

**Multi-Phased Remedial Investigation (RI)
of Surface and Subsurface Contamination of Soldier Creek
at Tinker AFB, Oklahoma
U.S. Air Force Installation Restoration Program**

FINAL

SAMPLING AND ANALYSIS PLAN

and

QUALITY ASSURANCE

PROJECT PLAN

MAY 1990

TINKER PROJECT NO: WWYK89-0196B
SITE ID NO: TINKER 0T03

Contract No.
DACA56-89-C-0062



SOLDIER CREEK RI/FS (NPL Site)
Prepared for: Tinker Air Force Base through
U.S. Army Corps of Engineers
Tulsa District

TINKER AFB - SOLDIER CREEK RI/FS
SAMPLING AND ANALYSIS PLAN and
QUALITY ASSURANCE PROJECT PLAN

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EXECUTIVE SUMMARY

This volume contains the Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) for completion of the Phase I remedial investigation (RI) activities for the Soldier Creek site located at Tinker Air Force Base, Oklahoma.

This SAP presents a detailed description of the field activities planned for the Phase I RI at the Soldier Creek site. It includes a description of the site and data quality objectives used to determine the type, number, and location of samples. It also presents information on the chemical and physical analyses to be performed on collected samples, as well as sample preservation, packaging, shipping, and custody procedures.

Site background information includes a summary of the Soldier Creek site location and history, as well as summary of previous investigations and analytical data pertinent to the understanding of existing site conditions. Studies completed over the past several years provide limited information on surface water, groundwater, and sediment contamination present at the site.

The SAP restates the following remedial investigation objectives presented in the Data Quality Objectives Report: (1) determine the lateral, vertical, and downstream extent of sediment contamination; (2) determine contaminant concentrations in the sediment, surface water, and groundwater; (3) determine surface water volume and flow for Soldier Creek and major tributaries of interest; and (4) determine stream morphology, off-base storm drain and outfall locations, and surrounding land use information to assess potential impacts on the stream by area residents and industry.

The sediment, surface water, and groundwater sampling procedures; the surface water flow and stream profile survey procedures; and the RI-derived

waste handling activities are described in detail in the SAP. The following summarizes each detailed presentation:

- o Approximately 84 sediment samples (not including blanks, duplicates, or background samples) collected from two depths at 42 locations will be submitted for chemical analysis of volatile organics, acid, base/neutral extractables, metals and cyanide. Sixteen of these 84 samples will be submitted for physical parameter analysis (i.e. particle size, Atterberg limits, density, and permeability). All the sediment samples will be analyzed for total organic carbon. One sediment background sample will be collected off-base and analyzed for the above-mentioned chemical parameters.
- o Approximately 42 surface water samples (not including blanks, duplicates, and background samples) will be analyzed for the same chemical parameters as the sediment samples. Sixteen samples will be analyzed for alkalinity, hardness, chemical oxygen demand, total suspended solids, biochemical oxygen demand, total organic carbon, oil and grease, and nitrates. One surface water background sample will be collected off-base and analyzed for the above-mentioned chemical parameters.
- o At approximately eight existing, off-base wells, groundwater levels will be measured and unfiltered samples will be collected and analyzed for the same chemical parameters as the surface water and sediment samples. Three filtered samples will be collected and analyzed for total metals. No background groundwater sample will be collected as previous investigations conducted by the Tulsa COE have established background groundwater chemical concentrations for the site vicinity.
- o A field survey will be conducted which will establish the stream bed profile at each sampling location and at stations located every 100 feet along the length of the creek within the Phase I RI study area. The field survey team will also measure flow 500 feet along the length of the creek within the study area. The survey team will establish the location of outfalls and drains discharging to the creek within the study area and not surrounding area land use characteristics of potential importance to the project.

- o RI-derived waste includes containerized excess sediment from sampling activities, decontamination solutions, and personal protective clothing. Following receipt of sample results, the disposal location of each type of RI-derived waste will be determined. All RI-derived wastes will be staged on-base and will be disposed of off-base. Tinker AFB is the generator of RI-derived waste and they will sign manifests for its transport and disposal.

The QAPP documents the quality assurance/quality control (QA/QC) measure to be implemented during sample collection and analysis, including data validation, reduction and evaluation activities. The QAPP provides specified levels of precision, accuracy, representativeness, completeness, and comparability that the data must meet in order to be considered acceptable for the purposes of the Phase I RI at the Soldier Creek site. The QAPP also describes sample custody and documentation procedures, including the field logbooks, photographs, sample numbering, sample documentation (labels, sample tracking forms, chain of custody forms, and custody seals), documentation procedures and corrections to documentation, and establishment of final project files. Laboratory and field activity quality assurance procedures are also described. These include sample custody, analytical and calibration procedures, internal quality control, data reduction/validation, performance and system audits, data assessment, preventive maintenance, accuracy/precision definitions, and corrective actions for unacceptable data.

TINKER AFB - SOLDIER CREEK RI/FS
SAMPLING AND ANALYSIS PLAN

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FINAL
SAMPLING AND ANALYSIS PLAN
TINKER AFB - SOLDIER CREEK RI/FS

Prepared for:
TINKER AIR FORCE BASE
through
TULSA DISTRICT CORPS OF ENGINEERS
CONTRACT NO. DACA56-89-C-0062

Prepared by:
B&V WASTE SCIENCE AND TECHNOLOGY CORP.
OVERLAND PARK, KANSAS
PROJECT NO. 40054
MAY 1990

Prepared under:
INSTALLATION RESTORATION PROGRAM
TINKER PROJECT NO. WWYK89-01968
SITE I.D. NO. TINKER OT03

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) defines the scope of work for the performance of sampling activities for the Tinker Air Force Base-Soldier Creek Remedial Investigation (RI)/Feasibility Study (FS). A brief summary of the site location and history, a discussion of the authority for the work, and an explanation of the purpose and scope of the sampling and analysis plan are included in this section.

1.1 SUMMARY OF SOLDIER CREEK SITE LOCATION AND HISTORY

Tinker Air Force Base (AFB) is located southeast of the Oklahoma City metropolitan area, bordering on Del City and Midwest City in central Oklahoma as illustrated on Figure 1-1. The main portion of Soldier Creek is located to the east of Tinker AFB, however two tributaries (West and East Soldier Creeks) originate on the base. Soldier Creek flows to the north from its headwaters near Southeast 59th Street to its confluence with Crutch Creek approximately six miles downstream. The Soldier Creek site includes Soldier Creek, its tributaries, and any areas underlying or adjacent to the waterway which may be contaminated by the migration of hazardous substances, pollutants, or contaminants released from Tinker AFB (EPA, 1988c).

For purposes of the Tinker AFB - Soldier Creek RI/FS project, West Soldier Creek is identified as the tributary which originates on the west side of Building 3001 and flows northward to its confluence with Soldier Creek approximately two miles downstream. East Soldier Creek is identified as the tributary which flows northward along the eastern side of Building 3001 and past the Industrial Waste Treatment Plant (IWTP), from its origin just to the north of Building 3705 to its confluence with Soldier Creek approximately one mile downstream. For the purposes of the Phase I RI, the study area primarily consists of the tributaries which directly receive

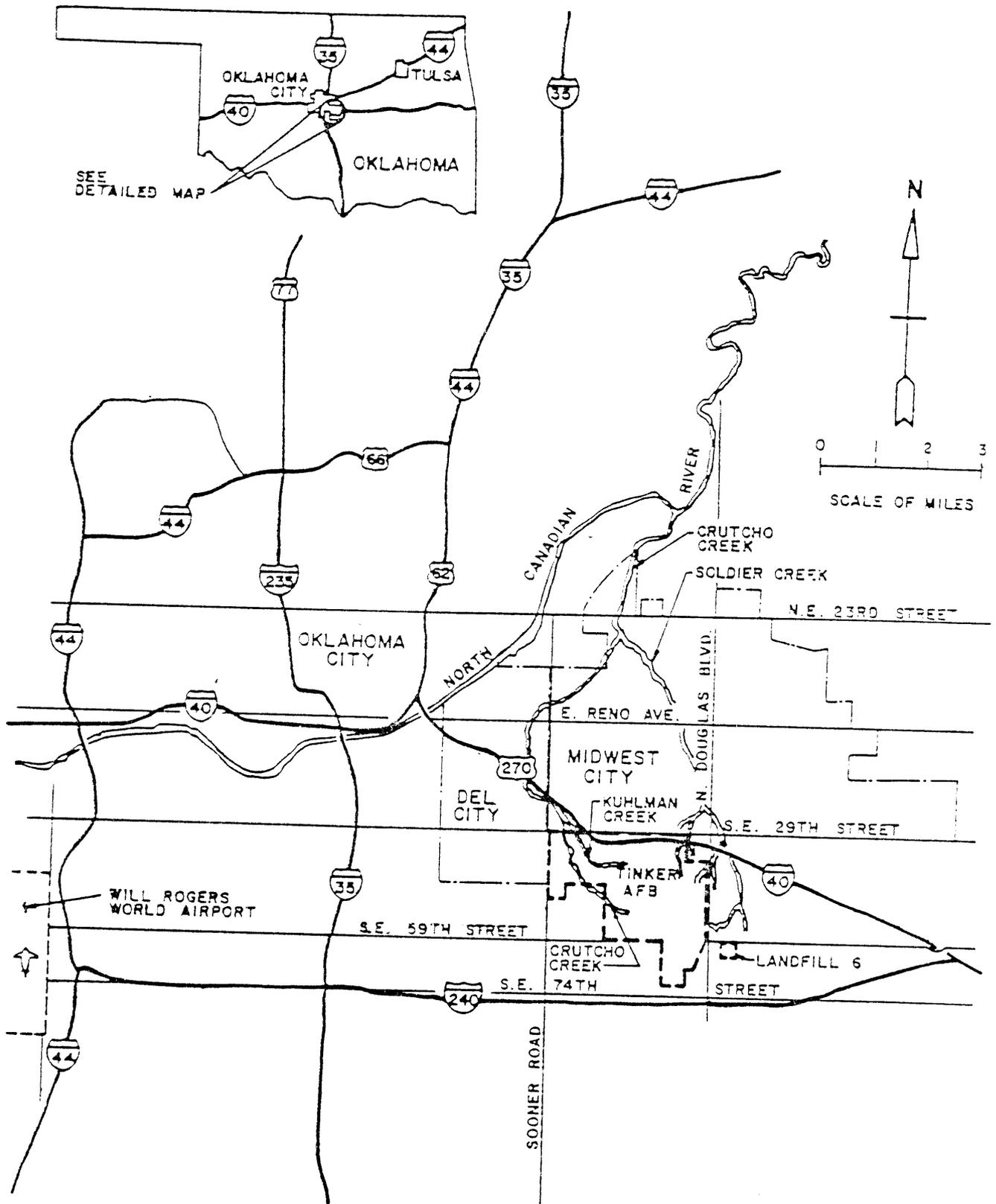


FIGURE 1-1
 SITE VICINITY
 TINKER AFB-SOLDIER CREEK RI/FS
 SAMPLING AND ANALYSIS PLAN

discharges or runoff from Tinker AFB (West and East Soldier Creeks) and the main stem of Soldier Creek from its headwaters downstream to East Reno Avenue as illustrated on Figure 1-2.

Soldier Creek and its tributaries receive surface runoff from an area covering approximately 9,000 acres. Areas on Tinker AFB which contribute runoff or discharge to Soldier Creek and its tributaries include the eastern-most runway area, the Building 3001 complex, and the IWTP. The Building 3001 complex consists of an aircraft overhaul and modification complex to support the emission of the Oklahoma City Air Logistics Center. The IWTP, located in the northeastern portion of the base, receives industrial process discharge water from the Building 3001 complex via a series of underground drains. Once received at the plant, these waters are treated and combined with treated sanitary wastewater prior to discharge to East Soldier Creek under an NPDES permit with the Oklahoma Water Resources Board (NUS, 1989).

Tinker AFB was activated in March 1942 under the name of the Midwest Air Depot. During World War II, the depot was responsible for reconditioning, modifying and modernizing aircraft, vehicles and equipment. The primary mission has not changed. Tinker AFB is still a major industrial complex for overhauling, modifying, and repairing military aircraft, aircraft engines, and accessory items.

As part of the overall Air Force Installation Restoration Program (IRP), Tinker AFB began an investigation of previously used waste disposal sites in 1981 (EPA, 1988a). A basewide sampling program was conducted in 1983. Analytical results from the sampling program detected trichloroethene in the groundwater. Remedial investigations were conducted by the Tulsa COE from 1986-1989 to determine the nature and extent of groundwater contamination in the Building 3001 complex area. These investigations determined that chromium, in addition to trichloroethene were contaminants of concern in the groundwater underlying the Building 3001 complex (Tulsa

DRAFT FINAL
SAMPLING AND ANALYSIS PLAN
TINKER AFB - SOLDIER CREEK RI/FS

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CONTRACT NO. DACA56-89-C-0062

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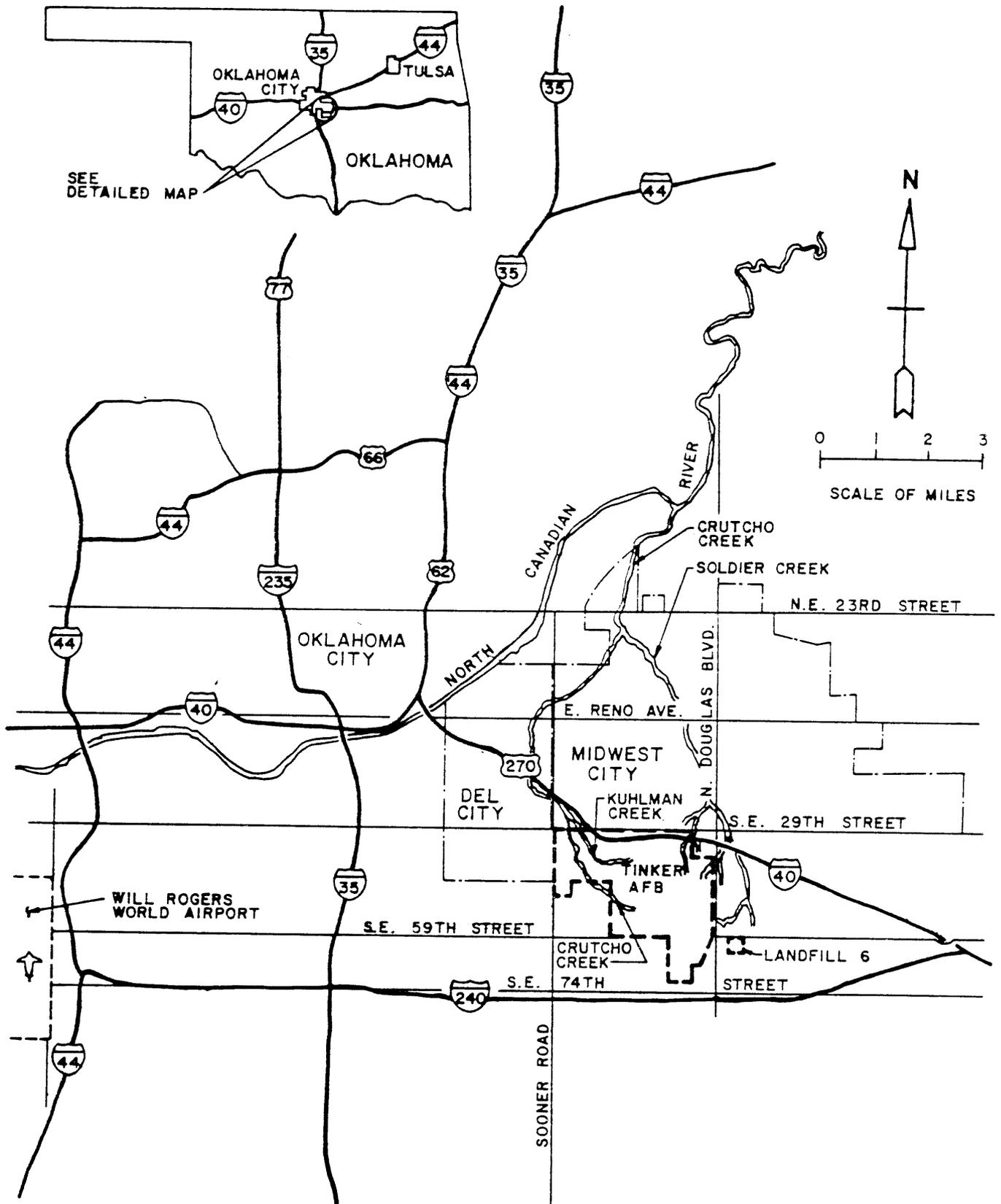


FIGURE 1-1
 SITE VICINITY
 TINKER AFB-SOLDIER CREEK RI/FS
 SAMPLING AND ANALYSIS PLAN

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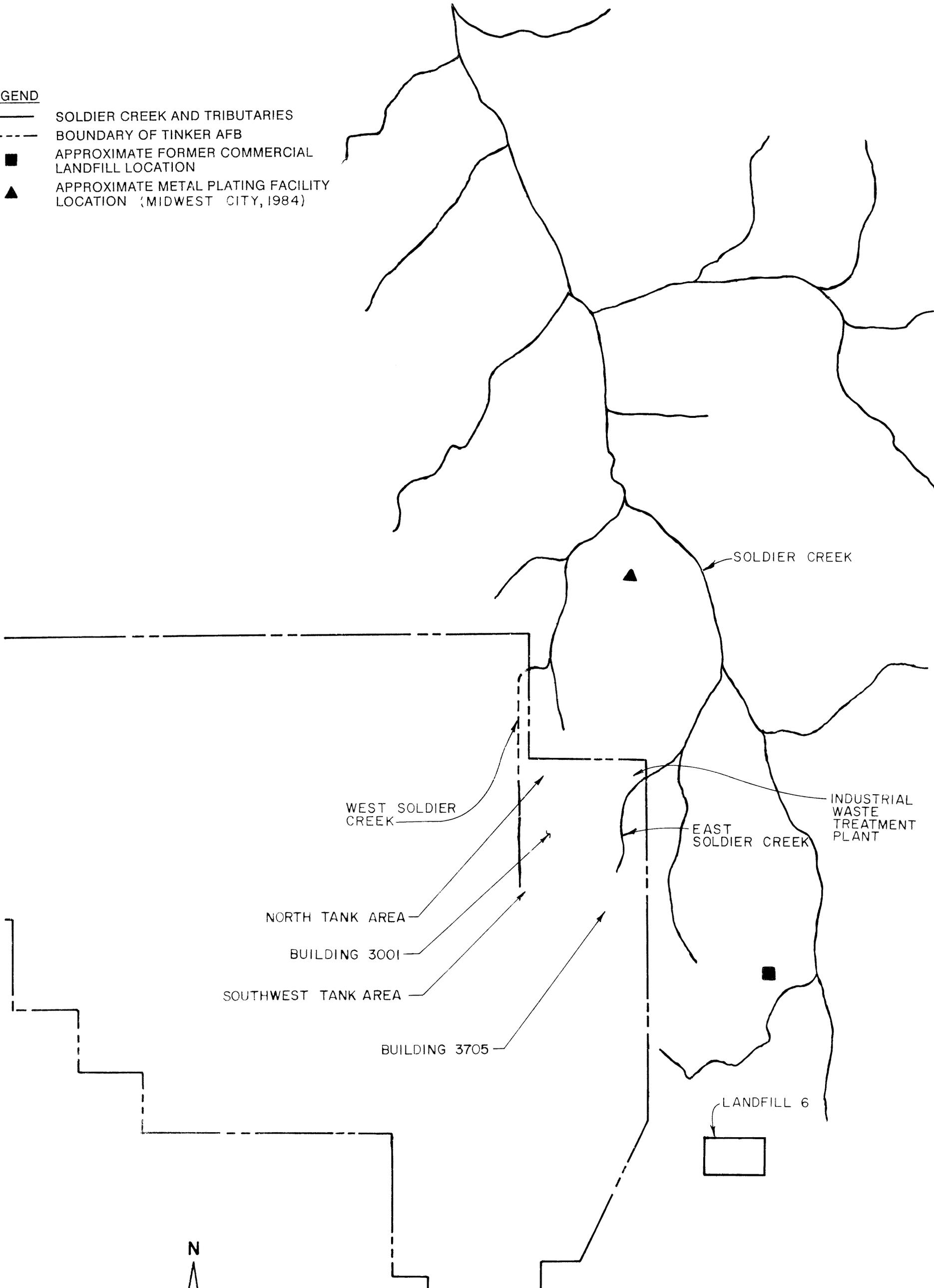
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LEGEND

- SOLDIER CREEK AND TRIBUTARIES
- - - BOUNDARY OF TINKER AFB
- APPROXIMATE FORMER COMMERCIAL LANDFILL LOCATION
- ▲ APPROXIMATE METAL PLATING FACILITY LOCATION (MIDWEST CITY, 1984)



SOLDIER CREEK

WEST SOLDIER CREEK

INDUSTRIAL WASTE TREATMENT PLANT

EAST SOLDIER CREEK

NORTH TANK AREA

BUILDING 3001

SOUTHWEST TANK AREA

BUILDING 3705

LANDFILL 6

N

COE, 1988a). On July 22, 1987, the Building 3001 site and the Soldier Creek site were added to the National Priorities List. On December 9, 1988, EPA Region VI, the Oklahoma State Department of Health (OSDH), and the United States Air Force entered into a Federal Facility Agreement under CERCLA Section 120 which mandated completion of specific investigations for the Building 3001 and Soldier Creek sites by the Air Force. These investigations include, but are not limited to, completion of RI/FS activities at the Soldier Creek site (EPA, 1988c).

1.2 AUTHORITY FOR THE WORK

The U.S. Environmental Protection Agency (EPA) Region VI, the OSDH, and the U.S. Department of Air Force, Tinker AFB signed a Federal Facility Agreement (Administrative Docket Number NDL-U3-2-27) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 120 and Superfund Amendments and Reauthorization Act of 1986 (SARA) on December 9, 1988. The intent of this agreement is to ensure that the past and present activities at Building 3001 and Soldier Creek, NPL sites, are thoroughly investigated and appropriately remediated to protect the public health, welfare, and environment. The Federal Facility Agreement establishes procedures and schedules for developing, implementing, monitoring, documenting, and approving response actions at both Building 3001 and Soldier Creek sites, in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Superfund guidance and policy, Resource Conservation and Recovery Act (RCRA), and RCRA guidance and policy. The Federal Facility Agreement establishes requirements for the performance of the RI and the FS at the sites in accordance with CERCLA. The agreement establishes procedures for remedial actions and conducting a separate Focused RI/FS for each Operable Unit identified. It also establishes procedures for proposing a new Operable Unit at either site. This process allows for remedial actions to be implemented as Operable Units that have been (or will be) identified prior to the final remedial action for the site. The Federal Facility

Agreement specifies that Tinker AFB will establish and maintain an administrative record that will include all documents that form the basis for the selection of a response action at both the Building 3001 and Soldier Creek sites (EPA, 1988c and Tulsa COE, 1989a).

The U.S. Army Corps of Engineers, Tulsa District (Tulsa COE) is acting as an agent on behalf of Tinker AFB for the completion of the RI/FS activities for the Soldier Creek site. This Sampling and Analysis Plan (SAP) and the companion documents including Data Quality Objectives (DQO) Report, Quality Assurance Project Plan (QAPP), Remedial Investigation (RI) Workplan, and Health and Safety Plan (HSP) have been prepared by B&V Waste Science and Technology Corp. (BVWST) for the Tulsa COE under Contract Number DACA 56-89-C0062.

The Building 3001 site has undergone extensive investigations to determine the nature and extent of contamination in and around this site (Tulsa COE, 1988a). In addition, a risk assessment (Tulsa COE, 1988b) and feasibility study (Tulsa COE, 1989a) have been completed for the Building 3001 site.

1.3 PURPOSE AND SCOPE OF THE SAMPLING AND ANALYSIS PLAN

This SAP presents a detailed description of field activities planned for the Phase I Remedial Investigation (RI) for the Soldier Creek site at Tinker AFB. It includes the following:

- o RI objectives and rationale.
- o Detailed descriptions of sampling methodology, duplicates and blanks, analytical requirements, sample containers and preservation for samples, and decontamination of sampling equipment.
- o Description of sample container decontamination, packaging, and shipping procedures.

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- o Descriptions of sample numbering and documentation.
- o Discussions of field organization and the field activities schedule.

2.0 SITE DESCRIPTION

2.1 SITE LOCATION AND DESCRIPTION

Tinker AFB is located in Oklahoma County to the southeast of the metropolitan area comprised of Oklahoma City, Del City, and Midwest City in central Oklahoma. The base is approximately bounded by Sooner Road to the west, Interstate 40 to the north, Douglas Boulevard to the east, and Southeast 74th Street to the South as illustrated on Figure 1-1. Soldier Creek is located mainly to the east of the base and flows to the north from its headwaters located mainly just to the north of Southeast 59th Street, to its confluence with Crutcho Creek approximately six miles downstream. Two tributaries, referred to as East Soldier Creek and West Soldier Creek, are located on the northeastern portion of Tinker AFB.

The Soldier Creek site includes Soldier Creek, its tributaries, and any areas underlying or adjacent to the waterway which may be contaminated by the migration of hazardous substances, pollutants, or contaminants from Tinker AFB (EPA, 1988c). For the purposes of the Phase I Soldier Creek RI, the study area will primarily consist of the tributaries which receive discharges or runoff from Tinker AFB (West and East Soldier Creeks) and the main branch of Soldier Creek from its headwaters to where it flows beneath East Reno Avenue.

Soldier Creek and its tributaries receive surface runoff from an area consisting of approximately 9,000 acres. Areas on Tinker AFB which contribute runoff or discharge to Soldier Creek and its tributaries include the Building 3001 site and the IWTP which comprises a total contributing area of approximately 300 acres. The Building 3001 site includes Building 3001 complex, two adjacent underground storage tank areas, and the surrounding areas encompassed by the lateral extent of contaminant plume (EPA, 1988c). The Building 3001 complex consists of an aircraft overhaul

and modification complex to support the mission of the Oklahoma City Air Logistics Center. The primary activities at Building 3001 include the following:

- o Disassembly, degreasing, cleaning, and inspection of aircraft and engine parts and components.
- o Plating, painting, heat treating, and testing of metal parts and components.
- o Assembly and repairing of accessories including electrical, valve and governor, gear box, tubing and cable, fuel controls, nozzles, pumps, and bearings.
- o Assembly, testing, and packaging of aircraft and aircraft components.

The North Tank Area contains abandoned underground storage tanks for fuel oil, diesel fuel, and gasoline, and is located north of Building 3001. The Southwest Tank Area contains abandoned fuel and solvent tanks and active solvent tanks, and is located to the southwest of Building 3001 (Tulsa COE, 1988a).

The IWTP, located in the northeastern portion of the base (Figure 1-2), receives industrial process discharge waters from the Building 3001 complex via a series of underground lines. Once received at the plant, these waters are treated and combined with treated sanitary wastewater prior to discharge to East Soldier Creek under an NPDES permit with the Oklahoma Water Resources Board (NUS, 1989).

2.2 SITE HISTORY

Tinker AFB was activated in March 1942 under the name of the Midwest Air Depot. During World War II, the depot was responsible for reconditioning, modifying and modernizing aircraft, vehicles and equipment. During this period, the civilian employment peaked at 14,925 employees.

At the conclusion of World War II, the Douglas Aircraft Plant located east of the north-south runway was annexed to the base. Tinker AFB became

involved in jet engine overhaul and later began modifying aircraft in a program to rebuild the nation's airpower. In 1948, Tinker AFB became a worldwide repair depot for several aircraft and a multitude of other weapons and engines. The level of activity has fluctuated during the history of the base, however the primary mission has not changed and Tinker AFB is still a major industrial complex for overhauling, modifying, and repairing military aircraft, aircraft engines, and accessory items.

The base has made several land acquisitions besides the Douglas Aircraft Plant. During 1951, the Air Force acquired a parcel of land located one half mile east of the southeast corner of Tinker AFB. The area was named the Oklahoma City Air Force Station and was supported by Tinker AFB. In 1956, the area officially became a separate entity; however support was still provided by Tinker AFB. The area was initially occupied by the 33rd Air Division and is presently occupied by the Engineering Installations Center, part of the Air Force Communications Command. In 1954 the base acquired a parcel of land south of the Southeast 59th Street boundary to extend the existing main runway. The land acquisition consisted of approximately 300 acres. During 1956, the base acquired additional land in the same area completing the parcel of land south of Southeast 59th Street presently within Tinker AFB jurisdiction. In 1957, a 638 acre tract of land immediately west of the original air base was acquired to develop permanent military housing and community support facilities. In 1975, the base acquired an additional 187 acres of land situated contiguous to the west side of Air Depot Boulevard between Southeast 59th Street and Southeast 44th Street (Engineering Science, 1982).

As part of the overall Air Force Installation Restoration Program (IRP), Tinker AFB began an investigation of previously used waste disposal sites in 1981 (EPA, 1988c). A basewide sampling program was conducted in 1983. Analytical results from the sampling program detected trichloroethene in the groundwater. Remedial investigations were conducted by the Tulsa COE

from 1986 - 1988 to determine the nature and extent of groundwater contamination in the Building 3001 complex area. These investigations determined that chromium, in addition to trichloroethene were contaminants of concern in the groundwater (Tulsa COE, 1988a). On July 22, 1987, the Building 3001 site and the Soldier Creek site were added to the National Priorities List (NPL). On December 9, 1988, EPA Region VI, the OSDH, and the United States Air Force, Tinker AFB signed into a Federal Facility Agreement under CERCLA Section 120 to "ensure that the environmental impacts associated with past and present activities at the [Building 3001 and Soldier Creek sites] are thoroughly investigated and appropriate remedial action taken as necessary to protect the public health, welfare, and the environment" (EPA, 1988c). The specific activities to be performed under the Federal Facilities Agreement include, but are not limited to, completion of RI/FS activities at the Soldier Creek site (EPA, 1988c).

The Building 3001 site has undergone extensive investigations to determine the nature and extent of contamination in and around the complex. In addition, a risk assessment (Tulsa COE, 1988b) and feasibility study (Tulsa COE, 1989a) have been completed for this site. The North Tank Area has been identified as a Separate Operable Unit and the Southwest Tank Area is being remediated in accordance with Underground Storage Tank Regulations.

Investigation of possible sediment and surface water contamination of Soldier Creek began in 1984 (Radian, 1985b). Additional information on investigations conducted to determine the extent of contamination in Soldier Creek is presented in Section 2.3, Previous Investigations and Reports. Based on the results of the investigations of Soldier Creek, a removal action was performed on portions of East and West Soldier Creeks on Tinker AFB in early 1986. Visibly contaminated sediments were removed and disposed in an approved hazardous waste landfill. Post-removal sampling and visual inspection indicated that some contaminants may still be present in the sediments in Soldier Creek (Tulsa COE, 1988a). A storm sewer

investigation for Soldier Creek was completed in October 1989 to determine which storm sewers could potentially transmit contaminants from Building 3001 to Soldier Creek (NUS, 1989).

2.3 PREVIOUS INVESTIGATIONS AND REPORTS

A variety of investigations pertaining to the Soldier Creek site have been conducted by a number of organizations since 1984. A summary of these previous investigations and pertinent reports is shown in Table 2-1. A description of each of these previous investigations is given in this section including, if known, the purpose of each investigation, sampling locations, pertinent analytical data, sample methodology and conclusions.

Data from previous investigations were compiled, reviewed, and evaluated by selected primary data users to assess the adequacy and uncertainty of the data gathered during each previous relevant investigation. Numerous inconsistencies were apparent from evaluation of existing surface water and sediment data for the Soldier Creek site. A summary of these inconsistencies is presented below:

- o The same types of chemical analyses were not completed for each medium across all previous investigations. For example, sediment samples taken by Radian Corporation in 1984 were analyzed for metals, PCBs, nitrates, and total organic carbon while sediment samples obtained by the OSDH in 1987 were analyzed for metals only.
- o Sample locations were not consistent for each medium across all previous investigations. For example, sediment samples were collected from off-base portions of West Soldier Creek by EPA in 1984 and the OSDH in 1987, but were collected from different points along West Soldier Creek.
- o Inadequate documentation was included in reports from several previous investigations to allow determination of sample locations, method of sampling, or analytical laboratory performing the analyses.

TABLE 2--1
 SUMMARY OF PREVIOUS INVESTIGATIONS
 LINKER AFB - SOLDIER CREEK RIIFS
 SAMPLING AND ANALYSIS PLAN

REFERENCE DOCUMENT	SAMPLER	DATES	SAMPLE MEDIUM	SAMPLE ANALYSIS	ANALYZED BY
Installation Restoration Program Phase II Confirmation/Quantification Stage 2 Final Report for Tinker AFB, Oklahoma (Radian, 1985b)	Radian Corporation	6/84	Sediment	Metals, Fluoride, Cyanide, PCBs, Pesticides, Phenols, Nitrates, and Total Organic Carbon	Radian Laboratories
An Evaluation of the Effects of Wastewater Discharge from TAFB on Water Quality of Crutchio & Soldier Creeks (EPA, 1984)	EPA	7/85	Sediment Water	Metals, VOCs, BNAS Metals, VOCs, BNAS, Water Quality Data	EPA Laboratory
Site Investigation Report (HKS, 1985)	Harry Keith & Sons, Inc.	10/85	Sediment	Metals, VOCs, BNAS, PCBs, Pesticides Fluoride, Nitrate, Cyanide, Phenols	Environmental Laboratories Inc.
* Sample Results* (1) Report (HKS, 1986)	Harry Keith & Sons, Inc.	4/86 & 5/86	Sediment	Metals, BTX, VOCs	Environmental Control Laboratory
* Sample Results* (1) Report IWTP & STP Discharges (Linker AFB, 1987a)	Linker AFB	3/87 - 9/87	Water	VOCs	ME-ILAB
* Sample Results* (1) Report (OSDH, 1987)	Oklahoma State Department of Health	6/87	Sediment Water	Metals Metals, VOCs	Oklahoma State Department of Health Laboratory
RIIFIES Analytical Results (Linker AFB, 1987b)	Linker AFB	9/86 - 7/87	Water	Water Quality Data (pH, TSS, Oil and Grease)	Analab of Texas
Building 3001 Remedial Investigations, Volumes I and II (Tulsa COE, 1988a and 1988b);	Tulsa COE	3/88, 10/88	Groundwater	VOCs, BNAS, Metals; TOC; pH, Specific Conductivity, TICs (2)	Southwestern Division Laboratory, COE
Building 3001 Supplemental Quarterly Remedial Investigation, Draft (Tulsa COE, 1989a); Linker AFB Groundwater Assessment Update (Tulsa COE, 1988b), and * Sampling Results* (1) Groundwater Report (Tulsa COE, 1988c)	Linker AFB				Oklahoma State Department of Health
Final Storm Sewer Investigation For Soldier Creek (NUS, 1989)	NUS Corporation	10/89	Water	VOCs, Metals (Cd, Cr, Cu, Pb, Ni, Zn), Oils and Grease, COD, Cyanide, Total Phenols, Phosphorus, Chromium (Hex)	Oklahoma State Department of Health Southwest Laboratory of Oklahoma NUS Corporation

NOTES:
 (1) *Sampling Results* - No reports were generated.
 (2) TICs - Tentatively Identified Compounds.

- o Inadequate documentation was included in reports from several previous investigations regarding QA/QC protocols (ie. submittal of trip blanks with samples to be analyzed for volatile organic compounds, and submittal of field method, equipment, and rinsate blanks.
- o Trends in the data could not be established because chemical compounds which were previously identified during one sampling investigation were not analyzed for during the subsequent investigation. For example, acid, base/neutral extractables were detected in sediment samples from on-base portions of West and East Soldier Creeks in the Harry Keith and Sons 1985 investigation, but they were not analyzed for in sediment samples taken from on-base portions of East Soldier Creek in a 1986 investigation.

The above-presented inconsistencies in existing data for the Soldier Creek site relate directly to the evaluation of precision, accuracy, representativeness, completeness, and comparability (PARCC) data quality parameters when assessing the adequacy and uncertainty associated with the sampling activities. Definitions for each of the PARCC parameters are included in the Quality Assurance Project Plan, (Chapter II). The evaluation of the existing data for the Soldier Creek site with regard to each PARCC parameter is presented below:

- o Precision - Information concerning the quality assurance of previous sampling investigations was limited or not available.
- o Accuracy - Information concerning blanks, sample method, sample preservation, sample custody, and analytical techniques was limited or not available.
- o Representativeness - Information regarding the sampling method and quality assurance of the resulting data was limited or not available.
- o Completeness - Information regarding the number of planned samples versus the number actually collected to assess field completeness, as well as information regarding the number of samples with valid analytical data versus the total number of samples analyzed to assess laboratory completeness, was limited or not available.

- o Comparability - The list of inconsistencies previously presented illustrates that existing data are comparable but with limitations. Sample locations and analytical parameters were not consistent within each medium across all previous investigations.

As a result of the above inconsistencies in the existing data, results from previous surface water and sediment sampling investigations at the site should be utilized with caution. Further data collection activities are required to characterize the nature and extent of contamination present at the Soldier Creek site.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The Soldier Creek site may be contracted to a lead contractor with two subcontractors including a geotechnical contractor and a contract laboratory program (CLP) laboratory by the Tulsa COE. Project organization for the Soldier Creek RI/FS is shown in Figure 3-1. The lead contractor will assume overall responsibility for the Phase I RI/FS. A CLP laboratory will analyze all samples for chemical analyses and subcontract the physical testing of sediment samples. The geotechnical contractor may not be used at this time because no drilling of borings for groundwater wells may be done.

The Project Manager will be in charge of the budget, schedule, and overall quality assurance of the project. The Project Engineer/Scientist will be responsible for completion of the technical tasks as described in the RI Workplan. The lead technical staff personnel will be in charge of directing work of subcontractors and coordinating work efforts by other discipline professionals used on the project.

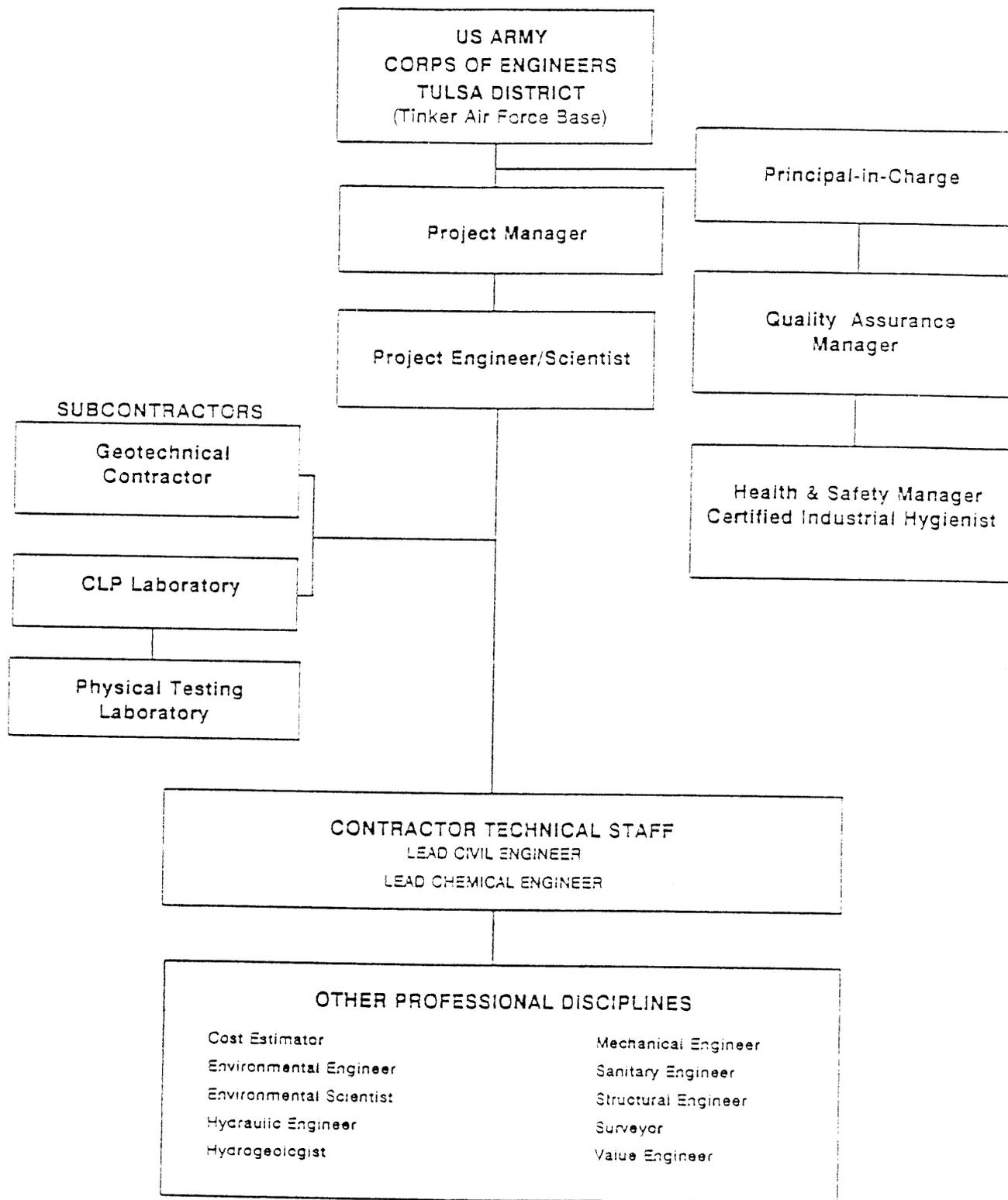


FIGURE 3-1
PROJECT ORGANIZATION
TINKER AFB - SOLDIER CREEK RIFES
SAMPLING AND ANALYSIS PLAN

4.0 SCOPE AND OBJECTIVES OF THE REMEDIAL INVESTIGATION

The purpose of the RI is to evaluate the nature and extent of the release or threat of release of hazardous substances from a site and to gather data to support the development and evaluation of remedial alternatives in the FS. During the review of existing data, a series of data gaps were identified which formed the basis for developing the proposed RI field investigation scope of work. These data gaps and suggested solutions are summarized in Table 4-1. As the RI proceeds, additional data gaps may be identified.

The following is a summary of the RI objectives, organized by medium for the Soldier Creek site.

o Sediment

- Determine depth of contamination within stream sediment.
- Determine downstream extent of contamination within Soldier Creek which may be attributable to Tinker AFB.
- Determine contaminant concentrations within Soldier Creek sediment.
- Determine physical and chemical characteristics of sediment for use in the development of potential remedial technologies.
- Determine sediment particle size fraction(s) which may be a transport mechanism for absorbed contaminants.
- Assess correlation of acid, base/neutral extractables (BNAs) vs. metals contamination within Soldier Creek by sample location (Phase I RI) to attempt to reduce analytical costs in the Phase II Field Investigation. If a correlation between BNAs and metals is determined, only selected metal analyses will be performed on samples collected in the Phase II investigation, thereby reducing overall project costs.

TABLE 4-1

DATA GAPS
TINKER AFB - SOLDIER CREEK RI/FS
SAMPLING AND ANALYSIS PLAN

AREA OR ITEM OF CONCERN	DATA GAPS	SUGGESTED SOLUTIONS
SEDIMENT	<p>What is the depth of contamination within the stream sediment?</p> <p>What is the extent of contamination within Soldier Creek sediment?</p> <p>What are the physical and chemical characteristics for use in the development of potential remedial technologies?</p>	<p>Sediment samples will be taken at two depths: 0-6 inches and 6-12 inches for all sediment sampling locations.</p> <p>Sediment samples will be taken downstream in Soldier Creek in areas not previously sampled for contamination.</p>
	<p>What is the sediment particle size fraction(s) which may be a transport mechanism for adsorbed contaminants?</p> <p>Is there a correlation between acid base/neutral extractables and metals contamination within Soldier Creek by sample location?</p>	<p>The following physical and chemical parameters will be analyzed: (1) Physical: total organic carbon, Atterberg limits, permeability, particle size, and density (2) Chemical: volatile organics, acid, base/neutral extractables, metals, and cyanide.</p> <p>The physical parameters including total organic carbon, Atterberg limits, permeability, particle size, and density will be analyzed.</p> <p>A statistical comparison between the analytical results for acid base/neutral extractables and metals will be done to determine if a correlation exists.</p>

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TABLE 4-1 (CONTINUED)

DATA GAPS
 TINKER AFB - SOLDIER CREEK RI/FS
 SAMPLING AND ANALYSIS PLAN

AREA OR ITEM OF CONCERN	DATA GAPS	SUGGESTED SOLUTIONS
SURFACE WATER	<p>What is the rate and volume of flow along Soldier Creek and major tributaries from Tinker AFB?</p> <p>Which segments of Soldier Creek and major tributaries from Tinker AFB are recharge (gaining) segments and which are discharge (losing) segments?</p> <p>What is the extent of contaminant concentrations within the Soldier Creek water column?</p> <p>Are there any off-base inflow points to Soldier Creek and major tributaries for Tinker AFB which may contribute to flow and/or contamination of the stream?</p>	<p>The surface water stream velocity in Soldier Creek and its major tributaries will be measured every 500 feet from East Reno Avenue to its headwaters and at sediment and surface water sampling locations. Flow volume will be calculated for each station.</p> <p>The stream velocity will be measured along Soldier Creek every 500 feet from East Reno Avenue to its headwaters and sediment and surface water sampling locations. Flow volume will be calculated for each station.</p> <p>Surface water samples within the Soldier Creek water column will be collected downstream of areas not previously sampled for contamination.</p> <p>Surface water sampling locations will be positioned within Soldier Creek and tributaries emanating from Tinker AFB such that potential contamination from identified off-base inflow points may be evaluated.</p>

TABLE 4-1 (CONTINUED)

DATA GAPS
 TINKER AFB - SOLDIER CREEK RI/FS
 SAMPLING AND ANALYSIS PLAN

AREA OR ITEM OF CONCERN	DATA GAPS	SUGGESTED SOLUTIONS
SURFACE WATER (CONTINUED)	<p>What are the chemical characteristics and contaminant concentrations which may affect selection of potential remedial action technologies?</p>	<p>The following chemical characteristics, which may affect selection of potential remedial action alternatives, will be analyzed: volatile organics, acid, base/neutral extractables, metals, cyanide, alkalinity, hardness, COD, BOD5, TOC, oil and grease, and nitrates.</p>
GROUNDWATER	<p>What are the water levels in the selected existing off-base wells located within the Soldier Creek drainage basin?</p>	<p>Water levels will be measured in the selected off-base wells located within the Soldier Creek drainage basin.</p>
	<p>What is the chemical contamination of groundwater collected from selected existing off-base wells?</p>	<p>Groundwater samples will be collected from selected existing off-base wells and analyzed for the following chemical parameters: volatile organics, acid base/neutral extractables, metals (filtered and unfiltered), and cyanide.</p>

o Surface Water

- Determine rate and volume of flow at specific locations along Soldier Creek and major tributaries from Tinker AFB.
- Assess potential losing and gaining segments of Soldier Creek and major tributaries from Tinker AFB using non-intrusive methods.
- Determine contaminant concentrations within the Soldier Creek water column.
- Determine off-base inflow points to Soldier Creek and major tributaries from Tinker AFB which may contribute to flow and/or contamination of the stream.
- Determine physical and chemical characteristics which may affect selection of potential remedial technologies.

o Groundwater

- Determine water levels in existing off-base wells located within the Soldier Creek drainage basin.
- Determine contaminant concentrations of groundwater collected from selected existing off-base wells.

To accomplish these objectives, the RI will include the collection and analysis of sediment, surface water and groundwater samples, the measurement of water levels in selected off-base groundwater monitoring wells, and the measurement of the stream velocity. The additional data gathered will be used to support a quantitative human health and a qualitative environmental risk assessment as well as to evaluate remedial alternatives in the FS.

Remedial objectives provide the foundation for the development of preliminary remedial alternatives and subsequent evaluation activities during the FS. They are developed to prevent contact between the receptors (population at risk) and the contaminant sources. Remedial objectives were developed for sediment, surface water, and groundwater media. Each of these sources and the corresponding remedial objectives were discussed in the Data Quality Objectives Report. The potential receptors for each medium, along with their corresponding remedial objectives are outlined in Table 4-2.

TABLE 4-2

SITE REMEDIAL OBJECTIVES
 TINKER AFB - SOLDIER CREEK RI/FS
 SAMPLING AND ANALYSIS PLAN

MEDIA	RECEPTORS	REMEDIAL OBJECTIVES
SEDIMENT	Humans or animals coming in contact with contaminated sediment (on-base and off-base).	Prevent human and animal contact with contaminated sediment (on-base and off-base).
	Humans or animals ingesting contaminated sediment (on-base and off-base).	Prevent contaminant release into surface water.
	Humans or animals ingesting game animals that have been contaminated while on-base or off-base.	Prevent contaminant release into groundwater. Prevent contaminant transport from distributing contaminants further downstream.
SURFACE WATER	Humans or animals coming in contact with contaminated surface water (on-base and off-base).	Prevent human or animal contact with contaminated surface water (on-base and off-base).
	Humans or animals ingesting contaminated surface water (on-base and off-base).	Prevent degradation of downstream surface water by on-base sources of surface water contamination.
		Prevent degradation of groundwater via recharge by contaminated surface water.
GROUNDWATER	Humans coming in contact with contaminated groundwater (off-base).	Prevent human contact with contaminated groundwater (off-base).
	Humans ingesting contaminated groundwater (off-base).	Prevent degradation of surface water via recharge by contaminated groundwater.
	Humans inhaling contaminants via use of contaminated groundwater (off-base).	

5.0 FIELD INVESTIGATION RATIONALE

The objectives of the RI are to supplement existing data with information that will make it possible to characterize the site, to prepare a risk assessment evaluating the level of endangerment posed to the human health and the environment by the contaminants, and to prepare an FS of remedial action alternatives.

The rationale for each of the RI activities is discussed in the subsequent subsections. The locations of proposed on-base sampling locations are shown on Figure 5-1. Proposed off-base sediment and surface water sampling locations are illustrated on Figure 5-2. Proposed off-base groundwater well sampling locations are given on Figure 5-3.

A summary of the number of samples, excluding duplicates and blanks, and the rationale for the chemical and physical analyses to be performed is provided in Table 5-1. The rationale for selection of each sampling location is shown in Table 5-2. A description of the off-base groundwater wells and rationale for sampling each well is shown in Table 5-3. The number of samples, sample locations, and analytical tests to be performed were based on the objectives of the RI. Field conditions may require an adjustment to the total number of samples.

Equipment rinsate blanks, trip blanks, and duplicates will be prepared to provide quality control data on decontamination measures, contamination due to transportation and sample collection techniques. A trip blank will be submitted with each shipment of water samples to be analyzed for volatile organics. The number of field blanks and duplicate samples will be reevaluated if the number of samples collected by the field team differs from the proposed value.

LEGEND

E09 ●
E10 ●

BUILDING E
SOLDIER C
● SAMPLING

W04 ●

● E07

● E06

- NOTES
- NUMBER NEXT TO DENOTES SAMPLING
 - OFF-FALL NUMB RESULT OF THE
 - OFF-BASE SAMPLING ON FIGURES 5-2 AND

W03 ●

● E05

REFERENCE : NUS , 1

W02 ●

● E04



● E03

● E02

W01 ●

● E01

FIGURE
ON BAS
TINKER /
SAMPLING

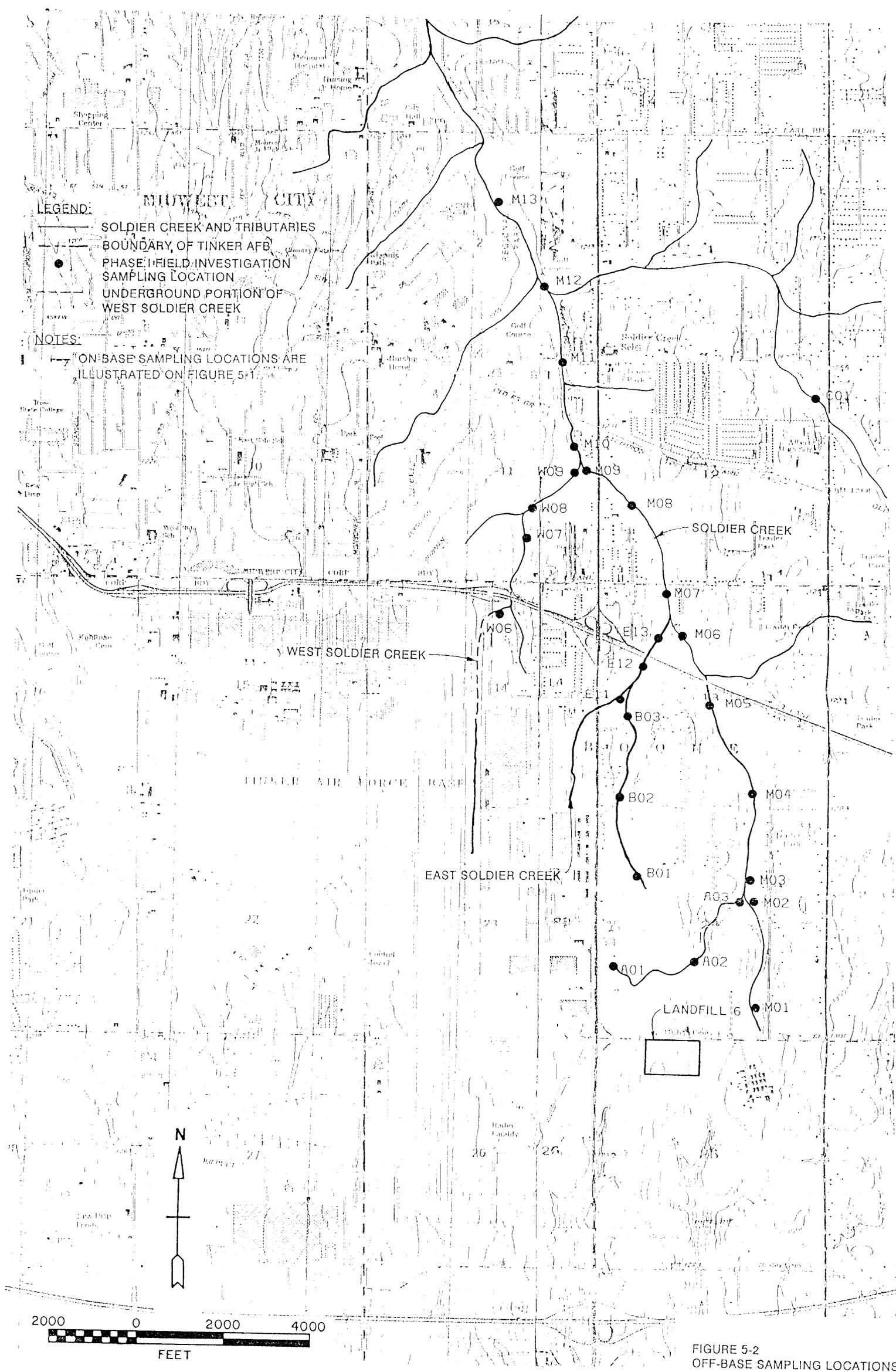


FIGURE 5-2
 OFF-BASE SAMPLING LOCATIONS
 TINKER AFB - SOLDIER CREEK RI/FS
 SAMPLING AND ANALYSIS PLAN

LEGEND:

- SOLDIER CREEK AND TRIBUTARIES
- - - UNDERGROUND PORTION OF WEST SOLDIER CREEK
- SAMPLING LOCATION

NOTES:

- OFF-BASE SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS ARE SHOWN ON FIGURE 5-2.
- ON-BASE SEDIMENT AND SURFACE WATER SAMPLING LOCATIONS ARE SHOWN ON FIGURE 5-1

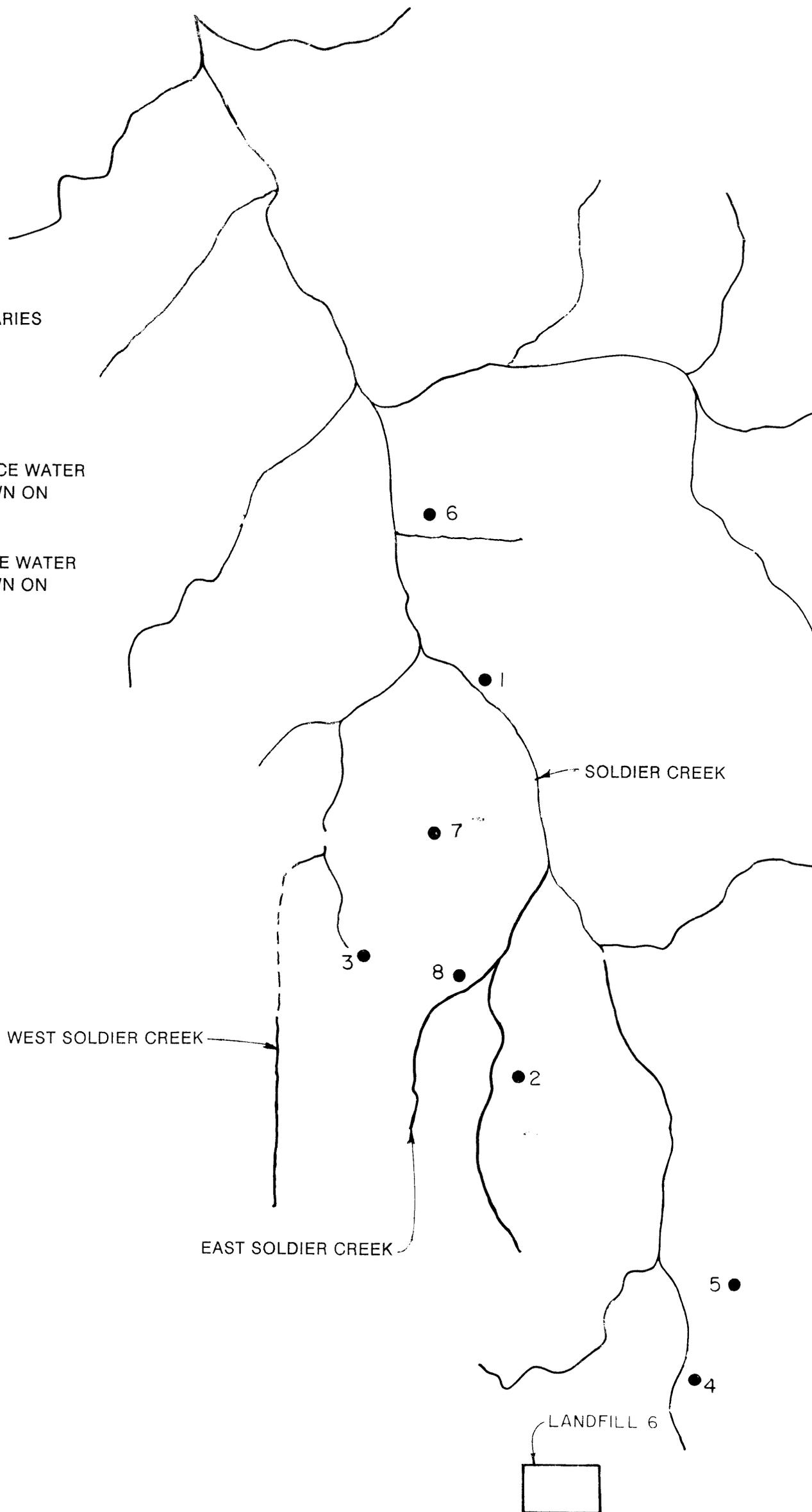


TABLE 5-2

SAMPLE LOCATION RATIONALE
TINKER AFB - SOLDIER CREEK RI/FS
SAMPLING AND ANALYSIS PLAN

<u>SAMPLING LOCATION</u>	<u>RATIONALE</u>
WO1-WO5, EO1-E10	On-base East and West Soldier Creek sampling locations established upstream and downstream of known outfalls (NUS, 1989).
WO6-WO9, E11-E13, BO1-BO3 M06, M07, M09, M10	Sampling locations upstream and downstream of each tributary along Soldier Creek and each tributary emanating from Tinker AFB, from its headwaters to East Reno Avenue.
A01 and M01	Determine contaminant concentrations at Headwaters locations on main branch of Soldier Creek. Evaluate potential use as additional background sediment and surface water locations.
AO2-AO3, MO2-MO3	Sampling locations upstream of the confluence of East Soldier Creek with main branch of Soldier Creek to evaluate possible contaminant contributions from possible off-base sources.
MO4, MO5, MO8, M11-M13	Sampling locations at a minimum of every 2000 feet along Soldier Creek unless dictated otherwise by confluences of the Creek or other physical field conditions. Preference will be given to existing sample locations. Location M04 is an existing sample location.
CO1	Background sediment and surface water location.

TABLE 5-3
 OFF-BASE GROUNDWATER WELL LOCATIONS AND RATIONALE
 TINKER AFB - SOLDIER CREEK RIIFS
 SAMPLING AND ANALYSIS PLAN

LOCATION NO.	WELL LOCATION	OWNER	DEPTH OF WELL (FT)	PRIMARY WATER USE	STATIC WATER LEVEL (FT)	WATER LEVEL DATE	RATIONALE
01	11N-02W-12 BCBI	FROST	35.9	D	5.99	4/21/87	Proximity to Soldier Creek; Static Water Level Within the Perched Aquifer; To help define the nature and extent of contamination.
02	11N-02W-13 NE, SW, SW	THOMPSON	100	D	80	03/25/85	Proximity to E Soldier Creek; Static Water Level Within the Regional Aquifer; To help define the nature and extent of contamination.
03	11W 02W-14 SE, SW, NE	SHADY WOOD PUMP	95	D	Unknown	08/28/86	Proximity to W Soldier Creek; To help define the nature and extent of contamination.
04	11N-02W-24 SE, NW, SE	BLUHYMAN	100	D	35	11/24/86	Proximity to Soldier Creek; Static Water Level Within the Perched Aquifer; To help define the nature and extent of contamination.
05	11N-02W-24 SW, SE, NE	LOCKHART	100	D	4	10/23/87	Proximity to Soldier Creek; Static Water Level Within the Perched Aquifer; To help define nature and extent of contamination.
06*	9026 S E 15th	SHANG-RI-LA	--	--	--	--	Proximity to Soldier Creek; To help define nature and extent of contamination.
07*	9101 S E 29th	FITZPATRICK	--	--	--	--	Proximity to Soldier Creek; To help define nature and extent of contamination.
08*	3253 S. Douglas	BLOCKYOU	--	--	--	--	Proximity to Soldier Creek; To help define nature and extent of contamination.

* This groundwater well information provided by EPA/TAFB. Dashes in the table indicate that the information was not known at the time of publication of this Final OAPP/SAP.

Primary Water Use
 D - Domestic
 IM - Test/Monitoring

ASSUMPTIONS:

- (1) ONLY WELLS WITHIN BASE MAY BE OF INTEREST WERE INVESTIGATED
- (2) ONLY WELLS HAVING WATER LEVELS < 50 FT FOR THE PERCHED AQUIFER AND WATER LEVELS < 150 FT FOR THE REGIONAL AQUIFER WERE CONSIDERED

Due to the location of potential sources of contamination with regard to Soldier Creek, surface water and sediment background samples will be on private property, located on an eastern branch within the creek's drainage basin. Background groundwater analytical data collected in the vicinity of the site will be provided by the Tulsa COE. The purpose of these background samples is to document the natural concentrations of compounds and parameters (if any) of the environmental media under investigation for comparison of soil and water samples in and along Soldier Creek. The rationale for inclusion or exclusion of field duplicates and the number of proposed duplicate samples per media is outlined in each of the following subsections.

5.1 SEDIMENT INVESTIGATION

Limited sediment sampling activities in previous investigations have been performed at the Soldier Creek site. These previous investigations do not provide enough analytical data to adequately evaluate the presence and extent of sediment contamination. The following areas will be investigated:

- o Depth of contamination within the Soldier Creek stream sediment.
- o Contaminant concentration within Soldier Creek sediment.
- o Physical and chemical characteristics of sediment for use in the development and evaluation of potential remedial technologies.
- o Sediment particle size fraction which may be a transport mechanism for adsorbed contaminants.
- o Correlation of acid, base/neutral extractables with metals contamination within Soldier Creek by location (Phase I RI) to attempt to reduce analytical costs in the Phase II Field Investigation. If a correlation between BNAs and metals is determined, only selected metals analyses will be performed on samples collected in the Phase II investigation thereby reducing overall project costs.

A variety of sediment sampling will be performed to gather information which will define these investigation objectives. Ninety-three sediment samples including QC and background samples will be taken at forty-two

sampling locations. These sediment samples will be collected over the entire off-base stretch of Soldier Creek of interest and on-base portions of East and West Soldier Creeks based on locations of existing outfalls (NUS, 1989).

The proposed on-base and off-base sediment sampling locations are shown in Figures 5-1 and 5-2, respectively.

These sediment sampling intervals were selected to determine contaminant concentrations at the following locations:

- o Upstream and downstream of known on-base outfalls (as denoted in NUS, 1989).
- o Upstream and downstream of each tributary along Soldier Creek and each tributary emanating from Tinker AFB, from its headwaters to East Reno Avenue.
- o At a minimum distance of 2000 feet along Soldier Creek, with preference given to previous sample locations.

Composite sediment samples across a transect will be collected at two depths (0-6 inches and 6-12 inches) at each sampling location. The composite sediment samples will be analyzed for substances on the Target Compound List (TCL) including acid, base/neutral extractables and Target Analyte List (TAL) including metals and cyanide. In addition, SAS analyses including Atterberg limits, sediment particle size, permeability, and density will be performed on samples from eight of the sampling locations. SAS analyses for total organic carbon will also be performed on sediment samples collected from each of the forty-two sampling locations. Results of the analyses will be used to determine pertinent physical characteristics which will be used during development and evaluation of remedial technologies.

At each sampling location, one discrete grab sediment sample will be taken at each depth and analyzed for volatile organics on the TCL. This grab sediment sample will be located at the subsample location which is most

likely to contain volatile organic contamination based on stream morphology and visual observations. For example, if the stream contains a meander, the grab sediment sample will be collected on the outside portion of the stream meander or is visually discolored sediment. All samples will be screened with an HNU photoionization unit.

One sediment background sample will be taken off-base, on a major tributary on an eastern branch within the Soldier Creek drainage basin, because of potential sources of contamination with regard to the creek. The precise location of this background sample will be determined in the field. The background sediment sample will be collected in the same manner and analyzed for the same parameters as sediment samples discussed previously.

Eight duplicate sediment samples will be collected. The exact locations of these sediment duplicate samples will be determined in the field and will be a function of the ability to obtain sufficient sediment sample volume. The duplicate samples will be used to assess the combined effects of sample collection, handling, and analysis on data precision. These duplicate samples will be analyzed for the same chemical parameters as the sediment samples.

One sediment equipment rinsate blank will be prepared corresponding to the sampling method used in collecting the sediment samples. These blank samples will be collected and analyzed to determine the extent to which field procedures contribute to sample contamination. These blank samples will be analyzed for the same chemical parameters as the sediment samples.

5.2 SURFACE WATER INVESTIGATION

Limited surface water sampling investigations have been performed at the Soldier Creek site. These previous investigations do not provide enough analytical data to adequately evaluate the presence and extent of surface water contamination. The following areas will be investigated:

- o Contaminant concentrations within Soldier Creek water column.

- o Physical and chemical characteristics which may affect development and evaluation of potential remedial technologies during the FS.
- o Rate and volume of flow at specific locations along Soldier Creek and major tributaries from Tinker AFB.
- o Potential losing and gaining segments of Soldier Creek and major tributaries from Tinker AFB.

Sixty-three surface water samples including QC and background samples will be collected at the same forty-two sampling locations as the sediment samples. Composite surface water samples across a transect will be collected at one depth (mid water column) at each sampling location. All composite surface water samples will be analyzed for substances on the TCL and TAL including acid, base/neutral extractables, metals, and cyanide. In addition, SAS analyses including alkalinity, hardness, chemical oxygen demand (COD), total suspended solids (TSS), 5-day biochemical oxygen demand (BOD5), total organic carbon (TOC), oil and grease, and nitrates will be performed on eight samples to be determined in the field.

At each sampling location, a discrete grab surface water sample will be collected and analyzed for volatile organics on the TCL. This grab surface water sample will be located at the subsample location which is most likely to contain volatile organic contamination based on stream morphology or visual observations. Temperature, specific conductivity, dissolved oxygen and pH measurements will be taken in the field at each surface water sample location after the collection of surface water samples.

One surface water background sample will be collected off-base at the same location as the sediment background sample. This background surface water sample will be collected at a location on an eastern tributary within the Soldier Creek drainage basin due to the location of potential sources of contamination with regard to the creek. The precise location of this background sample will be determined in the field. The background surface water sample will be collected in the same manner and analyzed for the same parameters as surface water samples discussed previously.

Five duplicate surface water samples will be collected. The exact locations of these duplicate samples will be determined in the field and will be collected at the same location as the sediment duplicate samples. The duplicate samples will be used to assess the combined effects of sample collection, handling, and analysis on data precision. These duplicate samples will be analyzed for the same chemical parameters as the surface water samples.

One surface water equipment rinsate blank will be prepared corresponding to the sampling method used in collecting the surface water samples. These blanks will be collected and analyzed to determine the extent to which field procedures contribute to sample contamination. These blank samples will be analyzed for the same chemical analyses as the matrix surface water samples.

Approximately fifteen surface water trip blanks will be prepared by the CLP laboratory, shipped to the Soldier Creek site, and shipped back to the CLP laboratory with each shipment of surface water samples. The actual number of trip blanks will be dependent on the number of coolers shipped to the CLP laboratory. The purpose of the trip blank is to determine if any contamination in the samples is caused by transportation of the samples.

5.3 SURFACE WATER FLOW INVESTIGATION

Soldier Creek surface water velocity will be determined in the field at each surface water sampling location. These measurements will allow computation of rates and volumes of flow which will allow for non-intrusive estimation of losing and gaining portions of Soldier Creek.

Measurements to calculate surface water flows will be taken at each sediment and surface water location and at stations located every 500 feet along Soldier Creek (including those tributaries that emanate from Tinker AFB) from its headwaters located just north of Landfill 6 to at least east

Reno Avenue. The 500 foot interval distance may be modified in the field to take into account stream morphology effects on flow measurements. The flow velocity measurement procedure will be described in section 6-4.

5.4 STREAM SURVEY INVESTIGATION

A visual, walking survey of the entire length of Soldier Creek (including those tributaries that emanate from Tinker AFB) from East Reno Avenue at its downstream end, upstream to the headwaters, will be completed to measure physical dimensions of the creek and to locate all outfalls and storm drains which enter the stream along this area of interest. As part of this visual survey, the field team will map and survey the stream profile at survey stations established approximately every 100 feet. In addition, the field team will note stream morphology characteristics and surrounding land use for future reference in identifying potential impacts on the stream by area residents and industry.

5.5 GROUNDWATER INVESTIGATION

Existing data are insufficient to characterize the groundwater off-base. The following areas will be investigated:

- o Contaminant concentrations of groundwater collected from selected existing off-base wells.
- o Water levels in existing off-base wells located within the Soldier Creek drainage basin.

Groundwater level measurements, total depth of well measurements, and groundwater samples will be collected at existing off-base private wells located within the Soldier Creek drainage system shown on Figure 5-3. The rationale for sampling each of these wells is given in Table 5-3.

Groundwater samples will be collected at each monitoring well. All groundwater samples will be analyzed for compounds on the TCL and TAL including acid, base/neutral extractables, metals, and cyanide. At three

wells determined in the field, the groundwater samples will also be filtered for metals based on the volume of groundwater collected from each well to determine the fraction of total metals adsorbed onto soil particles and the fraction in the dissolved phase.

At each well, a groundwater sample will be taken and analyzed for volatile organics on the TCL. This groundwater sample will be taken first and poured directly from the bailer into the sample bottle. Temperature, specific conductivity, and pH measurements will be taken at each off-base groundwater sampling location.

No background groundwater sample will be collected as previous groundwater investigations at Tinker AFB have determined background groundwater concentrations for the vicinity (Tulsa COE, 1989).

One duplicate groundwater sample will be taken. The exact location of this duplicate sample will be determined in the field. The duplicate sample will be used to assess the combined effects of sample collection, handling and analysis on data precision. This duplicate sample will be analyzed for the same chemical parameters as the groundwater samples.

One groundwater equipment rinsate blank will be prepared corresponding to the sampling method used in collecting the groundwater samples. This blank will be collected and analyzed to determine the extent to which field procedures contribute to sample contamination. This blank sample will be analyzed for the same chemical analyses as the groundwater samples.

Approximately three groundwater trip blanks to be analyzed for volatile organics will be collected using the same sampling method used in collecting groundwater samples. A trip blank will be sent with each shipment of groundwater samples. The trip blanks will be prepared by the CLP laboratory and shipped to the appropriate sampling locations. The purpose of the trip blank is to determine if any contamination in the samples is caused by transportation of samples.

6.0 SPECIFIC INVESTIGATION ACTIVITIES

Specific investigation procedures for the Phase I RI are discussed in the following subsections:

- o Sediment Investigation.
- o Surface Water Investigation.
- o Surface Water Flow Investigation.
- o Stream Survey Investigation.
- o Groundwater Investigation.

The sample container requirements, preservation methods, holding time requirements, and sample quantities for chemical analyses are summarized by sample matrix in Table 6-1. Samples for chemical analyses will be kept out of the sun and will be iced, as appropriate, as soon as possible after sample collection. Samples with limited holding times will be shipped by an overnight delivery service on the day they are collected. Samples without a critical holding time may be temporarily held in a secure area at Tinker AFB until enough samples of this type are collected to fill a sample cooler during shipment.

6.1 SEDIMENT INVESTIGATION

Ninety-three sediment samples including duplicates (8), and an equipment rinsate blank (1) will be collected at forty-two sampling locations. The approximate locations of these sediment samples are shown on Figures 5-1 and 5-2. It should be noted that sampling is proposed on property owned by several different individuals. Access to Soldier Creek to perform sediment sampling is dependent upon receipt of property access permission by the project team via the Tulsa COE.

TABLE 6-1

SAMPLE CONTAINER PRESERVATION AND HOLDING TIME REQUIREMENTS
 TINKER AFB - SOLDIER CREEK
 SAMPLING AND ANALYSIS PLAN

<u>Sample Matrix</u>	<u>Analyses</u>	<u>Number of Containers Per Analysis</u>	<u>Container Description</u>	<u>Preservation Requirements</u>	<u>Maximum Holding Time</u>	<u>Minimum Sample Volume Required</u>	<u>Packing</u>
Sediment	Volatille Organics	1	125 ml glass vial	Cool to 4 C,	-	50 g	Vermiculite or poly-foam cooler
	Acid, Base Neutral Extractables	1	500 ml glass jar	Cool to 4 C,	-	100 g	Vermiculite or poly-foam cooler
	Total Metals, Cyanide	1	8 oz wide-mouth glass jar	Cool to 4 C,	-	100 g	Vermiculite or poly-foam cooler
Groundwater, Surface Water	Volatille Organics	2	40 ml glass vial	Cool to 4 C, add 1 drop 1:1 HCL.	14 days	80 ml	Vermiculite or poly-foam cooler
	Acid, Base/Neutral Extractables	2	1 liter glass bottle	Cool to 4 C, if residual chlorine is present add 0.008% Na2S2O3.	7 days for extraction, 40 days after for analysis.	2 liters	Vermiculite or poly-foam cooler
	Total Metals (unfiltered)	1	1 liter poly bottle	Add HNO3 until until pH < 2.	6 months Mercury: 28 days	1 liter	Vermiculite or poly-foam cooler
	Dissolved metals (filtered), groundwater only	1	1 liter poly bottle	Add HNO3 until until pH < 2.	6 months	1 liter	Vermiculite or poly-foam cooler

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TABLE 6-1 (CONTINUED)

SAMPLE CONTAINER PRESERVATION AND HOLDING TIME REQUIREMENTS
 TINKER AFB - SOLDIER CREEK
 SAMPLING AND ANALYSIS PLAN

<u>Sample Matrix</u>	<u>Analyses</u>	<u>Number of Containers Per Analysis</u>	<u>Container Description</u>	<u>Preservation Requirements</u>	<u>Maximum Holding Time</u>	<u>Minimum Sample Volume Required</u>	<u>Packing</u>
Groundwater, Surface Water (continued)	Cyanide	1	1 liter poly bottle	Add NaOH until pH 12, cool to 4 degrees C, if residual chlorine is present, add 0.6 g ascorbic acid.	14 days	1 liter	Vermiculite or poly-foam cooler
	Alkalinity, Hardness, TSS	1	1 liter poly jug	Cool to 4 C.	Alk: 14 days Hard: 6 months TSS: 7 days	100 ml 100 ml 100 ml	Vermiculite or poly-foam cooler
	COD	1	1 liter poly jug or glass jar	Cool to 4 C, add 5 ml H ₂ SO ₄ per liter (pH <2).	28 days	100 ml	Vermiculite or poly-foam cooler
	BOD ₅	1	1 liter poly jug or glass jar	Cool to 4 C.	48 hours	500 ml	Vermiculite or poly-foam cooler
	TOC	1	500 ml glass jar	Cool to 4 C, add 5 ml H ₂ SO ₄ (pH <2).	28 days	100 ml	Vermiculite or poly-foam cooler

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TABLE 6-1 (CONTINUED)

SAMPLE CONTAINER PRESERVATION AND HOLDING TIME REQUIREMENTS
 TINKER AFB - SOLDIER CREEK
 SAMPLING AND ANALYSIS PLAN

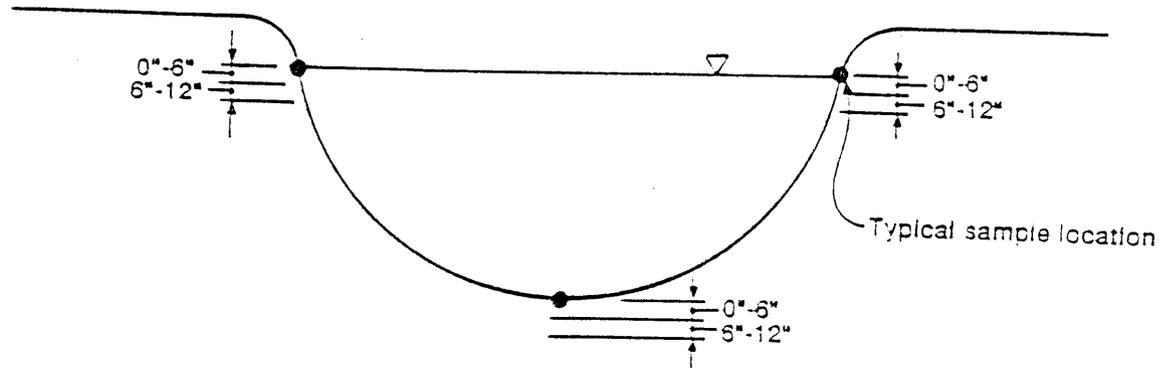
<u>Sample Matrix</u>	<u>Analyses</u>	<u>Number of Containers Per Analysis</u>	<u>Container Description</u>	<u>Preservation Requirements</u>	<u>Maximum Holding Time</u>	<u>Minimum Sample Volume Required</u>	<u>Packing</u>
Groundwater, Surface Water (continued)	Oil and Grease	2	1 liter glass jar	Cool to 4 C, add 5 ml H ₂ SO ₄ per liter (pH <2).	28 days	1 liter	Vermiculite or poly-foam cooler
	Nitrates	1	500 ml poly jug	Cool to 4 C,	28 days	100 ml	Vermiculite or poly-foam cooler

Composite and grab samples will be collected at each sampling location. The grab sediment sample will be collected first. One grab sediment will be taken at each depth (0-6 inches and 6-12 inches) and analyzed for volatile organics on the Target Compound List. Samples will be placed on ice and cooled to 4°C prior to shipment. Composite sediment subsamples will be collected across a transect at two depths (0-6 inches and 6-12 inches) and composited into two samples; one for each depth, at each sampling location. The composite sediment samples will be analyzed for substances on the Target Compound List (TCL) including acid, base/neutral extractables and Target Analyte List (TAL) including metals and cyanide. In addition, SAS analyses including Atterberg limits, sediment particle size, permeability, and density will be performed on samples collected at eight sampling locations. SAS analyses for total organic carbon will also be performed on sediment samples collected from each of the forty-two sampling locations.

6.1.1 Sediment Sampling Method

Composite sediment samples will be collected at each sampling location with each sampling location divided into subsamples across a transect. All samples and subsamples will be taken with a 2 inch diameter corer. The number of subsamples used to form a composite will be dependent upon the width of the stream at each sample location. There will be a minimum of three subsamples taken, spaced at a distance of 5 feet apart. At sample locations with a stream width less than 10 feet, subsamples will be taken at the stream banks and in the middle of the stream. An effort will be made in the field to move sample locations to nearby points where the stream is wider than 10 feet. The samples will be collected using the Equal-Width Increment (EWI) method as described in the National Handbook of Recommended Methods For Waste Data Acquisition" (USGS, 1980). This EWI method is depicted in Figure 6-1.

The EWI method may be used to obtain sediment and surface water samples in an open stream channel. In the EWI method, depth integration is performed at a series of verticals in the stream flow section that are equally spaced



NOTES:

- (1) Composite sediment samples across a transect at each sampling location will be collected at two depths (0'-6" and 6'-12").
- (2) The number of subsamples used to form a composite sample will be dependent upon the width of stream at each sampling location.
- (3) It is assumed up to 5 subsamples located at an approximate width of 5 feet will be required at each location.
- (4) The grab sediment sample for VOC analysis will be located at the subsample location which is most likely to contain VOC contamination based on stream morphology and visual inspection.
- (5) Composite surface water samples will be taken across a transect at the same location as the composite sediment samples before the sediment sample has been taken.

FIGURE 6-1
 EWI COMPOSITE SAMPLING SCHEME
 TINKER AFB - SOLDIER CREEK R/VFS
 SAMPLING AND ANALYSIS PLAN

across the transect to obtain a series of subsamples. However, the vertical transit rate used at each vertical is exactly the same as that used at every other vertical, and the subsamples are composited even though they represent different flow volumes. This procedure provides a transect sample whose concentration is discharge weighted both vertically and laterally and whose volume is proportional to the water discharge in the sampled zone. Because the transect sample is a composite, more than one vertical can be collected in a single sample container. An advantage of this method is that knowledge of the lateral distribution of discharge is not required.

A grab sediment sample will be located at the subsample location which is most likely to contain volatile organic contamination based on stream morphology and visual inspection. The field sampling procedure is as follows:

- (1) String a transect line across the stream perpendicular to the stream flow.
- (2) Measure and mark each sediment and surface water subsample location.
- (3) Determine the grab subsample location based on stream morphology and visual inspection.
- (4) Force the decontaminated 2 inch diameter corer into the sediment with a smooth continuous motion to a depth of 12 inches.
- (5) Twist the corer, and withdraw the corer in a single smooth motion.
- (6) Withdraw sample into a decontaminated stainless steel pan.
- (7) Transfer sample immediately into the appropriate sample bottle with a clean stainless steel spoon.

The composite sediment field sampling procedure is as follows:

- (1) String a transect line across the stream perpendicular to the stream flow.

- (2) Measure and mark each sediment and surface water subsample location.
- (3) Force the decontaminated 2 inch corer into the sediment at the first subsample location with a smooth continuous motion to a depth of 12 inches.
- (4) Twist corer, and withdraw the corer in a single smooth motion.
- (5) Withdraw the sample into a decontaminated stainless steel pan.
- (6) Separate the 12 inch sample into two equal portions: 0-6 inches and 6-12 inches. Remove each subsample portion with a clean stainless spoon and place in separate, marked clean stainless steel pan.
- (7) Decontaminate the sampling equipment using a setup and procedure outlined in Subsection 6.1.6.
- (8) Continue to sample at subsequent subsample location by following steps 2 through 5 and compositing each subsample portion of 0-6 inches and 6-12 inches into the appropriate stainless steel pan.
- (9) Cover the stainless steel pan, transport the sediment in the stainless steel pan to a secure area on Tinker AFB.
- (10) Composite the subsamples at Tinker AFB by mixing with a clean stainless steel spoon.
- (11) Transfer sample into the appropriate sample bottles with a clean stainless steel spoon.

6.1.2 Sediment Field Measurements

Each sediment subsamples will be scanned for volatile organic contamination with an HNU photoionization detector to determine the magnitude of volatile organic concentrations. The breathing zone of field personnel will also be scanned to protect field personnel from possible inhalation of volatile organic contaminants. Details pertaining to the protection of field personnel are described in the Health and Safety Plan.

6.1.3 Sediment Background Sample

One background sample will be collected off-base in a tributary to Soldier Creek at the same location as the surface water sample. The approximate location is shown on Figure 5-2. The surface water sample will be

collected prior to collecting the sediment sample. The sediment sample will be collected using the same sampling procedure previously outlined in Subsection 6.1.1.

6.1.4 Sediment Equipment Rinsate Blank

As discussed in Subsection 5.1, one equipment rinsate blank will be prepared for the sediment sampling method. This equipment rinsate blank will be decontaminated using the standard decontamination procedure outlined in Subsection 6.1.6. The equipment to be used in preparing the equipment rinsate blank is a corer, ladle, stainless steel pan, and stainless steel spoon. The equipment rinsate blank sample preparation to be performed is as follows:

- (1) HPLC (ASTM Type II) water will be used to rinse the properly decontaminated sampling equipment one piece at a time. This rinsate will be collected in the decontaminated stainless steel pan.
- (2) The rinsate will then be transferred from the pan to the containers specified in Table 6-1 for surface water samples. The equipment rinsate blank will analyzed for volatile organics and acid, base/neutral extractables on the TCL, and metals and cyanide on the TAL.

6.1.5 Sediment Duplicate Samples

Eight duplicate sediment samples will be collected. The number of duplicate samples may be changed in the field if the number of samples collected by the field team differs from the assumed number. The exact locations of these duplicate samples will be determined in the field depending on the volume of sample obtained. Each duplicate sample will be obtained concurrently with the sample it is intended to duplicate.

The sampling methods used for collection of the original sample will also be used for the duplicate sample, and the original and the duplicate sample will be placed in identical containers. The sample locations where the duplicates are collected will be documented in the field logbook.

6.1.6 Decontamination of Sediment Sampling Equipment

Sampling equipment will be decontaminated by the field team using a setup located at Tinker AFB and procedures as follows:

The standard decontamination procedure for sediment sampling equipment will consist of the following:

- (1) Wash withalconox soap and potable water.
- (2) Rinse with potable water.
- (3) Wash with reagent grade ethanol and allow to air dry.
- (4) Rinse with distilled water.

The decontamination procedure for sampling equipment that cannot be decontaminated using the standard procedure will consist of the following:

- (1) Remove soil with high pressure steam cleaner using potable water.
- (2) Wash with acetone to remove any organics from the equipment.
- (3) Wash with high pressure steam cleaner usingalconox soap and potable water.
- (4) Rinse with high pressure steam cleaner using potable water.
- (5) Wash with reagent grade ethanol and allow to air dry.
- (6) Rinse with distilled water.

6.2 SURFACE WATER INVESTIGATION

Sixty-three surface water samples including duplicates (5), equipment rinsate blank (1), and trip blanks (15) will be collected at forty-two sampling locations. The approximate locations of these surface water samples are shown on Figures 5-1 and 5-2.

Composite and grab samples will be collected at each sampling location. The grab surface water sample will be taken first. A grab surface water sample will be taken at the mid-water column and analyzed for volatile organics on the TCL.

Composite surface water samples will be taken across a transect at the same locations as the composite sediment samples before the sediment samples are taken and relocated on the upstream side of the transect and field sampling to minimize the amount of distilled sediment which enters the water column. Surface water subsamples will be collected across a transect at one depth (mid water column) and composited into one sample at each sampling station. All composite surface water samples will be analyzed for substances on the TCL and TAL including acid, base/neutral extractables, metals and cyanide. In addition, SAS analyses including alkalinity, hardness, chemical oxygen demand (COD), total suspended solids (TSS), 5-day biochemical oxygen demand (BOD5), total organic carbon (TOC), oil and grease, and nitrates will be performed.

6.2.1 Surface Water Sampling Method

A mid water column grab surface water sample will be collected first at the mid-water column subsample location which is most likely to contain volatile organic contamination based on stream morphology and visual inspection. The field sampling procedure is as follows.

- (1) String a transect line across the stream perpendicular to the stream flow.
- (2) Measure and mark each sediment and surface water subsample location.
- (3) Determine the grab subsample location.
- (4) Submerge the decontaminated polyethylene ladle in the water to the mid-water column depth with minimal surface disturbance and allow it to fill slowly and continuously.
- (5) Retrieve the ladle from the surface water with minimal disturbance.
- (6) Remove the cap from the sample bottle and slightly tilt the mouth of the bottle below the ladle edge. Empty the ladle slowly, allowing the sample stream to flow down the side of the bottle with minimal entry turbulence until the bottle is filled.

Composite surface water samples will be taken at each sampling location with each sampling location divided into subsamples across a transect. These subsamples will correspond to sediment subsamples taken at the same sampling location. An explanation of the EWI method which determines these subsample locations is given in Subsection 6.1.1. The actual sampling procedure is as follows:

- (1) String a transect line across the stream perpendicular to the stream flow.
- (2) Measure and mark each sediment and surface water subsample location.
- (3) Submerge the decontaminated polyethylene ladle in the stream to the mid-water column depth with minimal surface disturbance and allow it to fill slowly and continuously.
- (4) Retrieve the ladle from the surface water with minimal disturbance.
- (5) Pour the surface water into a decontaminated stainless steel container.
- (6) Decontaminate the sampling equipment using a setup and procedure outlined in Subsection 6.2.6.
- (7) Continue to sample at subsequent subsample locations by following steps 2 through 4 and putting each subsample in the stainless steel container.
- (8) Transfer the composited surface water samples into the appropriate sample bottle using a polyethylene label.

6.2.2 Surface Water Field Measurements

Following collection of surface water samples for chemical analyses, an additional quantity of water will be collected and field tested for temperature, dissolved oxygen, specific conductivity, and pH. Each surface water sample will be screened with an HNU photoionization detection to determine the magnitude of volatile organic contamination and to protect field personnel from possible inhalation of volatile organic contaminants.

6.2.3 Surface Water Background Sample

One background surface water sample will be collected off-base in a tributary to Soldier Creek at the same location as the sediment sample. The approximate location is shown on Figure 5-2. The surface water sample will be collected prior to collecting the sediment sample. The surface water sample will be collected using the same sampling procedure previously outlined in Subsection 6.2.1.

6.2.4 Surface Water Equipment Rinsate Blank

One surface water equipment rinsate blank will be prepared before the surface water sample is collected. This blank will be prepared in the following manner at a location on Tinker AFB:

- (1) HPLC water (ASTM Type II) will be poured into and over the properly decontaminated polyethylene ladle.
- (2) The water from the ladle will then be poured into the sample using the techniques previously specified for the surface water sample. Additional ASTM Type II water will be added to the ladle as required to fill the containers specified for surface water samples. The surface water field blank will be submitted for volatiles organic and acid, base/neutral extractable on the TCL; metals and cyanide on the TAL as well as the substances requiring SAS analytical services in Appendix B.

6.2.5 Surface Water Duplicate Samples

Five duplicate surface water samples will be collected. The exact location number of the duplicate samples will be determined in the field. Each duplicate sample will be obtained concurrently with the sample it is intended to duplicate and by the methods used to collect the original surface water sample. The original and the duplicate sample will be placed in identical containers and preserved in the same manner. The sample locations where the duplicates are collected will be documented in the field logbook.

6.2.6 Decontamination of Surface Water Sampling Equipment

Sampling equipment will be decontaminated prior to and between sampling events by the team. The team will use a setup and procedure identical to those specified in Subsection 6.1.6 for sediment sampling equipment. The pH meter probe, dissolved oxygen probe, specific conductivity probe, and thermometer will be rinsed with distilled water before and after each use.

6.3 SURFACE WATER FLOW INVESTIGATION

Soldier Creek RI surface water velocity measurements will be taken to calculate the rate and volume of flow at predetermined points (every 500 feet) along Soldier Creek and tributaries emanating from Tinker AFB.

Measurements to calculate surface water flows will be taken at 500 foot intervals along Soldier Creek (including those tributaries emanating from Tinker AFB) from its headwaters located just north of Southeast 59th Street to at least East Reno Avenue and at each surface water sampling location. Such interval distances may be modified in the field to take into account stream morphology effects on velocity measurements.

The flow velocity will be measured using a Gurley Current meter. Measurements will be made after all the sediment and surface water samples are taken. The flow velocity procedure is as follows:

- (1) String a transect line across the stream perpendicular to the stream flow.
- (2) Measure and mark flow measurement points at equal distance apart along the transect. It is estimated that the distance between such flow measurements will be 3 feet.
- (3) Measure depth at transect point and record in field logbook.
- (4) Place meter into the mid-water column depth of the stream.
- (5) Position the meter and verify that the meter is counting properly.

- (6) Reset counter button by depressing.
- (7) Start stop watch simultaneously with the electronic counter.
- (8) Run the meter for one full minute with the counter operating.
- (8) Record location along transect and number of revolutions per minute in field logbook.
- (9) Use specified charts found in the manufacturers operating manual to determine the stream velocity.
- (10) Decontaminate sampling equipment using a setup and procedure on Tinker AFB identical to those specified in Subsection 6.1.6.

6.4 FIELD SURVEY INVESTIGATION

A visual, walking survey of the entire stretch of Soldier Creek (including those tributaries emanating from Tinker AFB) from East Reno Avenue at its downstream end, upstream to the headwaters located just north of Southeast 59th Street, will be completed to locate and measure all outfalls and storm drains which enter the stream along this area of interest.

Field investigation personnel will perform a field ground survey which will include the following activities:

- o Establish the stream bed profile at each sampling location and each 100 foot station along the length of Soldier Creek from East Reno Avenue upstream to the headwaters and along each tributary where sampling will be conducted.
- o Establish the location and measure of outfalls and storm drains discharging into Soldier Creek within the study area.
- o Visually inspect Soldier Creek to identify off-base outfalls and storm drains.
- o Note surrounding land use and topographical characteristics for future reference in identifying potential impacts on Soldier Creek by area residents and industry.

The stream profile survey will have a third order accuracy and will be conducted by experienced field personnel in conducting third order surveys.

Established USGS bench marks will serve as the horizontal and vertical control points from which all other coordinates are established. The coordinates will be established in accordance with the state plane coordinate system.

Qualified personnel will use the survey data to locate sampling locations on the base maps developed for the Soldier Creek site and draw profiles of the stream bed. Flow rates and volumes will be used to determine gaining and losing portions of the stream.

6.5 GROUNDWATER INVESTIGATION

Thirteen groundwater samples including, an equipment rinsate blank (1), a duplicate (1), and trip blanks (3) will be collected at eight existing off-base wells. The approximate locations of these wells are shown on Figure 5-3.

Groundwater samples will be collected at each well. All groundwater samples will be analyzed for volatiles, acid, base/neutral extractables, metals, and cyanide on the TCL and TAL. At three wells determined in the field, additional groundwater samples will be collected, filtered, and submitted for metals analysis.

6.5.1 Methods for Groundwater Level Measurements

An Olympic Well Probe, Model 150 or equivalent, will be utilized for water level measurements if possible. Water levels will be measured and prior to well purging for sample collection.

The depth to the bottom of the well will be measured. Notation will be made of the condition of the well bottom.

The following procedure will be used by the project team in measuring the water levels:

- (1) Determine the length of the probe from the tip of the probe to the first measure indicator on the cable by measuring this section with a tape measure to the nearest unit defined by the tape. Record this length. Also measure the length of cable defined by the Standard Code markings and the length of cable corresponding to each ten-foot cable section up to 50 feet in length and record these measurements. Three field personnel may be necessary for these measurements to prevent the cable from coming into contact with the ground surface.

Colored bands should be located at five foot intervals according to the following coding system:

Each Orange Superimposed on White = 5 feet
Each White = 10 feet
Each Orange = 50 feet
Each Green = 100 feet

Example: one green, one orange, two white = 170 feet.

- (2) Decontaminate the cable by spraying the cable with distilled water and wiping with paper towels as the cable is rewound onto the reel.
- (3) Turn on well probe and immerse probe end in a glass of distilled water to check probe batteries. Note instrument response as the tip of the probe contacts the water. If no response occurs, replace the batteries and try again. Battery replacement can be accomplished by removing the three screws on the face plate. Two standard (AA) penlight batteries are used. Battery condition should be checked daily before well measurements are taken.
- (4) Lower the probe into the well by pulling the cable from the hand-held reel until the light comes on or buzzer sounds.
- (5) Move the cable up and down while observing the indicator and note the exact length of cable extended from the tip of the probe to the top of the well casing. Record the cable length to the nearest 1/100th of a foot, the well number, and the time and date of the measurement in the field logbook.
- (6) Decontaminate the cable by the procedure specified in step 2.
- (7) Tie a decontaminated weight to the end of the cable and measure the total depth of the well by allowing the weight to hit the bottom of the well.

6.5.2 Sampling Methods for Groundwater Samples--General

Prior to groundwater well sampling, Tinker AFB personnel will notify the well owner in an access agreement that the owner's well is to be sampled and purged. For groundwater wells with no sampling ports, the groundwater will be allowed to run for 5 to 10 minutes onto the grass near the well. For wells with a sampling port, five well volumes will be purged from each well prior to actual sampling. The purged water will be poured onto the ground near the well. The volume of water in the well will be calculated based on the measured depth of the well, the measured diameter of the well, and the elevation of the water in the well measured as described in Subsection 6.5.1. A bailer of known volume will then be used to purge the required number of well volumes. The well will be sampled within 24 hours of purging.

A bottom-filling, decontaminated Teflon bailer with clean polypropylene rope will be used to sample each off-base well. Each bailer and rope will be decontaminated at the Tinker AFB in accordance with the procedures in Subsection 6.1.6 prior to use. The Teflon bailer will be kept in a bag to protect the bailer from cross-contamination. These groundwater samples will be collected immediately after purging or as soon as enough volume is available if the well is slow to recharge.

After the well has been purged, unfiltered samples will be collected using bottom-filling Teflon bailers. The procedure to be used in collecting groundwater with the Teflon bailer will be as follows:

- (1) Lower the bailer slowly until it contacts the water surface.
- (2) Allow the bailer to sink and fill with a minimum of surface disturbance.
- (3) Slowly raise the bailer to surface.
- (4) Tip the bailer to allow slow discharge from the top to flow gently down the side of the sample bottle with a minimum of entry turbulence.

- (5) Repeat steps 1-4 as needed to acquire sufficient volume to fill all containers for the required analyses.

6.5.3 Sampling Methods for Groundwater--Filtration

A disposable 500 ml Nalgene Sterilization Filter Unit with a 0.45 um pore size membrane and a squeeze handle vacuum pump will be utilized to filter groundwater samples on the Tinker AFB. The following filtration procedure will be used by the project team:

- (1) While wearing clean impervious disposable gloves, place a 50 mm diameter glass fiber prefilter in the neck of the upper chamber of the filter unit, above the unit membrane.
- (2) Connect the upper chamber to the receiving chamber and attach the pump tubing to the filter unit.
- (3) Remove the lid on top of the upper chamber just prior to collection of the groundwater sample.
- (4) Collect a groundwater sample with the Teflon bailer as described in the preceding subsection and place into a clean intermediate sample bottle.
- (5) Cap the intermediate sample bottle transport the water to a secure area on Tinker AFB.
- (6) Fill the upper chamber of the filter unit with groundwater from the clean intermediate sample bottle.
- (7) Squeeze the handle of the vacuum pump to accelerate transfer of groundwater from the upper chamber to the receiving chamber.
- (8) After the water has been transferred to the receiving chamber, detach the receiving chamber from the filter unit.
- (9) Pour the groundwater from the receiving chamber into the sample containers for the filtered groundwater.
- (10) Repeat steps 5 through 8 until the required sample volume is collected.
- (11) Decontaminate the sampling equipment according to procedures described in subsection 6.1.6.
- (12) Repeat steps 1 through 9 for each groundwater sample to be filtered using a separate filter unit and prefilters for each sample.

6.5.4 Groundwater Field Measurements

Following collection of the samples for chemical analyses, field tests for temperature, pH, and specific conductivity will be conducted by the field team personnel according to the following procedure:

- (1) Water will be withdrawn from the well and poured into a clean glass container.
- (2) The temperature of the collected water will be taken once with a National Bureau of Standards thermometer immediately after the water is collected. The temperature will be recorded in a field logbook to the nearest 0.5 F. The thermometer will be decontaminated by rinsing the thermometer with deionized water. If the water sample is visibly contaminated with an oily or greasy substance, ethanol will be used for decontamination of the thermometer. Decontamination fluids will be collected in a stainless steel bowl.
- (3) The pH will be measured three times using a pH probe and the measurements and mathematical average will be reported to two decimal places in a field logbook. The pH probe will be calibrated prior to taking measurements. The pH probe will be decontaminated by rinsing the probe with deionized water. If the water sample is visibly contaminated with an oily or greasy substance, the pH of the sample will be measured with indicator paper having a pH range of 2 through 12.
- (4) The specific conductivity meter will be calibrated and adjusted for the correct temperature. The specific conductivity of the sample will be measured three times and the measurements and mathematical average recorded in a field logbook to three significant figures. The specific conductivity meter will be decontaminated by rinsing the meter with deionized water. If the water sample is visibly contaminated with an oily or greasy substance, specific conductivity measurements will not be taken.

6.5.5 Groundwater Equipment Rinsate Blank

As discussed in Section 5.5, one equipment rinsate blank will be prepared for the groundwater sampling method. A Teflon bailer and HPLC water will be used in preparing the equipment rinsate.

The equipment rinsate will be prepared at a location on Tinker AFB in the following manner:

- (1) HPLC (ASTM Type II) water will be poured into the containers for analyses of unfiltered groundwater for volatile organics.
- (2) The water from the bailer will be poured into the containers for analyses of unfiltered groundwater for volatile organics.
- (3) The water from the bailer will then be poured into the remaining sample containers for the unfiltered groundwater. The techniques used to fill the containers will be the same as those previously specified for groundwater sampling.
- (4) The remaining water from the bailer will be filtered according to the procedure specified in Subsection 6.5.3 (step 4 omitted) and poured into the containers for filtered groundwater.
- (5) Additional HPLC (ASTM Type II) water will be added to the bailer(s) as required to fill the containers for the filtered and unfiltered samples.

6.5.6 Groundwater Duplicate Sample

One duplicate sample will be collected. The number of duplicate samples may be changed in the field if the number of samples collected by the field team differs from the assumed number. The exact location of this duplicate sample will be determined in the field depending on the volume obtained. Each duplicate will be obtained concurrently by pouring approximately half of the volume from the teflon bailer into two separate containers.

The sampling methods used for collection of the original sample will also be used for the duplicate sample, and the original and the duplicate sample will be placed in identical containers. The sample locations where the duplicates are collected will be documented in the field logbook.

6.5.7 Decontamination of Groundwater Sampling Equipment

The bailer will be decontaminated on Tinker AFB prior to placing it in the well by rinsing with deionized water. Between the time the bailer is decontaminated and the time it is placed in the well, it will be wrapped

with clean plastic sheeting or placed in a clean plastic trash bag. A new piece of rope will be used at each well. The pH probe, specific conductivity probe, and thermometer will be rinsed with deionized water before and after each use.

6.6 WATER BOTTLE BLANK

No water bottle blanks will be required because quality control of sample bottles is covered for enforcement purpose under the CLP Sample Bottle Repository Program (SBRP). Contamination will be detected in the equipment rinsate blank, if the sample containers are contaminated.

6.7 SAMPLE CONTAINER DECONTAMINATION, PACKAGING AND SHIPMENT

6.7.1 Decontamination of Sample Containers

The collected sample and its container represent one of the major avenues of personnel and environmental exposure. Precautions will be taken to determine that samples removed from the site are inside the sample container and that no residue remains on the outside of the container.

To minimize the potential for contamination of the outside of a sample container the following procedure will be followed:

- (1) Prior to sampling, a small plastic bag will be placed around the outside of the sample container and the bag will be held in place with a rubber band or tape so that any sample spilled outside of the container will not contact the bottle.
- (2) The sample will be transferred directly from the source or mixing pan to the sample container by use of a decontaminated bailer, scoop or spoon. The container will be filled to the appropriate level.
- (3) The sample container lids will be screwed on firmly without dislodging the lid lining or overtightening the lids.
- (4) The sealed sample containers will be transported to the packaging area, where the outer plastic bag will be removed by the sampler without touching the external surface of the container any more than necessary.

6.7.2 Sample Packing and Shipping

Sample packaging and shipping procedures are based on U.S. EPA specifications, as well as U.S. Department of Transportation (DOT) Regulations (49CFR). Samples will be packed and shipped according to requirements for low and medium hazard level samples.

The steps outlined below will be followed by field personnel to pack samples:

- (1) Arrange decontaminated sample containers in groups by sample number.
- (2) Arrange containers in front of assigned coolers.
- (3) Affix appropriate adhesive sample label to each container. Protect sample label by covering with clear tape.
- (4) Wrap each glass sample container with protective bubble wrap or foam. Tape foam to secure in place.
- (5) Place approximately 2 inches of packing material in bottom of cooler for cushioning.
- (6) Line cooler with a large trash bag.
- (7) Place sample containers inside trash bag in cooler.
- (8) Fill remaining volume of trash bag with packing material.
- (9) Seal trash bag with tape.
- (10) Add ice packaged in double sealable plastic bags and placed on and around the containers if any samples require temperature control, and fill remaining volume of cooler with packing material.
- (11) Sign chain of custody form and indicate the time and date the cooler is relinquished to an overnight courier service and sealed. Record the time in the field logbook.
- (12) Separate copies of forms. Seal proper copies in a large sealable plastic bag and tape to inside lid of cooler.
- (13) Tape cooler drain shut.

- (14) Close lid and latch cooler. Tape cooler shut on both ends, making several revolutions with strapping tape. Do not cover any labels or custody seals.
- (15) Place airbill with the CLP Laboratory address on top of cooler.
- (16) Put "This Side Up" labels on both ends of cooler lid, and "Up Arrow" symbols on all four sides of the cooler.
- (17) Affix custody seals over lid openings (front right and back left corners of cooler). Cover seals with clear plastic tape.
- (18) Maintain file of all sample documentation with field team leader.

6.8 AIR QUALITY MONITORING

Air quality will be monitored during the field investigation to evaluate the potential hazards to on-site personnel.

All air quality monitoring for organic vapors will be conducted with an HNU photoionization detector using a 11.7 eV probe. Monitoring will be continuous during sampling as specified in the HSP. HNU readings will be recorded in the field logbook.

7.0 RI-DERIVED WASTES

Field investigation activities will result in the production of contaminated materials that must be properly managed. Management of the hazardous wastes generated during the investigation requires compliance with federal and state requirements for generation, storage, transportation, and disposal. Contaminated materials generated during the field investigation will include excess sediment from sampling activities, decontamination solutions, personal decontamination station fluids, and personal protective clothing.

All RI derived wastes will be containerized in DOT-approved 55 gallon drums and these drums will be staged at a designated on-base location. Tinker AFB is the generator of RI-derived waste and Tinker AFB personnel will sign manifests for its transport and disposal. The contents of all DOT-approved 55 gallon drums used to store the RI-derived waste will be labelled. An itemized list of DOT-approved 55 gallon drum contents will be recorded in a logbook. Following receipt of sample results, the disposal location for each type of RI-derived waste will be determined. Tinker AFB will select the disposal method and location. The contracting mechanism for transport and disposal of the RI-derived wastes generated during the Phase I field investigation will be selected upon determination of the disposal location for each type of waste.

Wastes produced by the field operations are divided into four categories:

- o Sediment from Sampling Activities. This is any excess sediment generated during the sampling activities. The procedure for handling this excess sediment will be to containerize the excess sediment in DOT-approved 55 gallon drums.
- o Personal Decontamination Station Liquids. These liquids include the wash water from the boot wash and the hand and face wash containers. Contaminants typically found in these liquids result from activities which bring personnel in contact with soil. The water will be containerized and stored for disposal.

- o Personal Protective Clothing. This category includes the disposable work clothing such as booties, gloves, and paper coveralls worn by field personnel during the Phase I RI field investigation. The procedure for handling disposable personal protective clothing will be to place such articles in DOT-approved 55 gallon drums which will be stored on-base until the completion of the Phase I field investigation.
- o Decontamination Fluids. Decontamination fluids include wash waters used to decontaminate the sampling equipment. The wash waters will be containerized in 55 gallon DOT-approved drums, labelled, and stored on-base until completion of the Phase I field investigation.

Efforts will be made to segregate types of wastes by activity to allow different disposal options based on sampling results. For example, if chemical analyses indicates no organic contaminants or no levels of inorganic contaminants above background in a sediment sample, then the excess sediment from that sample may be disposed as non-hazardous material. These specific decisions will be made by Tinker AFB at the conclusion of the Phase I field investigation.

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8.0 SAMPLE NUMBERING SYSTEM

A sample numbering system is provided in Subsection 4.3 of the QAPP (Chapter II).

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9.0 DOCUMENTATION

A discussion of sample custody and documentation is provided in Section 4.0 of the QAPP (Chapter II).

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10.0 FIELD ORGANIZATION/KEY PERSONNEL

Data on field organization and key personnel will become available after the actual date for initiation of field activities has been established.

11.0 FIELD INVESTIGATION SCHEDULE

A preliminary schedule for the Phase I RI field investigation is shown on Figure 11-1. In preparing the schedule, it was assumed that normal weather patterns would prevail during the fieldwork and that the sampling crew would have access to private properties where sampling shall occur in the time frame shown.

ACTIVITY	JUN 90	JUL 90	AUG 90	SEP 90	OCT 90
PHASE I FIELD INVESTIGATION					
EASEMENTS AND PERMITS					
SUPPORT					
QAPP/SAP/HSP/DQO IMPLEMENTATION					
EQUIP. PROCUREMENT & MOBILIZATION					
ANALYTICAL LABORATORY SUBCONTRACT					
SEDIMENT					
SURFACE WATER					
GROUNDWATER					
FIELD SURVEY					
RI-DERIVED WASTE DISPOSAL					
PHASE I SAMPLE/DATA ANALYSIS					
SAMPLE AND DATA MANAGEMENT					
DATA REDUCTION AND VALIDATION					
DATA EVALUATION					

FIGURE 11-1
 PROPOSED PHASE I FIELD INVESTIGATION
 SCHEDULE
 TINKER AFB-SOLDIER CREEK RI/FS
 SAMPLING AND ANALYSIS PLAN

FINAL
QUALITY ASSURANCE PROJECT PLAN
TINKER AFB - SOLDIER CREEK RI/FS

Prepared for:
TINKER AIR FORCE BASE
through
TULSA DISTRICT CORPS OF ENGINEERS
CONTRACT NO. DACA56-89-C-0062

Prepared by:
B&V WASTE SCIENCE AND TECHNOLOGY CORP.
OVERLAND PARK, KANSAS
PROJECT NO. 40054
MAY 1990

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FINAL
QUALITY ASSURANCE PROJECT PLAN
TINKER AFB - SOLDIER CREEK RI/FS

AUTHORIZATION PAGE

Contract No. DACA56-89-C-0062

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Date: MAY 1990

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Reviewed _____ Date _____
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Central Regional Laboratory

Approved _____ Date _____
EPA Region VI QA Officer

Approved _____ Date _____
EPA Region VI, Regional Administrator

TINKER AFB - SOLDIER CREEK RI/FS
QUALITY ASSURANCE PROJECT PLAN

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared to specify the data collection and environmental measurement efforts to be used during completion of remedial investigation activities at the Soldier Creek site located at Tinker Air Force Base (Tinker AFB), Oklahoma. The purpose of this QAPP is to document quality assurance/quality control (QA/QC) measures to be implemented during sample collection and analysis and data reduction, validation, and evaluation activities. This QAPP contains all the specified levels of quality for precision, accuracy, representativeness, completeness, and comparability that the data must meet in order to be considered acceptable for purposes of this investigation.

A comprehensive and well documented QAPP assists the project team in its efforts to obtain data that are scientifically and legally defensible and to achieve the levels of precision and accuracy specified by the data quality goals for a project using a cost effective project approach. This QAPP presents the organization, objectives, activities, and specific quality assurance (QA) and quality control (QC) activities designed to achieve the data quality objectives of the field and laboratory investigations for the Soldier Creek Remedial Investigation (RI)/Feasibility Study (FS).

Procedures and requirements specified in this QAPP are based on EPA guidelines contained in Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (EPA, 1980).

2.0 QUALITY ASSURANCE OBJECTIVES

The principal objective of the QAPP is to maintain the quality of operational activities and document the quality of data generated. Experienced personnel will be provided to conduct field operations. The project will also be staffed with personnel experienced in the technical and management disciplines appropriate for the Tinker AFB - Soldier Creek RI/FS project.

The overall project objectives are to:

- o Determine, by medium, the nature and extent of contamination of Soldier Creek.
- o Determine, by medium, the potential adverse effects of contamination on human health and the environment.
- o Develop and assess potential remedial alternatives for Soldier Creek.

This section contains measurement objectives, method detection limits, and quality control parameters. They are specified for completion of the RI/FS at the Soldier Creek site based upon the data quality objectives established for the project.

2.1 MEASUREMENT OBJECTIVES

Measurement parameters vary depending upon the circumstances surrounding a specific sampling event, the type and concentration of material, and media to be sampled. All measurements will be made using standard data collection techniques to yield consistent results that are representative of the media and conditions measured. All data will be reported in units consistent with those of other agencies and organizations to allow comparability of data bases.

The specific sampling rationale for each sample matrix is discussed in Section 5.0 of the Sampling and Analysis Plan (SAP) in Chapter I. An itemized list of all samples to be collected as part of the Phase I RI at the Soldier Creek site is presented in Table 2-1.

2.2 METHOD DETECTION LIMITS

To provide analytical data at the concentrations necessary for achieving overall project, remedial investigation, risk assessment, feasibility study, and remedial action objectives established for the Soldier Creek site, Routine Analytical Services (RAS) and Special Analytical Services (SAS) type of analyses will be employed. All RAS and SAS analytical methods and detection limits are specified in Appendix C for each parameter to be analyzed. RAS detection limits will be used for volatile organics, metals, and cyanide. SAS chemical parameter detection limits will be used for alkalinity, hardness, chemical oxygen demand (COD), total suspended solids (TSS), 5 day biochemical oxygen demand (BOD5), total organic carbon (TOC), oil and grease, and nitrates. SAS physical parameter detection limits will be used for total organic carbon, Atterberg limits, particle size, permeability, and density.

2.3 QUALITY CONTROL PARAMETERS

The objective of quality assurance for analytical data is to collect environmental monitoring data of known and acceptable quality. Precision and accuracy, completeness, representativeness, and comparability are indicators of acceptable data quality. They are discussed below.

2.3.1 Precision and Accuracy

The precision and accuracy quality control parameters measure the reproducibility of analytical results and the bias of a measurement method, respectively. Laboratory-based precision and accuracy quality control limits which must be met for RAS analytical data to be considered acceptable are established under separate guidelines. Quality control limits for RAS analytical data are established under EPA Contract

TABLE 2-1

SUMMARY OF SAMPLING AND ANALYSIS
 TINKER AFB - SOLDIER CREEK RI/FS
 QUALITY ASSURANCE PROJECT PLAN

SAMPLE MATRIX	FIELD PARAMETERS	LABORATORY PARAMETERS	NO. OF FIELD		NO. OF EQUIPMENT		NO. OF MATRIX SPIKE		NO. OF DUP. MATRIX SPIKE	
			MATRIX SAMPLES	DUPLICATE SAMPLES	RINSATE BLANKS	TRIP BLANKS	SAMPLES	SAMPLES (b)	SAMPLES	TOTAL
SEDIMENT	VOC Scan (a)	VOCs	84	8	1	0	5	5	5	93
		RAS Protocol								
		Acid, Base/Neutral Extractables	84	8	1	0	5	5	5	93
		RAS Protocol								
		Metals	84	8	1	0	5	5	5	93
		RAS Protocol								
		Cyanide	84	8	1	0	5	5	5	93
		RAS Protocol								
		Total Organic Carbon	84	8	1	0	5	5	5	93
		SAS Protocol								
Atterberg Limits	SAS Protocol		16	2	0	1	0	1	1	19
Sediment Particle Size	SAS Protocol		16	2	0	1	0	1	1	19
Permeability	SAS Protocol		16	2	0	1	0	1	1	19

(a) The VOC Scan using an organic vapor analyzer will give qualitative concentrations in the parts per million (ppm) range.
 (b) The Atterberg Limits, total organic carbon, sediment particle size, permeability, and density analyses do not require a duplicate matrix spike only a duplicate.

TABLE 2-1

SUMMARY OF SAMPLING AND ANALYSIS
 TINKER AFB - SOLDIER CREEK RI/FS
 QUALITY ASSURANCE PROJECT PLAN

SAMPLE MATRIX	FIELD PARAMETERS	NO. OF FIELD		NO. OF EQUIPMENT		NO. OF MATRIX		NO. OF DUP.	
		MATRIX SAMPLES	DUPLICATE SAMPLES	RINSATE BLANKS	THIP BLANKS	SPIKE SAMPLES	SPIKE SAMPLES	MATRIX SPIKE SAMPLES (b)	TOTAL
SEDIMENT (continued)	Density SAS Protocol	16	2	0	0	0	0	1	19
		42	5	1	15	3	3	3	63
SURFACE WATER	pH RAS Protocol Unfiltered Samples	42	5	1	15	3	3	3	48
		42	5	1	0	3	3	3	48
Specific Conductivity	Temperature	42	5	1	0	3	3	3	48
		42	5	1	0	3	3	3	48
Stream Velocity	Metals RAS Protocol Unfiltered Samples	42	5	1	0	3	3	3	48
		42	5	1	0	3	3	3	48
VOC Scan (a)	Cyanide RAS Protocol Unfiltered Samples	42	5	1	0	3	3	3	48
		8	1	1	0	1	1	1	10
	Alkalinity SAS Protocol Unfiltered Samples	8	1	1	0	1	1	1	10

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(a) The VOC Scan using an organic vapor analyzer will give qualitative concentrations in the parts per million (ppm) range.
 (b) The Atterberg Limits, total organic carbon, sediment particle size, permeability, and density analyses do not require a duplicate matrix spike only a duplicate.

TABLE 2--1

SUMMARY OF SAMPLING AND ANALYSIS
TINKER AFB - SOLDIER CREEK RI/FS
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SAMPLE MATRIX	FIELD PARAMETERS	NO. OF FIELD		NO. OF EQUIPMENT		NO. OF MATRIX		NO. OF DUP.		
		MATRIX SAMPLES	DUPLICATE SAMPLES	RINSATE BLANKS	TRIP BLANKS	SPIKE SAMPLES	SPIKE SAMPLES	MATRIX SAMPLES (b)	MATRIX TOTAL	
SURFACE WATER (continued)	pH	8	1	1	0	1	1	1	10	
	Dissolved Oxygen	SAS Protocol Unfiltered Samples								
	Specific Conductivity	8	1	1	0	1	1	1	10	
	Temperature	SAS Protocol Unfiltered Samples								
Stream Velocity	Total Suspended Solids	8	1	1	0	1	1	1	10	
	SAS Protocol Unfiltered Samples									
VOC Scan (a)	BOD5	8	1	1	0	1	1	1	10	
	SAS Protocol Unfiltered Samples									
	Total Organic Carbon	8	1	1	0	1	1	1	10	
	SAS Protocol Unfiltered Samples									
	Oil and Grease	8	1	1	0	1	1	1	10	
	SAS Protocol Unfiltered Samples									

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(a) The VOC Scan using an organic vapor analyzer will give qualitative concentrations in the parts per million (ppm) range.
(b) The Alterberg Limits, total organic carbon, sediment particle size, permeability, and density analyses do not require a duplicate matrix spike only a duplicate.

TABLE 2-1

SUMMARY OF SAMPLING AND ANALYSIS
TINKER AFB - SOLDIER CREEK RI/FS
QUALITY ASSURANCE PROJECT PLAN

SAMPLE MATRIX	FIELD PARAMETERS	LABORATORY PARAMETERS	NO. OF FIELD		NO. OF EQUIPMENT		NO. OF MATRIX SPIKE		NO. OF DUP. MATRIX SPIKE	
			MATRIX SAMPLES	DUPLICATE SAMPLES	RINSATE BLANKS	TRIP BLANKS	SAMPLES	SAMPLES	SAMPLES	SAMPLES (b) TOTAL
SURFACE WATER (continued)		Nitrates SAS Protocol Unfiltered Samples	8	1	1	0	1	1	1	10
GROUNDWATER	pH Specific Conductivity	VOCs SAS Protocol Unfiltered Samples	8	1	1	3	1	1	1	13
	Temperature VOC Scan (a)	Acid, Base/ Neutral Extractables SAS Protocol Unfiltered Samples	8	1	1	0	1	1	1	10
		Metals SAS Protocol Unfiltered Samples	8	1	1	0	1	1	1	10
		Metals SAS Protocol Filtered Samples	3	1	1	0	1	1	1	5

(a) The VOC Scan using an organic vapor analyzer will give qualitative concentrations in the parts per million (ppm) range.

(b) The Atterberg Limits, total organic carbon, sediment particle size, permeability, and density analyses do not require a duplicate matrix spike only a duplicate.

Laboratory Program (CLP) guidelines are specified in the Statement of Work (SOW) for Organics Analysis (EPA, 1988a) and in the SOW for Inorganics Analysis (EPA, 1988b).

Accuracy of chemical test results is assessed by establishing the average recovery. The recovery is determined by splitting a series of samples into two portions, spiking one of the portions (adding a known quantity of the contaminant of interest), and submitting both portions for laboratory analysis as independent samples. The percent recovery is then calculated as follows:

$$\% \text{ Recovery} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Where:

SSR = Spike Sample Results

SR = Sample Results

SA = Spike Added from Spiking Mix

The average recovery can then be calculated by taking the average of the individual recoveries for a given compound. Perfect recovery would be defined as 100 percent recovery. Acceptable accuracy limits are set based on past data bases as defined by the EPA. In general, two types of recoveries are measured, matrix spike recoveries and surrogate spike recoveries. For a matrix spike, known amounts of standard compounds identical to the compounds present in the sample of interest are added to the sample. For a surrogate spike, the standards are chemically similar but not identical to the compounds in the fraction being analyzed. The purpose of the surrogate spike is to provide quality control on every sample by constantly monitoring for unusual sample matrix effects and gross sample processing errors in analysis of organic compounds. Surrogates will be added and analyzed for all organic samples.

Precision of the sample collection activity can be measured by comparing results from samples and duplicate samples. The variation in results is a measure of precision. Precision can be expressed as the relative percent difference (RPD), which is expressed as follows:

$$\text{RPD} = \frac{(D_1 - D_2)}{(D_1 + D_2)/2} \times 100$$

Where:

- RPD = Relative Percent Difference
- D₁ = First Duplicate Value (percent recovery)
- D₂ = Second Duplicate Value (percent recovery)

Acceptable precision limits are based on past data bases. Analytical results for RAS analyses which fall within the limits of historical precision and accuracy will be considered acceptable. These ranges are established in the SOW for Organics Analysis (EPA, 1988a), the SOW for Inorganics Analysis (EPA, 1988b), and as specified by EPA for each SAS analysis.

2.3.2 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent actual site conditions. The determination of the representativeness of the data will be performed by:

- o Comparing actual sampling procedures to those delineated in the SAP.
- o Invalidating nonrepresentative data or identifying data to be classified as questionable or qualitative. Only representative data will be used in subsequent data reduction, data validation and site characterization activities.
- o Comparing analytical results of field duplicates to determine the spread in the analytical results.
- o Examining the results of QC blanks for evidence of external or cross-contamination; external or cross-contamination may be cause for invalidation or qualification of the affected samples.

The analytical results of the equipment rinsate blank samples (cross-contamination) and trip blank samples (external contamination) will be used to determine appropriate ranges of useful analytical results. The lower value of the detection limit range will be established using the values of contaminant concentrations detected in the equipment rinsate blank and trip blanks.

2.3.3 Completeness

Field completeness will be assessed by comparing the number of samples collected to the number of samples planned. Laboratory completeness will be assessed by comparing the number of samples with valid analytical results to the number of samples collected. The overall project completeness is, therefore, a comparison between the total number of valid samples to the number of samples planned. The results will be calculated following data validation and reduction and will be used in planning subsequent sampling phases. Completeness goals for the Tinker AFB - Soldier Creek RI/FS project are summarized in Table 2-2. The goals are based on the ratio of expected number of samples collected to the number of samples planned. The following percentages for each sample matrix correspond to the completeness goals shown in Table 2-2: Sediment (90%), Surface Water (90%), and Groundwater (75%).

2.3.4 Comparability

Comparability is a qualitative parameter used to express the confidence with which one data set can be compared with another. Other data sets that may be used for comparison purposes are applicable hazard criteria and where appropriate, data available from other studies conducted previously in the area. The analytical results will be compared to the contaminant levels of concern required to conduct the risk assessment. To meet the objectives of the comparability QA parameter, the units specified for analytical results obtained during the field investigations will be consistent with those specified for previous investigations, and analytical detection methods will be consistent for each set of analyses.

TABLE 2-2
PROJECT COMPLETENESS GOALS
TINKER AFB - SOLDIER CREEK RI/FS
QUALITY ASSURANCE PROJECT PLAN

<u>Sample Matrix</u>	<u>Analyses</u>	<u>Completeness Goal For Matrix Samples</u>	
Sediment	Volatile Organics	90%	
	Acid, Base/Neutral Extractables	90%	
	Total Metals	90%	
	Cyanide	90%	
	Atterberg Limits, total organic carbon, particle size, permeability density (shelby)	90%	
	Surface Water	Volatile Organics	90%
		Acid, Base/Neutral Extractables	90%
Metals		90%	
Cyanide		90%	
Alkalinity		91%	
Hardness		91%	
Chemical Oxygen Demand		91%	
Total Suspended Solids		91%	
Biochemical Oxygen Demand (5 day)		91%	
Total Organic Carbon		91%	
Oil and Grease		91%	
Nitrates		87%	
Temperature, pH, Dissolved Oxygen, Specific Conductivity (field measurements)		90%	
Groundwater		Volatile Organics	75%
	Acid, Base Neutral Extractables	75%	
	Metals (unfiltered)	75%	
	Metals (filtered)	50%	
	Cyanide	75%	
	Temperature, pH, Specific Conductivity (field measurements)	75%	

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3.0 SAMPLING PROCEDURES

Specific procedures to be followed during the collection of sediment, surface water, and groundwater samples are presented in Sections 6.1 through 6.5, respectively, of the SAP.

4.0 SAMPLE CUSTODY/DOCUMENTATION

Sample custody and documentation procedures are a vital aspect of any environmental sampling investigation. Each sample or field measurement must be properly documented to facilitate timely, correct, and complete analysis. Additionally, sample custody procedures are necessary to support the use of data in potential enforcement actions at a site. The sample chain of custody procedure provides the means to identify, track, and monitor each sample from the point of collection through final data reporting.

Samples obtained during field activities will be shipped via overnight carrier to the CLP Laboratory. Upon receipt of samples, the CLP Laboratory personnel will be responsible for the sample custody and documentation procedures.

The sample custody and documentation procedures described in this section pertain to sediment, surface water, and groundwater sample collection and include the following items:

- o Field logbooks.
- o Photographs.
- o Sample numbering system.
- o Sample documentation.
- o Documentation procedures.
- o Corrections to documentation.
- o Final project files.

4.1 FIELD LOGBOOK

The most important aspect of sample custody and documentation is thorough, accurate record keeping. All information pertinent to a field survey or sampling event will be recorded in a bound logbook with consecutively

numbered pages. All entries in logbooks and on sample documentation forms will be made in waterproof ink and corrections will consist of line out deletions that are initialed and dated. Entries in the logbook will contain the following, as applicable:

- o Name and title of author, date and time of entry, and physical and environmental conditions during field activity.
- o Purpose and sampling activity.
- o Name and address of field contact, and emergency contacts.
- o Names and responsibilities of field crew members.
- o Names and titles of any site visitors.
- o Type of waste, suspected waste concentrations, if known, and sample matrix.
- o Sample collection method.
- o Number and volume of samples taken.
- o Location, description, and log of photographs of the sampling points.
- o References for all maps and photographs of sampling sites.
- o Information pertaining to sampling changes, scheduling modifications and change orders.
- o Information concerning access agreements.
- o Details of the exact sampling locations (dimensioned sketches of sampling locations may be appropriate).
- o Date and time of sample or data collection.
- o Field observations.
- o Any field measurements made (e.g., pH, specific conductance, temperature, stream velocity, and depth to groundwater).
- o Sample identification numbers.

- o Documentation of procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., filters and absorbing reagents).
- o Information from container labels of reagents used, HPLC water used for blanks, etc.
- o Sampling methodology, including distinction between grab and composite samples.
- o Sample preservation.
- o Sample distribution and transportation. (e.g., CLP Laboratory and Federal Express).
- o All sample documentation, such as:
 - Bottle lot numbers as received from laboratory.
 - Chain of custody record numbers.
- o Decontamination procedures.
- o All documentation for RI derived wastes, such as:
 - Contents and approximate volume of waste.
 - Collection and storage.
 - Type and predicted level of contamination.
 - Labelling procedure and numbering.
- o Summary of daily tasks (including costs) and documentation of any cost or scope of work changes required by field conditions.
- o Signature and date by personnel responsible for observations.

Sampling situations vary widely. No general rules can specify the exact information that must be entered in a logbook for a particular site. However, the logbook will contain sufficient information so that someone can reconstruct the sampling activity without relying on the collector's memory. The logbooks will be kept in the field team member's possession or in a secure place during the investigation. Following the investigation, the logbooks will become part of the final project file.

4.2 PHOTOGRAPHS

Following the identification of specific sampling locations, photographs will be taken. These photographs will show the surrounding area and reference objects. The film roll will be identified by taking a photograph

of an informational sign on the first frame of the roll. The sign will contain information regarding the site name, initials of photographer, film roll number, and date to identify the pictures contained on the roll.

Example: TAFB - Soldier Creek RI/FS
REF, Roll No. 1
May 1, 1990

Logbook entries of photographs will have six major components: field personnel's initials, roll number, frame number, date, time and description of the subject matter.

Example: REF, 1-1, 05-01-90, 0800
Background sediment and surface water sampling location,
surrounding land to east.

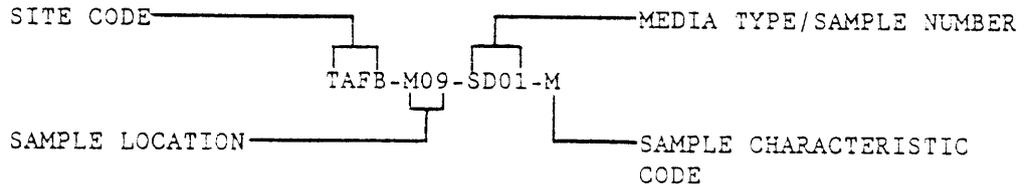
4.3 SAMPLE NUMBERING SYSTEM

A sample numbering system will be used to identify each sediment, surface water, and groundwater sample for chemical and physical analysis. The purpose of this numbering system is to provide a tracking system for retrieval of data on each sample. The sample identification numbers allocated for this sampling effort will be used on sample labels, sample tracking matrix forms, chain of custody records and all other applicable documentation used during the sampling activity. A listing of all sample identification numbers will be maintained in the field logbook by the field team representative.

Sample identification numbers will consist of four components, each separated by hyphens:

- (1) A four character alphabetic site identification code.
- (2) A three character alphanumeric sample location code.
- (3) A four character alphanumeric sample identification code for each sample location.
- (4) A three character alphabetic sample characteristic code.

An example of a completed sample number is shown below, with each component identified.



- (1) Site Code: Tinker AFB = TAFB
- (2) Sample Location: Main Soldier Creek/Location 09 = M09
- (3) Media Type/Sample Number Code: Sediment Sample (SD)/Sample Depth = SD01
- (4) Sample Characteristic Code: Matrix = M

The site code (TAFB) will remain the same for all samples collected at the Soldier Creek site.

The sample location code will be the same for all sediment and surface water samples collected. Four sample location designations will be used including M for Main Soldier Creek; E for East Soldier Creek; W for West Soldier Creek; and letters beginning with A for each separate tributary. The particular sampling location within each creek and tributary will be given a number designation beginning with "01". The groundwater samples collected from off-base wells will be given a G sample location designation with the sample location designation changing for each particular new location.

The media type/sample number code will be dependent on the type of sample collected and the number of samples collected at each sample location. The sample type will depend on the media sampled (i.e. sediment (SD), surface water (SW), and groundwater (GW)). The sample number at each location will be designated 01 for sediment samples taken at a depth of 0 - 6" and 02 for sediment samples taken at a depth of 6 - 12". The surface water and groundwater samples will have a 03 designation.

The fourth component of the sample identification number, the sample characteristic code, will indicate whether the sample is a routine matrix sample (M) including duplicates and blanks, a matrix spike sample (MS), or matrix spike duplicate sample (MSD).

Each sample collected will be assigned a unique sample number. Sample numbers should change when: (1) sample medium changes, or (2) sample location changes. Sample numbers do not change because different analyses are requested.

4.4 SAMPLE DOCUMENTATION

Each sample collected by field personnel at the Soldier Creek site will be placed in the appropriate sample container and the container will be labelled with a sample label. In addition to sample labels and chain of custody records, a sample tracking matrix form will be completed. Examples of these forms are presented in Appendix D. The following subsections describe procedures for completing sample documentation.

4.4.1 Sample Labels

The following information shall be included on the sample labels:

- o Site name.
- o Name of sampler(s).
- o Sample collection date and time.
- o Sample number.
- o Type of analysis.
- o Preservatives.

Information which is known prior to field activities (site name, month and year of sample collection, sample numbers, type of analysis, and preservatives) will be preprinted on the sample labels. Duplicate sample

labels can be printed for cases when various aliquots of a sample must be submitted separately for individual analyses. An example of the preprinted labels is shown in Appendix D.

4.4.2 Sample Tracking Matrix

A sample tracking matrix form will be used to record all pertinent information related to each sample. The following list indicates the information required for completing a sample tracking matrix form for the Soldier Creek site. An example form is shown in Appendix D.

- o Indicate sample matrix (i.e. sediment, surface water, groundwater).
- o Indicate the site name, Soldier Creek at Tinker AFB.
- o Indicate project number.
- o Enter the RAS or SAS case number (which ever applies), if known.
- o Indicate the sample identification number.
- o Indicate sample location and if sample is a duplicate, blank, etc.
- o Enter the date the sample was taken - time, date, month, and year.
- o Enter the name of the samplers.
- o If photographs are taken, enter the photographer's initials, roll number, frame number, date, and time (e.g., REF, 1-1, 05-01-90, 0800).
- o Enter pH, specific conductivity, dissolved oxygen (if surface water sample) and temperature measurements for water samples.
- o Note if the sample is filtered and/or preserved.
- o Since no traffic reports will be completed by field personnel for samples taken at the Soldier Creek site, the spaces for traffic report numbers should be left blank.
- o Indicate the analyses for each sample, and the CLP Laboratory doing the analyses.

- o Indicate the chain of custody report number.
- o Indicate the sample label number in the sample no. column.
- o Enter the airbill number and date for the shipment.
- o List the QC lot numbers of the sample containers.
- o Indicate the sample container type.
- o Add any remarks on back side of form and note at the bottom of the form.

4.4.3 Chain of Custody Records

The contractor will supply a chain of custody form to be completed for each sample shipment. An example of a chain of custody record is shown in Appendix D. After completion of the chain of custody form, the top, original signature copy of the chain of custody record will be enclosed in a plastic bag and secured to the inside of the cooler lid. A copy of the original custody record will be retained for the final project files.

Shipping coolers will be secured and custody seals will be placed across cooler openings. As long as custody forms are sealed inside the sample cooler and custody seals remain intact, commercial carriers are not required to sign off on the custody form.

4.4.4 Custody Seals

Custody will be used to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory. The seal must be attached to its container so that it is necessary to break the seal in order to open the container. All samples for the Tinker AFB - Soldier Creek RI/FS project will be shipped in coolers. Each cooler will be sealed on two opposite corners with custody seals. Examples of custody seals are shown in Appendix D.

4.5 DOCUMENTATION PROCEDURES

The itemized list below will be used as a general reference for completion of Soldier Creek sample documentation.

1. Make or obtain a list of the samples to be packaged and shipped that day.
2. Enter the RAS or SAS case number (which ever applies), matrix, sample numbers, laboratory, date sampled and date shipped for each sample on the sample tracking matrix.
3. Obtain the QC lot numbers of the prelabeled containers for each sample and enter these on the sample tracking matrix.
4. Determine the number of transferring containers (coolers) required to accommodate the day's shipment. This is based on the number of samples to be shipped, and the number of containers per sample that will fit in each cooler.
5. Follow specific instructions for packaging and shipping samples as shown in Section 4.7 of the SAP.
6. Assign a chain of custody record to each cooler and determine which sample containers will be shipped in each cooler.

(Note: More than one chain of custody record may be needed to accommodate the number of samples to be shipped in one cooler.)
7. Assign chain of custody record numbers to each sample by entering these numbers on the sample tracking matrix.
8. Assign sample labels to each sample container for each sample.
9. Complete chain of custody records based on the information provided on the sample tracking matrix.
10. Assign two custody seals to each cooler and temporarily clip seals to each chain of custody form.
11. Group all the paperwork associated with each cooler with a separate clip.
12. Obtain full signatures of the field team leader and initials of significant field team members on the sample identification labels and at the top of the chain of custody forms.
13. Prepare to package samples for shipment.

4.6 CORRECTIONS TO DOCUMENTATION

Unless prohibited by weather conditions, all original data recorded will be written with waterproof ink. No accountable serialized documents are to be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on an accountable document assigned to one individual, that individual shall make corrections by making a line through the error and entering the correct information. The erroneous information should not be obliterated. Any error discovered on an accountable document should be corrected by the person who made the entry. All corrections must be initialed and dated.

4.7 DOCUMENT CONTROL

The goal of document control is to account for all documents for a specified group of samples when the project is completed. Audits of Soldier Creek project files may be scheduled by the contractor Project Manager or the Tulsa COE. The document control audit consists of checking each document submitted for accountability. Written explanations must be present for any documents not accounted.

4.8 FINAL PROJECT FILES

Once the Tinker AFB - Soldier Creek RI/FS project is completed, the individual project files will be assembled, organized, and stored as final evidence for the project. A final project file for the Tinker AFB - Soldier Creek RI/FS project will be maintained by the contractor performing the services for the Tulsa COE at the Soldier Creek site.

5.0 QUALITY ASSURANCE PROCEDURES FOR LABORATORY AND FIELD ACTIVITIES

Samples will be analyzed using CLP protocols for volatile organics and BNA extractables on the Target Compound List (TCL) and metals and cyanide on the Target Analyte List (TAL) shown in Appendix C. Total metals analyses for groundwater samples will be conducted on two of the filtered groundwater samples and all of the unfiltered groundwater samples to determine the fraction of total metals adsorbed onto soil particles and the fraction present in the dissolved phase of the sample. In addition, SAS analyses including alkalinity, hardness, COD, TSS, BOD5, TOC, oil and grease, and nitrates will be conducted on surface water samples. Physical analysis, following SAS protocol, including Atterberg limits, permeability, sediment particle size, and density will be done on selected sediment samples. Total organic carbon analyses, following SAS protocol, will be performed on sediment samples collected from each of the forty-two sampling locations.

Several field activities will be performed before, during and after sample collection and analysis. The QAPP elements listed below are addressed separately for laboratory and field activities in the following sections.

- o Sample custody.
- o Analytical procedure.
- o Calibration procedure.
- o Internal quality control.
- o Data reduction/validation.
- o Performance and system audits.
- o Data assessment.
- o Preventative maintenance.
- o Accuracy/precision definitions.
- o Corrective action.

5.1 LABORATORY ACTIVITIES

A laboratory participating in the CLP will be used to provide CLP deliverable packages for chemical analytical services pertaining to the Soldier Creek site. The CLP laboratory chosen will, at a minimum, comply with Southwest Laboratory of Oklahoma's (SWLO) QAPP which is included as Appendix F. The specific analytical method and detection limits for each chemical analysis are shown in Appendix C. Laboratory quality assurance procedures to be used during laboratory activities are described in this section.

5.1.1 Sample Custody

Laboratory custody will conform to procedures established for the CLP. Sample custody and the required documentation for the entire sampling and analysis procedure is discussed in Section 4.0 of this QAPP. Specific chain-of-custody procedures for SWLO are described in detail in Appendix F of the Final SAP/QAPP, Section 6.0 of SWLO's QAPP.

5.1.2 Analytical Procedures, and Calibration Procedures/Frequency

The laboratory chosen to perform the chemical analytical services will follow CLP protocol for TCL and TAL analyses and SAS for specified analyses. All analyses will conform to the guidelines specified in the User's Guide to the CLP (EPA, 1984) and to those specified in the SOW for Organic Analysis (EPA, 1988a) and in the SOW for Inorganic Analysis (EPA, 1988b). SAS analyses will follow specific QA/QC requirements specified for the method. Specific analytical procedures and calibration procedures/frequency for SWLO are described in detail in Appendix F of the Final SAP/QAPP, Section 7.0 of SWLO's QAPP.

5.1.3 Internal Quality Control

Internal quality control procedures for analyses will follow the guidelines of the CLP specified in the SOW for Organic Analysis (EPA, 1988a) and in the SOW for Inorganic Analysis (EPA, 1988b) and method specific QA/QC

requirements for all other analyses. Specific internal quality control procedures are described in detail in Appendix F of the Final SAP/QAPP, Section 10.0 of SWLO's QAPP.

5.1.4 Data Validation and Reduction

Specific data validation procedures for SWLO are described in detail in Appendix F of the Final SAP/QAPP, Section 9.0 of SWLO's QAPP. The project team will validate analytical data in accordance with procedures specified in the Functional Guidelines for Evaluation Organics Analysis (EPA, 1988c) and the Functional Guidelines for Evaluating Inorganic Analyses (EPA, 1988d).

The project team will analyze the validated data and perform the data reduction activities necessary for presentation of these data in the Soldier Creek RI report. Methods used for data reduction will be described in the RI report. Data reduction includes all processes which change either the form of expression or quantity of data values reported or the number of data items.

5.1.5 Performance and System Audits

Performance and System Audits are performed by the EPA for all laboratories in the CLP. To become part of the CLP, laboratories must meet stringent requirements and standards for equipment, personnel, laboratory practices, analytical operations, and quality control as stated in the SOW for Organic and Inorganic Analyses (EPA 1988a and 1988b). As a continuing evaluation of performance, EPA reviews each laboratory's CLP contract deliverables in addition to evaluating analytical results from performance samples submitted on a quarterly basis. The contractor will receive analytical data in the form of CLP data packages from the CLP Laboratory, including associate QA/QC documentation. This data will be reviewed as part of the data validation process. Specific performance and system audits for SWLO are described in detail in Appendix F of the Final SAP/QAPP, Section 11.0 of SWLO's QAPP.

5.1.6 Data Assessment

Data assessment evaluations and data completeness will be evaluated by contractor personnel. The CLP laboratory will provide CLP deliverables.

5.1.7 Preventive Maintenance

Each CLP laboratory is responsible for the maintenance of equipment used during analyses procedures. Specific instrument calibration and tuning requirements must be completed to obtain reliable analytical results. It is the responsibility of the laboratory to ensure that backup systems and equipment are available as required. SWLO's QAPP is given in Appendix F as an example of the preventative maintenance done by a laboratory participating in the CLP program. Specific preventative maintenance procedures for SWLO are described in detail in Appendix F of the Final SAP/QAPP, Section 12.0 of SWLO's QAPP.

5.1.8 Procedures to Assess Precision, Accuracy, Sensitivity, and Completeness

Accuracy and precision definitions are listed in the method descriptions for specified analyses. Accuracy and precision will be assessed by the project team by examining analytical data for field duplicates and audit samples and calculating percent recovery and relative percent difference values for the chemical analyses. During data assessment, instrument sensitivity will be checked by reviewing the laboratory reports. Accuracy and precision data from analyses are compared with the established QC limits, and outliers (data lying outside specified QC limits) will be identified so that completeness can be assessed. For completeness, the CLP laboratory will provide data, meeting QC acceptance criteria, for 90% or more of the requested determinations. Specific procedures to assess precision, accuracy, sensitivity, and completeness are described in detail in Appendix F of the Final SAP/QAPP, Section 13.0 of SWLO's QAPP.

5.1.9 Corrective Action

If quality control audits or data reviews detect unacceptable data, the Project Manager will consult with the appropriate regulatory agencies, develop, and initiate corrective action. Four examples of corrective action may include:

- o Reanalyzing samples if the holding time criteria permits.
- o Resampling and analyzing.
- o Evaluating and amending sampling and analytical procedures.
- o Accepting data and acknowledging level of uncertainty.

Specific corrective actions for SWLO are described in detail in Appendix F of the Final SAP/QAPP, Section 14.0 of SWLO's QAPP.

5.2 FIELD ACTIVITIES

Contractor personnel will conduct the field activities as described in the SAP (Chapter I). Quality assurance procedures to be used during these field activities are described in this section.

5.2.1 Sample Custody

Sample custody and the required documentation for the Soldier Creek RI are discussed in Section 4.0 of this QAPP.

5.2.2 Analytical Procedures and Calibration Procedures/Frequency

Specific analytical procedures for field measurements are given in the SAP. Surface water and groundwater will be analyzed in the field at the time of sample collection for pH, specific conductivity, and temperature. Surface water samples will also be analyzed for dissolved oxygen at the time of sample collection. Water temperatures will be measured using a National Bureau of Standards (NBS) mercury thermometer.

Analytical and calibration procedures for pH, specific conductivity, dissolved oxygen and temperature are specified in Appendix E. Sediment, surface water, and groundwater samples will be scanned for the presence of volatile organic compounds using a portable photoionization analyzer. Instructions for use and calibration of the portable photoionization analyzer, as well as all other reasonable safety equipment to be used in the field, will be covered in the Health and Safety Plan (HSP). The static water elevation in each off-base groundwater well with respect to the top of the inner well casing will be measured using an electric water level meter. Since a specific water level meter will be dedicated for use on the project, specific operating instructions for this meter are also included in Appendix E. Stream surface water velocity will be measured using a horizontal-axis rotating current meter. Its operation and maintenance procedures are shown in Appendix E.

5.2.3 Internal Quality Control

Field blanks, duplicates, and background samples are included (when appropriate) with samples sent to the laboratory for analyses to monitor quality control of field sampling and laboratory analysis procedures. A list of QC samples can be found in Table 2-1, in Section 2.0 of this QAPP.

Field measurements such as pH, dissolved oxygen, specific conductivity and temperature will be performed at each specific sampling location and will not involve samples that are collected and retained. The primary QA objective for these data is to obtain reproducible measurements to a degree of accuracy consistent with limits imposed by analytical methodologies for the intended use of the data. Reproducibility of the measurements will be checked by taking multiple readings and by instrument calibration (where appropriate).

A separate volume of water will be collected for the measurement of pH, dissolved oxygen, specific conductivity, and temperature after surface water samples are collected.

A separate volume of water will be collected for the measurement of pH, specific conductivity, and temperature after groundwater samples are collected. The measurements will be taken immediately after the groundwater has been collected.

The requirements listed below will be followed for field measurements:

- o pH - The pH will be measured with an electrometric pH probe. Each reading and the arithmetic average will be reported to two decimal places.
- o Dissolved Oxygen - The amount of oxygen dissolved in the surface water will be measured using a dissolved oxygen meter. All readings will account for temperature and altitude and be reported to the nearest tenth.
- o Specific Conductivity - The specific conductivity will be measured with a specific conductivity meter. Readings will be reported to the number of significant figures appropriate for the measurement.
- o Temperature - Temperature will be measured with an NBS mercury thermometer and reported to the nearest 0.5 F.
- o Volatile Organic Scan - Sediment, surface water, and groundwater samples will be scanned with a portable photoionization analyzer to determine qualitative volatile organic contamination and to verify that appropriate personnel protective equipment is in use. These measurements will be in the ppm range. Measurements will be recorded in the field logbook, and the appropriate personnel protective actions will be taken as specified in the HSP.

5.2.4 Data Validation and Reduction

All field logbooks, documentation forms, and calculation worksheets, etc., used for the Tinker AFB - Soldier Creek RI/FS project, will be retained. These data will become part of the final project file. Raw data will be appropriately summarized in the Soldier Creek RI report.

5.2.5 Performance and System Audits

The Project Manager may schedule audits of field activities at various times to evaluate the execution of sample identification, sample control,

chain-of-custody procedures, field documentation and sampling and field measurement operations. The evaluation will be based on the extent to which the applicable SAP procedures are being followed.

The person conducting the audit is normally a senior technical reviewer who is familiar with the technical and procedural requirements of field sampling and with the applicable SAP. The auditor will keep a record of his evaluation using field notes and checklists. Following the audit, the auditor will review preliminary results with the person in charge of sampling. The auditor will also prepare an audit report containing the results of the evaluation and recommendations for corrective actions. Audits will be scheduled with the Project Manager and the Field Team Leader. An example of a typical audit checklist is shown in Appendix D.

Internal audit procedures were developed to conform to EPA requirements (NEIC, 1989).

5.2.6 Data Assessment

The project team will assess field measurement data to determine if field QA objectives are met.

5.2.7 Preventive Maintenance

Preventive maintenance of equipment is essential if project resources are to be used in a cost effective manner. Preventive maintenance will take two forms: (1) implementing a schedule of preventive maintenance activities to minimize downtime and to maintain the accuracy of measurement systems; and (2) maintaining availability of critical spare parts, backup systems, and equipment.

All equipment used at the site will be maintained in safe working order. Any equipment or device determined not to be in safe working order by field personnel or the Site Safety Coordinator will be replaced, repaired, or corrected.

5.2.8 Procedures to Assess Precision, Accuracy, Sensitivity, and Completeness

No specific quantitative levels for precision and accuracy are specified for field measurement. However, proper maintenance, calibration, and operation (per manufacturer's recommendations) will be followed to maintain adequate instrument accuracy so reliable results will be obtained. Instruments will be calibrated at appropriate intervals to maintain measurement accuracy. Multiple readings and analysis of duplicate samples will be performed to measure the precision of field measurements.

5.2.9 Corrective Action

If quality control audits of data result in detection of field data of unacceptable quality, the Project Manager will develop and initiate corrective action. Corrective action for field measurements may include:

- o Repeat the measurement to correct the error.
- o Check for all proper adjustments for ambient conditions such as temperature.
- o Check the batteries.
- o Check the calibration.
- o Check the power supply to the instrument, if any.
- o Replace the instrument or measurement devices.

Corrective action for sampling procedures may include:

- o Evaluating and amending sampling procedures.
- o Resampling.

A corrective action checklist is shown in Appendix D.

6.0 QUALITY ASSURANCE REPORTS

As part of the contractor's monthly status report, the following will be addressed: sampling and analytical progress, problem conditions, corrective actions, and current QA/QC assessments. The Soldier Creek RI report will contain sections pertaining to QA that summarize data quality information collected during the project.

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APPENDIX A
SUMMARY OF
PREVIOUS INVESTIGATIONS AND REPORTS

A.0 PREVIOUS INVESTIGATIONS AND REPORTS

A variety of investigations pertaining to the Soldier Creek site have been conducted by a number of organizations since 1984. A summary of these previous investigations and pertinent reports is shown in Table A-1. A description of each of these previous investigations is given in this Appendix including, if known, the purpose of each investigation, sampling locations, pertinent analytical data, sample methodology and conclusions. Each subsection is titled according to the organization that performed the sampling and the media sampled.

A.1 Radian Sediment Analytical Results

The purpose of the IRP Phase II Confirmation/Quantification Stage 2 investigation (Radian, 1985b) performed by the Radian Corporation was to determine if solvent storage and waste disposal practices resulted in environmental contamination at Tinker AFB. In addition, the investigation presented an estimate of the magnitude and extent of contamination, the identification of environmental consequences of migrating pollutants, and recommendations for additional investigations to identify the magnitude, extent and direction of movement of discovered contaminants.

As part of this investigation, twenty-four sediment samples were collected along Crutcho Creek (including significant tributaries), Kuhlman Creek, East Soldier Creek, West Soldier Creek, Soldier Creek, a tributary of Elm Creek and two drainage ditches within Tinker AFB on June 20 and July 19, 1984. Seven of these sediment sampling stations were located within East Soldier Creek, West Soldier Creek, Soldier Creek, and two drainage ditches on Tinker AFB and were identified by selected primary data users to be pertinent to the Soldier Creek RI. The locations of these sampling stations are shown on Figure A-1 along with the metals (cadmium, chromium, lead, zinc) analytical results for each station. The metals analytical

TABLE A-1

SUMMARY OF PREVIOUS INVESTIGATIONS
TINKER AFB - SOLDIER CREEK RIFFS
SAMPLING AND ANALYSIS PLAN

REFERENCE DOCUMENT	SAMPLER	DATES	SAMPLE MEDIUM	SAMPLE ANALYSIS	ANALYZED BY
Installation Restoration Program Phase II Confirmation/Quantification Stage 2 Final Report for Tinker AFB, Oklahoma (Hadian, 1985b)	Radian Corporation	6/84	Sediment	Metals, Fluoride, Cyanide, PCBs, Pesticides, Phenols, Nitrates, and Total Organic Carbon	Radian Laboratories
An Evaluation of the Effects of Wastewater Discharge from IAFB on Water Quality of Crotcho & Soldier Creeks (EPA, 1984)	EPA	7/85	Sediment Water	Metals, VOCs, BNAS Metals, VOCs, BNAS, Water Quality Data	EPA Laboratory
Site Investigation Report (HKS, 1985)	Harry Keith & Sons, Inc.	10/85	Sediment	Metals, VOCs, BNAS, PCBs, Pesticides Fluoride, Nitrate, Cyanide, Phenols	Environmental Laboratories Inc.
"Sample Results" (1) Report (HKS, 1986)	Harry Keith & Sons, Inc.	4/86 & 5/86	Sediment	Metals, BIX, VOCs	Environmental Control Laboratory
"Sample Results" (1) Report IWTP & STP Discharges (Tinker AFB, 1987a)	Tinker AFB	3/87 - 9/87	Water	VOCs	METLAB
"Sample Results" (1) Report (OSDH, 1987)	Oklahoma State Department of Health	6/87	Sediment Water	Metals Metals, VOCs	Oklahoma State Department of Health Laboratory
HPDF'S Analytical Results (Tinker AFB, 1987b)	Tinker AFB	9/86 - 7/87	Water	Water Quality Data (pH, TSS, Oil and Grease)	Analab of Texas
Building 3001 Remedial Investigations, Volumes I and II (Tulsa COE, 1988a and 1988b)	Tulsa COE	3/88, 10/88	Groundwater	VOCs, BNAS, Metals, TOC, pH, Specific Conductivity, TICs (2)	Southwestern Division Laboratory, COE
Building 3001 Supplemental Quarterly Remedial Investigation, Draft (Tulsa COE, 1989a); Tinker AFB Groundwater Assessment Update (Tulsa COE, 1988b); and "Sampling Results" (1) Groundwater Report (Tulsa COE, 1988c)					Oklahoma State Department of Health Oklahoma State Department of Health Southwest Laboratory of Oklahoma
Final Storm Sower Investigation for Soldier Creek (RUS, 1989)	RUS Corporation	10/89	Water	VOCs, Metals (Cd, Cr, Cu, Pb, Ni, Zn), Oils and Grease, COD, Cyanide, Total Phenols, Phosphorus, Chromium (Hex)	RUS Corporation

FOOTNOTES

- (1) "Sampling Results" - No reports were generated.
- (2) TICs - Tentatively Identified Compounds

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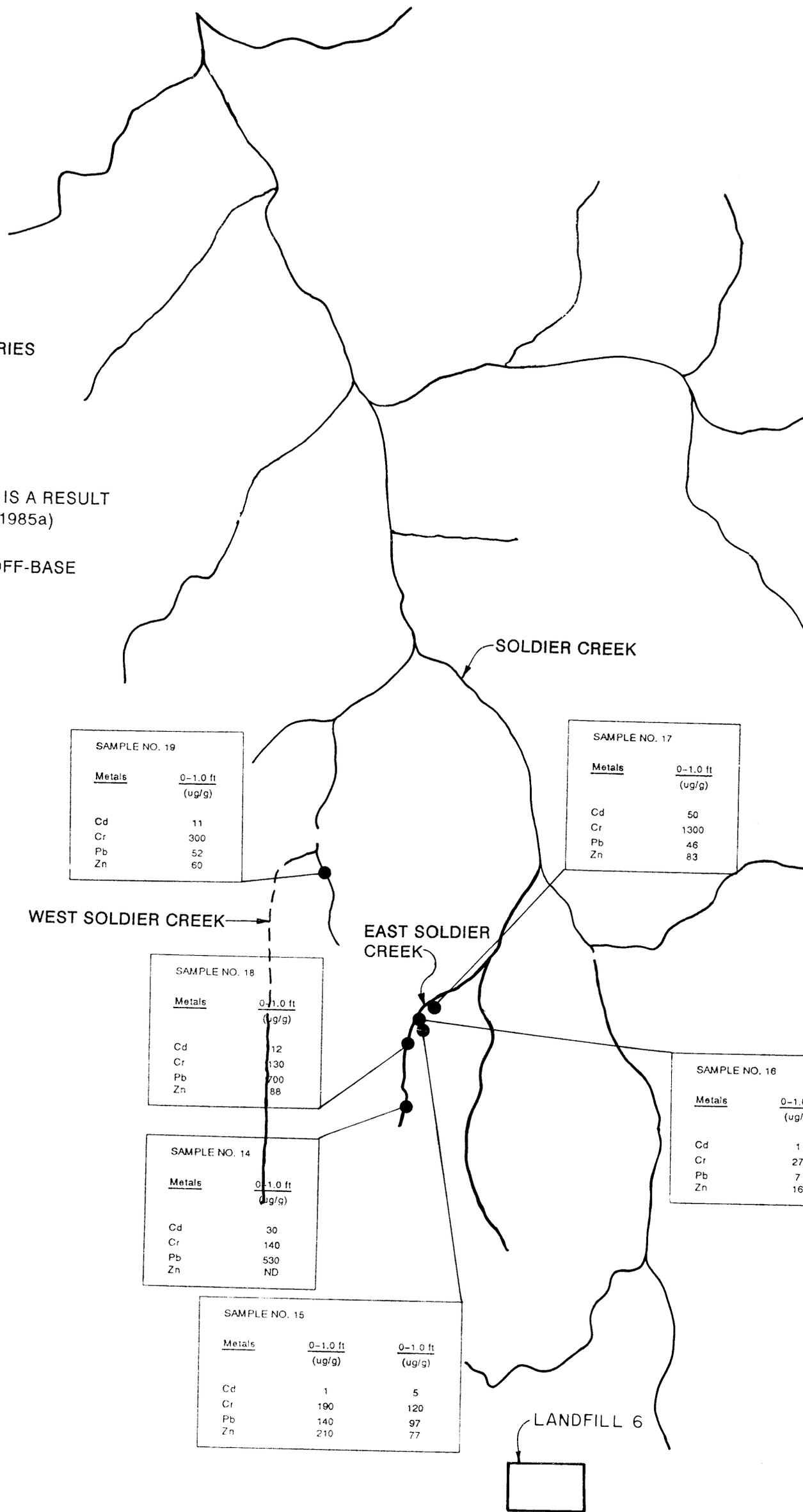
LEGEND:

- SOLDIER CREEK AND TRIBUTARIES
- - - UNDERGROUND PORTION OF WEST SOLDIER CREEK
- SAMPLING LOCATION

NOTES:

- THE SAMPLE NUMBERING SYSTEM IS A RESULT OF THE RADIAN REPORT (RADIAN, 1985a)
- SAMPLE NUMBER 24 IS LOCATED OFF-BASE NEAR LANDFILL NUMBER 6.

REFERENCE: RADIAN, 1985a



N
^

results were shown because of the relatively high concentrations in comparison to the other analyses results. Sediment sample analytical results for all analyzed parameters are shown in Table A-2.

Sediment samples were collected using either a hand trowel or a section of 2-inch outside diameter polycarbonate tube. The tube was employed as a "plug" or coring device. Generally, the depth of sampling extended from 6 to 12 inches below the channel bottom as conditions would allow. At several sampling locations, samples were collected as composites obtained from two or more discrete points in the area of the sampling station. Multiple point samples were collected for compositing at sample stations where stream conditions varied significantly with the station reach. Point samples were composited as the station sample to be representative of local stream conditions.

Immediately following the collection and compositing, each sediment sample was placed in a quart glass jar with a Teflon cap liner. Each sample was labeled and packed with ice in an insulated shipping container. Samples were shipped nightly to Radian Analytical Services using an overnight parcel service. All shipments were made under chain-of-custody control. Once in the laboratory, samples were frozen until analyses were begun.

In general, Radian concluded that sediment analytical results showed no evidence of widespread or elevated levels of industrial contaminants. Radian determined that no other follow-up action was deemed necessary for the area of study.

A.2 EPA Sediment and Surface Water Analytical Results

The purpose of the report titled "An Evaluation of the Effects of Wastewater Discharge from TAFB on Water Quality of Crutchko & Soldier Creeks," (EPA, 1985) was to present data and conclusions resulting from the

TABLE A-2

RADIAN SEDIMENT ANALYTICAL DATA
 TINKER AFB - SOLDIER CREEK RI/FS
 SAMPLING AND ANALYSIS PLAN

SAMPLE NO.	SAMPLE LOCATION	SAMPLER	DEPTH (FT.)	DATE	UNITS	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	Cu	Zn	Mn	Ni	FI	NITRATE	PCBs	TOC
24	T-SED-28	RADIAN	0-1.0	7/19/84	ug/g	1	110	1	12	8	ND	ND	ND	5	8	250	6	3	3	ND	1
14	T-SED-15	RADIAN	0-1.0	6/20/84	ug/g	1	330	30	140	530	2	ND	3	52	ND	140	19	ND	ND	ND	4
15	T-SED-13	RADIAN	0-1.0	6/20/84	ug/g	2	220	1	190	140	1	1	2	230	210	250	43	ND	ND	ND	1
15	T-SED-18	RADIAN	0-1.0	6/29/84	ug/g	1	200	5	120	97	ND	ND	2	54	77	250	12	ND	1	1	1
16	T-SED-14	RADIAN	0-1.0	6/20/84	ug/g	1	320	1	27	7	ND	ND	2	4	16	530	6	ND	1	1	ND
17	T-SED-12	RADIAN	0-1.0	6/20/84	ug/g	ND	410	12	130	700	ND	ND	2	160	88	330	83	ND	1	1	ND
17	T-SED-11	RADIAN	0-1.0	6/20/84	ug/g	1	170	50	1300	46	ND	ND	2	45	83	790	230	ND	1	1	ND
19	T-SED-16	RADIAN	0-1.0	6/20/84	ug/g	1	220	11	300	52	ND	ND	2	69	60	170	170	ND	1	2	2

NOTE:

Cyanide, phenols, pesticides and herbicides analysis were determined with no chemical concentrations detected.
 ND = Not Detected

Oklahoma Water Resources Board (OWRB) investigation of the potential toxics contamination of Crutcho and Soldier Creeks. EPA Region VI provided technical assistance to the OWRB by conducting chemical analyses and bioassays on three effluent and five stream samples. Samples were collected by the OWRB and EPA on October 30 through November 1, 1984.

Six of the sediment sampling locations within Soldier Creek were identified by selected primary data users as pertinent to the Soldier Creek RI. The locations of these sampling stations are shown in Figure A-2, along with the metals (cadmium, chromium, lead, iron), total BNAs, and total VOCs analytical data for each station. These data were shown to illustrate the metals concentrations and the possible "hot spots" for BNA and VOC contamination. The pertinent sampling analytical data for this investigation is shown in Table A-3.

The precise sampling methodology for collection of the sediment and surface water samples is unknown. The effluent sample from outfall sampling point 1 was collected as a 24 hour composite. The effluent samples from the two other outfall sampling points were collected as single grab samples. Grab samples were collected at each stream sampling station.

In general, EPA concluded that water quality of Crutcho and Soldier Creeks was considered poor due to the concentrations of organic, metal and conventional contaminants detected in the water column. Pollution of Crutcho and Soldier Creeks was considered to be primarily due to discharges from Tinker AFB, especially outfall 1 from Building 3001. Oklahoma Water Quality Criteria (WQC) for chromium, copper, mercury, and cyanide were exceeded, and Oklahoma Water Quality Standards (WQS) for chromium, copper, TDS, sulfate and hardness were violated. State sediment quality goals for cadmium and chromium, and the water quality goal for cyanide, were exceeded. Overall, water quality was considered best at the Crutcho Creek

SAMPLE D		
Metals	Water (ug/l)	Sediment (mg/kg)
Cd	ND	ND
Cr	ND	36
Pb	ND	13
Fe	1107	6940
<u>BNAs</u>		
TOTAL	31	1
<u>VOCs</u>		
TOTAL	ND	25

SAMPLE E		
Metals	Water (ug/l)	Sediment (mg/kg)
Cd	ND	ND
Cr	ND	22
Pb	ND	13
Fe	1030	6890
<u>BNAs</u>		
TOTAL	45	7921
<u>VOCs</u>		
TOTAL	ND	45

LEGEND:

- SOLDIER CREEK AND TRIBUTARIES
- - - UNDERGROUND PORTION OF WEST SOLDIER CREEK
- SAMPLING LOCATION

NOTES:

- THE SAMPLE NUMBERING SYSTEM IS A RESULT OF THE EPA REPORT (EPA, 1984b)
- SAMPLE NUMBERS D AND E ARE DOWNSTREAM ON SOLDIER CREEK.

REFERENCE: EPA, 1984b

SAMPLE NO. 2	
Metals	Water (ug/l)
Cr	ND
Cu	ND
Ni	36
<u>BNAs</u>	
TOTAL	5

SAMPLE B		
Metals	Water (ug/l)	Sediment (mg/kg)
Cd	ND	69
Cr	63	728
Pb	30	35
Fe	574	9190
<u>BNAs</u>		
TOTAL	45	5111
<u>VOCs</u>		
TOTAL	114	53

SAMPLE NO. 1	
Metals	Water (ug/l)
Cr	151
Cu	55
Ni	254
<u>BNAs</u>	
TOTAL	55

SAMPLE C		
Metals	Water (ug/l)	Sediment (mg/kg)
Cd	ND	20
Cr	58	329
Pb	1329	30
Fe	ND	17600
<u>BNAs</u>		
TOTAL	29	3089
<u>VOCs</u>		
TOTAL	75	ND

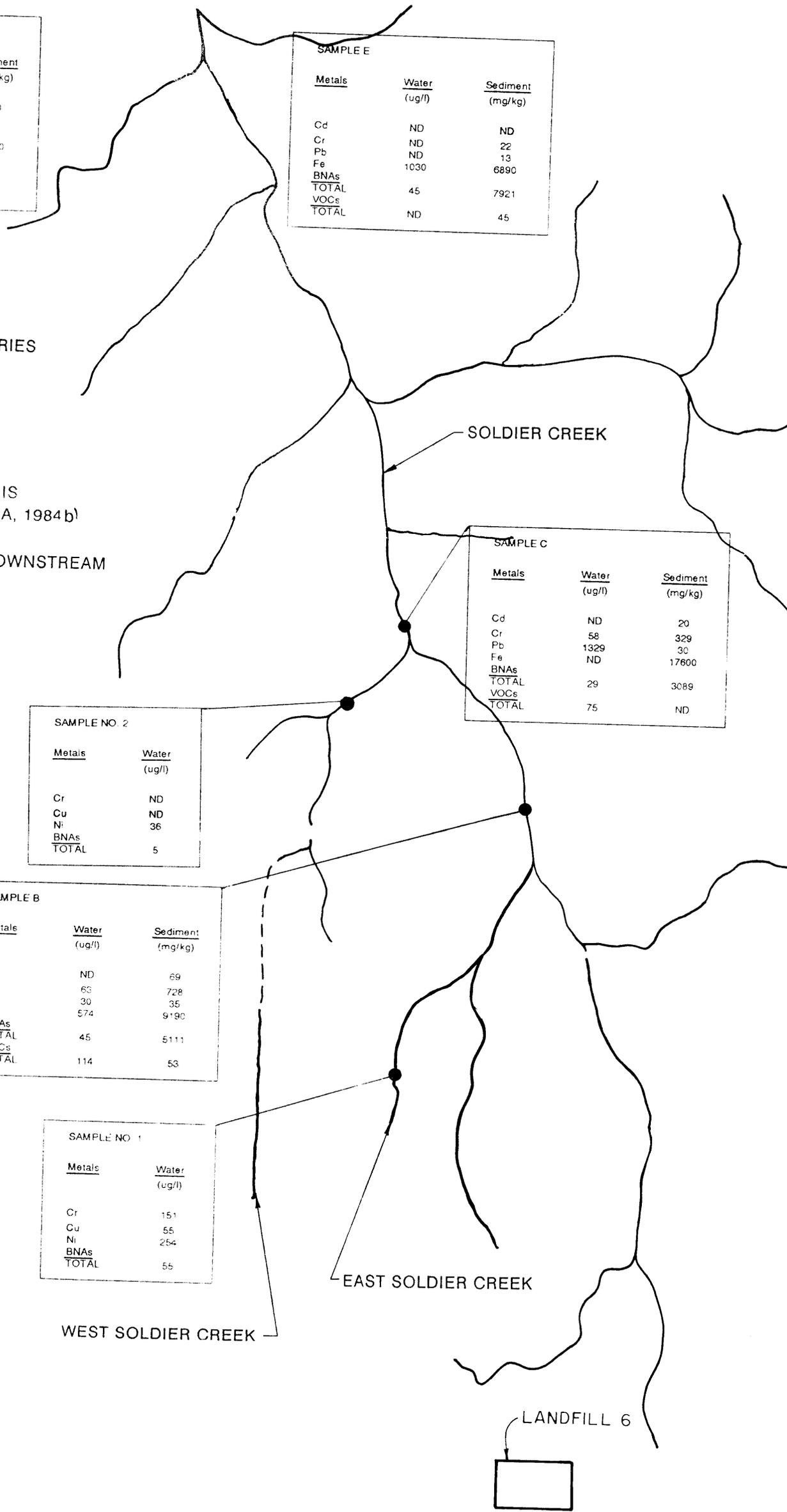


TABLE A-3

EPA SURFACE WATER AND SEDIMENT ANALYTICAL RESULTS
 TINKER AFB - SOLDIER CREEK RIFFS
 SAMPLING AND ANALYSIS PLAN

SAMPLE NO.	SAMPLER DATE	SURFACE WATER										SEDIMENT									
		UNITS	Cd	Cr	Cu	Pb	Fe	Ni	BNAS TOTAL	VOCs TOTAL	UNITS	Cd	Cr	Cu	Pb	Fe	BNAS TOTAL	VOCs TOTAL			
1	EPA 10/84	ug/l	ND	151	ND	ND	ND	254	55	ND	ng/kg	ND	ND	ND	ND	ND	ND	ND			
B	EPA 10/84	ug/l	ND	63	ND	30	574	ND	45	114	ng/kg	69	728	ND	35	9190	5111	53			
2	EPA 10/84	ug/l	ND	0	ND	ND	36	5	5	ND	ng/kg	ND	ND	ND	ND	ND	ND	ND			
C	EPA 10/84	ug/l	ND	58	ND	1329	ND	ND	29	75	ng/kg	20	329	ND	30	17600	3089	ND			
D	EPA 10/84	ug/l	ND	ND	ND	1107	ND	31	31	ND	ng/kg	ND	36	ND	13	6940	1	26			
E	EPA 10/84	ug/l	ND	ND	ND	1030	ND	45	45	ND	ng/kg	ND	22	ND	13	6890	7921	45			

ND = Not Detected

station A, poorest at Soldier Creek stations B and C below industrial discharges, and intermediate at stations D and E, located further downstream on Crutch Creek.

A.3 Harry Keith & Sons, Inc. (HKS) 1985 Sediment Analytical Results

The purpose of the HKS Site Investigation Report (HKS, 1985) prepared by HKS was to present analytical results from sediment sampling conducted to determine the magnitude of contamination found in East and West Soldier Creeks.

Sixty-five sediment samples were collected at various locations within East and West Soldier Creeks. Data, including cadmium, chromium, lead, zinc, and total BNA concentrations, for each sampling location along West Soldier Creek are shown on Figure A-3. The locations of samples collected within East Soldier Creek are unknown at this time. Analytical data from this investigation for both East and West Soldier Creeks are shown in Table A-4.

Sediment samples were collected using a hand trowel and scoop containing a plastic disposable sleeve that was changed at each sample point and depth. The samples were measured to the proper depth interval (0-2 and 3-5 inches) and placed into a "lab weight" plastic bag with an air tight seal. The sample bag was then placed into another plastic bag to ensure an air tight seal. An additional 400 grams of the same measured sample was placed into a glass jar with Teflon lid. Samples were transported for analysis immediately upon completion of the sample collection for all areas. Analysis was initiated approximately 12 hours after leaving the last sample location. All samples were rechecked for proper identification upon arrival at the laboratory.

HKS concluded that East Soldier Creek appeared to have a heavy buildup of black oily sludge in and adjacent to the stream bed. All sample sites and the adjacent areas exuded strong hydrocarbon odors. Many sample locations

SAMPLE NO. 135 and 136		
Metals	0-2 ft (135) (ug/g)	3-5 ft (136) (ug/g)
Cd	8	12
Cr	756	64
Pb	105	45
Zn	250	55
<u>BNAs</u>		
TOTAL	33	17
<u>VOAs</u>		
TOTAL	7	4

SAMPLE NO. 131 and 132		
Metals	0-2 ft (131) (ug/g)	3-5 ft (132) (ug/g)
Cd	945	605
Cr	778	1060
Pb	360	351
Zn	710	490
<u>BNAs</u>		
TOTAL	212	1198

SAMPLE NO. 133 and 134		
Metals	0-2 ft (133) (ug/g)	3-5 ft (134) (ug/g)
Cd	32	29
Cr	263	368
Pb	147	196
Zn	270	190
<u>BNAs</u>		
TOTAL	ND	12

SAMPLE NO. 119 and 120		
Metals	0-2 ft (119) (ug/g)	3-5 ft (120) (ug/g)
Cd	15	18
Cr	502	26
Pb	211	79
Zn	690	103
<u>BNAs</u>		
TOTAL	ND	79
<u>VOAs</u>		
TOTAL	14	2

SAMPLE NO. 129 and 130		
Metals	0-2 ft (129) (ug/g)	3-5 ft (130) (ug/g)
Cd	17	17
Cr	75	56
Pb	71	71
Zn	98	101
<u>BNAs</u>		
TOTAL	16	10

SAMPLE NO. 115 and 116		
Metals	0-2 ft (115) (ug/g)	3-5 ft (116) (ug/g)
Cd	2	1
Cr	23	27
Pb	28	23
Zn	28	69
<u>BNAs</u>		
TOTAL	2	9

SAMPLE NO. 127 and 128		
Metals	0-2 ft (127) (ug/g)	3-5 ft (128) (ug/g)
Cd	20	17
Cr	478	64
Pb	115	154
Zn	249	184
<u>BNAs</u>		
TOTAL	157	170

SAMPLE NO. 125 and 126		
Metals	0-2 ft (125) (ug/g)	3-5 ft (126) (ug/g)
Cd	103	8
Cr	764	205
Pb	102	28
Zn	190	37
<u>BNAs</u>		
TOTAL	5	23

SAMPLE NO. 123 and 124		
Metals	0-2 ft (123) (ug/g)	3-5 ft (124) (ug/g)
Cd	13	4
Cr	174	18
Pb	74	17
Zn	65	67
<u>BNAs</u>		
TOTAL	8	5
<u>VOAs</u>		
TOTAL	7	3

LEGEND:

- SOLDIER CREEK AND TRIBUTARIES
- - - UNDERGROUND PORTION OF WEST SOLDIER CREEK
- SAMPLING LOCATION

NOTES:

- THE SAMPLE NUMBERING SYSTEM IS A RESULT OF THE HKS REPORT (HKS, 1985)
- SAMPLE LOCATIONS 33-75 ARE UNDETERMINED AT THIS TIME

REFERENCE: HKS, 1985

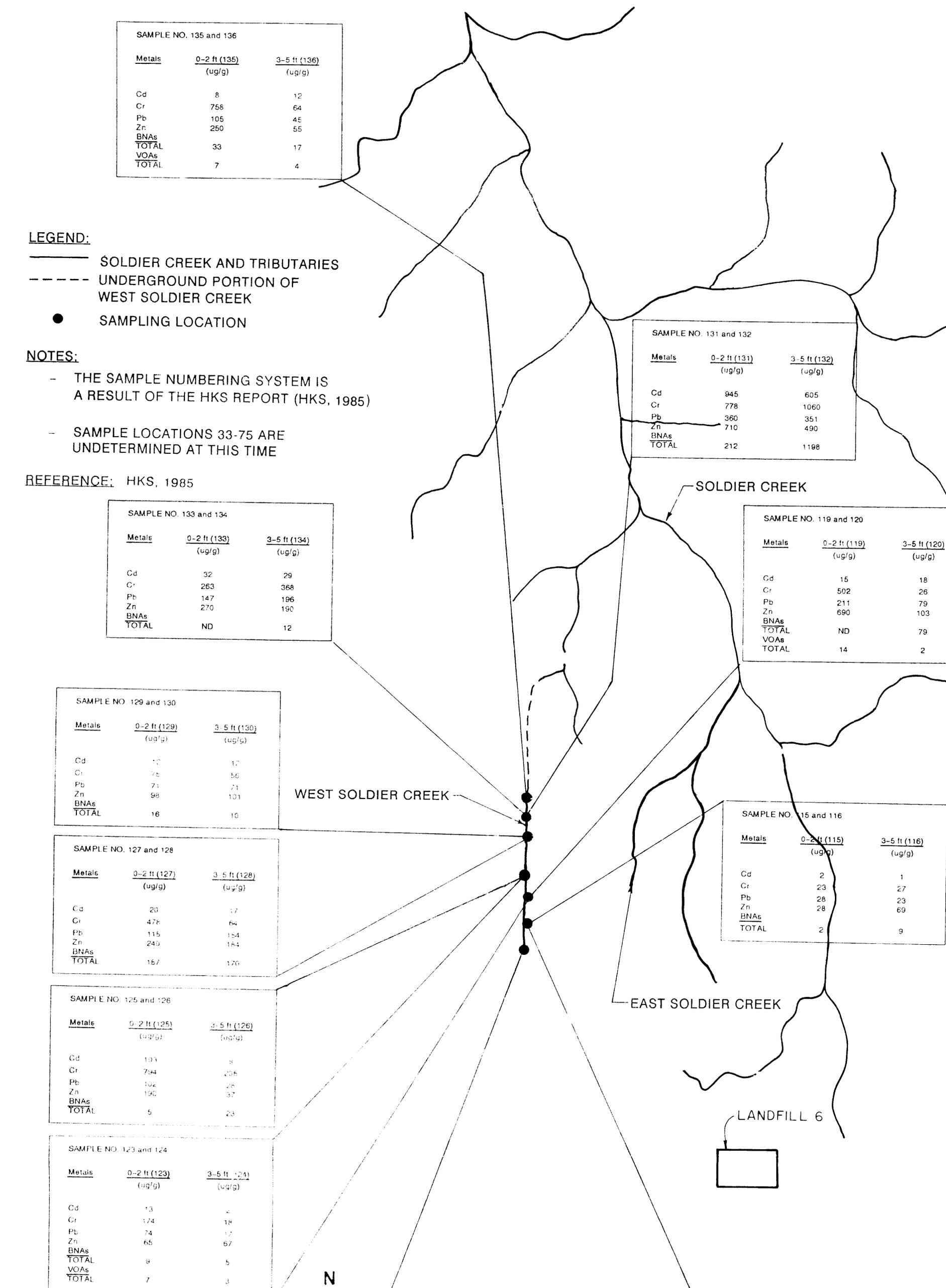


TABLE A-4

HKS 1985 SEDIMENT ANALYTICAL RESULTS
TINKER AFB - SOLDIER CREEK RI/FS
SAMPLING AND ANALYSIS PLAN

SAMPLE NO.	SAMPLE LOCATION	DEPTH (in.)	DATE	UNITS														TOTAL TOTAL	
					As	Ba	Cd	Cr	Pb	Hg	Se	Ag	Cu	Zn	Mn	Ni	BNAs	VOCs	
33	SOLD CREEK	0-2	10/05/85	mg/kg	1	210	386	108	118	ND	1	7	1010	218	275	43	ND	ND	
34	SOLD CREEK	3-5	10/05/85	mg/kg	1	262	6	87	196	ND	1	6	110	98	435	29	19	ND	
35	SOLD CREEK	*	10/05/85	mg/kg	1	185	12	164	139	ND	1	2	238	910	615	77	22	ND	
36	SOLD CREEK	0-2	10/05/85	mg/kg	1	227	15	105	170	1	1	17	308	252	173	87	18	ND	
37	SOLD CREEK	3-5	10/05/85	mg/kg	1	420	12	168	203	1	1	3	196	230	224	70	17	ND	
38	SOLD CREEK	0-2	10/05/85	mg/kg	1	152	12	114	216	ND	1	14	288	202	507	69	65	ND	
39	SOLD CREEK	3-5	10/05/85	mg/kg	1	168	8	149	251	1	1	8	135	144	336	51	31	ND	
40	SOLD CREEK	0-2	10/05/85	mg/kg	1	101	13	256	226	1	1	22	318	388	401	90	ND	ND	
41	SOLD CREEK	3-5	10/05/85	mg/kg	1	520	66	464	140	1	1	21	72	100	290	119	ND	ND	
42	SOLD CREEK	0-2	10/05/85	mg/kg	1	102	18	262	189	1	1	26	476	230	189	131	ND	ND	
43	SOLD CREEK	3-5	10/05/85	mg/kg	1	20	89	1310	435	2	1	26	51	520	447	306	140	ND	
44	SOLD CREEK	0-2	10/05/85	mg/kg	1	103	2	35	19	ND	1	5	51	43	224	28	ND	ND	
45	SOLD CREEK	3-5	10/05/85	mg/kg	1	242	1	12	13	ND	1	3	22	21	256	12	ND	ND	
46	SOLD CREEK	0-2	10/05/85	mg/kg	1	272	42	712	121	ND	1	18	362	240	853	175	26	ND	
47	SOLD CREEK	3-5	10/05/85	mg/kg	1	292	54	948	146	ND	1	26	520	525	844	197	154	ND	
48	SOLD CREEK	0-2	10/05/85	mg/kg	1	216	48	424	94	ND	1	14	231	178	282	160	12	ND	
49	SOLD CREEK	3-5	10/05/85	mg/kg	1	253	73	316	63	ND	1	10	220	62	161	53	3	ND	
50	SOLD CREEK	0-2	10/05/85	mg/kg	1	212	17	402	49	ND	1	19	122	81	290	136	ND	ND	
51	SOLD CREEK	3-5	10/05/85	mg/kg	1	101	43	1810	105	ND	1	24	91	115	180	158	11	ND	
52	SOLD CREEK	0-2	10/05/85	mg/kg	1	78	2	12	11	ND	1	2	7	10	109	10	2	ND	
53	SOLD CREEK	3-5	10/05/85	mg/kg	1	188	16	51	32	ND	1	6	24	34	273	28	159	1	
54	SOLD CREEK	0-2	10/05/85	mg/kg	1	308	17	201	93	ND	1	15	195	145	269	112	1	ND	
55	SOLD CREEK	3-5	10/05/85	mg/kg	1	403	35	485	73	1	1	12	93	580	451	127	6	ND	
56	SOLD CREEK	0-2	10/05/85	mg/kg	1	161	76	259	27	ND	1	9	60	85	304	151	ND	ND	
57	SOLD CREEK	3-5	10/05/85	mg/kg	1	88	185	184	77	ND	1	4	41	127	118	88	14	ND	
58	SOLD CREEK	0-2	10/05/85	mg/kg	1	192	7	585	672	ND	1	16	106	388	358	86	ND	ND	
59	SOLD CREEK	3-5	10/05/85	mg/kg	1	101	560	845	450	ND	1	6	83	401	700	43	ND	ND	
60	SOLD CREEK	0-2	10/05/85	mg/kg	1	103	16	100	50	ND	1	8	21	28	398	81	ND	ND	
61	SOLD CREEK	3-5	10/05/85	mg/kg	1	132	11	100	21	ND	1	5	16	26	320	42	ND	ND	
62	SOLD CREEK	*	10/05/85	mg/kg	1	402	42	585	105	ND	1	9	134	154	72	178	ND	ND	
63	SOLD CREEK	0-2	10/05/85	mg/kg	1	180	51	1010	79	ND	1	8	78	88	97	314	ND	ND	
64	SOLD CREEK	3-5	10/05/85	mg/kg	1	440	38	783	102	1	1	6	206	274	70	330	14	ND	
65	SOLD CREEK	0-2	10/05/85	mg/kg	1	93	1	45	10	ND	1	4	12	28	60	27	4	ND	
66	SOLD CREEK	3-5	10/05/85	mg/kg	1	167	1	16	10	ND	1	2	7	17	435	16	2	ND	
67	SOLD CREEK	0-2	10/05/85	mg/kg	1	293	1	232	161	ND	1	3	64	170	60	148	11	ND	
68	SOLD CREEK	3-5	10/05/85	mg/kg	1	325	84	1720	246	ND	1	27	63	140	398	450	177	ND	
69	SOLD CREEK	0-2	10/05/85	mg/kg	1	285	2	47	23	ND	1	8	16	38	435	38	ND	ND	
70	SOLD CREEK	3-5	10/05/85	mg/kg	1	230	1	18	14	ND	1	1	8	16	502	14	ND	ND	
71	SOLD CREEK	0-2	10/05/85	mg/kg	1	312	152	1760	625	ND	1	18	49	710	122	360	306	ND	
72	SOLD CREEK	3-5	10/05/85	mg/kg	1	461	1220	6970	885	ND	1	57	476	1250	156	3850	538	ND	
73	SOLD CREEK	*	10/05/85	mg/kg	1	245	2	22	171	2	1	2	16	53	420	10	ND	ND	
74	SOLD CREEK	0-2	10/05/85	mg/kg	1	321	76	620	172	ND	1	17	295	310	158	350	ND	ND	
75	SOLD CREEK	0-5	10/05/85	mg/kg	1	270	55	409	142	1	1	3	189	190	165	236	135	ND	

TABLE A-4 (Continued)

HKS 1985 SEDIMENT ANALYTICAL RESULTS
TINKER AFB - SOLDIER CREEK RI/FS
SAMPLING AND ANALYSIS PLAN

SAMPLE NO.	SAMPLE LOCATION	DEPTH (ft.)	DATE	UNITS														TOTAL TOTAL	
					As	Ba	Cd	Cr	Pb	Hg	Se	Ag	Cu	Zn	Mn	Ni	EMAs	/OCs	
110	DITCH	0-2	10/05/85	mg/kg	1	384	9	29	89	ND	1	5	13	69	341	28	8	ND	
114	DITCH	3-5	10/05/85	mg/kg	1	355	10	44	96	ND	1	1	12	32	482	14	6	ND	
115	DITCH	0-2	10/05/85	mg/kg	1	305	2	20	28	ND	1	3	17	23	354	18	2	ND	
116	DITCH	3-5	10/05/85	mg/kg	1	242	1	27	23	ND	1	1	11	69	515	18	9	ND	
117	DITCH	0-2	10/05/85	mg/kg	1	230	6	36	41	ND	1	1	14	66	155	33	31	ND	
118	DITCH	3-5	10/05/85	mg/kg	1	302	13	26	79	ND	1	6	14	103	226	26	73	ND	
119	DITCH	0-2	10/05/85	mg/kg	1	380	15	502	211	ND	1	19	229	690	81	200	ND	11	
120	DITCH	3-5	10/05/85	mg/kg	1	350	25	359	155	ND	1	31	30	450	66	490	ND	12	
121	DITCH	0-2	10/05/85	mg/kg	1	270	16	737	163	1	1	55	169	390	646	300	662	17	
122	DITCH	3-5	10/05/85	mg/kg	1	420	61	943	327	1	1	79	189	1100	48	935	32	11	
123	DITCH	0-2	10/05/85	mg/kg	1	353	10	174	74	ND	1	3	22	65	143	422	9	11	
124	DITCH	3-5	10/05/85	mg/kg	1	538	2	18	17	ND	1	1	3	67	69	42	6	ND	
125	DITCH	0-2	10/05/85	mg/kg	1	450	103	794	102	ND	1	4	64	190	100	3110	6	ND	
126	DITCH	3-5	10/05/85	mg/kg	1	310	9	205	28	ND	1	6	13	37	198	710	13	ND	
127	DITCH	0-2	10/05/85	mg/kg	1	180	20	473	115	1	1	55	95	240	61	97	157	ND	
128	DITCH	3-5	10/05/85	mg/kg	1	349	17	64	154	ND	1	21	59	184	91	167	170	ND	
129	DITCH	0-2	10/05/85	mg/kg	1	263	12	75	71	1	1	13	30	98	62	225	16	ND	
130	DITCH	3-5	10/05/85	mg/kg	1	315	12	56	71	1	1	12	23	101	68	165	11	ND	
131	DITCH	0-2	10/05/85	mg/kg	1	510	345	778	360	1	1	188	214	710	661	388	212	ND	
132	DITCH	3-5	10/05/85	mg/kg	1	310	105	1060	351	1	1	367	183	490	1180	321	1185	ND	
133	DITCH	0-2	10/05/85	mg/kg	1	310	32	263	147	ND	1	2	67	270	305	010	ND	ND	
134	DITCH	3-5	10/05/85	mg/kg	1	280	23	363	196	ND	1	3	44	190	398	170	12	ND	
135	DITCH	0-2	10/05/85	mg/kg	1	365	8	753	105	ND	1	2	64	250	790	820	33	17	
136	DITCH	3-5	10/05/85	mg/kg	1	103	12	64	45	ND	1	2	13	55	460	39	17	11	

ND = Not Detected

* = Depth not available at this time

contained an approximately 2 inch thick layer of sediment that appeared clean and covered the black oily sludge underneath. The contamination observed, but not sampled, was at depths greater than 5 inches. Further, HKS stated that this deeper contamination may be more heavily concentrated, had an odor, and may have a different chemical character.

Conclusions presented in the HKS Site Investigation Report are described below. Many of the sample sites and the adjacent areas displayed evidence of high water conditions that could have washed away soluble and insoluble compounds which may have been present in the top layer of sediment. Even the normal water level conditions of a stream may carry a portion of the organic and inorganic contaminants downstream by the physical action of stream flow. Therefore, HKS expected extensive downstream effect of the contaminants that were found or had been present in the stream sediment.

A.4 HKS 1986 Sediment Analytical Results

The purpose, sample methodology, specific sampling activities and conclusions of the 1986 HKS investigation (HKS, 1986) are unavailable at this time. The sampling locations, together with and pertinent metals (cadmium, chromium, lead) and VOC concentrations for each location, are shown on Figure A-4. The sediment analytical results for this investigation are shown in Table A-5.

A.5 Industrial Waste Treatment Plant (IWTP) and Sanitary Treatment Plant (STP) Discharge Surface Water Analytical Results

The purpose of this investigation (Tinker AFB, 1987a) was to sample the IWTP and STP water discharge and determine surface water concentrations of specific contaminants of interest. Tinker AFB personnel collected the surface water samples. The sample methodology, specific sampling activities and conclusions of the 1987 surface water analytical results are unavailable at this time. The sampling locations together with the volatile organic analysis results are shown on Figure A-5.

LEGEND:

SAMPLE

● SAMPLE

NOTES:

- THE SAM

- SAMPLE

REFERENCE:

H

SAMPLE NO. C-07

Metals	0-1.0 ft (4/86) (mg/kg)	0-1.0 ft (5/86) (mg/kg)
Cd	359	492
Cr	812	914
Pb	238	234
VOAs	(ug/kg)	(ug/kg)
Chloroform	133	ND
PCE	ND	ND
1-1,2-Dichl	ND	ND

SAMPLE NO. C-08

Metals	0-1.0 ft (4/86) (mg/kg)	0-1.0 ft (5/86) (mg/kg)
Cd	499	496
Cr	1260	900
Pb	293	261

SAMPLE NO. C-06 (5/86)

Metals	0-5 ft (mg/kg)	0.5-1.0 ft (mg/kg)	1.0-1.5 ft (mg/kg)	1.5-2.0 ft (mg/kg)
Cd	68	162	275	337
Cr	405	473	1046	893
Pb	118	178	312	208

SAMPLE NO. C-05

Metals	0-1.5 ft (4/86) (mg/kg)	0-1.5 ft (5/86) (mg/kg)
Cd	76	405
Cr	650	887
Pb	163	309
VOAs	(ug/kg)	(ug/kg)
Chloroform	2	ND
PCE	ND	ND
1-1,2-Dichl	12	ND

SAMPLE NO. C-03

Metals	0-1.5 ft (5/86) (mg/kg)
Cd	32
Cr	332
Pb	135



FIGURE A
HKS 1986
TINKER AFB
SAMPLING 7

TABLE A-5
 HKS 1986 SEDIMENT ANALYTICAL RESULTS
 TINKER AFB - SOLDIER CREEK RI/FS
 SAMPLING AND ANALYSIS PLAN

SAMPLE LOCATION	SAMPLER	DEPTH (ft)	DATE	UNITS	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	Cu	Zn	Mn	Ni	Chloroform		1-1,2-dichloroethene (ug/kg)	
																	(ug/kg)	PCE (ug/kg)		
6807	C-10	HKS	0-0.5	04/29/86	mg/kg	5	585	321	1140	170	ND	8	15	68	220	280	292	2	2	27
6808	C-11	HKS	0-0.5	04/29/86	mg/kg	3	372	233	838	206	ND	5	9	118	355	325	174	20	19	26
6804	C-07	HKS	0-1.0	04/29/86	mg/kg	1	392	359	812	238	ND	ND	9	145	375	386	173	133	ND	ND
6805	C-08	HKS	0-0.5	04/29/86	mg/kg	3	434	499	1260	293	ND	5	17	256	430	359	416	ND	ND	ND
6806	C-09	HKS	0-0.5	04/29/86	mg/kg	3	509	72	360	68	ND	8	12	32	90	560	94	ND	ND	ND
7006	C-08	HKS	0-0.5	05/27/86	mg/kg	ND	ND	496	900	261	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7007	C-07	HKS	0-1.0	05/27/86	mg/kg	ND	ND	492	914	234	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7008	C-05	HKS	0-1.5	05/27/86	mg/kg	ND	ND	405	887	309	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7009	C-03	HKS	0-1.5	05/27/86	mg/kg	ND	ND	32	332	135	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7010	C-06	HKS	1.5-2.0	05/27/86	mg/kg	ND	ND	337	893	208	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7011	C-06	HKS	0-0.5	05/27/86	mg/kg	ND	ND	68	405	116	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7012	C-06	HKS	0.5-1.0	05/27/86	mg/kg	ND	ND	162	473	176	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7013	C-06	HKS	1.0-1.5	05/27/86	mg/kg	ND	ND	275	1046	312	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6809	C-05	HKS	0-1.5	04/29/86	mg/kg	ND	ND	76	650	163	ND	ND	ND	ND	164	ND	ND	2	2	12

ND - Not Detected

NOTES:

- SAMPLE DISCH

REFERENCE:

IWTP & STP AVG. DISCHARGE - 3/87 - 9/87

VOAS	WATER (ug/l)
Benzene	15162.97
Bromodichloromethane	2.94
Carbon Tetrachloride	0.03
Chlorobenzene	17.05
2-Chloroethyl Vinyl Ether	0.79
Chloroform	11.99
Chloromethane	1.4
Dibromochloromethane	1.55
1,2-Dichlorobenzene	10.91
1,3-Dichlorobenzene	0.93
1,4-Dichlorobenzene	4.27
1,1-Dichloroethane	0.47
1,2-Dichloroethane	1.1
1,1-Dichloroethene	1.1
Trans-1,2-Dichloroethene	61.29
1,2-Dichloropropane	0.64
Cis-1,2-Dichloropropane	8.32
Ethyl Benzene	1.82
Methylene Chloride	142.64
1,1,2,2-Tetrachloroethane	2.52
Tetrachloroethene	32.48
Toluene	3.58
1,1,1-Trichloroethane	26.55
1,1,2-Trichloroethane	17.04
Trichloroethane	2.81
Trichlorofluoromethane	11.1



FIGURE 7
 IWTP & STP
 ANALYTICAL
 TINKER AF
 SAMPLING

A.6 OSDH Sediment and Surface Water Analytical Results

The purpose, sample methodology, specific sampling activities and conclusions of the OSDH investigation (OSDH, 1987) are unavailable at this time. The West Soldier Creek sampling location together with analytical results for the surface water and sediment samples are shown on Figure A-6.

A.7 NPDES Surface Water Analytical Results

The purpose of the NPDES surface water investigation (Tinker AFB, 1987b) done by Tinker AFB personnel was to determine surface water concentrations of specific contaminants at prescribed locations downstream of the IWTP effluent discharge. The sample methodology, specific sampling activities and the conclusions of the NPDES water analytical results are unavailable at this time. Sampling locations are shown on Figure A-7. The surface water analytical results are shown on Table A-6.

A.8 Groundwater Analytical Results

Quarterly groundwater sampling and analyses at Tinker AFB is conducted by the Tulsa COE as a part of the overall groundwater assessment at Tinker AFB and as a part of the remedial investigations at the Building 3001 site. As a part of the quarterly groundwater sampling, several wells, which are located in the vicinity of West and East Soldier Creeks and are screened in the perched aquifer, have been sampled. The results of the sample analyses have been presented in several reports prepared by the Tulsa COE (Tulsa COE, 1988d, Tulsa COE, 1989c; and Tulsa COE, 1989c) and are summarized on Tables A-7 and A-8 for samples from wells in the vicinity of West Soldier Creek and East Soldier Creek, respectively. The well locations are illustrated on Figure A-8. The analytical results have not been summarized on a figure due to the large volume of data that is available. The sampling methodology is presented in the Tinker AFB Sampling and Analysis Quality Assurance/Quality Control Plan for Corps of Engineers Site Investigations (Tulsa COE, 1986).

LEGEND:

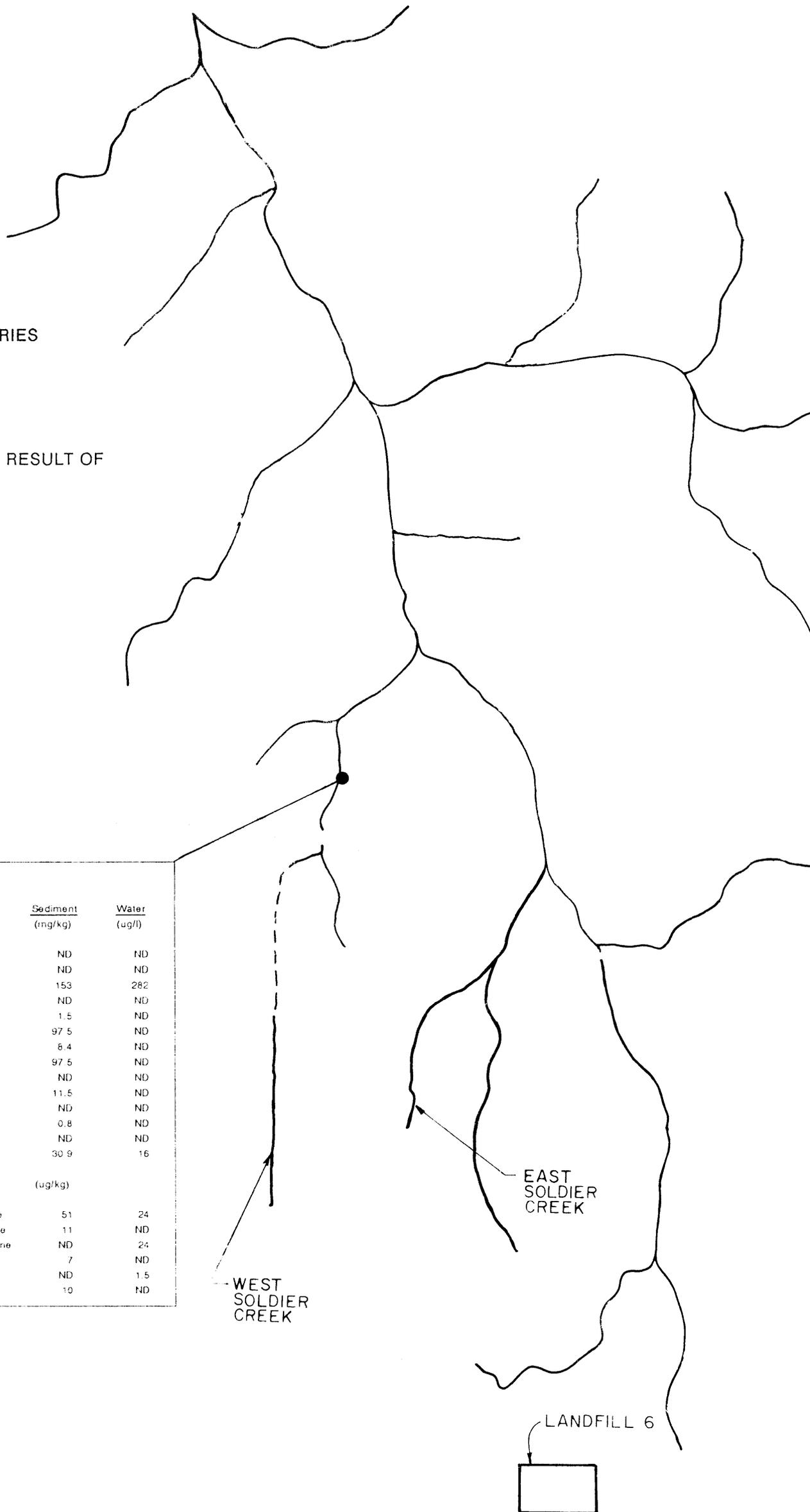
- SOLDIER CREEK AND TRIBUTARIES
- UNDERGROUND PORTION OF WEST SOLDIER CREEK
- SAMPLING LOCATION

NOTES:

- SAMPLE NUMBERING SYSTEM IS A RESULT OF THE OSDH REPORT (OSDH, 1987)

REFERENCE: OSDH, 1987

SAMPLE NO. T-2		
Metals	Sediment (mg/kg)	Water (ug/l)
Sb	ND	ND
As	ND	ND
Ba	153	282
Be	ND	ND
Cd	1.5	ND
Cr	97.5	ND
Cu	6.4	ND
Pb	97.5	ND
Hg	ND	ND
Ni	11.5	ND
Se	ND	ND
Ag	0.8	ND
Th	ND	ND
Zn	30.9	16
VOCs	(ug/kg)	
Methylene Chloride	51	24
1,1-Dichloroethene	11	ND
1,1,1-trichloroethene	ND	24
trichloroethene	7	ND
Tetrachloroethene	ND	1.5
Toluene	10	ND



● NP

NOTES:
- SAMPL

REFERENCE:

001

● 002N

● 005N

● 004N

● 003N

↖ EAST
SOLDIER
CREEK

0 3

FIGURE A-7
NPDES SURFAC
TINKER AFB - SOLD
SAMPLING AND AN

TABLE A-6

NPDES WATER ANALYTICAL RESULTS
TINKER AFB - SOLDIER CREEK RI/FS
SAMPLING AND ANALYSIS PLAN

DISCH LOCA	pH (MAX)	TSS LB/DY MG/L	OIL/GREASE LB/DY MG/L	FLO MG/L	MGD AVG MAX
001N	7.62	164.5 22.6	46.3	6.2	0.66 1.05
002N	7.98	NA 18.94	NA	7.2	0.32 0.71
003N	NA	NA NA	NA	NA	0.17 NA
004N	9.2	NA NA	NA	NA	ND NA
005N	NA	NA NA	NA	39.7	0.62 1.7
01SN	7.7	162.4 99.6	NA	NA	0.68 0.7

NA = Not Analyzed
ND = Not Detected

TABLE A-7
 GROUNDWATER ANALYTICAL RESULTS FOR WELLS MONITORING
 THE PERCHED AQUIFER IN VICINITY OF WEST SOLDIER CREEK
 TINKER AFB-SOLDIER CREEK RIIFS
 SAMPLING AND ANALYSIS PLAN

WELL	NUMBER	DATE	UMHS	As	Ba	Cd	Cr	Hg	Pb	Rh	Sb	TuG	pH	Conductivity (umhos/cm)	Chloro- benzene	1,2-Dichloro- ethane	1,2-Dichloro- benzene	1,4-Dichloro- benzene	Tetrachloro- ethane	Vinyl Chloride
	MW 1-105	05/02/86	ug/l	3/3	<500/540	<8/4.8	<10/1.0	0.7/0.4	25/30	68/11.0	<0.4/0.4	5/60	NA	NA	<5.000	<5.000	NA	NA	<5.000	<10.000
	MW 1-105	10/22/87	ug/l	2	8/30	8	<10	<0.10	<25	18	<0.4	1100	7.25	800	<2.000	10	NA	NA	<2.000	<2.000
	MW 1-105	03/14/88	ug/l	6	300	<8	<10	<0.10	60	35	0.4	3200	7.11	775	<5.000	<5.000	NA	NA	<5.000	<10.000
	MW 1-105	06/07/88	ug/l	1/2	720/780	<5/4.5	9/0	<0.10/0.10	<10/0.10	<5/4.5	NA	2900	6.96	819	<5.000	<5.000	NA	NA	<5.000	<10.000
	MW 1-105	09/19/88	ug/l	<1/1	860/930	<5/4.5	<5/4.5	<0.10/0.10	<10/0.10	<5/4.5	0.8/0.8	1400	8.52	528	<5.000	<5.000	NA	NA	<5.000	<10.000
	MW 1-105	03/12/89	ug/l	2	850	<5	NA	<0.10	<10	<5	0.7	900	7.02	890	<1.000	<1.000	<2.000	<1.000	<2.000	
	MW 1-128	09/10/88	ug/l	<1	<500	8	25	<0.4	63	75	<0.4	2600	7.33	970	<500.000	4900	NA	<500.000	<1000.000	
	MW 1-128	10/28/88	ug/l	2/8	<500/720	<8/4.8	<10/1.5	<0.4/0.4	60/73	63/60	<0.4/0.4	NA	7.17	708	32	2100	18000	NA	<8.000	23
	MW 1-128	11/11/87	ug/l	<40	2200	<10	100	<2.0	<30	110	<50	1700	7.06	550	1180	2000	32000	NA	1000	0.85
	MW 1-135	09/11/88	ug/l	2	840	8	13	<0.4	63	38	<0.4	2100	7.43	505	<5.000	<5.000	NA	<5.000	<10.000	
	MW 1-138	11/18/87	ug/l	<40	780	<10	<10	<2.0	<30	<10	<50	2600	7.34	578	NA	NA	NA	NA	NA	
	MW 1-138	12/01/87	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	MW 1-130	02/10/88	ug/l	4	405	<8	<10	<0.10	35	15	<0.4	4800	7.47	555	<2.000	<2.000	NA	<2.000	<2.000	
	MW 1-135	06/08/88	ug/l	1/2	470/470	<5/4.5	117/1	<0.10/0.10	<10/72	<5/4.5	NA	2600	7.09	544	<5.000	10	NA	NA	<5.000	<10.000
	MW 1-135	09/21/88	ug/l	3	460	<5	12	<0.10	<10	16	<0.4	400	7.68	425	<5.000	<5.000	NA	<5.000	<10.000	
	MW 1-138	03/19/89	ug/l	2	390	<5	NA	<0.10	<10	<5	0.7	500	7.75	490	<5.000	<5.000	NA	<5.000	<10.000	
	MW 1-143	09/18/88	ug/l	5	3300	13	240	<0.4	120	180	5	1700	NA	NA	<5.000	<5.000	NA	<5.000	<10.000	
	MW 1-143	10/29/88	ug/l	1/3	<500/890	<8/4.8	45/45	<0.4/0.4	43/63	68/100	<0.4/0.4	NA	7.27	1310	<5.000	<5.000	NA	<5.000	<10.000	
	MW 1-143	10/19/87	ug/l	2	<500	<8	<10	<0.10	<25	18	<0.4	5100	6.48	1920	<2.000	<2.000	NA	<2.000	<2.000	
	MW 1-143	02/10/88	ug/l	4	300	<8	<10	0.8	48	53	<0.4	4300	7.43	1283	<5.000	<5.000	NA	<5.000	<10.000	
	MW 1-143	06/08/88	ug/l	1/2	110/200	<5/4.5	9/0	<0.10/0.10	<10/0.10	17/22	NA	1700	8.86	878	<5.000	<5.000	<10.000	<5.000	<10.000	
	MW 1-143	09/21/88	ug/l	1	160	<6	11	<0.10	<10	<5	1	700	7.31	1049	<5.000	<5.000	NA	<5.000	<10.000	
	MW 1-143	03/28/89	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<5.000	<5.000	<10.000	<5.000	<10.000	
	MW-71	01/20/88	ug/l	6.8	1300	<8	18	0.3	95	55	5	5300	8.82	558	<5.000	<5.000	<10.000	<5.000	<10.000	
	MW-71	05/04/88	ug/l	1	310	7	<10	<0.10	<13	8	<0.4	3600	7.08	3330	<5.000	<5.000	<10.000	<5.000	<10.000	
	MW-71	07/25/88	ug/l	<1	380	<5	21	<0.10	13	45	0.5	2800	6.84	643	<5.000	<5.000	<10.000	<5.000	<10.000	
	MW-71	09/21/88	ug/l	<1	580	<5	89	<0.10	<10	81	<0.4	1500	7.66	654	<5.000	<5.000	<10.000	<5.000	<10.000	
	MW-71	03/27/89	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<5.000	<5.000	<10.000	<5.000	<10.000	

Notes: NA - Not Analyzed
 For metals, values provided are given for Dissolved Metals/Total Metals or otherwise as given as Total Metals
 References: Tulsa COE, 1988; Tulsa COE, 1986; and Tulsa COE, 1986

TABLE A B
 GROUNDWATER ANALYTICAL RESULTS FOR WELLS
 MONITORING PERCHED AQUIFER IN VICINITY OF EAST SOLDIER CREEK
 TINKER AFB - SOLDIER CREEK HHS
 SAMPLING AND ANALYSIS PLAN

WELL NUMBER	DATE	UNITS	As	Ba	Cd	Cr	Cu	Hg	Pb	Ni	Sr	TOC	pH	Conductivity (umhos/cm)	Chloro- benzene	1,2-dichloro- ethane	Trichloro- ethene	1,2-Dichloro- benzene	1,4-Dichloro- benzene	Tetrachloro- ethene	Vinyl Chloride	
MW-21B	10/27/87	ug/l	<5	1200	<10	<10	<2	<2	20	<10	<5	2400	7.85	1258	<2.000	<2.000	7.7	NA	NA	<2.000	<2.000	
MW 22B	05/07/88	ug/l	<1/2<1	560/800	<8/58	<10/13	<0.10/<0.10	<25/25	120/170	<0.4/<0.4	1600	7.13	1141	<5.000	<5.000	<5.000	NA	NA	NA	<5.000	<10.000	
MW-22B	10/26/87	ug/l	<5	600	<10	10	<2	12	10	<5	2400	7.07	816	<2.000	<2.000	<2.000	NA	NA	NA	<2.000	<2.000	
MW-22B	04/09/88	ug/l	2	800	<5	<5	<0.10	20	9	<0.4	7700	7.05	640	<5.000	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000		
MW-23B	05/07/88	ug/l	<1/2<1	1500/2000	<8/58	<10/28	<0.10/<0.10	<25/<25	120/130	<0.4/<0.4	2200	8.80	655	<5.000	<5.000	<5.000	NA	NA	NA	<5.000	<10.000	
MW 23B	10/30/87	ug/l	<5	2150	10	<10	<2	7	7	<5	2000	8.53	442	<2.000	<2.000	<2.000	NA	NA	NA	<2.000	<2.000	
MW 1-11B	10/16/87	ug/l	3	<500	<8	<10	<0.10/<0.10	28/28	110/140	<0.4/<0.4	4700	7.08	1368	6	<5.000	<5.000	<5.000	NA	NA	NA	<5.000	<10.000
MW 1-11B	03/15/88	ug/l	7	<300	<8	<10	<0.10	35	20	<0.4	1900	7.70	757	<2.000	<2.000	<2.000	NA	NA	NA	<2.000	<2.000	
MW 1-11B	06/05/88	ug/l	1/2	180/200	<5/5	10/14	<0.10/<0.10	<10/10	6/8	NA	4100	8.04	808	<5.000	<5.000	<5.000	NA	NA	NA	<5.000	<10.000	
MW 1-11B	06/19/88	ug/l	1/1	240/240	<5/5	11/12	<0.10/<0.10	<10/11	<5/5	<0.4/<0.4	3600	7.61	1053	<5.000	<5.000	<5.000	NA	NA	NA	<5.000	<10.000	
MW 1-11B	03/23/89	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10	<5.000	<5.000	NA	NA	NA	<10.000	
14WS	05/04/86	ug/l	12/12	<500/500	<8/58	25/30	<0.4/<0.4	25/<25	<10/10	130/140	4000	7.78	655	<5.000	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000		
14WS	09/24/86	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.500	<0.500	<0.500	NA	NA	NA	<1.000	
14WS	12/09/87	ug/l	<30	400	<10	40	<2.0	<30	<30	<10	<50	2200	7.62	308	<0.700	U0.2	0.4	<10.000	<10.000	<1.3	<1.000	
14WS	03/21/88	ug/l	4	<300	<8	15	<0.10	30	<10	42	1400	6.94	456	<5.000	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000		
14WS	07/12/88	ug/l	11	280	<5	12	<0.10	<10	<5	65	<1000	8.20	538	<1.000	<1.000	<1.000	<10.000	<10.000	<1.000	<2.000		
14WS	09/19/88	ug/l	10	350	<5	38	<0.10	<10	<5	68	<100	7.82	385	<5.000	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000		
14WS	12/12/88	ug/l	<1	400	<5	7	0.1	<10	<5	<0.4	300	7.13	448	<1.000	<1.000	<1.000	<10.000	<10.000	<1.000	<2.000		
15WS	06/04/88	ug/l	<1/2<1	680/500	<8/58	<10/10	<0.4/<0.4	<25/<25	20/10	<0.4/<0.4	8100	7.64	448	<5.000	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000		
15WS	09/24/88	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<0.500	<0.500	0.7	NA	NA	<0.500	<1.000	
15WS	12/09/87	ug/l	<40	480	<10	60	<2.0	<30	<20	<50	2100	7.48	346	<0.700	100.4	0.9	<10.000	<10.000	<1.300	<1.000		
15WS	03/17/88	ug/l	<1	<500	<8	11	<0.10	62	<10	<0.4	1100	7.04	418	<5.000	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000		
15WS	07/25/88	ug/l	<1	480	<5	11	<0.10	13	6	0.7	1200	7.60	413	<1.000	<1.000	<1.000	<10.000	<10.000	<1.000	<2.000		
15WS	08/18/88	ug/l	<1	460	<5	<5	<0.10	<10	<5	2	<100	7.48	278	<5.000	<5.000	<5.000	<10.000	<10.000	<5.000	<2.000		
15WS	12/12/88	ug/l	<1	460	<5	6	<0.10	<10	<5	<0.4	400	7.33	405	<1.000	<1.000	<1.000	<10.000	<10.000	<1.000	<2.000		
15WS	03/21/89	ug/l	1	410	<5	7	<0.10	<10	<5	1	200	7.11	410	<1.000	<1.000	<1.000	<10.000	<10.000	<1.000	<2.000		

TABLE A. B (Continued)

GROUNDWATER ANALYTICAL RESULTS FOR WELLS
 MONITORING PERCHED AQUIFER IN VICINITY OF EAST SOLDIER CREEK
 TINKER AFB--SOLDIER CREEK RIFFS
 SAMPLING AND ANALYSIS PLAN

WELL NUMBER	DATE	UNITS	As	Ba	Cd	Cr	Hg	Pb	Ni	Se	TOC	pH	Conductivity (microhm/cm)	Chloro- benzene	1,2-Dichloro- ethane	1,2-Dichloro- ethane	1,2-Dichloro- benzene	1,4-Dichloro- benzene	Tetrachloro- ethane	Vinyl Chloride
16WS	09/24/86	ug/l	2<1	900/680	8/13	10/10	<0.4/<0.4	<25/45	12/25	1/2	900	7.89	470	<0.500	1.9	1.9	<10.000	<10.000	0.7	<1.000
16WS	12/09/87	ug/l	<40	500	<10	90	<2.0	<30	20	<50	2200	7.66	360	<0.700	1.4	1.7	<10.000	<10.000	U0.6	<1.000
16WS	03/17/88	ug/l	<1	<300	<8	<10	<0.10	62	<10	<0.4	900	7.09	426	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000	
16WS	07/26/88	ug/l	<1	480	<5	12	0.5	12	8	0.4	1000	7.44	434	<1.000	<1.000	<10.000	<10.000	<1.000	<2.000	
16WS	09/22/88	ug/l	1	480	<5	<5	<0.10	<10	<5	0.7	300	7.42	421	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000	
16WS	12/12/88	ug/l	1	400	<5	8	<0.10	<10	<5	<0.4	500	7.31	401	<1.000	<1.000	<10.000	<10.000	<1.000	<2.000	
MW-72	01/21/88	ug/l	18	840	<8	<10	0.3	50	33	5	4500	7.00	1237	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000	
MW-72	05/04/88	ug/l	16	410	13	<10	<0.10	<13	8	<0.4	9800	7.02	8940	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000	
MW-72	07/26/88	ug/l	18	410	<5	9	<0.10	19	14	<0.4	11000	7.05	1570	<5.000	<5.000	<10.000	<10.000	<5.000	<10.000	
MW-72	09/13/88	ug/l	22	410	<14	<5	<0.10	10	8	<0.4	5300	7.00	1043	5	<5.000	<5.000	<10.000	<5.000	<10.000	
MW-72	03/28/89	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	<5.000	<5.000	U2	U2	<5.000	<10.000	

Notes NA - Not Analyzed

For metals, values provided are given for Dissolved Metals/Total Metals or otherwise are given as Total Metals
 References Tulsa COE, 1988d; Tulsa COE, 1988b; and Tulsa COE, 1988c.

LEGEND:

SO

● SAI

NOTES:

- MONIT
- ASSIG
- PERSC

- MW-71
2,100 F
LOCAT
ON TH

REFERENCE

FIGURE A.8
GROUNDW#
TINKER AFB - S
SAMPLING AND

Metals	Water (ug/l)	
	1-52A	1-52B
Ba	100	630
Cd	12	13
Cr	220	86
Ni	620	41

MW-72

WELL NO. 1-52A & 1-52B (10/89)

Metals	Water (ug/l)	
	1-52A	1-52B
Ba	150	240
Cd	13	14
Cr	ND	15
Ni	64	30

VOCs	
Chlorobenzene	26
1,2-Dichloroethene	ND
Trichloroethene	ND
1,2-Dichlorobenzene	ND
1,4-Dichlorobenzene	ND
tetrachloroethene	ND
Vinyl Chloride	ND

MW-22B

WELL NO. 1-51A & 1-51B (10/89)

Metals	Water (ug/l)	
	1-51A	1-51B
Ba	ND	ND
Cd	ND	ND
Cr	ND	ND
Ni	200	34

VOCs	
Chlorobenzene	360
1,2-Dichloroethene	ND
trichloroethene	ND
1,2-Dichlorobenzene	300
1,4-Dichlorobenzene	ND
tetrachloroethene	52
Vinyl Chloride	720

MW-23B

MW-11B

WELL NO. 1-49A (10/88)

Metals	Water (ug/l)	
	1-49A	
Ba	1600	ND
Cd	ND	ND
Cr	ND	ND
Ni	41	ND

VOCs	
Chlorobenzene	ND
1,2-Dichloroethene	230
trichloroethene	300
1,2-Dichlorobenzene	380
1,4-Dichlorobenzene	110
tetrachloroethene	ND
Vinyl Chloride	ND

15 WS

MW-1-13B

WELL NO. 1-50A & 1-50B (10/88)

Metals	Water (ug/l)	
	1-50A	1-50B
Ba	1300	ND
Cd	ND	ND
Cr	ND	ND
Ni	120	ND

VOCs	
Chlorobenzene	ND
1,2-Dichloroethene	1060
trichloroethene	ND
1,2-Dichlorobenzene	350
1,4-Dichlorobenzene	110
tetrachloroethene	ND
Vinyl Chloride	430

MW-21B

MW-1-14B

14 WS



The Building 3001 site remedial investigation indicated that the perched aquifer is contaminated with organic solvents, trace metals, and fuel product (Tulsa COE, 1988a). The areas with highest concentrations of contaminants are located beneath Building 3001, the North Tank Area, and the Southwest Tank Area. Trichloroethene (TCE) and chromium are considered the primary contaminants in the perched aquifer since their maximum concentrations were higher than the concentrations of other contaminants and they were consistently detected over a large portion of the site. Other significant contaminants include 1,2-dichloroethene, tetrachloroethene, acetone, toluene, benzene, and xylene. Other significant inorganic contaminants include lead, nickel, and barium.

The analytical results indicated that the source of the TCE contamination is primarily beneath Building 3001 and migration is away from the building in the east, west, and southwest directions. Highest concentrations of 1,2-dichloroethene were detected beneath and to the west of Building 3001. Tetrachloroethene was detected primarily beneath Building 3001 and appeared

to be moving east in the direction of East Soldier Creek. Analytical results indicated that the areal extent of chromium contamination was similar to the areal extent of TCE contamination.

The analytical results indicated that the contamination in the perched aquifer may be partially due to contaminants which were discharged into storm drains. Records indicated that West Soldier Creek had received discharges from storm drains that contained TCE. Therefore, the TCE contamination may partially be a result of leakage from storm drains and migration from storm drains and migration from West Soldier Creek.

Supplemental quarterly remedial investigations have indicated that the areal extent of TCE contamination has not changed significantly from the extent present in the RI Report (Tulsa COE, 1989b). The extent of chromium

contamination appears to have increased slightly in area. All other contaminants have appeared to remain fairly stable with a general trend for lower concentration of metals (Tulsa COE, 1989b).

The basewide groundwater assessment has detected the same contaminants in the perched aquifer as the remedial investigations (Tulsa COE, 1989c). The Groundwater Assessment update specifically mentioned the presence of three metals in well MW-73 which was referred to as the discharge point of West Soldier Creek (Tulsa COE, 1989c). (Note: MW-73 is located along the eastern boundary of Tinker AFB, south of East Soldier Creek and slightly north of Southeast 59th Street. It is unclear if the "West Soldier Creek" referred to in the Groundwater Assessment Update is the same as the West Soldier Creek defined for the Soldier Creek RI/FS. Reports have indicated that an off-base tributary to Soldier Creek may also be referred to as "West Soldier Creek.")

In addition to the quarterly sampling and analysis, Tulsa COE sampled wells in the vicinity of Building 3001 and the IWTP in October 1988 to monitor groundwater contaminant concentrations in these areas as a part of the overall groundwater assessment. The sample methodology is presented in the Tinker AFB Sampling and Analysis Quality Assurance/Quality Control Plan for Corps of Engineers Site Investigations (Tulsa COE, 1986). The sampling locations and analytical results are summarized in Table A-9 and Figure A-8. The specific sampling activities and the conclusions of this round of groundwater sampling are not available at this time.

A.9 NUS Surface Water Analytical Results

The purpose of the Storm Sewer Investigation (NUS, 1989) for Soldier Creek performed by NUS Corporation was to identify releases of potential contaminants from the storm sewers emanating from the Building 3001 complex and discharging to East and West Soldier Creeks on Tinker AFB.

TABLE A.9
 1988 GROUNDWATER ANALYTICAL RESULTS
 TINKER AFB - SOLDIER CREEK HHS
 SAMPLING AND ANALYSIS PLAN

BOHNS NO	SWD NO	DATE	UNITS	AS	Ba	Cd	Cr	Hg	Pb	Ni	Sa	TOC	pH	Conductivity (microhms/cm)	Chloro- benzene	1,2-Dichloro- ethene	Trichloro- ethene	1,2-Dichloro- benzene	1,4-Dichloro- benzene	Tetrachloro- ethene	Vinyl Chloride
1-52A	8-1510	10/01/88	ug/L	ND	150	13	ND	12	ND	64	ND	2	7	852	26	ND	ND	ND	ND	ND	ND
1-52B	8-1511	10/01/88	ug/L	ND	240	14	15	ND	11	30	ND	3	7	1235	ND	ND	ND	ND	ND	ND	ND
1-53A	8-1512	10/01/88	ug/L	1	1000	12	270	ND	ND	28	1	1	8	628	ND	ND	ND	ND	ND	ND	ND
1-53B	8-1513	10/01/88	ug/L	8	630	13	86	ND	ND	670	1	1	7	674	ND	ND	ND	ND	ND	ND	ND
1-49A	8-1514	10/01/88	ug/L	ND	1600	ND	ND	ND	ND	41	1	2	7	578	ND	230	300	380	110	ND	ND
1-50A	8-1515	10/01/88	ug/L	1	1300	ND	ND	ND	ND	120	1	2	7	8	ND	1050	ND	550	110	ND	ND
1-50B	8-1516	10/01/88	ug/L	ND	2400	ND	ND	ND	ND	77	1	2	7	577	780	480	ND	ND	26	430	140
1-51A	8-1517	10/01/88	ug/L	ND	1400	ND	ND	ND	ND	200	1	4	7	974	360	ND	ND	300	ND	52	720
1-51B	8-1518	10/01/88	ug/L	ND	370	ND	6	ND	ND	31	1	2	7	542	5	ND	ND	ND	ND	ND	ND

ND - Not Detected

As part of this investigation, seven surface water samples were collected at on-base outfall locations from Building 3001. The locations of these sampling stations are shown on Figure A-9 together with pertinent volatile organic, oil and grease, and metal analytical results for each location. Selected analytical results are shown on Figure A-9. Surface water analytical results pertinent to the Soldier Creek site are summarized in Table A-10.

Surface water samples were collected over a 24 hour period using an ISCO 2700 continuous samplers. Samples were collected through 3/8-inch diameter PVC tubing and automatically composited in a 3-gallon glass collection vessel. The composite samples were transferred from the collection vessel to individual sample bottles for shipment to the laboratory. Grab samples collected for volatiles and oil and grease analyses were obtained by filling the sample bottles directly from the storm water overflow at the v-notch. The sample bottles were tagged and sealed prior to shipment. Chain-of-custody forms were completed for all samples and sent with each container for tracking purposes. All sample collection bottles contained the required preservatives prior to being filled with surface water samples.

Conclusions regarding the condition of Building 3001 outfalls with regard to on-base portions of East and West Soldier Creeks are presented below. The outfalls on West Soldier Creek vary from partial to total submergence as a result of vegetative growth occurring in the water channel. Because of the vegetative growth, a semi-swamp condition exists that both traps contaminants and raises the water level to the outfalls. NUS suggested that the on-base West Soldier Creek area should be reconstructed as an open lined culvert incorporating a weir and gate at its discharge end to both measure flows and control the discharge in case of a spill condition. NUS also suggested that the individual outfall discharges to this culvert should be designed to accept simple weir plates to provide measurement capabilities for possible future water studies.

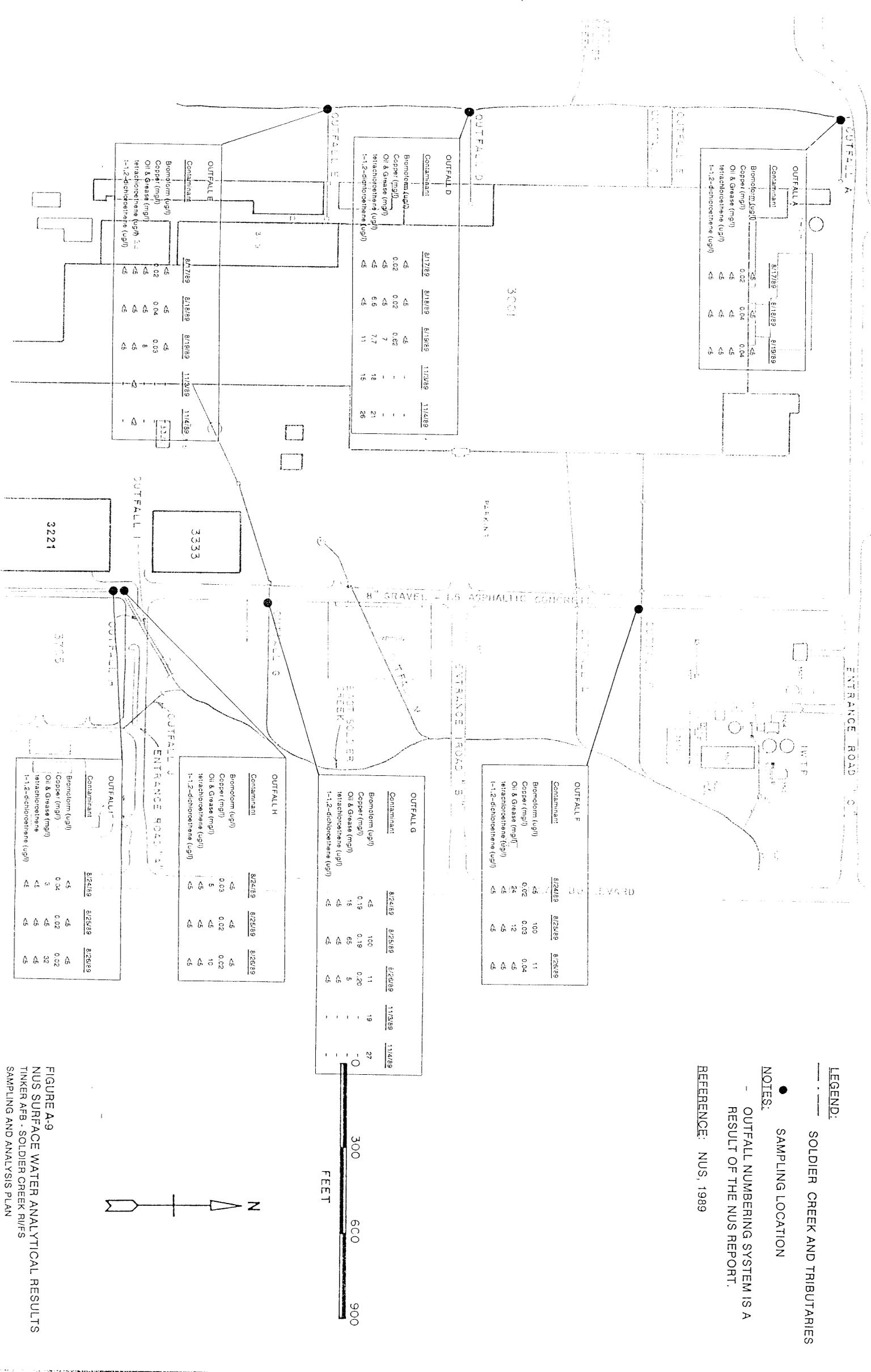


FIGURE A-9
 NUS SURFACE WATER ANALYTICAL RESULTS
 TINKER AFB - SOLDIER CREEK R/F/S
 SAMPLING AND ANALYSIS PLAN

TABLE A-10

NUS SURFACE WATER ANALYTICAL RESULTS
 TINKER AFB - SOLDIER CREEK RIIFS
 SAMPLING AND ANALYSIS PLAN

SAMPLING LOCATION	SAMPLER	BROMOFORM (ug/L)			COPPER (mg/L)			OIL & GREASE (mg/L)			TETRACHLOROETHENE (ug/L)			1,1,2-DICHLOROETHENE (ug/L)				
		8/17	8/18	8/19	11/3	11/4	11/4	8/17	8/18	8/19	11/3	11/4	11/4	8/17	8/18	8/19	11/3	11/4
Outfall A	NUS	<5	<5	<5	NA	NA	0.04	0.04	0.04	NA	NA	<5	<5	<5	<5	<5	NA	NA
Outfall D	NUS	<5	<5	<5	NA	NA	0.02	0.02	0.02	NA	NA	<5	<5	11	<5	<5	15	26
Outfall E	NUS	<5	<5	<5	NA	NA	0.02	0.04	0.03	NA	NA	<5	<5	<5	<5	<5	NA	NA
Outfall F	NUS	8/24	8/25	8/26	11/3	11/4	8/24	8/25	8/26	11/3	11/4	8/24	8/25	8/26	11/3	11/4		
Outfall G	NUS	<5	100	11	NA	NA	0.02	0.03	0.04	NA	NA	24	12	<5	<5	<5	NA	NA
Outfall H	NUS	<5	100	11	19	27	0.19	0.19	0.2	NA	NA	18	65	<5	<5	<5	NA	NA
Outfall I	NUS	<5	<5	<5	NA	NA	0.03	0.02	0.02	NA	NA	5	<5	<5	<5	<5	NA	NA
							NA	0.02	0.02	NA	NA	3	<5	<5	<5	<5	NA	NA

NA = Not Analyzed

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East Soldier Creek Outfall L consists of a 30-inch line through which three 4-inch reinforced plastic pipes have been placed. The three pipes were out of service. NUS concluded that all three pipes should be removed from the inside of the outfall line.

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APPENDIX B

LIST OF ABBREVIATIONS AND ACRONYMS

LIST OF ABBREVIATIONS AND ACRONYMS

Ag	Silver
As	Arsenic
ARAR	Applicable or Relevant and Appropriate Requirements
ASCS	Agricultural Stabilization and Conservation Service
Ba	Barium
BOD ₅	5-day biochemical oxygen demand
BNA	Acid, base/neutral extractable
BTX	Benzene, Toluene, Xylene
BVWST	B&V Waste Science and Technology Corp.
Cd	Cadmium
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CLP	Contract Laboratory Program
COD	Chemical Oxygen Demand
Cr	Chromium
Cu	Copper
DO	Dissolved Oxygen
DOT	Department of Transportation
DQO	Data Quality Objectives
Dups.	Duplicate Samples
EE/CA	Engineering Evaluation/Cost Analysis
EMSL	Environmental Monitoring and Support Laboratory (Las Vegas)
EPA	Environmental Protection Agency
EWI	Equal-Width Increment
F	Fahrenheit
F1	Fluoride
FS	Feasibility Study
Gal.	Gallon
Hg	Mercury
HPLC	High Pressure Liquid Chromatography
HKS	Harry Keith & Sons, Inc.
HRS	Hazardous Ranking System
HSL	Hazardous Substance List
HSP	Health and Safety Plan
IRP	Installation Restoration Program
IWTP	Industrial Waste Treatment Plant
l	Liter
MCL	Maximum Contaminant Level
Mg	Magnesium
mg	Milligram
ml	Milliliter
Mn	Manganese
MW	Monitoring well
NBS	National Bureau of Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

Ni	Nickel
No.	Number
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OERR	Office of Emergency and Remedial Response
OSDH	Oklahoma State Department of Health
OWRB	Oklahoma Water Resources Board
oz.	Ounce
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
Pb	Lead
PCBs	Polychlorinated biphenyls
PCE	Tetrachloroethene
ppb	Parts per billion
ppm	Parts per million
RA	Risk Assessment
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SAS	Special Analytical Services
SBRP	Sample Bottle Repository Program
Se	Selenium
SMCL	Secondary Maximum Contaminant Level
SMO	Sample Management Office
SOP	Standard operating procedures
SSP	Site Safety Plan
STP	Sanitary Treatment Plant
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
t-1,2-DCE	Trans-1,2-dichloroethene
TDS	Total Dissolved Solids
TLV	Threshold Limit Value
TOC	Total Organic Carbon
TSS	Total Suspended Solids
ug	Micrograms
USDA	United States Department of Agriculture
USGS	United States Geologic Survey
VOC	Volatile Organic Compounds
WQS	Water Quality Standards
Zn	Zinc

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APPENDIX C
ANALYTICAL DETECTION LIMITS

Target Compound List (TCL) and
Contract Required Quantitation Limits (CRQL) *
Tinker AFB - Soldier Creek RI/FS
Quality Assurance Project Plan

<u>Volatiles</u>	<u>CAS Number</u>	<u>Quantitation Limits**</u>	
		<u>Surface Water</u> (ug/L)	<u>Sediment^a</u> (ug/kg)
1. Chloromethane	74-87-3	10	10
2. Bromomethane	74-83-9	10	10
3. Vinyl Chloride	75-01-4	10	10
4. Chloroethane	75-00-3	10	10
5. Methylene Chloride	75-09-2	5	5
6. Acetone	67-64-1	10	10
7. Carbon Disulfide	75-15-0	5	5
8. 1,1-Dichloroethene	75-35-4	5	5
9. 1,1-Dichloroethane	75-34-3	5	5
10. 1,2-Dichloroethene (total)	544-59-0	5	5
11. Chloroform	67-66-3	5	5
12. 1,2-Dichloroethane	107-06-2	5	5
13. 2-Butanone	78-93-3	10	10
14. 1,1,1-Trichloroethane	71-55-6	5	5
15. Carbon Tetrachloride	56-23-5	5	5
16. Vinyl Acetate	108-05-4	10	10
17. Bromodichloromethane	75-27-4	5	5
18. 1,2-Dichloropropane	78-87-5	5	5
19. cis-1,3-Dichloropropene	10061-01-5	5	5
20. Trichloroethene	79-01-6	5	5
21. Dibromochloromethane	124-48-1	5	5
22. 1,1,2-Trichloroethane	79-00-5	5	5
23. Benzene	71-43-2	5	5
24. trans-1,3-Dichloropropene	10061-02-6	5	5
25. Bromoform	75-25-2	5	5
26. 4-Methyl-2-pentanone	108-10-1	10	10
27. 2-Hexanone	591-78-6	10	10
28. Tetrachloroethene	127-18-4	5	5
29. Toluene	108-88-3	5	5
30. 1,1,2,2-Tetrachloroethane	79-34-5	5	5
31. Chlorobenzene	108-90-7	5	5
32. Ethyl Benzene	100-41-4	5	5
33. Styrene	100-42-5	5	5
34. Xylenes (Total)	1330-20-7	5	5

^a Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Volatile TCL Compounds are 100 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** 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.

Target Compound List (TCL) and
Contract Required Quantitation Limits (CRQL) *
Tinker AFB - Soldier Creek RI/FS
Quality Assurance Project Plan

<u>Acid, Base/Neutral Extractables</u>	<u>CAS Number</u>	<u>Quantitation Limits**</u>	
		<u>Surface Water</u> (ug/L)	<u>Sediment^a</u> (ug/kg)
35. Phenol	108-95-2	10	330
36. bis(2-Chloroethyl ether	111-44-4	10	330
37. 2-Chlorophenol	95-57-8	10	330
38. 1,3-Dichlorobenzene	541-73-1	10	330
39. 1,4-Dichlorobenzene	106-46-7	10	330
40. Benzyl alcohol	100-51-6	10	330
41. 1,2-Dichlorobenzene	95-50-1	10	330
42. 2-Methylphenol	95-48-7	10	330
43. bis(2-Chloroisopropyl)ether	108-60-1	10	330
44. 4-Methylphenol	106-44-5	10	330
45. N-Nitroso-di-n-dipropylamine	621-64-7	10	330
46. Hexachloroethane	67-72-1	10	330
47. Nitrobenzene	98-95-3	10	330
48. Isophorone	78-59-1	10	330
49. 2-Nitrophenol	88-75-5	10	330
50. 2,4-Dimethylphenol	105-67-9	10	330
51. Benzoic acid	65-85-0	50	1600
52. bis(2-Chloroethoxy) methane	111-91-1	10	330
53. 2,4-Dichlorophenol	120-83-2	10	330
54. 1,2,4-Trichlorobenzene	120-82-1	10	330
55. Naphthalene	91-20-3	10	330
56. 4-Chloroaniline	106-47-8	10	330
57. Hexachlorobutadiene	87-68-3	10	330
58. 4-Chloro-3-methylphenol	59-50-7	10	330
59. 2-Methylnaphthalene	91-57-6	10	330
60. Hexachlorocyclopentadiene	77-47-4	10	330
61. 2,4,6-Trichlorophenol	88-06-2	10	330
62. 2,3,5-Trichlorophenol	95-95-4	50	1600
63. 2-Chloronaphthalene	91-58-7	10	330
64. 2-Nitroaniline	88-74-4	50	1600
65. Dimethylphthalate	131-11-3	10	330
66. Acenaphthylene	208-96-8	10	330
67. 2,6-Dinitrotoluene	606-20-2	10	330
68. 3-Nitroaniline	99-09-2	50	1600
69. Acenaphthene	83-32-9	10	330

^a Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Volatile
TCL Compounds are 100 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation
limits listed herein are provided for guidance and may not always be achievable.

** 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.

Target Compound List (TCL) and
Contract Required Quantitation Limits (CRQL) *
Tinker AFB - Soldier Creek RI/FS
Quality Assurance Project Plan

<u>Acid, Base/Neutral Extractables</u>	<u>CAS Number</u>	<u>Quantitation Limits**</u>	
		<u>Surface Water</u> (ug/L)	<u>Sediment^a</u> (ug/kg)
70. 2,4-Dinitrophenol	51-28-5	50	1600
71. 4-Nitrophenol	100-02-7	50	1600
72. Dibenzofuran	132-64-9	10	330
73. 2,4-Dinitrotoluene	121-14-2	10	330
74. Diethylphthalate	84-66-2	10	330
75. 4-Chlorophenyl-phenyl ether	7005-72-3	10	330
76. Fluorane	86-73-7	10	330
77. 4-Nitroaniline	100-01-6	50	1600
78. 4,6-Dinitro-2-methylphenol	534-52-1	50	1600
79. N-nitroadiphenylamine	86-30-6	10	330
80. 4-Bromophenyl-phenylether	101-55-3	10	330
81. Hexachlorobenzene	118-74-1	10	330
82. Pentachlorophenol	37-66-5	50	1600
83. Phenanthrene	85-01-8	10	330
84. Anthracene	120-12-7	10	330
85. Di-n-butylphthalate	84-74-2	10	330
86. Fluoranthene	206-44-0	10	330
87. Pyrene	129-00-0	10	330
88. Butylbenzylphthalate	85-68-7	10	330
89. 3,3-Dichlorobenzidine	91-94-1	20	660
90. Benzo(a)anthracene	56-55-3	10	330
91. Chrysene	218-01-9	10	330
92. bis(2-Ethylhexyl)phthalate	117-01-7	10	330
93. Di-n-octylphthalate	117-84-0	10	330
94. Benzo(b)fluoranthene	205-99-2	10	330
95. Benzo(k)fluoranthene	207-08-9	10	330
96. Benzo(a)pyrene	50-32-8	10	330
97. Indeno(1,2,3-cd)pyrene	193-39-5	10	330
98. Dibenz(a,h)anthracene	53-70-3	10	330
99. Benzo(g,h,i)perylene	191-24-2	10	330

^b Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Semi-volatile TCL Compounds are 60 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** 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.

Target Analyte List (TAL) Detection Limits
Tinker AFB - Soldier Creek RI/FS
Quality Assurance Project Plan

<u>Metals</u>	<u>CAS Number</u>	<u>Detection Limits*</u>	
		<u>Surface Water</u> (ug/l)	<u>Sediment</u> (mg/kg)
Aluminum		200	100
Antimony	7440-36-0	60	30
Arsenic	7440-38-2	10	5
Barium	7440-39-3	200	100
Beryllium	7440-41-7	5	2.5
Cadmium	7440-43-9	5	2.5
Calcium	7440-70-2	5000	2500
Chromium	7440-41-7	10	5
Cobalt	7440-48-4	50	25
Copper	7440-50-8	25	12.5
Iron	7439-89-6	100	50
Lead	7435-52-1	5	2.5
Magnesium	7439-95-4	5000	2500
Manganese	7439-96-5	15	7.5
Mercury	7439-97-6	.2	.1
Nickel	7440-02-0	40	20
Potassium	7440-09-7	5000	2500
Selenium	7782-49-2	5	2.5
Silver	7440-22-4	10	5
Sodium	7440-23-5	5000	2500
Thallium	7440-28-0	10	5
Tin	7440-31-5	40	20
Vanadium	7440-62-2	50	25
Zinc	7440-66-6	20	10
Cyanide		2	2.5

* Compounds and detection limits as of February 14, 1986.

NOTE: Detection limits will increase when interferences are present in a sample. Also, for soil samples, detection limits will fluctuate because detection limits are based on the dry weight of a sample and not the wet weight of the sample which was weighted out and analyzed.

GROUNDWATER QUANTITATION LIMITS
TINKER AFB - SOLDIER CREEK RI/FS
QUALITY ASSURANCE PROJECT PLAN

<u>ORGANICS</u>	<u>CAS NUMBER</u>	<u>QUANTITATION LIMITS GROUNDWATER (ug/L)</u>
BENZENE	71-43-2	.2(1)
BROMODICHLOROMETHANE	75-27-4	.3(1)
BROMOFORM	75-25-2	2.4(1)
BROMOETHANE	74-83-9	1.7(1)
CARBON TETRACHLORIDE	56-23-5	0.4(1)
CHLOROBENZENE	108-90-7	0.7(1)
CHLOROETHANE	75-00-3	2.1(1)
2-CHLOROETHYL VINYL EHTER	110-75-8	0.9(1)
CHLOROFORM	67-66-3	10.0(1)
CHLOROMETHANE	74-87-3	2.1(1)
DIBROMOCHLOROMETHANE	124-48-1	0.4(1)
1,1-DICHLOROETHANE	75-34-3	0.3(1)
1,2-DICHLOROETHANE	107-06-2	1.5
1,1-DICHLOROETHENE	75-35-4	0.6(1)
TOTAL 1,2-DICHLOROETHENES	156-60-5	0.5(1)
1,2-DICHLOROPROPANE	78-87-5	0.3(1)
cis-1,3-DICHLOROPROPENE	10061-01-5	0.3(1)
trans-1,3-DICHLOROPROPENE	10061-02-6	0.4(1)
ETHYL BENZENE	100-41-4	0.4(1)
METHYLENE CHLORIDE (*)	75-09-2	1
1,1,2,2-TETRACHLOROETHANE	79-34-5	2.8(1)
TETRACHLOROETHENE	127-18-4	1.6(1)
TOLUENE (*)	108-88-3	0.5(1)
1,1,1-TRICHLOROETHANE	71-55-6	0.3(1)
1,1,2-TRICHLOROETHANE	79-00-5	0.7(1)
TRICHLOROETHENE	79-01-6	0.3(1)
VINYL CHLORIDE	75-01-4	1.9(1)
ACROLEIN	107-02-8	100
ACETONE (*)	67-64-1	2.7(1)
ACRYLONITRILS	107-13-1	50
CARBON DISULFIED	75-15-0	3
2-BUTANONE	78-93-3	(50)
VINYL ACETATE	108-05-4	15
4-METHYL-2-PENTANONE	108-10-1	0.8
2-HEXANONE	519-78-6	(50)

(1) Oklahoma State Water Quality Standards
(*) Common Laboratory Solvent
Blank Limit is 5x method detection limit

GROUNDWATER QUANTITATION LIMITS
TINKER AFB - SOLDIER CREEK RI/FS
QUALITY ASSURANCE PROJECT PLAN
(CONTINUED)

<u>ORGANICS</u>	<u>CAS NUMBER</u>	<u>QUANTITATION LIMITS GROUNDWATER (ug/L)</u>
STYRENE	100-42-5	0.8(1)
m&c-XYLENE	95-47-6	0.8(1)
o-XYLENE	106-42-3	0.8(1)
bis (2-chloroethyl) ETHER	111-44-4	1.5
PHENOL	108-95-2	2
2-CHLOROPHENOL	95-57-8	2
1,3-DICHLOROBENZENE	541-73-1	2
1,4-DICHLOROBENZENE	106-46-7	2
1,2-DICHLOROBENZENE	95-50-1	2.5
BENZYL ALCOHOL	100-51-6	2
BIS (2-CHLOROISOPROPYL) ETHER	39638-32-9	2.5
2-METHYLPHENOL	95-48-7	1
HEXACHLOROETHANE	67-72-1	2
N-NITROSODIPROPYLAMINE	621-64-7	1.5
NITROBENZENE	98-95-3	2.5
4-METHYLPHENOL	106-44-5	1
ISOPHORONE	78-59-1	2.5
2-NITROPHENOL	88-75-5	2
2,4-DIMETHYLPHENOL	105-67-9	2
BIS (2-CHLOROETHOXY) METHANE	111-91-1	2.5
2,4-DICHLOROPHENOL	120-83-2	2
1,2,4-TRICHLOROBENZENE	120-82-1	2
NAPHTHALENE	91-20-3	2
4-CHLOROANILINE	106-47-8	2
HEXACHLOROBUTADIENE	87-68-3	2.5
BENZOIC ACID	65-85-0	(30)
2-METHYLNAPHTHALENE	91-57-6	2
4-CHLORO-3-METHYLPHENOL	59-50-7	1.5
HEXACHLOROCYCLOPENTADIENE	77-47-4	2
2,4,6-TRICHLOROPHENOL	88-06-2	1.5
2,4,5-TRICHLOROPHENOL	95-95-4	1.5
2-CHLORONAPHTHALENE	91-58-7	1.5
ACENAPHTHYLENE	208-96-8	1.5
DIMETHYL PHTHALATE	131-11-3	1.5
2,6-DINITROTOLUENE	606-20-2	1
ACENAPHTHENE	83-32-9	1.5

GROUNDWATER QUANTITATION LIMITS
TINKER AFB - SOLDIER CREEK RI/FS
QUALITY ASSURANCE PROJECT PLAN
(CONTINUED)

<u>ORGANICS</u>	<u>CAS NUMBER</u>	<u>QUANTITATION LIMITS GROUNDWATER (ug/L)</u>
3-NITROANILINE	99-09-2	2.5
DIBENZOFURAN	132-64-9	1
2,4-DINITROPHENOL	51-28-5	(15)
2,4-DINITROTOLUENE	121-14-2	1
FLUORENE	86-73-7	1
4-NITROPHENOL	100-02-7	1.5
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	1
DIETHYL PHTHALATE	84-66-2	1
4,6-DINITRO-2-METHYLPHENOL	534-52-1	(15)
N-NITROSODIPHENYLAMINE *	86-30-6	
DIPHENYLAMINE *	122-39-4	1.5
4-NITROANILINE	100-01-6	3
4-BROMOPHENYL PHENYL ETHER	101-55-3	1.5
HEXACHLOROBENZENE	118-74-1	1.5
PENTACHLOROPHENOL	87-86-5	2
PHENANTHRENE	85-01-8	1
ANTHRACENE	120-12-7	2.5
DI-n-BUTYL PHTHALATE	84-74-2	2
FLUORANTHENE	206-44-0	1.5
PYRENE	129-00-0	1.5
BUTYL BENZYL PHTHALATE	85-68-7	3.5
CHRYSENE **	218-01-9	
BENZO(a)ANTHRACENE **	56-55-3	1.5
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	1
DI-n-OCTYL PHTHALATE	117-84-0	1.5
BENZO(B)FLUORANTHENE ***	205-99-2	
BENZO(k)FLUORANTHENE ***	207-08-9	1.5
BENZO(A)PYRENE	50-32-8	2
INDENO(1,2,3-cd)PYRENE	193-39-5	3.5
DIBENZO(a,h)ANTHRACENE	53-70-3	2.5
BENZO(g,h,i)PERYLENE	191-24-2	4
2-NITROANILINE	88-74-4	1

* These two parameters are reported as a total.

** These two parameters are reported as a total.

*** These two parameters are reported as a total.

Values in parentheses are estimates. Actual values are being determined at this time.

NOTE: Limits are for reagent water.

Water Quality Inorganic Parameters
Tinker AFB - Soldier Creek RI/FS
Quality Assurance Project Plan

<u>Water Quality Inorganic Parameters</u>	<u>Analysis Method</u>	<u>Water</u>	<u>Detection Limits Units</u>
Alkalinity	310.1	1	MG/L
BOD (5-day)	405.1	.1	MG/L
COD	410.1	10	MG/L
Hardness	130.2	10	MG/L
Nitrate-N	352.1	.04	MG/L
Oil and Grease	413.1	10	MG/L
Total Suspended Solids	160.2	2	MG/L
Total Organic Carbon (TOC)	415.1	4	MG/L

Compounds and detection limits as of February 14, 1986.

Note:

Detection limits will increase when interferences are present in a sample. Also, for soil samples, detection limits will fluctuate because detection limits are based on the dry weight of a sample and not the wet weight of the sample which was weighed out and analyzed.

PHYSICAL SOIL TESTS SAMPLE MEASUREMENTS
TINKER AFB - SOLDIER CREEK RI/FS
QUALITY ASSURANCE PROJECT PLAN

<u>Physical Soil Parameter</u>	<u>Method</u>
Grain Size Distribution	ASTM D422
Permeability (Falling Head)	EM1110-2-1906
Field Density	ASTM D653
Soil Moisture	ASTM D2216
Atterberg Limits	ASTM D4318

APPENDIX D
STANDARD FORMS TO BE USED

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SAMPLE LABELS

B&V WASTE SCIENCE AND TECHNOLOGY CORP. LABEL NO. 0001
Site: Soldier Creek at Tinker AFB
Sample No.: _____ Date: _____
Collected by: _____ Time: _____
Analysis: _____
Preservative None HNO₃ H₂SO₄ NaOH
Other: _____

Official Sample Seal	SAMPLE NO.	DATE	SEAL BROKEN BY	DATE
	SIGNATURE			
	PRINT NAME AND TITLE			

Official Sample Seal	SAMPLE NO.	DATE	SEAL BROKEN BY	DATE
	SIGNATURE			
	PRINT NAME AND TITLE			

SYSTEMS AUDIT CHECKLIST

Sample Program Identification: _____

Sampling Dates: _____

Material to be Sampled: _____

Measurement Parameter: _____

Sampling and Monitoring Equipment in Use:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Audit Procedures and Frequency: _____

Field Calibration Procedures and Frequency: _____

Signature of QA Coordinator: _____

Date: _____

CORRECTIVE ACTIONS CHECKLIST

Sample Program Identification: _____

Sampling Dates: _____

Material to be Sampled: _____

Measurement Parameter: _____

Acceptable Data Range: _____

Corrective Actions Initiated By: _____

Title: _____ Date: _____

Problem Areas Requiring Corrective Action: _____

Measures to Correct Problems: _____

Means of Detecting Problems (field observations, systems audit, etc.):

Approval for Corrective Actions: _____

Title: _____ Date: _____

Signature: _____

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APPENDIX E
FIELD MEASUREMENTS

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Field Measurement of Temperature

Method: NBS Mercury Thermometer

Sensitivity: At least 0.5 degree

Optimum Range: -1 to 51^oC or equivalent Fahrenheit range

Reagents and Apparatus:

1. Thermometer.
2. Beakers or plastic cups.
3. Soap and water, deionized water.

Calibration: None

Measurement Procedures:

1. Wash the thermometer with soap and water and rinse with deionized water.
2. Pour the sample into a clean beaker or plastic cup.
3. Immerse the lower portion of the thermometer in the sample and allow adequate time for the temperature to stabilize.
4. Record the temperature reading in the field logbook, along with sampling location, date, and time.
5. Rinse the thermometer thoroughly with deionized water between individual temperature measurements.

Field Measurement of pH

Method: Electrometric

Sensitivity: 0.1 pH unit

Optimum Range: 1-12 pH units

Reagents and Apparatus:

1. pH meter.
2. Beakers or plastic cups.
3. pH buffer solutions, pH 4, 7, and 10.

Calibration:

1. Place electrode in pH 7 buffer solution.
2. After allowing several minutes for meter to stabilize, turn calibration dial until a reading of 7.00 is obtained.
3. Rinse electrode with deionized water and place in pH 4 or pH 10 buffer solution.
4. Wait several minutes and then turn adjustment dial until a reading of 4.00 or 10.00 is obtained.
5. Rinse electrode with deionized water and place in pH 7 buffer. If meter reading is not 7.00, follow Steps 2-5 again.

Measurement Procedures:

1. Calibrate meter using calibration procedure.
2. Pour the sample into a clean beaker or plastic cup.
3. Rinse electrode with deionized water between samples. Recheck calibration with pH 7 buffer solution after every 5 samples.
4. Immerse electrode in solution to the level specified in the user's guide.

Notes:

1. When calibrating the meter, use pH buffers 7 and 4 for samples with pH <8, and buffers 7 and 10 for samples with pH >8. If

meter will not read pH 4 or 10, something may be wrong with the electrode.

2. pH is a temperature dependent analysis. Therefore, temperatures of buffers and samples should be within about 2°C. For refrigerated or cool samples, use refrigerated buffers to calibrate meter.
3. Weak organic and inorganic salts and oil and grease are interferences in pH measurements. If oil and grease are visible, note on data sheet. Clean electrode with soap and water, followed by 10 percent HCl. Then recalibrate meter.
4. When not in use, the electrode should be stored in pH 4 buffer.
5. Before going into the field:
 - a) Check batteries;
 - b) Do a quick calibration at pH 7 and 4 to check electrode;
 - c) Obtain fresh solutions.
6. Following field measurements:
 - a) Report any problems;
 - b) Compare with previous data;
 - c) Clean all dirt off of meter and inside case;
 - d) Make sure electrode is stored in pH 4 buffer.

Field Measurement of Specific Conductance.

Method: Specific Conductance, umhos @ 25°C

Detection Limit: 1 umho/cm @ 25°C

Optimum Range: 0.1 - 100,000 umhos/cm

Reagents and Apparatus:

1. Conductivity meter and electrodes.
2. Deionized water in squirt bottle.
3. Calibration reagents as specified for the model of meter being used.
4. Beakers or plastic cups.

Calibration and Measurement Procedures:

1. Follow the user's guide and calibrate the conductivity meter as specified. Since the specific meter model to be used is not known, specific calibration instructions for the meter cannot be given.
2. After meter calibration and prior to sample conductivity measurement, rinse the probe thoroughly with deionized water.
3. Totally immerse probe in sample. Do not allow probe to touch the sample container.
4. Turn the mode switch to the appropriate scale to measure the conductivity. A scale should be used which will give a mid-range reading.
5. Record the specific conductivity reading. Sample temperature should be measured and recorded in conjunction with conductivity measurement.
6. Between individual conductivity measurements, the probe should be thoroughly rinsed with deionized water.

Field Measurement of Dissolved Oxygen.

Method: Electronic Dissolved Oxygen Meter

Sensitivity: 0.05 ppm on 0-10 scale; 0.1 ppm on 0-20 scale

Optimum Range: 0-20 ppm

Reagents and Apparatus:

1. Dissolved Oxygen Meter.
2. Probe.

Calibration:

1. Switch instrument to OFF and adjust meter mechanical zero.
2. Switch to RED LINE and adjust.
3. Prepare probe for operation, connect to instrument, wait up to 15 minutes for probe to stabilize. Probe can be in calibration chamber or ambient air.
4. Switch to ZERO and adjust to "0" on ppm scale.
5. Switch to TEMP and read on °C scale.
6. Use probe temperature and true local atmospheric pressure (or feet above sea level) to determine calibration values from Tables I and II of the manufacturers instruction manual.

Example: Probe temperature = 21°C; Altitude = 1000 feet From Table I the calibration value ofr 21°C is 9.0 ppm. From Table II the altitude factor for 1000 feet is approximately .96. The correct calibration value, then, is:

$$9.0 \text{ ppm} \times .96 \text{ factor} = 8.64 \text{ ppm}$$

7. Switch to 0-10 to 0-20 ppm range and adjust meter with CAL control to calibration value determined in Step 6.

Note: It is desirable to calibrate probe in a high humidity environment.

Measurement:

1. Place probe in sample and stir.

2. Allow sufficient time for probe to stabilize to sample temperature and dissolved oxygen.
3. Read dissolved oxygen on appropriate range (0-10 or 0-20 ppm).
4. The instrument should be left on between measurements to avoid the necessity to repolarize the probe.

Field Measurement of Well Water Level.

Method: Olympic Well Probe

Sensitivity: 0.1 feet

Optimum Range: 0-500 feet

Reagents and Apparatus:

1. Olympic Well Probe.
2. Distilled Water.
3. Paper Towels.

Calibration and Measurement Procedures:

1. Determine the length of the probe from the tip of the probe to the first measure indicator on the cable by measuring this section with a tape measure to the nearest unit defined by the tape. Record this length. Also measure the length of cable defined by the Standard Code markings and the length of cable corresponding to each ten-foot cable section up to 100 feet in length and record these measurements. Three people may be necessary for these measurements to prevent the cable from coming into contact with the ground surface.

Colored bands should be located at five foot intervals according to the following coding system;

Each Orange Superimposed on White = 5 feet
Each White = 10 feet
Each Orange = 50 feet
Each Green = 100 feet
Each Blue = 500 feet

Example: one green, one orange, two white = 170 feet.

2. Decontaminate the cable by spraying the cable with distilled water and wiping with paper towels as the cable is rewound into the reel.
3. Turn on well probe and immerse probe end in a glass of distilled water to check probe batteries. Note instrument response as the tip of the probe contacts the water. If no response occurs, replace the batteries and try again. Battery replacement can be accomplished by removing the three screws on the face plate. Two

standard (AA) penlight batteries are used. This procedure should be repeated daily before well measurements are taken.

4. Lower the probe into the well by pulling the cable from the hand-held reel until the light comes on or buzzer sounds.
5. Move the cable up and down fractionally while observing the indicator and note the exact length of cable extending from the tip of the probe to the top of the well casing. Record the cable length, station number, and time and date of the measurement in the field logbook.
6. Decontaminate the cable by the procedure specified in step number 2.

Field Measurement of Stream Velocity.

Method: Gurley Current Meter

Sensitivity: Not Applicable

Optimum Range: 0.1 to 11 feet per second

Apparatus:

1. Bucket Wheel.
2. Hub and Bearings.
3. Shaft.
4. Pivot.
5. Frame or Yoke.
6. Commutator Box.
7. Earphones.
8. Tail piece.
9. Wading Rod Set.
10. Stop Watch.

Calibration: Not Applicable.

Measurement Procedures:

1. Place meter into the stream.
2. Position the meter and verify that the meter is counting properly.
3. Reset counter button by depressing.
4. Start stop watch simultaneously with the electronic counter.
5. Run the meter for one full minute with the counter operating.
6. Use specified charts found in the operating manual to determine the stream velocity.

Maintenance:

Change the oil between each use by:

- 1) Screw out the threaded plug with a socket wrench.
- 2) Take out the spindle along with the ball bearings.
- 3) Change the oil.
- 4) Replace the spindle along with ball bearings.
- 5) Gently tighten the plug.

Field Scan for Volatile Organic Compounds.

Method: HNU Model PI 101 Portable Photoionization Analyzer

Sensitivity: 1.0 ppm

Optimum Range: 0-500 ppm

Apparatus:

1. Trace Gas Analyzer.
2. Probe Assembly.
3. Readout Assembly.
4. Battery Charger with Cord.
5. Isobutylene gas cylinder.
6. Regulator.

Calibration:

1. Connect the analyzer to the regulator and cylinder with a short pieces (butt connection) of tubing. The calibration gas in the cylinder consists of a mixture of isobutylene and zero air. Isobutylene is nontoxic and safe to use in confined areas. There are no listed exposure levels at any concentration.

The regulator sets and controls the flow rate of gas at a value preset at the factory. This will be about 100 to 300 cc/min. It is important that the tubing be clean since contaminated tubing will effect the calibration reading. Do not use the cylinder below about 30 psig as readings below that level can deviate up to 10% from the rated value.

Safely discard the disposable cylinder when empty.

Do not refill this cylinder.

It is against the law to transport refilled cylinders.

2. With the SPAN setting and the function switch at the same positions as listed in the Application Data Sheet or Calibration Report, open the valve on the cylinder until a steady reading is obtained.

3. If the reading is the same as the recorded data, the analyzer calibration for the original species of interest is still correct.
4. If the reading has changed, adjust the SPAN setting until the reading is the same.
5. Shut off the cylinder as soon as the reading is established.
6. Record and maintain this new SPAN setting. Then recalibrate the analyzer on the species of interest as soon as possible.
7. Whenever the analyzer is recalibrated, it is to be immediately checked with the smaller cylinder and the reading recorded. This can then be used for later checking in the field.

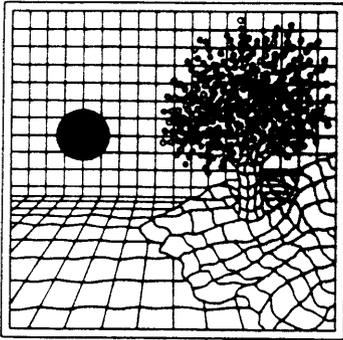
Measurement Procedures:

1. Take sample.
2. Put probe over sample allowing enough for probe and sample to equilibrate.
3. Record measurement.

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Revision No. 2
Date 05/04/90
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APPENDIX F

SOUTHWEST LABORATORY OF OKLAHOMA'S
QUALITY ASSURANCE PROJECT PLAN



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

QUALITY ASSURANCE PROJECT PLAN

Prepared for

B&V WASTE SCIENCE & TECHNOLOGY

*"Multi-Phased Remedial Investigation of Surface
and Subsurface Contamination of Soldier Creek at
Tinker Air Force Base, Oklahoma"*

VOLUME I of II

APPROVAL: _____

A handwritten signature in black ink, appearing to read "Robert Harris". The signature is written in a cursive style and is positioned above a horizontal line.

Laboratory Manager

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Copies of this document are in the possession of the Quality Assurance Officer (Chuck Hoover), Southwest Laboratory of Oklahoma's Administrative office, & B & V Waste Management.

SOUTHWEST LABORATORY OF OKLAHOMA, INC.
1700 West Albany, Suite "C"
Tulsa, Oklahoma 74012

SOUTHWEST LABORATORY OF OKLAHOMA (SWLO) is pleased to present its qualifications and capabilities for your review. Founded in 1976, SOUTHWEST LABORATORY now has two offices to provide greater assistance to its customers. The outstanding growth we have enjoyed is a result of our efforts to provide quality work in a timely manner.

SOUTHWEST LABORATORY OF OKLAHOMA's two laboratory facilities have a combined laboratory space of over 31,000 sq.ft.. The Cushing, Oklahoma office offers a complete range of petroleum tests for crude oils, petroleum products, and natural gas. The Cushing office is also well suited for environmental analysis of waters, waste waters and soil samples. While the office in Cushing, Oklahoma caters to the needs of the petroleum industry, our Tulsa, Oklahoma facility serves the more complex and sophisticated requirements of environmental analyses. SWLO's Tulsa Laboratory has the latest in analytical equipment necessary to meet the analytical needs of tomorrow. Our personnel are highly trained and experienced professionals capable of not only performing the analysis but assuring the quality of the data.

SWLO performs all analyses using accepted methodologies and techniques. SWLO provides the client with complete quality control and quality assurance program to insure the validity of data produced. As a part of our efforts to maintain a professional quality assurance program, SWLO participates in several state and federal certification programs, including membership in the ENVIRONMENTAL PROTECTION AGENCY's Contract Laboratory Program (CLP) and certification by D.E.R.A. (Defense Environmental Restoration Act).

SWLO's Tulsa Facility occupies over 28,000 sq.ft.. The laboratory is designed to handle a wide variety of analytical needs. This facility is divided into six distinct work areas. Each area has experienced professionals in supervision to assure safe, efficient, and accurate operations. A list of the work areas and the equipment associated with each area is included later in this package.

Sample preparation is an important part of any analysis. SWLO's facility has four 4 ft. and four 6 ft. hoods in the sample preparation laboratory to provide a safe working environment for large sample throughput. Continuous liquid extractors and sonic disrupters are routinely used in sample preparation. Surrogates and matrix spikes are added in sample preparation to monitor the quality and efficiency of our extraction process.

SWLO's inorganic and wet chemistry laboratories are equipped with the latest in modern equipment for performing a wide variety of analytical requests. The capabilities of this department has been enhanced by the addition of a Thermo Jarrel Ash ICAP-61 and (2) additional AAs (see equipment list - inorganics). Trace metals on soils and waters are performed according to strict protocol. Groundwater samples are analyzed for inorganic contaminants as well as Total Organic Carbon and Total Organic Halogen routinely as part of the many projects conducted by our wet chemistry laboratory.

Our chromatography department is one of the finest anywhere. With 19 gas chromatographs and one HPLC, we provide a wide range of analytical services. Once again the quality of our work is a result of the latest in technology and personnel whose experience and conscientious work have combined to form a unique team. Our chromatography department routinely analyzes samples for pesticides, herbicides, PCB's, volatiles and many other compounds. Trace quantities of explosives such as TNT, HMX, RDX and others are performed on a Kratos HPLC system. Data from the chromatographs are collected on four computer multi-channelled data systems where it can be processed or stored for later review.

One area which we are very proud of is our Gas Chromatography/Mass Spectrometer Laboratory. The GC/MS laboratory is the heart of our environmental department. SWLO is equipped with (11) GC/MS instruments, (1) Finnigan 5100 and (10) Hewlett Packard models (5985, 5995, 5988 and 5970 MSDs). The Hewlett Packard GC/MS instruments are equipped with (5) model 1000 data systems (with Aquarius REV E software). All of our GC/MS instruments are equipped with capillary and packed column options. This insures the flexibility and reliability necessary for large sample loads. The (5) computer data systems are available for data review, processing and archiving. These data systems have four 9 track tape drives, two 800 BPI and two 1600 BPI and 400 megabyte disk systems for use in reviewing and storing large amounts of data. This data may be stored on 9 track tapes in an EPA compatible format for submission to the EPA or for later review. All GC/MS units are equipped with automatic sampling devices which insure high sample throughput. Volatile organic analysis is performed utilizing Tekmar purge and traps with 32 port auto samplers.

Leading our efforts in this area is a group of dedicated scientists who thoroughly review and check all analyses. Blanks, spikes, and surrogate recoveries are monitored continuously to insure quality data is produced. This data is submitted to our data management section for final review and reporting.

The data management section provides sample tracking, data review, and data reporting. A very integral part of the analysis and reporting function is the tracking of the sample. Inadequate tracking can often result in missed deadlines. Sample management is accomplished with our *Custom* SWLO "Laboratory Information Management System" (LIMS) computer. Terminals are available throughout the laboratory to check on the status of any sample at any time. Results are entered into the Data Base where they can be reviewed along with the relevant QC data to determine accuracy and precision. Once the data has been validated and collated, reports are issued.

PROJECT DESCRIPTION

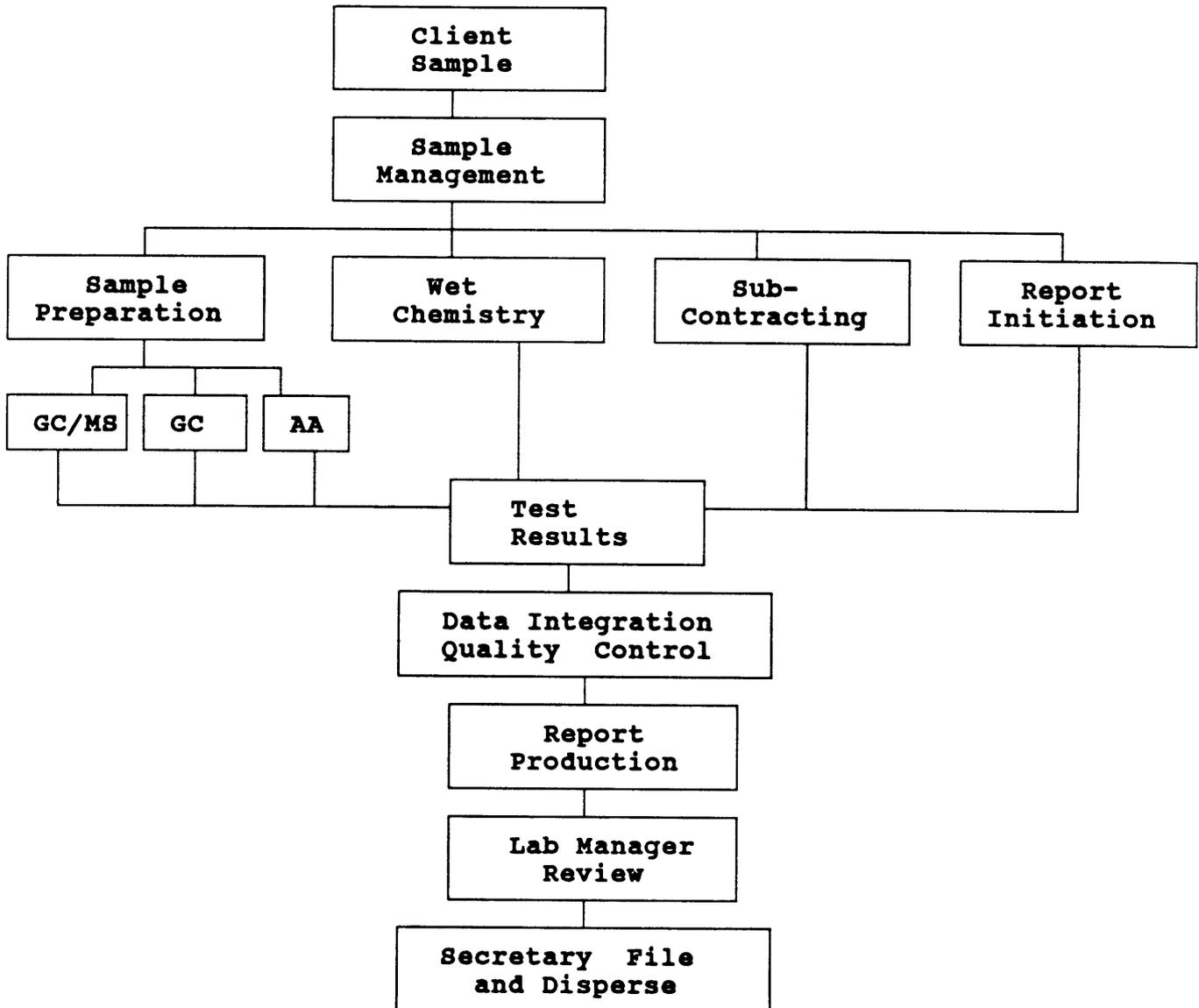
This quality assurance project plan is designed to meet the QA/QC and analytical requirements of B & V Waste Science & Technology Corporation.

To minimize sample contamination appropriate sample and shipping containers will be sent to the project site at the client's request. Sample request, Chain of Custody forms and sample labels will accompany the sample containers. Samples with completed forms and labels will be delivered to the laboratory from the client's sampling team. Samples will be logged into the Laboratory Management System (LIMS) and Chain of Custody forms updated. Samples along with control documents will be processed thru the analytical sequence. At the client's request samples will be retained for 60 days, and returned to the project site. For this project Southwest Laboratory of Oklahoma will use U.S. EPA's CLP Statement of Work for Organics & Inorganics, SW-846, ASTM, & Standard Methods.

Data reduction and validation will be performed in accordance with the referenced method, specific Standard Operating Procedures, or Contract Lab Program (CLP) Statement of Work (SOW) requirements. Data reporting will be in CLP equivalent format, and within 30 days of sample receipt.

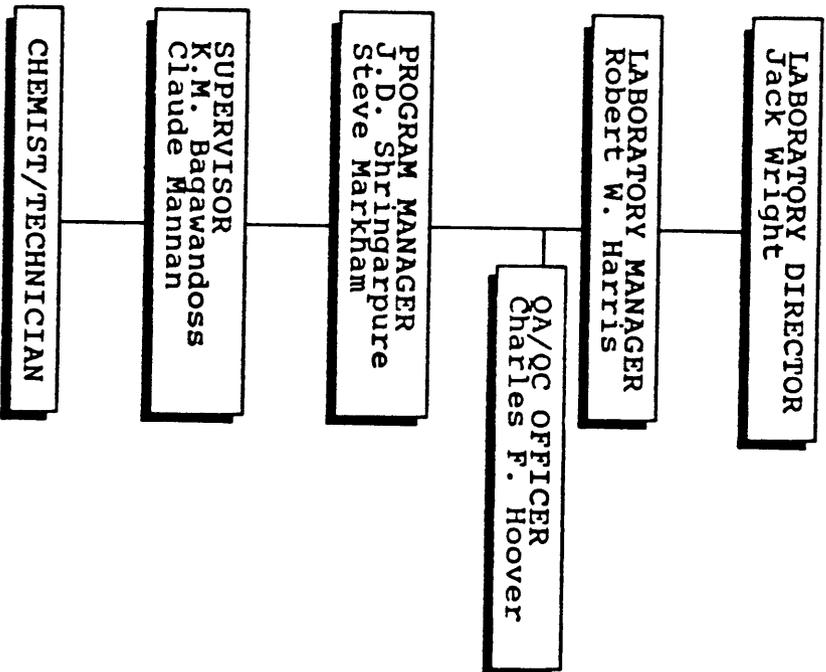
SOUTHWEST LABORATORY OF OKLAHOMA, INC.

PROJECT FLOW CHART



QUALITY ASSURANCE ORGANIZATIONAL CHART

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SOUTHWEST LABORATORY OF OKLAHOMA, INC.

RESPONSIBILITIES AND AUTHORITIES

A Quality Assurance Program for an environmental laboratory requires the attention and commitment of both management and staff to be effective. The Quality Assurance effort at SWL is managed by the Quality Assurance Officer which reports directly to the Laboratory Manager. The Quality Assurance Officer operates independently from all areas generating analytical data to insure complete objectivity in the evaluation of laboratory operations.

The implementation of the Quality Assurance Program within each individual laboratory is the responsibility of the Program Manager. We believe that the success of SWL is dependent upon the continued commitment of all within the organization to a strong and viable Quality Assurance Program. The responsibilities and levels of authority within the organization are described below.

The Quality Assurance effort within SWL is directed by the Laboratory Manager who reports directly to the President of SWL. The Quality Assurance Officer also assists the Laboratory Manager in carrying out the responsibilities of the laboratory.

LABORATORY MANAGER

Responsibilities

The Laboratory Manager is responsible for:

- Developing and implementing a corporate Quality Assurance Program which assures that all data generated in SWL laboratories is scientifically sound, legally defensible, and of known precision and accuracy.
- Developing and implementing new Quality Assurance procedures within the corporation to improve data quality.
- Directing the Program Manager in the implementation of the SWL Quality Assurance Plan within individual sections.
- Interfacing on Quality Assurance issues for both clients and laboratory staff.
- Promoting sound Quality Assurance practices within the environmental regulatory and analytical communities.

Authority

The Quality Assurance Officer is the final authority within each laboratory on all issues dealing with data quality. He has the authority to require that procedures be amended or discontinued or analyses suspended or repeated.

PROGRAM MANAGERS

The supervisors and managers who direct the analytical work at each section are directly responsible for ensuring that all employees reporting to them are complying with the SWL Quality Assurance Plan.

Responsibilities

The Program Managers are responsible for:

- Actively supporting the implementation of the SWL Quality Assurance Plan within the laboratory.
- Maintaining accurate SOP's and enforcing their use in the laboratory.
- Maintaining a work environment which emphasizes the importance of data quality.
- Providing management support to the Quality Assurance Officer and the Laboratory Manager.
- Prescribing and monitoring Corrective Action.

Authority

The Program Managers of the laboratory have the authority to accept or reject data based on well-defined Quality Control criteria. In addition, Program Managers, with the approval of the Quality Assurance Officer, can accept data which falls outside the normal Quality Control limits if, in their judgment, there are technical reasons which warrant the acceptance of the data. These circumstances must be well documented and any need for Corrective Action identified by the incident must be defined and initiated.

CHEMIST/TECHNICIAN

All laboratory personnel involved in the generation and reporting of data have a responsibility to understand and follow the SWL Quality Assurance Plan.

Authority

The Laboratory Manager is the final authority on all issues dealing with data quality and has the authority to require that procedures be amended or discontinued, or analyses suspended or repeated. The authority of the Laboratory Manager comes directly from the President of SWL, to whom the Laboratory Manager reports.

QUALITY ASSURANCE OFFICER

Responsibilities

The Quality Assurance officer is responsible for:

- Implementing SWL Quality Assurance policies.
- Monitoring the Quality Assurance Plan within the laboratory to ensure complete compliance with Quality Assurance objectives.
- Conducting in-house audits to identify potential problems and ensure compliance with written SOPs.
- Performing statistical analyses of Quality Control data and establishing data bases which accurately reflect the performance of the laboratory.
- Monitoring corrective actions.
- Serving as in-house client representative on all project inquiries involving data quality issues.
- Monitoring the preparation and verification of analytical standards.
- Distributing current SOPs to the laboratory staff.
- Monitoring laboratory performance in the areas of holding times, turn-around times, and meeting contractual obligations.
- Preparing Quality Assurance project plans when needed.
- Assisting the Laboratory Manager in the writing of Quality Assurance manuals and procedures.
- Auditing subcontractors.

CHEMIST/TECHNICIAN

All laboratory personnel involved in the generation and reporting of data have a responsibility to understand and follow the SWL Quality Assurance Plan.

The Chemists and Technicians are responsible for:

- Having a working knowledge of the SWL Quality Assurance Plan.
- Ensuring that all work is generated in compliance with the SWL Quality Assurance Plan.
- Performing all work according to written SOPs.
- Ensuring that all documentation related to their work is complete and accurate.
- Providing management with immediate notification of quality problems.

Authority

The chemists and technicians have the authority to accept or reject data based on compliance with well-defined Quality Control acceptance criteria. The acceptance of data which falls outside Quality Control criteria must be approved by laboratory management.

PERSONNEL EXPERIENCE

SECTION: III-F-3
REVISION: 2
DATE: 5/4/90
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NAME	EXPERIENCE
JACK WRIGHT, B.S., Chemical Engineering, 1975	
GC/MS	7 years
Purge and Trap	6 years
Gas Chromatography	12 years
Atomic Absorption	12 years
Sample Preparation	_____
ROBERT HARRIS, B.S., Microbiology, 1971	
GC/MS	3 years
Purge and Trap	3 years
Gas Chromatography	10 years
Atomic Absorption	10 years
Sample Preparation	10 years
J.D. SHRINGARPURE, Ph.D., Organic Chemistry, 1974	
GC/MS	8 years
Purge and Trap	8 years
Gas Chromatography	13 years
Atomic Absorption	_____
Sample Preparation	8 years
K.M. BAGAWANDOSS, Ph.D., Environmental Science, 1984	
GC/MS	10 years
Purge and Trap	8 years
Gas Chromatography	8 years
Atomic Absorption	2 years
Sample Preparation	8 years
CHUCK HOOVER, B.A., Biology, 1976 (Chemistry Minor)	
GC/MS	2 years
Purge and Trap	2 years
Gas Chromatography	5 years
Atomic Absorption	4 years
Sample Preparation	8 years
Data Review	2 years
CLAUDE MANNAN, M.S., Chemistry, 1982	
GC/MS	10 years
Purge and Trap	4 years
Gas Chromatography	15 years
High Perform. Liquid Chromatography	15 years
Atomic Absorption	2 years
Sample Preparation	15 years
STEVE MARKHAM, B.S., Zoology, 1977	
GC/MS	_____
ICP	8 years
Gas Chromatography	8 years
Atomic Absorption	8 years
Sample Preparation	9 years

PRECISION ACCURACY & COMPLETENESS OBJECTIVES
 (PAGE 1)

PARAMETER	METHOD	REFERENCE	ACCURACY %	PRECISION (MAX RPD) water/soil	COMPLETENESS
VOLATILE ORGANICS SURROGATE SPIKES TOLUENE d-8 (water) TOLUENE d-8 (soil) BROMOFLUOROBENZENE (WATER) BROMOFLUOROBENZENE (SOIL) 1, 2-DICHLOROETHANE -d4 (WATER) 1, 2-DICHLOROETHANE -d4 (SOIL) MATRIX SPIKE/DUPLICATE (RPD) 1, 1-DICHLOROETHENE TRICHLOROETHENE BENZENE TOLUENE CHLOROBENZENE	624/8240 CLP-SOW	EPA	88-110 81-117 86-115 74-121 76-114 70-121	14/22 14/24 11/21 13/21 13/21	90%
PESTICIDE/PCB SURROGATE SPIKE DIBUTYLCHLORENDATE (WATER) DIBUTYLCHLORENDATE (SOIL) MATRIX SPIKE/DUPLICATE (RPD) GAMMA-BHC HEPTACHLOR ALDRIN DIELDRIN ENDRIN 4, 4-DDT	608/8080 CLP-SOW	EPA	24-154 24-150	15/50 20/31 22/43 18/38 21/45 27/50	90%
METALS	CLP-SOW	EPA	80-120	20	90%

PRECISION ACCURACY & COMPLETENESS OBJECTIVES
 (PAGE 2)

PARAMETER	METHOD	REFERENCE	ACCURACY %	PRECISION (MAX RPD) water/soil	COMPLETENESS
CYANIDES	9010 CLP-SOW	EPA	80-120	20	90%
SULFIDES	9030	EPA	80-120	20	90%
BNA Surrogate Spikes Nitrobenzene 2-fluorobiphenyl p-terphenyl-d14 Phenol-ds 2-fluorophenol 2,4,6-Tribromophenol Matrix Spike/Duplicate(RPD) 1,2,4-Trichlorobenzene Acenaphthene 2,4-Dinitrotoluene Pyrene N-Nitroso-Di-n-Propylamine 1,4-Dichlorobenzene Pentachlorophenol Phenol 2-Chlorophenol 4-Chloro-3-Methylphenol 4-Nitrophenol	625/8270 CLP-SOW	EPA	35-114 43-116 33-141 10-94 21-100 10-123	28/23 31/19 38/47 31/36 38/38 28/27 50/47 42/35 40/50 42/33 50/50	90%

PRECISION ACCURACY & COMPLETENESS OBJECTIVES
 (PAGE 3)

PARAMETER	METHOD	REFERENCE	ACCURACY %	PRECISION (MAX RPD) water/soil	COMPLETENESS
HARDNESS	2340	SM	80-120	20	90%
CHEMICAL OXYGEN DEMAND	5220	SM	80-120	20	90%
TOTAL SUSPENDED SOLIDS	160.2	EPA	80-120	20	90%
BIOLOGICAL OXYGEN DEMAND	5210	SM	80-120	20	90%
TOTAL ORGANIC CARBON	9060	SW-846	80-120	20	90%
OIL AND GREASE	5520	SM	80-120	20	90%
NITRATES	300.0	EPA	80-120	20	90%
ALKALINITY	2320	SM	80-120	20	90%
ATTERBERG LIMITS	4318	ASTM	-	-	-
SEDIMENT PARTICLE SIZE	422	ASTM	-	-	-
PERMEABILITY	2434	ASTM	-	-	-
DENSITY	653	ASTM	-	-	-

SAMPLING PROCEDURES

For this project SWLOs sampling procedures are not applicable.

CHAIN OF CUSTODY & RECORDS

Field Sampling Operations will not be managed by Southwest Laboratory for this project.

Keeping in mind that all information received is important, SWLO's staff uses an extensive record system. It begins with a sample custodian's numbering of each sample before it leaves the receiving area. The sample custodian is responsible for the sample while it is in the receiving area. The identification number is entered in a computer log with other pertinent information such as client name and number, source of sample, sampling date, and date and time the sample is received. SWLO's sample custodians are Missy Sherman and Vikki Hodo.

An analysis sheet, (figure 1) which functions as an instruction sheet and report form, is prepared at the same time and contains, in addition to the above information, lab identification number, parameters to be determined, methods to be used, and special instructions. Special instructions are highlighted at the bottom of the sheet (i.e. holding time less than five days, RUSH sample, etc.). One analysis sheet accompanies each sample.

Internal Chain of Custody sheets are also produced by the LIMS System at the time of sample log in. These consist of two forms. A sample tracking sheet and also an extract tracking sheet (figure 2 and figure 3).

Sample tracking sheets follow the sample from storage check out through extractions and into archive. Extract tracking sheets follow the extracts from the sample preparation lab through the Instrumentation Laboratories and back to archive.

Both internal Chain of Custodies are placed in the case file along with other pertinent paper work.

The identification number is transcribed permanently on the label of the bottle or bottles which comprise one sample. Each bottle of a set constituting one sample is also permanently labeled with the type of preservative it contains.

Samples are separated by type, i.e., VOA, BNA, Pesticides, etc., then placed on carts in sequential order received, and taken to the laboratory by the laboratory supervisor. This ensures efficiency and keeps the supervisor apprised of samples.

QA/QC samples are split out at this time; One sample in every twenty is analyzed (in addition to regular analysis) as a Matrix Spike & Matrix Spike Duplicate.

The manager or supervisor assigns the analysis of perishable samples immediately. Other samples, at the direction of the lab supervisor, either remain on carts or are stored under refrigeration. The analysts are responsible for the orderly movement of samples through the laboratory so that all determinations are completed in minimum time.

The manager receives the analysis sheet and from it assigns in writing the daily schedule for the analyst. Analysis sheets are then placed in numeric order in the area where work is to be performed.

An extraction logbook, permanently bound and numbered is used during sample preparation (figure 4). It contains notes, descriptions, and test methods used. A typical entry in the notebook includes the date of analysis, permanent identification number, parameter being determined, the method used, aliquots taken, Surrogate/Matrix Spiking Solutions used, solvent amounts, cleanup used, and final process volume.

The supervisor is responsible for checking entries in the extraction log. The supervisor signs and dates the extraction notebook page and sends it along with the extracts to the Instrumentation Laboratory.

All pertinent information, identification number, client name and number, date received, date completed, and parameter results are transferred to a report. A copy of the computer generated report is sent to the client. Both the original sheet and original typed report are filed according to client name or report number; the date reported is recorded in the logbook.

Retrieval of data is possible by either client name and final report number, date received, or permanent identification number. Through this system of record keeping, the original data can be easily located.

All records, including analysts' retired extraction log books, are kept for three years.

When the requested parameters have been determined and results reviewed by the supervisor and laboratory manager, the manager directs that the samples be stored under appropriate conditions. Unless otherwise requested by the client, sample and bottles are returned to the client four weeks after the analysis report is issued.

WESTERN LABORATORY OF OKLAHOMA, INC.
 1500 W. ALBANY SUITE C
 TUKEN ARROW, OK 74012

Date: 05/12/90
 Episode: 2582
 Client: EPA

SID #	DATE	DESCRIPTION	MA	NC	TEST	PRI	DUE	DESCRIPTION	RESULTS	ANALYSTS	DATE/TIME
2582.01	05/12/90	AT609 (CASE#14059)	W	2	MS310	3	06/10/90	VOA - CLP			
2582.02	05/12/90	AT611 (CASE#14059)	S	4	GC810	3	06/10/90	PEST/PCB CLP			
								EXTRACTION			
					MS310	3	06/10/90	VOA - CLP			
					MS510	3	06/10/90	SEMIVOL CLP			
								EXTRACTION			
2582.03	05/12/90	AT614 (CASE#14059)	S	4	GC810	3	06/10/90	PEST/PCB CLP			
								EXTRACTION			
					MS310	3	06/10/90	VOA - CLP			
					MS510	3	06/10/90	SEMIVOL CLP			
								EXTRACTION			
2582.04	05/12/90	AT615 (CASE#14059)	S	4	GC810	3	06/10/90	PEST/PCB CLP			
								EXTRACTION			
					MS310	3	06/10/90	VOA - CLP			
					MS510	3	06/10/90	SEMIVOL CLP			
								EXTRACTION			
2582.05	05/12/90	AT617 (CASE#14059)	W	2	MS310	3	06/10/90	VOA - CLP			
2582.06	05/12/90	AT619 (CASE#14059)	S	4	GC810	3	06/10/90	PEST/PCB CLP			
								EXTRACTION			
					MS310	3	06/10/90	VOA - CLP			
					MS510	3	06/10/90	SEMIVOL CLP			
								EXTRACTION			
2582.07	05/12/90	AT622 (CASE#14059)	S	4	GC810	3	06/10/90	PEST/PCB CLP			
								EXTRACTION			
					MS310	3	06/10/90	VOA - CLP			
					MS510	3	06/10/90	SEMIVOL CLP			
								EXTRACTION			

INTERNAL CHAIN OF CUSTODY
 SAMPLE TRACKING SHEET
 Matrix : WATER

DATE LOGGED-IN/ ANALYST	SWLO ID	CASE/SAMPLE ID	NO	FRAC	DATE LOGGED-OUT FOR EXTRACTION/ ANALYST	DATE RETURNED TO STORAGE/ ANALYST	DATE DISCARDED/ ANALYST
01/20/89	123769	1FJ306 (CASE 11242)	6	1BNA			
01/20/89	123770	1FJ308 (CASE 11242)	6	1BNA			
01/20/89	123771	1FJ310 (CASE 11242)	6	1BNA			
01/20/89	123772	1FJ312 (CASE 11242)	6	1BNA			
01/20/89	123773	1FJ314 (CASE 11242)	6	1BNA			
01/20/89	123774	1FJ317 (CASE 11242)	6	1BNA			
01/20/89	123775	1FJ318 (CASE 11242)	6	1BNA			

(FIGURE 2)

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CALIBRATION/STANDARDIZATION

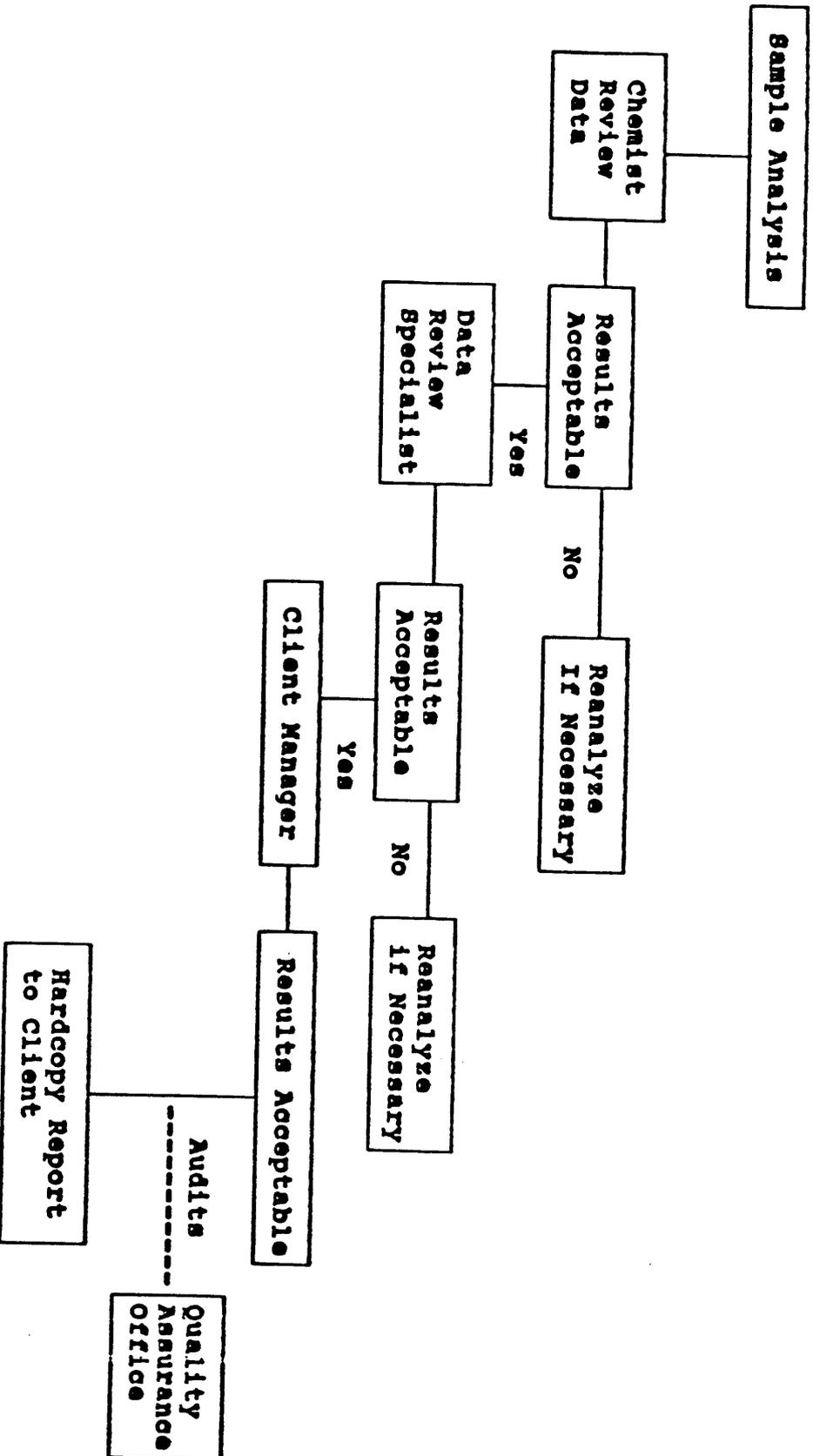
**See Standard Operating Procedures
(Appendix I)**

LABORATORY ANALYSIS

Analytical methods used in all SWLO laboratories include selected methods from the following: Standard Methods for the Examination of Water and Wastewater 17th Edition, American Public Health Associations' Annual Book of Standards, American Society for Testing and Materials, EPA's Methods for Chemical Analysis of Water and Waste, EPA's Test Methods for the Evaluation of Solid Waste (SW-846). Editions used are those currently specified in the Federal Register. The use of other methods may be requested in writing to the laboratory manager.

For this project SWLO will use the specific methods listed in Section 4.

SOUTHWEST LABORATORY OF OKLAHOMA, INC.



DATA VALIDATION SCHEME

DATA REDUCTION, VALIDATION AND REPORTING

1. **OPERATORS:** As data comes off instruments, operators check the data to see if the data meets the QC requirements. Operators fill out QC forms. If the QC requirements are met the data then goes to the data assembly clerk. If the QC requirements are not met, then the operator takes the appropriate action.
2. **DATA ASSEMBLY CLERK:** The data received from the operators is arranged according to each fraction. All the necessary forms are checked out. The clerk fills out yellow forms and sends the data to the Program Manager
3. **DATA REVIEW SPECIALIST:** The data is reviewed for all the analytes. He makes note of any problems with the data. If corrections are required or any data is missing then the operator is informed and the missing data is generated. The operators then transfer the data to the personal computer for the diskette delivery.
4. **OPERATORS:** Operators, using the Forms Master Program, generate all the forms and the diskettes. All the data is sent to data assembly clerks.
5. **DATA ASSEMBLY CLERK:** The data is arranged as per the delivery requirements. All the forms, header information and raw data are checked, the pages are numbered and the copies are made. The diskettes are labeled as per protocol.
6. **CLIENT/PROGRAM MANAGER:** The data is reviewed again, the case narrative is written, signed and the data package is mailed. The data clerk makes note of the mailing date in a log.
7. **DATA ASSEMBLY CLERK:** The pages of the package are numbered and the appropriate number of copies are made. The copies are bound and Federal Expressed to the locations designated by the client, retaining the original in-house.

INTERNAL QUALITY CONTROL CHECKS
METHOD BLANK ANALYSIS

It is the laboratory's responsibility to ensure that method interferences caused by contaminants in solvents, reagents, glassware, and other sample processing hardware be minimized.

Blanks are processed for each analysis (BNA, Tetra through Octa Dibenzo-p-Dioxins/Furans, Pesticides, Herbicides, and Inorganics). All reagents used in the method are taken through the analytical process to ensure that contamination is minimal. Usually a blank is performed with each set of twenty (20) samples of similar concentration or sample matrix, whichever is more frequent. Clients are urged to send field blanks to isolate contamination introduced by field sampling techniques.

Acceptable blank criteria for each parameter is discussed in the Standard Operating Procedures.

ACCURACY

Accuracy is the comparison between observed and known values. Again actual samples, if possible those used for precision data, are used for obtaining accuracy data. An aliquot of standard solution is added to the sample to approximately double the concentration of the parameter in question. The X value is calculated with the observation being the actual result and the theoretical being the calculated result.

The control charts are produced from historic spike recoveries (Surrogate, Internal, or Matrix Spikes), plotting those recoveries, the mean recovery, upper & lower warning limits (± 1 Standard Deviation), & upper & lower control limits (± 2 Standard Deviations).

Matrix Spike compounds are spiked into one sample from each set of twenty (20) or fewer samples of similar concentration or matrix. This establishes the accuracy and/or whether there is a matrix effect on analyte recovery.

Surrogate Spikes are added to each sample to establish accuracy and recovery of analytes.

Internal Standards are added to the samples just prior to the analysis. Each compound found in a sample is quantitated by it's response relative to the response of the nearest Internal Standard. The areas and retention times of these spikes are monitored and recorded on control charts.

Accuracy control charts are constructed for each parameter. Trends can be followed and sets or runs repeated if necessary.

$$\text{EXAMPLE: } \% \text{ Recovery} = \frac{\text{Observed}}{\text{Known}} * 100$$

PRECISION

Precision refers to the reproducibility of results. At SWLO labs these results are obtained from actual samples not from reference standards. The samples selected cover a range of concentrations and a variety of interfering materials that are normally encountered by the analyst. Every tenth sample, or one sample in each day's run for a specific parameter, is determined in duplicate using different aliquots, when practical. From data generated by this procedure, a control chart for each parameter is constructed showing the warning and control limits. The SWLO analyst calculates the X value for each set of duplicates and plots the values on the control chart to determine whether the method is in control. In this manner, trends can be detected and checked. If results are out of control, another set can be run to verify the observed difference.

EXAMPLE: % Difference =
$$\frac{A^1 - A^2}{(A^1 + A^2)/2} * 100$$

A¹ = First Reading

A² = Second Reading

REPLICATE ANALYSES

One sample of each twenty analyzed is run in triplicate. For Base-Neutral and Acid fractions, three extractions are performed, one of which is spiked with known quantities of the appropriate compounds, and concentrated extracts are analyzed separately. For Volatile Organics, three purge and trap concentrations are performed, one spiked with known quantities of the volatile analytes, and analyzed separately. Both accuracy and precision are established with these analyses.

REPRESENTATIVENESS

All measurements are made so that results are representative of the media (water, soil, etc.) and conditions being measured.

COMPLETENESS

Data Quality Objectives for completeness are at least 90%.

DETECTION LIMITS

The determination of detection limits can be found in the Standard Operating Procedure (Appendix I).

PERFORMANCE and SYSTEM AUDITS

PERFORMANCE (QUANTITATIVE) AUDITS

SWLO participates in a number of performance evaluation programs. The U.S. EPA Contract Laboratory Program sends "Quarterly Blind" samples, to assess the quality of our analytical procedures.

In addition SWLO participates in: - The EPA, WP & WS Proficiency Studies. - Various State Proficiency Studies.

Internal Performance Evaluation Samples are introduced each week as "Blinds" to assess the precision and accuracy of various parameters.

SYSTEM (QUALITATIVE) AUDITS IN-HOUSE AUDITS

In-house audits are performed monthly by the Quality Assurance/Control Officer. Audit results are reported to the Laboratory Director and Laboratory Manager along with Section Supervisors.

The purpose of the audit is to verify that the laboratory Quality Assurance Program is working, and new protocols are implemented and functioning within the laboratory stream.

Laboratory personnel are welcome to conduct audits with the Quality Assurance/Control Officer. This function reinforces the understanding of in-house audits by showing all laboratory personnel QA/QC function and protocols, within the laboratory stream.

EXTERNAL AUDIT AGENCIES

To supplement the in-house audit program, Southwest is audited under strict out-of-house protocols. The EPA-CLP audits the entire laboratory facility twice annually. Several states each audit the laboratory at least annually. These "System" audits involve an evaluation of the adequacy of the analytical process, procedure compliance, and use of "Good Laboratory Practices."

AUDIT RECORDS

Audit reports, laboratory inspections and implementations of protocol due to information generated from these actions are reported to the Laboratory Manager from the QA/QC Officer. These reports are then kept as QC records by the QA/QC Officer. External audits, on-site inspections and reports generated from those actions are kept as audit records by the QA/QC Officer.

PREVENTATIVE MAINTENANCE

Southwest Laboratory has developed an in depth program for preventative maintenance. Simplified operations are maintained by the chemist and technicians. The more difficult and intricate maintenance operations are scheduled and organized by the "Laboratory Facility and Equipment Manager".

Preventative maintenance schedules are placed in the front of each individual instrument logbook. Information acquired in this schedule would be written as the maintenance is performed. Maintenance to be performed is scheduled for the Laboratory Facility and Equipment Managers office.

Table 4.10 summarizes the preventative maintenance requirements for Southwest Laboratory. Instrument identification, items to be checked or serviced and the frequency in which each operation is performed are listed.

TABLE 4.10

Preventative Maintenance Requirement
 Southwest Laboratory Operations

<u>INSTRUMENT</u>	<u>ITEMS CHECKED/SERVICED</u>	<u>FREQUENCY</u>
Gas Chromatography	Replace column packing, clean detector, Change glass wool plug, Clean insert, Replace septa, Gas purity checks.	Determined by analyst so that the calibration is within the specifications.
Atomic Absorption Spectrometer	3 point calibration performed, burner head, Nebulizer, Tygon Tubing	Daily Daily Monthly 6 months
Inductively Coupled Plasma (ICP)	Capillary and pump tubing Liquid Argon Tank Slit Micrometer (reprofile) Replace/Realign Plasma Torch Nebulizer Primary Imaging Mirror	Twice weekly Weekly Twice weekly As needed Monthly Weekly

Preventative Maintenance Requirement
 Southwest Laboratory Operations

<u>INSTRUMENT</u>	<u>ITEMS CHECKED/SERVICED</u>	<u>FREQUENCY</u>
Ion Chromatograph	Check plumbing,	Daily
	Check filter (inlet)	Weekly
	Flush column	After each sample
	check bed support	
GC/MS	GC/MS maintenance is the same as GC with the following additions:	
	DP Oil	Bi-weekly
	Mech Oil	Quarterly
	Power Con. Air Filter	Bi-weekly
	QEM Filter	Bi-weekly
	Water Filter	Bi-weekly
	Vacuum Chaff Filter	Monthly
	Computer Air Filter	Bi-monthly
	Card Gage Air Filter	Monthly
	Interface Box	Bi-weekly

**Specific Routine Procedures Used To Assess
Data Precision, Accuracy, And Completeness**

**See QA Objectives (Section 4), Internal Quality Control
Checks (Section 10), & Sections 10 & 11 of the Standard
Operating Procedure (Appendix I)**

CORRECTIVE ACTIONS

When errors, deficiencies or out-of-control situations exist, the QA plan provides systematic procedures, called "corrective actions," to resolve problems and restore proper functioning of the analytical system. Laboratory personnel are alerted that corrective actions may be necessary if:

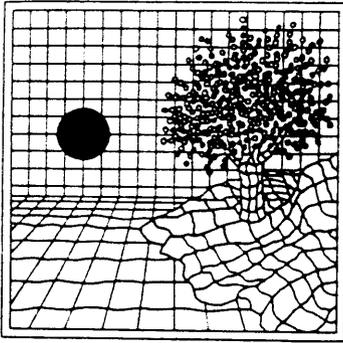
- 1) Data is outside the warning or acceptable windows for precision and accuracy.
- 2) Undesirable trends in concentration, spike recoveries and relative percent difference (RPD) are detected.
- 3) There are unusual changes in detection limits.
- 4) Deficiencies are detected by the QA Officer during internal and external walk-throughs, or from the results of performance evaluation samples.
- 5) Complaints are received from the clients.

Corrective action procedures are often handled at the bench level by the analyst, who will review the extraction procedure for possible errors, check the instrument calibration, spike mixes and standard mixes, instrument sensitivity, etc. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA Officer, who will further investigate. When the problem is resolved, the QA Officer is provided with full documentation of the problem, corrective action taken, and steps taken to avoid recurrence. This information is kept on file in the QA office.

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QUALITY ASSURANCE REPORTS TO MANAGEMENT

See Responsibilities



SOUTHWEST LABORATORY OF OKLAHOMA, INC.

QUALITY ASSURANCE PROJECT PLAN

Prepared for

B&V WASTE SCIENCE & TECHNOLOGY

*"Multi-Phased Remedial Investigation of Surface
and Subsurface Contamination of Soldier Creek at
Tinker Air Force Base, Oklahoma"*

CONFIDENTIAL

VOLUME II of II

APPROVAL: _____

Laboratory Manager

APPENDIX I

STANDARD
OPERATING
PROCEDURES

GC/MS
STANDARD OPERATING PROCEDURES
ANALYSIS OF PURGABLE ORGANICS

I. GC/MS ANALYSIS OF PURGEABLE ORGANICS

1.1 Summary of Method for Water Samples

An inert gas is bubbled through a 5 ml sample contained in a specifically designed purging chamber at ambient temperature. The purgeables are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the purgeables are trapped. After purging is completed, the sorbent column is heated and backflushed with the inert gas to desorb the purgeables onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate the purgeables which are then detected with a mass spectrometer.

An aliquot of the sample is diluted with reagent water when dilution is necessary. A 5 ml aliquot of the dilution is taken for purging.

1.2 Apparatus and Materials

Micro syringes - 25 uL and larger, 0.006 inch ID needle.

Syringe valve - two-way, with Luer ends (three each), if applicable to the purging device.

Syringe - 5 mL, gas tight with shut-off valve.

Balance-Analytical, capable of accurately weighing 0.0001 g. and a top-loading balance capable of weighing 0.1 g.

GLASSWARE

Bottle - 15 mL, screw cap, with Teflon cap liner.

Volumetric flasks - class A with ground-glass stoppers.

Vials - 2 mL for GC autosampler.

Purge and trap device - The purge and trap device consists of three separate pieces of equipment; the sample purger, trap and the desorber. (Tekmar LSC2)

1.3 GC/MS System

Gas chromatograph - An analytical system complete with a temperature programmable gas chromatograph suitable for on-column injection and all required accessories including syringes, analytical column, and gases.

DBC24, 30 m, 0.53 mm ID, 3.0 μ m Thick
Column - ~~6 ft. long x 0.1 in ID glass, packed with 1%
SP-1000 on Carboxack B (60/80 mesh) or equivalent.~~
(J&W Scientific Cat. No. 125-1334)

Mass spectrometer - Capable of scanning from 35 to 260 amu every three seconds, utilizing seventy volts (nominal) electron energy in the electron impact ionization mode and producing a mass spectrum which meets all the criteria when 50 ng of 4-bromofluorobenzene (BFB) is injected through the gas chromatograph inlet.

1.4 Reagents

Reagent water - prepared by boiling water for 15 minutes. subsequently, while maintaining the temperature at 90°C, bubble a contaminant-free inert gas through the water for one hour. While still hot, transfer the water to a narrow mouth screw-cap bottle and seal with a teflon-lined septum and cap.

Sodium thiosulfate - (ACS) Granular

Methanol - Pesticide quality or equivalent.

Stock standard solutions - Stock standard solutions are purchased and are traceable to EMLS/LV supplied standards. These solutions are stored into Teflon sealed screw-cap bottles at 10°C to 20°C.

Prepare fresh standards weekly for the four gases and 2-chloroethyl-vinyl ether. All other standards must be replaced after one month, or sooner if comparison with check standards indicate a problem.

Secondary dilution standards - Using stock standard solutions, prepare secondary dilution standards in methanol that contain the compounds of interest, either singly or mixed together. (See GC/MS Calibration in Exhibit E). Secondary dilution standards should be stored with minimal headspace and should be checked frequently for signs of degradation or evaporation especially just prior to preparing calibration standards from them.

Surrogate standard spiking solution. Prepare stock standard solutions for toluene-d8, p-bromofluorobenzene, and 1,2-dichloroethane-d4 in methanol. Prepare a surrogate standard spiking solution from these stock standards a concentration of 250 ug/10 mL in methanol.

Purgeable Organic Matrix Standard Spiking Solution.

Prepare a spiking solution in methanol that contains the following compounds at a concentration of 250 ug/10.0 mL:

Purgeable Organics

1,1-dichloroethene
trichloroethene
chlorobenzene
toluene
benzene

Matrix spikes also serve as duplicates; therefore, add an aliquot of this solution to each of two portions from one sample chosen for spiking.

Internal Standard Solution: The three internal standards are Bromochloromethane, 1,4-difluorobenzene and chlorobenzene-d5

Prepare a spiking solution containing each of the internal standards. It is recommended that the secondary dilution standard be prepared at concentration of 25 ug/mL of each internal standard compound. The addition of 10 uL of this standard to 5.0 mL of sample or calibration standard would be equivalent of 50 ug/L.

1.5 GC/MS Operating Conditions

These performance test require the following instrumental parameters:

Electron Energy: 70 Volts (nominal)
Mass Range: 35-260
Scan Time: to give 3 second scans per peak

1.6 Sample Analysis

WATER SAMPLES

All samples and standard solutions must be allowed to warm to ambient temperature before analysis.

Operating conditions for the gas chromatograph - Column Conditions: Carbowax B (60/80 mesh with 1% SP-1000 packed in a 6 foot by 2 mm ID glass column with helium carrier gas at a flow rate of 30 mL/min. Column temperature is

isothermal at 30°C for four minutes, then programmed at 8°C per minute to 220°C and held for 15 minutes.

After achieving the key ion abundance criteria, calibrate the system daily as described in QA/QC -SOP.

Adjust the purge gas (helium) flow rate to 40 ± 3 mL/min. Variations from this flow rate may be necessary to achieve better purging and collection efficiencies for some compounds, particularly chloromethane and bromoform.

Remove the plunger from a 5 mL syringe and attach a closed syringe valve. Open the sample or standard bottle which has been allowed to come to ambient temperature, and carefully pour the sample into the syringe barrel to just short of overflowing. Replace the syringe plunger and compress the sample. Open the syringe valve and vent any residual air while adjusting the sample volume to 5.0 mL. This process of taking an aliquot destroys the validity of the sample for future analysis so if there is only one VOA vial, the analyst should fill a second syringe at this time to protect against possible loss of sample integrity. This second sample is maintained only until such a time when the analyst has determined that the first sample has been analyzed properly. Filling one 20 mL syringe would allow the use of only one syringe. If a second analysis is needed from the 20 mL syringe, it must be analyzed within 24 hours. Care must also be taken to prevent air from leaking into the syringe.

Add 10.0 uL of the surrogate spiking solution and 10.0 uL of the internal standard spiking solution through the valve bore of the syringe, then close the valve. The surrogate and internal standards may be mixed and added as a single spiking solution to 5 mL of sample is equivalent to a concentration of 50 ug/L of each surrogate standard.

Attach the syringe-syringe valve assembly to the syringe valve on the purging device. Open the syringe valves and inject the sample into the purging chamber.

Close both valves and purge the sample for 12.0 ± 0.1 minutes at ambient temperature.

At the conclusion of the purge time, attach the trap to the chromatograph, adjust the device to the desorb mode, and begin the gas chromatographic temperature program. Concurrently, introduce the trapped materials to the gas chromatographic column by rapidly heating the trap to 180°C while backflushing.

the trap with an inert gas between 20 and 60 mL/min. for four minutes.

While the trap is being desorbed into the gas chromatograph, empty the purging chamber. Wash the chamber with a minimum of two 5 mL flushes of reagent water. After desorbing the sample for four minutes, recondition the trap by returning the purge and trap device to the purge mode. Wait 15 seconds then close the syringe valve on the purging device to begin gas flow through the trap. The trap temperature should be maintained at 180°C. Trap temperatures up to 230°C may be employed, however the higher temperature will shorten the useful life of the trap. After approximately seven minutes turn off the trap heater and open the syringe valve to stop the gas flow through the trap. When cool, the trap is ready for the next sample.

If the initial analysis of a sample or a dilution of a sample indicates saturated ions of HSL compounds, the sample must be reanalyzed at a higher dilution. When a sample is analyzed that has saturated ions from a compound, this analysis must be followed by a blank reagent water analysis. If the blank analysis is not free of interferences, the system must be decontaminated. Sample analysis may not resume until a blank can be analyzed that is free of interferences.

For low and medium level water samples, add 10 uL of the matrix spike solution to the 5 mL of sample purged. Disregarding any dilutions, this is equivalent to a concentration of 50 ug/L of each matrix spike standard.

All dilutions must keep the response of the major constituents (previously saturated peaks) in the upper half of the linear range of the curve.

1.7 Summary of the Methods for Sediment/Soil Samples

Two approaches may be taken to determine whether the low level medium level method may be followed.

Assume the sample is low level and analyze a 5 gram sample. If the peaks are saturated from the analysis of a 5 gram sample, a smaller sample size must be analyzed to prevent saturation. However, the smallest sample size permitted is 1 gm. If smaller than 1 gram sample size is needed to prevent saturation, the medium level method must be used.

LOW LEVEL METHOD

The low level method is based on purging a heated sediment/soil sample mixed with reagent water containing the surrogate and internal standards.

Use 5 grams of sample or use the X Factor to determine the sample size for purging.

If the X Factor is 0 (no peaks noted on the hexadecane screen) analyze a 5 gm sample. If the X Factor is between 0 and 1.0 analyze a 1 gm sample.

The GC/MS system should be set up as in 1.3 / 1.5. This should be done prior to the preparation of the sample to avoid loss of volatiles from standards and sample.

Remove the plunger from a 5 mL "Luerlock" type syringe equipped with a syringe valve and fill until overflowing with reagent water. Replace the plunger and compress the water to vent trapped air. Adjust the volume to 5.0 mL. Add 10 uL each of the surrogate spiking solution and the internal standard solution to the syringe through the valve. (Surrogate spiking solution and internal standard solution may be mixed together). The addition of 10 uL of the surrogate spiking solution to 5 gm of sediment/soil is equivalent to 50 ug/Kg of each surrogate standard.

The sample (for volatile organics) consists of the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula. Weigh the sample into a tared purge device. Use a top loading balance. Note and record the actual weight to the nearest 0.1 gm.

Immediately after weighing the sample weigh 5-10 g of the sediment into a tared crucible. Determine the percent moisture by drying overnight at 105°C. Allow to cool in a desiccator before weighing. Concentrations of individual analytes will be reported relative to the dry weight of sediment.

PERCENT MOISTURE

$$\frac{\text{gm of sample} - \text{gm of dry sample}}{\text{gm of sample}}$$

X 100 - % moisture

Add the spiked reagent water to the purge device and connect the device to the purge and trap system.

Heat the sample to $40^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and purge the sample for 12 ± 0.1 minutes.

Proceed with the analysis as outlined in 1.6. Use 5 mL of the same reagent water as the reagent blank.

For low level sediment/soils add 10 uL of the matrix spike solution to the 5 mL of water. The concentration for a 5 gram sample would be equivalent to 50 ug/Kg of each matrix spike standard.

1.8.1 Medium Level Method

The medium level method is based on extracting the sediment/soil sample with methanol. An aliquot of the methanol extract is added to reagent water containing the surrogate and internal standards. This is purged at ambient temperature. All samples with an X Factor >1.0 should be analyzed by the medium level method. If saturated peaks occurred or would occur when a 1 gram sample was analyzed, the medium level method must be used.

An estimated concentration for Non-HSL components tentatively identified shall be quantified by the internal standard method. For quantification, the nearest internal standard free of interferences shall be used.

The formula for calculating concentrations is the same as in paragraph 1.8.1. Total area counts from the total ion chromatograms are to be used for both the compound to be measured and the internal standard. A response factor (RF) of one (1) is to be assumed. The value from this quantitation shall be qualified as estimated. This estimated concentration should be calculated for all tentatively identified compounds as well as those identified as unknowns.

Xylenes (o,m, & p - isomers) are to be reported as total Xylenes. Since o- and p-Xylenes overlap, the Xylenes must be quantitated versus m-Xylene. The concentration of all Xylene isomers must be added together to give the total.

Calculate surrogate standard recovery on all samples, blanks and spikes. Determine if recovery is within limits and report on appropriate form.

Calculation for surrogate recovery.

$$\text{Percent Surrogate Recovery} = \frac{Q_s}{Q_a} \times 100\%$$

where: Q_a = quantity determined by analysis
 Q_a = quantity added to sample

The following Tabel 1 can be used to determine the volume of methanol extract to add to the 5 mL of reagent water for analysis. Estimate the concentration range of the sample from the low level analysis to determine the appropriate volume. If the sample was submitted as a medium level sample, start with 100 uL. All dilutions must keep the response of the major constituents (previously saturated peaks) in the upper half of linear range of the curve.

TABLE 1.

X Factor	<u>Estimated Concentration Range¹ /</u> ug/kg	<u>Take this Volume of Methanol Extract² /</u> uL
0.25 - 5.0	500 - 10,000	100
0.5 - 10.0	1000 - 20,000	50
2.5 - 50.0	5000 - 100,000	10
12.5 - 250	25,000 - 500,000	100 of 1/50 dilution

Calculate appropriate dilution factor for concentrations exceeding the table.

- 1/ Actual concentration ranges could be 10 or 20 times higher than this if the compounds are halogenated and the estimates are from GC/FID.
- 2/ The volume of methanol added to the 5 mL of water being purged should be kept constant. Therefore, add to the 5 mL syringe whatever volume of methanol is necessary to maintain a volume of 100 uL added to the syringe.
- 3/ Dilute an aliquot of the methanol extract and then take 100 uL for analysis.

HSL components identified shall be quantified by the internal standard method. The internal standard used shall be the one nearest the retention time to that of a given analyte. The EICP area of the characteristic ions of analytes listed in Tables 2 and 3 are used. The response factor (RF) from the daily standard analysis is used to calculate the concentration in the sample.

Water (low and medium level)

$$\text{Concentration} \quad \text{ug/L} = \frac{(A_x)(I_s)}{(A_{i_s})(RF)(V_o)}$$

Where:

- A_x = Area of the characteristic ion for the compound to be measured.
- A_{i_s} = Area of the characteristic ion for the specific internal standard from Exhibit E.
- I_s = Amount of internal standard added in nanograms (ng)
- V_o = Volume of water purged in milliliters (mL) (take into account any dilutions)

Sediment/Soil (medium level)

$$\text{Concentration} \quad \text{ug/Kg} = \frac{(A_x)(I_s)(V_c)}{(A_{i_s})(RF)(V_i)(W_s)(D)}$$

Sediment/Soil (low level)

$$\text{Concentration} \quad \text{ug/Kg} = \frac{(A_x)(I_s)}{(A_{i_s})(RF)(W_s)(D)}$$

(Dry weight basis)

Where:

- A_x, I_s, A_{i_s} = same as for water, above
- V_t = Volume of total extract (uL) (use 10,000 uL or a factor of this when dilutions are made.
- V_i = Volume of extract added (uL) for purging
- D = $\frac{100 - \% \text{ moisture}}{100}$
- W_s = Weight of sample extracted (gm) or purged

TABLE 2.
 Characteristic Ions for Surrogate and
 Internal Standards for Volatile Organic Compounds

<u>Compound</u>	<u>Primary Ion</u>	<u>Secondary Ion(s)</u>
<u>SURROGATE STANDARDS</u>		
4-Bromofluorobenzene	95	174, 176
1,2-Dichloroethane d-4	65	102
Toluene d-8	98	70, 100
<u>INTERNAL STANDARDS</u>		
Bromochloromethane	128	49, 130, 51
1,4-Difluorobenzene	114	63, 88
Chlorobenzene d-5	117	82, 119

TABLE 3.
 Characteristic Ions for Volatile HSL Compounds

<u>Parameter</u>	<u>Primary Ion</u>	<u>Secondary Ion(s)</u>
Chloromethane	50	52
Bromomethane	94	96
Vinyl chloride	62	64
Chloroethane	64	66
Methylene chloride	84	49, 51, 86
Acetone	43	58
Carbon disulfide	76	78
1,1-Dichloroethene	96	61, 98
1,1-Dichloroethane	63	65, 83, 85, 98, 100
trans-1,2-Dichloroethene	96	61, 98
Chloroform	83	85
1,2-Dichloroethane	62	64, 100, 98
2-Butanone	72	57
1,1,1-Trichloroethane	97	99, 117, 119
Carbon tetrachloride	117	119, 121
Vinyl acetate	43	86
Bromodichloromethane	83	85, 129
1,1,2,2-Tetrachloroethane	83	85, 131, 133, 166
1,2-Dichloropropane	63	65, 114
trans-1,3-Dichloropropene	75	77
Trichloroethene	130	95, 97, 132
Dibromochloromethane	129	208, 206
1,1,2-Trichloroethane	97	83, 85, 99, 132, 134
Benzene	78	
cis-1,3-Dichloropropene	75	77
2-Chloroethyl vinyl ether	63	65, 106
Bromoform	173	171, 175, 250, 252, 254, 256
2-Hexanone	43	58, 57, 114

continued.....

TABLE 3.
Characteristic Ions for Volatile HSL Compounds

<u>Parameter</u>	<u>Primary Ion</u>	<u>Secondary Ion(s)</u>
4-Methyl-2-pentanone	43	58, 100
Tetrachloroethene	164	129, 131, 166
Toluene	92	91
Chlorobenzene	112	114
Ethyl Benzene	106	91
Styrene	104	78, 103
Total xylenes	106	91

VOLATILE LABORATORY DAILY SOP

- 1) Raise the temperature of the GC oven to 180°C.
 - 2) Bake out the trap on the Tekmar to 225°C by stepping the Tekmar (200°C) to bake out cycle and holding in bake out until you have reviewed the data from the previous day.
 - 3) Take out standards (calibrations, SS & IS) from refrigerator and set out to equilibrate to room temperature. Note down the temperature of the refrigerator and record it.
 - 4) Check the data (surrogate recoveries, internal standard areas, linearity) for all the samples analysed on previous day. The details of the QC criteria is described in SOP attached. The raw data for all of the good and bad data samples along with the BFB, calibration and blank data should be given to the data clerk for further processing.
 - 5) Make a list of all reruns and additional samples to be run to accommodate the 12 hour sequence (22-25 samples total).
 - 6) Check the instrument for air leaks.
 - 7) Inject 50 ng of BFB. Manually check the spectrum to see that it meets the criteria specified in the SOP or use TR,BFTEST.>datafile. This will automatically search scans up to plus or minus 2 from the top of the peak and if it meets the criteria, then print the spectrum and mass listing. TR,BFTEST makes a RR file for BFB automatically (manually - RR,>_____,,=BFB.,!P). If the criteria is not met then reanalyse or tune the instrument. In case of problems, check with your supervisor.
 - 8) During the BFB run, load 50 PPB standard and blank (Refer to SOP for standard preparation) and start purging the standard (Tekmar method is in SOP). After BFB meets the QC criteria, then desorb the standard. Check the standard to see that it meets QC criteria (refer SOP). If it makes it then it updates the responses (QCal Procedure). Also, update the internal standard areas (use TR,HONK). Make RR files for standards (RR,>datafile,,.,!D*). This will help in checking the surrogate recoveries and internal standard areas for sample data printouts. If calibration does not meet the criteria, then reanalyse the calibration. Check for standards or chromatography problems. Check with you supervisor for analysing initial calibrations.
 - 9) While the standard is running, make up the batch file sequence for the samples to be run from the rerun list you have made.
- * - D for continuing calibration and C for initial calibration.

- 10) After the calibration makes it, then analyse a blank. Make sure the blank has Methylene Chloride less than 25 ppb and Acetone less than 50 ppb. Also, the blank should meet all of the other QC criteria (surrogate recoveries and internal standard areas).
- 11) While the blank is running, obtain all of the samples from the list you have made up (I don't want to see people just printing up 2 or 3 samples at a time and running around) from the VOA refrigerator.
- 12) Set up the autosampler to run a maximum number of samples during the 12 hours (Don't wait to start the batch, after loading all of the samples, set up a sample and start the batch and then load the rest of the samples).
- 13) Replace the samples in the refrigerator exactly in the same place where you had gotten the samples from.
- 14) Keep the raw data for BFB, calibration and blank to be submitted the next day with the other samples.
- 15) Complete the instrument run log and initial it.
- 16) Tables No 1.- 10. gives a quick reference to the QC requirements.

TABLE 1. BFB KEY IONS AND ABUNDANCE CRITERIA

<u>Mass</u>	<u>Ion Abundance Criteria</u>
50	15.0 - 40.0 percent of the base peak
75	30.0 - 60.0 percent of the base peak
95	base peak, 100 percent relative abundance
96	5.0 - 9.0 percent of the base peak
173	less than 2.0 percent of mass 174
174	greater than 50.0 percent of the base peak
175	5.0 - 9.0 percent of mass 174
176	greater than 95.0% but less than 101.0% of mass 174
177	5.0 - 9.0 percent of mass 176

TABLE 2. SURROGATE SPIKE RECOVERY LIMITS

<u>Fraction</u>	<u>Surrogate Compound</u>	<u>Water</u>	<u>Low/Medium Soil</u>
Volatile	Toluene-d ₈	88-110	81-117
Volatile	4-Bromofluorobenzene	86-115	74-121
Volatile	1,2-Dichloroethane-d ₄	76-114	70-121

TABLE 3. MATRIX SPIKE RECOVERY LIMITS

<u>Fraction</u>	<u>Matrix Spike Compound</u>	<u>Water</u>	<u>Soil/Sediment</u>
Volatile	1,1,-Dichloroethene	61-145	59-172
Volatile	Trichloroethene	71-120	62-137
Volatile	Chlorobenzene	75-130	60-133
Volatile	Toluene	76-125	59-139
Volatile	Benzene	76-127	66-142

TABLE 4. CHARACTERISTIC IONS FOR VOLATILE TCL COMPOUNDS

<u>Parameter</u>	<u>Primary Ion*</u>	<u>Secondary Ions</u>
Chloroemthane	50	
Bromomethane	94	52
Vinyl Chloride	62	96
Chloroethane	64	64
Methylene Chloride	84	66
Acetone	43	49, 51, 86
Carbon Disulfide	76	58
1,1-Dichloroethene	96	78
1,1-Dichloroethane	63	61, 98
1,2-Dichloroethene	96	65, 83, 85, 98, 100
Chloroform	83	61, 98
1,2-Dichloroethane	62	85
2-Butanone	72	64, 100, 98
1,1,1-Trichloroethane	97	57
Carbon Tetrachloride	117	99, 117, 119
Vinyl Acetate	43	119, 121
Bromodichloromethane	83	86
1,1,2,2-Tetrachloroethane	83	85
1,2-Dichloropropane	63	85, 131, 133, 166
trans-1,3-Dichloropropene	75	65, 114
Trichloroethene	130	77
Dibromochloromethane	129	95, 97, 132
1,1,2-Trichloroethane	97	208, 206
Benzene	78	83, 85, 99, 132, 134
cis-1,3-Dichloropropene	75	-
Bromoform	173	77
2-Hexanone	43	171, 175, 250, 252, 254, 256
4-Methyl-2-Pentanone	43	58, 57, 100
Tetrachloroethene	164	58, 100
Toluene	92	129, 131, 166
Chlorobenzene	112	91
Ethyl Benzene	106	114
Styrene	104	91
Total Xylenes	106	78, 103
		91
<u>Surrogate Standards</u>		
4-Bromofluorobenzene	95	
1,2-dichloroethane d-4	65	174, 176
Toluene d-8	98	102
		70, 100
<u>Internal Standards</u>		
Bromochloromethane	128	
1,4-Difluorobenzene	114	49, 130, 51
Chlorobenzene d-5	117	63, 88
		82, 119

TABLE 5. VOLATILE INTERNAL STANDARDS WITH CORRESPONDING TCL ANALYTES ASSIGNED FOR QUANTITATION

<u>Bromochloromethane</u>	<u>1,4-Difluorobenzene</u>	<u>Chlorobenzene-d₂</u>
Chloromethane	1,1,1-Trichloroethane	2-Hexanone
Bromomethane	Carbon Tetrachloride	4-Methyl-2-Pentanone
Vinyl Chloride	Vinyl Acetate	Tetrachloroethene
Chloroethane	Bromodichloromethane	1,1,2,2-Tetrachloroethane
Methylene Chloride	1,2-Dichloropropane	Toluene
Acetone	trans-1,3-Dichloropropene	Chlorobenzene
Carbon Disulfide	Trichloroethene	Ethylbenzene
1,1-Dichloroethene	Dibromochloromethane	Styrene
1,1-Dichloroethane	1,1,2-Trichloroethane	Xylene (total)
1,2-Dichloroethene (tot.)	Benzene	Bromofluorobenzene
Chloroform	cis-1,3-Dichloropropene	(surr)
1,2-Dichloroethane	Bromoform	Toluene-d ₆ (surr)
2-Butanone		
1,2-Dichloroethane-d ₂ (surr)		

Internal Standard area limits for all of the samples + 100%
- 50%.

Retention time change \leq 30 seconds.

TABLE 6. VOLATILE CALIBRATION CHECK COMPOUNDS (CCC)

1,1-Dichloroethene	Initial Calibration 20, 50, 100, 150, 200 ppb Max % RSD 30%
Chloroform	
1,2-Dichloropropane	
Toluene	
Ethylbenzene	Continuing Calibration 50 ppb Max %D 25%
Vinyl Chloride	

TABLE 7. VOLATILE SYSTEM PERFORMANCE CHECK COMPOUNDS (SPCC)

Chloromethane	Minimum relative response factor (RRF) 0.300 (0.250 for Bromoform)
1,1-Dichloroethane	
Bromoform	
1,1,2,2-Tetrachloroethane	
Chlorobenzene	

TABLE 8. TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMITS (CRQL)

Volatiles	CAS Number	Quantitation Limits	
		Water ug/L	Low Soil/Sediment* ug/kg
1. Chloromethane	74-87-3	10	10
2. Bromomethane	74-83-9	10	10
3. Vinyl Chloride	75-01-4	10	10
4. Chloroethane	75-00-3	10	10
5. Methylene Chloride	75-09-2	5	5
6. Acetone	67-64-1	10	10
7. Carbon Disulfide	75-15-0	5	5
8. 1,1-Dichloroethene	75-35-4	5	5
9. 1,1-Dichloroethane	75-34-3	5	5
10. 1,2-Dichloroethene (total)	540-59-0,	5	5
11. Chloroform	67-66-3	5	5
12. 1,2-Dichloroethane	107-06-2	5	5
13. 2-Butanone	78-93-3	10	10
14. 1,1,1-Trichloroethane	71-55-6	5	5
15. Carbon Tetrachloride	56-23-5	5	5
16. Vinyl Acetate	108-05-4	10	10
17. Bromodichloromethane	75-27-4	5	5
18. 1,2-Dichloropropane	78-87-5	5	5
19. cis-1,3-Dichloropropene	10061-01-5	5	5
20. Trichloroethene	79-01-6	5	5
21. Dibromochloromethane	124-48-1	5	5
22. 1,1,2-Trichloroethane	79-00-5	5	5
23. Benzene	71-43-2	5	5
24. trans-1,3-Dichloropropene	10061-02-6	5	5
25. Bromoform	75-25-2	5	5
26. 4-Methyl-2-Pentanone	108-10-1	10	10
27. 2-Hexanone	591-78-6	10	10
28. Tetrachloroethene	127-18-4	5	5
29. Toluene	108-88-3	5	5
30. 1,1,2,2-Tetrachloroethane	79-34-5	5	5
31. Chlorobenzene	108-90-7	5	5
32. Ethyl Benzene	100-41-4	5	5
33. Styrene	100-42-5	5	5
34. Xylenes (Total)	1330-20-7	5	5

* Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Volatile TCL compounds are 125 times the individual Low Soil/Sediment CRQL.

TABLE 9. STANDARDS PREPARATION

Compound	Conc. ug/mL	Aliquot uL	Total Vol.	Conc. ug/mL	Volume used/uL
Supelco purgable Int Std. Mix	1000	1000	20 mL	50	5
Supelco Surrogate Std. Mix	250	1000	5 mL	50	5
Purgable A Mix	200	1000	} 4 mL	50	} 5
Purgable B Mix	200	1000			
Purgable C Mix	200	1000			
HSL Volatile Mix	2000	100			
1,2-Dichlorobenzene	5000	40			
1,3-Dichlorobenzene	5000	40	} 4 mL	50	} 5
1,4-Dichlorobenzene	5000	40			
1,1-Dichloroethene	1000	200			
Trichloroethene	10,000	20			
Benzene	10,000	20	} 4 mL	50	} 5
Toluene	10,000	20			
Chlorobenzene	5,000	40			

These standards are verified with EPA standards regularly.

Every time a standard is made, it is recorded in the current standards note book.

TABLE 10. INSTRUMENT PARAMETERS

Parameters	Inst. C	Inst. D	Inst. E	Inst. I
Tune File	MT9108	#2 Tune	#E Tune	#I Tune
Methods Files	#1BFB #1VOA	#2V0BF #2V0A #2V0B0 (Bakeout)	#EBFB #EVOA	#1BFB #1VOA
ID/CB Files	IDV011}LDL CBV011}LDL	- -	- -	- -
	IDV012}W CBV012}W	IDV020}W CBV020}W	IDV0E1}W CBV0E1}W	IDV011}W CBV011}W
	IDSWC9}W CBSWC9}SWC	IDV023}S CBV023}S	IDV0E2}S CBV0E2}S	IDV012}S CBV012}S
	IDV01X}A-IX CBV01X}A-IX	IDV027}M.S. CBV027}M.S.		
		IDV01X}A-IX CBV01X}A-IX		
HP-1000				
Data System	HP-3	HP-3	HP-4	HP-4
Data File	L1.D4	L2.D6	D5.D6	D4
Cartridges	D5,D3	D7	D7	L2,L3
Method ID/CB File	EX,PS	EX,PS	EX,PS	EX,PS
Cartridges				

 Column for Instruments C, D, E, and I: DB624, 30M, 0.53 mm ID, 3.0 um film thickness.

TABLE 10. INSTRUMENT PARAMETERS (CONT.)

TEKMAR 2000 Method 1

Parameters	Inst. C	Inst. D	Inst. E	Inst. I
Standby	30°C	30°C	30°C	30°C
Purge	8 min.	8 min.	8 min.	8 min.
Prepurge	-	-	-	-
Preheat	-	-	-	-
Sample	-	-	-	-
Dry Purge	-	-	-	-
Cap Cooldown	-	-	-	-
Desorb Preheat	175°C	175°C	175°C	175°C
Desorb	4 min./180°C	4 min./180°C	4 min./180°C	4 min./180°C
Inject	NI min. at NI			
Bake	4 min./225°C	4 min./200°C	5 min./225°C	5 min./225°C
Auto Drain	On	Off	Off	Off
Bake Gas Bypass	Off	On	On	On
BGB Delay	-	60 sec.	-	-
Valve	100°C	100°C	100°C	100°C
Line	100°C	100°C	100°C	100°C
Mount	40°C	40°C	40°C	40°C
Aux. Heaters	-	-	-	-
2016 Valve	100°C	-	-	100°C
Line	100°C	-	-	100°C
2032 Valve	100°C	100°C	-	-
Line	100°C	100°C	-	-
Cap. Union Heater	-	-	-	-
Runs/Sample	1	1	-	-
Purge Pressure(PSI)	20	20	20	20

TABLE 8. SEMIVOLATILE CALIBRATION CHECK COMPOUNDS (CCC)

BASE/NEUTRAL FRACTION	ACID FRACTION
: Acenaphthene	: 4-Chloro-3-Methylphenol
: 1,4-Dichlorobenzene	: 2,4-Dichlorophenol
: Hexachlorobutadiene	: 2-Nitrophenol
: N-Nitroso-Di-n-Phenylamine	: Phenol
: Di-n-Octylphthalate	: Pentachlorophenol
: Fluoranthene	: 2,4,6-Trichlorophenol
: Benzo(a)pyrene	

Initial calibration 20, 50, 80, 120 and 160 ng.

Nine compounds: Benzoic Acid, 2,4-Dinitrophenol, 2,4,5-Trichlorophenol, 2-Nitroaniline, 3-Nitroaniline, 4-Nitroaniline, 4-Nitrophenol, 4,6-Dinitro-2-Methylphenol, and Pentachlorophenol will only require a four-point initial calibration at 50, 80, 120 and 160 total nanograms since detection at less than 50 nanograms per injection is difficult.

Maximum % RSD is 30%.

TABLE 9. SEMIVOLATILE SYSTEM PERFORMANCE CHECK COMPOUNDS (SPCC)

: N-Nitroso-Di-n-Propylamine	: Minimum relative response factor 0.05
: Hexachlorocyclopentadiene	
: 2,4-Dinitrophenol	
: 4-Nitrophenol	

TABLE 10.

Target Compound List (TCL) and
Contract Required Quantitation Limits (CROL)*

Semivolatiles	CAS Number	Quantitation Limits**	
		Water ug/L	Low Soil/Sediment ³ ug/Kg
35. Phenol	108-95-2	10	330
36. bis(2-Chloroethyl) ether	111-44-4	10	330
37. 2-Chlorophenol	95-57-8	10	330
38. 1,3-Dichlorobenzene	541-73-1	10	330
39. 1,4-Dichlorobenzene	106-46-7	10	330
40. Benzyl alcohol	100-51-6	10	330
41. 1,2-Dichlorobenzene	95-50-1	10	330
42. 2-Methylphenol	95-48-7	10	330
43. bis(2-Chloroisopropyl) ether	108-60-1	10	330
44. 4-Methylphenol	106-44-5	10	330
45. N-Nitroso-di-n- dipropylamine	621-64-7	10	330
46. Hexachloroethane	67-72-1	10	330
47. Nitrobenzene	98-95-3	10	330
48. Isophorone	78-59-1	10	330
49. 2-Nitrophenol	88-75-5	10	330
50. 2,4-Dimethylphenol	105-67-9	10	330
51. Benzoic acid	65-85-0	50	1600
52. bis(2-Chloroethoxy) methane	111-91-1	10	330
53. 2,4-Dichlorophenol	120-83-2	10	330
54. 1,2,4-Trichlorobenzene	120-82-1	10	330
55. Naphthalene	91-20-3	10	330
56. 4-Chloroaniline	106-47-8	10	330
57. Hexachlorobutadiene	87-68-3	10	330
58. 4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
59. 2-Methylnaphthalene	91-57-6	10	330
60. Hexachlorocyclopentadiene	77-47-4	10	330
61. 2,4,6-Trichlorophenol	88-06-2	10	330
62. 2,4,5-Trichlorophenol	95-95-4	50	1600
63. 2-Chloronaphthalene	91-58-7	10	330
64. 2-Nitroaniline	88-74-4	50	1600
65. Dimethylphthalate	131-11-3	10	330
66. Acenaphthylene	208-96-8	10	330
67. 2,6-Dinitrotoluene	606-20-2	10	330
68. 3-Nitroaniline	99-09-2	50	1600
69. Acenaphthene	83-32-9	10	330

(continued)

TABLE 10. (CONT.)

Semivolatiles	CAS Number	Quantitation Limits**	
		Water ug/L	Low Soil/Sediment ^b ug/Kg
70. 2,4-Dinitrophenol	51-28-5	50	1600
71. 4-Nitrophenol	100-02-7	50	1600
72. Dibenzofuran	132-64-9	10	330
73. 2,4-Dinitrotoluene	121-14-2	10	330
74. Diethylphthalate	84-66-2	10	330
75. 4-Chlorophenyl-phenyl ether	7005-72-3	10	330
76. Fluorene	86-73-7	10	330
77. 4-Nitroaniline	100-01-6	50	1600
78. 4,6-Dinitro-2-methylphenol	534-52-1	50	1600
79. N-nitrosodiphenylamine	86-30-6	10	330
80. 4-Bromophenyl-phenylether	101-55-3	10	330
81. Hexachlorobenzene	118-74-1	10	330
82. Pentachlorophenol	87-86-5	50	1600
83. Phenanthrene	85-01-8	10	330
84. Anthracene	120-12-7	10	330
85. Di-n-butylphthalate	84-74-2	10	330
86. Fluoranthene	206-44-0	10	330
87. Pyrene	129-00-0	10	330
88. Butylbenzylphthalate	85-68-7	10	330
89. 3,3'-Dichlorobenzidine	91-94-1	20	660
90. Benzo(a)anthracene	56-55-3	10	330
91. Chrysene	218-01-9	10	330
92. bis(2-Ethylhexyl)phthalate	117-81-7	10	330
93. Di-n-octylphthalate	117-84-0	10	330
94. Benzo(b)fluoranthene	205-99-2	10	330
95. Benzo(k)fluoranthene	207-08-9	10	330
96. Benzo(a)pyrene	50-32-8	10	330
97. Indeno(1,2,3-cd)pyrene	193-39-5	10	330
98. Dibenz(a,h)anthracene	53-70-3	10	330
99. Benzo(g,h,i)perylene	191-24-2	10	330

^b Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for SemiVolatile TCL Compounds are 60 times the individual Low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** 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.

TABLE 11. STANDARDS PREPARATION

Compound	Conc. ug/mL	Aliquot uL	Total Vol.	Conc. ug/mL	Volume used/uL
Supelco Internal Std. Mix	2000	2000	4 mL	1000	40

STOCK STANDARD					
Phenolic Mix	2000	400	} 4 mL	200	-
Haz. Subst. Mix	2000	400		200	-
Haz. Subst. Mix	2000	400		200	-
PAH Mix	2000	400		200	-
B-N Mix-1	2000	400		200	-
B-N Mix-2	2000	400		200	-
Benzidine Mix	2000	400		200	-
Acid Surr. Mix	2000	400		200	-
B-N Surr. Mix	1000	800		200	-

Stock Std.	200	750	} 3 mL	50	-
IS Mix	1000	120		50	-

Stock Std.	200	400	} 1 mL	80	-
IS Mix	200	40		80	-

Stock Std.	200	600	} 1 mL	120	-
IS Mix	1000	40		120	-

Stock Std.	200	800	} 1 mL	160	-
IS Mix	1000	40		160	-

Stock Std.	200	100	} 1 mL	20	-
IS Mix	1000	40		20	-

These standards are verified with EPA standards regularly. Everytime a standard is made, it is recorded in the current standards note book.

TABLE 12. INSTRUMENT PARAMETERS

Parameters	Inst. A	Inst. B	Inst. F	Inst. G
Tune File	#2 Tune	-	#2 Tune	#3 Tune
Method Files	#DFT02		#DFTF	#8281
	#STD02	SV	#STDF	
ID Files	ID-BN2	-	ID-BN2	ID-BMN
	CB-B2	-	CB-BN2	ID-D85
				ID-BN2
				ID-BN4
			ID-AP9	
			CD-AP9	
Data System	HP-2	-	HP-1	HP-2
Data File				
Cartridges	D2,L1,D4,D5	-	L1,D4,D5	D3,L2,D6,D7
Method ID/CB Files				
Cartridges	EX,PS	-	EX,PS	EX,PS

Parameters	Inst. H	Inst. J
Tune File	#4 Tune	#J Tune
Method Files	#HDFT	#JDFT
	#HSTD	#JSTD
ID Files	ID-BN4	ID-BN2
	CB-BN4	CB-BN2
	ID-AP9	IC-DCD
	CB-AP9	CB-DCD
		ID-DDD
		CB-DDD
Data System	HP-1	HP-5
Data File		
Cartridges	L2,D6,D7	D1,D2,L1,L2
Method ID/CB File		
Cartridges	EX,PS	EX,PS

II. GC/MS ANALYSIS OF EXTRACTABLES (BASE/NEUTRALS AND ACIDS)

2.1 GC/MS System

Gas chromatograph - An analytical system complete with a temperature programmable gas chromatograph suitable for splitless injection and all required accessories including, syringes, analytical columns, and gases.

Column - 30 m x 0.25 mm ID (or 0.32 mm) bonded-phase silicone coated fused silica capillary column (J & W Scientific DB-5 or equivalent). a film thickness of 1.0 micron is recommended because of its larger capacity. a film thickness of 0.25 microns may be used.

Mass Spectrometer - Capable of scanning from 35 to 500 amu every 1 second or less, utilizing 70 volts (nominal) electron energy in the electron impact ionization mode and producing a mass spectrum which meets all required criteria when 50 ng of decafluorotriphenylphosphine (DFTPP) is injected through the GC inlet.

NOTE: DFTPP criteria must be met before any sample extracts are analyzed.

2.2 Reagents

Internal Standards - 1,4 dichlorobenzene-d₄, naphthalene-d₈, acenaphthene-d₁₀, phenanthrene-d₁₀, chrysene-d₁₂, perylene-d₁₂. An internal standard solution can be prepared by dissolving 200 mg of each compound in 50 ml of methylene chloride. It may be necessary to use 5 to 10 percent benzene or toluene in this solution and a few minutes of ultrasonic mixing in order to dissolve all the constituents. The resulting solution will contain each standard at a concentration of 4000ng/uL. A 10 uL portion of this solution should be added to each 1 mL of sample extract. This will give a concentration of 40 ng/uL of each constituent.

2.3 GC/MS Operating Conditions

The following instrumental parameters are required for all performance tests and for all sample analyses:

Electron Energy	-	70 volts (nominal)
Mass Range	-	35 to 500 amu
Scan Time	-	1 second per scan

2.4 Sample Analysis

Combine 0.5 mL of the base/neutral extract and 0.5 mL of acid from the water extract prior to analysis.

Internal standard solution is added to each sample extract., For water and/or medium soil extracts, add 10 uL of internal standard solution to each accurately measured 1.0 mL of sample extract. For low soil extracts, which require a pesticide split, add 8 uL of internal standard solution to each accurately measured 0.8 mL of sample extract.

Analyze the 1.0 mL extract by GC/MS using a bonded-phase silicone-coated fused silica capillary column. The recommended GC operating conditions to be used are as follows:

Initial Column Temperature Hold	-	30° C for 4 minutes
Column Temperature Program	-	30-300 ° C at 8 deg./min.
Final Column Temperature Hold	-	300°C for 10 minutes
Injector Temperature	-	250-300°C
Transfer Line Temperature	-	250-300°C
Source Temperature	-	according to manufacturer's specifications
Injector-Grob-type, splitless		
Sample Volume	-	1 - 2 uL
Carrier Gas	-	Helium at 30 cm/sec

NOTE: Make any extract dilution indicated by characterization prior to the addition of internal standards. If any further dilutions of water or soil/sediment extracts are made, additional internal standards must be added to maintain the required 40 ng/uL of each constituent in the extract volume. If any compound saturated the detector, the extract must be diluted and reanalyzed.

2.5 Quantitation

HSL components identified shall be quantified by the internal standard method. The internal standard used shall be the one nearest the retention time to that of a given analyte. The EICP area of characteristic ions of analytes listed in Tables 4, 5, and 6 are used. The response factor (RF) from the daily standard analysis is used to calculate the concentration in the sample. Secondary ions may be used if interferences are present. The area of a secondary ion cannot be substituted for the area of a primary ion unless a response factor is calculated using the secondary ion.

Calculate the concentration in the sample using the response factor (RF) and the following equation:

Water

$$\text{Concentration: } \mu\text{g/L} = \frac{(A_x)(I_s)(V_t)}{(A_{i_s})(RF)(V_o)(V_i)}$$

A_x = Area of the characteristic ion for the compound to be measured.

A_{i_s} = Area of the characteristic ion for the internal standard.

I_s = Amount of internal standard injected in nanograms (ng).

V_o = Volume of water extracted in milliliters (mL).

V_i = Volume of extract injected (uL).

V_t = Volume of total extract.
(Use 2000 uL or a factor of this when dilutions are made. The 2000 uL is derived from combining half of the 1 mL BN extract and half of the 1 mL A extract.)

Sediment/Soil

$$\text{Concentration: } \mu\text{g/Kg} = \frac{(A_x)(I_s)(V_t)}{(A_{i_s})(RF)(V_i)(W_s)(D)}$$

(Dry weight basis)

- $A_x, I_s, A_i s$ = Same as given for water, above.
- V_t = Volume of low level total extract. (Use 1000 uL or a factor of this when dilutions are made. If GPC cleanup is used, the volume is 2000 uL. The 1000 uL is derived from concentrating the mL extract to to 0.8 mL.)
- or - V_t = Volume of medium level extract (Use 2000 uL or a factor of this when dilutions are made. The 2000 uL is derived from concentrating 5 mL of the 10 mL extract to 1 mL.)
- V_i = Volume of extract injected (uL)
- D = $\frac{100 - \% \text{ moisture}}{100}$
- W_s = Weight of sample extracted (grams)

An estimated concentration for Non-HSL components tentatively identified shall be quantified by the internal standard method. For quantification, the nearest internal standard free of interferences shall be used.

Calculate surrogate standard recovery on all samples, blanks and spikes. Determine if recovery is within limits and report on appropriate form.

continued.....

TABLE 4.

Characteristic Ions for Semivolatile HSL Compounds

Parameter	Primary Ion	Secondary Ion(s)
N-Nitrosodimethylamine	42	74, 44
Phenol	94	65, 66
Aniline	93	66
bis(-2-Chloroethyl)Ether	93	63, 95
2-Chlorophenol	128	64, 130
1,3-Dichlorobenzene	146	148, 113
1,4-Dichlorobenzene	146	148, 113
Benzyl Alcohol	108	79, 77
1,2-Dichlorobenzene	146	148, 113
2-Methylphenol	108	107
bis(2-chloroisopropyl)Ether	45	77, 79
4-Methylphenol	108	107
N-Nitroso-Di-Propylamine	70	42, 101, 113
Hexachloroethane	117	201, 199
Nitrobenzene	77	123, 65
Isophorone	82	95, 138
2-Nitrophenol	139	65, 109
2,4-Dimethylphenol	122	107, 121
Benzoic Acid	122	105, 77
bis(-2-Chloroethoxy)Methane	93	95, 123
2,4-Dichlorophenol	162	164, 98
1,2,4-Trichlorobenzene	180	182, 145
Naphthalene	128	129, 127
4-Chloroaniline	127	129
Hexachlorobutadiene	225	223, 227
4-Chloro-3-Methylphenol	107	144, 142
2-Methylnaphthalene	142	141
Hexachlorocyclopentadiene	237	235, 272
2,4,6-Trichlorophenol	196	198, 200
2,4,5-Trichlorophenol	196	198, 200
2-Chloronaphthalene	162	164, 127
2-Nitroaniline	65	92, 138
Dimethyl Phthalate	163	194, 164
Acenaphthylene	152	151, 153
3-Nitroaniline	138	108, 92
Acenaphthene	153	152, 154
2,4-Dinitrophenol	184	63, 154
4-Nitrophenol	139	109, 65
Dibenzofuran	168	139
2,4-Dinitrotoluene	89	63, 182
2,6-Dinitrotoluene	165	89, 121
Diethylphthalate	149	177, 150
4-Chlorophenyl-phenylether	204	206, 141

continues

TABLE 4. (continued)

Characteristic Ions for Semivolatile HSL Compounds

Parameter	Primary Ion	Secondary Ion(s)
Fluorene	166	
4-Nitroaniline	138	165, 167
4,6-Dinitro-2-Methylphenol	198	92, 108
N-Nitrosodiphenylamine	169	182, 77
4-Bromophenyl-phenylether	248	168, 167
Hexachlorobenzene	284	250, 141
Pentachlorophenol	266	142, 249
Phenanthrene	178	264, 268
Anthracene	178	179, 176
Di-N-Butylphthalate	149	179, 176
Fluoranthene	202	150, 104
Benzidine	184	101, 100
Pyrene	202	92, 185
Butylbenzylphthalate	149	101, 100
3,3'-Dichlorobenzidine	252	91, 206
Benzo(a)Anthracene	228	254, 126
bis(2-Ethylhexyl)Phthalate	149	229, 226
Chrysene	228	167, 279
Di-N-Octyl Phthalate	149	226, 229
Benzo(b)Fluoranthene	252	-
Benzo(k)Fluoranthene	252	253, 125
Benzo(a)Pyrene	252	253, 125
Indeno(1,2,3-cd)Pyrene	276	253, 125
Dibenz(a,h)Anthracene	278	138, 227
Benzo(g,h,i)Perylene	276	139, 279
		138, 277

TABLE 5.
 Characteristic Ions for Pesticides/PCB's

Parameter	Primary Ion	Secondary Ion(s)
Alpha-BHC	183	181, 109
Beta-BHC	181	183, 109
Delta-BHC	183	181, 109
Gamma-BHC (Lindane)	183	181, 109
Heptachlor	100	181, 109
Aldrin	66	272, 274
Heptachlor Epoxide	353	263, 220
Endosulfan I	195	355, 351
Dieldrin	79	339, 341
4,4'-DDE	246	263, 279
Endrin	263	248, 176
Endosulfan II	337	82, 81
4,4'-DDD	235	339, 341
Endrin Aldehyde	67	237, 165
Endosulfan Sulfate	272	345, 250
4,4'-DDT	235	387, 422
Methoxychlor	227	237, 165
Chlordane	373	228
Toxaphene	159	375, 377
Arochlor-1016	222	231, 233
Arochlor-1221	190	260, 292
Arochlor-1232	190	222, 260
Arochlor-1242	222	222, 260
Arochlor-1248	292	256, 292
Arochlor-1254	292	362, 326
Arochlor-1260	360	362, 326
Endrin Ketone	317	362, 394
		67, 319

TABLE 6.

Characteristic Ions for Surrogates and
Internal Standards for Semivolatile Compounds

Parameter	Primary Ion	Secondary Ion(s)
Phenol-5	99	42, 71
2-Fluorophenol	112	64
2,4,6-Tribromophenol	330	332, 141
d-5 Nitrobenzene	82	128, 54
2-Fluorobephenyl	172	171
Terphenyl	244	122, 212
<u>INTERNAL STANDARDS</u>		
1,4-Dichlorobenzene-d ₄	152	115
Naphthalene-d ₈	136	68
Acenaphthene-d ₈	164	162, 160
Phenanthrene-d ₈	188	94, 80
Chrysene-d ₁₂	240	120, 236
Perylene-d ₁₂	264	260, 265

VIII. EXTRACTION OF PESTICIDES FRACTIONS FROM SOILS/SEDIMENTS "LOW LEVEL"
PREPARATION OF EXTRACTABLE PESTICIDE FRACTIONS

HOMOGENIZE SAMPLE BEFORE TAKING SUB SAMPLES DETERMINE pH AND MOISTURE CONTENT OF EACH SAMPLE

- A. Weigh about 30 grams of the sample to the nearest 0.1 gram into a 400 ml beaker and add 60 grams of pre-extracted anhydrous sodium sulfate. Mix well with glass rod. Immediately add 100 mls of 1:1 methylene chloride/acetone.
 - B. Add 100 ul of pesticide surrogate to the pesticide solutions.
 - C. For pesticides matrix spike samples, add 400 ul of the pesticide matrix spike each of two additional sample aliquots. These are the pesticide matrix and matrix spike duplicate.
 - D. Sonicate the samples one at a time using the 3/4" probe held about 1/2" below the liquid surface but above the sediment level. Use full power and a 50% pulse for 3 minutes. Decant and filter the extracts through a filter paper in a glass funnel, collecting the extracts in a 500 ml K D flask. Repeat the extraction 2 more times with 2 more 100 ml portions of the 1:1 methylene chloride-acetone. Decant off the solvent after each sonication, pouring the entire sample into the funnel the last time. Rinse the beaker and soil/sediment with about 100 mls more extraction solution.
 - F. After each of the "soils" have been extracted these are concentrated in the K D assemblys consisting of a 10 ml concentrator tube and a 500 ml evaporative flask. Add one or two clean boiling chips and attach a 3-ball Snyder column. Wet the column with 1 ml methylene chloride. Evaporate the solution in the manner given in the BNA from soil procedure until there is an apparent volume of 10.0 ml.
 - G. For Pesticides, the 10.0 ml of Methylene chloride should be solvent exchanged with 50 mls hexane. Concentrate to an apparent volume of (5.0) ml. Final volume for GC should be (1.0) ml in hexane. To be done on nitrogen blowdown apparatus.
1. If there are sulfur crystals present, a sulfur clean-up must be done. Concentrate the hexane solution to 1 ml using the nitrogen evaporator. Transfer the 1 ml to a 40 ml clear glass bottle or vial with a teflon-lined screw cap. Rinse the concentrator tube with 1 ml hexane and add that to the bottle. Add 1 ml TBA-sulfite reagent and 2 ml 2-propanol. Cap the bottle and shake for at least 1 minute. If the sample is colorless or the initial color is unchanged and if clear crystals (precipitate sodium sulfite) are observed, sufficient sodium sulfite is present. If the precipitated sodium sulfite disappears, add more crystalline sodium sulfite in approximately 100 mg portions until the solid residue remains after repeated shaking. Add 5 mls distilled water and shake for at least one minute. Let the phases rest and separate for 5-10 minutes. Transfer the hexane layer (top) to a concentrator tube.

2. After the sulfur clean-up is complete, or if there were not sulfur crystals present, the concentrator tube is placed on the nitrogen evaporator and taken down to 1.0 ml (final volume) with several rinsings of the inside concentrations, the extract must not be allowed to become dry.

H. For GC analysis, follow directions in H. & G.

Note: This step to be performed by pesticide GC personnel:

For the alumina column clean-up, prepare a column for each extract. In a 5 ml disposable serological pipet (with the cotton plug removed) put a small plug of cleaned pyrex wool. Push it down to the tip of the pipet by using a clean 1 ml disposable pipet. Weigh out about 3 grams of activity III neutral alumina in a clean small (5 or 10 ml) glass beaker. Carefully pour the alumina into the column, tap the column to settle the alumina. Transfer the 1 ml of hexane acetone extract to the top of the column. Add 1 ml hexane to the concentrator tube to rinse it and put that on the column. Elute the column with 9 more mls of hexane. Collect the eluate in a clean 10 ml concentrator tube. When elution is complete, adjust the final volume of the extract to 10 mls with hexane. Transfer the extract to an appropriate vial with teflon-lined screw cap and label for pesticide fractions. Labels should contain EPA ID, SWLO # CASE #, and DATE.

IX. EXTRACTION OF PESTICIDES FORM MEDIUM LEVEL SAMPLES

- A. Transfer approximately 1 gram (record to nearest .01 gr) of sample to a 20 ml tared vial. Clean the mouth of the vial, re weigh, and cap. Check and record pH values on extraction sheets for BN/A. If not completed, perform and get moisture contents. Record these values on the extraction sheets. If pH is >11 or <5 recovery of dibutylchlorodate will be low. Contact Organics Manager who will in turn contact the Project Office (EPA) for instructions. Document the instructions in the Case Narrative. Add 2 g of preextracted anhydrous sodium sulfate to each of the samples. Also for each set prepare a sample for a method blank using all the reagents used for regular sample analysis.
- B. For the Pesticide extractions.
 1. Add 50 ul of Surrogate Spiking Standard to all sample vials and 1.0 ml of Matrix Spiking Standard to each of the two "sample vials" (label them MS & MSD)
 2. Immediately add 10 mls hexane to the blank and the plain sample and 9 mls hexane to the two matrix spikes. Disrupt with the ultrasonic probe for 2 minutes at 100 watts with a 50% pulse. Filter through glass wool in pasteur pipettes and collect 5 mls only. The sample extract is now ready for GC analysis.

3. If there are sulfur crystals present, a sulfur cleanup must be done. Concentrate the hexane solution to 1 ml using the nitrogen evaporator. Transfer the 1 ml to a 40 ml clear glass bottle or vial with a teflon-lined screw cap. Rinse the concentrator tube with 1 ml hexane and add that to the bottle. Add 1 ml TBA-sulfite reagent and 2 ml 2-propanol. Cap the bottle and shake for at least 1 minute. If the sample is colorless or the initial color is unchanged and if clear crystals (precipitated sodium sulfite) are observed, sufficient sodium sulfite is present. If the precipitated sodium sulfite disappears, add more crystalline sodium sulfite in approximately 100 mg portions until the solid residue remains after repeated shaking. Add 5 mls distilled water and shake for at least 1 minute. Let the phases rest and separate for 5-10 minutes. Transfer the hexane layer (top) to a concentrator tube.
4. After the sulfur cleanup is complete, or if there were no sulfur crystals present, 1.0 ml of the extract is transferred to the concentrator tube and placed on the nitrogen evaporator and taken down to 0.5 ml with several rinsings of the inside walls of the tube with hexane.
5. For the alumina column cleanup, prepare a column for each extract. In a 5 ml disposable serological pipet (with the cotton plug removed) put a small plug of cleaned pyrex wool. Push it down to the tip of the pipet by using a clean 1 ml disposable pipet. Weigh out about 3 grams of activity III neutral alumina in a clean small (5 or 10 ml) glass beaker. Carefully pour the alumina into the column, tap the column to settle the alumina. Transfer the 1 ml of hexane/acetone extract to the top of the column. Add 1 ml hexane to the concentrator tube to rinse it and put that on the column. Elute the column with 9 more mls of hexane. Collect the eluate in a clean scintillation vial. When the elution is complete, adjust the final volume of the extract to 10 mls with hexane. Transfer the extract to an appropriate vial with a teflon-lined screw cap and label for pesticide fractions.

X. COMBINED EXTRACTION FOR "LOW LEVEL" PREPARATION OF EXTRACTABLE BNA AND PESTICIDES FRACTIONS FROM SOIL/SEDIMENT SAMPLE

HOMOGENIZE SAMPLE BEFORE TAKING SUB SAMPLES. DETERMINE PH AND MOISTURE CONTENT OF EACH SAMPLE.

- A. Weigh approximately 30 grams of sample to the nearest 0.1 gram into a 400 ml beaker. Add 60 grams of pre-extracted anhydrous sodium sulfate. Mix well with clean spatula and immediately add 100 mls 1:1 methylene chloride/acetone.
- B. Add 0.5 ml of BNA surrogate standard and 100 ul of pesticide surrogate to the solution.
- C. For Matrix Spike samples and duplicates add 0.5 ml of BNA Matrix Spike and 400 ul of Pesticides Matrix Spike.
- D. Sonicate and filter the samples in the manner given for BNA or Pesticides in soils.
- E. After each sample has been extracted they are concentrated to exactly 10.0 mls in a scintillation vial. For the pesticide fraction, 0.5 ml of the extract is transferred to another clean scintillation vial containing 5.0 ml of hexane. After homogenizing, the pesticide fraction is blown to a final volume of 0.5 mls and ready for GC.
- F. The remaining 9.5 ml of extract is in methylene chloride (BNA fraction) and is blown to a final volume of 0.95 mls and is ready for GCMS analysis.
- G. For GC solution follow E. & F. Concentrate to 10.0 ml, split 2500:1.

XI. pH DETERMINATION

The pH meter is to be calibrated before use and calibration data recorded in the pH meter log book.

A. Water Samples

1. Shake the Sample. Transfer approximately 50 mls of the sample to a clean beaker. Add a magnetic stirring bar and place on the stir plate and adjust the speed to give a good mixing action but not to aeriate the sample. Place the probe into the liquid and allow the meter to obtain a stable reading. Record this answer on the sample data sheet and in the extraction lab record book.

B. Soil Samples

1. Homogenize the Sample. Weigh 25 grams of sample into a clean beaker and add 25 mls of DI water. Add a magnetic stir bar and place on the stir plate and allow to mix for one hour. Do not agitate fast enough as to entrain air in the sample. While the sample is mixing, keep it covered with a plastic film or aluminum foil. After 1 hour, place probe in the slurry and record the value on the data sheet and in the record book.

CONTROLLED DOCUMENT
 CONTROLLED DOCUMENT
 CONTROLLED DOCUMENT

DATE LOGGED-IN ANALYST	SALB ID	ORGE/SAMPLE ID	NO	FRAC	DATE LOGGED-OUT FOR EXTRACTION ANALYST	DATE RETURNED TO STORAGE ANALYST	DATE DISCHARGED ANALYST
01-20-88	20076	F0006 (CAGE 11242)	8	ENR			
01-20-88	20078	F0008 (CAGE 11242)	8	ENR			
01-20-88	20077	F0007 (CAGE 11242)	8	ENR			
01-20-88	20072	F0012 (CAGE 11242)	8	ENR			
01-20-88	20075	F0014 (CAGE 11242)	8	ENR			
01-20-88	20074	F0017 (CAGE 11242)	8	ENR			
01-20-88	20078	F0018 (CAGE 11242)	8	ENR			

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
 BUREAU OF LAND MANAGEMENT
 LAND MANAGEMENT SYSTEMS

DATE LOGGED-IN ANALYST	SWLC ID	CASE SAMPLE ID	NO. FRAC.	DATE LOGGED-OUT FOR EXTRACTION/ ANALYST	DATE RETURNED TO STORAGE/ ANALYST	DATE DISCARDED ANALYST
10/20/69	100769	FD006 (CASE 11242)	1 B (FEET)			
10/20/69	100770	FD008 (CASE 11242)	1 B (FEET)			
11/20/69	103771	FD010 (CASE 11242)	1 B (FEET)			
11/20/69	103772	FD012 (CASE 11242)	1 B (FEET)			
10/20/69	103773	FD014 (CASE 11242)	1 B (FEET)			
10/20/69	103774	FD017 (CASE 11242)	1 B (FEET)			
10/20/69	103775	FD018 (CASE 11242)	1 B (FEET)			

Figure II. (III.A.1)

INTERNAL CASES OF CUSTODY
EXTRACT RECORDING SHEET
APRIL 1968

DATE LOGGED-IN/ ANALYST	SWLD ID	CASE/SAMPLE ID	FRAC	EXT. VOL.	DATE TO ANALYZED/ ANALYST	DATE RETURNED TO STORAGE/ ANALYST	DATE DISCARDED/ ANALYST
	100769	FD006 (CASE 11242)	(FEET)				
	100770	FD008 (CASE 11242)	(FEET)				
	100771	FD010 (CASE 11242)	(FEET)				
	100772	FD012 (CASE 11242)	(FEET)				
	100773	FD014 (CASE 11242)	(FEET)				
	100774	FD017 (CASE 11242)	(FEET)				
	100775	FD018 (CASE 11242)	(FEET)				

Figure III (III.c.i.)

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

SOP : SWLO-015

Page: 1 of 2

Revised: 2/88

PESTICIDES/PCBS

By GC/EC

Summary: Soil and water extracts of Pesticides/PCBs are extracted according to the USEPA Statement of Work (10-86). Oil samples for PCBs are prepared as directed below. Pesticides/PCB standards and extracts are chromatographed on gas chromatographs equipped with electron capture detectors using 5% methane/argon as the carrier gas. The primary analysis and quantitation column is a 6 ft. long by 4mm I.D. glass column packed with a mixed phase support. The confirmation column is a 30 meter long fused silica capillary column.

APPARATUS AND MATERIALS:

Gas Chromatographs:

1. Varian Model 3400
Detectors - electron capture and flame ionization
Injectors - packed and capillary
Autosampler - Varian Model 8000
2. Varian Model 3700
Detectors - electron capture and flame ionization
Injectors - two packed and one capillary
Autosampler - Varian Model 8000
3. Hewlett-Packard Model 5890
Detectors - electron capture and flame ionization
Injectors - packed and capillary
Autosampler - H-P Model 7673A
4. Hewlett-Packard Model 5890
Detectors - (2) electron capture
Injectors - packed and capillary
Autosampler - H-P Model 7673A
6. Additional Hewlett-Packard Autosampler Model 7673A

Columns:

Packed - Glass, 6 ft. long by 4.0 mm I.D. x 1/4 in. O.D.
packed with 1.5% SP-2250/1.95% SP-2401 on 100/120
Supelco port. Use either catalog #2-0843 or 2-0847 for
Varian 3400. Use catalog #2-1681 for Hewlett-Packard.
The packing material should be the guaranteed
performance type catalog # 1-1947.

Capillary-J&W Scientific, Inc., 30m x 0.32mm I.D.
DB-5 fused silica column.
Film thickness, 1.0 micron.

Laboratory Data Systems:

(3) Dynamic Solutions Maxima Chromatography Workstation (PC based), each equipped with (4) asynchronous data acquisition channels plus (1) process only workstation.

NOTE: PACKED COLUMN OR CAPILLARY COLUMN ANALYSES MAY BE PERFORMED ON ANY OF THE ABOVE THREE SYSTEMS IF NEEDED. HOWEVER, IN THE USUAL MODE ALL PACKED COLUMN ANALYSES ARE PERFORMED ON EITHER THE VARIAN 3400 OR H-P 5890 AND CAPILLARY ANALYSIS ARE PERFORMED ON THE VARIAN 3700. THE H-P 5890 IS PREFERRED WHEN SAMPLE AMOUNTS ARE LIMITED SUCH AS IN SOME SOIL ANALYSES SINCE THE AUTOSAMPLER USES MUCH LESS SAMPLE. THE H-P 5890 IS ALSO USED FOR SCREENING WITH THE FID DETECTOR.

I . PREPARATION OF STANDARD MIXES

A. STOCK STANDARD SOLUTIONS

1. Prepare individual stock standard solutions of each Pesticide/PCB at the following concentrations: (Assign log numbers to each of the solutions and log them into the Standards Log Book.)

PESTICIDES

FINAL CONC (ug/ml)

INDIVIDUAL STANDARD A

gamma-BHC	
Heptachlor	1.0
Aldrin	1.0
Heptachlor epoxide	1.5
Endosulfan I	1.5
Dieldrin	1.5
Endosulfan II	2.5
4,4 DDT	2.5
Endrin Aldehyde	5.0
DBC	2.5
Methoxychlor	10.0
	20.0

INDIVIDUAL STANDARD B

alpha-BHC	
beta-BHC	1.0
delta-BHC	2.0
Aldrin	1.5
4,4 DDE	1.5
Endrin	2.0
4,4 DDD	5.0
Endosulfan Sulfate	2.5
DBC	5.0
Endrin Ketone	10.0
alpha-Chlordane	2.5
gamma-Chlordane	1.5
	1.5

PESTICIDES

FINAL CONC (ug/ml)

EVALUATION STANDARD C

Aldrin	3.0
Endrin	10.0
4,4-DDT	10.0
DBC	20.0

PCB and TOXAPHENE STANDARDS

Conc. of 3 ug/mL PCB and 1 ug/mL of DBC	Conc. of 6 ug/mL PCB and 1 ug/mL of DBC	Conc. of 5 ug/mL Toxaphene and 1 ug/mL of DBC
--	--	---

PCB Arochlor 1016	PCB Arochlor 1254	Toxaphene
PCB Arochlor 1221	PCB Arochlor 1260	
PCB Arochlor 1232		
PCB Arochlor 1242		
PCB Arochlor 1248		

All solutions are prepared in 30 ml VOA vials with teflon lined screwcaps and stored in a refrigerator (when not in use) and are monitored for evaporation and decomposition. Log numbers are assigned to each of the solutions and are recorded in the Standards Log Book.

B. WORKING STANDARD SOLUTIONS

1. Working standards solutions are obtained by diluting the stock standards to the following concentrations with hexane:

PESTICIDES

FINAL CONC (ug/L)

INDIVIDUAL STANDARD A

gamma-BHC	
Heptachlor	10.0
Aldrin	10.0
Heptachlor epoxide	15.0
Endosulfan I	15.0
Dieldrin	15.0
Endosulfan II	25.0
4,4 DDT	25.0
Endrin Aldehyde	50.0
DBC	25.0
Methoxychlor	100.0
	200.0

INDIVIDUAL STANDARD B

alpha-BHC	
beta-BHC	10.0
delta-BHC	20.0
Aldrin	15.0
4,4 DDE	15.0
Endrin	20.0
4,4 DDD	50.0
Endosulfan Sulfate	25.0
DBC	50.0
Endrin Ketone	100.0
alpha-Chlordane	25.0
gamma-Chlordane	15.0
	15.0

2. Working Evaluation Standards are obtained by diluting Stock Evaluation Standard C so that Evaluation Standard Mix A is approximately 20% above base line, Evaluation Standard Mix B is approximately half-scale (Dibutylchlorendate is 100 ug/L to correspond with the same concentration in the individual standards and with 100% surrogate recovery from sample extraction), and Evaluation Standard Mix C is approximately full scale. The final concentrations are as follows:

PESTICIDES

FINAL CONC (ug/L)

EVALUATION MIX A

Aldrin	7.5
Endrin	25.0
4,4-DDT	25.0
DBC	50.0

EVALUATION MIX B

Aldrin	15.0
Endrin	50.0
4,4-DDT	50.0
DBC	100.0

EVALUATION MIX C

Aldrin	30.0
Endrin	100.0
4,4-DDT	100.0
DBC	200.0

II - CALIBRATION OF COLUMNS

- A. Use the following sequence when running a group of samples on the quantitation column.

1. Evaluation Standard Mix A
2. Evaluation Standard Mix B
3. Evaluation Standard Mix C
4. Individual Standard Mix A

5. Individual Standard Mix B
6. Toxaphene
7. Arochlor 1016
8. Arochlor 1221
9. Arochlor 1232
10. Arochlor 1242
11. Arochlor 1248
12. Arochlor 1254
13. Arochlor 1260
14. Method Blank/4 samples
15. Evaluation Standard Mix B
16. 5 samples
17. Individual Standard Mix A or B
18. 5 samples
19. Evaluation Standard Mix B
20. 5 samples
21. Individual Standard Mix A or B
(whichever not run in step 17)
22. 5 samples
23. Repeat the above sequence starting with
Evaluation Standard Mix B (step 19)
24. Pesticide/PCB analysis sequence must end
with Individual Standard Mix A and B
regardless of number of samples analyzed.

B. Use the following order of analyzing samples on the confirmation column:

1. Evaluation Standard Mix A
2. Evaluation Standard Mix B
3. Evaluation Standard Mix C
4. Individual Standard Mix A/B
(if any pesticides are to be confirmed)
5. PCB, Toxaphene (if any to be confirmed)
6. Method Blank/4 samples
7. Evaluation Standard Mix B
8. 5 samples
9. Individual Standard Mix A/B
10. 5 samples
11. Repeat above sequence beginning with Evaluation
Standard Mix B (step 7)
12. Sequence must end with Individual Standard Mix A/B

C. After the evaluation standard analyses are completed, determine the response factor of each compound in all runs. Calculate the standard deviation of the calibration factors for each compound. The % RSD for the three evaluation standards should be <10%. If any compound does not meet this value the evaluation standard sequence must be repeated.

D. An evaluation check for 4,4-DDT/Endrin breakdown must be made. If the % breakdown for either compound exceeds 20%, corrective action must be taken. This applies to the initial Evaluation Standard Mix B run as well as subsequent continuing Evaluation Standard Mix B runs.

- E. Retention time windows are established each time a new column is installed. This entails 3 injections of each individual standard over the course of a 72 hour period. Calculate the standard deviation of the three retention times of each single component pesticide. Apply plus or minus three times the standard deviation to the retention time of each pesticide. For multiresponse pesticides/PCBs, the largest peak is used when calculating the retention time window determination.
- F. The retention time shift for DBC must be <2% difference for packed columns and <0.3% for capillary columns.
- G. Calibration factors are determined by dividing the standard response by the ng injected. These CFs are monitored throughout the analyses. If the % difference exceeds 15% for the quantitation un or 20% for the confirmation run, corrective action must be taken.

Calculation:

$$\% D = \frac{ABS (C1 - C2)}{C1}$$

where: % D = percent difference
 C1 = Calibration factor of pesticide in initial calibration
 C2 = Calibration factor of pesticide in continuing calibration run.

$$\text{Calibration Factor} = \frac{\text{Raw Area of Peak}}{\text{amt. on column (in pg)}}$$

- H. The method blank is analyzed prior to samples to determine whether contamination was encountered in the extraction process.
- I. Samples are analyzed and when a compound is tentatively identified on the quantitation (packed) column it must be confirmed on the capillary or a different packed column.

III. CALCULATIONS

- A. The data system may be used to calculate values for all pesticides and calibration factors if properly set up.

NOTE: THE FORMULAS GIVEN IN THE EPA STATEMENT OF WORK, D-42, PART B, MAY BE USED TO CHECK CALCULATIONS. HOWEVER, DEFINITIONS SHOULD BE NOTED CAREFULLY SINCE ERRORS CAN EASILY OCCUR.

- B. In general, the quantity of pesticide in the original sample matrix can be calculated from the following formula if only the raw areas of the peaks in the standards and samples are known as well as the amount of the standard injected.

$$\text{Original Pesticide Conc. in water: (ng/ml, ug/L, ppb)} = \frac{(Au)(Vu)(Df)(Ve)}{(Cs)(Vo)}$$

where:

- Au* = Area of pesticide peak in unknown sample
- Vu* = Volume of injection (ul)
- Ve* = Final volume of hexane extract (ml)
- Df* = Dilution factor (if any) of final hexane extract before injection.
- Cs* = Calibration factor of pesticide peak as defined above.
- Vo* = Volume of original sample extracted (ml).

$$\text{Original Pesticide Conc. in soils: (ng/g, ug/Kg, ppb)} = \frac{(Au)(Vu)(Df)(Ve)}{(Cs)(Ws)}$$

where:

all as defined above except;

Ws = wt. of original soil extract in grams dry wt.

PCB NOTE: FOR PCB CALCULATIONS IN SOIL AND WATER USE THE SUM OF AREAS OF SEVERAL OF THE LARGEST PEAKS IN THE SAMPLE AND STANDARD FOR THE RAW AREAS. THESE PEAKS ARE DEFINED FOR EACH PCB BY THE CHROMATOGRAPHER.

$$\text{Original PCB conc. in oil (ug/g, ppm)} = \frac{(Au)(Vu)(Df)(Ve)}{(Cs)(Ws)(1000)}$$

where:

all are defined above except;

- Ve* = Original extract volume
- Ws* = Wt. of oil in grams
- 1000 = Conversion factor to ug.

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

DISTILLATION PROCEDURE FOR TOTAL CYANIDES IN WATER

DISTILLATION SUMMARY

1. The cyanide as hydrocyanic acid (HCN) is released from cyanide complexes by means of a reflux-distillation operation and absorbed in a scrubber containing sodium hydroxide solution.

INTERFERENCES

1. The presence of surfactants may cause the sample to foam during refluxing. If this occurs, the addition of an agent such as Dow Corning 544 Antifoam Agent will prevent the foam from collecting in the condenser.

APPARATUS

1. Reflux distillation apparatus having a 1 liter boiling flask, gas-dispersion tube, allihn water-cooled condenser, air-inlet tube, vacuum source and screw clamp to adjust vacuum flow.

DISTILLATION REAGENTS

1. Sodium hydroxide solution, 1.25 N: Dissolve 50 grams of NaOH in distilled water. Dilute to 1 liter with distilled water.
2. Sulfuric Acid: Concentrated.
3. Magnesium chloride solution: Weigh 510 grams of $MgCl_2 \cdot 6H_2O$ into a 1000 ml flask. Dissolve and dilute to 1 liter with distilled water.

DISTILLATION PROCEDURE

1. Place 500 ml of sample into the 1 liter boiling flask.
2. Add 50 ml of sodium hydroxide to the absorbing tube.
3. Connect the boiling flask, condenser/absorber and trap to the train.

4. Start a slow stream of air entering the boiling flask by adjusting the screw clamp on the vacuum line. Adjust the vacuum so that approximately one bubble of air per second enters the boiling flask.

NOTE: The bubble rate will not remain constant after the reagents have been added and while heat is being applied to the flask. It will be necessary to readjust the air rate occasionally to prevent the solution in the boiling flask from backing up into the air inlet tube.

5. Slowly add 25 ml concentrated sulfuric acid through the air inlet tube. Rinse the tube with distilled water and allow the airflow to mix the flask contents for 3 minutes.
6. Pour 20 ml of magnesium chloride solution into the air inlet and wash down with a stream of water.
7. Heat the solution to boiling and reflux for one hour.
8. Turn off the heat and continue the air flow for at least 15 minutes.
9. After cooling the boiling flask, disconnect the absorber and close off the vacuum source.
10. Drain the solution from the absorber into a 250 ml volumetric flask and bring up to volume with distilled water washings from the absorber tube.

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

DISTILLATION PROCEDURE FOR TOTAL CYANIDES IN SOIL

INTERFERENCES

1. The presence of surfactants may cause the sample to foam during refluxing. If this occurs, the addition of an agent such as Dow Corning 544 Antifoam Agent will prevent the foam from collecting in the condenser.

APPARATUS

1. Reflux distillation apparatus having a 1 liter boiling flask, gas-dispersion tube, allihn water-cooled condenser, air-inlet tube, vacuum source and screw clamp to adjust vacuum flow.

DISTILLATION REAGENTS

1. Sodium hydroxide solution, 1.25 N: Dissolve 50 grams of NaOH in distilled water. Dilute to 1 liter with distilled water.
2. Sulfuric Acid: Concentrated.
3. Magnesium chloride solution: Weigh 510 grams of $MgCl_2 \cdot 6H_2O$ into a 1000 ml flask. Dissolve and dilute to 1 liter with distilled water.

DISTILLATION PROCEDURE

1. Place 1 gram of sample into the 1 liter boiling flask.
2. Add 500 ml of distilled water. Shake the sample so that it is dispersed.
3. Add 50 ml of sodium hydroxide to the absorbing tube.
4. Connect the boiling flask, condenser/absorber and trap in the train.

5. Start a slow stream of air entering the boiling flask by adjusting the screw clamp on the vacuum line. Adjust the vacuum so that approximately one bubble of air per second enters the boiling flask through the air inlet tube.
- NOTE:** The bubble rate will not remain constant after the reagents have been added and while heat is being applied to the flask. It will be necessary to readjust the air rate occasionally to prevent the solution in the boiling flask from backing up into the air inlet tube.
6. Slowly add 25 ml concentrated sulfuric acid through the air inlet tube. Rinse the tube with distilled water and allow the air flow to mix the flask contents for 3 minutes.
 7. Pour 20 ml of magnesium chloride solution into the air inlet and wash down with a stream of water.
 8. Heat the solution to boiling and reflux for one hour.
 9. Turn off the heat and continue the air flow for at least 15 minutes.
 10. After cooling the boiling flask, disconnect the absorber and close off the vacuum source.
 11. Drain the solution from the absorber into a 250 ml volumetric flask and bring up to volume with distilled water washings from the absorber tube.

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

TOTAL CYANIDE ANALYSIS IN WATER AND SOIL

- I. Tested Concentration Range: 5 to 100 ug/l.
- II. Approximate Instrument Detection Limit:
- III. Interferences
 - A. Sulfides adversely affect the colorimetric procedures. If a drop of sample on lead acetate paper indicates the presence of sulfides, treat 25 ml or more of the sample than that required for the cyanide determination with powdered cadmium carbonate. Repeat this operation until a drop of the treated sample solution does not darken the lead acetate paper. Filter the solution through a dry filter paper into a dry beaker, and from the filtrate, measure the sample to be used for analysis. Sulfides should be removed prior to preservation with sodium hydroxide.
- IV. Instrumentation
 - A. Spectrophotometer with a 1.0 cm cell with measurement at 578 nm.
- V. Reagents
 - A. Sodium hydroxide solution, 0.25 N: Dissolve 10 grams NaOH in distilled water and dilute to 1 liter.
 - B. Sodium dihydrogenphosphate, 1 M: Dissolve 138 grams $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ in a liter of distilled water. Refrigerate this solution.
 - C. Chloramine-T solution: Dissolve 1.0 gram of white, water soluble chloramine-T in 100 ml of distilled water and refrigerate until ready to use. Prepare fresh weekly.
 - D. Pyridine-barbituric acid reagent: Place 15 grams of barbituric acid in a 250 ml volumetric flask and add just enough distilled water to wash the sides of the flask and wet the barbituric acid. Add 75 ml

pyridine and mix. Add 15 ml of concentrated HCL. Mix and cool to room temperature. Dilute to 250 ml with distilled water and mix. This reagent is stable for approximately six months if stored in a cool, dark place.

VI. Initial Calibration

A. Preparation of Standards:

1. Stock cyanide solution: Dissolve 2.51 grams of KCN and 2 grams of KOH in 1 liter of ASTM Type I water. Standardize with 0.0192 N AgNO_3 .
2. Intermediate standard cyanide solution: Dilute 50.0 ml of stock solution (1 ml = 1 mg CN^-) to 1000 ml with distilled water.
3. Standard cyanide solution: Prepare fresh each day of analysis by diluting 100.0 ml of intermediate cyanide solution to 1000 ml with distilled water and store in a glass stoppered bottle (5.0 mg/l CN^-).
4. Standard silver nitrate solution, 0.0192 N: Prepare by crushing approximately 5 grams of AgNO_3 crystals and drying to constant weight at 40°C . Weigh out 3.2647 grams of dried AgNO_3 . Dissolve in distilled water and dilute to 1000 ml (1 ml = 1 mg CN^-).
5. Rhodanine indicator: Dissolve 20 mg of p-dimethylaminobenzalrhodanine in 100 ml of acetone.
6. Calibration standards are prepared by diluting the 5.0 mg/l standard solution to 250 ml with 0.25 N sodium hydroxide according to the following schedule:

<u>ml of Standard Solution (5 mg/l)</u>	<u>Conc. ug CN^- per 250 ml</u>
0	0.0
1.0	5.0
2.0	10.0
5.0	25.0
10.0	50.0
15.0	75.0
20.0	100.0

7. Prepare calibration standards daily.

B. Instrument Calibration:

1. Turn on spectrophotometer and let warm-up for at least 20 minutes.
2. Withdraw 50 ml of the calibration solutions from the flask and transfer to a 100 ml volumetric flask.
3. Add 15.0 ml of sodium phosphate solution and mix.
4. Add 2.0 ml of chloramine-T and mix. After 1 to 2 minutes, add 5 ml of pyridine-barbituric acid solution and mix.
5. Dilute to 100 ml with distilled water and mix again.
6. Allow 8 minutes for color development.
7. Read absorbance of the calibration standards at 578 nm in a 1 cm cell within 15 minutes.

C. Analysis of Calibration Data

1. Tabulate the calibration standard concentration versus absorbance for each standard, (per 250 ml).
2. Analyze data by linear regression on a calculator. Correlation coefficients must be greater than 0.995 before proceeding with analysis.

D. Calibration Checks

1. Initial calibration verification:
 - a. After the system has been calibrated, the accuracy of the initial calibration shall be verified and documented by the analysis of an independent standard carried through the distillation procedure. The concentration of the standard will be different than that used for calibration, but within the calibration range.
 - b. The measurement must be within $\pm 15\%$ of the true value or the analysis must be terminated, the problem corrected, the instrument recalibrated and the calibration reverified.

2. Calibration blank:

- a. A calibration blank, carried through the distillation procedure, is analyzed at the beginning and the end of the run, and at a frequency of 10% during the run.
- b. Blanks are to be reported down to the instrument detection limit.
- c. If the absolute value of the blank is greater than 10 ppb, terminate analysis, correct the problem and recalibrate.

3. Continuing calibration verification:

- a. To assure calibration accuracy during each analysis run, an independently prepared solution, carried through the distillation procedure, will be analyzed at a frequency of 10% and after the last analytical samples.
- b. The cyanide concentration will be at the mid-range level of the calibration curve.
- c. If the deviation of the continuing calibration verification is greater than 15%, the instrument will be recalibrated and the proceeding samples, since the last continuing calibration verification, will be reanalyzed.

VII. Instrument Analysis

- A. Set-up the instrument as discussed in Section VI.B.1.
- B. Transfer 50 ml of the calibration standards, blanks, control standards and samples to a 100 ml volumetric flask.
- C. Add 15.0 of sodium phosphate solution and mix.
- D. Add 2.0 ml of chloramine-T and mix.
- E. After 1 to 2 minutes, add 5.0 ml of pyridine-barbituric acid solution and mix. Dilute to the mark with distilled water and mix again.
- F. Allow 8 minutes for color development.
- G. Read absorbance at 578 nm in a 1 cm cell within 15 minutes.

- H. Using the calibration curve generated in Section VI.C., convert absorbances to concentration.
- I. Calculate the cyanide, in ug/l, in the original sample as follows:

$$\text{CN}^-, \text{ ug/l} = \frac{\text{A} \times 1,000 \text{ ml/l}}{\text{B}} \times \frac{50 \text{ ml}}{\text{C}}$$

Where: A = ug CN⁻ from standard curve
 B = ml of original sample for distillation
 C = ml taken from colorimetric analysis

or mg/Kg as follows:

$$\text{CN}^-, \text{ mg/Kg} = \frac{\frac{50 \text{ ml}}{\text{A} \times \text{B}}}{\text{C} \times \frac{\% \text{ solids}}{100}}$$

Where: A = ug CN⁻ read from standard curve
 B = ml of distillate taken for colorimetric determination
 C = Wet weight of original sample in grams

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

ACID DIGESTION PROCEDURE FOR
SOIL ICP AND FLAME AA ANALYSIS

1. Mix the sample thoroughly to achieve homogeneity.
2. Weigh (to the nearest 0.01 gram) a 1.0 to 1.5 gram portion of sample and transfer to a beaker.
3. Prepare a preparation blank by adding 100 ml of ASTM Type II water to a beaker.
4. Prepare a laboratory control sample by adding 1.0 to 1.5 grams of EPA solid LCS sample to a beaker.
5. Select a sample for duplicate and matrix spike analysis and transfer 1.0 to 1.5 grams of soil to each beaker. For the matrix spike add 2.0 ml of matrix spike solutions #1, 2 and 3.
6. Add 10 ml of (1+1) HNO_3 , mix and cover with a watch glass.
7. Heat the sample to 95°C and reflux for 10 minutes without boiling.
8. Allow the sample to cool. Add 5 ml of concentrated HNO_3 . Replace the watch glass and reflux for 30 minutes.

Note: Do not allow the volume to be reduced to less than 5 ml.
9. Allow the sample to cool then add 2 ml ASTM Type II water and 3 ml of 30% hydrogen peroxide (H_2O_2).
10. Return the beaker for heating to start the peroxide reaction. Heat until effervescence subsides.
11. Continue to add 30% H_2O_2 in 1.0 ml aliquots with warming until the effervescence is minimal.

Note: Do not add more than a total of 10 ml 30% H_2O_2 .
12. Allow the sample to cool. Add 5.0 ml of (1+1) HCl and 10 ml of ASTM Type II water and heat for an additional 10 minutes.
13. After cooling, filter through Whatman No. 42 filter paper (or equivalent) and dilute to 200 ml with ASTM Type II water.

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STANDARD OPERATING PROCEDURES

ACID DIGESTION PROCEDURE FOR
AQUEOUS ICP AND FLAME AA ANALYSIS

1. Shake the sample thoroughly to achieve homogeneity.
2. Transfer 100 ml of sample to a 150 ml digestion flask.
3. Add 2 ml of (1+1) HNO₃ and 10 ml of (1+1) HCl to the sample.
4. Heat for 2 hours at 95°C or until the sample volume is reduced to between 25 and 50 ml. Make certain the sample does not boil.
5. Cool the sample and filter to remove insoluble material that could clog the nebulizer.
6. Adjust the volume to 100 ml with ASTM Type II water.

Note: With every Sample Delivery Group or with each batch of samples digested, whichever is more frequent, at least one preparation blank and laboratory control sample (LCS) must be prepared and analyzed. The aqueous LCS solution must be obtained from EPA.

At least one duplicate and matrix spike sample analysis must be performed on each group of samples of a similar matrix type and concentration or for each Sample Delivery Group, whichever is more frequent. ICP matrix spike solutions #1, 2 and 3 are used for CLP analysis.

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

ACID DIGESTION PROCEDURE FOR
SOIL FURNACE ATOMIC ABSORPTION ANALYSIS

1. Mix the sample thoroughly to achieve homogeneity.
2. Weigh (to the nearest 0.01 gram) a 1.0 to 1.5 gram portion of sample and transfer to a beaker.
3. Prepare a preparation blank by adding 100 ml of ASTM Type II water to a beaker.
4. Prepare a laboratory control sample by adding 1.0 to 1.5 grams of EPA solid LCS sample to a beaker.
5. Select a sample for duplicate and matrix spike analysis and transfer 1.0 to 1.5 grams of soil to each beaker. For the matrix spike add 2.0 ml of matrix spike solution #4.
6. Add 10 ml of (1+1) HNO_3 , mix and cover with a watch glass.
7. Heat the sample to 95°C and reflux for 10 minutes without boiling.
8. Allow the sample to cool. Add 5 ml of concentrated HNO_3 . Replace the watch glass and reflux for 30 minutes.

Note: Do not allow the volume to be reduced to less than 5 ml.
9. Allow the sample to cool then add 2.0 ml ASTM Type II water and 3.0 ml of 30% hydrogen peroxide (H_2O_2).
10. Return the beaker for heating to start the peroxide reaction. Heat until effervescence subsides.
11. Continue to add 30% H_2O_2 in 1.0 ml aliquots with warming until the effervescence is minimal.

Note: Do not add more than a total of 10 ml 30% H_2O_2 .
12. Continue heating until the volume has been reduced to approximately 2.0 ml.
13. Add 10.0 ml of ASTM Type II water and warm.
14. After cooling, filter through Whatman No. 42 filter paper (or equivalent) and dilute to 200 ml final volume.

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

ACID DIGESTION PROCEDURE FOR
AQUEOUS FURNACE ATOMIC ABSORPTION ANALYSIS

1. Shake the sample thoroughly to achieve homogeneity.
2. Transfer 100 ml of sample to a 250 ml digestion flask.
3. Add 1 ml of (1+1) HNO_3 and 2 ml of 30% H_2O_2 to the sample.
4. Cover with a watch glass and heat for 2 hours at 95°C or until the sample volume is reduced to between 25 and 50 ml. Make certain the sample does not boil.
5. Cool the sample and filter to remove insoluble material.
6. Adjust the volume to 100 ml with ASTM Type II water.

Note: With every Sample Delivery Group or with each batch of samples digested, whichever is more frequent, at least one preparation blank and laboratory control sample (LCS) must be prepared and analyzed. The aqueous LCS solution must be obtained from EPA.

At least one duplicate and matrix spike sample analysis must be performed on each group of samples of a similar matrix type and concentration or for each Sample Delivery Group, whichever is more frequent. Furnace matrix spike solution #4 is used for CLP analysis.

STANDARD OPERATING PROCEDURES

METAL ANALYSIS

STANDARD OPERATING PROCEDURES

**STANDARD OPERATING PROCEDURES
FOR THE
INDUCTIVELY COUPLED ARGON PLASMA**

I. INTRODUCTION

This method is used for the determination of dissolved, suspended or total metals in a variety of matrices. Table I lists elements for which this method applies with current wavelengths used and laboratory detection limits. Elements and wavelengths will be added as new methods are developed. Detection limits are updated quarterly.

This method describes the technique for the simultaneous multi-element determination of trace metals in solution using a Thermal-Jarrel Ash ICAP-61. The basis of this method is the measurement of atomic emission by an optical spectroscopic technique. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer and the intensities of the lines are monitored by photomultiplier tubes. The photo currents from the photomultiplier tubes are processed and controlled by a computer system.

Table I Elements Analyzed by ICP and their corresponding wavelengths and detection limits.

<u>Element</u>	<u>Wavelength (nm)</u>	<u>Detection Limits, ug/L</u>
Aluminum	308.215	36.0
Antimony	217.581	25.8
Arsenic	193.606	32.1
Barium	493.409	16.1
Beryllium	313.042	0.7
Boron	249.678	42.0
Cadmium	228.802	2.8
Calcium	317.933	207.0
Chromium	267.716	1.9
Cobalt	228.616	7.6
Copper	324.754	3.9
Iron	249.940	27.0
Lead	220.353	17.4
Magnesium	279.079	126.0

continued.....

continued...

Table I Elements Analyzed by ICP and their corresponding wavelengths and detection limits.

<u>Element</u>	<u>Wavelength (nm)</u>	<u>Detection Limits, ug/L</u>
Manganese	257.610	2.5
Mercury	194.220	50.0
Molybdenum	202.030	32.9
Nickel	221.604	6.2
Osmium	225.585	---
Phosphorus	214.914	100.0
Potassium	766.491	453.0
Selenium	196.026	27.7
Silicon	288.158	100.0
Silver	328.068	9.0
Sodium	588.995	287.0
Thallium	190.864	32.4
Tin	189.989	80.0
Titanium	334.941	80.0
Vanadium	292.402	6.0
Zinc	213.856	4.0

II. INTERFERENCES

A. Spectral Interferences

1. Overlap of a spectral line from another element compensated by interelement correction by instrument.
2. Unresolved overlap of molecular band spectra may require selection of an alternate wavelength.
3. Background contribution from continuous or recombination phenomena.
4. Background contribution from stray light from the line emission of high concentration elements.

Note: Number 3 and 4 effects can usually be compensated by a background correction adjacent to the analyte line.

- ### B. Physical Interferences - affects associated with the sample nebulization and transport processes. Dilution by be necessary.

III. APPARATUS

- A. Thermal-Jarrel Ash ICAP-61 optical emission spectrophotometer.
- B. IBM PC/AT computer with ThermoSPEC operating software. Automated background correction and interelement corrections.
- C. Radio frequency power supply with 2500 watts capacity.
- D. Liquid argon supply, 4300 cu.ft.
- E. Gilson - 240 Autosampler with 240 sample positions and 14 QA/QC position.

IV. OPERATING CONDITIONS

- A. Start-Up
 1. Check that the argon tank main valve is open and the pressure is set to at least 60 psi.
 2. Turn on the plasma work coil coolant water and exhaust vents.
 3. Check that the drain tube is inserted into a plastic water bottle containing at least 8 inches of water.
 4. On the R.F. generator control panel, turn the forward power manual control rheostat knob counter clockwise to the off position.
 5. Turn the line and control circuit breaker switches on. The white power on lamp should be illuminated.
 6. Turn the torch gas toggle switch on and adjust flow meter to 18, turn the auxiliary flow on to 0.5 and the sample gas flow to 0.6.
 7. Purge the torch surfaces, the capillary tube and the drainage tube of air for at least 3 minutes.
 8. Check that the blue R.F. off lamp on the generator is illuminated.
 9. Turn the Automatic Power Control switch to the manual position.
 10. Press the red R.F. on button.
 11. Turn the sample gas flow control knob counter clockwise until the flowmeter ball stops falling.
 12. To ignite, slowly turn the forward power manual control rheostat knob clockwise until the forward power meter reads 0.5 KW.
 13. Press the ignitor button on the front panel of the generator. You should see a faint filamentary plasma swirling in the outer tube of the torch. Gradually increase the forward power until the plasma ignites.
 14. Once the plasma is lit, rotate the forward power rheostat knob until the forward power meter reading is 1.0 - 1.1 KW.

15. Turn the automatic power control switch to the automatic position.
16. Introduce the rinse solution into the plasma by rotating the sample gas control knob to a reading of 0.6.

B. Shutdown

1. Press the R.F. OFF button on the R.F. generator control panel.
2. Turn off the gas at the tank while the toggle switches are still open. When both gauges on the tank read 0, turn OFF the toggle switches.
3. Turn off the torch coolant water.
4. Turn the R.F. generator line and control circuit breakers off.

V. REAGENTS AND STANDARDS

- A. Nitric Acid, conc.: Baker Instra-analyzed for trace metal Analysis.
- B. Nitric Acid (1:1): Add 500 ml conc. HNO_3 to 400 ml ASTM Type II water and dilute to 1 liter.
- C. Hydrochloric Acid, conc.: Baker Instra-analyzed for trace metal analysis.
- D. Hydrochloric Acid (1:1): Add 500 ml conc HCl To 400ml ASTM Type II water and dilute to 1 liter.
- E. Hydrogen Peroxide, 30%: Method Control Blank meets ACS Standards.
- F. Standard Stock Solutions

1. Inorganic Ventures, Inc. - use high purity inorganics as starting materials. Place into solution with purified acids and 18 mega-ohm double deionized water. All standards are traceable to national standards.
2. Spex Industries, Inc. - prepared from 99.995% - 99.999% pure elements assayed by wet chemical methods dissolved in 18 mega-ohm, double deionized water and electronic grade acids. Date solutions are received and opened are posted on each bottle.

G. Blank Solutions

1. Calibration blanks - dilute 2.0 ml of (1:1) HNO_3 and 10.0 ml of (1:1) HCL to 100 ml with ASTM Type II water. This blank is used in establishing the analytical curve and to flush the system between standards and samples.
2. Preparation Blank - contains all the reagents and in the same volumes as used in the processing of the samples. The preparation blank is carried through the complete digestion procedures and

contains the same acid concentration in the final solution as the sample solution.

- H. Calibration Check Standard: A standard made from a different stock solution as that used for the calibration standards and analyzed immediately after calibration to validate calibration. Concentration of the calibration check standard is approximately at the mid-point of the calibration curve.

VI. SAMPLE PREPARATION

- A. Separate operating procedures are written for the digestion of samples to be analyzed by the ICP depending on the matrix of the sample.

VII. ANALYSIS

- A. Set up the instrument with proper operating parameters already established. The instrument must be allowed to become thermally stable before beginning. This usually requires at least 30 minutes of operation prior to calibration.
- B. Initiate appropriate method file configuration on computer.
- C. Calibrate the ICP starting with the highest mixed standard. Flush the system with the calibration blank between each standard. Use at least three replicate exposures for both standardization and sample analysis.
- D. Begin the sample run by analyzing the calibration blank and calibration verification check samples. Analyze the blank and calibration check samples every 10 samples. Flush the system with the calibration blank between each sample.

VIII. CALCULATION

- A. If dilutions were performed, the appropriate factor must be applied to sample values.
- B. Data should be reported in ug/L up to three significant figures.
- C. When rounding off values, use guidelines specified in EPA "Handbook for Analytical Quality Control in Water and Wastewater Laboratories".

IX. QUALITY CONTROL

- A. Initial Calibration Verification
 - 1. Immediately after the ICP has been calibrated, the accuracy of the initial calibration is verified and documented for every analyte by the analysis of EPA Initial Calibration Verification Solution at each wavelength used for analysis. If the

measurements exceed the control limits of 90 - 110% of the true value, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration reverified.

B. Continuing Calibration Verification

1. To ensure calibration verification during the analysis run, a continuing calibration verification standard is analyzed for every analyte at each wavelength at a frequency of 10% or every 2 hours during an analysis run, whichever is more frequent. The standard is also analyzed for every wavelength used for analysis at the beginning of the run and after the last analytical sample. The same continuing calibration standard must be used throughout the analysis runs for a case of samples received. If the measurements exceed the control limits of 90-110% of the true value, the instrument must be recalibrated and the preceding samples analyzed since the last good calibration verification must be reanalyzed.

C. CRDL Standard

1. To verify linearity near the CRDL an ICP standard at two times the CRDL or two times IDL, whichever is greatest, is analyzed at the beginning and end of each sample analysis, or a minimum of twice per 8 hour working shift, whichever is more frequent. This standard is run for every wavelength used for analysis except these for Aluminum, Barium, Calcium, Iron, Magnesium, Sodium, Potassium. No control limits for this standard have been set at this time.

D. Initial and Continuing Calibration Blank

1. A calibration blank is analyzed at each wavelength used for analysis immediately after each every initial and continuing calibration verification, at a frequency of 10% or every 2 hours during the run, whichever is more frequent. If the absolute value of the blank exceeds the CRDL, terminate analysis, correct the problem, recalibrate and reanalyze all analytical samples analyzed since the last good calibration blank.

E. Preparation Blank

1. At least one preparation blank must be prepared and analyzed with every Sample Delivery Group (SDG), or with each batch of samples digested, whichever is more frequent. This blank is used to

ascertain whether sample concentrations reflect contamination in the following manner:

- a. If the absolute value of the blank is less than or equal to the CRDL no corrective action is necessary.
- b. If any analyte concentration in the blank is above the CRDL, the lowest concentration of that analyte in the associated samples must be 10x the blank concentration. If not, all samples less than 10x the blank concentration and above the CRDL, must be redigested and reanalyzed for that analyte.
- c. If the concentration of the blank is below 10x CRDL, all samples associated with the blank must be redigested and reanalyzed.

F. Interference Check Sample (ICS)

1. To verify interelement and background correction factors an ICP interference check sample is analyzed at the beginning and end of each analysis run or a minimum of twice per 8 hour working shift, whichever is more frequent. The ICS is obtained from EPA and consists of two solutions. Solution A consists of the interferents and solution AB consists of the analytes mixed with the interferents. An ICS analysis consists of analyzing both solutions consecutively for all wavelengths used. Results for the analyses of solution AB must fall within the control limits of $\pm 20\%$ of the true value for the analytes. If not, terminate the analysis, correct the problem, recalibrate and reanalyze the analytical samples analyzed since the last good ICS.

G. Matrix Spike Sample

1. The spike solution is added before digestion to provide information about the effect of the sample matrix on the digestion and measurement methodology. At least one spike analysis is performed on each group of samples of a similar matrix type and concentration or for each Sample Delivery Group (SDG), whichever is more frequent.
2. Samples identified as field blanks cannot be used for spiked sample analysis.
3. If the spike recovery is not within the limits of 75-125% the data of all samples received associated with that spike sample and determined by the same analytical method will be flagged with the letter "N". An exception to this is when the sample concentration exceeds the spike concentration by a factor of four or more.

H. Post Digested Spike

1. When the pre-digested spike recovery falls outside the control limits and the sample result does not exceed 4x the spike added, a post-digested spike is performed except for Silver.
2. Spike the unspiked aliquot of the sample at 2x the indigenous level or 2x CRDL whichever is greater.

I. Duplicate Sample

1. One duplicate sample is analyzed from each group of samples of a similar matrix type and concentration or for each Sample Delivery Group, whichever is more frequent.
2. Samples identified as field blanks cannot be used for duplicate sample analysis.
3. A control limit of 20% for relative percent difference (RPD) is used for original and duplicate sample values greater than or equal to 5x CRDL. A control limit of \pm CRDL is used for sample values less than 5x CRDL.

J. Laboratory Control Sample (LCS)

1. Aqueous and solid LCS are analyzed for each analyte using the same sample preparations, analytical methods and QA/QC procedures employed for the samples. The aqueous LCS is obtained from EPA (or use the initial calibration verification solution). One aqueous LCS is prepared and analyzed for every group of aqueous samples in a Samples Delivery Group, or for each batch of aqueous samples digested, whichever is more frequent. If the percent recovery for the aqueous LCS falls outside the control limits of 80-120% (exception: Ag and Sb), the analyses must be terminated, the problem corrected, and the samples associated with that LCS redigested and reanalyzed.
2. The EPA provided solid LCS is prepared and analyzed using the same procedures as the samples, one solid LCS must be prepared and analyzed for every group of solid samples in a Sample Delivery Group, or for each batch of samples digested, whichever is more frequent. If the result for the solid LCS falls outside the control limits established by the EPA, the analyses must be terminated, the problem corrected and samples associated with that LCS redigested and reanalyzed.

K. ICP Serial Dilution

1. The ICP Serial Dilution analysis is performed on each group of samples of a similar matrix type and concentration or for each Sample Delivery Group, whichever is more frequent.
2. Samples identified as field blanks cannot be used for serial dilution analysis.
3. If the analyte concentration is at least a factor of 50 above the instrument detection limit in the original sample, an analysis of a 5 fold dilution must agree within 10% of the original determination.

L. Instrument Detection Limits

1. Detection limits for the ICP are determined quarterly (every 3 months). The detection limits are determined on three nonconsecutive days using the following protocol:
 - a. A low level standard at three to five times the estimated IDL is measured seven times and the standard deviation is multiplied by three.
 - b. The average detection limit for the three days is the IDL.

M. Interelement Corrections

1. Interelement corrections are determined quarterly by analyzing 1000 ppm standards of the interferences and determining the effect on the analytes.

N. Linear Ranger

1. A linear range check standard is analyzed quarterly for each element analyzed by ICP. The analytically determined concentration must be within $\pm 5\%$ of the true value. This concentration is the upper limit of the ICP linear range beyond which results cannot be reported without dilution of the analytical sample.

STANDARD OPERATING PROCEDURES

ARSENIC

Arsenic by Graphite Furnace Atomic Absorption

I. APPLICATION

- A. Tested Concentration range: 10.0 - 100 ug/L
- B. Approximate instrument detection limit: 6.0 ug/L
- C. Interferences
 - 1. Molecular absorption bands - the use of background correction should eliminate this interference.
 - 2. Memory effects - clean tube by operating at higher atomization temperature
 - 3. Carbide formation - the use of a pyrolytically-coated graphite tube reduces this interference.
 - 4. Anion interference - the use of nickel nitrate matrix modifier reduces this effect.
- D. Safety Information
 - 1. Never look directly at a hot furnace cuvette without proper eye protection.
 - 2. Never touch the atomizer cell until it has returned to ambient temperatures.
 - 3. Follow standard safety procedures for the handling of hazardous materials.

II. APPARATUS

A. INSTRUMENTATION

- 1. Thermo Jarrell Ash Video 22E AA spectrophotometer CTF 188 Atomizer and Smith-Hieftye background correction.
- 2. ISC 75 microprocessor controlled autosampler.
- 3. Arsenic Hollow Cathode Lamp
- 4. Zero grade Argon Supply

B. Parameters

- 1. Wavelength: 197.2
- 2. Lamp Current: 8 mA
- 3. Bandpass: 2.0 AM
- 4. Readout Mode: Peak Height
- 5. Integration Time: 8.0 seconds
- 6. Temperature and Ramp Time:

continued.....

- a. Dry stage: 150°C, 10 sec.
- b. First Pyrolysis: 850°C, 40 sec.
- c. Second Pyrolysis: 1050°C, 40 sec.
- d. Atomization: 2250°C, 8 sec.
- e. Clean: 2400°C, 20 sec.

Note: The above temperatures are employed as guidelines. Since temperature-sensing mechanisms and temperature controllers can vary with time, the validity of the furnace parameters must be periodically confirmed by systemically altering the furnace parameters while analyzing a standard. In this manner, losses of analyte due to higher than necessary temperature settings or losses in sensitivity due to less than optimum settings can be minimized.

III. CALIBRATION

A. Preparation of Standards

1. Stock solutions for Arsenic are prepared solutions from Inorganic Ventures containing 1,000 mg As/l.
2. An intermediate stock solution of 10 mg/l As, is prepared by diluting 1 ml of stock solution and 1 ml of conc. HNO₃ to 100 ml with ASTM Type II water. This standard is prepared weekly.,
3. A second intermediate standard solution of 1 mg/l As is prepared each day of analysis by diluting 10 ml of the 10 mg/l intermediate stock solution and 1.0 ml of conc. HNO₃ to 100 ml with ASTM Type II water.
4. Calibration standards are prepared by diluting the 1 mg/l intermediate stock solution, 1 ml conc. HNO₃ and 2 ml 30% H₂O₂ and 1.0 ml nickel nitrate to 100 ml with ASTM Type I water according to the following schedule.

Standard Concentration ug/l	ml of 1.0 ug/l Intermediate Stock
0	0.0
10	1.0
50	5.0
100	10.0

5. Solutions are stored in plastic containers and working calibration standards are prepared fresh each day of analysis.

B. INSTRUMENT CALIBRATION

1. Set up spectrophotometer, furnace and auto-sampler according to manufacturers recommendations.
2. Analyze the calibration blank to establish the baseline.
3. Optimize the instrument by adjusting operating parameters to achieve maximum response.
4. Beginning with the blank and working toward the highest standard, inject the solutions and record the readings.

C. ANALYSIS OF CALIBRATION DATA

1. Tabulate the calibration standard concentration versus peak height response for each calibration standard.
2. Analyze data by linear regression on calculator. Correlation coefficients must be greater than 0.995 before proceeding with analysis.

D. CALIBRATION CHECKS

1. Initial Calibration Verification
 - a. After the system has been calibrated, the accuracy of the initial calibration shall be verified and documented by the analysis of an EPA supplied standard at a concentration other than that used for calibration, but within the calibration range.
 - b. The measurement must be within $\pm 10\%$ of the trace value or the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration reverified.
2. Calibration Blank
 - a. A calibration blank is analyzed immediately after the calibration verifications.
 - b. Blanks are to be reported down to the instrument detection limit.
 - c. If the absolute value of the blank is greater than 10 ppb, terminate analysis, correct the problem and recalibrate.
3. Continuing Calibration Verification
 - a. To assure calibration accuracy during each analysis run, an independently prepared standard solution, will be analyzed at a frequency of 10% and after the last analytical sample.

- b. The same standard will be used throughout the analysis run for a batch of samples received.
- c. If the deviation of the continuing calibration verification is greater than $\pm 10\%$ of the true value, the instrument will be recalibrated and the preceding 10 samples reanalyzed.

IV. PROCEDURE

A. Instrumental Analysis

- 1. Set up instrument parameters as discussed in Section II B.
- 2. Calibrate instrument following procedure in Section III.
- 3. Analyze samples using the following procedures:

- a. Analyze each sample, except during Full Method of Standard Addition (MSA) with duplicate injections. If the value is within calibration range record the concentration values for both injections, the average value and the coefficient of variation (CV). For concentrations greater than 10.0 ppb, the CV between duplicate injections must agree within 20%, or the sample must be rerun once.
- b. All analytical samples, except the pre-digested spike sample, requires an analytical spike to determine if the MSA will be required for quantitation. For arsenic the spike concentration will be 20 ppb. The analytical spike of a sample will be run immediately after that sample. The percent recovery (%R) of the spike will then determine how the sample will be quantitated as follows:

- b.1 If the spike recovery is less than 40%, the sample will be diluted by a factor of 5 and rerun with another spike. If after dilution the spike recovery is still <40% the data will be reported and flagged with an "E" to indicate interference problems.
- b.2 If the spike recovery is greater than 40% and the sample concentration is <50% of the spike, the sample results will be reported to the IDL. If the spike recovery is less than 85% or greater than 115%, the data will be flagged with a "W".
- b.3 If the sample concentration is >50% of the spike and the spike recovery is

between 85-115%, the sample will be quantitated directly from the calibration curve and reported to the IDL.

- b.4 If the sample concentration is >50% of the spike and the spike recovery is less than 85% or greater than 115%, the sample will be quantitated by MSA.
- c. The following will be used for MSA analysis.
 - c.1 Data from MSA calculations will be within the linear range as determined by the calibration curve generated at the beginning of the analytical run.
 - c.2 The sample and three spikes will be analyzed consecutively for MSA quantitation, only single injections will be used.
 - c.3 Spikes will be prepared such that:
 - Spike 1 is approximately 50% of the sample absorbance.
 - Spike 2 is approximately 100% of the sample absorbance.
 - Spike 3 is approximately 150% of the sample absorbance.
 - c.4 The data for each MSA analysis will be identified in the raw data documentation along with the slope, intercept and correlation coefficient (r) for the least squares fit of the data. Reported values obtained by MSA will be flagged on the data sheet with the letter "S" if the correlation coefficient is greater than or equal to 0.995.
 - c.5 If the correlation coefficient (r) is less than 0.995, the MSA analysis will be repeated once. If the correlation coefficient is still less than 0.995, the result with the best correlation coefficient will be reported and flagged with a "+".

STANDARD OPERATING PROCEDURES

LEAD

Lead by Graphite Furnace Atomic Absorption

I. APPLICATION

- A. Tested Concentration range: 3.0 - 100 ug/L
- B. Approximate instrument detection limit: 2.0 ug/L
- C. Interferences
 - 1. Molecular absorption bands - the use of background correction should eliminate this interference.
 - 2. Memory effects - clean tube by operating at higher atomization temperature
 - 3. Carbide formation - the use of a pyrolytically-coated graphite tube reduces this interference.
 - 4. Anion interference - the use of a matrix modifier reduces this effect.
- D. Safety Information
 - 1. Never look directly at a hot furnace cuvette without proper eye protection.
 - 2. Never touch the atomizer cell until it has returned to ambient temperatures.
 - 3. Follow standard safety procedures for the handling of hazardous materials.

II. APPARATUS

A. INSTRUMENTATION

- 1. Thermo Jarrell Ash Video 22E AA spectrophotometer CTF 188 Atomizer and Smith-Hieftye background correction.
- 2. ISC 75 microprocessor controlled autosampler.
- 3. Lead Hollow Cathode Lamp
- 4. Zero grade Argon Supply

B. Parameters

- 1. Wavelength: 283.3
- 2. Lamp Current: 8 mA
- 3. Bandpass: 1.0 AM
- 4. Readout Mode: Peak Height
- 5. Integration Time: 8.0 seconds
- 6. Temperature and Ramp Time:

continued.....

- a. Dry stage: 150°C, 10 sec.
- b. First Pyrolysis: 300°C, 40 sec.
- c. Second Pyrolysis: 450°C, 40 sec.
- d. Atomization: 1900°C, 8 sec.
- e. Clean: 2200°C, 20 sec.

Note: The above temperatures are employed as guidelines. Since temperature-sensing mechanisms and temperature controllers can vary with time, the validity of the furnace parameters must be periodically confirmed by systemically altering the furnace parameters while analyzing a standard. In this manner, losses of analyte due to higher than necessary temperature settings or losses in sensitivity due to less than optimum settings can be minimized.

III. CALIBRATION

A. Preparation of Standards

1. Stock solutions for Lead are prepared solutions from Inorganic Ventures containing 1,000 mg Pb/l.
2. An intermediate stock solution of 10 mg/l Pb, is prepared by diluting 1 ml of stock solution and 1 ml of conc. HNO₃ to 100 ml with ASTM Type II water. This standard is prepared weekly.,
3. A second intermediate standard solution of 0.1 mg/l Pb is prepared each day of analysis by diluting 1 ml of the 10 mg/l intermediate stock solution and 1.0 ml of conc. HNO₃ to 100 ml with ASTM Type II water.
4. Calibration standards are prepared by diluting the 0.1 mg/l intermediate stock solution, 1 ml conc. HNO₃ and 2 ml 30% H₂O₂ to 100 ml with ASTM Type I water according to the following schedule.

Standard Concentration ug/l	ml of 0.1 mg/l Intermediate Stock
0	0.0
3.0	5.0
25.0	25.0
50.0	50.0

5. Solutions are stored in plastic containers and working calibration standards are prepared fresh each day of analysis.

B. INSTRUMENT CALIBRATION

1. Set up spectrophotometer, furnace and auto-sampler according to manufacturers recommendations.
2. Analyze the calibration blank to establish the baseline.
3. Optimize the instrument by adjusting operating parameters to achieve maximum response.
4. Beginning with the blank and working toward the highest standard, inject the solutions and record the readings.

C. ANALYSIS OF CALIBRATION DATA

1. Tabulate the calibration standard concentration versus peak height response for each calibration standard.
2. Analyze data by linear regression on calculator. Correlation coefficients must be greater than 0.995 before proceeding with analysis.

D. CALIBRATION CHECKS

1. Initial Calibration Verification

- a. After the system has been calibrated, the accuracy of the initial calibration shall be verified and documented by the analysis of an EPA supplied standard of a concentration other than that used for calibration, but within the calibration range.
- b. The measurement must be within $\pm 10\%$ of the trace value or the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration reverified.

2. Calibration Blank

- a. A calibration blank is analyzed immediately after the calibration verifications.
- b. Blanks are to be reported down to the instrument detection limit.
- c. If the absolute value of the blank is greater than 3 ppb, terminate analysis, correct the problem and recalibrate.

3. Continuing Calibration Verification

- a. To assure calibration accuracy during each analysis run, an independently prepared standard solution, will be analyzed at a frequency of 10% and after the last analytical sample.

- b. The same standard will be used throughout the analysis run for a batch of samples received.
- c. If the deviation of the continuing calibration verification is greater than $\pm 10\%$ of the true value, the instrument will be recalibrated and the preceding 10 samples reanalyzed.

IV. PROCEDURE

A. Instrumental Analysis

- 1. Set up instrument parameters as discussed in Section II B.
- 2. Calibrate instrument following procedure in Section III.
- 3. Analyze samples using the following procedures:
 - a. Analyze each sample, except during Full Method of Standard Addition (MSA) with duplicate injections. If the value is within calibration range record the concentration values for both injections, the average value and the coefficient of variation (CV). For concentrations greater than 3.0 ppb, the CV between duplicate injections must agree within 20%, or the sample must be rerun once.
 - b. All analytical samples, except the pre-digested spike sample, requires an analytical spike to determine if the MSA will be required for quantitation. For Lead the spike concentration will be 6.0 ppb. The analytical spike of a sample will be run immediately after that sample. The percent recovery (%R) of the spike will then determine how the sample will be quantitated as follows:
 - b.1 If the spike recovery is less than 40%, the sample will be diluted by a factor of 5 and rerun with another spike. If after dilution the spike recovery is still <40% the data will be reported and flagged with an "E" to indicate interference problems.
 - b.2 If the spike recovery is greater than 40% and the sample concentration is <50% of the spike, the sample results will be reported to the IDL. If the spike recovery is less than 85% or greater than 115%, the data will be flagged with a "W".
 - b.3 If the sample concentration is >50% of the spike and the spike recovery is

between 85-115%, the sample will be quantitated directly from the calibration curve and reported to the IDL.

- b.4 If the sample concentration is >50% of the spike and the spike recovery is less than 85% or greater than 115%, the sample will be quantitated by MSA.
- c. The following will be used for MSA analysis.
 - c.1 Data from MSA calculations will be within the linear range as determined by the calibration curve generated at the beginning of the analytical run.
 - c.2 The sample and three spikes will be analyzed consecutively for MSA quantitation, only single injections will be used.
 - c.3 Spikes will be prepared such that:
 - Spike 1 is approximately 50% of the sample absorbance.
 - Spike 2 is approximately 100% of the sample absorbance.
 - Spike 3 is approximately 150% of the sample absorbance.
 - c.4 The data for each MSA analysis will be identified in the raw data documentation along with the slope, intercept and correlation coefficient (r) for the least squares fit of the data. Reported values obtained by MSA will be flagged on the data sheet with the letter "S" if the correlation coefficient is greater than or equal to 0.995.
 - c.5 If the correlation coefficient (r) is less than 0.995, the MSA analysis will be repeated once. If the correlation coefficient is still less than 0.995, the result with the best correlation coefficient will be reported and flagged with a "+".

STANDARD OPERATING PROCEDURES

SELENIUM

Selenium by Graphite Furnace Atomic Absorption

I. APPLICATION

- A. Tested Concentration range: 5.0 - 100 ug/L
- B. Approximate instrument detection limit: 4.0 ug/L
- C. Interferences
 - 1. Molecular absorption bands - the use of background correction should eliminate this interference.
 - 2. Memory effects - clean tube by operating at higher atomization temperature
 - 3. Carbide formation - the use of a pyrolytically-coated graphite tube reduces this interference.
 - 4. Anion interference - the use of nickel nitrate matrix modifier reduces this effect.
- D. Safety Information
 - 1. Never look directly at a hot furnace cuvette without proper eye protection.
 - 2. Never touch the atomizer cell until it has returned to ambient temperatures.
 - 3. Follow standard safety procedures for the handling of hazardous materials.

II. APPARATUS

A. INSTRUMENTATION

- 1. Thermo Jarrell Ash Video 22E AA spectrophotometer CTF 188 Atomizer and Smith-Hieftye background correction.
- 2. ISC 75 microprocessor controlled autosampler.
- 3. Selenium Hollow Cathode Lamp
- 4. Zero grade Argon Supply

B. Parameters

- 1. Wavelength: 196.0
- 2. Lamp Current: 8 mA
- 3. Bandpass: 2.0 AM
- 4. Readout Mode: Peak Height
- 5. Integration Time: 8.0 seconds
- 6. Temperature and Ramp Time:

continued.....

- a. Dry stage: 150°C, 10 sec.
- b. First Pyrolysis: 850°C, 40 sec.
- c. Second Pyrolysis: 1050°C, 40 sec.
- d. Atomization: 2250°C, 8 sec.
- e. Clean: 2400°C, 20 sec.

Note: The above temperatures are employed as guidelines. Since temperature-sensing mechanisms and temperature controllers can vary with time, the validity of the furnace parameters must be periodically confirmed by systemically altering the furnace parameters while analyzing a standard. In this manner, losses of analyte due to higher than necessary temperature settings or losses in sensitivity due to less than optimum settings can be minimized.

III. CALIBRATION

A. Preparation of Standards

1. Stock solutions for Selenium are prepared solutions from Inorganic Ventures containing 1,000 mg Se/l.
- 2, An intermediate stock solution of 10 mg/l Se, is prepared by diluting 1 ml of stock solution and 1 ml of conc. HNO₃ to 100 ml with ASTM Type II water. This standard is prepared weekly.,
3. A second intermediate standard solution of 1 mg/l Se is prepared each day of analysis by diluting 10 ml of the 10 mg/l intermediate stock solution and 1.0 ml of conc. HNO₃ to 100 ml with ASTM Type II water.
4. Calibration standards are prepared by diluting the 1 mg/l intermediate stock solution, 1 ml conc. HNO₃ and 2 ml 30% H₂O₂ and 1.0 ml nickel nitrate to 100 ml with ASTM Type I water according to the following schedule.

Standard Concentration ug/l	ml of 1.0 ug/l Intermediate Stock
0	0.0
10	1.0
50	5.0
100	10.0

5. Solutions are stored in plastic containers and working calibration standards are prepared fresh each day of analysis.

B. INSTRUMENT CALIBRATION

1. Set up spectrophotometer, furnace and auto-sampler according to manufacturers recommendations.
2. Analyze the calibration blank to establish the baseline.
3. Optimize the instrument by adjusting operating parameters to achieve maximum response.
4. Beginning with the blank and working toward the highest standard, inject the solutions and record the readings.

C. ANALYSIS OF CALIBRATION DATA

1. Tabulate the calibration standard concentration versus peak height response for each calibration standard.
2. Analyze data by linear regression on calculator. Correlation coefficients must be greater than 0.995 before proceeding with analysis.

D. CALIBRATION CHECKS

1. Initial Calibration Verification
 - a. After the system has been calibrated, the accuracy of the initial calibration shall be verified and documented by the analysis of an EPA supplied standard at a concentration other than that used for calibration, but within the calibration range.
 - b. The measurement must be within $\pm 10\%$ of the trace value or the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration reverified.
2. Calibration Blank
 - a. A calibration blank is analyzed immediately after the calibration verifications.
 - b. Blanks are to be reported down to the instrument detection limit.
 - c. If the absolute value of the blank is greater than 10 ppb, terminate analysis, correct the problem and recalibrate.
3. Continuing Calibration Verification
 - a. To assure calibration accuracy during each analysis run, an independently prepared standard solution, will be analyzed at a frequency of 10% and after the last analytical sample.

- b. The same standard will be used throughout the analysis run for a batch of samples received.
- c. If the deviation of the continuing calibration verification is greater than $\pm 10\%$ of the true value, the instrument will be recalibrated and the preceding 10 samples reanalyzed.

IV. PROCEDURE

A. Instrumental Analysis

- 1. Set up instrument parameters as discussed in Section II B.
- 2. Calibrate instrument following procedure in Section III.
- 3. Analyze samples using the following procedures:

- a. Analyze each sample, except during Full Method of Standard Addition (MSA) with duplicate injections. If the value is within calibration range record the concentration values for both injections, the average value and the coefficient of variation (CV). For concentrations greater than 10.0 ppb, the CV between duplicate injections must agree within 20%, or the sample must be rerun once.
- b. All analytical samples, except the pre-digested spike sample, requires an analytical spike to determine if the MSA will be required for quantitation. For selenium the spike concentration will be 10 ppb. The analytical spike of a sample will be run immediately after that sample. The percent recovery (%R) of the spike will then determine how the sample will be quantitated as follows:

- b.1 If the spike recovery is less than 40%, the sample will be diluted by a factor of 5 and rerun with another spike. If after dilution the spike recovery is still <40% the data will be reported and flagged with an "E" to indicate interference problems.
- b.2 If the spike recovery is greater than 40% and the sample concentration is <50% of the spike, the sample results will be reported to the IDL. If the spike recovery is less than 85% or greater than 115%, the data will be flagged with a "W".
- b.3 If the sample concentration is >50% of the spike and the spike recovery is

between 85-115%, the sample will be quantitated directly from the calibration curve and reported to the IDL.

- b.4 If the sample concentration is >50% of the spike and the spike recovery is less than 85% or greater than 115%, the sample will be quantitated by MSA.
- c. The following will be used for MSA analysis.
 - c.1 Data from MSA calculations will be within the linear range as determined by the calibration curve generated at the beginning of the analytical run.
 - c.2 The sample and three spikes will be analyzed consecutively for MSA quantitation, only single injections will be used.
 - c.3 Spikes will be prepared such that:
 - Spike 1 is approximately 50% of the sample absorbance.
 - Spike 2 is approximately 100% of the sample absorbance.
 - Spike 3 is approximately 150% of the sample absorbance.
 - c.4 The data for each MSA analysis will be identified in the raw data documentation along with the slope intercept and correlation coefficient (r) for the least squares fit of the data. Reported values obtained by MSA will be flagged on the data sheet with the letter "S" if the correlation coefficient is greater than or equal to 0.995.
 - c.5 If the correlation coefficient (r) is less than 0.995, the MSA analysis will be repeated once. If the correlation coefficient is still less than 0.995, the result with the best correlation coefficient will be reported and flagged with a "+".

STANDARD OPERATING PROCEDURES

THALLIUM

Thallium by Graphite Furnace Atomic Absorption

I. APPLICATION

- A. Tested Concentration range: 10.0 - 100 ug/L
- B. Approximate instrument detection limit: 4.0 ug/L
- C. Interferences
 - 1. Molecular absorption bands - the use of background correction should eliminate this interference.
 - 2. Memory effects - clean tube by operating at higher atomization temperature
 - 3. Carbide formation - the use of a pyrolytically-coated graphite tube reduces this interference.
 - 4. Anion interference - the use of a matrix modifier reduces this effect.
- D. Safety Information
 - 1. Never look directly at a hot furnace cuvette without proper eye protection.
 - 2. Never touch the atomizer cell until it has returned to ambient temperatures.
 - 3. Follow standard safety procedures for the handling of hazardous materials.

II. APPARATUS

A. INSTRUMENTATION

- 1. Thermo Jarrell Ash Video 22E AA spectrophotometer CTF 188 Atomizer and Smith-Hieftye background correction.
- 2. ISC 75 microprocessor controlled autosampler.
- 3. Thallium Hollow Cathode Lamp
- 4. Zero grade Argon Supply

B. Parameters

- 1. Wavelength: 276.8
- 2. Lamp Current: 20 mA
- 3. Bandpass: 1.0 AM
- 4. Readout Mode: Peak Height
- 5. Integration Time: 8.0 seconds
- 6. Temperature and Ramp Time:

- a. Dry stage: 150°C, 10 sec.
- b. First Pyrolysis: 300°C, 40 sec.
- c. Second Pyrolysis: 450°C, 20 sec.
- d. Atomization: 1900°C, 8 sec.
- e. Clean: 2200°C, 16 sec.

Note: The above temperatures are employed as guidelines. Since temperature-sensing mechanisms and temperature controllers can vary with time, the validity of the furnace parameters must be periodically confirmed by systemically altering the furnace parameters while analyzing a standard. In this manner, losses of analyte due to higher than necessary temperature settings or losses in sensitivity due to less than optimum settings can be minimized.

III. CALIBRATION

A. Preparation of Standards

1. Stock solutions for Thallium are prepared solutions from Inorganic Ventures containing 1,000 mg Ti/l.
2. An intermediate stock solution of 10 mg/l Ti, is prepared by diluting 1 ml of stock solution and 1 ml of conc. HNO₃ to 100 ml with ASTM Type II water. This standard is prepared weekly.,
3. A second intermediate standard solution of 1 mg/l Ti is prepared each day of analysis by diluting 10 ml of the 10 mg/l intermediate stock solution and 1.0 ml of conc. HNO₃ to 100 ml with ASTM Type II water.
4. Calibration standards are prepared by diluting the 1 mg/l intermediate stock solution, 1 ml conc. HNO₃ and 2 ml 30% H₂O₂ to 100 ml with ASTM Type I water according to the following schedule.

Standard Concentration ug/l	ml of 1.0 ug/l Intermediate Stock
0	0.0
10	1.0
50	5.0
100	10.0

5. Solutions are stored in plastic containers and working calibration standards are prepared fresh each day of analysis.

B. INSTRUMENT CALIBRATION

1. Set up spectrophotometer, furnace and auto-sampler according to manufacturers recommendations.
2. Analyze the calibration blank to establish the baseline.
3. Optimize the instrument by adjusting operating parameters to achieve maximum response.
4. Beginning with the blank and working toward the highest standard, inject the solutions and record the readings.

C. ANALYSIS OF CALIBRATION DATA

1. Tabulate the calibration standard concentration versus peak height response for each calibration standard.
2. Analyze data by linear regression on calculator. Correlation coefficients must be greater than 0.995 before proceeding with analysis.

D. CALIBRATION CHECKS

1. Initial Calibration Verification
 - a. After the system has been calibrated, the accuracy of the initial calibration shall be verified and documented by the analysis of an EPA supplied standard at a concentration other than that used for calibration, but within the calibration range.
 - b. The measurement must be within $\pm 10\%$ of the trace value or the analysis must be terminated, the problem corrected, the instrument recalibrated, and the calibration reverified.
2. Calibration Blank
 - a. A calibration blank is analyzed immediately after the calibration verifications.
 - b. Blanks are to be reported down to the instrument detection limit.
 - c. If the absolute value of the blank is greater than 10 ppb, terminate analysis, correct the problem and recalibrate.
3. Continuing Calibration Verification
 - a. To assure calibration accuracy during each analysis run, an independently prepared standard solution, will be analyzed at a frequency of 10% and after the last analytical sample.

- b. The same standard will be used throughout the analysis run for a batch of samples received.
- c. If the deviation of the continuing calibration verification is greater than $\pm 10\%$ of the true value, the instrument will be recalibrated and the preceding 10 samples reanalyzed.

IV. PROCEDURE

A. Instrumental Analysis

1. Set up instrument parameters as discussed in Section II B.
2. Calibrate instrument following procedure in Section III.
3. Analyze samples using the following procedures:

- a. Analyze each sample, except during Full Method of Standard Addition (MSA) with duplicate injections. If the value is within calibration range record the concentration values for both injections, the average value and the coefficient of variation (CV). For concentrations greater than 10.0 ppb, the CV between duplicate injections must agree within 20%, or the sample must be rerun once.
- b. All analytical samples, except the pre-digested spike sample, requires an analytical spike to determine if the MSA will be required for quantitation. For thallium the spike concentration will be 10 ppb. The analytical spike of a sample will be run immediately after that sample. The percent recovery (%R) of the spike will then determine how the sample will be quantitated as follows:
 - b.1 If the spike recovery is less than 40%, the sample will be diluted by a factor of 5 and rerun with another spike. If after dilution the spike recovery is still <40% the data will be reported and flagged with an "E" to indicate interference problems.
 - b.2 If the spike recovery is greater than 40% and the sample concentration is <50% of the spike, the sample results will be reported to the IDL. If the spike recovery is less than 85% or greater than 115%, the data will be flagged with a "W".
 - b.3 If the sample concentration is >50% of the spike and the spike recovery

between 85-115%, the sample will be quantitated directly from the calibration curve and reported to the IDL.

- b.4 If the sample concentration is >50% of the spike and the spike recovery is less than 85% or greater than 115%, the sample will be quantitated by MSA.
- c. The following will be used for MSA analysis.
 - c.1 Data from MSA calculations will be within the linear range as determined by the calibration curve generated at the beginning of the analytical run.
 - c.2 The sample and three spikes will be analyzed consecutively for MSA quantitation, only single injections will be used.
 - c.3 Spikes will be prepared such that:
 - Spike 1 is approximately 50% of the sample absorbance.
 - Spike 2 is approximately 100% of the sample absorbance.
 - Spike 3 is approximately 150% of the sample absorbance.
 - c.4 The data for each MSA analysis will be identified in the raw data documentation along with the slope, intercept and correlation coefficient (r) for the least squares fit of the data. Reported values obtained by MSA will be flagged on the data sheet with the letter "S" if the correlation coefficient is greater than or equal to 0.995.
 - c.5 If the correlation coefficient (r) is less than 0.995, the MSA analysis will be repeated once. If the correlation coefficient is still less than 0.995, the result with the best correlation coefficient will be reported and flagged with a "+".

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

MERCURY ANALYSIS IN WATER BY MANUAL COLD VAPOR

I. Application

- A. Tested concentration range: 0.2 to 10.0 ug/l.
- B. Approximate instrument detection limit: 0.15 ug/l.
- C. Interferences:
 1. Sulfide - eliminated by the addition of potassium permanganate.

II. Apparatus

A. Instrumentation

1. Instrumentation Laboratories Model 357 Atomic Absorption Spectrophotometer.
2. Instrumentation Laboratories Model 440 Atomic Vapor Accessory.
3. Mercury hollow cathode lamp.
4. Zero-grade argon.
5. Absorption cell: Standard quartz spectrophotometer cell, 10 cm long with open ends.
6. Aeration tubing: Tygon tubing for passage of the mercury vapor from the sample bottle to the absorption cell.

B. Reagents

1. Sulfuric acid, conc.: Baker Instra-Analyzed for trace metals analysis.
2. Sulfuric acid, 0.5 N: Dilute 14.0 ml of conc. sulfuric acid to 1.0 liter.
3. Nitric acid, conc.: Baker Instra-Analyzed for trace metals analysis.

4. Hydrochloric acid, conc.: Baker Instra-Analyzed fortrace metals analysis.
5. Stannous chloride: Add 25 grams stannous chloride to 500 ml 25% HCl.
6. Sodium chloride - hydroxylamine hydrochloride solution: Dissolve 12 grams of NaCl and 12 grams hydroxylamine hydrochloride in distilled water and dilute to 100 ml.
7. Potassium permanganate, 5% solution, w/v: Dissolve 5 grams of potassium permanganate in 100 ml of distilled water.
8. Potassium persulfate, 5% solution, w/v: Dissolve 5 grams of potassium persulfate in 100 ml of distilled water.

C. Parameters

1. Wavelength: 253.3 nm
2. Lamp current: 3.0
3. Bandpass: 1.0 nm
4. Readout mode: Peak height
5. Integration time: 8.0 seconds
6. Background correction: D₂

III. Procedure

A. Standard Preparation

1. Stock solutions for mercury are prepared solutions from Spex Industries containing 1,000 mg mercury/l.
2. An intermediate stock solution of 10.0 mg/l mercury is prepared by diluting 1.0 ml of stock solution and 1.0 ml of conc. HNO₃ to 100 ml with ASTM Type II water. This standard is prepared weekly.
3. A second intermediate solution of 0.1 mg/l mercury is prepared each day of analysis by diluting 1.0 ml of the 10.0 mg/l intermediate stock solution and 1.0 ml of conc. HNO₃ to 100 ml with ASTM Type II water. Make fresh daily.

4. Calibration standards are prepared by diluting the 0.1 mg/l intermediate standard to 100 ml with ASTM Type II water according to the following schedule:

Standard Calibration ug/l	ml of 0.1 mg/l Intermediate Standard
0.0	0.0
0.5	0.5
1.0	1.0
5.0	5.0
10.0	10.0

5. Working calibration standards are prepared fresh each day of analysis and carried through the digestion procedure outlined in Section III.B.

B. Sample Preparation

1. Add the standards prepared above in Section III.A.4. to 300 ml fleaker.
2. Transfer 100 ml of well mixed sample to a 300 ml fleaker.
3. Add 5 ml of conc. sulfuric acid and 2.5 ml of conc. nitric acid to each bottle.
4. Add 15 ml of $KMnO_4$ solution to each bottle and allow to stand at least 15 minutes.
5. Add 8 ml of potassium persulfate to each bottle.
6. Heat for 2 hours in a water bath at 95°C.
7. Cool and add 6 ml of sodium chloride-hydroxylamine sulfate solution to reduce the excess permanganate.

C. Calibration

1. Instrument Calibration

- a. Set up instrument according to manufacturers recommendations.
- b. Attach the stannous chloride to the Atomic Vapor Accessory and cycle through several times to insure that stannous chloride is being pumped to the sample chamber.
- c. Pour the blank sample into a 150 ml fleaker and attach to the IL Atomic Vapor Accessory.

- d. Start the cycle and establish the baseline.
 - e. Beginning with the blank and working towards the highest standard, run the solutions and record the peak height readings.
2. Analysis of Calibration Data
- a. Tabulate the calibration standard concentration versus peak height response for each calibration standard.
 - b. Analyze data by linear regression on a calculator. The correlation coefficient must be greater than 0.995 before proceeding with analysis.
3. Calibration Checks
- a. Initial Calibration Verification
 - a.1. After the system has been calibrated, the accuracy of the initial calibration shall be verified and documented by the analysis of an EPA supplied standard carried through the digestion procedure.
 - a.2. The measurement must be within $\pm 20\%$ of the true value or the analysis must be terminated, the problem corrected, the instrument recalibrated and the calibration reverified.
 - b. Calibration Blank
 - b.1. A calibration blank is analyzed at the beginning and end of the run and at a frequency of 10% during the run.
 - b.2. Blanks are to be reported down to the instrument detection limit.
 - b.3. If the blank result is greater than 0.2 ppb, terminate analysis, correct the problem and recalibrate.
 - c. Continuing Calibration Verification
 - c.1. To assure calibration accuracy during each analysis run, an independently prepared standard solution carried through the digestion procedure will

analyzed at a frequency of 10% and after the last analytical samples.

c.2. The mercury concentrations will be at the mid-range level of the calibration curve.

c.3. If the deviation of the continuing calibration verification is greater than 20%, the instrument will be recalibrated and the proceeding samples since the last calibration verification will be reanalyzed.

D. Instrument Analysis

1. Set up instrument parameters as discussed in Section II.C.
2. Calibrate instrument as discussed in Section III.C.1.
3. Add samples to Atomic Vapor Accessory and record peak height responses.
4. Using the calibration curve generated in Section III.2., convert peak height responses to concentration.
5. Report mercury concentrations as follows:
Below 0.2 ug/l = 0.2 u
Between 0.2 and 10 ug/l = one decimal place
Above 10 ug/l = whole numbers

IV. Quality Control

- A. Initial calibration verification: Analyzed immediately after instrument calibration. Control limits are $\pm 20\%$ of the true value. (Supplied by EPA).
- B. Initial calibration blank: Analyzed immediately after initial calibration verification. Control limits are ± 0.2 ug/l.
- C. Continuing calibration verification: Analyzed at a frequency of 10% or every two hours during an analysis run, whichever is more frequent. Control limits are 80% to 120% of the true value.
- D. Continuing calibration blank: Analyzed at a frequency of 10% or every two hours during an analysis run, whichever is more frequent. Control limits are ± 0.2 ppb.

- E. Preparation blank: At least one preparation blank must be prepared and analyzed with every Sample Delivery Group or with each batch of samples digested, whichever is more frequent.
- F. Matrix spike sample: At least one spike analysis is performed on each group of samples of a similar matrix type and concentration or for each Sample Delivery Group, whichever is more frequent. Samples identified as field blanks cannot be used for spiked sample analysis.
- G. Post-digested spike: When the matrix spike sample recovery falls outside the control limits of 75% to 125% and the sample concentration does not exceed 4 times the spike added, a post-digested spike is performed. Spike the unspiked aliquot of the sample at 2 times the indigenous level or 2 times CRDL, whichever is greater.
- H. Duplicate sample: One duplicate sample is analyzed from each group of samples of a similar matrix type and concentration or for each Sample Delivery Group, whichever is more frequent. Samples identified as field blanks cannot be used for duplicate sample analysis. A control limit of 20% for relative percent difference (RPD) is used for original and duplicate sample values greater than or equal to 5 times CRDL. A control limit of \pm CRDL is used for sample values less than 5 times CRDL.
- I. Laboratory control sample: An aqueous LCS is not required for accuracy.
- J. Holding times: The holding time for mercury is 21 days from verified time of sample receipt to sample digestion.

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

MERCURY ANALYSIS IN SOIL BY MANUAL COLD VAPOR

I. Application

- A. Tested concentration range: 0.1 - 5.0 mg/kg.
- B. Approximate detection limit: 0.08 mg/kg.
- C. Interferences:
 1. Sulfide - eliminated by the addition of potassium permanganate.

II. Apparatus

A. Instrumentation

1. Instrumentation Laboratories Model 357 Atomic Absorption Spectrophotometer.
2. Instrumentation Laboratories Model 440 Atomic Vapor Accessory.
3. Mercury hollow cathode lamp.
4. Zero-grade argon.
5. Absorption cell: Standard quartz spectrophotometer cell, 10 cm long with open ends.
6. Aeration tubing: Tygon tubing for passage of the mercury vapor from the sample to the absorption cell.

B. Reagents

1. Sulfuric acid, conc.: Baker Instra-Analyzed for trace metals analysis.
2. Sulfuric acid, 0.5 N: Dilute 14.0 ml of conc. sulfuric acid to 1.0 liter.
3. Nitric acid, conc.: Baker Instra-Analyzed for trace metals analysis.

4. Hydrochloric acid, conc.: Baker Instra-Analyzed for trace metals analysis.
5. Stannous chloride: Add 25 grams stannous chloride to 500 ml 25% HCl.
6. Sodium chloride - hydroxylamine hydrochloride solution: Dissolve 12 grams of NaCl and 12 grams hydroxylamine hydrochloride in distilled water and dilute to 100 ml.
7. Potassium permanganate, 5% solution, w/v: Dissolve 5 grams of potassium permanganate in 100 ml of distilled water.
8. Potassium persulfate, 5% solution, w/v: Dissolve 5 grams of potassium persulfate in 100 ml of distilled water.

C. Parameters

1. Wavelength: 253.3 nm
2. Lamp current: 3.0
3. Bandpass: 1.0 nm
4. Readout mode: Peak height
5. Integration time: 8.0 seconds
6. Background correction: D₂

III. Procedure

A. Standard Preparation

1. Stock solutions for mercury are prepared solutions from Spex Industries containing 1,000 mg mercury/l.
2. An intermediate stock solution of 10.0 mg/l mercury is prepared by diluting 1.0 ml of stock solution and 1.0 ml of conc. HNO₃ to 100 ml with ASTM Type II water. This standard is prepared weekly.
3. A second intermediate solution of 0.1 mg/l mercury is prepared each day of analysis by diluting 1.0 ml of the 10.0 mg/l intermediate stock solution and 1.0 ml of conc. HNO₃ to 100 ml with ASTM Type II water. Make fresh daily.

4. Calibration standards are prepared by diluting the 0.1 mg/l intermediate standard to 100 ml with ASTM Type II water according to the following schedule:

Standard Calibration ug/l	ml of 0.1 mg/l Intermediate Standard
0.0	0.0
0.5	0.5
1.0	1.0
5.0	5.0
10.0	10.0

5. Working calibration standards are prepared fresh each day of analysis and carried through the digestion procedure outlined in Section III.B.

B. Sample Preparation

1. Add the standards prepared above in Section III.A.4. to 300 ml fleaker.
2. Weigh a representative 0.2 gram portion of wet sample and place in a 300 ml fleaker.
3. Add 5.0 ml of conc. sulfuric acid and 2.5 ml of conc. nitric acid to each bottle.
4. Heat 2 minutes in a water bath at 95°C.
5. Cool, add 50 ml distilled water, 15 ml potassium permanganate and 8 ml of potassium persulfate solution.
6. Mix thoroughly and place in the water bath for 30 minutes at 95°C.
7. Cool and add 6 ml of sodium chloride-hydroxylamine sulfate.
8. Add 55 ml of distilled water.

C. Calibration

1. Instrument Calibration
 - a. Set up instrument according to manufacturers recommendations.
 - b. Attach the stannous chloride to the Atomic Vapor Accessory and cycle through several times to insure that stannous chloride is being pumped to the sample chamber.

- c. Pour the blank sample into a 150 ml fleaker and attach to the IL Atomic Vapor Accessory.
 - d. Start the cycle and establish the baseline.
 - e. Beginning with the blank and working towards the highest standard, run the solutions and record the peak height readings.
2. Analysis of Calibration Data
- a. Tabulate the calibration standard concentration versus peak height response for each calibration standard.
 - b. Analyze data by linear regression on a calculator. The correlation coefficient must be greater than 0.995 before proceeding with analysis.
3. Calibration Checks
- a. Initial Calibration Verification
 - a.1. After the system has been calibrated, the accuracy of the initial calibration shall be verified and documented by the analysis of an EPA supplied standard carried through the digestion procedure.
 - a.2. The measurement must be within $\pm 20\%$ of the true value or the analysis must be terminated, the problem corrected, the instrument recalibrated and the calibration reverified.
 - b. Calibration Blank
 - b.1. A calibration blank is analyzed at the beginning and end of the run and at a frequency of 10% during the run.
 - b.2. Blanks are to be reported down to the instrument detection limit.
 - b.3. If the blank result is greater than 0.2 ppb, terminate analysis, correct the problem and recalibrate.
 - c. Continuing Calibration Verification
 - c.1. To assure calibration accuracy during each analysis run, an independently prepared standard solution carried through the

digestion procedure will be analyzed at a frequency of 10% and after the last analytical samples.

c.2. The mercury concentrations will be at the mid-range level of the calibration curve.

c.3. If the deviation of the continuing calibration verification is greater than 20%, the instrument will be recalibrated and the proceeding samples since the last calibration verification will be reanalyzed.

D. Instrument Analysis

1. Set up instrument parameters as discussed in Section II.C.
2. Calibrate instrument as discussed in Section III.C.1.
3. Add samples to Atomic Vapor Accessory and record peak height responses.
4. Using the calibration curve generated in Section III.2., convert peak height responses to concentration.
5. Convert concentrations to dry weight by the following:

$$\text{Concentration, ug/g} = \frac{C \times V}{W \times S}$$

Where: C = concentration , ug/l
V = final volume in liters after sample preparation
W = weight in grams of wet sample in preparation
S = percent solids/100

IV. Quality Control

- A. Initial calibration verification: Analyzed immediately after instrument calibration. Control limits are $\pm 20\%$ of the true value. (Supplied by EPA).
- B. Initial calibration blank: Analyzed immediately after initial calibration verification. Control limits are ± 0.2 ug/l.

- C. Continuing calibration verification: Analyzed at a frequency of 10% or every two hours during an analysis run, whichever is more frequent. Control limits are 80% to 120% of the true value.
- D. Continuing calibration blank: Analyzed at a frequency of 10% or every two hours during an analysis run, whichever is more frequent. Control limits are ± 0.2 ppb.
- E. Preparation blank: At least one preparation blank must be prepared and analyzed with every Sample Delivery Group or with each batch of samples digested, whichever is more frequent.
- F. Matrix spike sample: At least one spike analysis is performed on each group of samples of a similar matrix type and concentration or for each Sample Delivery Group, whichever is more frequent. Samples identified as field blanks cannot be used for spiked sample analysis.
- G. Post-digested spike: When the matrix spike sample recovery falls outside the control limits of 75% to 125% and the sample concentration does not exceed 4 times the spike added, a post-digested spike is performed. Spike the unspiked aliquot of the sample at 2 times the indigenous level or 2 times CRDL, whichever is greater.
- H. Duplicate sample: One duplicate sample is analyzed from each group of samples of a similar matrix type and concentration or for each Sample Delivery Group, whichever is more frequent. Samples identified as field blanks cannot be used for duplicate sample analysis. A control limit of 20% for relative percent difference (RPD) is used for original and duplicate sample values greater than or equal to 5 times CRDL. A control limit of \pm CRDL is used for sample values less than 5 times CRDL.
- I. Laboratory control sample: The EPA-provided solid LCS is prepared and analyzed using the sample procedures as the soil samples. If the result for the solid LCS falls outside the control limits established by EPA, the analyses must be terminated, the problem corrected and the samples associated with the LCS redigested and reanalyzed.
- J. Holding times: The EPA-CLP holding time for mercury is 21 days from verified time of sample receipt to sample digestion.

STANDARD OPERATING PROCEDURES

NITRATE BY ION CHROMATOGRAPHY

SOUTHWEST LABORATORY OF OKLAHOMA

STANDARD OPERATING PROCEDURES

NITRATE BY ION CHROMATOGRAPHY

I. Principle

A. A water sample is injected into a stream of carbonate-bicarbonate elvant and passed through a series of ion exchangers. The anion are separated on the basis of their relative affinities for a low capacity, strong basic anion exchanger (guard and separtor column). The anions are directed onto a strong acidic cation exchanger (soppressor column) where they are converted to their highly conductive acid form. The anions in their acid form are measured by conductivity. They are identified on the basis of retention time as compared to standards. Quantitation is by measurement of peak area or peak height.

II. Appartus

- A. Ion Chromatograph Dionex 2000
- B. Anion separtator column
- C. Guard column
- D. Supressor column

III. Reagents

- A. Deionized water
- B. Elvant solution: sodium bicarbonate - sodium carbonate
- C. Regenerant solution 1: 1N sulfuric acid (use when suppressor is not a continuous regenerated one).
- D. Regenerated solution 2: 0.025N sulfuric acid (use with continuous regeneration-fiber suppressor system.
- E. Standard anion solution: 1000 mg/L
- F. Combined working standard solutions.

IV. Procedure

- A. System equilibration: Turn on and adjust elvant flow rate to 2 to 3 ml/minute. Adjust detector to desired

setting and let system come to equilibrium (15 to 20 minutes). Adjust detector offset to zero out.

- E. Calibration: Inject standards containing a single or mixture of anions. Observe retention times. Inject at least three different concentrations for each anion to be measured and construct a calibration curve by plotting peak height or area against concentration on linear graph paper. Recalibrate whenever standards vary by $\pm 10\%$.
- C. Sample analysis: Remove sample particulates by filtering through a 0.2 micro-pore-diameter membrane filter. Using a syringe of 1 to 10 ml capacity, inject enough sample to flush sample loop several times. Switch ion chromatograph from load to inject mode and record peak height and retention times on strip chart recorders.
- D. Regeneration: For system without fiber suppressor regenerate with 1N sulfuric acid in accordance with the manufacturer's instructions when the conductivity base line exceeds 300 micro-mho when the suppressor column is on line.

V. Calculations:

- A. Calculate concentration of nitrate anion in mg/L, by referring to the appropriate calibration curve. Alternatively, when the response is shown to be linear, use the following equation:

$$C = H \times F \times D$$

Where:

C = mg anion/L

H = peak height or area

F = response factors = concentration of standard/height (or area) of standard

D = dilution factor for those samples requiring dilution

STANDARD OPERATING PROCEDURES

OIL AND GREASE

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

SOP : SWLO-015

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OIL and GREASE

Summary: Samples are extracted with trichlorotrifluoroethane to remove oil and grease. This extract is collected and the solvent is driven off leaving the oil and grease.

PROCEDURE:

I. WATER SAMPLES

A. SEPARATORY FUNNEL TECHNIQUE

1. Take 1 liter of sample and acidify to pH of <2 with HCl and extract with 30 mls of Trichlorotrifluoroethane.
2. Transfer to separatory funnel and allow the solvent and water layers to separate.
3. The solvent layer is filtered through approximately 1.0 gm Na₂SO₄ filter cone into a clean dry 400 ml beaker.
4. The water layer is then extracted two more times in the same manner.
5. The solvent extract is placed on a hot plate at 70°C until the solvent is driven off.
6. The beaker is placed in a desiccator and allowed to cool and then the beaker is weighed.
7. Oil and Grease determined as follows:

$$\frac{\text{mg Oil \& Grease / L}}{\text{mls sample}} = \frac{(A-B) \times 1000}{\text{mls sample}}$$

Where: A = weight of the beaker plus oil residue.
B = tare weight of beaker.

II. SOIL/SLUDGE SAMPLES

A. SOXHLET EXTRACTOR TECHNIQUE

1. Weigh out 1-25 gms sample in an extraction thimble
2. Mix with Anhydrous Na₂SO₄ at 2 times the weight of the sample and place in a soxhlet extractor. With a clean pre-weighed collection vessel, extract for 4 hours using Trichlorotrifluoroethane as the extraction solvent.

3. Cycle rate of the extractor should be maintained at 20 cycles per hour.
4. The extract solvent is then distilled off and the collection vessel is allowed to cool in a desiccator and then weighed.
5. The Oil and Grease is calculated as follows:

Oil & Grease as % of soil/sludge =

$$\frac{\text{gain in weight of flask, g} \times 100}{\text{wt./wet solids, g} \times \text{dry solids fraction}}$$

STANDARD OPERATING PROCEDURES

SAMPLE CUSTODIAN

SOUTHWEST LABORATORY OF OKLAHOMA, INC.

STANDARD OPERATING PROCEDURES

SAMPLE CUSTODIAN

I. SAMPLE RECEIVING AREA

- A. Samples are received through a separate receiving door directly into the designated "Sample Receiving Area".
- B. The sample receiving area is supplied with a large worktable, Terminal to Data Base Computer System and a 6'x 5' Bulletin Board (SMO shipment schedules are posted along with any important notations regarding incoming samples on the Bulletin Board).

II. SAMPLE RECEIPT

- A. Upon receipt of an EPA cooler the Sample Custodian signs the airbill and inspects cooler noting condition of custody seals, locks and evidence tape.
- B. Once condition of cooler has been established, the Sample Custodian removes the SMO paper work (i.e. the Chain of Custody and Organic Traffic Reports) and inspects condition of the sample containers.
 - 1. Sample condition is noted on the SMO Organic Traffic Report along with any necessary notations concerning the condition of the seals, locks and tape.
 - 2. If there is evidence of broken bottles the cooler is taken to an extraction laboratory hood where samples are removed.
- C. Samples are removed and placed on a work table and all tags are double checked to see that the information agrees with the labels on the actual sample containers. Any discrepancies are immediately reported to the Organics Program Manager, noted on the Organic Traffic Reports and the discrepancies are discussed with the Sample Management Office and recorded in a phone log. These phone logs are included in the case files.
- D. Once that the accuracy of the Chain-of-Custody has been established the Sample Custodian signs, dates and notes time received along with any appropriate comments.

- E. The Chain-of-Custody, Airbill and Tags may be set-aside to be organized and completed later. The Organic Traffic Reports contains the information needed to log the parameters requested along with other pertinent information and kept by the computer terminal during the logging procedure.

III. LOG-IN PROCEDURES

- A. All sample log-in information is inputted into a Data Base Computer System (LIMS). The computer assigns a unique and sequential number to each individual sample which serves as SWLO's Laboratory ID. The Sample Custodian notes the ID number that appears on the computer screen (each time she logs a new sample) on a 1" x 1/2" label. If there are 6 containers to 1 sample, 6 individual labels with the computer assigned number are made.

Note: SWLO IS IN THE PROCESS OF COMPUTERIZING THESE ID LABELS AND IS ALSO LOOKING INTO A BAR CODING SYSTEM FOR SAMPLE TRACKING.

- B. The following information is inputted into the computer by the Sample Custodian:
1. Client (EPA)
 2. Date and time received
 3. Date testing data is due
 4. Matrix of sample
 5. Number of containers per sample
 6. Sample location within laboratory (shelf and designated refrigerated)
 7. EPA region is noted
 8. Whether Chain-of-Custody form is received
 9. EPA sample ID (description) including the case number and whether or not the sample should be run as an MS/MSD.
 10. Any comments deemed appropriate by the Sample Custodian (i.e., samples are "low concentration", "medium", etc.)
- C. Parameters are then logged according to the requests made on the Organic Traffic Reports. The computer system is designed so that when the Sample Custodian enters an SWLO test code number, the computer will automatically designate not only the specific parameter but also the method to be used.
- D. Each sample container is then labeled with the corresponding SWLO sample ID number and stored along with internal sample tracking forms in the prescribed areas which are described in detail later in this SOP.

IV. COMPUTER GENERATED PRINT-OUTS

- A. Analysis sheets, which functions as an instruction sheet, is printed out after each sample logging procedure is completed per sample and contains the information inputted at logging including client, client ID, Lab ID, number of containers, specific location of the containers, parameters to be tested for, methods to be used, date logged, date due, and additional comment information. (example analysis sheet included)
- B. After all samples of the set are logged into the computer and analysis sheets are generated, the Sample Custodian computer generates the internal sample tracking forms.
 1. Volatile sample tracking form (~~fig. #1~~)
 2. Semi-Volatile and Pesticide sample tracking form. (~~fig. #2 and #3~~)
 3. Pesticide extraction tracking form (~~fig. #4~~)
 4. Semi-Volatile extraction tracking form (~~fig. #5~~)

V. SAMPLE STORAGE

- A. Each sample container is labeled with the corresponding SWLO computer log number and stored in the appropriate areas.
- B. Volatile Organics has dedicated refrigerated storage kept at a constant 4°C secured with combination locks. (~~see fig. #7, area #3~~)
 1. Sample Tracking Form for the Volatile Organic samples is posted at the VOA refrigerators
- C. Extractables and inorganics are stored in the large walk-in cooler kept at a constant 4°C and secured with combination locks. (~~see fig. #7, area #4~~)
 1. Sample Tracking Form for the Semi-Volatiles and Pesticides posted at the walk-in cooler.
- D. Once extractable samples have been extracted the vials containing the "extracts" are stored in a dedicated refrigerator kept at a constant 4°C temperature. (~~see fig. #7, area #2~~)
 1. The Extraction Tracking Sheet Form is posted (for both pesticides/PCBs and Semi-Volatiles) at the extraction refrigerator.

VI. DISTRIBUTION OF PAPERWORK

- A. After samples have been logged on computer, labeled with the lab ID, stored in appropriate storage areas and internal chain-of-custodies posted, paper work is completed and properly distributed.
- B. The original SWLO Analysis Worksheet, ~~(see fig #6)~~ generated by the logging procedure, is copied and distributed as follows:
 1. Copy to Volatile Organics GCMS operators
 2. Copy to Extractions Laboratory
 3. Copy to QA/QC manager
 4. Original worksheet to Organics Program Manager (to his data clerk)
- C. The Organic Traffic Report from SMO is completed noting date, time, sample custodian's name, contract number plus bid lot and price per sample. If shipment is not complete (if more samples will be shipped under that particular case number) then an SDG sheet is started and the Organic Traffic Reports are attached and held until such time as shipment is complete. When shipment is complete then the SDG sheets are completed and all Organic Traffic Reports to that Case and the SDG as a cover sheet are then mailed back to SMO.

VII TRANSFER OF PAPERWORK FOR CASE FILES

- A. All paperwork pertinent to Case Files are transferred to the Data Clerk which is an assistant to the Organics Program Manager. The following items are placed in a large brown envelope (9"x11"):
 1. Signed Airbill
 2. Signed Chain-of-Custody forms
 3. Sample Tags
 4. Yellow copy (lab) of the Organics Traffic Report.
 - a) Photostatic copy made of original and also included with the yellow copy for reasons of clarity for the Data Package
 5. The Laboratory analysis worksheet which lists all samples logged in under that shipment for a particular case. (Will match all sample tags, chain-of-custody and the Organic Traffic Reports).

- B. Once all the above items are placed in a sealed envelope and transferred to the Data Clerk they become the responsibility of that department.

VIII SHIPMENT OF COOLERS

- A. Once all logging and distribution of data is completed the coolers are returned (same day if at all possible).
- B. Return shipping address will be located on the inside of the cooler lid.
- C. Coolers are restrapped with "strapping tape" and shipped via United Parcel Service "collect" to the address designated.

IX EXTRACT ARCHIVING / PURGING

- A. When the analytical work is finished and the data has been sent out the extract are archived for 365 days in the extract hold refrigerator. ~~(see fig. #7, area #7)~~ Extract tracking forms are filled out including date and initials. Following 365 days of storage, the extracts are purged. The date of the purge is again recorded on the extract tracking forms.
- B. Samples are held 365 days following submission of data. After this time the samples are purged. The date and analyst initials are recorded on the sample tracking forms.

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APPENDIX G

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