sample containers. Rinsate blanks provide a qualitative assessment to determine if the decontamination procedure has been adequately performed.

One source water sample will be collected and analyzed prior to field activities to determine if potable water used during decontamination is free of contamination. The source water will be analyzed for VOCs only.

5.3 SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

The general requirements for sampling containers, preservation, and holding times are provided in Table 4.1.

5.4 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Following sample collection, each sample cooler will be packed with cushioning packing material and sufficient double-bagged wet ice to ensure that an internal ambient temperature of 4°C $\pm$ 2°C is maintained from the field to the laboratory. In addition, each sample cooler will contain an associated chain-of-custody form. After sample coolers have been sealed with packing tape, signed and dated custody seals will be placed across the front and back cooler openings and secured with clear tape. A broken seal upon arrival at the laboratory will indicate that the cooler was compromised during shipment.

6.0 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

Verifiable sample chain-of-custody will be an integral part of all field and laboratory operations. Traceable steps will be taken in the field and laboratory to document that all samples have been properly acquired, preserved, and identified. Section 2.5 of the FSP provides details related to carrying out verifiable field custody and documentation.

Samples collected in the field will be transported to the laboratory or field testing site as expeditiously as possible. When a requirement for preserving the sample at 4°C is indicated, the samples will be packed in ice or chemical refrigerant to keep them cool during collection and transportation. During transit, it is not always possible to control the temperature of the samples. As a general rule, storage at low temperature is the best way to preserve most samples. A temperature blank (a VOC sampling vial or similar-sized container filled with tap water) will be included in every cooler and used to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory. When samples arrive at the laboratory with a temperature outside the 4°C ± 2°C window, the laboratory will contact the HGL PM immediately to determine if analysis of the samples should proceed. The resolution of the problem will also be documented. Note that samples arriving at the laboratory below 2°C but not frozen will be considered usable and resampling will not be required.

Once a shipment of samples reaches the laboratory, each sample container will be checked against information on the chain-of-custody form for anomalies. To ensure the safety of laboratory personnel, sample coolers will be opened in a fume hood to prevent exposure in case there has been any breakage of containers or leakage of sample material during shipment. The condition, temperature, and appropriate preservation of samples will be checked and documented on the chain-of-custody form or a sample receipt (log-in) form. Checking an aliquot of the sample using pH paper is an acceptable procedure except for VOCs where an additional sample is required to check preservation. The occurrence of any anomalies in the received samples and their resolution will be documented in laboratory records. All sample information will then be entered into a tracking system, and unique analytical sample identifiers will be assigned. A copy of this information will be reviewed by the laboratory for accuracy. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. SOPs describing sample control and custody will be maintained by the laboratory. Procedures ensuring internal laboratory chain-of-custody will also be implemented and documented by the laboratory. Specific instructions concerning the analysis specified for each sample will be communicated to the analysts; analytical batches will be created; and laboratory QC samples will be introduced into each batch. Any subcontracted analyses will be repackaged by the primary laboratory and shipped to the secondary laboratory using inter-laboratory chain-of-custody forms.

Holding times for methods required for this project are presented in Table 4.1. *Note that all holding times expressed as 'days' refer to the number of elapsed 24-hour periods from the time of collection, not to calendar days.* If results are rejected due to samples not prepared or analyzed in accordance with holding time requirements, the affected samples will be recollected and analyzed at no additional cost to HGL.

Samples will be stored in limited-access, temperature-controlled areas while in the custody of the laboratory. Refrigerators, coolers, and freezers will be monitored for temperature seven days a week. The acceptance criterion for the temperatures of the refrigerators and coolers is 4°C ± 2°C. Acceptance criteria for the temperatures of the freezers will be -10°C. All of the cold storage areas will be monitored by thermometers that have been calibrated with a NIST-traceable thermometer. Correction factors will be applied to each thermometer as indicated by the findings of the calibration. Records that include acceptance criteria will be maintained. Samples for VOCs determination will be stored separately from other samples, standards, and sample extracts. Refrigerators storing VOC samples will contain a blank that will be analyzed at a minimum of every two weeks and the results of the last storage blank will be included with the associated sample results. Samples will be stored after analysis until disposed of in accordance with applicable local, state, and federal regulations. Disposal records will be maintained by the laboratory.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

All field and laboratory instrumentation will be calibrated prior to and during continued use. The calibration and maintenance history of the project-specific field and laboratory instrumentation is an important aspect of the project's overall QC program. Consequently, all initial and continuing calibration procedures will be implemented and overseen by trained personnel following the manufacturer's instructions and USEPA specifications. This will ensure that the equipment is functioning within the tolerances established by the manufacturer and USEPA method-specific analytical requirements.

7.1 FIELD INSTRUMENTS AND EQUIPMENT

Field instrumentation will be calibrated and maintained per manufacturers' operating instructions. The calibration and general maintenance of field instrumentation will be the responsibility of the SS and SSHO. All documentation pertaining to the calibration and maintenance of field equipment will be maintained in an active field logbook. Entries made into the logbook regarding the status of any field equipment will contain, but are not necessarily limited to, the following information:

- Date and time of calibration or maintenance;
- Name of person conducting calibration or maintenance;
- Type of equipment being serviced and identification number (such as the serial number);
- Reference standard used for calibration (such as pH of buffer solutions);
- Calibration or maintenance procedure used; and
- Other pertinent information.

Equipment that fails calibration or becomes otherwise inoperable during the field investigation will be removed from service and segregated to prevent inadvertent use. Such equipment will be properly tagged to indicate that it should not be used until the problem can be corrected. Equipment requiring repair or recalibration must be approved for use by the SS or SSHO before being placed back into service. Equipment that cannot be repaired or recalibrated will be replaced.

7.1.1 Photoionization Detectors

A photoionization detector (PID) equipped with a 10.6 electron volt (eV) lamp will be used to perform health and safety air monitoring and for screening samples. The PID will be calibrated daily while in the field. Measurements of background VOCs will be documented, the calibration gas concentration will be measured, the reading documented, and the instrument will be adjusted for proper calibration. The final reading will also be documented. Calibration protocols and measurement will be documented in the field logbook.

7.1.2 Water Quality Probe

Water quality parameters will be measured as part of the data required to determine aquifer conditions at the site. The water quality parameters to be measured include: pH, dissolved oxygen (DO), ORP, temperature, specific conductance, and turbidity.

The water quality probes will be calibrated before use, and at a minimum of once every week after that. The calibration process for water quality probes will follow the manufacturer's recommendations.

To ensure that the water quality probes are operating within criteria, a check solution will be analyzed daily. The check solutions will include standards for specific conductance, ORP, turbidity and pH. The temperature probe will be pre-calibrated by the equipment distributor and will not be calibrated in the field. The DO meter will be calibrated daily by inputting ambient barometric pressure into the probe. If the results do not meet the precision criteria shown below, the probe will be recalibrated. The pH, ORP, temperature, specific conductance and turbidity meter will be calibrated in the field per manufacture's instructions.

Parameter	Precision [1]
Specific Conductance	± 50 µS/cm
Oxidation/Reduction Potential	± 50 mV
pH	± 0.1 standard units

mV - millivolts
µS /cm - microsiemens per centimeter

[1] Precision criteria as established in *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, Wiedemier et al., Air Force Center for Environmental Excellence, Technology Transfer Division, Brooks Air Force Base, San Antonio, Texas (September 1996).

7.1.3 Ferrous Iron

In addition to the water quality parameters identified above, ferrous iron (Fe^{+2}) will be determined in the field using Hach test kits. Ferrous iron analysis will be completed immediately after sample collection activities.

Ferrous iron will be determined using the 1,10-phenanthroline method (Hach Method 8146), which employs a DR/700 colorimeter (module 50.01). The initial calibration utilizes the analysis of a blank sample to zero the instrument per the manufacturer's recommendation. In addition, a check standard will be analyzed once at the beginning of each sampling round to ensure the instrument is operating within criteria. If the check sample results do not meet the manufacturer's specifications, the instrument will be recalibrated per the manufacturer's recommendation.

7.2 LABORATORY INSTRUMENTATION

Calibration of all analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the required sensitivity to meet project-specific DQOs. Calibration acceptance criteria for project laboratory analytical methods are presented in the

method-specific QC tables of QC requirements and corrective actions that are included in Section 8. Each instrument will be calibrated with standard solutions appropriate to the instrument and analytical method in accordance with the SW-846 (USEPA, 1997) or other appropriate methodology.

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8.0 ANALYTICAL PROCEDURES

8.1 FIELD PROCEDURES

Field analytical procedures will be performed as described in Section 2 of the FSP.

8.2 LABORATORY PROCEDURES

The following paragraphs summarize the methodology to be followed for analytical methods, sample preparation, sample tracking, and documentation controls.

8.2.1 Volatile Organic Compounds

The VOCs that are the COCs for this project include VC, *cis*-1,2-DCE, TCE, and PCE. The VOCs analysis method for water and soil samples, SW-846 Method 8260B, employs gas chromatography/mass spectrometry (GC/MS) for separation and detection of target compounds. Samples are introduced into the GC/MS system by purge-and-trap Method 5030 (aqueous samples) or by closed-system purge-and-trap Method 5035. The power of GC/MS lies in the capacity for positive identification of relatively low detection limits. This methodology is also indicated where its capability for tentative identification of unlisted compounds is desired. QC criteria for the evaluation of VOC analyses are listed in Tables 4.2 and 8.1. Project PQLs for the target VOCs are presented in Table 4.3.

8.2.2 Metals

SW-846 Method 6010B is utilized to determine concentrations of metals by inductively-coupled plasma (ICP) atomic emission spectroscopy (AES). ICP-AES provides for the detection of a wide range of metals in a relatively quick time of analysis. Prior to analysis, aqueous samples are digested by Methods 3005, 3010, or 3015, and soil samples are digested by methods 3050 or 3051. Project groundwater metals analyses will be performed for aluminum, calcium, iron, and manganese only. For those sample fractions that require analysis for total metals, the samples will be preserved in the field with nitric acid. If dissolved metals are required, the samples will either be filtered in the field prior to preservation, or will be shipped to the laboratory unpreserved with instructions to filter and preserve the sample within 48 hours. QC criteria for metals analyses are listed in Table 8.2.

8.2.3 Methane, Ethane, and Ethene

Methane, ethane, and ethene will be analyzed using Method (Robert S. Kerr Environmental Research Laboratory Method 175 (RSK-175)). This method was originally designed for the analyses of air samples. Through a modification of the sample preparation methods, groundwater samples will be analyzed. Since RSK-175 is not a standard groundwater method, surrogate compounds are not included during analysis. Analysis is performed by a gas chromatograph equipped with a flame ionization detector (GC/FID). Because this is a non-standard analysis, the laboratory's internal QC limits will be employed for evaluation of the data. These limits are based on statistical evaluation of actual laboratory results and are updated at regular intervals by the laboratory. Therefore, the control limits for these analytes

are not presented in this document. QC elements and corrective actions applicable to this method are presented in Table 8.3.

8.2.4 Water Quality/Natural Attenuation Parameters

Various parameters are analyzed for the purposes of assessing groundwater quality and natural attenuation. The parameters to be analyzed are listed below:

- Nitrate/nitrite, sulfate, and orthophosphate by Method E300.1 or SW9056;
- Alkalinity by Method E310.1;
- TOC by Method E415.1 or SW9060A;
- Volatile fatty acids by laboratory-specific SOP;
- Hydrogen (using in-house methods following Laboratory SOP); and
- DNA (using in-house methods following Laboratory SOP).

Methods 300.1 and SW9056 use ion chromatography to separate dissolved anions, which are then detected by a conductivity detector. Alkalinity is determined using titration. TOC is measured by converting all the organic carbon in a sample to carbon dioxide (CO_2). The CO_2 formed can be measured 2 directly by an infrared detector or converted to methane (CH_4) and measured by a flame ionization detector. The amount of CO_2 or CH_4 is directly proportional to the concentration of carbonaceous material in the sample.

Because these are water quality-related analyses, the laboratory's internal QC limits will be employed for evaluation of the data. These limits are based on statistical evaluation of actual laboratory results and are updated at regular intervals by the laboratory. Therefore, the control limits for these methods are not presented in this document. QC elements and corrective actions applicable to these methods are presented in Table 8.3.

Table 8.1
Quality Control Criteria for VOC Analyses by SW-846 Method 8260B

QC Element	Frequency	Acceptance Criteria	Corrective Action
BFB Tune	Daily, prior to use	Must meet mass vs. ion abundance criteria as listed in the method	1) Evaluate System 2) Re-tune the instrument
Initial Calibration	Initially; thereafter as the continuing calibration fails	%RSD of CCCs ≥ 30%; RRFs for all SPCCs ≥0.300 (except chloromethane, bromoform; 1,1-dichloroethane ≥0.100) Primary Evaluation: r ≥0.995 or %RSD ≤30% for each analyte Secondary Evaluation: Mean %RSD ≤15% and Maximum individual analyte %RSD ≤30%	1) Evaluate System 2) Recalibrate as necessary
Initial Calibration Verification (ICV)	Following initial calibration	%R = 80% to 120%	1) Evaluate System 2) Recalibrate as necessary
Continuing Calibration Verification (CCV)	Every 12 hours	CCCs % D ≤20%; RRFs for SPCCs ≥0.300 (except chloromethane, bromoform, 1,1-dichloroethane ≥0.100) Target compound %Ds ≤20%	1) Evaluate System 2) Clean system 3) Reanalyze affected samples since the last in-control Continuing Calibration
Method Blank	Following CCV	Target analytes not detected.	1) Rerun. 2) Evaluate Batch. 3) Reanalyze or qualify results as necessary
LCS/LCSD	Every analytical batch (maximum of 20 samples)	%R: See Table 4.2 RPD: Laboratory limits (if LCSD performed)	1) Rerun. 2) Evaluate batch 3) Reanalyze or qualify results as necessary
MS/MSD	As indicated on chain of custody	%R: See Table 4.2 RPD: Laboratory limits	1) Evaluate MS/MSD to assess matrix interference 2) Evaluate batch and qualify results as necessary
Surrogate Recovery	Every sample	See Table 4.2	1) Rerun 2) Reanalyze or qualify results as necessary

% RSD - Percent Relative Standard Deviation
CCC - Calibration Check Compound
SPCC - System Performance Check Compound
BFB - Bromofluorobenzene
RRF - Relative Response Factor
%D - Percent Difference
%R - Percent Recovery
CCV - Continuing Calibration Verification

Table 8.2
Quality Control Criteria for Metals Analyses by SW-846 Method 6010B

QC Element	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration	Daily	Check Standard at PQL: %D ≤20% Alternative Evaluation: r ≥ 0.995	1) Evaluate system 2) Recalibrate
ICV	Following initial calibration	% R = 90% to 110%	1) Evaluate system 2) Recalibrate as necessary
ICB	Following ICV	Analytes not detected	1) Rerun 2) Clean system 3) Qualify results as appropriate
ICS	Beginning of analytical sequence	% R = 80% to 120%	1) Evaluate system 2) Recalibrate
CCV	Every 10 samples and at the end of analytical sequence	% R = 90% to 110%	1) Evaluate system 2) Repeat calibration check (ICV/CCV) 3) Recalibrate as necessary 4) Reanalyze affected samples
CCB	Following CCV	Analytes not detected	1) Rerun 2) Clean system 3) Reanalyze affected samples or qualify results as appropriate
MB	Every analytical batch (maximum of 20 samples)	Analytes not detected	1) Rerun 2) Evaluate batch 3) Re-digest affected samples or qualify results as appropriate
LCS	Every analytical batch (maximum of 20 samples)	%R: See Table 4.2 RPD: Laboratory limits (if LCSD performed)	1) Rerun for affected analytes 2) Evaluate batch 3) Re-digest affected samples or qualify results as appropriate
MS	Every analytical batch (maximum of 20 samples)	%R: See Table 4.2 (not applicable if parent sample concentration ≥4x the spike level) RPD: Laboratory limits (if MSD performed)	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate
LD	Every analytical batch (maximum of 20 samples)	RPD ≤25%	1) Rerun; if still out, perform post-digestion spike 2) Evaluate batch 3) Qualify sample results as appropriate
Post Digestion Spike	Every analytical batch of 20 samples, only if MS analysis fails	%R = 75% to 125%	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate
Serial Dilution	Every analytical batch (maximum of 20 samples)	%D ≤10%	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate

Table 8.3
Quality Control Criteria for Wet Chemistry Analyses[1]

QC Element	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration	Daily	Check Standard at RL: %RSD ≤method criteria Alternative Evaluation: r≤ 0.995	1) Evaluate system 2) Recalibrate
ICV	Following initial calibration	% R within method control limits	1) Evaluate system 2) Recalibrate as necessary
ICB	Following initial calibration verification	Analytes not detected	1) Rerun 2) Clean system 3) Qualify results as appropriate
CCV	Every 10 samples and at the end of analytical sequence	% R = within method control limits	1) Evaluate system 2) Repeat calibration check (ICV/CCV) 3) Recalibrate as necessary 4) Reanalyze affected samples
CCB	Following CCV	Analytes not detected	1) Rerun 2) Clean system 3) Reanalyze affected samples or qualify results as appropriate
Method Blank	Every analytical batch (maximum of 20 samples)	Analytes not detected	1) Rerun 2) Evaluate batch 3) Reprepare affected samples or qualify results as appropriate
LCS	Every analytical batch (maximum of 20 samples)	%R = within method control limits	1) Rerun for affected analytes 2) Evaluate batch 3) Reprepare affected samples or qualify results as appropriate
MS	Every analytical batch (maximum of 20 samples)	%R = within method control limits (not applicable if parent sample concentration > 4x the spike level)	1) Rerun MS 2) Evaluate batch 3) Qualify sample results as appropriate
LD	Every analytical batch (maximum of 20 samples)	RPD ≤method control limits	1) Rerun 2) Evaluate batch 3) Qualify sample results as appropriate

[1] Analyses include total organic carbon, nitrate/nitrite (total), orthophosphate, sulfate, dissolved gases (methane, ethane, and ethene), alkalinity, volatile fatty acids, hydrogen, and DNA. Note that not all QC elements are applicable to all the listed methods.

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9.0 DATA REDUCTION, VALIDATION, AND REPORTING

The analytical data generated by the laboratory will be checked for compliance with PARCCS requirements. The data validation process for this project will consist of data generation, reduction, and two levels of review.

9.1 ANALYTICAL LABORATORY DATA REVIEW AND REPORTING

The analytical laboratory Data Reviewer who has the initial responsibility for the correctness and completeness of the data will conduct the first level of review, which may contain multiple sublevels of all project related data. All data are generated and reduced following protocols specified in USEPA SW-846, 3rd Edition, Final Update III, and the Laboratory Quality Assurance Manual (LQAM). Data reduction, QA review, and reporting by the laboratory will be completed as follows:

- Raw data produced by the analyst are processed and reviewed for attainment of QC criteria as outlined in the LQAM and/or established USEPA methods and for overall reasonableness.
- After entry into the Laboratory Information Management System (LIMS), a computerized report is generated and sent to the laboratory Data Reviewer.
- The Data Reviewer will decide whether any sample reanalysis is required.
- Upon acceptance of the preliminary reports by the Data Reviewer, final reports will be generated.

The laboratory Data Reviewer will evaluate the quality of the work based on an established set of laboratory guidelines. This person will review the data package to ensure that:

- Sample preparation information is correct and complete;
- Analysis information is correct and complete;
- The appropriate SOPs have been followed;
- Analytical results are correct and complete;
- QC samples are within established control limits; and
- Special sample preparation and analytical requirements have been met.

Documentation is complete when all anomalies in the preparation and analysis have been documented.

The laboratory will perform the in-house analytical data reduction and QA review under the direction of the laboratory QA Director. The laboratory Program Administrator (PA) is responsible for assessing data quality and advising the PM of any data that were rated

"preliminary" or "unacceptable", or other notations that would caution the data user of possible unreliability.

The laboratory will prepare and retain full analytical and QC documentation. Such retained documentation will not be hard (paper) copy, but will be on other storage media (e.g., magnetic tape).

The contents of the laboratory data package will include both general information and method-specific information. Each sample delivery group (SDG) data report should comprise three parts: (1) analytical results for all environmental and field QC samples; (2) summary forms for QC measures such as surrogate and spike sample recoveries, and LCS results; and (3) supporting documentation and raw data that will substantiate the summarized data and also allow for verification and recalculation of all summarized data. General information required as part of each SDG would include the following items:

- Chain-of-Custody;
- Cooler Receipt Form;
- Complete list of samples in the SDG including QC samples and their relationship to the other samples in the SDG;
- Cross reference of laboratory ID to field ID; and
- SDG narrative describing in detail any problems encountered in processing and analyses of the samples or a statement that QC criteria were met if no problems were encountered.

9.2 HYDROGEOLOGIC DATA REVIEW PROCESS

The second stage of review, which contains multiple substages, will be performed by the HGL Project Chemist, whose function is to provide an independent review of the data package. Data review will be performed at a level of detail that is dependent on the ultimate use of the data and whether screening or definitive data are required. The data uses and review requirements for the data that will be collected for this project are identified in Table 9.1. All laboratory-generated data reports will be reviewed to ensure that:

- Documentation is complete and correct (all anomalies in the preparation and analysis have been documented; noncompliance forms, if required, are complete; holding times are documented);
- The data are ready for incorporation into the final report; and
- The data package is complete and ready for data archive.

In addition to this review for data acceptability, test result will be subject to the levels of review shown in Table 9.1. These levels of review, log review, QC review, full review, and validation, are described in the subsections below.

9.2.1 Log Review Process

Log reviews will be performed by the SS or SSHO on a daily basis. This review will be performed to ensure that all field monitoring equipment were maintained, calibrated, and operated properly and that all required information has been correctly documented in the field logbooks and log sheets.

9.2.2 QC Review Process

QC review is performed to verify that the QC analyses associated with the reported sample results were in control. Data that undergoes QC review is considered to be screening level of data quality. The QC review steps performed on each analytical fraction will be documented by the Project Chemist in a data review report.

QC review of VOC analytical data will include an evaluation of:

- Sample delivery and condition,
- Holding times,
- Blank results,
- Surrogate recoveries,
- LCS/LCSD results,
- MS/MSD results,
- Field duplicate samples,
- Laboratory case narrative, and
- Completeness of the data package.

QC review of metals analytical data will include an evaluation of:

- Sample delivery and condition,
- Holding times,
- Blank results,
- LCS results,
- MS results,
- Field duplicate samples,
- Laboratory duplicate results,
- Serial dilution results,
- Post-digest spike results (if performed),
- Laboratory case narrative, and
- Completeness of the data package.

QC review of other analytical data will include, where applicable, an evaluation of:

- Sample delivery and condition,
- Holding times,

- Blank results,
- Spike recoveries (LCS/LCSD and MS/MSD),
- Duplicate analysis precision (LCSD, laboratory duplicate, field duplicate, and MSD),
- Method-specific QC data,
- Laboratory case narrative, and
- Completeness of the data package.

9.2.3 Full Review Process

Only VOCs data will receive a full review, at the frequencies specified in Table 9.1. The full review process will include all features of the QC review process, with the addition of an examination of the following QC elements:

- GC/MS instrument performance check (tuning) data,
- Initial and continuing calibration data,
- Internal standard data, and
- Recalculation of selected reported sample and QC analysis results.

9.2.4 Data Validation Process

VOCs analytical data will undergo full data validation at the frequencies specified in Table 9.1. The full validation of the analytical data includes review of all parameters identified above and the additional parameters listed below:

- Sample result, QC sample result, and instrument calibration data including quantitation reports, chromatographs, and compound identification;
- Sample run, preparation, and batch log sheets (including digestion/extraction data);
- GC/MS instrument performance check (tuning) data including mass spectra and mass listing; and
- Moisture content.

9.3 REVIEW/VALIDATION RESULTS DOCUMENTATION

The Project Chemist will identify any out-of-control data points and data omissions and interact with the laboratory to correct data deficiencies. Analytical results will be reviewed using the QC criteria established in this document, following guidance from the *USEPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review* (USEPA, 1999) and the *USEPA CLP National Functional Guidelines for Inorganic Data Review* (USEPA, 1994), as modified by the guidance presented in *Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services* (USEPA Region IV, 1999). Decisions to repeat sample collection and analysis may be made by the Project Manager based on the extent of the deficiencies and their importance in the overall

context of the project. Note that the CLP validation guidelines were written to apply to CLP analytical methods. Where the control criteria for the specific methods conflict with the CLP criteria (e.g., calibration for VOCs), the method criteria will be used to evaluate the data. In such cases, data failing method QC criteria will be qualified using the analogous procedures from the CLP guidelines.

Table 9.1
Data Use and Review Requirements

Sampling Matrix	Parameters	Method	Field/ Lab	Intended Use	Review Level
Groundwater Plume Definition					
Atmospheric	Volatile organic vapors	PID	Field	1) Health and safety monitoring; 2) Screening soil cores for sample collection	Log review
Subsurface soil	VOCs	SW8260B/SW5035A	Lab	Determine source areas for COCs	QC review
Groundwater	VOCs	SW8260B/5030B	Lab	Characterize nature, extent, and migration of contaminants	QC review
Surface water	VOCs	SW8260B/5030B	Lab	Determine if groundwater has impacted the pond	QC review
Groundwater	Water quality parameters[1]	Varies (real-time probe)	Field	1) Stabilization check; 2) Determine groundwater conditions	Log review
Pilot Study Monitoring					
Atmospheric	Volatile organic vapors	PID	Field	Health and safety monitoring	Log review (first sampling event only)
Groundwater	VOCs	SW8260B/5030B	Lab	Evaluate efficacy of pilot plant operations in removing contaminants	QC review (first sampling event only)
Groundwater	Natural attenuation parameters[2] and hydrogen, volatile fatty acids, and DNA	Varies	Lab	Evaluate potential of groundwater system to support MNA/ERC	QC review (first sampling event only)
Groundwater	Water quality parameters[1]	Varies (real-time probe)	Field	1) Stabilization check; 2) Determine groundwater conditions	Log review (first sampling event only)
Groundwater	Ferrous iron	Test kit	Field	Determine groundwater conditions	Log review (first sampling event only)
Monitoring Well Installation and Sampling					
Atmospheric	Volatile organic vapors	PID	Field	1) Health and safety monitoring; 2) Screening soil cores for sample collection	Log review
Groundwater	VOCs	SW8260B/5030B	Lab	Evaluate efficacy of pilot plant operations in removing contaminants	QC review / Full review (10% of all data)
Groundwater	Natural attenuation parameters[2] and hydrogen, volatile fatty acids, and DNA	Varies	Lab	Evaluate potential of groundwater system to support MNA/ERC	QC review (10% of all data)
Groundwater	Water quality parameters[1]	Varies (real-time probe)	Field	1) Stabilization check; 2) Determine groundwater conditions	Log review
Groundwater	Ferrous iron	Test kit	Field	Determine groundwater conditions	Log review

Table 9.1 (continued)
Data Use and Review Requirements

Sampling Matrix	Parameters	Method	Field/ Lab	Intended Use	Review Level
Corrective Action Monitoring and Long-Term Monitoring					
Atmospheric	Volatile organic vapors	PID	Field	Health and safety monitoring	Log review
Groundwater	VOCs	SW8260B/5030B	Lab	Evaluate efficacy of corrective action operations in removing contaminants	Full review / Validation (10% of all data)
Groundwater	Natural attenuation parameters[2] and hydrogen, volatile fatty acids, and DNA	Varies	Lab	Optimize corrective action to support MNA/ERC	QC review (10% of all data)
Groundwater	Water quality parameters[1]	Varies (real-time probe)	Field	1) Stabilization check; 2) Determine groundwater conditions	Log review
Groundwater	Ferrous iron	Test kit	Field	Determine groundwater conditions	Log review

[1] Water quality parameters include: temperature, pH, oxidation-reduction potential, conductance, DO, and turbidity.
[2] Natural attenuation parameters include: metals, anions, TOC, alkalinity, and dissolved gases.

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10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and systems audits may be conducted to verify documentation and implementation of the QC program, assess the effectiveness of the QAPP, identify any deviations from the QC program, and verify correction of identified deficiencies. The Program QA/QC Officer will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation.

10.1 PERFORMANCE AUDITS

The Program QA/AC Officer will evaluate the need for performance audits with due consideration given to the recommendations of the PM. Performance audits are utilized to quantitatively assess the accuracy of measurement data through the use of performance evaluation and blind check samples. The performance audit, if conducted, will be conducted by the Program QA/QC Officer or designee. Performance audits of the laboratory supporting site activities will be performed in accordance with the procedures outlined in this section.

10.2 SYSTEM AUDITS

If determined to be necessary, a system audit on fieldwork performance will be conducted by the Program QA/QC Officer during activities at the site. The SS is responsible for supervising and checking that samples are collected and handled in accordance with the approved project plans and that documentation of work is adequate and complete. The PGM is responsible for overseeing that the project performance satisfies the QC objectives as set forth in the QAPP. Reports and technical correspondence will be peer reviewed by an assigned qualified individual, otherwise external to the project, before being finalized.

The laboratory will regularly conduct the following internal audits:

- Monthly project review of 10 percent of all projects, to be conducted by the QA department;
- Quarterly audits conducted by Divisional QA Director;
- Special audits by the QA Director or corporate management when a problem is suspected or identified; and
- Yearly audits conducted by the Corporate QA Officer.

10.3 AUDIT PROCEDURES

This procedure provides requirements and guidance for performing internal and external audits to verify compliance with the elements of the QAPP.

10.3.1 Audit Notification

The PM and, if appropriate, the corresponding manager of the audited entity (e.g., SS, Laboratory Supervisor) will be notified by the Program QA/QC Officer of an audit at a reasonable time before the audit is performed. This notification will be in writing and will include information such as the general scope and schedule of the audit and the name of the audit team leader.

10.3.2 Pre-Audit Conference

A pre-audit conference will be conducted at the audit site with the appropriate manager or designated representative (e.g., SS, Laboratory Supervisor). The purpose of the conference will be to confirm the audit scope, present the audit plan, discuss the audit sequence, and plan for the post-audit conference.

10.3.3 Audit

The audit is then implemented by the audit team. Checklists prepared by the audit team and approved by the Program QA/QC Officer will be sufficiently detailed to document major audit components. Selected elements of the QAPP will be audited to the depth necessary to evaluate the effectiveness of implementation. Conditions requiring immediate corrective action will be reported immediately to the Program QA/QC Officer.

10.3.4 Post-Audit Conference

At the conclusion of the audit, a post-audit conference will be held with the SS or Laboratory Supervisor, or their designated representative, to present audit findings and clarify any misunderstandings. Audit findings will be concisely stated by the audit team leader on a list of findings. The findings will be acknowledged by signature of the PM or designated representative upon completion of the post-audit conferences.

10.3.5 Audit Report

An audit report will be prepared by the audit team leader and signed by the Program QA/QC Officer. The report will include the following:

- Description of the audit scope;
- Identification of the audit team;
- Persons contacted during preaudit, audit, and postaudit activities;
- A summary of audit results, including an evaluation statement regarding the effectiveness of the QAPP elements which were audited;
- Details of findings and program deficiencies; and
- Recommendations for correcting the findings to the Program QA/QC Officer, with a copy to the PM and others as appropriate.

10.3.6 Audit Responses

The PM or designated representative will respond to the audit report within two days of receipt. The response will clearly state the corrective action for each finding, including action to prevent recurrence and the date the corrective action will be completed.

10.3.7 Follow-Up Action

Follow-up action will be performed by the Program QA/QC Officer or designated representative to:

- Evaluate the adequacy of the PM's response;
- Assess that corrective action is identified and scheduled for each finding; and
- Confirm that corrective action is accomplished as scheduled.

Follow-up action may be accomplished through written communications, the performance of a Follow-On audit, or other appropriate means. When all corrective actions have been verified, a memo will be sent to the PM signifying the satisfactory close-out of the audit, with copies to the Responsible Professional and others as appropriate.

10.3.8 Audit Records

Original records generated for all audits will be retained within the central project files. Records will include audit reports, written replies, the record of completion of corrective actions, and documents associated with the conduct of audits which support audit findings and corrective actions as appropriate.

10.4 LABORATORY AUDIT PARTICIPATION

Environmental laboratories participate in internal and external audit and performance evaluation processes. The project laboratory will also be required to participate in the audit program established to maintain USACE certification.

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11.0 PREVENTIVE MAINTENANCE

To ensure that analytical data generated for site activities are reliable, all equipment and instruments will have an established routine maintenance schedule in addition to a calibration schedule. Preventive maintenance will be performed and documented by qualified project personnel.

11.1 FIELD INSTRUMENTS

All field instrumentation, sampling equipment, and accessories will be maintained in accordance with the manufacturer's recommendations and specifications and established field practice. All maintenance will be performed by qualified project personnel and will be documented by the appointed equipment manager or his designee under the direction of the equipment manager.

The SS and SSHO will review calibration and maintenance records on a regular basis to ensure that required maintenance is occurring. These activities will be recorded in the field logbook to document that established calibration and maintenance procedures have been followed. Field instruments will be checked and calibrated prior to their use on site, and batteries will be charged and checked daily where applicable.

11.2 LABORATORY INSTRUMENTS

The laboratory is responsible for the maintenance of laboratory equipment. Preventive maintenance will be provided on a scheduled basis to minimize down time and the potential interruption of analytical work. All instruments will be maintained in accordance with manufacturer's recommendations, the laboratory's SOPs, and good laboratory practices.

Designated laboratory personnel will be trained in routine maintenance procedures for all major instrumentation. When repairs become necessary, they will be performed by either trained staff or trained service engineers/technicians employed by the instrument manufacturer. The laboratory will have multiple instruments to serve as backup to minimize the potential for down time. All maintenance will be documented and kept in permanent logs. These logs will be available for review by auditing personnel.

Both scheduled maintenance and unscheduled maintenance required by operational failures will be recorded. The designated laboratory operations coordinator will review maintenance records on a regular basis to ensure that required maintenance is occurring.

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12.0 CORRECTIVE ACTION

The ultimate responsibility for maintaining quality throughout investigations at the MCA Barracks site rests with the PM. Responsibility for the routine operation of the QA process falls upon the SS, the Project Chemist, the Program QA/QC Officer, and the Laboratory Project Manager.

Any and all deviations from established QC procedures will be promptly identified and controlled. No additional work which is dependent on the nonconforming activity will be performed until the identified nonconformance is corrected.

12.1 FIELD CORRECTIVE ACTION

The SS will review the procedures being implemented in the field for consistency with the established protocols. Activities such as sample collection, preservation, and labeling will be checked for completeness. Where procedures are not strictly in compliance with the established protocol, the deviations will be field documented and reported to the Program QA/QC Officer. Corrective actions will be defined by the SS and PM and documented as appropriate. Upon implementation of the corrective action, the SS will provide the Project Chemist with a written memorandum documenting field implementation. The memorandum will become part of the project file.

12.2 LABORATORY CORRECTIVE ACTION

The laboratory department supervisors will review the data generated to ensure that all QC samples have been analyzed as specified in the protocol. MS/MSD results and laboratory QC data will be evaluated using the accuracy and precision QC criteria listed in Table 4.2. Data generated with LCSs that do not fall within control limits are considered suspect, and the analyses are repeated. If this is not possible, results are qualified.

Laboratory personnel are alerted that corrective actions may be necessary if:

- QC data are outside the warning or acceptance windows for precision and accuracy established for LCSs
- Blanks contain measurable concentrations for any target analyte
- Undesirable trends are observed in MS/MSD recoveries or RPD between MS/MSDs or laboratory duplicates
- There are unusual changes in instrument sensitivity
- Deficiencies are detected by the laboratory QA director during internal or external audits, or from the results of performance evaluation samples.

If any discrepancies in analytical methodologies, QC sample results, or method performance are identified by the bench analyst, corrective actions will be implemented immediately at the bench level by the analyst. The analyst will review the preparation or extraction procedure for

possible errors, check the instrument calibration, spike and calibration mixes, instrument sensitivity, and other relevant information. The analyst will immediately notify his/her supervisor of the problem that has been identified and the investigation that is being conducted. If the problem persists or cannot be identified, the matter will be referred to the Laboratory PM for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the Laboratory PM and the Program QA/QC Officer is provided a corrective action memorandum for inclusion into the project file if data are affected.

Corrective action may include, but will not be limited to:

- Re-extracting and reanalyzing suspect samples
- Re-collecting and analyzing new samples
- Evaluating and amending sampling or analytical procedures
- Accepting data with an acknowledged level of uncertainty
- Recalibrating analytical instruments and reanalyzing affected samples.

Data deemed unacceptable following the implementation of the required corrective action measures will not be accepted by the PM, and follow-up corrective actions will be implemented.

13.0 RECORDKEEPING

Bound logbooks will be utilized for all recordkeeping purposes both in the field and laboratory. The use of bound books will result in a chronological sequence of data insertion. To facilitate data validation and to enable project personnel to accurately recreate the sequence of field events, the time of all recorded entries must be noted in the logbook, and all logbook entries must be signed and dated by the person making the entry. All entries must be recorded in ink. Correction to entries shall be made by drawing a line through the incorrect entry, recording the correct information, and initialing and dating the corrected entry. If computerized information is utilized, a hard copy that has been permanently affixed to the logbook will be acceptable as an original record of sampling and laboratory logging.

Logbooks containing information specific to the project will be forwarded to USACE at the end of the project. Should the need for corporate controlled logbooks arise, copies of all relevant logbook pages shall be submitted.

13.1 PROJECT FILES

Documents used or generated during the course of the project will be accounted for and become a part of the project files upon completion of the task. Complete project file records will be maintained in HGL's Albany, New York, office and will be updated by the Project Administrator under direction by the PM. Project records included in the file may include, but are not limited to the following:

- Sample identification documents and field logbooks;
- Chain-Of-Custody records;
- Inventory of IDW;
- Project deliverables (such as test plans, operations manuals, design drawings, and specifications);
- Analytical logbooks, laboratory data, calculations, graphs, control charts, field logs (to include instrument identification numbers, calibration, and measurements), and software;
- Reports and correspondence material;
- Records of deviation from the Work Plan, FSP, and QAPP; and
- Photographs.

When an error is made on a primary document, corrections are made by drawing a single line through the error and entering the correct information. The correction must also be initialed and dated. If appropriate, a brief explanation may be provided explaining the reason the correction was made. The marked copies of checked material shall be retained for future reference. Notes, calculations, and other information marked on documents assist in follow-up design and aid in rechecking portions of documents.

13.2 FIELD LOGBOOKS

Logbooks for sampling and field investigation purposes must meet the requirement procedures provided in Section 2.9 of the FSP. They must be bound and entries recorded in waterproof ink. The logbook must contain sufficient information to distinguish samples from each other.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The SS will report to the PM on a daily basis regarding progress of the fieldwork and QC issues associated with the field activities. Details will be provided in a Daily Quality Control Report (DQCR). Laboratory QA reports to management will be prepared in accordance with the laboratory SOPs.

The project laboratory will maintain detailed procedures for laboratory recordkeeping in order to support the validity of all analytical work (see Section 6.0). Each SDG report submitted to the Project Chemist will contain the laboratory's written certification that the requested analytical method was run and that all QA/QC checks were within the established control limits on all samples. The Laboratory PM will provide the Project Chemist and the Program QA/QC Officer with QA reports of their external and internal audits on request (see Section 10.5).

After receipt of all the analytical data, the Project Chemist will submit a QA report to the Program QA/QC Officer and PM describing the accuracy and precision of the data collected. If necessary, verbal reports will be made based on the data reports and other information reported orally to the Project Chemist by the contract laboratory. If any problems are encountered, the Laboratory PM will issue a written report to the Project Chemist who will immediately report the problem(s) to the Program QA/QC Officer and the PM.

After the fieldwork has been completed and the final analyses are completed and checked, a final Quality Control Summary Report (QCSR) will be prepared by the Project Chemist. The report will summarize the quality assurance and audit information, indicating any corrective actions taken and the overall results of all QC activities. The Project Chemist, in coordination with the contract laboratory's QA Director or their qualified designee, will prepare this final corrective action summary and submit this to the Program QA/QC Officer for review.

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15.0 REFERENCES

U.S. Air Force Center for Environmental Excellence (AFCEE), September 1996. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater.*

U.S. Army Corps of Engineers (USACE), August 1998. *Technical Project Planning (TPP) Process*. Engineer Manual EM 200-1-2.

USACE, February 2001. *Requirements for the Preparation of Sampling and Analysis Plans.* Engineer Manual EM 200-1-3.

U.S. Department of Defense (DoD), 2002. *Environmental Data Quality Workgroup, Department of Defense Quality Systems Manual for Analytical Laboratories*.

U.S. Environmental Protection Agency (USEPA), February 1994. USEPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.*

USEPA, 1997. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, including updates I, II, and III.

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USEPA Region IV, 1999. *Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services*

USEPA, August 2000. *Guidance for the Data Quality Objectives Process*. EPA QA/G-4.

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APPENDIX A

STL LABORATORY
QUALITY ASSURANCE PROJECT PLAN

projects or revealed except in conjunction with project work to anyone outside the laboratory without permission of the client.

STL's reports, and the data and information provided therein, are for the exclusive use and benefit of client, and are not released to a third party without written consent from the client (*Client Confidentiality*; UQA-004).

4.8 Complaints

STL believes that effective client complaint handling processes have important business and strategic value. Listening to and documenting client's concerns captures 'client knowledge' that helps to continually improve processes and outpace the competition. Implementing a client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly. The investigation of the cause, resolution and authorization of corrective action is documented [*Sample Discrepancy Report (SDR), Resubmitted Data Request (RDR), Corrective Action Report (CAR)*; UQA-029].

Client complaints are documented by the employee receiving the complaint. The documentation can take the form of a Resubmitted Data Request (RDR) or in a format specifically designed for that purpose (e.g., phone conversation record or e-mail). The Laboratory Director, Project Manager and/or QA Manager are informed of client complaints and assist in resolving the complaint.

The RDR is used after the client has received the analytical report and their specifications, expectations, or client satisfaction was not achieved. RDRs are prepared when clients request re-evaluation of submitted data, when additional information is requested or for general complaints.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA department is required to conduct a special audit to assist in resolving the issue. A written confirmation, or letter to the client outlining the issue and response taken, is strongly recommended as part of the overall action taken.

The number and nature of client complaints is reported by the QA Manager to the QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the *Quality Systems Management Review* (UQA-002).

4.9 Control of Non-conformances

Non-conformances include any out of control occurrence. Non-conformances may relate to client specific requirements, procedural requirements, or equipment issues. All non-conformances in the laboratory are documented at the time of their occurrence on Corrective Action Reports (CARs) specifically formatted for each department or on a SDR.

4.6.1 Solvent and Acid Lot Verification

Pre-purchase approval is performed for solvents and acids purchased in large quantities unless a certificate of conformance has been furnished. These may include acetone, ethyl ether, hexane, methylene chloride, nitric acid, hydrochloric acid, sulfuric acid, and hydrogen peroxide. Each lot of incoming supplies requiring pre-approval is checked against the previously approved lot number. If the lot number is not approved, the lot is refused. If the lot number is an approved lot number, it is accepted and documented. Solvents and acids are pre-tested in accordance with STLs Corporate *Testing Solvents and Acids* procedure (S-T-001) for all of the STL laboratories.

4.7 Service to the Client

4.7.1 Sample Acceptance Policy

Samples are considered "compromised" if the following conditions are observed upon sample receipt:

- Cooler and/or samples are received outside of temperature specification.
- Samples are received broken or leaking.
- Samples are received beyond holding time.
- Samples are received without appropriate preservation.
- Samples are received in inappropriate containers.
- COC does not match samples received.
- COC is not properly completed or not received.
- Breakage of any Custody Seal.
- Apparent tampering with cooler and/or samples.
- Headspace in volatiles samples.
- Seepage of extraneous water or materials into samples.
- Inadequate sample volume.
- Illegible, impermanent, or non-unique sample labeling.

When "compromised" samples are received, it is documented on the hardcopy COC, the LabNet Sample Receipt Checklist and on a Sample Discrepancy Report (SDR); and the client is contacted for instructions. If the client decides to proceed with the analysis, the project report will clearly indicate any of the above conditions and the resolution.

4.7.2 Client Confidentiality and Proprietary Rights

Data and sample materials provided by the client or at the client's request, and the results obtained by STL, shall be held in confidence (unless such information is generally available to the public or is in the public domain or client has failed to pay STL for all services rendered or is otherwise in breach of the terms and conditions set forth in the STL and client contract) subject to any disclosure required by law or legal process. Technical, business and proprietary information provided by a client and data/information generated by the laboratory are restricted for the use within the laboratory for purposes of accomplishing the project. Client information is not to be used on other

4.5 Subcontracting

Subcontracting is arranged with the documented consent of the client, in a timely response which shall not be unreasonably refused. All QC guidelines specific to the client's analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Proof of holding required certifications from the subcontract facility are maintained in the project records. Where applicable, the specific QC guidelines, QAPPs, and/or SAPs are transmitted to the subcontract laboratory. Samples are subcontracted under formal Chain of Custody (COC).

Subcontract laboratories may receive an on-site audit by a representative of STL's QA staff if it is deemed appropriate by the QA Manager. The audit involves a measure of compliance with the required test method, QC requirements, as well as any special client requirements (e.g., Technical Profile and LabNet Project Notes). STL may also perform a paper audit of the subcontractor, which would entail reviewing the LQM, the last two PT studies, and a copy of any recent regulatory audits with the laboratory's responses.

Intra-company subcontracting may also occur between STL facilities. Intra-company subcontracting within STL is arranged with the documented consent of the client (e.g., QAPP). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. STL has implemented a standard form for Intra-laboratory subcontracting, refer to the following document for specific details: *Work Sharing Process – Policy No.: S-C-001.*

Project reports from both STL and external subcontractors are not altered and are included in their original form in the final project report provided by STL. This clearly identifies the data as being produced by a subcontractor facility. All data, as required in Section 5.9.4, is included.

4.6 Purchasing Services and Supplies

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specific requirements, all purchases from specific vendors are approved by a member of the supervisory or management staff.

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Purchasing guidelines for equipment and reagents meet with the requirements of the specific method and testing procedures for which they are being purchased. The measurements for evaluation and selection of suppliers; the acceptance of supplies and services; and certificates of conformance are described in the procurement SOP (*Procurement Quality Assurance Process*; UQA-020).

4.4.3.6 Additional DQOs

Method Detection Limits

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to Appendix B of 40 CFR 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants". MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually. *(UQA-017)*

For the performance of non-routine methods, e.g., client/contract requirement, MDLs or Method Validation Studies will be completed on an as needed basis. The turnaround time for such studies will be as determined by the client and Project Manager. Such studies will be reviewed and approved by the client and/or regulatory agency prior to project implementation.

Instrument Detection Limits

There are a number of ways to determine Instrument Detection Limit (IDL) sensitivity (e.g., signal-to-noise ratio; precision of the low-level standard; lowest calibration curve point or the IDL study defined within CLP). The method and means in which IDLs are determined are documented and maintained in the QA department for each individual instrument.

IDLs are generated for each element by the metals laboratory quarterly via each instrument as specified in CLP. These limits are used to gauge instrument sensitivity and when routinely evaluated, instrument performance without the introduction of method variance can be determined. *(UQA-010)*

Reporting Limits

Reporting Limits are defined as the lowest concentration of an analyte determined by a given method in a given matrix that the laboratory feels can be reported with acceptable quantitative error or client requirements, values specified by the EPA methods or other project and client requirements. The laboratory reporting limits are further related and verified by the lowest point on a calibration curve. Because of the high level of quantitative error associated with determinations at the level of the MDL, the laboratory maintains reporting limits higher than the MDL. Wherever possible, reporting is limited to values approximately 2-5x the respective MDL to ensure confidence in the value reported. Client specific requests for reporting to the IDL or MDL are special circumstances not to be confused with the previous statement. Data evaluated down to the MDL/IDL is qualified as estimated with a 'J' for organic analyses and a 'B' for inorganic analyses on the data report.

MDL studies are performed annually, and reporting limits are assessed. If the MDL does not meet the routine laboratory reporting limit or the method specified limit, it is repeated or the laboratory reporting limit is reassessed. If the laboratory continually demonstrates that the method reporting limits are not achieved, equipment, technique, and the method are reviewed to assure optimal performance or appropriate action is taken.

Both random and systematic errors can affect accuracy. For chemical properties, accuracy is expressed either as a percent recovery (R) or as a percent bias (R - 100). Accuracy is determined, in part, by analyzing data from LCSs, MS and MSD.

Accuracy and Precision objectives employed by the laboratory are as defined in the CERCLA's Inorganic and Organic Statements of Work (SOW); statistically-derived control limits; or default limits as listed in each respective method SOP.

4.4.3.3 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, a variation in a physical or chemical property at a sampling point, or an environmental condition. Data representativeness is primarily a function of sampling strategy; therefore, the sampling scheme must be designed to maximize representativeness. Representativeness also relates to ensuring that, through sample homogeneity, the sample analysis result is representative of the constituent concentration in the sample matrix. STL makes every effort to analyze an aliquot that is representative of the original sample, and to ensure the homogeneity of the sample before sub-sampling.

4.4.3.4 Completeness

Completeness is defined as the percentage of measurements that are judged valid or useable. Factors negatively affecting completeness include the following: sample leakage or breakage in transit or during handling, loss of sample during laboratory analysis through accident or improper handling, improper documentation such that traceability is compromised, or sample result is rejected due to failure to conform to QC specifications. A completeness objective of greater than 90% of the data specified by the statement of work is the goal established for most projects.

4.4.3.5 Comparability

Comparability is a measure of the confidence with which one data set can be compared to another. To ensure comparability, all laboratory analysts are required to use uniform procedures (e.g., SOPs) and a uniform set of units and calculations for analyzing and reporting environmental data.

A measure of inter-laboratory comparability is obtained through the laboratory's participation in proficiency testing (PT) programs established with Water Supply (WS), Water Pollution (WP), Solid Waste (SW), and Underground Storage Tank (UST) programs. In addition, the laboratory employs the use of NIST or EPA traceable standards, when available, to provide an additional measure of assurance of the comparability of data.

Project representativeness and comparability are dependent upon the sampling plan on a project specific basis, and are therefore not covered in this LQM. Assessment of site and collection representativeness and comparability is performed by the field engineer.

STL strongly encourages our clients to visit the laboratory and hold formal or informal sessions with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

4.4.3 Data Quality Objectives

Data quality objectives (DQO) are qualitative and quantitative statements used to ensure the generation of the type, quantity, and quality of environmental data that will be appropriate for the intended application. Typically, DQOs are identified before project initiation and during the development of a QAPPs and SAPs. The analytical DQOs addressed in this section are precision, accuracy, representativeness, completeness, and comparability.

The components of analytical variability (uncertainty) can be estimated when QC samples of the right types and at the appropriate frequency are incorporated into the measurement process of the laboratory. STL incorporates numerous QC samples to obtain data for comparison with the analytical DQOs and to ensure that the measurement system is functioning properly. The control samples and their applications, described in Section 5.8.2, are selected based on regulatory, method- or client-specific requirements. Analytical QC samples for inorganic and organic analyses may include calibration blanks, instrument blanks, method blanks, LCS, calibration standards, MS, MSD, MD, surrogate spikes, and yield monitors.

The DQOs discussed below ensure that data are gathered and presented in accordance with procedures appropriate for its intended use, that the data is of known and documented quality, and are able to withstand scientific and legal scrutiny.

4.4.3.1 Precision

Precision is an estimate of variability. It is an estimate of agreement among individual measurements of the same physical or chemical property, under prescribed similar conditions. Precision is expressed either as Relative Standard Deviation (RSD) for greater than two measurements or as Relative Percent Difference (RPD) for two measurements. Precision is determined, in part, by analyzing data from LCSs, MS, MSD, and MD. A description of these control samples is provided in Section 5.8.2.

Precision also refers to the measurement of the variability associated with the entire process, from sampling to analysis. Total precision of the process can be determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations.

4.4.3.2 Accuracy

Accuracy is the degree of agreement between a measurement and the true or expected value, or between the average of a number of measurements and the true or expected value. It reflects the total error associated with a measurement.

acceptance of the contract. Contract amendments, initiated by the client and/or STL, are documented in writing for the benefit of both the client and STL.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the permanent project record as defined in Section 4.12.1.

4.4.2 Project-Specific Quality Planning

Communication of contract specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, STL assigns a Project Manager (PM) to each client. The PM is the first point of contact for the client. It is the PM's responsibility to ensure that project specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project (*Project Planning Process*; UPM-003). QA department involvement may be needed to assist in the evaluation of custom QC requirements.

PM's are the direct client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure that the available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project Technical Profile (e.g., LabNet Project Notes) turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through *Project Kick-Off Meetings (UPM-002)* or to the supervisory staff during *Production Meetings (UPM-004)*. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition, the LabNet Project Notes are associated with each sample batch (e.g., Job) as a reminder upon sample receipt and analytical processing.

Any changes that may occur within an active project is agreed upon between the client/regulatory agency and the Project Manager/laboratory. These changes (e.g., use of a non-standard method or modification of a method) must be documented prior to implementation. Documentation pertains to any document, e.g., letter, variance, contract addendum, which has been signed by both parties.

Such changes are also communicated to the laboratory through the management Production Meetings which are conducted three times per week (T,W,Th). Such changes are updated to the LabNet Project Notes and are introduced to the managers at these meetings. The laboratory staff is then introduced to the modified requirements via the Project Manager or the individual laboratory section manager. After the modification is implemented into the laboratory procedure, documentation of the modification is made in the case narrative of the data report(s).

4.3.2 Data Control

All raw data, such as bound logbooks, instrument printouts, magnetic tapes, electronic data, as well as final reports, are retained for a minimum period of 5 years. Such data may be maintained longer, as defined by client and project requirements. The procedure for archiving records and client or project specific requirements is contained in the *Record Retention and Purging* SOP (UDM-002).

Raw data and reports are documented and stored in a manner in which they are easily retrievable. The procedure for maintaining raw data records is briefly described below:

- Instrument print-outs for conventional inorganic parameters are filed by LabNet Batch Number. Inorganic Metals are filed by Instrument and Filename. Generally, current year and previous year documents are kept on file in the laboratory sections.
- All raw data, for example, instrument print-outs and logbooks, are maintained in an on-site and secured storage area.
- The computer information is backed up on tape daily, and stored in a secured and temperature/humidity controlled environment to maintain the integrity of the electronic information in the event of system failure. Copies of all back-up tapes are maintained in secured off-site locations.
- All copies of client final reports are maintained electronically (e.g., Adobe Acrobat).

4.4 Request, Tender, and Contract Review

4.4.1 Contract Review

For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is STL's intent to provide both standard and customized environmental laboratory services to our clients. To ensure project success, technical staff performs a thorough review of technical and QC requirements contained in contracts. Contracts are reviewed for adequately defined requirements and STL's capability to meet those requirements.

All contracts entered into by the laboratory are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity, accuracy, and precision requirements. The reviewer ensures that the laboratory's test methods are suitable to achieve these requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The review also includes the laboratory's capabilities in terms of turnaround time, capacity, and resources to provide the services requested, as well as the ability to provide the documentation, whether hardcopy or electronic. If the laboratory cannot provide all services but intends to subcontract such services, whether to another STL facility or to an outside firm, this will be documented and discussed with the client prior to contract approval.

Any contract requirement or amendment to a contract communicated to STL verbally is documented and confirmed with the client in writing. Any discrepancy between the client's requirements and STL's capability to meet those requirements is resolved in writing before

The QA Manager reports where appropriate action can be affected. However, should a situation arise where acceptable resolution of identified problems cannot be agreed upon at the laboratory level, direct access to STL's Corporate Quality Director is available. This provides laboratory QA personnel non-laboratory management support, if needed, to ensure that QA policies and procedures are enforced.

The QA Manager or QA Specialist conducts annual LQM training for all laboratory and administrative personnel to ensure their familiarity with the quality documentation and the implementation of the policies and procedures in their work.

4.3 Document Control

The laboratory maintains procedures to control documents and analytical data. Since intensive data is generated and this is our primary product, document control is inherently segregated from data control, as described further in Sections 4.3.1 and 4.3.2.

4.3.1 Document Control Procedure

Security and control of documents are necessary to ensure that confidential information is not distributed and that all current copies of a given document are from the latest applicable revision (*Document Control*; UQA-006). Unambiguous identification of a controlled document is maintained by identification of the following items in the document header: Document Number, Revision Number, Effective Date, and Number of Pages. Document control may be achieved by either electronic or hardcopy distribution.

Controlled documents are authorized by the QA Department and are marked as either "Controlled" or "Uncontrolled" and records of their distribution are kept by the QA Department. Controlled status is defined as the continuous distribution of document updates. Uncontrolled status is defined as the single distribution of the current SOP. Document updates are not distributed to uncontrolled status holders. For tracking purposes, a control copy number is assigned to documents distributed with a controlled status. All copy numbers are written or typed in red to easily identify the SOP as a controlled copy.

4.3.1.1 Document Revision

Changes to documents occur when a procedural change warrants a revision of the document. When an approved revision of a controlled document is ready for distribution, obsolete copies of the document are replaced with the current version of the document. The previous revision of the controlled document is stamped "ARCHIVED COPY" and is filed by the QA Specialist in the QA library. Only the most current revision is maintained electronically.

SOPs are updated on a 12-18 month basis, which is tracked by an established review schedule (*Approved SOP Listing*; CHI-22-09-SOP List). These reviews are conducted by the creator of the SOP and/or Department Manager, QA Specialist and/or QA Manager, and the Health and Safety Coordinator, all of whom provide the approval signature for each SOP.

4.2 Quality System

Organizational support for implementing the quality system and achieving the quality objectives is derived from this LQM, SOPs and Work Instructions. Within these documents, management with executive responsibilities ensures that the quality policy is understood, implemented, and maintained at all levels of the organization. The development and implementation of appropriate accountabilities, duties, and authority by organizational positions are clearly delineated. Line organizations achieve and verify that specifications are achieved; QA organizations assist and provide oversight and verification of processes through planning, reviews, audits, and surveillances. Top management leadership, support and direction ensures that the policies and procedures are appropriately implemented.

4.2.1 Objectives of the Quality System

The goal of the quality system is to ensure that business operations are conducted with the highest standards of professionalism in the industry.

To achieve this goal, it is necessary to provide our clients with not only scientifically sound, well documented, and regulatory compliant data, but also to ensure that we provide the highest quality service available in the industry with uncompromising data integrity. A well-structured and well-communicated quality system is essential in meeting this goal. The laboratory's quality system is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

As stated in Section 1.3, this LQM, Work Instructions and the SOPs themselves are the basis and outline for our quality and data integrity system and contains requirements and general guidelines under which the laboratory conducts our operations. In addition, other documents may be used by the laboratory to clarify compliance with quality system or other client requirements. As you read this LQM, you will note SOP or Work Instruction numbers in parenthetic text. These numbers refer to the laboratory procedure(s) associated with the subject item. A table listing these quality system policies and procedures is appended to this document.

The QA Manager and QA Specialist are responsible for implementing and monitoring the Quality System. The QA Manager reports to the Laboratory Director on the performance of the quality system for review and continuous improvement. The QA Manager has sufficient authority, access to work areas, and organizational freedom (including sufficient independence from cost and schedule considerations) to:

- Initiate action to prevent the occurrence of any nonconformities related to product, process and quality system,
- Identify and record any problems affecting the product, process and quality system,
- Initiate, recommend, or provide solutions to problems through designated channels,
- Verify implementation of solutions, and
- Assure that further work is stopped or controlled until proper resolution of a non-conformance, deficiency, or unsatisfactory condition has occurred and the deficiency or unsatisfactory condition has been corrected.

The Health and Safety Coordinator responsibilities additionally include waste management of laboratory generated hazardous waste in accordance with appropriate regulations. This includes maintenance of required documentation, such as waste manifests, segregation of waste in accordance with requirements, and training of personnel in proper segregation of waste.

4.1.2.9 Information Technology Manager

The overall role of the Information Technology (IT) Manager is to enhance laboratory productivity through improved information access, flow, and security. For information to be of greatest value, it must be readily accessible and reliable. It is the responsibility of the IT Manager to provide software tools that allow quick and user friendly access to that information, while at the same time controlling access to that information to those that have the need and proper authority.

Information flow can be enhanced through automation. Automation is the minimization of human intervention in a process. Reduction in human intervention can result in significant error reductions and time savings. The IT Manager assists the laboratory in automation by providing hardware and software solutions to help minimize human intervention in data collection, processing, and storage.

The IT Manager is responsible for providing data security by controlling access, as mentioned above, and for providing for disaster recovery. Data stored on the central Laboratory Information Management System (LIMS, a.k.a., LabNet) is the direct responsibility of the IT Manager. No fewer than two copies of all data should exist at any time so that lost or destroyed data can always be retrieved from an alternate source. These copies may consist of data within the system and on magnetic tape in the case of live data, or two copies on magnetic tape for archived data. Data stored electronically in other departments is the direct responsibility of those departments. However, the IT Manager is responsible for providing procedures and training to all laboratory operations, as appropriate, to assist in making backup copies of local data within the respective operating unit.

STL has established procedures for IT management:

- *Internet Use Policy* – P-I-001
- *Electronic Mail Use* – P-I-002
- *Computer Systems Account and Naming Policy* – P-I-003
- *Computer Systems Password Policy* – P-I-004
- *Software Licensing Policy* – P-I-005
- *Virus Protection Policy* – P-I-006

4.1.2.10 Chemists / Technicians

Any effective laboratory quality assurance/quality control program depends on the entire organization, including management and every individual on the laboratory staff. The initial review for acceptability of analytical results rests with the analysts conducting the various tests. Observations made during the performance of an analytical method may indicate that the analytical system is not in control. Analysts must use quality control indicators to assure that the method is in-control before reporting results.

4.1.2.6 Data Management Section Manager

The Data Management Section Manager is responsible for coordinating receipt of all data from the various service groups within the laboratory, reviewing data for compliance to laboratory QC criteria and/or criteria in the Project Technical Profile, and ensuring that data are reported in a timely manner and in the proper format.

4.1.2.7 Quality Assurance Specialist

The QA Specialist is responsible for QA documentation and involvement in the following activities:

- Assist the QA Manager in performing the annual internal laboratory audits, compiling the evaluation, and coordinating the development of an action plan to address any deficiency identified.
- Facilitate external audits, coordinating with the QA Manager and Laboratory Staff to address any deficiencies noted at the time of the audit and subsequently presented in the final audit report.
- Assist the QA Manager in the preparation of new SOP's and in the maintenance of existing SOPs, coordinating annual reviews and updates.
- Manages the performance testing (PT) studies, coordinates follow up studies for failed analytes and works with QA Manager and Laboratory Staff to complete needed corrective action reports.
- Personnel training records review and maintenance.
- Document control maintenance.
- Assists the Quality Manager and Project Management Group in the review of program plans for consistency with organizational and contractual requirements. Summarize and convey to appropriate personnel anomalies or inconsistencies observed in the review process.
- Manages certifications and accreditations.
- Monitors for compliance the following QA Metrics: Temperature Monitoring of refrigeration units and incubators; thermometer calibrations; balance calibrations; eppendorf/pipette calibrations; and proper standard/reagent storage.
- Periodic checks on the proper use and review of instrument logs.
- Initiate the Mint-miner data file review process for organic instrumentation. Maintain tracking sheet of activity.
- Initiate the annual Instrument review.
- Assist in the technical review of data packages which require QA review.

4.1.2.8 Health and Safety Coordinator / Waste Management

The Health and Safety Coordinator is responsible for the safety and well-being of all employees while at the laboratory. This includes, but is not limited to, administering the Corporate Safety Manual that complies with federal regulations, MSDS training and review, conducting laboratory safety orientation and tours for all new employees, providing instructions on safety equipment, cleaning up laboratory spills, and instructing personnel of laboratory procedures for emergency situations. The Health and Safety Coordinator is on-call 24-hours a day, 7-days a week for all laboratory situations.

requirements are understood by the laboratory, and advising the Laboratory, QA and Technical Managers of all variances. The laboratory Project Manager will provide technical guidance and the necessary laboratory-related information to the preparer of project-specific QAPPs and provide peer review of the final document to ensure accuracy of the laboratory information.

4.1.2.4 Technical Managers

The Technical Managers are the Laboratory Director, laboratory Section Managers and the QA Manager. They are as follows:

- Michael J. Healy, Laboratory Director, BS Environmental Biology,
- 22 years laboratory experience.
- Terese A. Preston, Quality Assurance Manager, BA Biology,
- 20 years laboratory experience.
- Diane L. Harper, Inorganics Section Manager, MA Biology,
- 24 years laboratory experience.
- Jodi L. Wojcik, Metals Section Manager, BS Biology,
- 18 years laboratory experience.
- Patti J. Gibson, Chromatography/Organic Extractions Section Manager, BS Biology,
- 15 years laboratory experience.
- Gary L. Rynkar, GC/MS Section Manager, BS Environmental Biology,
- 16 years laboratory experience.

All of these managers report to the Laboratory Director and serve as the technical experts on assigned projects, provide technical liaison, assist in resolving any technical issues within the area of their expertise; and implement established policies and procedures to assist the Laboratory Director in achieving section goals. The Technical Managers are responsible for ensuring that their personnel are adequately trained to perform analyses; that equipment and instrumentation under their control is calibrated and functioning properly; that system and performance audits are performed on an as-needed basis; provide input and review in the development and implementation of project-specific QA/QC requirements; and for providing the critical review of proposal and project work for programs as directed by the Laboratory Director. The Technical Managers coordinate these activities with the project management and quality assurance sections.

4.1.2.5 Sample Management Coordination

The Project Manager is designated as the Sample Management Coordination for any work subcontracted under their management. The Project Manager verifies each subcontracting request to ensure that special client restrictions are not jeopardized (e.g., samples must be analyzed by the receiving affiliated or network laboratory and must maintain specific certification(s)). The Project Manager is also responsible for verifying the credentials; establishing the service agreement; ensuring data review; and invoicing of all laboratory subcontractors. The Project Manager discusses any deficiencies or anomalies with the subcontractor prior to reporting any data to the client.

4.1.2.1 Laboratory Director

The ultimate responsibility for the generation of reliable laboratory data rests with the Laboratory Director, who is accountable to his General Manager and oversees the daily operations of the laboratory. The Laboratory Director's responsibilities include allocation of personnel and resources, setting goals and objectives for both the business and employees, achieving the financial, business and quality objectives of STL. Furthermore, to see that all tasks performed in the laboratory are conducted according to the requirements of this LQM, the Project Technical Profile and/or the appropriate QAPP; and to assure that the quality of service provided complies with the project's requirements.

The Laboratory Director has the authority to affect those policies and procedures to ensure that only data of the highest level of excellence are produced. As such, the Laboratory Director supports a QA Section which has responsibilities independent from sampling and analysis.

The Laboratory Director, with the assistance of the Quality Assurance Manager, has the overall responsibility for establishing policies that ensure the quality of analytical services meet our clients expectations. These policies are defined in this LQM.

4.1.2.2 Quality Assurance Manager

The Quality Assurance (QA) Manager has the full-time responsibility to evaluate the adherence to policies and to assure that systems are in place to produce the level of quality defined in this LQM. The QA Manager is responsible for the approval of IDL/MDL studies, method validation studies, IDOC and CDOC evaluations, the annual review of statistical control limits, data package inspections, and LIMS system method development, validation and maintenance. In addition, the QA Manager assists in the preparation, compilation, and submittal of quality assurance plans; reviews program plans for consistency with organizational and contractual requirements and advises appropriate personnel of deficiencies. The QA Manager is assisted by the QA Specialist in the maintenance of QA records, certifications, accreditations, internal and external audits, corrective action procedures, management of the laboratory's PT Program, and maintenance of training documentation.

The QA Manager shall have the final authority to accept or reject data, and to stop work in progress in the event that procedures or practices compromise the validity and integrity of analytical data. The QA Manager is available to any employee at the facility to resolve data quality or ethical issues. The QA Manager must address any data integrity issue identified internally or externally, establish a corrective action plan and resolve the issue to the client's satisfaction. Issues that involve data recall must be discussed with the Corporate Quality Director Ray Frederici. The QA Manager shall be independent of laboratory operations and has an indirect reporting relationship to the QA Director.

4.1.2.3 Project Managers

The laboratory recognizes the importance of efficient project management. The laboratory Project Managers (PM) are responsible for preparing the Project Technical Profile which summarizes QA/QC requirements for the project, maintaining the laboratory schedule, ensuring that technical

4.1.1 Laboratory Facilities

The laboratory is located in University Park, IL, which is approximately 30 miles south of Chicago, and is staffed by 84 professionals. The laboratory is comprised of 51,000 square feet of state-of-the-art commercial laboratory and office space and houses both inorganic and organic operations. The facility is divided into separate work areas to facilitate sample throughput. These areas include the following:

- Sample receipt and refrigerated storage
- Organic sample preparation
- Glassware preparation
- Metals digestion
- Wet chemistry laboratory
- Instrumentation laboratories

The main instrumentation laboratory is equipped with state-of-the-art instrumentation and sufficient duplicate equipment to provide back-up service for most major systems. A listing of laboratory equipment and instrumentation is referenced as Work Instruction No. CHI-22-09-103. Table 3 is a summary of the major laboratory instruments.

Table 3. Major Equipment List

GC	GC/MS	AA	ICP	CVAA	HPLC	AutoAnalyzer	IC	TOC	TOX
15	14	3	3	2	6	2	2	2	2

Each of these areas has separate heating, ventilation, and air conditioning systems. Non-destructive gas chromatographic detectors and GC/MS rotary pumps are vented out of the instrumentation through charcoal filters.

4.1.2 Roles and Responsibilities

The specific duties and responsibilities of the Laboratory Director, Quality Assurance Manager, Project Managers, Technical Managers, Sample Management Coordination, Data Management Section Manager, Quality Assurance Specialist, Health and Safety Coordinator/Waste Management, Information Technology Manager, and Chemists/Technicians are as follows.

In the absence of any one individual, the staff or assistant within each department is professionally skilled in the ability to administer the function of the administrator or support personnel. This will allow for the continuance of the day-to-day operations of the laboratory.

STL Chicago Operations

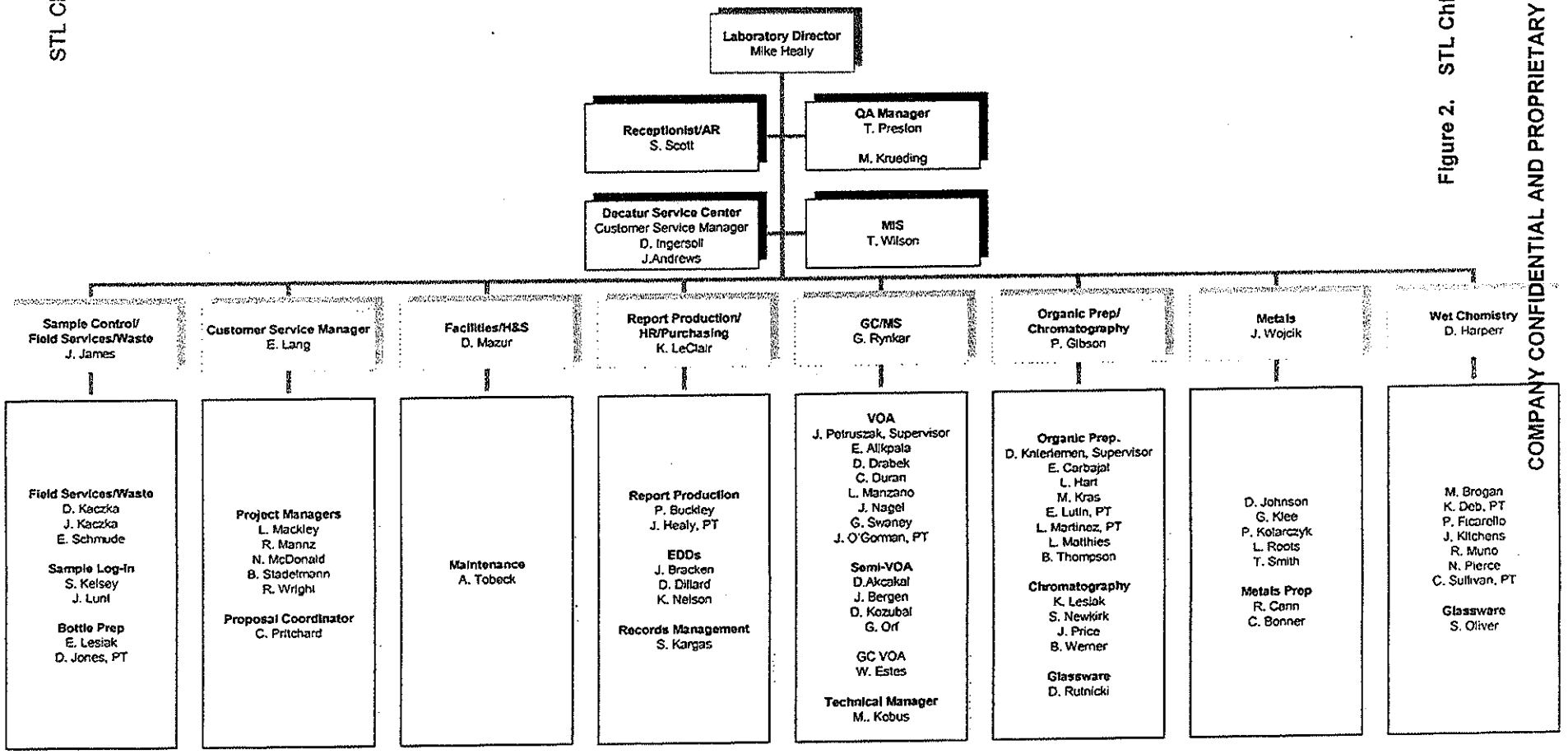


Figure 2. STL Chicago Organizational Chart

May 27, 2004

SEVERN TRENT STL

Severn Trent Laboratories, Inc.
Management Structure
January 1, 2004

Figure 1. STL Organization Chart

Storage Blank: A blank matrix stored (2-weeks) with field samples of a similar matrix (volatiles only) that measures storage contribution to any source of contamination. OR A blank matrix stored with field samples of a similar matrix.

Systems Audit: A thorough, systematic, on-site, qualitative review of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system.

Test Method: Defined technical procedure for performing a test.

Toxic Substances Control Act (TSCA): Legislation under 15 U.S.C. 2601 et seq., (1976).

Traceability: The property of a result of a measurement that can be related to appropriate international or national standards through an unbroken chain of comparisons.

Trip Blank (TB): A blank matrix placed in a sealed container at the laboratory that is shipped, held unopened in the field, and returned to the laboratory in the shipping container with the field samples.

Verification: Confirmation by examination and provision of evidence against specified requirements.

4.0 Management Requirements

The organizational chart of STL is presented in Figure 1. Corporate employees are located at various STL facilities as outlined in the organizational structure. The organizational chart of STL Chicago is presented in Figure 2.

4.1 Organization and Management

The Laboratory Director and Quality Assurance Manager are responsible and have the signature authority for approving and implementing this plan. Additional signatory authorities for the approval of work and release of reports are defined in the *Signature Authority* SOP (UQA-030).

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA/QC.

Quantitation Limit (QL): The minimum amount of a substance that can be quantitatively measured with a specified degree of confidence and within the accuracy and precision guidelines of a specific measurement system. The QL can be based on the MDL, and is generally calculated as 3-5 times the MDL, however, there are analytical techniques and methods where this relationship is not applicable. Also referred to as Practical Quantitation Level (PQL), Estimated Quantitation Level (EQL), Limit of Quantitation (LOQ).

Raw Data: Any original information from a measurement activity or study recorded in laboratory notebooks, worksheets, records, memoranda, notes, or exact copies thereof and that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic/optical media, including dictated observations, and recorded data from automated instruments. Reports specifying inclusion of "raw data" do not need all of the above included, but sufficient information to create the reported data.

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions.

Reference Standard: A standard, generally of the highest metrological quality, available at a given location from which measurements made at that location are derived.

Reporting Limit (RL): The level to which data is reported for a specific test method and/or sample. The RL is generally related to the QL. The RL must be minimally at or above the MDL.

Resource Conservation and Recovery Act (RCRA): Legislation under 42 U.S.C. 321 et seq. (1976).

Safe Drinking Water Act (SDWA): Legislation under 42 U.S.C. 300f et seq. (1974), Public Law 93-523.

Sampling and Analysis Plan (SAP): A formal document describing the detailed sampling and analysis procedures for a specific project.

Selectivity: The capability of a measurement system to respond to a target substance or constituent.

Sensitivity: The difference in the amount or concentration of a substance that corresponds to the smallest difference in a response in a measurement system using a certain probability level.

Spike: A known amount of an analyte added to a blank, sample or sub-sample.

Standard Operating Procedure (SOP): A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks.

which the relative uncertainty is ±100%. The MDL represents a range where qualitative detection occurs using a specific method. Quantitative results are not produced in this range.

Method Detection Limit Check (MDLCK): A standard that is processed with the MDL Study that is spiked at approximately ½ the low standard or reporting limit in the method.

Method Reporting Limit Check (MRL): A standard that is not processed, is spiked at approximately 2x the low standard or reporting limit. This standard check is used in conjunction with the LCG analysis.

Non-conformance: An indication, judgment, or state of not having met the requirements of the relevant specifications, contract, or regulation.

Precision: An estimate of variability. It is an estimate of agreement among individual measurements of the same physical or chemical property, under prescribed similar conditions.

Preservation: Refrigeration and/or reagents added at the time of sample collection to maintain the chemical, physical and/or biological integrity of the sample.

Proficiency Testing: Determination of the laboratory calibration or testing performance by means of inter-laboratory comparisons.

Proficiency Test (PT) Sample: A sample, the composition of which is unknown to the analyst, that is provided to test whether the analyst/laboratory can produce analytical results within specified performance limits. Also referred to as Performance Evaluation (PE) Sample.

Proprietary: Belonging to a private person or company.

Quality Assurance (QA): An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

Quality Assurance (Project) Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.

Quality Control (QC): The overall system of technical activities, the purpose of which is to measure and control the quality of a product or service.

Quality Control (QC) Sample: A control sample, generated at the laboratory or in the field, or obtained from an independent source, used to monitor a specific element in the sampling and/or testing process.

Quality Management Plan (QMP): A formal document describing the management policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an agency, organization or laboratory to ensure the quality of its product and the utility of the product to its users.

Laboratory Control Sample (LCS): A blank matrix spiked with a known amount of analyte(s), processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

Laboratory Quality Manual (LQM): A document stating the quality policy, quality system and quality practices of the laboratory. The LQM may include by reference other documentation relating to the laboratory's quality system.

Limit of Detection (LOD): The minimum amount of a substance that an analytical process can reliably detect.

Matrix: The substrate of a test sample. Common matrix descriptions are defined in Table 2.

Table 2. Matrix Descriptions

Matrix	Description
Aqueous	Aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine source. Includes surface water, groundwater, effluents, leachates and wastewaters.
Drinking Water	Aqueous sample that has been designated a potable water source.
Saline	Aqueous sample from an ocean or estuary, or other salt-water source such as the Great Salt Lake.
Liquid	Liquid with <15% settleable solids.
Solid	Soil, sediment, sludge, ash, paint chips, filters, wipes or other matrices with ≥15% settleable solids.
Waste	A product or by-product of an industrial process that results in a matrix not previously defined (i.e., drum liquid or oils).
Tissue	Sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.

Matrix Duplicate (MD): Duplicate aliquot of a sample processed and analyzed independently; under the same laboratory conditions; also referred to as Sample Duplicate; Laboratory Duplicate.

Matrix Spike (MS): Field sample to which a known amount of target analyte(s) is added.

Matrix Spike Duplicate (MSD): A replicate matrix spike.

Method Blank (MB): A blank matrix processed simultaneously with, and under the same conditions as, samples through all steps of the analytical procedure.

Method Detection Limit (MDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific measurement system. The MDL is a statistical estimation at a specified confidence interval of the concentration at

Equipment Blank (EB): A portion of the final rinse water used after decontamination of field equipment; also referred to as Rinsate Blank and Equipment Rinsate.

Extraction Blank (EB1, EB2, EB3): A blank that has been taken through the extraction procedure such as TCLP/SPLP; 5035, AVS/SEM.

Document Control: The act of ensuring that documents (electronic or hardcopy and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA): Legislation under 7 U.S.C. 135 et seq., as amended.

Federal Water Pollution Control Act (Clean Water Act, CWA): Legislation under 33 U.S.C. 1251 et seq., Public Law 92-50086 Stat. 816.

Field Blank (FB): A blank matrix brought to the field and exposed to field environmental conditions.

Field Duplicate (FD): Duplicate field-collected sample.

Field of Testing (FOT): A field of testing is based on NELAC's categorization of accreditation based on program, matrix and analyte.

Good Laboratory Practices (GLP): Formal regulations for performing basic laboratory operations outlined in 40 CFR Part 160 and 40 CFR Part 729 and required for activities performed under FIFRA and TSCA.

Holding Time: The maximum time that a sample may be held before preparation and/or analysis as promulgated by regulation or as specified in a test method.

Instrument Blank: A blank matrix that is the same as the processed sample matrix (e.g. extract, digestate, condensate) and introduced onto the instrument for analysis.

Internal Chain of Custody (COC): An unbroken trail of accountability that ensures the physical security of samples, data and records. Internal COC refers to additional documentation procedures implemented within the laboratory that includes special sample storage requirements, and documentation of all signatures and/or initials, dates, and times of personnel handling specific samples or sample aliquots.

Instrument Detection Limit (IDL): The minimum amount of a substance that can be measured with a specified degree of confidence that the amount is greater than zero using a specific instrument. The IDL is associated with the instrumental portion of a specific method only, and sample preparation steps are not considered in its derivation. The IDL is a statistical estimation at a specified confidence interval of the concentration at which the relative uncertainty is ±100%. The IDL represents a range where qualitative detection occurs on a specific instrument. Quantitative results are not produced in this range.

3.0 Terms and Definitions

Accuracy: The degree of agreement between a measurement and true or expected value, or between the average of a number of measurements and the true or expected value.

Audit: A systematic evaluation to determine the conformance to specifications of an operational function or activity.

Batch: Environmental samples, which are prepared and/or analyzed together with the same process, using the same lot(s) of reagents. A preparation batch is composed of 1 to 20 environmental samples of a similar matrix, meeting the above mentioned criteria. Where no preparation method exists (e.g., volatile organics, water), the batch is defined as environmental samples that are analyzed together with the same process and personnel, using the same lots of reagents, not to exceed 20 environmental samples. An analytical batch is composed of prepared environmental samples, extracts, digestates or concentrates that are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.

Chain of Custody (COC): A system of documentation demonstrating the physical possession and traceability of samples.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/Superfund): Legislation (42 U.S.C. 9601-9675 et seq., as amended by the Superfund Amendments and reauthorization Act of 1986 (SARA), 42 U.S.C. 9601et seq.

Compromised Sample: A sample received in a condition that jeopardizes the integrity of the results. See Section 4.7.1 for a description of these conditions.

Confidential Business Information (CBI): Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products.

Confirmation: Verification of the presence of a component using an additional analytical technique. These may include second column confirmation, alternate wavelength, derivatization, mass spectral interpretation, alternative detectors, or additional cleanup procedures.

Corrective Action: Action taken to eliminate the causes of an existing non-conformance, defect or other undesirable situation in order to prevent recurrence.

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality.

Demonstration of Capability (DOC): Procedure to establish the ability to generate acceptable accuracy and precision.

Detection Limit Check Standard (DLCK): A non-processed standard spiked at approximately ½ the method reporting limit. Used in conjunction with the MRL Check standard in LGC analysis.

Table 1.

Correlation of QAPP Sections with NELAC 5.5.2 Quality Manual Requirements

NELAC Chapter 5.5.2 Quality Manual	Laboratory Quality Manual Section
j. Reference to the calibration and/or verification test procedures used	5.3.4 Method Verification 5.3.5 Method Validation & Verification Activities 5.3.6 Data Reduction & Review 5.4.3 Equipment Verification and Calibration
k. Procedures for handling submitted samples	4.7.1 Sample Acceptance Policy 5.7 Sample Handling, Transport and Storage
l. Reference to the major equipment and reference measurement standards used as well as the facilities and services used in conducting tests	1.6 Servicing 4.1.1 Laboratory Facilities 4.6 Purchasing Services & Supplies 5.2 Facilities 5.4.2 Equipment Maintenance 5.4.3 Equipment Verification and Calibration
m. Reference to procedures for calibration, verification and maintenance of equipment	5.4.2 Equipment Maintenance 5.4.3 Equipment Verification and Calibration
n. Reference to verification practices including inter-laboratory comparisons, proficiency testing programs, use of reference materials and internal QC schemes	5.8.1 Proficiency Testing 5.8.2 Control Samples
o. Procedures for feedback and corrective action whenever testing discrepancies are detected, or departures from documented procedures occur	4.8 Complaints 4.9 Control of Non-Conformances 4.10 Corrective Action 4.11 Preventive Action 5.8.6 Permitting Departures from Documented Procedures
p. Laboratory management arrangements for exceptionally permitting departures from documented policies and procedures	4.4.1 Contract Review 4.4.2 Project-Specific Quality Planning 5.8.6 Permitting Departures from Documented Procedures
q. Procedures for dealing with complaints	4.8 Complaints
r. Procedures for protecting confidentiality and proprietary rights	4.7.2 Client Confidentiality and Proprietary Rights
s. Procedures for audits and data review	4.13 Internal Audits 4.14 External Audits 5.3.6 Data Reduction and Review
t. Process/procedures for establishing that personnel are adequately experienced in duties they are expected to carry out and are receiving any needed training	5.1.2 Training
u. Ethics policy statement developed by the laboratory and training personnel in their ethical & legal responsibilities	5.1.3 Ethics Policy
v. Reference to procedures for reporting analytical results	5.3 Test Methods 5.3.6 Data Reduction and Review 5.9 Project Reports
w. Table of contents, listing reference, glossaries and appendices	TOC Table of Contents Appendix List of Cited SOPs and Work Instructions

Good Automated Laboratory Practices, Principles and Guidance to Regulations for Ensuring Data Integrity in Automated Laboratory Operations with Implementation Guidance, EPA 2185, US EPA Office of Information Resources Management, August 1995.

Air Force Center for Environmental Excellence (AFCEE) Quality Assurance Project Plan (QAPP), Version 3.1, August 2001.

National Environmental Laboratory Accreditation Conference, Constitution, Bylaws, and Standards, EPA 600/R-00/084, US EPA Office of Research and Development, June 2000.

Navy Installation Restoration Laboratory Quality Assurance Guide, Interim Guidance Document, Naval Facilities Engineering Service Center (NFESC), February 1996.

Navy Installation Restoration Chemical Data Quality Manual, Navy IR CDQM, Special Publication SP-2056-ENV, September 1999.

Department of Defense Quality Systems Manual for Environmental Laboratories, Version 1, October 2000.

Shell for Analytical Chemistry Requirements, US Army Corps of Engineers, EM 200-1-3, Appendix I, February 2001

This LQM was written to comply with the National Environmental Laboratory Accreditation Conference (NELAC) standards. Refer to Table 1 for a cross-section comparison of this LQM to the NELAC standards.

Table 1.

Correlation of QAPP Sections with NELAC 5.5.2 Quality Manual Requirements

NELAC Chapter 5.5.2 Quality Manual	Laboratory Quality Manual Section
a. Quality policy statement, including objectives and commitments	1.2 Quality Assurance Policy 4.2.1 Objectives of the Quality System
b. Organization and management structure	4.1 Organization and Management
c. Relationship between management, technical operations, support services and the quality systems	4.1.2 Roles and Requirements 4.2 Quality System
d. Records retention procedures; document control procedures	4.3 Document Control 4.12.2 Record Retention
e. Job descriptions of key staff and references to job descriptions of other staff	4.1.2 Roles and Requirements
f. Identification of laboratory approved signatories	4.1 Organization and Management
g. Procedures for achieving traceability of measurements	5.5 Measurement Traceability
h. List of all test methods under which the laboratory performs its accredited testing	5.3.1 Method Selection
i. Mechanisms for assuring the laboratory reviews all new work to ensure that it has the appropriate facilities and resources before commencing such work	4.4.2 Project-Specific Quality Planning

- Accuracy and precision;
- Reporting limits;
- Personnel qualifications, training, and experience;
- Calibration and quality control measures employed;
- Regulatory requirements;
- Report contents;
- Supporting documentation, records and evidence; and
- Review of data

1.6 Servicing

Project Managers are the direct client contact and they ensure resources are available to meet project requirements. Although Project Managers do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure that available resources are sufficient to perform work for the client's project. Project Managers provide a link between the client and laboratory resources.

The laboratory has established procedures for performing and verifying that client servicing meets requirements. Typical services provided are:

- Sample Containers/Supplies – *Container Management: Process Operation* (UCM-001)
- Project QAP preparation – *Project Planning Process* (UPM-003)
- Regulatory advisory functions – *Project Planning Process* (UPM-003)
- Consulting -- *Project Planning Process* (UPM-003)

Regulatory and advisory functions are addressed under the same procedures used for project planning.

2.0 References

The following references were used in preparation of this document and as the basis of the STL Quality System:

EPA Guidance for Preparing Standard Operating Procedures (SOPs), EPA QA/G-6, US EPA, Office of Environmental Information, EPA/240/B-01/004, March 2001.

EPA Requirements for Quality Management Plans, EPA QA/R-2, US EPA, Office of Environmental Information, EPA/240,B-01/002 March 2001.

EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5, US EPA, Office of Environmental Information, EPA/240/B-01/003, March 2001.

EPA Quality Manual for Environmental Programs, 5360 A1, US EPA Office of Environmental Information – Quality Staff, May 2000.

General Requirements for the Competence of Testing and Calibration Laboratories, ISO/IEC 17025, December 1999.

1.2 Quality Assurance Policy

It is STL's policy to:

- Provide high quality, consistent, and objective environmental testing services that meet all federal, state, and municipal regulatory requirements.
- Generate data that are scientifically sound, legally defensible, meet project objectives, and are appropriate for their intended use.
- Provide STL clients with the highest level of professionalism and the best service practices in the industry.
- Build continuous improvement mechanisms into all laboratory, administrative, and managerial activities.
- Maintain a working environment that fosters open communication with both clients and staff and ensures data integrity.

1.3 Management Commitment to Quality Assurance

STL management is committed to providing the highest quality data and the best service in the environmental testing industry. To ensure that the data produced and reported by STL meet the requirements of its clients and comply with the letter and spirit of municipal, state and federal regulations, STL maintains a quality system that is clear, effective, well communicated, and supported at all levels in the company.

Line organizations verify that specifications are achieved; QA organizations assist and provide oversight and verification of processes through planning, reviews, audits, and surveillances. The quality objectives are derived from this Laboratory Quality Manual (LQM), Standard Operating Procedures (SOPs) and Work Instructions.

1.4 Purpose

The purpose of the LQM is to describe STL's Quality System and to outline how that system enables all employees to meet the Quality Assurance (QA) policy. This LQM also describes specific QA activities and requirements and prescribes their frequencies. Roles and responsibilities of management and laboratory staff in support of the Quality System are also defined in this LQM.

1.5 Scope

This LQM is specific to STL Chicago's quality systems and laboratory operation's. All other STL locations have LQMs under the Corporate Quality Management Plan (QMP) or the Corporate QMP itself.

The laboratory is committed to ensuring that resources are available and deployed to meet client expectations. This includes gathering project information prior to sample receipt to ensure client expectations will be met with respect to:

- Sampling containers;
- Analytical methods employed;

1.0 Introduction, Purpose, and Scope

1.1 STL Overview

STL Chicago (STL) is a part of Severn Trent Laboratories, a major group of U.S. based companies. The companies are owned by Severn Trent, plc, an international provider of water and wastewater services headquartered in Birmingham, UK.

STL is a full-service environmental laboratory that provides quality comprehensive and integrated professional analytical services effectively and efficiently. A broad range of environmental testing services are offered that span a variety of matrices including aqueous, saline, solid, tissue and drinking water.

Associated with this activity are services to assure client requirements are known, communicated and satisfactorily addressed, and a deliverables package presenting the analytical results. The laboratory provides expert personnel for supervision, technical consultation, and project review for effective planning and implementation of analytical assignments.

STL operates under the regulations and guidelines of the following federal programs:

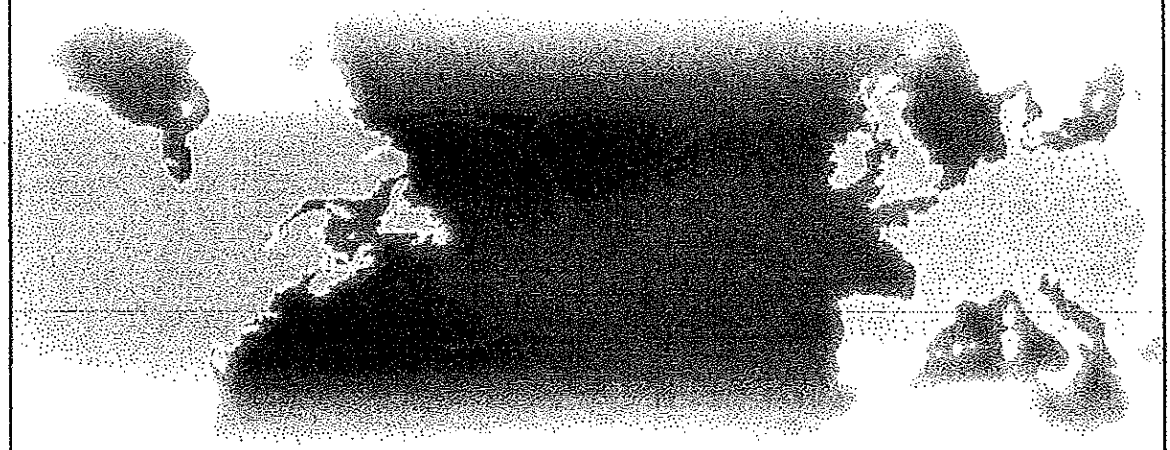
- Air Force Center for Environmental Excellence (AFCEE)
- US Army Corp of Engineers, Hazardous, Toxic and Radioactive Waste (USACE HTRW)
- Clean Water Act (CWA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Navy Facilities Engineering Service Center (NFESC)
- National Pollution, Discharge, and Elimination System (NPDES)
- Occupational Safety and Health Administration (OSHA)
- Resource Conservation and Recovery Act (RCRA)
- Safe Drinking Water Act (SDWA)
- Toxic Substances Control Act (TSCA)

STL also provides services under various state and local municipal guidelines. A current table of analytical services, list of certifications and general service listing is presented on the MySTL webpage or available from the laboratory. www.stl-inc.com

SEVERN TRENT STL

Vision

STL will be the recognized industry leader for environmental analysis.



Mission

Through the innovation and dedication of our people, together with the quality of our systems, we will deliver levels of performance that delight our clients, retain the confidence of our stakeholders and enable the profitable growth of our business.

Severn Trent Laboratories

Tables

Figures

Appendix

TABLE OF CONTENTS

LABORATORY QUALITY MANUAL

STL Chicago
2417 Bond Street
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(708) 534-5200

Approved by (Signature / Date):

Michael J. Healy
Laboratory Director

Terese A. Preston 6/4/04
Terese A. Preston
Quality Assurance Manager

CONTROLLED DISTRIBUTION	
COPY # :	**Uncontrolled**
ISSUED TO :	

Full Signature Approvals Are Kept on File
with STL's QA Standard Practice Records

All non-conformances that affect a sample and/or sample data become part of the affected project's permanent record. When appropriate, reanalysis is performed where QC data falls outside of specifications, or where data appears anomalous. If the reanalysis comes back within established tolerances, the results are approved. If the reanalysis is still outside tolerances, further reanalysis or consultation with the Section Manager, Project Manager or QA Manager for direction may be required. All records of reanalysis are kept with the project files.

Where non-conformances specifically affect a client's sample and/or data, the client is informed and action must be taken. Action can take the form of reporting and flagging the data, and including a description of the non-conformance in the project narrative.

4.10 Corrective Action

To consistently achieve technical and regulatory requirements, the laboratory data must be supported by an effective corrective action system. The system must be capable of isolating and rectifying both random and systematic errors. Identification of systematic errors, or errors that are likely to occur repetitively due to a defect or weakness in a system, is particularly valuable in maintaining an environment of continuous improvement in laboratory operations.

Mechanisms used to ensure problem definition include SOPs; internal and external audits and surveillances; and regular laboratory management meetings. When evaluation of performance against established criteria for good laboratory practices shows a condition that could adversely affect the quality of services provided, corrective action is initiated.

Any employee in STL can initiate a corrective action. The initial source of corrective action can also be external to STL (i.e., corrective action due to client complaint, regulatory audit, or PT(s)). When a problem that requires corrective action is identified, the following items are identified by the initiator on the corrective action report: the nature of the problem, the name of the initiator, and the date. If the problem affects a specific client project, the PM is informed immediately.

All corrective actions, whether immediate or long-term, will comprise the following steps to ensure a closed-loop corrective action process:

- Define the problem.
- Assign responsibility for investigating the problem.
- Determine a corrective action to eliminate the problem.
- Assign, and obtain commitment to, responsibility for implementing the corrective action.
- Implement the correction.
- Assess the effectiveness of the corrective action and verify that the corrective action has eliminated the problem.

4.10.1 Immediate Corrective Action

Immediate corrective actions to correct or repair non-conforming equipment and systems are generally initiated in response to adverse conditions identified through QC procedures. The analyst has relatively quick feedback that a problem exists, e.g., calibration does not meet or QC check samples exceed allowable criteria, and can take immediate action to repair the system.

The initial responsibility to monitor the quality of a function or analytical system lies with the individual performing the task or procedure. DQOs are evaluated against laboratory-established or against method or client specified QA/QC requirements. If the assessment reveals that any of the QC acceptance criteria are not met, the analyst must immediately assess the analytical system to correct the problem. When the appropriate corrective action measures have been defined and the analytical system is determined to be "in-control" or the measures required to put the system "in-control" have been identified and scheduled, the problem and resolution or planned action is documented in the appropriate logbook or CAR. Data generated by an analytical system that is determined to be out-of-control must never be released without approval of the Section Manager, QA Manager, Laboratory Director, Project Manager and client notification.

When an acceptable resolution cannot be met or data quality is negatively affected, the analyst will notify their Section Manager and initiate an SDR. If an SDR is required, it is routed for proper authorizations and direction. Proper authorization and direction is given by the Project Manager and/or QA Manager. Based upon the circumstances and judgment of the Project Manager, the client may be notified of the situation.

Data generated concurrently with an out-of-control system will be evaluated for usability in light of the nature of the deficiency. If the deficiency does not impair the usability of the results, data will be reported and the deficiency will be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by a written SDR and appropriate corrective action (e.g., reanalysis) is taken and documented.

A CAR documents analytical problems at the bench level. This form allows for the documentation of the out-of-control situation, actions undertaken to correct the problem and a return-to-control status. All CARs are signed/dated by the respective laboratory Section Manager.

The QA Manager has the authority to stop the analysis, e.g., failure to meet method or project requirements, and to hold all analyses of samples affected by an out-of-control situation. The method cannot be restarted without appropriate documentation leading to the QA Manager's approval and sign-off.

4.10.2 Long-term Corrective Action

Long-term corrective action is generally initiated due to QA issues, which are most often identified during internal and external audits (Sections 4.13 & 4.14). Typically, a deeper investigation into the root cause of the nonconformance is warranted, and the problem may take much longer to identify and resolve. Staff training, method revision, replacement of equipment, and LabNet reprogramming are examples of long-term corrective action.

4.10.3 Responsibility and Closure

The Section Manager is responsible for correcting out-of-control situations, placing highest priority on this endeavor. Associated corrective actions, once verified for effectiveness, are incorporated into standard practices. Ineffective actions will be re-evaluated until acceptable resolution is achieved. Section Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved.

The QA Department also may implement a special audit (Section 4.13). The purpose of inclusion of the corrective action process in both routine and special audits is to monitor the implementation of the corrective action and to determine whether the action taken has been effective in overcoming the issue identified.
Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation. This provides laboratory QA personnel non-laboratory management support, if needed, to ensure that QA policies and procedures are enforced.

4.11 Preventative Action

The laboratory's preventive action programs improve, or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive continuous process improvement activity which can be initiated by clients, employees, business providers, and affiliates. The QA section has the overall responsibility to ensure that the preventive action process is in place, and that relevant information on actions is submitted for management review.

Preventive action opportunities may be identified from information obtained through activities related to but not limited to the corrective action process, performance evaluation program, internal audits, management review, and/or market trends, industry trends and competitive comparisons.

Established standard practices for preventive action are included in the *Preventive Action Measures* SOP (UQA-019); the *SDR / RDR / CAR* SOP (UQA-029) and the *Quality System Management Review* SOP (UQA-002). These procedures describe the information sources used to detect, analyze, and eliminate potential causes of nonconformities and to ensure effective implementation of solutions.

4.12 Records

4.12.1 Record Types

Record types are described in Table 4.

4.12.2 Record Retention

Data reports are filed electronically as .pdf files by sample job number. Hardcopy COC files are maintained and are filed in Job Number order.
Laboratory data, project management files, QA records (e.g., PT scores/corrective actions; MDLs/IDLs, statistical analysis, QAPPs, etc.), Human Resources information, etc.., are compiled by date order. The same procedure is followed both in current and archived hardcopy storage.

Upon archiving, a *Records Management Form* (CHI-22-05-032) is prepared for each storage box of records. This form documents the department, department manager, contents (description and dates), term of retention (e.g., no. of years) and an assigned identification number. The original of this form is maintained with the data management department with a carbon copy filed within the storage box. Upon purging of records, the individual department managers sign the original form as confirmation for the destruction of the associated data. This signature indicates that the laboratory has maintained the information for the required amount of time and is no longer required to store it.
Table 5 outlines the laboratory's standard record retention time. For raw data and project records, record retention is calculated from the date the project report is issued. For other records, such as Controlled Documents, QC, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 6 have lengthier retention requirements and are subject to the requirements in Section 4.12.3.

Table 4. STL Record Types

Raw Data	Controlled Documents	QC Records	Project Records	Administrative Records
See Section 3. Terms and Definitions	LQMs/ QAPPs	Audits/ Responses	COC Documentation	Accounting
	QMP (Corporate)	Certifications	Contracts and Amendments	Corporate Safety Manual, Permits, Disposal Records
	SOPs	SDRs/RDRs	Correspondence	Employee Handbook
		Logbooks*	QAPP	Personnel files, Employee Signature & Initials, Training Records
		Method & Software Validation, Verification	SAP	
		Standards Certificates	Telephone Logbooks	Technical and Administrative Policies
	Work Instructions	MDL/IDL/IDC Studies	E-mails	
		PTs	Electronic Data Report	
		Statistical Evaluations		

*Examples of Logbook types: Maintenance, Instrument, Preparation (standard and samples), Standard and Reagent Receipt, Archiving, and Balance Calibration.

Table 5. STL Record Retention

Record Type		Archival Requirement *
Raw Data	All* (Electronic Data Reports (.pdf & EDD)	5 Years from completion
Controlled Documents	All*	5 Years from document retirement date
QC	All*	5 Years from archival
Project	All*	5 Years from project completion
Administrative	Personnel/Training	Indefinitely
	Accounting	10 years

* Exceptions listed in Table 6.

4.12.3 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the laboratory's standard record retention time. These are detailed in Table 6 with their retention requirements and client-specific requirements are listed in the *Record Retention and Purging* SOP (UDM-002). In these cases, the longer retention requirement is implemented and noted in the archive. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Table 6. Special Record Retention Requirements

Program	Retention Requirement
Colorado – Drinking Water	10 years
Commonwealth of MA – All environmental data 310 CMR 42.14	10 years
FIFRA – 40 CFR Part 160	Retain for life of research or marketing permit for pesticides regulated by EPA
Massachusetts – Drinking Water	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
Minnesota – Drinking Water	10 years
Navy Facilities Engineering Service Center (NFESC)	10 years
OSHA - 40 CFR Part 1910	30 years
Pennsylvania – Drinking Water	10 years
TSCA – 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement

4.12.4 Archives and Record Transfer

Archives are indexed such that records are accessible on either a project or temporal basis. Archives are protected against fire, theft, loss, deterioration, and vermin. Electronic records are protected from deterioration caused by magnetic fields and/or electronic deterioration. Access to archives is controlled and documented.

STL ensures that all records are maintained as required by the regulatory guidelines and per this LQM upon facility location change or ownership transfer. Upon facility location change, all archives are retained by STL in accordance with this LQM. Upon ownership transfer, all final test reports generated by the laboratory will be submitted to the clients if not previously provided. Any further record retention requirements will be addressed in the ownership transfer agreement and the responsibility for maintaining archives will be clearly established.

In the event that the laboratory is closed, all final test reports generated by the laboratory will be submitted to the clients if not previously provided. All records will then be transferred to STL's corporate record storage location. All boxes and contents will be appropriately labeled with the dates of destruction (Refer to Tables 5 and 6) and managed in accordance their policies.

4.13 Internal Audits

Quality assurance audits and surveillances are conducted to assess the performance of laboratory systems in meeting technical, regulatory and client requirements; and to evaluate the operational details of the QA program (*Internal Audits*; UQA-013). They provide a means for management to be apprised of, and to respond to, a potential problem before it actually impacts the laboratory operations. They also are a mechanism for ensuring closure of corrective actions resulting from external audits.

4.13.1 Audit Types and Frequency

A number of types of audits are performed at STL. These audit types and frequency are categorized in Table 7.

Table 7. Audit Types and Frequency

Audit Type	Performed by	Frequency
Systems	QA Department or Designee	Annual
Data Authenticity	QA Department or Designee	**Data Report Review:** As necessary to ensure an effective secondary review process and to meet special program independent review objectives
		Analyst Data Audits: 100% of all analysts annually
Electronic		**Electronic Data Audits:** 100% of all organic instruments
Special	QA Department or Designee	As Needed

4.13.2 Systems Audits

Systems audits are technical in nature and are conducted on an ongoing basis by the QA Manager or the QA Specialist. Systems audits cover all departments of the facility, both operational and support. The review consists of laboratory systems, procedures, documentation and issues noted in external audits.

The audit report is issued by the QA Manager or QA Specialist within 21 calendar days of the audit. The audit report is addressed to the department Section Manager and copied to the QA department and the Laboratory Director.

Written audit responses are required within 30 calendar days of the audit report issue. A maximum of one calendar month is given to address any recommended corrective actions. The audit response is directed to all individuals copied on the audit report. Where a corrective action may require longer than a calendar month to complete, the target date for the corrective action implementation is stated and evidence of the corrective action is submitted to the QA Department in the agreed upon time frame.

4.13.3 Data Audits

Data audits are focused to assess the level of customer service, SOP compliance, regulatory compliance, accuracy and completeness of test results and reports, documentation, and adherence to established QC criteria, laboratory SOPs, technical policy, and project specific QC criteria.

The QA Department provides feedback and/or corrections and revisions to project reports where necessary. Records of the data audits are kept, and the frequency of data audits is included in the monthly QA report. In performing data audits, it is essential that data be assessed in terms of differentiating between systematic and isolated errors. Upon noting anomalous data or occurrences in the data audits, the QA Department is responsible for seeking clarification from the appropriate personnel, ascertaining whether the error is systematic or an isolated error, and overseeing correction and/or revision of the project report if necessary. Errors found in client project reports are revised and the revision sent to the client (Section 4.8). The QA Department is also responsible for assisting in the corrective action process where a data audit leads to identification of the need for permanent corrective action.

The frequency of data auditing may also be dependent upon specific clients and regulatory programs. All active laboratory logbooks and QC files are subject to periodic audits/ surveillances by the QA personnel.

4.13.3.1 Data Authenticity Audits

Data authenticity audits shall be performed on 100% of all analysts by the QA department or a designee independent from laboratory operations. Performing data authenticity checks will typically include verifying raw data, evaluating calculation tools and independently reproducing the final results and comparing it to the hardcopy on randomly selected batches of data. The QA Manager will report the percentage of analysts reviewed (for the year) in the monthly QA report and should average about 8% per month.

4.13.3.2 Electronic Data Audits

Electronic data audits are performed on 100% of all organic instruments by the QA department or a designee independent from the operations. This may include Mint Miner® scanning of randomly selected batches of electronic data followed by a chromatography system review. The QA manager will report the percentage of instruments reviewed (for the year) in the monthly QA report and should average about 8% of instruments per month. Electronic data audits include spot-checking of manual integrations by QA personnel in order to determine that the manual integration is appropriate and documented according to Section 5.3.6.1.

4.13.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, proficiency testing results, data audits, systems

audits, validation comments, or regulatory audits. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

4.14 External Audits

STL is routinely audited by clients and external regulatory authorities – both government and non-government. Whether the audit is scheduled or unannounced, full cooperation with the audit team is provided by the laboratory and administrative staff. STL recommends that the audits be scheduled with the QA Department so that all necessary personnel are available on the day of the audit.

4.15 Management Reviews

4.15.1 QA Reports to Management

A monthly QA report is prepared by QA Manager and forwarded to the Laboratory Director, Project Managers, Section (Technical) Managers and the Corporate Quality Director. The reports include statistical results that are used to assess the effectiveness of the quality system. The format of the monthly report is shown in Figure 3.

4.15.2 Quality Systems Management Review

A quality systems management review is performed at least annually by the QA Manager. This review ensures that the laboratory's quality system is adequate to satisfy the laboratory's policies and practices, government requirements, certification, accreditation, approval requirements, and client expectations. Quality systems management reviews are accomplished through the evaluation and revision of this LQM, monthly quality assurance reporting and goal setting.

Management reviews of specific quality system elements may be performed through continuous improvement activities, monthly QA reports, process changes, SOP revisions, and/or audit reports/responses. Documentation of these reviews are not required unless it is inherent in the review mechanism (e.g., approval signatures on SOP revisions).

4.15.3 Monthly QA Report and Metrics

By the 3rd day of the month, the QA manager prepares a monthly QA report. The report is sent to the Laboratory Director and Corporate Quality Director. The report contains a narrative summary and metrics spreadsheet. At a minimum, the report content contains the items listed below (Figure 3). During the course of the year, the Laboratory Director, General Manager or Corporate Quality Director may request that additional information be added to the report.

Figure 3. Monthly QA Report Format

1	Audits
	External System Audits Internal System Audits Internal Training Record Audits Internal Data Audits
2	Revised Reports / Client Complaints / Client Compliments
	Revised Reports (RDR) Client Complaints Client Compliments
3	Certification Changes
	Certification Status Losses / Revocations
4	Proficiency Testing
	Study participation PT scores PT failures History of failures
5	SOP Status
	SOPs totals summarized by manager On-Time percentages calculated for SOPs < 1 year
6	Project/QAPP Review Status
7	Holding Time Violations
8	Monthly QA Report Metrics
	Summarize metrics in template provided by the Corporate Quality Director

5.0 Technical Requirements

5.1 Personnel

5.1.1 General

STL management believes that its highly qualified and professional staff is the single most important aspect in assuring the highest level of data quality and service in the industry. The staff consists of professionals and support personnel that include the following positions:

- Laboratory Director
- QA Manager
- Health & Safety Coordinator / Waste Management
- Project Manager
- Information Technology Manager
- Department Section Manager (Technical Manager)
- Analyst
- Sample Custodian
- Technician
- Quality Assurance Specialist
- Data Review Specialist

In order to ensure that employees have sufficient education and experience to perform a particular task, job descriptions are developed for all personnel (Section 4.1.2).

5.1.2 Training

STL is committed to furthering the professional and technical development of employees at all levels. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for STL employees are outlined in Table 8.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. The QA department, in conjunction with the Human Resources coordinator and Section Supervisor are responsible for maintaining the documentation of these activities.

Each laboratory section maintains documentation associated with analytical training (e.g., training records, document control). The QA department maintains documentation of initial and continued method proficiency for laboratory instrumentation and for each analyst. This documentation is represented in the following forms: MDLs, IDMPs, IDOCs, CDOCs, PT Sample results, Instrument QC and Batch QC Control Charts. This information is available to managers and staff for planning and evaluation.

The Human Resource coordinator maintains documentation and attestation forms on employment status & records; benefit programs; time keeping/payroll; and employee conduct (e.g., ethics). This information is maintained in the employee's secured personnel file.

The following evidence items are on file for each technical employee:

- Initial Demonstration of Capability (IDOC) for each method.
- Attestation that the employee has read and understood the latest version of the laboratory's quality documentation.
- The employee has read and understood the latest, approved version of all test methods and/or SOPs for which the employee is responsible.
- Annual evidence of Continued Demonstration of Capability (CDOC) that may include, but is not limited to, successful analysis of a blind sample on the specific test method or a similar test method; an annual DOC of four successive and acceptable LCSs.
- An Ethics Agreement signed by each staff member (renewed each year).
- A Confidentiality Agreement signed by each staff member (renewed each year).

Table 8. STL Employee Minimum Training Requirements

Specialty	Experience
General Chemistry and Instrumentation	Six months
Gas Chromatography	One year
Atomic Absorption	One year
Mass Spectrometry	One year
Spectra Interpretation	Two years

Required Training	Time Frame [1]	Employee Type
Environmental Health & Safety	Month 1	All
Ethics – Corporate Overview	Week 1	All
Ethics	Month 1	All
Data Integrity	Month 1	Technical and PMs
Ethics Refresher	Annually	All
Quality Assurance	Quarter 1	All
Initial Demonstration of Capability (IDOC)	Prior to unsupervised method Performance	Technical

[1] From the date of initial employment unless otherwise indicated.

The quality assurance training includes an overview of regulatory programs and program goals, a review of the ethics statement, and group discussions about data integrity and data misrepresentation.

When an analyst does not meet these requirements, they can perform a task under the supervision of a qualified analyst, peer reviewer or section manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

IDOCs (Initial Demonstration of Method Capability) are performed by the analysis of four replicate QC samples. Results of successive LCS analyses can be used to fulfill the IDOC requirement, however, LCSs performed over several batches is desirable. The accuracy and precision, measured as average recovery and standard deviation (using n-1 as the population), of the 4 replicate results are calculated and compared to those in the test method (where available). If the test method does not include accuracy and precision requirements, the results are compared to target criteria set by the laboratory. The laboratory sets the target criteria such that they reflect the DQOs of the specific test method or project. An IDOC Certification Statement is recorded and maintained in the employee's training file. Tabulated results summary and raw data are completed and signed by the analyst and section manager with the proper entries made onto the analysts training record. The data is submitted to the QA department for approval and entry into the master IDOC spreadsheet and for filing. Figure 4 shows an example of an *IDOC Certification Statement.* (CHI-22-09-271)

On an annual basis, the analyst's method capabilities must be evaluated. The requirement that a CDOC (Continued Demonstration of Capability) be completed for each method currently being analyzed must be presented for approval to the QA department. (e.g. *Yearly Method Capability Review Work Instruction-Wet Chemistry*: CHI-22-09-279)

Further details of the laboratory's training program are described in the Laboratory Training SOP (UQA-014).

Figure 4. Demonstration of Capability Certification Statement

Demonstration of Capability
Certification Statement

Date:
STL Chicago
2417 Bond Street
University Park, IL 60466

Analyst Name:_____
SOP No.:_____
Method No.:_____
Description:_____
Matrix:_____
Effective Date:_____

We the undersigned certify that:

1. The analyst identified above, using the cited test method(s), which is in use at this laboratory for the analysis of samples under the National Environmental Laboratory Accreditation Program, have met the Demonstration of Capability.
2. The test method(s) was performed by the analyst identified on this certification.
3. A copy of the reference method and laboratory-specific SOP(s) are available for all personnel on-site.
4. The data associated with the demonstration capability are true, accurate, complete and self-explanatory.
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the laboratory, and that the associated information is well organized and available for review by authorized assessors.

_____	_____		_____
Technical Manager	Signature	Date	
_____	_____		_____
Quality Assurance Manager	Signature	Date	

5.1.3 Ethics Policy

Establishing and maintaining a high ethical standard is an important element of a Quality System. In order to ensure that all personnel understand the importance the company places on maintaining high ethical standards at all times; STL has established an Ethics Policy (P-L-006) and an Ethics Agreement (Figure 5). Each employee signs the Ethics Agreement, signifying agreed compliance with its stated purpose on an annual basis.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize the Company's ability to do work on Government contracts, and for that reason, the Company has a Zero Tolerance approach to such violations.

Ethics is also a major component of STL's quality and data integrity systems. Each employee is trained in ethics within thirty days of hire and quality training within three months of hire. Annual ethics refresher training will be provided. Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. A data integrity hotline is maintained by STL and administered by the Corporate Quality Director.

Figure 5. STL Ethics Agreement

I understand that STL is committed to ensuring the highest standard of quality and integrity of the data and services provided to our clients. I have read the Ethics Policy of the Company.

With regard to the duties I perform and the data I report in connection with my employment at the Company, I agree that:

- I will not intentionally report data values that are not the actual values obtained;
- I will not intentionally report the dates, times, sample or QC identification, or method citations of data analyses that are not the actual dates, times, sample or QC identifications, or method citations;
- I will not intentionally misrepresent another individual's work;
- I will not intentionally report data values that do not meet established quality control criteria as set forth in the Method and/or Standard Operating Procedures, or as defined by Company Policy;
- I agree to inform my Supervisor of any accidental reporting of non-authentic data by me in a timely manner; and I agree to inform my Supervisor of any accidental or intentional reporting of non-authentic data by other employees; and
- If a supervisor or a member of STL management requests me to engage in or perform an activity that I feel is compromising data validity or quality, I will not comply with the request and report this action immediately to a member of senior management, up to and including the President of STL.

As a STL employee, I understand that I have the responsibility to conduct myself with integrity in accordance with the ethical standards described in the Ethics Policy. I will also report any information relating to possible kickbacks or violations of the Procurement Integrity Act, or other questionable conduct in the course of sales or purchasing activities. I will not knowingly participate in any such activity and will report any actual or suspected violation of this policy to management.

The Ethics Policy has been explained to me by my supervisor or at a training session, and I have had the opportunity to ask questions if I did not understand any part of it. I understand that any violation of this policy subjects me to disciplinary action, which can include termination. In addition, I understand that any violation of this policy which relates to work under a government contact or subcontract could also subject me to the potential for prosecution under federal law.

EMPLOYEE SIGNATURE:_____ Date: _____
Supervisor/Trainer:_____ Date:_____

5.2 Facilities

The laboratory is a secure facility with controlled and documented access. Access is controlled by various measures including locked doors, electronic access cards, security codes, and a staffed reception area. All visitors sign in and are escorted by STL personnel while at the facility. The laboratory is locked at all times, unless a receptionist is present to monitor building access (e.g., between the hours of 8:00 a.m. and 5:00 p.m. Monday through Friday).

The facility is designed for efficient, automated high-quality operations. The laboratory is equipped with Heating, Ventilation, and Air Conditioning (HVAC) systems appropriate to the needs of environmental testing laboratories. Environmental conditions in the facility, such as hood flow, are routinely monitored and documented.

The facility is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. STL also provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc..

5.3 Test Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices.

5.3.1 Method Selection

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager in a Technical Profile and within LabNets Project Notes feature. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services (e.g., special matrices, non-routine compound lists, etc..), the method of choice is selected based on client needs and available technology.

Most of the test methods performed at STL originate from test methods published by a regulatory agency such as the US EPA and other state and federal regulatory agencies. These include, but are not limited to, the following published compendiums of test methods. A listing of methods in which the laboratory is capable of performing is listed in laboratory's *Methods Capabilities* Work Instruction (CHI-22-09-255).

Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water.

Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM); Non-polar Material) by Extraction and Gravimetry, EPA-821-R-98-003, February 1999.

Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.

Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.

Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.

NIOSH Manual of Analytical Methods, 4th ed., August 1994.

Statement of Work for Inorganics Analysis, ILM04.0, USEPA Contract Laboratory Program Multi-media, Multi-concentration.

Statement of Work for Organics Analysis, OLM04.2 and OLC02.1, USEPA Contract Laboratory Program, Multi-media, Multi-concentration.

Standard Methods for the Examination of Water and Wastewater, 18th/19th /20th edition; Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.

Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996.

Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc.., and establishes an implementation schedule. As such, the laboratory strives to perform only the latest versions of each approved method.

5.3.2 SOPs

STL maintains an *Approved SOP Listing* (CHI-22-09-SOP) for both Method and Process SOPs. Method SOPs are maintained to describe a specific test method. Process SOPs are maintained to describe function and processes not related to a analytical testing (e.g., administrative procedures).

Method SOPs contain the following information:

Title Page with Document Name, Document Number, Revision Number, Effective Date, Page Numbers and Total # of Pages, Authorized Signatures, Dates and Proprietary Information Statement (Figure 6).

1. Identification of Test Method
2. Applicable Matrix
3. Scope and Application, including test analytes
4. Summary of the Test Method
5. Reporting Limits
6. Definitions
7. Interferences
8. Safety
9. Equipment and Supplies
10. Reagents and Standards
11. Sample Collection, Preservation and Storage
12. Quality Control
13. Calibration and Standardization
14. Procedure
15. Calculations
16. Method Performance
17. Pollution Prevention
18. Data Assessment and Acceptance Criteria for Quality Control Measures
19. Corrective Actions for Out-of-Control Data
20. Contingencies for Handling Out-of-Control or Unacceptable Data
21. Waste Management
22. References
23. Tables, Diagrams, Flowcharts and Validation Data

Process SOPs contain the following information:

Title Page with Document Name, Document Number, Revision Number, Effective Date, Page Numbers and Total # of Pages, Authorized Signatures, Dates and Proprietary Information Statement (Figure 6).

1. Scope
2. Summary
3. Definitions
4. Responsibilities
5. Procedure
6. References
7. Tables, Diagrams, and Flowcharts

The QA Department is responsible for maintenance of SOPs, archival of SOP historical revisions, maintenance of an SOP index, and records of controlled distribution. SOPs, at a minimum, undergo annual review (12-18 months). Where an SOP is based on a published method, the laboratory maintains a copy of the reference method.

Figure 6. Proprietary Information Statement

SOP Change Form

The SOP Change Form is used for implementation, documentation, and authorization of changes to SOPs (*SOP Change Protocol*; UQA-032). Immediate changes in SOPs may be necessary to accommodate improvements; to implement acceptable changes in practices; or to correct potential errors in the existing version. The reason for the change will be identified and a detailed description of the procedure change will be presented. Since this form will become part of the referenced SOP, until such time that the SOP is updated, it must be legible and comprehensible. The Change Form must provide an exact description and identify the affected sections.

Once this form is completed and changes are authorized, it becomes an official part of the SOP for which it revises, and is subject to all document control and records management policies.

5.3.3 Method Validation

Laboratory developed methods are validated and documented according to the procedure described in Section 5.3.5.

5.3.4 Method Verification

Method verification is required when a validated standard test method or a method modification is implemented. The level of activity required for method verification is dependent on the type of method being implemented, or on the level of method modification and its affect on a method's robustness. Method modification often takes advantage of a method's robustness, or the ability to make minor changes in a method without affecting the method's outcome.

It is the responsibility of the section manager to present to the QA manager all applicable method validation studies for review and approval. The documented approval by the section manager and QA manager must be applied to all applicable validation records before the method is released for use. Method verification may require some, but not all, of the activities described in Section 5.3.5.

5.3.5 Method Validation and Verification Activities

Before analyzing samples by a particular method, method validation and/or method verification must occur. A complete validation of the method is required for laboratory developed methods. While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

Determination of Method Selectivity
Method selectivity is demonstrated for the analyte(s) in the specific matrix or matrices. In some cases, to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

Determination of Method Sensitivity
Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed. The laboratory determines MDLs are described in Section 4.4.3.6 and within UQA-017 and the corporate procedure S-Q-003.

Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)
An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The QL is the minimum level at which both the presence of an analyte and its concentration can be reliably determined. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

Determination of Interferences
A determination that the method is free from interferences in a blank matrix is performed.

Determination of Range
Where appropriate, a determination of the applicable range of the method may be performed. In most cases, range is determined and demonstrated by comparison of the response of an analyte in a curve to established or targeted criteria. The curve is used to establish the range of quantitation

and the lower and upper values of the curve represent upper and lower quantitation limits. Curves are not limited to linear relationships.

Demonstration of Capability
DOCs are performed prior to method performance.

Determination of Accuracy and Precision
Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

Documentation of Method
The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Appendix describing the specific differences in the new method is acceptable in place of a separate SOP.

Continued Demonstration of Method Performance
Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch specific QC samples such as LCS and Method Blanks.

5.3.6 Data Reduction and Review

Analytical data are entered/downloaded directly into LabNet or recorded on pre-formatted bench sheets that are paginated and bound into laboratory logbooks. These logbooks are issued and controlled by the laboratory's QA Section. A unique document control code is assigned to each book to assure that chronological record keeping is maintained. Analytical data may be electronically stored as a secure .pdf file to which the analyst applies an electronic signature.

Analytical data is referenced to a unique sample identification number for internal tracking and reporting. Both LabNet entries and logbook pages contain the following information, as applicable: analytical method, analyst, date, sequential page number, associated sample numbers, standard concentrations, instrument settings, and raw data. Entries are in chronological order and maintained so as to enable reconstruction of the analytical sequence.

The analyst is responsible for entering / recording all appropriate information, and for signing and dating all logbook entries daily. All entries and logbook pages are reviewed for completeness by a supervisor, peer reviewer or the analyst themselves. Data review checklists document the analytical review of the LabNet entries, logbook and associated QC indicators. Copies of instrument outputs (chromatograms, mass spectra, etc..) are maintained on file or electronically with the analyst's signature/initials and date.

5.3.6.1 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved (e.g., extractions, dilutions, instrument readings and concentrations). The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by the section manager or alternate analyst prior to updating the data in LabNet. The spreadsheets, or any other type of applicable documents, are signed by both the analyst and alternate reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the STL Corporate SOP entitled *Acceptable Manual Integration Practices* (S-Q-004).

Copies of all raw data and the calculations used to generate the final results, such as bound logbooks, are retained on file for a minimum of 5 years or as otherwise requested by the client/project.

Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

5.3.6.2 Data Review

All data, regardless of regulatory program or level of reporting, are subject to a thorough review process. The individual analyst continually reviews the quality of the data through calibration checks, quality control sample results and performance evaluation samples. Data review is initiated by the analyst during, immediately following, and after the completed analysis.

All levels of the review are documented on Data Review Checklists that are specific to each laboratory section.

GC Extractables/HPLC:	CHI-22-17-034
GC Volatiles:	CHI-22-19-003
GC/MS Volatiles and Semivolatiles:	CHI-22-20-038
Metals:	CHI-22-14-004, CHI-22-14-005, CHI-22-14-006
Wet Chemistry:	CHI-22-12-014

Primary Review

The primary review is often referred to as a "bench-level" review. In most cases, the analyst who generates the data (e.g., logs in, prepares and/or analyzes the samples) is the primary reviewer. In some cases, an analyst may be reducing data for samples run by an auto-sampler set up by a different analyst. In this case, the identity of both the analyst and the primary reviewer is identified in the raw data.

One of the most important aspects of primary review is to make sure that the test instructions are clear, and that all project specific requirements have been understood and followed.

Once an analysis is complete, the primary reviewer ensures, where applicable, that:

- Sample preparation information is complete, accurate, and documented.
- Calculations have been performed correctly.
- Quantitation has been performed accurately.
- Qualitative identifications are accurate.
- Manual integrations are appropriate.
- Data flags to indicate manual integrations are recorded.
- Manual integrations are authorized by a date and signature or initials of primary analyst.
- Client specific requirements have been followed.
- Method and process SOPs have been followed.
- Method QC criteria have been met.
- QC samples are within established limits.
- Dilution factors are correctly recorded and applied.
- Non-conformances and/or anomalous data have been properly documented and appropriately communicated.
- COC procedures have been followed.
- Primary review is documented by date and initials/signature of primary analyst.

Any anomalous results and/or non-conformances noted during the Primary Review are documented on the Data Review Checklist and on an SDR; and are communicated to the Section Manager and the Project Manager for resolution. Resolution can require sample reanalysis, or it may require that data be reported with a qualification. Non-conformances are documented per Section 4.9.

Secondary Review

The secondary review is also a complete technical review of a data and is performed by the Section Manager, analyst or data specialist. The secondary review is documented on the same Data Review Checklist as the primary review.

The following items are reviewed:

- Qualitative Identification
- Quantitative Accuracy
- Calibration
- QC Samples
- Method QC Criteria
- Adherence to method and process SOPs
- Accuracy of Final Client Reporting Forms
- Manual Integrations – Minimal requirement is to spot-check raw data files for manual integration, as verified by date and initials or signature of secondary data reviewer. Some regulatory programs require 100% secondary review of manual integrations.
- Completeness
- Special Requirements/Instructions

If problems are found during the secondary review, the reviewer must work with the appropriate personnel to resolve them. If changes are made to the data, such as alternate qualitative identifications, identifications of additional target analytes, re-quantitation, or re-integration, the secondary reviewer must contact the laboratory analyst and/or primary reviewer of the data so that the primary analyst and/or reviewer is aware of the appropriate reporting procedures.

Completeness Review

The completeness review includes the generation of a project narrative and/or cover letter which outlines anomalous data and non-compliances using project narrative notes and SDRs or CARs (non-compliance reports) generated during the primary and secondary review. The completeness review addresses the following items:

- Is the project report complete?
- Does the data meet with the client's expectations?
- Were the data quality objectives of the project met?

Are QC outages and/or non-conformances approved and appropriately explained in the narrative notes?

The laboratory Section Manager(s), Data Management personnel and the Project Manager contribute to the completeness review.

5.3.7 Data Integrity and Security

This section details those procedures that are relevant to computer systems that collect, analyze, and process raw instrumental data, and those that manage and report data.

Security and Traceability

Access to the laboratory's LabNet system, STL's proprietary LIMS, that collects, analyzes, and processes raw instrumental data, and those that manage and report data is both controlled and recorded. System users are granted access levels that are commensurate with their training and responsibilities.

Control of the system is accomplished through limitation of access to the system by users with the education, training and experience to perform the task knowledgeably and accurately. System users are granted privileges that are commensurate with their experience and responsibilities.

Computer access is tracked by using unique login names and passwords for all employees that have access to the computer system. Entries and changes are documented with the identity of the individual making the entry, and the time and date. Where a computer system is processing raw instrumental data, the instrument identification number as described in Section 5.4.1 is recorded. The system has the capability of maintaining audit trails to track entries and changes to the data. This function is activated on any computer system that has that capability (e.g., Target).

Verification

All the LabNet software programs have been verified prior to use and prior to the implementation of any version upgrades. Verification involves assessing whether the computer system accurately performs its intended function. Verification generally is accomplished by comparing the output of the program with the output of the raw data manually processed, or processed by the software being replaced. The verification of LabNet software programs are conducted by the QA manager with the assistance of the section managers and unit leaders. The QA manager documents the approval of the program verifications. All records of the verification are retained as QC records.

Validation

Software validation involves documentation of specifications and coding as well as verification of results. Software validation is performed by the QA manager on all in house programs. (LabNet) Records of validation include original specifications, identity of code, printout of code, software name, software version, name of individual writing the code, comparison of program output with specifications, and verification records as specified above. Records of validation are retained as QC records.

The QA manager must retain documentation of the validation process as defined above. The QA manager is the sole LabNet Methods Administrator at the laboratory and has the responsibility to validate any LabNet methods, calculations or criteria codes prior to use for sample analysis.

Auditing

STLs LabNet System Managers continually review the control, security, and tracking of IT systems and software.

Version Control

The laboratory maintains copies of outdated versions of software and associated manuals for all software in use at the laboratory for a period of 5 years from its retirement date. The associated hardware, required to operate the software, is also retained for the same time period.

5.4 Equipment

5.4.1 Equipment Operation

STL is committed to routinely updating and automating instrumentation. The laboratory maintains state of the art instrumentation to perform the analyses within the QC specifications of the test methods. The laboratory maintains an Equipment Tracking Form (CHI-22-09-068) for each piece of equipment and instrumentation that documents the following information:

- Identity
- Date In Service
- Manufacturer's Name, Model Number, Serial Number
- Current Location
- Preventative Maintenance Schedule

All equipment is subject to rigorous checks upon its receipt, upgrade, or modification to establish that the equipment meets with the selectivity, accuracy, and precision required by the test method for which it is to be used. All manufacturer's operations and maintenance manuals are kept up to date and accessible for the use of the equipment operator. Documentation of equipment usage is maintained using analytical run and maintenance logbooks.

5.4.2 Equipment Maintenance

STL employs a system of preventative maintenance in order to ensure system up time, minimize corrective maintenance costs and ensure data validity. All routine maintenance is performed as recommended by the manufacturer and may be performed by an analyst, instrument specialist or outside technician. Maintenance logbooks are kept on all major pieces of equipment in which both routine and non-routine maintenance is recorded.

Any item of equipment or instrumentation that has been subjected to overloading or mishandling, provides suspected results, has been shown by verification or otherwise to be defective, is new or not been used for an extended period of time, is taken out of services and tagged as "DO NOT USE INSTRUMENT". The tag is signed/dated by the person removing the item from service and noted as to the reason of in-operation *(Instrument and Equipment Out-of-Service Tagging*; UQA-012).

Any instrumentation that is brought back on-line must have MDLs and DOCs performed and have acceptance within prescribe criteria; or calibrated by a certified agency (e.g., balances or Class S weights) and tagged as being within calibration specifications; and proven to provide consistent measurements (e.g., refrigerators, eppendorf pipettes, ovens).

The return to analytical control following instrument repair is documented in the maintenance logbook. Maintenance logbooks are retained as QC records. Notation of the date and maintenance activity is recorded each time service procedures are performed. Maintenance logbooks are retained as QA records.

Table 9. Major Equipment Maintenance

Instrument	Procedure	Frequency
Hewlett Packard GC/MS	Ion gauge tube degassing Pump oil-level check Pump oil changing Analyzer bake-out Analyzer cleaning Resolution adjustment COMPUTER SYSTEM AND PRINTER: Air filter cleaning Change data system air filter Printer head carriage lubrication Paper sprocket cleaning Drive belt lubrication	As required Monthly Annually As required As required As required As required As required As required As required As required
Gas Chromatograph	Compare standard response to previous day or since last initial calibration Check carrier gas flow rate in column Check temp. of detector, inlet, column oven Septum replacement Check system for gas leaks with SNOOP Check for loose/frayed wires and insulation Bake injector/column Change/remove sections of guard column Replace connectors/liners Change/replace column(s)	Daily Daily via use of known compound retention Daily As required W/cylinder change as required Monthly As Required As Required As Required As Required
Electron Capture Detector (ECD)	Detector wipe test (Ni-63) Detector cleaning	Semi-annually As required
Flame Ionization Detector (FID)	Detector cleaning	As required
Photoionization Detector (PID)	Change O-rings Clean lamp window	As required As required
HPLC	Change guard columns Change lamps Change pump seals Replace tubing Change fuses in power supply Filter all samples Change autosampler rotor/stator	As required As required Semi-annually or as required As required As required Daily As required
Balances	Class "S" traceable weight check Clean pan and check if level Field service	Daily, when used Daily At least Annually
Conductivity Meter	0.01 M KCl calibration Conductivity cell cleaning	Daily As required
Turbidimeter	Check light bulb	Daily, when used

Maintenance contracts are held on specific pieces of equipment where outside service is efficient, cost-effective, and necessary for effective operation of the laboratory. Table 9 lists STL's major equipment and the suggested maintenance procedures.

Table 9. Major Equipment Maintenance

Instrument	Procedure	Frequency
AA (Graphite Furnace)	Clean lens and furnace head	Daily
	Replace windows	As required
	Check or change cuvette	Daily
	Check & drain compressor drain	Daily
	Clean atomizer cell/furnace hood	Daily
	Nebulizer cleaned/dried	Weekly or as required
	Check/change marble stones	Weekly
	Clean filters	Weekly
	Change graphite tube/platform	As required
	Empty waste container	Daily
	Remove carbon tube and check wear	Daily
	Check sample introduction probe	Daily
Leeman Mercury Analyzer	Check tubing for wear	Daily
	Fill rinse tank with 10% HCl	Daily
	Insert clean drying tube filled with Magnesium Perchlorate	Daily
	Fill reductant bottle with 10% Stannous Chloride	Daily
ICP	Check pump tubing	Daily
	Check liquid argon supply	Daily
	Check fluid level in waste container	Daily
	Check filters	Weekly
	Clean or replace filters	As required
	Check torch	Daily
	Check sample spray chamber for debris	Monthly
	Clean and align nebulizer	Monthly
	Check entrance slit for debris	Monthly
	Change printer ribbon	As required
	Replace pump tubing	As required
UV-Vis Spectrophotometer	Clean ambient flow cell	As required
	Precision check/alignment of flow cell	As required
	Wavelength verification check	Semi-annually
Auto Analyzers	Clean sampler	Daily
	Check all tubing	Daily
	Clean inside of colorimeter	Daily
	Clean pump well and pump rollers	Quarterly
	Clean wash fluid receptacle	Weekly
	Oil rollers/chains/side rails	Weekly
	Clean optics and cells	Quarterly

Table 9. Major Equipment Maintenance

Instrument	Procedure	Frequency
Deionized/Distilled Water	Check conductivity Check deionizer light Monitor for VOA's System cleaning Replace cartridge & large mixed bed resins	Daily Daily Daily As required As required
Drying Ovens	Temperature monitoring Temperature adjustments	Daily As required
Refrigerators/ Freezers	Temperature monitoring Temperature adjustment Defrosting/cleaning	Daily As required As required
Vacuum Pumps/ Air Compressor	Drained Belts checked Lubricated	Weekly Monthly Semi-annually
pH/Specific Ion Meter	Calibration/check slope Clean electrode	Daily As required
BOD Incubator	Temperature monitoring Coil and incubator cleaning	Daily Monthly
Centrifuge	Check brushes and bearings	Every 6 months or as needed
Water baths	Temperature monitoring Water replaced	Daily Monthly or as needed

5.4.3 Equipment Verification and Calibration

All equipment is calibrated prior to use (Initial Calibration) to establish its ability to meet the QC guidelines contained in the test method for which the instrumentation is to be used. All sample measurements are made within the calibrated range of the instrument and in compliance with method requirements. The calibration data, which includes instrument conditions and standard concentrations, is documented in pre-formatted instrument runlogs or within LabNet itself. The preparation of all reference materials used for calibration is documented via LabNet.

Once an instrument is calibrated, ongoing instrument calibration is demonstrated (Continuing Calibration) at the appropriate frequency as defined in the test method. Refer to the STL Corporate Policy *Selection of Calibration Points* (P-T-001), for guidance on using calibration data. Any instrument that is deemed to be malfunctioning is clearly marked and taken out of service. When the instrument is brought back into control, acceptable performance is documented.

5.4.3.1 Instrument Calibration

Specific instrument calibration procedures for various instruments are summarized further in this section, and detailed in the respective analytical methods. Typically, more than one analytical method is available for an analysis. These various methods and other program requirements (e.g., U.S. EPA CLP, AFCEE, NFESC, USACE, QAPPs, contracts, etc..) may specify different calibration

requirements. Therefore, calibration details as specified in the respective laboratory SOPs, Technical Profiles, QAPP, program requirements, and contracts supersede the general instrument calibration procedures are described further in Table 10. Complete details are provided in each method SOP.

Table 10. Minimum Instrument Calibration Procedures

Technique	Activity	Minimum Requirements
Metals (ICAP)	Initial Calibration	Following a period of time sufficient to warm up the instrument, the ICP is calibrated prior to each analytical run or minimally every 24 hours. Calibration standards are prepared from reliable reference materials and contain all metals for which analyses are being conducted. Working calibration standards are prepared fresh daily. Quarterly, multi-concentration calibration is performed to document linearity. On a day-to-day basis, 4 calibration standards (blank, high standard, 50% standard, and 20% standard) are analyzed. Prior to an analytical run, the instrument is calibrated using three standards. An Initial Calibration Verification (ICV) standard is analyzed immediately after standardization, followed by an Initial Calibration Blank (ICB). The ICV is from a source other than that used for initial calibration and the ICB must be free of target analytes at and above the value to be reported or appropriate corrective action must be taken. ICP Interference Check Samples (ICSA/ICSAB) are analyzed at the frequency described in each method SOP.
	Continuing Calibration	The initial calibration is verified during the analysis sequence by analysis of a Continuing Calibration Verification (CCV) standard and a Continuing Calibration Blank (CCB). The response of the CCV must be within the SOP-specified criteria (e.g., ± 10% recovery of the true value). The CCB must be free of target analytes at or above the value to be reported or appropriate corrective action must be taken. If any ICVs/CCVs or blanks exceed their acceptance criteria, appropriate corrective action must be taken.
Atomic Absorption (GFAA/ CVAA)	Initial Calibration	Initial calibration will include analysis of a calibration blank and a minimum of four (4) calibration standards covering the anticipated range of measurement. Duplicate injections are made for each concentration. Response readings, e.g., absorbance, are recorded and the resultant standard calibration curve calculated. If the SOP or program-specified criteria are not met, appropriate corrective action must be taken. An ICV standard will be analyzed immediately after standardization. The ICV must be within SOP-specified criteria (e.g., ±5% of the true value for drinking water, and ±10% in most other cases), or the initial calibration must be repeated. The ICV must be from a source other than that used for initial calibration. An ICB will be analyzed after the ICV. The ICB must be free of target analytes at and above a concentration in which sample results are reported, or corrective action must be taken.
	Continuing Calibration	The initial calibration is verified during the analysis sequence by evaluation of a CCV standard and a CCB, as described above. The CCV value must be within SOP-specified criteria (e.g., ±10% recovery of the true value except for mercury within ±20 % of the true value). The CCB must be free of target analytes at and above the concentration reported in samples. If any ICVs/CCVs or blanks exceed their acceptance criteria, corrective action must be taken.

Table 10. Minimum Instrument Calibration Procedures

Technique	Activity	Minimum Requirements
Inorganic Colorimetric Methods	Initial Calibration	A full initial standard calibration curve will be prepared for all colorimetric analyses on a daily basis. Working standards to define this curve will include a minimum of five (5) concentrations which cover the anticipated range of measurement, plus a calibration blank. At least one of the calibration standards will be at a concentration which will enable verification of instrument response near the reporting limit as defined in Section 8.6 or a level suitable for meeting specific program requirements. The requirement for an acceptable initial calibration is described in the analytical SOP. If the criteria are not met, appropriate corrective action must be taken. Calibration data, e.g., correlation coefficient, is entered into the laboratory notebook, or associated instrument printouts, and retained with the sample data. In lieu of a full initial curve, a daily calibration verification may be analyzed. This daily calibration will at a minimum consist of a blank and a mid-range standard. Results must be within SOP-specified criteria. If not, reanalysis of the standards may be done once to verify the readings; otherwise, a new curve will be developed. For procedures that require pretreatment steps, a minimum of one standard shall be prepared with the pretreatment. If the pre-treated standard is within SOP-specified criteria, the curve will be used. If the pre-treated sample is not within the criteria, the reason will be determined. If it is determined that the difference between the curves is inherent in the procedure, the curve will be based on the standards prepared and carried through the pretreatment. An ICV will be analyzed immediately after the standardization, followed by an ICB. The ICV must be from a source other than that used for initial calibration. The ICV must be within SOP-specified criteria and the ICB must be free of target analytes or appropriate corrective action must be taken.
	Continuing Calibration	The initial calibration is verified during the analysis sequence by analysis of a CCB and a CCV. If any ICVs/CCVs or blanks exceed their acceptance criteria, analysis is terminated, and the instrument is recalibrated. All samples since the last valid calibration verification are reanalyzed.
Ion Chromato-graphy	Initial Calibration	The ion chromatograph will be calibrated prior to each day of use. Calibration standards will be prepared from appropriate reference materials and will include a blank and a minimum of three concentrations to cover the anticipated range of measurements. At least one of the calibration standards will be at a concentration which will enable verification of instrument response near the reporting limit. If SOP-specified calibration criteria cannot be achieved, appropriate corrective action must be taken. Calibration data, e.g., correlation coefficient, will be archived with sample raw data.
	Continuing Calibration	A continuing calibration standard and blank will be analyzed at a frequency of 10% and at the end of the analysis shift. The response calculated as a percent recovery of the standard must meet SOP or program-specific criteria. The response of the blank must be less than the concentration to be reported for samples analyzed.

Table 10. Minimum Instrument Calibration Procedures

Technique	Activity	Minimum Requirements
GC/MS		All GC/MS instrumentation is calibrated to set specifications prior to sample analysis. These specifications vary depending on the requirements of the analytical program and the designated analytical method.
	Tuning and Mass Calibration	Mass spectrometers are calibrated with perfluorotributylamine (FC-43) or perfluorophenanthrene (FC- 5311) as required to ensure correct mass assignment. In addition, at the beginning of the daily work shift, the GC/MS system must be tuned with decafluorotriphenylphosphine (DFTPP) for semivolatiles analysis and 4-bromofluorobenzene (BFB) for volatiles analysis, and calibrated to target compounds. The majority of the laboratory work utilizes U.S. EPA-CLP or SW-846 protocols, which define the work shift as a 12-hour period initiated by the injection of DFTPP, BFB, or the dioxin/furan window mix. For drinking water programs (500 series methods), a 12-hour work shift is specified in the method for calibration frequency. For wastewater programs (600 series methods), the tune expires when the day's analytical sequence is complete; however, no time limit is given for the length of the daily GC/MS work shift. Ion abundances will be within the windows dictated by the specific program requirements.
	Initial Calibration	After an instrument has been tuned, initial calibration curves (minimum of 3-5 points) are generated for the compounds of interest. The low level standard must be at a concentration which will enable verification of instrument response near the reporting limit or at a concentration acceptable to meet program requirements. The other standards must extend through the linear working range of the detector. The parameters requiring quantitation must meet SOP or program-specified criteria prior to initiation of sample analysis. Any sample extracts containing parameters of interest which exceed the concentration of the high level standard, must be diluted to bring the parameters within the range of the standards. Instrument response to these target compounds are evaluated against SOP-specified criteria. Linearity is verified by evaluating the response factors (RF) for the initial calibration standards against SOP-specified criteria. Once an acceptable calibration is obtained, samples may be analyzed up until the expiration of the tune. At that time, the instrument must be re-tuned prior to further analysis. After acceptable tuning, a continuing calibration standard may be analyzed in lieu of a full multi-point calibration if the SOP-specified criteria are met. The majority of compounds analyzed for GC/MS comprise EPA's Target Compound List (TCL) or Priority Pollutant List (PPL). For add-on compounds not on the current TCL or PPL, initial calibration may be performed using a single point calibration of the additional compound(s), unless prior arrangements are made for a full three-to-five point calibration. Calibration data, to include linearity verification, will be maintained in the laboratory's records of instrument calibrations.
	Continuing Calibration	During each operating shift, a single calibration standard may be analyzed to verify that the instrument responses are still within the initial calibration determinations, as defined in the specific SOPs. If criteria cannot be met, appropriate corrective action must be taken.

Table 10. Minimum Instrument Calibration Procedures

Technique	Activity	Minimum Requirements
GC and HPLC		Gas chromatographs and high performance liquid chromatographs will be calibrated prior to use as described in analytical SOP or program requirements. Calibration standard mixtures will be prepared from appropriate reference materials and will contain analytes appropriate for the method of analysis or program requirements.
	Initial Calibration	Initial calibration will include a minimum of 3 to 5 calibration standards covering the anticipated range of measurement. The low level standard must be at a concentration which will enable verification of instrument response near the reporting limit or at a concentration acceptable to meet program requirements. The other standards must extend through the linear working range of the detector. The parameters requiring quantitation must meet SOP or program-specified criteria prior to initiation of sample analysis. Any sample extracts containing parameters of interest which exceed the concentration of the high level standard, must be diluted to bring the parameters within the range of the standards.
	Continuing Calibration	The response of the instrument will be verified for each analysis sequence by evaluation of a daily calibration verification standard at a mid-range concentration. In order to demonstrate that the initial calibration curve is still valid, the calibration check standard must be within SOP or program-specified acceptance criteria for the compounds of interest or the instrument must be recalibrated. For multi-analyte methods, this check standard may contain a representative number of target analytes rather than the full list of target compounds. Optionally, initial calibration (e.g., the full range of concentration levels) can be performed at the beginning of the analysis sequence. Within the analysis sequence, instrument drift will be monitored by analysis of a mid-range calibration standard every ten samples or 12 hour sequence (depending on the method protocol), including external QC. If the SOP or program-specified calibration criteria are not met for the compounds of interest, appropriate corrective action must be taken.

5.5 Measurement Traceability

5.5.1 General

Traceability of measurements is assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard is subject to ongoing certifications of accuracy.

At a minimum, these include procedures for checking specifications for balances, thermometers, temperature, De-ionized (DI) and Reverse Osmosis (RO) water systems, automatic/eppendorf pipettes and other volumetric measuring devices. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards [with the exception of class A glassware (including glass microliter syringes that have a certificate of accuracy)].

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balances are calibrated on each day of use (*Balance Calibration, Care and Use*; UQA-003). All thermometers and temperature monitoring devices are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use (*Thermometer Calibrations*; UQA-034).

Laboratory DI and RO water systems have documented preventative maintenance schedules and the conductivity of the water is recorded on each day of use (*Water Quality*; UQA-035).

5.5.2 Reference Standards

The receipt of all reference standards is documented in LabNet. Standards are obtained from commercial vendors and sources may vary depending upon the availability of mixes and solutions from vendors. Each production unit is responsible to ensure, when available, that all standards are traceable to EPA, NIST, A2LA, SARMs and are accompanied by a Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis.

The receipt of each dry chemical, purchased stock solution or reference material to be used as a standard is assigned a unique ID number. The chemical name, manufacturer, lot number, date received, expiration date, date opened and initials of the analyst who opened the chemical are documented. The expiration dates for ampulated solutions shall not exceed the manufacturer's expiration date. Expiration dates for laboratory-prepared stock and diluted standards shall be no later than the expiration date of the stock solution or material or the date calculated from the holding time allowed by the applicable analytical method, whichever comes first. Expiration dates for pure chemicals shall be established by the laboratory and be based on chemical stability, possibility of contamination, and environmental and storage conditions. Expired standard materials shall be either revalidated prior to use or discarded. Revalidation may be performed through assignment of a true value and error window statistically derived from replicate analyses of the material as compared to an unexpired standard. The laboratory labels all standard and QC materials with expiration dates.

The preparation of all daughter solutions, whether a single or multiple-component stock, intermediate, or working standard solution, is documented in a standard solution preparation logbook, in a designated section of the analytical logbook or in the LabNet systems reagent program. This documentation references the Standard ID of the respective parent solution(s) used in its preparation, providing a solid trail back to the solution or chemical received from the vendor. These records include the standard name, final volume, matrix, final concentration, analyst initials, prep date and expiration date. A daughter solution should not have an expiration date which post-dates any of the parent solutions used in its preparation.

References standards are labeled with a unique Standard Identification Number, date received, and the expiration date. All documentation received with the reference standard or documentation of standard purity is retained as a QC record and references the Standard Identification Number. All efforts are made to purchase standards that are $\geq$ 97.0% purity. If this is not possible, the purity is used in performing standards calculations.

The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a different lot is acceptable for use as a second source. The appropriate QC criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an ICV or LCS is used as the second source confirmation.

Storage conditions, such as shelf life, ambient or chilled, controlled or restricted access, wet or desiccated, etc.., are in conformance with the specifications set in the associated method, the program requirements, or the manufacturer's recommendation, as appropriate.

5.5.3 Reagents

Reagents are, in general, required to be analytical reagent grade unless otherwise specified in method SOPs. Reagents must be, at a minimum, the purity required in the test method. The date of reagent receipt, date the reagent was opened, and the date of reagent preparation (where applicable) are documented in LabNet for reagent traceability.

5.6 Sampling

Sample representativeness and integrity are the foundations upon which meaningful analytical results rely. Where documented and approved SAPs and/or QAPPs are in place, they must be made available to the laboratory before sample receipt, and approved by laboratory management before sample receipt.

5.7 Sample Handling, Transport, and Storage

5.7.1 General

COC can be established either when bottles are sent to the field, or at the time of sampling. STL can provide all of the necessary coolers, reagent water, sample containers, preservatives, sample labels, custody seals, COC forms, ice, and packing materials required to properly preserve, pack,

and ship samples to the laboratory. Complete details for sample container preparation are contained within UCM-001. A summary of sample receipt is as follows with complete details available within the *Sample Receipt and Handling* SOP (USR-001).

Samples are received at the laboratory by the designated sample custodians and a unique LabNet job (batch) number and unique bottle ID is assigned. The following information is recorded for each sample shipment:

- Client/Project Name.
- Date and Time of Laboratory Receipt.
- Laboratory Job Number
- Signature or initials of the personnel receiving the cooler and making the entries.

Upon inspection of the cooler and custody seals, the sample custodian opens and inspects the contents of the cooler, and records the cooler temperature. If the cooler arrival temperature exceeds the required or method specified temperature range by $\pm 2^{\circ}C$ (for samples with a temperature requirement of $4^{\circ}C$, a cooler temperature of just above the water freezing temperature to $6^{\circ}C$ is acceptable); sample receipt is considered "compromised" and the procedure described in Section 4.7.1 is followed. All documents are immediately inspected to assure agreement between the test samples received and the COC.

Any non-conformance, irregularity, or compromised sample receipt as described in Section 4.7.1 is documented in an SDR and Sample Receipt Checklist and brought to the immediate attention of the Project Manager for resolution with the client. The COC, shipping documents, documentation of any non-conformance, irregularity, or compromised sample receipt, record of client contact, and resulting instructions become part of the permanent project record.

Samples that are being tested at another STL facility or by an external subcontractor are repackaged, iced, and sent out under COC.

Following sample labeling as described in Section 5.7.2, the sample is placed in storage. Refrigerated storage coolers are maintained at $4 \pm 2^{\circ}C$. The temperature is continually being monitored by an electronic monitoring software program. *(Thermometer Calibrations and Electronic Monitoring: UQA-034)* All samples are stored according to the requirements outlined in the test method, and in a manner such that they are not subject to cross contamination or contamination from their environment.

Access to the laboratory is restricted to laboratory personnel or escorted guests as described in Section 5.2. Therefore, once sample possession is relinquished to the laboratory, the sample is in a designated secure area (e.g., the laboratory facility) accessible only to authorized personnel. Locked storage coolers are available for protocol (e.g., AFCEE and CLP) that require internal COC procedures.

5.7.2 Sample Identification and Traceability

The sample custodian organizes the sample containers, COCs, and all pertinent information associated with the samples. The sample identity is verified against all associated sample information. Any inconsistencies are documented via an SDR and forwarded to the Project Manager for resolution with the client prior to identifying the sample(s) into LabNet.

Each sample container is assigned a unique Sample Identification Number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label.

All unused portions of samples, including empty sample containers, are returned to the secure sample control area.

5.7.3 Sub-Sampling

Taking a representative sub-sample from a container containing a soil or solid matrix is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample need consideration when sub-sampling for sample preparation.

After thoroughly mixing the sample within the sample container or transfer to a wip bag (or other suitable plastic bag), a sub-sample from various quadrants and depths of the sample are taken to acquire the required sample weight. Any non-homogenous looking material is avoided and noted as such within the sample preparation record.

5.7.4 Sample Preparation

Sample preparation procedures vary for each matrix and analytical method are as referenced in the laboratory SOPs.

5.7.5 Sample Disposal

Samples are retained in STL storage facilities for 30 days after the project report is sent unless prior written arrangements have been made with the client. Samples may be held longer or returned to the client per written request. Unused portions of samples are disposed of in accordance with federal, state and local regulations. The laboratory removes or defaces sample labels prior to disposal unless this is accomplished through the disposal method (e.g., samples are incinerated). Complete details on the disposal of samples, digestates, and extracts is available within the *Laboratory Waste Disposal Procedures* SOP (UWM-001).

5.8 Assuring the Quality of Test Results

5.8.1 Proficiency Testing

The laboratory analyzes Proficiency Test (PT) samples as required for accreditation and as outlined in NELAC. The laboratory participates in the PT program semi-annually for each PT field of testing for which it is accredited, according to the NELAC PT field of testing published guidelines. This includes drinking water, wastewater and solid/soil matrices.

The laboratory also participate various client PT programs, when submitted.

PT samples are handled and tested in the same manner (procedural, equipment, staff) as environmental samples. Results of PT samples are distributed to the laboratory section managers for review and corrective action, if required. Any required corrective action response to deficiencies is submitted to the QA department for review and are filed with the PT study records. PT test sample data is archived using the requirements for project and raw data record retention. Refer to the SOP: *PT Sample Tracking/Analysis (UQA-018)* for further details.

5.8.1.1 Double Blind Performance Evaluation

The laboratory participates in an annual double blind performance evaluation study. An external vendor is contracted to submit double blind samples to the laboratory. Both the level of customer service and the accuracy of the test results are assessed objectively by the external contractor, who provides a detailed report to the Corporate Quality Director and to the laboratory. This is administered as a double blind program in order to assess all facets of the laboratory's operations.

5.8.2 Control Samples

Control samples (e.g., QC indicators) are analyzed with each batch of samples to monitor laboratory performance in terms of accuracy, precision, sensitivity, selectivity, and interferences. Control samples must be uniquely identified and correlated to unique batches. Control samples further evaluate data based upon (1) Method Performance, which entails both the preparation and measurement steps; and (2) Matrix Effects, which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed. Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch.

Control sample types and typical frequency of their application are outlined Sections 5.8.2.1 through 5.8.2.5 and Tables 11 through 15. Note that frequency of control samples vary with specific regulatory, methodology and project specific criteria. Complete details on method and regulatory program control samples are as listed in Sections 7 and 8 of each method SOP.

5.8.2.1 Method Performance Control Samples: Preparation Batch

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment.

Control samples are added to each prep batch to monitor method performance (Table 11) and are processed through the entire analytical procedure with investigative/field samples.

Field blanks, equipment blank and trip blanks, when received, are analyzed in the same manner as other field samples. However, a field blank should not be selected for matrix QC, as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB".

5.8.2.2 Method Performance Control Samples: Matrix

Matrix control samples include sample duplicates (MD), sample matrix spikes (MS), and sample surrogate spikes. These control samples help monitor for potential physical and chemical effects which may interfere with the precision and/or accuracy of the selected analytical method. Since interferences can enhance or mask the presence of target analytes, matrix control samples measure the degree of interference and are used to assist in the interpretation of the analytical results. The laboratory avoids performing matrix QC on known field blank samples, such as trip blanks and rinsates, since these samples are not indicative of the sample matrix.

Table 11. Preparation Batch Control Samples

Control Type	Details	
Method Blank (MB)	Use	Monitors for potential contamination introduced during the sample preparation and analytical processes.
	Typical Frequency [1]	1 per batch of ≤ 20 samples per matrix type per sample extraction or preparation method.
	Description	Organics: Laboratory pure water for water samples or a purified solid matrix for soil or solid samples (when available or when requested); solid matrices commonly include sodium sulfate, vendor or agency supplied soil or solid, or purchased sand; these solids may require purification at the laboratory prior to use. Inorganics: Laboratory pure water for both water and soil or sediment samples. Volume/weights are selected to approximately equal the typical sample volume/weight used in sample preparation; and final results in a soil/solid batch may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison to actual field samples.
Laboratory Control Sample (LCS)	Use	Measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix affects.
	Typical Frequency [1]	1 per batch of ≤ 20 samples per matrix type per sample extraction or preparation method. For multi-analyte methods, the LCS may consist of surrogates in the blank matrix, and or a representative selection of target analytes/internal standards.
	Description	Prepared from a reference source of known concentration and processed through the preparation and analysis steps concurrently with the field samples. Aqueous LCS's may be processed for solid matrices unless a solid LCS is requested; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.
Known QC Sample	Use	Comply with regulatory requirements; check the accuracy of an analytical procedure; troubleshoot method performance problems; verify an analyst in training's ability to accurately perform a method; to verify the return-to-control after method performance problems; and may also be used as an LCS.
	Typical Frequency [1]	As defined by the client or QAPP.
	Description	Obtained from outside suppliers or agencies; generally require preparation from concentrated materials by dilution into a standard matrix; contain known analytes or compounds; acceptance limits are provided by the vendor.

[1] Denotes an STL required frequency.

Table 12. Matrix Control Samples

Control Type	Details	
Matrix Duplicate (MD)	Use	Monitors the effect of site matrix on the precision of the method; and of the reproducibility of laboratory preparation and measurement techniques. **Note:** Precision may also be affected by the degree of homogeneity of the sample, particularly in the case of non-aqueous samples or aqueous samples with particulates. Sample homogeneity and matrix effect should be considered when field samples are used to assess reproducibility. **Note:** A field duplicate, when received, measures Representativeness of sampling and the effect of the site matrix upon precision.
	Typical Frequency [1]	1 per 20 samples per matrix or per SAP/QAPP [2].
	Description	Performed by analyzing two aliquots of the same field sample independently; analyzed for each associated sample matrix (e.g., when requested by the client or the analytical method).
Matrix Spike (MS)	Use	Measures the effect of site sample matrix on the accuracy of the method.
	Typical Frequency [1]	1 per 20 samples per matrix or per SAP/QAPP.
	Description	Aliquot of a field sample which is spiked with the analytes or compounds of interest; analyzed for each associated sample matrix (when requested by the client or analytical method). The determination of MS percent recovery (% R) requires an analysis of a fortified sample and a non-fortified sample under the same procedural conditions (e.g., sample volumes, dilutions, procedural conditions, etc..). The concentration determined in the non-fortified sample is subtracted from the fortified sample concentration before determining the %R. The degree of homogeneity of the sample, particularly in the case on non-aqueous samples or samples with particulates, may affect the ability to obtain representative recoveries.
Matrix Spike Duplicate (MSD)	Use	Measures effect of site sample matrix on precision of method.
	Typical Frequency [1]	1 per 20 samples per matrix, when requested by the client or the analytical method, or per SAP/QAPP [2].
	Description	Alternative to sample duplicate. Generally, inorganic protocols specify an MD/MS and organic protocols specify an MS/MSD.
Surrogate Spike	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency [1]	Every QC and analytical sample.
	Description	Compounds similar to the target analytes in structure, composition and chromatography, but not typically found in the environment, are added to each QC and analytical sample, prior to preparation (e.g., extraction). If the surrogates in an analytical batch do not all conform to established control limits, the pattern of conformance in investigative and control samples is examined to determine the presence of matrix interference or the need for corrective action.
Internal Standards	Use	Monitor the qualitative aspect of organic and inorganic analytical measurements.
	Typical Frequency [1]	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

[1] Denotes an STL required frequency.
[2] Either an MSD or an MD is required per 20 samples per matrix or per SAP/QAPP.

5.8.2.3 Matrix QC Frequencies

The frequency of matrix QC indicators depends on regulatory program compliance, a project's data quality objectives, or a client's requirements. The following frequency will be applied to samples when the regulatory programs are known and it does not conflict with project or client requirements.

Table 13. EPA Program Requirements

Program	Description [1]
SDWA	MD performed at a 10% frequency or 1 per preparation batch of ≤10 samples, whichever is more frequent.
CWA	MS (GC methods) and MD is performed at a 10% frequency or 1 per preparation batch of ≤10 samples, whichever is more frequent. For GC/MS Methods, MS is performed at a 5% frequency or 1 per preparation batch of ≤20 samples, whichever is more frequent.
RCRA	MS/MSD or MS/MD is performed at a rate of 5% per client (independent of the preparation batch). For clients submitting less than 10 samples, the method matrix QC requirement may be satisfied by another clients sample within the same prep batch unless the paperwork indicates a client requirement for matrix QC. Matrix QC will only be reported to the client who owns the data.
U.S. EPA CLP	MS/MSD or MS/MD is performed at a rate of 5% or 1 set per Sample Delivery Group (SDG) per matrix, independent of the prep batch. For NFESC samples, samples are processed in simultaneous or continuous batches.

[1] MS, MSD and MD may not be applicable to some analytical protocols because of the nature of the sample or protocol.

5.8.2.4 Method Performance Control Samples: Instrument Measurement

Control samples are used to ensure that optimum instrument performance is achieved. These samples help ensure that the proper identification and quantitation of target compounds or analytes are achieved. The instrument control samples appropriate to each analytical technique are described in laboratory SOPs for each respective method. A brief description of these checks is included in Table 14.

Table 14. Instrument Performance Control Samples

Control Type		Description
		Inorganics
ICV	Use	Calibration standard of known concentration prepared from a source other than that used for the calibration standards.
	Sequence	Analyzed after the standard curve to confirm calibration.
ICB	Use	Blank water or solvent; confirms the calibration and assures that any potential contamination is less than the reporting limit.
ICP Interference Check Samples (ICSA/ICSB)	Sequence Use	Analyzed immediately after the ICV. Verifies the absence of spectral interferences.
	Sequence	Analyzed consecutively at the beginning of each eight hour analytical sequence, after the ICV/ICB, and again at an eight hour frequency following a CCV/CCB. When CLP protocols are followed, the ICSA/B will be analyzed with the analytical sequence, before the final CCV/CCB.
Reporting Limit Verification Standard (CRA & CRI)	Use	Verifies linearity near the reporting limit for CLP metals analyses. (Note: CRI is at a level 2X the CRDL; CRA is near the CRDL).
	Sequence	Analyzed after the ICB. The CRI is also analyzed at the end of the eight hour analytical sequence, prior to analysis of the final CCV/CCB.
CCV	Use	Confirm that the instrument performance has not significantly changed during the analytical sequence; to verify stable calibration throughout the sequence; and/or to demonstrate that instrument response did not drift over a period of non-use. Made from a source other than that used for the standard curve.
	Sequence	Analyzed at 10% or every two hours, whichever is more frequent; also analyzed at the end of the analytical sequence.
CCB	Use	Water blank used to confirm that the baseline has not drifted and to monitor for contamination at the reporting limit.
	Sequence	Analyzed at a rate of 10% for inorganics and at a rate of 1 per 10 readings/injections or every two hours, whichever is more frequent, for CLP metals; also analyzed at the end of the analytical sequence.
ICP Metals Linear Range	Use	Verify linearity and document the upper limit of the calibration range for each element.
Analysis Standard (LRS)	Sequence	Performed quarterly with a blank and a minimum of five standard concentrations to cover the anticipated range of measurement; one of the calibration standards will be at or near the reporting limit. The calibration curve generated must have a correlation coefficient $\geq$ 0.995 in order to consider the responses linear over that range.
ICP Inter-Element Correction (IEC)	Use	Correction factors for spectral interference (particularly due to Al, Ca, Fe, and Mg).
	Sequence	Determined at least annually for all wavelengths used for each analyte reported by ICP; or any time the ICP is adjusted in any way that may affect the IECs.

Table 14. Instrument Performance Control Samples

Control Type	Description	
	Organics	
GC/MS Tuning & Performance	Use	Ensures correct mass assignment and is monitored through response to target compounds during initial and continuing calibration, with minimum response criteria for specified system performance check compounds (SPCCs), and linearity is verified by evaluating the response factors (RF) for calibration check compounds (CCCs).
	Sequence	Tuned at the beginning of the daily work shift. Throughout the analysis, blanks, internal standard areas, surrogates, chromatographic baseline, resolution of peaks, and overall quality of the chromatography are used collectively to monitor instrument performance.
GC & HPLC Instrument Performance	Use	Monitored through retention time shift evaluation, linearity checks, and degradation checks of selected target compounds (e.g., for Endrin or DDT as appropriate).
	Sequence	Continuing calibration verification (e.g., blanks, shifts in chromatographic baseline or retention times, resolution of peaks, and overall quality of the chromatography) throughout the analytical sequence is accomplished through analysis of calibration check standards.

5.8.2.5 Method Performance Control Samples: Analysis Batch

Matrix specific control samples are used to assess the precision and accuracy of the method as applied to the specific sample matrix. These indicators provide information on sample matrix effects that is independent of the efficiency of the preparatory technique. The method performance control samples appropriate to each analytical technique are identified in the respective method. A brief description of these checks is included in Table 15.

These control samples are performed to provide a tool for evaluating how well the method performed for the respective matrix. These values are used by the client to assess the validity of a reported result within the context of the project's data quality objectives. For matrix specific QC results falling outside laboratory control limits which are attributed to matrix affects, no systematic corrective action is taken.

Table 15. Analysis Batch Performance Control Samples

Control Sample Type	Description	
ICP Serial Dilution	Use	5X Dilution of a field sample (performed at the instrument) to check for possible physical and/or chemical interferences.
	Sequence	5% of field samples or 1 per <20 samples per batch.
GFAA Analytical Bench Spike	Use	Required by the method; prepared at the instrument by fortifying the digestate with a known quantity of the analyte of interest.
	Sequence	Performed on each sample immediately following the unspiked original analysis.
Method of Standard Addition (MSA)	Use	When specified by the analytical protocol or by client request.
	Sequence	When specified by the analytical protocol or by client request.

5.8.3 Statistical Control Limits and Charts

Statistical control limits and control charts are used to establish method performance of a given analysis and to monitor trends of QC results graphically over time. Once a data base of the laboratory results for a method/matrix/QC analyte combination is established, the acceptability of a given analysis of that QC parameter (and of the analytical batch to which it belongs) can be evaluated in light of the laboratory's normal performance. This is intended to help identify problems before they might affect data. Often, patterns of response that are not at all evident in sets of numbers are very distinct when the same values are viewed as a chronological graph.

Establishment of Limits

The purpose of using statistical control limits is to define, for each analyte in a given method/matrix/QC type combination, a range of expected values. This range encompasses the random variation that occurs normally in the laboratory and allows one to evaluate control samples in that context, rather than according to an arbitrary or external set of values. Limits for accuracy and precision are defined below:

Accuracy

As recoveries of a QC analyte in a given matrix are tabulated over time, a mean value for recovery is established, as is the standard deviation (s) of those recoveries. If the analysis is in statistical control (e.g., if the set of QC recoveries over time show random variation about the mean) approximately 99.7% of all recoveries for that QC will fall within three standard deviations (3s) of the mean. Thus, assuming that the mean itself is an acceptable level of recovery, the values corresponding to 3s above and 3s below the mean are defined as the Control Limits. Any single recovery outside these values is assumed to have resulted from some circumstance other than normal variation and shall be investigated.

Roughly 95% of points should fall within 2s of the mean. The values +2s and -2s are the Warning Limits. Any normal result has approximately a 1/20 chance of being between 2s and 3s from the

mean, so a result in this region doesn't necessarily warrant corrective action, but attention should be paid to such points.

Precision

Precision is used to indicate matrix variability so that appropriate decisions can be made by the client when repeated analyses vary significantly. The coefficient of variation, expressed as a percentage (e.g., the %RSD) for the data set used to calculate accuracy control limits defines the control limit for precision. Duplicate analyses of the QC samples, such as duplicates or MS/MSD, should have an RPD less than or equal to this established precision control limit to be considered free of matrix interferences.

The laboratory calculates statistical control limits on an annual basis. Such limits are available on a project or QAPP-specific basis.

5.8.4 Calibration

Calibration protocols are method-specific, are briefly described in Table 10 and are defined in the Sections 6 & 7 of the method SOPs.

5.8.5 Glassware Cleaning

All glassware is thoroughly cleaned prior to use to ensure that sample integrity is not affected from artifacts caused by contaminated glassware.

A summary of general cleaning procedures follows with details provided in the *Laboratory Glassware Cleaning* SOP (UQA-009):

General laboratory glassware is cleaned with a low- or non-phosphate detergent, followed by thorough rinsing with tap water and deionized water.

Volumetric flasks and pipettes used for inorganics (method dependent), test tubes and caps used for micro-COD procedures, phosphate glassware, and metals-related glassware include an acid-washing step.

BOD glassware cleaning includes a nitric or sulfuric acid and/or a NOCHROMIX-washing step.

Organic glassware includes a solvent-wash.

Non-volumetric organic glassware may optionally be kiln dried at 400°C.

5.8.6 Permitting Departures from Documented Procedure

Where a departure from a documented SOP, test method, or policy is determined to be necessary, or unavoidable, the departure is documented in a CAR or SDR and reported in the case narrative. In most cases, these departures can be made with the approval of the section manager, project manager and the client. Issues of serious concern, as determined by the Section Manager or Project Manager, will be brought to the attention of the Laboratory Director and/or QA Manager. In some

instances, it is appropriate to inform the client before permitting a departure. The Project Manager will make the determination as to the degree of notification required by the client.

On rare occasions, special analytical techniques will be requested for research, project specific requirements, or client needs. In these instances, SOPs may not be available, however, the analyst will thoroughly record the analytical steps and observations within a bound preformatted logbook.

5.8.7 Development of QC Criteria, Non-Specified in Method/Regulation

Where a method or regulation does not specify acceptance and/or rejection criteria, the laboratory must examine the data user's needs and the demonstrated sensitivity, accuracy and precision of the available test methods in determining appropriate QC criteria.

Data users often need the laboratory's best possible sensitivity, accuracy, and precision using a routinely offered test method, or are unsure of their objectives for the data. For routine test methods that are offered as part of STL's standard services, the laboratory bases the QC criteria on statistical information such as determination of sensitivity, historical accuracy and precision data, and method verification data. The method SOP includes QC criteria for ongoing demonstration that the established criteria are met (e.g., acceptable LCS accuracy ranges, precision requirements, method blank requirements, initial and continuing calibration criteria, etc..).

In some cases, a routine test method may be far more stringent than a specific data user's needs for a project. The laboratory may either use the routinely offered test method, or may opt to develop an alternate test method based on the data user's objectives for sensitivity, accuracy, and precision. In this case, it can be appropriate to base the QC criteria on the data user's objectives, and demonstrate through method verification and ongoing QC samples that these objectives are met.

For example, a client may require that the laboratory to test for a single analyte with specific DQOs for sensitivity, accuracy, and precision as follows: Reporting Limit of 10 ppm, Accuracy $\pm$25%, and RSD of <30%. The laboratory may opt to develop a method that meets these criteria and document through the Method Blank results, MDL study, and LCS results that the method satisfies those objectives. In this case, both the method and the embedded QC criteria have been based on the client's DQOs.

In some cases, the data user needs more stringent sensitivity, accuracy, and/or precision than the laboratory can provide using a routine test method. In this case, it is appropriate that the laboratory provide documentation of the sensitivity, accuracy, and precision obtainable to the data user and let the data user determine whether to use the best available method offered by the laboratory, or determine whether method development or further research is required.

5.9 Project Reports

The SOP for data package assembly and reporting formats is defined in the *Data Management, Process Operation SOP* (UDM-001) and a summary of this procedure follows.

Analytical reports comprise final results (uncorrected for blanks and recoveries unless specified), methods of analysis, levels of reporting, surrogate recovery data, and method blank data. In addition, special analytical problems will be noted in the case narratives. The number of significant figures reported are consistent with the limits of uncertainty inherent in the analytical method. Consequently, most analytical results will be reported to no more than two (2) or three (3) significant figures. Data are normally reported in units commonly used for the analyses performed.

Concentrations in liquids are expressed in terms of weight per unit volume (e.g., milligrams per liter, mg/L). Concentrations in solid or semi-solid matrices are expressed in terms of weight per unit weight of sample (e.g., micrograms per kilograms, ug/kg). Reporting limits take into account all appropriate concentration, dilution, and/or extraction factors, unless otherwise specified by program requirements (e.g., IRPMS reports).

A client report is generated with various steps of approval prior to printing of the final version. If any analytical anomalies were encountered during the analyses, e.g., an out-of-control matrix duplicate, it is documented in a case narrative. The case narrative is prepared by the respective operating unit and submitted to the data management section to insert in the final report.

The final report forms are printed, data packages are organized, a glossary of flags and acronyms is added, and reports are paginated.

5.9.1 General

The criteria described in Section 5.9.2 apply to all Project Reports that are generated under NELAC requirements. The criteria described in Section 5.9.3 and 5.9.4 apply to all Project Reports.

5.9.2 Project Report Content

- Title
- Laboratory name, address, telephone number, contact person
- Unique Laboratory Project Number
- Name and Address of Client
- Client Project Name (if applicable)
- Laboratory Sample Identification
- Client Sample Identification
- Matrix and/or Description of Sample
- Dates: Sample Receipt, Collection, Preparation and/or Analysis Date
- Definition of Data Qualifiers
- Reporting Units
- Test Methods
- Report Paginated

The following are required where applicable to the specific test method or matrix:

- Solid Samples: Indicate Dry or Wet Weight
- Whole Effluent Toxicity: Statistical package used
- If holding time ≤ 48 hours, Sample Collection, Preparation and/or Analysis Time
- Indication by flagging where results are reported below the quantitation limit.

5.9.3 Project Narrative

A Project Narrative and/or Cover Letter is included with each project report and, at a minimum, includes an explanation of any and all of the following occurrences:

- Non-conformances
- "Compromised" sample receipt (see Section 4.7.1)
- Method Deviations
- QC criteria failures

Project Release

The Project Manager or his designee authorizes the release of the project report with a signature.

Where amendments to project reports are required after issue, these are documented in the form of an RDR (refer to Section 4.8) and can be in the form of a separate document and/or electronic data deliverable resubmittal. The revised report is clearly identified as revised with the date of revision and the initials of the person making the revision. Specific pages of a project report may be revised using the above procedure with an accompanying cover letter indicating the page numbers of the project revised. The original version of the project report will be kept intact and the revisions and cover letter included in the project files.

5.9.4 Subcontractor Test Results

Subcontracted data is clearly identified as such, and the name, address, and telephone number for the laboratory performing the test is included in the project report. Subcontracted results from laboratories external to STL are not reported on STL report forms or STL letterhead. Test results from more than one STL facility are clearly identified with the name of the STL facility that performed the testing, address, and telephone number for that facility. Data from subcontractors' reports may be added to an STL electronic deliverable.

Data subcontracted within STL may be reported on the originating laboratory's report forms provided the following mandatory requirements are met:

- The name, address, and telephone number of the facility are provided.
- Analytical results produced by the STL intra-company subcontractor are clearly identified as being produced by the subcontractor facility.
- The intra-company subcontractor's original report, including the chain of custody is retained by the originating laboratory.
- Proof of certification is retained by the originating laboratory.
- All information as outlined in Section 5.9.2 is included in the final report where the report is required to be compliant with NELAC, for both the originating and subcontracting laboratory.

5.9.5 Electronic Data Deliverables

Electronic Data Deliverables (EDD) are routinely offered as part of STL's services. STL offers a variety of EDD formats including Environmental Restoration Information Management System (ERPIMS), New Agency Standard (NAS), Format A, Excel, Dbase, GISKEY, and Text Files.

EDD specifications are submitted to the EDD development staff by the PM for review and undergo the contract review process in Section 4.4.1. Once the laboratory has committed to providing diskettes in a specific format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained as a QC record.

EDDs are subject to a secondary review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory demonstrates that it can routinely generate that EDD without errors. Any revisions to the EDD format are reviewed until it is demonstrated that it can routinely be generated without errors. (*EDD SOP*: UIS-001)

5.9.6 Project Report Format

STL offers a wide range of project reporting formats, including EDDs, short report formats, and complete data deliverable packages modeled on the Contract Laboratory Protocol (CLP) guidelines. More information on the range of project reports available in the Data Management SOP (UDM-001). Regardless of the level of reporting, all projects undergo the levels of review as described in Section 5.3.6.

Appendix. List of Cited SOPs and Work Instructions

Cited Sec. No(s)	Description	Document No.
1.6; 5.7.1	Container Management: Process Operation	UCM-001
1.6; 4.4.2	Project Management: Project Planning Process	UPM-003
4.1	Signature Authority	UQA-030
4.1.1	Work Instruction: Equipment & Instrumentation Listing	CHI-22-09-103
4.1.2.9	Internet Use Policy Electronic Mail Use Computer System Account and Naming Policy Computer System Password Policy Software Licensing Policy Virus Protection Policy	P-I-001 P-I-002 P-I-003 P-I-004 P-I-005 P-I-006
4.3.1	Document Control	UQA-006
4.3.1.1; 5.3.2	Approved SOP Listing	CHI-22-09-SOP
4.3.2; 4.12.3	Data Management: Record Retention & Purging	UDM-002
4.4.2	Project Kick-Off Meetings	UPM-002
4.4.2	Production Meetings	UPM-004
4.4.3.6	IDL's for CLP Metals and Cyanide	UQA-010
4.4.3.6; 5.3.5	Method Detection Limits (MDLs)	UQA-017
4.5	Work Sharing Process - Policy	S-C-001
4.6	Procurement Quality Assurance Process	UQA-020
4.6.1	Testing Solvents and Acids	S-T-001
4.7.2	Client Confidentiality	UQA-004
4.8; 4.11	Sample Discrepancy Reports (SDRs) / Resubmitted Data Reports (RDRs) / Corrective Action Reports (CARs)	UQA-029
4.8; 4.11	Quality Systems Management Review	UQA-002
4.11	Preventive Action Measures	UQA-019
4.12.2	Work Instruction: Records Management Form	CHI-22-05-032
4.13	Internal Audits	UQA-013
5.1.2	Training Program: Mechanisms and Documentation Processes Defined by Operational Assessment	UQA-014
5.1.2	STL Chicago Demonstration of Capability Certification Statement	CHI-22-09-271
5.1.2	STL Chicago Yearly Method Capability Review Work Instruction: WC	CHI-22-09-279
5.1.3	Ethics Policy	P-L-006
5.3.1	Work Instruction: Methods Capabilities	CHI-22-09-255
5.3.2	SOP Change Protocol	UQA-032
5.3.5	MDL Policy	S-Q-003
5.3.6.1	Acceptable Manual Integration Practices	S-Q-004
5.3.6.2	Data Review Checklists GC Extractables / HPLC GC Volatiles GC/MS: Volatiles and Semivolatiles Metals Wet Chemistry	 CHI-22-17-034 CHI-22-19-003 CHI-22-20-038 CHI-22-14-004; 5; 6 CHI-22-12-014
5.4.1	Work Instruction: Equipment Tracking Form	CHI-22-09-068
5.4.2	Instrument and Equipment Out-of-Service Tagging.	UQA-012

Appendix. List of Cited SOPs and Work Instructions

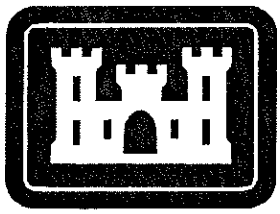
Cited Sec. No(s)	Description	Document No.
5.4.3	Selection of Calibration Points	P-T-001
5.5.1	Balance Calibration, Care and Use	UQA-003
5.5.1; 5.7.1	Thermometer Calibrations and Electronic Monitoring	UQA-034
5.5.1	Water Quality	UQA-035
5.7.1	Sample Receipt: Handling and Processing	USR-001
5.7.5	Laboratory Waste Disposal Procedures	UWM-001
5.8.1	PT Sample Tracking/Analysis	UQA-018
5.8.5	Glassware Cleaning Procedures	UQA-009
5.9.5	EDD SOP	UIS-001
5.9; 5.9.6	Data Management: Process Operation	UDM-001

ATTACHMENT C

INVESTIGATION DERIVED WASTE MANAGEMENT PLAN

FINAL
INVESTIGATION DERIVED WASTE MANAGEMENT PLAN
MCA BARRACKS SITE
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

Prepared for



U.S. Army Corps of Engineers
Savannah District

Contract No. DACA4500-03-D-0029
Delivery Order 001

September 2005

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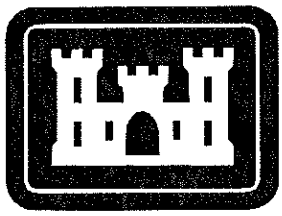
FINAL
INVESTIGATION DERIVED MANAGEMENT PLAN
MCA BARRACKS SITE
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

Prepared for



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September 2005

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TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF ACRONYMS AND ABBREVIATIONS

° C	degree Celsius
CFR	Code of Federal Regulations
DOT	Department of Transportation
FSP	Field Sampling Plan
GEPD	Georgia Environmental Protection Div.
GSV	Glass Septum Vial
HAAF	Hunter Army Airfield
HCL	Hydrochloric Acid
HGL	HydroGeoLogic, Inc.
HSI	Hazardous Site Inventory
HSRA	Hazardous Site Response Act
IDW	investigation derived waste
L	liter
ml	milliliter
ms	matrix spike
msd	matrix spike duplicate
HNO_3	nitric acid
oz	ounce
PID	photoionization detector
Poly	Polyethylene Bottle
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
SI	site investigation
SVOC	semi-volatile organic compound
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

VOC	volatile organic compound

FINAL
INVESTIGATION DERIVED WASTE MANAGEMENT PLAN
MCA BARRACKS SITE
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

1.0 INTRODUCTION

This Investigation Derived Waste (IDW) Management Plan describes the general methodologies and specific field activities related to the handling, sampling, and disposal of IDW at the Hunter Army Airfield (HAAF) MCA Barracks site located in Savannah, Georgia. The field activities that will generate IDW will be conducted by HydroGeoLogic, Inc. (HGL) under Contract Number DACA45-03-D-0029, which is administered by the U.S. Army Corps of Engineers (USACE)-Savannah District.

1.1 SITE LOCATION AND FACILITY DESCRIPTION

The HAAF occupies 53,370 acres along the western edge of the City of Savannah, Georgia (Work Plan Figure 2.1) (HGL, 2005). The HAAF site falls under the regulatory authority of Georgia's Department of Natural Resources, Environmental Protection Division (GEPD) Hazardous Site Response Act (HSRA) (HSI# 10521). The MCA Barracks site is located north of Lightning Road, west of Mitchell Boulevard, east of Griffin Street and south of Cook Boulevard (Work Plan Figure 2.2) (HGL, 2005). The site consists of approximately 75 acres.

A summary of the historical use of the facility and the results of previous investigations are presented in Sections 2.1 and 3.0 of the Work Plan (HGL, 2005).

1.2 DOCUMENT ORGANIZATION

Procedures for the handling, sampling, and disposal of IDW are discussed in the following sections:

- Sections 2.0 and 2.1 present field methodologies and techniques to be used for IDW;
- Site specific handling and staging procedures are discussed in Section 2.2;
- The specific sampling rationale and protocol for IDW is presented in Section 2.3; and
- References are provided in Section 3.0.

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2.0 FIELD METHODOLOGIES FOR HANDLING, SAMPLING, AND DISPOSAL OF IDW

This section identifies the methodology for conducting IDW handling, sampling, and disposal at the MCA Barracks site. A variety of field methods will be employed during the pilot test and site investigation (SI) which will generate a variety of IDW including:

- Decontamination water,
- Well development water,
- Drilling fluids,
- Soil cuttings,
- Disposable equipment, and
- Personal protective equipment (PPE).

All IDW will be handled in a manner consistent with USACE and U. S. Environmental Protection Agency (USEPA) guidance for managing IDW for site investigations (USEPA, 1991) and applicable federal and state regulations.

2.1 DISPOSAL OF IDW

In general, the following procedures will be used to dispose of IDW:

- Resource Conservation and Recovery Act (RCRA) nonhazardous wastes (except disposable equipment and PPE) will be disposed of on site when possible. Liquid wastes from uncontaminated areas such as monitoring well development and purge water, will be poured onto the ground down-gradient from the well and allowed to infiltrate near the well head. Soil cuttings from uncontaminated areas will be returned to the borehole or spread on the surface near the borehole.
- When wastes cannot be pre-determined to be RCRA non-hazardous or on-site disposal is not possible, the wastes will be containerized as described below.
- Decontamination waters will be containerized in a watertight container. After sample analysis, non-hazardous waters will be disposed of in the sanitary sewer.
- RCRA non-hazardous and decontaminated disposable equipment and PPE will be double bagged and placed inside a dumpster for disposal at a sanitary landfill.
- IDW that is considered RCRA hazardous waste will be disposed of at an appropriate licensed hazardous waste disposal facility.

2.2 HANDLING OF IDW

Investigation-derived soils and water will be field screened by visual inspection and with a photoionization detector (PID) to determine whether these wastes are contaminated by volatile organic components. If samples have positive PID readings, all IDW associated from that location will be placed in Department of Transportation (DOT) approved 55-gallon drums or other approved container. If clean cuttings cannot be placed at the well location as indicated above, they will be containerized. If potentially contaminated groundwater is identified by field screening or historical sample analysis, this water will be containerized in DOT approved 55-gallon drums or other approved container.

All drums and containers shall be labeled "UNCLASSIFIED-WASTE ANALYSIS PENDING". In addition, the following information shall be included on the waste label: the well number, HGL's point-of-contact and telephone number (Jennifer Carter, 518-877-0390), the HAAF point-of-contact and telephone number (Algeana Stevenson, 912-767-2281), and a description of the container's contents.

All drummed cuttings and water will be transported to Building 720 as agreed upon by HGL and the Directorate of Public Works, Environmental Branch until analytical results for the respective sites are received. The area(s) in which the containers are stored will be flagged with surveying tape and stakes. Composite samples will be collected from the storage containers and analyzed for RCRA metals, volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC) to determine the suitability of subsequent disposal methods. Contents of drums from sites that are later determined to be non-hazardous can be disposed of at a sanitary landfill (soil) or at an area designated for disposal of clean liquids by HAAF's point-of-contact.

All IDW will be characterized for disposal within 30 days of the date of generation and disposed of off-site within 60 days of generation. All emptied drums, roll-offs, and pallets, will be removed from the site by HGL or its subcontractors. All required manifests for waste disposal will be completed by HGL and signed by HAAF Environmental Branch representative. HAAF will be given a 72-hour notice prior to any waste hauling activity. HGL will be on-site during all waste removal activities. Algeana Stevenson (HAAF's point-of-contact) will be provided with an original and three copies of all manifests, destruction/disposal documents, and any analytical results within 30 day of disposal. Waste manifests will be signed by base personnel.

2.3 SAMPLING PROTOCOL

This section discusses the sampling protocol that will be used by HGL to determine whether the generated IDW will be handled and disposed of as a hazardous waste. Tables 2.1 and 2.2 summarize the various components of the IDW sampling procedures and rationale. Sampling procedures and documentation will follow the protocols detailed in Section 2 of the Field Sampling Plan (FSP) and Sections 5 and 6 of the Quality Assurance Project Plan (QAPP).

Decontamination and well development water will be generated during the SI. These liquids will be managed on-site using double contained Baker Tanks (or equivalent); thereby ensuring that a release will not occur. Depending on the volume, purge water from the wells will either be placed in 55-gallon drums or bulked with the development water discussed above. Drill cuttings will be stockpiled in roll off bins or in drums, whichever is most practical. If roll off bins are used, they will be covered and secured by tarps or roll off covers. Potential precipitation water that may enter the roll off bins will be collected and managed with the liquid wastes discussed above. All waste will be stored in a central secure area that will be arranged with the HAAF Environmental Branch point-of-contact (Algeana Stevenson).

Once site activities for the SI are complete, composite waste characterization samples will be obtained from the water tanks and roll-off bins or drums and analyzed to ensure that it does not meet the definition of a hazardous waste 40 Code of Federal Regulations (CFR) 261. Before disposal, the IDW water will be sampled for VOCs, SVOCs, and RCRA metals.

Prior to disposal, the IDW soils will be sampled and analyzed for VOCs, SVOCs, and RCRA metals to determine if they need to be classified as a "Special Waste". After profiling those soils that require treatment as Special Waste will be loaded onto transport trucks for disposal at the licensed Special Waste Disposal Facility. Tables 2.1 and 2.2 provide detailed sampling information.

Table 2.1
Summary of Field Sampling Rationale
IDW Sampling and Disposal

Sampling Rationale	Proposed Investigations				
	Sample Type	Number of Locations*	Samples Per Location**	Sample Location	Analytical Test
Decontamination and well development water will be generated during the SI. These liquids will be managed on-site using double contained Baker Tanks (or equivalent), thereby ensuring that potential release of impacted liquid will not occur. Depending on the volume, purged water from the wells will either be placed in 55-gallon drums or bulked with the development water.	Decontamination, well development, and purge water	4	1	Storage tanks	VOCs, SVOCs, and RCRA metals.
The soils will be tested to determine their waste status. Drill cuttings will be stockpiled in roll off bins or in drums, which ever is most practical. If roll off bins are used, they will be covered and secured by tarps or roll off covers. Potential precipitation water that may enter the roll off bins will be collected and managed with the liquid waste discussed above.	Subsurface soil	2	1	Roll-off bins or drums	VOCs, SVOCs, and RCRA metals.

SVOC – Semivolatile organic compound
VOC – Volatile Organic Compound
RCRA – Resource Conservation and Recovery Act
SI - Site Investigation

* This assumes 4 bulk storage areas will be needed. Additional storage containers will be added if necessary.
** Additional composite samples will be collected if needed

Table 2.2
Sampling and Analytical Summary
IDW Sampling and Disposal

Sample Type / Matrix	Analytical Parameter (Method Number)	Number of Field Samples	Field QC Samples				Holding Times	Preservation Requirements	Sample Containers (per sample)	Total Sample Containers
			Duplicates	Equipment Rinsate	MS/MSD	Trip Blanks				
Subsurface Soil	VOCs (SW8260B)	2	0	0	0	0	14 Days	Ice to 4 °C HCl	Three Encore Samples	6
	SVOCs (SW8270C)	2	0	0	0	0	14 Days	Ice to 4 °C	One 8-oz Glass Jar	2
	RCRA Metals (6000/7000s)	2	0	0	0	0	6 months	Ice to 4 °C	One 8-oz Glass Jar	2
Decontamination and well development water	VOCs (SW8260B)	4	0	0	0	0	14 Days	Ice to 4 °C HCl	Two 40-ml GSV	8
	SVOCs (SW8270C)	4	0	0	0	0	7 Days	Ice to 4 °C	One 1-L Amber Glass	4
	RCRA Metals (6000/7000s)	4	0	0	0	0	6 Months	Ice to 4 °C HNO_3	One 1-L poly	4

°C - degree Celsius
GSV - Glass Septum Vial
HCl - Hydrochloric Acid
L - Liter
ml - Milliliter
HNO_3 - Nitric Acid
MS - Matrix Spike
oz - ounce
Poly - Polyethylene Bottle
RCRA - Resource Conservation and Recovery Act
QC - Quality Control
VOC - Volatile Organic Compound
SVOC - Semi-volatile Organic Compound
MSD - Matrix Spike Duplicate

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3.0 REFERENCES

HydroGeoLogic, Inc. (HGL), 2005. *Draft Site Investigation Work Plan, MCA Barracks Site, Hunter Army Airfield, Savannah, GA.* March, 2005.

U.S. Environmental Protection Agency (USEPA), 1991. *Management of Investigation-Derived Wastes During Site Inspections.* Washington, DC. EPA/540-G-91/009

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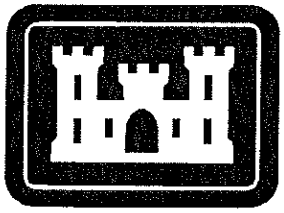
FINAL
INVESTIGATION DERIVED WASTE MANAGEMENT PLAN
MCA BARRACKS SITE
HUNTER ARMY AIRFIELD
SAVANNAH, GEORGIA

Prepared for



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