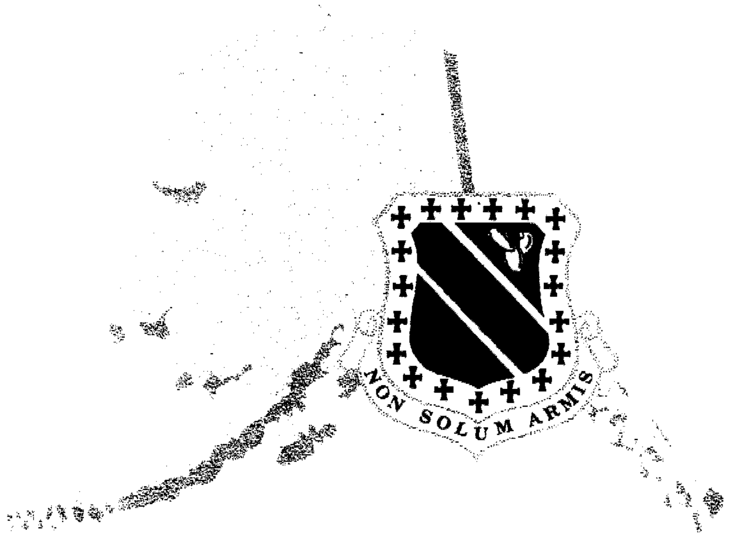

UNITED STATES AIR FORCE

ELMENDORF AIR FORCE BASE, ALASKA

ENVIRONMENTAL RESTORATION PROGRAM

BIANNUAL TECHNICAL MEMORANDUM, BASEWIDE SUPPORT AND GROUNDWATER MONITORING PROGRAM

AUGUST 1997

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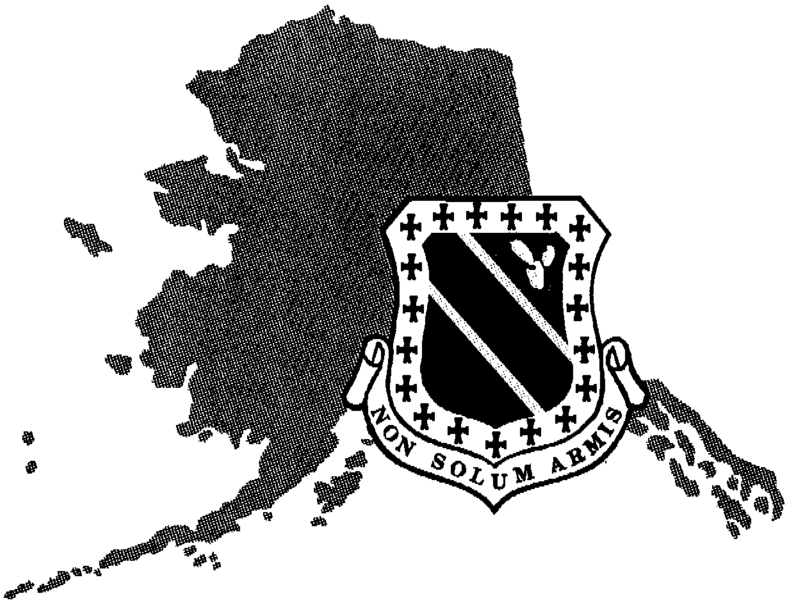

UNITED STATES AIR FORCE
ELMENDORF AIR FORCE BASE, ALASKA

ENVIRONMENTAL RESTORATION PROGRAM

ENVIRONMENTAL MONITORING PLAN, BASEWIDE SUPPORT AND GROUNDWATER MONITORING PROGRAM

FINAL

MAY 1996

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PREFACE

Work on the Basewide Support and Groundwater Monitoring Program is authorized under the Air Force Center for Environmental Excellence (AFCEE) Contract F41624-94-D-8049/0037. As outlined in the Delivery Order Statement of Work (SOW), the Environmental Monitoring Plan contains program area background information, a work plan for tasks to be performed, a schedule of Basewide activities for the period of performance, a health and safety plan reference, and a sampling and analysis plan (SAP) which contains the field sampling plan (FSP) and the quality assurance project plan (QAPP). This document will be revised as necessary to reflect changes in the program scope or to report supplemental information.

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Section 1.0
INTRODUCTION

The basewide support strategy addresses the needs for multiple programs at Elmendorf Air Force Base (Figure 1-1), including the Federal Facilities Agreement (FFA), the State-Elmendorf Environmental Restoration Agreement (SERA), and the Resource Conservation and Recovery Act (RCRA). As part of the Elmendorf AFB Installation Restoration Program (IRP), this component of the basewide strategy will generate data on groundwater quality, groundwater aquifer characteristics, and groundwater monitoring wells.

Elmendorf AFB was proposed for inclusion on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) in July 1989, and listed as final on August 30, 1990 (55 Federal Register 35502). A Federal Facilities Agreement was signed in November 1991 by representatives of the U.S. Environmental Protection Agency (USEPA), the USAF, and the Alaska Department of Environmental Conservation (ADEC).

1.1 Purpose of Document

The purpose of the Basewide Support and Groundwater Monitoring Program is to provide information on groundwater quality, groundwater flow characteristics, and monitoring well integrity at specified locations throughout Elmendorf AFB. This assessment includes data collection, via groundwater level measurements and groundwater sampling. Plate 1 illustrates the locations of all monitoring wells currently in the program. Groundwater level measurements are conducted at monitoring wells located in six Operable Units (OUs), and at SERA Program locations within Elmendorf AFB (Figure 1-2). Groundwater sampling as part of site specific long-term monitoring programs will occur at OUs 1, 2, 4, 5, and 6 and at SERA Program locations. Although no other program sites have been identified for groundwater sampling at present, wells from other Elmendorf programs may be added to the long-term monitoring program as deemed necessary. These additions will be made as addenda to the Environmental Monitoring Plan. Since OUs and SERA sites in various portions of the base are interconnected hydraulically, groundwater quality data collected will be integrated between the areas investigated, in a basewide environmental evaluation. The findings will be reported in the Annual Groundwater Report.

Groundwater analytical data will be evaluated statistically to characterize the extent of contamination associated with each OU; to establish the existence of trends in contaminant levels over time and in differing seasonal conditions; to identify any new or unsuspected contaminant releases, and to delineate the extent of the corresponding plume; to ensure that the assumptions made in site specific Record of Decision (ROD) documents are accurate; to validate the groundwater model; and to track the flow of known contaminant sources between OUs in order to evaluate the risk to other environmental receptors (e.g. Ship Creek).

Basewide groundwater measurements will build upon the information already available in order to establish seasonal and long-term trends on general flow directions, gradients, and effects upon Ship Creek. The information obtained through monthly (prior to 1995) and biannual manual measurements, and continuous (automated) water level measurements, will be used to supplement the information collected in the basewide groundwater model. The groundwater measurement program was initiated in 1992.

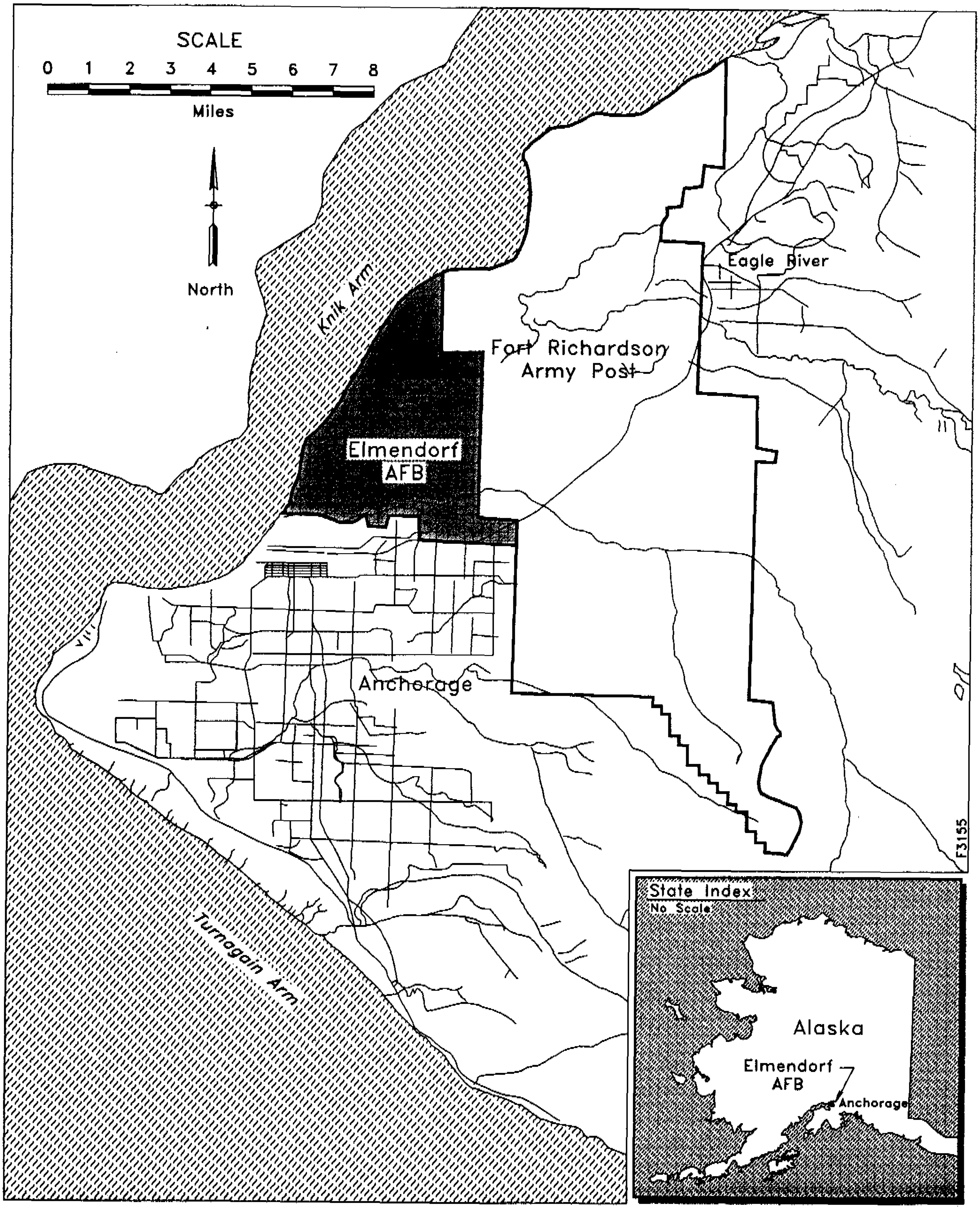


Figure 1-1. Site Location Map, Elmendorf AFB, Anchorage, Alaska

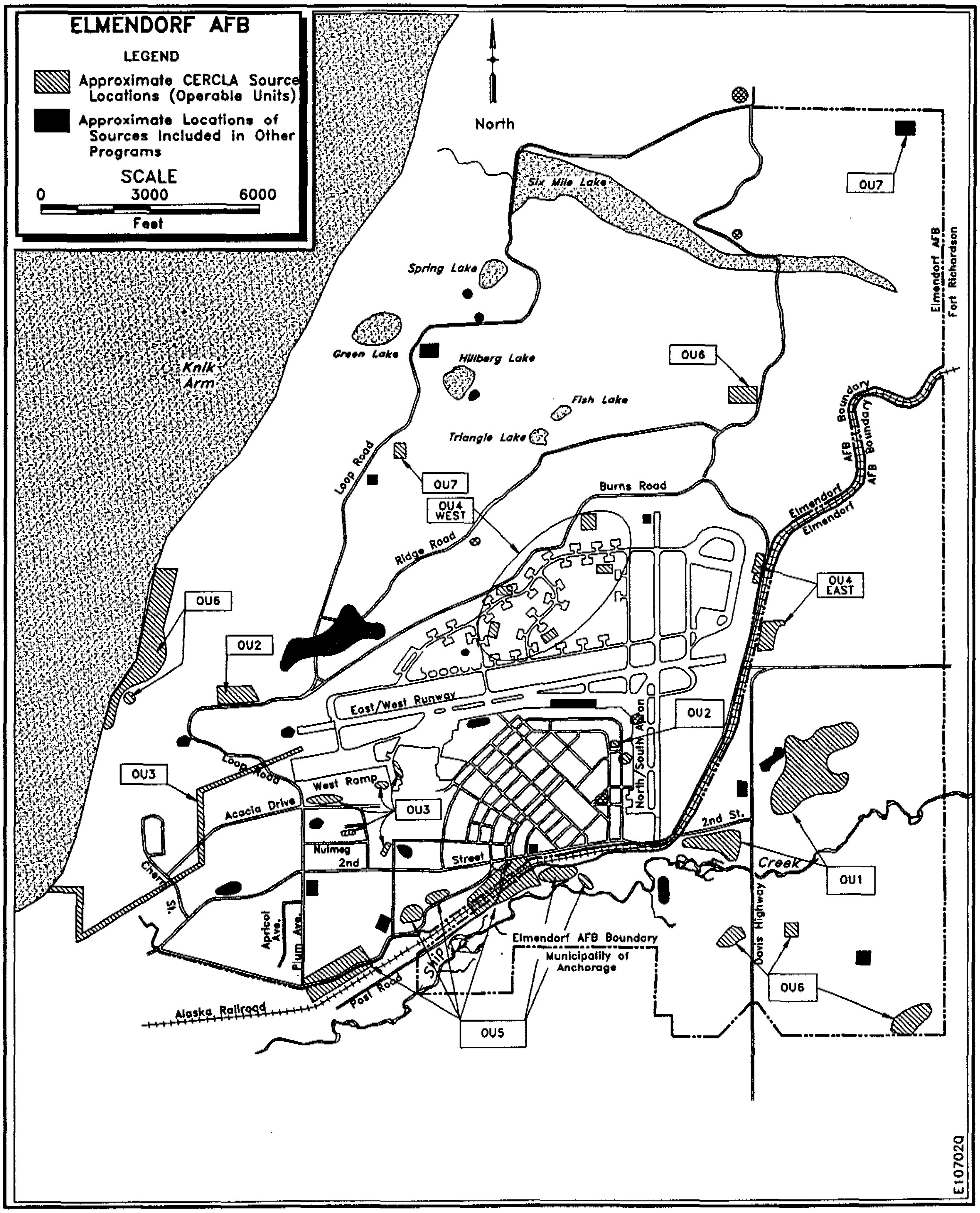


Figure 1-2. Location of CERCLA and Other Regulatory Program Sites at Elmendorf AFB

The Basewide Environmental Monitoring Plan (EMP) will be periodically reviewed to determine if modifications in the long-term monitoring program are necessary. Revisions or updates to the EMP will be made as needed. Modifications impacting the long-term monitoring program will be based on decisions reached between the USAF, the State, and the EPA.

1.2 Organization of the Document

This Work Plan includes the scoping documents necessary for addressing each of the field and reporting tasks for the 1996 Basewide Support and Groundwater Monitoring Program. This document will be revised as necessary to reflect changes in the Program scope or to report supplemental information. Additional background information on the sites included in this program may be obtained from the RI/FS Reports, the Final Record of Decision documents, and the Basewide Investigation Work Plan (CH2M Hill, 1992). Each of these documents are available as part of the Administrative Record at information repositories for Elmendorf AFB.

Specifically, this work plan includes introductory information in Section 1, a description of the project tasks in Section 2, and a description of reporting requirements in Section 3. A schedule for the Basewide Environmental Monitoring Program is included in Section 4. References are provided as Section 5. Three appendices are also included in this document. Appendix A, the Field Sampling Plan, provides detailed methodologies for the various field tasks. A reference for a Health and Safety Plan for this program is included as Appendix B. The Quality Assurance Project Plan for this program is included as Appendix C.

Specific subtasks, as outlined in the SOW and addressed in the EMP, consists of both field activities and reporting.

Field tasks include:

- Biannual Groundwater Level Measurements - manual measurements at groundwater monitoring well locations specified by the base point-of-contact (POC);
- Continuous Groundwater Level Measurements - electronic measurements at groundwater monitoring well locations specified by the base POC;
- Well Operation and Maintenance - to include all monitoring wells used for sampling and water level monitoring in the Basewide program. Repair work shall be coordinated with the base POC on an as-needed basis; and
- Biannual Groundwater Sampling - to include sampling and analysis of groundwater from monitoring wells at various OUs and SERA sites identified by the base POC.

Reporting tasks include:

- Environmental Monitoring Plan - describes field program activities, provides background on program areas, and contains the FSP, SAP, QAPP, and SHSP;
- Groundwater Monitoring Reports - including a description of field activities performed, data summary tables, and a complete set of analytical data derived;

- Monthly Trip Reports - documenting field activities, any problems encountered, and recommendations, by event, for manual groundwater level measurements and downloading of data loggers (used for electronic measurements); and a summary of groundwater well operation and maintenance activities;

- Biannual Technical Memoranda - includes data, interpretations, and recommendations by event, for all of the groundwater level measurements, both manual and automated, taken as part of the Basewide Environmental Monitoring Program. These reports will also include program recommendations and a summary of operation and maintenance activities;

- Annual Groundwater Report - documenting results, interpretations, conclusions, and recommendations, by Operable Unit, for all of the groundwater samples collected during the year as part of the Basewide Environmental Monitoring Program; and

- Basewide Program Summary Report - comprehensive overview of groundwater sampling and measurement program for 1995-1996.

1.3 Environmental Setting

This section provides a brief synopsis of the environmental setting at Elmendorf AFB, with site specific descriptions for OU 1, OU 2, OU 4, OU 5, OU 6, and SERA program locations. For the purposes of this program, environmental setting refers to physiography, geology, and hydrogeology.

Elmendorf AFB is a roughly triangular-shaped installation in southcentral Alaska, along the head of Cook Inlet. Elmendorf AFB comprises 13,130 acres and extends along approximately 7.4 miles of Knik Arm. It is bordered to the north and west by Cook Inlet; to the south by residential, industrial, and business districts of Anchorage, Alaska; and to the east by Fort Richardson (Figure 1-1).

Regional landforms in the Cook Inlet-Susitna Lowlands are the result of glacial or glacier-related processes, and include moraines, ground moraines, and outwash plains. The most obvious landform feature on the base is the Elmendorf Moraine, a series of long, hummocky ridges forming a terminal moraine. The Elmendorf Moraine (trending northeast-southwest) traverses the base. The southern boundary of the Elmendorf Moraine is visible as a rising bluff line on the north side of the Elmendorf AFB east-west runway. The topography of this terminal moraine is rough and hilly with elevations ranging from 200 feet above mean sea level (msl) at the bluff edge of Knik Arm to about 380 feet at the eastern boundary.

The smooth outwash plain south of the Elmendorf Moraine was formed by a series of coalescing streams from glacial meltwater. While composed mainly of sand and gravel, the plain is also overlain with a thin veneer of loess (windblown silt). Relief is generally flat with elevations ranging from 25 feet along Knik Arm bluffs to 225 feet at the flank of the Elmendorf Moraine. The outwash plain has also been incised by stream channels, displaying the meandering nature of fast-flowing streams in glacial material.

The Basewide Support Program will include data collection at groundwater monitoring wells on both the Elmendorf Moraine, and in the outwash plain. Current program sites being sampled under the Environmental Monitoring Plan (EMP) are located in both outwash and morainal deposits.

Two sources of groundwater have been identified at the base. These include a shallow, unconfined aquifer system, and a deeper, confined aquifer. The Bootlegger Cove Formation forms the lower limit of the shallow aquifer, acting as an aquitard, and is the confining layer of the deeper confined aquifer. Figures are provided in Section 2 which illustrate monitoring well locations and groundwater contour and flow direction lines for all of the OUs and SERA program sites.

The following subsections include a brief discussion of the environmental setting of the five operable units and SERA Program locations, where long-term monitoring and groundwater sampling will be conducted. Additional information on the environmental setting for a particular OU may be found in the remedial investigation/feasibility study (RI/FS) report for that OU (see Section 5.0). Additional information on the environmental setting for other locations within Elmendorf AFB, including SERA Program locations, may be found in the Basewide Investigation Work Plan (CH2M Hill, 1992).

1.3.1 Operable Unit 1

Operable Unit 1 is part of the lower Ship Creek drainage area. Ship Creek, located directly south of OU 1, forms the major topographic feature. The general location of OU 1 is provided in Figure 1-2; a detailed location map of wells to be sampled is provided in Section 2 of the EMP. The stream valley of Ship Creek crosses through Elmendorf AFB for 4.2 miles between Fort Richardson and Post Road. Elevations range from a high point of approximately 215 feet above msl in the northeast portion of OU 1 to a low point of approximately 175 feet above msl in the southwest portion of OU 1.

The surface of OU 1 is underlain by unconsolidated, permeable sands and gravels of the glacial outwash plain. Portions of the area are near enough to Ship Creek to be underlain by Ship Creek alluvium. The sediments are flat lying to gently sloping in a southern to southwestern direction toward Ship Creek. The horizontal gradient is approximately 110 feet per mile.

Operable Unit 1 is underlain by both the shallow (unconfined) aquifer, and the deeper confined aquifer. These two units are underlain by the Bootlegger Cove formation. Depth to groundwater in the shallow aquifer ranges from ground surface to more than fifty feet. The top of the Bootlegger Cove formation ranges from 74 to 116 feet bgs. The thickness of the Bootlegger Cove Formation is approximately fifty to sixty feet in the vicinity of OU 1.

Along the eastern boundary of OU 1, groundwater flows west/northwest; and near the western extent of OU 1, it has a west/southwest component. Groundwater contour and flow direction for OU 1 sites are delineated in Section 2 of the EMP. The shallow aquifer units near Ship Creek share a complex hydraulic relationship. Substantial amounts of water are lost from Ship Creek to the underlying deposits between its headwaters in the Chugach Mountains to the Davis Highway. However, the lower reach of Ship Creek, where it has incised the Bootlegger Cove formation, gains groundwater flow. Thus, Ship Creek is both a losing and gaining system (Weeks, 1970). The reaches where Ship Creek is a gaining or losing stream vary seasonally.

1.3.2 Operable Unit 2

Operable Unit 2 is located in the central (ST20) and western (ST41) portions of the base. Because groundwater monitoring within the Basewide Support Program is currently confined to source area ST41 at OU 2, only this region will be addressed. ST41, known as "four million gallon hill", was originally constructed as the "War Emergency Fuel Storage" facility in 1942. It is situated about one-half mile east of the Knik Arm of Cook Inlet at the west end of the Elmendorf Moraine. ST41 covers approximately 20 acres and is comprised of two source areas. The first consists of four 1,000,000-gallon aviation gasoline storage tanks and associated piping. A second is a 1-acre sludge disposal area suspected at the western edge of ST41. The tanks and piping were drained and taken out of service in 1991. The land surface at ST41 is relatively flat where the tanks and out building lie, with sloping terrain up to the north and down to the south. Elevation ranges from 210 feet above msl to 270 feet above msl. The general location of OU 2 is provided in Figure 1-2; a detailed location map of wells to be sampled is provided in Section 2 of the EMP.

Morainal deposits make up the upper ten to twenty feet of the subsurface soil through most of the ST41 area. The morainal soils are composed of a heterogeneous mixture of interbedded sands, silts and clays. This lithologic assortment is typically associated with low aquifer yield, due to the fine-grained nature of the material and subsequent limitations in lateral conductivity. The Bootlegger Cove Formation at ST41 underlies the shallow aquifer at depths ranging from approximately 20 to 30 feet bgs. The Bootlegger Cove Formation is approximately sixty feet thick in the vicinity of ST41.

A groundwater divide, primarily the result of the topography of the Elmendorf Moraine, causes groundwater in the shallow aquifer to flow to the northwest on the northern side of the moraine, and to the southeast on the southern side. The groundwater flow in this area is also locally influenced by the irregular surface of the Bootlegger Cove Formation. The depth to the shallow aquifer varies across the site; the average depth to groundwater is 15 feet bgs. The thickness of the saturated interval averages 13 feet. Groundwater contour and flow direction for OU 2 sites are delineated in Section 2 of the EMP.

1.3.3 Operable Unit 4

Operable Unit 4 is located on relatively flat terrain sloping gently to the southwest, at an approximate elevation of 200 feet (msl). Most of OU 4 consists of improved grounds, taxiways and buildings, since the OU is situated within the main base flightline area. The general location of OU 4 is provided in Figure 1-2; a detailed location map is provided in Section 2.0 of the EMP.

Like OU 1, OU 4 is situated on the outwash plain, and is underlain predominantly by sands with varying amounts of gravels and silts. The outwash overlies the silt and clay units of the Bootlegger Cove Formation at a depth of about 100 feet. The Bootlegger Cove is approximately 50 feet thick at OU 4, and is underlain by the deep, confined aquifer.

The shallow aquifer at OU 4 occurs at a depth ranging from approximately 25 to 50 feet bgs. Groundwater in the shallow aquifer underlying OU 4 flows predominantly westward, turning more southerly as the groundwater approaches the Elmendorf Moraine. The groundwater gradient in the eastern portion of OU 4 is about 10 feet per mile. Further west, the gradient becomes more gradual near the moraine, and then steepens to about 40 feet per mile as it turns south towards Ship Creek. Groundwater contour and flow direction for OU 4 sites are delineated in Section 2 of the EMP.

1.3.4 Operable Unit 5

Operable Unit 5 is located at the southern perimeter of Elmendorf AFB just north of Ship Creek. The general location of OU 5 is provided in Figure 1-2; a detailed location map of wells to be sampled is provided in Section 2.0 of the EMP. The topography at OU 5 is dominated by a bluff that rises approximately 30 feet above beaver ponds at the eastern end of the OU, and 60 feet above railroad tracks at the western end. Operable Unit 5 is hydraulically downgradient from portions of several SERA sites and OUs 1, 2, 3, and 4. Hence, groundwater monitoring at OU 5 provides not only OU-specific information, but also an indication of the degree of upgradient contaminant degradation related to other program and source areas.

The geology at OU 5 is consistent with outwash plain sand and gravel found throughout the area south of the Elmendorf Moraine. The outwash overlies the Bootlegger Cove formation at depths of between 10 and 80 feet. The Bootlegger Cove is approximately 50 to 200 feet thick, and is underlain by the deep, confined aquifer.

Groundwater flow within OU 5 is generally south/southwest, toward Ship Creek. Although both unconfined and confined aquifers exist within OU 5, groundwater contamination occurred exclusively in the upper aquifer. Water table elevation contours indicate that groundwater enters Ship Creek as base flow at OU 5. Groundwater contour and flow direction for OU 5 sites are delineated in Section 2. Groundwater also emerges as surface water seeps and ponds at OU 5. The elevation of the ponds and seeps along the base of the bluffs and the presence of halogenated VOCs in both groundwater and seeps substantiate that these surface waters are fed by groundwater. These surface water bodies are also fed by storm-water runoff from the base.

1.3.5 Operable Unit 6

Operable Unit 6 currently consists of six different source areas located at Elmendorf AFB (SD73, LF02, LF03, LF04, WP14, and SD15). Groundwater sampling at OU 6 for the Basewide Support Program will be confined to four of these locations (LF02, LF04, WP14, and SD15). Three of these source areas are located on the northern portion of the base, on the Elmendorf End Moraine. These are source LF04 (the Knik Bluff Landfill), source WP14 (POL Sludge Disposal Site No. 1) and source SD15 (POL Sludge Disposal Site No. 2). The one remaining OU 6 source area is located in the southeastern portion of the base on the glacial outwash plain to the south of Ship Creek, LF02 (a landfill located west of the intersection of Davis Highway and Oilwell Road). The general location of OU 6 is provided in Figure 1-2; a detailed location map of wells to be sampled is provided in Section 2 of the EMP.

LF02

Source LF02 is a landfill located in the vicinity of the Boniface Gate and the Federal Aviation Administration (FAA) Air Traffic Control Center in the southeastern corner of Elmendorf AFB. Although the environmental setting at LF02 has not been studied in detail, the source appears to be located on a bluff which separates the main floodplain of Ship Creek from an upper stream terrace. The change in elevation associated with the bluff is approximately 30 to 40 feet. Groundwater contour and flow direction for OU 6 sites are delineated in Section 2.

Geologically, LF02 is situated on glacial outwash plain deposits consisting primarily of gravels with very minor sand lenses. The extent of the Bootlegger Cove Formation has not been established at LF02. Hydrogeologically, groundwater flow in the shallow aquifer is generally to the west/southwest toward Ship Creek. The average depth to groundwater is 30 feet bgs at LF02.

LF04

The Knik Bluff Landfill (source LF04) is the westernmost source area located on the Elmendorf End Moraine. LF04 coincides mostly with the presence of a steep bluff which drops from an elevation in excess of 200 feet to sea level. The landfill parallels Knik Arm for a distance of approximately 3000 feet and extends approximately 600 feet into the end moraine deposits. Along the southern end of the landfill, the ground surface slopes toward Knik Arm and the bluff is less pronounced.

The moraine deposits are comprised of heterogeneous mixtures of fine-grained, poorly sorted glacially transported materials. These discontinuous till deposits grade both horizontally and vertically into silts, sands, and overlie a predominantly clayey section whose top is found at an elevation ranging from 90 to 110 feet above msl. These predominantly clayey deposits with discontinuous lenses of gravels and sands are up to 60 feet thick, and could potentially coincide with the top of the Bootlegger Cove Formation, based on information from source area ST41 (OU 2) investigations.

Hydrogeologically, source LF04 appears to be at least partially underlain by the regional deep aquifer for which the Bootlegger Cove Formation acts as a confining unit. Groundwater flow in the shallow aquifer at LF04 is toward the west/southwest as expected from the topography, with discharge into Knik Arm. Groundwater contour and flow direction for OU 6 sites are delineated in Section 2. The depth to the shallow aquifer formations and their thickness vary considerably across the site. Depth varies from as much as 98 feet bgs at K303 to as little as 9 feet bgs at OU6MW-81. Thickness of the saturated interval appears to be between 10 and 30 feet.

WP14

Source WP14 is located a few hundred feet to the east of source LF04. The environmental setting at WP14 has not been studied in detail. This area was used to dispose of sludge generated from POL tank cleanout operations and to weather fuel filters and pads. The site is located at an elevation of approximately 200 feet above msl. The site slopes slightly to the west and surface drainage occurs in the general direction of Knik Arm. The surface of the site has been altered by construction activities, and is currently covered by low alder growth.

Geologically, the surface deposits at WP14 consist of Elmendorf End Moraine silty sand and gravel. The depth and extent of the Bootlegger Cove Formation at WP14 has not been established. Hydrogeologically, groundwater flow in the shallow aquifer at WP14 is toward the west/southwest, with discharge into Knik Arm. Groundwater contour and flow direction for OU 6 sites are delineated in Section 2 of the EMP. Depth to groundwater at WP14 is variable with an average estimate of 20 feet bgs.

SD15

Source SD15 is located in the northeast portion of Elmendorf AFB off of Hubble Road. The source area consists of three separate 30 by 50-foot concrete pads that were used for weathering fuel filters and pads and for disposal of POL tank sludge. This source area is located several thousand feet to the east of sources LF04 and WP14 at an elevation of approximately 275 feet above msl.

Geologically, SD15 contains glacial moraine surficial deposits consisting of silty sands, sandy and silty gravels, and to a lesser extent, sandy or gravelly clays. These lithologies interfinger both horizontally and vertically. Apparently absent from the site are the sediments of the Bootlegger Cove Formation, which was not encountered during the OU 6 RI. It is possible that the soil borings drilled during the RI were not deep enough to identify the top of this formation.

Hydrogeologically, two different unconfined aquifer systems were identified at SD15 during the 1994 RI: a perched groundwater system, and a deeper aquifer system. Flow direction for both aquifers appears to be primarily to the northwest. However, contours for these systems indicate an almost flat water surface. The perched groundwater system was encountered in a relatively localized area at relatively shallow depths ranging between 20-45 feet bgs. The deeper unconfined aquifer was located at an average depth of 115 feet bgs.

1.3.6 SERA Program Locations

As illustrated in Figure 1-2, SERA locations (shown as "other" program source locations), are distributed throughout the base. The environmental settings where sampling will occur, as part of the Basewide EMP, vary among individual locations. Eight source areas will be included for SERA Phase I and SERA Phase II locations where groundwater sampling will occur, they include: SS43, ST32, ST36, ST48, ST61, ST64, ST68, and ST71. All eight areas to be sampled within this program are located on relatively flat terrain. Groundwater sampling will also occur at SERA Phase III locations which are yet to be determined. SERA Phase III monitoring wells will be installed during the 1996 field season. For SERA Phase I and SERA Phase II sites, wells located in the northern section of the base are in remote areas, whereas the remaining wells are situated within the main base near hangars, taxiways and buildings. A map of wells to be sampled at SERA locations is provided in Section 2.0 of the EMP.

The SERA program wells are located in both outwash plain and morainal deposits, associated with the southern and northern portions of the base, respectively. The outwash deposits are characteristically more coarse than morainal deposits. Where outwash deposits consist primarily of sand and gravel, morainal deposits (till) consist of sand, silt, gravel, clay, and boulders. Both formations overly the Bootlegger Cove Formation at depths ranging between 10 and 120 feet bgs. The Bootlegger Cove Formation varies in thickness between 50 and 200 feet.

Groundwater flow at SERA sites is generally south or northwest, depending on site location in relation to the groundwater divide. The groundwater divide corresponds closely with Ridge Road (Figure 1-2). For wells located north of the divide, groundwater typically flows north to northwest. Groundwater primarily flows south, for those wells located south of the divide. Depth to groundwater ranges between 10 feet to over 100 feet in morainal deposits. Groundwater contour and flow direction for SERA Program locations sites are delineated in Section 2 of the EMP.

Section 2.0
ENVIRONMENTAL MONITORING PROGRAM TASKS

Three principal field tasks, groundwater sampling, groundwater level measurements, and field operations and maintenance, are included in the Basewide Support and Groundwater Monitoring Program. The following subsections present a brief discussion of the scope and purpose of each task. Reporting requirements are addressed in Section 3.

2.1 Groundwater Sampling

Groundwater sampling for long-term monitoring will be conducted as part of the Basewide Environmental Monitoring Program at OUs 1, 2, 4, 5, 6 and selected SERA program wells. A listing of all wells to be sampled, by location, is provided in Table 2-1.

Monitoring wells in the sampling program and analytical methods utilized were selected by the U.S. Air Force. Wells were chosen based on location within source areas and associated contaminant plumes, where applicable. Analytical methods were selected based on known or suspected contaminant presence, identified from prior investigations. Analytical methods will be eliminated from the suite of analyses for a particular program area when analytes no longer pose a threat to groundwater or environmental receptors. In addition, wells will be eliminated from the sampling program if contamination is not detected within specified criteria (Figure 2-1). Figure 2-1 provides a decision making guide for evaluation and fate of analytical methods used and wells included in the Basewide Support and Groundwater Monitoring Program. The sampling to be conducted at each location is discussed below.

2.1.1 Operable Unit 1

Groundwater samples will be collected from twelve wells as part of the OU 1 long-term monitoring program (Table 2-1). These wells will be sampled biannually, during the months of May and September 1996.

The groundwater samples at OU 1 will be analyzed for anions, metals, volatile organics, pesticides, and herbicides. A list of field and laboratory analytical methods to be used at OU 1 is presented in Section 2.1.1 of Appendix A. The methods prescribed for this OU are based on the decisions documented in the ROD for OU 1. These methods include, but are not limited to, constituents which have either exceeded MCLs or were identified as contaminants of concern (COCs) during the RI/FS. Three constituents; 1,2-dibromoethane; trichloroethene; and vinyl chloride have been identified in excess of MCLs. Manganese was identified as a contaminant of concern in the ROD. The remedial action goals for OU 1 include reduction of these contaminant levels to below MCLs or background concentrations.

The base is currently seeking closure status with the state for the decommissioned landfill within OU 1. A Closure Plan has been submitted for approval. As a result, this sampling protocol may be modified during 1996 in order to meet compliance requirements of ADEC for Solid Waste Management Regulations for Closure Activities (18 AAC 60.410). Sampling frequency and analytical methods employed would likely change to comply with the final closure plan.

Manganese levels will be tracked at OU 1 to evaluate the natural processes which are thought to govern the concentration of manganese at the site. Manganese is naturally abundant in the sediments forming the aquifer at OU 1. Microbial degradation of organic materials may cause elevated manganese

Table 2-1

Program Area Monitoring Wells for Long-Term Sampling: Basewide Support Program, 1996-1997

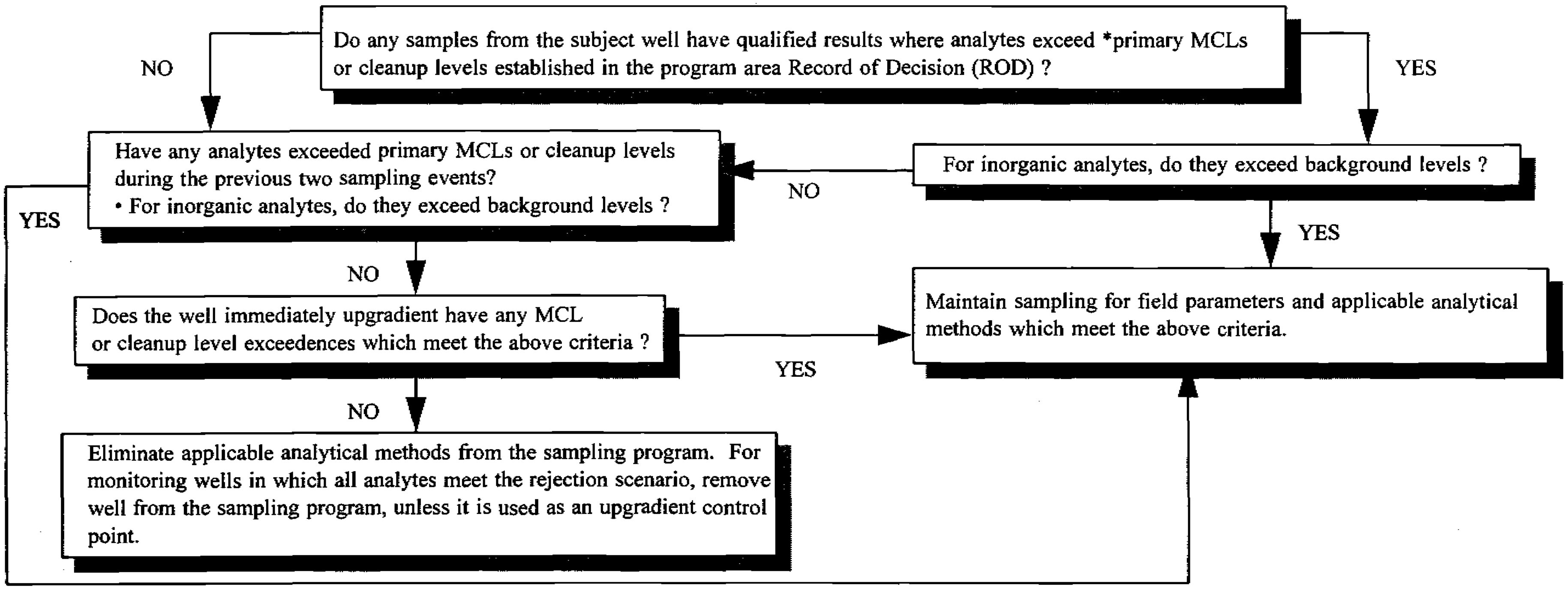
Operable Unit 1 (12 wells)	Operable Unit 2 (16 wells)	Operable Unit 4 (11 wells)	Operable Unit 5 (19 wells)
LF05-GW-1A [LF05]	46-WL-01 [ST41]	43-WL-10 [SD25]	48-WL-03 [ST37]
LF05-GW-1C [LF13]	ST41-07 [ST41]	52-WL-04 [SD25]	GW-4A [ST37]
LF05-GW-2A [LF05]	ST41-10 [ST41]	FP-56 [FT23]	LF59-MW-06 [ST37]
LF05-GW-2B [LF07]	ST41-16 [ST41]	OU3MW-11 [SD25]	NS3-02 [ST37]
LF05-MW-03 [LF07]	ST41-18 [ST41]	OU4W-03 [FT23]	OU5MW-01 [ST37]
LF05-MW-04 [OT56]	ST41-19 [ST41]	OU4W-04 [FT23]	OU5MW-02 [ST37]
LF05-MW-10 [LF13]	ST41-20 [ST41]	OU4W-06 [FT23]	OU5MW-06 [ST37]
LF05-MW-11 [LF07]	ST41-24 [ST41]	OU4W-08 [SD25]	OU5MW-07 [ST37]
LF05-W-5 [LF07]	ST41-25 [ST41]	OU4W-09 [FT23]	OU5MW-08 [ST37]
LF59-MW-01 [LF59]	ST41-26 [ST41]	OU4W-11 [FT23]	OU5MW-09 [ST37]
LF59-MW-03 [LF59]	ST41-28 [ST41]	OU4W-12 [FT23]	OU5MW-10 [ST37]
OU1MW-99 [OT56]	ST41-30 [ST41]		OU5MW-11 [ST37]
	ST41-34 [ST41]		OU5MW-13 [ST37]
	ST41-ES4A [ST41]		OU5MW-14 [ST37]
	ST41-MW-37A [ST41]		OU5MW-16 [ST37]
	ST41-W7 [ST41]		OU5MW-31 [ST37]
			OU5MW-33 [ST37]
			SP1-02 [ST37]
			SP2/6-05 [ST37]

Operable Unit 6 (23 wells)	SERA Phase I (17 wells)	SERA Phase II (21 wells)	SERA Phase III (up to 17 wells)
53-WL-01 [LF02]	43-WL-01 [SS43]	42-WL-01 [ST32]	*Locations to Be Determined*
53-WL-04 [LF02]	43-WL-07 [SS43]	59-WL-29 [ST32]	
53-WL-05 [LF02]	43-WL-11 [SS43]	59-WL-30 [ST32]	
K301 [LF04]	45-WL-02 [ST61]	59-WL-31 [ST32]	
K302 [LF04]	48-WL-01 [ST71]	59-WL-35 [ST32]	
OU6MW-01 [LF02]	49-WL-01 [ST71]	59-WL-36 [ST32]	
OU6MW-06 [WP14]	52-WL-03 [ST64]	59-WL-37 [ST32]	
OU6MW-13 [LF04]	56-WL-01 [ST36]	59-WL-38 [ST32]	
OU6MW-17 [SD15]	56-WL-03 [ST36]	59-WL-39 [ST32]	
OU6MW-18 [SD15]	56-WL-04 [ST36]	59-WL-40 [ST32]	
OU6MW-28 [SD15]	56-WL-05 [ST36]	59-WL-41 [ST32]	
OU6MW-46 [WP14]	56-WL-06 [ST36]	59-WL-42 [ST32]	
OU6MW-48 [LF02]	AP3567 [ST61]	59-WL-43 [ST32]	
OU6MW-49 [LF02]	AP3606 [ST61]	60-WL-04 [ST48]	
OU6MW-51 [LF02]	SP7/10-01 [SS43]	62-WL-02 [ST68]	
OU6MW-53 [LF04]	SP7/10-04 [SS43]	62-WL-05 [ST68]	
OU6MW-63 [LF04]	W4 [SS43]	62-WL-06 [ST68]	
OU6MW-67 [LF04]		64-WL-01 [ST68]	
OU6MW-70 [SD15]		ST20-03 [ST48]	
OU6MW-77 [WP14]		ST41-22 [ST32]	
OU6MW-81 [LF04]		ST41-23 [ST32]	
OU6MW-82 [WP14]			
OU6MW-85 [LF04]			

Site-specific source ID numbers are shown in brackets [ ].

Figure 2-1. GROUNDWATER MONITORING AND ANALYSIS DECISION GUIDE: Basewide Support and Groundwater Monitoring Program, Elmendorf AFB, Alaska

The purpose of this guide is to facilitate the removal of monitoring wells from the sampling program and/or the elimination of analytical methods from the suite of analyses performed in program areas of the Basewide Support and Groundwater Monitoring Program. Assumptions for use of this guide are listed below. Application of the guide is accomplished by running analytical results from monitoring well samples through the flow chart provided.



*The only exception to this qualifier is manganese, based on a secondary MCL, at OU 1.

Assumptions:

1. For the scenario in which sampling is continued for a particular well, another evaluation using the decision guide for well removal, would not be required until two additional sampling rounds have been completed;
2. For the evaluation of analytical methods, any analyte within a method which falls into the "yes" scenario would require that the applicable analytical method be maintained in the sampling program (eg. if benzene exceeds the MCL, the SW8260 method is maintained regardless of the status of other SW8260 analytes);
3. There are no regulatory requirements to sample a particular well or utilize a specific analytical method for a mandated period of time (eg. well OU6MW-85 will be sampled for SW8260 for a period of 10 years as part of the long-term monitoring requirements);
4. Removal of analytical methods from a sampling program will be performed on a program area basis, with program area being an Operable Unit or SERA site. In order for a method to be eliminated from a program area list, all of the wells in the program area must meet the "no" scenario for no further sampling required.

levels to exist where fuel related hydrocarbons are present. The process attributed to this phenomenon consists of reducing conditions releasing manganese from soil into the underlying aquifer. Under these circumstances, manganese levels will be higher where POL contaminated soil is present.

The purpose of long-term monitoring at OU 1 is to compare concentrations of these and other constituents in the samples collected to historic OU 1 concentrations, and to available background information, such that changes or trends in concentrations can be established, and any unsuspected increases in contaminant concentrations can be identified. When sufficient data are collected, groundwater sampling results will be evaluated statistically to ensure that the assumptions made in the OU 1 ROD are accurate; to validate the groundwater model; and to provide early warning of increased contaminant levels or migration of contaminant plumes. A discussion of statistical methods to be employed is provided in Section 5 of the FSP.

Any trends observed in groundwater quality may be the result of a variety of factors, including seasonal variations in the water table, the influence Ship Creek water level fluctuations and corresponding recharge/discharge effects on the water table, or, solely in a quality improvement scenario, natural attenuation of contaminants. As part of the Annual Groundwater Report, all constituents of interest will be plotted against historic results, and conclusions will be drawn regarding their fate and transport within OU 1. Recommendations for changes in the sampling frequency or changes in the array of ground-water monitoring wells currently in the monitoring program will be included in the Annual Groundwater Report.

The field schedule for OU 1 sampling activities is provided in Section 4 of this report. The locations of the wells to be sampled are shown in Figure 2-2 along with groundwater contour and flow direction lines. A list of specific laboratory analyses to be conducted is provided in Section 2 of Appendix A. A detailed discussion of the analytical methods, along with the Quality Assurance/Quality Control (QA/QC) sampling requirements, is provided in the Quality Assurance Project Plan (QAPP), included as Appendix C.

2.1.2 Operable Unit 2

Groundwater samples will be collected from sixteen wells as part of the OU 2 long-term monitoring program (Table 2-1). These wells will be sampled biannually, during the months of May and September 1996.

The groundwater samples at OU 2 will be analyzed for nitrate/nitrite, sulfates, metals, volatile organics, and diesel and gasoline range hydrocarbons. A list of field and laboratory analytical methods to be used at OU 2 is presented in Section 2 of Appendix A. The methods prescribed for this OU are based jointly on the results of the RI/FS program conducted at OU 2 and in accordance with COCs identified in the ROD for OU 2. Like OU 1, the purpose of the groundwater monitoring at OU 2 is to compare newly obtained contaminant concentrations to historic and/or background concentrations, such that changes or trends can be established. The data collected will be used to help establish the long-term monitoring approach for OU 2, and in addition, will be used to help assess the levels of contaminants which might be migrating towards environmental receptors such as Ship Creek. The data will also help calibrate the groundwater model and validate associated predictions made concerning contaminant fate and transport.

The field schedule for the OU 2 groundwater sampling activities is provided in Section 4.0 of this report. The location of the wells to be sampled are shown in Figure 2-3 along with groundwater contour and flow direction lines. A detailed discussion of the analytical methods, along with the QA/QC

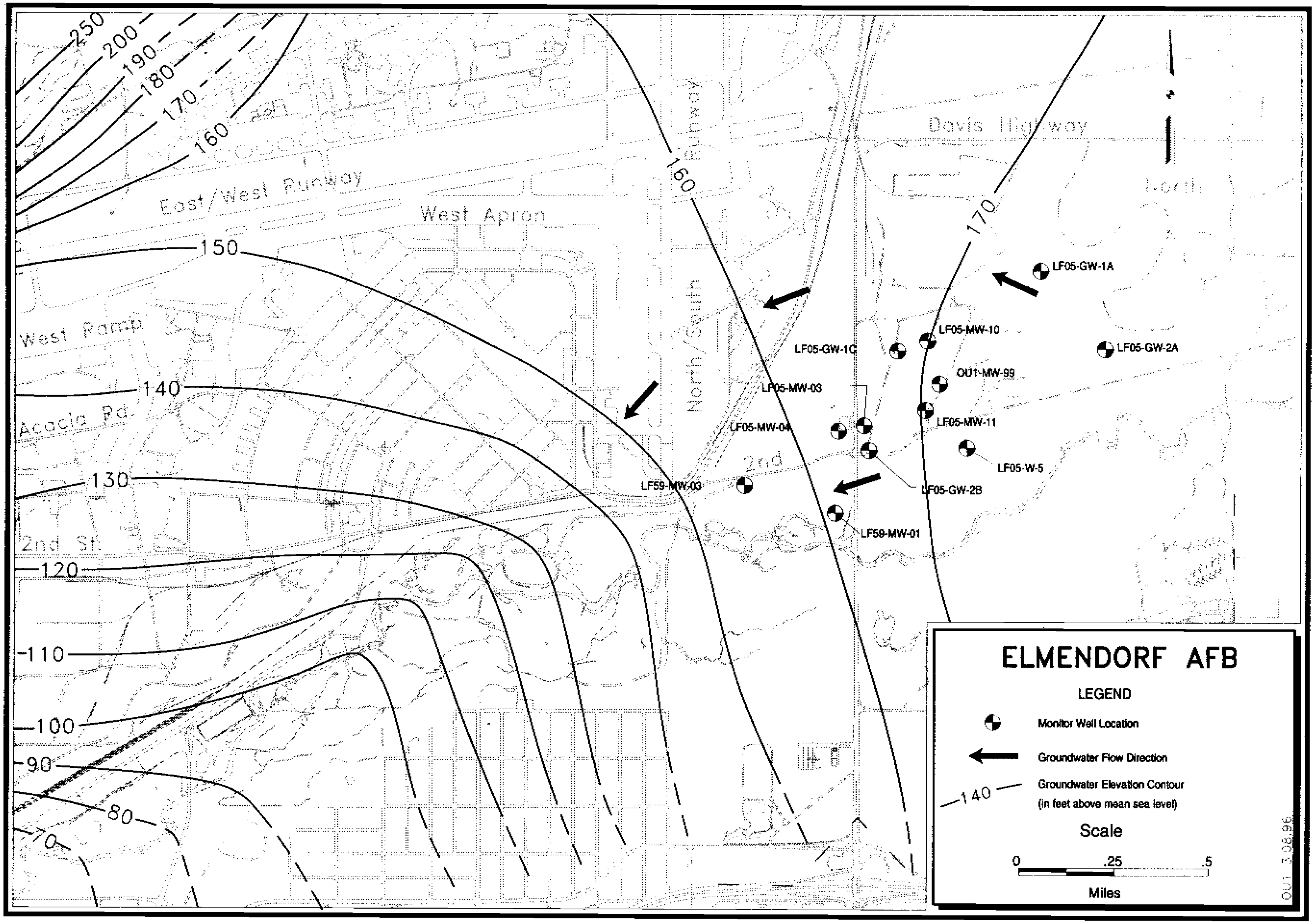


Figure 2-2. Location of Monitoring Wells to be Sampled at Operable Unit 1

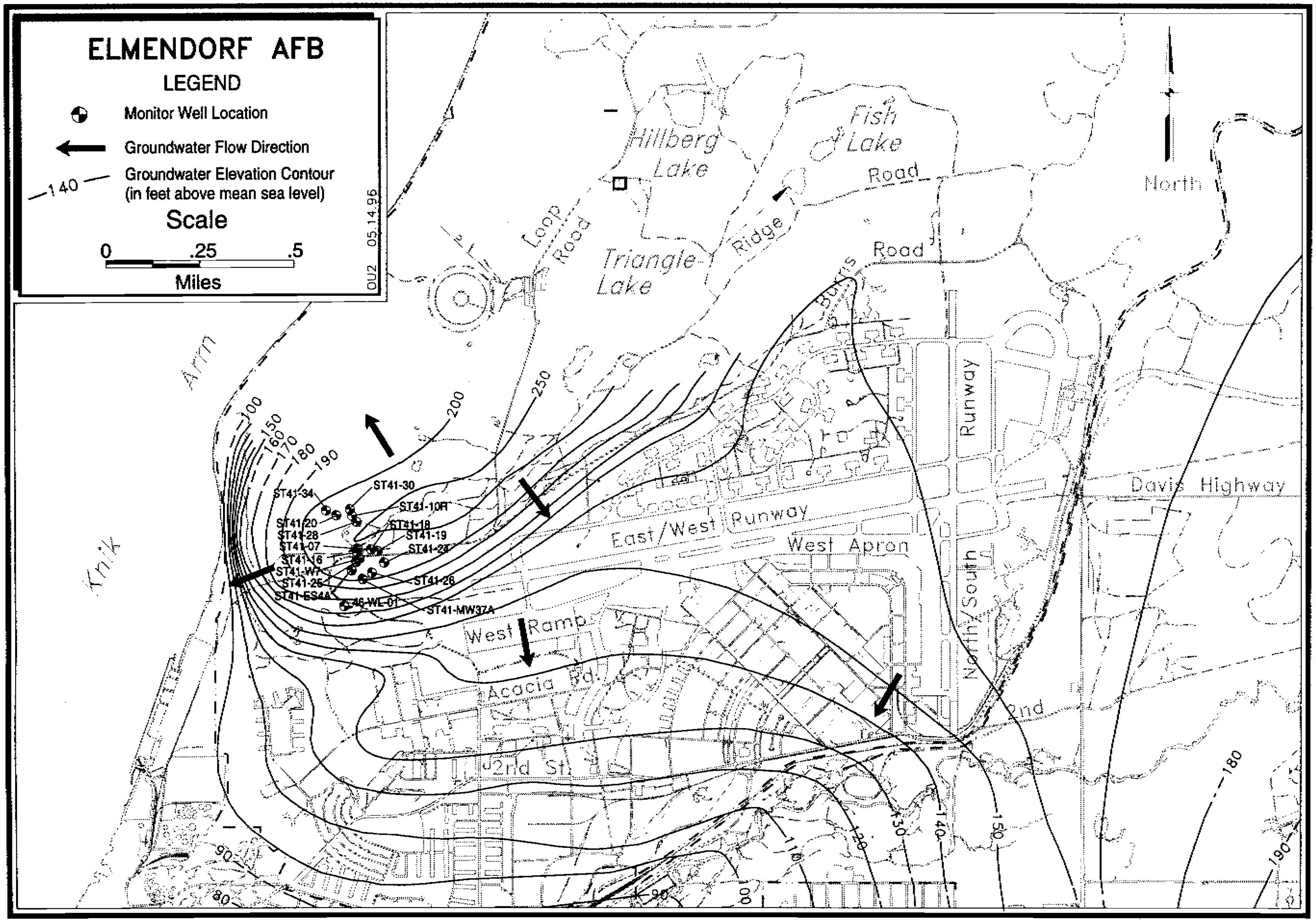


Figure 2-3. Location of Monitoring Wells to be Sampled at Operable Unit 2

sampling requirements, is provided in the QAPP, included as Appendix C.

2.1.3 Operable Unit 4

Eleven wells will be sampled within OU 4 as part of the Basewide Support and Groundwater Monitoring Program. These wells will be sampled to collect additional data at key locations where future long-term groundwater monitoring may be required, and to obtain additional data for comparison with the basewide model data upgradient from OU 5. The eleven wells will be sampled biannually, during the months of June and October 1996 (see the project schedule in Section 4).

The groundwater samples at OU 4 will be analyzed for the same analytical suite as OU 2. A list of field and laboratory analytical methods to be used at OU 4 is presented in Section 2 of Appendix A. Like OU 2, the methods prescribed for this OU are based jointly on the results of the RI/FS programs conducted at OU 4 and at OU 5 and on assumptions made in the OU 4 ROD, during which constituents were identified as COCs. The proposed analytical methods for OU 4 include, but are not limited to, these COCs. A comparison of the data to the outwash plain modeling results will be included as part of the conclusions for OU 4, as well as a discussion of observable trends of contaminant concentrations over time.

The field schedule for the OU 4 groundwater sampling activities is provided in Section 4 of this report. The locations of the wells to be sampled are shown in Figure 2-4 along with groundwater contour and flow direction lines. A detailed discussion of the analytical methods, along with the QA/QC sampling requirements, is provided in the QAPP, included as Appendix C.

2.1.4 Operable Unit 5

Groundwater samples will be collected from nineteen wells as part of the OU 5 long-term monitoring program. A listing of these wells is provided as Table 2-1. Under this program, these wells will be sampled biannually, during the months of May and September.

The groundwater samples at OU 5 will be analyzed for nitrate/nitrite, metals, volatile organics, and diesel and gasoline range hydrocarbons. A list of field and laboratory analytical methods to be used at OU 5 is provided in Section 2 of Appendix A. The methods prescribed for this OU are based on the decisions documented in the ROD for OU 5. These methods include, but are not limited to, constituents which have either exceeded MCLs or were identified as COCs during the RI/FS. Two constituents, benzene and trichloroethene, have been identified in excess of MCLs. Fuel constituents were also identified as COCs in the ROD. The remedial action goal for OU 5 is to reduce these contaminant levels to below MCLs. Like OU 1, the primary purpose of the long-term monitoring at OU 5 is to compare concentrations of these and other constituents in the samples collected to historic OU 5 concentrations and/or background concentrations, such that changes or trends in concentrations can be established. When sufficient data are collected, groundwater sampling results will be evaluated statistically to ensure that the assumptions made in the OU 5 ROD are accurate; to validate the ground-water model; and to provide early warning of increased contaminant levels or migration of contaminant plumes.

At OU 5 (as well as at OU 1), establishing the levels of contaminants in key wells upgradient of Ship Creek is essential to monitoring the potential for any adverse impact to this body of water due to OU 5 contaminant migration. As part of the Annual Groundwater Report, all constituents of interest will be plotted against historic results, and conclusions will be drawn regarding the fate and transport of the OU 5 groundwater contaminants. Recommendations for changes in the sampling frequency or changes in the array of groundwater monitoring wells currently in the monitoring program will be included in the Annual Groundwater Report as appropriate.

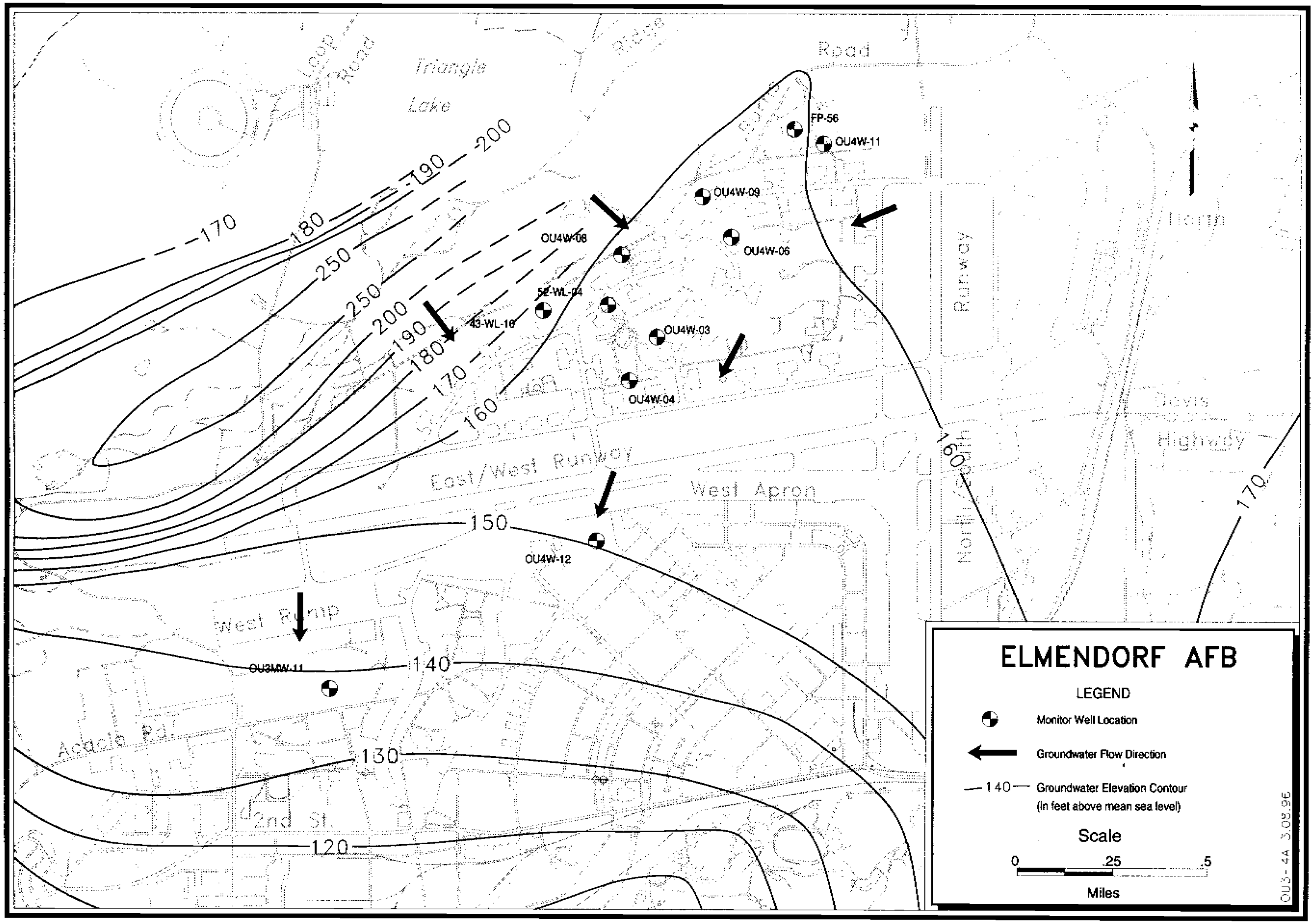


Figure 2-4. Location of Monitoring Wells to be Sampled at Operable Unit 4

The field schedule for the OU 5 activities is provided in Section 4 of this report. The locations of the wells to be sampled are shown in Figure 2-5 along with groundwater contour and flow direction lines. A detailed discussion of the analytical methods, along with the QA/QC sampling requirements, is provided in the QAPP, included as Appendix C.

2.1.5 Operable Unit 6

Groundwater samples will be collected from twenty-three wells as part of the OU 6 long-term monitoring program (Table 2-1). These wells will be sampled biannually, during the months of June and October 1996.

The groundwater samples at OU 6 will be analyzed for the same analytical suite as OU 4. A list of field and laboratory analytical methods to be used at OU 6 is presented in Section 2 of Appendix A. The methods prescribed for this OU are based on the results of the RI/FS program conducted at OU 6 in which COCs for groundwater were identified. The purpose of groundwater monitoring at OU 6 is to compare newly obtained contaminant concentrations to historic and/or background concentrations, such that changes or trends can be established. The data collected will be used to help establish the long-term monitoring approach for OU 6, and in addition, will be used to help assess the levels of contaminants which might be migrating towards environmental receptors such as Ship Creek. The data will also help calibrate the groundwater model and validate associated predictions made concerning contaminant fate and transport.

The field schedule for the OU 6 groundwater sampling activities is provided in Section 4.0 of this report. The location of the wells to be sampled are shown in Figure 2-6 along with groundwater contour and flow direction lines. A detailed discussion of the analytical methods, along with the QA/QC sampling requirements, is provided in the QAPP, included as Appendix C.

2.1.6 SERA Phase I Sites (SS43, ST36, ST61, ST64, and ST71)

Groundwater samples will be collected from seventeen wells at SERA Phase I locations (Table 2-1). These wells will be sampled biannually, during the months of May and September (see the project schedule in section 4).

Groundwater samples from SERA Phase I monitoring wells will be analyzed for nitrate/nitrite, metals, volatile organics, diesel and gasoline range hydrocarbons, and organic lead. A list of field and laboratory analytical methods to be used at SERA sites is presented in Section 2 of Appendix A. Like OU 5, the primary purpose of long-term monitoring at SERA Phase I locations is to compare concentrations of these and other constituents in the samples collected to historic concentrations and/or background concentrations, such that changes or trends in concentrations can be established and to provide early warning of increased contaminant levels or migration of contaminant plumes.

The locations of the SERA Phase I wells to be sampled are shown in Figure 2-7 along with groundwater contour and flow direction lines. A detailed discussion of the analytical methods, along with the QA/QC sampling requirements, is provided in the QAPP, included as Appendix C.

2.1.7 SERA Phase II Sites (ST32, ST48, and ST68)

Groundwater samples will be collected from twenty-one wells at SERA Phase II locations (Table 2-1). These wells will be sampled biannually, during the months of May and September (see the project schedule in section 4).

Groundwater samples from SERA Phase II monitoring wells will be analyzed for nitrate/nitrite,

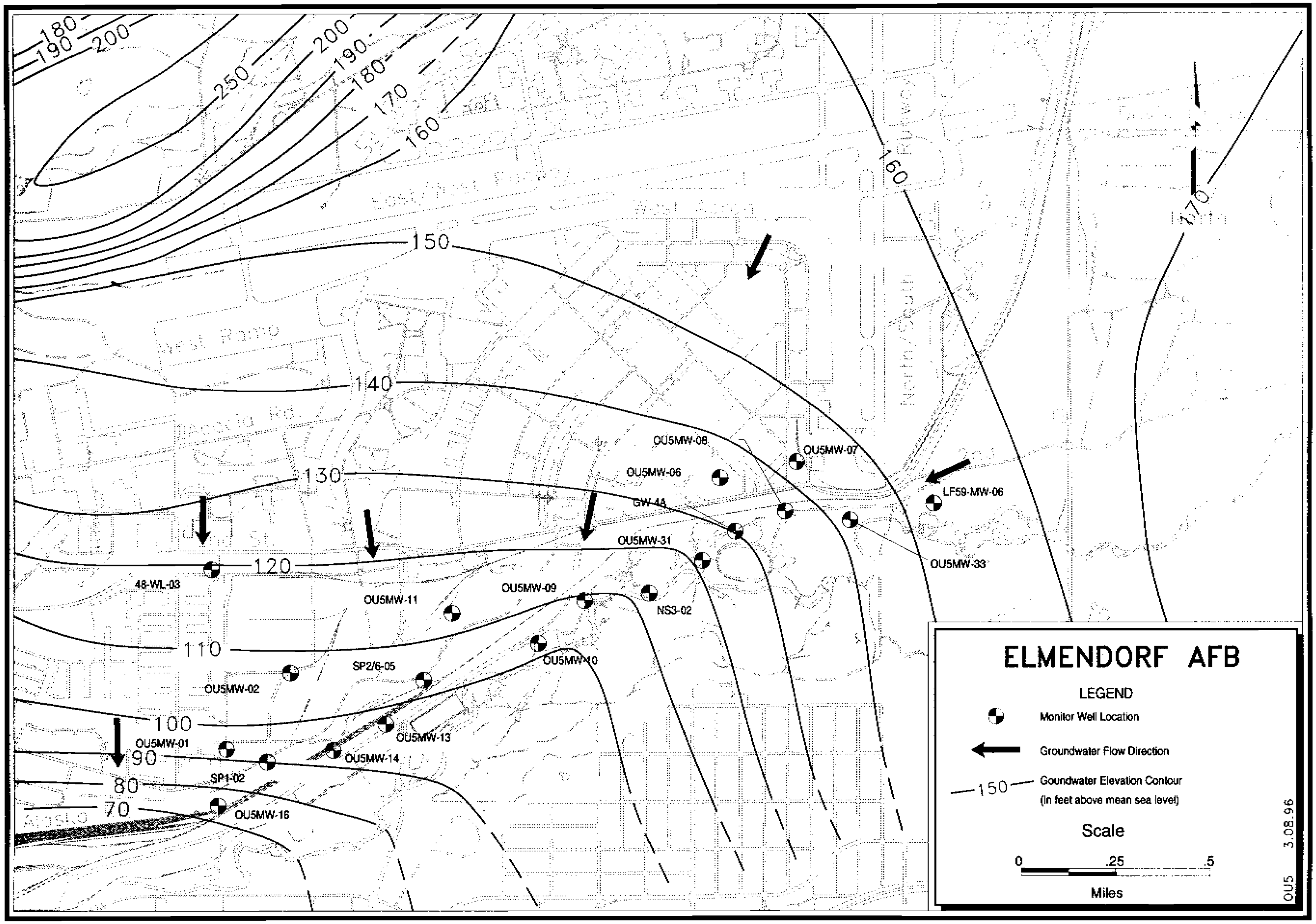


Figure 2-5. Location of Monitoring Wells to be Sampled at Operable Unit 5

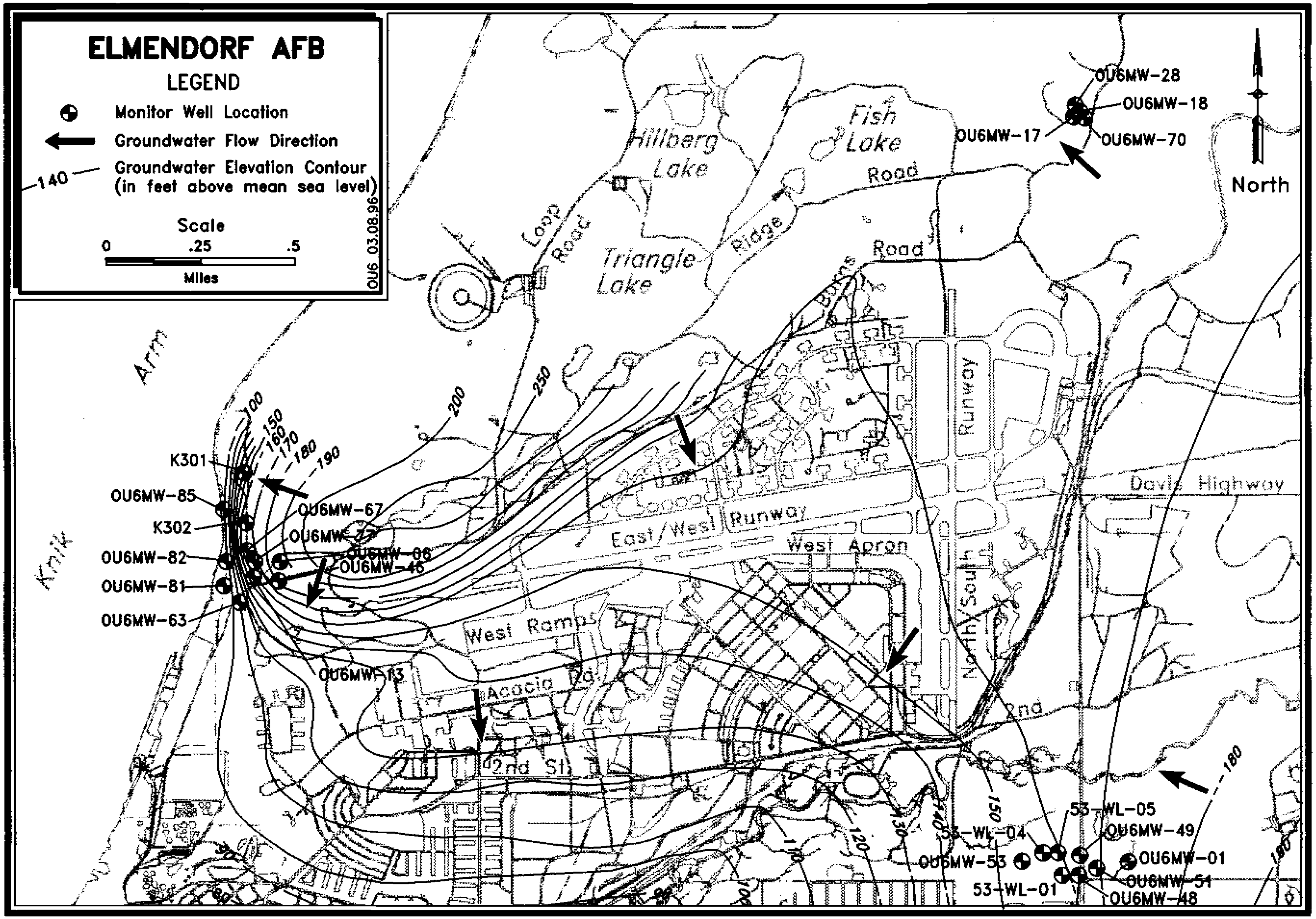


Figure 2-6. Location of Monitoring Wells to be Sampled at Operable Unit 6

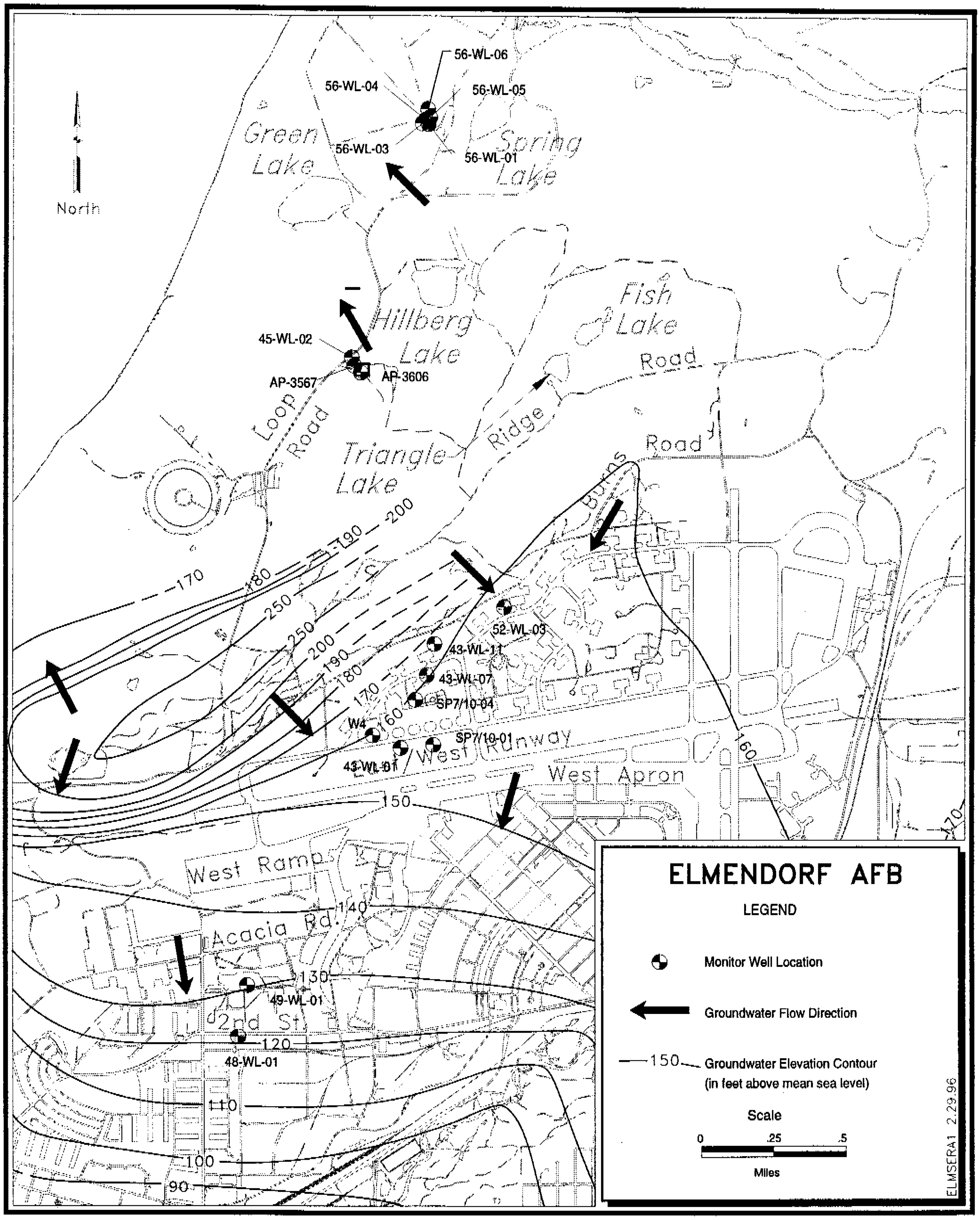


Figure 2-7. Location of Monitoring Wells to be Sampled at SERA Phase I Locations

metals, volatile organics, diesel and gasoline range hydrocarbons, and organic lead. A list of field and laboratory analytical methods to be used at SERA sites is presented in Section 2 of Appendix A. Like SERA Phase I, the primary purpose of long-term monitoring at SERA Phase II locations is to compare concentrations of these and other constituents in the samples collected to historic concentrations and/or background concentrations, such that changes or trends in concentrations can be established and to provide early warning of increased contaminant levels or migration of contaminant plumes.

The locations of the SERA Phase II wells to be sampled are shown in Figure 2-8 along with groundwater contour and flow direction lines. A detailed discussion of the analytical methods, along with the QA/QC sampling requirements, is provided in the QAPP, included as Appendix C.

2.1.8 SERA Phase III Sites

Groundwater samples will be collected from up to seventeen monitoring wells at SERA Phase III locations (Table 2-1). The wells will be installed during the 1996 field season and will be sampled biannually, during the months of July and October, providing that installation and development are completed on schedule (see the project schedule in Section 4).

Groundwater samples from SERA Phase III monitoring wells will be analyzed for nitrate/nitrite, metals, volatile organics, diesel and gasoline range hydrocarbons, and organic lead. A list of field and laboratory analytical methods to be used at SERA sites is presented in Section 2 of Appendix A. The primary purpose of long-term monitoring at SERA Phase III locations will be to compare concentrations of these and other constituents in the samples collected to background concentrations, such that changes or trends in concentrations can be established and to provide early warning of increased contaminant levels or migration of contaminant plumes.

The locations of the SERA Phase III wells to be sampled will appear in revised versions of the EMP. A detailed discussion of the analytical methods, along with the QA/QC sampling requirements, is provided in the QAPP, included as Appendix C.

2.2 Groundwater Level Measurements

Groundwater elevation measurements within the Basewide Support Program will take place throughout the period of performance for this program. Groundwater level measurements will be recorded manually base-wide and electronically at select monitoring wells where site-specific groundwater phenomena are being investigated. The purpose and scope of both manual and electronic water level measurements is described below.

2.2.1 Manual Water Level Measurements

Manual water level measurement will be performed at 63 basewide wells on a biannual basis using an audible water level indicator meter. The purpose of performing manual water level measurements is to establish base-wide contours for the unconfined aquifer. Biannual measurements are necessary to log the seasonal low (April) and high (October) groundwater elevation periods. Contour maps are produced from these data sets and are included in the Biannual Technical Memoranda documents. The groundwater level contour map is used to establish basewide groundwater flow directions and seasonal fluctuations that may occur within the unconfined (shallow) aquifer. The wells included in this program are listed in Table 2-2. Where free product is suspected to exist in wells, organic vapor readings will be taken from the breathing zone and down the well casing during manual water level measurements. Where organic vapors are detected inside the well, measurements will be made to delineate the surface elevation and thickness of any free floating product with an Oil/Water Interface probe (discussed in detail in Appendix A).

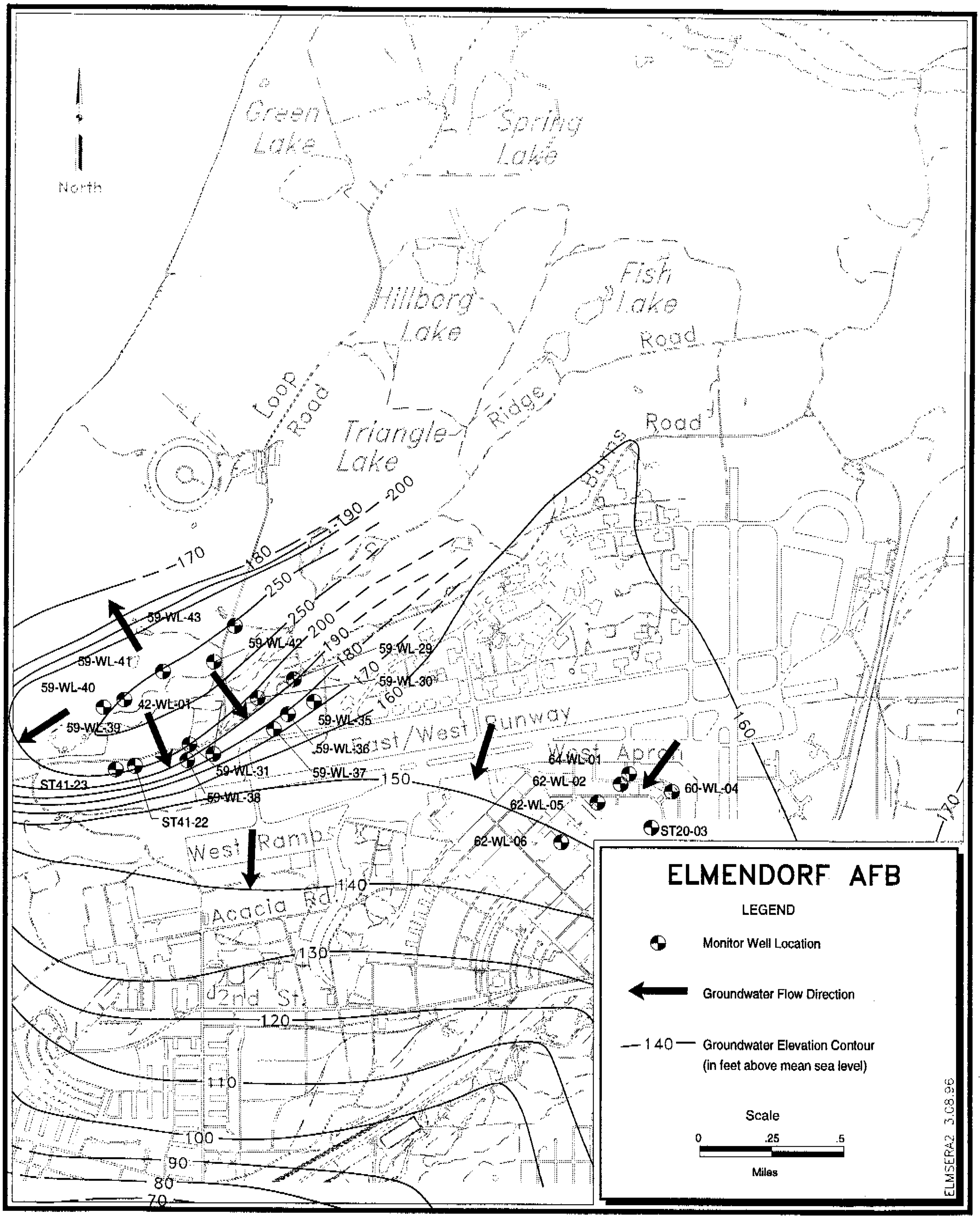


Figure 2-8. Location of Monitoring Wells to be Sampled at SERA Phase II Locations

Table 2-2

Groundwater Monitoring Wells for Manual Water Level Measurements
Basewide Support Program

OU1MW-99
OU3MW-01
OU3MW-02
OU3MW-03
OU3MW-04
OU3MW-11
OU3MW-16
OU3MW-21
OU3MW-24
OU4E-02
OU4W-03
OU4W-08
OU4W-12
OU4W-14
OU4W-17
OU5MW-08
OU5MW-09
OU5MW-10
OU5MW-16
OU5MW-31
OU5MW-33
OU6MW-01
OU6MW-33
OU6MW-46
OU6MW-55
OU6MW-57
OU6MW-63
OU6MW-70
OU6MW-77
OU6MW-81
OU6MW-85
LF59-PZ01
LF59-MW-03
LF59-MW-06
LF05-MW-07
43-WL-01
43-WL-04
46-WL-03
48-WL-02
GW-2B
GW-5A
GW-7A
D3-02
SP2/6-01
53-WL-01
60-WL-04
62-WL-04
ST20-MW-10
ST41-MW-36
ST41-08
ST41-18
ST41-26
ST41-33A
NS3-02
BH-01
BH-04
BH-05
BH-06
T40503
T41206
T41709
K302
W-4

In a similar fashion as the groundwater chemistry data being collected, measurement data will also be used to help calibrate the groundwater model which was performed on the outwash plain under the OU 5 and OU 6 RI/FS programs. Trends and/or seasonal fluctuations in the basewide groundwater surface will be addressed as part of the interpretation and reporting associated with this task. Special attention will be given to changes which might impact the predicted fate and transport of contaminants within the various sites, and how this change might impact potential receptors. Recommendations for changes in the array of wells included in the basewide water level monitoring program, or changes in the frequency of the water level measurements, will be addressed in Biannual Technical Memoranda documents. A detailed field schedule for the basewide water level measurement task is provided in Section 4. The locations of the wells to be measured are provided in Plate 1.

2.2.2 Electronic Water Level Measurements

Fifteen wells at Elmendorf AFB are currently equipped with continuous water level monitoring instruments (data loggers). These wells are listed in Table 2-3. As part of the continuous water level monitoring program, these wells are currently being downloaded bimonthly (Section 4) and the data interpreted and presented as hydrographs in Biannual Technical Memoranda documents.

Continuous water level measurements are being collected in key wells where atypical groundwater measurements have occurred, or where unexplained fluctuations have been observed in the water table. The continuous water level monitoring program facilitates a more accurate interpretation of the relationship between different aquifers and provides more detailed and specific information for the interpretation of groundwater anomalies. Results from data logger measurements will appear in the Biannual Technical Memoranda documents. In light of the dynamic nature of the Basewide Support and Groundwater Monitoring Program, an effort will continuously be made to improve the efficiency of the groundwater level measurement program. This will be accomplished by removing wells from the program when adequate data have been collected and adding new locations where new anomalies have been identified. Recommendations for changes in the array of wells included in the continuous water level monitoring program, or changes in downloading frequency and/or the interval of continuous water level measurements taken, will be included in Biannual Technical Memoranda documents. Any changes

Table 2- 3

Data Logger Equipped Monitoring Wells, Basewide Support Program

Wells with 12-hour interval measurements	Wells with 3-hour interval measurements
53-WL-01	D3-01
59-WL-08	D3-02
GW-5A	K303
LF59-PZ01	OU6MW-06
OU6MW-18	OU6MW-13
OU6MW-70	OU6MW-81
SP2/6-01	
ST41-18	
T41206	

in the number or location of wells included in the program will be noted in EMP Work Plan revisions.

2.3 Well Operation and Maintenance

Well operation and maintenance checks will be performed to assure that monitoring wells used during the groundwater sampling and water level measurement programs are functional. Items such as locks, hinges, identification tags, well pads, surveyed reference points, etc., will be inspected, and the need for any significant repairs noted in monthly trip reports. Minor repairs will be made to the wells as needed to maintain their material integrity and to confirm that affixed equipment (i.e. data loggers) is in working order. The ultimate purpose of the monitoring well operations and maintenance program is to ensure that the integrity of any data collected at these locations is maintained. Operations and maintenance activities will occur throughout the field season as deficiencies are noted during regularly scheduled field events (manual water level measurements, data logger downloads, and groundwater sampling).

Section 3.0
REPORTING REQUIREMENTS

The following reports are required as part of the Basewide Support and Groundwater Monitoring Program.

3.1 Groundwater Monitoring

Reporting associated with groundwater sampling activities will be accomplished via Groundwater Monitoring Reports and an Annual Report of Groundwater Sampling Activities. Monitoring reports will be prepared after each sampling event to present data and summarize field activities. For groundwater sampling activities, a sampling event is defined as one round of sampling within a particular program area (OU or SERA site). Recommendations will only be provided where significant changes in the sampling program may be needed, or in the case where severe structural or operational deficiencies in wells have been noted. In order to report data in a timely manner, and because sampling events are staggered between sites during the calendar year, a separate report will be prepared for each event per site.

At the conclusion of the environmental monitoring program for 1996, a comprehensive Annual Report of Groundwater Sampling Activities will be generated to address monitoring activities at all sites. This report will include a summary of all of the data collected, along with data interpretation and significant findings. Data will be statistically compared to historical results, the results from previous sampling events, and any available background data, so that trends in contaminant transport can be observed, and/or any unsuspected increases in contaminant concentrations can be identified. Data will also be compared to predictions in the groundwater model in an attempt to validate the modeling efforts. In addition, a comparison will be made of the data between sites, and recommendations for improvements in the environmental monitoring program for the following year will be provided.

3.2 Groundwater Measurement Reporting

Two types of reports will be generated to communicate groundwater measurement data recordings: Biannual Technical Memoranda, and Monthly Trip Reports. Biannual technical memoranda will be prepared following each basewide manual water level measurement event. Included in this report will be the contoured results of the basewide measurements, along with the significant findings and recommendations for follow-on work or changes in the water level measurement program. Technical memoranda will also include a detailed analysis of the downloading of continuous water level measurement data. Finally, the biannual reports will include a synopsis of the well operation and maintenance activities conducted during the previous reporting period. A table of the operations and maintenance activities performed, as well as additional recommended maintenance activities, will be provided.

In addition to the biannual technical memoranda, monthly trip reports will be prepared to document field measurement activities. The monthly trip reports will include information from the automated data logger downloading, which will occur two times per month, as well as from biannual manual water level measurements. The trip reports will include a discussion of activities performed, field conditions, operation and maintenance status, and any problems encountered. In addition, trip reports will be used to present organic vapor readings and the amount of free product present in wells measured with an Oil/Water Interface probe.

3.3 Well Operation and Maintenance Reporting

A summary of the well operation and maintenance O&M activities, including work performed, and recommendations for additional work, will be included in the Biannual Technical Memoranda. Monthly O&M activities will be reported in Monthly Trip Reports.

3.4 Program Summary

A Basewide Program Summary Report will be generated when all field tasks are completed and all analytical data summarized and interpreted. This document will be comprehensive in nature, presenting findings from both water level monitoring and measurement programs, and including a summary of O&M activities.

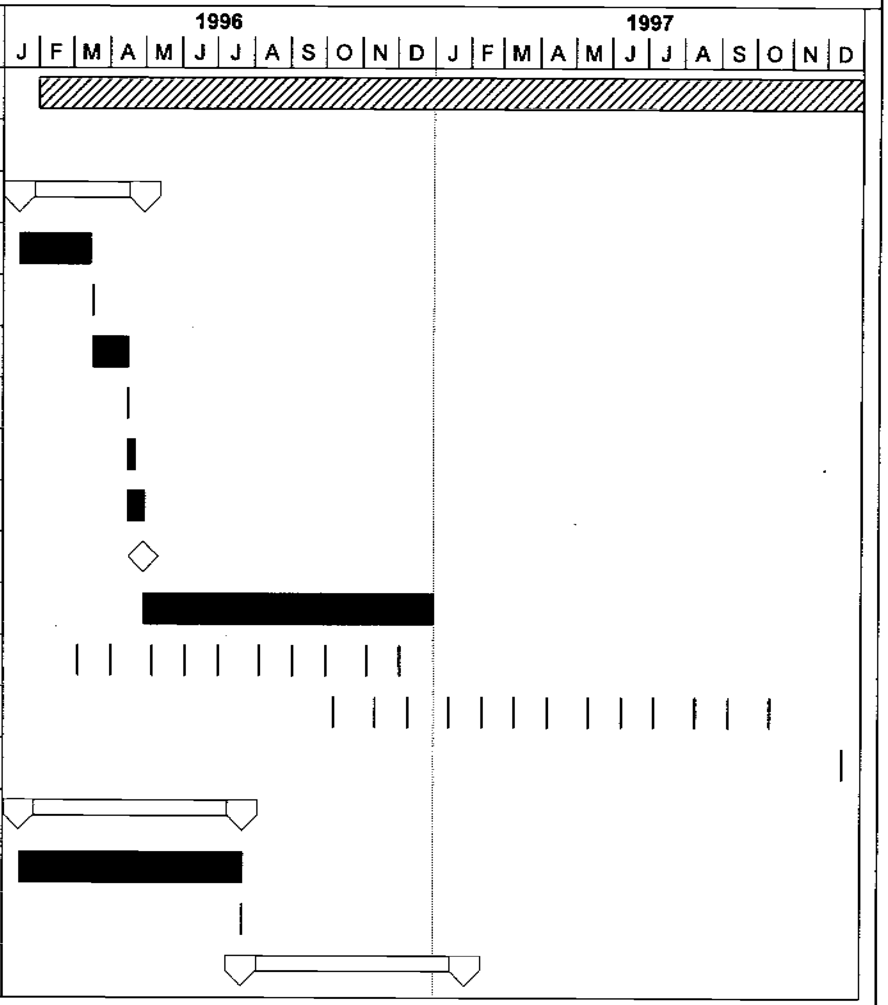
Section 4.0
TASK SCHEDULE

The project schedule, including both field and reporting tasks, is provided as Table 4-1.

Table 4-1

BASEWIDE SUPPORT PROGRAM, DO-037, ELMENDORF AFB
Activity Schedule 1996-1997

ID	Task Name	Duration	Start	Finish
1	**DELIVERABLE DOCUMENTS:**	640d	2/1/96	1/14/98
2				
3	**Env. Monitoring Plan - I**	**106d**	**1/16/96**	**4/30/96**
4	Draft Document Preparation	60d	1/16/96	3/15/96
5	Draft Due to Air Force and Agencies	1d	3/18/96	3/18/96
6	Comment Period	30d	3/18/96	4/16/96
7	Comments Due from Reviewers	1d	4/16/96	4/16/96
8	Comment Responses Due to Reviewers	7d	4/16/96	4/22/96
9	Final Document Preparation	15d	4/16/96	4/30/96
10	Final Document Due	1d	4/30/96	4/30/96
11	**Env. Monitoring Plan Revisions (min 2)**	246d	4/30/96	12/31/96
12	**Trip Reports (Due first Tue/month)**	**274d**	**3/5/96**	**12/3/96**
23	**OU 5 Sampling Trip Report (Due second Tue/month)**	**324d**	**10/8/96**	**10/14/97**
37	**OU 5 Sampling Results for 1996-1997**	1d	12/16/97	12/16/97
38	**Technical Memorandum - I**	**190d**	**1/16/96**	**7/23/96**
39	Document Preparation	190d	1/16/96	7/23/96
40	Due to Air Force	1d	7/23/96	7/23/96
41	**Technical Memorandum - II**	**190d**	**7/23/96**	**1/28/97**



Task	■	Milestone	◇	Rolled Up Critical Task	▨
Critical Task	▨	Summary	▭	Rolled Up Milestone	◇
Progress	▬	Rolled Up Task	■	Rolled Up Progress	▬

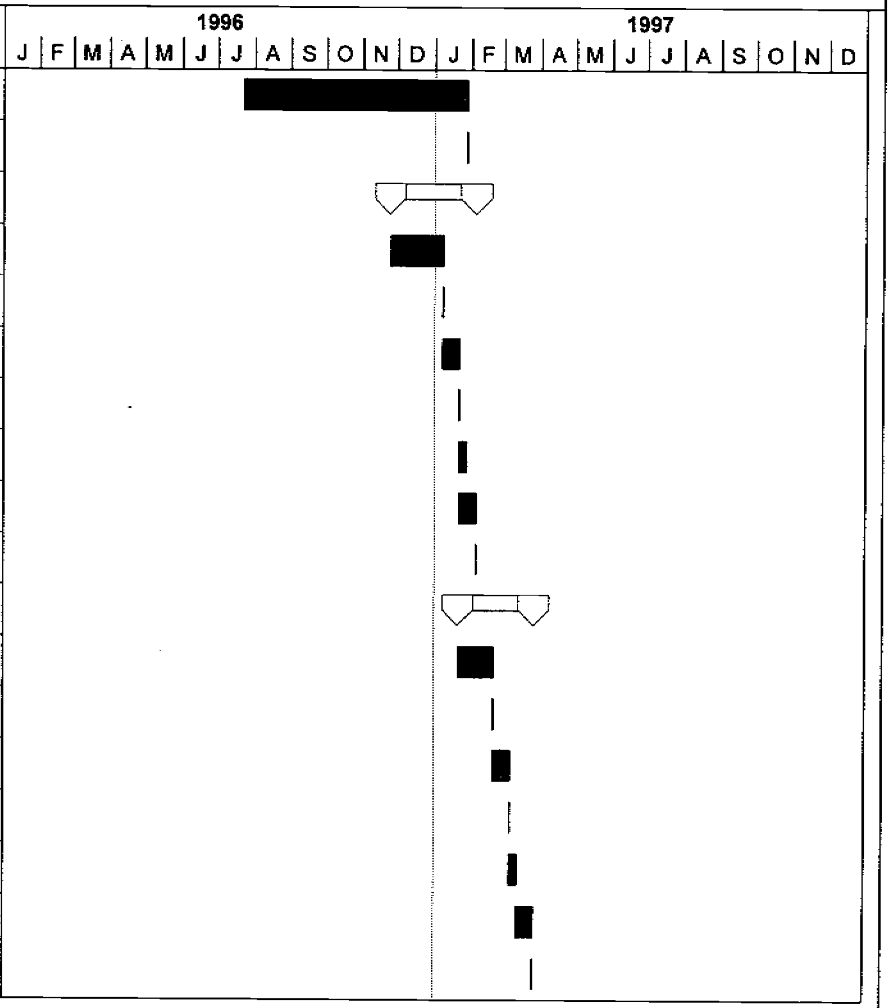
Project: Basewide DO 037 Schedule
Date: 3/14/96

Table 4-1

(Continued)

BASEWIDE SUPPORT PROGRAM, DO-037, ELMENDORF AFB
Activity Schedule 1996-1997

ID	Task Name	Duration	Start	Finish
42	Document Preparation	190d	7/23/96	1/28/97
43	Due to Air Force	1d	1/28/97	1/28/97
44	**Annual Groundwater Report**	**73d**	**11/25/96**	**2/5/97**
45	Draft Document Preparation	45d	11/25/96	1/8/97
46	Draft Due to Air Force and Agencies	1d	1/8/97	1/8/97
47	Comment Period	15d	1/8/97	1/22/97
48	Comments Due from Reviewers	1d	1/22/97	1/22/97
49	Comment Responses Due to Reviewers	7d	1/22/97	1/28/97
50	Final Document Preparation	15d	1/22/97	2/5/97
51	Final Document Due	1d	2/5/97	2/5/97
52	**Basewide Program Summary Report**	**64d**	**1/22/97**	**3/26/97**
53	Draft Document Preparation	30d	1/22/97	2/20/97
54	Draft Due to Air Force and Agencies	1d	2/20/97	2/20/97
55	Comment Period	15d	2/20/97	3/6/97
56	Comments Due from Reviewers	1d	3/6/97	3/6/97
57	Comment Responses Due to Reviewers	7d	3/6/97	3/12/97
58	Final Document Preparation	15d	3/12/97	3/26/97
59	Final Document Due	1d	3/26/97	3/26/97



Project: Basewide DO 037 Schedule
Date: 3/14/96

Task	■	Milestone	◇	Rolled Up Critical Task	▨
Critical Task	▨	Summary	⊏⊐	Rolled Up Milestone	◇
Progress	▬	Rolled Up Task	■	Rolled Up Progress	▬

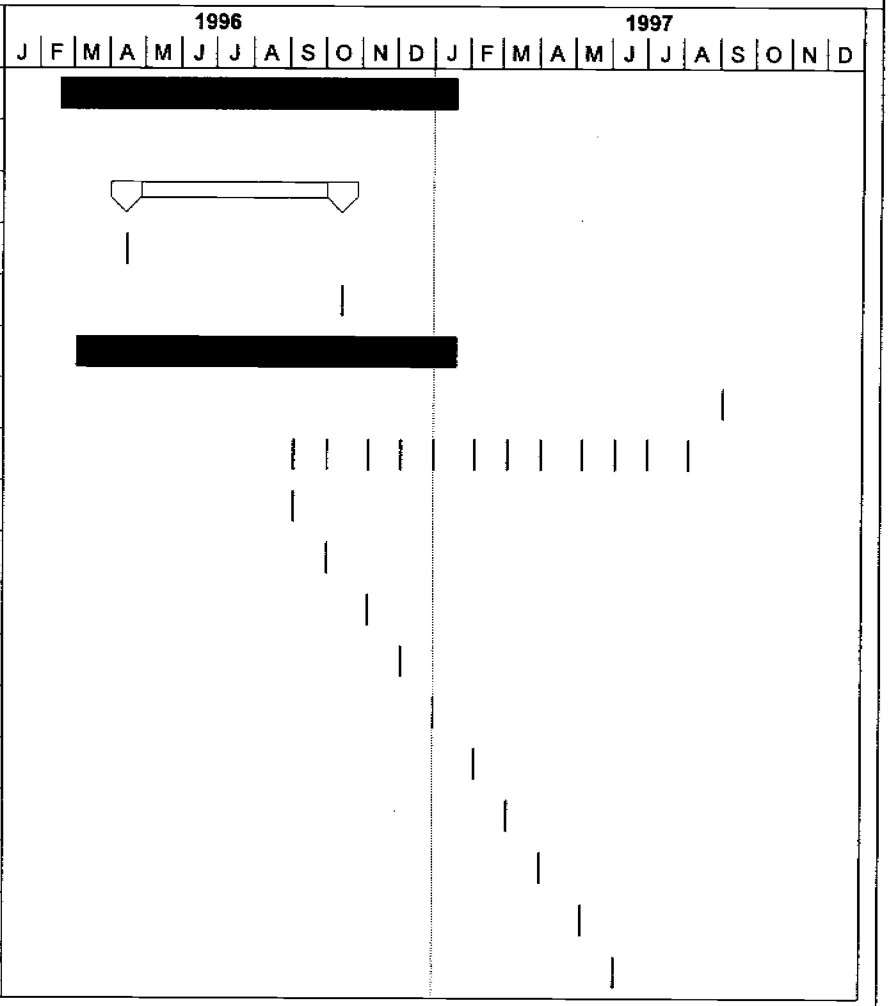
Table 4-1

(Continued)

BASEWIDE SUPPORT PROGRAM, DO-037, ELMENDORF AFB

Activity Schedule 1996-1997

ID	Task Name	Duration	Start	Finish
60	**FIELD PROGRAM:**	337d	2/19/96	1/20/97
61				
62	**Manual Water Level Measurements**	**183d**	**4/16/96**	**10/15/96**
63	Spring Measurement	1d	4/16/96	4/16/96
64	Fall Measurement	1d	10/15/96	10/15/96
65	**Data Logger Download (1st and 3rd Mon/month)**	323d	3/4/96	1/20/97
66	**Sediment Sampling (OU 5)**	1d	9/4/97	9/4/97
67	**Surface Water Sampling (OU 5)**	**309d**	**9/4/96**	**8/6/97**
68	Surface Water Sampling (OU 5) 1	1d	9/4/96	9/4/96
69	Surface Water Sampling (OU 5) 2	1d	10/2/96	10/2/96
70	Surface Water Sampling (OU 5) 3	1d	11/6/96	11/6/96
71	Surface Water Sampling (OU 5) 4	1d	12/4/96	12/4/96
72	Surface Water Sampling (OU 5) 5	1d	1/1/97	1/1/97
73	Surface Water Sampling (OU 5) 6	1d	2/5/97	2/5/97
74	Surface Water Sampling (OU 5) 7	1d	3/5/97	3/5/97
75	Surface Water Sampling (OU 5) 8	1d	4/2/97	4/2/97
76	Surface Water Sampling (OU 5) 9	1d	5/7/97	5/7/97
77	Surface Water Sampling (OU 5) 10	1d	6/4/97	6/4/97



Project: Basewide DO 037 Schedule
Date: 3/14/96

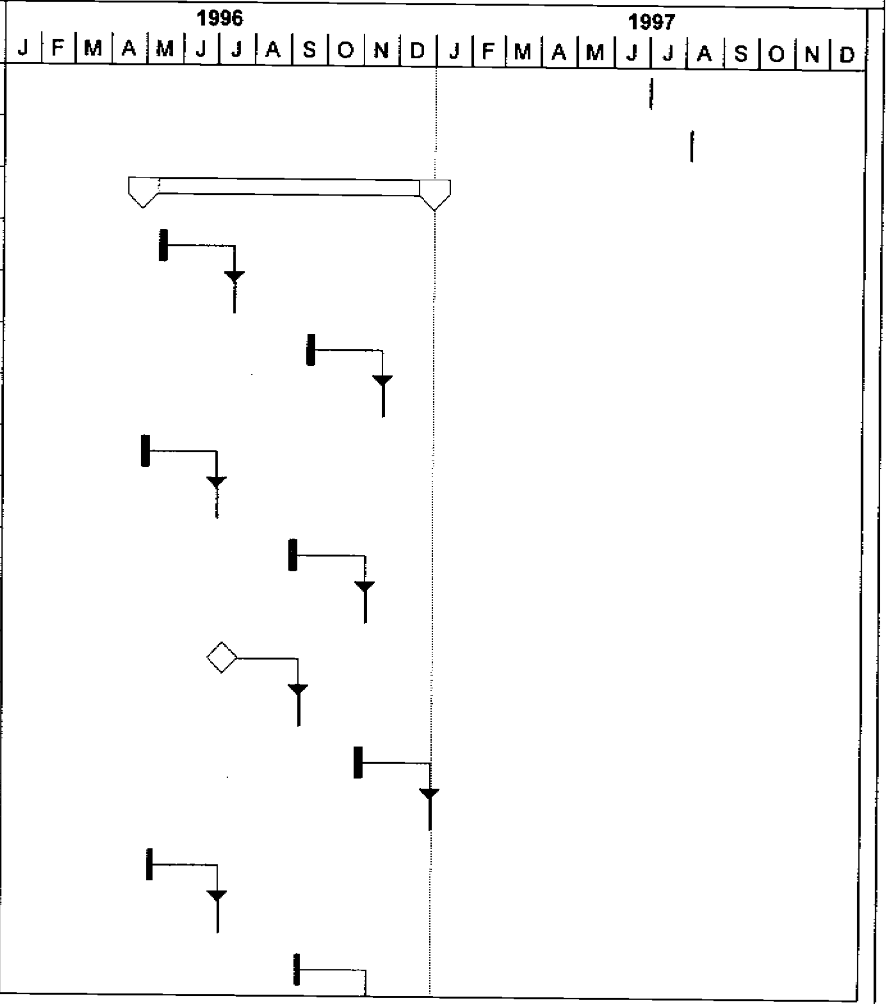
Task	▬	Milestone	◇	Rolled Up Critical Task	▨
Critical Task	▨	Summary	⊏⊐	Rolled Up Milestone	◇
Progress	▬	Rolled Up Task	▬	Rolled Up Progress	▬

Table 4-1

(Continued)

BASEWIDE SUPPORT PROGRAM, DO-037, ELMENDORF AFB
Activity Schedule 1996-1997

ID	Task Name	Duration	Start	Finish
78	Surface Water Sampling (OU 5) 11	1d	7/2/97	7/2/97
79	Surface Water Sampling (OU 5) 12	1d	8/6/97	8/6/97
80	**Groundwater Sampling/Reporting**	**247d**	**4/29/96**	**12/31/96**
81	SERA Phase I - Event 1	6d	5/13/96	5/18/96
82	Analytical Rpt Due to Air Force	1d	7/16/96	7/16/96
83	SERA Phase I - Event 2	6d	9/16/96	9/21/96
84	Analytical Rpt Due to Air Force	1d	11/19/96	11/19/96
85	SERA Phase II - Event 1	6d	4/29/96	5/4/96
86	Analytical Rpt Due to Air Force	1d	7/2/96	7/2/96
87	SERA Phase II - Event 2	6d	9/2/96	9/7/96
88	Analytical Rpt Due to Air Force	1d	11/5/96	11/5/96
89	SERA Phase III - Event 1	6d	7/8/96	7/13/96
90	Analytical Rpt Due to Air Force	1d	9/10/96	9/10/96
91	SERA Phase III - Event 2	6d	10/28/96	11/2/96
92	Analytical Rpt Due to Air Force	1d	12/31/96	12/31/96
93	OU 1 - Event 1	4d	5/6/96	5/9/96
94	Analytical Rpt Due to Air Force	1d	7/5/96	7/5/96
95	OU 1 - Event 2	4d	9/9/96	9/12/96



Project: Basewide DO 037 Schedule
Date: 3/14/96

Task	■	Milestone	◇	Rolled Up Critical Task	▨
Critical Task	▨	Summary	▭	Rolled Up Milestone	◇
Progress	▬	Rolled Up Task	■	Rolled Up Progress	▬

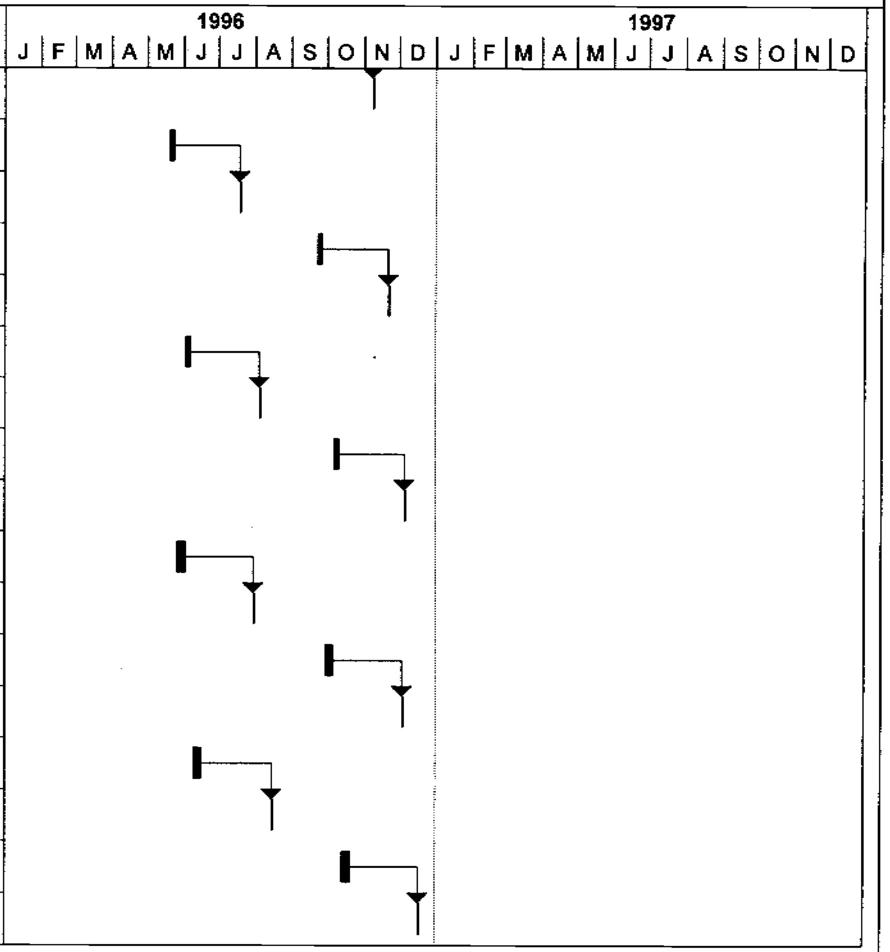
Table 4-1

(Continued)

BASEWIDE SUPPORT PROGRAM, DO-037, ELMENDORF AFB

Activity Schedule 1996-1997

ID	Task Name	Duration	Start	Finish
96	Analytical Rpt Due to Air Force	1d	11/8/96	11/8/96
97	OU 2 - Event 1	4d	5/20/96	5/23/96
98	Analytical Rpt Due to Air Force	1d	7/19/96	7/19/96
99	OU 2 - Event 2	4d	9/23/96	9/26/96
100	Analytical Rpt Due to Air Force	1d	11/22/96	11/22/96
101	OU 4 - Event 1	4d	6/3/96	6/6/96
102	Analytical Rpt Due to Air Force	1d	8/5/96	8/5/96
103	OU 4 - Event 2	4d	10/7/96	10/10/96
104	Analytical Rpt Due to Air Force	1d	12/6/96	12/6/96
105	OU 5 - Event 1	7d	5/27/96	6/2/96
106	Analytical Rpt Due to Air Force	1d	7/31/96	7/31/96
107	OU 5 - Event 2	7d	9/30/96	10/6/96
108	Analytical Rpt Due to Air Force	1d	12/4/96	12/4/96
109	OU 6 - Event 1	7d	6/10/96	6/16/96
110	Analytical Rpt Due to Air Force	1d	8/16/96	8/16/96
111	OU 6 - Event 2	7d	10/14/96	10/20/96
112	Analytical Rpt Due to Air Force	1d	12/18/96	12/18/96



Project: Basewide DO 037 Schedule
Date: 3/14/96

Task	■	Milestone	◇	Rolled Up Critical Task	▨
Critical Task	▨	Summary		Rolled Up Milestone	◇
Progress	▬	Rolled Up Task	■	Rolled Up Progress	▬

Section 5.0
REFERENCES

United States Air Force. Basewide Investigation Work Plan, Elmendorf Air Force Base, Alaska. February 1992.

United States Air Force. Management Plan (Final), Operable Unit 6, Environmental Restoration Program, Elmendorf Air Force Base, Alaska. April 1994a.

United States Air Force. Remedial Investigation/Feasibility Study (Final), Operable Unit 1, Environmental Restoration Program, Elmendorf Air Force Base, Alaska. October 1993.

United States Air Force. Remedial Investigation/Feasibility Study (Draft Final), Operable Unit 3, Environmental Restoration Program, Elmendorf Air Force Base, Alaska. January 1995.

United States Air Force. Remedial Investigation/Feasibility Study (Final), Operable Unit 4, Environmental Restoration Program, Elmendorf Air Force Base, Alaska. September 1994b.

United States Air Force. Remedial Investigation/Feasibility Study (Final), Operable Unit 5, Environmental Restoration Program, Elmendorf Air Force Base, Alaska. March 1994c.

United States Environmental Protection Agency (USEPA). Statistical Analysis of Groundwater Monitoring Data. EPA, 530-SW-89-026. 1989, 1992.

Weeks, J.B. *The Relationship Between Surface Water and Groundwater in Ship Creek Near Anchorage, Alaska.* U.S. Geological Survey Professional Paper 700-B, pp. B224-B226.

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Plate 1

Monitoring Wells used in the Basewide Support Program, Elmendorf AFB

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APPENDIX A

Field Sampling Plan

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LIST OF TABLES

Section 1.0
INTRODUCTION

The following Field Sampling Plan (FSP) provides a description of program requirements and procedural guidelines relating to the activities associated with this investigation. Appendix A of the OU 6 Management Plan (U.S. Air Force, 1994) should be referenced for additional details on field procedures.

1.1 General Requirements

Field personnel will comply with the requirements and guidelines given in Section 4 of the Installation Restoration Program (IRP) Handbook pertaining to Hydraulic Investigations. In the event that conflicting guidance exists, the requirements in the approved Environmental Monitoring Plan (EMP) will take precedence. The current work is covered under the Federal Facilities Agreement (FFA) negotiated with the U.S. Environmental Protection Agency (USEPA) covering Air Force Bases.

1.2 Recordkeeping

Field records shall be maintained in a manner that will enable the recreation of all sampling and measurement activities performed during this investigation. The field sampling and analysis activities will be designed to meet the requirements of the Installation Restoration Program Information Management System (IRPIMS). In addition, specific data requirements for certain activities as listed in the following sections will be met. All information will be recorded with indelible ink in a permanently bound, numbered notebook with sequentially numbered pages. These records will be archived during and upon completion of the project in an easily accessible form and will be available, upon request, to the USAF.

The records kept for all activities conducted during this investigation will include the location, date, and time, identity of people performing the activity, and weather conditions. For all field measurements, the numerical value and units of each measurement, the type of instrument, and the calibration results will be recorded. Notes on all sampling activities will include: sample type and sampling method used, sample identity, sample volume, a sample description (water color, clarity, etc.), identification of sampling device, and any uncontrollable conditions that may affect the sample integrity (weather, air quality, etc.). All sample logs generated will be filed in a master sample logbook.

Section 2.0
GROUNDWATER SAMPLING ACTIVITIES

Groundwater sampling will be conducted at Operable Units (OUs) 1, 2, 4, 5, 6, and at selected SERA Program monitoring wells, as part of the Basewide Support and Groundwater Monitoring Program. The following subsections provide a discussion of the site specific approach at each location, as well as the procedures which will be adhered to during the sampling activities. Procedures to be followed during sampling support activities, such as shipping and handling, are also provided.

2.1 Site Specific Approach

The following subsections provide the site specific strategies for groundwater sampling at all locations included in the Basewide Support and Groundwater Monitoring Program.

2.1.1 Operable Unit 1

Twelve monitoring wells will be sampled as part of the long-term monitoring efforts at OU 1. The locations of these wells are provided in Figure 2-1. All of the wells will be sampled biannually in 1996, with events occurring during the months of May and September. A detailed field schedule for this program is provided in Section 4 of the EMP.

All wells will be sampled according to the procedures outlined in the Field Sampling Plan (FSP). The samples from the OU 1 wells will be collected using a hand bailer, following purging via a submersible pump or dedicated sampling device, where installed and operable.

The samples collected will be analyzed according to the methods outlined in Table 2-1. Details on the requirements for sample holding times and preservation, and the applicable QA/QC sample requirements, are provided in Appendix C of the EMP, the QAPP.

Table 2-1

Analytical Methods
Operable Unit 1 - Groundwater Sampling

Parameter	Analytical Method Water
Turbidity[a]	E180.1
Specific Conductance[a]	SW9050
pH[a]	SW9040
Temperature[a]	E170.1
Dissolved Oxygen[a]	E360.1
Total Alkalinity[a]	SM403
Anions	SW9056
Chromium VI	SW7196
Trace Metals by ICP Screen	SW6010
Mercury - CVAAS	SW7470
Volatile Organics	SW5030/SW8260
Organochlorine Pesticides & PCBs	SW3510/SW8080
Chlorinated Herbicides	SW3510/SW8150

[a] Field parameters

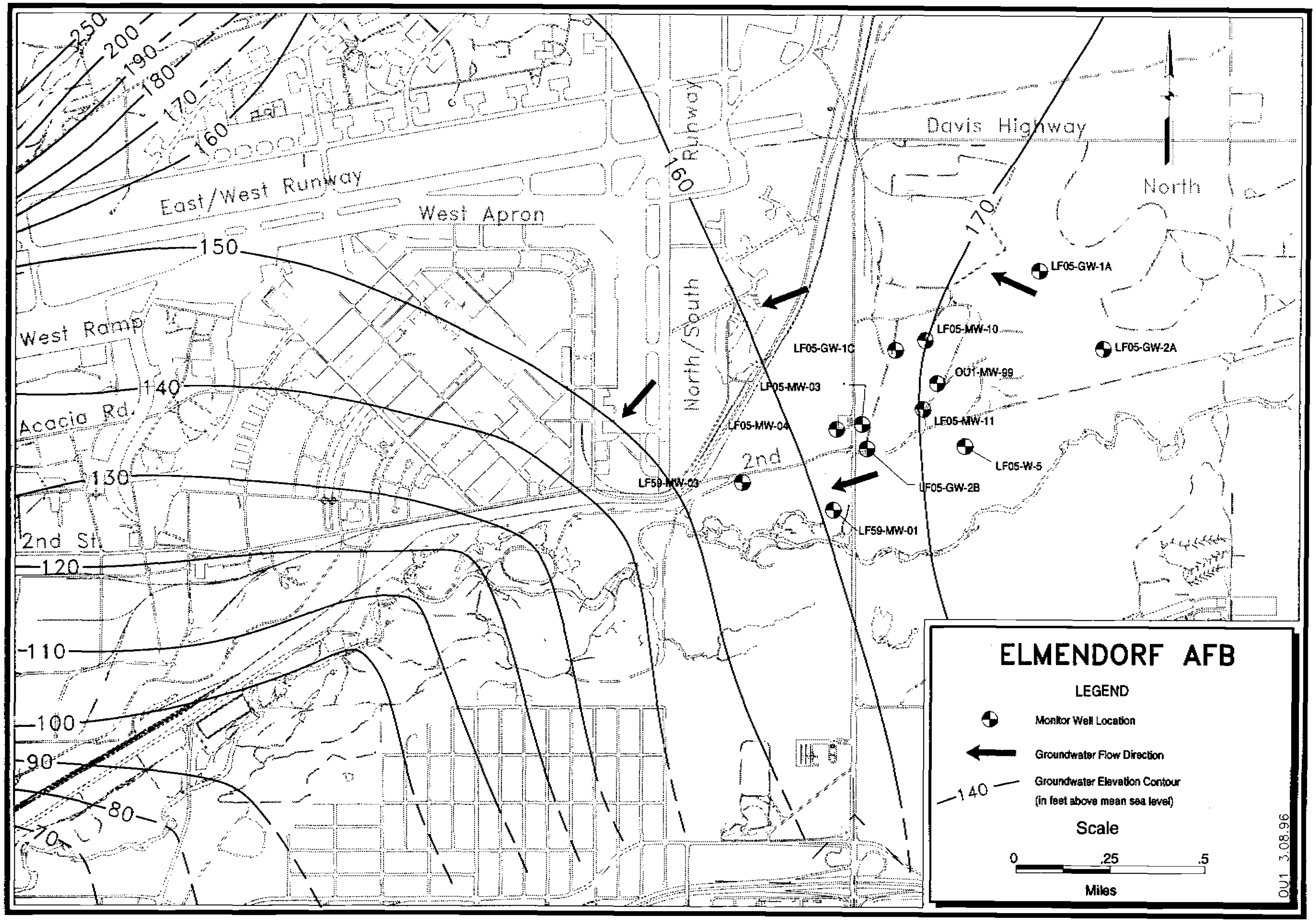


Figure 2-1. Location of Monitoring Wells to be Sampled at Operable Unit 1

2.1.2 Operable Unit 2

Sixteen monitoring wells will be sampled as part of the long-term monitoring efforts at OU 2. The locations of these wells are provided in Figure 2-2. All of the wells will be sampled biannually in 1996, with events occurring during the months of May and September. A detailed field schedule for this program is provided in Section 4 of the EMP.

All wells will be sampled according to the procedures outlined in the Field Sampling Plan (FSP). The samples from the OU 2 wells will be collected using a hand bailer, following purging via a submersible pump or dedicated sampling device, where installed and operable.

The samples collected will be analyzed according to the methods outlined in Table 2-2. Six of the wells will also be analyzed for sulfate presence using SW9056 (ST41-07, ST41-16, ST41-18, ST41-19, ST41-28, and ST41-W7). It should be noted that these six wells are being added to the program as part of a contract modification which was not finalized at the time this document was written. Therefore, it is possible that these wells will not be included in the program if the modification is not finalized. Details on the requirements for sample holding times and preservation, and the applicable QA/QC sample requirements, are provided in Appendix C of the EMP, the QAPP.

Table 2-2

Analytical Methods
Operable Units 2, 4, 5 and 6 - Groundwater Sampling

Parameter	Analytical Methods Water
Turbidity[a]	E180.1
Specific Conductance[a]	SW9050
pH[a]	SW9040
Temperature[a]	E170.1
Dissolved Oxygen[a]	E360.1
Total Alkalinity[a]	SM403
Nitrate/Nitrite	E353.1
Trace Metals by ICP Screen	SW6010
Volatile Organics	SW5030/SW8260
Hydrocarbons as Gasoline	SW3540/SW8015MP
Hydrocarbons as Diesel	SW3540/SW8015ME

[a] Field parameters

2.1.3 Operable Unit 4

A total of eleven wells will be sampled from OU 4 as part of the Basewide Support and Groundwater Monitoring Program. The locations of these wells are provided in Figure 2-3. All of the wells will be sampled biannually in 1996, with events occurring during the months of June and October. A detailed field schedule for this program is provided in Section 4 of the EMP.

All wells will be sampled according to the procedures outlined in this Field Sampling Plan. Samples from OU 4 wells will be collected using a hand bailer, following purging via a submersible pump or dedicated sampling device, where installed and operable. Samples collected from wells within OU 4 will be analyzed according to the methods outlined in Table 2-2. Details on the requirements for sample holding times and preservation, and the applicable QA/QC sample requirements, are provided in Appendix C of the EMP, the QAPP.

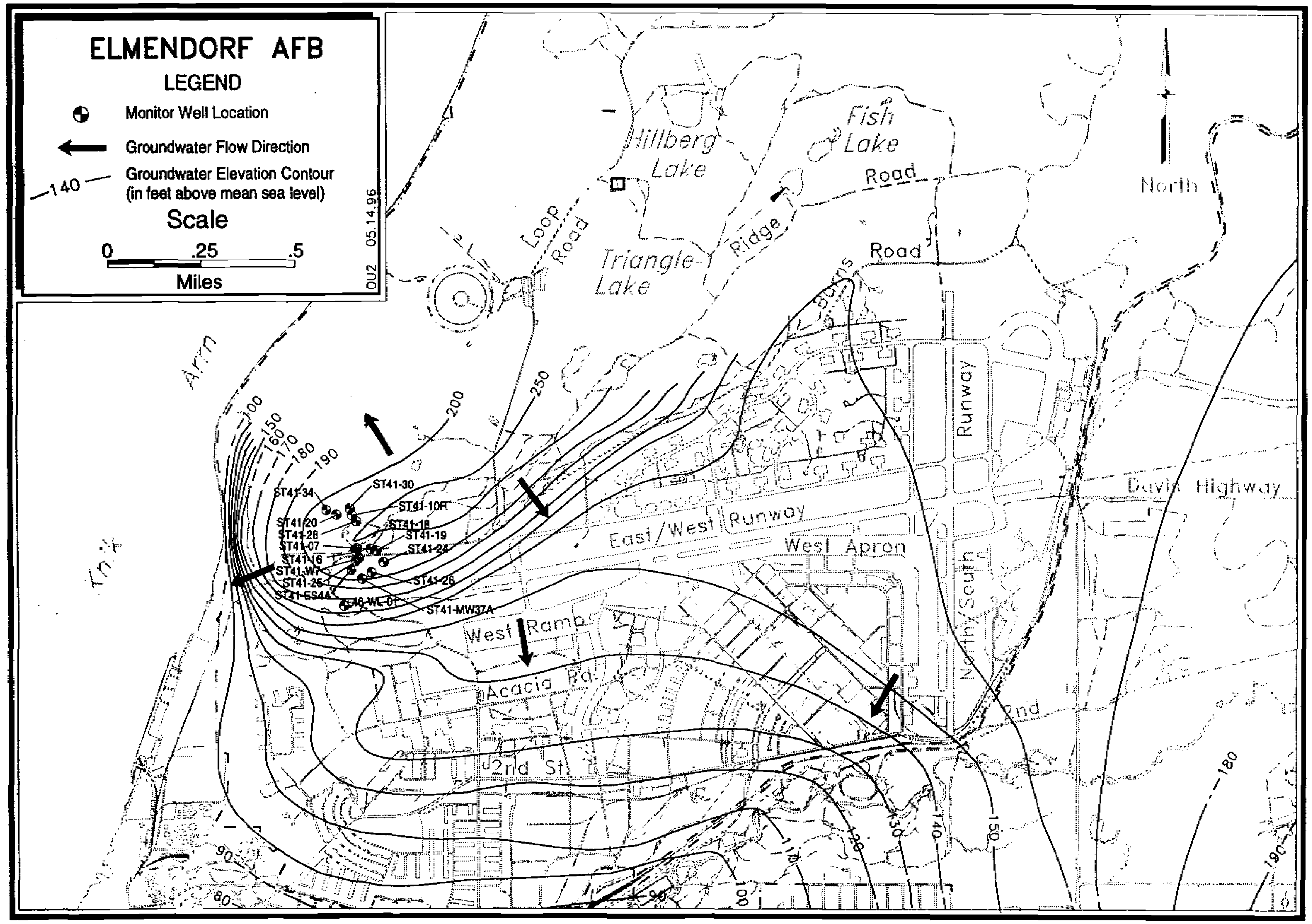


Figure 2-2. Location of Monitoring Wells to be Sampled at Operable Unit 2

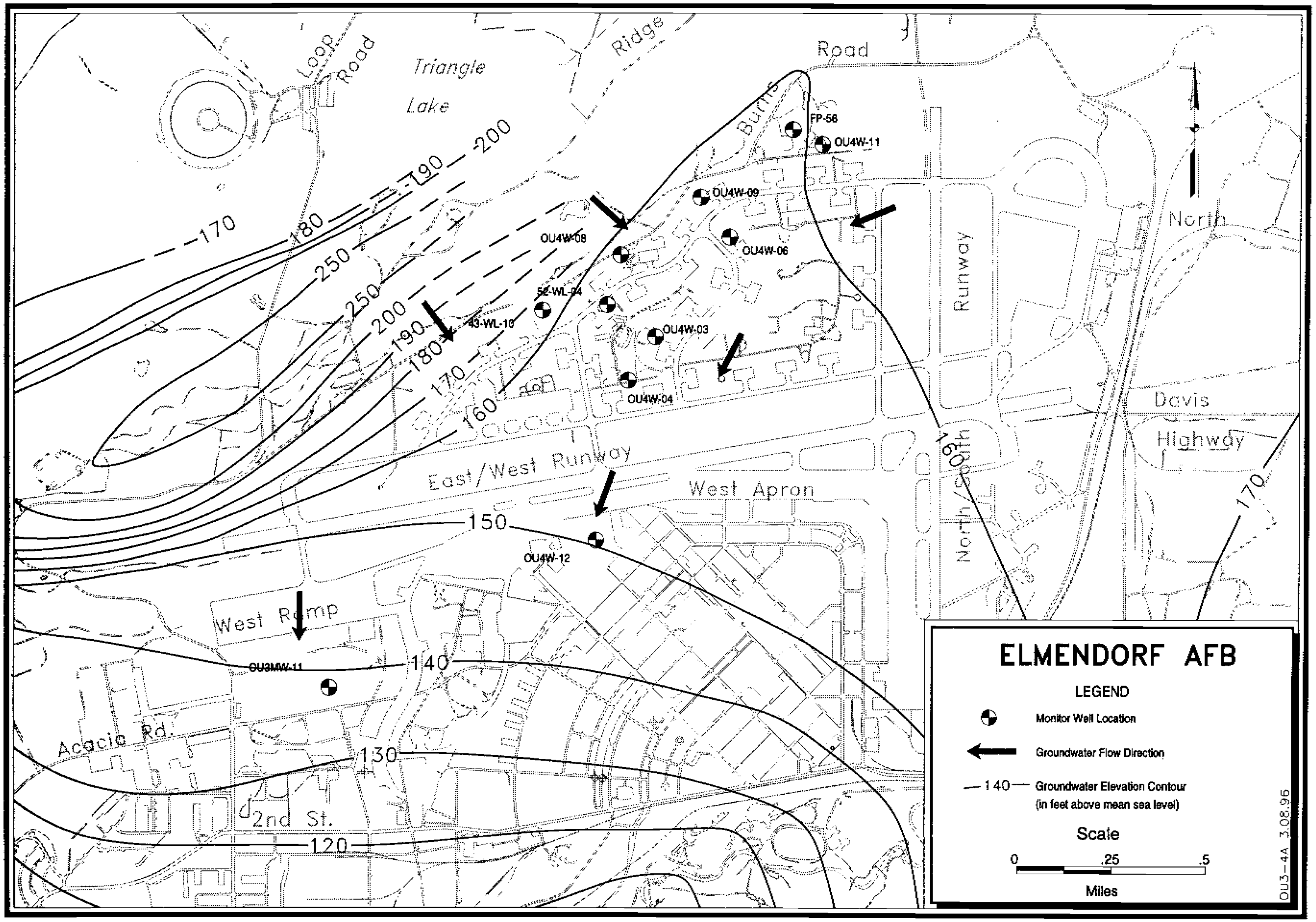


Figure 2-3. Location of Monitoring Wells to be Sampled at Operable Unit 4

2.1.4 Operable Unit 5

A total of nineteen monitoring wells are included in the long-term monitoring program for OU 5. The locations of these wells are provided in Figure 2-4. All of the wells will be sampled biannually in 1996, with events occurring during the months of May and September. Since groundwater from OUs 4 and 5 is hydraulically interconnected, it is intended that the samples from these two OUs be taken consecutively, such that the analytical results will be as synoptic as possible. A detailed field schedule for this program is provided in Section 4 of the EMP.

Historically, access has been a problem at several of these wells during peak winter months, such that the total number of wells has had to be reduced. Sampling is no longer planned at OU 5 for mid-winter, but should access problems arise due to unseasonable conditions during the fall or spring sampling events, a decision to alter the list of wells to be sampled will be made in conjunction with the Base point-of-contact (POC) and the Air Force Center for Environmental Excellence (AFCEE).

All wells will be sampled according to the procedures outlined in this Field Sampling Plan. All of wells in the OU 5 sampling program are retro-fitted with dedicated sampling devices, and will be sampled accordingly. Like OU 4, the samples collected will be analyzed according to the methods outlined in Table 2-2. Details on the requirements for sample holding times and preservation, and the applicable QA/QC sample requirements, are provided in Appendix C of the EMP, the QAPP.

2.1.5 Operable Unit 6

A total of twenty-three monitoring wells are included in the long-term monitoring program for OU 6. The locations of these wells are provided in Figure 2-5. All of the wells will be sampled biannually in 1996, with events occurring during the months of June and October. A detailed field schedule for this program is provided in Section 4 of the EMP.

All wells will be sampled according to the procedures outlined in this Field Sampling Plan. Samples from OU 4 wells will be collected using a hand bailer, following purging via a submersible pump or dedicated sampling device, where installed and operable. Like OU 5, the samples collected will be analyzed according to the methods outlined in Table 2-2. Details on the requirements for sample holding times and preservation, and the applicable QA/QC sample requirements, are provided in Appendix C of the EMP, the QAPP.

2.1.6 SERA Locations

Groundwater sampling at SERA sites will occur within three program areas (SERA Phase I, SERA Phase II, and SERA Phase III). Seventeen wells will be sampled at SERA Phase I, twenty-one wells will be sampled at SERA Phase II, and up to seventeen additional wells will be sampled at SERA Phase III as part of the Basewide Support and Groundwater Monitoring Program. The locations of monitoring wells at SERA Phase I are shown in Figure 2-6 and the locations of SERA Phase II wells are shown on Figure 2-7. SERA Phase III wells will be installed during the 1996 field season. All SERA Program area wells will be sampled biannually in 1996. SERA Phase I and Phase II wells will be sampled during the months of May and September, and SERA Phase III wells will be sampled during the months of July and October, providing that installation and development are completed on schedule (see the project schedule in Section 4 of the EMP).

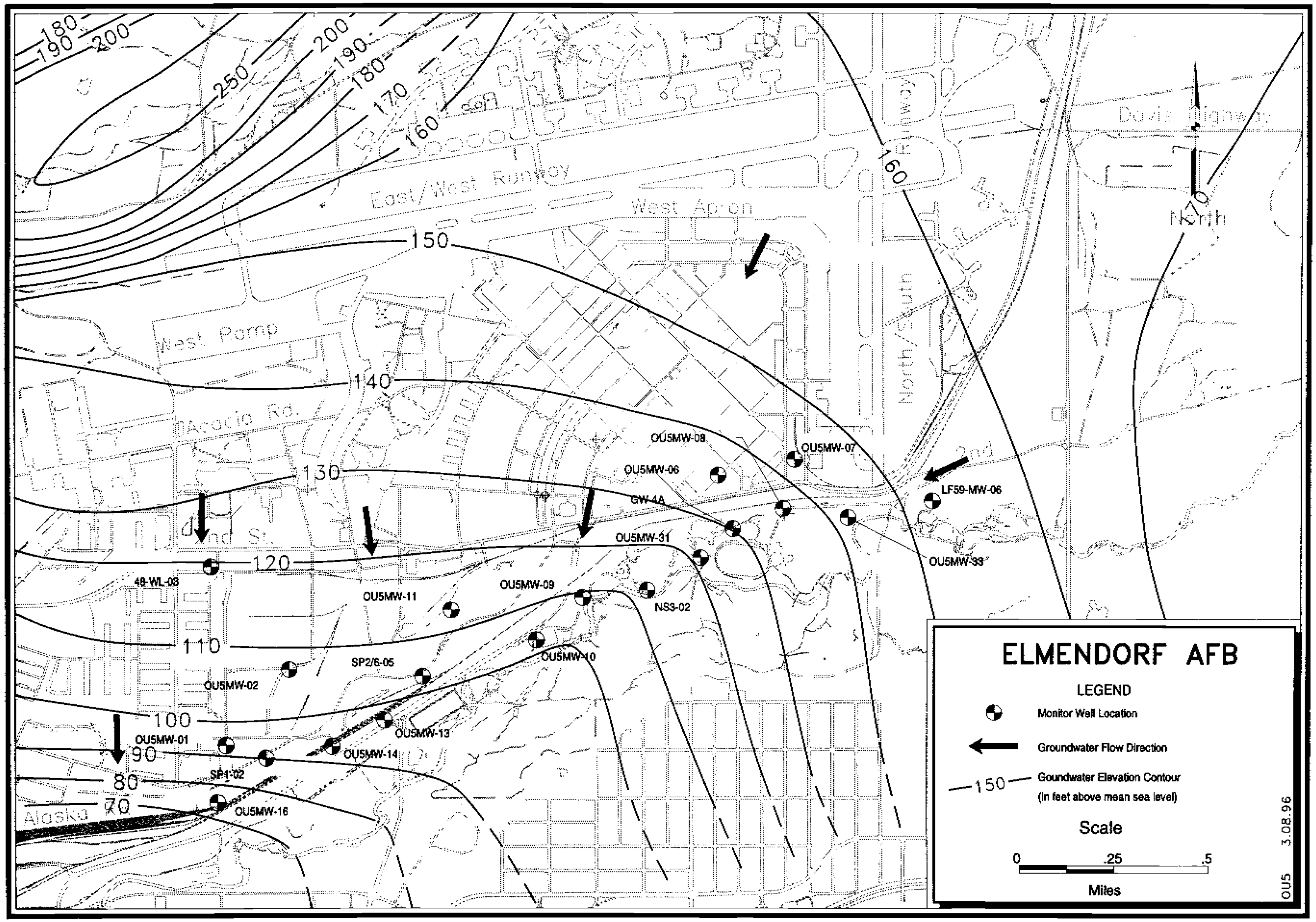


Figure 2-4. Location of Monitoring Wells to be Sampled at Operable Unit 5

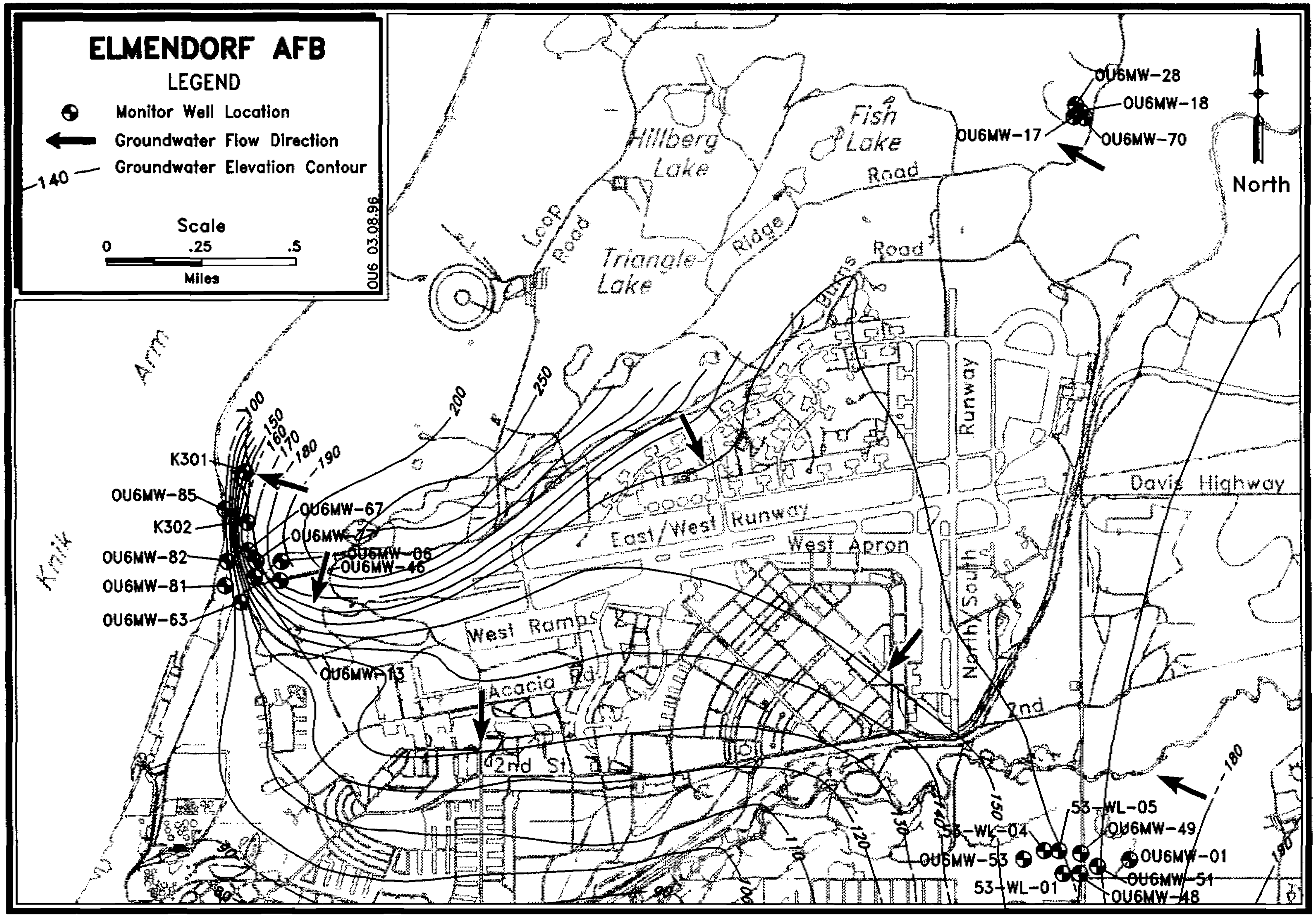


Figure 2-5. Location of Monitoring Wells to be Sampled at Operable Unit 6

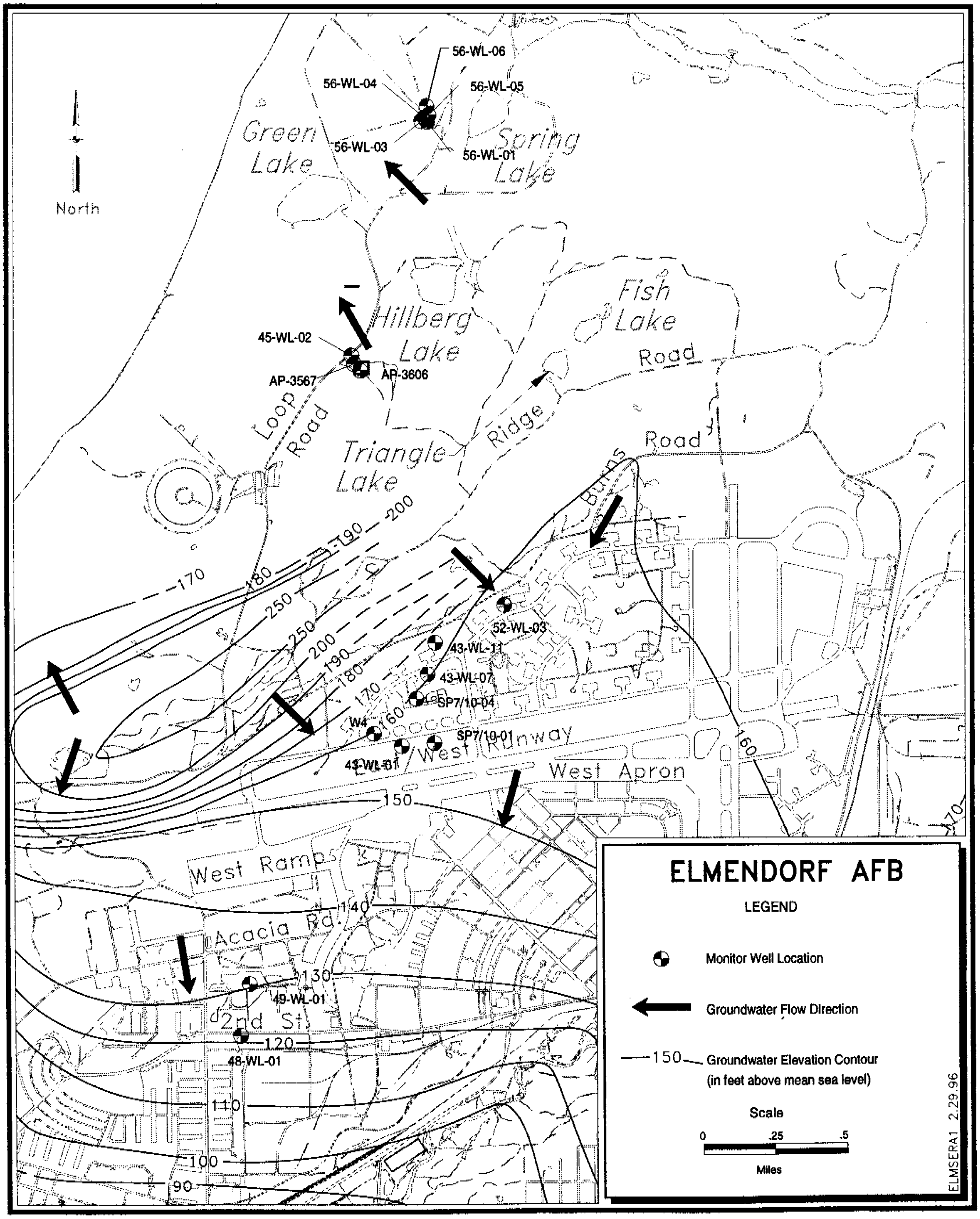


Figure 2-6. Location of Monitoring Wells to be Sampled at SERA Phase I Locations

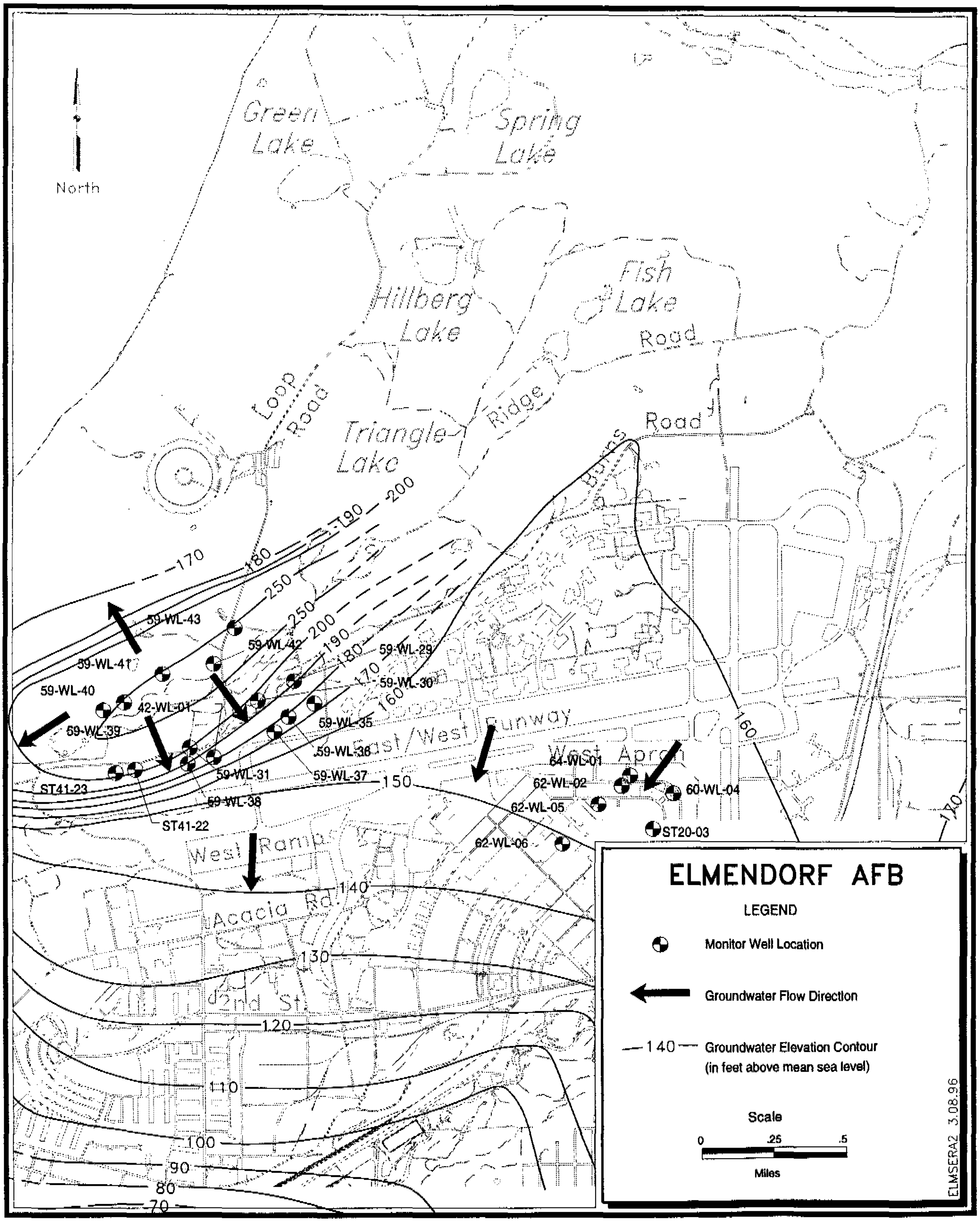


Figure 2-7. Location of Monitoring Wells to be Sampled at SERA Phase II Locations

All wells will be sampled according to the procedures outlined in this Field Sampling Plan. Samples will be collected via a hand bailer or dedicated pump (if present). A list of field and laboratory analytical methods to be used at SERA Program locations is presented in Table 2-3. Details on the requirements for sample holding times and preservation, and the applicable QA/QC sample requirements, are provided in Appendix C of the EMP, the QAPP.

Table 2-3

Analytical Methods
SERA Program Monitoring Wells - Groundwater Sampling

Parameter	Analytical Methods Water
Turbidity[a]	E180.1
Specific Conductance[a]	SW9050
pH[a]	SW9040
Temperature[a]	E170.1
Dissolved Oxygen[a]	E360.1
Total Alkalinity[a]	SM403
Nitrate/Nitrite	E353.1
Trace Metals by ICP Screen	SW6010
Volatile Organics	SW5030/SW8260
Hydrocarbons as Gasoline	SW3540/SW8015MP
Hydrocarbons as Diesel	SW3540/SW8015ME
Organolead	CADHS

[a] Field parameters

2.2 Sampling Procedures

The sampling and analysis plan is designed to obtain quality groundwater samples to characterize water quality, in the shallow aquifer, within the area of concern. Sampling and analysis procedures include calibration of field sampling equipment, sample collection, and decontamination of sampling tools prior to use and between samples.

2.2.1 Well Purging

Well purging is an integral step in recovering samples that are representative of in-situ groundwater chemistry. Each monitoring well will be purged immediately prior to sample collection. This ensures the sample consists of fresh formation water rather than stagnant water that has been stored in the well casing. During all sampling activities, well purging equipment will be positioned so that any potential volatile organic sources, such as vehicles, gasoline-driven generators, air compressors, and fuel tanks are downwind of the well. This avoids contamination caused by entrainment of volatile contaminants in the sample. Any potential sources of volatile organics that are unavoidable will be noted on a groundwater sampling log (Figure 2-8).

If a well is not equipped with a dedicated pump system, it will be purged with an electric submersible pump. Purging and sampling rates will be adjusted to minimize the potential release of VOCs during sampling. The bailer or submersible pump will be positioned near the middle of the screened interval of the well to ensure that standing water is removed and fresh formation water is drawn into the well. Purged groundwater will be collected in temporary storage and settling tanks prior to conditioning and disposal.

TITLE: IRP Groundwater Sampling Log

PROJECT ______________________ DATE ____________

SUBJECT ______________________ SHEET ___ OF ___ SHEETS

INSTALLATION ID (AFID)	**WELL ID (LOCID)**	**(LOGDATE)**	**(LOGTIME)**
PERFORMED BY (LOGCODE)	**WATER LEVEL (STATDEP)** **INITIAL** **FINAL**	**TOTAL DEPTH (SOUNDING)** **INITIAL** **FINAL**	
SATURATED THICKNESS	**WELL VOLUME**	**AMOUNT TO PURGE**	

PURGE METHOD:

Time (LOGTIME)	Cum. Volume (gal)	Water Quality				Water Level	Comments
		Temp	pH	Cond.	Turb.		
Final Measurements:							

SAMPLING METHOD (SMCODE)

Sample ID	(MATRIX)	Preservative	Analysis	Sample Type Code (SACode)	Comments

Figure 2-8. Groundwater Sampling Log

For permanent groundwater monitoring wells, well purging is considered complete when the indicator parameters of pH, temperature, conductivity, and turbidity have stabilized and a minimum of three well bore volumes have been removed from the well.

The wetted wellbore volume is calculated by using the following equation:

$$V = [(3.14b^2L - 3.14c^2L)(0.30) + (3.14c^2L)] \times 7.48$$

where:

V = One wetted borehole volume (gallons);
b = Borehole radius (feet);
c = Casing radius (feet);
L = Height of water column in well (feet);

and the porosity of the filter pack is assumed to be 30 percent.

To determine when stabilization has occurred, pH, temperature, and conductivity are monitored on a regular basis until two successive readings of all three parameters do not vary by more than ±0.1 pH unit, ±1.0 degree°C, and ±5 percent change in micromhos, respectively. If stabilization does not occur, samples may be collected after a total of six wellbore volumes have been removed from the well. Turbidity will also be measured regularly during well purging. To promote consistency in the field data, one person will collect all water parameter data during well purging and will conduct water level and total depth measurements.

In low-yield wells which are purged dry before three well bore volumes have been removed, the sample shall be collected as soon as sufficient recharge has occurred in the well to collect samples. The time at which the well was purged dry will be recorded on the groundwater field sheets, as well as the volume of water removed prior to sampling.

A calibrated 5-gallon bucket (or similar container of known capacity) will be used to measure the amount of water being removed from the well during the purging process. Elapsed time will be noted as the container is filled, thereby allowing the calculation of the discharge rate. The total amount of water purged from each well will be recorded on the groundwater sampling log (Figure 2-8).

2.2.2 Sample Collection

One of two types of sampling equipment or systems will be used to collect groundwater samples from monitoring wells; a dedicated Well Wizard® pump system, or a hand bailer. The dedicated sampling systems are used for individual wells, minimizing the potential of cross-contamination to other wells. A bailer will be used to sample wells if dedicated pumps are not used. A submersible pump may be used to purge the well prior to the collection of groundwater samples. Standard operating procedures are followed for each type of sampling system to ensure that representative and comparable groundwater samples will be collected.

A groundwater sampling log (Figure 2-8) will be used to record well purging and sampling measurements. The objective of the groundwater sampling protocol is to obtain samples that are representative of the aquifer in the well vicinity, so the analytical results reflect the composition of the groundwater as accurately as possible. In order to achieve this objective, all factors that may affect the physical and chemical integrity of the sample must be controlled before, during, and after sample collection. Sample preparation and preservation requirements are discussed in the QAPP, attached as

Appendix C.

For wells with dedicated pumps, samples will be drawn with the Well Wizard® Controller/Compressor unit via Teflon® sampling tubes which remain with each well to prevent cross-contamination of samples. A Teflon® hand bailer will be utilized for volatile organic samples (VOAs) if the Well Wizard Controller is found to introduce oxygen into the sampling tubing prior to sample removal. If a Teflon® bailer is utilized, a controlled flow Teflon® bottom assembly, with spigot, should utilized to obtain VOA samples.

Wells not equipped with a dedicated pump system will be sampled using a decontaminated Teflon® bailer. A stainless-steel or Teflon®-coated leader (8 ft. length) or dedicated rope will be securely attached to the bailer if a bailer is used. The bailer will be lowered slowly into the well, taking care to cause as little disturbance as possible to the water surface. Water will be collected from the middle of the screened interval of the well. As the bailer is lowered and raised, the sampler will be careful to keep the line clean and off the ground surface. To minimize this problem, the polypropylene line (tied to the Teflon® leader) can be directed into a clean bucket or similar container as the bailer is being raised in the well. The bailer will be filled and emptied twice with well water, into a secondary container, to condition it before collecting samples. A bottom emptying device may be used to transfer water from the bailer into the sample containers. Sample bottles will be filled over a secondary container to prevent any excess sample from reaching the ground.

Groundwater samples will be recovered in a prearranged priority, so that all collection and handling takes place as efficiently as possible. Although the actual sample collection protocol will depend on the analytes of interest, it is important to be consistent in general sample collection procedures. Prior to using the bailer, or collecting a sample from the discharge line, the samplers will wear new, clean protective gloves to avoid cross contamination. Care is taken to minimize disturbance of the groundwater. Samples are typically taken in the following order to minimize the loss of volatile compounds:

- Volatile organic compounds;
- Pesticides and PCBs;
- Other organics;
- Metals; and
- Water quality parameters (anions, nitrates, etc.).

The sample bottles for VOCs must be filled slowly to prevent the entrapment of air bubbles, splashing, or agitation of the water. Care will be taken to avoid touching the mouth of the discharge line, the top of the sample bottle, the inside of the cap, or the Teflon® septa. A septum that falls out of the cap onto the ground cannot be used. The bottle will be filled completely such that a meniscus forms. The cap will be screwed on and the bottle inverted, tapped firmly, and checked for the presence of air bubbles. Accurate analytical results for volatile organic compounds may be compromised if there is anyfree air trapped in the sample container.

Samples are immediately placed on ice and maintained at 4 degrees°C until they are received by the laboratory. As required, samples will be pH-adjusted prior to shipment. Samples will be packaged, shipped, and stored in a manner which avoids contamination and ensures sample integrity.

2.2.3 Sampling Equipment Decontamination

Strict procedures for equipment decontamination will be implemented to avoid cross contamination between samples. Care will also be taken to avoid contact between clean equipment and contaminated clothing. The following procedures will be used to decontaminate sampling equipment:

- Scrub the equipment with a solution of potable water and Alconox®, or equivalent laboratory-grade detergent;
- Rinse equipment with copious quantities of potable water followed by a reagent grade Type II water rinse;
- Rinse equipment with pesticide-grade methanol;
- Rinse equipment with pesticide-grade hexane; and
- Air dry equipment on a clean surface such as Teflon®, stainless steel, or aluminum.

If the sampling device will not be used immediately after being decontaminated, it will be wrapped in aluminum foil with the shiny side out.

2.2.4 Waste Management

Purge water and decontamination waste water (solvents, detergent rinse, etc.) will be the only waste generated during this project requiring special handling/disposal considerations. Purge water (including water used to condition the bailer and any sample spill-over) and decontamination water will be contained in separate, labeled 55-gallon drums. Drums generated will be stored within bermed holding facilities at the Elmendorf AFB Environmental Staging Facility. Each container will be marked with a non-fading marker or paint, and a log kept on the number, location, contents, and date generated. Data from all drummed or containerized material will be recorded on log sheets as specified in the OU 6 Management Plan (U. S. Air Force, 1994), and in accordance with the Elmendorf AFB Environmental Staging Facility Operation & Maintenance (O&M) Manual. Sample standards and reagent waste will be disposed of in the decontamination solvent drum(s). At the end of the project, wastewater will be analyzed, characterized and disposed of according to base guidelines. All other waste generated from this task will be general refuse and will be disposed of at the Municipality of Anchorage Landfill.

2.2.5 Sample Handling and Analysis

This section outlines the procedures for handling and analysis of the groundwater samples collected during the course of this investigation. These procedures are in accordance with those outlined in the OU 6 Management Plan (U.S. Air Force, 1994).

2.2.5.1 Labeling

Labels will be computer generated, completed in the field using a waterproof permanent marker, and securely attached to the sample jar. All samples will be clearly labeled with the following information:

- Project name/client;

- Sample location;
- Sample type (analytical method);
- Preservatives used;
- Sampler's name and initials; and
- Date and time of collection.

Adhesive tape will be used, if necessary, to secure labels. In no case shall tape be used to seal sample containers.

2.2.5.2 Chain of Custody

Field personnel will maintain chain-of-custody records for all field and field QC samples. A sample is defined as being under a person's custody if any of the following conditions exist:

- It is in their physical possession;
- It is in their view, after being in their physical possession;
- It was in their possession, and they locked it up or otherwise sealed it so that tampering would be evident; or
- It is in a designated secure area.

Field personnel will complete a chain-of-custody record for each sample. The chain-of-custody (COC) form will accompany each sample shipment container from the field to the laboratory to establish the documentation needed to trace sample possession. Figure 2-9 is an example of the chain-of-custody form which will be used for this task.

Upon arrival at the designated laboratory, the chain-of-custody form will be completed with:

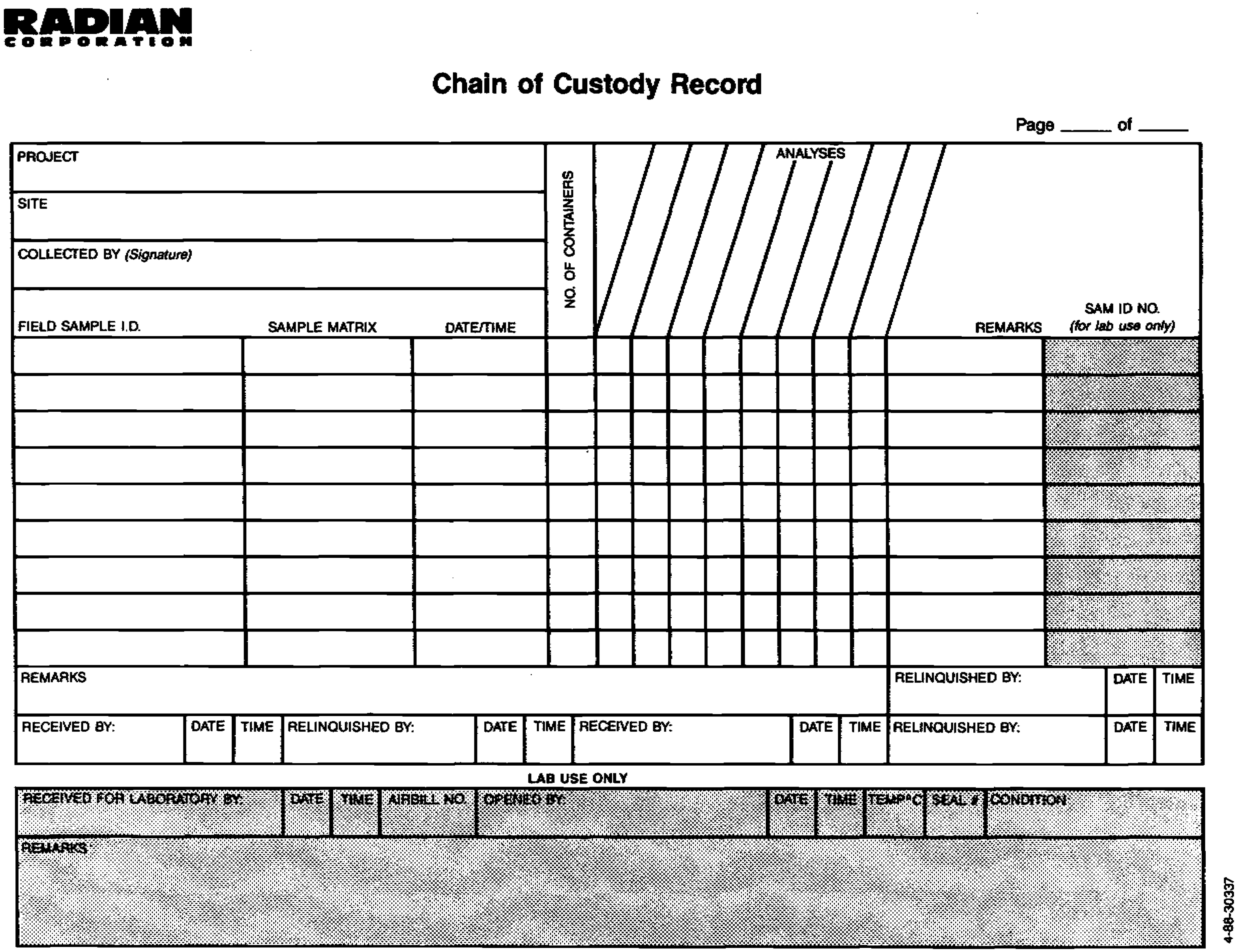
- Name of the person receiving the container and date of arrival or receipt of samples;
- Name of the person opening the shipping container, along with date, time, temperature of shipping container, seal number, and condition of shipping container; and
- Any remarks regarding sample condition upon arrival.

All sample coolers will be sealed in a manner that will prevent or detect tampering.

2.2.5.3 Sample Storage and Transportation

Samples will be packaged, shipped, and stored in a manner which avoids contamination and ensures sample integrity. All samples are stored in coolers on ice or in properly monitored refrigerators from immediately after collection until analysis.

When packaging samples for commercial transport, an absorbent material such as vermiculite



RADIAN
CORPORATION

Chain of Custody Record

Page _____ of _____

PROJECT

SITE

COLLECTED BY *(Signature)*

FIELD SAMPLE I.D.	SAMPLE MATRIX	DATE/TIME	NO. OF CONTAINERS	ANALYSES								REMARKS	SAM ID NO. *(for lab use only)*

REMARKS									RELINQUISHED BY:	DATE	TIME
RECEIVED BY:	DATE	TIME	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME	RELINQUISHED BY:	DATE	TIME

LAB USE ONLY

RECEIVED FOR LABORATORY BY:	DATE	TIME	AIRBILL NO.	OPENED BY:	DATE	TIME	TEMP°C	SEAL #	CONDITION
REMARKS									

4-88-30337

Figure 2-9. Chain-of-Custody Form

will be used to minimize the effect of any breakage and to absorb any spills. Protective packaging will be used on sample bottles to minimize the risk of breakage during transport, to prevent any cross-contamination in the event of breakage, and to ensure that the samples do not freeze. Sample packaging requirements for hazardous materials requiring interstate transport are defined in the Code of Federal Regulations (CFR) 49, Chapter 1, Part 171 and will be utilized, if required, during sample transport. The samples from this task are not expected to be classified as hazardous.

2.2.6 Laboratory Analyses

Following receipt of samples by the laboratory, the samples will be logged in and analyzed as indicated on the chain-of-custody forms. Appendix C, the QAPP, provides information on analytical methods, sample holding times, and preservation requirements. Appendix C also includes information on the quantitation limits and quality control and calibration requirements for each analytical method. Finally, a summary of parameters to be tested for, analytical methods used, and the number of regular and quality control samples to be collected during each sampling event is also provided in Appendix C.

2.2.7 Field Analyses

Temperature, pH, conductivity, and dissolved oxygen content can change over the sample holding time. Consequently, these parameters will be determined in the field at the time of sample collection. The field measurements, outlined in Table 2-1, Table 2-2 and Table 2-3, will be conducted at all sample locations during all sampling events. Groundwater temperature will be measured concurrently with pH and conductivity. Values for pH, conductivity, and temperature are recorded with a minimum accuracy of ±0.1 pH unit, 5 percent in micromhos, and ±1.0°C, respectively. Turbidity will also be measured in the field during well purging. A goal of 3 nephelometric turbidity units (NTUs) has been established prior to well sampling.

All field analysis equipment, such as probes and beakers, are to be rinsed with reagent grade water and with the water to be tested prior to making the measurements. Periodic checks will be made by the field crew to determine the reproduceability of the field measurements. In addition, all field measurement equipment will be calibrated according to the manufacturers procedures and frequency.

Section 3.0
GROUNDWATER LEVEL MEASUREMENTS

Two types of groundwater level measurements will be taken as part of the Basewide Support and Groundwater Monitoring Program. These include manual water level measurements and electronic water level measurements. The methodology for each of the two procedures are described below.

3.1 Manual Measurements

Manual water level measurements will be performed biannually at 63 monitoring wells. The location of the wells currently being measured is presented on Plate 1 of the EMP. A detailed field schedule for these activities is provided in Section 4 of the Environmental Monitoring Plan. Depth to water and total well depth shall be measured from a common reference point at the wellhead prior to each measuring event. Depth to groundwater shall also be measured routinely prior to purging and sampling. The elevation of the water surface will be calculated relative to the surveyed reference point and entered into the Elmendorf AFB database. In addition to the water level measurements, organic vapor readings will also be taken from the breathing zone and down the well casing at locations where free product has been measured in the past. Where organic vapors are detected inside the well, measurements will be made to delineate the surface elevation and thickness of any free floating product with an Oil/Water Interface probe.

Water-level measurements are reported to the nearest 0.01 foot. The measurements are to be taken with audible electronic water level indicator meters. The visual or audio signal is activated when water is encountered. The depth to water is measured repeatedly until two consecutive measurements are consistent within 0.01 foot. In new wells or wells where a hydrocarbon layer is suspected, an oil/water interface probe will be used.

The following procedures will be followed when performing water-level measurements:

- Uncap the well and measure the organic vapor (where deemed necessary) content of the casing air and breathing zone with an organic vapor monitor and upgrade protective equipment, if required, as described in the Health and Safety Plan;

- If no vapors are detected and the well has historically been free of floating product, decontaminate the water-level indicator tape using the methods prescribed in Section 2.2.3 and lower the electronic probe into the well until water is encountered and note the depth on the calibrated tape relative to the surveyed reference point; repeat the water-level measurement until two consecutive measurements agree within 0.01 foot; lower the probe to the bottom of the well and measure the total depth of the well;

- If the well has historically contained free product, or if organic vapors are detected inside of the well casing, water level, total well depth, depth to product, and product thickness will be measured with a decontaminated Oil/Water Interface probe;

- Record the depth to water, total well depth, and, if applicable, depth to and thickness of floating product, on the sample recovery log form; and

- Decontaminate the probe and the portion of the tape that had contact with the groundwater.

To promote organization and consistency in field data collection, one field team member measures the depth to water for the well, while the other records the data on field logs.

3.2 Data Logger Measurements

Manual downloading of data logger measurement readings will be performed bi-monthly at up to 15 monitoring wells. The location of those wells currently fitted with data loggers is shown in Plate 1 of the EMP. A detailed field schedule is provided in Section 4 of the Environmental Monitoring Plan. Data loggers continuously take water level measurements at 3- or 12-hour intervals. Information downloaded includes water level elevation (to the nearest 0.01 foot), submergence of transducer, and system status data (i.e. battery charge, interval times, etc.).

The following procedures will be followed when downloading data logger measurements:

- Uncap the well and measure the organic vapor content of the casing air and breathing zone with an organic vapor monitor and upgrade protective equipment if necessary as described in the Health and Safety Plan;
- Visually inspect the desiccant tube, where applicable, and replace spent desiccant as necessary;
- Decontaminate the water-level indicator tape using the methods prescribed in Section 2.2.3;
- Lower the electronic water level probe into the well until water is encountered and note the depth on the calibrated tape relative to the surveyed reference point (manual reading);
- Repeat the water-level measurement until two consecutive measurements agree within 0.01 foot;
- Record the manual depth to water reading on the continuous water level monitor data collection and maintenance form;
- Decontaminate the probe and the portion of the tape that had contact with the groundwater;
- Connect the laptop computer accessory cable to the download port of the data logger and initiate the download process. Complete instructions for data download operations are included in Attachment D of the Basewide Water Level Program Standard Operating Procedures Report;
- Disconnect the cable and replace well cap.

Section 4.0
WELL OPERATION AND MAINTENANCE

Monthly inspections will be made of all wells equipped with an electronic data logger. In addition, all wells included in the basewide environmental monitoring program (Plate 1) will be inspected for operation and maintenance on at least a biannual basis, during regularly scheduled field events. These inspections will include a visual inspection of the well casing exterior and the well pad. Snow and/or debris will be removed from around the well and the pad so that an accurate assessment of the condition of the well can be made. Notes on any damage will be made in a bound field log book, dedicated to the monitoring well operation and maintenance task. In addition, the condition of any equipment associated with the well used in the Basewide Support and Groundwater Monitoring Program should be inspected and the condition noted.

After inspection of the exterior, each protective cover will be unlocked, and the inside of the well cover inspected. Notes regarding any cracks in the casing, improper fitting of PVC materials, damage to the surveyed reference points, etc., should be made in the field log book. When possible, an organic vapor meter should be carried during the well operations and maintenance inspections so that the inside of the well casing can also be examined. The interior of the well casings will be routinely inspected as part of the groundwater measuring program.

Any small repairs, such as missing or loose screws, ill-fitting parts which can be replaced, etc., should be made in the field at the time of the inspection. A supply of common well parts should be carried in the field at all times, to maximize efficiency. Any and all repairs made should be noted in the field logbook. Notes should be sufficient such that a trip report, including all findings, can be prepared on a monthly basis, which includes details of repairs made, and recommendations for additional repairs, and/or well abandonment. Any well sampling or monitoring equipment noted in poor condition should also be repaired when possible in the field, or noted and reported in the monthly reports.

Section 5.0
STATISTICAL DATA EVALUATION

Statistical tests of central tendency will be performed to determine if the "average" 1996 results and "average" historical concentrations differed significantly. Tests will be performed for target analytes that had 50% or more numerical measurements reported. That is, target analytes with more than 50% "not detected" results will not be assessed. This cut-off is chosen because comparisons using more than 50% proxy concentrations for "not detected" results may be biased by the method chosen to estimate the proxy concentration. A Student's t-Test will be performed when two populations are both normally distributed, and the Wilcoxon test will be performed when the two populations are not normally distributed. Normality is a basic assumption for many statistical tests, such as the Student's t-Test. When this assumption cannot be met, the Wilcoxon test, a nonparametric test that does not require that the data be normally distributed, can be used (USEPA, 1989 and 1992).

For the Wilcoxon test, measured concentrations are ranked and the test is performed on the ranks of the data. For both the t-Test and the Wilcoxon test, proxy concentrations are estimated for the few values reported as ND by using a uniform random number between 0 and the minimum "J" flagged result. Two-tailed tests are performed to determine if the average concentration of recent results is either significantly less than or significantly greater than the average historical concentration. The results of this analysis will be addressed in the comprehensive Annual Groundwater Report.

It should be noted that the Wilcoxon test, since it is a nonparametric test, is not as statistically "powerful" as the t-Test. The power of a statistical test is the ability to detect a difference when if fact there is a difference. This is partly due to the fact that the Wilcoxon test is performed on a ranking of the data rather than on actual measured concentrations. Wilcoxon test results of "NS" (i.e., not significantly different) may be false-negative conclusions due to a lack of data or lower power of the test.

Section 6.0
REFERENCES

United States Air Force. Management Plan (Final), Operable Unit 6, Environmental Restoration Program, Elmendorf Air Force Base, Alaska. April 1994.

United States Environmental Protection Agency (USEPA). Statistical Analysis of Groundwater Monitoring Data. EPA, 530-SW-89-026. 1989, 1992.

APPENDIX B

Reference for Site Health and Safety Plan

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SITE HEALTH AND SAFETY PLAN

A detailed discussion of health and safety hazards and guidelines is presented in Appendix C of the OU 6 Management Plan (EMP reference: U.S. Air Force, 1994a). This plan will be studied and followed by all project personnel.

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APPENDIX C

Quality Assurance Project Plan

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Section 1.0
INTRODUCTION

The U.S. Air Force (USAF) contracted Radian to provide support for various activities as part of the Environmental Restoration Program at Elmendorf Air Force Base (AFB), Alaska. Within the framework of the Air Force (AF) Installation Restoration Program (IRP), the objective of the study is to assess past hazardous waste disposal and spill sites at Elmendorf AFB and develop remedial actions consistent with the National Contingency Plan (NCP) for sites which pose a threat to human health and welfare or the environment. This objective is achieved through the staged process in which conclusions and recommendations made from accurate and validated data are used to make decisions regarding subsequent activities.

The process includes scoping to define data requirements and objectives, a remedial investigation (RI) to characterize sites for a baseline risk assessment, and a feasibility study (FS) to define and evaluate alternative remedial actions so that a remedial action may be selected. Treatability studies to measure the effectiveness of proposed treatment methods are included as part of the FS portion of the process. Each of the steps of the process can be conducted in stages that focus on particular aspects of the process.

1.1 U.S. Air Force Installation Restoration Program

The Installation Restoration Program (IRP) was developed to provide response actions for Department of Defense (DoD) installations as required by Section 120 of CERCLA, as clarified by Executive Order 12316 and amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. The current DoD policy was specified in Defense Environmental Quality Program Policy Memorandum 81-5, dated December 11, 1981, and was implemented by the USAF in a message dated January 21, 1982. The DoD policy is to identify and fully evaluate suspected problems associated with past operations which may have caused hazardous waste contamination, and to implement remedial actions that will minimize the hazards to human health and the environment resulting from such past operations.

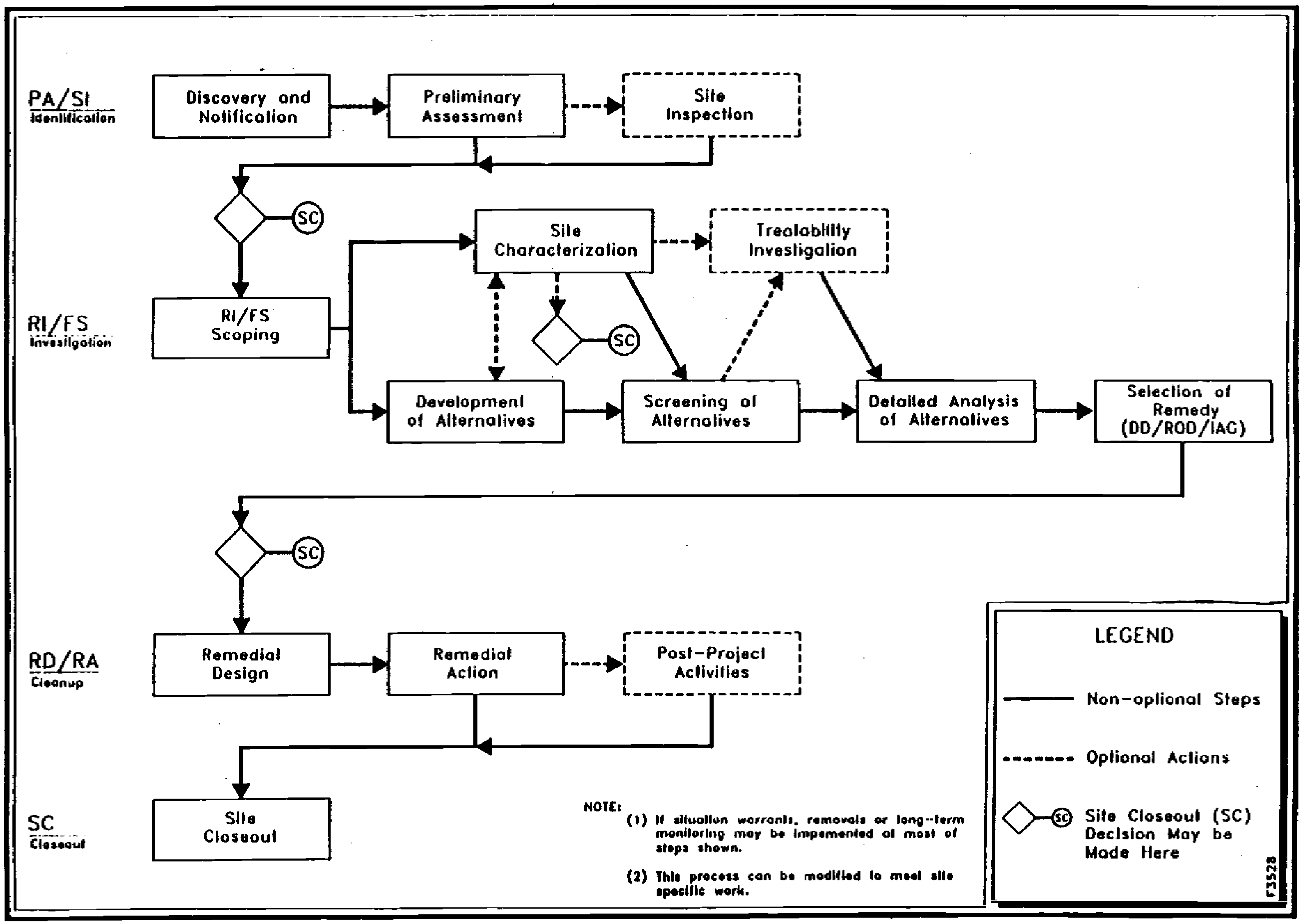
The USAF has developed the IRP in compliance with federal regulations. In the past, the IRP was a sequential four-phased program. The USAF has modified its IRP to make it similar to the U.S. EPA Remedial Investigation/Feasibility Study (RI/FS) program. It has combined phases of the program in order to conduct the remedial investigation and feasibility study in parallel, where practical. With this approach, preliminary remedial alternatives can be identified and screened as information on the nature and extent of contamination is obtained. The early identification of remedial alternatives that are potentially applicable contributes to the identification of further data requirements. Figure 1-1 shows the present IRP remedial action process.

1.2 Purpose and Scope

The purpose of the Quality Assurance Project Plan (QAPP) is to describe the project objectives, the work to be performed toward the objective goals, and the methods used to obtain quality, interpretable data. The QAPP presents requirements for performing analytical procedures including specific measurement objectives for chemical analyses, sampling and calibration procedures, sample custody, data review and reporting, and internal quality control checks.

A separate document, entitled the Field Sampling Plan (FSP), Appendix A of the EMP, provides requirements and procedures for all field work to be conducted. Descriptions of specific field operations are included in the FSP. Additionally, instructions for environmental sampling, field measurements, field QA/QC, record keeping, and site management are found in the FSP.

These two documents, the QAPP and the FSP, together will make up an AF-IRP Sampling and Analysis Plan (SAP).



NOTE:
(1) If situation warrants, removals or long-term monitoring may be impemented at most of steps shown.
(2) This process can be modified to meet site specific work.

Figure 1-1. Current IRP Remedial Action Process (from Air Force IRP Management Guide, 1989)

Section 2.0
PROJECT DEFINITION

This section provides some general information about Elmendorf AFB and summarizes the objectives for this phase of the Environmental Restoration Program.

2.1 Project Background

Elmendorf AFB is located in Anchorage, Alaska (See Figure 2-1 of the EMP) at an approximate elevation of 195 feet. The terrain, in general, is relatively flat and slopes gradually to the southwest.

The 1996 Basewide Groundwater Monitoring Program will include sampling sites from five of the Elmendorf Operable Units (OU 1, OU 2, OU 4, OU 5, and OU 6) plus three SERA Program locations. Figure 2-2 (of the EMP) shows the location of the operable units and the SERA sites. A brief description of the environmental setting at Elmendorf AFB and each of the sites is presented in Section 1.3 of the Environmental Management Plan.

2.2 Project Scope and Objectives

The specific objectives of the 1996 Basewide Groundwater Monitoring Program are presented in Section 2 of the Environmental Management Plan. Objectives for future activities at Elmendorf will be presented in the Environmental Management Plan and site specific QAPP prepared for those tasks. The Basewide Quality Assurance Project Plan (this document) will serve as the reference document for any site specific QAPPs needed for any additional activities to be conducted during 1996 and 1997.

2.3 Subcontractors and Their Roles

Radian will utilize the competitive bid process to subcontract qualified companies to perform the following tasks:

- **Laboratory Analytical** - The contracted chemical analytical laboratory will perform analytical work in accordance with the Elmendorf project Field Sampling Plan and Quality Assurance Project Plan. Radian Analytical Services will perform all soil and water analyses. In the unlikely event of scheduling or analytical capability problems, a qualified backup lab, (To be assigned), will be available to analyze samples. Analyses for organolead will be performed by BC Analytical laboratory of Glendale, California. Chromium IV and the common anions will be analyzed by a CT&E Environmental Services, Inc. laboratory of Anchorage, Alaska.

Section 3.0
PROJECT ORGANIZATION AND RESPONSIBILITY

The organization of the Elmendorf Basewide Support team is presented in this section. A brief review of the primary staff, and responsibilities for the management, quality assurance, peer review and task leadership on field tasks and support tasks is given below.

Project Management

- Ms. Ty Lane (Austin) and Mr. Scott Blount are the Contract Program Manager and the Program Manager, respectively, with responsibility for the contractual aspects of the project. Ms. Lane is the primary Radian contact person for the United States Air Force.
- Bill Hickey is the Radian Project Director, with responsibility for directing project planning activities and ensuring that qualified technical staff are assigned to the various tasks. He also is responsible for overall technical quality and consistency of all project activities and deliverables.

The Radian Program Managers and Project Director have overall responsibility to ensure that all activities are performed in accordance with United States Environmental Protection Agency (US EPA), USAF, state, and local requirements, and according to Radian policy.

Quality Assurance

- Ms. Barbara Hayes is the independent QA project officer, and is responsible for planning, implementing, and tracking quality assurance activities and maintaining communication with quality control and analytical task staff members. Her duties include QC task staffing for field activities, ensuring that quality control data evaluation, data validation, and reporting procedures are followed, issuing and tracking malfunction report forms, coordinating analytical laboratory and field sampling audits and updating the QAPP as necessary. The ultimate goal of these activities is to produce data that satisfy the data quality objectives (DQOs) for the program.

Health and Safety

- Dr. C. Herdon Williams, CIH, is responsible for general Health and Safety Plan development and training for field personnel. He is also responsible for ensuring that the health and safety procedures are understood and followed by all field personnel through training and Health and Safety audits, and for reporting and correcting any violations of these procedures.

Analytical Services

- Ms. Monica Elizondo will act as the Radian laboratory Client Services Coordinator, with responsibility for the logistical aspects of sample analysis and reporting. These areas of responsibility include scheduling sample analysis, coordinating sample shipment, and issuing analytical results to the project staff.

Primary Task Leaders

- Ms. Beth Sharp will serve as Field Coordinator and is responsible for overall direction of field investigations, including the sampling and analysis program, monitor well installation, aquifer testing program, and preparation of reports.

- Ms. Deb Bisson is the Radian Project Chemist in charge of coordination of sampling materials to field teams, interfacing with the client services, coordinating resolution of lab problems, and reviewing lab results.

As the work plans are developed, project team members will be identified based on their experience and ability to perform the required work. Resumes of all project personnel are available for review.

The responsibilities of individuals identified as task leaders are to review and update training files for team members, and to conduct training or a refresher course for all members to ensure that all field, QA, and Health and Safety procedures are understood and will be properly conducted in the field. The team members are responsible for reading and understanding the protocols established in the Field Sampling Plan, the Quality Assurance Project Plan, and the Management Plan; the task leaders and the project manager will provide time for review and be available to answer questions that may arise during that review.

Section 4.0
OBJECTIVES FOR MEASUREMENT DATA

The purpose of a quality assurance/quality control (QA/QC) program is to produce data of known quality that satisfy the DQOs. In regards to measurement data quality, the QA/QC program shall:

- Provide a mechanism for ongoing control and evaluation of measurement data quality; and
- Provide measures of data quality in terms of accuracy, precision, completeness, representativeness, and comparability to assess whether the data meet the project objectives and can be used for their intended purpose.

The basis for assessing precision, accuracy, completeness, representativeness, and comparability is discussed in the following subsections. Specific calculations for data quality measurements, and the data assessment procedure, are presented in Section 13.

4.1 Definition of Criteria

This section defines how Data Quality Objectives will be assessed during all activities at Elmendorf AFB, Alaska.

4.1.1 Analytical Measurement Data Objectives

This section defines the criteria that will be used to determine if measurement data quality objectives are met.

Precision

Precision measures the reproducibility of repetitive measurements and is usually expressed in terms of imprecision. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Analytical precision is a measurement of the variability associated with duplicate (2) or replicate (more than 2) analyses of the same sample in the laboratory and is determined by analysis of matrix spike duplicates or laboratory control sample duplicates. Total precision is a measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and includes all possible sources of variability. Imprecision will be estimated for the Elmendorf AFB project using the relative percent difference (RPD) between duplicate measurements of laboratory control samples.

Precision goals are presented in tables in Section 10 for each method and matrix. Precision goals will be met if duplicate analyses of laboratory control samples agree within RPDs specified in Section 10. RPDs for laboratory control samples outside specified criteria indicate the analytical system is out of control and require samples to be reanalyzed. Precision will not be assessed by matrix spike duplicates nor field duplicates; both of which contain matrix effects which cannot be controlled. Results of these duplicate determinations will be used to evaluate the total imprecision possible in natural-matrix sample results.

Accuracy

Accuracy is a statistical measurement of correctness, and includes components of random error (variability due to imprecision) and systematic error (bias). It therefore reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value. Analytical accuracy is typically measured by determining the percent recovery of known target analytes that are spiked into a field sample (a matrix spike) or reagent water or soil (a method spike) before extraction, at known concentrations. Surrogate compound recovery is another spiking technique used to assess method accuracy for each sample analyzed for volatile and semivolatile compounds. The stated accuracy objectives apply to spiking levels at five times the method detection limits or higher. The individual methods provide equations for acceptance criteria at lower spiking levels.

Both accuracy and precision are calculated for specific sampling or analytical batches, and the associated sample results must be interpreted considering these specific measures. Application of calculated precision and accuracy to measurement sample results is discussed in Section 13. An additional consideration in applying accuracy and precision is the concentration level of the samples; a procedure capable of producing the same value within 50 percent would be considered precise for low-level (near the detection limit) analyses of minor constituents, such as metals in groundwater samples, but would be unacceptable, and possibly useless for major constituents at high concentrations.

Accuracy goals for laboratory control samples are presented in tables in Section 10. Accuracy goals will be met if individual laboratory control sample recoveries are within listed criteria. Laboratory control sample recoveries outside criteria indicate the analytical system is out of control and require samples to be reanalyzed.

Completeness

Completeness is calculated from the aggregation of data for each method for any particular sampling event. For each method and each site, the number of valid results, divided by the number of individual analyte results initially planned for, expressed as a percentage, determines the completeness for the data set. The objective for completeness is 90 percent. If there are any instances of samples that could not be analyzed for any reason (holding time violations in which resampling and reanalysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.

Valid results used to meet completeness objectives are those results which provide defensible estimates of the true concentration of an analyte in a sample. These valid results include data which is not qualified and data which QC results indicate qualification is necessary but the data may still be used to meet project objectives. Invalid results are those data for which there is an indication that the prescribed sampling or analytical protocol was not followed.

Representativeness

Objectives for representativeness will be defined for each sampling and analysis task and will be a function of the investigative objectives. Representativeness will be achieved in part, as discussed further under Site Characterization Data Quality Objectives in Section 4.1.2, through use of the standard sampling and analytical procedures described in this QAPP and the Field Sampling Plan. Representativeness is also determined or influenced by appropriate program design, considering elements such as proper well locations, drilling and installation procedures, or sampling locations.

Comparability

Comparability is the confidence with which one data set can be compared to other data sets. The objectives for this QA/QC program are to produce data with the greatest degree of comparability possible. The number of matrices that will be sampled and the range of field conditions encountered must be considered in ultimately determining comparability. Comparability will be achieved by using standard methods for sampling and analysis, reporting data in standard units, and using standard and comprehensive reporting formats. Analysis of reference samples may also be used to provide additional information that can be used to assess comparability of analytical data produced within the laboratory and among laboratories if more than one laboratory is used on the project.

4.1.2 Site Characterization Data Quality Objectives

Site characterization data will be obtained from the drilling of numerous soil borings and monitoring wells. While it is more difficult to measure the precision, accuracy, completeness, representativeness, and comparability of the data collected from these activities, several steps will be undertaken to ensure the data obtained are representative, standardized, and as accurate as possible.

The compilation of hydrologic data will be conducted during the site characterization and hydrogeologic assessment. Hydrologic data to be compiled will consist primarily of water-level measurements collected over specific time intervals. Electronic sounders, used to measure water levels, will be checked for accuracy and precision before each use and each sounder will have a unique identification number that can be used to document instrument use and performance. If more than one sounder is used during a sounding event, sounders will be checked for comparability of measurements and calibrated against a standard sounder prior to use.

In cases of electronic water level measurements during aquifer tests, pressure transducers mounted in each observation well will be used to gather readings. Prior to use, the transducers will be calibrated and checked for precision, accuracy, and comparability of pressure readings.

Additional hydrologic data which may be collected are pump discharge rates measured during well purging or aquifer testing. The methods used to measure pump discharge rates will be selected based on the intended uses of the discharge data. For monitoring well purging, discharge data are needed to demonstrate that the well to be sampled was adequately purged and that the discharge was sufficient to induce groundwater flow from the formation into the well casing. Discharge measurement to assure purging can be obtained with sufficient accuracy by using a bucket of known volume and a stop watch.

For aquifer testing, a calibrated flow meter may be needed to obtain sufficient accuracy, precision, and comparability depending on the flow velocity during the test. If pumping test flow is 10 gallons per minute or less, a calibrated flow meter capable of reading to the nearest 0.1 gallon per minute (gpm) will be used to collect total discharge data. However, if discharge rates are near 50 gpm, as expected, a calibrated bucket and stop watch will be employed.

4.2 Goals

The quality assurance objective (i.e., goal) for the project is to have all analyses performed on an analytical system that is in statistical control and meets method specifications. Numerically, the goal is to have all individual results traceable to a laboratory control sample whose recovery (for both precision and accuracy) is within method-specified limits. Method specifications will be used as tolerance limits for the project. Laboratory derived limits used to statistically monitor analytical system control will be within method specifications. The method-specified limits for laboratory control samples are supplied in Section 10 along with method-specified limits for spike recoveries in natural matrix samples. Inaccurate or imprecise recovery of laboratory control samples will invalidate results. Inaccurate or imprecise recovery of spikes in natural-matrix samples will not necessarily invalidate results. Poor recoveries of spikes in natural-matrix samples indicates the potential for matrix effects. A conclusion of matrix effects must be supported by laboratory control sample results within acceptance criteria for the analytical batch for which the matrix spike was performed.

Section 5.0
SAMPLING PROCEDURES

This section describes the components of the sampling procedures that will be performed to meet the quality assurance objectives for the Elmendorf Air Force Base.

5.1 Sampling Protocols

Procedures for collecting soil and aqueous samples will be selected, as appropriate, from the SOPs. Detailed sampling protocols are provided and discussed in the Field Sampling Plan.

Prior to beginning each type of sampling event, a detailed sampling plan will be prepared and the field manager will meet with the assigned sampling personnel and review the purpose and objectives of the event. This meeting will provide final clarification of the sampling event details. Topics of review and discussion will include sampling locations, types of samples to be collected, number of samples collected, sample numbering, preservation requirements, parameter(s) to be analyzed, sampling procedures, equipment decontamination procedures, and chain-of-custody requirements.

5.2 Sample Handling

The field manager is responsible for ensuring that samples are collected with properly decontaminated equipment and containerized in properly cleaned sample bottles. A summary of the recommended sample containers, volume, preservation, and hold times for each analytical method and sample matrix is provided in Table 5-1.

5.3 Sampling Equipment Decontamination

Equipment decontamination is an integral part of the data collection and QA process. The implementation of proper decontamination practices and procedures will begin in the field prior to use of sample collection equipment. All field sampling equipment will be decontaminated before use and after each sample location, according to procedures outlined in the Field Sampling Plan. Wash water and other fluids generated during decontamination will be containerized and considered hazardous until determined otherwise.

Table 5-1

Water and Soil Sample Storage and Preservation Requirements

Parameter	Analysis Method(s)	Holding Time[a]	Container(s)[a,b]	Preservation	Storage Requirements
ORGANIC COMPOUNDS:					
Petroleum (Fuel) Hydrocarbons, Purgeables	SW8015MP (modified)	14 days (w, s), 7 days if not preserved with acid (w)	Three 40-mL glass vials with Teflon® seals (w); 4-oz wide-mouth glass bottle with Teflon® liner or California brass ring[c] (s)	HCl to pH <2 (w), none (s)	4°C
Petroleum (Fuel) Hydrocarbons, Extractables	SW8015ME (modified)	14 days (7 days, w) until extraction, 40 days to analyze extract	Two 1-Liter glass bottle with Teflon® seals (w); 4-oz wide-mouth glass bottle with Teflon® liner or California brass ring[c] (s)	None (w, s)	4°C
Organochlorine Pesticides and PCBs	SW8081	7 days until extraction, 40 days to analyze (w); 14 days until extraction, 40 days to analyze extract (s)	Two 1-Liter glass bottle with Teflon® seals (w); 8-oz wide-mouth bottle with Teflon® liner or California brass ring[c] (s)	None (w, s)	4°C
Chlorinated Herbicides	SW8151	7 days until extraction, 40 days to analyze (w); 14 days to extraction, 40 days to analyze extract (s)	Two 1-Liter glass bottles with Teflon® seals (w); 8-oz wide-mouth glass bottle with Teflon® liner or California brass ring[c] (s)	pH 5-9	4°C
Volatile Organic Compounds	SW8240A	14 days (w, s); 7 days if unpreserved by acid (w)	Three 40-mL glass vials with Teflon® seals (w); 4-oz wide-mouth glass bottle with Teflon® liner or California brass ring[c] (s)	HCl to pH <2 (w); none (s)	4°C
Volatile Hydrocarbons	SW8260A	14 days (w), 7 days if not preserved with acid (w)	Three 40-mL VOA vials with Teflon® seals (w)	HCl to pH <2 (w)	4°C
Semivolatile Organic Compounds	SW8270B	7 days until extraction, 40 days to analyze (w); 14 days to extraction, 40 days to analyze extract (s)	Two 1-Liter glass bottles with Teflon® seals (w); 8-oz wide-mouth glass bottle with Teflon® liner or California brass ring[c] (s)	0.008% $Na_2S_2O_3$ (w)[d] ; None (s)	4°C
Polychlorinated Dioxins and Furans	SW8280	30 days until extraction, 45 days to analyze (w); 30 days to extraction, 45 days to analyze extract (s)	Two 1-Liter glass bottles with Teflon® seals (w); 8-oz wide-mouth glass bottle with Teflon® liner or California brass ring[c] (s)	0.008% $Na_2S_2O_3$ (w)[d] ; None (s)	4°C
Polynuclear Aromatic Hydrocarbons	SW8310	7 days until extraction, 40 days to analyze (w); 14 days to extraction, 40 days to analyze extract (s)	Two 1-Liter glass bottles with Teflon® seals (w); 8-oz wide-mouth glass bottle with Teflon® liner or California brass ring[c] (s)	0.008% $Na_2S_2O_3$ (w)[d] ; None (s)	4°C

Table 5-1

(Continued)

Parameter	Analysis Method(s)	Holding Time[a]	Container(s)[a,b]	Preservation	Storage Requirements
INDICATOR AND INORGANIC COMPOUNDS/PARAMETERS:					
Specific Conductance	SW 9050	Field Test	250-mL wide-mouth glass bottle or 250-mL polyethylene bottle	None	Analyze immediately; 4°C, if stored
pH	SW9040A (w) SW9045A (s)	Field Test (w); Not specified (s)	500-mL polyethylene bottle or directly from bailer (w); 4-oz wide-mouth glass bottle (s)	None	None, analyze immediately (w); 4 °C (s)
Temperature	E170.1	Field Test	250-mL polyethylene bottle	None	Analyze immediately
Turbidity	E180.1	Field Test	500-mL polyethylene bottle	None	Analyze immediately; 4°C, if stored
Dissolved Oxygen	E360.1	Field Test	300-mL BOD bottle or directly from bailer	None	Analyze immediately
Alkalinity	SM403	Field Test	1-L polyethylene bottle (w)	None	Analyze immediately; 4°C, if stored
Moisture	A-2216	Not specified	8-oz wide-mouth glass bottle or California brass ring[c]	None	4°C
Ammonia	E350.1	28 days (w)	500-mL glass or polyethylene bottle (w)[f]	H_2SO_4 to pH <2	4°C
Anions (Cl, F, NO_3, PO_4, SO_4)	E9056	28 days for Cl, F, SO_4; 48 hours for NO_3, PO_4	500-mL polyethylene bottle (w)	None	4°C
Filterable Residue (TDS)	E160.1	7 days (w)	100-mL polyethylene bottle (w)	None	4°C
Chromium VI	SW7196A	24 hours (w, s)	500-mL glass or polyethylene bottle (w)[f]	None	4°C
Cyanide, Total	SW9012	14 days (w, s)	1-Liter polyethylene bottle (w); 8-oz wide-mouth glass bottle with Teflon®-lined cap (s)	NaOH to pH >12, 0.6 g ascorbic acid[e] (w); none (s)	4°C
Nitrite + Nitrate	E353.1	28 days (w)	500-mL glass or polyethylene bottle (w)[f]	H_2SO_4 to pH <2	4°C
Total Kjeldahl Nitrogen	E351.2	28 days (w)	500-mL glass or polyethylene bottle (w)[f]	H_2SO_4 to pH <2	4°C
Phosphate, Total	E365.2	28 days (w)	500-mL glass or polyethylene bottle (w)[f]	H_2SO_4 to pH <2	4°C
Chemical Oxygen Demand	E410.4	28 days (w)	500-mL glass or polyethylene bottle (w)[f]	H_2SO_4 to pH <2	4°C

Table 5-1

(Continued)

Parameter	Analysis Method(s)	Holding Time[a]	Container(s)[a,b]	Preservation	Storage Requirements
Total Organic Carbon (TOC)	SW9060 (w)	28 days (w)	500-mL glass bottle with Teflon®-lined cap (w)[f]	pH <2 H_2SO_4 (w)	4°C
ICP Metals	SW6010A	180 days (w, s)	1-Liter polyethylene bottle (w); 8-oz wide-mouth glass bottle with Teflon®-lined cap (s)	pH <2 with HNO_3 (w); none (s)	4°C
Organolead	CADHS	14 days (w)	500-mL polyethylene bottle (w)[f]	None	4°C
Arsenic Antimony Cadmium Lead Selenium Mercury	SW7060A SW7041 SW7131A SW7421 SW7741 SW7470A SW7471A	180 days (w, s) except Hg 28 days (w, s)	Aliquot taken from 1-Liter polyethylene bottle (w); 8-oz wide-mouth glass bottle with Teflon®-lined cap(s)	pH <2 with HNO_3 (w); none (s)	4°C

[a] (w) = water; (s) = soil
[b] All containers are pretreated and cleaned before being purchased by the laboratory.
[c] California brass ring or equivalent. The ends of the ring will be covered with Teflon® or oil-free metal foil and sealed with end caps.
[d] $Na_2S_2O_3$ will be added only to those samples suspected of containing residual chlorine.
[e] Ascorbic acid will be added to only those samples suspected of containing oxidizing agents such as residual chlorine.
[f] Samples to be analyzed for multiple parameters requiring the same preservation technique can be analyzed from the same sample bottle.

A - ASTM
E - U.S. Environmental Protection Agency
SM - Standard Methods for the Examination of Water and Wastewater, 16th edition
SW - SW846 Third edition

Section 6.0
SAMPLE CUSTODY

Sample possession during all sampling efforts must be traceable from the time of collection until the results are verified and reported. The sample custody procedures provide a mechanism for documentation of all information related to sample collection and handling to achieve this objective.

The field sampling task leader will be responsible for ensuring that the field team adheres to proper custody and documentation procedures for all sampling operations. Preformatted chain-of-custody forms will be used as the primary documentation mechanism to ensure that information pertaining to each sample is recorded. In addition, field notebooks and a master sample logbook (Master Log) will be maintained for all samples collected during each sample collection activity. Copies of the chain-of-custody forms and the field logs will be retained in the project file.

6.1 Field Operations

This section describes field procedures for maintaining sample custody. Other information describing field operations may be found in the Field Sampling Plan.

6.1.1 Field Records

Field personnel will be required to keep accurate written records of their daily activities in a bound logbook. All entries will be legible, written in waterproof ink, and contain accurate and inclusive documentation of an individual's field activities, including field data and observations, any problems encountered, and actions taken to solve the problem. The type of data recorded in the field logbook includes field measurements (pH, conductivity), ambient conditions, and any other information pertinent to sample collection. Entry errors or changes will be crossed out with a single line, dated, and initialed by the person making the correction. Entries made by individuals other than the person to whom the logbook was assigned will be dated and signed by the individual making the entry. Field logbooks will be available for review by the quality assurance (QA) coordinator during systems audits or at any other time for quality control checks by field team leaders. This documentation provides verification of sampling procedures.

6.1.2 Sample Labels

Each sample container will receive a sample label. Sample labels will identify the sample by documenting the unique sample identification number, the sample type, the analytical method, the sampler's initials, date collected, and the preservation method used. Sample labels are waterproof and will be completed with a permanent marker, affixed to the sample container, and over taped with clear tape. Additional information concerning sample labeling can be found in the Field Sampling Plan.

6.1.3 Sample Identification

A numbering system has been developed in coordination with the base RPM to uniquely identify each well and sample taken during water, sediment, and soil sampling programs. This numbering system will provide a tracking procedure to allow data retrieval and will ensure that sample identifiers are not duplicated. A listing of the sample identification numbers will be maintained by the project data administrator and the field supervisor will ensure that it is universally applied to samples collected during this project. Tables 6-1 to 6-10 summarize the number of samples that will be collected and the number of field measurements to be taken by sample type for the 1996 Basewide Support and Groundwater Monitoring Program. A detailed listing of samples and QC samples to be collected will be developed for each future Elmendorf support activity.

Table 6-1

Number and Type of Groundwater Analyses for OU 1, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
pH-field	SW9040A (pH units)	24	3	--	--	--	--	--	27
Specific Conductance-field	SW9050 (µmho/cm)	24	3	--	--	--	--	--	27
Turbidity-field	E180.1 (NTU)	24	3	--	--	--	--	--	27
Temperature-field	E170.1 (°C)	24	3	--	--	--	--	--	27
Dissolved Oxygen -field	E360.1 (mg/L)	24	3	--	--	--	--	--	27
Total Alkalinity-field	SM403 (mg/L)	24	3	--	--	--	--	--	27
Anions, Cl, F, NO_3, PO_4, SO_4	SW9056 (mg/L)	24	3	1	1	3	--	--	34
Chromium VI	SW7196A (mg/L)	24	3	1	1	3	--	--	34
Trace ICP (ICP 23 less B and Si)	SW3005A/SW6010A (mg/L)	24	3	1	1	3	--	--	34
Mercury	SW7470A (mg/L)	24	3	1	1	3	--	--	34
Volatile Organics	SW5030A/SW8260A (µg/L)	24	3	1	1	3	8	8	50
Organochlorine Pesticides and PCBs	SW3510B/SW808 (µg/L)	24	3	1	1	3	--	--	34
Chlorinated Herbicides	SW3510B/SW815 (µg/L)	24	3	1	1	3	--	--	34

Note:
1) QC sample count is based 10% field duplicates, 10% equipment blanks, 5% matrix spikes, 5% matrix spike duplicates, one ambient blank per downwind VOC source (assume one per day of sampling), and one trip blank per day of sampling.
2) Two rounds of samples to be collected at 12 wells.
3) Assume eight days to sample these wells.

Table 6-2

Number and Type of Groundwater Analyses for OU 2, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
pH-field	SW9040A (pH units)	32	3	--	--	--	--	--	35
Specific Conductance-field	SW9050 (µmho/cm)	32	3	--	--	--	--	--	35
Turbidity-field	E180.1 (NTU)	32	3	--	--	--	--	--	35
Temperature-field	E170.1 (°C)	32	3	--	--	--	--	--	35
Dissolved Oxygen -field	E360.1 (mg/L)	32	3	--	--	--	--	--	35
Total Alkalinity-field	SM403 (mg/L)	32	3	--	--	--	--	--	35
Nitrate-Nitrite	E353.1 (mg/L)	32	3	1	1	3	--	--	40
Trace ICP (ICP 23 less B and Si)	SW3005A/SW6010A (mg/L)	32	3	1	1	3	--	--	40
Volatile Organics	SW5030A/SW8260A (µg/L)	32	3	1	1	3	8	8	56
Hydrocarbons as Gasoline	SW5030A/SW8015MP (µg/L)	32	3	1	1	3	8	8	56
Hydrocarbons as Diesel	SW3510B/SW8015ME (µg/L)	32	3	1	1	3	--	--	40

Note:
1) QC sample count is based 10% field duplicates, 10% equipment blanks, 5% matrix spikes, 5% matrix spike duplicates, one ambient blank per downwind VOC source (assume one per day of sampling), and one trip blank per day of sampling.
2) Two rounds of samples are to be collected at 10 wells.
3) Assume eight days to sample these wells.

Table 6-3

Number and Type of Groundwater Analyses for OU 4, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
pH-field	SW9040A (pH units)	22	2	--	--	--	--	--	24
Specific Conductance-field	SW9050 (µmho/cm)	22	2	--	--	--	--	--	24
Turbidity-field	E180.1 (NTU)	22	2	--	--	--	--	--	24
Temperature-field	E170.1 (°C)	22	2	--	--	--	--	--	24
Dissolved Oxygen -field	E360.1 (mg/L)	22	2	--	--	--	--	--	24
Total Alkalinity-field	SM403 (mg/L)	22	2	--	--	--	--	--	24
Nitrate-Nitrite	E353.1 (mg/L)	22	2	1	1	2	--	--	28
Trace ICP (ICP 23 less B and Si)	SW3005A/SW6010A (mg/L)	22	2	1	1	2	--	--	28
Volatile Organics	SW5030A/SW8260A (µg/L)	22	2	1	1	2	8	8	44
Hydrocarbons as Gasoline	SW5030A/SW8015MP (µg/L)	22	2	1	1	2	8	8	44
Hydrocarbons as Diesel	SW3510B/SW8015ME (µg/L)	22	2	1	1	2	--	--	28

Note:
1) QC sample count is based 10% field duplicates, 10% equipment blanks, 5% matrix spikes, 5% matrix spike duplicates, one ambient blank per downwind VOC source (assume one per day of sampling), and one trip blank per day of sampling.
2) Two rounds of samples are to be collected at 11 wells.
3) Assume eight days to sample these wells.

Table 6-4

Number and Type of Groundwater Analyses for OU 5, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
pH-field	SW9040A (pH units)	38	4	--	--	--	--	--	42
Specific Conductance-field	SW9050 (µmho/cm)	38	4	--	--	--	--	--	42
Turbidity-field	E180.1 (NTU)	38	4	--	--	--	--	--	42
Temperature-field	E170.1 (°C)	38	4	--	--	--	--	--	42
Dissolved Oxygen -field	E360.1 (mg/L)	38	4	--	--	--	--	--	42
Total Alkalinity-field	SM403 (mg/L)	38	4	--	--	--	--	--	42
Nitrate-Nitrite	E353.1 (mg/L)	38	4	2	2	4	--	--	50
Trace ICP (ICP 23 less B and Si)	SW3005A/SW6010A (mg/L)	38	4	2	2	4	--	--	50
Volatile Organics	SW5030A/SW8260A (µg/L)	38	4	2	2	4	14	14	78
Hydrocarbons as Gasoline	SW5030A/SW8015MP (µg/L)	38	4	2	2	4	14	14	78
Hydrocarbons as Diesel	SW3510B/SW8015ME (µg/L)	38	4	2	2	4	--	--	50

Note:
1) QC sample count is based 10% field duplicates, 10% equipment blanks, 5% matrix spikes, 5% matrix spike duplicates, one ambient blank per downwind VOC source (assume one per day of sampling), and one trip blank per day of sampling.
2) Two rounds of samples are to be collected at 19 wells.
3) Assume 14 days to sample these wells.

Table 6-5

Number and Type of Groundwater Analyses for OU 6, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
pH-field	SW9040A (pH units)	48	5	--	--	--	--	--	53
Specific Conductance-field	SW9050 (µmho/cm)	48	5	--	--	--	--	--	53
Turbidity-field	E180.1 (NTU)	48	5	--	--	--	--	--	53
Temperature-field	E170.1 (°C)	48	5	--	--	--	--	--	53
Dissolved Oxygen -field	E360.1 (mg/L)	48	5	--	--	--	--	--	53
Total Alkalinity-field	SM403 (mg/L)	48	5	--	--	--	--	--	53
Nitrate-Nitrite	E353.1 (mg/L)	48	5	3	3	5	--	--	64
Trace ICP (ICP 23 less B and Si)	SW3005A/SW6010A (mg/L)	48	5	3	3	5	--	--	64
Volatile Organics	SW5030A/SW8260A (µg/L)	48	5	3	3	5	14	14	92
Hydrocarbons as Gasoline	SW5030A/SW8015MP (µg/L)	48	5	3	3	5	14	14	92
Hydrocarbons as Diesel	SW3510B/SW8015ME (µg/L)	48	5	3	3	5	--	--	64

Note:
1) QC sample count is based 10% field duplicates, 10% equipment blanks, 5% matrix spikes, 5% matrix spike duplicates, one ambient blank per downwind VOC source (assume one per day of sampling), and one trip blank per day of sampling.
2) Two rounds of samples are to be collected at 24 wells.
3) Assume 14 days to sample these wells.

Table 6-6

Number and Type of Groundwater Analyses for SERA I, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
pH-field	SW9040A (pH units)	34	4	--	--	--	--	--	38
Specific Conductance-field	SW9050 (µmho/cm)	34	4	--	--	--	--	--	38
Turbidity-field	E180.1 (NTU)	34	4	--	--	--	--	--	38
Temperature-field	E170.1 (°C)	34	4	--	--	--	--	--	38
Dissolved Oxygen -field	E360.1 (mg/L)	34	4	--	--	--	--	--	38
Total Alkalinity-field	SM403 (mg/L)	34	4	--	--	--	--	--	38
Nitrate-Nitrite	E353.1 (mg/L)	34	4	2	2	4	--	--	46
Trace ICP (ICP 23 less B and Si)	SW3005A/SW6010A (mg/L)	34	4	2	2	4	--	--	46
Organolead	CADHS (mg/L)	34	4	2	2	4	--	--	46
Volatile Organics	SW5030A/SW8260A (µg/L)	34	4	2	2	4	12	12	70
Hydrocarbons as Gasoline	SW5030A/SW8015MP (µg/L)	34	4	2	2	4	12	12	70
Hydrocarbons as Diesel	SW3510B/SW8015ME (µg/L)	34	4	2	2	4	--	--	46

Note:
1) QC sample count is based 10% field duplicates, 10% equipment blanks, 5% matrix spikes, 5% matrix spike duplicates, one ambient blank per downwind VOC source (assume one per day of sampling), and one trip blank per day of sampling.
2) Two rounds of samples are to be collected at 17 wells.
3) Assume 12 days to sample these wells.

Table 6-7

Number and Type of Groundwater Analyses for SERA II, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
pH-field	SW9040 (pH units)	42	4	--	--	--	--	--	46
Specific Conductance-field	SW9050 (μmho/cm)	42	4	--	--	--	--	--	46
Turbidity-field	E180.1 (NTU)	42	4	--	--	--	--	--	46
Temperature-field	E170.1 (°C)	42	4	--	--	--	--	--	46
Dissolved Oxygen -field	E360.1 (mg/L)	42	4	--	--	--	--	--	46
Total Alkalinity-field	SM403 (mg/L)	42	4	--	--	--	--	--	46
Nitrate-Nitrite	E353.1 (mg/L)	42	4	2	2	4	--	--	54
Trace ICP (ICP 23 less B and Si)	SW3005A/SW6010A (mg/L)	42	4	2	2	4	--	--	54
Organolead	CADHS (mg/L)	42	4	2	2	4	--	--	54
Volatile Organics	SW5030/SW8260 (μg/L)	42	4	2	2	4	12	12	78
Hydrocarbons as Gasoline	SW5030/SW8015MP (μg/L)	42	4	2	2	4	12	12	78
Hydrocarbons as Diesel	SW3510/SW8015ME (μg/L)	42	4	2	2	4	--	--	54

Note:
1) QC sample count is based 10% field duplicates, 10% equipment blanks, 5% matrix spikes, 5% matrix spike duplicates, one ambient blank per downwind VOC source (assume one per day of sampling), and one trip blank per day of sampling.
2) Two rounds of samples are to be collected at 21 wells.
3) Assume 12 days to sample these wells.

Table 6-8

Number and Type of Groundwater Analyses for SERA III, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
pH-field	SW9040A (pH units)	34	4	--	--	--	--	--	38
Specific Conductance-field	SW9050 (µmho/cm)	34	4	--	--	--	--	--	38
Turbidity-field	E180.1 (NTU)	34	4	--	--	--	--	--	38
Temperature-field	E170.1 (°C)	34	4	--	--	--	--	--	38
Dissolved Oxygen -field	E360.1 (mg/L)	34	4	--	--	--	--	--	38
Total Alkalinity-field	SM403 (mg/L)	34	4	--	--	--	--	--	38
Nitrate-Nitrite	E353.1 (mg/L)	34	4	2	2	4	--	--	46
Trace ICP (ICP 23 less B and Si)	SW3005A/SW6010A (mg/L)	34	4	2	2	4	--	--	46
Organolead	CADHS (mg/L)	34	4	2	2	4	--	--	46
Volatile Organics	SW5030A/SW8260A (µg/L)	34	4	2	2	4	12	12	77
Hydrocarbons as Gasoline	SW5030A/SW8015MP (µg/L)	34	4	2	2	4	12	12	70
Hydrocarbons as Diesel	SW3510B/SW8015ME (µg/L)	34	4	2	2	4	--	--	46

Note:
1) QC sample count is based 10% field duplicates, 10% equipment blanks, 5% matrix spikes, 5% matrix spike duplicates, one ambient blank per downwind VOC source (assume one per day of sampling), and one trip blank per day of sampling.
2) Two rounds of samples are to be collected at 17 wells.
3) Assume 12 days to sample these wells.

Table 6-9

Number and Type of Surface Water Analyses for OU5, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
pH-field	SW9040A (pH units)	360	36	--	--	--	--	--	396
Specific Conductance-field	SW9050 (µmho/cm)	360	36	--	--	--	--	--	396
Turbidity-field	E180.1 (NTU)	360	36	--	--	--	--	--	396
Temperature-field	E170.1 (°C)	360	36	--	--	--	--	--	396
Dissolved Oxygen -field	E360.1 (mg/L)	360	36	--	--	--	--	--	396
Total Alkalinity-field	SM403 (mg/L)	360	36	--	--	--	--	--	396
Nitrate-Nitrite	E353.1 (mg/L)	360	36	18	18	24	--	--	456
Total Phosphate	E365.2 (mg/L)	360	36	18	18	24	--	--	456
Hydrocarbons as Gasoline	SW5030A/SW8015MP (µg/L)	360	36	18	18	24	24	24	504
Hydrocarbons as Diesel	SW3510B/SW8015ME (µg/L)	360	36	18	18	24	--	--	456

Note:
1) QC sample count is based 10% field duplicates, equipment blanks (one per day of sampling), 5% matrix spikes, 5% matrix spike duplicates, one ambient blank per downwind VOC source (assume one per day of sampling), and one trip blank per day of sampling.
2) Twelve rounds of samples are to be collected at 30 locations.
3) Assume 24 days to collect the surface water samples.
4) Equipment blanks willnot be required if samples are collected directly into the sample containers.

Table 6-10

Number and Type of Surface Sediment Analyses for OU5, Elmendorf AFB, Alaska

Parameter	Analytical Method (reporting units)	Total Field Samples	Field Duplicates	Matrix Spike	Matrix Spike Dup	Equip. Blank	Ambient Blank	Trip Blank	Total Samples
Hydrocarbons as Gasoline	SW5030A/SW8015MP (µg/L)	9	1	1	1	1	--	1	14
Hydrocarbons as Diesel	SW3510B/SW8015ME (µg/L)	9	1	1	1	1	--	--	13

Note:
1) QC sample count is based 10% field duplicates, 10% equipment blanks, 5% matrix spikes, 5% matrix spike duplicates, and one trip blank per day of sampling.
2) Assume one day to sample these site.

6.1.4 Chain-Of-Custody

All sample shipments will be accompanied by the chain-of-custody record, which identifies its contents. The original record plus copies will accompany the shipment with one copy retained in the project file. Another copy will be returned to the project teams with analytical results and the original is retained in the laboratory files with the analytical data. An example of a chain-of-custody form is shown in the Field Sampling Plan.

When samples are split for duplicate analysis, a separate chain-of-custody record will be prepared. The person relinquishing the samples to the facility or agency will request the signature of a representative to acknowledge receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Received By" space. When appropriate, as in the case of overnight shipment, the custody record should contain a statement that the samples were delivered to the designated location and the date and time noted. Sample collection and shipment will be coordinated to ensure that the receiving laboratory has staff available to process the samples according to method specifications.

All shipping containers will be secured with chain-of-custody seals for transportation to the laboratory. The method of shipment, courier name(s), and other pertinent information is entered in the "Remarks" section when the samples are to be shipped (i.e., Federal Express, Express Mail, etc.) instead of hand-delivered.

6.1.5 Shipping Procedures

The objective of sample handling procedures is to ensure that samples arrive at the laboratory intact, at the proper temperature, and free of external contamination. All samples will be shipped to the analytical services laboratory via overnight carriers, according to Department of Transportation standards. Chain-of-custody procedures will be followed during transport.

Sample packaging requirements for hazardous materials requiring interstate transport are defined in the Code of Federal Regulations 40 (CFR) 49, Chapter 1, Part 171. These requirements outline in detail the proper classification and procedures for transportation of hazardous materials that will be used for transport of the samples. However, it is not anticipated that any of the sample shipments will be classified as hazardous materials.

When samples are required to be stored at 4°C or less, generous amounts of double-bagged ice will be packed with the samples. The double-bagged ice will be of sufficient volume and will be distributed in the coolers so that the proper storage temperature will be maintained until the samples reach the laboratory. When the samples are delivered to the laboratory the temperature of each cooler of samples will be measured and recorded on the chain-of-custody form or addendum. The samples will be immediately placed in the sample control refrigerator after sample log-in.

The following procedures will be used to prevent bottle breakage and cross-contamination:

- All samples will be transported inside hard plastic coolers;
- All 40-milliliter (mL) volatile organic analysis (VOA) bottles will be placed in blocks of foam;
- All other glass bottles will be placed in plastic mesh sleeves to prevent glass-to-glass contact;

- Plastic sample bottles, bags of ice, and protective foam blocks will be used to separate glass bottles;

- Vermiculite or absorbent paper will be used to isolate the bottles from each other;

- The coolers will be taped shut and sealed with chain-of-custody tape to indicate unauthorized opening of the cooler; and

- Samples that are known or suspected to be highly contaminated (based on field screening data or observation) will be packaged and shipped separately from other samples. Field screening will be noted on the accompanying chain-of-custody.

6.2 Laboratory Operations

The analytical services laboratory will follow standard operating procedures (SOPs) for handling, identification, control, and chain-of-custody procedures and to maintain the validity of the samples. These SOPs are based on the use of a laboratory information management system (LIMS) for tracking samples from receipt through reporting of the analytical results.

6.2.1 Sample Handling

The following section describes the activities related to sample receipt, storage and tracking.

Sample Receipt

At a minimum, sample receipt considerations will address the following:

- When samples are received, the sample custodian will inspect all sample containers for integrity. The presence of leaking or broken containers or custody seals will be noted on the chain-of-custody form. The sample custodian will sign the chain-of-custody form (with date and time of receipt), thus assuming custody of the samples.

- The information on the chain-of-custody form will be compared with that on the sample tags and labels to verify sample identity. Any inconsistencies will be resolved with the field sampling representative before sample analysis proceeds.

- The temperature of incoming coolers of samples will be checked and the temperature recorded on the internal chain-of-custody.

- Preserved samples (i.e., those requiring pH adjustment), except for VOC samples, will be checked and any improperly preserved samples noted on the chain-of-custody.

- Samples will be moved to a secured sample storage refrigerator for storage prior to analysis. A separate storage refrigerator will be used to store low level samples for volatile organic analysis. The storage location will be recorded on laboratory generated work order sheets (SAM®).

- Document control will retain the original chain-of-custody form.

- The sample custodian will alert the appropriate section managers and analysts of any analyses requiring immediate attention because of short holding times.

Sample Storage

Samples will be maintained in storage in one of the secured storage refrigerators in Sample Control prior to sample preparation and analysis. The storage refrigerators will be maintained at 4°±2°C. Analytical laboratory personnel will request or check out samples for analysis from the sample custodian. The sample custodian and analyst will sign and date the internal chain-of-custody record to acknowledge transfer of custody to the analyst.

If samples are known or suspected to be highly contaminated, laboratory sample control will be notified, so those samples can be stored separately from less contaminated samples, minimizing the potential for cross contamination.

Sample Tracking

Organic Analysis. For samples that require extraction prior to analysis, a sample extraction form will be completed during the time of extraction. When samples are extracted for analysis by GC, GC/MS, or liquid chromatography, all pertinent data will be entered on the sample extraction form and/or recorded in a bound laboratory notebook. Extraction data are entered into the laboratory information management system by the person performing the extraction. A hard copy of the form will be printed and used as the vehicle for custody transfer to the analyst. Copies will be provided to the analysts to inform them that extracts are ready for analysis. The bound laboratory notebook will be kept in the extraction laboratory.

Extracts will be maintained in refrigerated storage by the sample preparation section until transferred to the analysts.

Metals Analysis. Samples will be received by the inorganic sample preparation section for digestion prior to analysis for metals by atomic absorption/inductively coupled plasma spectroscopy. When samples are prepared for digestion, the preparation technician will fill out a sample digestion record.

All information regarding sample digestion will be entered onto the sample digestion record and recorded in a bound laboratory notebook as the sample preparation proceeds. The digestion record will be maintained to acknowledge custody transfer of digestates to the metals analysis section. Upon completion of sample digestion, a copy of the sample digestion record will be provided to the metals analysis section to alert them that digestates are ready for analysis. The bound laboratory notebook containing the digestion record will be retained by the metals digestion laboratory.

6.2.2 Sample Identification

As samples are logged into the laboratory sample tracking system (SAM®) each sample is assigned a unique sample control number. This number is derived from the date of receipt and the sample receiving area involved and is correlated with the field sample numbers obtained from the field chain-of-custody forms as both numbers are entered into the SAM® system for a given job. Analytical requirements for each sample are entered into the computer. A hard copy of the work order and other information is printed and filed with the received documentation in the sample Control Center. Labels are printed with sample information and secured to each sample. Data sheets and work sheets are printed for each batch of samples and are distributed to the appropriate laboratory managers. The work sheets list sample information, storage location, and analytical requirements.

6.2.3 Sample Custody Records

Sample custody and documentation in the Analytical Services Laboratory are organized around the Sample and Analysis Management System (SAM®). SAM® is a computer software system specifically designed for tacking and handling the large amount of information required for the efficient management of an analytical chemistry laboratory.

Following sample log-in, the samples are placed in a designated locked storage area. Samples are maintained at <4°C from the time of receipt until the analyses are complete. Subsequent sample custody and all transactions are documented. Samples are checked in and out of the sample control area in a bound notebook.

The analyst receives the samples from the Sample Control Center and complete the sample work sheets or custody sheet. After analysis, the sample is returned to the designated storage location in the Sample control Center. The sample is stored until the assigned time or written permission is given to either properly dispose of or return the sample to the client. All sample documentation are maintained in locked filing cabinets in the sample control area.

6.2.4 Recordkeeping

Data related to sample preparation and analysis procedures and observations by laboratory analysts will be recorded in bound and numbered laboratory notebooks issued by the laboratory Document Control section. Laboratory notebook pages will be signed and dated daily by laboratory analysts. Corrections to notebook entries will be performed by drawing a single line through the erroneous entry and by writing the correct entry next to or above the one crossed out. All corrections will be initialed and dated by the analyst.

Section 7.0
CALIBRATION PROCEDURES AND FREQUENCY FOR FIELD TEST EQUIPMENT

Calibration procedures for field and laboratory instrumentation are performed to ensure that the instruments are operating properly and produce data that can satisfy the objectives of the sampling program.

The analytical and health and safety screening instruments that may be used in the field during the various base support activities at Elmendorf are listed below:

- Specific Conductance and Temperature Meter;
- pH meter;
- Thermometer;
- Turbidity meter;
- Dissolved Oxygen Meter; and
- Data logger and pressure transducer.

The instruments will be calibrated according to manufacturers' specifications before and after each field use, or as otherwise described below. Instruments will be calibrated, at minimum, each day during field use.

Specific Conductance Meter
A Yellow Springs Instrument Company (YSI) Model 33 Specific Conductance Meter, or equivalent, will be used to measure salinity, specific conductance, and temperature in surface water, groundwater, and wastewater systems. The YSI model 33 Specific Conductance Meter is a portable, battery-operated, transistorized instrument. This instrument will be calibrated daily according to the manufacturer's specifications. This electronic calibration will be verified by using two potassium chloride (KCl) solutions of known conductivity. Temperature will be recorded with each conductivity measurement using a mercury-in-glass, or equivalent, thermometer.

pH Meter
A Fisher Model No. 107 pH meter, or equivalent portable pH monitoring instrument, will be used for determining pH (to ± 0.1 pH unit) in surface water, groundwater, waste systems, and for other water quality applications. This instrument will be calibrated according to the manufacturer's specifications daily with a multi-point calibration prior to sample analysis and with a single-point check at each well location. If the drift exceeds 0.2 pH units, a new multi-point calibration will be performed.

Temperature
On-site water temperature is measured using a standard mercury thermometer. Thermometers will be checked yearly against a NIST traceable standard thermometer. Temperature readings will be measured to the nearest °C.

Turbidity

Turbidity will be measured on-site using a nephelometer or standard turbidity meter. A standard suspension of Formazin with turbidity within the expected range of sample turbidities will be used to calibrate the instrument daily to check the instruments' precalibrated scale. The working range for the instrument is 0-40 NTU.

Dissolved Oxygen Meter

A YSI Model 51A, or equivalent portable dissolved meter, will be used for measuring dissolved oxygen in groundwater and monitoring well waters. The meter calibration will be checked daily using water saturated air or air saturated water and the theoretical oxygen content given in the chart in Standard Methods based on temperature and altitude.

Water Level Measurements

Water level measurements will be obtained using either a data logger and pressure transducer or a standard water level measuring tape or well sounder.

Data logger and Pressure Transducer

The Omnidata E-Logger Datapod, or equivalent, will be used to record water level measurements. The calibration frequency and procedures for the data logger and pressure transducer are described in detail in the manufacturer's specifications and procedures.

Well Sounder

Water level measurements obtained with a well sounder will be measured to the nearest 0.01 ft and will be recorded in a bound field book.

Section 8.0
ANALYTICAL PROCEDURES

This section contains brief descriptions of calibration procedures and analytical methodology for the analysis of water and soil samples that will be collected during various phases of the Environmental Restoration Program. In this section, the analogous water and soil methods are described together and detection limits are given for each method.

8.1 Identification of Methods

Methods to be used for sample analysis are presented in Table 8-1. Most of laboratory methods identified in this document were published by the United States Environmental Protection Agency (U.S. EPA, 1986) in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW846, Third Edition, or Methods for Chemical Analysis of Water and Wastes (U.S. EPA, 1983). Additional methods identified were published in "Criteria for Identification of Hazardous and Extremely Hazardous Wastes," "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," 40 CFR, Part 136, Federal Register 49 (209), 26 October 1984, Annual Book of ASTM (American Society for Testing and Materials) Standards, Volume 4.08, and Standard Methods for the Examination of Water and Wastewater.

8.2 Method Detection and Quantitation Limits

This section presents and defines limits to be used in describing detectable concentrations.

8.2.1 Terminology

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero.

8.2.2 Procedures

The laboratory will perform MDL studies on an annual or quarterly basis (depending on the method) to demonstrate that it can meet or exceed the method recommended MDLs. The U.S. EPA procedure used for establishing MDLs is described in Appendix B to Part 136 "Definition and Procedure for the Determination of the Method Detection Limit" - Revision 1.11, 40 CFR 136, 1986. This procedure consists of analyzing (using all sample processing steps specified in the method) seven aliquots of a standard spiked at three to five times the expected MDL. The MDL is defined as three times the standard deviation of the mean value for the seven analyses. In addition, the laboratory may establish Reporting Limits which are verified by the MDL studies and included on the laboratory's analytical reports.

8.2.3 Values

Analytical methods and corresponding Practical Quantitation Limits (PQL) are presented in Tables 8-2 to 8-11. The PQL is defined in Chapter 1 of Test Methods for Evaluation of Solid Waste (SW-846) as "the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions". Laboratory reporting limits are given for those methods that do not have a defined PQL.

8.3 Method Description and Calibration

This section describes the extraction and analytical methods to be used during the RI/FS of Elmendorf AFB. Calibration information is summarized for each analytical method.

Table 8-1

Analytical Methods to be Used During Activities at Elmendorf AFB

Parameter	Analytical Method	
	Water	**Soil**
Alkalinity	SM403	NA
Specific Conductance	SW9050	NA
pH	SW9040A	SW9045B
Dissolved Oxygen	E360.1	NA
Turbidity	E180.1	NA
Temperature	E170.1	NA
Soil Moisture Content (geotechnical/chemical)	NA	A-D2216/SW846
Ammonia	E350.1/E350.2	NA
Inorganic Anions (Cl, F, NO_3, PO_4, and SO_4)	SW9056	NA
Chromium (VI)	SW7196A	NA
Nitrate + Nitrite	E353.1	NA
Total Kjeldahl Nitrogen	E351.2	NA
Total Phosphate	E365.2	NA
Filterable Residue (TDS)	E160.1	NA
Total Cyanide	SW9012	SW9012
Chemical Oxygen Demand (COD)	E410.4	NA
Total Organic Carbon (TOC)	SW9060	NA
ICP Metals (ICP 23 less B and Si)	SW3005A/SW6010A	SW3050A/SW6010A
Antimony	Modified SW3020A/SW7041	SW3050A/SW7041
Arsenic	Modified SW3020A/SW7060A	SW3050A/SW7060A
Cadmium	Modified SW3020A/SW7131A	SW3050A/SW7131A
Lead	Modified SW3020A/SW7421	SW3050A/SW7421
Mercury	SW7470A	SW7471A
Selenium	Modified SW3020A/SW7740	SW3050A/SW7740
Organolead	CADHS	NA
Petroleum Hydrocarbons, Modified Purgeables	SW8015MP	SW8015MP
Petroleum Hydrocarbons, Modified Extractables	SW3510B/SW8015ME	SW3540B/SW8015ME
Organochlorine Pesticides and PCBs	SW3510B/SW8081	SW3540B/SW8081
Chlorinated Herbicides	SW3510B/SW8151	NA
Volatile Organic Compounds	SW8260A	SW8240A
Semivolatile Organic Compounds	SW3510B/SW8270B	SW3540B/SW8270B
Chlorinated Dioxins and Furans	SW8280	SW8280
Polynuclear Aromatic Hydrocarbons	SW3510B/SW8310	SW3540B/SW8310

NA = Not Applicable.

Table 8-2

Quantitation Limits for Indicator and Inorganic Analytical Methods

Method	Parameter	Practical Quantitation Limits[a]	
		Water mg/L	Soil mg/kg[b]
SW9050	Specific Conductance	1 µmhos/cm	NA
SW9040A/SW9045B	pH	NA	NA
E170.1	Temperature	NA	NA
E180.1	Turbidity	NA	NA
E360.1	Dissolved Oxygen	0.5	NA
SM403	Alkalinity	10	NA
E350.1/E350.2	Ammonia	0.1	NA
SW9056	Anions - Chloride	0.2	NA
SW9056	Anions - Fluoride	0.2	NA
SW9056	Anions - Sulfate	0.2	NA
SW9056	Anions - Nitrate	0.1	NA
SW9056	Anions - ortho-Phosphate	0.1	NA
E353.1	Nitrate + Nitrite	0.1	NA
SW7196A	Chromium VI	0.5	NA
SW9012	Total Cyanide	0.02	1.0
E351.2	Total Kjeldahl Nitrogen	0.1	NA
E365.2	Total Phosphate	0.1	NA
E410.4	Chemical Oxygen Demand (COD)	10	NA
SW9060	Total Organic Carbon (TOC)	1.0	NA
E160.1	Filterable Residue (TDS)	10	NA

[a] Per IRP Handbook- Required practical quantitation limits or laboratory derived limits if not specified in IRP Handbook.

[b] Quantitation limits are given for the low-level methods. Mid- and high-level methods will have corresponding adjustments in limits. These specific limits will be verified by matrix spiking.

E - methods from Unites States Environmental Protection Agency, 1983
NA - Not applicable.
SW - Methods from SW846, Third Edition.

Table 8-3

Practical Quantitation Limits for Trace Elements (Metals) for ICPES and Graphite Furnace

Method	Parameter	Analytes	Practical Quantitation Limits[a]	
			Water (mg/L)	Soil (mg/kg)[b, c]
SW6010A	ICP Metals	Aluminum	0.5	50
		Antimony	0.4	40
		Arsenic	0.6	60
		Barium	0.02	2
		Beryllium	0.003	0.3
		Cadmium	0.04	4
		Calcium	0.1*	10*
		Chromium	0.07	7
		Cobalt	0.07	7
		Copper	0.06	6
		Iron	0.07	7
		Lead	0.5	50
		Magnesium	0.3	30
		Manganese	0.02	2
		Molybdenum	0.08	8
		Nickel	0.15	15
		Potassium	5	500
		Selenium	0.8	80
		Silver	0.07	7
		Sodium	0.3	30
		Thallium	0.4	40
		Vanadium	0.08	8
		Zinc	0.02	2
SW7060A	Graphite furnace	Arsenic	0.005	0.5
SW7041	Graphite furnace	Antimony	0.005	0.5
SW7131A	Graphite furnace	Cadmium	0.001	0.1
SW7421	Graphite furnace	Lead	0.005	0.5
CADHS	Flame AA	Organolead	0.5	NA
SW7470A/7471A	Cold Vapor	Mercury	0.001	0.1
SW7740	Graphite furance	Selenium	0.005	0.5

[a] These are the Air Force IRP practical quantitation limits for SW846 methods under the RI/FS program. Specific quantitation limits are highly matrix dependent.

[b] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

[c] Quantitation limits are for the low-level method. Mid- and high-level methods will have corresponding adjustment in limits. These specific limits will be verified by matrix spiking.

*Laboratory cannot meet the detection limit for this element.

CADHS - California Department of Health Services.
SW - Methods from SW846, Third Edition.

Table 8-4

Reporting Limits for Total Petroleum Hydrocarbons Plus Gasoline (Modified SW8015MP, SW8015ME)

Method	Parameter	Analytes	Method Reporting Limits	
			Water (µg/L)	Soil (mg/kg)
Modified SW8015MP	Petroleum (Fuel) Hydrocarbons Purgeables	Benzene	0.3	0.03
		Toluene	0.3	0.03
		Ethylbenzene	0.3	0.03
		Xylene	0.5	0.05
		Gasoline	50	5.0
Modified SW8015ME	Extractables	Diesel Fuel	50	5
		Jet Fuel	100	10
		Kerosene	100	10

Table 8-5

Quantitation Limits for Method SW8081, Organochlorine Pesticides and PCBs

Method	Parameter	Analytes	Practical Quantitation Limits[a,b]	
			Water (µg/L)	Low Soil/ Sediment (mg/kg)
SW8081	Organochlorine Pesticides and PCBs	Alpha-BHC	0.03	0.002
		Beta-BHC	0.06	0.004
		Delta-BHC	0.09	0.006
		Gamma-BHC (Lindane)	0.04	0.003
		Heptachlor	0.03	0.002
		Aldrin	0.04	0.003
		Heptachlor epoxide	0.83	0.06
		Endosulfan I	0.14	0.009
		Dieldrin	0.02	0.01
		4,4'-DDT	0.12	0.008
		Endrin	0.06	0.004
		Endosulfan II	0.04	0.003
		4,4'-DDD	0.11	0.007
		Endosulfan sulfate	0.66	0.04
		4,4'-DDE	0.04	0.003
		Methoxychlor	1.76	0.1
		Endrin aldehyde	0.23	0.02
		Chlordane	0.14	0.009
		Toxaphene	2.4	0.2
		Aroclor-1016	1	1
		Aroclor-1221	1	1
		Aroclor-1232	1	1
		Aroclor-1242	1	1
		Aroclor-1248	1	1
		Aroclor-1254	1	1
		Aroclor-1260	1	1

[a] These are the Air Force IRP practical quantitation limits for SW846 methods under the RI/FS program. Specific quantitation limits are highly matrix dependent.

[b] Sensitivity of the method depends on the level of interference rather than instrumental limitations. Typical waste samples may have higher reporting limits and may require additional cleanup techniques.

Table 8-6

Quantitation Limits for Total Chlorinated Herbicides by SW8151

Method	Parameter	Analytes	Practical Quantitation Limits	
			Water (µg/L)	Soil (mg/kg)
SW8151	Chlorinated Herbicides	2,4-D	12	0.8
		2,4-DB	9	0.6
		2,4,5-T	2	0.1
		2,4,5-TP	1.7	0.1
		Dalapon	60	4
		Dicamba	2.7	0.2
		Dichloroprop	6.5	0.5
		Dinoseb	0.7	0.05
		MCPA	2500	170
		MCPP	1900	130

Table 8-7

Quantitation Limits for Method SW8240A, Volatile Organic Compounds

Method	Parameter	Analytes	Practical Quantitation Limits [a]	
			Water (µg/L)	Soil (mg/kg)[b,c]
SW8240A	Volatile Organic Compounds	Acetone	100	0.100
		Benzene	5	0.005
		Bromodichloromethane	5	0.005
		Bromoform	5	0.005
		Bromomethane	10	0.010
		2-Butanone (MEK)	100	0.1
		Carbon disulfide	5	0.005
		Carbon tetrachloride	5	0.005
		Chlorobenzene	5	0.005
		Chloroethane	10	0.01
		2-Chloroethyl vinyl ether	10	0.01
		Chloroform	5	0.005
		Chloromethane	10	0.01
		Dibromochloromethane	5	0.005
		1,1-Dichloroethane	5	0.005
		1,2-Dichloroethane	5	0.005
		1,1-Dichloroethene	5	0.005
		1,2-Dichloroethene (total)	5	0.005
		1,2-Dichloropropane	5	0.005
		trans-1,3-Dichloropropene	5	0.005
		cis-1,3-Dichloropropene	5	0.005
		Ethylbenzene	5	0.005
		2-Hexanone	50	0.05
		Methylene chloride	5	0.005
		4-Methyl-2-pentanone	50	0.05
		Styrene	5	0.005
		Tetrachloroethene	5	0.005
		1,1,2,2-Tetrachloroethane	5	0.005
		Toluene	5	0.005
		1,1,1-Trichloroethane	5	0.005
		1,1,2-Trichloroethane	5	0.005
		Trichloroethene	5	0.005
		Vinyl acetate	50	0.05
		Vinyl chloride	10	0.01
		Total xylenes	5	0.005

[a] These are the Air Force IRP practical quantitation limits for SW846 methods under the RI/FS program. Specific quantitation limits are highly matrix dependent.

[b] Quantitation limits are for the low-level method. Mid- and high-level methods will have corresponding adjustments in limits. These specific limits will be verified by matrix spiking.

[c] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the contract, will be higher.

SW - Methods from SW846, Third Edition.

Table 8-8

Reporting Limits for Method SW8260A, Volatile Organic Compounds

Method	Parameter	Analytes	Reporting Limits [a]
			Water (µg/L)
SW8260A	Volatile Organic Compounds	Acetone	20
		Benzene	0.3
		Bromodichloromethane	0.1
		Bromoform	0.2
		Bromomethane	0.3
		2-Butanone (MEK)	5.0
		Carbon disulfide	1.0
		Carbon tetrachloride	0.2
		Chlorobenzene	0.3
		Chloroethane	0.3
		2-Chloroethyl vinyl ether	0.3
		Chloroform	0.15
		Chloromethane	0.5
		Dibromochloromethane	0.2
		1,2-Dibromoethane	0.15
		1,2-Dichlorobenzene	0.3
		1,3-Dichlorobenzene	0.8
		1,4-Dichlorobenzene	0.3
		1,1-Dichloroethane	0.2
		1,2-Dichloroethane	0.15
		1,1-Dichloroethene	0.3
		cis-1,2-Dichloroethene	0.2
		trans-1,2-Dichloroethene	0.25
		1,2-Dichloropropane	0.15
		trans-1,3-Dichloropropene	0.15
		cis-1,3-Dichloropropene	0.2
		Ethylbenzene	0.2
		2-Hexanone	3.3
		Methylene chloride	2.
		4-Methyl-2-pentanone	3.3
		Styrene	0.2
		1,1,1,2-Tetrachloroethane	0.2
		Tetrachloroethene	0.2
		1,1,2,2-Tetrachloroethane	0.3
		Toluene	0.2
		1,1,1-Trichloroethane	0.2
		1,1,2-Trichloroethane	0.2
		1,2,3-Trichloropropane	0.5
		Trichloroethene	0.4
		Vinyl acetate	0.5
		Vinyl chloride	0.25
		m/p-Xylenes	0.3
		o-Xylene	0.3

[a] These are the laboratory reporting limits. The laboratory cannot meet the IRP Handbook PQLs for this method.

Table 8-9

Quantitation Limits for Method SW8270B, Semivolatile Organic Compounds

Method	Parameter	Analytes	Practical Quantitation Limits[a]	
			Water (µg/L)	Soil (mg/kg)[b,c]
Base/Neutral Extractables				
SW8270B	Semivolatile Organic Compounds	Acenaphthene	10	0.7
		Acenaphthylene	10	0.7
		Anthracene	10	0.7
		Benzo(a)anthracene	10	0.7
		Benzo(b)fluoranthene	10	0.7
		Benzo(k)fluoranthene	10	0.7
		Benzo(g,h,i)perylene	10	0.7
		Benzo(a)pyrene	10	0.7
		Benzyl alcohol	20	1.3
		bis(2-Chloroethoxy)methane	10	0.7
		bis(2-chloroethyl)ether	10	0.7
		bis(2-Chloroisopropyl)ether	10	0.7
		bis(2-Ethylhexyl)phthalate	10	0.7
		4-Bromophenyl phenyl ether	10	0.7
		Butyl benzyl phthalate	10	0.7
		4-Chloroaniline	20	1.3
		2-Chloronaphthalene	10	0.7
		4-Chlorophenyl phenyl ether	10	0.7
		Chrysene	10	0.7
		Dibenz(a,h)anthracene	10	0.7
		Dibenzofuran	10	0.7
		Di-n-butylphthalate	10	0.7
		1,2-Dichlorobenzene	10	0.7
		1,3-Dichlorobenzene	10	0.7
		1,4-Dichlorobenzene	10	0.7
		3,3′-Dichlorobenzidine	20	1.3
		Diethyl phthalate	10	0.7
		Dimethyl phthalate	10	0.7
		2,4-Dinitrotoluene	10	0.7
		2,6-Dinitrotoluene	10	0.7
		Di-n-octylphthalate	10	0.7
		Fluoranthene	10	0.7
		Fluorene	10	0.7
		Hexachlorobenzene	10	0.7
		Hexachlorobutadiene	10	0.7
		Hexachlorocyclopentadiene	10	0.7
		Hexachloroethane	10	0.7
		Indeno(1,2,3-cd)pyrene	10	0.7
		Isophorone	10	0.7
		2-Methylnaphthalene	10	0.7
		Naphthalene	10	0.7
		2-Nitroaniline	50	3.3
		3-Nitroaniline	50	3.3
		4-Nitroaniline	50	3.3
		Nitrobenzene	10	0.7
		n-Nitrosodiphenylamine	10	0.7
		n-Nitrosodipropylamine	10	0.7
		Phenanthrene	10	0.7
		Pyrene	10	0.7
		1,2,4-Trichlorobenzene	10	0.7

Table 8-9

(Continued)

Method	Parameter	Analytes	Practical Quantitation Limits[a]	
			Water (µg/L)	Soil (mg/kg)[b,c]
Acid Extractables				
SW8270		Benzoic acid	50	1.6
		4-Chloro-3-methylphenol	20	1.3
		2-Chlorophenol	10	0.3
		2,4-Dichlorophenol	10	0.3
		2,4-Dimethylphenol	10	0.3
		4,6-Dinitro-2-methylphenol	50	3.3
		2,4-Dinitrophenol	50	3.3
		2-Methylphenol	10	0.3
		4-Methylphenol	10	0.3
		2-Nitrophenol	10	0.3
		4-Nitrophenol	50	1.6
		Pentachlorophenol	50	3.3
		Phenol	10	0.3
		2,4,5-Trichlorophenol	50	3.3
		2,4,6-Trichlorophenol	10	0.3

[a] These are the Air Force IRP practical quantitation limits for SW846 methods under the RI/FS program. Specific quantitation limits are highly matrix dependent.

[b] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

[c] Quantitation limits are for the low-level method. Mid- and high-level methods will have corresponding adjustment in limits. These specific limits will be verified by matrix spiking.

SW - Methods from SW846, Third Edition.

Table 8-10

Reporting Limits for Method SW8280, Polychlorinated Dioxins and Furans

Method	Parameter	Analytes	Reporting Limits[a]	
			Water (µg/L)	Soil (mg/kg)[b,c]
SW8280	Polychlorinated Dioxins and Furans	2,3,7,8-TCDD	0.0038	0.00015
		TCDD	0.0038	0.00015
		TCDF	0.0028	0.00011
		PeCDD	0.0045	0.00018
		PeCDF	0.0035	0.00014
		HxCDD	0.0046	0.00018
		HxCDF	0.0030	0.00012
		HpCDD	0.0061	0.00024
		HpCDF	0.0041	0.00016
		OCDD	0.0079	0.00032
		OCDF	0.0058	0.00023

[a] These are the laboratory reporting limits. Specific limits are highly matrix dependent.

[b] Reporting limits are for the low-level method. Mid- and high-level methods will have corresponding adjustment in limits. These specific limits will be verified by matrix spiking.

[c] Reporting limits listed for soil/sediment are based on wet weight. The reporting limits calculated by the laboratory for soil sediment, calculated on a dry weight basis as required by the contract, will be higher.

SW - Methods from SW846, Third Edition.

Table 8-11

Quantitation Limits for Method SW8310, Polynuclear Aromatic Hydrocarbons by HPLC

Method	Parameter	Analytes	Practical Quantitation Limits[a]	
			Water (µg/L)	Soil[b] (mg/kg)
SW8310	Polynuclear aromatic hydrocarbons	Acenaphthene	18	1.2
		Acenaphthylene	23	1.54
		Anthracene	6.6	0.44
		Benzo(a)anthracene	0.13	0.009
		Benzo(a)pyrene	0.23	0.015
		Benzo(b)fluoranthene	0.18	0.012
		Benzo(g,h,i)perylene	0.76	0.05
		Benzo(k)fluoranthene	0.17	0.011
		Chrysene	1.5	0.1
		Dibenzo(a,h)anthracene	0.3	0.02
		Fluoranthene	2.1	0.14
		Fluorene	2.1	0.14
		Indeno(1,2,3-cd)pyrene	0.43	0.03
		Naphthalene	18	1.2
		Phenanthrene	6.4	0.42
		Pyrene	2.7	0.18

[a] Per IRP Handbook- Required practical quantitation limits for SW846 methods under the IR/FS program. Specific quantitation limits are highly matrix dependent.

[b] Quantitation limits are given for the low-level methods. Mid- and high-level methods will have corresponding adjustments in limits. These specific limits will be verified by matrix spiking.

SW - Methods from SW846, Third Edition.

8.3.1 Extraction Methods

Extraction methods for liquid and solid matrices are briefly described in this section.

Method SW3005A--Acid Digestion of Aqueous Samples for Analyses by ICP

This method is an acid digestion procedure used to prepare water samples for metals analysis. The digested samples can be analyzed for total recoverable and dissolved metals determination by either flame (FLAA) or inductively coupled plasma emission spectroscopy (ICPES). Samples may be analyzed for the following metals:

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Molybdenum
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc

For analysis of total recoverable metals, the entire sample is acidified at collection time with nitric (HNO_3) acid to a $pH<2$. At the time of analysis, a 50-mL aliquot of the sample is heated with 1 mL of nitric acid and 5 mL of 1:1 hydrochloric acid and reduced to a specific volume. The sample must not be boiled because antimony is volatile and easily lost. The digestate is then filtered and adjusted to a final volume of 50 mL with reagent water.

For analysis of dissolved metals, the samples are filtered through a 0.45 µm filter immediately upon collection in the field, and acidified with nitric (HNO_3) acid to a $pH<2$. For analysis, the sample is digested as described above.

Modified Method SW3020A--Acid Digestion of Aqueous Samples for Analyses by Graphite Furnace Atomic Absorption Spectroscopy

Water samples will be digested according to Method SW3020A which has been modified by adding hydrogen peroxide to help digest and eliminate organic interferences. In modified method SW3020A, a mixture of the sample, nitric acid, and hydrogen peroxide is heated in a Griffin beaker. This step is repeated with an additional portion of nitric acid and refluxed until the digestate is light in color or until its color has stabilized. After, the digestion is complete, it is cooled and brought up to the original sample volume with deionized water. Matrix modifiers are added at the bench as appropriate for the element of interest.

Method SW3050A--Acid Digestion for Solids, Sediments, and Sludges for Metals Determinations

Method SW3050A is applicable to the preparation of sediment, sludge, and soil samples for metals analysis by FLAA or GFAA or ICP.

A 1 g (wet weight) sample is treated and digested in nitric acid and hydrogen peroxide. The digestate is then refluxed with nitric or hydrochloric acid, depending on the type of analysis to be performed. When using HCl as the final refluxing acid, care is taken not to boil the solution because antimony is volatile and easily lost. A separate sample is dried for a total solids and/or percent moisture determination.

Some sludge samples can contain diverse matrix types, which may present specific analytical problems. Spiked samples and any relevant standard reference material should be processed to aid in determining whether Method SW3050A is applicable to a given waste.

SW3500A Series Methods--Organic Extraction and Sample Preparation

The SW3500A series methods are used to quantitatively extract nonvolatile and semivolatile organic compounds from various sample matrices. Prior to analysis, a sample of a known volume or weight is solvent extracted, then dried and concentrated in a Kuderna-Danish apparatus.

Method SW3510B--Separatory Funnel Liquid-Liquid Extraction

Method SW3510B is designed to quantitatively extract nonvolatile and semi-volatile organic compounds from liquid samples using standard separatory funnel techniques. The sample and extracting solvent must be immiscible in order to yield recovery of target compounds. Subsequent cleanup and detection methods are described in the organic analytical method that will be used to analyze the extract.

Samples are adjusted to a specified extraction pH and extracted with the appropriate solvent for the analytical method. Methylene chloride should be employed when a solvent is not specified.

Method SW3520B--Continuous Liquid-Liquid Extraction

Method SW3520B is designed to quantitatively extract nonvolatile and semivolatile organic compounds from liquid samples using standard liquid/liquid techniques. The sample and extracting solvent must be immiscible in order to yield recovery of target compounds. Subsequent cleanup and detection methods are described in the organic analytical method that will be used to analyze the extract.

Samples are adjusted to a specified extraction pH and extracted with the appropriate solvent for the analytical method. Methylene chloride should be employed when a solvent is not specified.

Method SW3540B--Soxhlet Extraction

Method SW3540B is a procedure for extracting nonvolatile and semi-volatile organic compounds from solids such as soils and sludges. The Soxhlet extraction process ensures intimate contact of the sample matrix with the extraction solvent. Extraction is accomplished by mixing the solid sample with anhydrous sodium sulfate, placing it in an extraction thimble or between two plugs of glass wool, and extracting it with an appropriate solvent in the Soxhlet extractor. Methylene chloride should be employed when a solvent is not specified. The extract is dried and concentrated, and then treated using a clean-up method, or analyzed directly by the appropriate measurement technique.

Method SW3550A--Sonication Extraction

Method SW3550A is a procedure for extracting nonvolatile and semi-volatile organic compounds from solids such as soils and sludges. The sonication process ensures intimate contact of the sample matrix with the extraction solvent. Extraction is accomplished by mixing the solid sample with anhydrous sodium sulfate, mixing with the extraction medium, and dispersing into the solvent by sonication. The extract is dried and then concentrated. The resulting solution may then be cleaned up or analyzed directly using the appropriate technique.

Method SW5030A--Purge-and-Trap Method

Method SW5030A is used to determine the concentration of volatile organic compounds (VOCs) in a variety of liquid and solid matrices. It is based upon a purge-and-trap gas chromatographic procedure. The method is applicable to nearly all types of samples, including aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, water, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. The success of this method depends on the level of interferences in the sample; results may vary due to the large variability and complexity of matrices of solid wastes samples.

A direct purge-and-trap can be performed for low concentration samples. If higher concentrations are expected, a portion of the solid sample is dispersed in methanol to dissolve the volatile organic constituents. A portion of the methanol solution is combined with water in a purging chamber. An inert gas is then bubbled through the solution at ambient temperature to transfer the volatile components to the vapor phase. The vapor is swept through a sorbent column where the volatile components are trapped. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the components onto a gas chromatographic column. For SW8020 and SW8010A, drying of the trap for four minutes under helium flow is required. The gas chromatographic column is heated to elute the components that are detected by the appropriate detector (SW8010A, SW8020A, SW8240A).

8.3.2 Organic and Inorganic Analytical Methods for Water and Soil Samples

These subsections contain brief descriptions of the currently anticipated analytical methods that will be used for samples collected during the RI/FS. The maximum Quantitation Limits shown in Tables 8-2 through 8-11 listed are those listed in the Air Force IRP handbook when given. Estimated method detection limits given in the methods are used for those methods such as the EPA 500 series methods that are not listed in the IRP handbook. Actual reporting limits established by MDL studies performed by the contracting laboratory will be less than or equal to these values.

Method SM403--Alkalinity

Water samples are analyzed for alkalinity using Standard Method 403. Alkalinity of a substance is expressed as its ability to neutralize acid. It is commonly referred to as the sum of its titratable bases and is expressed as mg/L of $CaCO_3$ at the reaction end point. Determinations will be made according to indicator color change (phenolphthalein, metacresol purple, or bromocresol green). Concentrations of the hydroxide, carbonate, and bicarbonate alkalinity are determined by the relationship of phenolphthalein alkalinity (at pH 8.3) to the total alkalinity (at pH 4.5).

Method SW9050--Specific Conductance

Sample conductance is measured on site according to Method SW9050. Standard field meters are used and the electrode is rinsed with sample prior to measuring conductance; temperature is also reported. The meters are standardized daily using KCl solutions of known conductance with an allowance of ±5% of true value. Method detection limits are presented in Table 8-2.

Method SW9040A/SW9045A--pH

Field and laboratory pH measurements may be taken for water samples; the pH of soil samples is measured in the laboratory. All measurements are determined electrometrically using either a glass electrode in combination with a reference potential, or a combination electrode. The meters are calibrated daily using a minimum of two buffer solutions. The calibration readings must be within 0.05 units of the known buffer pH.

Method E170.1--Temperature

On-site water temperature is measured using U.S. EPA Method 170.1. A standard mercury thermometer is rinsed twice with sample prior to recording the temperature. Thermometer calibration is checked against an NIST traceable standard thermometer prior to field use.

Method EPA 360.1--Dissolved Oxygen

Dissolved oxygen (DO) will be determined using EPA method 360.1. A YSI Model 51A or equivalent oxygen meter will be used to measure the DO in groundwater and monitoring well waters. The meter calibration will be checked daily using water saturated air or air saturated water and the theoretical oxygen content given in the chart in Standard Methods based on temperature and altitude.

Method E180.1--Turbidity

Turbidity will be determined on-site using U.S. EPA Method 180.1. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension. The higher the intensity, the higher the turbidity. Turbidity measurements are made in a nephelometer and are reported in terms of nephelometric turbidity units (NTU). The working range for the method is from 0-40 NTU. Higher levels of turbidity can be measured by diluting the sample with turbidity free deionized water.

Calibration--A standard suspension of Formazin, prepared under conditions as defined in the method, is used to calibrate the instrument. A new stock standard should be prepared monthly. At least one standard should be run at each range as a check of the instrument's precalibrated scale.

ASTM Method D2216 (SW846)--Percent Moisture

Percent moisture is determined for solid samples undergoing analysis for organic and inorganic analytes. The percent moisture must be known so that the analytical results can be reported on a dry weight basis (i.e., μg/kg or mg/kg). The sample is weighed, dried, and then re-weighed. Percent moisture is calculated as (per modification on page 2-46 of the IRP Handbook):

$$\frac{\text{Initial Weight} - \text{Dried Weight}}{\text{Wet Weight}} \times 100$$

Method SW9056--Anions (Cl, F, NO_3, o-PO_4, and SO_4) by Ion Chromatography

Water samples are analyzed for fluoride, chloride, nitrate, ortho-phosphate and sulfate anions by ion chromatography using Method SW9056. Ion chromatography is a rapid method for separating and analyzing complex solutions of ionic species. The technique employs a carbonate/bicarbonate eluent and ion exchange resins to separate individual ions, and a suppressor column to remove the eluent ions. The detection and quantitation of the anions is performed conductimetrically. Quantitation limits for this method are presented in Table 8-2.

Calibration--A multi-point calibration curve (minimum of five points) is prepared daily by analyzing standard solutions containing the anions of interest. The calibration curve is verified by analyzing quality control check samples. A calibration curve is acceptable if the correlation coefficient for the anion is greater than, or equal to, 0.995 and recoveries for the QC check samples are in the range as shown in Table 10-1.

Method E350.1--Nitrogen, Ammonia

Ammonia nitrogen in water samples can be measured by U.S. EPA Method 350.1. This method is an automated colorimetric procedure in which alkaline phenol and hypochlorite react with ammonia to form an indophenol blue complex that is proportional to the ammonia concentration. The blue color is intensified with sodium nitroprusside and is measured at 630-660 nm. Prior to the colorimetric analysis, samples are distilled using U.S. EPA Method 350.2 to remove interference.

Calibration-- A calibration curve is constructed using a reagent blank and five standards on a daily basis. The correlation coefficient must exceed 0.995. Samples are analyzed in duplicate and spiked at a 10% frequency. The RPD must be <20 percent for duplicate determinations. A quality control check sample is analyzed for every 10 samples; recovery must be within 85 - 115 percent of the expected value.

Method SW7196A--Chromium (VI)

Chromium (VI) will be determined using method SW7196A. Dissolved hexavalent chromium, in the absence of interfering amounts of substances such as molybdenum, vanadium, and mercury, can be determined colorimetrically by reaction with diphenylcarbizide in acid solution. A red-violet color of unknown composition is produced . The reaction is very sensitive, the absorbancy index per gram atom of chromium is about 40,000 at 540 nm. Addition of an excess of diphenylcarbizide yields the red-violet product which is measured at 540 nm and the absorbance compared to a set of standards of known composition.

Calibration--a daily calibration curve must contain a minimum of a blank and four standards, with a correlation coefficient greater than 0.995. A quality control check sample is analyzed every 10 samples. Acceptable recoveries are within 15 percent of the expected value.

Method SW9012--Cyanide, Total

Water and waste samples are analyzed for total cyanide using SW9012. Cyanide as hydrocyanic acid (HCN) is released from cyanide complexes by means of an reflux-distillation under highly acidic conditions. The released cyanide is absorbed into a scrubber containing sodium hydroxide solution. The cyanide ion in the absorbing solution is then determined using an automated UV colorimetry. The colorimetric procedure is sensitive to about 0.02 mg/L. The quantitation limits for cyanides are presented in Table 8-2.

Total cyanide in soils is determined colorimetrically after acidification of the soil with sulfuric acid, distillation, and absorption in a NaOH scrubber as well.

Calibration--a daily calibration curve must contain a minimum of a blank and five standards, with a correlation coefficient greater than 0.995. A quality control check sample is analyzed every 10 samples. Acceptable recoveries are within 15 percent of the expected value.

Method E353.1--Nitrate + Nitrite

This method determines nitrate plus nitrite concentrations by hydrazine reduction. Nitrate is reduced to nitrite with hydrazine sulfate and the nitrite (combination of original nitrite plus reduced nitrate) is determined by diazotizing with sulfanilamide under acidic conditions and coupling with N-(1-naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye which is measured colorimetrically at 529 nm.

Calibration--A calibration curve will be generated daily using a reagent blank and five or more standards. The correlation coefficient must exceed 0.995 for the calibration equation. A quality control check sample will be analyzed for every 10 samples; recovery must be within ±15 percent of the expected value.

Method E351.2--Kjeldahl Nitrogen

Total Kjeldahl nitrogen (TKN) will be determined by EPA Method 354.2. In this method, nitrogen bound in the trinegative state is digested to ammonium sulfate in the presence of sulfuric acid, potassium sulfate, and a mercuric sulfate catalyst. The digested sample is decomposed by sodium thiosulfate and the ammonia distilled from the solution under basic conditions. The ammonia in the distillate is collected in a boric acid solution. The ammonia content can then be measured by acid titration, colorimetry, or with an ammonia sensing electrode.

Method 362.2--Total Phosphate

Total phosphate will be determined on acid preserved water samples using EPA Method 365.2. Complexed phosphates are digested to the ortho-phosphate form by heating with sulfuric acid and potassium persulfate. The ortho-phosphate is reacted with ammonium molybdate and antimony potassium tartrate to form an antimony-phospho-molybdate complex which is reduced to an intensely blue-colored complex by ascorbic acid. The sample intensity is measured at 650 or 880 nm and compared with the intensity of a standard phosphate solution.

Method E160.1--Filterable Residue (TDS)

Filterable residue (also known as total dissolved solids or TDS) in water is determined using U.S. EPA Method 160.1. In this gravimetric method, the sample is filtered, transferred to a pre-weighed evaporating dish, and evaporated to dryness at 180°C. The sample is cooled, and then weighed; the drying cycle is repeated until a constant weight is obtained. Reporting limits are presented in Table 8-2.

Method E 410.4-- Chemical Oxygen Demand

Chemical oxygen demand (COD) will be determined using EPA Method 410.4. In this method the sample is refluxed with potassium dichromate and sulfuric acid for two hours at 150 in a closed tube. After cooling, the residual potassium dichromate is measured colorimetrically. The amount of potassium dichromate consumed is proportional to the amount of oxidizable organic matter in the sample.

Method SW9060--Total Organic Carbon (TOC) - Water

Total organic carbon in water samples is measured using a carbonaceous analyzer by quantitatively converting the organic carbon in the sample to carbon dioxide which is measured by an infrared detector.

Calibration--A multi-point calibration curve is generated daily, prior to sample analysis, using a blank and a minimum of five standards prepared from potassium hydrogen phthalate. The correlation coefficient for the curve must exceed 0.995. A QC check sample is analyzed after every 10 samples; recovery must be within 20 percent of the expected value.

Method SW6010A--ICP Metals

Samples are analyzed for trace elements or metals, using SW6010A for water and soils. Analysis for most metals requires digestion of the sample with acid. This digestion is performed as SW846 Method 3005A for water or SW846 Method 3050A for soil. Following digestion, the trace elements are simultaneously or sequentially determined using ICPES. The elements and corresponding quantitation limits for this method are listed in Table 8-3.

Calibration--Detailed calibration procedures for ICPES systems are described in SW846, Third Edition. A response factor is calculated daily for each metal based on three exposures of a calibration standard and calibration blank. The RF is calculated and stored in the ICPES computer. Following calibration, a mid-level calibration check sample is analyzed; agreement between the measured value and the expected value must be within 5 percent for analyses to proceed. Calibration is verified by analyzing a QC check standard (prepared independently of calibration standards) every 10 samples; agreement within ±10 percent of the expected value is required for all metals analyzed by ICPES.

Methods SW7060A/SW7041/SW7131A/SW7421/SW7741--Graphite Furnace Atomic Absorption Metals Analyses for Arsenic, Antimony, Cadmium, Lead, and Selenium

Graphite furnace AA spectrometry is used to measure concentrations of Arsenic (As), Antimony (Sb), Cadmium (Cd), Lead (Pb), and Selenium (Se) in water and soil samples. The samples are extracted using modified SW3020A or SW3050A as appropriate. Discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is resistively heated by an electrical current. The sample solution is dried and charred to remove sample matrix components, and then atomized at temperatures sufficient to vaporize the element of interest. Matrix modification is used to eliminate interference effects, and may also enhance the vaporization efficiency and allow lower detection limits. This method usually has a linear analysis range at the ppb or sub-ppb level. Quantitation limits for this method are presented in Table 8-3.

Calibration--The calibration procedures for the graphite furnace AAS systems are described in the respective methods in SW846, Third Edition. A multi-point calibration curve is generated daily for each element using a calibration blank and at least three upscale standards. The correlation coefficient for the linear regression equation must exceed 0.995 to be acceptable. Calibration will be verified every 10 samples by analyzing a QC check sample and calibration blank. Agreement within ±10 percent of the expected value is required; otherwise, a new calibration curve must be generated.
The results in μg/l are converted to total μg and divided by the sample size (one gram) to obtain the concentrations of the target analytes in the sample (in μg/g).

Method SW7470A/SW7471A--Mercury - Manual Cold-Vapor Technique

Water and soil samples are analyzed for mercury using SW7470A and SW7471A, respectively. This method is a cold-vapor flameless AA technique based on the absorption of radiation by mercury vapor. Mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an AA spectrophotometer. Mercury concentration is measured as a function of absorbance. Quantitation limits for this method are presented in Table 8-3.

Calibration--The calibration procedures for the mercury analysis follow those previously described for the graphite furnace metals analysis. Agreement for the QC check sample must be within ± 20 percent of the expected value or a new calibration curve must be generated.

California Department of Health Services Method (CADHS)--Organolead

Organolead in water samples will be analyzed by the California Department of Health Services method. In this method, xylene is used to extract the organolead from the matrix followed by reaction with a solution of iodine in benzene combined with tri-capryl ammonium chloride in MIBK. The extract is then analyzed by flame atomic absorption spectrometry.

Calibration--A multi-point calibration is performed using a blank and three standards. The laboratory reporting limits for this method are given in Table 8-3.

Modified SW8015--Petroleum (Fuel) Hydrocarbons Plus Gasoline

Petroleum Hydrocarbons including BTEX, diesel, gasoline, and jet fuel can be analyzed by a modification of Method SW8015. (BTEX analysis will be optional for those samples also analyzed by SW8240A). Water samples are analyzed for purgeable TPH/BTEX using the purge and trap method described in Method SW5030A. Soil samples are analyzed using either the low-level (direct purge) purge and trap technique or the medium/high level (methanol extraction) purge and trap technique as appropriate. Final detection and quantitation is by gas chromatography using a photoionization detector

(PID for the volatile aromatics and a flame ionization detector (FID) for gas. Quantitation limits for this method are listed in Table 8-5. The SOPs for Purgeable Total Petroleum Hydrocarbons by SW8015 and Extractable Total Petroleum Hydrocarbons by SW8015 are presented in Attachments C and D, respectively.

Calibration--Calibration of the GC is performed at a minimum of five levels using BTEX compounds. Chlorobenzene, the surrogate for purgeable TPH, is dissolved in purge and trap grade methanol at a concentration of 20 µg/mL.

Method SW8081--Organochlorine Pesticides and PCBs

Organochlorine pesticides and polychlorinated biphenyls (PCBs) in water and soil samples are analyzed using Method SW8081. This analytical method involves extraction of the sample with methylene chloride, followed by exchange to hexane and concentration of the extract. The pesticides and PCBs are separated and quantified by gas chromatography using electron capture detection. Both neat and diluted liquids may be analyzed by direct injection on to the chromatographic column. Quantitation limits for this method are presented in Tables 8-6.

Calibration--The external standard quantitation discussed in the method is used to quantitate all pesticides/PCBs. The retention time window is calculated for each pesticide/PCB after adjusting the GC operating conditions for the routine retention times of 4,4′-DDT. The GC/ECD is initially calibrated at a minimum of five concentrations. The average calibration factor is acceptable if the RSD for the calibration factors at each level does not exceed 20 percent or linear regression may be used if the correlation coefficient is 0.995 or greater. Concentration of the components in a standard varies depending on the response of the compounds in the analytical system. Breakdown of 4,4′-DDT and endrin is also monitored. Breakdown may not exceed 20 percent. A daily single-point calibration check must agree within ±15 percent of the multi-point response or the instrument is recalibrated.

Method SW8151-- Chlorinated Herbicides

Chlorinated herbicides will be analyzed using Method SW8151. Esters present in the samples are hydrolyzed with potassium hydroxide and washed with solvent to remove the extraneous organic material. Next samples are acidified, extracted with solvent, and converted to methyl esters using diazomethane as the derivatizing agent.

After excess regent is removed, the esters are determined by gas chromatography employing an electron capture detector. Any compounds tentatively identified in the primary analysis are confirmed with a second column analysis. Results are reported as the acid equivalents (i.e., chlorinated herbicides).

Method SW8240A/SW8260A--Volatile Organic Compounds

Volatile, or purgeable, organics in water and soil samples are analyzed using Methods SW8240A and/or SW8260A. These methods use a purge-and-trap GC/MS technique. An inert gas is bubbled through the water samples, or a soil-water slurry for soil samples, to transfer the purgeable organic compounds from the liquid to vapor phase. Soil samples with higher contaminant levels are extracted using methanol before purging. The vapor is then swept through a sorbent trap where the purgeable organics are trapped. The trap is backflushed and heated to desorb the purgeable organics onto a gas chromatographic column where they are separated and then detected with a mass spectrometer. The species detected and quantitation limits for this method are listed in Table 8-7 and 8-8.

Alternate methods for determination of these species are the GC methods SW8010 and SW8020, which generally yield slightly lower detection limits. Nonspecified compounds cannot be determined using GC. Acrolein and acrylonitrile can be determined using SW8240A if specifically requested.

Calibration--The mass spectrometer is tuned daily to give an acceptable spectrum for bromofluorobenzene (BFB). Relative ion abundance criteria for BFB are given in SW846, see Table 8-12.

Table 8-12

BFB Key Ion Abundance Criteria

Mass	Ion Abundance Criteria
50	15 to 40% of mass 95
75	30 to 60% of mass 95
95	Base peak, 100% relative abundance
96	5 to 9% of mass 95
173	Less than 2% of mass 95
174	Greater than 50% of mass 95
175	5 to 9% of mass 174
176	Greater than 95%, but less than 101% of mass 174
177	5 to 9% of mass 176

System performance is verified initially and after every 12 hours to ensure a minimum average response factor of 0.3 (0.25 for bromoform) for method 8240A and a minimum response factor of 0.3 (except 0.1 for bromoform and 0.2 for 1,1,2,2-tetrachloroethane) for 8260A for the following system performance check compounds (SPCCs):

- Chloromethane;
- 1,1 Dichloroethane;
- Bromoform;
- 1,1,2,2-Tetrachloroethane; and
- Chlorobenzene.

A five-point calibration, used for generating response factors, is performed initially using 10, 20, 50, 100, and 200 μg/L standards (acetone - 50, 100, 250, 500 and 1000; cis-1,3-dichloropropane- 5, 10, 25, 50, 100; m-& p-xylene - 20, 40, 100, 200, and 400; o- xylene-10, 20, 50, 100, 200). The calibration standards for 8260A are about a factor of three times lower than those for 8240A. The relative standard deviation (RSD) must be less than 30 percent for the five response factors calculated for each of the following calibration check compounds (CCCs):

- 1,1-Dichloroethene;
- Chloroform;
- 1,2-Dichloropropane;
- Toluene;
- Ethylbenzene; and
- Vinyl chloride.

The laboratory uses the same surrogates and internal standards for both 8240 and 8260. It should be noted that 8260 recommends a 25 mL purge volume, but the laboratory may use a smaller volume (i.e., 15 mL) as long as the reporting limits are met.

Method SW8270B--Semivolatile Organic Compounds

Semivolatile organics, also known as base/neutral and acid extractables (BNA), in water and soil samples are analyzed using Method SW8270B. These techniques quantitatively determine the concentration of a number of semivolatile organic compounds. Organic compounds are extracted from the sample with methylene chloride at pH greater than 12 to obtain base/neutral extractables. Acid extractable compounds are obtained from the sample by extraction with methylene chloride at pH 2 or less. Both base/neutral and acid extracts are then concentrated by removal of the methylene chloride through evaporation. Compounds of interest are separated and quantified using a GC/MS. The compounds that can be detected using Method SW8270B and the quantitation limits are listed in Table 8-9.

Alternate methods for determination of these species are the GC methods, SW8010, SW8040, and SW8081. These GC techniques generally yield slightly lower detection limits and have lower costs. Many of the base/neutral extractable species have no corresponding GC method, and nonspecified compounds cannot be determined using GC.

Calibration--The mass spectrometer is tuned daily to give an acceptable spectrum for decafluorotriphenyl phosphene (DFTPP). Decafluorotriphenyl phosphene ion abundance criteria are given in SW846, see Table 8-13.

System performance is verified initially and after every 12 hours to ensure a minimum average response factor of 0.050 for the following system performance check compounds (SPCCs):

- N-nitroso-di-n-propylamine;
- Hexachlorocyclopentadiene;
- 2,4-Dichlorophenol; and
- 4-Nitrophenol.

Table 8-13

DFTPP Key Ion Abundance Criteria

Mass	Ion Abundance Criteria
51	30 to 60% of mass 198
68	Less than 2% of mass 69
70	Less than 2% of mass 69
127	40 to 60% of mass 198
197	Less than 1% of mass 198
198	Base peak, 100% relative abundance
199	5 to 9% of mass 198
275	10% to 30% of mass 198
365	Greater than 1% of mass 198
441	Present, but less than mass 443
442	Greater than 40% of mass 198
443	17 to 23% of mass 442

A five-point calibration, used for generating response factors, is performed initially using 10, 20, 50, 80, and 160 μg/L standards. The variability for specific ion response factors for the SW8270 calibration check compounds must be less than 30 percent RSD over the range calibrated. The CCCs are:

- Phenol;
- 1,4-Dichlorobenzene;
- 2-Nitrophenol;
- 2,4-Dichlorophenol;
- Hexachlorobutadiene;
- 4-Chloro-3-methylphenol;
- Acenaphthene;
- 2,4,6-Trichlorophenol;
- N-nitroso-di-n-phenylamine;
- Pentachlorophenol;
- Fluoranthene;

- Di-n-octylphthalate; and
- Benzo(a)pyrene.

A continuing (every 12 hours) calibration check is performed, following the system performance check, using the CCCs listed above. A single concentration of each CCC is analyzed and a response factor calculated. The single-point RF for each CCC must be within 30 percent of the average five-point RF; otherwise, a new five-point calibration must be generated.

Method SW8280--Chlorinated Dioxins and Furans

Soil samples will be analyzed for chlorinated dioxins and furans using method SW8280. The dioxins and furans are extracted from the soils with hexane using Method SW3550A. The extracts are cleaned by passing the solvent through alumina, silica gel, and carbon columns. The cleaned extracts are concentrated and injected onto the a fused silica capillary column of a gas chromatograph/mass spectrometer. The compounds detected in the screening analysis and quantitation limits are given in Table 8-10.

Calibration--Response factors for each PCDD/PCDF isomer class is determined initially using a five point calibration. This five-point calibration is performed in triplicate and the average response factors are calculated. The response factors for each isomer class must have a RSD less than 15 percent. A TCDD chromatographic test mixture is analyzed daily to verify that there is at least 25 percent valley resolution between 2,3,7,8-TCDD and 1,2,3,4-TCDD. A PCDD/PCDF standard is analyzed daily to verify that the daily response factors are within 30 percent of the multi-point calibration and that the isotope ratios for each isomer class is within 15 percent of their theoretical values.

SW8310--Polynuclear Aromatic Hydrocarbons (PAHs)

SW8310 is used to determine the concentration of selected PAHs in groundwater and wastes. SW8310 provides high performance liquid chromatographic (HPLC) conditions for the detection of ppb levels of PAHs. Samples are analyzed by direct injection. Detection is by ultraviolet (UV) and fluorescence detectors. Reporting Limits are listed in Tables 8-11.

Calibration--For initial calibration, standards at five concentration levels are prepared by dilution of stock standards with acetonitrile. The average calibration factor is acceptable if the relative standard deviation (RSD) does not exceed 20 percent or linear regression may be used if the correlation coefficient is 0.995 or greater. Daily calibration checks are acceptable if the difference between the daily response versus the initial (multi-point) response does not exceed ±15 percent.

Section 9.0
DATA REDUCTION, VALIDATION, AND REPORTING

The data reduction, validation, and reporting procedures described in this section will ensure that complete documentation is maintained, that transcription and data reduction errors are minimized, the quality of the data is reviewed and documented, and the reported results are properly qualified.

9.1 Data Management

The primary data management activities for the Elmendorf AFB project will include:

- Data transfer from field and laboratory activities to a project filing system;
- Data management to ensure that data are stored and output in a manner that continues the chain of custody;
- Requirements review to ensure that plans for data collection were fulfilled;
- Analytical data validation which will report data to be used for site interpretation activities;
- Analytical and field data evaluation resulting in a report of guidance to be followed for using project data in site interpretation, risk assessment, etc.; and
- Reporting functions may include outputting data for report tables, statistical analysis, site interpretation, risk assessment, and electronic transfer.

A computerized project database will be used for data management on the Elmendorf AFB project. The proposed database will be implemented in a relational data management software and will be based upon project databases used for other Air Force projects. The Sample and Analysis System (SAM®) and Electronic Benchsheet System (EBS) are used to store, transfer, and report analytical data. A series of programs, called EXPORT®, allows electronic reporting of data. The Document Control group is responsible for generating hard copies and EXPORT® files for the analytical results.

Both the SAM®/EBS data sheets and EXPORT® data files are transferred to the project QA coordinator and/or data management staff. The laboratory provides additional documentation regarding chain-of-custody procedures, etc., that are not transmitted via SAM® sheets or EXPORT® files.

9.2 Data Reduction

Data reduction activities described in this section are applicable to Radian Analytical Services.

The laboratory analyst is responsible for the reduction of raw data generated at the laboratory bench. The data interpretation that is required to calculate sample concentrations follows the methodology described in the specific analytical standard operating procedure (SOP). After all analyses have been completed and reported, the laboratory manager or designee reviews the raw data and verifies that the analyses were properly performed and reported. The laboratory manager may then transfer the raw data to the Document Control area, where the raw data are filed if needed for a subsequent QC review. Raw data, together with all supporting documentation, are stored in confidential files by Document Control.

After all analyses for a report are complete, the data are entered into the laboratory reporting system and a preliminary report is generated for review by the laboratory managers. This review is followed by a quality check carried out by the Document Control group to verify that the quality control (QC) meets the specifications of the method.

Identification of outliers is also a part of the data review. An outlier is an unusually large (or small) value in a set of observations. There are many possible reasons for outliers including:

- Faulty instruments or component parts;
- Inaccurate reading of a record, dialing error, etc;
- Errors in transcribing data; and
- Calculation errors.

Sometimes analysts or operators can identify outliers by noting the above types of occurrences when they record the observations. In these instances, the errors are corrected, or if correction is not possible, the suspect observations may be removed from the data before calculations are performed. If no such information exists, the Dixon Criteria are used to test suspected outliers at the 5 percent significance level if there are three or more points in the data set containing the outlier. Outliers identified by this method may be removed from the data before further processing (Dixon, 1953).

9.3 Data Quality Assessment

Data validation activities for the Elmendorf AFB project will approximate activities followed for an EPA Level III project (EPA, 1987). The following summarizes the expected level of effort for this project. Initial data review will be performed by laboratory staff at the laboratories standard level of effort. This standard level of effort includes:

- Peer review of natural matrix and QC measurement data at the analyst level;
- Preliminary report review by laboratory managers; and
- A quality check performed by peer review within the laboratory.

The QA Coordinator, or other QA staff, will validate data in a review of field and laboratory documentation and measurement data for acceptable sample collection and analysis procedures, consistency with expected results or other results, adherence to prescribed QA procedures, and agreement with the acceptance criteria described in Section 10.0. The data will be validated by reviewing sample conditions after shipment to the laboratory, hold-time compliance, and a review of laboratory blanks and control samples. This will allow the validation to determine if an overall project objective of 90% is met.

Validated data will be reported in the Informal Technical Information Report (ITIR) and used for data analysis activities such as site interpretation and risk assessment.

9.4 Data Validation and Reporting

The Project QA Coordinator, or other QA staff, will review and summarize all QC sample results to evaluate the sampling and analytical performance. Reagent and field blank results will be evaluated to identify any systematic contamination; spike and duplicate results will be compared to the QA objectives presented in Section 10, and the results used to calculate precision and accuracy for the data set. This process will identify analytical methods and compounds for which the QA objectives are not satisfied and corresponding sample data will be qualified with a "flag" indicating the problem. Samples collected on the same day, or analyzed in the same run or batch, or individual samples may be flagged, depending on the type of problem that has been identified. Re-analysis or resampling may be recommended as a corrective action at this time if data are determined to be unacceptable for the intended application. Corrective actions and data assessment procedures are described in Sections 13 and 14.

Data reporting for this project will consist of Installation Restoration Program (IRP) reporting. General reporting practices for measurement data will include:

- Heading information identifying the sample ID and the analytical method, as provided on laboratory reports;
- Unique sample identification number or code;
- Consistent units of measure;
- Consistent number of significant figures; and
- Comparison with regulatory threshold values.

QC results will be reported by sample matrix and analytical method in tabular form. The measurement data will be discussed and qualified as appropriate based on the QC results. For example, matrix spike interference will influence specific samples or matrices, while laboratory blank contamination will influence all samples extracted or analyzed on a specific day or during a specific analytical run.

In cases where there are a large number of QC analyses of one type, a second level, or summary, table may be constructed. The summary tables will typically report mean or pooled statistics to describe the overall performance of the method. For example, the summary table of duplicate sample results might report the average RPD for all duplicates measured for the compound, and indicate the number of individual RPDs that did not meet the acceptance criteria. This type of table can serve as an indication of the overall QC results. However, these applications will often have to be developed or modified from existing programs for individual investigations. A summary assessment of the data presented in these tables will be prepared for each phase of sampling, or specific, as appropriate.

Finally, custom table formats will be used as an aid to interpretation of the investigative data. The particular format will depend on how the QC results are expected to influence the investigative data and will be developed by data management staff through discussion with the users. For example, QC results may be grouped with analytical batches, field collection batches, or summarized for the entire project.

Section 10.0
INTERNAL QUALITY CONTROL CHECK

Internal quality control (QC) is achieved by collecting and/or analyzing a series of duplicate, replicate, blank, spike, and spike duplicate samples to ensure that the analytical results are within quality control limits specified by the program. Laboratory QC samples are documented at the bench and reported with the analytical results. The QC sample results are used to quantify precision and accuracy and identify any problems or limitations associated with sample results.

10.1 Field Qnality Control

Field QC samples will be documented in field logbooks and submitted "blind" to the laboratory, so that the laboratory cannot distinguish between natural and QC samples during analysis. These components of the sampling program will ensure that data of known quality are produced throughout the sampling and analysis component of all field programs.

10.1.1 Field Duplicate Samples

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate sample results are used to assess precision, including variability associated with both the laboratory analysis and the sample collection process. Duplicate samples will be collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. Duplicate samples will be collected at a frequency of 10%.

Precision of soil samples to be collected for volatile organic compounds (VOCs) will be assessed from co-located samples because the mixing required to obtain more homogenous samples could result in loss of the volatile compounds of interest. The co-located samples will otherwise be handled and analyzed in the same manner. Soil samples to be analyzed for nonvolatile compounds will be recovered by collecting a single sample, mixing/homogenizing and dividing it into equal portions for laboratory analysis.

10.1.2 Ambient Blank

Ambient blanks are samples of Type II reagent grade water that are collected and processed using the same sampling and handling procedures as other samples. Ambient blanks are used to assess the potential introduction of contaminants to the samples during sample collection and analysis, and are prepared only for VOC samples. Analytical blanks are taken each sampling day for any sample points at which VOCs are collected and which are sampled downwind of possible VOC sources (a minimum of one sample will be collected per day).

Organic-free water will be prepared with Type II water that has been filtered, deionized, and boiled to volatilize organic compounds. Water used for sensitive gas chromatography analysis (SW8020) will also be boiled for at least 20 minutes and kept under positive pressure by purging with nitrogen. This water is tested by GC analysis prior to its use in the field blanks to ensure complete purity.

10.1.3 Equipment Blanks

Equipment blanks consist of Type II reagent water or organic-free water (for volatile organic analyses) poured into the groundwater or soil sampling device, collected in the sampling bottle, transported to the laboratory for analysis. The frequency for collecting equipment blanks will be to collect one blank per ten field samples. (The IRP Handbook guidelines are for each sampling team to collect one equipment blank each day. Representatives of Elmendorf AFB, AFCEE, and EPA agreed to reduce this to one equipment blank for each 10 field samples.) This blank will be analyzed for all analytes requested for that sampling point.

10.1.4 Trip Blanks

A trip blank is a sample of organic-free water (prepared as for ambient blanks) that is placed in the sample bottle in an uncontaminated area in the laboratory prior to going to the field. Trip blanks are prepared only for VOC samples and are subjected to the same handling as other samples. Trip blanks serve to identify contamination from sample containers or transportation and storage procedures. One trip blank will accompany each shipment or cooler of soil and water samples sent to the laboratory for the analysis of VOCs. The trip blank for soils will be the same as for waters.

10.2 Laboratory Quality Control

Laboratory QC is necessary to control the analytical process, to assess the accuracy and precision of analytical results, and to identify assignable causes for atypical analytical results. The QC checks in the laboratory are specific to the analytical method and generally include the use of the following QC samples as appropriate for the method.

10.2.1 Calibration Standards

Initial calibration is performed as required for each analytical method, usually using a range of calibration standards with the low standard near the detection limit for the compound. These standards are used to determine the linear dynamic range for the initial instrument calibration. EPA, NIST, CRADA (Cooperative Research and Development Agreement) or other approved standards will be used when possible. Calibration is discussed in more detail in Sections 7 and 8.

10.2.2 Laboratory Check Samples

Laboratory Check samples (LCS) are quality control check solutions containing certain analytes of interest (Air Force requires that this include all target analytes) at a specified concentration, usually in the mid-calibration range. These samples are used to demonstrate that the instrument and the method is operating within acceptable accuracy limits. Laboratory Check Samples are required for all analytical methods performed in the laboratory, and their preparation and the required frequency of analysis is described in each analytical standard operation procedure (SOP). For this program acceptance criteria pertain to liquid LCS samples. Liquid LCS samples will determine whether or not the analytical system is in control.

10.2.3 Method Blanks

A method (reagent) blank is a sample composed of all the reagents (in the same quantities) used in preparing a sample for analysis. It is carried through the same sample preparation (digestion/extraction) procedure as a sample. As stated in SW846 Method 8000 procedures, reagent blanks are used to ensure that interferences from the analytical system, reagents, and glassware are under control. The required frequency for analyzing reagent blanks is specified in the analytical SOP for each method and generally consists of one per day for each method/instrument and/or one per extraction batch.

10.2.4 Matrix Spike/Matrix Spike Duplicates

A matrix spike is a solution of the target analytes at known concentrations that is spiked into a field sample before sample preparation and analysis. Two aliquots of the sample are spiked for the duplicate analysis. The results of the duplicate spiked samples are used to measure the percent recovery of each spiked compound and compare the recovery between samples, which provides estimates of the accuracy and precision of the method. The calculations for accuracy and precision are outlined in Section 13. The frequency for matrix spike analysis is 5 percent of samples analyzed for each method where spikes are performed. The solution of target analytes in matrix spikes for metals includes all target analytes. The solution of target analytes in matrix spikes for organic analyses is based on Method 3500 and does not include all target analytes, but is rather a representative subset.

10.2.5 Surrogate Spikes

Surrogate spikes are a group of compounds that are not otherwise found in nature but behave similarly to the target analytes that have been selected for each organic analytical method. A solution of known concentration is prepared and spiked into each sample prior to sample preparation and analysis. The recovery of the surrogate spike compounds is reported for each sample, and the results are compared to the recovery objectives established for the method. Surrogate compounds are recommended in each analytical method for organic constituents. Where feasible, the method recommended surrogates will be used.

10.2.6 Laboratory Duplicates (Duplicate Analyses)

Laboratory duplicates are repeated but independent determinations of the same sample, by the same analyst, at essentially the same time, and under the same conditions. The sample is split in the laboratory and each fraction is carried through all stages of sample preparation and analysis. Duplicate analyses measure the precision of each analytical method. The method of calculation for precision is outlined in Section 13. Laboratory duplicate analyses are performed for 10 percent of samples analyzed or at least one per day, for analytical methods that do not require matrix spike/matrix spike duplicates.

10.3 Control Limits

Control limits and acceptance criteria for QC samples are presented by method in Tables 10-1 through Table 10-22. Tables 10-1 through 10-10 present the quality control acceptance criteria and Tables 10-11 through 10-22 present the required corrective action guidelines to be followed when results fall outside the prescribed QC limits. The corrective action activities listed are to be used as guidelines and are not necessarily followed in the order listed. The primary intent of these guidelines are to identify any problems and correct the problem before proceeding.

Table 10-1

Quality Control Acceptance Criteria for Indicator and Inorganic Methods

Parameter	Aqueous Matrix Spike[a]		Solid Matrix Spike[a]		LCS Spike[b]
	Accuracy (% Recovery)	Precision (RPD)	Accuracy (% Recovery)	Precision (RPD)	Accuracy (% Recovery)
Alkalinity SM403	80-120	20[c]	NA	NA	80-120
Conductivity SW9050	NA	20[c]	NA	NA	NA
Turbidity E180.1	NA	20[c]	NA	NA	NA
pH SW9040A/SW9045B	NA	0.1 pH units[c]	NA	0.5 pH units[c]	NA
Dissolved Oxygen E360.1	NA	20	NA	NA	NA
Soil Moisture SW846	NA	NA	NA	30[c]	NA
Anions-Chloride SW9056	80-120	20	NA	NA	90-110
Anions-Fluoride SW9056	80-120	20	NA	NA	90-110
Anions-Nitrate SW9056	80-120	20	NA	NA	90-110
Anions-Phosphate SW9056	80-120	20	NA	NA	90-110
Anions-Sulfate SW9056	80-120	20	NA	NA	90-110
Ammonia E350.1/350.2	80-120	20	NA	NA	80-120
COD E410.4	80-120	20	NA	NA	80-120
Chromium (VI) SW7196A	75-125	20	NA	NA	80-120
Nitrate + Nitrite E353.1	80-120	20	NA	NA	85-115
Total Kjeldahl Nitrogen E351.2	80-120	20	NA	NA	80-120
Total Phosphate E365.2	85-115	20	NA	NA	85-115
Total Cyanide SW9012	75-125	25	75-125	25	75-125
Total Organic Carbon SW9060	80-120	20	NA	NA	80-120
Filterable Residue (TDS) E160.1	NA	20[c]	NA	NA	80-120

[a] Reference guide for post-analysis, project review.
[b] Used for control of the analytical system
[c] Based on analytical duplicates or duplicate samples instead of matrix spiked duplicates.

LCS - Laboratory control sample.
NA - Not applicable.
NSM - Not specified in method.
RPD - Relative percent difference.

Table 10-2

Quality Control Acceptance Criteria for Metals

Parameter	Aqueous Matrix Spike[a]		Solid Matrix Spike[a]		LCS Spike[b]
	Accuracy (% Recovery)	Precision (RPD)	Accuracy (% Recovery)	Precision (RPD)	Accuracy (% Recovery)
ICP Metals SW6010A	75-125	20	75-125	35	80-120
Arsenic SW7060A	75-125	20	75-125	35	75-125
Antimony SW7041	75-125	20	75-125	35	75-125
Cadmium SW7131A	75-125	20	75-125	35	75-125
Lead SW7421	75-125	20	75-125	35	75-125
Mercury SW7470A/7471A	75-125	20	75-125	35	80-120
Selenium SW7740	75-125	20	75-125	35	75-125
Organolead CADHS	75-125	20	NA	NA	75-125

[a] Reference guide for post-analysis project review.
[b] Used for control of analytical system. Recoveries are based on a LCS which is a blank spike.

LCS - Laboratory control sample.
RPD - Relative percent difference.

Table 10-3

Quality Control Acceptance Criteria for Petroleum (Fuel) Hydrocarbons Plus Gasoline (by Modified Method SW8015)

Parameter	Aqueous Matrix Spike		Solid Matrix Spike		LCS Spike
	Accuracy[a] (% Recovery)	Precision (RPD)	Accuracy[a] (% Recovery)	Precision (RPD)	Accuracy[b] (% Recovery)
Purgeables					
Benzene	50-150	≤30	50 - 150	≤50	62-133
Toluene	50-150	≤30	50 - 150	≤50	61-129
Ethylbenzene	50-150	≤30	50 - 150	≤50	67-137
Xylene	50-150	≤30	50 - 150	≤50	64-136
Gasoline	NS		NS		65-135
Surrogate:					
Chlorobenzene	52-140[c]		53-141[c]		52-140/53-141
Extractables					
Diesel Fuel	68 - 142	39	61 - 157	22	68-142/61-157[c]
Jet Fuel	NS		NS		NS
Kerosene	NS		NS		NS
Surrogate:					
Octacosane	49-148[c]		53-149[c]		49-148/53-149[c]

[a] Method specified limits from Chapter One, SW-846 and tables in method. Used for post-analysis, project review.
[b] Used for control of the analytical system.
[c] Laboratory derived tolerances.

LCS - Laboratory control sample.
NA - Not applicable. This matrix will not be analyzed for these constituents.
NS - Not specified and/or not spiked.
NSM - Not specified in method.
RPD - Relative percent difference.

Table 10-4

Quality Control Acceptance Criteria for Organochlorine Pesticides and PCBs by Method SW8081[a]

	Aqueous Matrix Spike		Solid Matrix Spike		LCS Spike
Parameter	Accuracy[b,c] (% Recovery)	Precision (RPD)	Accuracy[b,c] (% Recovery)	Precision (RPD)	Accuracy[b,c] (% Recovery)
Aldrin	59 - 122	18	60-122	23	59-122/60-122
alpha-BHC					69-132/56-134
beta-BHC					NS
Chlordane					NS
alpha-Chlordane					62-153/74-134
gamma-Chlordane					58-148/67-139
4,4′-DDD					NS
4,4′-DDE					NS
4,4′-DDT	69-137	18	64-134	21	69-137/64-134
delta-BHC					62-137/51-137
Dieldrin	70-134	15	66-129	22	70-134/66-129
Endosulfan I					NS
Endosulfan II					57-136/61-123
Endosulfan sulfate					NS
Endrin	58-132	32	30-147	55	58-132/30-147
Endrin aldehyde					67-157/D-178
Endrin ketone					NS
gamma-BHC (Lindane)	72-127	17	60-127	12	72-127/60-127
Heptachlor	58-133	18	57-128	14	58-133/57-128
Heptachlor epoxide					65-142/61-135
Methoxychlor					NS
PCB-1016	51-114	20	50-114	17	51-114/50-114
PCB-1221					NS
PCB-1232					NS
PCB-1242					NS
PCB-1248					NS
PCB-1254					NS
PCB-1260	47-127	23	35-127	21	47-127/35-127
Toxaphene					NS
Surrogates					
Dibutylchlorendate	46-142	NA	35-149	NA	
TCMX	47-119	NA	52-129	NA	

[a]All limits are based on a certain spike concentration. If this concentration changes, the limits also change. See Tables 3 and 4 in SW8080.

[b]The LCS will be spiked at a minimum with the matrix spike analytes. MS/MSD resutls are used for post-analysis, project review; LCS results are used for control of the analytical system.

[c] Laboratory derived tolerances.

LCS - Laboratory control sample.
NA - Not applicable.
NS - Not specified and/or not spiked.
RPD - Relative percent difference.

Table 10-5

Quality Control Acceptance Criteria for Chlorinated Herbicides by Method SW8151

Parameter	Aqueous Matrix Spike Accuracy[a] (% Recovery)	Aqueous Matrix Spike Precision (RPD)	Solid Matrix Spike Accuracy[a] (% Recovery)	Solid Matrix Spike Precision (RPD)	LCS Spike Accuracy[b] (% Recovery)
2,4-D	42-152	≤36	58 -152	≤33	42-152/58-152
2,4,5-TP	60-132	≤18	42 -139	≤33	60-132/42-139
Dicamba	NS	NA	NS	NA	33-127/32-150
Dinoseb	23-116	≤50	20-116	≤57	23-116/20-116
2,4,5-T	69-167	≤50	40-178	≤32	69-167/40-178
Surrogate:					
2,4-DCAA	42-148	NA	45-153[c]		42-148/45-153

[a] Method specified limits from Chapter One, SW-846 and tables in method. Used for post-analysis, project review.
[b] Used for control of the analytical system.
[c] Laboratory derived tolerances.

LCS - Laboratory control sample.
NA - Not applicable. This matrix will not be analyzed for these constituents.
NS - Not specified and/or not spiked.
NSM - Not specified in method.
RPD - Relative percent difference.

Table 10-6

Quality Control Acceptance Criteria for Volatile Organic Compounds by Method SW8240A[a]

Parameter	Aqueous Matrix Spike Accuracy[b] (% Recovery)	Aqueous Matrix Spike Precision (RPD)	Solid Matrix Spike Accuracy[b] (% Recovery)	Solid Matrix Spike Precision (RPD)	LCS Spike Accuracy[b] (% Recovery)
Acetone					D-174[c]/D-213[d]
Benzene	77 - 135	≤10	67 - 141	≤15	77-135[c]/67-144[d]
Bromodichloromethane					61-143[c]/61-131[d]
Bromoform					45-145[c]/45-136[d]
Bromomethane					26-171[c]/48-168[d]
2-Butanone (MEK)					D-182[c]/24-174[d]
Carbon disulfide					D-258[c]/49-255[d]
Carbon tetrachloride					70-140[c]/70-140[d]
Chlorobenzene	74 - 124	≤12	67 - 127	≤12	74-124[c]/67-127[d]
Chloroethane					53-147[c]/62-158[d]
2-Chloroethyl vinyl ether					NS
Chloroform					66-130[c]/62-130[d]
Chloromethane					13-155[c]/29-161[d]
Dibromochloromethane					69-123[c]/53-122[d]
1,1-Dichloroethane					59-139[c]/62-134[d]
1,2-Dichloroethane					58-142[c]/64-136[d]
1,1-Dichloroethene	45 - 149	≤29	31 - 172	≤61	45-149[c]/31-172[d]
trans-1,2-Dichloroethene					63-141[c]/56-156[d]
1,2-Dichloropropane					72-130[c]/68-128[d]
trans-1,3-Dichloropropene					58-137[c]/66-118[d]
cis-1,3-Dichloropropene					73-145[c]/67-137[d]
Ethylbenzene					74-131[c]/70-133[d]
2-Hexanone					51-161[c]/43-172[d]
Methylene chloride					58-142[c]/35-192[d]
4-Methyl-2-pentanone					46-158[c]/50-156[d]
Styrene					67-143[c]/77-133[d]
Tetrachloroethene					68-126[c]/66-128[d]
1,1,2,2-Tetrachloroethane					66-138[c]/46-157[d]
Toluene	79 - 131	≤12	75 - 131	≤14	79-131[c]/75-131[d]
1,1,1-Trichloroethane					57-145[c]/56-144[d]
1,1,2-Trichloroethane					73-123[c]/74-120[d]
Trichloroethene	75 - 119	≤11	71 - 149	≤35	75-119[c]/71-149[d]
Vinyl acetate					47-171[c]/D-245[d]
Vinyl chloride					37-146[c]/41-161[d]
m,p-Xylene					75-131[c]/78-134[d]
o-Xylene					75-134[c]/79-131[d]
Surrogates					
1,4-Bromofluorobenzene	87 - 111	NA	74 - 121	NA	87 - 111[c], 74 - 121[d]
1,2-Dichloroethane-d_4	64 - 136	NA	70 - 121	NA	64 - 136[c], 70 - 121[d]
Toluene-d_8	90 - 110	NA	81 - 117	NA	90 - 110[c], 81 - 117[d]

[a] All limits are based on a certain spike concentration. If this concentration changes, the limits also change. See Tables 6 and 7 of SW8240.

[b] Method specified limits from Chapter One, SW-846 and tables in method. MS/MSD results used for post-analysis, project review; LCS results used to control analytical system.

[c] Aqueous matrix limits.

[d] Solid matrix limits.

LCS	-	Laboratory control sample.
NA	-	Not applicable.
NS	-	Not specified and/or not spiked.
RPD	-	Relative percent difference.

Table 10-8

(Continued)

	Aqueous Matrix Spike		Solid Matrix Spike		LCS Spike
Parameter	Accuracy[a,b] (% Recovery)	Precision (RPD)	Accuracy[a,b] (% Recovery)	Precision (RPD)	Accuracy[a,b,c/d] (% Recovery)
Acid Extractables					
Benzoic acid					0 - 244/0 - 197
4-Chloro-3-methylphenol	59 - 129	≤20	60 - 126	≤20	59 - 129/60 - 126
2-Chlorophenol	62 - 118	≤22	60 - 122	≤32	62 - 118/60 - 122
2,4-Dichlorophenol					60 - 126/64 - 120
2,4-Dimethylphenol					32 - 111/32 - 101
4,6-Dinitro-2-methylphenol					38 - 210[e]/43 - 200[e]
2,4-Dinitrophenol					17 - 240[e]/35 - 225[e]
2-Methylphenol					29 - 133/33 - 132
4-Methylphenol					20 - 135/25 - 135
2-Nitrophenol					61 - 131/62 - 128
4-Nitrophenol	26 - 132	≤21	25 - 132	≤25	26 - 132/25 - 132
Pentachlorophenol	22 - 124	≤26	26 - 120	≤22	22 - 155[e]/26 - 150[e]
Phenol	63 - 129	≤18	53 - 131	≤27	63 - 129/53 - 131
2,4,5-Trichlorophenol					37 - 153/61 - 145
2,4,6-Trichlorophenol					48 - 130/49 - 125
Surrogates					
2-Fluorobiphenyl	43 - 116	NA	54 - 115	NA	43 - 116, 54 - 115
2-Fluorophenol	60 - 124	NA	46 - 119	NA	60 - 124, 46 - 119
Nitrobenzene-d_5	43 - 114	NA	49 - 120	NA	45 - 114, 49 - 120
Phenol-d_5	28 - 122	NA	50 - 122	NA	28 - 122, 50 - 122
p-Terphenyl-d_{14}	66 - 122	NA	53 - 133	NA	66 - 122, 53 - 133
2,4,6-Tribromophenol	26 - 123	NA	19 - 122	NA	26 - 123, 19 - 122

[a] MS/MSD results used for post-analysis, project review; LCS results are used for control of analytical system.
[b] Laboratory derived limits.
[c] Aqueous matrix limits
[d] Solid matrix limits.
[e] Interim tolerance; the laboratory is collecting data to establish tolerance based on historical data.

D	-	Detected.
LCS	-	Laboratory control sample.
NA	-	Not applicable.
NS	-	Not specified.
RPD	-	Relative percent difference.

Table 10-6

Quality Control Acceptance Criteria for Volatile Organic Compounds by Method SW8240A[a]

	Aqueous Matrix Spike		Solid Matrix Spike		LCS Spike
Parameter	Accuracy[b] (% Recovery)	Precision (RPD)	Accuracy[b] (% Recovery)	Precision (RPD)	Accuracy[b] (% Recovery)
Acetone					D-174[c]/D-213[d]
Benzene	77 - 135	≤10	67 - 141	≤15	77-135[c]/67-144[d]
Bromodichloromethane					61-143[c]/61-131[d]
Bromoform					45-145[c]/45-136[d]
Bromomethane					26-171[c]/48-168[d]
2-Butanone (MEK)					D-182[c]/24-174[d]
Carbon disulfide					D-258[c]/49-255[d]
Carbon tetrachloride					70-140[c]/70-140[d]
Chlorobenzene	74 - 124	≤12	67 - 127	≤12	74-124[c]/67-127[d]
Chloroethane					53-147[c]/62-158[d]
2-Chloroethyl vinyl ether					NS
Chloroform					66-130[c]/62-130[d]
Chloromethane					13-155[c]/29-161[d]
Dibromochloromethane					69-123[c]/53-122[d]
1,1-Dichloroethane					59-139[c]/62-134[d]
1,2-Dichloroethane					58-142[c]/64-136[d]
1,1-Dichloroethene	45 - 149	≤29	31 - 172	≤61	45-149[c]/31-172[d]
trans-1,2-Dichloroethene					63-141[c]/56-156[d]
1,2-Dichloropropane					72-130[c]/68-128[d]
trans-1,3-Dichloropropene					58-137[c]/66-118[d]
cis-1,3-Dichloropropene					73-145[c]/67-137[d]
Ethylbenzene					74-131[c]/70-133[d]
2-Hexanone					51-161[c]/43-172[d]
Methylene chloride					58-142[c]/35-192[d]
4-Methyl-2-pentanone					46-158[c]/50-156[d]
Styrene					67-143[c]/77-133[d]
Tetrachloroethene					68-126[c]/66-128[d]
1,1,2,2-Tetrachloroethane					66-138[c]/46-157[d]
Toluene	79 - 131	≤12	75 - 131	≤14	79-131[c]/75-131[d]
1,1,1-Trichloroethane					57-145[c]/56-144[d]
1,1,2-Trichloroethane					73-123[c]/74-120[d]
Trichloroethene	75 - 119	≤11	71 - 149	≤35	75-119[c]/71-149[d]
Vinyl acetate					47-171[c]/D-245[d]
Vinyl chloride					37-146[c]/41-161[d]
m,p-Xylene					75-131[c]/78-134[d]
o-Xylene					75-134[c]/79-131[d]
Surrogates					
1,4-Bromofluorobenzene	87 - 111	NA	74 - 121	NA	87 - 111[c], 74 - 121[d]
1,2-Dichloroethane-d_4	64 - 136	NA	70 - 121	NA	64 - 136[c], 70 - 121[d]
Toluene-d_8	90 - 110	NA	81 - 117	NA	90 - 110[c], 81 - 117[d]

[a] All limits are based on a certain spike concentration. If this concentration changes, the limits also change. See Tables 6 and 7 of SW8240.

[b] Method specified limits from Chapter One, SW-846 and tables in method. MS/MSD results used for post-analysis, project review; LCS results used to control analytical system.

[c] Aqueous matrix limits.

[d] Solid matrix limits.

LCS	-	Laboratory control sample.
NA	-	Not applicable.
NS	-	Not specified and/or not spiked.
RPD	-	Relative percent difference.

Table 10-7

Quality Control Acceptance Criteria for Volatile Organic Compounds by Method SW8260A[a]

Parameter	Aqueous Matrix Spike Accuracy[b] (% Recovery)	Aqueous Matrix Spike Precision (RPD)	Solid Matrix Spike Accuracy[b] (% Recovery)	Solid Matrix Spike Precision (RPD)	LCS Spike Accuracy[b, c/d] (% Recovery)
Acetone					37 - 127/D - 213
Benzene	74 - 132	≤14	67 - 141	≤15	74 - 132/67 - 141
Bromodichloromethane					64 - 132/61 - 131
Bromoform					41 - 135/45 - 136
Bromomethane					46 - 152/48 - 168
2-Butanone (MEK)					D - 160/24 - 174
Carbon disulfide					29 - 223/49 - 255
Carbon tetrachloride					53 - 157/70 - 140
Chlorobenzene	73 - 119	≤13	67 - 127	≤12	73 - 119/67/127
Chloroethane					50 - 154/62 - 158
2-Chloroethyl vinyl ether					NS
Chloroform					64 - 130/62 - 130
Chloromethane					39 - 135/29 - 161
Dibromochloromethane					60 - 122/53 - 122
1,2-Dibromoethane					NS
1,1-Dichloroethane					65 - 131/62 - 134
1,2-Dichloroethane					68 - 138/64 - 136
1,1-Dichloroethene	51 - 133	≤23	31 - 172	≤61	51 - 133/31 - 172
trans-1,2-Dichloroethene					58 - 144/56 - 156
1,2-Dichloropropane					77 - 119/68 - 128
trans-1,3-Dichloropropene					64 - 132/66 - 118
cis-1,3-Dichloropropene					75 - 131/67 - 137
Ethylbenzene					72 - 130/70 - 133
2-Hexanone					58 - 140/43 - 172
Methylene chloride					49 - 151/35 - 195
4-Methyl-2-pentanone					58 - 142/50 - 156
Styrene					73 - 131/77 - 133
Tetrachloroethene					62 - 124/66 - 128
1,1,2,2-Tetrachloroethane					60 - 134/46 - 157
Toluene	81 - 121	≤14	75 - 131	≤14	81 - 121/75 - 131
1,1,1-Trichloroethane					58 - 144/56 - 144
1,1,2-Trichloroethane					68 - 122/74 - 120
Trichloroethene	73 - 117	≤13	71 - 149	≤35	73 - 117/71 - 149
Vinyl acetate					35 - 199/D - 245
Vinyl chloride					27 - 161/41 - 161
Xylenes					74 - 128/78 - 134
					79 - 125/79 - 131
Surrogates					
1,4-Bromofluorobenzene	77 - 117	NA	27 - 145	NA	84 - 114, 80 - 114
1,2-Dichloroethane-d_4	61 - 143	NA	57 - 145	NA	63 - 137, 60 - 142
Toluene-d_8	87 - 113	NA	61 - 135	NA	90 - 110, 91 - 109

[a] All limits are laboratory derived based on historical data.
[b] MS/MSD results used for post-analysis, project review; LCS results used to control analytical system.
[c] Aqueous matrix limits.
[d] Solid matrix limits.

LCS - Laboratory control sample.
NA - Not applicable.
NS - Not specified and/or not spiked.
RPD - Relative percent difference.

Table 10-8

Quality Control Acceptance Criteria for Semivolatile Organic Compounds by Method SW8270B

	Aqueous Matrix Spike		Solid Matrix Spike		LCS Spike
Parameter	Accuracy[a,b] (% Recovery)	Precision (RPD)	Accuracy[a,b] (% Recovery)	Precision (RPD)	Accuracy[a,b,c/d] (% Recovery)
Base/Neutral Extractables					
Acenaphthene	65 - 109	≤16	63 - 111	≤28	65 - 135[e]/63 - 140[e]
Acenaphthylene					73 - 119/70 - 120
Anthracene					67 - 126/63 - 127
Benzo(a)anthracene					70 - 122/65 - 119
Benzo(b)fluoranthene					51 - 125/ 50 - 124
Benzo(k)fluoranthene					64 - 138/59 - 140
Benzo(ghi)perylene					44 - 145/35 - 143
Benzo(a)pyrene					63 - 115/58 - 110
Benzyl alcohol					19 - 180/52 - 149
bis(2-Chloroethoxy)methane					58 - 124/55 - 127
bis(2-Chloroethyl)ether					49 - 120/48 - 124
bis(2-Chloroisopropyl)ether					36 - 142/37 - 137
bis(2-Ethylhexyl)phthalate					57 - 126/53 - 127
4-Bromophenyl phenyl ether					64 - 127/61 - 119
Butyl benzyl phthalate					63 - 135/58 - 134
4-Chloroaniline					55 - 153/59 - 163
2-Chloronaphthalene					60 - 140[e]/60 - 140[e]
4-Chlorophenyl phenyl ether					75 - 135/70 - 128
Chrysene					68 - 120/61 - 121
Dibenzo(a,h)anthracene					49 - 133/40 - 132
Dibenzofuran					67 - 122/67 - 126
Di-n-butylphthalate					61 - 131/59 - 133
1,2-Dichlorobenzene					67 - 123/69 - 124
1,3-Dichlorobenzene					65 - 117/66 - 120
1,4-Dichlorobenzene	55 - 119	≤21	58 - 116	≤35	55 - 119/58 - 116
3,3′-Dichlorobenzidine					60 - 179[e]/50 - 171[e]
Diethyl phthalate					67 - 131/67 - 131
Dimethyl phthalate					70 - 155/68 - 155
2,4-Dinitrotoluene	61 - 123	≤17	61 - 119	≤28	61 - 123/61 - 119
2,6-Dinitrotoluene					67 - 133/69 - 129
Di-n-octylphthalate					56 - 146/48 - 161
Fluoranthene					60 - 124/60 - 122
Fluorene					54 - 140[e]/59 - 145[e]
Hexachlorobenzene					54 - 138/52 - 135
Hexachlorobutadiene					54 - 128/53 - 130
Hexachlorocyclopentadiene					0 - 308/0 - 249
Hexachloroethane					61 - 121/64 - 122
Indeno(1,2,3-cd)pyrene					40 - 134/42 - 126
Isophorone					64 - 136/63 - 141
2-Methylnaphthalene					37 - 150/30 - 168
Naphthalene					65 - 116/65 - 117
2-Nitroaniline					40 - 149/28 - 167
3-Nitroaniline					45 - 157/60 - 152
4-Nitroaniline					25 - 162/42 - 155
Nitrobenzene					52 - 129/51 - 131
n-Nitrosodiphenylamine					33 - 124/42 - 134
n-Nitrosodipropylamine	56- 118	≤17	46 - 120	≤26	58 - 118/46 - 120
Phenanthrene					60 - 145/57 - 140
Pyrene	65 - 115	≤17	61 - 115	≤16	65 - 145[e]/61 - 145[e]
1,2,4-Trichlorobenzene	65 - 121	≤19	62 - 124	≤20	65 - 121/62 - 124

Table 10-8

(Continued)

Parameter	Aqueous Matrix Spike		Solid Matrix Spike		LCS Spike
	Accuracy[a,b] (% Recovery)	Precision (RPD)	Accuracy[a,b] (% Recovery)	Precision (RPD)	Accuracy[a,b,c/d] (% Recovery)
Acid Extractables					
Benzoic acid					0 - 244/0 - 197
4-Chloro-3-methylphenol	59 - 129	≤20	60 - 126	≤20	59 - 129/60 - 126
2-Chlorophenol	62 - 118	≤22	60 - 122	≤32	62 - 118/60 - 122
2,4-Dichlorophenol					60 - 126/64 - 120
2,4-Dimethylphenol					32 - 111/32 - 101
4,6-Dinitro-2-methylphenol					38 - 210[e]/43 - 200[e]
2,4-Dinitrophenol					17 - 240[e]/35 - 225[e]
2-Methylphenol					29 - 133/33 - 132
4-Methylphenol					20 - 135/25 - 135
2-Nitrophenol					61 - 131/62 - 128
4-Nitrophenol	26 - 132	≤21	25 - 132	≤25	26 - 132/25 - 132
Pentachlorophenol	22 - 124	≤26	26 - 120	≤22	22 - 155[e]/26 - 150[e]
Phenol	63 - 129	≤18	53 - 131	≤27	63 - 129/53 - 131
2,4,5-Trichlorophenol					37 - 153/61 - 145
2,4,6-Trichlorophenol					48 - 130/49 - 125
Surrogates					
2-Fluorobiphenyl	43 - 116	NA	54 - 115	NA	43 - 116, 54 - 115
2-Fluorophenol	60 - 124	NA	46 - 119	NA	60 - 124, 46 - 119
Nitrobenzene-d_5	43 - 114	NA	49 - 120	NA	45 - 114, 49 - 120
Phenol-d_5	28 - 122	NA	50 - 122	NA	28 - 122, 50 - 122
p-Terphenyl-d_{14}	66 - 122	NA	53 - 133	NA	66 - 122, 53 - 133
2,4,6-Tribromophenol	26 - 123	NA	19 - 122	NA	26 - 123, 19 - 122

[a] MS/MSD results used for post-analysis, project review; LCS results are used for control of analytical system.
[b] Laboratory derived limits.
[c] Aqueous matrix limits
[d] Solid matrix limits.
[e] Interim tolerance; the laboratory is collecting data to establish tolerance based on historical data.

D - Detected.
LCS - Laboratory control sample.
NA - Not applicable.
NS - Not specified.
RPD - Relative percent difference.

Table 10-9

Quality Control Acceptance Criteria for Method SW8280 Polychlorinated Dioxins and Furans

Analyte	LCS Soil % Recovery	Precision Sample Duplicates RPD
2,3,7,8-TCDD	66-140[a]	20.5[a]
Surrogates:		
C13-2,3,7,8-TCDD	40-120	50
C13-CTCDD	40-120	50
C13-TCDF	40-120	50
C13-PeCDD	40-120	50
C13-PeCDF	40-120	50
C13-HxCDD	40-120	50
C13-HxCDF	40-120	50
C13-HpCDD	40-120	50
C13-HpCDF	40-120	50
C13-OCDD	40-120	50
C13-OCDF	40-120	50

[a] Laboratory derived value.

SW - Methods from SW846, Third Edition.

Table 10-10

Quality Control Acceptance Criteria for Method SW8310

Parameter	Aqueous Matrix Spike Accuracy[a] (% Recovery)	Aqueous Matrix Spike Precision (RPD)	Solid Matrix Spike Accuracy[a] (% Recovery)	Solid Matrix Spike Precision (RPD)	LCS Spike Accuracy[b] (% Recovery)
Acenaphthene	D - 124	≤50	D - 124	≤50	D-124
Acenaphthylene	D - 139	≤50	D - 139	≤50	D-139
Anthracene	D - 126	≤50	D - 126	≤50	D-126
Benzo(a)anthracene					12-135
Benzo(a)pyrene					D-128
Benzo(b)fluoranthene					6-150
Benzo(ghi)perylene					D-116
Benzo(k)fluoranthene	D - 159	≤50	D - 159	≤50	D-159
Chrysene					D-199
Dibenzo(a,h)anthracene	D - 110	≤50	D - 110	≤50	D-110
Fluoranthene					14-123
Fluorene	D - 142	≤50	D - 142	≤50	D-142
Indo(1,2,3-cd)pyrene					D-116
Naphthalene	D - 122	≤50	D - 122	≤50	D-122
Phenanthrene	D - 155	≤50	D - 155	≤50	D-155
Pyrene					D-140
Surrogate					
Terphenyl-d_{14}	50 - 150	NA	50 - 150	NA	NA

[a] Method specified limits.

[b] This criteria will be used until laboratory acceptance limits can be established. Also, the LCS will be spiked at a minimum with the matrix spike analytes.

D - Detected
NA - Not applicable.
RPD - Relative percent difference.
LCS - Laboratory control sample.

Table 10-11

Summary of Calibration and Internal Quality Control for Indicator and Inorganic Parameters

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action*
SW9050	Specific Conductance (Field Test)	Calibration Two-Levels	Daily	95-105%	1) Clean Cell 2) Recalibrate
		Duplicate Analysis	10%	RPD<20	1) Obtain third value 2) Recalibrate 3) Flag data
		Blank	10%	None	Used to assess for contamination
SW9040A/SW9045A	pH (Field Test)	Two Point Calibration	Daily, prior to analysis	± 0.05 pH units	1) Evaluate system 2) Repeat Calibration
		Single Calibration Check	Each sampling point	± 0.05 pH units	1) Evaluate system 2) Repeat calibration
		Duplicate Analysis	10%	RPD <20	1) Obtain third value 2) Recalibrate 3) Flag data
EPA 180.1	Turbidity (Field Test)	Calibrate	Daily	10% of instrument scale	1) Evaluate system 2) Recalibrate
		Duplicate Analysis	10%	RPD <20	1) Obtain third value 2) Recalibrate 3) Flag data
SM403	Alkalinity (Field Test)	Laboratory Control Check Sample	Daily	80-120%	1) Reanalyze 2) Evaluate system 3) Flag data
		Duplicate Analysis	10%	RPD <20	1) Obtain third value 2) Reanalyze LCS 3) Flag data
EPA 170.1	Temperature (Field Test)	Thermometer Calibration	Yearly	±1°C	Replace thermometer
		Duplicate Analyses	10%	NA	Will be used to determine analytical variability
EPA 360.1	Dissolved Oxygen (Field Test)	Single Calibration Check	Daily	Set to theoretical dissolved oxygen value based on temperature	Check membrane for leaks, refill electrode with KCl, and replace membrane. Recalibrate.
		Duplicate analysis	10%	RPD <25%	1) Obtain third value 2) Flag Data

Table 10-11

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
ASTM D2216 (SW846)	Moisture	Balance calibration	Daily	0.0001g	Service balance
		Duplicate analysis	10%	RPD < 30%	Obtain third value; flag data
SW9056	Anions: Cl, F, NO_3, PO_4, SO_4	Multipoint calibration	Daily	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points.
		Laboratory Control Sample (LCS)	One LCS per analytical batch	Recovery within 90-110%	Analyze a second LCS. If recovery is still outside limits, stop identify and correct problem before proceeding.
		Continuing calibration verification (CCV)	Every 10 samples	Within ± 10% of expected value	1) Repeat CCV; 2) Repeat all samples back to the last valid CCV
		Method blank	Daily	Measured concentration for all analytes must be < method reporting limits	1) Investigate sources of contamination; 2) Appropriate corrective action taken and documented; 3) All samples processed with a contaminated blank are to be reanalyzed.[b]
		Matrix spike (MS)	1 MS per every 20 Air Force project samples	Recovery within 80-120%; RPD <20%	1) Reanalyze MS/MSD 2) If still out, and LCS results are within acceptable limits, flag data
SW7196A	Chromium VI	Multipoint calibration	Daily prior to sample analysis	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points.
		Laboratory Control Sample (LCS)	One LCS per analytical batch	Recovery 80-120%	Analyze a second LCS. If recovery is still outside limits, stop identify and correct problem before proceeding.
		Continuing calibration verification (CCV)	Every 10 samples	Recovery 80-120%	1) Repeat CCV; 2) Repeat all samples back to the last valid CCV
		Method Blank	Daily	Measured concentration for analyte must be < method reporting limits	1) Investigate sources of contamination; 2) Appropriate corrective action taken and documented; 3) All samples processed with a contaminated blank are to be reanalyzed.[b]
		Matrix spike (MS)	1 MS per every 20 Air Force project samples	Recovery within 75-125%; RPD <20%	1) Reanalyze MS/MSD 2) If still out, and LCS results are within acceptable limits, flag data

Table 10-11

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
EPA 350.1	Ammonia	Laboratory Multi-Point Calibration	Daily before any other analysis	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points
		Initial calibration verification (ICV)	Daily before first analytical batch is analyzed	85-115% recovery	1) Repeat verification standard analysis 2) If still out, prepare another verification standard and reanalyze. If still out repeat multipoint calibration.
		Laboratory Control Check Sample (LCS/LCSD	One LCS/LCSD pair for each preparation batch and analytical batch	Recovery 80-120% of actual value, RPD ≤ 20%	Accuracy: Analyze a third LCS, if recovery is still out, stop, identify, and correct problem before proceeding. Precision: Analyze a third LCS, if precision is still out, stop, identify, and correct problem before proceeding.
		Method Blank Analysis	One for each preparation batch and each analytical batch	Measured concentration must be <PRDL	1) Analyze system blank. 2) If system blank is contaminated, identify and correct source of problem, then repeat method blank analysis. 3) If system blank is clean, reprepare samples with a new method blank.
		Matrix Spike	1 MS and 1 MSD for every 20 Air Force Project samples	Recovery 80-120%; RPD <20%	Accuracy: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference.
		Continuing calibration verification (CCV)	After every 10th sample and at the end of the batch	Within ±15% of expected value	1) Repeat CCV 2) If still out, identify and correct problem, then reanalyze all samples analyzed since the last valid calibration verification

Table 10-11

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action*
EPA 353.1	Nitrate-Nitrite	Laboratory Multi-Point Calibration	Daily before any other analysis	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points
		Initial calibration verification	Daily before 1st batch of samples analyzed	85-115% recovery	1) Repeat calibration verification. 2) If still out, identify and correct problem, run calibration verification again; if still out repeat multipoint calibration.
		Laboratory Control Check Sample (LCS/LCSD)	One LCS/LCSD pair for each preparation batch and analytical batch	Recovery 85-115% of actual value, RPD ≤ 20%	Accuracy: Analyze a third LCS, if recovery is still out, stop, identify, and correct problem before proceeding. Precision: Analyze a third LCS, if precision is still out, stop, identify, and correct problem before proceeding.
		Method Blank Analysis	One for each analytical batch	Measured concentration must be <PRDL	Identify and correct source of contamination, then repeat method blank analysis.
		Matrix Spike (MS/MSD)	1 MS and 1 MSD for every 20 Air Force Project samples	Recovery 80-120%; RPD <20%	Accuracy: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference.
		Continuing calibration verification (CCV)	After every 10th sample and at the end of the batch	Within ±15% of expected value	1) Repeat CCV 2) If still out, identify and correct problem, then reanalyze all samples analyzed since the last valid calibration verification
		Reduction Check Sample	At start of analytical batch	NO_3-N peak response must equal NO_2-N peak response ±15%	1) Adjust concentration of hydrazine sulfate solution 2) Repeat analysis

Table 10-11

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW9012	Total Cyanide	Laboratory Multi-Point Calibration	Daily before any other analysis	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points
		Initial calibration verification (ICV)	Following multi-point calibration	85-115% recovery	1) Repeat calibration verification. 2) If still out, identify and correct problem, run calibration verification again; if still out repeat multipoint calibration.
		Laboratory Control Check Sample (LCS/LCS Dup)	One LCS/LCSD pair per each preparation and analytical batch	Recovery 75-125% of actual value, RPD ≤ 20%	Accuracy: Analyze a third LCS, if recovery is still out, stop, identify, and correct problem before proceeding. Precision: Analyze a third LCS, if precision is still out, stop, identify, and correct problem before proceeding.
		Method Blank Analysis	One per each preparation and analytical batch	Measured concentration must be <PRDL	1) Perform system blank; 2) If system blank is contaminated, identify and correct source of contamination then repeat method blank analysis 3) If system blank is clean, reprepare samples with a new method blank.
		Matrix Spike	1 MS and 1 MSD for every 20 Air Force Project samples	Recovery 75-125%; RPD <25%	Accuracy: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference.
		Low and high range distilled standards	Each batch of 20 samples	±15 of undistilled standard concentrations	1) Check distillation apparatus for leaks; 2) Check and replace standards if LCS results are within acceptable limits.

Table 10-11

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW9012 (cont'd)	Total Cyanide	Continuing calibration blank (CCB)	Every 10 samples	Measured concentration must be <PRDL	1) Repeat calibration blank 2) If still out, identify and correct problem, then reanalyze all samples analyzed since the last valid calibration blank
		Continuing calibration verification (CCV)	Every 10 samples	Within ±15% of expected value	1) Repeat CCV 2) If still out, identify and correct problem, then reanalyze all samples analyzed since the last valid calibration verification
EPA 351.2	Total Kjeldahl Nitrogen	Multipoint Calibration	Daily before any other analysis	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points
		Laboratory Control Samples (LCS/LCSD)	One LCS/LCSD pair for each preparation batch and each analytical batch	80-120% recovery	Accuracy: Analyze a third LCS, if recovery is still out, stop, identify, and correct problem before proceeding. Precision: Analyze a third LCS, if precision is still out, stop, identify, and correct problem before proceeding.
		Matrix spiked sample (MS/MSD)	1 MS and 1 MSD for every 20 Air Force Project samples	Spike recovery between 80-120%; RPD <20%	Accuracy: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference.
		Method Blank	One for each preparation batch and each analytical batch	Measured concentration of analyte must be <PRDL	1) Investigate sources of contamination; 2) Appropriate corrective action taken and documented; 3) All samples processed with a contaminated blank are to be reanalyzed.[b]

Table 10-11

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
EPA 351.2 (cont'd)	Total Kjeldahl Nitrogen	Continuing calibration verification (CCV)	Every 10th sample and at the end of analytical batch	80-120% recovery	1) Repeat CCV 2) If still out, identify and correct problem, then reanalyze all samples analyzed since the last valid calibration verification
EPA 365.2	Total Phosphate	Multi-point Calibration	Daily before any other analysis	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points
		Initial calibration verification (ICV)	Daily immediately following calibration curve	90-1110% recovery	1) Repeat calibration verification. 2) If still out, identify and correct problem, run calibration verification again; if still out repeat multipoint calibration.
		Laboratory control sample (LCS/LCSD)	Daily after multi-point calibration	Recovery 85-115% of theoretical	Accuracy: Analyze a third LCS, if recovery is still out, stop, identify, and correct problem before proceeding. Precision: Analyze a third LCS, if precision is still out, stop, identify, and correct problem before proceeding.
		Method blank	One per each preparation and analytical batch	Measured concentration must be <PRDL	1) Investigate sources of contamination; 2) Appropriate corrective action taken and documented; 3) All samples processed with a contaminated blank are to be reanalyzed.[b]
		Continuing calibration verification (CCV)	Every 10 samples	Within ±15% of expected value	1) Repeat CCV 2) If still out, identify and correct problem, then reanalyze all samples analyzed since the last valid calibration verification

Table 10-11

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
EPA 365.2 (cont'd)	Total Phosphate	Matrix spiked samples (MS/MSD)	1 MS and 1 MSD for every 20 Air Force Project samples	85-115% recovery	Accuracy: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference.
EPA 160.1	Filterable Residue (TDS)	Balance calibration with Class S weights	Daily at two levels	±0.00199g for 200 mg weight, ±0.0199g for 100 g weight	Recheck calibration Service balance
		Laboratory Control Samples (LCS/LCSD)	One LCS/LCSD pair for each analytical batch	80-120% recovery	Accuracy: Analyze a third LCS, if recovery is still out, stop, identify, and correct problem before proceeding. Precision: Analyze a third LCS, if precision is still out, stop, identify, and correct problem before proceeding.
		Duplicate analysis	10%	RPD < 20%	Obtain third value; flag data
EPA 410.4	Chemical Oxygen Demand	Multipoint calibration	Daily before any other analysis	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points
		Method Blank	One per each preparation and analytical batch	NA	Used to determine amount of available potassium dichromate for reaction
		Laboratory control sample (LCS/LCSD)	One LCS/LCSD pair for each analytical batch	80-120% recovery	Accuracy: Analyze a third LCS, if recovery is still out, stop, identify, and correct problem before proceeding. Precision: Analyze a third LCS, if precision is still out, stop, identify, and correct problem before proceeding.

Table 10-11

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
EPA 410.4 (cont'd)	Chemical Oxygen Demand	Matrix spiked samples (MS/MSD)	1 MS and 1 MSD for every 20 Air Force Project samples	Spike recovery between 80-120%; RPD <20%	Accuracy: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference.
SW9060	Total Organic Carbon (TOC)	Multipoint calibration	Daily before any other analysis	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points
		Laboratory control sample (LCS/LCSD)	One LCS/LCSD pair for each analytical batch	Recovery 80-120%	Accuracy: Analyze a third LCS, if recovery is still out, stop, identify, and correct problem before proceeding. Precision: Analyze a third LCS, if precision is still out, stop, identify, and correct problem before proceeding.
		Continuing calibration verification (CCV)	Every 10th sample	Within ±20% of expected value	1) Repeat CCV 2) If still out, identify and correct problem, then reanalyze all samples analyzed since the last valid calibration verification
		Matrix spiked samples (MS/MSD)	1 MS and 1 MSD for every 20 Air Force Project samples	Spike recovery between 80-120%; RPD <20%	Accuracy: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample 2) If still out and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference.

Table 10-11

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW9060 (cont'd)	Total Organic Carbon (TOC)	Method Blank	One per each preparation and analytical batch	Measured concentration must be <PRDL	1) Investigate sources of contamination; 2) Appropriate corrective action taken and documented; 3) All samples processed with a contaminated blank are to be reanalyzed.[b]
CADHS	Organolead	Multipoint Calibration	Daily prior to analysis	Correlation coefficient ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points
		Laboratory Control sample	1 per batch	Recovery between 75-125%	Accuracy: Analyze a second LCS, if recovery is still out, stop, identify, and correct problem before proceeding.
		Duplicate Samples	10%	None	Used to assess sampling and analytical variability
		Matrix spike	1 MS and 1 MSD for every 20 Air Force Project samples	Recovery between 75-125%; RPD ≤20%	Accuracy: 1) Reanalyze spiked sample 2) If still out and LCS results are within acceptable limits, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample 2) If still out and LCS results are within acceptable limits, flag MS/MSD results as matrix interference.
		Method blank	One per each preparation and analytical batch	Measured concentration must be <PRDL	1) Investigate sources of contamination; 2) Appropriate corrective action taken and documented; 3) All samples processed with a contaminated blank are to be reanalyzed.

[a] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory as specified in the IRP Handbook.
[b] Reanalysis at no cost to Air Force.

NA - Not applicable.

Table 10-12

Summary of Calibration and Internal Quality Control Procedures for SW6010A

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW6010A	Trace ICP Metals Refer to: SW846-3005A[a] SW846-3050A[a] SW6010A[a] IRP Handbook[b]	Two point mixed calibration standard as per SW846-6010	Daily, prior to sample analysis	NA	NA
		Initial calibration verification (ICV) Reanalysis of upscale calibration standard	Daily immediately following initial calibration	Within ±5% of expected value	Repeat initial calibration verification; if still out, repeat calibration.
		Continuing calibration verification (CCV), single point	Following interference check standards, after every 10 samples, and at end of the batch	Within ±10% of expected value	Identify and correct problem, then reanalyze all samples analyzed since last valid calibration verification.
		Calibration blank (undigested reagent blank)	Prior to start of batch and after every 10 samples	Measured concentrations must be < PRDL or ± 3 standard deviations of the mean value of the calibration blank, whichever is less	1) Reanalyze calibration blank. 2) If blank is still contaminated, identify and correct source of contamination, then repeat calibration blank analysis. 3) If still out, reanalyze all samples since last valid calibration blank
		Second source Laboratory Control Sample (LCS/LCSD) with all analytes. For soil samples a commercially prepared solid is also prepared and analyzed.	One LCS/LCSD for each digestion and analysis batch	80-120% recovery	Accuracy: 1) Reanalyze LCS/LCSD. If recoveries for same analytes are still out, stop, identify, and correct problem before proceeding. 2) If LCS/LCSD recoveries are still out, reanalyze associated samples with failed LCS/LCSD. Precision: 1) Reanalyze LCS/LCSD. If recoveries for same analytes are still out, stop, identify, and correct problem before proceeding.
		Interference check sample	Daily at beginning and end of analytical run; or twice during every 8-hour work shift	Within ±20% of expected value for instrument check standard elements	Correct source of interference and rerun sample. If still out, contact Lab Manager
		Method blank (digested reagent blank)	Once per batch	Measured concentrations for all analytes must be < PRDL unless the lowest concentration of the analyte in the samples is >20 times the blank concentration	1) Reanalyze method blank 2) If method blank is still contaminated, identify and correct source of contamination. 3) All samples processed with a contaminated blank are to be redigested and reanalyzed at no cost to the Air Force

Table 10-12

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW6010A (cont'd)	Trace ICP Metals	Matrix spike (MS)/matrix spike duplicate (MSD) (portion of sample is spiked prior to digestion)	1 MS and 1 MSD per every 20 Air Force project samples	75-125% recovery; RPD = ±20% waters RPD = ±35% for soils	Accuracy: 1) If there is an assignable cause, and the LCS/LCSD are within acceptable limits, flag data. 2) If there is no assignable cause, run analytical spike. 3) If analytical spike fails, and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference. 4) Contact CSC and project QA officer to determine is special measures should be performed in an attempt to resolve matrix interferences. Precision: 1) If there is an assignable cause, and the LCS/LCSD are within acceptable limits, flag data. 2) If there is no assignable cause, run analytical spike.
		MDL Study	Once per year	Detection limits established shall not exceed those in Table 2-1 of IRP Handbook[b]	Detection limits which exceed established criteria shall be submitted to the Air Force for approval prior to analysis of any project samples[b]
		Serial Dilution, fivefold dilution of sample (1 + 4)	Once per analytical batch if concentrations >5x PDRL	10% of undiluted value	Run an analytical spike.
		Analytical Spike	When serial dilution fails or when MS/MSD fails with no assignable cause	75-125% recovery	1. Flag data. 2. Contact CSC.
		Linearity Check	Quarterly	Highest point at which the recovery of the standard is within 5% of the expected value	No data will be reported for any element that exceeds the upper limit of the linear range by more than 5%

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.
[b] IRP Handbook, May 1991.
[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as specified in the IRP Handbook.

NA - Not Applicable.

Table 10-13

Summary of Calibration and Internal Quality Control Procedures for Atomic Absorption Methods

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW7060A SW7131A SW7470 SW7421 SW7041 SW7741	Metals (AA) - As, Cd, Hg, Pb, Sb, Se Refer to: SW846-7000A[a] SW846-3005A[a] SW846-3050A[a] IRP Handbook[b]	Multipoint calibration (minimum of three standards and a reagent blank - For Hg - 5 standards and a reagent blank)	Daily before any other analysis	Correlation coefficient ≥0.995	Identify and reanalyze outlying point(s); recalculate curve using repeated points
		Initial Calibration Blank (ICB)	After initial calibration verification	< PDRL	1) Reanalyze calibration blank 2) If still out, recalibrate
		Continuing calibration blank (CCB)	Following each continuing calibration verification and at end of analytical batch	< PDRL	1) Reanalyze calibration blank 2) If still out, correct the problem and reanalyze all samples since last valid calibration blank
		Initial calibration verification (ICV)	Daily before sample batch	Within ±10% of expected value	1. Repeat calibration verification. 2. If still out, identify and correct problem, then reanalyze all samples analyzed since last valid calibration verification.
		Continuing calibration verification (CCV)	After 10th sample and at the end of the analytical batch	80-120% of true value	1. Repeat calibration verification. 2. If still out, identify and correct problem, then reanalyze all samples analyzed since last valid calibration verification.
		Method Blank (digested reagent blank)	Once for each preparation and analytical batch	Measured concentrations must be < PRDL	1) Reanalyze method blank. 2) If method blank is still contaminated, identify and correct source of contamination. 3) All samples processed with a contaminated blank are to be redigested and reanalyzed at no cost to the Air Force
		Digested, liquid, second source Laboratory Control Sample (LCS/LCSD) for all analytes	One LCS/LCSD for each digestion and analytical batch	75-125% recovery	Accuracy: 1) Reanalyze LCS/LCSD. If recoveries for same analytes are still out, stop, identify, and correct problem before proceeding. 2) If LCS/LCSD recoveries are still out, reanalyze associated samples with failed LCS/LCSD. Precision: 1) Reanalyze LCS/LCSD. If recoveries for same analytes are still out, stop, identify, and correct problem before proceeding.

Table 10-13

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW7060A SW7131A SW7470 SW7421 SW7041 SW7741 (cont'd)		Matrix spike (MS)/matrix spike duplicate (MSD) (portion of sample is spiked prior to digestion)	1 MS and 1 MSD per every 20 Air Force project samples	75-125% recovery, RPD = ±20%	Accuracy: 1) If there is an assignable cause, and the LCS/LCSD are within acceptable limits, flag data. 2) If there is no assignable cause, run analytical spike. 3) If analytical spike fails, and LCS/LCSD results are within acceptable limits, flag MS/MSD results as matrix interference. 4) Contact CSC and project QA officer to determine is special measures should be performed in an attempt to resolve matrix interferences. Precision: 1) If there is an assignable cause, and the LCS/LCSD are within acceptable limits, flag data. 2) If there is no assignable cause, run analytical spike.
		Serial Dilution, a five-fold (1+4) dilution of a sample	Once per analytical batch	Within 10% agreement with undiluted value if undiluted sample concentration is >25 times the MDL	Perform analytical spike.
		Analytical Spike	As corrective action for serial dilution or matrix spike	85-115% recovery	Perform method of standard additions.
		Method of Standard Additions (MSA)	As corrective action when analytical spike fails	Correlation coefficient ≤0.995; slope ≤20% difference compared to calibration curve	1. Reanalyze samples by MSA. 2. If still out, flag data.
		MDL Study	Once per year	Detection limits established shall not exceed those in Table 2-1 of IRP Handbook[b]	Detection limits which exceed established criteria shall be submitted to the Air Force for approval prior to analysis of any project samples [b]

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.
[b] IRP Handbook, May 1991.
[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as specified in the IRP Handbook.

NA - Not Applicable.

Table 10-14

Summary of Calibration and Internal Quality Control Procedures for SW8015ME

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8015ME	Total Petroleum Hydrocarbons, Extractable	Five-Point calibration (for all analytes)	Biannually or when daily initial calibration verification fails to meet acceptance criteria	a) For single responses analytes calibration curve r ≥0.995 b) For patterns, use average response factor RSD <20%,	1) Recalculate results 2) Adjust Instrument 3) Repeat calibration
	Refer to: SW846-3500A[a] SW846-5030B[a] SW846-8000A[a] IRP Handbook[b]	Initial calibration verification (ICV)	Daily, before sample analysis	Response for any analyte within ±15% of predicted response.	1) Repeat calibration verification 2) If still out, identify and correct problem 3) Reanalyze verification standard 4) If still out, perform new multipoint calibration
		Retention time (RT) windows calculated for each analyte	One 72-hour study performed on each GC column and whenever a new column is installed	See Method 8000A	1) Perform maintenance 2) Repeat test
		Mid-level second source Laboratory Control Sample (LCS/LCSD)	One LCS/LCSD pair for each extraction batch and each analytical batch	Within laboratory limits see Table 10-3	1) If recovery of diesel is out in either or both the LCS and LCSD, check the initial calibration verification. If the initial calibration verification is acceptable, contact CSC for decision to proceed or re-extract. If unacceptable, recalibrate and rerun samples.
		Continuing calibration verification	Prior to every 10 samples and at end of each analtyical batch	Response for any analyte within ±15% of predicted response.	1) Repeat calibration verification 2) If still out, identify and correct problem, then reanalyze all samples analyzed since last valid calibration verification
		Matrix spike (MS/MSD); level of spike should be the larger of the following two criteria: 1) the regulatory concentration limit (if applicable), or 2) concentration of the CCV	1 MS and 1 MSD per every 20 Air Force project samples	QC Acceptance Criteria Table 10-3	1) If either MS or MSD is outside of either accuracy or precision tolerances and LCS/LCSD results are acceptable, then flag MS/MSD results. 2) Contact CSC to determine if special measures should be performed to resolve matrix interferences.

Table 10-14

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8015ME (cont'd)	Total Petroleum Hydrocarbons, Extractable	Surrogate standard spike	Every sample, spike, standard, and reagent blank	Limits determined as per Table 10-3 (limits are to be updated annually on a matrix-by-matrix basis)	For method blanks and LCS: Reanalyze calibration verification sample. If surrogate recovery is within tolerances, reextract and reanalyze samples in the associated preparation batch if the extractions can be completed within holding times. If surrogate recovery is outside tolerances, correct instrument problem and reanalyze extracts. For field samples: Contact CSC for options which may include the following if there is no assignable cause: Reextract and reanalyze if enough sample is available and still within hold time. If additional samples is unavailable or sample is out of hold time, then reanalyze extract and flag results.
		Method blank	Each extraction batch and each analytical batch	Measured concentrations for all analytes must be <PRDL	1) If contamination is > than PRDL, then the concentration of the affected analytes in the associated samples must be >10 times the concentration in the method blank. 2) Analyze system blank. 3) If system blank is contaminated, identify and correct source of contaminated, then repeat method blank analysis. 4) If system blank is clean reanalyze method blank. 5) If extracted contamination is indicated, contact CSC. Sample results associated with method blank contamination are to be re-extracted/ repurged and re-analyzed at no cost to the Air Force.

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.
[b] IRP Handbook, September 1993.
[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as is specified in the IRP Handbook.

Table 10-15

Summary of Calibration and Internal Quality Control Procedures for SW8015MP

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8015MP	Total Petroleum Hydrocarbons, Purgeable Refer to: SW846-3500A[a] SW846-5030A[a] SW846-8000A[a] IRP Handbook[b]	Five-Point calibration (for all analytes)	Annually or when daily initial calibration verification fails to meet acceptance criteria	a) For single response analytes (BTEX), r ≥ 0.995 b) For gasoline, <20% RSD	Identify and repeat outlying point(s); recalculate curve using repaeted points
		Initial daily calibration factor verification (ICV)	At the beginning of each analytical batch	Response for any analyte within ±20% of predicted response.	1) Repeat calibration verification 2) If still out, identify and correct problem 3) Reanalyze verification standard 4) If still out, perform new multipoint calibration
		Retention time (RT) windows calculated for each analyte	One 72-hour study performed on each GC column and whenever a new column is installed	See Method 8000A	1) Perform maintenance 2) Repeat test
		Mid-level second source Laboratory Control Sample (LCS) see Table 10-3 for list of analytes spiked	One LCS/LCSD pair per analytical batch	Within laboratory limits see Table 10-3	1) If recoveries for the same analytes are out in both the LCS and LCSD, stop and correct problem 2) If one or more analytes are out in either the LCS or LCSD, analyze a third LCS. If the recoveries for the third LCS are acceptable, proceed with the analyses 3) If the same analytes are out, stop and correct instrument problem.
		Continuing calibration verification (CCV)	After every 10 samples and at the end of each analytical batch	Recovery for all FID- active analytes must be within ±20% of expected result	1) Repeat calibration check 2) If still out, identify and correct problem, then rerun and note any changes
		Matrix spike (MS) and matrix spike duplicate (MSD); level of spike should be the larger of the following two criteria: 1) the regulatory concentration limit (if applicable), or 2) concentration of the ongoing calibration check	1 MS and 1 MSD per every 20 Air Force project samples	QC Acceptance Criteria Table 10-3	Accuracy: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within tolerances, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within tolerances, flag MS/MSD results as matrix interference.
		Surrogate standard spike	Every sample, spike, standard, and reagent blank	Limits determined as per SW846-8000 (limits are to be updated annually on a matrix-by-matrix basis); see Table 10-3	1) Repeat analysis. 2) If still out, flag result and document in report that step 1 was performed.

Table 10-15

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8015MP (cont'd)	Total Petroleum Hydrocarbons, Purgeable	Method blank	One per analytical batch	No analytes detected above method reporting limits	1) Repeat method blank analysis. 2) If still contaminated, identify and correct source of contamination, then repeat method blank analysis. 3) If still contaminated, but below project- specific level, flag blank 4) Sample results associated with method blank contamination at ≤3 times the reporting limits (5 times for common laboratory contaminants) are to be flagged

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.

[b] IRP Handbook, September 1993.

[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as is specified in the IRP Handbook.

[d] Methylene chloride, acetone, toluene, and 2-butanone are considered to be common laboratory contaminants. Therefore, corrective action is not required when their presence is detected in laboratory blanks at less than three times the noted detection limit, nor is it required that second-column confirmation be performed for the sole purpose of confirming the presence of any one of these four analytes.

Table 10-16

Summary of Calibration and Internal Quality Control Procedures for SW8081

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8081	Organochlorine pesticides, and PCBs Refer to: SW846-3500A[a] SW846-3600B[a] SW846-8000A[a] IRP Handbook[b]	Multi-point calibration (for all analytes) ICAL	Biannually or when daily initial calibration verification fails to meet acceptance criteria	Correlation coefficient or coefficient of determination ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points
		Calibration verification (CV) using one or more calibration standards	At the beginning, following every 10th sample and at the end of each analytical batch	Primary Column: Response for any analyte within ±15% of predicted response Secondary Column: ±20% of nominal concentration	1) Repeat calibration verification 2) If still out, identify and correct problem, repeat calibration verification again; if still out, repeat multipoint calibration. Reanalyze all samples analyzed since last valid calibration verification.
		Retention time (RT) windows calculated for each analyte	One 72-hour study performed on each GC column and whenever a new column is installed	Must be ±3 times the standard deviation of the absolute retention times or ±1.5% of the absolute retention time	1) Identify and correct source of problem 2) Repeat study
		Mid-level second source Laboratory Control Sample (LCS/LCSD)	One LCS/LCSD pair with each extraction batch and each analytical batch	Recovery for all analytes within QC acceptance criteria Table 10-4	1) If recoveries for the same analytes are out in both the LCS and LCSD, check recoveries for CV performed immediately before and after the LCS/LCSD. If recoveries for the CVs are within tolerances, an extraction problem is suspected; contact the CSC for a decision whether to proceed or re-extract. If the samples must be analyzed without re-extraction, flag the sample results. 2) If one or more analytes are out in either the LCS or LCSD, check recoveries for CV performed immediately before and after the LCS/LCSD. If recoveries for the CVs are within tolerances, proceed with the analyses. If one or both the recoveries are outside tolerances, correct instrument problem before proceeding.
		Breakdown check (Endrin and DDT)	Daily prior to analysis of samples and as needed during analysis	Degradation ≤20% (each)	1) Identify and correct source of problem 2) Repeat DDT and Endrin breakdown evaluation analysis

Table 10-16

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8081 (Cont'd)	Organochlorine pesticides, and PCBs	Matrix spike (MS) and matrix spike duplicate (MSD)	1 MS and 1 MSD per every 20 Air Force project samples	QC Acceptance Criteria Table 10-4	1) If either MS or MSD is outside of either accuracy or precision tolerances and LCS/LCSD results are acceptable, then flag MS/MSD results. 2) Contact CSC to determine if special measures should be performed to resolve matrix interferences.
		Two surrogate standards spiked into each sample. Dibutylchlorendate (DBC) is primary surrogate	Every sample spike, standard, and method blank	All surrogates must be within tolerance for method blanks and the LCS/LCSD (see Table 10-4 for limits). DBC is an exception when GPC is used for cleanup	For method blanks and LCS: Reanalyze calibration verification sample. If surrogate recovery is within tolerances, reextract and reanalyze samples in the associated preparation batch if the extractions can be completed within holding times. If surrogate recovery is outside tolerances, correct instrument problem and reanalyze extracts. For field samples: Contact CSC for options which may include the following if there is no assignable cause: Reextract and reanalyze if enough sample is available and still within hold time. If additional samples is unavailable or sample is out of hold time, then reanalyze extract and flag results.
		Method blank	One per extraction batch and each analytical batch	< Method reporting limits	1) If contamination is >PRDL, then the concentration of the affected analyte in the associated samples must be > 10 times the concentration in the method blank. 2) If system blank is contaminated, identify and correct source of contamination, then repeat method blank analysis, and proceed with analysis. 3) If system blank is clean, reprepare samples with a new method blank. Contact CSC. 4) Flag data.
		System blank - reagent grade hexane analyzed as a sample	Before each calibration and calibration verification check standard	Measured concentrations for all analytes must be <PRDL	1) Repeat system blank analysis 2) Identify and correct source of contamination

Table 10-16

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8081 (Cont'd)	Organochlorine pesticides, and PCBs	MDL study	Once per year	Detection limits established shall not exceed those in Table 2-1 of IRP Handbook[b]	Detection limits that exceed estab-lished criteria shall be submitted to the Air Force for approval prior to the analysis of any project samples[b]

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.
[b] IRP Handbook, September 1993
[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as specified in the IRP Handbook.

Table 10-17

Summary of Calibration and Internal Quality Control Procedures for SW8151

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8151	Chlorinated Herbicides	Initial Calibration, (five-point calibration for all analytes) ICAL	Biannually or when daily caibration check fails to meet acceptance criteria	Correlation coefficient or coefficient of determination ≥0.995	Identify and repeat outlying point(s); recalculate curve using repeated points.
	Refer to: SW846-3500A [a] SW846-3600B [a] SW846-8000A [a] SW846-8151 [a] IRP Handbook [b]	Calibration verification using one or more calibration standards	At the beginning, following every 10th sample, and at the end of each analytical sequence	Response for any analyte within ±15% of true value for primarycolumn and ±20% for secondary column	1) Repeat calibration verification. 2) If still out, identify and correct, then reanalyze all samples since the last valid calibration verification.
		Retention time (RT) windows calculated for each standard	One 72-hour study performed on each HPLC column and whenever a new column is installed	Must be ±3 times the standard deviation of the absolute retention times or ±1.5% of the absolute retention time	1) Perform maintenance 2) Repeat study
		Mid-level second source Laboratory Control Sample (LCS/LCSD)	One LCS/LCSD pair with each extraction batch and each analytical batch	Laboratory acceptance limits shown in Table 10-5	1) If recoveries for the same analytes are out in both the LCS and LCSD, check recoveries for CV performed immediately before and after the LCS/LCSD. If recoveries for the CVs are within tolerances, an extraction problem is suspected; contact the CSC for a decision whether to proceed or re-extract. If the samples must be analyzed without re-extraction, flag the sample results. 2) If one or more analytes are out in either the LCS or LCSD, check recoveries for CV performed immediately before and after the LCS/LCSD. If recoveries for the CVs are within tolerances, proceed with the analyses. If one or both the recoveries are outside tolerances, correct instrument problem before proceeding.

Table 10-17

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8151 (cont'd)	Chlorinated Herbicides	Matrix spike (MS) and matrix spike duplicate (MSD)	1 MS and 1 MSD per every 20 Air Force project samples	QC Acceptance Criteria Table 10-5	Accuracy: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within tolerances, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within criteria, flag MS/MSD results as matrix interference
		Surrogate standard spike	Every sample spike, standard, and reagent blank	QC limits given Table 10-5 (limits are to be updated annually on a matrix-by-matrix basis)	For method blanks and LCS: Reanalyze calibration verification sample. If surrogate recovery is within tolerances, reextract and reanalyze samples in the associated preparation batch if the extractions can be completed within holding times. If surrogate recovery is outside tolerances, correct instrument problem and reanalyze extracts. For field samples: Contact CSC for options which may include the following if there is no assignable cause: Reextract and reanalyze if enough sample is available and still within hold time. If additional samples is unavailable or sample is out of hold time, then reanalyze extract and flag results.
		Method blank	One per extraction batch and each analytical batch	Measured concentrations for all analytes must be <PRDL	1) If contamination is >PRDL, then the concentration of the affected analyte in the associated samples must be >10 times the concentration in the method blank. 2) If system blank is contaminated, identify and correct source of contamination, then repeat method blank analysis, and proceed with analysis. 3) If system blank is clean, reprepare samples with a new method blank. Contact CSC. 4) Flag data.

Table 10-17

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8151 (cont'd)	Chlorinated Herbicides	System Blank (reagent-grade hexane analyzed as a sample)	Minimum of one per analysis sequence	Measured concentrations for all analytes must be <PRDL	1) Repeat blank analysis. 2) identify and correct source of contamination.
		MDL study	Once per year	See MDL table	Detection limits that exceed estab-lished criteria shall be submitted to the Air Force for approval prior to the analysis of any project samples[b]

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.

[b] IRP Handbook, May 1991.

[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as specified in the IRP Handbook.

NA - Not applicable.

Table 10-18

Summary of Calibration and Internal Quality Control Procedures for SW8240A

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8240A	Volatile Organic Compounds Refer to SW846-8240A[a] IRP Handbook[b]	Check of mass spectral ion intensities using BFB	Analyzed at the beginning of each analytical sequence and at the beginning of every subsequent 12 hours	Established criteria in Table 3 of SW846-8240[a] See Table 8-12	1) Reanalyze BFB. 2) Adjust MS tune until analysis of BFB passes specifications. 3) Do not proceed until acceptance criteria are met.
		Five-point calibration (for all analytes)	Biannually or when daily calibration check fails to meet acceptance criteria	1) SPCCs[d] average RF ≥0.30[e] 2) RSD <30% for CCC[f] RFs	1) Repeat after corrective action if either criterion is not met.
		Calibration verification (CV)	Analyzed at the beginning of each analytical sequence and at the beginning of every subsequent 12 hours	1) SPCCs[d] average RF ≥0.30[e] 2) CCC[f] percent difference <25% from average response factors calculated following initial calibration	1) Repeat calibration verification. 2) If still out, identify and correct, run calibration verification again; if still out, a new five-point calibration must be generated.
		Internal Standards' (IS) Retention Time (RT) and responses check from calibration check standard	All samples, standards, and method blanks	RT ±30 seconds at EICP[g] within -50% to + 100% of last calibration verification (12 hrs) for each IS compound	1) Inspect MS or GC for malfunctions. 2) Take appropriate corrective actions. 3) Mandatory reanalysis of samples analyzed while system was malfunctioning.
		Method Blank	One per analytical batch	Measured concentrations for all analytes nust be <PRDL, except for common lab contaminants[h]	1) Repeat method blank. 2) If still contaminated, identify and correct source of contamination, then repeat method blank analysis. 3) If still contaminated but below project specified level, flag blank data. 4) Sample results associated with method blank contamination >

Table 10-18

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]
SW8240A (cont'd)	Volatile Organic Compounds	Mid-level second source laboratory control sample (LCS) see Section 10.0 QAPP tables for list of analytes spiked	One LCS/LCSD pair per analytical batch	Recovery for all analytes within QC Acceptance Criteria Table 10-6	Accuracy: 1) If recoveries for the same analytes are out for both the LCS and LCSD, stop and correct problem. 2) If one or more analytes is out in either the LCS or LCSD, analyze a third LCS. If the recoveries for the third LCS are acceptable proceed with the analyses. If the same analytes are out, stop and correct instrument problem. Precision: 1) Demonstrate acceptable RPDs for analytes failed by analyzing a third LCS. If the RPDs between the third LCS and LCS or LCSD are acceptable proceed with analyses. If RPDs are still not acceptable, stop and correct instrument problem.
		Matrix spike (MS) and matrix spike duplicate (MSD); level of spike should be the larger of the following two criteria: 1) the regulatory concentration limit (if applicable, otherwise 20 µg/L), or 2) the concentration of the daily calibration check.	1 MS and 1 MSD per every 20 Air Force project samples.	QC Acceptance Criteria Table 10-6	Accuracy: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within tolerances, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within criteria, flag MS/MSD results as matrix interference
		Surrogate standards spike	Every sample, spike, standard, and reagent blank	See Table 10-6 (limits are to be updated annually on a matrix-by-matrix basis).	If all CV, LCS/LCSD, and method blank surrogates meet tolerance, flag sample result

Table 10-18

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8240A (cont'd)	Volatile Organic Compounds	MDL study	Once per year	Detection limit established shall not exceed those in Table 2-1 of IRP Handbook[b]	Detection limits that exceed established criteria shall be submitted to the Air Force for approval prior to the analysis of any project samples[b].

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.

[b] IRP Handbook, May 1991.

[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as specified in the IRP Handbook.

[d] SPCC = System Performance Check Compounds.

[e] SPCC = for bromoform is ≥0.25.

[f] CCC = Calibration Check Compounds.

[g] EICP = Extracted Ion Current Profile.

[h] Methylene chloride, acetone, toluene, and 2-butanone are considered to be common laboratory contaminants. Therefore, corrective action is not required when their presence is detected in laboratory blanks at less then three times the noted reporting limits.

NA - Not applicable.

Table 10-19

Summary of Calibration and Internal Quality Control Procedures for SW8260A

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8260A	Volatile Organic Compounds Refer to SW846-8260A[a] IRP Handbook[b]	Check of mass spectral ion intensities using BFB	Initially, prior to calibration, again prior to sample analyses and once per every 12-hour shift	Established criteria in Table 3 of SW846-8260[a] See Table 8-12	1) Reanalyze BFB. 2) Adjust MS tune until analysis of BFB passes specifications. 3) Do not proceed until acceptance criteria are met.
		Five-point calibration (for all analytes) ICAL	Annually or when daily caibration check fails to meet acceptance criteria	1) SPCCs[d] average RF ≥0.30[e] 2) RSD <30% for CCC[f] RFs	1) Repeat after corrective action if either criterion is not met.
		Calibration verification (CV)	Once per each 12 hours, prior to sample analysis (criteria for these checks must be met prior to sample analysis) (prepare calibration standards weekly)	1) SPCCs[d] average RF ≥0.30[e] 2) CCC[f] percent difference <20% relative to ICAL	1) Repeat calibration verification. 2) If still out, identify and correct, run calibration verification again; if still out, a new five-point calibration must be generated.
		Internal Standards' (IS) Retention Time (RT) (three internal standards, added to each sample, standard, and method blank	All samples, standards, and method blanks	Retention Times: Must be <30 second change from daily calibration verification Internal Standards: EICP[g] area must be within a factor of 2 from daily calibration verification (12 hrs) for each IS compound	1) Inspect MS or GC for malfunctions. 2) Take appropriate corrective actions. 3) Mandatory reanalysis of samples analyzed while system was malfunctioning.
		Surrogate standards spike	Every sample, spike, standard, and reagent blank	QC Acceptance Criteria Table 10-5 (limits are to be updated annually on a matrix-by- matrix basis).	QC samples: 1) Reanalyze if still outside QC tolerances. 2) In still out, identify and correct problem. Samples: 1) Reanalyze if outside sample tolerances. 2) If still out, flag result .

Table 10-19

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8260A (cont'd)	Volatile Organic Compounds	Mid-level second source laboratory control sample (LCS) see Section 10.0 QAPP tables for list of analytes spiked	One LCS/LCSD pair per analytical batch	Recovery for all analytes within QC Acceptance Criteria Table 10-7	Accuracy: 1) If recoveries for the same analytes are out for both the LCS and LCSD, stop and correct problem. 2) If one or more analytes is out in either the LCS or LCSD, analyze a third LCS. If the recoveries for the third LCS are acceptable proceed with the analyses. If the same analytes are out, stop and correct instrument problem. Precision: 1) Demonstrate acceptable RPDs for analytes failed by analyzing a third LCS. If the RPDs between the third LCS and LCS or LCSD are acceptable proceed with analyses. If RPDs are still not acceptable, stop and correct instrument problem.
		Matrix spike (MS) and matrix spike duplicate (MSD); level of spike should be the larger of the following two criteria: 1) the regulatory concentration limit (if applicable, otherwise 20 µg/L), or 2) the concentration of the daily calibration check.	1 MS and 1 MSD per every 20 Air Force project samples.	QC Acceptance Criteria Table 10-7	Accuracy: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within tolerances, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within criteria, flag MS/MSD results as matrix interference
		Method blank	Once per analytical batch	Measured concentration for all analytes <PRDL	1) Repeat method blank. 2) If still contaminated, identify and correct source of contamination, then repeat method blank analysis. 3) If still contaminated but below project specified level, flag blank data. 4) Sample results associated with method blank contamination > method reporting limit (3 times for common laboratory contamination[b]) are to be flagged.

Table 10-19

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8260A (cont'd)	Volatile Organic Compounds	MDL study	Once per year	Detection limit established shall not exceed those in Table 2-1 of IRP Handbook[b]	Detection limits that exceed established criteria shall be submitted to the Air Force for approval prior to the analysis of any project samples[b].

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.
[b] IRP Handbook, May 1991.
[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as specified in the IRP Handbook.
[d] SPCC = System Performance Check Compounds.
[e] SPCC = for bromoform is ≥0.25.
[f] CCC = Calibration Check Compounds.
[g] EICP = Extracted Ion Current Profile.
[h] Methylene chloride, acetone, toluene, and 2-butanone are considered to be common laboratory contaminants. Therefore, corrective action is not required when their presence is detected in laboratory blanks at less then three times the noted reporting limits.

NA - Not applicable.

Table 10-20

Summary of Calibration and Internal Quality Control Procedures for SW8270B

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8270B	Semivolatile Organic Compounds Refer to: SW846-3500A[a] SW846-3600B[a] SW846-8270B[a] IRP Handbook[b]	Check of mass spectral ion intensities using DFTPP, (4,4'-DDT, pentachlorophenol and benzidine also to be included in tuning standard to verify injection port inertness and GC column performance)	At the beginning of each analytical sequenceand at the beginning of each sebsequent 12-hour period	1) Ion abundance criteria in Table 8-13 2) Pentachlorophenol and benzidine must each have 7000 area counts with a trailing factor <3 at 10% peak height. Degradation of DDT to DDE and DDD should not exceed 20%	If ion abundance criteria are not met: 1) Reanalyze DFTPP. 2) Adjust MS tune until analysis of DFTPP passes specifications. If column performance and injection port inertness are not met: 1) Remove first 6 to 12 inches of column. 2) Clean or replace injection port liner and or glass wool. Do not proceed until acceptance criteria are met>
		GC/MS Mass Scale Calibration using PFTBA	Every 24 hours at the beginning of each analytical sequence	Masses must be assigned correctly to: m/z 69, 119, 131, 219, 314, 414, 464, and 502	If masses incorrectly assigned: 1) Adjust MS tune. 2) Reanalyze PFTBA
		Five-point calibration for all commercially available analytes	Biannually or when daily calibration check fails to meet acceptance criteria	1) %RSD <30% for each individual CCC[e] 2) SPCCs[d] average RF ≥0.050	Repeat concentrations not meeting acceptance criteria.
		Calibration verification (CV)	At the beginning of each analytical sequenceand at the beginning of each sebsequent 12-hour period	1) SPCCs[d] average RF≥0.050 2) CCC[e] percent difference <30% 3) Retention times must be <30 sec. change from last CV 4) Internal standards- extracted ion area must be within factor of 2 from last CV	1) Reanalyze calibration verification standard. 2) If still out, identify, and correct problem. 3) Reanalyze verification standard. 4) If source of problem cannot be determined, a new five-point calibration <u>must</u> be generated.
		Internal Standards' (IS) Retention Time (RT) and Responses check from calibration check standard.	Every sample, spike, standard, and blank.	1) Retention times must be <30 sec. change from last CV 2) Internal standards- extracted ion area must be within factor of 2 from last daily CV	1) Reanalyze sample out of specification. 2) If still out, identify, and correct problem. 3) Reanalyze affected samples.

Table 10-20

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8270B (cont'd)	Semivolatile Organic Compounds	Mid-level second source extracted Laboratory Control Sample (LCS) see Section 10.0 tables for list of analytes spiked	One LCS/LCSD pair per analytical batch	Recovery for all analytes within QC Acceptance Criteria Table 10-8	Accuracy: 1) If the same analytes are out for both the LCS and LCSD, analyze a third previously acceptable LCS. If the third LCS is acceptable, contact CSC for decision to proceed or re-extract. If samples must be analyzed without re-extraction flag sample data for failed analytes. If analytes in 3rd LCS are out, correct instrument problem. 2) If one or more analytes is out in either the LCS or LCSD, analyze a third previously acceptable LCS. If the recoveries for the third LCS are acceptable proceed with the analyses. If the same analytes are out, stop and correct instrument problem. Precision: 1) Demonstrate acceptable RPDs for analytes failed by analyzing a third previously acceptable LCS. If the RPDs between the third LCS and LCS or LCSD are acceptable proceed with analyses. If RPDs are still not acceptable, stop and correct instrument problem.
		Matrix spike (MS) and matrix spike duplicate (MSD); level of spike should be the larger of the following two criteria: 1) the regulatory concentration limit, if applicable, otherwise near the top of the calibration range, or 2) concentration of ongoing calibration check.	1 MS and 1 MSD per every 20 Air Force project samples	QC Acceptance Criteria Table 10-8	Accuracy: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within tolerances, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within criteria, flag MS/MSD results as matrix interference

Table 10-20

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8270B (cont'd)	Semivolatile Organic Compounds	Surrogate standards spike.	Every sample, spike, standard, and reagent blank.	Laboratory established limits Table 10-8 (limits are to be updated annually on a matrix-by-matrix basis). Corrective action required only if more than 1 acid and 1 base surrogate exceeds criteria.	1) Notify CSC. 2) Re-extract and reanalyze sample, if still in hold time and sufficient sample is available. 4) If additional sample is not available or sample is out of hold time, then reanalyze extract and flag results if still out.
		Method blank	Each extraction batch and each analytical batch	Measured concentrations for all analytes must be <PRDL	1) If contamination is >PRDL, then the concentration of the affected analytes in the associated samples must be >10 times the concentration in the method blank. 2) Repeat method blank analysis. 3) If still contamination is still present, determine source. a. If instrument contamination indicated, correct problem, reanalyze blank and proceed with analysis. b. If extraction contamination is indicated, contact CSC.
		MDL study	Once per year	Detection limits established shall not exceed those in Table 2-1 of IRP Handbook[b]	Detection limits that exceed established criteria shall be submitted to the Air Force for approval prior to the analysis of any project samples[b]

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.

[b] IRP Handbook, May 1991.

[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as specified in the IRP Handbook.

[d] SPCC - System Performance Check Compounds.

[e] CCC - Calibration Check Compounds.

Table 10-21

Summary of Calibration and Internal Quality Control Procedures for SW8280

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8280	Polychlorinated Dioxins and Furans Refer to: SW846-3500A[a] SW846-3600B[a] SW846-8280[a] IRP Handbook[b]	Mass scale calibration using DFTPP	Every 12-hours at the beginning of each analytical sequence	m/e 198, base peak; 199, 5-9% of 198; 275, 10-30 of 198; 365,>1% 0f 198; 441, present but <443; 442, >40% of mass 198; 443, 17-23% of mass 442	Repeat Calibration
		Initial five-point calibration	Biannually or when daily calibration verification fails to meet acceptance criteria.	Percent relative standard deviation (RSD) ≤15%	Identify and repeat outlying point(s); recalculate curve using repeated points
		Continuing calibration verification	Every 12-hour period and at the beginning of each analytical sequence	Response factor aggrement within 30% of value predicted from multipoint calibration. Isotope ratio agreement within ±15% with theoretical values.	Accuracy: 1) Repeat calibration verification 2) If still out, identify and correct problem. 3) Reanalyze verification standard. 4) If still out, perform new multi-point calibration.
		Resolution verification with standard C13-1,2,3,4-TCDD and C13-2,3,7,8-TCDD	Daily with continuing calibration	≤25 % valley between C13-1,2,3,4-TCDD and C13-2,3,7,8-TCDD	Replace column.
		Retention Window verification	When retention times of internal standards vary by more than 0.2 minutes from last window calibration.	<0.2 minute variation on internal standard	Rerun retention time standard, adjust SIM windows.
		Sensitivity Verification using calibration containing 0.2ug 1,2,3,7,8-TCDD	Every 12 hours at the beginning of each analytical sequence	>150,000 area counts from 334 ion from 1 ng injection C13-2,3,7,8-TCDD	Evaluate instrument Take corrective action
		Surrogate standards spike with 50 ng each C13-PCDD/Fs added before extraction	Every sample, spike, standard, and method blank.	Laboratory established limits determined as per SW846-8000A (see Table 10-9)	Accuracy: 1) If outside limits, evaluate S/N; if S/N >10:1, LCS/LCSD passes and DLs are acceptable, flag results. 2) If S/N< 10:1, run 8% fraction. If 8% fraction surrogates have S/N >10:1, combine results. If LCS/LCSD passes and DLs acceptable, flag results. 3) If no surrogates detected, re-extract sample

Table 10-21

(Continued)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8280 (cont'd)	Polychlorinated Dioxins and Furans	Method blank	Once per extraction batch	Measured concentration for all analytes <PRDL	1) Source of contamination investigated. 2) Appropriate corrective action taken and documented. 3) All Samples processed with a contaminated blank are to be reextracted and reanalyzed at no cost to the Air Force. 4) Sample results associated with reagent blank contamination at ≤3 times the detection limit are to be flagged.
		Duplicate sample analysis	One per batch	50% RPD for results > 5 x MRL	If LCS/LCSD passes, flag data.

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.
[b] IRP Handbook, September 1993.

NA - Not applicable.

Table 10-22

Summary of Calibration and Internal Quality Control Procedures for SW8310

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8310	Polynuclear Aromatic Hydrocarbons Refer to: SW846-3500A [a] SW846-3600B [a] SW846-8000A [a] IRP Handbook [b]	Initial Calibration, (five-point calibration for all analytes) ICAL	Biannually or when daily caibration check fails to meet acceptance criteria	Correlation coefficient ≥0.995 or RSD for response factors <20%	Identify and repeat outlying point(s); recalculate curve using repeated points.
		Calibration verification using one or more calibration standards	At the beginning, following every 10th sample, and at the end of each analytical sequence	Response for any analyte within ±15% of predicted response	1) Repeat calibration verification. 2) If still out, identify and correct, then reanalyze all samples since the last valid calibration verification.
		Retention time (RT) windows calculated for each standard	One 72-hour study performed on each HPLC column and whenever a new column is installed	See Method 8000A	1) Perform maintenance 2) Repeat test
		Mid-level second source Laboratory Control Sample (LCS/LCSD)	One LCS/LCSD pair per batch	Laboratory acceptance limits shown in Table 10-10	Accuracy: Analyze a third LCS. If recovery for same analyes are still out, stop, identify, and correct problem before proceeding. Precision: Analyze a third LCS. If recovery for same analyes are still out, stop, identify, and correct problem before proceeding.
		Matrix spike (MS) and matrix spike duplicate (MSD)	1 MS and 1 MSD per every 20 Air Force project samples	QC Acceptance Criteria Table 10-10	Accuracy: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within tolerances, flag MS/MSD results as matrix interference. Precision: 1) Reanalyze spiked sample. 2) If still out, and LCS/LCSD results are within criteria, flag MS/MSD results as matrix interference
		Surrogate standard spike	Every sample spike, standard, and reagent blank	QC limits given Table 10-10 (limits are to be updated annually on a matrix-by-matrix basis)	1) Repeat analysis. 2) If still out, indicate by flagging result
		Method blank	One per batch	Measured concentrations for all analytes must be <MDL	1) Perform system blank. 2) If system blank is contaminated, identify and correct source of contamination, then repeat method blank analysis. 3) If system blank is clean, reprepare samples with a new method blank.

Table 10-22

(Contined)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action[c]
SW8310 (cont'd)	Polynuclear Aromatic Hydrocarbons	System Blank	minimum of one per analysis sequence	Measured concentrations for all analytes must be <MDL	1) Repeat blank analysis. 2) identify and correct source of contamination.
		MDL study	Once per year	See MDL table	Detection limits that exceed estab-lished criteria shall be submitted to the Air Force for approval prior to the analysis of any project samples[b]

[a] Test Methods for Evaluating Solid Waste, U.S. EPA, SW846, September 1986.

[b] IRP Handbook, May 1991.

[c] All corrective actions associated with Air Force project work shall be documented and the records maintained by the laboratory, as specified in the IRP Handbook.

NA - Not applicable.

Section 11.0
SYSTEMS AND PERFORMANCE AUDITS

A quality assurance (QA) audit is an independent appraisal of a measurement system. It typically includes a performance evaluation using apparatus and/or standards that are different from those used in the measurement system. It also may include an evaluation of the potential of the system to produce data of adequate quality to satisfy the objectives of the measurement efforts. The independent, objective nature of the audit requires that the auditor be functionally independent of the sampling/analytical team.

Quality assurance audits play an important role in an overall QA/QC program. This section describes the role of the QA auditor and the nature of both systems and performance audits.

11.1 Quality Assurance Auditor

The QA auditor is the person who designs and/or performs QA systems and performance audits. Since QA audits represent, by definition, independent assessments of a measurement system and associated data quality, the auditor must be functionally independent of the measurement effort to ensure objectivity. However, the auditor is experienced with the objectives, principles, and procedures of the measurement efforts to perform a thorough and effective evaluation of the measurement system. The auditor's technical background and experience provides a basis for appropriate audit standard selection, audit design, and data interpretation. Especially important is the ability to identify components of the system that are critical to overall data quality, so that the audit focuses heavily upon these elements. The auditor also has writing skills sufficient to clearly document the findings and recommendations of the audit. The function of the QA auditor is to:

- Observe procedures and techniques in use in the various measurement efforts, including field sampling and analysis;
- Check and verify instrument calibration records;
- Assess the effectiveness of and adherence to the prescribed QC procedures;
- Review and document control and chain-of-custody procedures;
- Submit audit samples of comparable composition as those being tested for analysis;
- Review the malfunction reporting procedures;
- Identify and correct any weaknesses in the sampling/analytical approach and techniques;
- Assess the overall data quality of the various sampling/analytical systems; and
- Challenge the various measurement systems with certified audit standards.

11.2 Technical Systems Audit

A technical systems audit (TSA) is a qualitative review of the various aspects of a total sampling and/or analytical system to assess its overall effectiveness. It represents an objective evaluation of a set of interactive systems with respect to strengths, weaknesses, and potential problem areas. The audit provides an evaluation of the adequacy of the overall measurement system(s) to provide data of known quality that are sufficient, in terms of quantity and quality to meet the program objectives.

The technical systems audit consists of observations and documentation of all aspects of the sampling and analytical activities. Checklists that delineate the critical aspects of each methodology are used by the auditor during the audit and to serve to document all observations. In addition to evaluating sampling and analytical procedures and techniques, the systems audit emphasizes review of all recordkeeping and data handling systems including:

- Calibration documentation for analytical instrumentation and sampling apparatus;
- Documentation of quality control data (control charts, etc.);
- Completeness of data forms and notebooks;
- Data review and validation procedures;
- Data storage and filing procedures;
- Sample logging procedures;
- Chain-of-custody procedures;
- Documentation of maintenance activities; and
- Review of malfunction reporting procedures.

Radian's Quality Assurance Group conducts technical systems audits of each laboratory area in the Analytical Chemistry Division. This effort is supplemented by periodic "project specific" audits which focus on unique project requirements.

11.3 Performance Audit

A performance audit is an independent check to evaluate the data produced by a measurement system. Audit standards and test equipment which are traceable to acceptable reference standards are used to assess the performance of each analytical method and/or measurement device (performance audit). Performance audits must be conducted at a frequency consistent with the objectives of each individual project. Large sampling projects conducted to support regulatory requirements are audited more frequently than small projects intended for screening purposes. The performance audits are designed to provide a quantitative, point-in-time evaluation of the data quality of the sampling and analytical systems being tested. This is accomplished by addressing specific component parts of the overall system. Each performance audit addresses the two general measurement categories of a project:

- Chemical analysis of samples, and
- Physical measurements supporting the sampling effort.

Audit activities consist of challenging the various measurement systems with standards and test equipment traceable to accepted reference standards. Laboratories conducting the analytical work on a program are given performance audit samples prepared by spiking representative sample matrices with target analytes at representative concentration levels. Results for these audit samples are tabulated and considered in evaluating the analytical performance and data reporting protocols for each laboratory.

An audit report is subsequently prepared and distributed to the task leaders and the Project Director. This report outlines the audit approach and presents a summary of results and recommendations. Upon completion of systems and performance audits, the auditor discusses any specific weaknesses with the task leaders and the Project Director and makes recommendations for corrective action.

Radian's analytical laboratories participate in a number of regularly scheduled performance audit programs sponsored by EPA and various state agencies.

Section 12.0
PREVENTIVE MAINTENANCE

The primary objective of a preventative maintenance program is to promote the timely and effective completion of a measurement effort. The preventive maintenance is designed to minimize the downtime of crucial sampling and/or analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas.

- Establishment of maintenance responsibilities;
- Establishment of maintenance schedules for major and/or critical instrumentation and apparatus; and
- Establishment of an adequate inventory of critical spare parts and equipment.

12.1 Responsibilities and Procedures

Equipment and apparatus used in Radian's environmental measurement programs fall into two general categories:

- Equipment permanently assigned to a specific laboratory (e.g., gas chromatography {GC} laboratory, gas chromatography/mass spectrometry {GC/MS} laboratory, etc.); and
- Field sampling equipment available for use on an as-needed basis (e.g., field meters, pumps, vehicles, etc.).

Maintenance of laboratory instruments is the responsibility of the laboratory contracted to perform the analytical portion of this program. Generally, the laboratory manager or supervisor of a laboratory is responsible for the instruments and equipment in his or her work area. The laboratory manager will establish maintenance procedures and schedules for each major equipment item. This responsibility may be delegated to laboratory personnel, although the managers retain responsibility for ensuring adherence to prescribed protocol. All laboratories are bound by analytical contractual agreements to maintain the ability to produce data that meet the project objectives and to follow method specifications. This ensures that adequate spare parts, maintenance, schedules, and emergency repair services are available.

Maintenance responsibilities for field equipment are assigned to the project director and task leaders for specific sampling tasks. However, the field team using the equipment is responsible for checking the status of the equipment prior to use, and reporting any problems encountered. The field team is also responsible for ensuring that critical spare parts are included as part of the field equipment checklist. Non-operational field equipment is removed from service and a replacement obtained.

All field instruments will be properly protected against inclement weather conditions during the field investigation. Each instrument is specially designed to maintain its operating integrity during variable temperature ranges that are representative of ranges that will be encountered during hot or cold-weather working conditions. At the end of each working day, all field equipment will be taken out of the field and placed in a cool, dry room for overnight storage.

12.2 Maintenance Schedules

The effectiveness of any maintenance program depends to a large extent on adherence to specific maintenance schedules for each major equipment item. Other maintenance activities are conducted on an as-needed basis. Manufacturers' recommendations will provide the primary basis for the established maintenance schedules, and manufacturers' service contracts provide the primary maintenance for many major instruments (e.g., GC/MS instruments, atomic absorption spectrometers, analytical balances, etc.).

Instrument Maintenance Logbooks

Each analytical instrument is assigned an instrument logbook. All maintenance activities are to be recorded in the instrument log. The information to be entered includes:

- Date of service;
- Person performing service;
- Type of service performed and reason for service;
- Replacement parts installed (if appropriate); and
- Miscellaneous information.

12.3 Spare Parts

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment down time. The inventory includes those parts (and supplies) that:

- Are subject to frequent failure;
- Have limited useful lifetimes; or
- Cannot be obtained in a timely manner should failure occur.

Field sampling task leaders and the respective laboratory managers will be responsible for maintaining an adequate inventory of spare parts. In addition to spare parts and supply inventories, a backup supply of much of the equipment and instrumentation for the field sampling will be maintained.

Section 13.0
PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

The evaluation/assessment of measurement data is required to ensure that the quality assurance (QA) objectives for the program are met and that quantitative measures of data quality are provided. The data evaluation procedures, calculations and applications used for the Elmendorf Air Force Base (AFB) Environmental Restoration Program are based on the United States Environmental Protection Agency (USEPA) Guidelines for Assessing and Reporting Data Quality for Environmental Measurements, January 1983.

A distinction must be made between routine quality control and data assessment that is conducted as a part of laboratory operations, and the project-related data assessment process conducted after the data have been reported. It must be assumed that the planning, standard procedures, and monitoring activities conducted during the sampling and analysis process have served to control the process as much as possible to produce data of sufficient quality for project needs. After the data have been reported, it is necessary to identify any part of the process that could not be controlled, and to what extent that may affect the quality of the reported data.

The routine quality control procedures conducted in the laboratory are established in the published methods, this document, and the analytical standard operating procedures (SOPs). The laboratory is responsible for following those procedures and operating the analytical systems within statistical control limits. These procedures include proper instrument maintenance, calibration and continuing calibration checks, and internal quality control sample analyses at the required frequencies (i.e., reagent blanks, surrogate spikes, matrix spike/matrix spike duplicate [MS/MSD], analytical spikes, laboratory duplicates). One of the additional ongoing data assessment processes is maintaining control charts for representative quality control (QC) sample analyses to monitor system performance. This provides verification that the system is in statistical control, and indicates when performance problems occur, so the problems can be corrected as soon as possible. When reporting the sample data, the laboratory is required to provide the results of associated QC sample analyses so the project staff can evaluate the performance of the analytical process.

Problems with analytical data usually occur in spite of all precautions taken in planning and execution of the sampling and analysis task. In these cases, the data assessment conducted by the project QA staff after the data have been reported must identify the problem, determine which data are affected, state how these data may be limited for use in the intended applications, and make recommendations for corrective actions as necessary.

The discussion of data assessment presented in this section pertains to the project-related assessment of data that is performed after data have been reported and laboratory analyses have been completed.

Data assessment procedures that will be performed for the Elmendorf AFB program include:

- Initial review of analytical and field data for complete and accurate documentation, holding time compliance, and required frequency of QC samples;
- Evaluation of blank results to identify systematic contamination;

- Statistical calculations for accuracy and precision using the appropriate quality control sample results;

- Estimates of completeness, in terms of the percent of valid unqualified data; and

- Assigning data qualifier flags to the data as necessary to reflect limitations identified by the process.

Qualified data would be discussed in the task reports, and data flags could be transmitted to users via data tables from the database and in analytical data reports.

13.1 Formulas

Several of the data validation acceptance criteria involve specific calculations. Example calculations are presented below.

13.1.1 Instrument Response Linearity (Calibration)

Acceptance criteria for instrument response linearity checks are based upon the correlation coefficient, r, of the best fit line for the calibration data points. The correlation coefficient reflects the linearity of response to the calibration standards and is calculated as:

$$r = \frac{n\sum(xy) - (\sum x)(\sum y)}{\sqrt{\left[n(\sum x^2) - (\sum x)^2\right]\left[n(\sum y^2) - (\sum y)^2\right]}}$$

where:
x = calibration concentrations;
y = instrument response (peak area); and
n = number of calibration points (x,y data pairs).

13.1.2 Precision

Control limits for control sample analyses, acceptability limits for replicate analyses, and response factor agreement criteria specified for calibration and internal QC checks are based upon precision, in terms of the coefficient of variation (CV) or the relative percent difference (RPD). The standard deviation of a sample set is calculated as:

$$S = \text{standard deviation} = \sqrt{\frac{\sum(x - \bar{x})^2}{(n-1)}}$$

where:
x = individual measurement;
$\bar{x}$ = mean value for the individual measurements; and
n = number of measurements.

The CV is then calculated as:

$$CV = \left(\frac{S}{\bar{x}} \right) x\ 100\%$$

The relative percent difference (RPD) calculation allows for the comparison of two analysis values in terms of precision with no estimate of accuracy. Relative percent difference is calculated as:

$$RPD = \frac{|M - m|}{\left(\frac{M + m}{2} \right)} x\ 100\%$$

where: M = first measurement value; and
m = second measurement value.

For duplicate measurements, CV is related to RPD by the following:

$$CV = \frac{RPD}{\sqrt{2}}$$

13.1.3 Accuracy

The accuracy of data is typically summarized in terms of relative error (RE). This calculation reflects the degree to which the measured value agrees with the actual value, in terms of percent of the actual value. Relative error is calculated as:

$$\%\ \text{Relative Error} = \frac{\text{Measured Value} - \text{Actual Value}}{\text{Actual Value}}\ x\ 100$$

This way of expressing accuracy allows for a comparison of accuracy at different levels (e.g., different concentrations), and for different parameters of the same type (e.g., different compounds analyzed by the same method). Control sample analyses are typically evaluated using this calculation.

In this program, another calculation is frequently used to assess the accuracy of a procedure. Percent recovery is a calculation used to determine the performance of many of the quality control checks. Percent recovery is calculated as:

$$\%\ \text{Recovery} = \frac{\text{Measured Value}}{\text{Actual Value}}\ x\ 100$$

Another similar calculation used to determine the performance of a method for recovery of a spike concentration added to a sample is the percent spike recovery calculation. The percent spike recovery is determined as:

$$\%\ \text{Spike Recovery} = \frac{(\text{Value of Sample Plus Spike}) - (\text{Value of Unspiked Sample})}{(\text{Value of Spike Added})} \times 100$$

13.2 Control Limits

Control limits for central tendency and variability are generated by the laboratory to statistically monitor system performance. These limits are within method specified tolerances. Since control limits may change as the analytical system is improved and matrices change, these limits are not provided in this plan.

13.3 Documentation

Data reviewed to perform each of the above procedures and the implications to natural sample results are discussed in each of the following subsections.

13.3.1 Blank Data Assessment

Reagent blank results indicate whether any of the contaminants reported in sample results may be attributed to laboratory sources (reagents, glassware, instrumentation) and were not likely present in the sampled medium. The most common laboratory contaminants are methylene chloride, phthalates, acetone, and toluene; these are recognized as being ubiquitous in the laboratory environment and controlling them to within acceptable low levels is part of standard laboratory procedures.

If contamination from these compounds is reported in reagent blanks, the samples associated with the blank, either the same analytical or extraction batch, may be qualified to indicate that some or all of these compounds may be from laboratory sources. If the concentrations reported in the samples are similar to the blank concentrations, it is likely that all of the contamination was introduced, and this assessment is made in the QA/QC report for the sampling task.

In some cases, where there is a large sampling task and reagent blank results indicate a more significant contamination problem, a more systematic approach may be applied. This approach is only used when a series of reagent blanks analyzed over a period of time are reported. The assessment criterion is calculated from reagent blank results as the mean concentration plus three standard deviations for each contaminant reported. The sample data are assessed using this criterion. Sample concentrations below the criterion are considered to be most likely from laboratory sources, and at least some of the sample concentrations higher than that are considered to be from the sampled medium (well, soil, etc.). This semi-quantitative approach is used only as a tool to screen the sample results and provide a common basis for further assessment; none of the results are censored or changed in any way. The assessment is discussed in the QA report for the sampling task. Samples with blank contamination problems will be assigned a data qualifier flag.

Results for other types of blanks such as equipment, ambient, or trip blanks are assessed individually. The probable source of contamination is identified and the associated sample results are qualified as necessary. For example, if equipment blank results show contamination, and the sample collected from the bailer shows the same compound, the sample results will be qualified to indicate the probable level of introduced contamination.

13.3.2 Accuracy

As previously defined, accuracy is associated with correctness, and is a comparison between a measured value and a known, or 'true' value. Accuracy is calculated from method spike (spikes of the pure matrix) matrix spike, or Laboratory Check Sample results.

Spike results are reported by the laboratory as percent recovery and are compared to the accuracy objectives stated in Section 10. Results that do not satisfy the objectives are assigned a data qualifier flag to indicate uncertainty associated with inaccuracy.

Method spikes are spikes of a reference material into a water matrix. If recovery is outside the established limits, samples from the same extraction batch may be qualified. Matrix spike results are generally more sample-specific. If matrix spike recovery is outside the established limits, results for samples collected from similar conditions and/or handled in the same batch will be examined. If any results appear atypical and could be related, those results may also be qualified. The flagged data will be discussed in the QA/QC report for the sampling task, and specific limitations such as poor or enhanced recovery for specific compounds will be stated. Further investigation or corrective action may be taken to find methods to reduce the interferences.

Surrogate spike results are also reported and used to assess recovery of target analytes on a sample by sample basis and provide a measure of system performance. Surrogate spike recoveries are compared to recovery limits. Any results outside the limits are flagged on laboratory reports and in the database. Any corrective action taken in the laboratory is documented in laboratory performance records and/or discussed in the comment section of the data report.

Confidence intervals can be calculated for an analytical method if performance evaluation samples are submitted or a series of method spikes is analyzed. The results are used to define confidence intervals for the recovery of each compound analyzed.

13.3.3 Precision

Precision is a measure of variability between duplicate or replicate analyses, and is calculated for field and laboratory replicates. By definition, field or total, precision incorporates laboratory precision. Precision is calculated as the relative percent difference (RPD) between duplicate samples or analyses, or matrix spike/matrix spike duplicates as appropriate. The calculated RPDs are compared to the objectives stated in Section 10. Results that do not satisfy the objectives are assigned a data qualifier flag indicating uncertainty associated with imprecision.

An average RPD may be calculated and reported as a measure of overall analytical precision for compounds with multiple measurements. The specific samples collected or analyzed in duplicate are flagged if they do not satisfy the QA objectives. In addition, associated samples may be flagged to indicate variability due to poor precision. For poor field duplicate precision, samples collected by the same sampling team, from the same equipment, or on the same day may be affected; close evaluation of those results should indicate the most likely source of variability, and the corresponding samples will be qualified as warranted. For poor laboratory precision, samples processed and analyzed in the same batch will be more closely evaluated, and any anomalous results will be qualified.

The QA coordinator is responsible for ensuring that data qualifier flags are assigned to the data as required by the established QC criteria, and that they are reported and understood by project staff using the data for specific applications. The QA coordinator is also responsible for initiating corrective actions for analytical problems identified during the QC data assessment process. These corrective actions range from verifying that the method was in statistical control during the analytical runs, to re-analysis of the sample, or resampling.

13.3.4 Completeness

Completeness is calculated after the QC data have been evaluated, and the results applied to the measurement data. In addition to results identified as being outside of the QC limits established for the method, broken or spilled samples, or samples that could not be analyzed for any other reason are included in the assessment of completeness. The percentage of valid results is reported as completeness.

For the Elmendorf AFB project, completeness will be calculated as follows:

$$\frac{T - (I+NC)}{T} \times 100\% = \textit{Completeness.}$$

where: T = Total number of expected measurements for a method and matrix;
I = Number of invalidated results for a method and matrix; and
NC = Number of results not collected (e.g., bottles broken etc.) for a method and a matrix.

Section 14.0
CORRECTIVE ACTION

During the course of the Elmendorf Air Force Base (AFB) Environmental Restoration Program, it is the responsibility of the Project Manager, Task Leaders, Quality Assurance (QA) Coordinator, and the sampling team members to see that all measurement procedures are followed as specified and that measurement data meet prescribed acceptance criteria presented in the Tables in Section 10. In the event that a problem arises, it is imperative that prompt action be taken to correct the problem(s).

14.1 Corrective Action Report Form (CAR)

The on-site QA Coordinator, task leaders, or other project members initiate a corrective action request in the event that quality control (QC) results exceed acceptability limits, or upon identification of some other problem or potential problem. Method specified responses are presented in Section 10, Tables 10-11 through 10-22. Such problem are followed up by the Technical Director or QA Officer. Corrective action is also initiated by the QA Coordinator based on QC data or audit results. Corrective actions range from use of data qualifier flags, to reanalysis of the sample or samples affected, to resampling and re-analysis, to recommending a change in procedures, depending on the severity of the problem. Problems that require corrective action are documented by the use of a Corrective Action Report (CAR), as presented in Figure 14-1.

14.2 Reestablishment of Control

Procedures for reevaluation and reestablishment of control are summarized in Section 10, Tables 10-11 through 10-22 for each method. The corrective action scheme is shown in the form of a flowchart in Figure 14-2.

14.3 Recommendation for Corrective Action (RCA)

In addition to the malfunction reporting system for addressing problems identified from within the program through the internal quality control system, a system for issuing formal Recommendations for Corrective Action (RCAs) exists for addressing problems identified through independent quality assurance review. RCAs are issued only by a member of the Quality Assurance (QA) Group, or by their designee in a specific role. Each RCA addresses a specific problem or deficiency, usually identified during QA audits of laboratory or project operation (Section 10). Although the RCA system (and form) provides for distinguishing among problems of different urgency, RCAs are typically issued only to address significant, systematic deficiencies. An example RCA form is presented as Figure 14-3. Each of these formal written recommendations requires a written response from the responsible party (i.e., to whom the RCA was issued). A system exits to tract these RCAs and their corresponding responses. On a monthly basis, a summary of the "unresolved" RCAs is prepare by the QA group and issued to Radian Management. These reports list all RCAs that have been issued to the work areas that each manager is responsible for and the current status of each. Each RCA response requires verification by the QA group that the corrective action has been implemented before the status is changed in the monthly report. In the event that there is no response to the RCA within 30 days, or if the corrective action is disputed, the recommendation and/or conflict is pursued to successively higher management levels until the issue is resolved.

RADIAN
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Corrective Action Report (CAR)

Part I Initial Information (Furnished by Originator)

Originator: ______________________

SAM #: __________ Method #: __________

Client: __________ Matrix: __________

Date:

Urgency Level:

Requires resolution for immediate job ☐

Requires resolution for future jobs ☐

To Person Responsible for Action: ______________________

Present Situation Requiring Action:

Site / Lab: Type: QC Limit ☐ Documentation ☐ System ☐ Other ☐

Date / Time Identified:

Description of Situation: (attach supporting data if available)

Recommended Corrective Action or Improvement:

Description: Implemented by:

Technical Director Copy (White)

Figure 14-1. Corrective Action Report

Part II Reply / Resolution (Furnished by Technical Director)

Proposed by: Date: CAR #:

Description: Scheduled Implementation:

Part III Implemented Correction Action (by:)

Description: Date Implemented:

Part IV Follow-Up Required: Yes ☐ No ☐ (by:)

Verified by: Date: Comments:

Information Copies, Distributed by Technical Director:

Figure 14-1. (Continued)

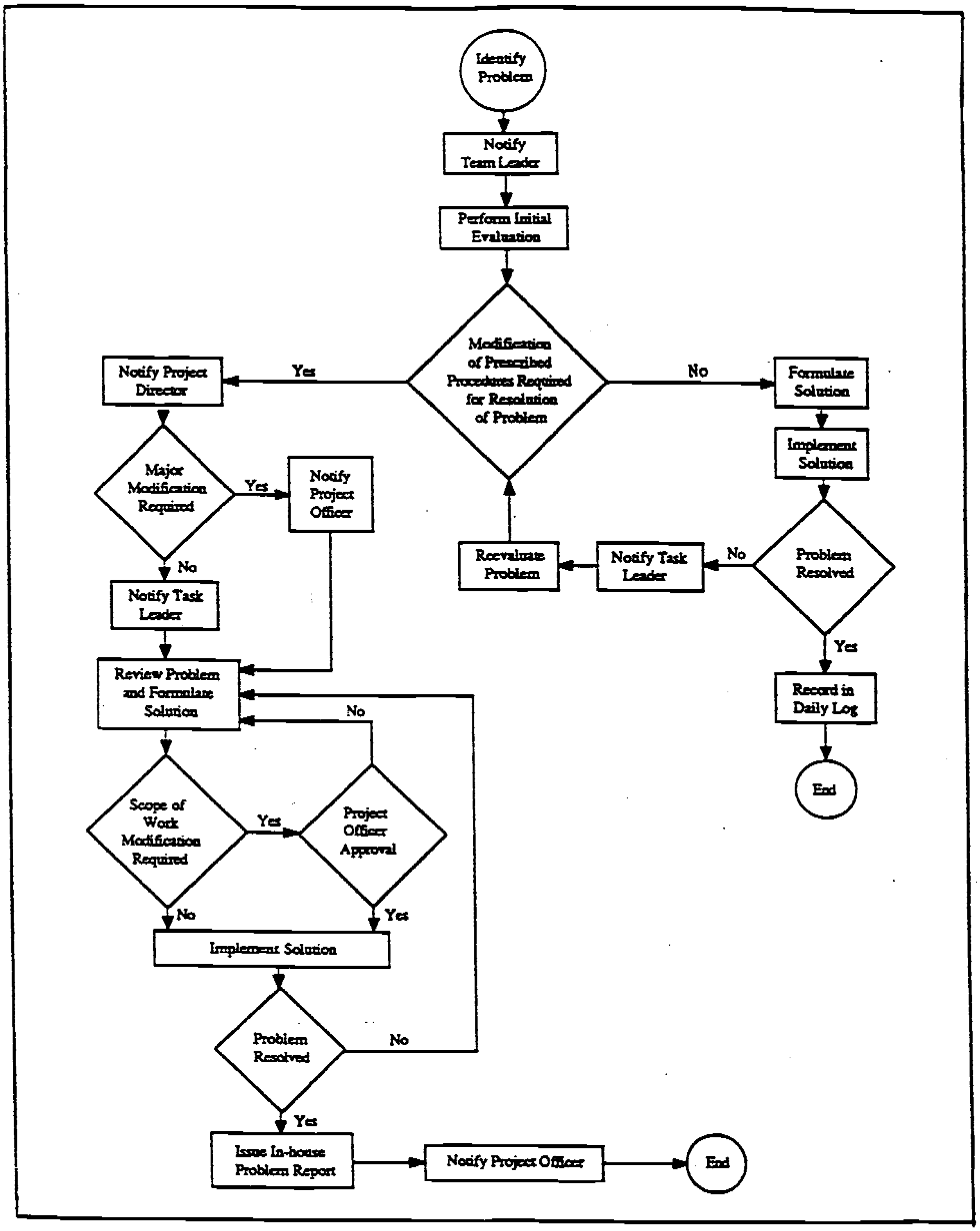

Figure 14-2. Radian Corrective Action Flowchart

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RECOMMENDATION FOR CORRECTIVE ACTION

A. Initial Information

RCA NO.:	DATE:	URGENCY LEVEL ☐ 1. Potential for major data loss or invalidation. 2. Potential for failure to achieve data quality objectives. 3. Suggested improvement.
ORIGINATOR:	APPROVED BY:	
ORGANIZATION/INDIVIDUAL RESPONSIBLE FOR ACTION:		

B. Problem Identification

SITE/LAB:	SYSTEM:	DATE PROBLEM IDENTIFIED:
DESCRIPTION OF PROBLEM:		

C. Recommended Corrective Action

DESCRIPTION:	IMPLEMENT BY:

D. Problem Resolution

PLANNED CORRECTIVE ACTION:	PROPOSED BY:	DATE PROPOSED:	SCHEDULED IMPLEMENTATION:
IMPLEMENTED CORRECTIVE ACTION:			DATE IMPLEMENTED:

E. QA Verification

VERIFIED BY:	DATE:	COMMENTS:

White: Return for Implemented Corrective Action   Yellow: Return for Planned Corrective Action   Pink: File copy   Gold: Originator's Copy

Information Copies Distribution: ____________ ____________ ____________ ____________ ____________ ____________ ____________

____________ ____________ ____________ ____________ ____________ ____________ ____________

Figure 14-3. Recommendation for Corrective Action

Section 15.0
QUALITY ASSURANCE

The Quality Assurance (QA) Coordinator and Quality Control (QC) task members will issue quality assurance reports to the project management, task leaders, and laboratory supervisors describing the results of QC measurements, performance audits, and systems audits performed for each sampling and analysis task. Audit results will be summarized in the reports; detailed audit results and checklists will be submitted according to the procedures described in Section 11.

15.1 Reporting Procedure

At least one QA report is needed for each phase of the Elmendorf AFB project. This report will be issued with the ITIR and will publish results of data validation and evaluation tasks.

15.2 Report Content

The content and format for the Quality Assurance Reports are presented in the following outline:

ELMENDORF AIR FORCE BASE
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
QUALITY ASSURANCE REPORTS

1.0 Summary of sampling and analytical activity and highlights of quality assurance results

2.0 Measurement data accuracy, precision, and completeness (per sample matrix and method)

3.0 Results of audits

4.0 Significant quality assurance problems and recommended action

Two types of quality control results will be reported as appropriate for each sampling and analytical task:

- Sampling Quality Control:
    - -- Equipment blank analyses,
    - -- Trip blank analyses,
    - -- Ambient blank analyses, and
    - -- Field duplicate sample analyses; and
- Analytical Quality Control:
    - -- Method spike analyses,
    - -- Matrix spike analyses,
    - -- Matrix spike duplicate analyses,
    - -- Laboratory Check sample (LCS) analyses,
    - -- Laboratory Check sample duplicate (LCSD) analyses,
    - -- Reagent blank analyses, and

- Surrogate spike analyses.

These data will be reported in tables by method and matrix.

Tables summarizing all QC data for the task will be prepared. The range of the results for each type of data (blanks, spikes), the total number of samples, and number of acceptable results will be indicated.

An evaluation of project data with regards to QC results will also be provided in the technical report. This evaluation will present guidelines for data usability during site interpretation and risk assessment in terms of bias and imprecision.

Section 16.0
REFERENCES

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United States Department of the Air Force, Headquarters Air Force Center for Excellence (AFCEE) 1993. Handbook for the Installation Restoration Program (IRP)--Remedial Investigation/Feasibility Studies (RI/FS).

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United States Environmental Protection Agency (USEPA). Guidelines for Assessing and Reporting Data Quality for Environmental Measurements. 1983.

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