Final
Former Ramey Air Force Base
Installation-Wide Sampling and Analysis Plan
Aguadilla, Puerto Rico

Revision 1

Contract Number DACA21-96-D-0018
Task Order No. 0008

February 2000

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Contract: Total Environmental Restoration Contract DACA21-96D-0018
Task Order #0008

Subject: Final Installation-Wide Sampling and Analysis Plan
Former Ramey AFB

Dear Mr. Keiser:

The Final Installation-Wide Sampling and Analysis Plan for Ramey AFB is submitted as indicated on the enclosed distribution list.

Sincerely,

Daniel W. Bowholtz, P.E.
Project Manager

Enclosure

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Final

Installation-Wide Sampling and Analysis Plan
Former Ramey Air Force Base, Aguadilla, Puerto Rico

Revision 1

Prepared for:

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February 2000

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List of Acronyms

Accutest	Accutest Laboratories Southeast
AFB	Air Force Base
AR	analysis request
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
BTEX	benzene, toluene, ethyl benzene, xylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	chain of custody
CX	center of expertise
DERP-FUDS	Defense Environmental Restoration Program - Former Used Defense Sites
DI	deionized
DO	dissolved oxygen
DOT	U.S. Department of Transportation
DQO	data quality objective
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FADL	field activity daily log
FDEM	Frequency Domain Electromagnetic
GC	gas chromatography
gpm	gallon per minute
GPR	ground-penetrating radar
GSA	General Services Administration
GSSI	Geophysical Survey Systems, Inc.
HCl	hydrochloric acid
HSA	hollow-stem auger
HTRW	hazardous toxic and radiologic waste
ID	inside diameter
IDW	investigation-derived waste
IRA	interim remedial action

List of Acronyms *(Continued)*

IT	IT Corporation
ITEMS	IT Environmental Management System
LCSD	laboratory control sample duplicate
LTM	long-term monitoring
LCS	laboratory control sample
µg/kg	micrograms per kilogram
MDL	method detection limits
MHz	megahertz
MS/MSD	matrix spike/matrix spike duplicate
NGVD	National Geodetic Vertical Datum (1929)
NTU	nephelometric turbidity unit
O&M	operation and maintenance
°C	degrees Celsius
O&M	operation and maintenance
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	polychlorinated biphenyls
PM	project manager
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QAM	quality assurance manual
QC	quality control
QCSR	quality control summary report
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RI	remedial investigation
RL	reporting limit
RPD	relative percent difference
RSD	relative standard deviation
SAD	South Atlantic Division
SAP	sampling and analysis plan
SHP	safety and health plan

List of Acronyms *(Continued)*

SI	site investigation
SOP	standard operating procedure
SOW	scope of work
SPCS	State Plane Coordinate System
SPM	sample planning module
SRM	standard reference material
SVOC	semivolatile organic compound
TAL	target analyte list
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TERC	Total Environmental Restoration Contract
TIC	tentatively identified compound
TM	technical manager
TPH	total petroleum hydrocarbon
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
UST	underground storage tank
VOA	volatile organic analysis
VOC	volatile organic compound
WAD	Work Allocation Directive

1.0 Introduction

This installation-wide sampling and analysis plan (SAP) for the Former Ramey Air Force Base (AFB) Aguadilla, Puerto Rico, has been prepared by IT Corporation (IT) for the U.S. Army Corps of Engineers (USACE), Savannah District and Jacksonville District under Task Order Number 0008 of indefinite delivery term contract number DACA21-96-D-0018.

This document will serve as the installation-wide SAP prepared for work to be conducted at the Former Ramey AFB. This SAP contains detailed general procedures for installation-wide activities such as planning, quality control (QC) sampling, documentation, analysis, and data management and reporting. Task-specific field sampling plans and work plans will be prepared for site activities that will describe the task objectives and discuss task-specific procedures and requirements.

This document should be considered complete, but subject to periodic review and update. Laboratory reporting limits and control limits are performance based and are updated annually by the laboratory. This document may require updates as new sites are added to the current scope of work (SOW). Revisions to this document will be made by IT with guidance and approval from all pertinent regulatory offices.

This SAP was prepared in compliance with the document, R*equirements for the Preparation of Sampling and Analysis Plan*, EM200-1-3, USACE, September 1, 1994. Data quality sections were prepared to meet with the guidance specified in the manual, *Technical Project Planning Guidance for HTRW Data Quality Design*, EM200-1-2, USACE, July 31, 1995.

1.1 Project Description

The Former Ramey AFB covered approximately 4,357 acres north of the city of Aguadilla, on the extreme northwestern tip of the island of Puerto Rico. The U.S. Government acquired the property between 1939 and 1963, and utilized the site as a fully operational AFB until its deactivation in 1973. On 1 March 1974, ownership of most of the property was transferred to the Puerto Rican Industrial Development Company. Since March 1974 there have been numerous transfers of parcels of land between the U.S. Government agencies, between the government and private companies, and between the U.S. Government and local government agencies. This area

is now operated by the Puerto Rico Ports Authority as the Rafael Hernandez Airport, a municipal airport and industrial park, except for approximately 125 acres, which are still utilized by the U.S. Government as a U.S. Coast Guard installation. The USACE is now performing the environmental work at the Former Ramey AFB under the Defense Environmental Restoration Program-Former Used Defense Sites (DERP-FUDS).

Under Task Order 0008, IT and its subcontractors will provide all scientific engineering, technical, and construction services needed to complete the project. Currently, planned activities include preparing work plans, reports, and regulatory documents; obtaining permits, clearances, and easements; conducting all project planning and management duties; and completing and implementing investigation and remediation design.

Figure 1-1 shows the overall Former Ramey AFB with the general location of each site to be investigated.

1.2 Site Descriptions

Pipeline System. The pipeline system at the Former Ramey AFB was a ring or loop system that encircled most of the base. This pipeline was approximately 8.5 miles of 8 and 10-inch diameter pipelines. Approximately 2,500 linear feet (~.5miles) of the pipeline was aboveground while about 8 miles of the pipeline was underground. The aboveground portions of the pipeline were removed in 1998 by Caribco. The underground portions of the pipeline were abandoned in-place by grouting also by Caribco in 1998. The system included pumps, valves, controls, pits, support structures, fill stands and other appurtenances.

Tank Farm No. 1. This tank farm consisted of twelve 50,000 gallon steel USTs used to store aviation gas (AVGAS). Each tank was 12 feet in diameter and 59 feet long The tanks were paired in tankholds that were approximately 20 feet in depth. This tank farm is located in the southwestern corner of the installation. All twelve USTs have been removed.

A contamination assessment involving a soil sampling program using direct push technology will be performed and a report of findings will be made.

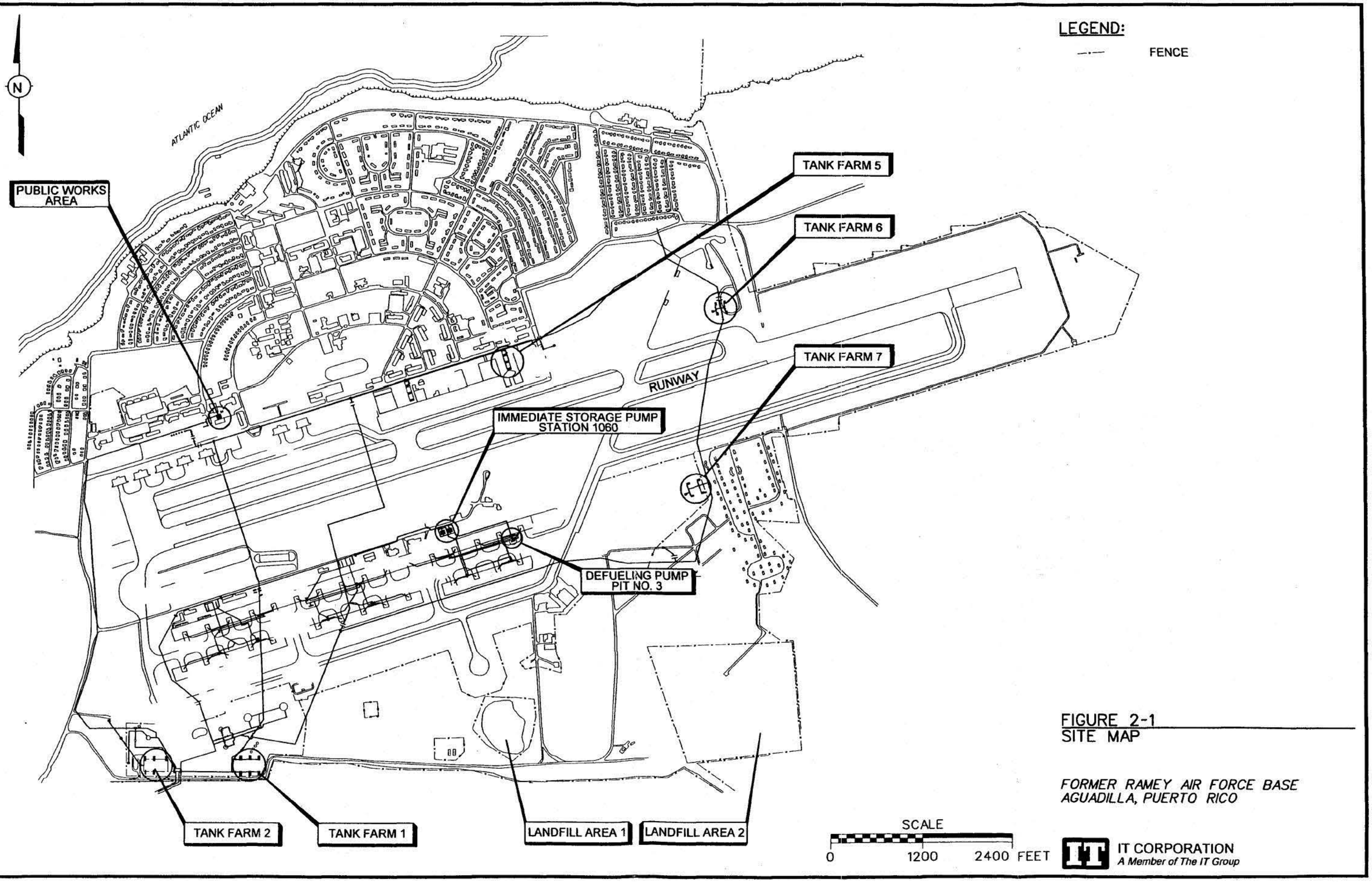

FIGURE 2-1
SITE MAP

FORMER RAMEY AIR FORCE BASE
AGUADILLA, PUERTO RICO

STARTING DATE: 01/12/00	DATE LAST REV.:	DRAFT. CHCK. BY: C. TUMLIN	INITIATOR: THORBJORNSEN
DRAWN BY: T. BRADSHAW	DRAWN BY:	ENGR. CHCK. BY: THORBJORNSEN	PROJ. MGR.: BOWHOLTZ
			DWG. NO.: \783146es.043
			PROJ. NO.: 783146

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Tank Farm No. 2. This tank farm is located in the southwestern corner of the former Ramey AFB approximately 700 ft. west of Tank Farm No. 1. This tank farm originally consisted of eleven 50,000-gallon steel USTs used to store AVGAS. Each tank was approximately 12 feet in diameter and 59 feet long, paired in tankholds that were approximately 21 feet in depth. According to airport personnel, eight of these tanks have been used (or are currently being used) by the airport, but the other three have not been used since transfer of the property in March 1974. These three tanks were removed and disposed of in 1998 by Caribco.

A contamination assessment involving a soil sampling program using direct push technology will be performed and a report of findings will be made.

Tank Farm No. 5. Tank farm No. 5 is a former aviation fuel farm located on the U.S. Coast Guard facility on the southeast corner of the intersection of Hangar and Belt Roads. This facility is now U.S. Coast Guard Air Station Borinquen, which is an active aircraft fueling and maintenance base. The tank farm consists of six 50,000-gallon capacity USTs, a water system pit, valve pits, and associated piping. Each tank is located approximately 8 feet BGS beneath a concrete pit, which has dimensions of 12 feet x 7 feet. Each tank pit contains a steel pressure cylinder, pipeline, and valves situated on the exposed top of each tank. Each tank is also equipped with a 14-inch diameter tank access manhole, a 2-inch vent pipe and a 1.75-inch measurement pipe. Water pressure was formerly used to transfer fuel to and from the tanks. When in use, the tanks were under constant pressure.

According to the USCG personnel, tanks 1 through 4 (the four southernmost tanks) are currently used for fuel storage. The two northernmost tanks (tanks Nos. 5 and 6), the water system pit, and valve pits 8 and 8A have not been used since the base was deactivated in 1973. . Tanks No. 5 and 6 are currently under contract for removal by Douglas Environmental Services, Indianapolis, Indiana, under the DERP-FUDS program.

A contamination assessment involving a soil sampling program using direct push technology will be performed and a report of findings will be made.

Tank Farm No. 6. This tank farm is located in the eastern portion of the former Ramey AFB approximately 2400 ft. northeast of Tank Farm No. 5 and north of the runway. This tank farm

consisted of eight 25,000-gallon steel USTs used to store AVGAS. Each tank was approximately 10.5 feet in diameter and 39 feet long. Two tanks were paired in each of four tankholds that were approximately 17.5 feet in depth. All tanks were removed and disposed of by Caribco in 1998.
A contamination assessment involving a soil sampling program using direct push technology will be performed and a report of findings will be made.

Tank Farm No. 7. This tank farm is located on the eastern side of the installation, south of the runway. This tank farm consisted of eight 25,000-gallon steel USTs used to store AVGAS. Each tank was approximately 10.5 feet in diameter and 39 feet long, paired in tankholds that were approximately 17.5 feet in depth. The tanks were removed and disposed of in 1998 by Caribco.

A contamination assessment involving a soil sampling program using direct push technology will be performed and a report of findings will be made.

Immediate Storage Station No. 1060. This tank farm consisted of eight 25,000-gallon steel USTs, located in the south-central area of the installation, south of the runway. Each tank was approximately 10.5 feet in diameter and 39 feet long. The site also included a 30-foot by 80-foot concrete block pump house/canopy containing pumps, motors, piping, filters, etc. The tanks were removed and disposed of in 1998 by Caribco.

A contamination assessment involving a soil sampling program using direct push technology will be performed and a report of findings will be made.

Public Works Site. This site is located in the northwest portion of the installation, north of Hangar Road. This site includes the power plant and the Base laundry facility. There were two 9,000-gallon USTs that were used to store diesel fuel approximately 8 feet in diameter and 24 feet long serving the Base laundry. There were three 50,000-gallon USTs used to store fuel oil, each approximately 12 feet in diameter and 59 feet long, serving the Power Plant. The tankholds for the laundry USTs were approximately 13 feet in depth while the tankholds for the Power Plant USTs were approximately 16 feet in depth.

A contamination assessment involving a soil sampling program using direct push technology will be performed and a report of findings will be made.

Defueling Pump Pit No. 3. The Defueling Pump Pit No. 3 is located in the southeast part of the installation, just east of the aircraft fueling and maintenance area. This site included one 50,000-gallon steel UST, approximately 12 feet in diameter and 59 feet long, with a tankhold that was approximately 23 feet in depth. This tank was beneath a 12-foot-square by 11-foot-deep concrete pit containing pumps, valves and piping. The tank was removed and disposed of in 1998 by Caribco.

A contamination assessment involving a soil sampling program using direct push technology will be performed and a report of findings will be made.

Landfill No. 1. Landfill No. 1 is a six-acre disposal site for installation waste used from 1939 to 1973. Originally waste was disposed of in a low area where a sinkhole has developed that is capturing the waste disposal area. Analysis of groundwater samples indicated groundwater contamination of volatile organics. Ecology & Environment of Gainesville, Florida investigated the area in 1996 & 1997.

The IT investigation will consist of sampling existing wells, and collecting surface soil, sediment, and surface water samples.

Landfill No. 2. Landfill No. 2 is a twenty-acre tract currently used for grazing and crop growing. Disposals were probably from nearby housing complex called "Tropical Acres." Gently sloping with surface drainage to the south. Two geophysical surveys have roughly defined the limits of burial. The IT investigation will consist of sampling existing wells, and collecting surface soil, sediment, and surface water samples.

Base Laundry. The Base laundry is located about 50 feet east of the Power Plant Building. It is currently used by Port Authority for storage. Potential sources of environmental contamination include two boilers, ten 750-gallon water tanks, and associated piping and appurtenances. Additionally, four water tanks were coated with a 3-inch layer of insulating material of 35% chrysotile asbestos. The IT investigation will consists of sampling areas that appear to have a high probability for environmental contamination such as storage areas, drain

line outlets, USTs, or sumps to determine whether or not contamination is present, and if so, its nature.

Power Plant Assessment. IT will perform a facility-wide building assessment at the Former Ramey AFB Power Plant Building and Dry Cleaning Building No. 508. Sampling will include, suspect asbestos-containing materials, lead-based paint, visually inspect vessel and equipment for product, sampling for PCBs, and hazardous characterizations and sampling of unknown materials. During this sampling event, IT will document the quantity of each material sampled, photograph each suspect material or composite sampling points, and construct a sampling diagram. Based on sampling and analysis, IT will be able to provide the USACE with a list of hazardous materials required for disposal, estimated disposal costs for hazardous waste, and a design to remove asbestos-containing materials.

Crashboat Pipeline Removal. The Crash Boat Basin is located approximately 4 miles southwest of the main portion of the former Air Force Base, near the western end of Highway 458. The site is now a public beach. This facility was used to off-load fuel from ocean-going tankers and pump it up to the Base tank farms for storage and distribution. Old fuel system drawings of this installation indicate three pipelines (one 4-inch, one-8 inch, and one-12 inch) running from the Crash Boat Basin Pumphouse, located across the access road from the beach, to the area of tank farms 1 and 2 in the southwestern corner of the Base. A note on one drawing states that the 4-inch pipeline has been "cut, plugged, and abandoned." There is no indication of how or when this was done. A 12-inch and an 8-inch pipeline also run from the Crash Boat Basin Pumphouse under the access road, then emerge above ground on the beach side of the road. These two lines continue across the beach to an abandoned dock that extends approximately 300 feet out into the ocean. These pipelines are approximately 900 feet long, are abovegrade and are supported by concrete foundations.

A removal action is planned to remove the 900 feet of 12-inch and 8-inch aboveground pipeline and any associated impacted soils.

Group II UST Removals

The USTs and any associated inpacted soils will be excavated and transported at the following sites.

Control Tower (Building 400). The control tower site is located adjacent to the southwest corner of the Rafael Hernandez Airport Hangar on property currently owned by the Puerto Rico Ports Authority. Figure 2-1 shows the layout of the facilities associated with the control tower. This site consists of one 5,000-gallon capacity UST (7 feet diameter by 18 feet) located adjacent to the control tower. According to a 1958 map of the control tower layout, the UST was used for storage of fuel oil to power the control tower emergency generator. The tank is currently accessible via the former fill port, which is flush with the ground surface and located near the southern end if the tank. According to Port Authority personnel, the control tower facility, including the tank, has not been used since the Air Force abandoned the Base in 1973. The current control tower for the municipal airport is located south of the main runway (E&E, 1996).

Hospital (Building 701). The former Base hospital is located immediately east of the intersection of B Street and Fourth Street on the northwestern portion of the Base. The former Base hospital building is unoccupied, although the parking lot is currently used for overflow parking by the U.S. Department of Transportation. According to a 1949 fuel facility map, the site contained a 10,000-gallon fuel oil UST (9 feet diameter by 24 feet) that supplied the hospital boiler room. As shown on Figure 2-2, the UST is located beneath the parking lot adjacent to the boiler room. The UST is currently accessible via 2-inch-diameter ports located at each end of the tank. According to the present owner of the property, the facility has not been used since the Base closure in 1973 (E&E, 1996).

Crash Boat Pumphouse. Near the western end of Highway 458 and approximately four miles southwest of the main portion of the former Ramey AFB is the Crash Boat Basin. (This area is now known as Crash Boat Beach.) The Crash Boat facility was used to transfer fuel from ocean-going barges to the Base. The facility consists of a small, cinder block building or pumphouse partitioned into two rooms. This building contains various pumps, valves, and piping, as well as a 5-foot-diameter, 14-foot long 2,000-gallon capacity AST (see Figures 2-3 and 2-4). The tank rests on a floor that is approximately 5 feet below the surrounding ground surface. The tank is accessible via an 18-inch-diameter entry port situated on the top of the tank.

According to Port Authority personnel, a second fuel storage tank was reportedly located underground immediately east of the pumphouse building. A geophysical study of this area

revealed no indication of a UST. According to Port Authority personnel, the facility has not been used since the Base closure in 1973 (E&E, 1996).

Crash Boat Maintenance Shop. This facility is located approximately 150 feet south of the Crash Boat Pumphouse (see Figure 2-5). The site consists of a paved parking area associated with the former Crash Boat Maintenance Shop building and is currently owned by the Puerto Rico Port Authority. According to a 1949 map of the Crash Boat fuel facilities, two 25,000-gallon (10.5 feet diameter by 39 feet) diesel USTs were located in the northern portion of the current parking area (E&E, 1996).

Officer's Club (Building 704). The former Officer's Club facility is located in the northwestern-most portion of the former Ramey AFB on Cliff Road near the intersection of E Street and Fourth Street. The property is currently unoccupied and primarily consists of a large building and an outdoor pool area (see Figure 2-6). According to a 1949 fuel facility map, a 1,000-gallon diesel fuel oil UST (5 feet diameter by 8 feet) supplied an emergency generator and boiler room at the facility. The tank is located within the building and is accessible via two access ports that extend through a concrete floor. According to the present property owner, the tank has not been used since the Air Force abandoned the Base in 1973 (E&E, 1996).

Transformer Removal Action. Previous investigations have concluded that 53 transformers and 5 oil filled switches are abandoned and are designated for removal and disposal. Six of the transformers are pole-mounted while the remaining 47 transformers (or portions of) and the five oil filled switches are located in vaults, buildings, and on concrete pads. Therefore, a total of 58 transformers/switches and contents are scheduled for removal and disposal at an offsite licensed facility.

1.3 Project Schedule

Under Task Order 0008, the project is divided into two Work Allocation Directives (WAD): These WADs are as follows: WAD 3, Multi-Site Investigation; WAD 5, Underground Storage Tank (UST)/Pipeline Removal and Power Plant Assessment.

Table 1-1 summarizes the proposed activities currently planned for the Former Ramey AFB. This table will be updated as necessary.

Table 1-1

Summary of Planned Activities
Former Ramey AFB, Aguadilla, Puerto Rico

WAD No.	Area of Concern	Planned Activities
3	Background Assessment	Gather background soil chemical data that will be used to compare investigation-derived data to the existing background conditions. Background data will be collected by performing surface and subsurface soil sampling and analysis.
	Fuel System Contamination Assessments: Pipeline System, Tank Farm 1, Tank Farm 2, Tank Farm 5, Tank Farm 6, Tank Farm 7, Immediate Storage Station No. 1060, Public Works Site, Defueling Pump Pit #3	Define the extent of soil contamination through a program of visual inspection, surface and subsurface soil sampling/analysis following the applicable PR EQB petroleum regulations. Both onsite and offsite analytical methods will be used.
	Landfill Remedial Investigations: Landfill #1 and Landfill #2	An investigation to determine the nature and extent of suspected contamination will be performed at each these sites. Surface soil, surface water, and sediment samples will be collected. Groundwater samples will be collected from the existing monitoring wells. A surface survey and inspection will be conducted.
	Fuel Distribution System Reconnaissance and Phase I Assessment at Crashboat Basin Pipeline	A pipe tracing/geophysical survey will be performed and passive soil gas survey will be conducted. Surface soil samples will be collected for offsite sampling and analysis based on the soil gas survey data.
	Base Laundry Site Inspection (Building 508)	An investigation to determine the nature and extent of suspected soil contamination will be performed. Surface and subsurface soil samples will be collected.
5	Power Plant Assessment and Abatement Design	A field assessment will be performed that includes a survey for asbestos containing materials (ACM) with bulk samples of friable and non-friable materials collected. A lead-based paint survey will be performed with onsite XRF techniques used to gather data with confirmation samples collected for offsite analysis. Hazard categorization (HAZCAT) onsite analytical techniques will be used to analyze unknown solids and liquid wastes for disposal. PCB, total petroleum hydrocarbon and metals analyses will also be performed for selected sample locations.
	Crash Boat Basin Pipeline Removal	Pipeline that may contain residual free product will be removed and disposed. Visual assessments and surface soil samples will be collected and the impacted soil will be removed. After excavation, confirmation soil samples and waste characterization samples (for disposal) will be collected and analyzed. Excavated area will be backfilled.

Table 1-1

Summary of Planned Activities
Former Ramey AFB, Aguadilla, Puerto Rico

WAD No.	Area of Concern	Planned Activities
5	Group II UST Removals: Control Tower (Building 400), Hospital (Building 701, Crash Boat Pumphouse, Crash Boat Maintenance Shop, Officer's Club (Building 704)	USTs and piping will be removed and disposed at each site. Visual assessments and PID readings will be conducted and petroleum-impacted soil will be removed. After excavation, confirmation soil samples and waste characterization samples (for disposal) will be collected and analyzed. Excavated areas will be backfilled.

1.4 Historical Data Summary

Limited historical data have been made available to IT at this time. As data are made available, its impact on the Former Ramey AFB site will be discussed in the task-specific work plans.

2.0 Project Organization and Responsibility

2.1 Project Organization

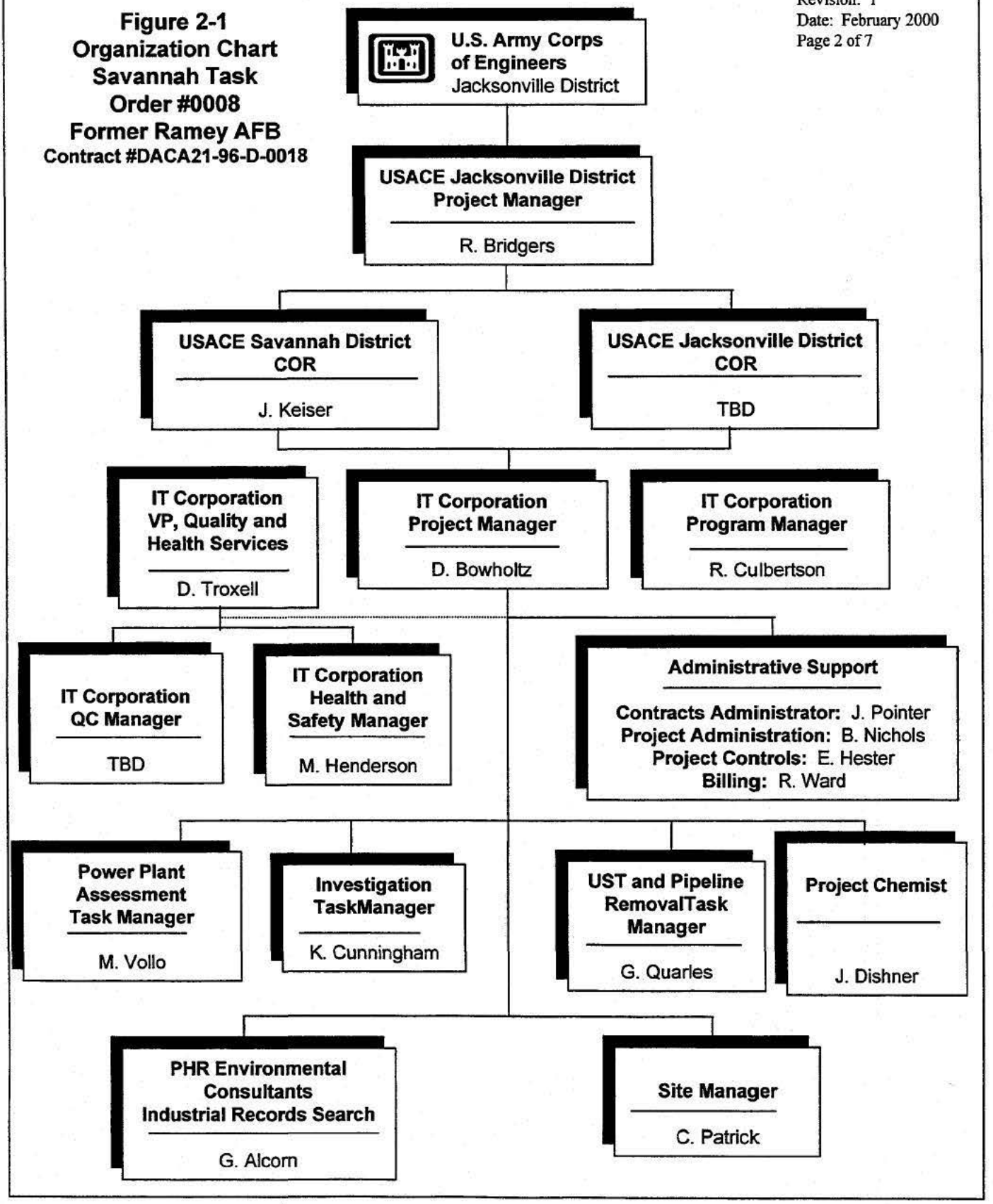
IT personnel associated with the activities at the Former Ramey AFB may include various engineering and scientific disciplines, such as geologists; hydrogeologists; human health and ecological risk assessment specialists; chemists; construction managers; civil, electrical, mechanical, and chemical/process engineers; sampling technicians; QC coordinators; health and safety professionals; and subcontractor personnel. Figure 2-1 shows the organization of the IT project team as it relates to responsibilities and lines of communication. Appendix A includes the resumes of the IT personnel who will form the Former Ramey AFB project team. The text in this section discusses the responsibilities of the members of the Former Ramey AFB team.

USACE Technical Manager. Representing the client, the USACE has designated a technical manager (TM) for the Former Ramey AFB activities from their Savannah District Office. The TM appointed from the Savannah District Office is Zainul Kidwai. The USACE TM will represent the government interests in the project and administer the implementation of the contract. The USACE TM will designate a project chemist who will work with the IT project chemist and oversee data reporting activities. To assist the USACE TM, the USACE will also designate a project geologist who will work with the IT task managers and field manager and oversee on-site activities.

IT Program Manager. The IT program manager is IT's representative responsible for execution of the entire Total Environmental Restoration Contract (TERC) program, which includes the work to be performed at the Former Ramey AFB as well as other projects covered under the TERC program. Bob Culbertson is the IT Program Manager for all South Atlantic District (SAD) TERC projects. The IT PM reports to the IT program manager for guidance and consistency in project execution.

IT Project Manager. The IT project manager (PM) is responsible for the effective execution of all projects at the Former Ramey AFB and serves as the focal point for all contract environmental restoration activities. The IT PM will be Dan Bowholtz. The IT PM oversees the activities of all IT personnel, ensures compliance with the project SOW, and controls project

Figure 2-1
Organization Chart
Savannah Task Order #0008
Former Ramey AFB
Contract #DACA21-96-D-0018



consistency. He provides the USACE TM an IT point of contact for the Former Ramey AFB project.

IT Quality Assurance/Quality Control Coordinator. The IT quality assurance (QA)/QC coordinator for the Former Ramey AFB is responsible for ensuring the overall project quality, specifically the outgoing project plans and reports, and ensuring each project deliverable meets the quality standards established in the IT quality program and in the contract. He will coordinate with the technical members of the project team to evaluate status, procedures, and nonconformances from a quality program standpoint. He will gather and coordinate corporate resources and references in the areas of quality improvement, corrective action control, and quality systems auditing for the project. This person may have additional duties assigned by the IT PM.

IT Task Managers. The IT task managers are responsible for supervising and issuing major task work plans and reports, and for providing technical oversight to field activities. Each IT task manager will coordinate with the health and safety officer in the preparation of a health and safety addendum and with the IT project chemist in the preparation of all sampling and analysis portions of each task-specific work plan. The IT task manager will work with on-site personnel and may have additional duties assigned by the IT PM.

IT Health and Safety Officer. The IT health and safety officer will evaluate the health and safety aspects of the on-site tasks to ensure that these activities are performed in a safe and conscientious manner. Mike Henderson has been designated the IT Health and Safety Officer for the Former Ramey AFB project. The coordinator will work with the IT task manager and complete a health and safety plan addendum for each major task work plan. He will also work with the on-site personnel to achieve compliance with the project safety and health plan (SHP) and corporate SAP. This person may have additional duties assigned by the IT PM.

IT Site Coordinator. The IT site coordinator will oversee all on-site activities including the supervision of subcontracted drilling crews and subsurface investigations. He will be responsible for all geologic field documentation forms such as field activity daily logs (FADL), and boring and drilling logs, and will oversee on-site and central document filing and storage of these forms. He will oversee all sampling activities and supervise field teams.

IT Regulatory Specialist. The IT regulatory specialist will oversee waste characterization and waste disposal practices. He will coordinate with the IT PM and USACE on disposal options for generated wastes. This person may have additional duties assigned by the IT PM.

IT Project Chemist and Sample Coordinator. Due to the nature and complexity of the program, this position's responsibilities will be filled using two people: The IT project chemist and the IT on-site sample coordinator. The IT project chemist will be Joyce Dishner. The on-site sample coordinator will be chosen prior to the field effort.

The project chemist will work with the project management team in formulating plans and approaches and help to assess sampling, analytical, and QA/QC requirements for each project task. The chemist will help to ensure consistency of approach among the various tasks regarding these areas and ensure that all activities are performed as specified in EM 200-1-3. The chemist will review analytical data and assist in the interpretation and use of sampling and QA/QC data. This individual will also receive and review all analytical data. The project chemist coordinates the receipt of incoming field data and analytical data from the laboratory in both hard copy and electronic formats. The chemist will also oversee and track the data review process and the preparation and submittal of the IT Environmental Management System (ITEMS) database deliverables.

The IT sample coordinator will work with the project team on-site to ensure the complete and accurate transfer of samples and information from field to laboratory. The sample coordinator will support the field team's sample collection and documentation efforts in the field by helping the project chemist preplan all samples to be collected in the ITEMS field module using the ITEMS Sample Planning Module (SPM). The sample coordinator and project chemist will work together to identify and resolve analytical issues and nonconformances and will participate in project and laboratory audits. Other responsibilities of the project chemist and sample coordinator may include:

- Interface with the laboratory PM and laboratory QA officer to ensure the laboratory is aware of the project data quality objectives (DQO), program goals, and analytical quality objectives.

- Monitor the deliverables from the laboratory; ensure conformance with authorized policies, procedures, and sound practices; and assist in identifying and resolving nonconformances.

- Ensure that all records, logs, standard procedures, and plans are distributed to the laboratory PM, site coordinator, and the IT sample coordinator.

- Communicate with the laboratory PM concerning the schedule of sample shipments and the shipment contents, including QA samples. Based on this information, provide status tracking of sample shipments to project management.

- Review all data submittals and communicate directly with a Puerto Rican-certified chemist designated to review and approve all analytical submittal.

- Ensure that sampling is conducted in a manner consistent with the QA program through ongoing communication with field personnel.

- Review all laboratory data before those data are transferred to permanent storage, reported to other project participants, or submitted via ITEMS.

Data Validation Task Leader. For tasks that require data validation, a data validation leader will be selected to perform the SOW described in the task work plan. Task work plans will define the data validation requirements based on the SOW. The validation leader will work with the project chemist to receive the data packages from the laboratory and review the data. They will be responsible for validating the data and providing a data validation report that will summarize the assigned data qualifiers.

Contractor Laboratory Organization. For the Former Ramey AFB, all sample analyses will be performed by laboratories using the SAP prescribed EPA methods. The laboratory must hold current USACE-Hazardous, Toxic, and Radiologic Waste (HTRW) Center of Expertise (CX) approval as defined in EM200-1-1, "Validation of Analytical Chemistry Laboratories," July 1994. The laboratory will maintain and follow standard operating procedures (SOP) for each method, and as required by the USACE, these SOPs will be maintained in the laboratory SOP manual. The SOP manual will be updated as needed during the project.

IT has selected Accutest Laboratories Southeast (Accutest) of Orlando, Florida to be the primary supplier of analytical laboratory services for the Former Ramey AFB project. As such, Accutest meets all the specifications of this SAP. Accutest has designated a laboratory PM and QA/QC

officer who will support the laboratory efforts to analyze and report the Former Ramey AFB sample data.

Laboratory Project Manager. The laboratory will designate a laboratory PM for the duration of the Former Ramey AFB program. The laboratory PM will work with the IT project chemist on designing and implementing each task-specific analysis program. The laboratory PM will also:

- Verify that the laboratory achieves and maintains USACE HTRW CX validation approval for applicable analyses as is the requirement in the subcontractor agreement with IT.
- Verify that the laboratory can quantify the planned parameters and routinely achieve the reporting limits using the methods specified in Section 7.0 and in task work plans.
- Coordinate sample receipt, processing, analysis, and data reporting with members of the laboratory technical staff to ensure accurate and on-time deliverables.
- Review the deliverables for completeness, accuracy, and compliance with the analysis program.

Laboratory Quality Assurance Officer. In addition to the laboratory PM, the laboratory will identify their laboratory QA/QC officer in the contract. He will assist the laboratory PM with the Former Ramey AFB projects for their duration and will be responsible for the overall implementation of the laboratory QA program, as well as ensuring adherence to this SAP and individual task work plans. The laboratory QA/QC officer will assist the laboratory PM during the initial review of analytical data generated to verify that the data meet DQOs established in this SAP and in task work plans. He will also assist in defining and resolving analytical nonconformances and participate in any project/laboratory audits.

2.2 Primary Data Users

Data generated by personnel in the field will be initially reviewed, processed, and evaluated on site by the field coordinator and task manager. Copies of the original forms will be maintained on-site for reference and the originals will then be forwarded to the project chemist for further review, inclusion into the ITEMS database, and final storage in the project Central Files. The IT task manager will review the field data and compare the data gathered against project objectives.

Hard copy and electronic analytical data will be delivered to the project chemist for initial review, copying, and distribution, with the original hard copy going to project Central Files. If required, data validators will receive a working hard copy to review. Electronic files will be forwarded to the IT database manager for checking and uploading into the database. The IT project management team will then be issued summary reports and updates as required as final data reviews are completed. A Puerto Rican certified chemist employed by the analytical laboratory or a subcontracted chemist, will review and approve all analytical reports prior to submittal.

3.0 Project Quality Assurance Objectives

3.1 Data Quality Objectives

As defined in the U.S. Environmental Protection Agency (EPA) guidance document entitled *Data Quality Objectives Process for Superfund* (EPA, 1993a), DQOs are qualitative and quantitative statements that specify the quality of data required to support decisions during investigation and remedial response activities. This guidance and the DQO process were developed specifically for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) DQOs are applicable to all data collection activities, and the level of detail and data quality needed will vary based on the intended uses of the data.

The DQO process helps define the purpose for which environmental data will be used and sets guidelines for designing a data collection program that will meet regulatory objectives. The process also provides a logical, objective, and quantitative framework for determining the time and resources that will be used to generate data of the desired level of quality. The DQO definition process will be performed on each project task and described in site-specific SAPs.

3.2 Development of DQO Requirements

The DQO process identifies the end use of the data for which the samples are to be collected, establishes the quality level that data must meet to support decisions made during an investigation on remedial/corrective action, and helps to identify potential data gaps. The decisions that must be made concern: The sampling strategies and decontamination procedures; appropriate analytical parameters for a particular investigation; appropriate investigation or remediation actions to be taken at a site; requirements that the investigated media must meet; and implementation of remedial/corrective actions.

Data Collection and Measurement. Developing DQOs should be the first step in initiating any significant environmental data collection program. The DQO process provides a quantitative basis for designing a rigorous, defensible, and cost-effective data collection and management program. Decision-making is driven by risks to public health and the fact that the level of uncertainty in decisions will be affected by the type and quality of data collected.

3.3 DQO Planning Process

Remediation activities and supporting investigations at the Former Ramey AFB will require the collection of different kinds of data for each site, including both qualitative and quantitative data. From the DQO perspective, quantitative data will be categorized as screening data (previously defined by EPA as Analytical Levels I and II) or definitive data (previously defined by EPA as Analytical Levels III and IV). The following discussion of the DQO processes will serve as guidance for developing site-specific task work plans to ensure that the goals for investigation or other program activities are met. The DQO development process consists of seven stages:

- State the problem.
- Identify the decision/objective.
- Identify inputs to the decision/objective.
- Define the study boundaries.
- Develop a decision rule.
- Specify limits on decision errors.
- Optimize the design for obtaining data.

Several of the steps in the seven-stage DQO process can occur simultaneously, and in some situations, the process does not have to include all steps. For example, when enforcement or compliance monitoring programs are being developed to comply with existing regulations, many of the steps may have already been completed. Also, when activities in any stage reveal that new environmental data are not needed to make decisions, the process can be stopped.

3.3.1 DQO Seven-Stage Process

3.3.1.1 State the Problem

This step requires that the contamination problem that will require new environmental data be summarized. The resources available to resolve the contamination problem must be specified. Key activities associated with this step include:

- Identifying members of the scoping team
- Developing or refining the conceptual site model
- Defining the exposure pathways and exposure scenarios
- Specifying available resources
- Writing a brief summary of the contamination problem.

The main output of this step is a complete description of the contamination problem that includes the regulatory and programmatic context of the problem. This description typically consists of:

- A list of the known and suspected contaminants in each environmental medium and estimates of their concentration, variability, distribution, and location
- The conceptual site model and exposure pathways
- A summary of the outcome and status of any previous response(s) at the site, such as early actions or previous data collection activities
- The site's physical and chemical characteristics that influence migration and associated human, environmental, and physical target(s)
- An estimate of the budget, schedule, and available personnel necessary to implement the appropriate response for the site.

3.3.1.2 Identify the Decision/Objective

This step requires identification of the decision/objective that requires new environmental data. For example, an early assessment decision is to determine whether a chemical release poses a potential threat to human health or the environment. Key activities associated with this step include:

- Identifying the key objective for the current phase or stage of the project
- Identifying alternative actions that may be taken based on the findings of the field investigation
- Identifying relationships between this objective and any other current or subsequent objectives.

The output from this step should include the following:

- A statement of the objectives that will use environmental data
- A list of the actions that will be taken toward remediation or removal of the potential contamination problem based on the outcome of the field investigation.

3.3.1.3 Identify Inputs to the Decision/Objective

The purpose of this step is to identify the information needed to support the objective, and specify which inputs require new environmental measurements. Key activities associated with this step include:

- Identifying the informational inputs needed to resolve the objective
- Identifying sources for each informational input, and listing those inputs that are obtained through environmental measurements
- Defining the basis for establishing contaminant-specific action levels
- Identifying potential sampling approaches and appropriate analytical methods.

The outputs that will result from this step include a list of informational inputs needed to make the decision, and a list of environmental variables or characteristics that will be measured. The outputs from this step are actually the inputs that will be used to support the objective, sometimes referred to as the "decision."

3.3.1.4 Define the Study Boundaries

This step requires definition of the spatial and temporal aspects of the environmental media that the data must represent to support the objective. Key activities associated with this step include:

- Defining the geographic areas of the field investigation
- Defining each environmental medium of concern
- Dividing each medium into strata having relatively homogeneous characteristics
- Defining the scale of decision-making (this is the smallest area, volume, or time frame of the medium) in which the scoping team wishes to control decision errors
- Determining the time frame to which the objective applies
- Determining when to take samples
- Identifying practical constraints that may hinder sample collection (reconsider previous steps as necessary).

Outputs from this step may include:

- A detailed description and physical representation (map) of the geographic limits (boundaries) of each environmental medium (soil, water, air, etc.) within which the decision(s) will be made
- A detailed description of the characteristics that define the population of interest
- Definition of the time period in which samples will be taken and to which objectives will apply
- The most appropriate scale of decision-making for each medium of concern
- A description of practical constraints that may impede sampling.

3.3.1.5 Develop a Decision Rule

The purpose of this step is to integrate the output from the previous steps of the DQO process into a statement that defines the conditions that would cause the decision-maker to choose among alternative actions. Key activities associated with this step include:

- Specifying the parameter of interest (such as mean, medium, maximum, or proportion)
- Specifying the action level for the decision
- Combining the output of the previous DQO steps into an "if...then..." decision rule that includes the parameter of interest, the action level, and the alternative actions.

The output from this step is an "if...then..." statement that defines the conditions that would cause the decision-maker to choose among alternative courses of action. It should include the decision, the actions, the parameter of interest, the action level, and the scale (magnitude of impact) of decision-making.

3.3.1.6 Specify Limits on Decision Errors

The purpose of this step is to specify the acceptable decision error rates based on a consideration of the consequences of making an incorrect decision. These limits will be used in the last step of the process.

Key activities associated with this step include the following:

- Determining the possible range of the parameter of interest
- Defining both types of decision errors and identifying the potential consequences of each
- Specifying a range of possible parameter values where the consequences of decision errors are relatively minor (gray region), whenever possible
- Assigning probability values to points above and below the action level that reflect the acceptable probability for the occurrence of decision errors, when necessary
- Checking the limits on decision errors to ensure that they accurately reflect the decision maker's concern about the relative consequences for each type of decision error.

The outputs from this step are the acceptable decision error rates based on a consideration of the consequences of making an incorrect decision. These limits on decision errors can be expressed in a decision error limits table, or in a design goal diagram.

3.3.1.7 Optimize the Design for Obtaining Data

The purpose of this step is to identify the most resource-effective sampling design that generates data that satisfy the DQOs specified in the preceding steps. To develop the optimal design for this study, it may be necessary to work through this step more than once after revisiting previous steps of the DQO process.

3.4 DQO Quality Indicators

Part of the review to determine whether DQOs were met will be to evaluate a series of data quality indicators that include measurements of the precision, accuracy, representativeness, comparability, and completeness (PARCC) parameters. How each of these measurements are to be performed and assessed is discussed in this section. The target acceptance criteria for the results have been developed for a wide variety of anticipated analyses on soil/sediment, surface water, and groundwater matrix samples and are presented in the internal laboratory QC check discussion found in Section 7.0. Section 8.0 discusses the data review process and includes a detailed discussion of PARCC parameter data interpretation. Other data quality indicators will

be developed as needed for other sampling media and other analysis programs and presented in their task work plans.

For a given investigation task, a specific list of target constituents will be formulated and if they cannot be quantified by the methods summarized in this SAP, then they will be addressed in a task-specific work plan. All applicable analyses will meet the recommended method guidance found in *Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition (EPA, 1986) and its subsequent updates, EPA, Office of Solid Waste and/or EPA's Contract Laboratory Program (CLP) *Statement of Work for Organics* (EPA, 1994a) and *Statement of Work for Inorganic Analysis* (EPA, 1992), as supplemented by the information presented in Section 7.0. All other requested analyses must conform to their specified method(s). These may include the *Annual Book of ASTM Methods*, American Society for Testing and Materials (ASTM, 1998); *Methods for Chemical Analysis of Water and Waste* (EPA, 1979), and similar sources.

3.4.1 Precision

Precision is defined as a measurement of mutual agreement among individual measurements of the same property, usually under "prescribed similar conditions." Precision is expressed in terms of the relative percent difference (RPD) between duplicate determinations, or in terms of the relative standard deviation (RSD) when three or more determinations are made. Various measures of precision exist depending on the prescribed similar conditions.

Overall sampling and analysis precision will be assessed using RPD for duplicate environmental samples to assess overall sampling and analysis precision. The RPD for matrix spike and matrix spike duplicate (MS/MSD) sample results will be used to assess laboratory spike and recovery precision. RPD is defined as the difference between two measurements divided by their mean and expressed as a percent as shown in Equation (1):

$$\textit{Relative Percent Difference (RPD)} = \left[\frac{|D_1 - D_2|}{\left(\frac{D_1 + D_2}{2} \right)} \right] x\,100 \qquad (1)$$

where:

D_1	=	the result from the original determination
D_2	=	the result from a duplicate measurement.

RSD is the standard deviation of a set of values divided by the average value expressed as a percent as shown in Equation (2):

$$Relative\ Standard\ Deviation\ (\%\ RSD) = \left(\frac{\sigma_{n-1}}{\overline{X}\ (x_1 .. x_n)} \right) x\ 100 \qquad (2)$$

where:

σ_{n-1}	=	the sample standard deviation of the sample data
n	=	the number of determinations
$\overline{X}\ (x_1..x_n)$	=	the arithmetic mean of the sample data.

3.4.2 Accuracy

Accuracy is a measure of the bias in a system or the degree of agreement of a measurement X (or an average of measurements of the same parameter), against an accepted reference or true value, T. Accuracy is typically expressed as a percent recovery calculated by the ratio of the measurement and accepted true value as shown in Equation (3):

$$Percent\ Recovery = \left(\frac{(X - S)}{T} \right) x\ 100 \qquad (3)$$

where:

X	=	the experimentally determined concentration
S	=	the sample concentration before spiking
T	=	the "true" concentration.

Analytical accuracy is assessed through the analysis of spikes such as surrogates, MS/MSDs and laboratory control samples (LCS), audit samples, and/or standard reference materials (SRM), and calibration check samples. With the surrogates and MS/MSDs that are spiked onto the actual sample matrix and analyzed, these accuracy indicators must take into account the nature of the matrix in question and the native concentration of the analyte spiked. Matrix variability or

interferences from high concentrations of native compounds may adversely affect spike recovery and yield less than conclusive data. Accuracy checks that focus on analytical method and consist of compounds spiked in a "blank" or noninterfering matrix (e.g., LCSs, SRMs, or calibration check samples) address the accuracy of the method and/or instrumentation at detecting the target analyte(s) at a certain quantification level and are not considered to be subject to matrix effects. Measuring the bias of the overall sampling program is also difficult, especially with respect to collection of samples for analysis for volatile organic compounds (VOC). These organic compounds can be volatilized and lost from collected samples and result in a negative bias, or the sample can become contaminated with foreign compounds during sample collection, handling, and preparation, and result in a positive bias. Using proven sample collection methods that incorporate steps to minimize sample disturbance during collection, provide for the isolation of samples from known sources of contamination, and incorporate the immediate preservation of samples on ice should reduce the potential for bias. Accuracy of the sampling system, emphasizing cross-contamination with volatile compounds will be assessed by evaluating analytical results for field QC samples, including field-prepared field blanks, laboratory-prepared trip blanks, equipment rinsate blanks, and laboratory storage blanks and analytical method blanks.

3.4.3 Completeness

Data completeness represents the percentage of valid data collected from a sampling/analytical program or measurement system compared to the amount expected to be obtained under optimal or normal conditions. The completeness goal for critical samples (i.e., field samples requiring chemical or geotechnical analysis) is 95 percent. Task-specific completeness goals may also be defined in task-specific work plans. To calculate the 95 percent completeness goal, all validated data will be considered for usability purposes. All data collected will be considered usable for their intended purpose with the exception of those qualified "R" rejected during data validation.

3.4.4 Representativeness

Representativeness is a qualitative parameter that expresses the degree to which sample data actually represent the matrix conditions. For example, in conducting groundwater monitoring, representativeness requires proper location of wells and the collection of samples under consistent, documented procedures. Wells are located based upon the results of the hydrogeologic study in progress and are designed to provide maximum coverage of the flow conditions. Requirements and procedures for sample collection and handling are designed to maximize

sample representativeness. Representativeness can also be monitored by reviewing field documentation and by performing field audits.

Other sampling approaches where representativeness is a concern is in building composite samples and using an unbiased grid sampling system. In compositing, individual subsamples are collected and combined to represent a greater physical area or cover a particular time period. Often to characterize a large unknown surface area, a grid sampling pattern is established and then samples are collected at randomized node locations where horizontal and vertical traverse lines intersect. Considerations such as number of samples required and their spatial relationship will affect how representative the unbiased grid sample results are. In such cases, the sampling objective must be well defined and the intended purpose for the sample data generated must be reviewed to establish the DQOs for representativeness through statistical analysis. Parameters such as the number of subsamples composited, the number of samples submitted for analysis, and the sampling interval can then be specified to increase confidence interval and improve representativeness when warranted by the performance objective.

3.4.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Comparability for sampling and analysis tasks is achieved by the following:

- Specifying well-recognized techniques and accepted standard methods for sampling and analysis reporting using well-trained sampling and analysis technicians to execute the prescribed methods consistently

- Requiring that all involved sampling and analysis personnel use adequate documentation to record how the prescribed methods were actually executed, noting nonconformances and corrective measures taken.

The specification for standardized fixed-base laboratory methods helps to ensure that the data generated for an event are comparable to past and future activities. Periodic field and laboratory audits to assess consistency of method implementation for these prescribed procedures is also critical in determining comparability.

3.5 DQOs for the Former Ramey AFB Investigations

Overall precision and accuracy DQOs have been established for this project based on the laboratory's previous experience and on analytical method guidance. These DQOs are summarized in Section 7.0. As each new decision point or objective in a project is defined, the DQOs must be reviewed to ascertain that the subsequent collected data is suitable for enviro-mental decision making. This evaluation is conducted by going through the seven-step process, as discussed in Section 3.3.

The DQO development process has both a quantitative and a qualitative aspect. Data generated from nonrepresentative samples should not be used for the goal of characterizing some property of the site as a whole. Where a given property of a site is being characterized, a statistical design basis should be included within the task, addressing the following:

- Definition of both types of decision errors (false negative/false positive) and the consequences of each
- Identification of acceptable decision error rates
- Definition of the portion of the site being characterized
- Definition of the statistical model to be employed and design assumptions
- Description of resultant design (grid layout, sample size, etc.).

3.5.1 Site Investigation DQOs

The objectives of an SI are as follows:

- Confirm the presence or absence of contamination.
- Conduct a limited characterization to address the nature and possible extent of contamination.
- Obtain adequate data to support:
  - Implementing an immediate response
  - Proceeding with a remedial investigation
  - No further action.

The DQO planning process for an SI allows both data users and data suppliers to resolve issues in a stepwise fashion. The process brings together all key players and enables each participant to play a constructive role in:

- Defining the problem
- Deciding how to address the problem and what data will be needed to make the decision
- Determining how the data will be used
- Deciding the level of data quality required for that use.

Figure 3-1 presents a decision diagram for an SI.

3.5.2 Remedial Investigation DQOs

The objectives of an RI are to characterize the presence and concentration of chemicals of concern in the media at the sites, and to evaluate the level of risk to human health and the environment posed by releases of the chemicals of concern. Development of DQOs for an RI involves a stepwise planning process that is applied to the collection and use of environmental data. The DQO process begins by stating the environmental problem to be addressed, or the decision to be made. Next, the information required to select an appropriate course of action is identified. Specifications regarding the type of data needed, the way data will be used, and the acceptable degree of uncertainty in conclusions to be derived from the data are then developed through a process that involves the decision-makers and data-generators. A decision diagram for an RI is shown in Figure 3-2.

3.5.3 Remedial Design/Remedial Action DQOs

The objectives of a remedial design (RD)/remedial action (RA) investigation are to:

- Provide the data needed to predict the effects of an RA and rate of contaminant reduction.
- Evaluate the potential of further impacts.
- Correctly design a remedy that will cost-effectively reduce the levels of chemicals of concern at a site.

Objectives:
- Confirm or deny the presence of contamination.
- Conduct a limited characterization of the nature and extent of contamination
- Obtain adequate data to support
  - implementing an immediate response
  - proceeding with a remedial investigation
  - a no further action

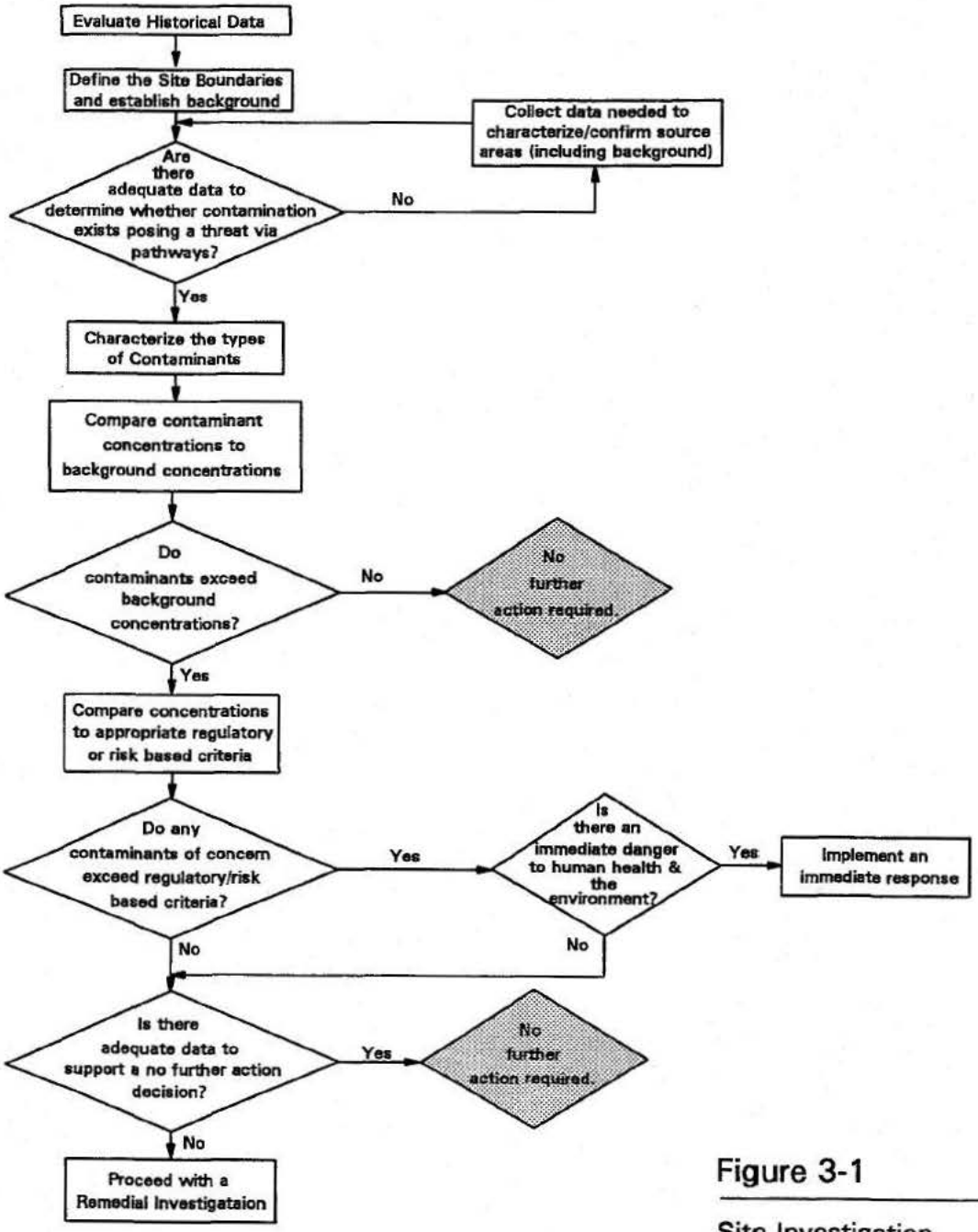


Figure 3-1

Site Investigation Decision Diagram

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Objective:
- Characterize the nature and extent of chemicals of concern in environmental media.
- Evaluate the level of risk to human health and the environment posed by releases of the chemicals of concern.

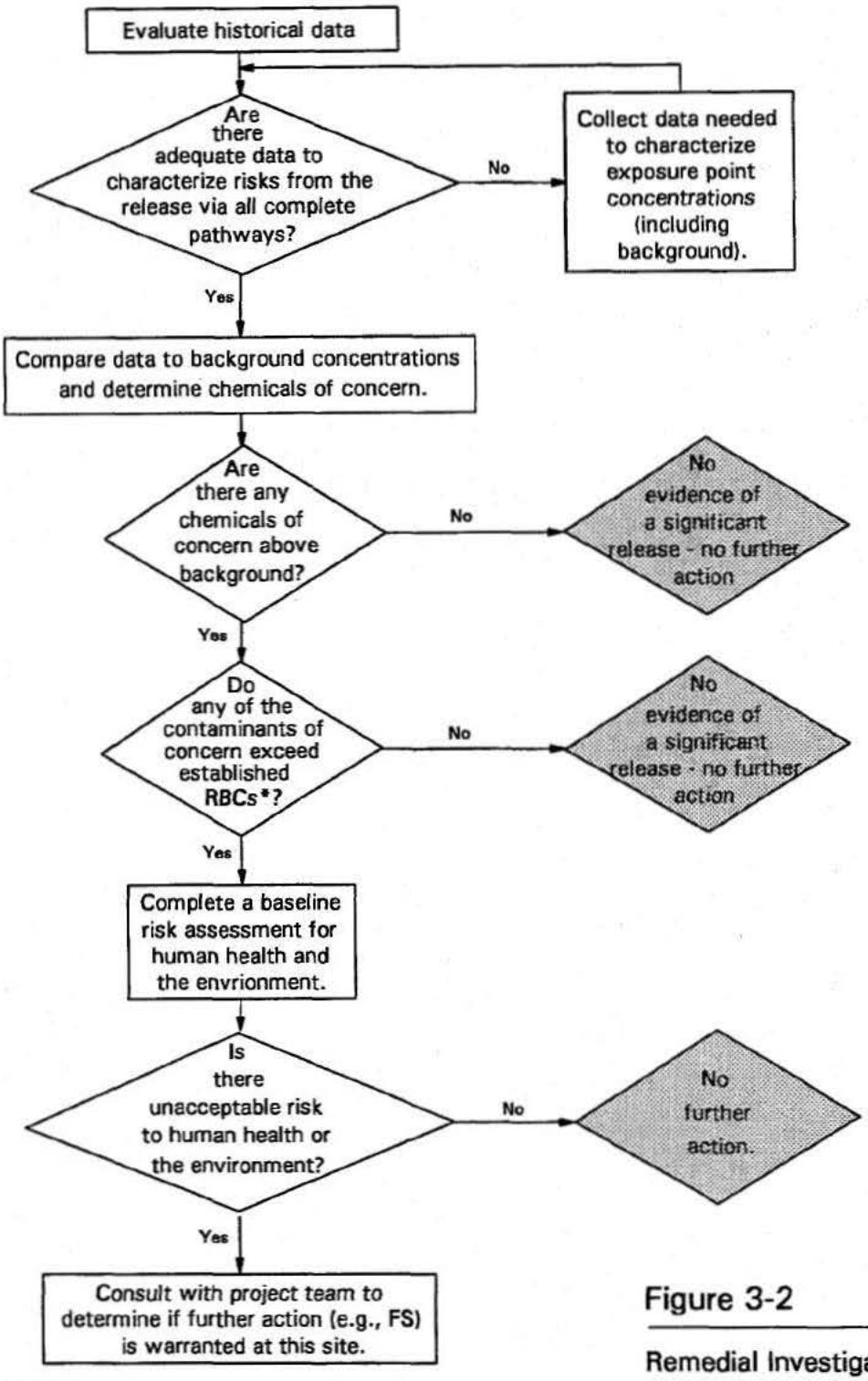

Figure 3-2

Remedial Investigation Decision Diagram

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*RBCs - Risk Based Concentrations

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- Reduce the potential for adverse effects on human health and the environment.

Development of DQOs for an RD/RA investigation involves evaluation of existing data, identification of significant data gaps that result in uncertainty in design, and identification of additional data required to establish the cleanup goals. The DQO process begins by identifying the cleanup goals and the information required to select and design an appropriate remedy. The process is similar to that for an RI with regard to the type of data needed, the way data will be used, and determining the acceptable degree of uncertainty; however, the types of data required are different. Physical properties of the media and chemical properties of the contaminants are usually required for making design decisions. A decision diagram for an RD/RA investigation is shown in Figure 3-3.

3.5.4 Investigation-Derived Waste DQOs

During the course of an investigation, wastes are usually generated and data of sufficient quality to ensure proper waste disposal are collected. Process knowledge may also be used to determine the proper waste disposal method. Materials destined for off-site disposal will be evaluated with regard to off-site disposal regulations and other criteria specified in task-specific work plans.

3.5.5 Long-Term Monitoring DQOs

The objective of a long-term monitoring (LTM) program is to verify that contaminant levels have not increased and migration is not occurring. Application of the DQO process for LTM ensures that all data, and the decisions based on the data, are technically sound.

A decision diagram for LTM is provided in Figure 3-4 to determine whether to take an action in the monitoring program. Several options for LTM will be considered as deemed appropriate. Some examples of LTM options are as follows: natural attenuation, bioremediation, or pump and treatment system installation, etc.

Objectives:
- **Determine the system design parameters**
- **Determine the rates of contaminant reduction**
- **Evaluate the reduction in risk to health and the environment**

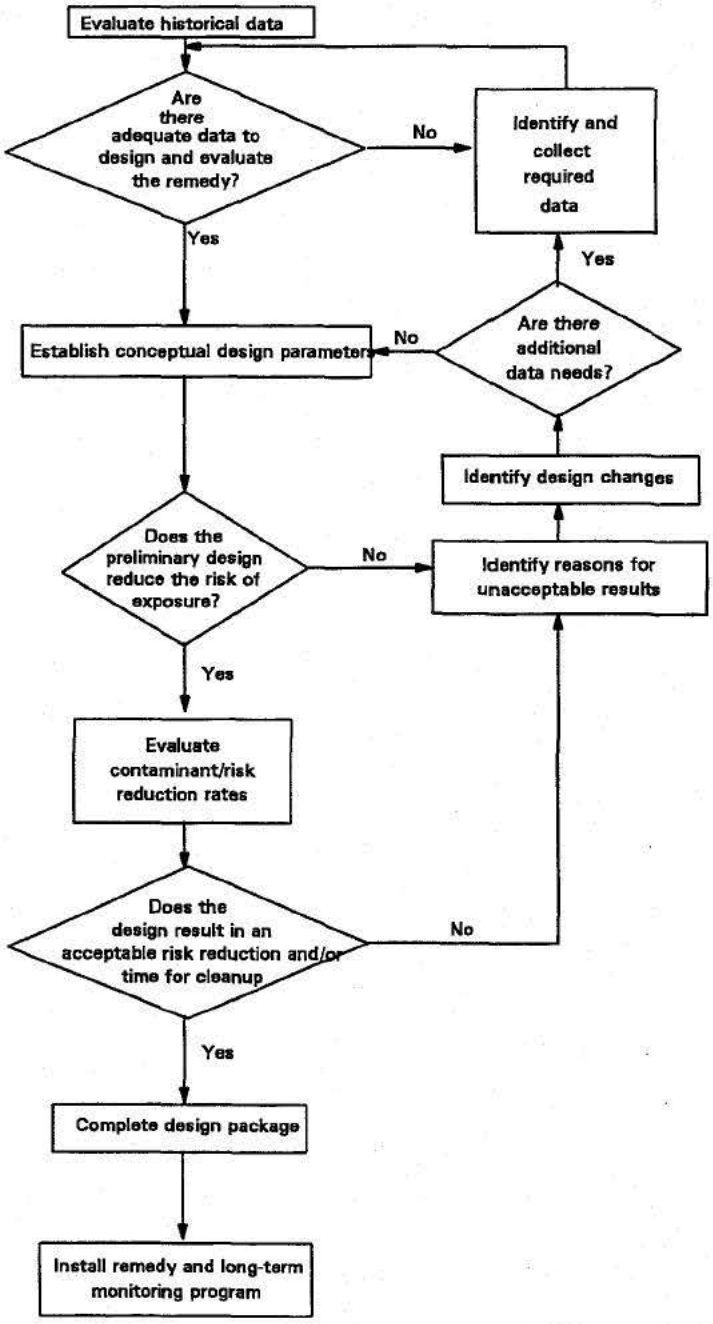

Figure 3-3

RD/RA Investigation Decision Diagram

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Objectives:
- Ensure that contaminant levels have not increased and that migration is not occuring
- Ensure that remedy is meeting cleanup or risk reduction goals

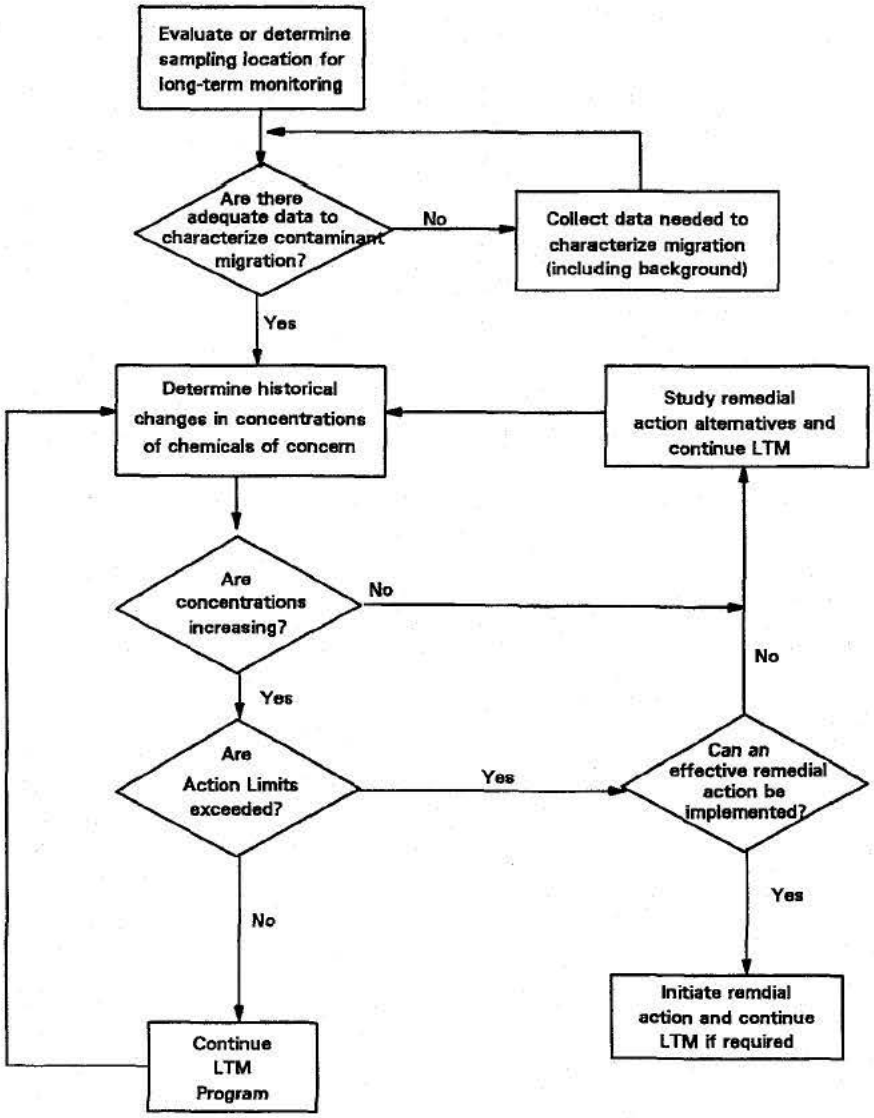

Figure 3-4

Long-Term Monitoring Decision Diagram

INTERNATIONAL TECHNOLOGY CORPORATION

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4.0 Project Documentation, Record Keeping, and Field Operations

4.1 Overall Project Documentation

In the performance of the Former Ramey AFB project tasks, IT and its subcontractor personnel will be required to complete the necessary documentation to record such events as nonconformances, variances, and decisions and action items from meetings held with regulatory agencies or USACE. This project documentation will supplement basic documentation that consists of field investigation data (discussed in Section 5.0), sample collection information (discussed in Section 6.0) and analytical data records (discussed in Section 8.0). To assist in the collection of information, project documentation procedures have been developed and specialized forms designed. These procedures and documents are discussed in the following sections.

The examples of required project forms are included in Appendix B of this SAP. Field forms are discussed in Section 7.0 of this SAP.

4.1.1 Nonconformance Documentation

Complex field investigation, sampling, and analysis tasks such as those performed routinely as part of the Former Ramey AFB project are sometimes subject to nonconformances. A nonconformance is defined as an unplanned deviation that occurs during the implementation of a task that cannot usually be corrected until after it has occurred. All nonconformances must go through a cycle of being identified, documented, assessed, corrected, and reported. Each of these steps is critical in handling nonconformances as they are encountered.

The identification of a nonconformance is the responsibility of every person who works on the Former Ramey AFB project. This responsibility is incorporated into each person's understanding of the tasks assigned to them by their supervisor or task leader and their function on the project. As individuals perform their duties on the project, they must constantly be aware of the scope of the activity and recognize when a deviation from the planned activity has occurred or is occurring. After recognizing the deviation, they must take action by informing their supervisor or task leader and documenting in writing the specifics of what occurred using a nonconformance log. An example nonconformance log is included in Appendix B. When completed, the

nonconformance log is then reviewed by a peer or supervisor and presented to project management. The IT PM will assign a lead individual who will work with the person who identified the nonconformance, and other team members as needed, to assess its impact on the project and develop a corrective action plan.

As warranted by the situation, the USACE TM and/or appropriate technical support person will be contacted and asked to provide input into the assessment and corrective action process. In all cases, the IT PM will be consulted and the corrective action will be decided upon and recorded on the nonconformance log. Once the corrective action is implemented, the IT PM will assign a person to verify the corrective action is successful in preventing future occurrences of the nonconformance. When this has been verified, the nonconformance log is completed and copies distributed to all individuals who participated in the identification, assessment, and resolution of the nonconformance. The completed log will be included as a permanent part of the project file and discussed in the task final report.

For example, a nonconformance occurs when a sample from a particular well location specified in the task work plan is omitted. This omission, due to an oversight, is noted by the sample coordinator after the investigation has been completed. The coordinator would describe the deviation in a nonconformance log, and notify the task investigation leader. The task investigation leader would review the log and notify the IT PM. In this example, the USACE TM would be notified, and together, the group would assess the impact of the omission on the objectives of the investigation. If the data point is determined to be critical to the outcome of the investigation, the group may decide the corrective action would be to collect the sample at this point and accelerate the analysis and reporting process to meet the final report due date. Alternatively, the group may decide that the data would have marginal impact on the investigation results and simply waive the sampling requirement as the corrective action. A long-term solution to the nonconformance must be addressed to prevent reoccurrence. In this example, this may include actions such as initiating a sample checklist based on the sampling information presented in the work plan and having a peer review of the sample documentation before the investigation is completed. In any case, the nonconformance log would be finalized by recording the corrective action and the results of the deviation. The nonconformance and actions taken would be discussed in the task final report.

Before the next periodic revision of the SAP, documented nonconformances will be reviewed and appropriate resolutions incorporated into the revised document. Nonconformances will also be used by project auditors to help focus audits on the historical project deviations. The auditors will review the corrective action procedures established from the resolution of the nonconformances and determine if the original nonconformance issues have been permanently resolved. Modified corrective actions may be indicated by the findings of the audit.

4.1.2 Variance Documentation

Variances are similar to nonconformances with respect to how they are defined, resolved, and documented. The primary difference is the timing of when the deviation occurs. A variance can be identified prior to implementation of a task, whereas a nonconformance is generally not identified until the task is in progress or complete. Therefore, with a variance, alternative techniques, modified methods, or a change in task DQOs can be considered. Substitute data, alternate success criteria, or even the deletion of data points may be contemplated after gathering information about why the deviation is necessary and examining what was the intended use of the data as planned. Project variances do go through the same step-wise process of identification, documentation, assessment, correction, and reporting as nonconformances.

An example project variance form is included in Appendix B. This form has been designed to ensure key information is recorded by the personnel who identify variances, review the documentation, assess the impact on task objectives, and consider alternative strategies for corrective action.

A hypothetical example of a project variance would be a sample technician being directed by a task leader to collect a surface water sample from a location in a base drainage ditch area. When the technician surveys the area, no surface water is present to sample. A project variance would then be initiated by the technician to document the change from the plan. The variance form would be completed and the IT PM would be notified; the IT PM would then notify the USACE TM. A decision would be made by the group to either select an alternative sample location where both a surface water and sediment sample could be collected, or delete the sample from the scope. The decision-making process would take into consideration the intended use of the surface water data. When the decision has been made, the result would be recorded on the variance log and reported in the task final report.

Variances will be documented in the project file and will be referenced and discussed in the final task report. Issued variances will be reviewed prior to SAP revision and during preparation for project audits.

4.1.3 Record of Telephone Conferences and Meetings

Meetings are frequently held via telephone or in person between members of the IT project team and the USACE, the Air Force, and/or the regulatory agencies. During these meetings, often critical decisions are made and action items assigned. Some of these decisions include scope and schedule changes that may impact project objectives and budgets. These decisions must be carefully documented and distributed to all team members who will participate in or implement the decisions. The primary form to record these meeting minutes is the Record of Telecon/ Meeting. An example of this form, along with all other pertinent field forms, is included in Appendix B. A blank version of this form should be used by at least one designated person during the meeting to record project decisions and assigned action items.

This completed record form would be circulated as a draft and reviewed by other participants in the meeting. Comments would be added as needed based on their meeting notes, and a final typewritten version of the form would be completed and signed by the preparer. The preparer is then responsible for distributing the form to the appropriate team personnel. The preparer will work with the IT PM in determining the distribution. The original of all completed Record of Telecon/Meeting forms will be sent to the project central files for storage and reference. The IT PM will collect the completed forms for a given time period and transmit copies of the forms to the USACE TM.

4.2 Record Keeping

Project documentation consists of field investigation data, sample collection information, and analytical data records (hard copy analytical reports and electronic data deliverables [EDD]). Supplemental documentation such as nonconformance reports, variance logs, Record of Telecon/Meeting forms, letters of transmittal, general correspondence, project proposals/plans, drawings, and reports, along with the project documentation will comprise the project files. Copies of these documents may exist elsewhere, but the originals shall be kept in the project file. The project files will be kept in a secure, central location and indexed by delivery order and type of record for easy cross-referencing.

The IT PM will designate an individual to assume overall responsibility for maintaining project files using file tracking forms for inventory and control. The project files will be a focal point for project audits and must be kept current at all times. Project files will be kept in the IT Knoxville office. Original documents produced in the field will be copied, the copies filed in the field, and the original forwarded to the Knoxville office in a timely manner. Task managers will be responsible for verifying that original project plans, field forms, and reports are transferred to the project file for long-term storage. Updated information will be noted and added to the file as appropriate.

At the conclusion of the Former Ramey AFB project, the project file will be duplicated and the original files transferred to the USACE Savannah District Office for permanent storage.

4.3 Overview of Anticipated Field Operations

Field operations at the Former Ramey AFB may be conducted as part of SIs, RIs, RD/RAs, operation and maintenance (O&M) activities, and post-remediation confirmation sampling. This chapter outlines activities, which may be conducted as part of field operations. Additional activities may be required during future tasks, and will be discussed in the task-specific work plans. Field operations that are either currently planned or may be performed in future activities include:

- Measuring static water levels in monitoring wells
- Geophysical survey
- UST removals
- HAZCAT characterization
- PCB transformer bank removal and PCB disposal
- Drilling and sampling boreholes in soil and unconsolidated sediment
- Surface water sampling
- Surface soil and sediment sampling
- Purging and sampling monitoring wells

- Conducting in situ permeability tests in selected monitoring wells
- Installing monitoring wells, piezometers, and possibly extraction wells
- Conducting pump tests
- Surveying and locating sampling points
- Soil excavation and confirmation sampling
- Performing direct-push soil and groundwater investigations
- Collecting samples of investigation-derived waste (IDW), excavated soil or sediment, and "treated" samples for disposal characterization.

Brief descriptions of these field procedures are provided in Section 5.0. Specifications for all applicable activities for each individual site will be provided in the site-specific task work plans.

4.4 Project Audits, Corrective Action, and Follow-Up Procedures

Project audits will consist of audits of field activities, audits of project files and record keeping practices, laboratory or other subcontractor audits, or a combination of one or more of these. A health and safety audit is a specific type of project audit that is discussed in detail in the Former Ramey AFB installation-wide SHP. Project audits are planned and scheduled independently of project tasks, but take into account when major project tasks or changes are occurring, and will be scheduled relative to these events. Audits will include their own objectives, plans, personnel, and reports, and be separate from the tasks to be implemented. The following sections discuss the purpose of audits and the types of audits to be performed.

Field audits and laboratory or subcontractor audits may involve an on-site visit by a project designated auditor. Items to be examined may include the availability and implementation of approved work procedures and sample collection methods; calibration and operation and maintenance of equipment; packaging, storing, and shipping samples; performance documentation; and nonconformance documentation. An example field audit checklist is included in Appendix B.

Project file and record keeping procedural audits are usually initiated at the request of IT corporate QA management or the IT PM. These audits focus primarily on the management of project records, status of the files, and adherence to the project and corporate QA policy and procedures by the Former Ramey AFB project team. These audits may illuminate areas where the actual processes are not completely compliant with approved corporate methods and improvement is needed.

In all cases, the records of operation will be reviewed to verify that home office support, laboratory, and field-related activities were performed in accordance with approved procedures. Items reviewed will include, but will not be limited to, the equipment calibration records, FADL, chain-of-custody (COC) documentation, and data resulting from field and laboratory operations.

Audit Schedule and Records. Field and project audits will be conducted as the scheduled activities necessitate and at least annually. Audits may cover field work as well as other project and laboratory actions. A project-designated auditor or audit team is responsible for planning the audit, coordinating activities with the client and auditee, developing an audit "checklist," and scheduling and performing audits. Audits will be initiated at the request of the IT PM or client. Within 20 working days of completion of an audit, the auditor will prepare and submit an audit report that summarizes the relevant findings and recommendations of the auditors. The report will be addressed to the IT PM and copies will be sent to the auditee.

Within 30 working days after receipt of the audit report, the auditee will prepare and submit a reply to the audit for the IT PM or client. This reply will include, as a minimum, a plan for implementing the corrective action to be taken on any findings indicated in the audit report, the date by which such corrective action will be completed, and actions taken to prevent reoccurrence. If the corrective action has been completed, supportive documentation should be attached to the reply. The auditor will ascertain (by reaudit or other means) whether appropriate and timely corrective action has been taken. Reaudits will be conducted and reported in the same manner as the original audit. A summary of audit findings and corrective action implementation will be prepared and forwarded to the USACE TM for informational purposes.

For short-term field activities, an abbreviated field auditing schedule and scope will be initiated as needed. Using an abbreviated schedule, the scope of the audit will be reduced and focus only on the current activity or task. Instead of a formal audit report, a summary of audit findings and

recommendations will be presented in an audit result memorandum. The memorandum, while less formal than an audit report, will completely document the audit findings. Corrective actions will be planned and immediately executed to resolve audit findings. Follow-up audits on short-term activities will also occur on an accelerated basis to meet project time lines.

Records of audits will be maintained in the project files. Audit files will include, as a minimum, the audit report or audit result memoranda, the audit responses, and any supporting documents. It is the responsibility of the auditee to conform to the established procedures, particularly with timely replies to audit reports and implementation of such corrective action as may be indicated.

4.5 Inspection and Acceptance Criteria for Supplies and Consumables

Standard IT procurement procedures will be used to obtain supplies and consumables. These procedures are initiated by the task manager, field coordinator, or other technical lead person and then forwarded to project management and procurement personnel for approval and supplier contact. In the request for supplies, the requestor must specify the needed characteristics of the material such as any required certifications of purity or QC level. Sample supplies and consumables must be inspected upon receipt to verify that they do meet these specifications and that any required manufacturer's documentation is present and retained for the project files. Any damaged, unsealed, or used equipment (unless adequately cleaned and returned to service) will not be accepted.

For items that may come in contact with the sampled matrix or sampling device, assurances should be made, through adequate receiving inspection, that such materials are not contaminated. They must remain sealed or be decontaminated adequately before field use. Examples include, decontamination water, chemical reagents, sampling probes/instruments, bailers, soil spoons, or augers.

5.0 Field Investigation Procedures

This section provides brief descriptions of SOPs to be followed for performance of proposed tasks necessary for conducting SIs, RIs, RD/RA investigations, and post-remediation confirmation sampling at the Former Ramey AFB. Currently, planned procedures that may be performed at the Former Ramey AFB may include the following:

- Excavation, stockpiling, and sampling of contaminated soil
- Drilling and sampling soil borings
- Installing groundwater monitoring wells or piezometers
- Conducting single and multiple well aquifer tests
- Conducting land surveys
- Conducting geophysical surveys
- Groundwater sampling
- Surface water and sediment sampling
- Surface and subsurface soil sampling
- Performing direct-push soil and groundwater investigations.

These activities may be conducted in support of work that is carried out at specific sites at the Former Ramey AFB; the site-specific specifications for each of the activities required for each investigation or RA is provided in site-specific task work plans that will reference this SAP. General sampling procedures will be discussed in Section 6.1.

5.1 Soil Boring Installation and Abandonment

Soil borings may be drilled to sample the subsurface soil and sediment for lithologic descriptions, geotechnical testing, or chemical analysis. The soil sample collection method used will depend on the depth to which the boring will be advanced, and the purpose for which the sample is to be taken.

5.1.1 Boring Advancement and Drilling Methods

All proposed soil borings will be advanced to the specified total depth by using any of a variety of methods: hollow-stem auger (HSA), hand (bucket) auger, split-barrel sampler such as portable power auger, or hydropunch. If a HSA is used for well installation, it will have a nominal inside diameter (ID) of at least 4.25 inches and outside diameter of 8.25 inches. This

will allow a 2-inch annular space between outer well casing and borehole sidewall. The boring locations and depths for each site are described in the site-specific task work plans.

5.1.2 Borehole Abandonment

Boreholes installed using hydropunch samplers will be abandoned by backfilling with bentonite pellets. A 3-inch-thick grout cap will be placed flush to the ground over the boring to prevent the vertical migration of water.

Boreholes drilling using hollow-stem augers that do not have wells installed will be abandoned by placing the a bentonite grout slurry into the borehole and will be capped with a 3-inch thick grout cap.

5.2 Monitoring Well and Extraction Well Installation and Development

At this time, the planned scope of work does not include the installation of monitoring or extraction wells for the purpose of monitoring groundwater contamination at the Former Ramey AFB. If well installation becomes a part of the scope of work, all equipment decontamination, drilling, monitoring or extraction well installation activities, well development, and field documentation will be conducted according to the procedures outlined in this section.

The screened interval for new wells will be placed in a representative depth and will not extend deeper than the expected contamination interval. Borings for the installation of the wells will be advanced through the soils using hollow-stem auger drilling methods whenever possible. Mud rotary, rotasonic, driven casing, and/or reverse circulation drilling methods may be recommended to the USACE, but will be performed only if approved during the task planning stage. The rationale for the well placement and anticipated depths will be given in the site-specific task work plans. If confined aquifers exist and the deeper aquifers will be penetrated, double-cased wells will be installed.

For all wells, soil samples will be collected continuously from the upper 10 feet and at 5-foot intervals (or as otherwise deemed necessary) thereafter to provide a detailed lithologic log. Selected samples will be collected for grain size analysis and Atterberg Limit analysis using the ASTM methods listed in Section 6.1.1.

A geologist will supervise the drilling of each borehole and will maintain a record of the drilling and soil conditions encountered. The geologist will maintain continuous, detailed subsurface HTRW logs by examining drill cuttings, recording the collection of samples/cores, and noting first-encountered groundwater levels for each borehole as per USACE specifications. Daily field notes will be kept and will include sufficient information to reconstruct the progress of drilling operations, problems encountered, well installation procedures, etc. After completion of site work and report writing, original copies of all field forms and documents will be archived in the project files at the IT offices in Knoxville.

5.2.1 Monitoring and Extraction Well Installation

After completion of the borings, well installations will be performed in conformance with USACE and Region II EPA geotechnical requirements. Representative samples of graded sand pack material will be evaluated; the filter sand will be selected before drilling and will be specified in the site-specific task work plans. Screens for monitoring wells and extraction wells will be continuous wrap. Screen and casing specifications will be given in site-specific task work plans where required. Monitoring and extraction wells will be constructed by placing less than a 1-foot layer of sand in the borehole below the screen and bringing the sand pack to at least 2 feet above the top of screen.

An annular seal will be formed above the filter pack with either fine sand or bentonite pellets. If the top of the filter pack is in the unsaturated zone, then an approximate 3-foot-thick layer of fine sand will be placed on top of the filter pack, assuming there is adequate distance between the top of the filter pack and ground surface. If not, then sufficient fine sand will be emplaced to bring the annular materials to within 0.5 feet of ground surface. A cement grout will be used to seal the borehole above the find sand. If less than 3 feet of the fine sand seal is able to be used, then the initial grout mixture will be sufficiently viscous to prevent significant penetration into the fine sand.

If the top of the filter pack is below the water table, then an approximate 3-foot-thick bentonite seal will be emplaced on top of the filter pack. The remaining annulus will be grouted continuously from the top of the hydrated bentonite seal to ground surface. Screen lengths for the wells are provided in the site-specific task work plans.

A stainless-steel warning plaque will be permanently affixed to the outer protective casing upon completion. The plaque will be inscribed with a warning stating the well is not for drinking water and also show pertinent information such as well ID, date installed, total well depth, screen length, borehole size, and who installed the well.

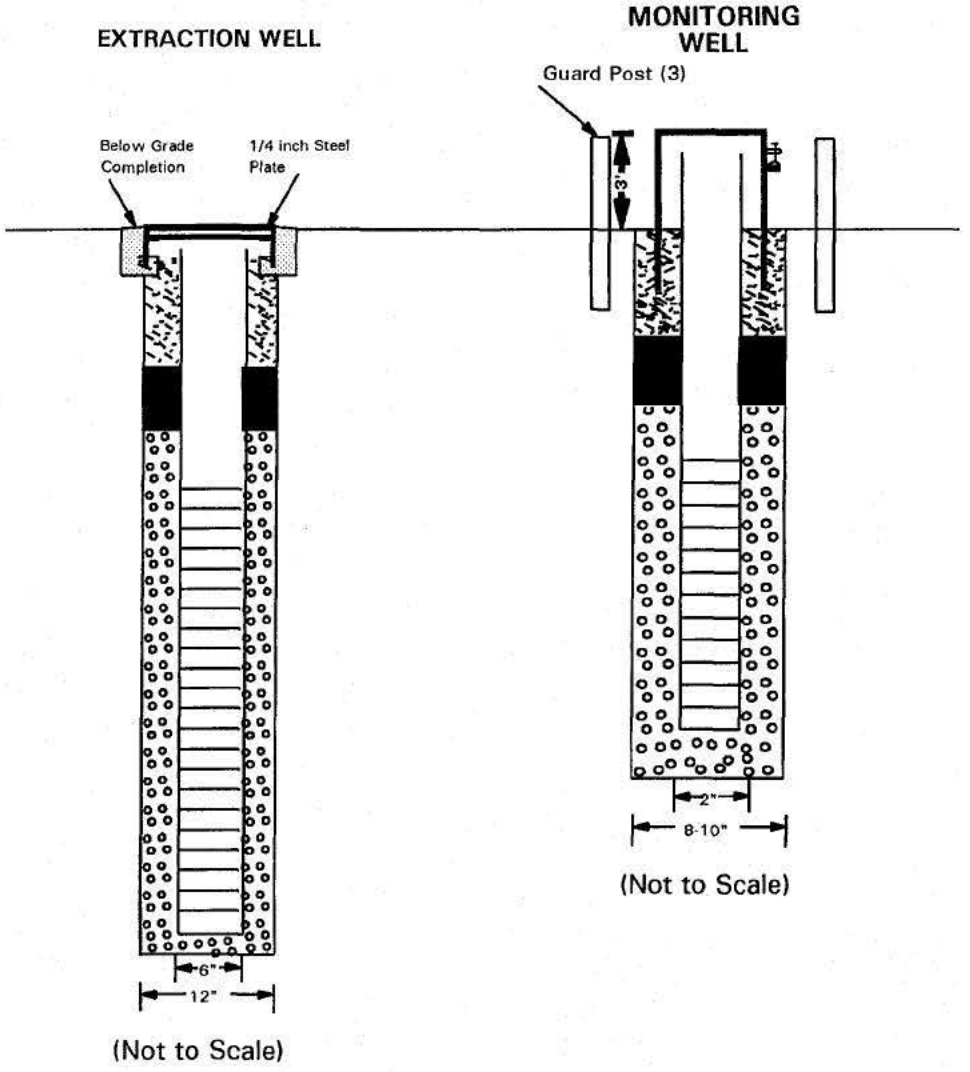
Typical monitoring well and extraction well completions are shown in Figure 5-1. Depending on task objectives, final completion methods may differ from this description. When necessary, task-specific requirements will be defined in task work plans.

5.2.2 Monitoring Well Completion

A 5-foot length of 6-inch ID protective, clean steel casing with a locking cap will be installed over the well pipe to a depth of approximately 2 feet below the ground surface (Figure 5-1). An internal mortar collar will be placed within the steel protective casing and outside the well casing to a height of 0.5 foot above the external concrete pad. A square concrete pad will be constructed around the well and will be a minimum of 3 feet square and 6 inches thick, and will slope away from the well. An internal drainage hole will be drilled through the steel casing just above the mortar collar. After the grout has thoroughly set, the protective steel casing will be painted and identified by number in a contrasting color. Three concrete posts will be set radially around the well. Depending on site requirements, flush-mounted wells may be alternatively installed. When specified, their completion requirements will be described in task-specific work plans.

5.2.3 Extraction Well Completion

As shown in Figure 5-2, a concrete below-grade vault will typically be installed at each extraction well to house the well head, winch assembly, and discharge lines. The vault will be 5 feet in diameter with the access port 2.5 feet below grade. The vault will be formed to accommodate the OD of the well riser, and an access port large enough to accept the 2-inch polyvinyl chloride (PVC) discharge line, and electrical lines. The vault shall have a one-quarter-inch-thick steel cover that rests securely on the top, be flush with the vault edges, and be constructed such that the vault is waterproof. Bolts secure the vault lid in place. The well will be prepared for the vaults by excavating the soils below grade around the well and filling the excavation with a base aggregate. The vault will be lowered over the well riser and leveled on the aggregate where appropriate, above grade well-head completions may be used.



NOTES:

Riser	Sch 40, 6 inch diameter extraction wells 2 inch diameter monitoring wells and piezometer
Slot size:	Monitoring Well: typically 0.010 inch, to be confirmed with grain size analysis.
	Extraction Well: minimum 0.020 inch, to be based on grain size analysis.
Screen:	Monitoring Wells: Slotted Sch 40 PVC, 2 inch diameter and piezometer.
	Extraction Wells: Screened Sch 40 PVC, 6 inch diameter, threaded well plug
Seal	Bentonite pellets minimum 2 feet 1/4 to 1/2 inch diameter pellets.
Filter Pack	Clean filter sand to at least 2 feet above screen. Sample must be provided with size distribution curve.
Grout	Bentonite neat cement, typical: 98 lb cement 7 gal water 2 lb. bentonite

FIGURE 5-1

TYPICAL WELL CONSTRUCTION FOR MONITORING AND EXTRACTION WELLS

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RAMEY AIR FORCE BASE
AGUADILLA, PUERTO RICO

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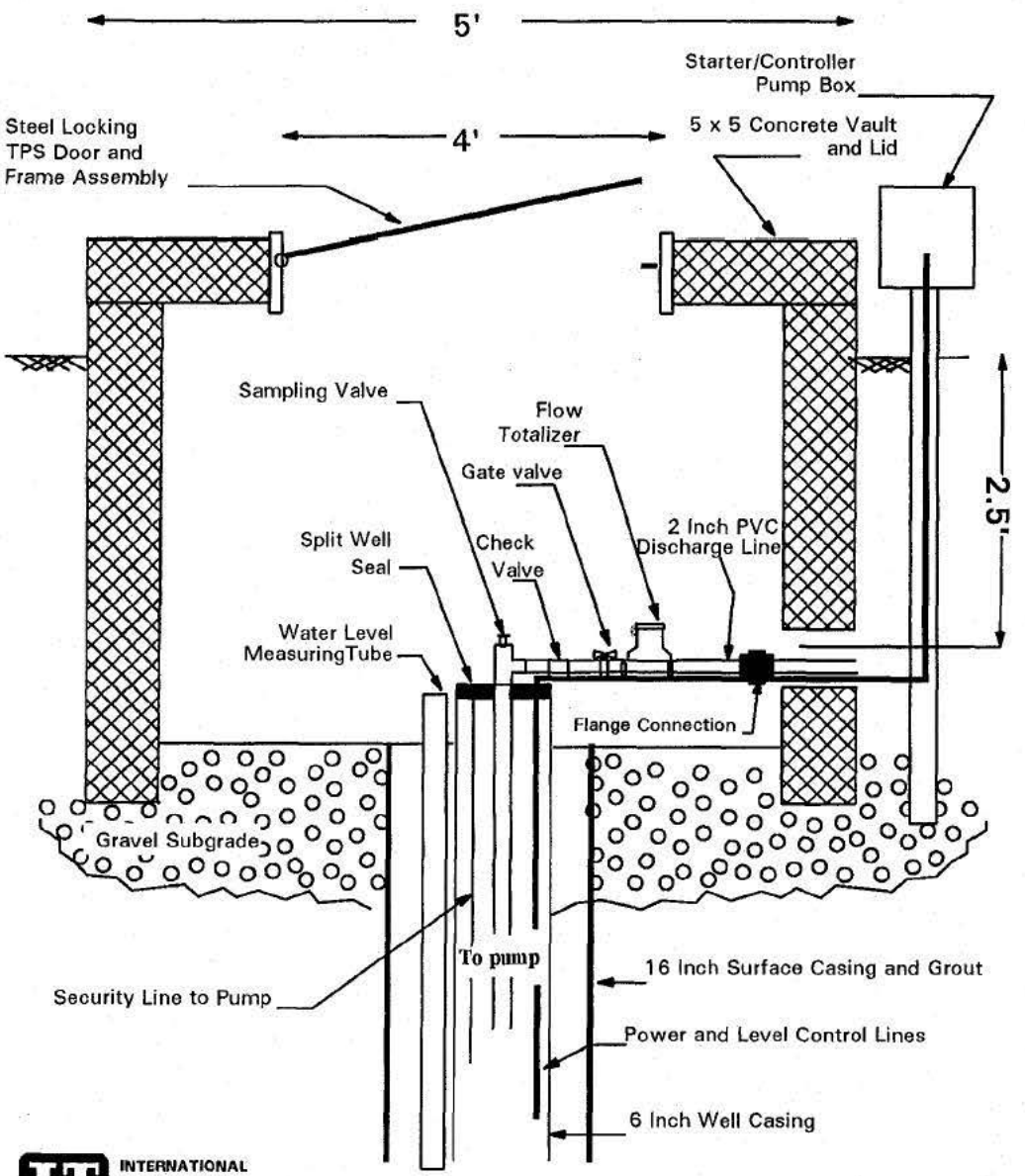

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Notes:

Vault shall be constructed such that the well head is located in the center of the manway, with a steel, lockable, waterproof lid.

The well head will be secured with a well seal constructed with a central hole for the discharge pipe and a hole for the cable securing the pump.

Access port in side of vault must be large enough to accommodate the discharge line and electrical power and control lines, at about 2.5 feet below grade for frost protection.

Dimensions as shown.

FIGURE 5-2

DETAIL OF BELOW GROUND COMPLETION BOX FOR EXTRACTION WELLS

RAMEY AIR FORCE BASE
AGUADILLA, PUERTO RICO

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Stainless-steel submersible pumps equipped with an externally mounted control/starter box will be installed in each extraction well. The pump will be equipped with a 2-inch adapter for connection to the 2-inch Schedule 40 PVC discharge line, shutoff and restart protection, and electrical line for the pump. Pumps will be sized in the field, based on the results of the step-drawdown tests (Section 5.4.2) and other engineering requirements.

As shown in Figure 5-3, the extraction well pump will be centrally mounted. The discharge line from the pump will be coupled to a check valve and gate valve, then connected to a PVC discharge pipe that will extend through the access port located about 1.5 feet below grade. The discharge line will extend 1 foot beyond the vault for connection to a main trunk line.

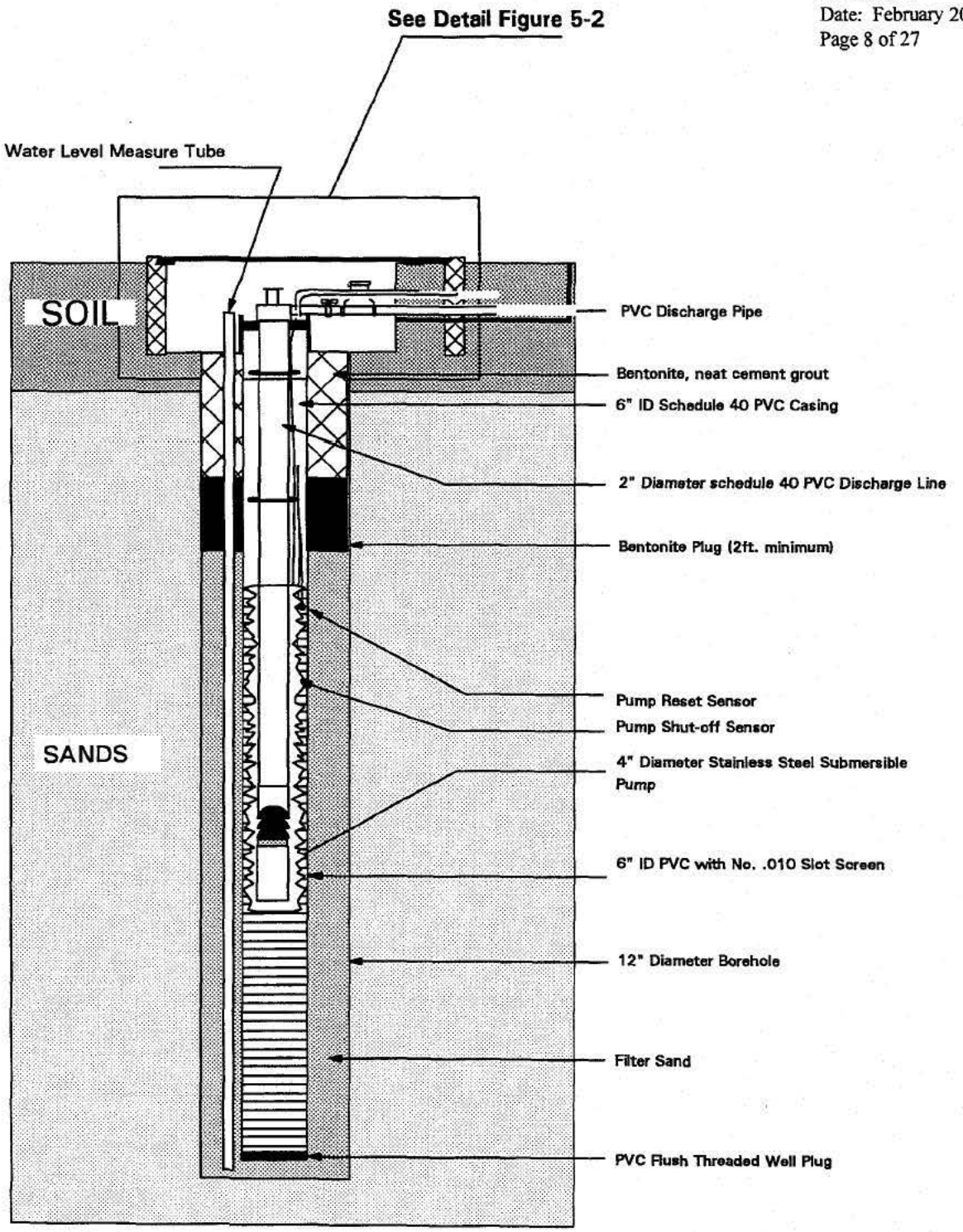
5.2.4 Well Completion Diagrams

A well installation diagram will be submitted to USACE within 5 days of well completion and will be included in the final construction report for each site. This diagram will illustrate the depth of the boring, screen location, sand filter pack material, seals, grout, height above or below ground surface of the well head, all pumping hardware installed, and other pertinent data.

5.2.5 Well Development

Each well will be developed by pumping or bailing as soon as practical, but no sooner than 48 hours nor longer than 7 calendar days after the placement of the surface pad and outer protective casing. The well will be developed by bailing, pumping and surging, or by a closed air-lift system. During development, the pump inlet will be moved through the entire screened interval or the bailer will be lifted from different depths in the well. The development procedure will continue until the following conditions are met:

- Water is clear to the unaided eye, free of sand, and free of drilling fluids
- Thickness of the accumulated sediment in the well is less than 5 percent of the length of the well screen
- Temperature, pH, turbidity, and specific conductance values stabilize
- A volume of water equal to five times the volume of standing water in the well and annular space has been removed from the well. For well development purposes, one well volume will be taken to be the sum of the volume of water within the



(Not to Scale)

FIGURE 5-3

TYPICAL PUMP INSTALLATION
FOR EXTRACTION WELLS

RAMEY AIR FORCE BASE
AGUADILLA, PUERTO RICO

INTERNATIONAL TECHNOLOGY CORPORATION

annulus assuming 30 percent porosity in the annulus, and using the height of the water column in the well at the time just prior to development.

Typically, well development can be completed within 4 hours if the seal has not yet been placed. If after two attempts to develop a well, all development criteria are not achieved, the USACE will be notified for further direction.

5.3 Water Level Measurements

As previously stated, groundwater monitoring is not anticipated as a part of the planned scope of work at the Former Ramey AFB. If in the future water level measurements are necessary, they will be collected using the procedures described in this section. The depth to water will be measured to the nearest 0.01 foot from the highest point on the riser (inner casing), or from a marking on the riser from which the elevation has been surveyed. Measurements will be performed with a decontaminated water level meter that has been scale- calibrated by the manufacturer to certified lengths.

5.4 Aquifer Testing

As previously stated, groundwater monitoring is not anticipated as a part of the planned scope of work at the Former Ramey AFB. If in the future aquifer testing is necessary, they will be collected using the procedures described in this section. Aquifer tests will be conducted to address specific objectives:

- Slug tests (in situ permeability) will be conducted to provide hydraulic conductivity from the aquifer materials directly adjacent to the well screens.

- Step-drawdown tests will be conducted to establish the specific capacity and optimum pumping rates for extraction wells, and to properly size the pump for each extraction well.

- Constant rate, long-term (72-hour or more) aquifer tests will be conducted to provide quantitative estimates of hydraulic properties of the water table aquifer, including transmissivity, hydraulic conductivity, and storativity, as well as long-term aquifer performance and chemical concentrations during discharge within the area of contamination.

5.4.1 Slug Tests

As previously stated, groundwater monitoring is not anticipated as a part of the planned scope of work at the Former Ramey AFB. If in the future slug tests are necessary, they will be collected using the procedures described in this section. Slug tests provide an estimate of the hydraulic properties of an aquifer in the immediate vicinity of a well where the test is conducted, and involves causing an instantaneous change in the water level in a well and measuring the recovery of the water level with time (Freeze and Cherry, 1979). The procedure outlined in this section is based on using a bailer or solid cylinder to remove a volume of water from the monitoring well, and will follow the sequence of rising head/falling head tests. The full bailer should be placed in a bucket for return to the well to complete a falling head test. If a solid slug is used instead, then the sequence is reversed (falling head/rising head).

The equipment required for this procedure is:

- Electronic data logger with a pressure transducer
- Stop watch
- Aquifer test form
- Bailer, nylon rope, and 5-gallon bucket.

The following procedure will be followed for conducting the permeability tests and for recording the data:

- Measure the static water level from the top of casing.
- Install a pressure transducer and initiate reference information for the electronic data recording device.
- Lower the slug or bailer into the water column.
- Allow the water level to re-equilibrate, then initiate the data logging sequence on the recording device and remove the slug to start the rising head test. During the test, the depth to water shall be recorded on the aquifer test form.
- After the rising head test is completed, the bailer is re-inserted, and the data logging sequence re-initiated on the recording device to begin the falling head test.
- During both rising and falling head tests, the depth to water should be recorded on the aquifer test form.

Following the tests, the data recorded by the logging device shall be recovered and stored on a magnetic medium. Recovery data should be graphed and inspected in the field for consistency and completeness.

Once the test is completed, the pressure transducer and bailer shall be decontaminated following the procedures outlined in Section 6.1.7.

5.4.2 Step-Drawdown Tests

Once an extraction well has been completed and developed, a step-drawdown test in each extraction well will be conducted. Steps will be approximately 1 hour long and pumping rates will range from 2 to 80 gallons per minute (gpm); however, higher rates will be used if the specific yield has not been exceeded. The discharge rate from the well will be controlled by a gate valve or globe valve and measured using a flow meter or totalizer. Calibration of the discharge measuring device will be accurate to 10 percent or better and capable of measuring flows of 5 to 100 gpm.

During the pump tests, water levels will be monitored in the extraction well and in selected monitoring wells and piezometers. A pressure gauge should be used within the discharge line to provide a direct reading of the total head pressure at which the pump is operating. The data collected during the step-drawdown tests will be analyzed and used to determine the pumps to be installed in each well. Water produced during the pump test will be collected and transported to an on-site treatment facility, or disposed of via other approved discharge point.

5.4.3 Constant Rate Aquifer Tests

Contaminant levels are expected to change during long-term extraction well operations; thus, data on the flowing concentrations are required for long-term design purposes. Constant rate aquifer tests will be conducted within the areas of known groundwater contamination. The pumping test locations will be chosen based on the concentrations of contaminants in monitoring wells. Constant rate tests will provide data required to evaluate the actual flowing concentrations during operation of a groundwater recovery system.

Constant rate aquifer tests will involve the following tasks:

- Selection of existing monitoring wells as observation points and installation of piezometers at selected points for observation
- Installation of pressure transducers at selected observation points
- Collection of static water levels in piezometers and nearby wells
- Collection of groundwater samples to determine the initial concentrations of the target compounds
- Installation of a test pump and performance of a step-drawdown test to determine the optimum discharge rate
- Recovery to near static level
- Initiation of aquifer test, including periodic manual water level measurements at all observation points during the test.

Additional details of specific aquifer tests will be provided in the site-specific task work plans for those sites where aquifer tests will be required.

5.4.4 Aquifer Test Analysis

Pumping test data are analyzed to obtain estimates of hydraulic parameters and to establish the presence of recharge and impermeable boundaries. Analyses are made by plotting drawdown versus time on log-log or semilog paper and applying either graphical curve matching or mathematical treatment to the data.

Data from aquifer tests will be analyzed using aquifer models and analytical tools common to the industry. For slug test data, the Bouwer and Rice model (Bouwer and Rice, 1988) will typically be used for the unconfined aquifer and the Cooper, Bredehoeft, Papodopulos model (Cooper, et al., 1967) will typically be used for confined conditions. Step-drawdown tests will be used to compute the specific capacity and, where possible, to determine the well efficiency (Driscol, 1987). Constant rate test data will be graphically matched to theoretical type curves, and the appropriate aquifer model will be chosen for analysis (Dawson and Istok, 1991).

5.5 Geophysical Surveys

5.5.1 Electromagnetic Surveys

Frequency Domain Electromagnetic (FDEM) profiling using a Geonics EM-31DL (EM-31) coupled with an OMNI Systems Digital Data Logger will be used to delineate metallic pipes and cables, USTs, pits and trenches containing metallic debris, and fill areas. Electromagnetic utility locators will be used, when necessary, to trace metallic pipes and cables.

Prior to collecting data, geophysical survey control points will be marked with surveyor's paint/chalk such that the resolution objectives of the investigation are met. This process generally involves marking a 10-by-10-foot or 20-by-20-foot control point within a surveyed base grid. A site map will be generated in the field showing the geophysical survey area and obvious surface cultural features that could potentially affect the data (e.g., structures, fences, surface metallic objects, or overhead utilities).

A geophysical survey base station will be established near the site in an area unaffected by buried metallic debris or cultural interference (i.e., subsurface or overhead utilities, fences, structures, etc.). Before acquiring EM-31 data, the instrument will be calibrated and the in-phase component set to zero at the base station, and several measurements of conductivity and the in-phase component will be taken and stored in the data logger. Measurements of conductivity and the in-phase component will then be made at 5-foot intervals along survey lines and stored in the data logger. After completing the survey, the base station will be reoccupied and several measurements of conductivity and in-phase component will be taken. Comparison of base station measurements before and after the survey will provide a quantitative measure of instrument drift. The EM-31 survey will also be conducted along perpendicular lines to allow for a more accurate delineation of subsurface features such as pipelines and trenches. After completing the EM-31 survey, data will be downloaded to a laptop computer and prepared for processing.

Contour maps of conductivity and in-phase component will be generated using the GEOSOFT® mapping system. Contour maps will be color-enhanced to facilitate the recognition and interpretation of subtle anomalies. The contour maps of EM-31 data will be interpreted to determine the locations of fill areas containing buried metallic objects, debris, USTs, and subsurface pipelines

and cables, and to assess the effects of surface cultural features such as high-voltage electric lines, fences, and buildings.

5.5.2 Magnetic Surveys

Magnetic surveys will be conducted using an optically pumped cesium Geometrics G-858G magnetic gradiometer (or equivalent instrument) at sites suspected of containing buried ferrous metallic objects or debris.

Prior to starting the magnetic survey, a magnetic base station will be located away from the site in an area free of cultural interferences capable of producing magnetic anomalies. The base station magnetometer will be programmed to measure the intensity of the earth's magnetic field every 20 seconds or less and store the data in the instrument's internal memory. The magnetic base station will provide a record of diurnal variations in the earth's magnetic field during the survey period.

Measurements of the earth's total magnetic field and vertical magnetic gradient will be made with the magnetic gradiometer at the pre-established geophysical survey base station prior to conducting the magnetic survey. Magnetic data will then be collected along north-south oriented survey lines at 10-foot intervals or less and stored in the instrument's internal memory.

Following the survey, the geophysical base station will be reoccupied with the magnetic gradiometer and several measurements will be taken to provide a quantitative measure of instrument drift during the survey period. All data stored in the internal memory of the magnetic base station and magnetic gradiometer will be downloaded to a laptop computer. The data from the field gradiometer and the base station magnetometer will be downloaded simultaneously, with corrections for diurnal magnetic drift during the survey period being made automatically.

Contour maps of total magnetic field and vertical magnetic gradient data will be generated using the GEOSOFT geophysical mapping system. The contour maps will be color-enhanced to facilitate the recognition and interpretation of subtle anomalies. Contour maps of magnetic data will be interpreted to determine the locations of buried ferrous metallic objects or debris and to assess the effects of surface cultural features such as high-voltage electric lines, fences, and buildings.

5.5.3 Ground-Penetrating Radar Surveys

Ground-penetrating radar (GPR) surveys will be conducted with a Geophysical Survey Systems, Inc. (GSSI) SIR System 3 or System 10 coupled to either 300- or 500-megahertz (MHz) antennas, depending on site conditions. GPR surveys will be conducted to determine the lateral extent and approximate depth below ground surface of significant EM-31 and magnetic anomalies, to delineate nonmetallic features such as vitrified clay or concrete pipes, and to characterize the subsurface in areas inaccessible with electromagnetic or magnetic instruments (e.g., near buildings, fences, reinforced concrete pads).

Prior to collecting GPR data, the instrument will be calibrated by pulling the antenna over an object whose depth is known and observing where the anomaly occurs on the record. The electromagnetic signal velocity may then be calculated and used to determine approximate depths of other anomalies located in similar subsurface conditions. If no known object is available, approximate signal velocities may be obtained from published tables by selecting a velocity for the type of soil that most closely resembles the site soil conditions. The GPR signal will then be gained by applying specific multipliers relative to depth to the amplitudes of the signal in order to maximize the signal to noise ratio. This procedure is done to account for the rapid loss of energy of the electromagnetic waves as they travel through the subsurface.

Following system calibration, GPR data will be acquired semicontinuously as the antenna is hand-towed along each survey line. A marker switch on the antenna unit will be used at a predetermined interval to mark control points on the GPR records. If the System 3 is used, the black and white graphic records of the data will be appropriately labeled after each traverse is completed. If the System 10 is used, the data will be stored on digital tape and later processed and printed on a color printer.

Digital GPR data acquired with the System 10 will be processed daily during the field program using the RADAN 3® program written by GSSI. Data will first be downloaded from 8-millimeter digital tape to an external hard disk or other storage device. Horizontal and/or vertical filters will be applied to the data where necessary to enhance features of interest and reduce noise. Additionally, the data will be horizontally stacked to increase the signal-to-noise ratio. Color-enhanced GPR records will then be printed on a color printer.

GPR records will be evaluated to determine the depth penetration at each site and to determine the approximate lateral extent and depth below the ground surface of known or suspected targets visible on the profiles.

5.6 Land Surveying

Survey requirements in general will include the following:

- Establish grid corners.
- Locate soil borings, monitoring wells, surface soil, surface water, and sediment sampling positions.
- Establish elevation of installed groundwater monitoring wells and actual drilling sites of soil borings.

Each survey location will be surveyed to determine the horizontal map coordinates referenced to the State Plane Coordinate System (SPCS). These surveys will be connected to the SPCS by third order, Class II control surveys in accordance with the Standards and Specifications for Geodetic Control Networks (Federal Geodetic Control Committee 1983). All horizontal survey coordinates will have an accuracy of ±0.1 foot within the SPCS.

Elevations including monitoring well ground elevations and well casings (top of PVC casing) and soil boring locations (and other samples as considered necessary) will be surveyed to the nearest 0.01 feet and will be referenced to the National Geodetic Vertical Datum of 1929 (NGVD 1929). These surveys shall be connected by third order leveling to the NGVD 1929 in accordance with the Standards and Specifications for Geodetic Control Networks.

Survey field data (as corrected), to include loop closures and other statistical data in accordance with the Standards and Specifications referenced above, will be provided to IT upon completion of the survey efforts. Closure shall be within the horizontal and vertical limits given above. The data shall be clearly listed in tabular form, including the coordinates (and system) and elevation (ground surface and top of well) as appropriate, for all borings, wells, sample locations, and reference marks. All permanent and semi-permanent reference marks used for horizontal and vertical control (benchmarks, caps, chiseled cuts, rail spikes, etc.) shall be described in terms of their name, character, physical location, and reference value.

5.6.1 Control Monuments

Existing permanent control monuments will be used for each site. If existing permanent control monuments are unavailable, new control monuments will be provided after consultation with the USACE. Each new control monument will be located horizontally to the nearest 0.1 foot and referenced to the previously established SPCS site coordinate system. The elevation of each monument will be measured to the nearest 0.01 foot and referenced to the NGVD 1929. Each monument will consist of a standard 4-inch-diameter brass or aluminum monument embedded permanently in concrete. The identification, elevation, and coordinates will be inscribed on the monument. Control monument data will be included with other surveying data in the final report.

5.6.2 Soil Boring Surveys

Soil boring locations will be established in the field by the field coordinator or site geologist. Each location, once sampled, will be clearly marked with a stake, pin, or similar item until it can be surveyed. The sample location identifier will be written in waterproof ink on each marker.

Soil boring locations (samples below the 1-foot depth), once grouted or backfilled and properly marked, will be surveyed for horizontal coordinates to the nearest 0.01 foot and referenced to the SPCS. Surface elevations of soil borings will be measured to the nearest 0.01 foot referenced to the NGVD 1929, when required or requested.

5.6.3 Extraction and Monitoring Well Surveying

Horizontal coordinates for all new extraction and monitoring wells will be measured to the nearest 0.1 foot and referenced to the SPCS. Elevations will be measured at ground surface and at the top of the well casing to the nearest 0.01 foot. All elevation measurements will be referenced to the NGVD 1929. The measurement point on the top of the well casing will be clearly and permanently marked for future water level measurements. The unique monitoring well identification number will be permanently marked on the protective cover.

5.6.4 Surface Water/Sediment Sample Location Surveys

Surface water and their corresponding sediment sampling locations will be surveyed for horizontal coordinates to the nearest 0.1 foot and referenced to the SPCS. These locations will be marked with a surveyor's stake, buoy, or flag after sampling until surveyed.

5.7 Direct-Push Investigations

In addition to more traditional subsurface soil investigations techniques, direct-push investigations may be conducted to gather data useful in defining contamination plumes, properly locating monitoring wells relative to contaminant plumes, or helping to further define or confirm the nature of contamination present in a given area. The direct-push system is a less expensive alternative to drill rig-installed soil borings and has the capability of collecting both soil and groundwater samples from the same sample location. Because the soil probe is pushed pneumatically to depth, the direct-push produces little IDW and, therefore, reduces associated disposal costs. Specific procedures are included in Chapter 6.0 to support soil and groundwater sampling activities associated with direct-push investigations.

5.8 AST/UST Removal Procedures

A procedure required for AST or UST removal activities will be discussed in each applicable site-specific work plan.

5.9 On-Site Analysis

Although it is not anticipated at this time that an on site laboratory will be necessary at the Former Ramey AFB, investigations frequently utilize on-site analysis (or a local laboratory may be used if available) to provide fast turnaround for soil and water samples. As dictated by the site contaminants of concern, this analysis is often performed with a portable gas chromatography (GC) system. On-site analysis is used to produce data on a real-time basis so same-day interpretation in the field is possible. Additional push points may be located or deeper depths sampled as determined from the interpretation to further characterize the site. Knowing the objective of the investigation, the task manager can plan DQOs for on-site analysis to meet either "definitive" or "field screening" data quality levels. These DQOs in turn would then be applied to the investigation by the on-site analyst who would be responsible for implementing and documenting the corresponding QC program. If definitive data quality level is required, then an analysis program would include the use of standard methods such as those from the EPA or ASTM, with as few modifications as possible. The analyses as implemented should follow method guidance for the following procedures:

- Initial and continuing calibrations
- Method blanks
- Surrogate spiking and recovery calculation (where applicable)

- Blank spike analysis
- Sample matrix spiking and recovery calculation
- Sample calculations and quantification of results
- Data reporting.

Field analysis data generated by a direct-push subcontractor should be reported to the IT task leader on a daily basis and should provide raw data summaries that include the results of the field and QC samples analyzed. Analytical methods and reporting limits, internal QC checks, and target precision and accuracy acceptance criteria for the common field GC methods (EPA Method 8021B) have been developed and are included in Tables 5-1 through 5-3. The QC indicators can be evaluated relative to these target goals and the results interpreted on an ongoing batch basis. The data that show suspect results can be flagged and reanalyzed or resampled as needed.

Off-Site Confirmation Analysis. In addition to the method QC checks summarized on Tables 5-2 and 5-3, the task work plan will specify a frequency criteria for off-site confirmation analysis. To meet this frequency, all direct-push samples analyzed on site will be collected in duplicate and the original analyzed in the onsite lab with the duplicate placed in archive. When the on-site data have been reviewed, the archived duplicate samples will be selected, based on the absence or presence of contamination determined by the on-site laboratory. Unless specified in the task work plan, approximately half of all off-site samples will contain some quantified target analytes to verify the accuracy of the on-site analytical method. The other half of off-site confirmation samples will be performed on samples that were less than reporting limits to verify "clean" samples. Samples receiving VOC analysis will be archived on site no longer than 24 hours from collection. While archived, samples will be stored in a secure refrigerator on site that will be monitored for temperature compliance (4 degrees Celsius [°C] plus or minus 2°C) at least once daily.

The subcontractor will also issue an interpretive final report of the direct-push investigation results that includes a thorough discussion of the QC program, its results, and the impact on data quality and usability. This report will be sent to the task leader and the results reviewed by the project chemist. The on-site data report will then be incorporated into the draft task report and the associated quality control summary report (QCSR).

Table 5-1

Field Analysis
Summary of Analysis Methods and Reporting Limits
Former Ramey AFB, Aguadilla, Puerto Rico

Parameter Group	Water		Soil	
	RL	Units	RL	Units
Halogenated Hydrocarbons - EPA Method 8021				
Bromoform	1.0	µg/L	0.010	mg/kg
Bromomethane	1.0	µg/L	0.010	mg/kg
Carbon tetrachloride	1.0	µg/L	0.010	mg/kg
Chlorobenzene	1.0	µg/L	0.010	mg/kg
Chloroethane	1.0	µg/L	0.010	mg/kg
Chloroform	1.0	µg/L	0.010	mg/kg
Chloromethame	1.0	µg/L	0.010	mg/kg
Dibromochloromethane	1.0	µg/L	0.010	mg/kg
1,3-Dichlorobenzene	1.0	µg/L	0.010	mg/kg
1,2- and 1,4-Dichlorobenzene	1.0	µg/L	0.010	mg/kg
1,1-Dichloroethane	1.0	µg/L	0.010	mg/kg
1,2-Dichloroethane	1.0	µg/L	0.010	mg/kg
1,1-Dichloroethene	1.0	µg/L	0.010	mg/kg
cis-1,2-Dichloroethene	1.0	µg/L	0.010	mg/kg
trans-1,2-Dichloroethene	1.0	µg/L	0.010	mg/kg
1,2-Dichloropropane	1.0	µg/L	0.010	mg/kg
cis-1,3-Dichloropropene	1.0	µg/L	0.010	mg/kg
trans-1,3 Dichloropropene	1.0	µg/L	0.010	mg/kg
Ethylene dibromide	1.0	µg/L	0.010	mg/kg
Methylene chloride	1.0	µg/L	0.010	mg/kg

Table 5-1

Field Analysis
Summary of Analysis Methods and Reporting Limits
Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter Group	Water		Soil	
	RL	Units	RL	Units
1,1,2,2-Tetrachloroethane	1.0	µg/L	0.010	mg/kg
Tetrachlorethane	1.0	µg/L	0.010	mg/kg
1,1,1-Trichloroethane	1.0	µg/L	0.010	mg/kg
1,1,2-Trichloroethane	1.0	µg/L	0.010	mg/kg
Trichloroethane	1.0	µg/L	0.010	mg/kg
Trichloroethene	1.0	µg/L	0.010	mg/kg
Trichlorofluoromethane	1.0	µg/L	0.010	mg/kg
Vinyl chloride	1.0	µg/L	0.010	mg/kg
Aromatic Hydrocarbons				
Benzene	1.0	µg/L	0.010	mg/kg
Toluene	1.0	µg/L	0.010	mg/kg
Chlorobenzene	1.0	µg/L	0.010	mg/kg
Ethyl benzene	1.0	µg/L	0.010	mg/kg
1,3-Dichlorobenzene	1.0	µg/L	0.010	mg/kg
1,2 and 1,4-Dichlorobenzene	1.0	µg/L	0.010	mg/kg
m/p-Xylene	1.0	µg/L	0.010	mg/kg
o-Xylene	1.0	µg/L	0.010	mg/kg

µg/L - Micrograms per liter.
mg/L - Milligrams per liter.
RL - Reporting limit.

Table 5-2

Field Analysis
Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions
Former Ramey AFB, Aguadilla, Puerto Rico

Parameter/Method	Calibration QC Check	Frequency	Acceptance Criteria	Corrective Action
VOCs 8021	Initial 5 point Calibration (include all target compounds)	As needed	RSD< 20%	Reanalyze. If still unacceptable, perform instrument maintenance and repeat.
	Continuing Calibration Verifications (include all target compounds)	Daily, after every 10 samples and at the end of the analytical sequence	RSD < 15%	Reanalyze. If still unacceptable, prepare and analyze fresh standard. If still unacceptable, repeat initial calibration.
	Method Blank	Daily and after every 20 samples	<PQL	Reanalyze. If same, identify source, correct problem, reanalyze.
	Laboratory Control Sample (LCS)	1 per sample batch, same matrix as samples.	See Table 5-3[a]	Reanalyze. If still outside criteria, flag data.`
	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	1 pair per sample batch, minimum 1 per 20 samples.	See Table 5-3[a]	Reanalyze. If still outside criteria, prepare and analyze LCS.
	Field Duplicate	1 pair per sample batch, minimum 1 per 10 sample (as requested)	≤ 35% RPD (soil) ≤ 25% RPD (water)	Reanalyze duplicate samples.
	Analytical Duplicate	Minimum 1 per 20 samples	≤ 25% RPD (all matrices)	Reanalyze duplicate sample.

[a]LCS and MS/MSD spike compound lists are task specific and are based on the target compound list. Table 5-3 lists all compounds that can be spiked. All LCS/MS will be conducted at 20 parts per billion and may be adjusted higher if field sample concentrations are significantly higher.

RSD - Relative/standard deviation.
PQL - Practical quantification limit.
RPD - Relative percent difference.

Table 5-3

Field Analysis Control Limits for QC Samples
Former Ramey AFB, Aguadilla, Puerto Rico

		Matrix Spike/Matrix Spike Duplicate				Laboratory Control Standard/ Laboratory Control Standard Duplicate			
		% Recovery		RPD		% Recovery		RPD	
Method Reference	Parameter	Water	Soil	Water	Soil	Water	Soil	Water	Soil
Volatile Organics									
Halogenated Hydrocarbons – 8021	Bromoform	65-135	60-135	20	20	65-135	65-135	20	20
	Bromomethane	65-135	60-135	20	20	65-135	65-135	20	20
	Carbon tetrachloride	65-135	65-135	20	20	65-135	65-135	20	20
	Chlorobenzene	65-135	65-135	20	20	65-135	65-135	20	20
	Chloroethane	65-135	65-135	20	20	65-135	65-135	20	20
	Chloroform	65-135	65-135	20	20	65-135	65-135	20	20
	Chloromethame	65-135	65-135	20	20	65-135	65-135	20	20
	Dibromochloromethane	65-135	65-135	20	20	65-135	65-135	20	20
	1,3-Dichlorobenzene	65-135	65-135	20	20	65-135	65-135	20	20
	1,2-and 1,4-Dichlorobenzene	65-135	65-135	20	20	65-135	65-135	20	20
	1,1-Dichloroethane	65-135	65-135	20	20	65-135	65-135	20	20

Table 5-3

Field Analysis Control Limits for QC Samples
Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Method Reference	Parameter	Matrix Spike/Matrix Spike Duplicate				Laboratory Control Standard/ Laboratory Control Standard Duplicate			
		% Recovery		RPD		% Recovery		RPD	
		Water	Soil	Water	Soil	Water	Soil	Water	Soil
Halogenated Hydrocarbons – 8021 (Continued)	1,2-Dichloroethane	65-135	65-135	20	20	65-135	65-135	20	20
	1,1-Dichloroethene	65-135	65-135	20	20	65-135	65-135	20	20
	trans-1,2-Dichloroethene	65-135	65-135	20	20	65-135	65-135	20	20
	1,2-Dichloropropane	65-135	65-135	20	20	65-135	65-135	20	20
	cis-1,3-Dichloropropene	65-135	65-135	20	20	65-135	65-135	20	20
	trans-1,3-Dichloropropene	65-135	65-135	20	20	65-135	65-135	20	20
	Ethylene dibromide	65-135	65-135	20	20	65-135	65-135	20	20
	Methylene chloride	65-135	65-135	20	20	65-135	65-135	20	20
	1,1,2,2-Tetrachloroethane	65-135	65-135	20	20	65-135	65-135	20	20
	Tetrachlorethane	65-135	65-135	20	20	65-135	65-135	20	20
	1,1,1-Trichloroethane	65-135	65-135	20	20	65-135	65-135	20	20
	1,1,2-Trichloroethane	65-135	65-135	20	20	65-135	65-135	20	20
	Trichloroethane	65-135	65-135	20	20	65-135	65-135	20	20
	Trichlorofluoromethane	65-135	65-135	20	20	65-135	65-135	20	20

Table 5-3

Field Analysis Control Limits for QC Samples
Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Method Reference	Parameter	Matrix Spike/Matrix Spike Duplicate				Laboratory Control Standard/ Laboratory Control Standard Duplicate			
		% Recovery		RPD		% Recovery		RPD	
		Water	Soil	Water	Soil	Water	Soil	Water	Soil
Halogenated Hydrocarbons – 8021 (Continued)	Vinyl chloride	65-135	65-135	20	20	65-135	65-135	20	20
Aromatic Hydrocarbons – 8021	Benzene	65-135	65-135	20	20	65-135	65-135	20	20
	Toluene	65-135	65-135	20	20	65-135	65-135	20	20
	Chlorobenzene	65-135	65-135	20	20	65-135	65-135	20	20
	Ethyl benzene	65-135	65-135	20	20	65-135	65-135	20	20
	1,3-Dichlorobenzene	65-135	65-135	20	20	65-135	65-135	20	20
	1,2 and 1,4-Dichlorobenzene	65-135	65-135	20	20	65-135	65-135	20	20
	m/p-Xylene	65-135	65-135	20	20	65-135	65-135	20	20
	o-Xylene	65-135	65-135	20	20	65-135	65-135	20	20

RPD - Relative percent difference.

5.10 Field Analysis Procedures

Field analysis procedures such as the analysis of groundwater or surface water samples for monitored physical parameters (temperature, pH, and conductivity) and use of organic vapor monitor instruments to "field screen" headspace vapors of soil or water samples are commonly performed. These analysis data are recorded and documented as part of the sample collection log, well sampling log, or FADL.

Because the instruments used to perform such analysis are designed for field use and are relatively stable in fluctuating field environments, daily calibration checks should be a sufficient indicator of performance. Calibration checks are performed by the manufacturer's recommended method or SOP and usually consist of a linearity check of the instrument reading while analyzing single-point or multiple-point standards of known concentration or value. If the instrument reading is inconsistent with the reference value, the instrument calibration will be adjusted or the instrument will undergo maintenance or replacement, if warranted. Instrument calibration checks and maintenance activities are documented on project data forms and placed in the permanent field data record file.

In addition to field meters, other instrumentation and/or field test kits such as those from Hach or immunoassay tests may be used to generate on-site data. Hach test kits are usually specified in task work plans to measure water quality parameters such as ferrous iron, sulfide, dissolved oxygen (DO), or alkalinity where a field meter may not exist or off-site laboratory results may not provide the accuracy required. Immunoassay test kits are used to generate soil sample screening data for a variety of organic compound types and are semiquantitative in nature. Both types of kits use chemical reagents and some type of quantification meter to analyze the tested sample aliquot. The kit manufacturer produces explicit step-by-step instructions that must be followed consistently by the field analyst. The IT project chemist will review the purpose of the kits, the procedures for analysis, and assist in the development of analysis-specific check list forms that incorporate the manufacturer's procedures and any additional project-specific QC procedures. These forms would be developed during plan preparation and be incorporated with the example forms presented in the task work plan appendix. Text will be included in the task-specific work plan to address the off-site confirmation analysis strategy and include a frequency of analysis and sample selection criteria.

For Hach kits, duplicate analysis should be periodically performed to assess precision. Blank analysis and the analysis of check standards should be performed as applicable. The instrumentation used to complete the quantification should be calibrated daily or be checked daily against standards as required by the manufacturer. All results will be recorded on reporting forms that include the documentation of the QC checks performed. For immunoassay kits, duplicate analyses, blanks, and calibration checks shall be performed routinely at a frequency assigned in the task-specific work plan and documented on the appropriate pre-designed result summary forms. All completed forms will be reviewed in the field by a peer or task leader and by the project chemist during preparation of the draft report, and discussed in the associated QCSR.

6.0 Sample Collection and Data Acquisition

It is the intent in this section of the SAP to identify and describe the pertinent quality aspects of the anticipated sampling types/approaches that will be implemented to support Former Ramey AFB environmental activities. This section includes a general discussion of planning steps, as well as a broad range of specific sampling procedures including: soil/sediment, groundwater, and surface water sampling. This section includes a detailed discussion of sampling documentation, field data recording, and data flow procedures. This section of the SAP also discusses field quality topics such as equipment decontamination procedures; sampling containers, preservation, and holding time requirements; and specific field QC sample requirements, including the sample types, purpose, and frequency.

During the establishment of project DQOs, situations may be identified where specialized procedures are needed to address task-specific sampling activities that fall outside the scope of this SAP. In these cases, the task manager must rely on the guidance in this SAP, EPA documents, and in the USACE document EM 200-1-3 to determine the most appropriate method and address the specific quality concerns related to those special procedures. The task-specific work plan will then describe the selected method and its related quality concerns identified through the DQO process.

6.1 Overview of Sample Collection Procedures

During task-specific planning and DQO planning, careful thought should be given to the design of the sampling program. This includes an evaluation of not only the currently planned, intended use of the data, but possible future use as well. This is accomplished primarily through a thorough definition of the task scope of work and evaluation of anticipated future needs. When the scope and future needs are well defined, then the objectives for the sampling program can be established to meet these task needs. Once the sampling objectives are known, the fundamental questions of sample method selection, the actual field procedures to be implemented, the spatial or timed frequency of collection, and total sample population can be determined and discussed in the task-specific work plan. Included in this SAP are some of the generalized approaches and quality concerns associated with the individual sample collection procedures, field QC samples and their sampling procedures, sample handling and documentation, and equipment handling

along with calibration. References to these generalized approaches should be incorporated as appropriate into the sampling sections of the task-specific work plans, with supplementary text added to address additional task-specific issues.

The following considerations from the basis for each site-specific sampling program:

- Selection of sampling points
- Frequency of sampling
- Methods of sampling to be used
- Media to be sampled
- Number of samples to be collected
- Volume of samples to be collected
- Types and kinds of analyses to be performed in the field
- Types and kinds of analyses to be performed at the laboratories
- Sample turnaround time
- Procedures and precautions to be followed during sampling
- Methods of preservation and shipment.
- Holding time.

Sampling will be conducted frequently enough to satisfy all program objectives. The methods used during sampling will preserve the integrity of the material parameters. Field procedures for sample collection and analysis are presented in the SAP.

Any sample obtained during the field sampling should be representative of the sample location and free of contaminants from sources other than the immediate environment being sampled. The equipment and techniques that will be employed to obtain representative samples will be in accordance with procedures specified in the SAP.

Proposed sample matrices include: soils, sediment, surface water, or groundwater. Sample collection will be accomplished using standard EPA-approved methods and protocols by experienced and trained IT personnel. Sample technicians selected to collect and document samples will review with the task manager and/or field coordinator the requirements of this SAP, the task work plans and field sampling plans, and reference documents. Technicians will also review the operation and calibration procedures and manufacturer's instructions for field analytical instruments such as vapor analyzers, field meters, and test kits before use. Task managers and the field coordinator will take responsibility for overseeing the implementation of

sample collection activities and will review project-specific documents with all technicians before initiating these activities.

Copies of example forms referenced and discussed in the following sections are included in Appendix B.

6.1.1 Surface and Subsurface Soil Sampling and Logging

Surface and subsurface soil samples may be collected and analyzed for chemical and/or physical parameters and the data used to meet the task objectives, which may include risk assessment. Soil samples may also be collected from stock piles that have been generated as part of an IM at a site to determine disposal options based on hazardous material classification. This section provides the general details for collection of soil samples.

Surface soil, at depths between 0 and 12 inches, will be collected using a split-spoon sampler, hand auger, spoon, trowel, or scoop. Borings advanced for subsurface soil samples greater than 1-foot depth will be advanced using hollow-stem augers or by steel hand augers, direct-push sampling probes, split-core samplers, or portable power augers. If hollow-stem augers are used, it will be in accordance with ASTM Method D-1452. If a power auger is used, it will be used only to advance the boring to the desired depth and not to collect samples for chemical analyses. All soil sampling equipment that may come into contact with samples or sampling surfaces will be constructed of stainless steel.

A soil sample collection log will be completed for each sample. All soils will be described using the Unified Soil Classification System (USCS) soil taxonomy nomenclature. For surface soil samples, the soil description will be kept on the soil sample collection log. HTRW drilling logs as used by the USACE will be kept for soil borings that have been advanced to depths greater than 3 feet.

Thorough and detailed documentation of the procedures used to collect the samples in the field is of great importance to the project. Section 6.3.3 discusses the sample collection forms that are used to document the sample location, identification, type, and number of sample bottles filled; any additional QC samples collected in conjunction with the field sample; and the field notes of the sampling technician used to record the actual conditions encountered. The information

required to complete these forms must be recorded by the technician in the field during sample collection and should be peer-reviewed by other technicians before leaving the sampling location. Following this procedure will help ensure that the field data recorded are accurate and complete for each sample collected. In areas of the form that require observations and notes to be recorded by the technician, an effort to record factual, observed characteristics such as a visual description, odor, surrounding area, and problems encountered in collecting the sample will be made. The technician must use judgement to record observations that are based on what actually occurred or was observed and not what was inferred or interpreted (e.g., sample odor or visual inspection indicated chemical contamination).

Method 5035. To comply with the EPA SW-846 Update III Method 5035, IT will use a self-sealing, headspace-free coring device such as the EnCore sampler manufactured by EnNovative Technologies whenever VOCs are part of the analysis program. The individual task work plans will specify if both high range (i.e., when compound concentrations are expected to exceed 200 micrograms per kilogram [µg/kg]) and low range (i.e., when concentrations are expected to fall within 5 to 200 µg/kg) analyses are needed. At a minimum, at least two, 5-gram capacity samplers will be collected. If both high- and low-range analyses are planned, a total of four, 5-gram samplers will be collected.

Each EnCore sampler will be filled to capacity from the soil collected in the soil sampling device using the EnNovative Technology stainless-steel T-handle. The position of the sampler plunger's o-ring will be checked frequently during filling to verify that the sampler is completely filled with soil. Once filled, the technician will check to ensure that no residual soil extends out from the open end of the sampler's core barrel and that no rocks or vegetative material has been included in the sampled volume. Any residual soil, rocks, or vegetation may be removed using a decontaminated sampling spoon or spatula. Paper toweling or dry wipes will be used to clean the outside contact surfaces of the sampler's core barrel of any residual soil to ensure a tight seal before the EnCore cap is applied. The position and seal of the cap will be checked as recommended in the manufacturer's instructions (provided with each sampler).

Once the samplers are capped and sealed, each device will be individually sample numbered using the manufacturer's provided sample labels. Completed sampling devices will be sealed in a foil ziplock bag (provided by EnNovative Technology) and the completed sample label will be

affixed to the outside of this bag. For moisture protection during shipment, the foil bag will be sealed into an outer plastic ziplock bag and placed into a cooler on ice and chilled to 4°C upon collection. All EnCore samplers must be prepared for same-day laboratory shipment as all VOC samples collected by Method 5035 must be extracted within 48-hours of collection. With this restriction, no soil VOC samples can be collected on Saturday or Sunday, but the laboratory will accept and prepare VOC samples on Saturday for soils collected on Friday.

Using the EnCore samplers does not require field decontamination of the sampler and no equipment rinsate samples are required for VOC analysis. Additional quality assurance is discussed in Section 6.1.6.

Due to the potential problems associated with shipping of samples, it may become necessary to preserve VOC samples in the field. Field preservation would increase the holding time of the VOC sample and allow more time for sample shipment. If this becomes necessary, the EnCore sampling procedures described above may not apply to the soil samples collected and the SAP will be updated to include the alternative procedures.

Surface Soil Sampling. Before collecting a surface sample, nonrepresentative debris such as rocks and vegetative material will be cleared from the immediate area. After the sample is collected, the soil will be homogenized as thoroughly as possible in a stainless-steel bowl. Samples for VOC analysis will not be homogenized, but instead will be directly collected from the sampling device using the EnCore sampler(s). Vapors from surface soil samples may be field screened using an organic vapor meter or analyzed via headspace analysis method as described in Appendix D. Samples collected for chemical analysis will be placed in the appropriate sample containers, labeled for proper identification, and packed in a cooler with ice pending shipment to the laboratory. The criteria for sample selection will be documented on the FADL and notes as to location, identification, methodology, analysis program, and other information will be recorded on the soil sample collection log.

To be representative of the matrix, the sample must be free of excess vegetation or rock. These can be removed using a sampling spoon during the sample mixing step. Sample technicians must be careful not to handle the sample with gloves to avoid phthalate contamination. Special care must be taken with soil and sediment samples for volatile compound analysis not to cause

volatilization and loss of compounds through agitation of the matrix during collection. This will be prevented if sampling precautions are taken and the material is transferred directly from the sampling device into the designated sample bottle or EnCore device(s). To maintain representativeness, samples collected in the field must be placed in a dedicated sample ice chest, on ice, and chilled to 2 to 6°C from the time of collection until receipt by the laboratory for analysis.

If collection techniques are performed that require compositing or mixing, the EPA quartering method presented in *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* (QAM), Revised May 1, 1996 (EPA, 1996) will be implemented. A copy of this document will be available on site for review. This method includes the following procedures:

- Extrude the sample from the sampling device.
- Place sample in a glass or stainless-steel mixing bowl.
- Divide into four equal quarters using a stainless-steel spatula or glass rod.
- Mix each quarter individually.
- Combine the quarters into a central composite.
- Redivide the sample into four equal quarters and repeat procedure until the soil is homogenized as much as possible.
- Withdraw aliquots from the four quarters equally to fill each sample container.

It is strongly recommended that this procedure be used especially in cases where field duplicate or split samples are performed. <u>This procedure is not to be performed on samples requiring VOC analysis</u>. VOC samples will be collected into the EnCore sampler(s) directly from the sampling device, as previously described.

All equipment used for collection, transfer, and homogenization will be properly decontaminated before collecting samples and between sampling locations, as described in Section 6.1.7.

Excavation Confirmation. The excavation confirmation sample is a particular type of surface soil sample. This is a soil sample collected from the surfaces of an excavation and is usually used to characterize the extent of the excavation to judge completeness. The surfaces sampled may consist of the excavation floor, sidewalls, or perimeter, and as such, exact sample locations may be slightly different than traditional surface soil samples. The task-specific work plan will describe the number and the relative position of the excavation confirmation samples on a case-by-case basis, as this will vary with the size and shape of the excavation pit. The text must describe the process for establishing a representative sample location and whether the sample collected will be a grab sample submitted for individual analysis or an aliquot of a larger composite sample. Supplementary confirmation samples may be required if additional excavation is performed based on the results of the first round of confirmation samples. The task work plans must include a sampling strategy to address how these supplemental samples will be collected.

Subsurface Soil Borings and Direct-Push Locations. Two types of soil borings will be used to determine subsurface contamination: shallow subsurface (less than or equal to 5 feet deep) and deep subsurface (greater than 5 feet deep). Because the intended use of the data is different for these types of borings, different techniques will be implemented to collect them. Shallow subsurface borings will be advanced and sampled to assess contamination in the vadose zone at a single point. They shall be collected manually using a hand auger or split spoon or by mechanical means such as a portable power auger or direct-push rig. Deep subsurface soil borings will be advanced to sample multiple depths at a single location to investigate the vertical extent of contamination in that location. Drill rigs, powered augers, or direct-push rig will be used to drill and sample these deep subsurface samples.

All soil borings will be logged on USACE HTRW forms and will be completed in accordance with ASTM Method D 2488 using the USCS soil taxonomy. Soil samples will be continuously collected from 6 inches below the surface to the water table. Some soil may be collected below the water table, to determine soil characteristics. The entire length of the sample collected from the sampler will be field screened for the presence of organic vapors using a hand-held organic vapor monitor and the soil will be visually classified. Depending on task- specific objectives, the headspace vapors of an aliquot of the collected soil may also be measured by the headspace screening procedure summarized in Appendix D. All soil screening and classification procedures

will be detailed in the task work plan. The depth interval and reading in units of parts per million (ppm) will be recorded on the HTRW log for any portion of the sample where organic vapors are detected. Soil collected for VOC analysis or headspace screening shall be collected directly from the split spoon into the EnCore sampler(s) as soon as possible after the spoon is opened. If required, the remaining soil shall be transferred to a stainless-steel or Pyrex® container and thoroughly mixed by the quartering method before subsequent sample containers are filled.

Samples for chemical analysis will be placed in the appropriate sample containers, labeled for proper identification, and packed in a cooler with ice pending transport to the site office and laboratory shipment.

To supplement the HTRW log, a soil sample collection log will be completed for each sample collected from deep or shallow borings, and will provide the following information about the sample: location and identity, data sampling team members, soil boring number, sample number, screening results, sample depth interval, analytical parameters, sample containers, QA/QC information, and any comments or observations.

All soil cuttings generated during the drilling of deep subsurface soil borings will be handled in accordance with IDW disposal procedures outlined in the task work plan. The specific sampling and analysis program for the IDW from each site will be addressed in the task-specific work plans.

Soil Samples for Geotechnical Analyses. Selected soil samples may be collected for geotechnical analysis. All soil and sediment samples collected and submitted to the laboratory for chemical analysis will also undergo a moisture content analysis (ASTM D2216) to allow the laboratory to report results on a dry weight basis. In addition to this analysis, certain samples may be submitted for geotechnical analyses that may include one or more of the following:

- Sieve analysis (grain size with hydrometer) - ASTM D421/D422
- Atterberg limits - ASTM D4318
- Moisture content - ASTM D2216.

The numbers of samples to be submitted for geotechnical analysis are summarized in the task-specific work plans.

6.1.2 Sediment Sampling

Sediment samples may be obtained from the bottoms of surface water features such as ponds, creeks, ditches, or sumps with sample collection devices such as an Eckman dredge, sludge sampler, or bucket auger. Also, some sediments may be collected from areas with no surface water present using spoons, split spoon, or bucket auger. The sample technician should assess the entire area and unless the sample location is predefined in the task work plan, he should use his judgment on selecting the most representative location. The samples will be analyzed for chemical and/or physical parameters and the data used to meet the objectives of the task, which may include risk assessment. All sediment sampling equipment that may come in contact with samples or sampling surfaces will be constructed of stainless steel and will be properly cleaned and decontaminated as described in Section 6.1.7 before collecting samples and between sampling locations. Collected sediment samples will be handled in a similar way as surface soils in that VOC aliquots will be collected directly from the sampling device using the EnCore sampler(s). Remaining sediment will be transferred to a stainless-steel mixing bowl and any free water will be decanted from the collected sediment samples, if possible. The homogenized solid sample will be transferred from the mixing bowl into the appropriate container for each requested analysis. Sample container specifications are discussed later in this section. After collection, the samples will be packed in coolers with ice and chilled to 4°C until sample shipment.

In cases where sediment and surface water samples are to be collected at the same sampling location, the surface water sample will be collected first, followed by the sediment sample, to avoid disturbing the sediment and possibly biasing the surrounding surface water with suspended sediment. The location, identity, sampling method, analytical requirements, and sample collection observations will be recorded using the soil sample collection log.

6.1.3 Groundwater Sampling

Groundwater samples will be collected from existing or newly installed monitoring wells and direct-push points. The samples will be analyzed for chemical and/or physical parameters and the data used to meet the objectives of the task, which may include risk assessment. If samples are collected from monitoring wells, a well development/purge log and groundwater sample

collection log will be completed for each sample. A groundwater elevation log is used to record the static water level and total depth (when required) and note the general condition of the well. Only a groundwater sample collection log is usually used to document direct-push samples because these locations are not typically purged or developed before sampling. Proposed and existing groundwater monitoring well and direct-push locations will be shown in the site map figures presented in the task-specific work plans. The analyses to be performed on samples collected from each of the wells and direct-push points will be identified in tables located in these documents.

To address potential concerns about the sample collection method used to collect groundwater samples from monitoring wells at the Former Ramey AFB, a SOP is included in Appendix D. This SOP provides specific procedures on how the monitoring wells will be purged and groundwater samples collected either using a low-flow peristaltic pump, submersible pump, or using a disposable bailer. This SOP is to be used throughout the Former Ramey AFB for sampling all installation wells. If field conditions are encountered that require an alternative sampling approach, the encountered conditions will be reviewed and the best approach will be decided by the task leader after consultation with appropriate members of the Former Ramey AFB project team and the USACE. The decision to use an alternative method, other than by pump or bailer, will be recorded as a project variance.

Prior to collecting groundwater samples, a review of previously collected well information and analytical data will be performed. A master summary table will be prepared that includes all wells to be sampled, known information about the well (well depth, purge volume, history), and planned QA/QC sample locations. This list will summarize the specific analytical program to be performed for each well location. Groundwater sampling will be conducted from the areas assumed to be least contaminated to the areas assumed to be most contaminated based on this review of historical data and contaminant plume maps. The sampling sequence will be provided on the master list. All sampling and purging equipment (pumps, tapes, discharge piping) will be decontaminated before use and before each successive use in accordance with the decontamination procedures in Section 6.1.7. Decontamination notes will be made on the master list.

Direct-Push Groundwater Locations. Frequently during site investigations, direct-push techniques are used to gain access to the groundwater for sample collection. Data from these samples are then used to determine the best sample locations and depths for more definitive samples to be collected from monitoring wells that are installed later. In this role, the data quality objectives for these samples would be considered a "screening" quality level and often they are analyzed in an "on-site" laboratory situation.

At the Former Ramey AFB, direct-push groundwater sampling methods is not anticipated generally because groundwater is too deep for this method. If this method is used, it will include using extended tip and a "dual wall" screen approaches to gain access to the groundwater for sampling. If the site hydrogeologic conditions warrant and the location is not producing an adequate volume of water to sample quickly, a temporary direct-push groundwater sampling point may be installed into the boring as an alternative. This point will consist of a 1-inch diameter PVC riser pipe and 5-foot screen. If necessary, a pre-packed wells screen may be used to prevent excessive formation materials from entering the wellpoint. After the wellpoint has been installed, the upper 2 feet of the hole will be filled with bentonite and topped with a few inches of grout to prevent surface water from entering the screen. Groundwater samples will be collected within 24-hours of the installation if possible. This time should be sufficient to allow groundwater to accumulate in the wellpoint. Before sampling, stagnant groundwater in the point will be purged until water clarity improves and at least approximately one pipe volume of water has been removed. Purging and sampling of the well point will be accomplished using teflon-lined tubing and a peristaltic pump. Sample collection, documentation, and packing will be performed using the same general procedures as monitoring well groundwater samples.

Groundwater Sampling Procedure. Sampling of newly installed monitoring wells will take place no sooner than 14 days after well development has been completed. Reference Appendix D for the monitoring well sampling procedures to be used when collecting samples using pumps and bailers. The following are specific QA/QC considerations when implementing this SOP.

As is the case with all environmental samples, complete and accurate documentation of the field data recorded in conjunction with water sampling activities is of the utmost importance. This is particularly true of groundwater sampling where the sampling technician must measure and

record physical parameters of the groundwater during well purging to help assess when the well is ready to be sampled. A groundwater sample collection log and groundwater well development/purge log sample collection log, which are discussed later in this section, have been designed for use in collecting these samples and provide space for the technician to record field measured values during collection. Use of these log forms prompts the technician to record field information. Due to the possible variability of sampling technique because of the encountered conditions, thorough documentation by the technician of the actual sampling method used is imperative for maintaining data comparability. It is highly recommended that the technician who records the information on the form have that information peer-reviewed and verified by another technician involved in collecting the sample at that location before leaving the area. Implementation of this practice will help eliminate recording errors and improve overall field data quality.

To collect groundwater samples from a well, certain basic information must be provided to the sampling technician. The master well list will summarize the following:

- Type of well to be sampled - well depth and diameter, depth to water, aquifer sampled
- Condition of the well - e.g., slow recharge, located in contaminant plume
- History of the well's groundwater - e.g., organic layer observed, high turbidity
- Data from previously monitored field sampling parameters - pH, temperature, conductivity, turbidity, DO
- Analytical program.

Many of these items will be recorded on the well development/purge log and the groundwater sample collection log, which prompts the technician to confirm and record each of these important observations before and during sampling. The master well list will also be updated after each sampling event to include the most recent information recorded about the well conditions or ability to collect samples. Sampling technique and selected equipment may then be altered because of the conditions encountered and recorded on the log.

A primary concern in collecting groundwater samples is avoiding potential high bias by artificial contamination. Groundwater samples generally contain a very low concentration of contaminants and, as such, are susceptible to trace contamination biases. Good field practice includes the following:

- Remove obvious sources of contamination away from the sample location area such as vented fuel tanks, exhausts, and motors.
- Use caution when handling gasoline. Fill gasoline powered equipment no less than 50 feet away from sample containers and supplies. Use disposable gloves when filling equipment with gasoline.
- Thoroughly decontaminate and properly store all reusable sampling and measuring equipment.
- Use clean outer gloves during well purging and immediately before sampling.
- Use plastic sheeting to provide a barrier between the ground and the sampling area to prevent contact.
- When sampling flush-mounted wells, the sampling team will take precautions to prevent water or debris falling into the well. Flush-mounted wells will be recapped as soon as possible after removing pump and/or tubing.

The sampling technician must also be aware of the condition of any equipment entering the well including sampling devices, water level measurement tapes, field instrument probes, or purging pumps and tubing that may introduce an outside source of contamination into the well's groundwater. The technician should note the condition of any instruments and sampling equipment used on the sample collection log during sampling.

Because most groundwater samples contain only trace level contamination, any possible analyte loss incurred when collecting or handling the sample may result in a measurable low bias. The sampling technician must be aware that any excessive turbulence introduced into the sampling stream may lead to the volatilization of organic compounds in the sample. Whenever samples are collected for a list of parameters, the following collection order will be generally used: VOC, field measured parameters, semivolatile organic compounds (SVOC), pesticides/ PCBs, metals, and then miscellaneous parameters unless a different collection order is specified in the task

work plan. Note for low flow peristaltic pump sampling, the sample collection order will be reversed, with VOCs collected last directly from the groundwater trapped in the pump inlet tubing. Immediately after collection, the prelabeled samples should be sealed and volatile samples should be checked for headspace. If bubbles are observed in the volatile organic analysis (VOA) vials, additional sample is added and the vial rechecked. Following collection, the sample bottle(s) are enclosed in an outer Ziplock® storage bag, placed on ice in a dedicated sample ice chest and chilled to 4°C (plus or minus 2°C) and maintained at this temperature until the samples are received at the analytical laboratory.

The following procedures will be followed when collecting groundwater samples from all monitoring wells:

- The well will be checked for proper identification and structural integrity.
- After unlocking the well and removing the well cap, an appropriate hand-held organic vapor monitor will be used to measure the concentration or organic vapors at the top of casing and in the breathing zone. If readings are above background, safety precautions outlined in the health and safety plan will be followed. Water quality parameters to be measured in the field during purging include: pH, temperature, specific conductance, and turbidity, DO and redox potential. Other parameters may be monitored as detailed in the work plan. These parameters will be measured either with meters mounted to a flow through cell or probes placed down the well (for DO) or grab sampled (turbidity). If DO is measured by direct reading during purging instead of down the well, precautions will be taken to avoid introducing oxygen to the water before the measurement.
- The depth to water will be measured using a decontaminated water level indicator. This information will be used to calculate the volume of water in the well casing and screen.
- Where recharge rates permit, the well will be purged by low-flow peristaltic or submersible pump or by using a bailer. At least three times the volume of water in the well casing will be removed. Purging shall continue until the parameters have stabilized. Where recharge rates are low, wells will be purged to dry and allowed to recharge. Physical parameters will be measured at least once each well volume.
- If a submersible pump is used, then the pump is decontaminated between sampling and operated so that it does not force air through the water column to generate pressure (this may strip volatiles from the sampled matrix). All groundwater

samples will be collected with a low-flow peristaltic pump whenever possible. If pumps of these types are not available, or are unusable due to an encountered countered condition, a single-use polyethylene bailer will be used. When collecting samples with a bailer, use caution in filling and emptying the bailer to avoid VOC loss through volatilization. If the sample is collected with a pump, the samples will be collected in the order previously described in this section. For those samples collected with a bailer, aliquots for VOCs will be collected first, followed by field measured parameters, SVOCs, pesticides/PCB, and metals as required to fulfill the requirements of the task-specific scope.

- After sample collection, if acid or base preservatives are added in the field, the preserved sample pH will be checked by placing dropwise a small aliquot of preserved sample on the pH strip paper. Except for VOA vials, the preservative will be added to a sample container after collecting the sample. Chemical preservatives are acquired from the laboratory in specially prepared sealed ampules. As each sample is collected, chemical preservatives will be added as specified in Section 6.3.2 and as indicated on the prepared sample label. With exception of VOC analysis, all samples that are preserved will be checked for the appropriate pH using pH paper. Based on the measured pH of the groundwater sample, an extra VOA vial will be collected in the field, and the vial opened and the pH of the extra vial measured to ensure the final pH of the preserved sample is ≤ 2.

- When sampling for VOCs, duplicate samples should always be collected from each location. Sample containers should always be 40-milliliter septum vials equipped with screw caps and Teflon®-lined silicone disks in the cap to prevent contamination of the sample by the cap. The disks should be mounted in the caps by the manufacturer prior to laboratory purchase. Hydrochloric acid (HCl) preservative will also be added by the laboratory during bottle preparation for shipment to the field. During sampling, the VOC vials will be completely filled, with no headspace to prevent volatilization, and extreme caution should be exercised when filling a vial to avoid any turbulence that could also produce volatilization. As a rule, it is best to gently pour the last few drops into the vial so that surface tension holds the water in a "convex meniscus." The cap is then carefully applied and, although some over-flow may be lost, air space in the bottle is eliminated. After capping, the bottle is turned over and tapped to check for bubbles; if any are present, additional sample is added to the vial and the vial is rechecked.

- Sample containers will be labeled with appropriate identifying information (location, date, time, condition, added preservatives, etc.) using the preprinted labels provided by the field coordinator or task leader. Each sample will be logged on a groundwater sample collection log at the time of collection. Sample containers of appropriate volume and composition will be prepared in advance to ensure the

collection of sufficient volumes for all specified analyses including duplicate, split, and MS/MSD aliquots.

- In general, samples for metals analysis shall consist of two separate aliquots, both filtered and unfiltered. The analysis performed on the unfiltered sample aliquot will be representative of the "total" metals concentration present in the groundwater. The analysis of the filtered aliquot will be representative of the "dissolved" metals concentration. Proper purging of wells using the low flow peristaltic pump SOP will yield low turbidity (less than 20 nephelometric turbidity unit (NTU) for nonmetals analysis samples and 10 NTU for metals) samples. Sample filtering to determine dissolved metals will be performed in the field using a single-use disposable inline 0.45 millimeter filter. Both filtered and unfiltered aliquots will be preserved with nitric acid to a pH of less than 2 in the field upon collection. Dissolved metals will not be analyzed and reported without a corresponding analysis for total metals for comparison.

- All sample containers will be transferred immediately upon collection to an ice chest, kept on ice at 4°C plus or minus 2°C, and delivered to the laboratory in a timely manner. If solid samples are submitted for metals analysis only, then ice will not be used. For some general chemistry analysis, the samples must be delivered to the laboratory within 24 hours to avoid exceeding the holding time. Otherwise, all other samples must be shipped from the field within 48 hours of collection unless special field holding requirements are described in task-specific work plans.

6.1.4 Surface Water Sampling

Surface water samples may be collected from standing water in the ditches, creeks, ponds, and seeps located at the Former Ramey AFB. The collected samples will be analyzed for chemical and physical parameters and the data used to meet the task objectives, which may include risk assessment. The sampling points will be selected to obtain information related to surface water and groundwater interactions and to detect residual contamination in basins used to contain potentially hazardous constituents. The proposed sampling locations will be discussed in the task-specific work plans.

Surface Water Sampling Equipment. The equipment that may be required for surface water sampling includes:

- Shallow draft row boat and safety flotation vests

- Pyrex ladle, Teflon dipper, or glass beaker, or Wheaton subsurface water sampling apparatus or similar apparatus
- Nylon rope
- pH, temperature, turbidity, and specific conductance meters
- Appropriate sample bottles and ice chest with ice
- Plastic sheeting
- 5-gallon buckets with lids.

Surface water sampling, like groundwater sampling, is also generally considered to be "trace level" in nature. Many of the same quality concerns, such as representativeness and introduction of bias either from contamination or analyte loss, are also of immediate concern when collecting surface water samples. In addition to these issues, the sampling technician who collects surface water samples must also be careful to thoroughly document the following:

- Location of the sample in the body of water sampled
- The presence or absence of possible interfering surface water features such as:
  - Tributaries
  - Outfalls
  - Disturbances (eddies, rapids, falls)
- Sample collection method
- Physical description of the collected sample
- Water depth
- Measured field parameters.

Use of the sample log should prompt the technician to investigate these conditions that may impact the selection of sampling location, technique, or equipment.

To collect a representative sample of a stream or canal, the technician must also take into account the approximate depth and width of the body at the anticipated location. EPA provides guidance

on the selection of sampling points and compositing techniques in the EPA SOP/QAM document. For most locations where the depth and width of the stream is not great, a single sample collected in midstream is usually sufficiently representative. Use of a water grab-sampling device that allows the technician to submerge a sample collection vessel just beneath the surface so that surface water flows into the collection device is recommended. In cases where surface water and sediment samples are to be collected in the same location, the surface water will be collected first, followed by the sediment sample to avoid undue disturbance of the sediment and possible contaminant release into the surrounding surface water.

A representative sample for water quality testing will be collected at each surface water sampling location. The following sample collection procedures will be used to collect these samples:

- All equipment will be decontaminated as per Section 6.1.7, and will be protected from contact with foreign materials and contamination through use of clean plastic sheeting.
- Grab samples will be collected using a Teflon or stainless-steel sampling device. Where pond samples are being collected, the mouth of the sample collection device will be maintained completely under water, when possible. Note that chemical preservatives will not be added until the sample aliquots for analysis are transferred from the collection vessel to the sample collection jars.
- Sample handling requirements will be generally the same as for groundwater samples.
- At the time of sampling, after collection of the sample for chemical analysis, a second sample will be collected, analyzed for water quality parameters, and the field data recorded.
- pH will be analyzed immediately after collection.
- Sample containers will be completely filled with water, wiped clean and dry, labeled with a preprinted label, and stored for shipment. Identifying information will include the project name and number, time, date, matrix, sampler's initials, added preservatives, required analyses, and identification number, as specified in Section 6.3.1.
- Sampling information including instrument readings for temperature, pH, conductivity, and additional parameters such as turbidity as required in the work plan will be

logged on field forms at the time of collection. The labeling and logging requirements specified in Section 6.3.1 will be met.

- All sample containers will be transferred to an ice chest, kept on ice at 4°C plus or minus 2°C, and delivered to the laboratory in a timely manner. For general chemistry analysis, the samples must be delivered to the laboratory within 24 hours to avoid exceeding the holding time. Otherwise, all other samples must be shipped from the field within 48 hours of collection.

- If filtered metals analysis is required the sample will be collected into a sample container and then filtered.

6.1.5 Ecological Samples

Ecological evaluation techniques can include qualitative field surveys, comparative ecological studies, toxicity assessment/testing, bioaccumulation studies, and biomarker investigations. Each of these techniques contributes a different type of information to the evaluation. Also, although most of these techniques are not invasive, it may be necessary to collect specimens for study and/or chemical analyses. Most of these sampling efforts will be focused on a particular task or investigation and, as such, shall be covered in a task-specific work plan. This work plan should address major quality issues such as determination of representativeness during sample collection, sample collection techniques, field preparation and preservation techniques, analytical laboratory preparation and analysis techniques, and general field and laboratory QC procedures for biota samples.

6.1.6 QA/QC Sampling

As established by the DQO process discussed in Section 3.0, certain field and laboratory QC indicator samples and analyses will be planned to support the task objectives. These samples and analyses will yield critical information concerning the measured quality and usability of the field sample data. Measured quality indicators will include precision, accuracy, and representativeness. Example types of field QC samples collected during a task may include: field duplicates, QA split samples to the USACE laboratory, MS/MSD aliquots, and blank samples. The type and frequency of these QC samples for each investigation will be specified in the task-specific work plans. Consideration will be given during planning to the types of media sampled, the analysis program, the expected duration of the task, and the number of sample shipments or events. Table 6-1 outlines the types of QC samples and the expected frequency.

Table 6-1

Suggested Field QC Sample Types, Matrix, and Frequency
Former Ramey AFB, Aguadilla, Puerto Rico

QC Sample Type	QA Sample Matrix	Applicable Field Sample Matrix	Analysis Program	Frequency
Field Duplicates	Same as the field sample matrix	All	Same as the corresponding field sample	1 in 10 (10%) or as specified in task work plan
USACE QA Split Samples	Same as the field sample matrix	All	Same as the corresponding field sample	1 in 10 (10%) or as specified in task work plan
MS/MSD	Same as the field sample matrix	All	Organic compounds, metals, and ion chromatography parameters	1 in 20 (5%) or as specified in task work plan
Trip Blanks[a]	Water	Water	VOCs only	1 per shipment or ice chest that contains aqueous VOA samples
Equipment Rinse Blanks	Water	All	Same as the corresponding field sample	Per event or as specified in task work plan
Material Blank	Varies[b]	All	Same as the corresponding field sample	As specified in task work plan (or annually for the DI water filtration system)

[a] Trip blanks are required only if water matrix samples for VOC analysis are collected.
[b] Material blank samples will consist of an unused or unexposed sample of the media used to collect the sample (e.g., the source water or chemical reagent source) and, therefore, may be of any media.

DI - Deionized.
MS/MSD - Matrix spike/matrix spike duplicate.
QA - Quality assurance.
QC - Quality control.
VOA - Volatile organic analysis.
VOC - Volatile organic compound.

When these QC samples are specified in the task work plan to be collected, the field investigation personnel will review the requirements of the plan, and select the sites where these samples will be collected to meet the planned frequency. The selected sites may be chosen randomly, every tenth sample for example, or may be selected based on historical data or field indications of the potential contamination present. It is recommended that field duplicates and field split QC sample locations be selected based on the probability that the samples will contain moderate to high concentrations of the targeted analytes so that the resulting analytical data will be able to yield a valid precision estimate. Equipment rinsate blanks, if required, are recommended to be collected after the expected highest concentration location has been sampled to assess cross-contamination under the most likely conditions. A representative location of the matrices tested will be selected for the MS/MSDs and should contain relatively low concentrations of the site contaminants so that the laboratory applied spikes can be adequately quantified. In all cases, the specific location where the field QC sample is collected is always recorded on the sample collection log by the sampling technician during collection. Allowing the field personnel to select the location allows for a more representative sample take and prompts the field personnel to collect the additional sample volume necessary to perform the multiple analyses specified.

If a deionized (DI) water system is used, daily inspection and quarterly maintenance will be performed on the system to ensure analyte-free water is being produced. If a DI system is not available, DI water will be purchased from an IT-approved vendor and shipped to the site. Material blank samples from the DI water source will be collected annually or as the source changes and submitted for laboratory analysis as discussed in Section 6.1.6.5.

The information in the following sections defines and describes how QC samples will be collected, identified, and documented. All field QC samples will be given unique sample numbers except for MS/MSD aliquots.

6.1.6.1 Field Duplicates and USACE QA Split Samples

To evaluate sampling and analysis method precision, surface soil, subsurface soil, sediment, groundwater, and surface water samples will be collected as described in the previous sections, homogenized, and split into field duplicates and split samples at a rate of approximately 10

percent. The original field sample and field duplicate aliquots will be sent to the contractor laboratory and the QA split sample will be packaged and shipped to a laboratory designated by the USACE. The QA laboratory will be specified to IT by the USACE chemist prior to project startup. All sets of the samples will be analyzed for the same parameter list by the same analysis methods.

Within each sampling event, at least a portion of the QA split samples will be collected in the same batch as the project MS/MSD samples. This will help ensure MS/MSD data are available to the USACE to meet their data reporting requirements. Each task-specific work plan shall include the mailing address the government QA laboratory that will analyze the QA split samples, and all of IT's contracted laboratories for the project. The task work plan will specify the field duplicate and QA split sample frequencies, matrices, and analytical parameters.

For duplicate or split solid samples not requiring VOC analysis, the solid material will be homogenized in a stainless steel or glass pan or bowl using a spoon, scoop, or spatula, following the "quartering" method discussed in the EPA Region IV SOP/QAM (EPA, 1996). Homogenized samples will then be split into multiple equal fractions, placed into separate sample containers as required, and individually labeled. For duplicate or split solid samples requiring VOC analysis, multiple sets of EnCore sample(s) will be collected separately from the same sample taken at a given location by alternating sampling devices so that each sealed soil amount and will equally represent the sampled medium at a given time. VOC samples will not be homogenized. Split subsurface soil samples collected with a split spoon may require use of a 3-inch-diameter by 2-foot-long split-spoon barrel to obtain the required sample volume. Once the material is visually logged, the soil will be homogenized and split. If inadequate soil volume is collected from the first sample aliquot, multiple sample aliquots from the same depth may be required to fill all required sample containers.

For field duplicate and QA split water samples, the volumes for all three samples will be collected for analysis in the following order: VOCs, other organics, and inorganics. All samples for an analysis must be collected at the same time, alternating VOA vials (if VOCs are included).

For duplicate or QA split samples, the field sampling team will collect double (or triple) volume into separate labeled and identified sample collection containers. With the samples collected in this manner, the field sample technician will be able to use judgment in selecting the most representative location/ for a duplicate analysis and ensure that a sufficient sample volume is collected for analysis.

6.1.6.2 Matrix Spike and Matrix Spike Duplicates

An MS is an aliquot of sample fortified in the laboratory with known concentrations of representative analytes of interest (before sample preparation and analysis). An MS is used to document the analytical accuracy of the method in a given sample matrix. When this is performed in duplicate as an MSD, a second aliquot of the sample is spiked with identical concentrations of target analytes. The MSD data are used to verify the results of the MS and to evaluate the analytical precision of the spiked samples. MS/MSD samples may be required for some events or media at a frequency specified in the task-specific work plans. At least one MS/MSD pair will typically be included for every 20 environmental samples of similar matrix. For solid matrix samples, no homogenization will occur for VOC analysis. Instead, multiple sets of EnCore samplers (i.e., either three sets of two samplers or three sets of four samplers, if both high and low-level analyses are required) will be used to collect the soil directly from the device. For ease of tracking, field samples will be collected, thoroughly homogenized (only if no VOC analyses are required), and placed in separate containers for the original, MS, and MSD. Although the sample will be given a single sample number, each aliquot will be individually designated as the original, MS, or MSD for analysis on the sample label and the analysis request (AR)/COC form. The sample number followed by the "MS" or "MSD" suffix will be recorded on the label and AR/COC forms to indicate the purpose of those aliquots to the laboratory. In this manner, a representative sample may be taken for use in the MS/MSD spike program and adequate sample volume will be collected to perform all of the requested analyses.

The data and the sample collection identity of the split sample(s) will be forwarded to the USACE as requested to meet the USACE minimum data reporting requirements.

Samples submitted for toxicity characteristic leaching procedure (TCLP) extraction by EPA Method 1311 will have associated samples for MS/MSD spiking and analysis collected in the field and provided in the same manner as other samples. Because the TCLP extraction is

susceptible to matrix variabilities, MS/MSDs will be applied to samples of each distinct waste stream type at least once during the program or at the frequency specified in the task work plans.

6.1.6.3 Trip Blanks

Trip blanks are defined as ASTM Type II analyte-free water samples preserved with HCl and filled by the laboratory into 40-milliliter VOA vials and shipped to the sampling site. Upon receipt in the field, the trip blanks are stored along with the VOA vials for water matrix sample collection. A trip blank set is labeled and placed in the ice chest along with the vials used for field sample collection. Trip blank samples follow the aqueous field samples from the time of collection to laboratory receipt and analysis. The purpose of the trip blank is to monitor potential cross contamination of the samples during handling and shipment. Where appropriate, one trip blank shall accompany each cooler containing water samples to be analyzed for VOCs. A trip blank will also be required for all shipments of QA split samples requiring VOC analysis.

6.1.6.4 Equipment Rinsate Blank Samples

To determine the representativeness of the field sampling data, equipment rinsate blank samples will be collected during investigation and monitoring events to verify the effectiveness of sampling equipment decontamination and to monitor the potential for cross contamination between samples. Equipment rinsate blanks are collected from the final analyte-free DI water rinse of the equipment decontamination process during all sampling activities that re-use sampling equipment. Once a piece of sampling equipment is fully decontaminated, analyte-free water is poured over, across, and through all sample collection surfaces and the water is directly collected into appropriate water matrix sample containers. Note for dedicated Teflon tubing used in conjunction with low flow peristalic pump sampling, the tubing will be decontaminated after its previous use and stored sealed with Teflon tape endcaps in a polyethylene bag. If the tubing is stored in a bag for several days, the tubing inside and outside will be rinsed and a rinsate blank will be collected prior to being submerged into a well. An equipment rinsate blank will be collected once per event (at a minimum) on a decontaminated tubing set before sampling.

Equipment rinsate samples are collected at the frequency given in the task-specific work plans, which is generally once per event. To maximize the effectiveness of this blank check, it is recommended that if historical data are available, the equipment rinsate blank be collected immediately after the decontamination of equipment used to collect the potentially highest

concentration samples. If dedicated sampling equipment (e.g., Teflon tubing) is used for each sampling event, rinsate blanks shall be collected at least once per event immediately before collecting the field sample by pumping analyte-free water through this decontaminated tubing. If disposable equipment is used, then no equipment rinsate blanks are required.

6.1.6.5 Material Blanks/Field Blanks

Material blank samples are defined for the purpose of this SAP as a sample of a "clean" reagent source such as a DI water, a chemical reagent source, or sampling medium such as air filter or sorbent cartridge that would represent "analyte-free" or "background" contamination. If material blanks show elevated concentrations of target analytes, the corresponding data set may be considered biased and corrective action implemented to eliminate this bias source.

Material blank samples will be collected from an analyte-free DI water filtration system if available or from the purchased source DI water. If a DI water filtration system is available, a routine maintenance program must be followed to ensure that the water produced is of a known quality. As part of that program, samples from this source are collected at least annually and analyzed for target parameters. Modifications to the routine maintenance are indicated by the results of these material blanks.

It is anticipated that if samples are chemically preserved, preservatives will be made available in sealed ampules. If this is not the case and the reagent must be drawn from a common container, a material blank of the preservative source may be collected and analyzed to verify that the preservative has not become contaminated during use.

As appropriate, other material blanks may be specified in a task-specific work plan.

6.1.6.6 Sample Temperature Verification

To verify that samples have been maintained at 4°C (plus or minus 2°C) during shipment from the field to the laboratory, the temperature of the interior of the cooler will be measured by recording the receipt temperature of a temperature blank. This blank consists of a tap water sample preserved on ice to 4°C during shipping. The temperature blank will be placed in a representative location and covered with ice in the same manner as the shipped field samples. Temperatures monitored in excess of 2°C to 6°C will be flagged in a laboratory nonconformance

report. Corresponding sample data usability will be judged by the project chemist and data coordinator based on the analysis program and the intended use of the data. Application of proper shipping and packing techniques by field personnel will reduce the likelihood of a temperature receipt nonconformance.

6.1.7 Decontamination of Equipment and Supplies

One purpose for defining an equipment decontamination procedure is to ensure adequate steps are taken to remove residual chemical contamination before the equipment is used to collect a sample for environmental analysis. Decontamination procedures are also important in reducing the risk of cross contamination and worker exposure when removing contaminated nonsampling equipment from a contaminated area, as discussed in the health and safety plans. Different levels of decontamination stringency are applied for the different types of equipment used. For sampling equipment used to collect environmental samples, the most stringent program will be required, and it is this program that is the focus of this discussion. For sampling equipment used to collect samples for geotechnical analysis or soil classification and general nonsampling equipment, a simple soap and water rinse or a high-pressure steam cleaning with soap and water should be sufficient to remove contamination. If specific health and safety requirements are imposed that require a further level of decontamination for grossly contaminated equipment, additional decontamination steps may be required. Usually in both cases, an area of the site will be designated as the decontamination area and decontamination supplies, water, and solvents will be staged in the area for use.

Field instruments, such as water level meters and pH and temperature probes that come in direct contact with the sample matrix, will be adequately decontaminated between measurements by detergent solution wash, DI water rinsing, wiping, and final rinsing with DI water. Grossly contaminated or stained probes can be cleaned by dipping the probe momentarily in strong acids such as a 70 percent HCl (muriatic acid) solution. Electrometric probes will be stored between use in a clean environment in the manner specified by the manufacturer. Decontaminated water level meters will be sealed in a clean plastic bag or stored in the original shipping case.

To minimize the possible contribution of even trace levels of contamination from sampling equipment, adequate equipment decontamination must be completed prior to the first use of the equipment (if new) or reuse at a different sampling location. The decontamination procedure

may vary depending on the sample matrix, the analytical program, or the materials or construction of the sampling equipment used; therefore, task-specific work plans should address the specific decontamination procedures. The following general guidelines, however, will be followed:

- ***Post-Sample Collection Cleanup***. After the required samples have been properly prepared at a given sampling location, residual visible soil will be removed as much as possible from the sampling equipment by scraping or shaking. These residues will be handled as IDW. For water sampling equipment, residual water should be drained and placed into a waste container (e.g., groundwater purge water drums) and handled as IDW.

- ***Gross Wash and Water Rinse***. Following the recovery of the sampling equipment to the decontamination area, the equipment will undergo a vigorous brushing with laboratory-grade, phosphate-free detergent in water and will then be rinsed with tap water to remove visible particulate.

- ***Acid Rinse***. If glass equipment is used and metals are part of the analysis program, rinse the interior/exterior surfaces of the glass equipment that will come in contact with the sample matrix with 10 percent nitric acid (HNO_3) solution.

- ***Analyte-Free Water Rinse***. Rinse decontaminated equipment with DI analyte-free water. The water used should be certified as analyte-free by the manufacturer and prepared using filters, an activated carbon bed filtration apparatus, and deionizing resin columns. Water that has been field or laboratory prepared using this equipment and has been sampled, analyzed for target parameters, and verified to contain less than detectable quantities may also be used. For all water sources, verify that the same lot or batch that has been documented as analyte-free is consistently used or that documentation exists for multiple lots.

- ***Solvent Rinse***. Depending on the target VOCs and SVOCs and sampling matrix, rinse the sample with isopropanol and air dry. (If high concentrations of pesticides or PCBs are expected, perform an additional rinse with hexane.) If specific solvents are to be used, they will be discussed in the task-specific work plan.

  All solvents should be certified by the American Chemical Society as reagent grade equivalent where such specifications exist. Solvents must be stored in a secured, health and safety approved storage cabinet. Each solvent container must be tagged with the date of receipt, date opened, and expiration date(s). The expiration date of the solvent will be calculated as 180 days from the date received or 30 days from the date opened.

- ***Second, Analyte-Free Water Rinse***. Rinse the equipment following the solvent rinse again with analyte-free water. Analyte-free water for this rinse is drawn from a secondary container source (such as a Teflon squeeze bottle). (This rinse water may be collected as the equipment rinse sample when such a sample is required.).

- ***Protective Wrap***. Prepare decontaminated equipment for storage by draining all residual DI water from the equipment, then allowing equipment to air dry (if possible) or towel dry. Wrap sampling surfaces in layers of aluminum foil (if applicable) and store in a designated storage location, free from sources of contamination. Apply outer protection such as sealing in a ziplock bag or plastic basin/tub with a lid to avoid dust.

For dedicated Teflon tubing used to sample wells, drain all residual DI water and seal ends using Teflon tape. Secure Teflon tape with caps and place sealed tubing in a prelabeled polyethylene bag for storage.

When sampling equipment is used to collect samples that contain high concentration organic compounds, oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with reagent-grade acetone followed by hexane to remove the materials before proceeding with the soap and water wash. If acetone is used in the field to clean equipment, extreme caution must be taken by the field crew to avoid sample contamination. In extreme cases, it may be necessary to steam-clean the field equipment before washing. If the field equipment cannot be adequately cleaned using these procedures, it should be discarded and possibly substituted with equipment constructed from a more resistant material.

6.2 Sample Custody and Tracking Procedures

Sample custody is a vital aspect of environmental investigation, remediation, and monitoring activities because these types of programs generate data that may be used as evidence in a court of law. The samples must be traceable from the time of sample collection until the time the data are introduced as evidence in enforcement proceedings.

The key aspect of documenting sample custody is thorough record keeping. The appropriate logs for geologic interpretation, well completion, well abandonment, and sample collection previously described will be filled out for each well drilled and/or each sample collected. All loose-leaf log

sheets will be arranged in sequential order and bound together upon completion of each sampling event. All documents will be completed in ink, dated, and signed by the field person conducting the work.

Transportation and custody procedures will meet U.S. Department of Transportation (DOT) and EPA requirements. COC procedures will document sample possession from collection to disposal in accordance with IT internal procedures and federal guidelines. A sample is considered in custody if:

- It is in the sampler's or the transferee's actual possession.
- It is in the sampler's or the transferee's view, after being in his/her physical possession.
- It was in the sampler's or the transferee's physical possession and then he/she secured it to prevent tampering.
- It is placed in a designated secure area, with restricted access. This includes a locked on-site refrigerator or ice chest sealed with custody seals.
- It is released to a courier service for shipment to the laboratory.

6.2.1 Notification to Laboratory of Sample Shipment

Prior to any sampling activity, the project chemist and data manager, along with the field sample coordinator will contact the laboratory project PM to:

- Review sample quantities, types, identification procedures, and analytical methods
- Task-specific analysis requirements, reporting limits, or target analytes
- Review schedule
- Set up lines of communication under nonconformance conditions
- Review deliverable requirements.

During project implementation, the project chemist or data coordinator notifies the laboratory at least weekly of anticipated samples and changes in sampling schedule or scope. Accutest accepts samples Monday through Saturday.

At least three weeks before sampling begins, the data coordinator or project chemist must contact the USACE chemist for the Former Ramey AFB project to verify the address and contact name for the USACE SAD-designated laboratory. The USACE chemist is Dr. Franz Froelicher (912) 652-5677.

6.2.2 Field Custody Procedures

Adequate field custody procedure activity includes:

- The sampling team and field sampling coordinator have overall responsibility for the care and custody of the samples collected until they are transferred or properly dispatched to the laboratory.
- Samples must be secured in a locked on-site refrigerator or ice chest sealed with custody seals.
- Shipment information is recorded for shipment of samples at the end of the shift, day, or collection period on the FADL and on the site logbook.

6.2.3 Transfer of Custody and Shipment

Samples may be stored on site longer than 24 hours provided they are stored in a secure location (locked refrigerator or sealed ice chest) and temperature blanks are monitored at least twice per day. Storage temperatures will be logged and recorded on a log form and in the logbook.

Transfer of custody and shipping procedures include:

- All coolers must be secured at the site with custody seals prior to transport. Seals should be signed and dated by person relinquishing samples.
- An AR/COC record will be initiated in the field for each sample shipment. The original of this record will accompany each sample. The copies will be retained at the site and will be placed in the project files at the conclusion of field activities.
- If the laboratory sample custodian judges sample custody to be compromised (i.e., samples arrive damaged or seals were applied but broken), the data manager and/or project chemist will be notified and the situation reviewed. A consensus decision will be made as to the fate of the sample(s) in question.

- Each time responsibility for custody of the sample changes, the new custodian will sign the COC portion of the AR/COC record and note the date and time of acceptance. Courier personnel who handle the enclosed sealed coolers will not be required to sign for custody transfer. Instead, the airbill or shipping paper will signify transfer.

- The custody of individual sample containers will be documented by recording each container's identification on the AR/COC form.

- Upon sample destruction or disposal, the laboratory custodian responsible for the disposal will complete the COC record, file a copy, and send a copy to the IT PM for project files.

6.3 Documentation

6.3.1 Sample Identification and Labeling

All physical samples for laboratory analysis collected at the sites will be placed in an appropriate sample container for shipment to the respective laboratories. Samples will be adequately marked for identification from the time of collection and packaging through shipping and storage. The sample identification and collection information will be presented on a label attached to the sample container. The label will be completed with permanent ink or preprinted from the sample tracking system. At a minimum, all sample labels will include the following sample information:

- Field sample number
- Field sample description
- Project name and number
- Analysis requested for the sample collected
- Method of preservation/conditioning
- Date and time of collection
- Initials of the person collecting the sample.

6.3.1.1 Sample Numbering System

The sample numbering system to be utilized in the field has been developed to uniquely identify each sample collected at the Former Ramey AFB. Each sample will be assigned a unique four- to six-digit alphanumeric sample number. The sample number will be incorporated into a sample description comprised of five elements and formatted as follows:

Site ID	Location[1]	Sample Type[2]	Sample Number	Sample Purpose[3]
RAFB #	XXX	XX	XXXX	XXX

[1] Where location is described as a boring number for soils, well identification for groundwater, etc.

[2] Where sample type describes the matrix of the sample collected:

SD = Sediment
SO = Soil
GW = Groundwater
SW = Surface Water

[3] Where sample purpose describes the purpose of the sample collected:

REG = Regular Field Sample
MS = Matrix Spike
MSD = Matrix Spike Duplicate
TB = Trip Blank
EB = Equipment Rinsate
FB = Field Blank/Material Blank
FD = Field Duplicate
FS = Field Split
SS = Screening Sample
GS = Geotechnical Sample.

The sample number and the entire sample description will be preassigned prior to the initiation of the field sampling effort. The samples to be collected at each site and their designated descriptions are presented in each of the site-specific field sampling plans. For example, RAFB39-SB001-SO-AA1001-REG represents a regular soil sample collected from boring 001 located at Site 39 with a sample number of AA1001. The depth of the sample collected, as well as other collection information, is retrieved by linking the sample number to the collection data entered into the sample tracking/field module of the electronic database employed.

Each sample to be collected at each site will be described in each site-specific work plan.

6.3.1.2 Sample Collection Information

Sample collection information uniquely defines and describes a sample collected during an investigation, removal action or other field events. The sample information for samples collected at the Former Ramey AFB will consist of the following:

- Site from which the sample is collected
- Sample location (well or boring)
- Sample matrix
- Sample depth interval
- Sample type
- Associated QC samples
- Sample collection date and time.

This information will be recorded on the sample collection forms and will be entered into the database.

All QA/QC samples will be associated with their corresponding original samples on the sample collection forms. The sampling team will enter this information on the sample collection form during collection.

Sample date (mmddyy) and time (hh:mm) will also be recorded on the sample collection forms and the AR/COC. The sampling team will enter this information on the log, label, and AR/COC form as well.

In summary, the following information describing a specific sample will either be preprinted or presented as choices on the sample collection log and the sample label:

- Project name and number
- Site designation
- Sample location/description
- Sample matrix
- Preservatives
- Analytical methods
- Analytical laboratory.

The sample team will be required to enter the following information on the sample collection log and/or the sample label:

- Sample number
- Sample depth interval (if applicable)
- Date and time of collection
- QA/QC sample associations (on log only).

6.3.2 Sample Analytical Parameters, Containers, Preservation Methods, and Holding Times

Samples must be placed in sample containers that are certified by the manufacturer to be pre-cleaned to EPA specifications. Containers must be compatible with the intended analysis and properly prepared and preserved to maintain sample integrity. Contracted analytical laboratories often have a laboratory-specific quantity requirement or sample bottle type. The contracted laboratory will be expected to furnish the sampling technician with a sufficient quantity of containers to complete a sampling task.

Containers, preservation methods, and holding times for parameters that may be analyzed for at the Former Ramey AFB sites are provided in Table 6-2. If other analytes are found to be necessary, these will be addressed in the task-specific work plans.

Physical and chemical preservation techniques are designed to stabilize the concentrations of analytes in the sample matrix from the time samples are collected through preparation and analysis. Examples of physical preservation include filling to zero headspace for volatile samples, sealing the vials, and chilling samples to 2°C to 6°C. Examples of chemical preservation include adding strong acids (HCl, HNO_3) or bases (NaOH) to adjust sample pH. For those samples requiring field pH adjustment, the final pH of the preserved sample will be checked using pH paper and the result recorded the sample log or AR/COC forms. A sample's "holding time" establishes the recommended maximum time that a sample may be held under preservation before extraction and analysis without compromising sample integrity or representativeness. Preservation techniques and suggested holding times are standardized by the EPA according to analytical method. Table 6-2 summarizes the latest information on preservation techniques and holding times for the most commonly requested the Former Ramey AFB analyses.

Table 6-2

Laboratory Sample Containers, Preservation Methods, and Holding Times for Potential Analyses Former Ramey AFB, Aguadilla, Puerto Rico

Matrix	Analytical Parameter	Analytical Reference	Container Type and Quantity	Preservative	Holding Time[a]
Water	Diesel Range Organics	SW 8015B	1x1 L amber glass w/Teflon-lined cap	H_2SO_4 to pH <2, cool to 4°C	7 days pre-extraction, 40 days post-extraction
	Gasoline Range Organics	SW 8015B	2x40 mL glass w/Teflon-lined septum (minimum)	HCl to pH <2, cool to 4°C	14 days
	Organochlorine PCBs/Pesticides	SW 8081A SW 8082	2x1 L amber glass w/Teflon-lined cap	Cool to 4°C	7 days pre-extraction, 40 days post-extraction
	GC/MS or GC Volatile Organics	SW 8260B SW8021	2x40 mL glass w/Teflon-lined septum (minimum)	HCl to pH <2, cool to 4°C	14 days
	Semivolatile Organics	SW 8270C	2x1 L amber glass w/Teflon-lined cap	Cool to 4°C	7 days pre-extraction, 40 days post-extraction
	HPLC Nitroexplosives	SW 8330	2x1 L amber glass w/Teflon-lined cap	Cool to 4°C	7 days pre-extraction, 40 days post-extraction
	PAH Compounds	SW 8310	2x1 L amber glass w/Teflon-lined cap	Cool to 4°C	7 days pre-extraction, 40 days post-extraction
	ICAP/CVAA/GFAA Metals Metals-Filtered [b] (Dissolved)	SW 6010B/7000 Series	1x500 mL poly	HNO_3 to pH <2	6 months (mercury - 28 days)

Table 6-2

Laboratory Sample Containers, Preservation Methods, and Holding Times for Potential Analyses Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Matrix	Analytical Parameter	Analytical Reference	Container Type and Quantity	Preservative	Holding Time[a]
Water (Continued)	Metals - Unfiltered [b] (Total)	SW 6010B/7000 Series	1x500 mL poly	HNO_3 to pH <2	6 months (mercury - 28 days)
	Wet Chemistry				
	Alkalinity	EPA 310.1	1x250 mL poly	Cool to 4°C	14 days
	BOD	EPA 405.1	1x1 L poly	Cool to 4°C	48 hours
	COD	EPA 410.4	1x125 mL poly or glass	H_2SO_4 to pH <2	28 days
	Sulfide	EPA 376.1	1x1 L poly	Zinc acetate/NaOH pH >9, cool to 4°C	7 days
	Chloride, Fluoride, Nitrate, Nitrite, Orthophosphate, Sulfate	EPA 300.0 (ion chromatography)	1x250 mL poly	None	28 days
	Cyanide	SW 9010B	1x1 L poly	NaOH to pH >12, cool to 4°C	14 days
	Phenol	EPA 420.1	1x1 L glass	H_2SO_4 to pH <2, cool to 4°C	28 days
	Sulfite	EPA 377.1	1x125 mL poly	None	Immediate
	Hardness	EPA 130	1x250 mL poly or glass	HNO_3 to pH <2	6 months
	Nitrogen, Kjeldahl	EPA 351.3	1x1 L poly	H_2SO_4 to pH <2, cool to 4°C	28 days
	Nitrate/Nitrite	EPA 353.1	1x250 mL poly	H_2SO_4 to pH <2, cool to 4°C	28 days
	Ammonia	EPA 350.2	1x1L mL poly	H_2SO_4 to pH <2, cool to 4°C	28 days

Table 6-2

Laboratory Sample Containers, Preservation Methods, and Holding Times for Potential Analyses Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Matrix	Analytical Parameter	Analytical Reference	Container Type and Quantity	Preservative	Holding Time[a]
Water (Continued)	pH	SW 9040B	1x100 mL poly or glass	None required	Analyze immediately
	Sulfate	EPA 375.4	1x500 mL poly or glass	Cool to 4°C	28 days
	TDS	EPA 160.1	1x250 mL poly or glass	Cool to 4°C	7 days
	TOC	EPA 415.1	1x125 mL poly or glass	HCl or H_2SO_4 to pH <2, cool to 4°C	28 days
	TSS	EPA 160.2	1x250 mL poly or glass	Cool to 4°C	7 days
	Methane, Ethane, Ethane	RSK SOP	2 x 40 mL glass – VOA vials	Cool to 4°C	48 hours
	Fe^{2+}	HACH (Field)	1 x 250 mL poly	Cool to 4°C	Immediately
Soil/Sediment	GC				
	Field GC/Volatile Organics	SW 8021B	1x120mL glass wide-mouth w/Teflon cap	Cool to 4°C	24 hours
	Diesel Range Organics	SW 8015B	250 mL wide-mouth glass w/Teflon-lined cap	Cool to 4°C	14 days pre-extraction, 40 days post-extraction
	Gasoline Range Organics	SW 8015B	2 x 5 gm EnCore (minimum); 4x5 gram for medium and low level	Cool to 4°C	48 hours pre-extraction, 14 days post extraction
	Organochlorine PCBs/Pesticides	SW 8081A SW 8082	250 mL wide-mouth glass w/Teflon-lined cap	Cool to 4°C	14 days pre-extraction, 40 days post-extraction
	GC/MS or GC				
	Volatile Organics	SW 8260B SW8021	2 x 5 gm EnCore (minimum); 4x5 gram for medium and low level	Cool to 4°C	48 hours pre-extraction, 14 days post-extraction

Table 6-2

Laboratory Sample Containers, Preservation Methods, and Holding Times for Potential Analyses Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Matrix	Analytical Parameter	Analytical Reference	Container Type and Quantity	Preservative	Holding Time[a]
Soil/Sediment (Continued)	*Semivolatile Organics*	*SW 8270C*	*250 mL wide-mouth glass w/Teflon-lined cap*	*Cool to 4°C*	*14 days pre-extraction, 40 days post-extraction*
	HPLC				
	Nitroexplosives	SW 8330	250 mL wide-mouth glass w/Teflon-lined cap	Cool to 4°C	14 days pre-extraction, 40 days post-extraction
	PAH Compounds	SW 8310	250 mL wide-mouth glass w/Teflon-lined cap	Cool to 4°C	14 days pre-extraction, 40 days post-extraction
	ICAP/CVAA/GFAA Metals				
	Metals	SW 6010B/7000 Series	120 mL wide-mouth glass w/Teflon-lined cap	None	6 months (mercury - 28 days)
	TCLP (Extraction)	SW 1311			
	Metals	SW 6010B/7000 Series	120 mL wide-mouth glass w/Teflon-lined cap	Cool to 4°C	7 days TCLP extraction, 6 months to analysis (mercury - 28 days)
	Volatiles	SW 8260B	120 mL wide-mouth glass w/Teflon-lined cap	Cool to 4°C	7 days TCLP extraction, analyze 14 days
	Semivolatiles	SW 8270C	250 mL wide-mouth glass w/Teflon-lined cap	Cool to 4°C	7 days TCLP extraction, 14 days to prep extraction, analyze 40 days
	Pesticides	SW 8081A	250 mL wide-mouth glass w/Teflon-lined cap	Cool to 4°C	7 days TCLP extraction, 14 days to prep extraction, analyze 40 days

Table 6-2

Laboratory Sample Containers, Preservation Methods, and Holding Times for Potential Analyses Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Matrix	Analytical Parameter	Analytical Reference	Container Type and Quantity	Preservative	Holding Time[a]
Soil/Sediment (Continued)	Miscellaneous				
	Grain size and moisture	ASTM D2216, D421, D422	1x250 mL wide-mouth glass	Cool to 4°C	None specified
	Atterberg Limits	ASTM D-4318	Air tight container	Cool to 4°C	None specified
	Heating value	ASTM D-3588	1x250 mL wide-mouth glass	Cool to 4°C	Suggested 30 days
	Total Organic Carbon	SW 9060	1 x 120 mL wide-mouth glass	Cool to 4°C	28 days

ASTM - American Society of Testing and Materials.
BOD - Biological oxygen demand.
EPA - U.S. Environmental Protection Agency.
GC/MS - Gas chromatography/mass spectrometry.
H_2SO_4 - Sulfuric acid.
HCl - Hydrochloric acid.
HNO_3 - Nitric acid.
HPLC - High-performance liquid chromatography.
ICAP/CVAA /GFAA - Inductively coupled argon plasma/cold vapor atomic adsorption/graphite furnace atomic adsorption
L - Liter.
mL - Milliliter.
NaOH - Sodium hydroxide.
OD - Chemical oxygen demand.
PAH - Polynuclear aromatic hydrocarbon.
PCB - Polychlorinated biphenyls.
TCLP - Toxicity characteristic leaching procedure.
TDS - Total dissolved oxygen.
TSS - Total suspended solids.

[a]Holding time is calculated from the sample collection date and time.
[b]*Filtered groundwater samples will be collected in the field using a disposable inline filter. Samples will be preserved in the field.*

Chemical preservation is not usually recommended for solid matrix samples nor for samples known to contain high concentrations of organic solvents such as waste samples. Unpreserved or suspected high concentration samples sent to the laboratory should be indicated on the sample label and/or should be flagged on the shipment's AR/COC form. Clear identification of these samples is necessary to ensure that the laboratory receiving personnel handle the sample appropriately.

For soil samples collected for VOC analysis, solvent preservation (methanol and acidified water) in the field may be used to allow for additional sample travel time to the laboratory and extend the 48-hour hold time requirement for unpreserved samples to 14 days. If solvents are used in the field, a detailed procedure will be prepared and included in the work plan for review. A field blank for each lot number of source solvent material will be collected for QC at a minimum.

Sample holding times are generally calculated from the date and time a sample is collected in the field until the time the sample is extracted, digested, or otherwise prepared for analysis. In the case of extractable organic compound analyses, sample extracts are assigned a secondary holding time from the extraction date to the analysis date. The sample AR/COC must document for the laboratory when the sample was collected so that the holding time for each sample in the shipment can be calculated in reference to its requested analytical program. Field personnel must make every possible effort to collect and prepare samples for shipment or courier pickup no later than 48 hours following collection (or within 24 hours for soils for VOC analysis). For samples shipped to the laboratory, overnight express delivery must be requested to ensure timely delivery. No soil matrix samples for VOC analysis will be collected on Saturday or Sunday due to holding time restrictions. Laboratory personnel must then take responsibility for calculating the correct sample holding time when preparing and analyzing the sample as needed to meet the holding time requirements. The corresponding sample data must be flagged for samples that are not analyzed within the holding time window and a discussion on usability of the data included in the analytical report.

6.3.3 Field Documentation

Copies of example forms referenced and discussed in the following sections are found in Appendix B.

6.3.3.1 Field Activity Journals

To document all field activities, journals are kept on site by the field coordinator, geologist, and task investigation leader who supervise the activity. The journal records the daily progress of the field work for tasks under each delivery order tasks. Larger tasks have their own dedicated journals. Examples of the specific information included in the journals are daily narratives of the activities that occurred during that day consisting of the personnel on site; daily progress of the investigation, excavation, or monitoring; samples that were collected and shipped; daily equipment calibration results; summaries of telephone conversations or meetings attended; a record of decisions made; and current action items. The journal will supplement but not duplicate the information recorded on the other data forms kept by the field teams.

6.3.3.2 Field Activity Daily Logs

With the use of the field activity journals, the FADL is no longer a project-required form of documentation. In certain situations, site personnel will complete FADLs that can be used to supplement the information recorded in the journal.

6.3.3.3 Soil Sample Collection Logs

The soil sample collection log will be used during all soil/sediment sample collection activities and to document collection information as previously specified. A comments section is also included on the form, which will be used to document additional information, such as observations or problems, during the sampling event. Once the information is reviewed for accuracy and completeness, it will be entered into the database.

6.3.3.4 Deep Soil Boring and Soil Classification Logs

Documentation of deep soil borings will be included in the overall data collection procedures. The USCS will be used to provide a common language to briefly express the general characteristics of soils. The HTRW drilling log and lithology logs will be used to collect and document field data during soil boring activities. Once this information is reviewed for accuracy and completeness, the data will be keyed into the database.

6.3.3.5 Well Completion Logs

The well completion log will be used in the field to record the data collected during monitoring well construction activities. This form includes client, location, driller, site information, and detailed well construction information. All fields will be completed during the field effort to ensure accuracy and completeness.

6.3.3.6 Well Development/Purge Logs

Development or redevelopment of monitoring wells and purging of wells will be documented on the well development/purge log. General information, site-specific information, and physical parameters will be recorded.

6.3.3.7 Groundwater or Surface Water Sample Collection Logs

Information gathered during groundwater or surface water sampling activities will be documented on the groundwater or surface water sample collection logs. This form provides fields for general project information, location, and environmental conditions at the time of sampling. The form also references AR/COC and waybill numbers, which provide a means for cross referencing to other pertinent forms. The engineer or geologist responsible for a groundwater sampling event will review each log to ensure accuracy and completeness and the forms will then be maintained at IT-Knoxville. As with the soil sample collection logs, once the information is reviewed for accuracy and completeness, it will be keyed into the database.

6.3.3.8 Groundwater Elevation Logs

Groundwater depth information for each well will be documented using the groundwater elevation log. Groundwater and any potential free-phase product level readings will be monitored as required during the investigation. Information changes in elevation as a function of time will provide a correlation between changes in water or product level by well and by site.

6.3.3.9 Aquifer Test Form

Data collection for formation drawdown and recovery of water levels during aquifer tests (Section 5.4) will be documented on the aquifer test form. A separate form will be maintained for each observation point. For step-drawdown tests, the discharge will be recorded along with the elapsed time and depth-to-water measurements.

6.4 Field Instrument Calibration

Many types of field analysis may be performed as part of the tasks at the Former Ramey AFB. The following section focuses on the calibration of field meters for water quality testing and vapor monitors. Additional calibration information for field instruments to perform GC analysis or spectrometry analysis is presented in Section 5.0.

6.4.1 General Procedures and Frequency

Field testing and monitoring equipment will be inspected and calibrated before use. Testing and monitoring equipment includes hand-held organic vapor monitors used for health and safety air monitoring, screening soil vapors, combination pH/temperature/specific conductivity meters, and Eh/DO meters, and turbidity meters. Calibration standards for these instruments will be representative of the measured parameter's concentrations on site, stored in good condition, and replaced when expired. Each day an instrument is used, its calibration will be checked against at least one of these certified standards. Equipment calibration protocols are given in Appendix C.

The date, time, and results will be noted in an instrument calibration log. If an instrument is out of calibration, it will be recalibrated and noted in the log. Calibrated equipment will be uniquely identified using the manufacturer's serial number or other unique identification.

6.4.2 Field Calibration Failures

Equipment that fails calibration or becomes inoperable during use will be tagged, removed from service, and separated from serviceable equipment to prevent inadvertent use. Such equipment will be repaired and recalibrated or replaced as appropriate. No equipment that has failed calibration will be used until the equipment has been repaired or replaced.

6.4.3 Field Calibration Records

All equipment to be used during the field sampling will be examined to certify that it is in operating condition. This examination includes checking the manufacturer's operating manuals and the instructions with each instrument to ensure that all maintenance items are being observed. Field notes from previous sampling trips will be reviewed to ensure that any prior equipment problems have been remedied. Spare instruments or parts will be maintained in the advent of instrument failure.

Field calibration records will be kept for all instruments that are used during the field work. These records will include:

- Type and identification number of instrument
- Calibration frequency and acceptable tolerances
- Identification of individual(s) and/or organizations performing the calibration
- Reference standards, including sources and lot numbers used for each calibration
- Calibration data
- Certifications or statements of calibration provided by manufacturers and external agencies, and traceability of calibration standards to national standards
- Information on calibration acceptances or failure.

6.5 Field Record Retention

As field logs, forms, and other field documentation are completed by the sampling team and reviewed by the field coordinator, copies will be maintained on site and the originals forwarded to IT-Knoxville for storage. Incoming field data will be reviewed by the task leader, copied, and distributed as needed with the original data forms held for organizing and filing. These files will be labeled, numbered, and delivered to the project central files for long-term storage as discussed in Section 4.0.

7.0 Analytical Program

The purpose of the analytical QA/QC program is to produce data of known quality that accurately represents the composition of the matrices sampled at the site and that satisfy or exceed the seven requirements of the DQOs defined in Section 3.0 of this SAP. To meet this objective, samples will be prepared and analyzed by the methods specified in Table 7-1 of this plan following the designated quality control requirements listed in Tables 7-2 and 7-3. Any modifications or deviations from the methods required by this document must have the approval of the USACE prior to implementation and are to be addressed in the site-specific task work plans. Table 7-1 presents the standard list of compounds/analytes that will be reported when the target compound list (TCL) or target analyte list (TAL) is requested. Soil and water matrix default reporting units are also shown. These limits may change if different preparation methods, dilutions, or purge volumes are used. Table 7-3 summarizes the current Accutest precision and accuracy criteria, which are statistically derived values based on actually measured and control charted spike recoveries and duplicate results. As such, these values are updated by the laboratory periodically and have been included in this SAP for reference only.

The fundamental process that will be used to achieve the project analytical objectives can be categorized as prevention, assessment, correction, and implementation and is summarized as follows:

- Prevention of deficiencies in the data quality through proper observance of the PARCC parameter requirements defined for the project by the DQO process
- Assessment of data quality through a comparison of the data to the established project DQOs
- Correction of problems affecting data quality
- Implementation of changes originating from corrective actions designed to improve the quality of the project analytical data.

7.1 Chemical Analysis Program

All analyses will be performed by laboratories using the prescribed EPA SW846 Update III methods and will meet the QA/QC requirements described in the document entitled *Engineering*

Table 7-1

Summary of Sample Preparation and Analysis Methods and Their Standard Reporting List and Limits Former Ramey AFB, Aguadilla, Puerto Rico

Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Total Petroleum Hydrocarbons by GC (5030B, 5035/8015B, 3500B/8015B-SW-846) [c]						
Diesel Range Organics (DRO)	500	µg/L	8	mg/kg		
Gasoline Range Organics (GRO)	100	µg/L	5	mg/kg		
Volatile Organic Compounds by GC (5030B, 5035/8021B - SW-846) [d]						
1,1,1,2-Tetrachloroethane	1	µg/L	1	µg/kg	50	µg/kg
1,1,1-Trichloroethane	1	µg/L	1	µg/kg	50	µg/kg
1,1,2,2-Tetrachloroethane	1	µg/L	1	µg/kg	50	µg/kg
1,1,2-Trichloroethane	1	µg/L	1	µg/kg	50	µg/kg
1,1-Dichloroethane	1	µg/L	1	µg/kg	50	µg/kg
1,1-Dichloroethene	1	µg/L	1	µg/kg	50	µg/kg
1,1-Dichloropropene	1	µg/L	1	µg/kg	50	µg/kg
1,2,3-Trichlorobenzene	1	µg/L	1	µg/kg	50	µg/kg
1,2,3-Trichloropropane	1	µg/L	1	µg/kg	50	µg/kg
1,2,4-Trichlorobenzene	1	µg/L	1	µg/kg	50	µg/kg
1,2,4-Trimethylbenzene	1	µg/L	1	µg/kg	50	µg/kg
1,2-Dibromo-3-chloropropane	1	µg/L	1	µg/kg	50	µg/kg
1,2-Dibromomethane	1	µg/L	1	µg/kg	50	µg/kg
1,2-Dichlorobenzene	1	µg/L	1	µg/kg	50	µg/kg
1,2-Dichloroethane	1	µg/L	1	µg/kg	50	µg/kg
1,2-Dichloroethene (total)	2	µg/L	2	µg/kg	100	µg/kg
1,2-Dichloropropane	1	µg/L	1	µg/kg	50	µg/kg
1,3,5-Trimethylbenzene	1	µg/L	1	µg/kg	50	µg/kg
1,3-Dichlorobenzene	1	µg/L	1	µg/kg	50	µg/kg
1,3-Dichloropropane	1	µg/L	1	µg/kg	50	µg/kg
1,4-Dichlorobenzene	1	µg/L	1	µg/kg	50	µg/kg
2,2-Dichloropropane	1	µg/L	1	µg/kg	50	µg/kg
2-Chloroethyl vinyl ether	1	µg/L	1	mg/kg	50	µg/kg
2-Chlorotoluene	1	µg/L	1	µg/kg	50	µg/kg
4-Chlorotoluene	1	µg/L	1	µg/kg	50	µg/kg
Benzene	1	µg/L	1	µg/kg	50	µg/kg
Bromobenzene	1	µg/L	1	µg/kg	50	µg/kg
Bromodichloroemethane	1	µg/L	1	µg/kg	50	µg/kg
Bromoform	1	µg/L	1	µg/kg	50	µg/kg
Bromomethane	1	µg/L	1	µg/kg	50	µg/kg
Carbon tetrachloride	1	µg/L	1	µg/kg	50	µg/kg
Chlorobenzene	1	µg/L	1	µg/kg	50	µg/kg
Chloroethane	1	µg/L	1	µg/kg	50	µg/kg
Chloroform	1	µg/L	1	µg/kg	50	µg/kg
Chloromethane	1	µg/L	1	µg/kg	50	µg/kg
cis-1,2-Dichloroethene	1	µg/L	1	µg/kg	50	µg/kg
cis-1,3-Dichloropropene	1	µg/L	1	µg/kg	50	µg/kg
Dibromomethane	1	µg/L	1	µg/kg	50	µg/kg
Dichlorodifluoromethane	1	µg/L	1	µg/kg	50	µg/kg
Ethyl benzene	1	µg/L	1	µg/kg	50	µg/kg
Hexachlorobutadiene	1	µg/L	1	µg/kg	50	µg/kg
Isopropylbenzene	1	µg/L	1	µg/kg	50	µg/kg

Table 7-1

Summary of Sample Preparation and Analysis Methods and Their Standard Reporting List and Limits Former Ramey AFB, Aguadilla, Puerto Rico

Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Volatile Organic Compounds by GC (5030B, 5035/8021B - SW-846) (Continued)						
m-/p-Xylenes	2	µg/L	2	µg/kg	100	µg/kg
Methyl tert butyl ether	1	µg/L	1	µg/kg	50	µg/kg
Methylene chloride	5	µg/L	5	µg/kg	250	µg/kg
n-Butylbenzene	1	µg/L	1	µg/kg	50	µg/kg
n-Propylbenzene	1	µg/L	1	µg/kg	50	µg/kg
o-Xylene	1	µg/L	1	µg/kg	50	µg/kg
p-Isopropyltoluene	1	µg/L	1	µg/kg	50	µg/kg
sec-Butylbenzene	1	µg/L	1	µg/kg	50	µg/kg
Styrene	1	µg/L	1	µg/kg	50	µg/kg
tert-Butylbenzene	1	µg/L	1	µg/kg	50	µg/kg
Tetrachloroethene	1	µg/L	1	µg/kg	50	µg/kg
Toluene	1	µg/L	1	µg/kg	50	µg/kg
trans-1,2-Dichloroethene	1	µg/L	1	µg/kg	50	µg/kg
trans-1,3-Dichloropropene	1	µg/L	1	µg/kg	50	µg/kg
Trichloroethene	1	µg/L	1	µg/kg	50	µg/kg
Trichlorofluoromethane	1	µg/L	1	µg/kg	50	µg/kg
Vinyl Chloride	1	µg/L	1	µg/kg	50	µg/kg
Xylene (total)	3	µg/L	3	µg/kg	150	µg/kg
Pesticides by GC (3500B\8081A - SW-846) [e]						
4,4'-DDD	0.1	µg/L	3.3	µg/kg		
4,4'-DDE	0.1	µg/L	3.3	µg/kg		
4,4'-DDT	0.1	µg/L	3.3	µg/kg		
Aldrin	0.05	µg/L	1.7	µg/kg		
alpha-BHC	0.05	µg/L	1.7	µg/kg		
beta-BHC	0.05	µg/L	1.7	µg/kg		
Chlordane (alpha)	0.1	µg/L	3.3	µg/kg		
Chlordane (gamma)	0.1	µg/L	3.3	µg/kg		
Chlordane (technical)	0.5	µg/L	15	µg/kg		
delta-BHC	0.05	µg/L	1.7	µg/kg		
Dieldrin	0.05	µg/L	1.7	µg/kg		
Endosulfan I	0.05	µg/L	1.7	µg/kg		
Endosulfan II	0.1	µg/L	3.3	µg/kg		
Endosulfan sulfate	0.1	µg/L	3.3	µg/kg		
Endrin	0.1	µg/L	3.3	µg/kg		
Endrin aldehyde	0.1	µg/L	3.3	µg/kg		
Endrin ketone	0.1	µg/L	3.3	µg/kg		
gamma -BHC (Lindane)	0.05	µg/L	1.7	µg/kg		
Heptachlor	0.05	µg/L	1.7	µg/kg		
Heptachlor epoxide	0.05	µg/L	1.7	µg/kg		
Methoxychlor	0.2	µg/L	6.7	µg/kg		
Toxaphene	2.5	µg/L	170	µg/kg		
Polychlorinated Biphenyls by GC (3500B\8082A - SW-846) [e]						
Aroclor 1016	0.5	µg/L	33	µg/kg		
Aroclor 1221	0.5	µg/L	33	µg/kg		
Aroclor 1232	0.5	µg/L	33	µg/kg		

Table 7-1

Summary of Sample Preparation and Analysis Methods and Their Standard Reporting List and Limits Former Ramey AFB, Aguadilla, Puerto Rico

Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Aroclor 1242	0.5	µg/L	33	µg/kg		
Polychlorinated Biphenyls by GC (3500B\8082A - SW-846) [e] (continued)						
Aroclor 1248	0.5	µg/L	33	µg/kg		
Aroclor 1254	0.5	µg/L	33	µg/kg		
Aroclor 1260	0.5	µg/L	33	µg/kg		
Organophosphorous Pesticides by GC (8141A - SW-846) [e]						
Azinphos-methyl	1	µg/L	33	µg/kg		
Bolstar	1	µg/L	33	µg/kg		
Chlorpyrifos	1	µg/L	33	µg/kg		
Coumaphos	1	µg/L	33	µg/kg		
Demeton-O	1	µg/L	33	µg/kg		
Demeton-S	1	µg/L	33	µg/kg		
Diazinon	1	µg/L	33	µg/kg		
Dichlorvos	1	µg/L	33	µg/kg		
Dimethoate	1	µg/L	33	µg/kg		
Disulfoton	1	µg/L	33	µg/kg		
EPN	1	µg/L	33	µg/kg		
Ethion	1	µg/L	33	µg/kg		
Ethoprop	1	µg/L	33	µg/kg		
Famphur	1	µg/L	33	µg/kg		
Fensulfothion	1	µg/L	33	µg/kg		
Fenthion	1	µg/L	33	µg/kg		
Hexamethylphosphoramide	0.5	µg/L	0.02	mg/kg		
Malathion	1	µg/L	33	µg/kg		
Merphos	1	µg/L	33	µg/kg		
Methyl parathion	1	µg/L	33	µg/kg		
Mevinphos	1	µg/L	33	µg/kg		
Naled	1	µg/L	33	µg/kg		
o,o,o-Triethyl phosphorothioate	1	µg/L	33	µg/kg		
Parathion	1	µg/L	33	µg/kg		
Phorate	1	µg/L	33	µg/kg		
Ronnel	1	µg/L	33	µg/kg		
Stirophos	1	µg/L	33	µg/kg		
Tetraethyldithiopyrophosphate (Sulfotepp)	1	µg/L	33	µg/kg		
Thionazin	1	µg/L	33	µg/kg		
Tokuthion	1	µg/L	33	µg/kg		
Trichlorfon	NA		170	µg/kg		
Trichloronate	1	µg/L	33	µg/kg		
Herbicides by GC (8151A - SW-846) [e]						
2,4,5-T	0.1	µg/L	1.6	µg/kg		
2,4,5-TP (Silvex)	0.1	µg/L	1.8	µg/kg		
2,4-D	0.5	µg/L	8.4	µg/kg		
2,4-DB	0.5	µg/L	4.8	µg/kg		
Dalapon	0.1	µg/L	9.6	µg/kg		
Dicamba	0.1	µg/L	4.8	µg/kg		
Dichlorprop	0.5	µg/L	24	µg/kg		

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Summary of Sample Preparation and Analysis Methods and Their Standard Reporting List and Limits Former Ramey AFB, Aguadilla, Puerto Rico

Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Herbicides by GC (8151A - SW-846) [e]						
Dinoseb	0.5	µg/L	4.8	µg/kg		
MCPA	50	µg/L	2,400	µg/kg		
MCPP	50	µg/L	1,200	µg/kg		
Volatile Organic Compounds by GC/MS (5030B, 5035/8260B – SW846) [d]						
1,1,1,2-Tetrachloroethane	2	µg/L	2	µg/kg	100	µg/kg
1,1,1-Trichloroethane	2	µg/L	2	µg/kg	100	µg/kg
1,1,2,2-Tetrachloroethane	2	µg/L	2	µg/kg	100	µg/kg
1,1,2-Trichloroethane	2	µg/L	2	µg/kg	100	µg/kg
1,1-Dichloroethane	2	µg/L	2	µg/kg	100	µg/kg
1,1-Dichloroethylene	2	µg/L	2	µg/kg	100	µg/kg
1,1-Dichloropropene	2	µg/L	2	µg/kg	100	µg/kg
1,2,3-Trichlorobenzene	2	µg/L	2	µg/kg	100	µg/kg
1,2,3-Trichloropropane	2	µg/L	2	µg/kg	100	µg/kg
1,2,4-Trichlorobenzene	2	µg/L	2	µg/kg	100	µg/kg
1,2,4-Trimethylbenzene	2	µg/L	2	µg/kg	100	µg/kg
1,2-Dibromo-3-chloropropane	2	µg/L	2	µg/kg	100	µg/kg
1,2-Dibromoethane	2	µg/L	2	µg/kg	100	µg/kg
1,2-Dichloroethane	2	µg/L	2	µg/kg	100	µg/kg
1,2-Dichloropropane	2	µg/L	2	µg/kg	100	µg/kg
1,3,5-Trimethylbenzene	2	µg/L	2	µg/kg	100	µg/kg
1,3-Dichloropropane	2	µg/L	2	µg/kg	100	µg/kg
2,2-Dichloropropane	2	µg/L	2	µg/kg	100	µg/kg
2-Chloroethyl vinyl ether	5	µg/L	5	µg/kg	250	µg/kg
2-Hexanone	10	µg/L	10	µg/kg	500	µg/kg
4-Methyl-2-pentanone	10	µg/L	10	µg/kg	500	µg/kg
Acetone	50	µg/L	50	µg/kg	2,500	µg/kg
Acrolein	10	µg/L	10	µg/kg	500	µg/kg
Acrylonitrile	10	µg/L	10	µg/kg	500	µg/kg
Benzene	2	µg/L	2	µg/kg	100	µg/kg
Bromobenzene	2	µg/L	2	µg/kg	100	µg/kg
Bromochloromethane	2	µg/L	2	µg/kg	100	µg/kg
Bromodichloromethane	2	µg/L	2	µg/kg	100	µg/kg
Bromoform	2	µg/L	2	µg/kg	100	µg/kg
Carbon disulfide	10	µg/L	10	µg/kg	500	µg/kg
Carbon tetrachloride	2	µg/L	2	µg/kg	100	µg/kg
Chlorobenzene	2	µg/L	2	µg/kg	100	µg/kg
Chloroethane	5	µg/L	5	µg/kg	250	µg/kg
Chloroform	2	µg/L	2	µg/kg	100	µg/kg
cis-1,2-Dichloroethylene	2	µg/L	2	µg/kg	100	µg/kg
cis-1,3-Dichloropropene	2	µg/L	2	µg/kg	100	µg/kg
Dibromochloromethane	2	µg/L	2	µg/kg	100	µg/kg
Dichlorodifluoromethane	5	µg/L	5	µg/kg	250	µg/kg
Ethyl benzene	2	µg/L	2	µg/kg	100	µg/kg
Hexachlorobutadiene	2	µg/L	2	µg/kg	100	µg/kg

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Summary of Sample Preparation and Analysis Methods and Their Standard Reporting List and Limits Former Ramey AFB, Aguadilla, Puerto Rico

Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Volatile Organic Compounds by GC/MS (5030B, 5035/8260B – SW846) [d] (Continued)						
Isopropylbenzene	2	µg/L	2	µg/kg	100	µg/kg
m-/p-Xylenes	4	µg/L	4	µg/kg	200	µg/kg
m-Dichlorobenzene	2	µg/L	2	µg/kg	100	µg/kg
Methyl bromide	5	µg/L	5	µg/kg	250	µg/kg
Methyl chloride	5	µg/L	5	µg/kg	250	µg/kg
Methyl ethyl ketone	10	µg/L	10	µg/kg	500	µg/kg
Methyl tert butyl ether	2	µg/L	2	µg/kg	100	µg/kg
Methylene bromide	2	µg/L	2	µg/kg	100	µg/kg
Methylene chloride	5	µg/L	5	µg/kg	250	µg/kg
Naphthalene	5	µg/L	5	µg/kg	250	µg/kg
n-Butylbenzene	2	µg/L	2	µg/kg	100	µg/kg
n-Propylbenzene	2	µg/L	2	µg/kg	100	µg/kg
o-Chlorotoluene	2	µg/L	2	µg/kg	100	µg/kg
o-Dichlorobenzene	2	µg/L	2	µg/kg	100	µg/kg
o-Xylene	2	µg/L	2	µg/kg	100	µg/kg
p-Chlorotoluene	2	µg/L	2	µg/kg	100	µg/kg
p-Dichlorobenzene	2	µg/L	2	µg/kg	100	µg/kg
p-Isopropyltoluene	2	µg/L	2	µg/kg	100	µg/kg
sec-Butylbenzene	2	µg/L	2	µg/kg	100	µg/kg
Styrene	2	µg/L	2	µg/kg	100	µg/kg
tert-Butylbenzene	2	µg/L	2	µg/kg	100	µg/kg
Tetrachloroethylene	2	µg/L	2	µg/kg	100	µg/kg
Toluene	2	µg/L	2	µg/kg	100	µg/kg
trans-1,2-Dichloroethylene	2	µg/L	2	µg/kg	100	µg/kg
trans-1,3-Dichloropropene	2	µg/L	2	µg/kg	100	µg/kg
Trichloroethylene	2	µg/L	2	µg/kg	100	µg/kg
Trichlorofluoromethane	5	µg/L	5	µg/kg	250	µg/kg
Vinyl acetate	10	µg/L	10	µg/kg	500	µg/kg
Vinyl chloride	5	µg/L	5	µg/kg	250	µg/kg
Semivolatile Organics by GC/MS (3500B/8270C - SW-846) [e]						
1,2,4-Trichlorobenzene	10	µg/L	330	µg/kg		
1,2-Dichlorobenzene	10	µg/L	330	µg/kg		
1,2-Diphenylhydrazine	10	µg/L	330	µg/kg		
1,3-Dichlorobenzene	10	µg/L	330	µg/kg		
1,4-Dichlorobenzene	10	µg/L	330	µg/kg		
1,4-Dioxane	10	µg/L	330	µg/kg		
1-Methylnaphthalene	10	µg/L	330	µg/kg		
2,3,4,6-Tetrachlorophenol	10	µg/L	330	µg/kg		
2,4,5-Trichlorophenol	10	µg/L	330	µg/kg		
2,4,6-Trichlorophenol	10	µg/L	330	µg/kg		
2,4-Dichlorophenol	10	µg/L	330	µg/kg		
2,4-Dimethylphenol	50	µg/L	830	µg/kg		
2,4-Dinitrophenol	50	µg/L	830	µg/kg		
2,4-Dinitrotoluene	10	µg/L	330	µg/kg		

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Summary of Sample Preparation and Analysis Methods and Their Standard Reporting List and Limits Former Ramey AFB, Aguadilla, Puerto Rico

Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Semivolatile Organics by GC/MS (3500B/8270C - SW-846) (Continued)						
2,6-Dichlorophenol	10	µg/L	330	µg/kg		
2,6-Dinitrotoluene	10	µg/L	330	µg/kg		
2-Chloronaphthalene	10	µg/L	330	µg/kg		
2-Chlorophenol	10	µg/L	330	µg/kg		
2-Methylnaphthalene	10	µg/L	330	µg/kg		
2-Methylphenol	10	µg/L	330	µg/kg		
2-Nitroaniline	10	µg/L	330	µg/kg		
2-Nitrophenol	10	µg/L	330	µg/kg		
3,3'-Dichlorobenzidine	20	µg/L	670	µg/kg		
3-/4-Methylphenols	10	µg/L	330	µg/kg		
3-Nitroaniline	10	µg/L	330	µg/kg		
4,6-Dinitro-o-cresol	20	µg/L	670	µg/kg		
4-Bromophenyl-phenyl ether	10	µg/L	330	µg/kg		
4-Chloro-3-methyl phenol	10	µg/L	330	µg/kg		
4-Chloroaniline	10	µg/L	330	µg/kg		
4-Chlorophenyl-phenyl ether	10	µg/L	330	µg/kg		
4-Nitroaniline	10	µg/L	330	µg/kg		
4-Nitrophenol	50	µg/L	830	µg/kg		
Acenaphthene	10	µg/L	330	µg/kg		
Acenapthylene	10	µg/L	330	µg/kg		
Aniline	10	µg/L	330	µg/kg		
Anthracene	10	µg/L	330	µg/kg		
Benzidine	50	µg/L	830	µg/kg		
Benzo(a)anthracene	10	µg/L	330	µg/kg		
Benzo(a)pyrene	10	µg/L	330	µg/kg		
Benzo(b)fluoranthene	10	µg/L	330	µg/kg		
Benzo(g,h,i)perylene	10	µg/L	330	µg/kg		
Benzo(k)fluoranthene	10	µg/L	330	µg/kg		
Benzoic acid	50	µg/L	830	µg/kg		
Benzyl alcohol	10	µg/L	330	µg/kg		
bis(2-Chloroethoxy)methane	10	µg/L	330	µg/kg		
bis(2-Chloroethyl)ether	10	µg/L	330	µg/kg		
bis(2-Chloroisopropyl)ether	10	µg/L	330	µg/kg		
bis(2-Ethylhexyl)phthalate	10	µg/L	330	µg/kg		
Butyl benzyl phthalate	10	µg/L	330	µg/kg		
Carbazole	10	µg/L	330	µg/kg		
Chrysene	10	µg/L	330	µg/kg		
Dibenzo(a,h)anthracene	10	µg/L	330	µg/kg		
Dibenzofuran	10	µg/L	330	µg/kg		
Diethyl phthalate	10	µg/L	330	µg/kg		
Dimethyl phthalate	10	µg/L	330	µg/kg		
Di-n-butyl phthalate	10	µg/L	330	µg/kg		
Di-n-octyl phthalate	10	µg/L	330	µg/kg		
Fluoranthene	10	µg/L	330	µg/kg		
Fluorene	10	µg/L	330	µg/kg		

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Summary of Sample Preparation and Analysis Methods and Their Standard Reporting List and Limits Former Ramey AFB, Aguadilla, Puerto Rico

Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Semivolatile Organics by GC/MS (3500B/8270C - SW-846) (Continued)						
Hexachlorobenzene	10	µg/L	330	µg/kg		
Hexachlorobutadiene	10	µg/L	330	µg/kg		
Hexachlorocyclopentadiene	10	µg/L	330	µg/kg		
Hexachloroethane	10	µg/L	330	µg/kg		
Indeno(1,2,3-cd)pyrene	10	µg/L	330	µg/kg		
Isophorone	10	µg/L	330	µg/kg		
Naphthalene	10	µg/L	330	µg/kg		
Nitrobenzene	10	µg/L	330	µg/kg		
n-Nitroso-di-n-propylamine	10	µg/L	330	µg/kg		
n-Nitrosodimethylamine	10	µg/L	330	µg/kg		
n-Nitrosodiphenylamine	10	µg/L	330	µg/kg		
Pentachlorophenol	50	µg/L	830	µg/kg		
Phenanthrene	10	µg/L	330	µg/kg		
Phenol	10	µg/L	330	µg/kg		
Pyrene	10	µg/L	330	µg/kg		
Pyridine	10	µg/L	330	µg/kg		
Dioxins/Furans by GC/Low Res MS (8280 - SW-846)						
2,3,7,8-TCDD	10	ng/L	1	ng/g		
Total-TCDD	10	ng/L	1	ng/g		
1,2,3,7,8-PeCDD	10	ng/L	1	ng/g		
Total-PeCDD	10	ng/L	1	ng/g		
1,2,3,4,7,8-HxCDD	10	ng/L	1	ng/g		
1,2,3,6,7,8-HxCDD	10	ng/L	1	ng/g		
1,2,3,7,8,9-HxCDD	10	ng/L	1	ng/g		
Total-HxCDD	10	ng/L	1	ng/g		
1,2,3,4,6,7,8-HpCDD	10	ng/L	1	ng/g		
Total-HpCDD	10	ng/L	1	ng/g		
OCDD	10	ng/L	1	ng/g		
2,3,7,8-TCDF	10	ng/L	1	ng/g		
Total-TCDF	10	ng/L	1	ng/g		
1,2,3,7,8-PeCDF	10	ng/L	1	ng/g		
2,3,4,7,8-PeCDF	10	ng/L	1	ng/g		
Total-PeCDF	10	ng/L	1	ng/g		
1,2,3,4,7,8-HxCDF	10	ng/L	1	ng/g		
1,2,3,6,7,8-HxCDF	10	ng/L	1	ng/g		
2,3,4,6,7,8-HxCDF	10	ng/L	1	ng/g		
1,2,3,7,8,9-HxCDF	10	ng/L	1	ng/g		
Total-HxCDF	10	ng/L	1	ng/g		
1,2,3,4,6,7,8-HpCDF	10	ng/L	1	ng/g		
1,2,3,4,7,8,9-HpCDF	10	ng/L	1	ng/g		
Total-HpCDF	10	ng/L	1	ng/g		
OCDF	10	ng/L	1	ng/g		
Dioxins/Furans by GC/High Res MS (8290 - SW-846)						
2,3,7,8-TCDD	0.01	ng/L	0.001	ng/g		
Total-TCDD	0.01	ng/L	0.001	ng/g		

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Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Dioxins/Furans by GC/High Res MS (8290 - SW-846)						
1,2,3,7,8-PeCDD	0.01	ng/L	0.001	ng/g		
Total-PeCDD	0.01	ng/L	0.001	ng/g		
1,2,3,4,7,8-HxCDD	0.01	ng/L	0.001	ng/g		
1,2,3,6,7,8-HxCDD	0.01	ng/L	0.001	ng/g		
1,2,3,7,8,9-HxCDD	0.01	ng/L	0.001	ng/g		
Total-HxCDD	0.01	ng/L	0.001	ng/g		
1,2,3,4,6,7,8-HpCDD	0.01	ng/L	0.001	ng/g		
Total-HpCDD	0.01	ng/L	0.001	ng/g		
OCDD	0.01	ng/L	0.001	ng/g		
2,3,7,8-TCDF	0.01	ng/L	0.001	ng/g		
Total-TCDF	0.01	ng/L	0.001	ng/g		
1,2,3,7,8-PeCDF	0.01	ng/L	0.001	ng/g		
2,3,4,7,8-PeCDF	0.01	ng/L	0.001	ng/g		
Total-PeCDF	0.01	ng/L	0.001	ng/g		
1,2,3,4,7,8-HxCDF	0.01	ng/L	0.001	ng/g		
1,2,3,6,7,8-HxCDF	0.01	ng/L	0.001	ng/g		
2,3,4,6,7,8-HxCDF	0.01	ng/L	0.001	ng/g		
1,2,3,7,8,9-HxCDF	0.01	ng/L	0.001	ng/g		
Total-HxCDF	0.01	ng/L	0.001	ng/g		
1,2,3,4,6,7,8-HpCDF	0.01	ng/L	0.001	ng/g		
1,2,3,4,7,8,9-HpCDF	0.01	ng/L	0.001	ng/g		
Total-HpCDF	0.01	ng/L	0.001	ng/g		
OCDF	0.01	ng/L	0.001	ng/g		
Polynuclear Aromatic Hydrocarbons by HPLC (3500B/8310 - SW-846) [e]						
1-Methylnaphthalene	1	µg/L	35	µg/kg		
2-Methylnaphthalene	1	µg/L	35	µg/kg		
Acenaphthene	1	µg/L	35	µg/kg		
Acenapthylene	1	µg/L	35	µg/kg		
Anthracene	1	µg/L	35	µg/kg		
Benzo(a)anthracene	0.15	µg/L	5.3	µg/kg		
Benzo(a)pyrene	0.15	µg/L	5.3	µg/kg		
Benzo(b)fluoranthene	0.15	µg/L	5.3	µg/kg		
Benzo(g,h,i)perylene	0.15	µg/L	5.3	µg/kg		
Benzo(k)fluoranthene	0.15	µg/L	5.3	µg/kg		
Chrysene	0.15	µg/L	5.3	µg/kg		
Dibenz(a,h)anthracene	0.15	µg/L	5.3	µg/kg		
Fluoranthene	1	µg/L	5.3	µg/kg		
Fluorene	1	µg/L	35	µg/kg		
Indeno(1,2,3-cd)pyrene	0.15	µg/L	5.3	µg/kg		
Naphthalene	1	µg/L	35	µg/kg		
Phenanthrene	1	µg/L	35	µg/kg		
Pyrene	1	µg/L	5.3	µg/kg		

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Summary of Sample Preparation and Analysis Methods and Their Standard Reporting List and Limits Former Ramey AFB, Aguadilla, Puerto Rico

Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Nitroaromatics and Nitramines by HPLC (8330-SW-846) [e]						
1,3,5-Trinitrobenzene	0.2	µg/L	0.25	mg/kg		
1,3-Dinitrobenzene	0.2	µg/L	0.25	mg/kg		
2,4,6-Trinitrotoluene	0.2	µg/L	0.25	mg/kg		
2,4-Dinitrotoluene	0.2	µg/L	0.25	mg/kg		
2,6-Dinitrotoluene	0.2	µg/L	0.25	mg/kg		
2-Nitrotoluene	0.2	µg/L	0.25	mg/kg		
3-Nitrotoluene	0.2	µg/L	0.25	mg/kg		
4-Amino-4,6-dinitrotoluene	0.2	µg/L	0.25	mg/kg		
4-Nitrotoluene	0.2	µg/L	0.25	mg/kg		
HMX	0.5	µg/L	0.5	mg/kg		
Nitrobenzene	0.2	µg/L	0.25	mg/kg		
RDX	0.5	µg/L	0.5	mg/kg		
Tetryl	0.5	µg/L	0.5	mg/kg		
Metals by ICP and CVAA (3000/6010B, 7470/7471 - SW-846) [f]						
Aluminum	200	µg/L	20	mg/kg		
Antimony	5	µg/L	6	mg/kg		
Arsenic [g]	5	µg/L	1	mg/kg		
Barium	200	µg/L	20	mg/kg		
Beryllium	5	µg/L	0.5	mg/kg		
Cadmium	4	µg/L	0.4	mg/kg		
Calcium	5000	µg/L	500	mg/kg		
Chromium, total	10	µg/L	1	mg/kg		
Cobalt	50	µg/L	5	mg/kg		
Copper	25	µg/L	2.5	mg/kg		
Iron	100	µg/L	10	mg/kg		
Lead [g]	3	µg/L	10	mg/kg		
Magnesium	5000	µg/L	500	mg/kg		
Manganese	15	µg/L	1.5	mg/kg		
Mercury [h]	0.25	µg/L	0.035	mg/kg		
Nickel	40	µg/L	4	mg/kg		
Potassium	5000	µg/L	500	mg/kg		
Selenium [g]	5	µg/L	10	mg/kg		
Silver	10	µg/L	1	mg/kg		
Sodium	5000	µg/L	500	mg/kg		
Thallium [g]	5	µg/L	1	mg/kg		
Vanadium	50	µg/L	5	mg/kg		
Zinc	20	µg/L	2	mg/kg		
Anions by Ion Chromatography (300.0 - EPA 600)						
Chloride	1	mg/L	10	mg/kg		
Fluoride	1	mg/L	10	mg/kg		
Nitrate	0.5	mg/L	5	mg/kg		
Nitrite	0.5	mg/L	5	mg/kg		
Orthophosphate	1	mg/L	10	mg/kg		
Sulfate	1	mg/L	10	mg/kg		

Table 7-1

Summary of Sample Preparation and Analysis Methods and Their Standard Reporting List and Limits Former Ramey AFB, Aguadilla, Puerto Rico

Group/Parameter	Water		Soil [a]			
			Low Level		High Level [b]	
	RL	Units	RL	Units	RL	Units
Other Parameters (Methods in Parentheses)						
Alkalinity (310.1-EPA 600)	5	mg/L				
Ammonia (350.2-EPA 600)	0.1	mg/L	10	mg/kg		
BOD (405.1-EPA 600)	1	mg/L				
COD (410.4-EPA 600)	20	mg/L	200	mg/kg		
Cyanide (9010B-SW846)	0.01	mg/L	0.5	mg/kg		
Methane, Ethane, Ethene (RSKSOP-175)	0.001	mg/L				
Oil and Grease (n-Hexane extractable material) (1664-	5	mg/L	330	mg/kg		
pH (9040B/9045C-SW-846)	0.01	SU	0.01	SU		
Sulfate (375.3-EPA 600)	5	mg/L	50	mg/kg		
Sulfide (376.1-EPA 600)	0.5	mg/L	50	mg/kg		
Sulfite (377.1- EPA 600)	2	mg/L	20	mg/kg		
Total Kjeldahl Nitrogen (TKN) (351.3-EPA 600)	1	mg/L	50	mg/kg		
Total Organic Carbon (TOC) (415.1-EPA 600)	1	mg/L				
Total Organic Carbon (TOC) (9060-SW-846)			0.2	Percent		
TSS (160.2- EPA 600)	4	mg/L	NA	--		

[a] Reporting limits for VOCs in soil matrix using Method 5035; high and low level preparation methods. High-level method using methanol extraction will be performed in all cases. Low-level method using sodium bisulfate solution may be performed in cases where DQOs require lower reporting limits.

[b] These are the expected reporting limits for Method 5035. Actual reported RLs may be lightly higher or lower.

[c] For TPH-GRO, Method 5030B (purge and trap) will be performed for water matrix samples. Method 5035 will be used for soil matrix samples. For TPH-DRO, Method 3520C will be used for liquids and Method 3550C (sonication extraction) will be used for soils.

[d] Reporting limits for water matrix samples assume a 25-mL purge volume.

[e] For liquid matrix samples, Method 3520C (continuous liquid-liquid extraction) is the preferred method. Method 3510C (separatory funnel liquid-liquid) may be used if needed (i.e., fast turnaround required). For soil matrix samples 3540C (or 3541) (Soxhlet extraction) will be used. Waste matrix samples will be prepared by Method 3540C (waste dilution). Only the waste dilution preparation method will yield RLs that are different than those indicated, assuming sample extraction volumes and final extract concentration volumes are standard. Task-specific requirements may require method changes that result in the RLs to be adjusted to meet the DQOs and these requirements will be discussed in the task-specific work plans.

[f] For water/aqueous matrix samples, Method 3010A (acid digestion) is used. For solid samples, Method 3050B (acid digestion) is used. For oil or organic wastes, Method 3031 (acid digestion) or 3040A (dissolution) may be used. Method 3052 (microwave assisted acid digestion) may be used if superior performance is expected.

[g] Analysis for this element is performed by trace ICP method.

[h] Analysis for mercury is performed by cold vapor atomic absorption (CVAA) method (7470 - water, 7471 - soil).

RL - reporting limits
GC - gas chromatography
µg/L - micrograms per liter
mg/kg - milligrams per kilogram
µg/kg - micrograms per kilogram
GC/MS - gas chromatography/mass spectroscopy
HPLC - high pressure liquid chromatography
mg/L - milligrams per liter
ICP - inductively coupled plasma-atomic emission spectrometry
CVAA - cold vapor atomic absorption
SU - standard units

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Former Ramey AFB, Aguadilla, Puerto Rico

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Total Petroleum Hydrocarbon - Diesel Range Organics by 3500B/8015B	Initial 5-point calibration with low standard at RL	Initially and as needed	RSD of the average calibration factors is ≤20% or correlation coeff. (r) ≥ 0.995 (or r^2≥ 0.99)	1) Determine problem 2) Clean/service GC 3) Recalibrate
	Continuing calibration verification (CCV) - at the midpoint of the initial calibration	Beginning and end of each run, and after 20 injections (max).	%D is ≤ 15%	1) Determine problem 2) Clean/service GC and/or purge and trap system, if needed 3) Reanalyze samples not bracketed by acceptable CCVs or recalibrate
	Retention Time Range Check (C10 to C28)	Verified every 12 hour shift and as needed	± 3 standard deviations; analyst's judgement	Repeat check if needed.
	Solvent Blank	Every 12 hour shift and as needed	All concentrations are ≤1/2 the RL	1) Identify and correct source 2) Reprep and/or reanalyze blank and associated samples
	Method blank	1 per batch consisting of no more than 20 samples	All concentrations are ≤1/2 the RL	1) Identify and correct source 2) Reprep and/or reanalyze blank and associated samples or flag data
	LCS (Blank Spike)	1 per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria	1) Check calculations and instrument performance 2) Re-extract and reanalyze

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Former Ramey AFB, Aguadilla, Puerto Rico

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Total Petroleum Hydrocarbon - Diesel Range Organics by 3500B/8015B (Continued)	MS/MSD	1 per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria	1) Check calculations and instrument performance 2) Re-extract and reanalyze as needed 3) Flag data that exceed criteria as estimated due to matrix effects as indicated
	Surrogate	Every sample, QA sample, and standard	Refer to Table 7-3	1) Check calculations and instrument performance 2) Re-extract and reanalyze as needed 3) Flag data that exceed criteria as estimated due to matrix effects as indicated
Total Petroleum Hydrocarbon – Gasoline Range Organics by 5030B/5035/8015B	Initial 5-point calibration with low standard at the RL	Initially and as needed	RSD of the average calibration factors is ≤20% or correlation coeff. (r) ≥ 0.995 (or $r^2 \geq 0.99$)	1) Determine problem 2) Clean/service GC 3) Recalibrate
	CCV	Beginning and end of each 24 hour shift and after every 10 samples	%D is ≤ 15%	1) Determine problem 2) Clean/service GC and/or purge and trap system, if needed 3) Reanalyze samples not bracketed by acceptable CCVs or recalibrate
	Retention Time Range Check (C6 to C10)	Verified every 12 hour shift and as needed	± 3 standard deviations; analyst's judgement	Repeat check if needed.
	Solvent Blank	Every 12 hour shift and as needed	All concentrations are ≤1/2 the RL	1) Identify and correct source 2) Reprep and/or reanalyze blank and associated samples

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Former Ramey AFB, Aguadilla, Puerto Rico

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Total Petroleum Hydrocarbon – Gasoline Range Organics by 5030B/5035/8015B (Continued)	Method blank	1 per batch consisting of no more than 20 samples	All concentrations are ≤1/2 the RL	1) Identify and correct source 2) Reprep and/or reanalyze blank and associated samples or flag data
	LCS (Blank Spike)	1 per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria	1) Check calculations and instrument performance 2) Re-extract and reanalyze
	MS/MSD	1 per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria	1) Check calculations and instrument performance 2) Re-extract and reanalyze as needed 3) Flag data that exceed criteria as estimated due to matrix effects as indicated
	Surrogate	Every sample, QA sample, and standard	Within the performance based, control chart derived acceptance criteria	1) Check calculations and instrument performance 2) Re-extract and reanalyze as needed 3) Flag data that exceed criteria as estimated due to matrix effects as indicated

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
VOCs by 5030B, 5035/8021B	Initial calibration: 5 levels, otherwise 6 levels for quadratic	Initially and as needed	$R^2 \geq 0.995$ or compound-specific RSD criteria per SOP	Recalibrate
	CCV	After initial calibration, after 10 samples, and at end of sequence	Compound-specific % D as per SOP	Samples must be bracketed by acceptable CCVs or recalibrate/reanalyze
	Surrogates	Method-specific, added to every sample, QA sample	Within the performance based, control chart derived acceptance criteria	1) Recalibrate, evaluate system performance 2) Check surrogate and standard mix concentra-tions/aliquots 3) Reanalyze sample if above checks reveal problem
	Method blank	1 per batch of $\leq$ 20 samples	< RL or <5% of the measured concentration of that analyte in associated samples	Reanalyze blank samples unless samples are 20X blank value or are < RL
	LCS	1 per batch of $\leq$ 20 samples	Within the performance based, control chart derived acceptance criteria	Reanalyze LCS and associated samples unless MS/MSD show acceptable accuracy
	MS/MSD	1 pair per batch of $\leq$ 20 samples (each batch must have LCS or MS)	Within the performance based, control chart derived acceptance criteria	Check LCS data if LCS is unacceptable reprep and reanalyze batch; else, reanalyze to confirm suspected matrix effects and flag associated sample data as necessary

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Pesticides by 3500B/8081A and PCBs by 3500B/8082A	5-point calibration	Initially for pesticides; calibration as required for multi-peak pesticides/PCBs for qualitative purposes only	<20% RSD or $R^2 \geq 0.995$	1) Service/clean instrument 2) Recalibrate
	Daily continuing calibration check standard	Each 24 hours	% difference ≤15% for reported as found analytes or average % D <15%. Multicomponents % D≤ 15%.	1) Determine problem 2) Clean/service GC injector liner/or EC detector/or capillary column 3) Repeat calibration
	Calibration check verification (CCV)	Every 10 samples, and at the end of the sequence (excluding CCVs and instrument blanks)	±15 to -15% difference from expected concentration. Up to ±30% if no targets within bracketed standards	Repeat samples that were analyzed after the invalid CCV
	Degradation standard (% breakdown for DDT and endrin [PEM])	Every 24 hours of analysis	Not to exceed 15%	1) Stop sequence 2) Determine cause and repair 3) Reanalyze PEM
	Method blank	1 per batch consisting of no more than 20 samples	<RL; surrogate recovery within method limits or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher	Investigate source; re-extract and reanalyze associated samples
	MS/MSD	1 per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Compare to control limits 2) Re-extract and reanalyze or flag data as necessary

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Pesticides by 3500B/8081A and PCBs by 3500B/8082A (continued)	Surrogates	Every sample, QA sample, standard	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Check for calculation errors 2) Check instrument performance 3) Recalculate data and/or reanalyze 4) Re-extract and reanalyze if within holding time and not as a result of matrix interference 5) Flag data as necessary
	LCS	One per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Evaluate system 2) Re-extract and reanalyze LCS and all samples
	Second column confirmation	All detects	1) Within retention time windows on both columns 2) Quantitated >PQL on both columns 3) Values agree within factor of 50% difference 4) For multi-responders compare chromatograms	Do not accept value as detect if first two items are not met Flag data that meet items 1 and 2 but not item 3
	Retention times and retention time window	For each column type	Refer to method SW 846 - 8000	Refer to method SW 846 - 8000

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Organophosphorous Pesticides by 8141	Initial Calibration: 7 levels	Initially, then as needed	$R^2 \geq 0.992$	Recalibration
	ICV	Immediately following 5-point calibration.	Within 20% of the true value	Repeat samples that were analyzed before (since the last acceptable ICV) and after the invalid ICV to next acceptable ICV
	ICB	Immediately following the ICV	± the CRDL from zero	Reanalyze samples that were analyzed before (since last acceptable ICB) and after the invalid ICB to next acceptable ICB
	CCV: mid-point calibration standard	Analyze at the beginning of the day, after every ten samples, and at the end of the run	%D ≤ 15% on the primary column and %D ≤ 25% on the confirmation column	1) Re-analyze CCV and if acceptable, re-analyze samples back to last acceptable CCV 2) Recalibrate
	CCB	Same as CCV	± the CRDL from zero	1) Re-analyze CCB and if acceptable, re-analyze samples back to last acceptable CCB 2) Recalibrate
	Surrogates	Method specific; added to every sample, QA sample, and standard	Within the performance based, control chart derived acceptance criteria	1) Recalibrate, evaluate system performance, 2) Check surrogate and standard mix concentration, or 3) Reanalyze sample if above checks reveal a problem

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Organophosphorous Pesticides by 8141 (Continued)	Method Blank	One per extraction batch of not more than 20 samples or 1 per 12 hours, whichever is more frequent	< RL or < 5% of the measured concentration of that analyte in the associated samples, whichever is higher.	Reanalyze blank and/or samples unless the samples are ≥20X the blank value or <RL
	LCS	At a minimum, one per batch of not more than 20 samples	Within the performance based, control chart derived acceptance criteria	1) Repeat LCS 2) Reanalyze LCS and associated samples as indicated
	MS/MSD	One per batch of not more than 20 samples, or per client request	Within the performance based, control chart derived acceptance criteria	1) Reanalyze; confirm suspected matrix effects 2) For associated samples, flag data as necessary
Chlorinated Herbicides by 8151A	Initial Calibration: a minimum of 5 levels or 6 levels for quadratic calibrations	Initially, then as needed	$R^2 \geq 0.995$ or compound specific RSD criteria per the SOP	Recalibration
	Continuing Calibration Standard: mid-point calibration standard	Analyze at the beginning of the sequence, after every twelve hours, and at the end of the sequence	1) %D ≤ 15% or 2) If all analytes are non-detect, average %D for all analytes ≤ 15%	1) Re-analyze CCV and if acceptable, re-analyze samples back to last acceptable CCV or 2) Recalibrate.

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Chlorinated Herbicides by 8151A (Continued)	Surrogates	Method specific; added to every sample, QA sample, and standard	Within the performance based, control chart derived acceptance criteria	1) Recalibrate, evaluate system performance, 2) Check surrogate and standard mix concentration, 3) Reanalyze sample if above checks reveal a problem
	Method Blank	One per extraction batch of not more than 20 samples or 1 per 12 hours, whichever is more frequent	< RL or < 5% of the measured concentration of that analyte in the associated samples, whichever is higher.	Reanalyze blank and/or samples unless the samples are 20X the blank value or < RL
	LCS	At a minimum, one per batch (or SDG) of not more than 20 samples	Within the performance based, control chart derived acceptance criteria	Reanalyze LCS and associated samples unless MS/MSD show acceptable accuracy
	MS/MSD	One per batch (or SDG) of not more than 20 samples, or per client request	Within the performance based, control chart derived acceptance criteria	1) Reanalyze; confirm suspected matrix effects 2) For associated samples, flag data as necessary
VOCs by 5030B, 5035/8260B	Check of mass spectral ion intensities using BFB	Every 12 hours	Refer to Method 8260B and the SOP Rev.: SW846 Update III, Date: 12/96 (or latest version	1) Retune or service mass spectrometer 2) Repeat BFB analysis

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
VOCs by 5030B, 5035/8260B *(continued)*	Initial 5-point calibration	Initially and as needed	1) %RSD of target compounds ≤15% except for CCCs 2) %RSD for CCCs ≤30% 3) Min. RF < 0.10 (0.3 for 1,1,2,2-tetrachloroethane and chlorobenzene) for SPCCs	1) If %RSD for any non-CCC target compound exceeds criteria, check mean RSD for all analytes. If ≤15%, the calibration may be accepted. 2) Clean/service GC/MS and/or purge and trap system 3) Repeat calibration
	CCV: BFB tune check, mid-level calibration standard	Every 12 hours	1) Acceptable BFB Tune 2) %D≤20% for CCCs; %D≤20% for target analytes 3) Min. RF for SPCCs meet same criteria as initial calibration	1) Evaluate system 2) Repeat calibration check 3) Perform new initial calibration 4) Reanalyze affected samples
	Internal standards	Every sample, 3 compounds per sample, QA sample, and standard	1) Retention times for internal standard in the continuous calibration cannot change by more than 0.5 minutes from the mid-level initial calibration standard. 2) Internal standard response is continuous calibration within 50-200% of the *response in the mid-level of the initial* calibration standard.	1) Check system Reanalyze if change in sensitivity is due to instrument problems 2) Flag data as necessary

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
VOCs by 5030B, 5035/8260B (continued)	Surrogates	Four compounds added to every sample, QA sample, standard	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Evaluate system performance, recalculate 2) Check surrogate and standard mix concentrations/aliquots 3) Reanalyze sample if above checks reveal problem 4) Reanalyze at least once to confirm suspected matrix effect. Flag data as "estimated concentration" if indicated.
	Method blank	One per 12 hour shift or one per batch of not more than 20 samples at a minimum	No target compounds >RL or at above of the measured concentration of that analyte in the associated sample, whichever is higher (except for common laboratory contaminants).	1) Service system/glassware to eliminate contamination 2) Reanalyze blank and all associated samples if samples have target compound concentrations ≤20X the blank value and are >RL.
	LCS	One per batch of not more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Evaluate instrument 2) Reanalyze/reprep LCS 3) Reanalyze samples in associated batch
	MS/MSD	One pair per batch of not more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Evaluate system 2) Reanalyze; confirm suspected matrix effects 3) For assoc. samples flag data as necessary (minimize)
SVOCs by 3500B/8270C	Check of mass spectral ion intensities using DFTPP	Every 12 hours	Refer to Method 8270C and SOP; SW846 Update III (12/96) - or latest revision	1) Retune or service mass spectrometer 2) Repeat DFTPP analysis

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
SVOCs by 3500B/8270C (continued)	Initial 5-point calibration	Initially and as needed	1) %RSD for CCCs ≤ 30%; min. avg RRF ≥0.050 for SPCCs 2) All other (non-CCC) compounds, %RSD ≤15%. If >15%, use linear or quadratic regression (r≥0.995)	1) Clean/service GC/MS injector liner/or capillary column 2) Repeat calibration
	CCV	Every 12 hours	RF ≥0.050 for SPCCs; %D≤20% for CCCs and target compounds	1) Evaluate system 2) Repeat calibration check 3) Repeat initial calibration and reanalyze affected samples
	Method blank	One per extraction batch	No target compounds >RL or at above 5% of the measured concentration of that analyte in the associated samples, whichever is greater (exception for common laboratory contaminants)	1) Evaluate system/glassware 2) Re-extract and reanalyze samples if samples have target compound concentrations ≤20X the blank value and >RL
	Surrogates (six; three base/natural fraction and three acid fraction compounds)	Every sample, QA sample, and standard	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Evaluate system 2) Check surrogate and standard mix 3) Re-extract and reanalyze sample if outliers are not from matrix interference 4) Flag data as necessary
	Internal standard (six; three base/neutral fraction and three acid fraction compounds)	Every sample, QA sample, and standard	1) Internal standard (I/S) retention times ±30 seconds from last calibration 2) I/S EICP area does not change more than 50% to 200% from last daily CCV	1) Check system/reanalyze, if still outside criteria 2) Flag data as necessary

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
SVOCs by 3500B/8270C (continued)	MS/MSD	One per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Compare to control limits 2) Re-extract and reanalyze and flag data as necessary
	LCS	One per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Evaluate system 2) Reanalyze LCS 3) Re-extract batch and reanalyze
Dioxins/Furans by 8280 and 8290	Method Blank	One per extraction batch of not more than 20 samples or 1 per 12 hours, whichever is more frequent	< Minimum level (water: 10 ng/L; soil: 2 ng/g; waste: 10 ng/g)	If blank fails, evaluate data. May re-extract if sufficient sample volume remains.
	LCS	At a minimum, one per batch (or SDG) of not more than 20 samples	Native analyte % Recovery: 60-140%	If LCS fails, evaluate the data. May re-extract the batch if sufficient sample volume remains.
	MS/MSD	One pair for every 20 samples for a given matrix	Native analyte % Recovery: 60-140%	Evaluate LCS recovery. If LCS is ok and MS/MSD outside limits due to matrix, note in narrative.

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Dioxins/Furans by 8280 and 8290 (Continued)	Window defining mixture	Prior to initial calibration, continuing calibration and at end of 12 hour shift	Set the switchpoints for the MID descriptors.	Recalibrate
	Column Performance Check Mixture	Prior to initial calibration, continuing calibration and at end of 12 hour shift	Chromatographic resolution of 2,3,7,8-TCDD and closest eluting TCDD isomer ≤25% valley	Perform GC and/or column maintenance. Replace column if necessary. Reanalyze column performance check mixture.
	Initial Calibration (5 calibration standards analyzed in triplicate).	Initially, then as needed	RSD for natives is ≤15% Ion ratios must meet limits specified in SOP. 0.2 ng/uL std must meet signal to noise ratio specified in SOP.	Identify root cause, perform corrective action and repeat initial calibration. If root cause points to problems with individual analysis, repeat that analysis and recalculate RSD. If acceptable, continue with analysis. If still unacceptable, repeat initial calibration.
	Continuing Calibration	Every 12 hours	Window defining mixture or column performance mixture must meet criteria specified in SOP. Continuing calibration std must meet instrument sensitivity and ion abundance criteria specified in SOP. Daily RRFs for natives must be within ±30% of avg. RRF of initial calibration.	Repeat continuing calibration. If samples are ND and daily RRFs are high, may be able to narrate. Recalibrate.
	Internal Standards	Every sample & QA sample	% Recovery; > 40% or S/N ratio ≥ 10:1	If IS recovery is <40%, S/N of IS should be > 10, and minimum levels met. Report data with qualifiers.

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Dioxins/Furans by 8280 and 8290 (Continued)	5-Point calibration	Initially and as required	Response factors < 20% RSD or the correlation coefficient ≥ .995	1) Service/clean instrument 2) Recalibrate
Polynuclear aromatic hydrocarbons by 3500B/8310	Daily calibration check standard	Before sample analysis	±15% difference from expected concentration	1) Evaluate system. 2) Repeat calibration standard. 3) Recalibrate. 4) Reanalyze affected samples
	Calibration check standard (CCV)	Every 10 analyses and end of sequence, excluding CCVs and instrument blanks	±15% difference from expected concentration for each standard bracketing samples	1) Evaluate system 2) If greater than 15%, and samples are ND, report data and evaluate standard for trends 3) If still out, reanalyze samples back to last acceptable CCV 4) Perform new ICAL as needed.
	Method blank	1 per batch consisting of no more than 20 samples	<RL; surrogate recovery within method limits	Investigate source; re-extract and reanalyze associated samples
	MS/MSD	1 per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Compare to control limits 2) Re-extract and reanalyze or flag data as necessary

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Polynuclear aromatic hydrocarbons by 3500B/8310 (Continued)	Surrogates	Every sample, QA sample, standard	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Check for calculation errors 2) Check instrument performance 3) Recalculate data and/or reanalyze 4) Re-extract and reanalyze if within holding time and not result of matrix interference 5) Flag data as necessary
	LCS	One per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Evaluate system 2) Re-extract and reanalyze LCS and all samples
	Retention times and retention time window	For each column type	Refer to method	Refer to method
	Initial Calibration	Initially , then as needed	% RSD of CV < 20% or correlation coefficient >0.995	Recalibrate
Nitroaromatics and Nitramines by HPLC by 8330	Daily Calibration (triplicate injection of mid-level std)	At beginning of analytical sequence and every 24 hours	%D $\pm$ 15%	If the standard is outside QC limits after the second injection, the sequence is done. A new initial calibration is required.
	Continuing Calibration	Every 24 hours and at the end of the analytical sequence	%D $\leq$ 15%	%D must be $\leq$ 15% for any reportable analyte. %D may be – 15% to +30% for any analyte not detected in the samples.

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Nitroaromatics and Nitramines by HPLC by 8330 (Continued)	Surrogates	Every sample, QA sample, and standard	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	Evaluate data. Re-extraction and/or reanalysis may be necessary.
	Second Column Verification	If analyte found above RL.	If analyte found above RL, must be detected within retention time window for both columns	NA
	Method blank	1 per batch consisting of less than or equal to 20 samples	< RL, or less than 5% of the measured concentration of that analyte in the associated samples, whichever is greater	Investigate source, re-extract and reanalyze associated samples.
	LCS	1 per batch consisting of less than or equal to 20 samples	Within the performance based, control chart derived acceptance criteria	If LCS fails, evaluate the data. May re-extract the batch if sufficient sample volume remains.
	MS/MSD	1 per batch consisting of no more than 20 samples	Within the performance based, control chart derived acceptance criteria	Evaluate LCS recovery. If LCS is OK and MS/MSD outside limits due to matrix, note in narrative.
ICP Metals by 3000/6010B	1-point calibration (Blank + 1 Std)	Daily, as needed prior to analysis of samples or once every 24 hours and each time instrument is set up	Analysis of calibration standard within ±5% of true value	1) Service/adjust instrument 2) Recalibrate
	Initial calibration verification (ICV)	Immediately following the calibration	Within ±10% of true value	Recalibrate
	Initial calibration blank (ICB)	Immediately following ICV	<RL for each element	Recalibrate

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
ICP Metals by 3000/6010B (continued)	Continuing calibration verification (CCV)	After every 9 samples and at end of run	Within ± 10% of true value	1) Reanalyze CCV to confirm initial value 2) If reanalysis is outside criteria, reanalyze all affected samples
	Continuing calibration blank (CCB)	After every 9 samples and at end of run	<RL for each element	1) Reanalyze CCB to confirm initial value 2) If reanalysis is outside criteria, reanalyze all affected samples
	CRI standards and chemical interference check: Low level sample analyses 2x RL	Immediately after ICB at the beginning and end of run; or every 8-hours, whichever is more frequent	For all spiked elements ±20% of true value, for unspiked elements <RL	Adjust instrument and recalibrate. Reanalyze affected samples.
	Serial dilution	One per prep batch of not more than 20 samples, or whenever matrix interference is suspected	±10% of reported concentrations (undiluted) (provided that the sample and dilution results are >10x the RL or 50x the IDL)	1) Report using different dilution levels 2) Flag data for matrix effects
	Method blank (digestion blank)	1 per prep batch (consisting of ≤10 samples) prepared per day	<RL or the measured concentration of that analyte in associated samples is ≥10x higher	1) Identify and correct source 2) Reanalyze blank and associated samples or flag data as indicated
	MS/MSD	1 per prep batch (consisting of ≤10 samples) prepared per day	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Compare data to LCS 2) Flag sample data as necessary for matrix effects as indicated
	LCS	1 per prep batch (consisting of ≤10 samples) prepared per day	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Reanalyze LCS to confirm 2) Re-prepare and reanalyze all affected samples

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
ICP Metals by 3000/6010B (continued)	Interelement corrections	Yearly or when instrument is adjusted	See SOP	Update corrections annually
Mercury by 3000/7470A/7471A (Cold Vapor)	5-point calibration	Initially	Correlation coefficient ≥0.995	1) Service/adjust instrument 2) Recalibrate 3) Reprep and reanalyze
	ICV	Immediately following 5-point calibration.	Within 20% of the true value	Repeat samples that were analyzed before (since the last acceptable CCV) and after the invalid CCV to next acceptable CCV
	CCV	Every 10 samples or every 2 hours and at end of sequence	Within 20% of the true value	1) Reanalyze CCV to confirm initial value 2) If reanalysis is outside criteria, reanalyze all affected samples
	Initial calibration blank (ICB)	Immediately following the ICV	± the CRDL from zero	Reanalyze samples that were analyzed before (since last acceptable CCB) and after the invalid CCB to next acceptable CCB
	Continuing calibration blank (CCB)	Every 10 bottles and end of sequence	± the CRDL from zero	
	Method blank (digestion blank)	1 per batch consisting of ≤20 samples prepared per day	<RL (see SOP for exceptions)	1) Identify and correct source 2) Reprep and reanalyze blank and associated samples or flag data

Table 7-2

Summary of Calibration and Internal Quality Control Procedures, Criteria, and Associated Corrective Actions Ramey AFB, Aguadilla, Puerto Rico

(Continued)

Parameter/Method	Calibration or QC Check	Frequency	Acceptance Criteria	Corrective Action
Mercury by 3000/7470A/7471A (Cold Vapor) (continued)	MS/MSD	1 per batch consisting of not more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	Flag data as necessary
	LCS	1 per batch consisting of not more than 20 samples	Within the performance based, control chart derived acceptance criteria (example criteria are shown in Table 7-3)	1) Evaluate system 2) Reanalyze LCS and associated samples
Ion Chromatography by 300.0 (chloride, fluoride, nitrate, nitrite, orthophosphate, sulfate)	Initial calibration (5 levels plus a blank)	Daily when samples are run	Correlation coefficiency $\geq$0.995	Recalibrate
	CCV	1 level every 10 samples and at the end of the sequence	± 10% of true value	Reanalyze samples not bracketed by acceptable CCVs
	Method blank	1 per batch of not greater than 20 samples	< RL	Reanalyze samples and blank unless samples are greater than 20 times the blank value or less than the RL
	LCS	1 per batch of not greater than 20 samples	Within the performance based, control chart derived acceptance criteria	Reanalyze LCS and associated samples
	MS/MSDs	1 pair per batch of not greater than 20 samples	Within the performance based, control chart derived acceptance criteria	Flag data associated with unacceptable MS

BFB = p-Bromofluorobenzene
CCC = Continuing Calibration Compounds
SPCC = System Performance Check Compounds
RF = Response Factor
RSD = Relative Standard Deviation
RL = Reportable limit
SOP - Standard operating procedure.
LCS = Laboratory Control Sample.
DFTPP = Decafluorotriphenylphosphine.
ND - Not detected.
VOC - Volatile organic compounds.
GC/MS = Gas chromatography/mass spectrometry

Table 7-3

Example Laboratory Control Limits for QC Samples
Former Ramey AFB, Aguadilla, Puerto Rico

Spiked Compound	Water		Soil	
	% Recovery Range	Precision RPD (%)	% Recovery Range	Precision RPD (%)
Volatile Organic Compounds, Method 8260B				
1,1,1,2-Tetrachloroethane	125 - 75	10	130 - 35	33
1,1,1-Trichloroethane	125 - 72	10	126 - 37	33
1,1,2,2-Tetrachloroethane	125 - 68	12	132 - 35	38
1,1,2-Trichloroethane	125 - 75	12	130 - 46	33
1,1-Dichloroethane	125 - 75	10	134 - 44	29
1,1-Dichloroethylene	125 - 73	10	130 - 36	34
1,1-Dichlororpropene	125 - 71	18	125 - 35	34
1,2,3-Trichlorobenzene	130 - 66	21	137 - 5	37
1,2,3-Trichloropropane	125 - 68	14	137 - 40	37
1,2,4-Trichlororbenzene	127 - 71	25	137 - 5	34
1,2,4-Trimethylbenzene	125 - 74	10	146 - 5	35
1,2-Dibromo-3-chloropropane	125 - 65	18	153 - 7	41
1,2-Dibromoethane	125 - 76	13	128 - 44	31
1,2-Dichloroethane	130 - 66	18	129 - 39	27
1,2-Dichlororethene (total)	137 - 57	11	125 - 39	30
1,2-Dichlororpropane	125 - 75	10	130 - 42	28
1,3,5-Trimethylbenzene	125 - 74	10	132 - 22	40
1,3-Dichloropropane	125 - 74	11	129 - 44	31
1,4-Dioxane	141 - 53	25	156 - 20	42
1-Chlorohexane	125 - 75	10	125 - 35	24
2,2-Dichloropropane	129 - 42	10	133 - 34	29
2-Chloroethyl vinyl ether	191 - 5	73	280 - 5	39
2-Hexanone	135 - 60	19	147 - 37	24
4-Methyl-2-pentanone	131 - 64	19	135 - 38	25
Acetone	160 - 37	20	172 - 17	27
Acrolein	187 - 5	24	245 - 5	40
Acrylonitrile	178 - 5	15	206 - 5	37
Benzene	141 - 61	16	125 - 40	27
Bromobenzene	125 - 75	10	129 - 29	43
Bromochloromethane	125 - 74	10	125 - 51	26
Bromodichloromethane	125 - 72	10	130 - 37	30
Bromoform	126 - 62	15	125 - 27	32
Carbon disulfide	146 - 70	11	139 - 33	28
Carbon tetrachloride	126 - 62	17	131 - 30	32
Chlorobenzene	125 - 75	10	129 - 34	34
Choroethane	134 - 58	12	145 - 33	32
Chloroform	125 - 73	10	127 - 40	30
cis-1,2-Dichloroethylene	131 - 65	11	125 - 48	29

Table 7-3

Example Laboratory Control Limits for QC Samples
Former Ramey AFB, Aguadilla, Puerto Rico

Spiked Compound	Water		Soil	
	% Recovery Range	Precision RPD (%)	% Recovery Range	Precision RPD (%)
Volatile Organic Compounds, Method 8260B (Continued)				
cis-1,3-Dichloropreopene	136 - 58	13	125 - 35	28
Di-Isopropyl ether	125 - 75	10	130 - 50	23
Dibromochloromethane	125 - 75	11	135 - 32	37
Dichlorodifluoromethane	165 - 22	23	137 - 15	39
Ethyl benzene	128 - 67	10	139 - 18	34
Hexachlorobutadiene	148 - 41	30	135 - 5	47
Isopropylbenzene	125 - 75	10	144 - 17	38
m,p-Xylene	125 - 75	10	129 - 32	34
m-Dichlorobenzene	125 - 75	10	131 - 16	45
Methyl Bromide	149 - 32	27	143 - 34	32
Methyl Chloride	143 - 59	18	146 - 33	29
Methyl Ethyl Ketone	133 - 54	18	143 - 35	31
Methyl Iodide	123 - 81	12	NA	NA
Methyl Tert-Butyl Ether	125 - 72	14	135 - 41	25
Methylene Bromide	125 - 75	14	132 - 40	27
Methylene Chloride	125 - 73	11	142 - 39	24
n-Butylbenzene	128 - 71	12	136 - 5	40
n-Propylbenzene	126 - 75	10	141 - 12	37
Naphthalene	132 - 64	28	142 - 5	47
o-Chlorotoluene	125 - 75	10	152 - 9	44
o-Dichlorobenzene	125 - 75	10	127 - 18	43
o-Xylene	125 - 75	10	137 - 36	34
p-Chlorotoluene	125 - 75	10	135 - 19	36
p-Dichlorobenzene	125 - 75	10	128 - 16	43
p-Isopropyltoluene	125 - 74	10	135 - 12	35
sec-Butylbenzene	126 - 75	10	137 - 14	38
Styrene	127 - 74	10	131 - 21	34
tert-Butylbenzene	125 - 74	10	130 - 20	42
Tetrachloroethylene	125 - 75	10	135 - 27	37
Toluene	125 - 72	10	138 - 24	30
trans-1,2-Dichloroethylene	133 - 65	10	121 - 39	30
trans-1,3-Dichloropropene	139 - 49	19	129 - 36	32
Trichloroethylene	125 - 72	10	125 - 40	33
Trichlorofluoromethane	126 - 37	13	143 - 24	34
Vinyl Acetate	283 - 5	12	315 - 5	43
Vinyl Chloride	138 - 63	17	131 - 42	39
Xylene (total)	127 - 69	10	137 - 32	34

Table 7-3

Example Laboratory Control Limits for QC Samples
Former Ramey AFB, Aguadilla, Puerto Rico

Spiked Compound	Water		Soil	
	% Recovery Range	Precision RPD (%)	% Recovery Range	Precision RPD (%)
VOC Surrogate Compounds:				
1,2-Dichloroethane-d4	128 - 69		122 - 71	
4-Bromofluorobenzene	125 - 75		158 - 53	
Dibromofluoromethane	125 - 75		122 - 71	
Toluene-d8	125 - 75		128 - 73	
Semivolatile Organic Compounds, Method 8270C				
1,2,4-Trichlorobenzene	125 - 73	20	125 - 56	14
1,2-Dichlorobenzene	125 - 72	18	125 - 57	15
1,2-Diphenylhydrazine	137 - 73	15	126 - 56	20
1,3-Dichlorobenzene	125 - 71	18	125 - 55	14
1,4-Dichlorobenzene	125 - 70	19	125 - 56	15
2,4,5-Trichlorphenol	125 - 75	13	125 - 59	15
2,4,6-Trichlorophenol	125 - 75	15	125 - 54	17
2,4-Dichlorophenol	125 - 75	14	125 - 59	12
2,4-Dimethylphenol	125 - 69	16	139 - 30	17
2,4-Dinitrophenol	133 - 28	25	125 - 5	48
2,4 Dinitrotoluene	132 - 75	11	125 - 68	12
2,6-Dinitrotoluene	127 - 75	10	125 - 69	12
2-Chloronaphthalene	125 - 75	20	125 - 64	18
2-Chlorophenol	125 - 70	14	125 - 56	14
2-Methylnaphthalene	125 - 75	17	125 - 63	12
2-Methylphenol	125 - 62	14	125 - 57	13
2-Nitroaniline	135 - 70	15	125 - 61	11
2-Nitrophenol	125 - 75	18	125 - 56	15
3&4-Methylphenol	125 - 58	13	125 - 49	14
3,3'-Dichlorobenzidine	125 - 31	42	125 - 44	23
3-Nitroaniline	125 - 56	15	125 - 50	18
4,6-Dinitro-o-cresol	132 - 55	19	125 - 16	24
4-Bromophenyl phenyl ether	125 - 69	14	125 - 56	18
4-Chloro-3-methyl phenol	125 - 71	10	125 - 56	10
4-Chloroaniline	125 - 53	26	125 - 49	12
4-Chlorophenyl phenyl ether	125 - 75	12	125 - 66	12
4-Nitroaniline	130 - 60	19	133 - 40	21
4-Nitrophenol	125 - 32	19	141 - 25	22
Acenaphthene	125 - 75	15	125 - 62	14
Acenaphthylene	133 - 75	15	137 - 76	13
Aniline	128 - 25	25	128 - 16	48
Anthracene	125 - 75	12	125 - 68	12

Table 7-3

Example Laboratory Control Limits for QC Samples
Former Ramey AFB, Aguadilla, Puerto Rico

Spiked Compound	Water		Soil	
	% Recovery Range	Precision RPD (%)	% Recovery Range	Precision RPD (%)
Semivolatile Organic Compounds, Method 8270C (Continued)				
Benzidine	125 - 5	53	151 - 5	75
Benzo(a)anthracene	125 - 75	11	126 - 64	22
Benzo(a)pyrene	125 - 75	12	133 - 60	16
Benzo(b)fluoranthene	125 - 75	11	130 - 54	20
Benzo(g,h,i)perylene	144 - 68	27	174 - 34	29
Benzo(k)fluoranthene	125 - 75	12	128 - 55	20
Benzoic Acid	125 - 5	39	125 - 5	52
Benzyl Alcohol	131 - 44	18	125 - 52	16
bis(2-Chloroethoxy)methane	125 - 74	19	138 - 43	15
bis(2-Chloroethyl)ether	130 - 59	17	136 - 39	14
bis(2-Chloroisopropyl)ether	132 - 69	18	125 - 59	15
bis(2-Ethylhexyl)phthalate	140 - 75	12	137 - 70	14
Butyl benzyl phthalate	139 - 75	10	134 - 68	15
Carbazole	130 - 75	13	141 - 46	13
Chrysene	125 - 75	11	130 - 57	16
Di-n-butyl phthalate	127 - 74	11	125 - 65	18
Di-n-octyl phthalate	127 - 74	12	136 - 49	16
Dibenzo(a,h)anthracene	125 - 45	21	133 - 34	31
Dibenzofuran	125 - 75	14	125 - 65	13
Diethyl phthalate	130 - 52	11	125 - 65	12
Dimethyl phthalate	148 - 9	31	125 - 66	14
Fluoranthene	125 - 75	14	158 - 31	16
Fluorene	125 - 75	12	125 - 63	11
Hexachlorobenzene	125 - 75	13	125 - 68	17
Hexachlorobutadiene	125 - 70	23	131 - 51	17
Hexachlorocyclopentadiene	139 - 36	24	138 - 36	33
Hexachloroethane	130 - 67	21	127 - 61	16
Indeno(1,2,3-cd)pyrene	144 - 64	22	162 - 39	25
Isophorone	130 - 72	16	144 - 40	14
N-Nitroso-di-n-propylamine	132 - 61	15	125 - 52	15
N-Nitrosodimethylamine	125 - 29	20	116 - 37	17
N-Nitrosodiphenylamine	125 - 75	12	131 - 64	17
Naphthalene	125 - 74	19	125 - 60	13
Nitrobenzene	125 - 68	21	125 - 55	14
Pentachlorophenol	128 - 68	14	126 - 20	21
Phenanthrene	125 - 75	12	138 - 49	20
Phenol	125 - 22	19	125 - 48	12
Pyrene	128 - 75	10	156 - 39	16
Pyridine	125 - 12	33	125 - 26	20

Table 7-3

Example Laboratory Control Limits for QC Samples
Former Ramey AFB, Aguadilla, Puerto Rico

Spiked Compound	Water		Soil	
	% Recovery Range	Precision RPD (%)	% Recovery Range	Precision RPD (%)
SVOC Surrogate Compounds				
2,4,6-Tribromophenol	141 - 45		144 - 37	
2-Fluorobiphenyl	137 - 44		135 - 44	
2-Fluorophenol	125 - 11		129 - 36	
Nitrobenzene-d5	133 - 54		135 - 36	
phenol-d5	125 - 5		135 - 38	
Terphenyl-d14	147 - 54		149 - 42	
Pesticide and PCB Compounds, Methods 8081A/8082A				
4,4'-DDD	138 - 35	26	141 - 50	32
4,4'-DDE	139 - 45	24	156 - 57	33
4,4'-DDT	149 - 33	29	157 - 33	41
Aldrin	132 - 34	20	157 - 35	48
alpha-BHC	132 - 39	23	132 - 48	36
beta-BHC	151 - 28	28	135 - 45	30
delta-BHC	137 - 16	27	130 - 11	48
Dieldrin	139 - 43	24	182 - 12	35
Endosulfan Sulfate	140 - 26	28	188 - 5	42
Endosulfan-I	143 - 55	22	127 - 47	34
Endosulfan-II	186 - 35	45	149 - 36	59
Endrin	151 - 35	27	174 - 36	36
Endrin Aldehyde	141 - 10	27	120 - 5	51
Endrin Ketone	141 - 35	27	145 - 41	36
gamma-BHC	127 - 31	24	129 - 47	38
Heptachlor	125 - 31	20	134 - 59	33
Heptachlor epoxide	129 - 69	13	157 - 37	30
Methoxychlor	138 - 40	25	148 - 40	40
alpha Chlordane	128 - 45	18	128 - 45	28
gamma Chlordane	128 - 45	18	128 - 45	28
Aroclor-1016	152 - 66	20	152 - 66	20
Aroclor-1260	146 - 44	24	146 - 44	24
Pesticide/PCB Surrogate Compounds				
Tetrachloro-m-xylene	128 - 50		144 - 50	
Decachlorobiphenyl	157 - 11		180 - 10	
Metals, Methods 6010B/7470A				
Aluminum	120 - 80	20	156 - 39	20
Antimony	122 - 80	20	125 - 39	20

Table 7-3

Example Laboratory Control Limits for QC Samples
Former Ramey AFB, Aguadilla, Puerto Rico

Spiked Compound	Water		Soil	
	% Recovery Range	Precision RPD (%)	% Recovery Range	Precision RPD (%)
Metals, Methods 6010B/7470A (Continued)				
Arsenic	120 - 80	20	120 - 66	20
Barium	120 - 80	20	129 - 56	20
Beryllium	125 - 80	20	120 - 68	20
Cadmium	120 - 80	20	120 - 57	20
Calcium	132 - 65	20	159 - 35	20
Chromium	124 - 74	20	127 - 55	20
Cobalt	120 - 80	20	120 - 65	20
Copper	120 - 80	20	127 - 61	20
Iron	121 - 86	20	161 - 31	20
Lead	124 - 72	20	141 - 41	20
Magnesium	120 - 80	20	137 - 45	20
Manganese	120 - 80	20	137 - 47	20
Nickel	120 - 80	20	120 - 61	20
Potassium	123 - 80	20	125 - 61	20
Selenium	123 - 80	20	110 - 67	20
Silver	120 - 80	20	126 - 44	20
Sodium	123 - 70	20	127 - 56	20
Thallium	126 - 80	20	122 - 66	20
Vanadium	120 - 80	20	121 - 61	20
Zinc	120 - 80	20	136 - 43	20
Mercury	120 - 76	20	128 - 64	20

Note: The accuracy and precision values shown on this table are performance based values derived from control chart statistics and are periodically updated by the laboratory per the SOP. They are shown for reference only. During data review, the most current laboratory-provided criteria will be used to evaluate precision and accuracy acceptability.

RPD - relative percent difference.

and Design, Chemical Data Quality Management for Hazardous Waste Remedial Activities, ER1110-1-263, April 1996 (USACE, 1996). Analysis will be performed by a laboratory that holds current USACE HTRW CX approval. The laboratory will maintain and follow SOPs for each method, and as required by the USACE, these SOPs will be maintained in the laboratory SOP manual, which will be updated as needed during the project.

All laboratory personnel will be trained in the correct implementation of the laboratory SOPs and the analytical methods referenced in Table 7-1 of this plan, as well as general laboratory procedures and sound laboratory practices, prior to analyzing samples from the Former Ramey AFB. The laboratory will be responsible for documenting and maintaining personnel training records, which will be required to be available for review in the event of a laboratory audit.

IT has selected Accutest of Orlando, Florida, to be the primary supplier of analytical laboratory services for the Former Ramey AFB project. As such, Accutest meets or exceeds all specifications, approvals, and certifications in this SAP. Currently, Accutest will be able to provide all the methods specified in this section of the SAP with the exception of organophosphorus pesticides by Method 8141A and dioxin and furan analysis by Methods 8280A or 8290. These methods will be subcontracted to Southwest Analytical Services and Core Labs, respectively. Some tasks or situations may require the procurement of analytical services from another vendor and, in those cases, the qualifications of those vendors will be reviewed by the IT and USACE project chemists before approval is given. Task-specific work plans will include the names and shipping addresses of the selected analytical laboratories.

7.2 Geotechnical Analysis Program

Selected soil samples will be analyzed for geotechnical properties, which may include one or more of the following: sieve analysis with hydrometer (ASTM D421 and D422), Atterberg limits (ASTM D4318), and moisture content (ASTM D2216). All soil and sediment samples collected will undergo moisture content analysis as part of the chemical analyses in accordance with standard chemical analysis laboratory procedures. The moisture results will be used to correct and report data on a dry weight basis.

The geotechnical laboratory selected is the IT Environmental Technology Development Center. This laboratory has all Resource Conservation and Recovery Act (RCRA) licenses needed to handle a variety of wastes, soils, or sediment matrix samples for testing.

7.3 Laboratory Sample Custody and Tracking Procedures

Shipments of samples from the field to the laboratory will be typically within 24 or 48 hours of collection. Samples requiring analyses with short holding times will be identified and designated as such on the AR/COC forms and will be shipped on the date of collection, if possible. This is especially true if soil matrix samples are collected for VOC analysis using the EnCore samplers. Upon receipt of the samples at the laboratory, the laboratory sample custodian will note the condition and temperature of the cooler received, as well as any questions or observations concerning sample integrity. The laboratory sample custodian will record the condition and verify the presence of each sample named on the AR/COC record. Any nonconformances noted either in the sample identifications, type of analysis, or condition upon receipt will be noted and project management notified. The laboratory will maintain an internal sample-tracking record that will document the date of sample removal from storage, extraction, preparation, and analysis, as well as the laboratory-assigned sample number, which is affixed to each sample container upon sample receipt. These tracking records will be used to confirm compliance with the handling and holding time requirements specified in Table 6-2.

Field samples may be held for a reasonable time, such that the required method extraction and analysis holding times are not exceeded or jeopardized. They may be accumulated at the laboratory to form an analytical batch consisting of a maximum of 20 field samples that are of the same matrix or of similar composition. Associated field QC samples, including trip blanks (if required), equipment rinsates, field duplicates, and project-specific MS/MSDs (if required), are to be designated on the AR/COC forms and may be included in the analytical batch.

Samples and sample extracts will be stored by the laboratory in their original container in refrigerators designated by the subcontracted laboratory. The minimum storage time for the samples and the sample extracts is a function of the analytical method holding time for a given analysis. Storage beyond the required holding time for an analysis will depend on whether the laboratory is requested to perform additional analyses outside of the holding time.

As part of the information on the AR/COC record, the samples will be marked for laboratory disposal. The laboratory project manager will authorize and oversee the disposal of samples when the project is complete and the samples are no longer needed. The disposal of samples will be performed in accordance with laboratory SOPs and be in compliance with all EPA and state requirements.

7.4 Laboratory Quality Assurance Plan

The subcontracted laboratory should be aware of and concur with the project DQOs and will be responsible for maintaining the project PARCC and sensitivity requirements in the absence of confirmed matrix interferences. Should there be an impediment to meeting the project QA/QC objectives, the project chemist, or designee, will be notified by the laboratory QA officer in order to establish an appropriate course of corrective action.

7.4.1 Quality Objectives for Measurement of Data

The laboratory will provide the necessary documentation that will enable the IT project chemist and the USACE chemist to evaluate the laboratory's compliance with analytical QA/QC requirements in the following areas:

- Accuracy and precision of the analytical data
- Completeness of the data sets
- Comparability between analyses of the same compounds
- Reporting limits (RL) and project required RLs
- Traceability of the sample custody from the field to the laboratory.

Accuracy and precision, having been defined in detail in Section 3.4 of this SAP, are the agreement between a measurement and the true value and the degree of variability in replicate measurements, respectively. Accuracy and precision are the primary QC indicators for the analytical result and are discussed in the following text.

Analytical Accuracy Assessments. One way to determine analytical accuracy can be through the results of analyte surrogate, matrix, and blank spikes performed. Surrogate spikes are applied to all field samples, MS aliquots, method blanks, and blank spike samples to assess the preparation and analysis efficiency for targeted organic analytes. MSs are performed on selected samples to assess analytical accuracy for a given sample duplicate. At a minimum, an

LCS is prepared on a blank soil or water matrix. When performed together, MS/MSDs and LCS/laboratory control sample duplicates (LCSD) provide important information that is used to determine when matrix interferences are present and to indicate a potential bias in the quantitated sample results.

Analytical Precision. Laboratory replicates, field duplicate samples, and duplicate analysis (such as MS/MSD and LCS/LCSD) are used to quantify precision. Laboratory replicates measure the analytical precision, whereas field duplicate sample analysis provides a precision measurement that includes the sampling and the potential variability of the sample matrix. Soil sample measurements are usually less precise than water sample measurements, because it is much harder to achieve a homogeneous, representative sample. In addition to sample heterogeneity, other factors may negatively impact the precision, such as a different extraction efficiency of the duplicate and original aliquots during preparation, or the subsampling technique of the laboratory analysts obtaining the aliquot required for the sample preparation.

Completeness. Completeness of the data set is evaluated by comparing the data reported to the data requested. This issue requires a prompt response, should the contract requirement of 95 percent for field samples not be met.

Comparability. Comparability is the extent to which comparisons among different measurements of the same quantity or quality will yield valid conclusions. For this project, comparability among measurements will be achieved through the use of standard procedures, standard field data sheets, and uniform concentration units.

Representativeness. Representativeness is a qualitative parameter that expresses the degree to which sample data actually represent the matrix conditions. For example, the approach taken to collect samples is indicative of the representativeness of soil samples for an excavated area. The samples to be collected from the Former Ramey AFB will be taken as described in this SAP and in the site-specific work plans. Samples will be collected which fully represent the areas of concern at each site to ensure that they are usable for delineating any contamination present.

Reporting Limits. As a rule, the RL cannot be lower than the lowest calibration standard for a given analysis. At a minimum, a verification standard at or near the RL is required to technically support the degree of accuracy indicated by the RL.

The RL for a given analysis should be compared to the RL specified for that analysis in the SAP. Table 7-1 contains a laboratory summary listed by method of the list of analytes quantified by the method and the laboratory RLs in soil and water matrices. In the absence of matrix interferences, the sample RL should be less than or equal to the project-required RL, but in the presence of matrix interferences that require sample dilutions, the project-specified RL often cannot be met. When a dilution of a sample is performed, the RL is elevated by multiplying the RL by the dilution factor, and the sensitivity of the measurement is decreased by that same factor. Therefore, when a dilution of the sample is required, either due to a confirmed matrix interference or due to the necessity of bringing targets into the working calibration range of an instrument, the lowest possible dilution of that sample is to be reported by the laboratory in order to meet the project objectives as closely as possible.

Reporting Limits and Method Detection Limits. Method detection limits (MDL) are determined as required in Title 40, Code of Federal Regulations, Part 136, Appendix B or SW-846, Chapter 1 for each method, instrument, project-specified analyte, and applicable matrix (soil/water). The MDLs are recorded and documented and updated annually. After the MDLs are generated, the laboratory establishes its RLs, which are higher than the MDL but below the project required limit, to meet the analytical objectives in all cases. As the MDLs are re-evaluated, the RLs may be adjusted to reflect the new MDL. When this occurs, the laboratory will notify the project chemist and the revised limits will be compared to the project requirements to ensure that the limits still meet the analytical objectives. If they do not, alternate preparation and analysis methods will be employed to lower the RL so that the project target level can be attained. Task-specific work plans will detail these procedures for tasks that require lower-than-standard RLs.

7.4.2 Calibration Procedures and Frequency

Traceability. Traceability is the extent to which data can be substantiated by hard-copy documentation. Traceability documentation exists in two essential forms: one that links quanti-

tation to authoritative standards, and a second that explicitly describes the history of each sample from collection to analysis. The sample COC, condition upon receipt, and any associated nonconformance reports are to be provided with the sample results in order to track the sample history from the field to the laboratory and to assess any negative impact on the sample data arising from nonconformances occurring in the field or during the transport of the samples. Implementation of the Former Ramey AFB SAP, work plans, and site-specific field sampling plans will facilitate compliance with the traceability requirement.

7.4.2.1 General Calibration Procedures and Frequency

Laboratory equipment (e.g., balances, refrigerators, water supply, reagents) will be calibrated or monitored in accordance with the requirements of the EPA, ASTM or the laboratory SOPs. Measuring equipment, test equipment, and reference standards will be calibrated at prescribed intervals and/or before use. The calibration and maintenance records are subject to examination, as the laboratory performing the analytical work is to be USACE validated and is to be audited periodically by the contractor.

The calibration of analytical instrumentation is necessary to ensure that the system is optimized to achieve the proper quantitation and maximum sensitivity, and can reliably meet the required RLs. Initial and continuing calibrations are to employ primary reference standards and standard solutions appropriate to the type of instrument and the working range established for the analytical method. The continuing calibration serves to verify the initial calibration and to bracket the project samples with acceptable verification standard data. Acceptable initial and continuing calibrations are required for all method target analytes prior to analyzing project samples. The requirements for initial and continuing calibrations specific to the analytical method and are to be performed in accordance with the requirements and corrective action indicated in Table 7-3.

7.4.2.2 Calibration Reference Standards

Physical reference standards shall be used only for calibration and shall be stored separately from equipment used for analyses. In general, physical reference standards shall be at least four to ten times as accurate as the requirements for the equipment that they are used to calibrate. In general, physical standards should be recalibrated every 3 years by a certified external agency.

Chemical standards and standard solutions must be traceable to a reliable source, such as National Institute of Standards and Technology or the EPA, and are to be used within the expiration date indicated by the supplier or the method, whichever is first. The concentration of stock and working standard solutions is to be verified by analysis prior to use. Laboratory documentation for all standards and standard solutions must identify the supplier, lot number, purity, concentration, expiration date, preparation date, and any other necessary information, with all documentation signed and dated.

7.4.2.3 Calibration Failures

If an equipment malfunction is suspected, the device will be tagged and removed from service. In the laboratory, such action should be reported to the laboratory PM, laboratory QA officer, and project chemist. In the field, the sampling coordinator or field supervisor will be notified.

7.4.2.4 Calibration Records

Records will be prepared and maintained for each piece of calibrated measuring and test equipment and each piece of reference equipment to indicate that established calibration procedures have been followed. Records for equipment used will be kept in the appropriate project file.

7.5 Laboratory Nonconformances and Corrective Action Procedures

Nonconforming equipment, items, activities, conditions, and unusual incidents that could affect compliance with project requirements will be identified, controlled, and reported in a timely manner. A nonconformance is defined as a deviation from the objectives stated in the project plans, cited methods, or SOPs. Some examples of nonconformances may include:

- Nonconformances associated with an instrument malfunction
- Change in organization or procedure
- Substitution of equipment or method
- Undesirable trends in laboratory QC or method QC data
- Loss of sensitivity as indicated by significant changes in the RLs

- Deficiencies noted by the laboratory QA department such as performance evaluation sample performance or internal/external audits.

Once a nonconformance is noted and documented, the situation is monitored by project and QA personnel who determine how best to still achieve the objectives planned. The formulation of how the nonconformance situation will be resolved is defined as the corrective action.

The laboratory QA officer and laboratory PM are responsible for the initial assessment of QC sample information. If data fall outside accepted limits, the laboratory QA officer will immediately notify the IT project chemist. If the situation is not corrected and a condition occurs that is not planned or expected to occur, the IT project chemist, the laboratory QA officer, the laboratory PM, and department leaders are responsible for identifying the source of the nonconformance, determining the impact of the nonconformance on overall data quality and usability, and initiating corrective action. A corrective action may result in a reanalysis method modification, the use of qualified data, or if necessary, resampling. Completion of corrective action should be evidenced by data returning to prescribed target limits or assurances that future data will be within target limits. Surveillance of the activity or a project audit of the process may be warranted to document the success of the corrective action approach. For instance, if due to oversight, a sample is not spiked with a surrogate compound, a laboratory nonconformance would be initiated. If the sample was still within holding times, the laboratory PM could direct the laboratory to extract, spike, and reanalyze additional volume from the sample as a corrective action. Table 7-2 summarizes the laboratory corrective action steps to be taken in conjunction with analytical method QC checks that are performed on a specified frequency.

The modification, repair, rework, or replacement of nonconforming equipment, items, or activities will require the reverification of acceptability. In certain instances, as determined by the project chemist, these actions may require that corrective action be completed and verified before site work continues.

The equipment, item, or activity that has the deficiency may be temporarily stopped while the nonconformance is being investigated. If, in the opinion of the IT project chemist or IT PM, the nonconformance does not significantly affect the technical quality or use of the work, the work may continue pending resolution of the nonconformance. The basis for such decisions will be documented on the Nonconformance Report and submitted to the QA officer for review and

approval. The documentation will include the statement that the decision was made prior to continuing the work. The records of nonconformance and their dispositions will be kept in the project central files.

7.6 QC Program

QC procedures are implemented to provide the quality of data suitable for their intended use and to ensure that the project DQOs are satisfactorily met. Field QC and laboratory QC checks are used to determine if the analysis is in control, as well as if the sample matrix adversely affects the quantitated result. To clarify these requirements, the following definitions are provided.

7.6.1 Field QC

Field QC or matrix-specific QC is performed to check the sampling and analytical accuracy and precision of field data and to determine the origin of contamination originating from the collection, transport, or storage of samples. The purpose of field QC data is to provide important information about field operations. Analytical data are not to be altered or corrected for any results from the field QC samples. The requirements and frequency is determined by the method or specified by the project. The types of matrix-specific QC are MS/MSDs field duplicates, trip blanks, equipment blanks, field blanks, and material blanks, as discussed in detail in Section 6.0 of this SAP.

Matrix Spike/Matrix Spike Duplicates. MS/MSDs are used to determine the accuracy and precision of the method for a sample matrix. The spiked compounds include representative compounds that are quantified during the method and spiked during sample preparation on a specially prepared aliquot of the sample matrix. Results of these spiked aliquots are then compared to the native concentrations of the analytes spiked, and a recovery is calculated. Recovery of the spiked compound is used as an assessment of analytical accuracy on the sample matrix analyzed. These results are essential to identifying sample matrix interferences. Often, matrix spikes are performed in duplicate (as an MSD) on a second aliquot of the sample. In this manner the precision of the assessment can be quantified as the RPD of the original and duplicate spike. The target acceptance limits for MS recovery and RPD are performance based and are statistically determined by the analytical laboratory as specified in the method. As such, these values are periodically updated by the laboratory. Example acceptance limits for precision and accuracy are presented in Table 7-3 of this SAP for reference.

Field Duplicates. Field duplicates are used to assess the precision of the sample collection procedures for a specific matrix. No data are qualified based solely on the results of field duplicate analyses.

Field duplicate sample analysis will be performed on a task-specific frequency to address the variability of contaminant concentrations in the sample matrix. Because of the additional variability introduced during sampling, the target acceptance criteria has been increased to less than or equal to 50 percent RPD (whereas, analytical duplicates are generally less than or equal to 20 percent RPD). These checks are summarized in Table 7-2.

Trip Blanks. Trip blanks are used to evaluate contamination from volatile organic compounds originating from the transport of the samples. In the event of trip blank contamination, the associated sample data are evaluated for false positive results.

Equipment Blanks. Equipment blanks are used to check the adequacy of the decontamination of the sampling equipment used for the samples collected. In the event of equipment blank contamination, the associated sample data are evaluated for false positive results.

Field Blanks. Field blanks are used to check for contamination originating from the ambient conditions affecting the field samples. In the event of field blank contamination, the associated sample data are evaluated for false positive results.

Material Blanks. Material blanks are used to assess the purity of the source-water and to determine whether contamination originated from the source water on site or from the decontamination process. In the event of material blank contamination, the associated sample data are evaluated for false positive results.

7.6.2 Laboratory QC Procedures

Laboratory QC implements internal QC checks to monitor the precision and accuracy of an analytical method in the absence of known matrix interferences and can be categorized as batch QC and method QC. These internal QC checks are used together to ensure that the data quality is satisfactory and are required to provide confidence in the consistent quality of the data. Table

7-2 summarizes the QC acceptance criteria, and the subsequent corrective action for each analytical method.

The sample batch is a group consisting of a maximum of 20 samples that are of the same matrix or of similar composition and that are prepared and/or analyzed together under the same analytical conditions. Samples that are prepared together should be analyzed together, with the exception of failed QC indicators that warrant reanalysis. There is a distinction between a preparation batch and an analytical batch.

The preparation batch is defined as samples that are prepared together using the same equipment, method sequence, the same reagents and undergoing the same process. Each preparation batch must contain the required number and type of blanks, laboratory QC samples, and field QC samples defined for the method or the project.

The analytical batch consists of a group of samples that are analyzed together within the same analytical run sequence and within the same time period or in sequential time periods with the required number of calibration standards and QC samples defined by the method or the project.

7.6.2.1 Batch QC

Samples that are required for every batch are, at a minimum, the method blank and an LCS or blank spike. Further QC requirements are addressed by the method or on a project-specific basis.

Method Blanks. Method blanks are either water or soil matrices that are known to be free of matrix effects, analyzed with each analytical batch and are processed on a per matrix (i.e., soil and water) basis. These blanks are carried stepwise through the same analytical procedure as the field samples, including the addition of solvents, spikes, and reagents required in the analysis process. The purpose of the blank is to identify any possible contaminants that may be introduced to the sample as a result of any part of the analytical process. Contamination identified in the method blank can be compared to the results of the field samples and can be used to assess the origin of the reported concentration and to identify cases where elevated concentrations might be false positive data.

Laboratory Control Samples or Blank Spikes. LCS or blank spike samples consist of known amounts of target analytes in an analyte-free matrix (soil or water). The spiked compounds include representative compounds that are quantified during the method and spiked during the sample preparation on a specially prepared aliquot of the sample or blank matrix. Results of these spiked aliquots are then compared to the known concentrations of amounts the analytes spiked and a recovery calculated. Recovery of the spiked compound is used as an assessment of analytical accuracy of the analytical method and to determine control limits for the method. These results are useful in distinguishing sample matrix interferences from analysis interferences through a comparison of MS and blank spike recovery data. Often, the LCS is performed in duplicate (as an LCSD) on duplicately prepared aliquots. In this manner, the precision of the assessment can be quantified as the RPD of the original and duplicate spike. The target acceptance limits for the LCS recovery and RPD are performance based and are statistically determined by the analytical laboratory as specified in the method. As such, these values are periodically updated by the laboratory. Example acceptance limits for precision and accuracy are presented in Table 7-3 of this SAP for reference.

MS/MSDs. MS/MSDs, prepared by spiking duplicately prepared sample matrix aliquots, are often requested to be analyzed every 20 samples. The percent recoveries from each spiked sample and the RPDs between the spiked pairs provide an assessment of the precision and accuracy of the method for the matrix being analyzed.

Laboratory Replicates. Laboratory replicates are analyses of replicate aliquots or split aliquots of a field sample. When specified in the task-specific work plan, these samples can provide an indication of the precision of the analytical process.

7.6.2.2 Method QC

Surrogates. Surrogates are halogenated or isotopically labeled compounds, not typically occurring in nature, that are used in the analytical program to monitor the efficiency of the sample preparation and analysis procedures on a sample-by-sample basis for organic compound analysis (Methods 8021, 8260B, 8270C, 8082, and 8015B). Known spike concentrations of the surrogate compounds are added to laboratory QC and field samples to determine the accuracy of the method for each sample matrix. The compounds used as surrogates are specified in the

method and their acceptance criteria are performance based and statistically determined by the laboratory. Example acceptance limits are shown in Table 7-3 for reference.

Internal Standards. Internal standards are analytes that have the same characteristics as the surrogate, but are added to a sample just prior to analysis. The internal standard area and retention time are QC indicators, as well as indicators of instrument response for each sample, and are controlled according to method specifications. Each sample concentration is normalized to its internal standard response. Any QC deficiency for the internal standard will directly impact and drive the direction of the bias of a sample result.

Interelement Correction Standards. Interelement correction standards are used in the inductively coupled plasma analysis to verify interelement correction factors that are designed to correct for a predetermined spectral interference from one element to another. The acceptance criteria for the interelement correction standards are stated in the analytical method.

Verifications Standards. Verification standards are standards that originate from a different source or lot than the calibration standards and are used to verify initial and continuing calibrations for accuracy or linearity after the initial calibration and at a specified frequency of sample analysis. Acceptable continuing calibration verification standards are to bracket all sample analyses for the Former Ramey AFB.

7.6.3 Preventive Maintenance Procedures

Periodic preventive maintenance is required for all sensitive equipment. Instrument manuals will be kept on file for reference purposes should equipment need repair.

Laboratory equipment requiring routine maintenance has a control system indicating the date of required maintenance, person maintaining the equipment, and the next maintenance date. Information pertaining to life histories of equipment maintenance will be kept in individual logs for each instrument.

7.6.4 Performance and Systems Audits

Scheduled project/laboratory audits will be performed as project activities allow, to review and evaluate the adequacy of field activities and laboratory performance, and to ascertain if the SAP

is being completely and uniformly implemented. The IT PM is responsible for requesting and establishing an audit team. Annual audits may be supplemented by additional audits for one or more of the following reasons:

- When significant changes are made in field or laboratory protocols
- When it is necessary to verify that corrective action has been taken on a nonconformance reported in a previous audit
- When requested by the PM.

The objectives of performance and systems audits are to verify that the SAP developed for this project is being implemented according to the specified requirements, to assess the effectiveness of the plan, to identify nonconformances, and to verify that identified deficiencies are corrected. Upon discovery of any significant deviation from the SAP, the IT PM and QA officer shall be informed of the nature and extent, and a nonconformance documented and corrective action taken to remedy the deviation.

More information concerning audits is presented in Section 4.0.

7.7 Laboratory Data Reduction, Review, and Reporting

The data provided by the laboratory will have been internally reviewed and judged with respect to compliance to the QA/QC requirements discussed in Section 7.4. Review of the data by the laboratory will be of sufficient quality to assure the validity of the reported data. The laboratory is responsible for complying with internal SOPs during the review process, including data generation, data reduction, data review, and data reporting.

Data reduction involves calculating analyte concentration from instrument outputs. The equations used to calculate analyte concentrations should be addressed in the laboratory SOP for each method. Applicable units and term definitions should also be specified. All software used to generate analytical results should be validated by the manufacturer or by following procedures established in a laboratory SOP.

The data review process consists of at least three levels of review. Each stage of the review process should be documented with an appropriate checklist form that is signed and dated by the reviewer. The following are required elements of the review process:

Review Level 1. One-hundred percent of all generated data must be reviewed by the analyst. Each analyst reviews their work based on established guideline for each method. The review shall at a minimum ensure:

- Sample preparation information is correct and complete.
- Analysis information is correct and complete.
- Appropriate SOPs have been followed.
- Analytical results are correct and complete.
- QC samples are within established control limits.
- Blanks and laboratory control samples are within appropriate QC limits.
- Special sample preparation and analytical requirements have been met.
- Documentation is complete (all anomalies have been documented and forms completed, holding time violations documented, etc.).

Review Level 2. Twenty-five percent of the generated data are reviewed by a supervisor or data review specialist to provide an independent review of the data package. This review shall also be based on established guidelines and shall ensure:

- All appropriate laboratory SOPs have been followed.
- Calibration data are scientifically sound, appropriate to the method, and completely documented.
- QC samples are within established guidelines.
- Qualitative identification of sample components is correct.

- Quantitative results are correct.
- Documentation is complete and accurate and anomalies have been documented.
- Data are ready for incorporation into the final report.
- The data package is complete and ready for data archive.

Review Level 3. Level 3 review is performed by the technical director or PM who is ultimately responsible for the issued report. The review should include the elements of a Level 2 review and provide a total overview of the data package to ensure consistency and compliance with project-specific DQOs.

Errors discovered during the review process are formally transmitted to the appropriate analyst. The cause of the error is then addressed and appropriate corrective action is taken to ensure that similar errors do not occur.

In addition to this review process, the laboratory QC coordinator is responsible for reviewing hard copy analytical data packages periodically, as specified in the corporate SOP, to ensure that the total review process complies with internal guidelines. It is the QC coordinator's responsibility to investigate any failures to follow protocol and to take corrective action.

7.8 Laboratory Reporting and Deliverables

A standard data reporting format will be required for all laboratory reports. Site-specific field sampling plans will address the need for full data package deliverables. EDDs in an ITEMS format will be submitted with each report. Certificate of Analysis deliverables will be sufficient for TCLP or IDW samples.

A standard report contains the following elements:

- A case narrative including a description of any method modifications, anomalies, or nonconformances occurring during the transportation, receipt, storage, preparation, or analysis of samples
- Sample results Contract Laboratory Program (CLP) Form 1s or similar document) and all associated raw data

- A copy of the COC
- QC sample results including surrogate recoveries, spike (LCS/LCSD, MS/MSD or blank spike/blank spike duplicate) recoveries, RPDs, method blanks, as well as all field-specified QC samples such as trip blanks, equipment rinse blanks, and field duplicates. The temperature of the cooler upon receipt will also be reviewed.

Each page of data should include the project number and name, date of issue, and client name. Data will be presented in a tabular format when possible. Data presentation must include:

- Sample identification number provided to the laboratory and associated laboratory number
- Analytical method
- Chemical parameters analyzed, reported values, and units of measurement
- RLs of the analytical procedures
- Flagging of data detected and reported at less than the RL
- Consistent number of significant figures for sample results
- Precision and accuracy limits
- Soil and sediment samples reported on a dry weight basis
- Footnotes referenced to specific data if required for explanation of results.

Although not included in a standard report, the laboratory should maintain all raw data including instrument chromatograms necessary to produce a Level IV package containing "CLP-like" summary forms. Independent validation of data packages may be required based on specific site or data requirements. If validation is required, the laboratory must provide all documentation necessary for the level of validation requested by IT.

All original laboratory documents are to be stored by the laboratory in a safe controlled environment for a period of not less than 7 years. All original documents should be available for review upon request.

EDDs should be verified by the laboratory to be free of defects and in agreement with the hard copy data. All disks should be scanned for viruses before submittal. Information should comply with specified ITEMS format and valid values. EDDs found to have significant defects in format or information will be returned to the laboratory for correction and resubmittal. It is the responsibility of the laboratory to perform corrective action to prevent reoccurrence of errors, and to provide the documentation necessary to support the review and correction of the errors.

8.0 Contractor Data Management and Reporting System

8.1 Data Reduction and Review of Field Activities

Data collected during the field activities will be reviewed by checking the procedures used and comparing the data to previous measurements. The field coordinator or sampling coordinator will be responsible for checking field QC samples to verify that sample collection and field measurement protocols have been observed. These checks will include:

- Use of SOPs
- Calibration method and frequency
- QC bottle lot number
- Date/time sampled
- Preservation
- Samplers
- Laboratory
- COC number
- Date shipped
- Airbill number.

The field data will be reported in the following units:

- Water levels - Reported to the nearest 0.01 foot
- pH - Digital reading rounded to 0.1 pH units
- Electrical conductivity - Reported to 100 micromhos
- Survey data - Well casing elevations surveyed to 0.01 foot; coordinates to 0.01 foot
- Water temperature - °C reported to 0.1 degree unit
- Eh - Oxidation/reduction potential digital reading to nearest 0.1 millivolt
- Dissolved O_2 - Milligrams per liter to nearest scale reading
- Turbidity - Reported to nearest 1.0 NTU.

Laboratory data will be reviewed on an on-going basis. All data reported by the laboratory will undergo a three-tiered internal review process by the analyst, a peer or supervisor review, and a project management review before being sent to the task manager and data coordinator for additional project review. In the data review process, the data are compared to information such as the sample history, sample preparation, and QC sample data to evaluate the validity of the results.

8.2 Data Assessment and Validation Activities

8.2.1 Data Evaluation/Assessment

The hard copy and the electronic copy of the data are to be submitted to the IT data coordinator and project chemist for QC review. This process involves several steps that require a complete accuracy check of the hard copy package, the EDD format and content, and the hard copy against the EDD to ensure that they agree. Once this is complete, the data are then ready to be evaluated for compliance with the project DQOs to assess the data usability and to identify problem areas that require data validation. After the validation or review process has been completed, the data will proceed to a data evaluation/assessment to determine the ability of the data collected to address the project objectives. Outliers will be evaluated using statistical procedures and will be described in the task final reports. Issues to be addressed in this evaluation/assessment include, but are not limited to, the issues defined in the following sections.

8.2.2 Reporting Limits

RLs will be reviewed during the initial accuracy check evaluation/assessment to determine if the objectives of the project are being met. If project objectives are not being met, the PM will be notified and an appropriate course of action will be determined. Possible corrective actions include reanalysis by the original method, the addition of sample cleanup steps prior to analysis, resampling and analysis, or analysis by an alternative method. When an appropriate action is identified or when it is determined that no reasonable action is apparent to remedy the situation, the USACE will be notified and a reasonable solution sought.

The RL cannot be lower than the lowest calibration or verification standard. In the event that this occurs, data reported lower than the lowest standard are to be considered as estimated, or alternatively, the RL is to be elevated to the concentration of the lowest standard.

8.2.3 Qualifiers

8.2.3.1 Laboratory Qualifiers

The laboratory uses qualifiers to flag analyses for a variety of reasons. Laboratory qualifiers are specified in the case narrative along with an explanation of their meaning. Qualifiers are used to provide additional detail to support the review and interpretation of data. These qualifiers and their definitions are listed in Table 8-1.

Table 8-1

Definitions of Common Data Qualifiers Assigned by the Laboratory for Organic and Inorganic Analyses Ramey AFB, Aguadilla, Puerto Rico

Qualifiers	Definition
Organic Qualifiers	
U	The analyte is not detected at a concentration above the MDL. The sample result is reported as not detected at the reporting limit (Reference Table 7-1).
J	The analyte is detected at a concentration above the MDL but below the reporting limit. The sample result is reported at the concentration detected as an estimated value.
B	The analyte was detected in an associated laboratory preparation blank.
D	The sample result reported is taken from the analysis of a diluted sample.
Inorganic Qualifiers	
U	The analyte is not detected at a concentration above the IDL. The sample result is reported as not detected at the reporting limit (Reference Table 7-1).
B	The analyte is detected at a concentration above the IDL but below the reporting limit. The sample result is reported at the concentration detected as an estimated value.

IDL - Instrument detection limit.
MDL - Method detection limit.

8.2.3.2 Validation Qualifiers

Data qualifiers may be added or changed as required by validation guidelines. If 30 percent of the results for a given method, or 50 percent of the results for one compound, are qualified as estimated, the PM will determine an appropriate course of action. Factors that will be considered in determining the appropriate course of action include the number of results qualified, the reason for qualification, any pattern in the qualified data, the importance of the qualified compound(s), and the importance of the samples. Data validation qualifiers are listed in Table 8-2.

The addition of validation qualifiers does not indicate that data are unusable for any purpose, unless they are rejected (R). Data may be rejected for various reasons such as: massive exceedance of holding time, situations where organic compounds (primarily volatiles) exhibit poor calibration responses (i.e., ketones and halogenated hydrocarbons) or compounds with extremely low surrogate or MS/MSD recoveries. They do, however, identify the level of confidence that can be placed in the data when using it to establish the presence or absence of a compound or to quantify the result. Thus, data validation is a mechanism for indicating the limits of use of the data, if limits must be applied.

8.2.4 Blank Verification

All analytical results reported by the laboratory will be evaluated for blank contamination. Field QC samples will be associated with corresponding original samples on the sample collection logs, which are completed during sampling. This association information will be entered into the database. Upon receipt of data packages, the QC associations will be completed, indicating all laboratory QC samples, their sample numbers, the date they were run, and the associated field samples. Both field and laboratory blank results will also be identified and assessed for inputs on data quality.

When all blanks are associated with the appropriate field samples, each field sample will be evaluated based on the 5x/10x rule for blank contamination. Blanks that contain concentrations of target analytes above the MDLs (including estimated concentrations below RLs) will be flagged. The corresponding sample results will be evaluated and additional qualifiers recorded for these values where blank contamination was noted. The results of this evaluation will be entered into the database and a summary of these results will be prepared. No blank correction will be applied in any presentation of the sample data unless directed by the method.

Table 8-2

Definitions of Common Data Qualifiers Assigned by Data Validation for Organic and Inorganic Analyses Ramey AFB, Aguadilla, Puerto Rico

Qualifier	Definition
J	The associated value is an estimated quantity. See the data validation report for explanation.
R	The data are unusable. See the data validation report for an explanation.
UJ	The material was analyzed for, but was not detected at the given reporting limit. The associated reporting limit is an estimate and may be imprecise due to method QC problems as summarized in the data validation report.
B	Contamination present in the associated blank samples.

For site contaminants of concern, the level of analyte detected in the blank should not exceed the MDL. During data review, the project chemist or data validator will determine if any contaminants of concern were detected in the associated blanks and make a recommendation to the IT PM or task leader concerning data use. The task-specific final reports will identify any contaminants of concern that have been possibly affected.

8.2.5 Assessment of Data Precision, Accuracy, and Completeness

Table 7-3 summarizes the target acceptance criteria for the analyses requested. Note that all criteria that are included in the SAP are to be considered as target goals. When QC data fall outside these ranges, it may be necessary to reanalyze the samples. Generally, the data are flagged in the laboratory with lab qualifiers. Evaluation of the data by the project chemist, data validator, analytical data coordinator, the laboratory project manager, and the laboratory QA officer will be completed and a recommendation made to the PM concerning the usefulness of the data. Corrective action procedures may then be formulated and implemented in the field or laboratory to avoid reoccurrence of the condition. In all cases, the results of the data usefulness evaluation will be documented and discussed in a QCSR and all other project reports. During data validation all data anomalies will be assessed for their impact on the usability of the data. Data anomalies will be flagged with the appropriate qualifiers defined in the National Functional Guidelines. The lab qualifiers and data validation qualifiers to be used are summarized in Tables 8-1 and 8-2, respectively.

To determine the precision of an analytical method and/or laboratory analyst, a routine program of replicate analyses is performed. The results of the replicate analyses are used to calculate the RPD, which is the governing quality control parameter for precision. IT will determine the precision of the analyses conducted during this investigation by reviewing the results of field replicate samples and laboratory duplicate samples (where applicable), then, if sufficient data are obtained, the arithmetic mean and standard deviation of a group of results may be calculated.

Statistical comparison of both field and laboratory duplicate samples as a measure of precision evaluating both sample collection procedures and laboratory instrument performance, may be accomplished by first comparing the obtained duplicate results with the published EPA criteria for method precision. If EPA criteria are not available, the RPD may be calculated and compared to the precision criteria established by the laboratory for the analysis of laboratory

duplicates. Should the RPD exceed the QC acceptance range, the associated data should be considered as estimated.

The accuracy of a method is an estimate of the difference between the true value and the determined mean value. Certain QA parameters such as LCSs, reagent water spike samples, QC check samples, MS samples, and surrogate spike samples all have known concentrations prior to analysis. By comparing the percent recovery of the analysis of these samples to the true value, it is possible to measure the accuracy of the analysis.

Percent recovery values, and control limits or DQOs, are reported by the laboratory as a measure of method accuracy and will be compared with the published EPA criteria for the accuracy of an individual method. QC data not meeting the EPA target criteria for accuracy will be flagged during data validation using the appropriate qualifiers as defined in the National Functional Guidelines as previously discussed.

Data completeness will be expressed both as the percentage of total tests conducted that are deemed valid and as the percentage of the total tests required in the scope of work that are deemed valid. Percent completeness is calculated with respect to the purpose of analysis (i.e., chemical, geotechnical, soil classification) as well as type of sample (i.e., field sample or QA/QC sample). The purpose and total number of each type of sample planned in the scope of work will be calculated and tabularized in the task work plan for each specific task. As part of the evaluation of the task completeness performed in the task final report, the actual number of samples collected will be compared to the planned number, and completeness will be discussed in the task-specific report. The completeness goal for all the different types of samples on this project is 95 percent, except for QA/QC samples. Completeness of QA/QC samples will have to be judged on a case-by-case basis in the report documents. Enough QA/QC data must be available to allow a thorough assessment of data quality to be performed.

Representativeness is discussed in Section 7.4.1 of this SAP.

8.2.6 Background

For investigation activities, a sufficient number of background samples to gather mean, standard deviation, and concentration range data may be collected and analyzed. These samples may be collected from multiple sites, then averaged for installation-wide background. These data will be

reviewed to determine if any chemicals of concern are present and at what concentration. Site data will then be compared to mean background data to determine if site concentrations are statistically different from background concentrations. If background samples contain significant concentrations of chemicals of concern, or if it is determined that site samples contain concentrations of these chemicals that are statistically different from background, determinations will be made concerning the appropriate actions. Possible actions could include relocating background samples, and collecting additional background or site samples to determine the extent of contamination.

8.2.7 Tentatively Identified Compounds

Tentatively identified compounds (TIC) will be quantified only when incorporated as part of the planned SOW for each individual site. They will be reviewed to determine if they appear in the field samples at concentrations significantly greater than the field and laboratory blanks. TICs present at concentrations significantly greater than the blank concentration in less than 5 percent of the field samples for a given matrix will not be considered in the data review. It is not anticipated at this time that TICs will be reported.

8.2.8 Data Validation Requirements and Procedures

One hundred percent of the samples collected will be validated by the IT data validation staff. Data validation will be based on the QC acceptance criteria specified in Table 7-3 of this SAP or according to the DQOs established in the site-specific task work plans. In addition, the National Functional Guidelines (EPA, 1993b, 1994b) will be followed for application of the data validation qualifiers, and they will serve as default data validation guidelines for method or instrument QC requirements not addressed in this SAP. Since samples will mainly be analyzed by SW-846 methodologies, the data validators will evaluate the QA/QC guidance provided in each method used to analyze samples. Overall, the SW-846 guidelines mimic the most current edition of the National Functional Guidelines. Following completion of the data validation, the validator will compile the data review notes and assemble them into a standardized data validation report format. The IT project chemist or her designee will review all data and assess the usability of the data based on the validation effort findings.

8.3 Field Data Evaluation/Assessment

Upon receipt, the field data package will be reviewed by the data coordinator and task manager for completeness and accuracy. The field data package includes all of the field records and

measurements developed by the sampling team personnel. The field data package verification procedure will consist of:

- Reviewing field data contained in water, air, soil, and sediment sampling lots for accuracy and completeness
- Verifying that field samples and field QC samples were properly prepared, preserved, and identified
- Checking on field analyses (pH, specific conductance, and temperature) for equipment calibration and instrument condition
- Reviewing AR/COC records for proper completion with signatures of field personnel and dates.

8.4 Quality Control Summary Report

The QCSR is designed to evaluate all of the representative data from the field analyses and the fixed laboratory analyses. For each group of data, a data review checklist is completed that addresses specific QC indicators for each method and enables the reviewer to identify problem areas that may require additional data validation. In addition to laboratory data, field and sample collection data are also reviewed. This includes a review of daily quality control reports completed by the field manager and/or lead field geologist. The QCSR addresses nonconformances, QC deficiencies, or other problems that would impact the data quality. The overall useability of the data is summarized in this report.

8.5 Record Keeping

At least two copies of all data forms and deliverables will be generated during the project and stored at different locations. Wherever practical, original forms will be archived at IT in Knoxville, Tennessee, and copies will be retained by the laboratory and field personnel. Analytical data will be archived at least 7 years by the laboratory. Upon project completion, all original forms and data will be transferred to the USACE.

8.6 Nondirect Measurements

Nondirect measurements are sometimes used to gather data. Examples of these include literature searches and database query and retrieval. In these measurements, it is important to use reliable, documented sources. Once the source of the data is identified and verified as reliable, a reference

of this source document should be cited in all data summaries and reports. Whenever possible, verification from multiple, independent sources that yield comparable data should be obtained and documented. This should then be noted in associated data summaries and reports.

8.7 Electronic Data Management

Data for the project will be managed using the IT Environmental Management System™ (ITEMS™), IT's Oracle-based information management system. A Former Ramey AFB project database is used to store all the data collected and to produce site reports with various analytical, physical, and geographic data. The field program will yield data from planned field samples and associated QA/QC samples that will be planned, tracked, validated, reported, and entered into the database. Using ITEMS, IT will manage, report, and produce an electronic data deliverable (if required) upon completion of the project for all samples collected.

Analytical data will be managed beginning at the point of sampling, continuing through the laboratory analysis, data reporting and validation, and culminating with any requested electronic data submission for the project. During the field program, samples will be packaged and shipped to the laboratory, submitted for analysis, and tracked through the laboratory system. Reported data will be reviewed, validated as required, and entered into the Former Ramey AFB database for use by IT technical staff in the preparation of reports and submit any electronic deliverables to the USACE. Waste samples sent offsite during the field program for analysis to characterize the waste for disposal will not typically be validated or submitted electronically.

Database Management. The existing Former Ramey AFB database will be used to store both field and laboratory analytical data. ITEMS will be used to access, manage, and report the data and produce the any specified electronic data deliverables for the project. The following tasks will be performed in the data management activity:

- Sample Planning. The Former Ramey AFB database will be set up in this task and all planned field and QC samples will be entered into the database using the ITEMS Sample Planning Module. The existing ITEMS Sample Planning Module will be used to produce a detailed sampling plan for review prior to field mobilization. This will help to ensure QC sample requirements are met, as well as providing a basis for logistical planning.

- Field Data Entry. This task includes manual entry (and QC checking) of key field measured parameters into the database. The existing ITEMS Field Module will be used to generate sample labels and chain-of-custody forms, and store field recorded data onsite. This information will be integrated into the Former Ramey AFB database.

- Data Validation Qualifier Entry. The task includes the manual entry (and QC checking) of data validation-assigned qualifiers into the database.

- Data Management and Routine Reporting. This task includes receiving, uploading, and checking electronic data deliverables from Accutest; populating database; and producing reports for end users. This includes the following subtasks:

  - Database administration (table space, backups, system maintenance, technical support, etc.).

  - Database maintenance, review, and setup of tables by the database manager for planned locations, chemical parameters, sampling methods, and generating field forms for data collection.

  - Loading of the laboratory-provided electronic data deliverables into the database by the database manager. Coordination by the database manager with Accutest on the format of their electronic data deliverable and creation of import specifications to accept the deliverables. Appendix E describes the default specifications for the submittal of laboratory data in ITEMS format.

  - Programming by the database manager to support the project-required report formats specified in the work plan. Adding these formats to the list of available reports is also addressed. Downloading the data for error identification and verification of error correction by the database manager is also included.

  - Additional customization by the database manager to add the specific field projects into the Former Ramey AFB database. Typical additional requests, based on experience, may include additional reports, new forms, customization to existing forms or the need to include other data not required at the beginning of the project. The forms and reports are written using Oracle Developer products.

- Production of Electronic Deliverables. Generating electronic data deliverables of the field and analytical data from the Former Ramey AFB database is the focus of this task. These deliverables will be prepared after the final report is complete based on the specific needs of the USACE. The database manager will be responsible to resolve any errors and perform any correction to the data.

9.0 References

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