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FINAL
OVERALL QUALITY ASSURANCE PROJECT PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
FORT SHERIDAN, ILLINOIS

VOLUME 1 OF 2

Contract No. DAAA15-90-D-0017
Delivery Order 2

March 15, 1995

Distribution unlimited approved for public release.

U.S. ARMY ENVIRONMENTAL CENTER
Aberdeen Proving Ground, MD 21010-5401

Prepared by:

ESE Environmental Science & Engineering, Inc.

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OVERALL QUALITY ASSURANCE PROJECT PLAN FOR FORT SHERIDAN

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03/08/95

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LIST OF ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
AAS	atomic absorption spectroscopy
ACBM	asbestos-containing building materials
ANL	Argonne National Laboratory
Army	Department of the Army
AST	aboveground storage tank
atm	atmosphere
BCD	Base Closure Division
BCT	BRAC Cleanup Team
BEC	BRAC Environmental Coordinator
BFB	bromofluorobenzene
bgs	below ground surface
BNA	base-neutral and acid extractable
BOD	biochemical oxygen demand
BRAC	Base Realignment and Closure
CCC	calibration check compound
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERFA	Community Environmental Response Facilitation Act
CLASS™	Chemical Laboratory Analysis and Scheduling System
CLP	Contract Laboratory Program
COD	chemical oxygen demand
COR	Contracting Officer's Representative
cpm	counts per minute
CPR	cardiopulmonary resuscitation

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 2 of 7)

CRDL	contract required detection limit
CRL	certified reporting limit
CSA	coal storage area
D	deep
DEH	Directorate of Engineering and Housing
DFFS	draft final FS
DFRI	draft final remedial investigation
DFTPP	decafluorotriphenylphosphine
DHRS	Department of Health and Rehabilitative Services
DI	deionized
DOD	Department of Defense
DOT	Department of Transportation
DPDO	Defense Property Disposal Office
EBS	environmental baseline survey
ELAP	Environmental Laboratory Approval Program
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science & Engineering, Inc.
FID	flame ionization detector
FS	feasibility study
ft	feet
ft-bgl	feet below ground level
ft-bgs	feet below ground surface
g	gram
gal	gallon
GC	gas chromatography

LIST OF ACRONYMS AND ABBREVIATIONS
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GC/MS	gas chromatography/mass spectrometry
GC/HPLC	gas chromatography/high-performance liquid chromatography
GWMR	Groundwater Monitoring Review
HASP	Health and Safety Plan
H_2S	hydrogen sulfide
HCl	hydrochloric acid
HDPE	high density polyethylene
HNO_3	nitric acid
ICAP	inductively coupled argon plasma
ICP	inductively coupled plasma
ICS	interference check solution
ICV	initial calibration verification
ID	identification
IDW	investigative derived waste
IEPA	Illinois Environmental Protection Agency
IR	infrared
IRDMIS	Installation Restoration Data Management Information System
IRP	Installation Restoration Program
KCl	potassium chloride
KOH	potassium hydroxide
L	liter
LF	landfills
LCL	Lower control limit
LDP	Landfill Parameters

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 4 of 7)

Lpm	liters per minute
LWL	lower warning limit
MDL	method detection limit
mmHg	millimeters of mercury
mR/hr	milliroentgens per hour
MRD	Missouri River Division
MRR	method reporting range
MS	matrix spike
MSC	matrix spike compound
MSD	matrix spike duplicate
MS/MSD	matrix spike/matrix spike duplicate
MSL	mean sea level
MYA	miscellaneous yard area
NCP	National Oil and Hazardous Substances Contingency Plan
NFRAP	No Further Response Action Planned
ng	nanogram
ng/m^3	nanograms per cubic meter
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NTU	national turbidity unit
NVLAP	National Voluntary Laboratory Accreditation Program
OCP	organochlorine pesticides
OU	operable unit
OVA	organic vapor analyzer
OVM	organic vapor meter

LIST OF ACRONYMS AND ABBREVIATIONS
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PAH	polynuclear aromatic hydrocarbons
PAT	Proficiency Analytical Testing Program
PCB	polychlorinated biphenyl
PEM	Performance Evaluation Mixture
PFS	prefield setup
PID	photoionization detector
PM	pad-mounted
POL	petroleum, oils, and lubricants
ppb	part per billion
ppbv	parts per billion volume
ppm	parts per million
PT	pole-mounted
PTFE	polytetrafluoro-ethylene
PUF	polyurethane foam
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QCC	quality control check analyte
%R	percent recovery
RA	risk assessment
RDL	required detection limit
RF	response factor
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
RPD	relative percent difference

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 6 of 7)

ROD/RS	Record of Decision/Responsiveness Summary
S	shallow
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SARM	Standard Analytical Reference Material
scc/m	standard cubic centimeters per minute
SOP	standard operating procedure
SPCC	system performance check compounds
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TDS	total dissolved solids
THM	trihalomethane
TIC	tentatively identified compound
TIP	total ionizables present
TOC	total organic carbon
TOX	total organic halides
TPH	total petroleum hydrocarbons
TSS	total suspended solids
UCL	upper control limit
µg/g	micrograms per gram
µg/L	micrograms per liter
µm	micrometer
URL	upper reporting limit
µS/cm	microSiemens per centimeter
USACE	U.S. Army Corps of Engineers

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 7 of 7)

USAEC	U.S. Army Environmental Center (formerly USATHAMA)
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
UST	underground storage tank
UV	ultraviolet
UWL	upper warning limit
VES	vehicle and equipment storage area
VOC	volatile organic compound
YSI	Yellow Springs Instruments
YSI S-C-T	Yellow Springs Instruments Salinity Conductivity Temperature

EXECUTIVE SUMMARY TO BE PROVIDED

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This Overall Quality Assurance Project Plan (OQAPP) has been prepared as a component of Delivery Order No. 2 of Contract DAAA15-90-D-0017. The purpose of this OQAPP is to define responsibilities and authorities, and to prescribe requirements for assuring that the remedial investigation (RI) and feasibility study (FS) for Fort Sheridan are planned and executed in a manner consistent with U.S. Army Environmental Center (USAEC), U.S. Environmental Protection Agency (EPA) Region V, and Illinois Environmental Protection Agency (IEPA) quality assurance (QA) objectives.

The format of the OQAPP is based on "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans - QAMS-005/80" prepared by the EPA Office of Research and Development. The elements of the OQAPP incorporate the Environmental Science & Engineering, Inc. (ESE) laboratory quality control data; requirements contained in the EPA Region V Model OQAPP; USAEC Guidelines for Implementation of ER 1110-1-263 for USAEC Projects (May 1993) (Appendix A); and the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) "Geotechnical Requirements for Drilling, Monitoring Wells, Data Acquisition, and Reports," (March 1987) (Appendix B), for the installation of borings and monitor wells, and for land survey location.

This OQAPP provides guidance and specifications to ensure that:

1. Field determinations and laboratory analytical results are of known quality and are valid, consistent, and compatible with the USAEC chemical database through the use of approved methods,

preventive maintenance procedures, calibration and analytical protocols, quality control (QC) measurements, reviews, and audits.

2. Samples are obtained using appropriate, documented procedures; identified uniquely; and controlled through sample tracking systems and chain-of-custody procedures.
3. Records are retained as documentary evidence of the quality of samples, applied processes, equipment, and results.
4. Generated data are validated.
5. Calculations and evaluations are accurate, appropriate, and consistent throughout the project.

The RI/FS program is being conducted in accordance with the EPA RI/FS Draft Guidance Manual, which addresses the Superfund Amendments and Reauthorization Act (SARA) amendments to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and state guidelines (EPA, 1988). The program is supported by three documents: (1) the site-specific Overall Sampling and Analysis Plan; (2) the OQAPP; and (3) the Health and Safety Plan (HASP) (ESE, 1993). For each work assignment this OQAPP will be used as a site-specific QA Plan and will be supplemented by a site-specific Sampling and Analysis Plan (SAP), as required.

1.2 PROJECT BACKGROUND

1.2.1 BACKGROUND INFORMATION

The U.S. Army Installation Restoration Program (IRP) was designed to identify and control or abate contaminant migration resulting from past operations at the Department of the Army (Army) installations. The IRP is the Army's environmental response authority under CERCLA of 1980, as amended by SARA of 1986. As delegated by Executive Order 12580, the

Army is responsible for determining response actions, consistent with the National Contingency Plan (NCP) (40 CFR Part 300), necessary for the abatement of contamination resulting from releases of hazardous substances.

The Assistant Chief of Engineers was designated as the responsible proponent for the Department of the Army Environmental Program. The USAEC, formerly USATHAMA, is an operating entity for the Army Staff, under supervision of the Director of Environmental Programs. The task of compiling this document was performed under the auspices of USAEC.

Fort Sheridan was recommended to the Secretary of Defense for closure by the Commission on Base Realignment and Closure (BRAC). To support Army decisions regarding preparation of the property for release, USAEC is responsible for implementing environmental studies and restoration activities (if needed) before property transfer. The Base Closure Division (BCD) of USAEC plans, directs, coordinates, and controls environmental investigation projects in support of the Army BRAC Program. These studies will comply with CERCLA, SARA, and the NCP, and will be conducted in consultation with the IEPA and USEPA.

Preliminary assessments of Fort Sheridan, conducted in 1982 and 1989, identified several areas on the installation affected by previous post landfilling activities; storage and handling of petroleum, oils, and lubricants (POL), as well as other motor pool wastes; polychlorinated biphenyl (PCB)-containing electrical equipment; and storage and handling of pesticides (Gross et al., 1982; and Argonne National Laboratory, 1989). The nature and duration of these activities at Fort Sheridan justify conducting an RI/FS to verify and quantify the nature and extent of associated constituents,

perform human health and environmental risk assessments, and evaluate remedial action alternatives leading to individual study area response actions, if necessary.

1.2.2 FORT SHERIDAN LOCATION

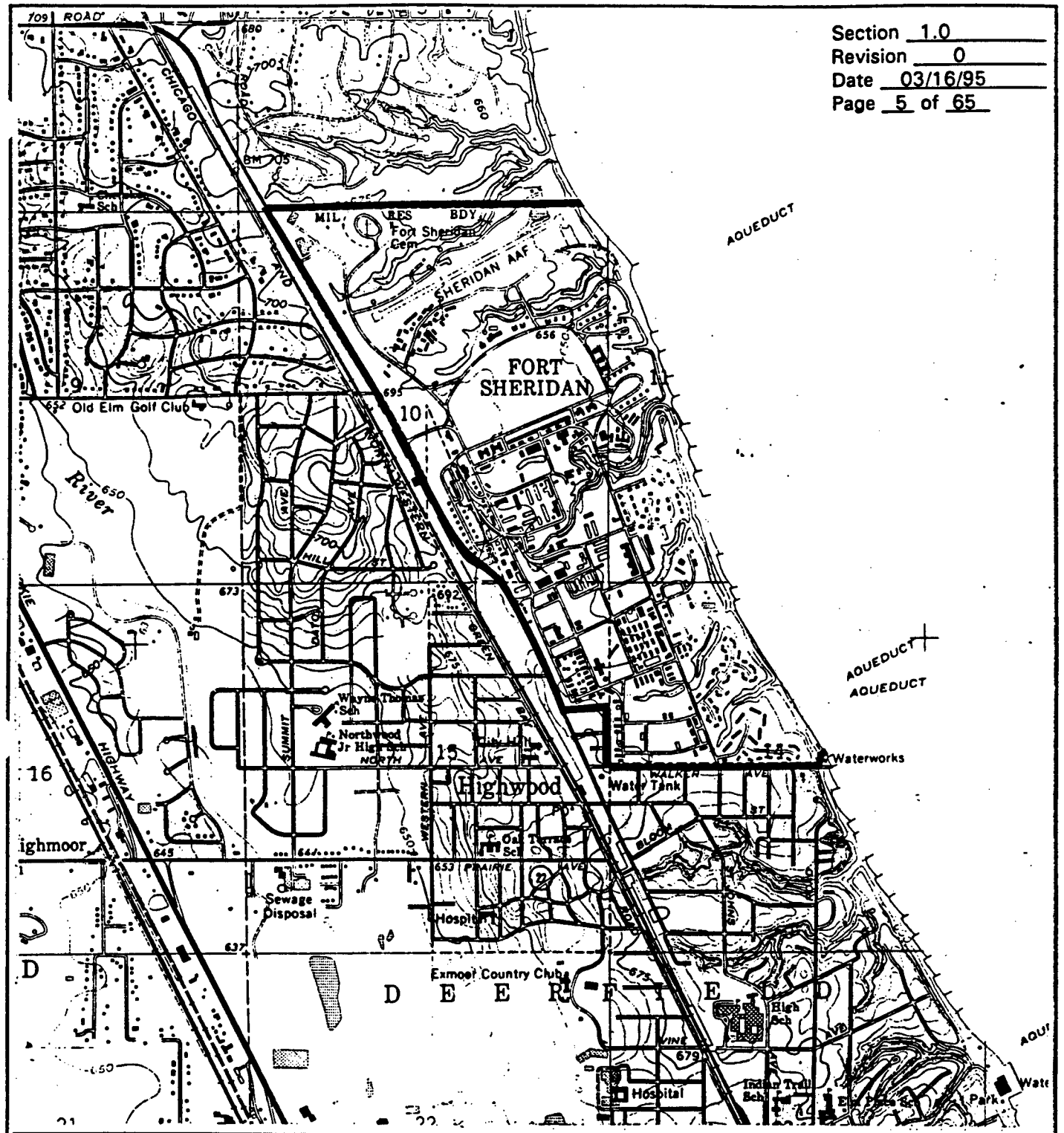
Fort Sheridan is located along the western shore of Lake Michigan, approximately 25 miles north of Chicago, Illinois (Figure 1-1). The installation is roughly rectangular in shape and extends 9,500 feet (ft) by 3,500 ft, along its long and short axes, respectively, encompassing an area of 695 acres. The site is adjacent to three suburban areas, Highwood to the west, Highland Park to the south, and Lake Forest to the north.

1.2.3 NATURAL HISTORY

Topography

Fort Sheridan lies along the western shore of Lake Michigan. The Fort is approximately 50 ft above Lake Michigan. The topography is relatively flat and dissected by several east-west oriented ravines. The lake side of the base terminates in a bluff or embankment which extends the full length of the boundary and beyond. The beach at the foot of the bluff is approximately 20 to 50 ft wide and is composed of sand to boulder-sized material with the coarser fraction dominant. Elevations, exclusive of the beach, range from about 650 to 695 ft above mean sea level (msl).

With few exceptions, the ravines are largely undisturbed and contain trees and other natural vegetation. In large part the original surface character of Fort Sheridan has been altered by construction activities including buildings, roads, parking lots, and the post golf course. A few of the ravines have been altered either by use as landfills or construction of roads for access to the lake shore.





QUADRANGLE LOCATION

Project #490-2087
Adapted From USGS Topographic Quadrangle:
Highland Park, Illinois, 1980.

ESE Environmental Science & Engineering, Inc.

0 2000
feet

Figure 1-1

Site Location

Quality Assurance Project Plan

Fort Sheridan
Fort Sheridan, Illinois

Surface Water Hydrology

Surface water runoff flows either into the nearest ravine or into the installation's storm sewer system; both ultimately discharge into Lake Michigan. Main storm drains underlie branches of Bartlett and Wells Ravine. Surface ditches along roadways and branch storm sewers channel water into main storm sewers. A small pond is located at the north end of the installation and is stocked for sport fishing for base residents.

Geology

The surficial geology of the northern Illinois area is the result of the Wisconsin glacial period of Pleistocene Age. The maximum southerly extent of the glacier occurred during Woodfordian Time. As the ice sheet retreated, glacial till was deposited. The till in the Fort Sheridan area consists of a calcareous gray clayey material.

Regional Geology

Fort Sheridan is located within the Lake Border Morainic System of the Central Lowland Physiographic Province. This system consists of five closely-spaced moraines that are parallel except near the Wisconsin state line where they appear to overlap. Specifically, the Fort is located on the easternmost moraine, Highland Park Moraine, in southern Lake County.

The till material deposited in the Fort Sheridan region has been classified as the Wadsworth Till Member of the Wedron Formation. This till consists mostly of gray clayey material with isolated pockets and lenses of sand, gravel, or silt within the till. Deposition of the Wadsworth Till Member probably occurred during several fluctuations of the ice margin (Johnson, W.H., et al, 1985).

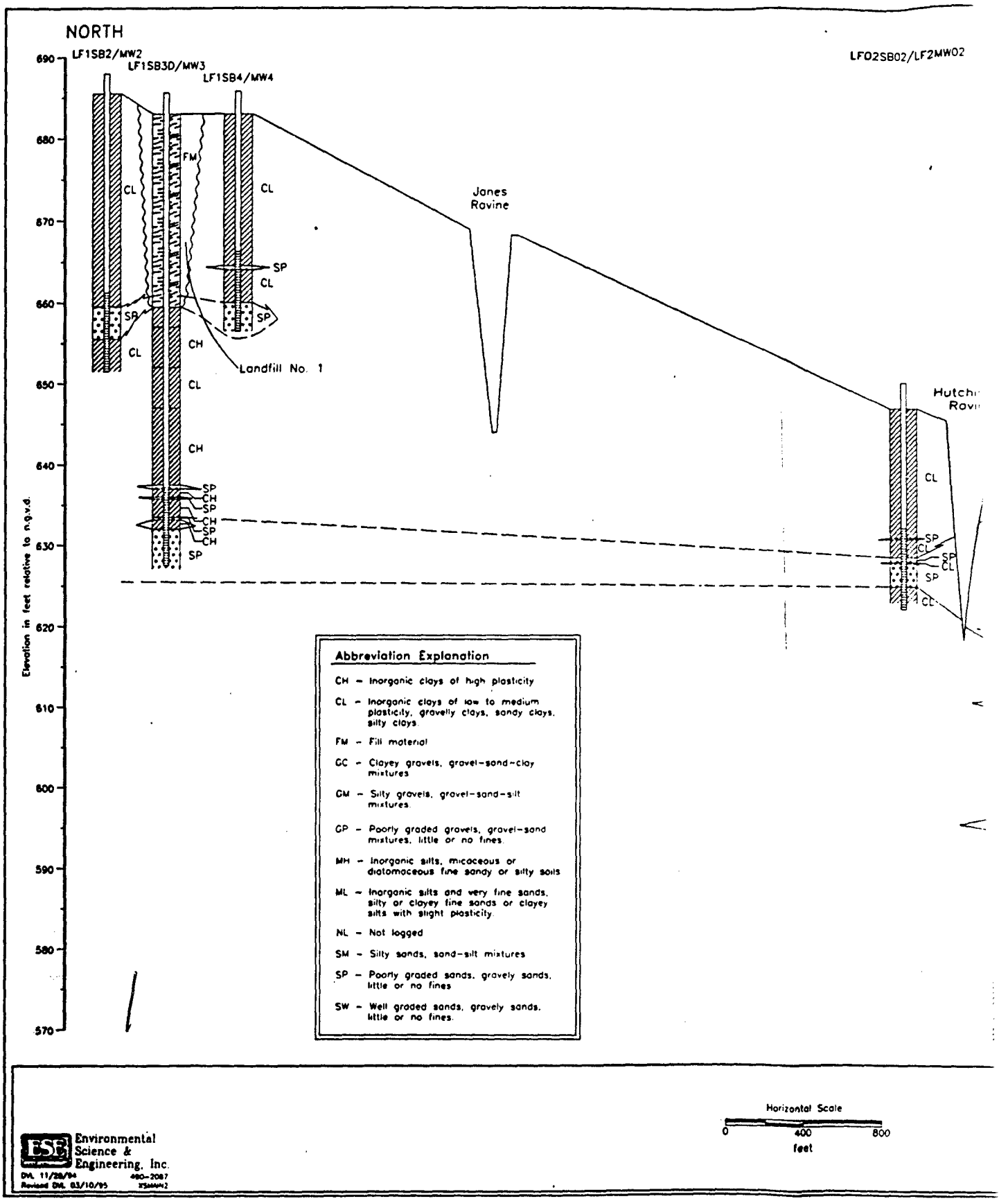
Underlying the Wadsworth Till is dolomite of Silurian Age. Specifically, this dolomite has been classified as the Niagaran Series. The dolomite from the Niagaran and underlying Alexandrian Series is locally known as the shallow dolomite aquifer. The Ordovician Maquoketa Group consisting of non-water bearing shales separates the Silurian dolomites from the deeper bedrock aquifer. However, significant downward leakage has been reported in the Maquoketa shales (Argonne National Laboratory, 1989), (i.e., the aquifers are not hydraulically isolated from each other).

Site Geology

The topography at Fort Sheridan is relatively flat, with a gentle easterly slope terminating in a bluff that runs along Lake Michigan. The flatness of the area is interrupted by ravines eroded into the till which extend towards Lake Michigan. These ravines, which drain Fort Sheridan, are generally perpendicular to the lake's shoreline.

The composition of the unconsolidated material at the Fort was determined through a review of the boring logs compiled during the initial assessment. This review identified the unconsolidated material at the Fort to be composed primarily of a clayey till. Small isolated zones of sand, gravel, and/or silt are scattered throughout this till material. Overlying the clayey till is a beach sand along the shoreline and fill material in many areas on the bluff.

Geologic cross-sections have been constructed for each of the landfill areas and one north-south cross-section extending the length of Fort Sheridan has been constructed. Figure 1-2 shows the north-south cross-section.

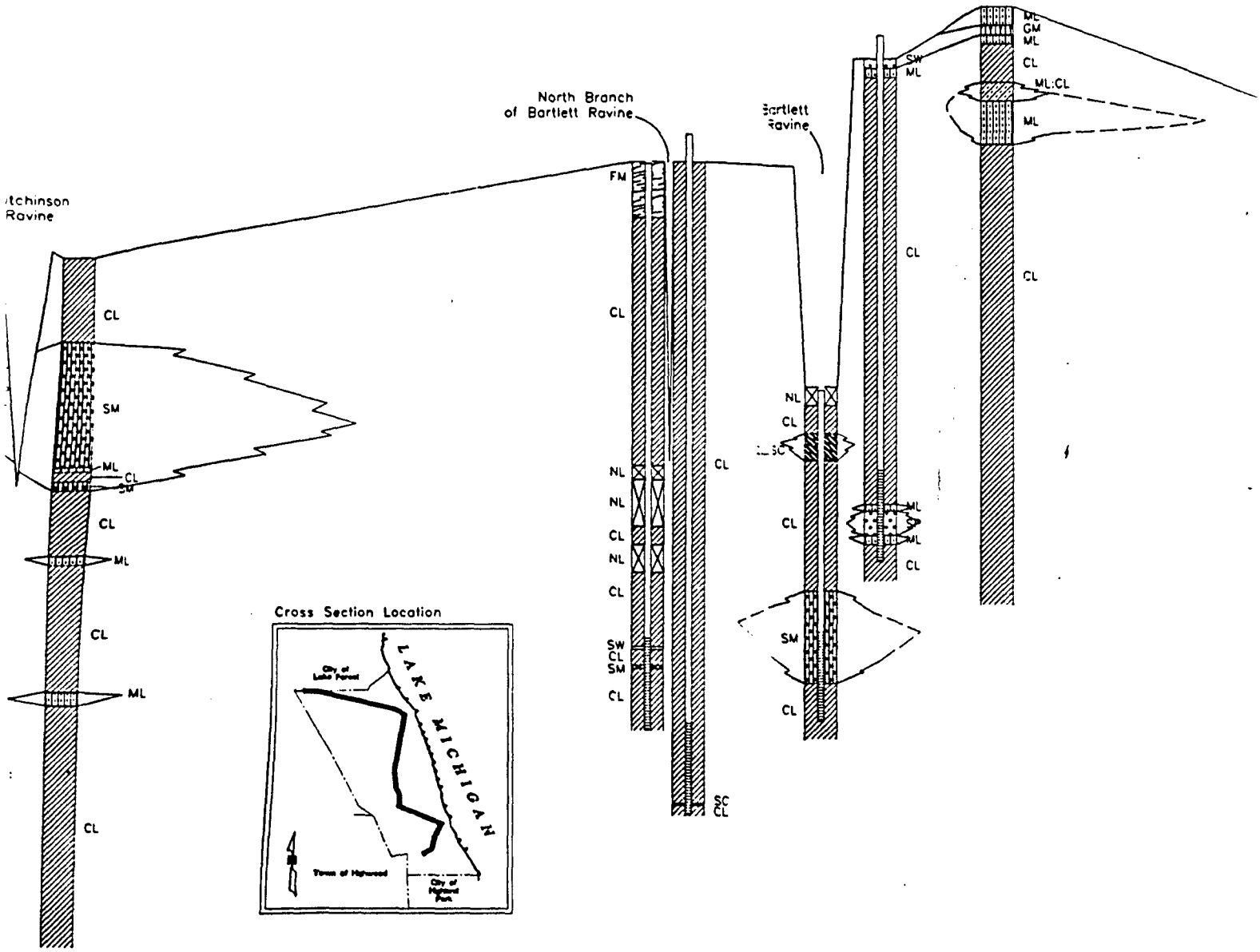

NORTH
LF1SB2/MW2
LF1SB3D/MW3
LF1SB4/MW4
LF2SB02/LF2MW02
690
680
670
660
650
640
630
620
610
600
590
580
570
Elevation in feet relative to n.g.v.d.
FM
CL
SP
CH
Landfill No. 1
Janes Ravine
Hutchi
Ravi
Abbreviation Explanation
CH – Inorganic clays of high plasticity
CL – Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
FM – Fill material
GC – Clayey gravels, gravel–sand–clay mixtures
GM – Silty gravels, gravel–sand–silt mixtures.
GP – Poorly graded gravels, gravel–sand mixtures, little or no fines.
MH – Inorganic silts, micaceous or diatomaceous fine sandy or silty soils
ML – Inorganic silts and very fine sands, silty or clayey fine sands or clayey silts with slight plasticity.
NL – Not logged
SM – Silty sands, sand–silt mixtures
SP – Poorly graded sands, gravely sands, little or no fines
SW – Well graded sands, gravely sands, little or no fines.
Horizontal Scale
0
400
800
feet
ESE Environmental Science & Engineering, Inc.
DWL 11/28/94 480-2087
Revised DWL 03/10/95

W02 LF02SB03

LF3SB5/MW5
LF3SB4/MW4d

LF5SB04D/MW04D
LF5MW02

LF5SB01



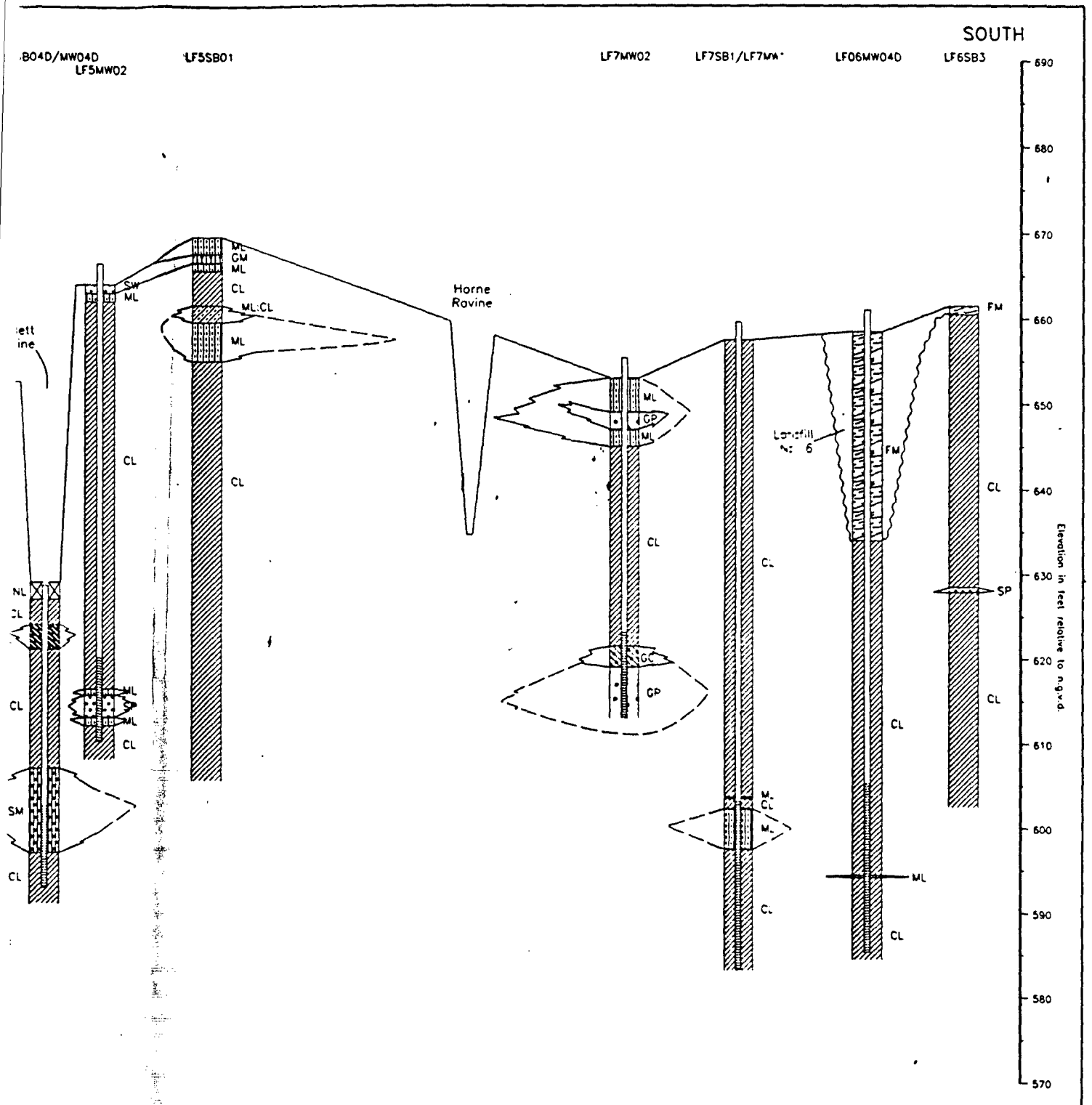


Figure 1-2
North-South Cross Section
Quality Assurance Project Plan
Fort Sheridan
Fort Sheridan, Illinois

The cross-sections illustrate the predominance of clayey sediments underlying Fort Sheridan and the occurrence of laterally discontinuous, thin sand lenses. The sediments deposited by glacial and sub-glacial activity during the Pleistocene epoch, and predominantly consist of sediments deposited during fluctuations of glacial lakes. Sand lenses occurring within the clays probably represent deposition in east-west oriented fluvial channels.

Hydrogeology

The sediments underlying Fort Sheridan consist predominantly of clay to silty clay with occurrences of thin (generally less than 3 ft in thickness) and laterally discontinuous silt, sand, or gravel lenses. Figure 1-2 illustrates the laterally discontinuous sand beds and the predominance of clay. The portion of the section between borings LF1SB03D, LF2SB02, and LF2SB03 shows a possibly laterally extensive sand unit ranging from 6 to 16 feet in thickness. There is approximately 0.5 mile between LF1SB03D and LF2SB02 for which no information is available. While the similar elevations of sand beds at these two locations indicate lateral continuity, the lack of data between locations and lateral discontinuity elsewhere on the base suggest these may not be continuous as indicated.

Assuming the lenticular sand beds are a cross-sectional representation of channel sands, the indication is these units were deposited by streams flowing to (or from) the general direction of Lake Michigan. Since these channel sands are stratigraphically and topographically higher to the west, groundwater within the sands apparently would flow from west to east, toward Lake Michigan. Possible channel sands occur at many different elevations in Figure 1-2 indicating numerous channels may be present in the area of the installation.

Due to slow recovery rates on monitor wells, accurate static water levels could not be obtained. Groundwater levels have been obtained from piezometers previously installed by Zimmer Howell Engineering in 1984 as part of a sanitary sewer investigation. Piezometer locations and groundwater elevations are shown in Figure 1-3. These data show that local groundwater flow appears to be into the ravines and regional shallow groundwater flow is to Lake Michigan. Static water level varied from 2 to 3 feet below ground level (ft-bgl) to 15 ft-bgl.

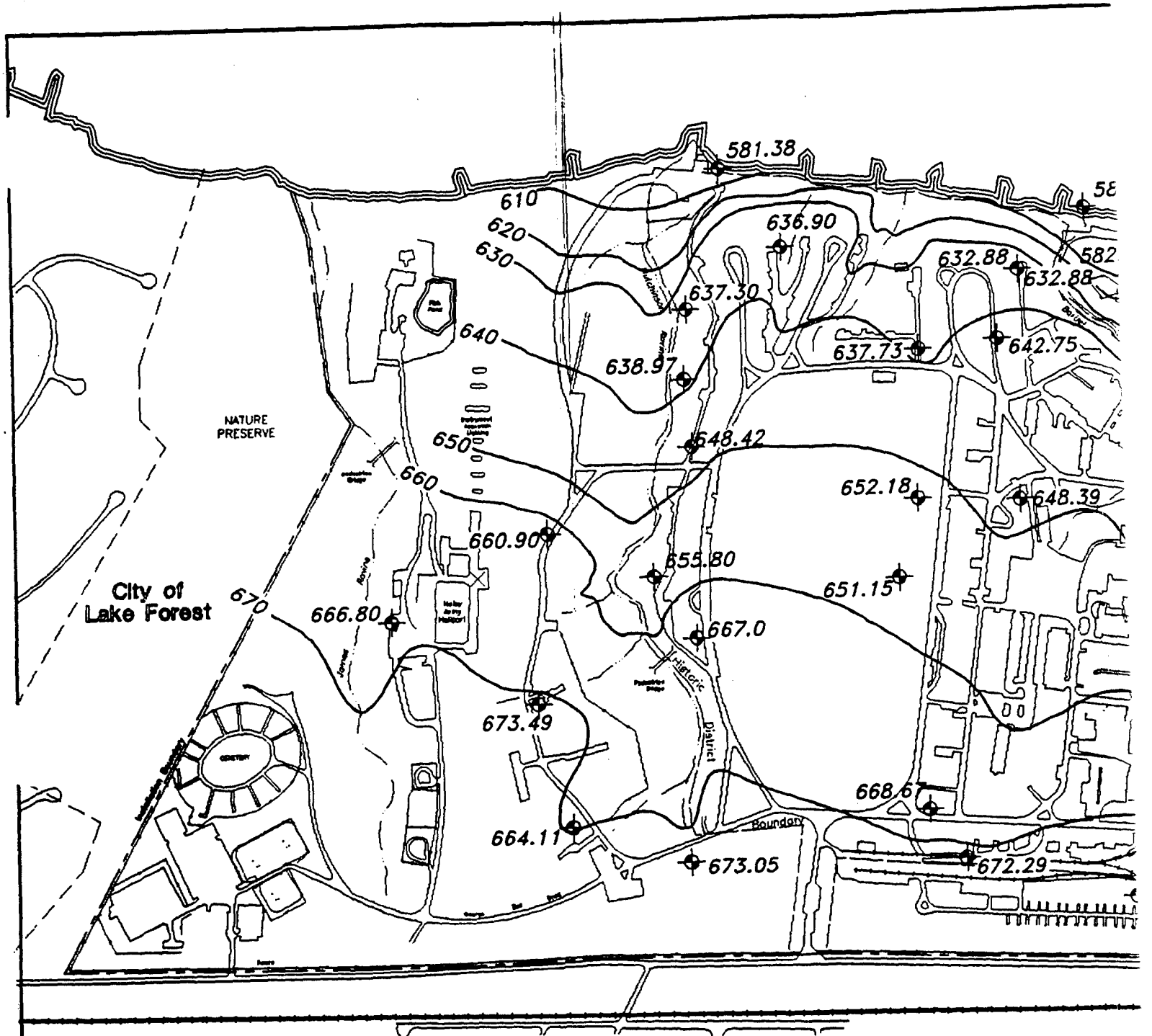
Several monitor wells appeared to be artesian all or part of the time during field investigations. The artesian character of these wells may be explained by their topographic and down-hydraulic gradient location. The remaining deeper-screened wells located at the beach in Landfill 2 in topographically low areas are not artesian.

1.2.4 SITE HISTORY

Site historical information is, in part, derived from reports prepared by Argonne National Laboratory (October 1989), E.C. Jordan Company (July 1990), Environmental Science & Engineering, Inc. (August 1987), Chemical Systems Laboratory, and Environmental Technology Division (May 1982).

The Potawatomi Indian Tribe originally lived in the area until the Treaty of 1836. The tribe later moved west of the Mississippi River, the last tribe to leave the area.

The Fort, named for General Phil Sheridan, was established in 1888 in the wake of the Great Chicago fire of 1871 and at the request of Chicago city leaders following labor riots of 1886. Land was donated to the government for a token fee of $10 by three members of the Commercial Club of



Approximate Piezometer Location

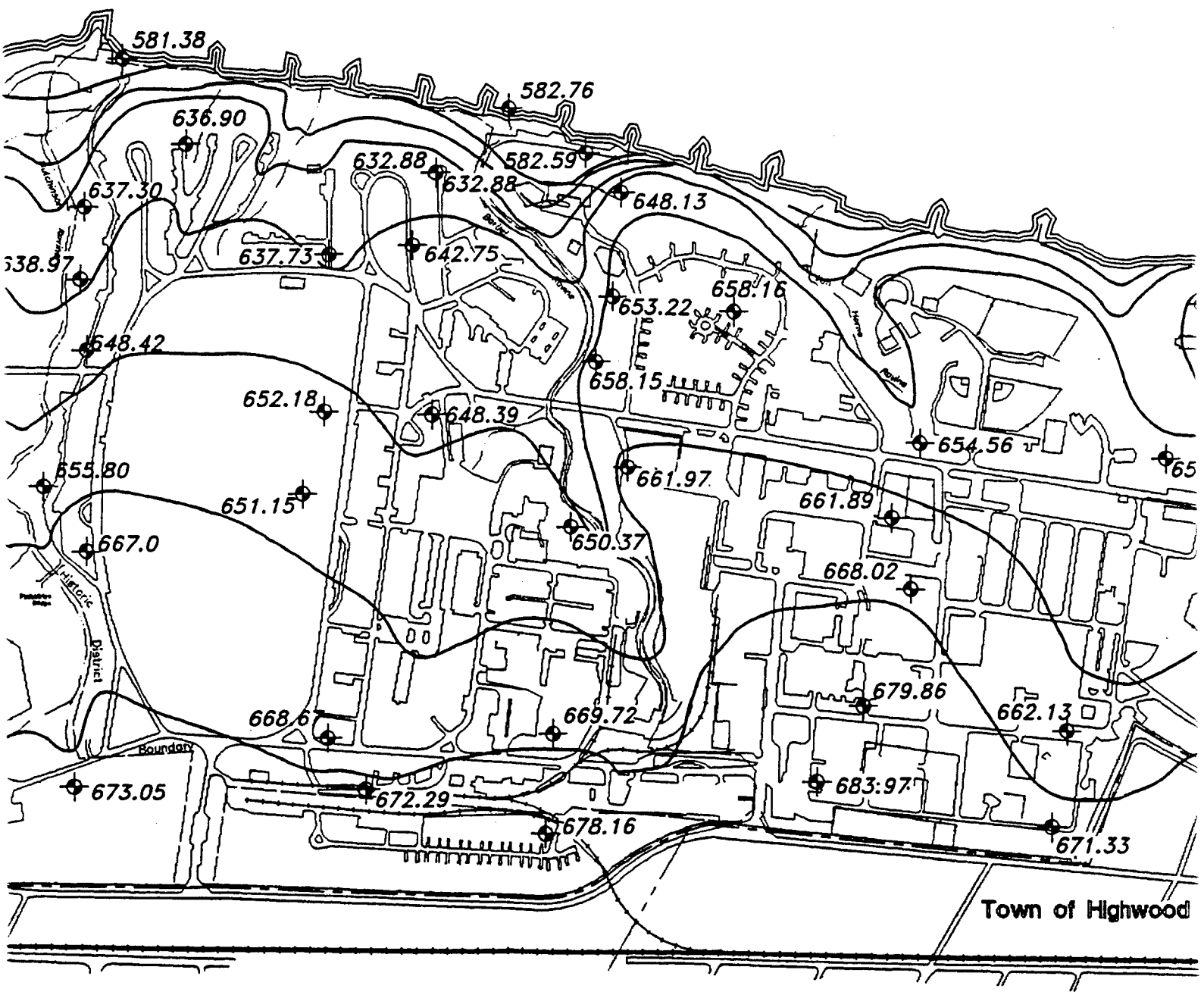
673.05 Groundwater Elevation in feet relative to N.G.V.D. (data collected 11/28/84)

0 700 1400
feet

Environmental Science & Engineering, Inc.

DVL 11/28/94 490-2087
Revised DVL 03/14/95 FSGWPZL2

Adapted from Official Post Map, Directorate of Engineering and Housing, Fort Sheridan, Illinois, January 6, 1989



ɔmeter Location

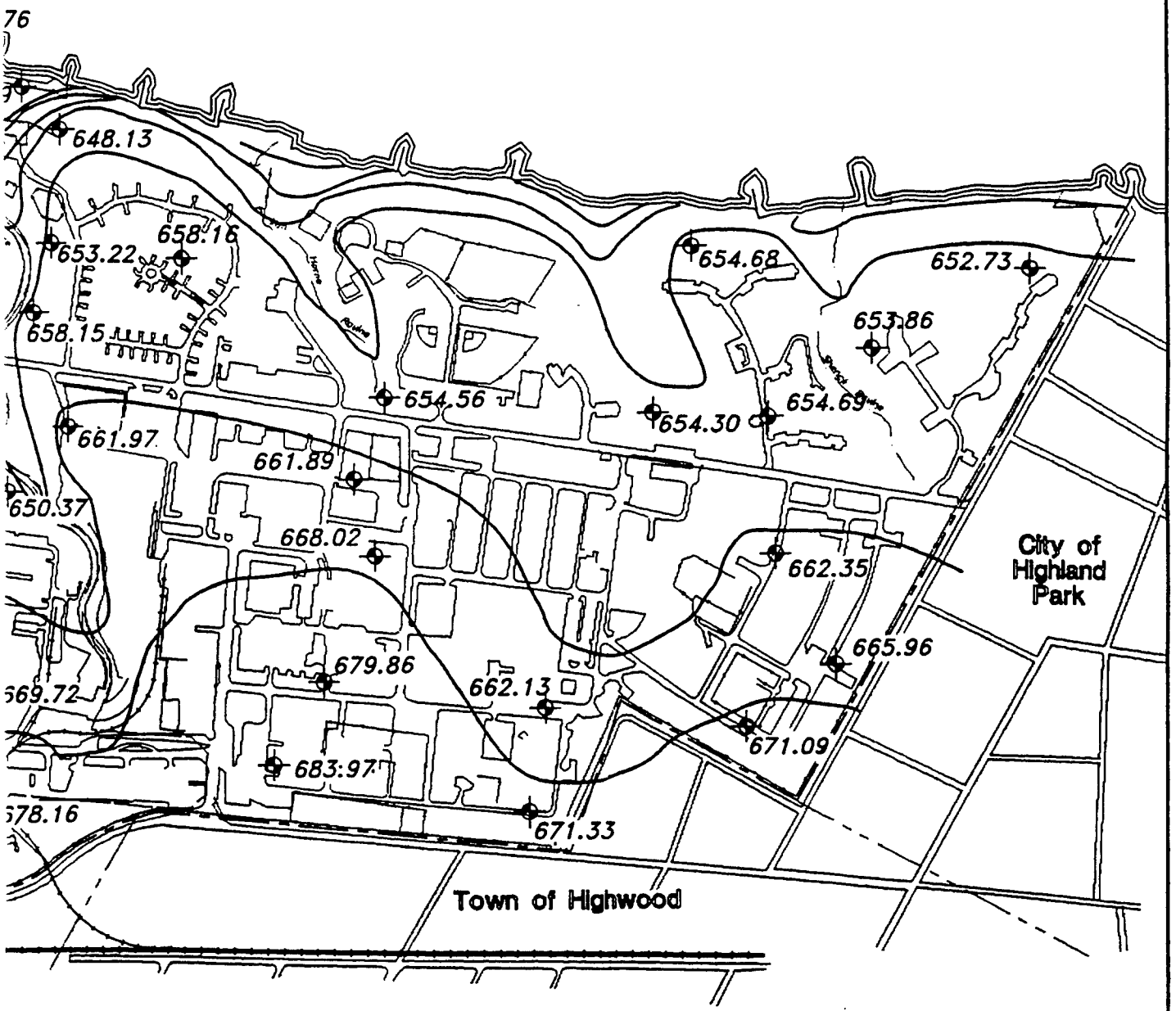
ıtion in feet
).
1/28/84)

0 700 1400
feet

NOTE: All Locations & contours are approximate. Adapted from E.C. Jordan drawing 6075-04 Fig.1-3

Engineering and Housing, Fort Sheridan, Illinois, January 6, 1989

Figure
Interpı
Elevat
Quality
Fort Si
Fort Sher



NOTE: All Locations & contours are approximate. Adapted from E.C. Jordan drawing 6075-04 Fig.1-3

Figure 1-3
Interpretive Groundwater Elevation Contours 11/28/84
Quality Assurance Project Plan
Fort Sheridan
Fort Sheridan, Illinois

3

Chicago. The donors were Adolphus Bartlett, Charles Hutchinson, and John Janes. Three ravines on the Fort were later named for these individuals.

Troops trained at the Fort served in the Spanish-American War in 1898, the Mexican War in 1913, and World Wars I and II. Fort Sheridan was a training center for anti-aircraft artillery units during World War II.

From the 1950s until 1974 the Fort served as maintenance and supply center to NIKE air-defense missile systems for Chicago, Gary, Detroit, Minneapolis-St. Paul, and Milwaukee air-defense network. Three NIKE missile silos were installed in the northern part of the Fort. These silos have been largely stripped of equipment and abandoned.

1.2.5 CURRENT USE

Fort Sheridan has been closed since 1993 pursuant to the Base Realignment and Closure Act of 1988. Approximately 90 acres are now owned by the U.S. Army Reserve and used for equipment storage and disbursement, training, and administrative functions. Approximately 200 acres are owned by the Navy and are used for family housing. The remaining property has a small Army caretaker force pending eventual disposal of the property. Approximately 200 acres of this property is leased to the local Lake County Forest Preserve for a golf course. There are approximately 425 structures including administrative offices, maintenance and storage buildings, barracks, and family housing on the entire former Fort Sheridan property. The base also contains a fire station, clinic, and cemetery.

Future use of the remaining Army property is being defined by the Fort Sheridan Joint Planning Commission, comprised of representatives of the

neighboring towns of Lake Forest, Highwood, and Highland Park. The property is expected to be assigned to residential and recreational uses.

1.2.6 PREVIOUS INVESTIGATIONS

A preliminary environmental assessment was performed in 1981 by Chemical Systems Laboratory, Environmental Technology Division, Installation Restoration Branch of Aberdeen Proving Ground, Maryland, and the results presented in "Preliminary Assessment of Fort Sheridan and Joliet Training Area, Illinois" (1982).

Argonne National Laboratory (ANL), Argonne, Illinois, performed an enhanced preliminary assessment in 1989. The results of this study were reported in "Enhanced Preliminary Assessment Report: Fort Sheridan, Fort Sheridan, Illinois" in October 1989. In addition to providing an excellent background history of Fort Sheridan, this report also identified areas of known or suspected contaminant releases. The report concludes that no imminent and substantial environmental threat exists from present or past activities.

Fourteen areas were identified in the ANL report as having a potential, limited environmental impact. These areas include pesticide storage areas, underground storage tank (UST) areas, and abandoned landfills. The ANL report also stated no major spills or releases have been documented; however, small specific releases may have occurred at several sites.

Based on the findings of these preliminary assessments, and at the request of USAEC, E.C. Jordan Company prepared a technical plan for a RI/FS, "Environmental Survey Plans, Fort Sheridan, Illinois, Final Technical Plan"

(1990). This report identified 42 sites, grouped into 12 categories, which required further investigation. These 12 categories are as follows:

1. Landfills (LF),
2. Coal storage areas (CSA),
3. Underground storage tanks (USTs),
4. Vehicle and equipment storage areas (VES),
5. Miscellaneous yard areas (MYA),
6. Buildings,
7. NIKE missile installations,
8. Storm drainage and ravine systems,
9. Pole-mounted transformers,
10. Radon in housing units,
11. Asbestos-containing materials in buildings, and
12. Small arms and coastal artillery impact areas.

ESE was contracted to implement the E.C. Jordan Company technical plan. Field investigations were performed from October 1990 through October 1991, to implement work plans prepared by E.C. Jordan Company in July 1990 and amended by ESE in the following documents:

1. Amendment to Final Technical and Sampling and Analysis Plan for Underground Storage Tank Investigation, Fort Sheridan, Illinois, November 1990.
2. Amendment to Final Technical and Sampling and Analysis Plans for Landfill Investigations, Fort Sheridan, Illinois, October 1990.
3. Amendment to Final Technical and Sampling and Analysis Plan for Storage Area Investigations, Fort Sheridan, Illinois, September 1990.

4. Amendment to Final Technical and Sampling and Analysis Plan for Hazardous Materials, Radon, and Asbestos at Fort Sheridan Illinois, April 18, 1991.
5. Letter Amendments to Final Technical and Sampling and Analysis Plan for Storm Sewer and Ravine Sampling dated April 16, 1991 and May 6, 1991.
   Addendum to Final Sampling and Analysis Plan, Storage Area Investigations dated October 31, 1991.
6. Addendum to Final Quality Assurance Program Plan dated October 31, 1991.
7. Site-Specific Health and Safety Plan (Storm Sewer and Missile Silo sampling) April 15 and July 19, 1991.

The ESE document Draft Final RI Report Risk Assessment (RA)/FS, Fort Sheridan, Illinois dated June 10, 1992 (ESE, 1992), subsequently referred to as the RI-RA/FS Report, comprises the documentation of these field efforts.

1.2.7 STUDY AREA DESCRIPTIONS

A total of 38 separate study areas were identified for investigation; these are grouped into categories similar to those designated by E.C. Jordan and include the following:

1. Landfills - 7 study areas,
2. Coal storage areas - 4 study areas,
3. Underground storage tank areas - 3 study areas,
4. Vehicle and equipment storage areas - 6 study areas,
5. Miscellaneous yard areas - 6 study areas,
6. Buildings - 7 study areas,
7. NIKE missile silos - 3 study areas, and
8. Pole-mounted transformers.

Most of the study areas and investigative methodologies were identified in the E.C. Jordan report. ESE, with the approval of USATHAMA, modified several of the E.C. Jordan recommendations.

Landfills

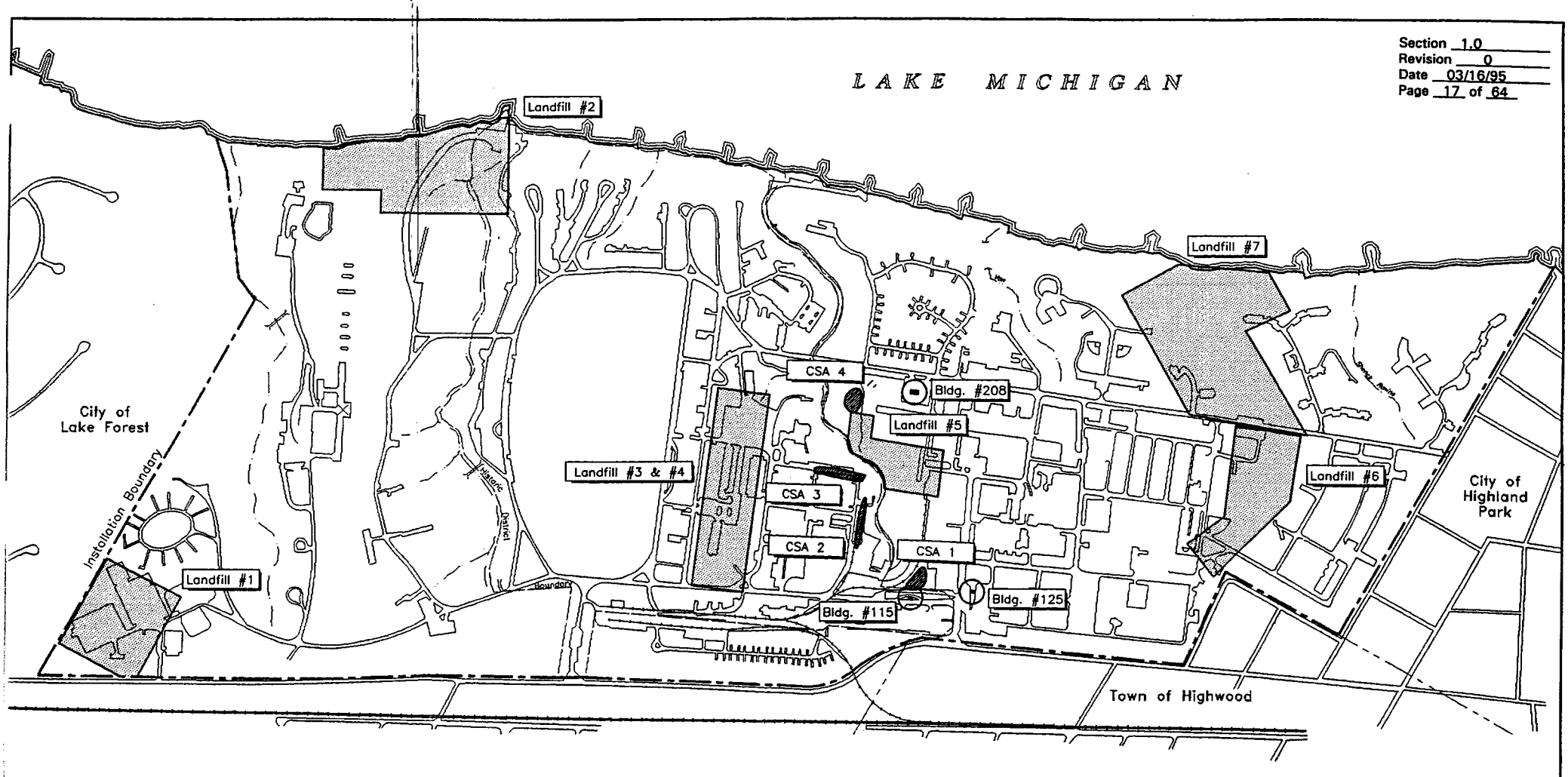
Locations of seven former landfills have been identified during the previous work at Fort Sheridan. These landfills are located in ravines throughout the Fort, and have been designated from north to south 1 through 7, with Landfill 1 along the northern boundary and Landfill 7 near the southern base boundary (Figure 1-4). The landfills have been covered over with topsoil and seeded or paved. With the exception of Landfill 2, the landfills are underlain by storm drains. Few visible signs remain of former landfill activity. Investigations in these areas included surface geophysical surveys, soil borings, and monitor well installations, and soil and groundwater sampling.

No formal records were maintained on materials dumped into landfills and the contents of an individual landfill cannot be known with any certainty. In general, the contents of landfills are likely to include the following:

1. Industrial and domestic wastes,
2. Soil and liquid wastes, and
3. Cinders, rubble, and building debris

In addition to these materials (or wastes), Landfill 2 may contain unexploded ordnance as documented in records of the Fort Sheridan museum.

A total of 45 soil borings, in two separate phases, were completed around seven landfills. Forty-three were converted to monitor wells. Thirty-eight borings, 36 of which were converted to monitor wells, were installed in



Environmental Science & Engineering, Inc.

DVL 11/28/94 490-2087
Revised DVL 03/14/95 FSLFCSA2

Adapted from Official Post Map, Directorate of Engineering and Housing, Fort Sheridan, Illinois, January 6, 1989

0 700 1400
feet

Figure 1-4
Locations of Landfills, Coal Storage Areas, and UST Investigations
Quality Assurance Project Plan
Fort Sheridan
Fort Sheridan, Illinois

Phase 1. Seven borings which were converted to wells were installed in Phase 2.

Four wells were installed within two former landfills (Landfill 1 and 6). The remaining borings/wells were located adjacent to landfills.

Monitor well locations were selected based on the apparent direction of groundwater flow inferred from topography and static water level studies conducted by E.C. Jordan. Well locations were placed hydraulically upgradient and downgradient based on this information.

Landfill 1

Landfill 1, located in the northwestern corner, is in a former tributary to Janes Ravine and is currently the site of parking lots and the Army Reserve vehicle maintenance shop and yard. Disposal operations were probably initiated here prior to the 1940s and continued to the early 1950s. The landfill was also used for open burning.

Six soil borings were completed at Landfill 1 and monitoring wells were installed in five of these borings. Two borings and wells were installed within the former landfill and four borings and three wells installed adjacent to the former landfill.

Landfill 2

Landfill 2 is located along the bluff overlooking Lake Michigan in the northeast corner of the Fort. Part of the former landfill may underlie portions of a golf course and landing strip. Disposal operations appear to have occurred prior to World War I and the area was used as a small arms firing

range until the 1950s. Ordnance were reportedly disposed of at Landfill 2 by burning in demolition pits and possibly detonation.

Fifteen borings were completed and monitoring wells were installed in fourteen of these borings in two investigative phases. In Phase 1, four wells were located along the beach with one deep and one shallow well installed at each location for a total of eight wells installed. Three borings were completed on the embankment above the beach, adjacent to the landfill. Monitoring wells were installed in two of the three borings. In Phase 2, an additional four wells were installed at two locations on the beach. No borings were placed within the former landfill.

Landfills 3 and 4

Landfills 3 and 4 are adjacent to, and occupy a portion of, a tributary to Bartlett's Ravine in the middle portion of the Fort. The area is now a series of parking lots. Disposal operations at Landfill 3 occurred prior to 1947 and prior to 1967 at Landfill 4.

Five borings and monitoring wells were installed around Landfills 3 and 4 at separate locations. No borings or wells were placed within the former landfill.

Landfill 5

Landfill 5 is the smallest of the landfills and lies along the western embankment of Bartlett's Ravine. The area is now a parking lot and equipment storage area. The landfill was in operation in the mid-1960s, but may have also been used in the early 1900s.

A total of five borings and monitoring wells were installed adjacent to the former landfill at four separate locations, one of these wells was installed during Phase 2. At one location, LF5MW04, two separate wells, one deep (D) and one shallow (S), were installed.

Landfill 6

Landfill 6 lies in the southwestern corner of the Fort and, along with Landfill 7, completely occupies the western onpost portion of Wells Ravine. The area is now covered with grass and sparse trees. Disposal operations occurred in the 1960s with materials consisting, in part, of debris from barracks demolition.

Five borings and wells were installed at Landfill 6. Two wells were installed within the former landfill, one deep and one shallow at the same location, the remaining wells were installed adjacent to the landfill.

Landfill 7

Landfill 7 lies east of Landfill 6 in Wells' Ravine and ends at the bluff along the shore of Lake Michigan. Landfill 7 is covered with a domed cap of native soil and has a storm drain around the edge to collect runoff from precipitation. Seven gas vent pipes have been installed to release methane from bacterial action. A curtain drain with a 6-inch diameter collection pipe is installed across the face of the landfill to intercept leachate which might otherwise migrate to Lake Michigan. Lying beneath the landfill at the bottom of the former ravine is a storm drain which terminates at Lake Michigan. Landfill 7 was used as a disposal site in the 1940s, 1960s, and 1970s. Open burning was conducted and coal ash was disposed of in Landfill 7. This landfill is the most likely of the seven to have received transformers.

Four groundwater monitor wells were installed by a contractor around Landfill 7 prior to 1986. Water quality results from previous sampling of these wells, as reported by Argonne National Laboratories, indicate no analyses were performed for toxic compounds. Three of these wells were re-sampled as part of the RI.

ESE installed a total of nine monitoring wells around Landfill 7 at six separate locations in two phases. During Phase 1 four wells were installed at two locations on the beach below the landfill. One deep and one shallow well were installed at each of the three beach locations. One well was installed at each remaining location. During Phase 2, an additional two wells were installed at one beach location. No wells or borings were installed within the former landfill.

Coal Storage Areas (CSAs)

Four areas have previously been used to store coal to supply fuel for heating. Central heating, using natural gas, was installed prior to 1967 and coal is no longer used or stockpiled. The storage areas, designated CSAs 1-4 were included in the investigation. Polynuclear aromatic hydrocarbons (PAH) may have been leached from these stockpiles by infiltrating precipitation. Locations of these areas are shown in Figure 1-4.

The principal method of investigation for these areas involved the excavation of test pits using a backhoe. In addition, one soil boring was completed at CSA1. Nine test pits were planned for these areas and eight were excavated. One pit in CSA3 was not excavated due to its proximity to buildings and a swimming pool. The planned excavation depth for test pits was 15 ft. Due to the limitations of the equipment used, a maximum depth of 14.5 ft was obtained.

Coal Storage Area 1

CSA 1, located near buildings B137 and B115, covers about 1 acre. The site is currently grass-covered and a gravel parking lot occupies a portion of the area.

Two test pits, designated CSA1TP1 and CSA1TP2, were excavated to a depth of approximately 14.5 ft. One soil boring, CSA1SB01 was completed to a depth of 24 ft.

Coal Storage Area 2

CSA 2, located west of building B40 covers, with a long narrow strip, an area of about 0.5 acre. The site is presently grass covered and two USTs containing fuel are located in the area immediately west of B40. Two test pits, CSA2TP1 and CSA2TP2, are located at opposite ends of this area and were excavated to a depth of 14.5 ft.

Coal Storage Area 3

CSA3, located south of the swimming pool, occupies a long narrow strip parallel to Chapman Road. Three pits were originally planned, but only two were completed, CSA3TP1 and CSA3TP2. The third pit, CSA3TP1, located near the swimming pool and outlying buildings encountered a concrete slab at an approximate depth of 2 ft and was not completed to the planned depth of 14.5 ft. CSA3TP2 did not encounter this slab and was completed to 14.5 ft.

Coal Storage Area 4

The last coal storage area, CSA4, is located on Patten Road south of Bartlett Ravine. This CSA is circular and covers about two-thirds of an acre. Two pits, CSA4TP1 and CSA4TP2, were excavated to a depth of 14.5 ft.

Underground Storage Tank Areas

E.C. Jordan identified 37 USTs on Fort Sheridan and were all leak-tested prior to the RI (Figure 1-4). Based on the results of these tests, three sites were investigated by ESE for possible fuel and oil releases. Based on verbal communication with Directorate of Engineering and Housing (DEH) personnel, the leak tests conducted on USTs and piping at Buildings 115, 125, and 208 rendered inconclusive results. Reports submitted to the installation by the leak- testing contractor provided either no documentation of testing results or insufficient data to fully assess the integrity of the USTs or underground piping. In summary, the results of the leak tests at these three sites are as follows:

1. Building 115--No documentation on leak tests.
2. Building 125--One 12,000-gallon (gal) UST passed the leak test and there are no data on another 12,000-gal UST.
3. Building 208--USTs passed integrity tests although piping tests were inconclusive.

Seventeen borings were completed at these sites and 14 wells were installed in two phases of investigations.

Building 115

Three borings were completed and one monitoring well was installed during the RI.

Building 125

Six borings were completed and five wells were installed during Phase 1 and 2. During Phase 2, borings and monitor wells installed.

Building 208

Eight borings and wells were installed during Phase 1 and 2.

Vehicle and Equipment Storage Areas (VES)

Several areas have been identified where vehicles, drums, and other containers that may be associated with hazardous materials were stored.

Six vehicle and equipment storage areas, VES1, VES2, VES5, VES6, VES7, VES9, were investigated. Two additional storage areas near building 122 and near buildings 137, 137X, and 139 were also investigated. These locations are shown on Figure 1-5.

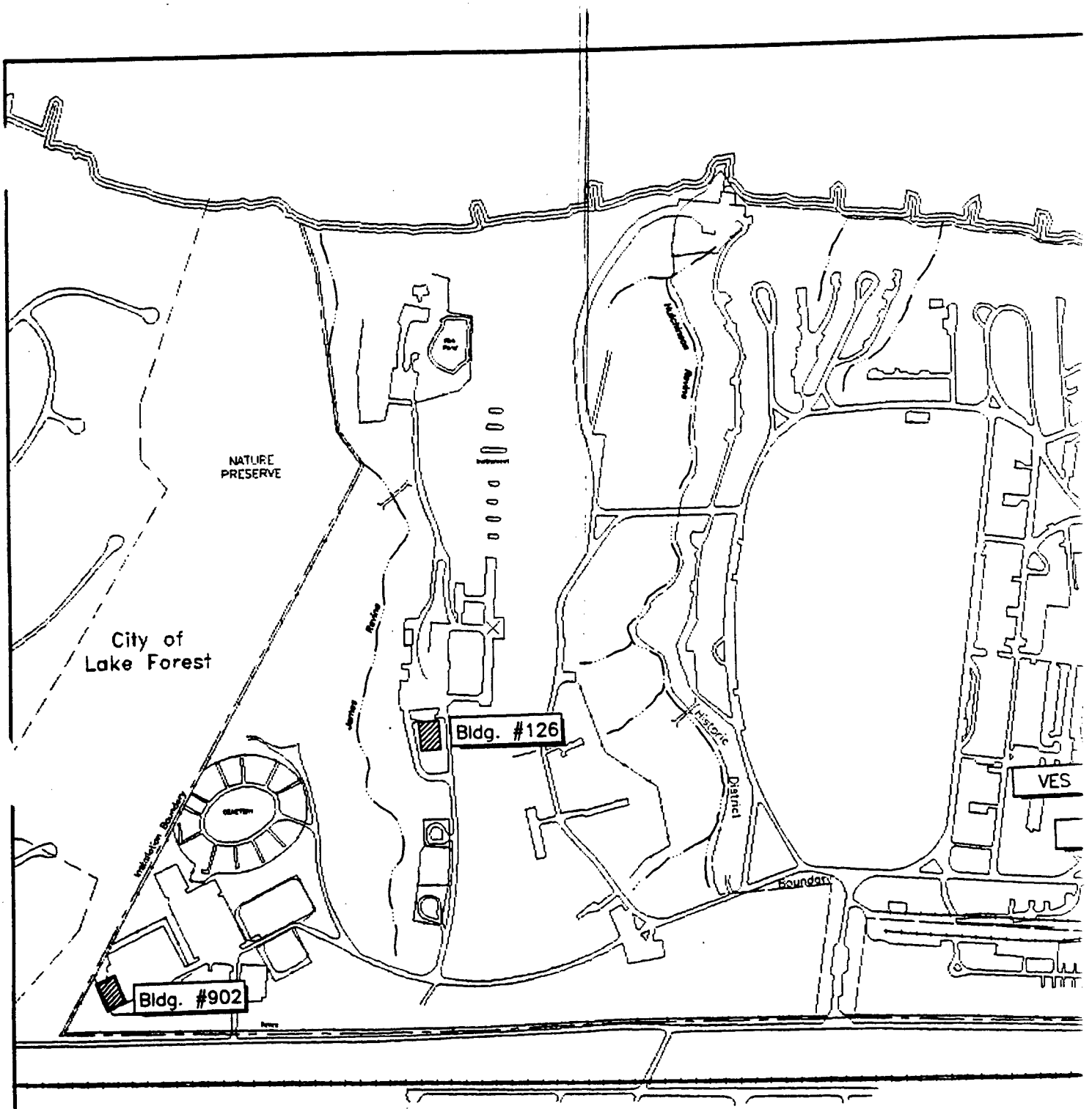
Investigations in these areas included both soil borings and test pits. Twenty-three test pits and 14 borings were completed, and two monitoring wells installed.

Vehicle and Equipment Storage Area 1

From the 1950s through 1989, this area was used for maintenance of automobiles. This area is presently an asphalt parking lot covering an area of about 500 by 120 ft and is located between Buildings 51, 55, 58, and 112. Three test pits were excavated to a depth of 14.5 ft.

Vehicle and Equipment Storage Area 2

VES-2 lies between Buildings 370 and 65 and is presently a gravel-surfaced parking area measuring 200 by 160 ft. Two test pits were excavated to a depth of 14.5 ft.

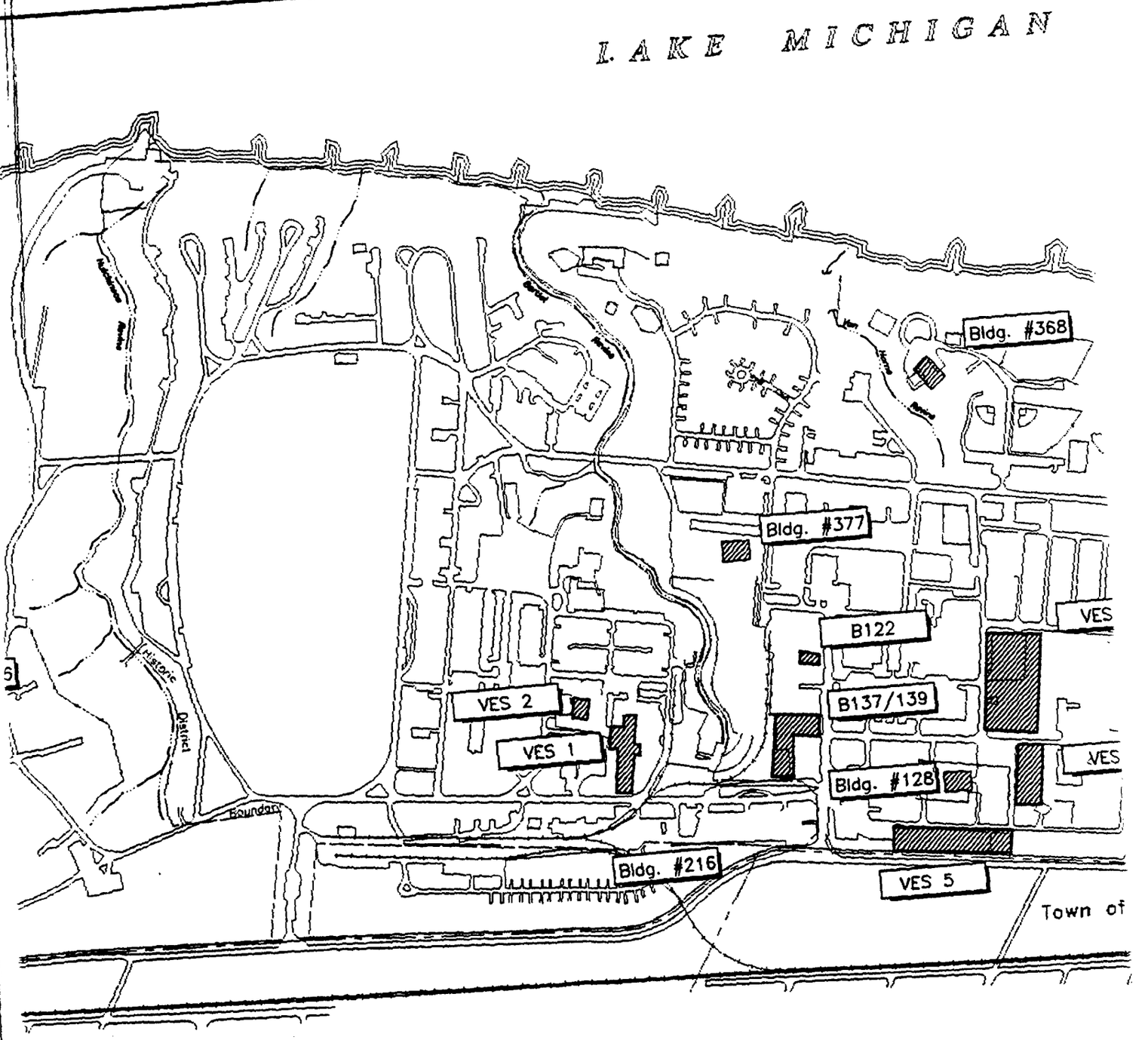


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feet

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Directorate of Engineering and Housing, Fort Sheridan, Illinois, January 6, 1989

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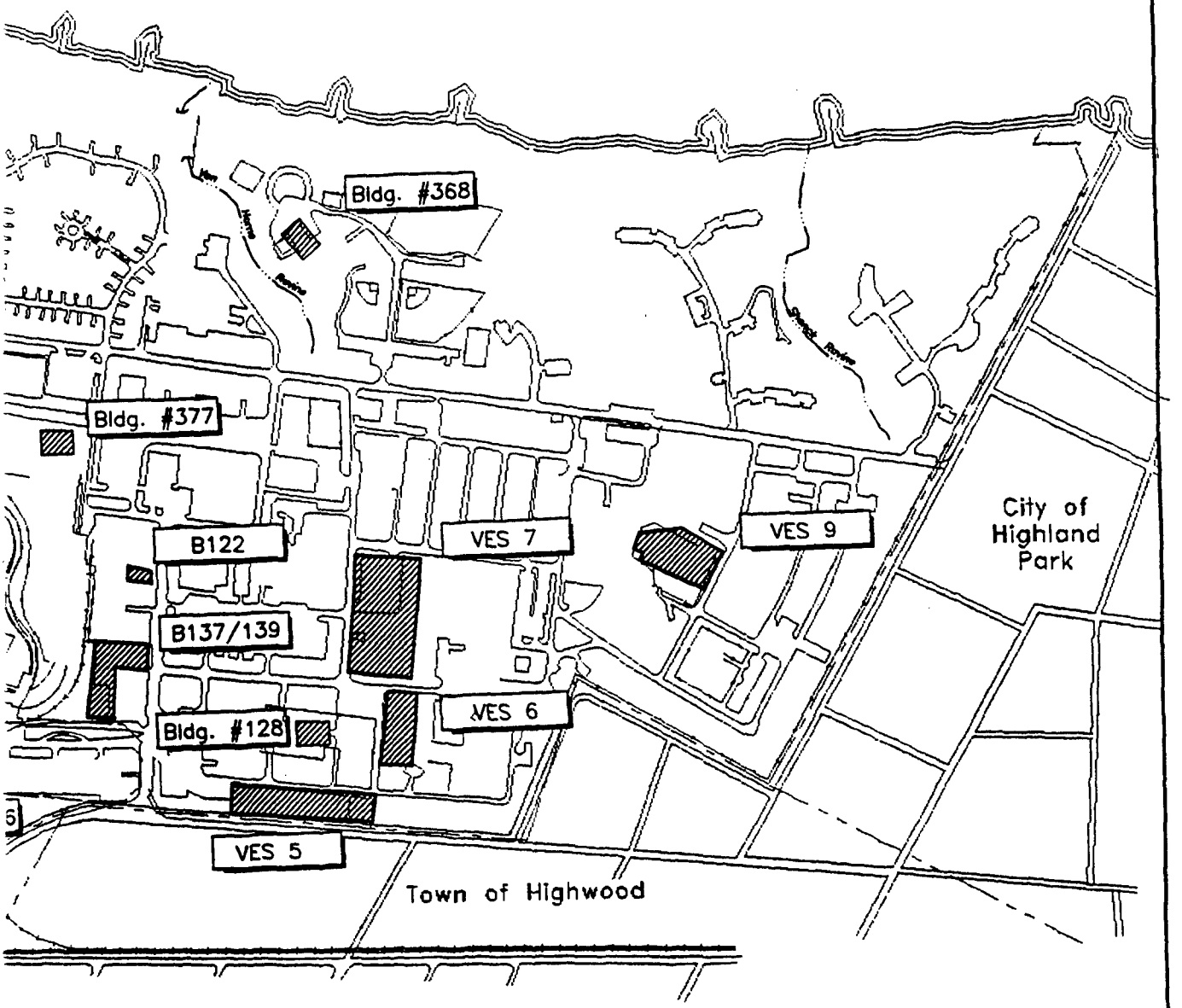


Figure 1-5
Locations of Vehicle, Equipment and Miscellaneous Storage Area Investigations
Quality Assurance Project Plan
Fort Sheridan
Fort Sheridan, Illinois

(3)

Vehicle and Equipment Storage Area 5

VES-5 is currently a gravel-surfaced vehicle storage lot and measures 500 by 100 ft lying parallel to D Street. Four test pits were completed to a depth of 14.5 ft.

Vehicle and Equipment Storage Area 6

VES-6 is currently a gravel/asphalt-surfaced vehicle storage lot measuring 300 by 120 ft. This area lies behind Building 128 adjacent to D and Fourth Streets. Three test pits and one soil boring were completed.

Vehicle and Equipment Storage Area 7

VES-7 measures 500 by 350 ft between B and C Streets, south of Third Street. The area is currently occupied by barracks, a parking lot, and grassy areas. Three test pits were excavated to 14.5 ft.

Vehicle and Equipment Storage Area 9

VES-9 is located on Tenth Street between Patten Road and H Street, and currently measures approximately 140 by 80 ft, but may have been larger in the past. The area is currently a gravel-surfaced lot used for stockpiling materials such as gravel and sand. Four pits were excavated in the this area.

Building 122 Storage Area

The B122 storage area is located on an asphalt-surfaced yard behind Building 70. B122 is 60 by 30 ft and has served as a storage shed for chemicals and out-of-service transformers. Thirteen soil borings and two monitoring wells were installed at this location. Soil borings ranged in depth from 8 to 14 ft. Two monitoring wells with 5-foot by 4-inch PVC screens

were installed in two borings. Phase 1 involved installation of eight borings and Phase 2 involved an additional five borings and two wells.

Buildings 137X, 137, and 139 Storage Area

This storage area was used to store various equipment and containers since 1952. It is located behind the buildings and is a gravel lot 400 by 160 ft. Volatile and semivolatile organic compounds (SVOC) were detected in analyses of previous soil samples. Four test pits were excavated within and adjacent to the area.

Miscellaneous Yard Areas

This category includes six sites, including yards at Buildings 126, 128, 216, 368, 377, and 902. Twelve pits, seven borings, and two monitoring wells were installed in these areas.

Building 126 Yard Area

The B126 yard area is located near the post airstrip. This area was used to formulate some of the fertilizers and pesticides for maintaining the golf course and to clean equipment used for its application. These activities were performed before and after a portion of the area was paved.

Two test pits were excavated and one monitoring well was installed. The monitoring well was completed to a depth of 24 ft and a 10-ft, 4-inch diameter, PVC screen was installed.

Building 128 Yard Area

The B128 yard area measures 120 x 80 feet and located immediately north of Building 128. This yard is presently an asphalt-covered parking lot. Previously this area served, in part, as the location of a 500-gal,

aboveground waste oil storage tank and storage for 55-gal drums of solvents and antifreeze. Two test pits were excavated adjacent to these former storage tanks.

Building 216 Yard Area

The B216 yard area is located immediately south of B216. Automotive painting and sandblasting are conducted at the site. One pit was excavated.

Building 368 Yard Area

This yard is located at the end of McKibben Road and is adjacent to the Auto Craft Shop (B368). It is used by post personnel for personal vehicle maintenance. The area is bordered on three sides by asphalt-surfaced parking lots and on the fourth side by a grassy area. A 500-gal fuel tank and several 55-gal drums of oil are located here.

Two test pits, six soil borings, and one monitoring well were completed at the site. One test pit (B368TP2) could not be excavated to the intended depth of 14.5 ft due to the collapse of gravel fill underlying the asphalt. Gravel collapsing into the pit prevented excavation below a depth of 3 ft. Soil borings were completed to depths ranging from 9 to 35 ft. One well was installed at a depth of about 15 ft.

Building 377 Yard Area

The area consists of a gravel-covered lot used for equipment and personnel vehicle parking. Pesticides are also mixed and stored at this site. Two test pits were excavated and one soil boring was completed to a depth of 24 ft.

Building 902 Yard Area

This yard is located at the northern end of the post and is the vehicle maintenance yard for five reserve units. Three test pits were excavated.

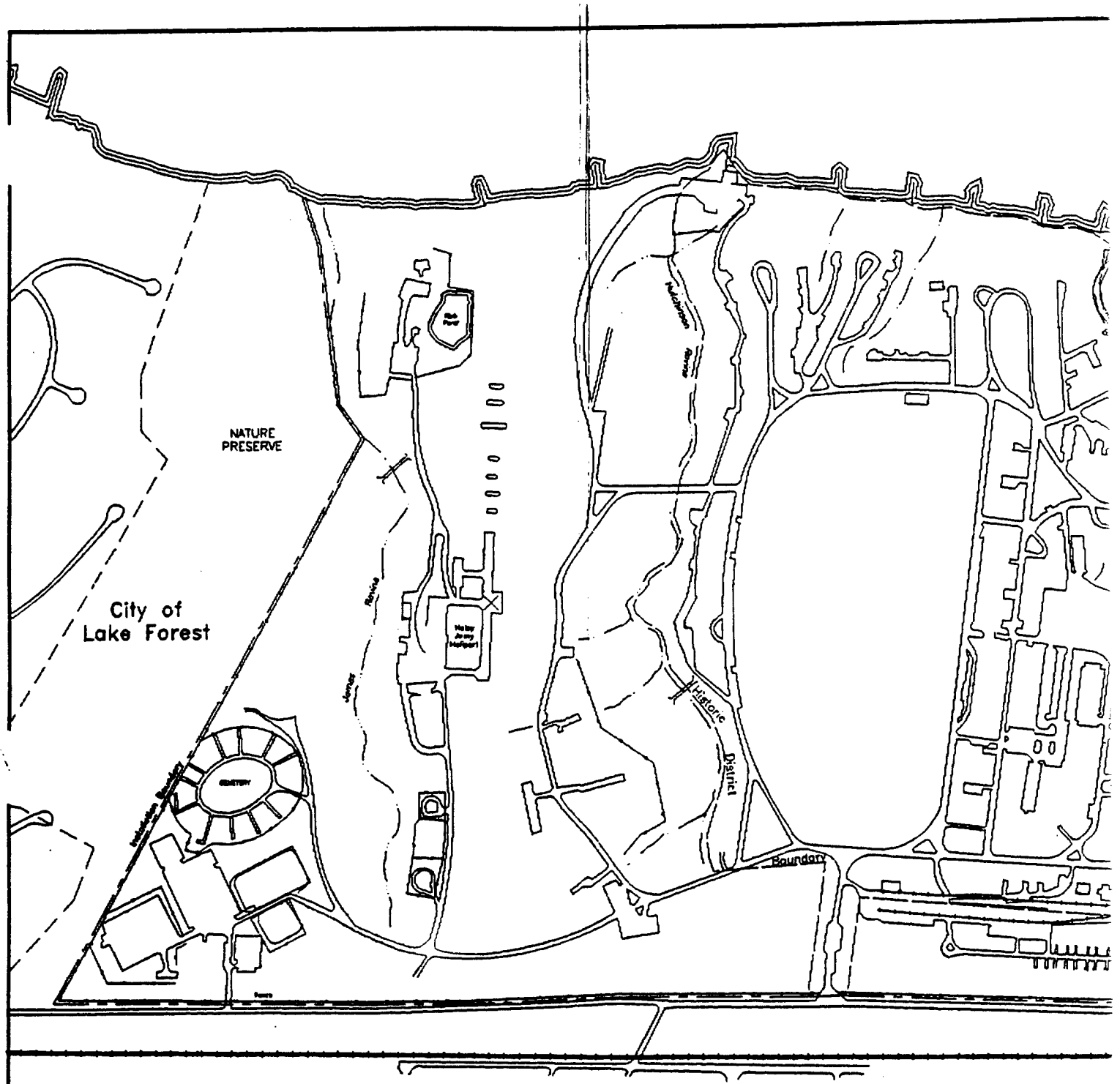
Buildings

Various buildings were identified by E.C. Jordan that housed environmentally sensitive operations. Among the operations identified as environmentally sensitive were; vehicle maintenance, furniture stripping, and photograph development. Visual observations made at the buildings identified areas of staining, the deterioration of floors, and the discharges of waste fluids into the storm or sanitary sewer systems. Areas identified as requiring further evaluation included Buildings 43, 70, 122, 137, 139, 142, and 361. The building locations are shown in Figure 1-6.

Floor areas and pipes or areas where applicable effluent discharged from the buildings were sampled. The floors were characterized primarily through the use of wipe sampling, although pieces of the floor were obtained from some of the buildings. Sediment samples were obtained from storm or sanitary sewers if waste effluent from the building's operations were discharged into them.

Building 43

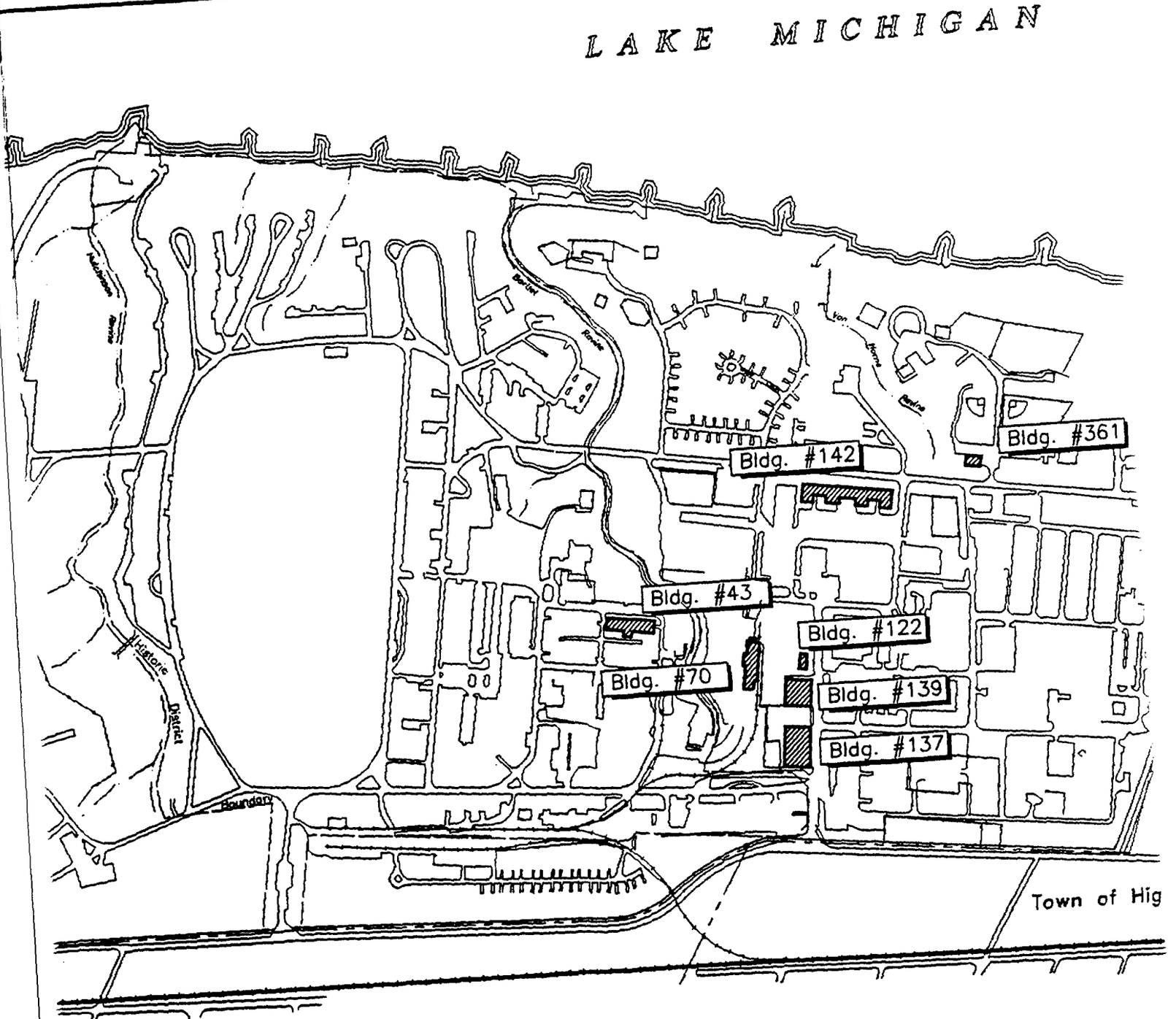
Building 43 contains the General Support Shop, which includes furniture cleaning, stripping, and painting activities. A commercial water-soluble stripper is used to remove old finish from furniture. After application, the bulk of the stripper is removed from the furniture with steel wool and scrappers. The waste is then disposed of offsite.



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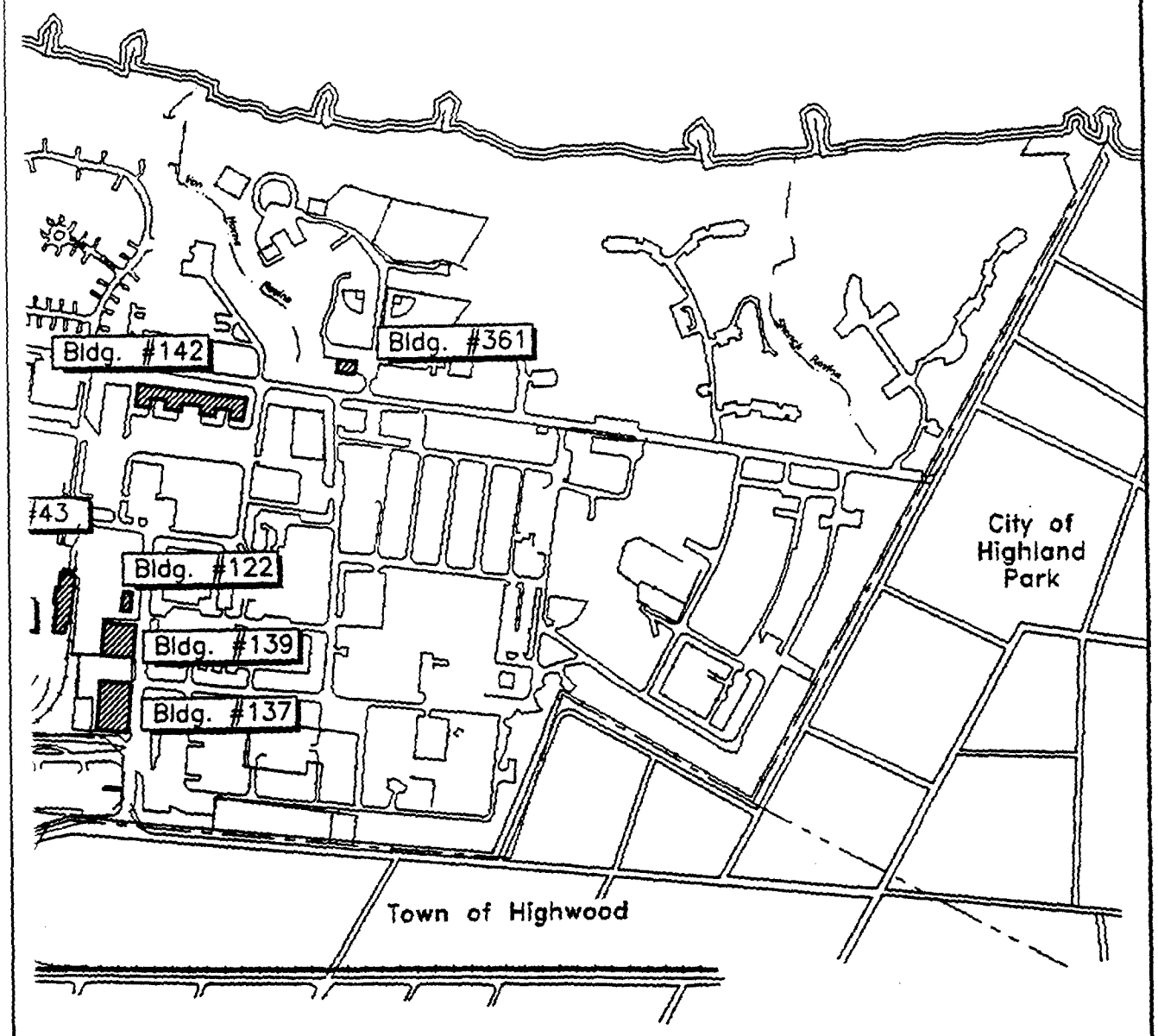


Figure 1-6
Buildings #43, #70, #122, #137, #139, #142, #361 Locations
Quality Assurance Project Plan
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The furniture stripper, not retrieved by hand, is washed off with water. The water is collected in a floor drain and directed through a chemical separator system. After passing through the separator, the effluent is discharged to Bartlett Ravine through the storm sewer.

E.C. Jordan recommended obtaining samples of the effluent after it had passed through the chemical separator and two composite soil samples from the point of discharge in Bartlett Ravine. Sediment and water samples were collected from the storm sewer downgradient from the chemical separator. Samples were then analyzed for volatile organic compounds (VOCs), semi-volatile organics, and metals.

Building 70

Building 70 is a World War II vintage building which contains a wooden plank floor. This floor is visibly discolored and contains dark stains. The nature of the staining is unknown, since the building has been used to warehouse different materials by the Directorate of Engineering and Housing.

The investigation at Building 70 consisted of obtaining three samples of the wood floor. The samples were analyzed for semi-volatile organics, pesticides, and herbicides. Each sample was taken from an area where the wood floor is discolored or stained to ascertain if any of the various analytes have soaked into the wood.

Building 122

Building 122 is used to store hazardous waste and/or hazardous materials. It is a steel-framed building with a concrete slab floor. There are no floor drains located in the building. No visual evidence of spills (i.e., staining, discoloration, corrosion) were identified. Sampling of Building 122 consisted

of obtaining two wipe samples from the concrete floor. The samples were then analyzed for SVOCs, herbicides, and pesticides.

Building 137

The Tactical/Combat Armament Shop is located in Building 137. Repairs are made to various sizes of military vehicles and equipment in this building. Staining of the concrete floor was observed throughout the building, and the floor of the battery room exhibited significant corrosion.

The building also contains a bay devoted to parts cleanup and equipment washing. Small parts are cleaned in recirculating washers and vehicles and large pieces of equipment are cleaned directly on the bay floor. The floor drains in this area collect the wash water and direct it through an oil-water separator before it is discharged into the sanitary sewer.

Samples obtained during the investigation of this building included two wipe samples and three concrete samples. The wipe samples were collected from the floor in the engine repair room near the fly wheel grinding area and in the fuel and electrical section near a brake drum. The wipe samples were analyzed for semi-volatile organics and metals.

The concrete samples were obtained from locations adjacent to the above noted wipe samples and from a vehicle repair bay. The samples were analyzed for metals. No samples were obtained from the sanitary sewer.

Building 139

The Heavy Equipment Maintenance Shop was reported to be housed in Building 139 by E.C. Jordan. Observation of the current operations at the facility revealed work was being done primarily on small engines such as

lawn mowers. Various pieces of lawn equipment was also stored in the building. Areas of concern in the building included the stained concrete floor around two aboveground storage tanks and the small engine repair shop.

The investigation of Building 139 consisted of obtaining two wipe, three concrete floor samples, and one blank sample. The wipe samples were collected from the floor of the small engine repair area and the stained area associated with the aboveground storage tank on the east wall of the building. The concrete samples were obtained from areas adjacent to the wipe samples and from a stained area associated with the aboveground storage tank on the building's north wall. The wipe samples were analyzed for semi-volatile organics and metals. The concrete was analyzed for metals.

Building 142

General office space comprises all of Building 142. E.C. Jordan noted that two large transformers had previously been located in the building. In 1981, the transformers were discovered to be leaking and a contractor was hired to replace the PCB cooling oil in the transformers and clean up the spill. The transformers have subsequently been removed from the building and new transformers have been installed outside the building.

The investigation at Building 142 consisted of collecting two wipe samples from the floor. The tile floor had no visual evidence of staining or discoloration. After the samples were obtained, they were analyzed for pesticides and PCBs.

Building 361

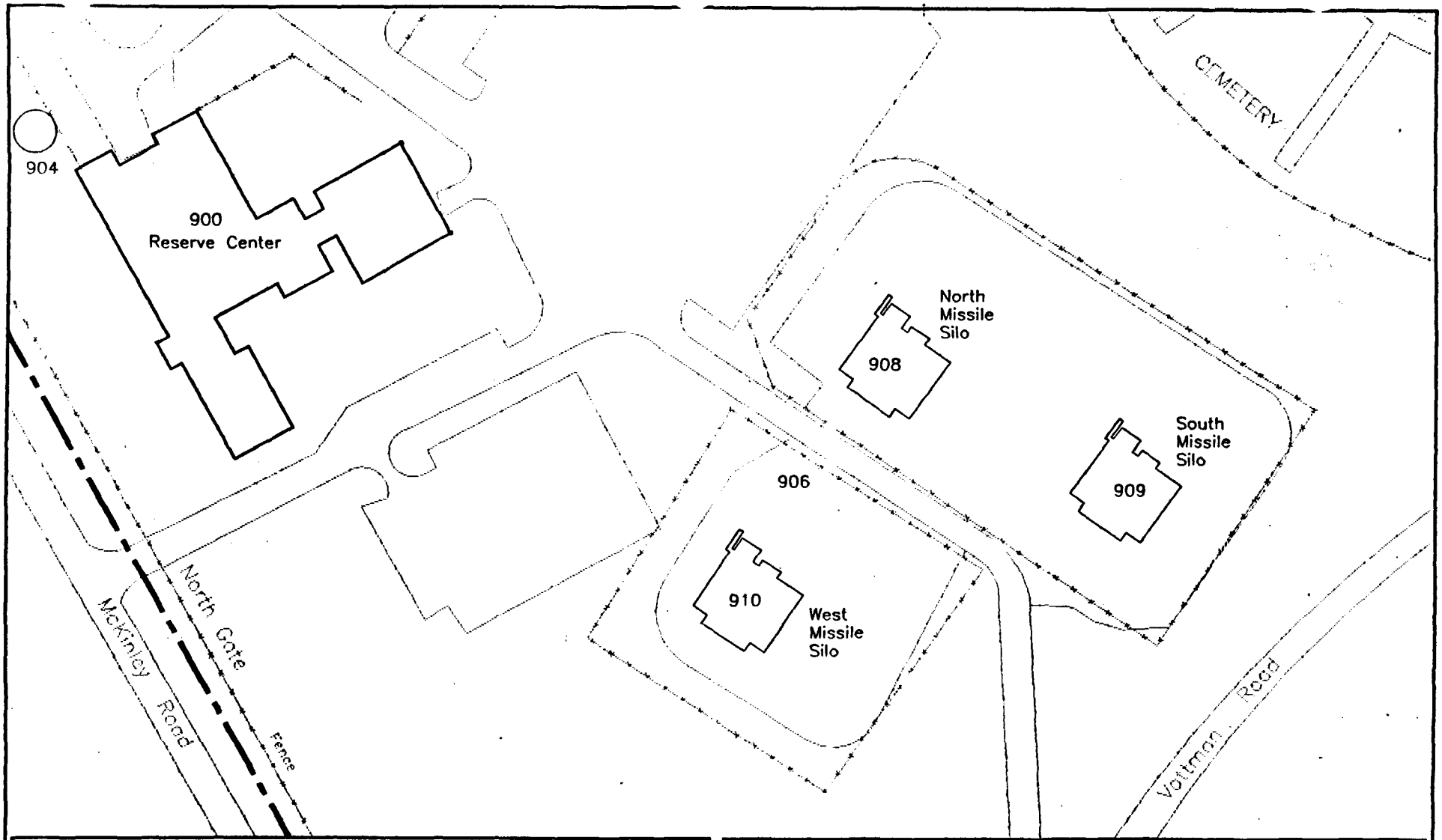
The base photographic laboratory is located in Building 361. The masonry building contains three film processors used to develop black-and-white and color film. In 1978, a silver-recovery system for spent sodium thiosulfate solution (i.e., photographic fixer; sodium hypochlorite) was installed. The treated solution is containerized and sent to the Defense Property Disposal Office (DPDO) at the Great Lakes Naval Training Center for disposal.

Prior to disposal by DPDO, spent sodium hypochlorite and rinse water was discharged to the sanitary sewer via three floor drains. Spent developer is discharged to the sanitary sewer. A manhole, on the north side of the building, receives the discharge and directs it to the sanitary sewer. Floor tiles around the drains and in the finishing, color, and chem-mix rooms are discolored and deteriorating due to their exposure to photoprocessing chemicals.

Three wipe samples were collected from the tile floor in the finishing, color, and chem-mix rooms at Building 361. The wipe samples were analyzed for volatile organics, SVOCs, and metals. Additionally, a sediment sample was obtained from the sewer north of the building. This sample was analyzed for SVOCs and metals.

NIKE Missile Installation

From 1953 to 1974, a NIKE missile installation was located at Fort Sheridan. It consisted of three missile batteries, 908, 909, and 910, located in the northwest section of the base near the Reserve Center Complex (Figure 1-7).



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Figure 1-7
NIKE Missile Installation

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After the missiles were decommissioned in 1974, the silos were converted to fallout shelters. The shelters were later abandoned because the silos repeatedly flooded during rain storms.

The north and west silos contained a large quantity of water, while the south silo contained very little. To facilitate the inspection and sampling of the silos, the water from the north and west silos had to be removed. Water samples were obtained from the two silos and analyzed for volatiles, semi volatiles, and pesticides/PCBs. Based on the analytical results, permission to pump the water from the two silos to the storm sewer was granted by base personnel.

The inspection and sampling of the silos was conducted by a team utilizing Level B protection. The team consisted of two people who entered silo in Level B protection, two backup people suited in Level B protection, and a fifth person in Level D protection. Key members of the team were trained in CPR. Two air-monitoring instruments were taken into the silos to monitor the air quality, a flame ionization detector (FID) organic vapor analyzer (OVA) and an explosimeter with hydrogen sulfide (H_2S) measurement capability. Communication between the team members was maintained with portable radios. Telephones in the vehicles provided access to outside entities.

The three silos are identical in their construction and had the same floor plans. The primary entrance to the silos is a stairway located at the northeast corner. The stairway leads to the main room, which is 56 by 60 ft. The floor of the missile silo is approximately 17 ft-bgl. Each silo is primarily constructed of concrete. The center portion of the room formerly contained the NIKE missile and has a metal floor 14 inches lower than the main floor with a large metal door at the ground surface. It appears the

hydraulics used to lift the missile may have been located under the metal floor.

Each missile silo has a hallway, which leads to a small control room on its east side. The hallway is located in the northeast corner near the main stairway. The hall is constructed of concrete overlain by fiberglass insulation and pegboard. The control room is constructed of concrete block and accesses to the ground surface via a ladder and hatch.

North Missile Silo

The North Missile Silo is located in an area currently used to store recreational vehicles and is immediately adjacent to the South Missile Silo. The silo contained approximately 4 inches of water at the time of the investigation. The silo also contained drums of drinking water and crackers, pallets, and hoses were scattered about the floor. All instrumentation had been removed from the control room. Some machinery had been left in the large room near the former missile location.

The sampling portion of this investigation included three wipe samples obtained from the walls, a sludge sample, and an asbestos sample. The wipe samples were obtained from the north, west, and east walls and analyzed for SVOCs. The sludge sample was collected from a pallet which was above the water level in the silo. The sample was analyzed for SVOCs and metals. The last sample collected in the North Missile Silo was a suspect asbestos-containing material identified as pipe wrapping.

West Missile Silo

The West Missile Silo is located within an enclosed, high security area used for data communication. The silo contained approximately 4 inches of

water. Fifteen to 20 drums containing drinking water and crackers were located in the northern one-third of the silo. The walls of the rooms were painted gray and white. The instrumentation had been removed from the control room, and some machinery remained in the main room near the location of the former missile.

The sampling program for this missile silo involved obtaining four wipe samples. A sample was obtained from each of the walls of the main room. The wipe samples were then analyzed for SVOCs.

South Missile Silo

The South Missile Silo is located within an area currently used to store recreational vehicles belonging to base personnel. There was no standing water in the silo. It was observed that an area below the metal floor probably contained the hydraulics. Debris in the main room of the silo included drums containing drinking water and crackers, window frames, wood pallets, and a metal vat (photos are in Appendix A). The instrumentation had been removed from the control room and some machinery remained in the main room. The walls of the main room were also painted gray and white.

The sampling program consisted of collecting four wipe samples and an asbestos sample. The wipe samples were obtained from each of the walls of the main room. The samples were then analyzed for SVOCs. A sample was obtained from a possible asbestos-containing material identified as aircell. The aircell was found lying on the floor near the west wall of the silo. No other material identified as aircell was observed in the building. The control room contained another possible asbestos-containing material

identified as ceiling tile. The ceiling tile was not sampled because it could not be accessed.

Missile Fueling Point

An area located southeast of Building 900 was designated as the Missile Fueling Point. Fueling of the missiles prior to placement in the silo and defueling before maintenance work was conducted in this area.

Two types of NIKE missiles (Ajax and Hercules) were deployed at Ft. Sheridan. The Ajax, deployed in 1954, was a two-staged missile which used a solid-fuel booster rocket and a liquid-fuel sustainer motor. The liquid fuel is believed to have been jet fuel (JP-4), possibly with unsymmetrical dimethyl hydrazine as an additive. Red fuming nitric acid was used as a liquid fuel oxidizer.

The NIKE Hercules missile was introduced in 1958, and the conversion from Ajax to Hercules missiles took place between 1958 and 1961. The Hercules was a two-stage missile like the Ajax, but both stages utilized a solid-fuel. The composition of the solid-fuel for both missile types is not known.

The investigation of the missile fueling point involved the sampling of two test pits and a soil boring. The tests pits were completed to an approximate depth of 14.5 feet. Soil samples were obtained from each test pit at depths of 2.5 feet, 7.0 feet, and the bottom of the pit. The soil boring was sampled from 1 to 3 feet then continuously from 4 to 36 feet.

Selected soil samples from the soil boring and each test pit were submitted to the laboratory for analysis. The samples selected from TP1 were those with the highest headspace screening values (2.5 feet and 14.0 feet). The

samples submitted from TP2 were from 7.0 and 14.5 feet. These were samples of the native clay. Soil samples were also obtained from the near surface (1 to 3 feet), mid-point (14 to 16 feet), and the bottom (34 to 36 feet) of the soil boring and submitted for analysis. All of the samples were analyzed for SVOCs, VOCs, and metals.

Electrical Transformers

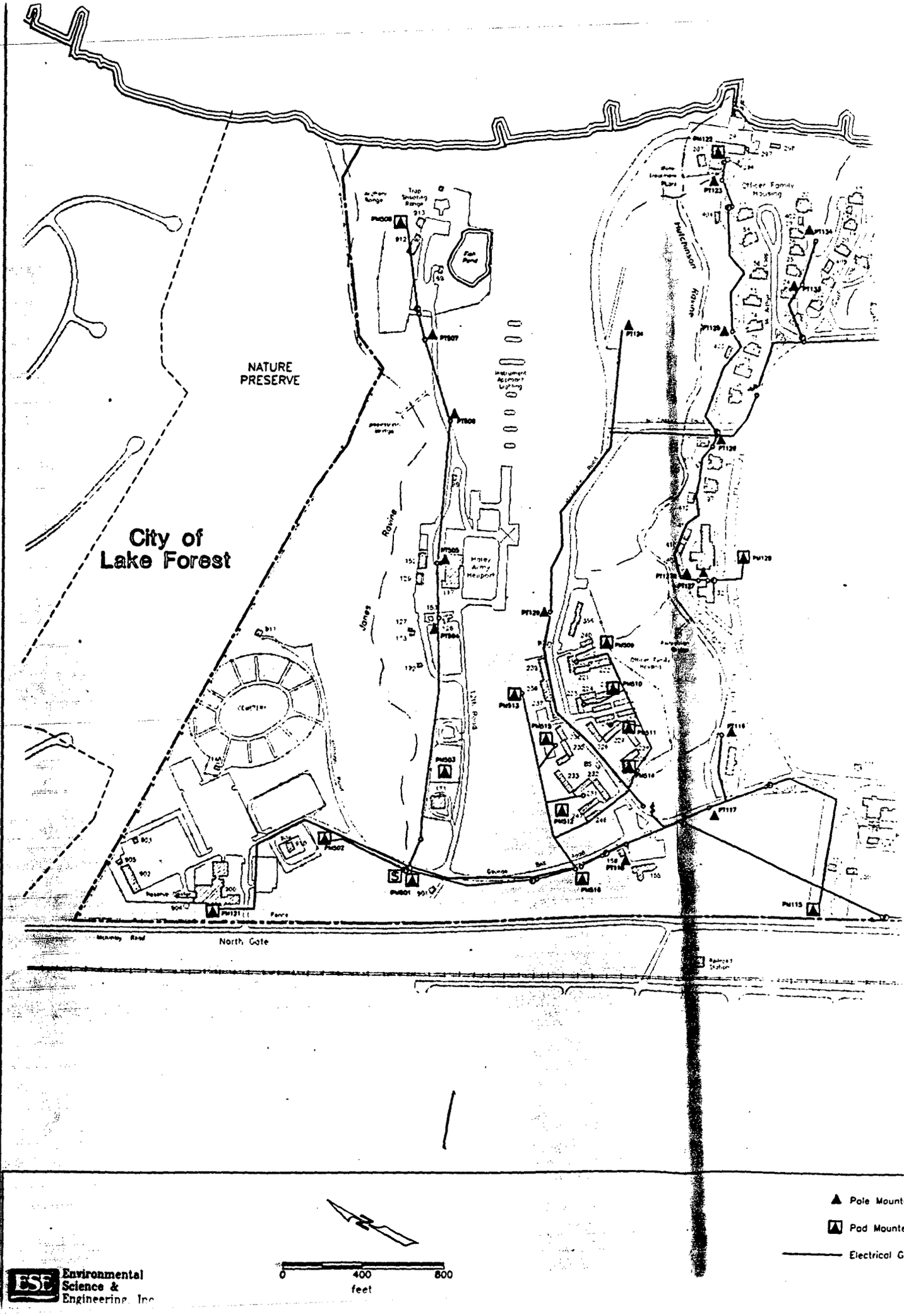
Pole and pad-mounted electrical transformers are located at Fort Sheridan which may contain PCB contaminated insulating fluids. A total of 110 electrical transformers on the post were inspected for integrity, signs of leakage and the dielectric fluids were sampled for Aroclor concentrations. Figure 1-8 displays the locations of electrical transformers inspected and sampled during this program.

Of the 110 transformers sampled, 9 contained PCB contaminated insulating fluids. Seven of these were pad-mounted (PM) and 2 were pole-mounted (PT) transformers. According to the EPA, if analysis shows that the insulating fluid contains >50 ppm Aroclor, the fluid test is considered positive for PCBs. None of the pad-mounted transformers were damaged or showed signs of leaks or spills.

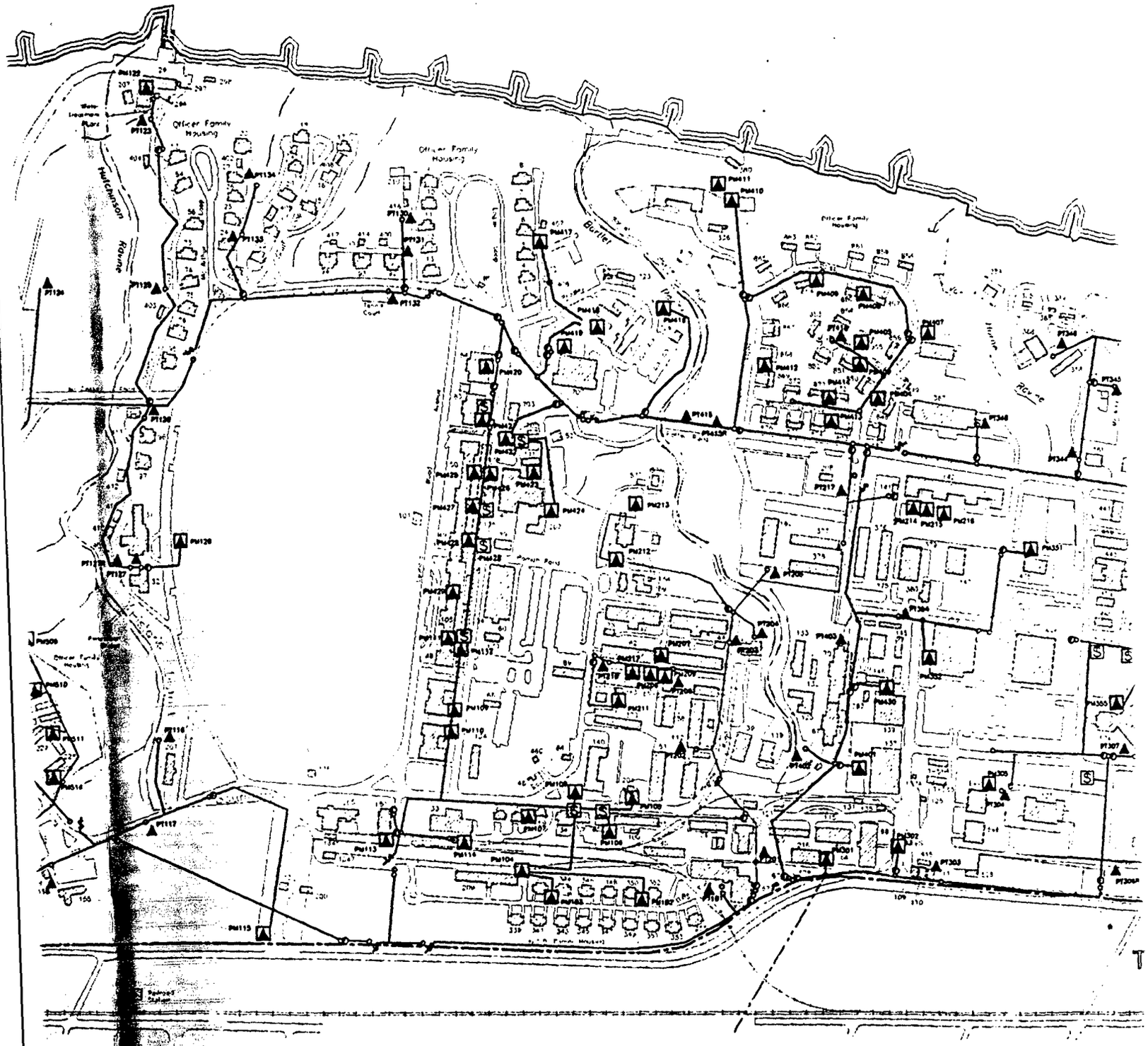
A report of the findings of this study titled "Report of Findings for PCB Transformer Sampling Conducted at Fort Sheridan, Illinois" was issued by ESE as a draft on November 11, 1991.

Asbestos-Containing Materials in Buildings

Four previous surveys have been conducted at Fort Sheridan to assess the presence of asbestos-containing building materials (ACBM) in various buildings and sites. In September 1986, Carnow, Conibear, and Associates


NATURE
PRESERVE
City of
Lake Forest
North Gate
Officer Family Housing
Trap Shooting Range
Instrument Approach Lighting
Hutchinson
Ravine
Jones
Ravine
Tank Road
Marine Corps
Reserve Center
Helo Army Heliport
Pole Mounted
Pad Mounted
Electrical Grid
0
400
800
feet
Environmental
Science &
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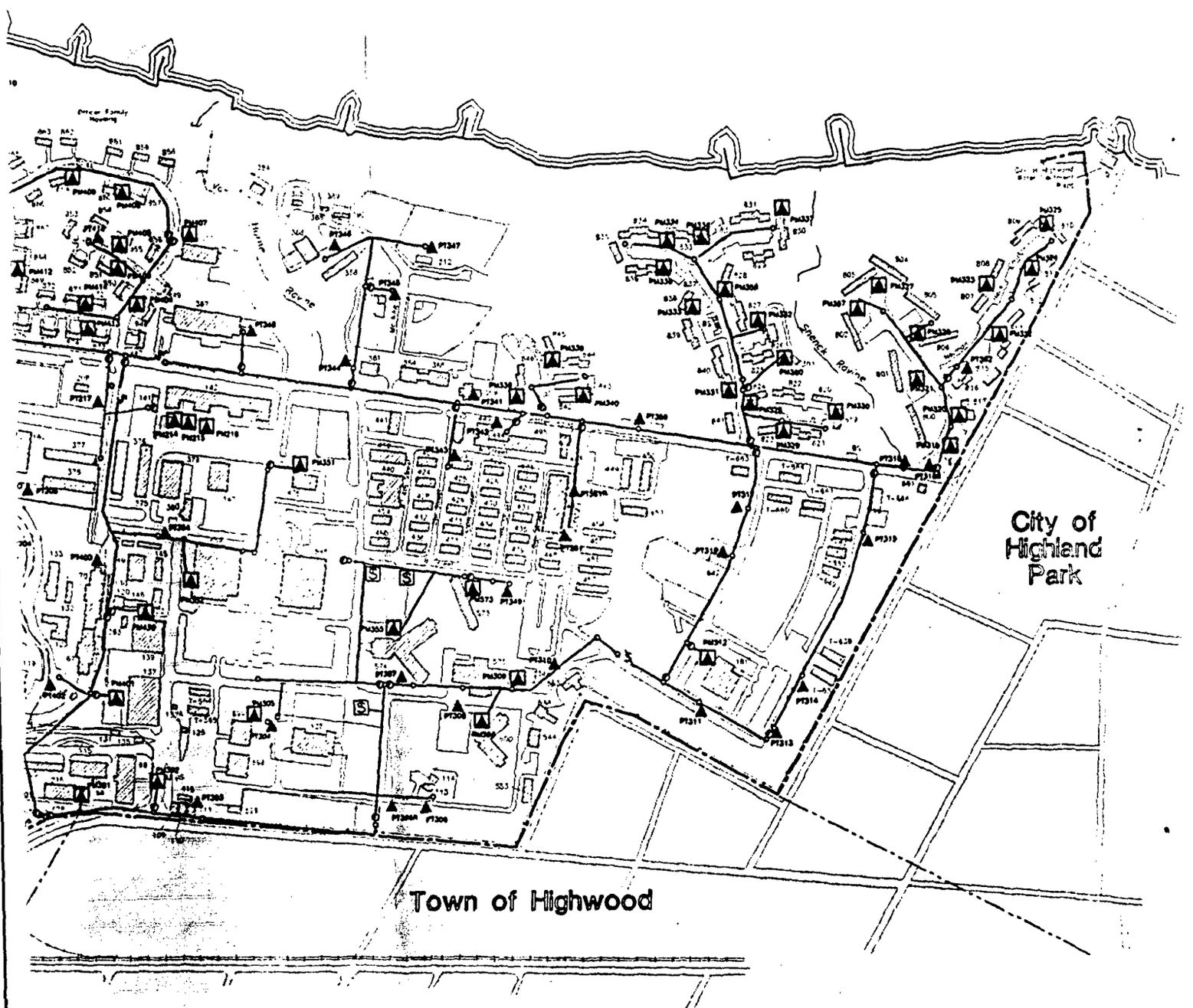


Figure 1-8
Transformer Locations
and Electrical Distributio

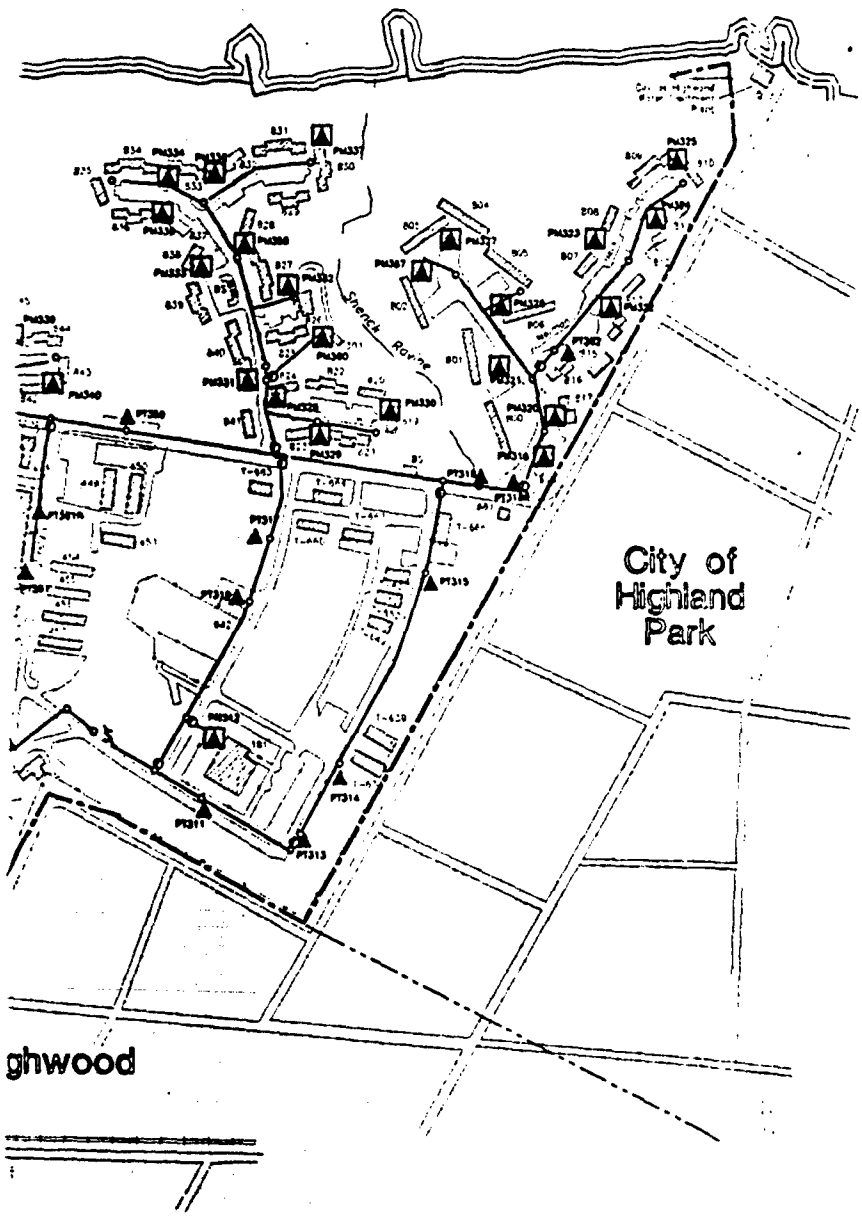


Figure 1-8

Transformer Locations and Electrical Distribution

Quality Assurance Project Plan

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surveyed 34 buildings and in March 1987, they surveyed an additional five buildings. Occusafe, in March 1989, surveyed 15 buildings. In September 1989, Hall-Kimbrell surveyed 183 buildings and 27 steam-line pits. A total of 237 buildings were surveyed. Of that number, 204 still exist. Thirty-three of the surveyed buildings were subsequently demolished and one was reported as not containing asbestos. According to the E.C. Jordan documents, an estimated 150 buildings dedicated to personnel housing remained to be surveyed prior to this study.

ESE subsequently inspected 172 housing units and 47 administrative units. Ten structures also designated to be surveyed were found to be non-buildings such as a flagpole, swimming pool, transformers, etc. Sixteen additional facilities were later added for a total of 245 structures. These structures included single and multi-unit residential, administrative buildings, barracks, warehouse/storage facilities, maintenance/repair shops, commercial, and recreational facilities. Inspection of these targeted facilities was performed to identify, locate, sample, analyze and assess the condition of ACBM.

A draft report which contains a comprehensive discussion of this sampling and analytical program was submitted to USATHAMA on November 11, 1991 entitled "Draft Report of Findings Asbestos Study for Fort Sheridan, Illinois."

Surface Water and Sediment Investigation

The storm drainage system at the base primarily follows the ravine system. Samples were obtained from various points along a drainage system. Up-gradient samples were obtained on the base to determine the quality of the water coming on base. Various points along the storm water drainage

system were sampled to determine if runoff from a specific area of the base affected the water quality. Finally, a sample was obtained at the discharge point to determine the water quality of runoff from the drainage system as it exited the base. The locations sampled during the surface water and sediment investigation program are shown in Figure 1-9.

1.2.8 OTHER AREAS OF INTEREST

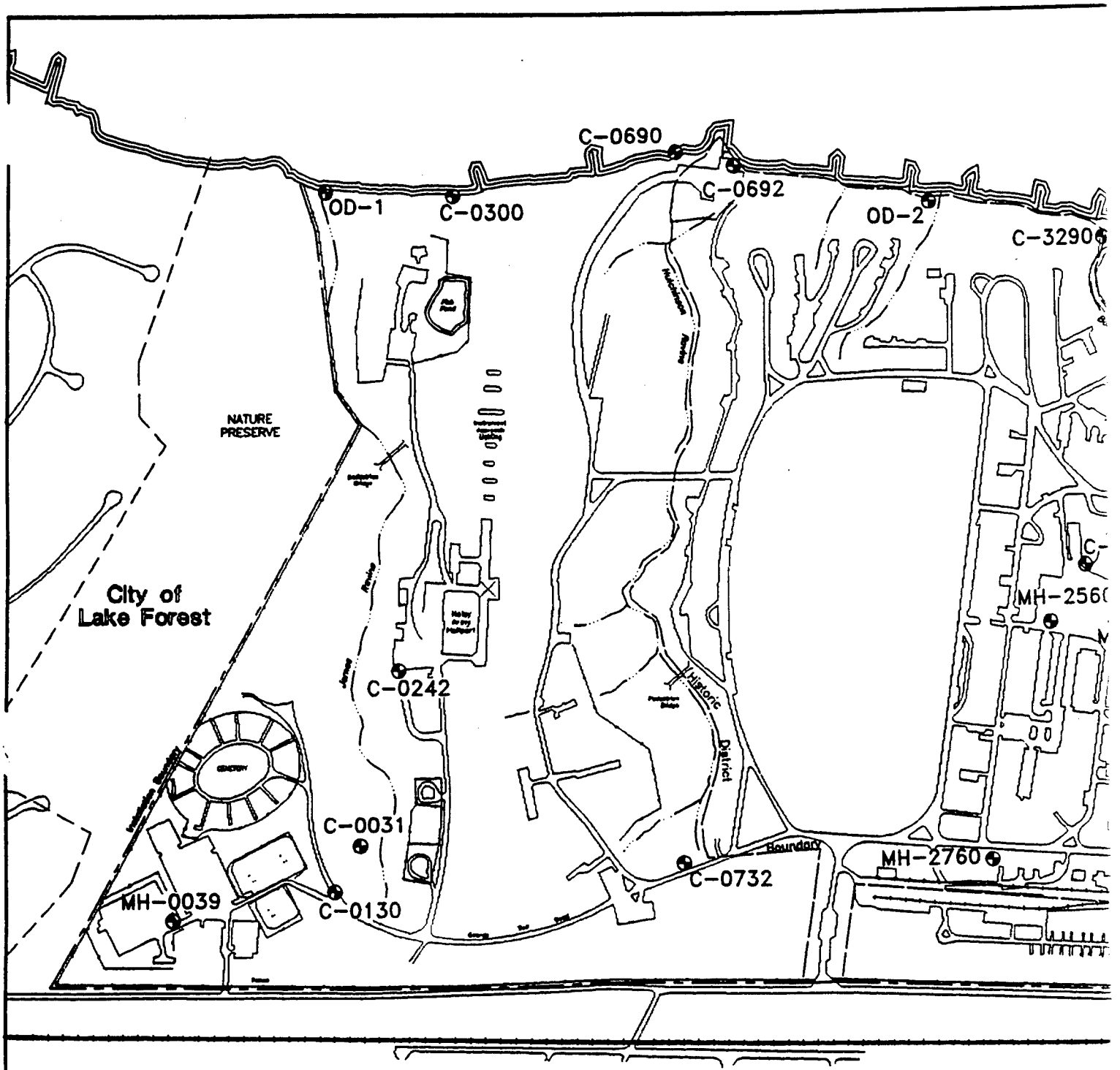
Recent review of available project information has identified other areas of interest, including the following:

1. Disturbed Area,
2. Trap Range,
3. Sanitary Treatment Plant,
4. Fill Area No. 8
5. Miscellaneous Storage and Distribution Areas and
6. Background Sampling Areas

The following paragraphs present brief descriptions of these categories and the specific study areas included in them.

Background Sampling

The existing background database is insufficient to permit a determination of background concentrations at acceptable statistical confidence levels. During a site visit conducted by the BRAC Cleanup Team (BCT) on July 19, 1994, four areas for the collection of these samples were identified. A Background Sampling and Analysis Plan (BSAP) has been developed which is designed to address the issue. The background sampling locations, indicated on Figure 1-10, were selected because there is no indication from previous data that these areas have been affected by activities conducted at Fort Sheridan.



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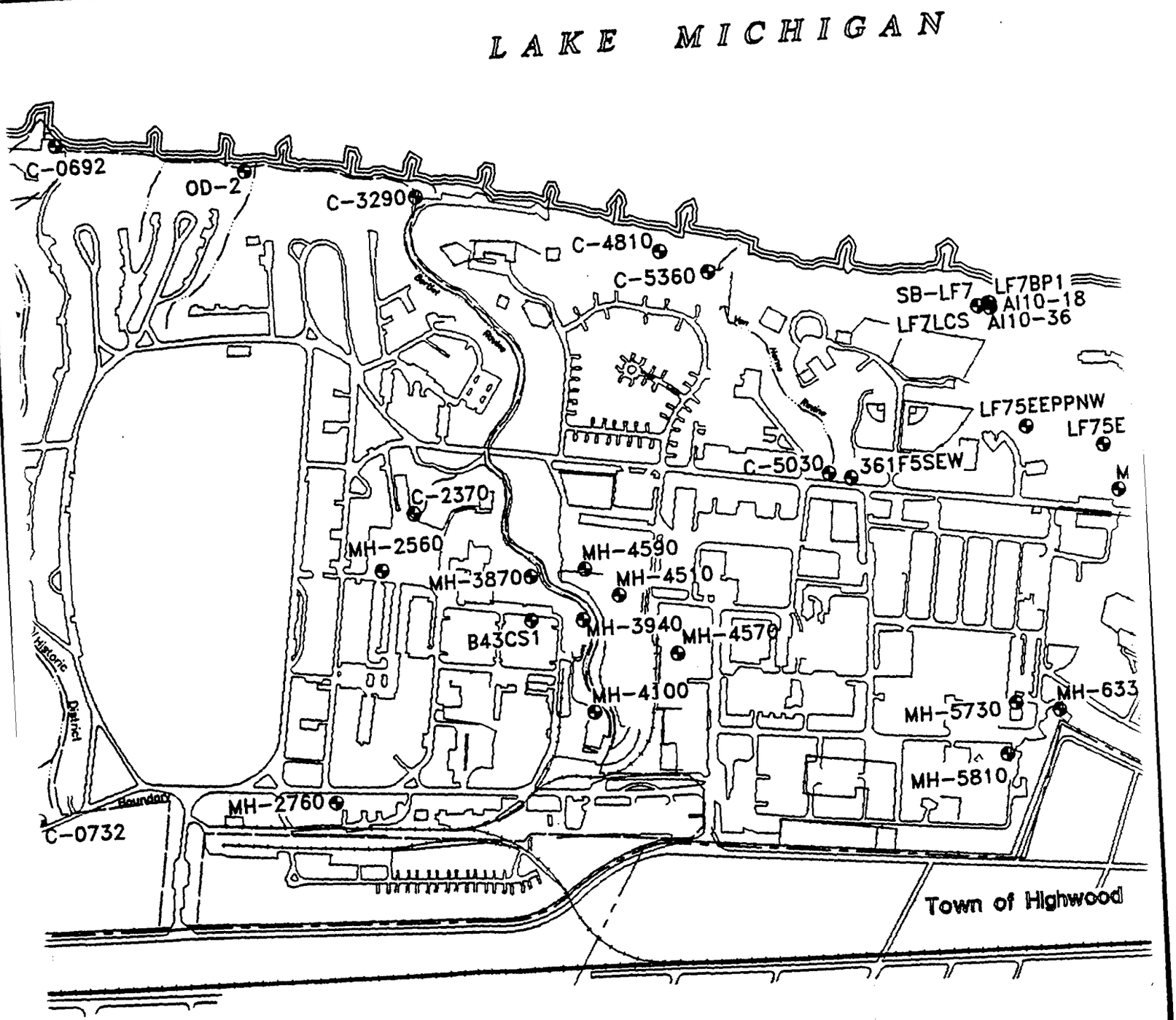
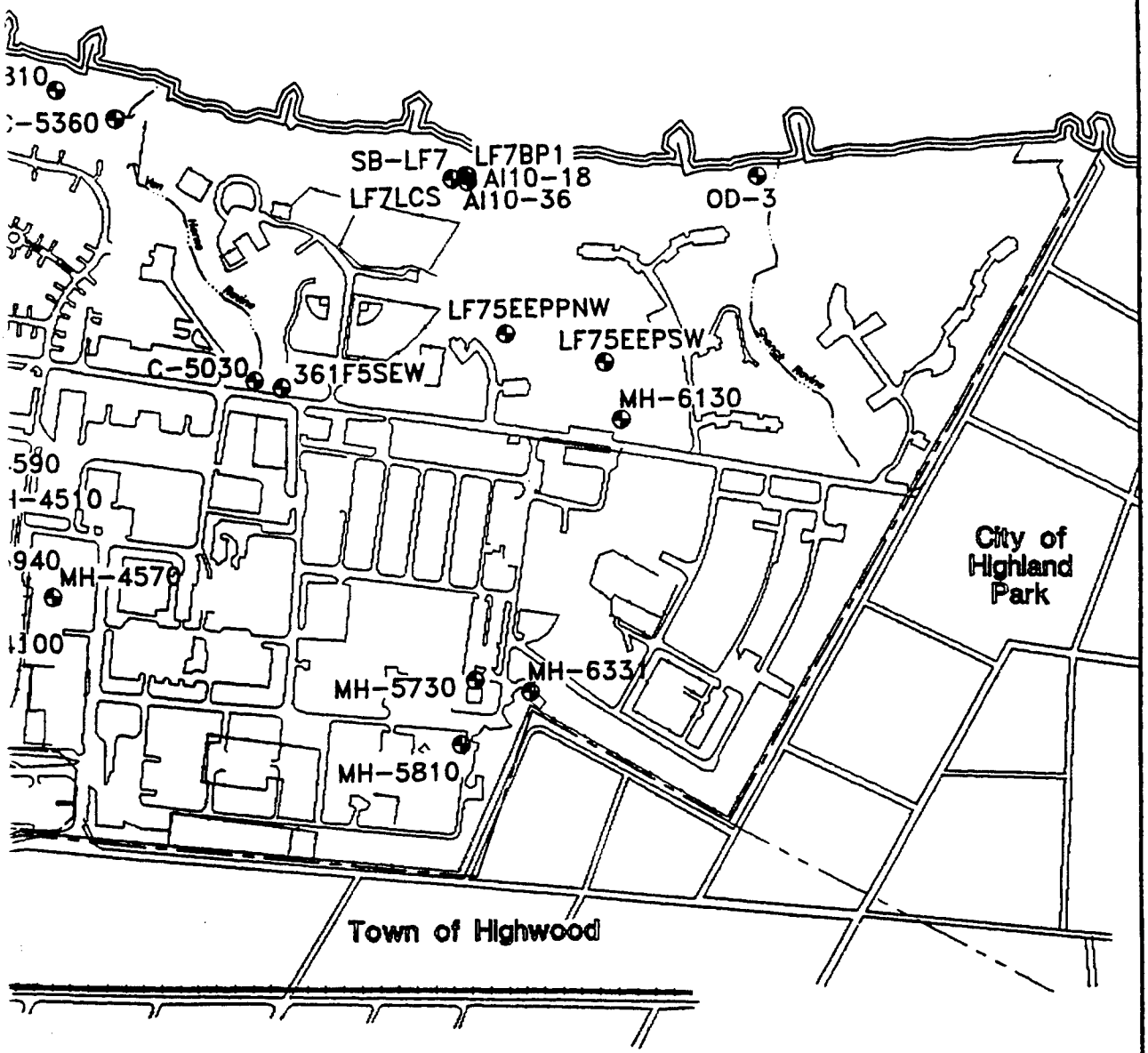


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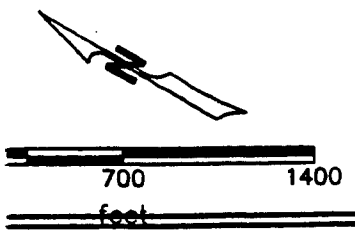
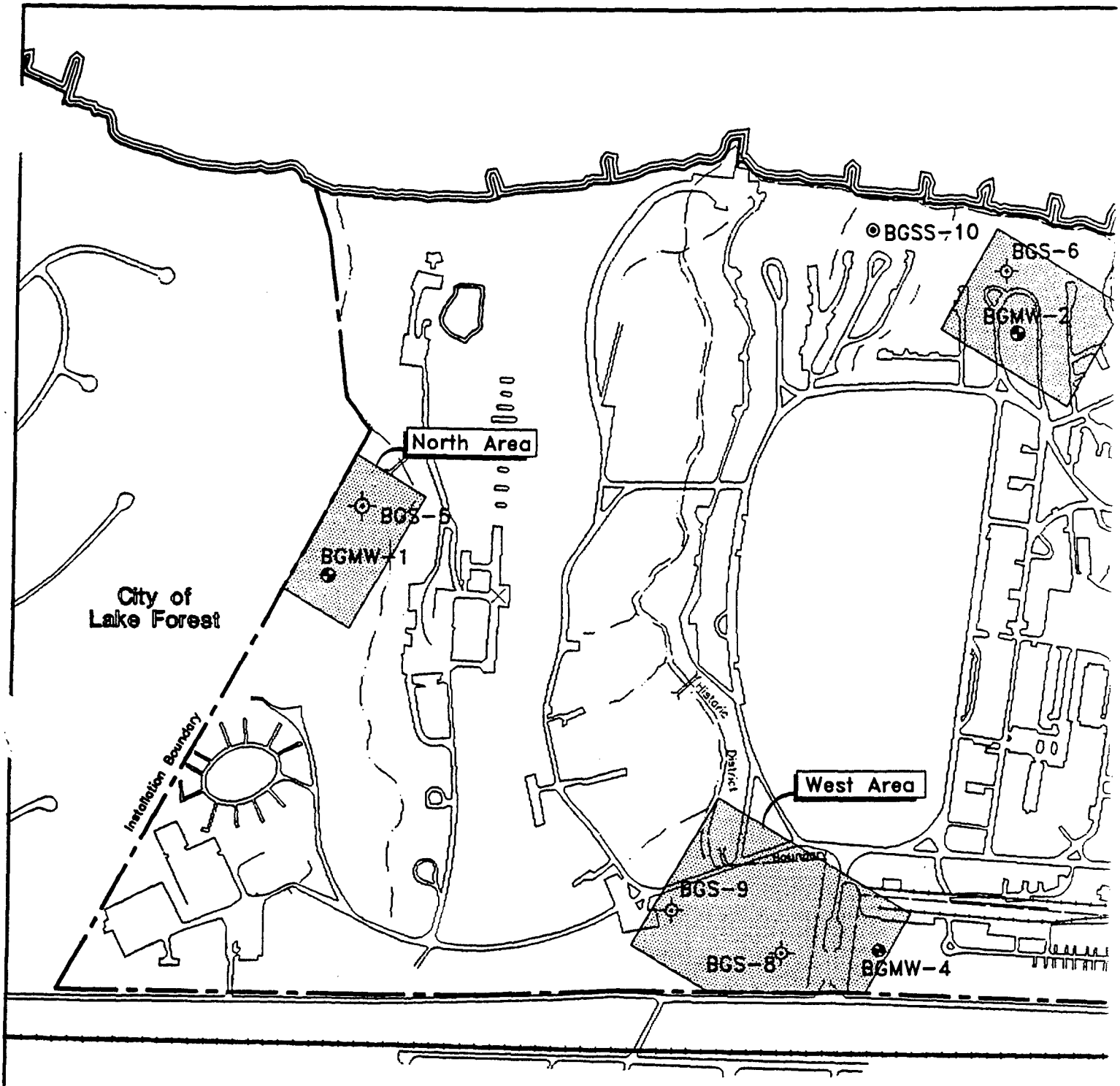


Figure 1-9
Surface Water and Sediment Sample Locations
Quality Assurance Project Plan
Fort Sheridan
Fort Sheridan, Illinois

3



Proposed Background Soil Sample Location

Proposed Background Soil Sample/Monitoring Well Location

Proposed Background Surface Soil Sample Location

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DVL 11/28/94 490-2087

Revised DVL 03/15/95 FSBKS2Q

Adapted from Official Post Map, Directorate of Engineering and Housing, Fort Sheridan, Illinois, January 6, 1989.

LAKE MICHIGAN

BGSS-10

BGS-6

BGMW-2

East Area

West Area

Historic District

Roundhouse

BGS-9

BGS-8

BGMW-4

Town of Highwoo

Background Soil Sample Location

Background Soil Sample/Monitoring Well Location

Background Surface Soil Sample Location

0 700 1400

feet

of Engineering and Housing, Fort Sheridan, Illinois, January 6, 1989.

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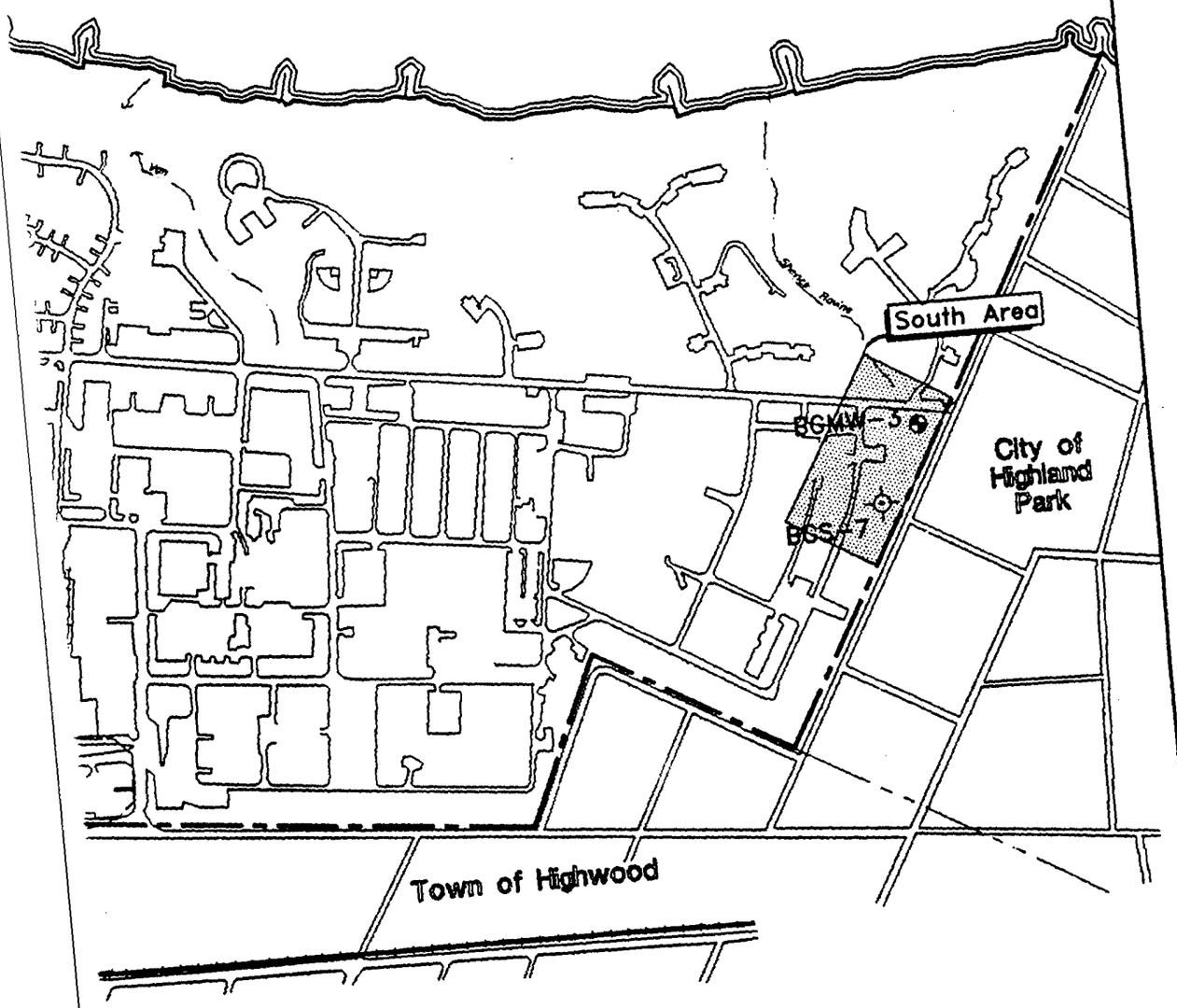
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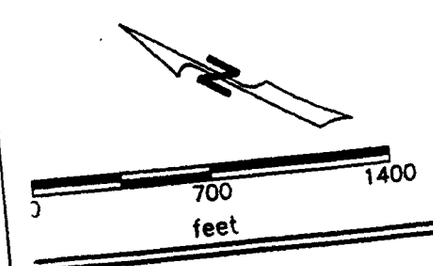


Figure 1-10
Background Sampling Areas
Quality Assurance Project Plan
Fort Sheridan
Fort Sheridan, Illinois

3

Disturbed Area

An area of disturbed ground has been identified from historical aerial photographs. The area is located along the western boundary of the facility at the head of Hutchinson Ravine. The location of the Disturbed Area is indicated on Figure 1-11.

Trap Range

The Trap Range has been identified as a potentially affected area. The Trap Range is located on the bluff overlooking Lake Michigan and occupies a portion of the area which was formerly Landfill 2. The location of the Trap Range is indicated on Figure 1-11.

Sanitary Treatment Plant

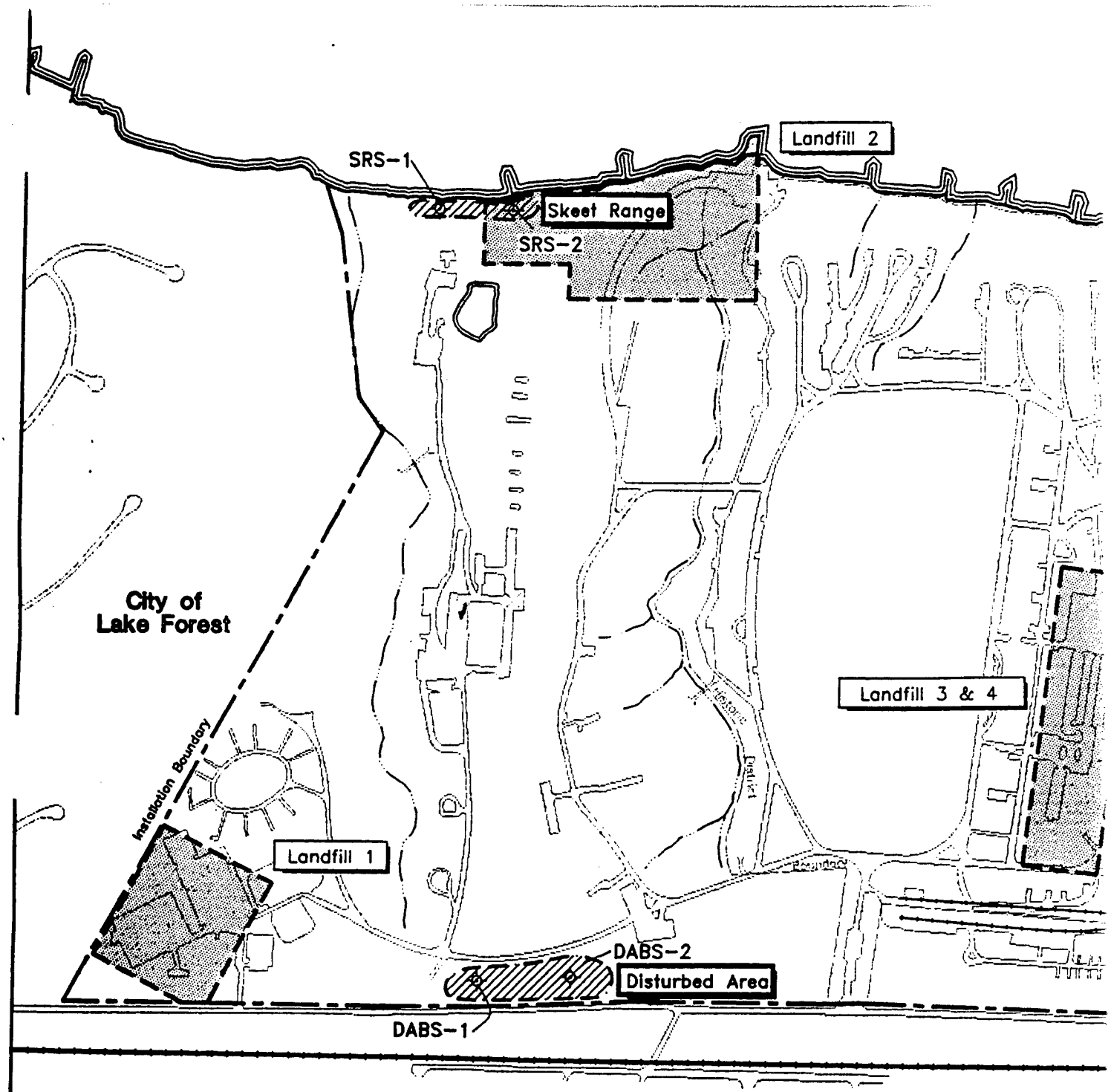
The area formerly occupied by a sanitary treatment plant has been identified as a potentially affected area. This area, the location of which is indicated on Figure 1-11, was identified in the EPIC aerial photograph survey of April, 1990. It is situated on the bluff overlooking Lake Michigan.

Fill Area 8

In addition to the seven landfills, an area of disturbed ground has been identified from aerial photograph studies conducted by EPIC in April, 1990. The area, as indicated on Figure 1-11, is located on the Lake Michigan shoreline just south of Landfill No. 7. The area is referred to as Fill Area No. 8 because there is no evidence that waste material has been disposed of in this area.

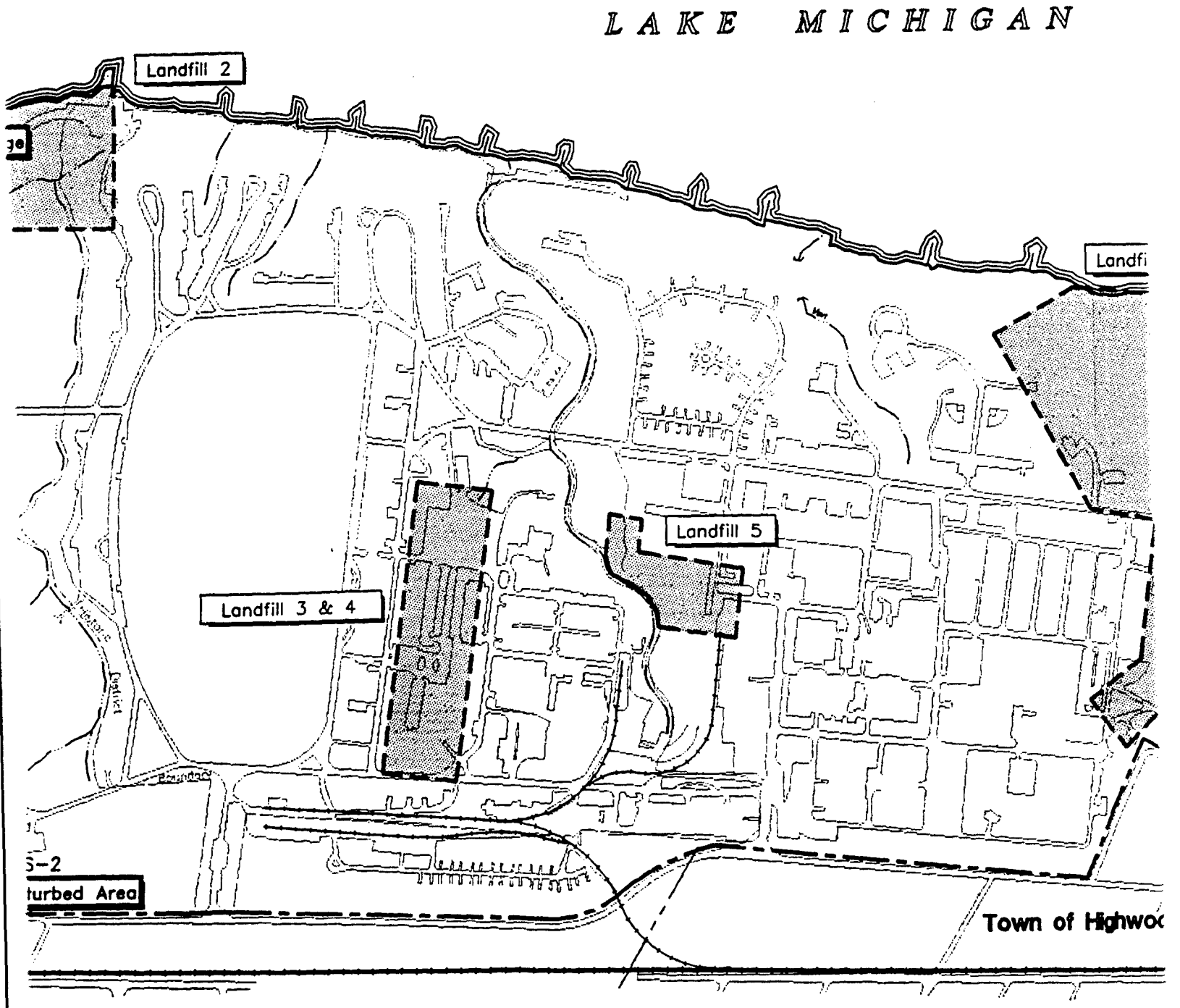
Miscellaneous Storage and Distribution Areas

Information discovered by the Environmental Baseline Survey (EBS) and the Community Environmental Response Facilitation Act (CERFA) Report has



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Revised DVL 03/15/95 FSDISTA2 Adapted from Official Post Map, Directorate of Engineering and Housing, Fort Sheridan, Illinois, January 6, 1989



andfill Areas

Soil Sample Location

Sediment and Surface Water Sample Location

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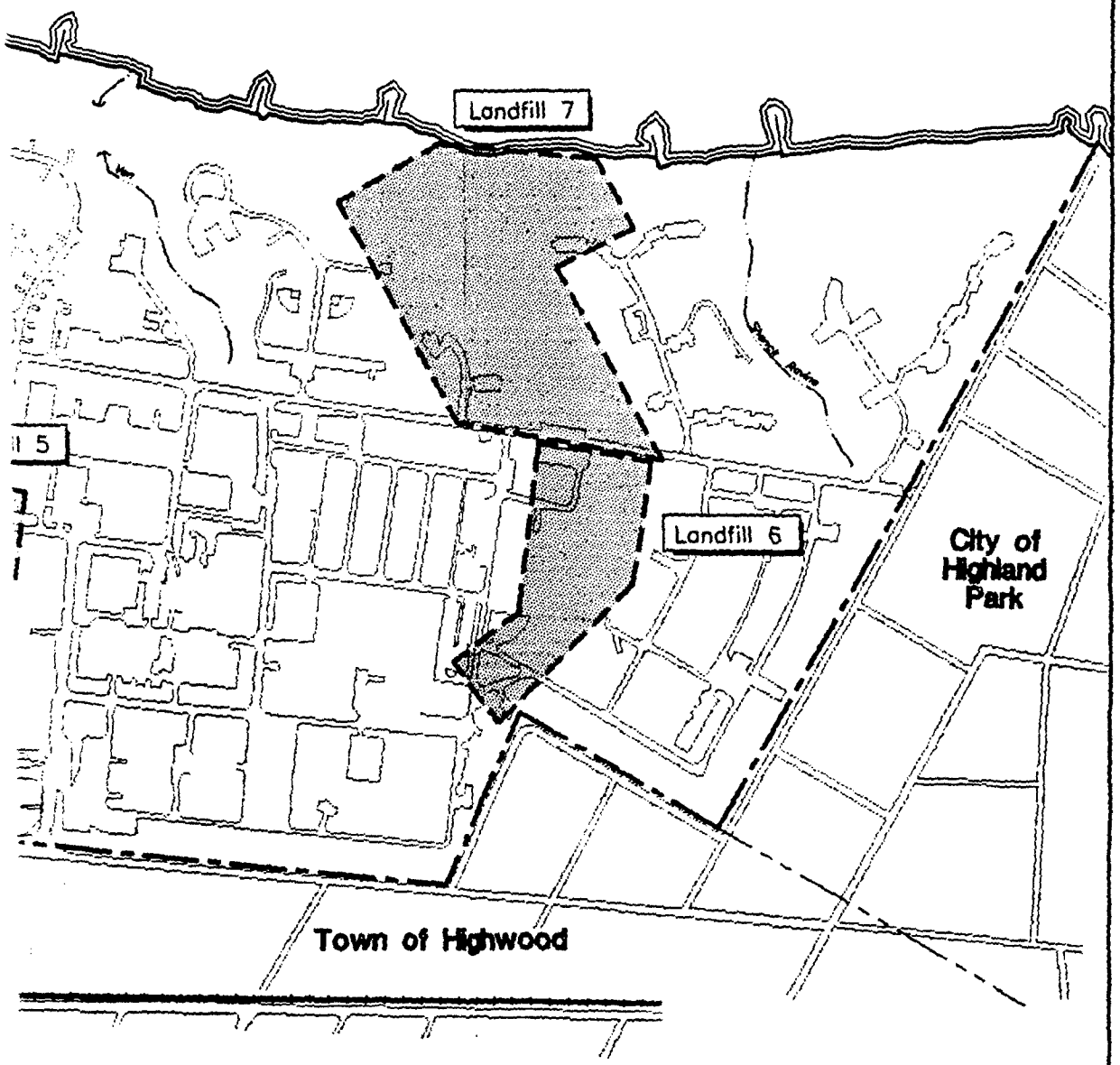


Figure 1-11
Disturbed Area and Trap Range Sample Locations
Quality Assurance Project Plan
Fort Sheridan
Fort Sheridan, Illinois

3

identified several other potentially affected areas including but not limited to the following:

- USTs reportedly abandoned in place in front of Buildings 800 through 806.
- a drum storage area at Building 172.
- a drum storage area at Building 211.
- potential leaks of hazardous substances at Building 86.
- potential aboveground storage tank (AST) leaks at Building 420.

1.3 OBJECTIVES

At Fort Sheridan, the continuing RI objectives are generally to acquire the data necessary to define the distribution, types, and concentrations of site-related constituents; assess potential current and/or future risks to human health and the environment from exposure to these constituents; and support the evaluation of remedial alternatives in the FS. The RI data will be sufficient in those instances where necessary to support "no-action" decisions at identified potential study areas.

Individual tasks have more specific objectives (e.g. the collection and analysis of background samples to provide a benchmark for comparing site specific data) which will be discussed in the site specific SAPs as they are developed. An example format for the organization of the SAPs is provided in Figure 1-12. Tables 1-1 and 1-2 indicate data quality objectives and uses and appropriate analytical levels, respectively, for analytical parameters and media to be analyzed.

Fort Sheridan has been divided into two operable units (OUs) to facilitate the implementation of the RI/FS program and expedite the reuse of surplus Army

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- 1.2 Project Purpose
- 1.3 Report Format

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- 2.2 Site Access and Control
- 2.3 Documentation
- 2.4 Field Instrumentation
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  - 5.5.2 Technical Objective
  - 5.5.3 Sampling Program

Figure 1-12
EXAMPLE FORMAT FOR SITE/ACTIVITY SPECIFIC SAMPLING AND ANALYSIS PLANS (PAGE 1 OF 2)

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

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Figure 1-12
EXAMPLE FORMAT FOR SITE/ACTIVITY SPECIFIC SAMPLING AND ANALYSIS PLANS
(PAGE 2 OF 2)

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

Table 1-1. Data Uses and Quality Objectives

Analytical Parameter	Media	Data Uses	Required Quantitation Limits To Be Met	Appropriate Quality Level
Volatiles	Water	Evaluate whether constituents are present	CLP CRQL	Level IV
		Characterize nature and extent of constituents	CLP CRQL	Level IV
	Soil	Gather preliminary data for potential remedial actions	CLP CRQL	Level III
		Perform baseline risk assessment	CLP CRQL	Level IV
Semi-Volatiles	Water	Evaluate whether constituents are present	CLP CRQL	Level IV
		Characterize nature and extent of constituents	CLP CRQL	Level IV
	Soil	Gather preliminary data for potential remedial actions	CLP CRQL	Level III
		Perform preliminary baseline risk assessment	CLP CRQL	Level IV
Pesticides/ PCBs/PAH	Soil and Water	Evaluate whether constituents are present	CLP CRQL	Level IV
		Characterize nature and extent of constituents	CLP CRQL	Level IV
		Gather preliminary data for potential remedial actions	CLP CRQL	Level III
		Perform baseline risk assessment	CLP CRQL	Level IV
Metals, Cyanide	Water and Soil	Evaluate whether groundwater and/or soil are affected	CLP CRQL	Level IV
		Characterize nature and extent of constituents	CLP CRQL	Level IV
		Gather preliminary data for potential remedial actions	CLP CRQL	Level III
		Perform baseline risk assessment	CLP CRQL	Level IV
Petroleum Hydrocarbons (TRPH)/Phenols	Water and Soil	Evaluate source areas contribution to regional presence of constituents	Standard method detection limit	Level III
	Water	Evaluate whether constituents are present	Standard method detection limit	Level III
		Characterize source areas	Standard method detection limit	Level III
		Perform qualitative baseline risk assessment	Standard method detection limit	Level III
Gross alpha/beta Gamma	Water and Soil	Evaluate whether groundwater and/or soil contamination exists	Standard method detection limit	Level III
		Evaluate whether radioactive materials are present in groundwater and/or soil	Standard method detection limit	Level III
		Characterize source areas	Standard method detection limit	Level III
		Gather preliminary data for potential remedial actions	Standard method detection limit	Level III
		Perform baseline risk assessment	Standard method detection limit	Level III
Explosives	Soil and Water	Evaluate whether constituents are present	CLP CRQL	Level IV

Table 1-1. Data Uses and Quality Objectives (Continued, Page 2 of 4)

Analytical Parameter	Media	Data Uses	Required Quantitation Limits To Be Met	Appropriate Quality Level
Explosives (continued)		Characterize nature and extent of constituents	CLP CRQL	Level IV
		Gather preliminary data for potential remedial actions	CLP CRQL	Level III
		Perform preliminary baseline risk assessment	CLP CRQL	Level IV
Hexavalent Chromium	Water and Soil	Evaluate whether groundwater and/or soil constituents are present	Standard method detection limit	Level III
		Characterize source areas	Standard method detection limit	Level III
		Evaluate whether emergency removal is necessary	Standard method detection limit	Level III
		Gather preliminary data for potential remedial actions	Standard method detection limit	Level IV
		Perform preliminary baseline risk assessment	Standard method detection limit	Level IV
		Evaluate source areas' contribution to regional constituents	Standard method detection limit	Level IV
Herbicides	Water	Evaluate whether constituents are present	Standard method detection limit	Level III
		Characterize source areas	Standard method detection limit	Level III
	Soil	Evaluate whether emergency removal is necessary	Standard method detection limit	Level III
		Gather preliminary data for potential remedial actions	Standard method detection limit	Level III
		Perform preliminary baseline risk assessment	Standard method detection limit	Level III
Fluoride	Water and Soil	Evaluate whether groundwater and/or soil constituents are present	Standard method detection limit	Level III
		Characterize source areas	Standard method detection limit	Level III
		Gather preliminary data for potential remedial actions	Standard method detection limit	Level III
		Perform preliminary baseline risk assessment	Standard method detection limit	Level III
Organo-Phosphorus Pesticides	Water and Soil	Evaluate whether groundwater and/or soil constituents are present	Standard method detection limit	Level IV
		Characterize source areas	Standard method detection limit	Level IV
		Gather preliminary data for potential remedial actions	Standard method detection limit	Level IV
		Perform preliminary baseline risk assessment	Standard method detection limit	Level IV
Ortho-Phosphate	Water	Evaluate whether groundwater constituents are present	Standard method detection limit	Level III
		Characterize source areas	Standard method detection limit	Level III
		Gather preliminary data for potential remedial actions	Standard method detection limit	Level III

Table 1-1. Data Uses and Quality Objectives (Continued, Page 3 of 4)

Analytical Parameter	Media	Data Uses	Required Quantitation Limits To Be Met	Appropriate Quality Level
Ortho-Phosphate (continued)		Perform preliminary baseline risk assessment	Standard method detection limit	Level III
pH	Water	Indicator parameter	N/A	Level II
	Soil	Preliminary FS information	N/A	Level II
Field measurements -pH -Temperature -Conductivity -Turbidity	Water and Soil	Indicator parameters to determine well purging requirements; geochemical evaluations	N/A	Level II
-Volatiles	Soil	Preliminary soils characterization	N/A	Level II
-Radiation	Soil	Safety monitoring	N/A	Level I
COD MBAS Diesel fuel	Water	Regular monitoring	5 mg/L 0.1 mg/L	Level III Level III
COD MBAS	Water	Regular monitoring	5 mg/L 0.1 mg/L	Level III Level III
Nitrates Nitrogen TKN	Water	Quarterly monitoring	1 mg/L	Level III
Chloride Sulfate	Water	Regular monitoring	1 mg/L	Level III
Anions	Water	Evaluation of the sources and movement of groundwater by mapping ionic species	5 ppm or Standard method detection limit, whichever is less	Level III
-Chloride -Alkalinity as $CaCO_3$ -Nitrate and Nitrite TDS E.C. Ammonia Hardness	Water and Soil	Preliminary FS information Assist in fate and transport analysis	Standard method detection limits	Level III
	Water and Soil	Evaluation of the sources and movement of groundwater by mapping ionic species Preliminary FS information	5 ppm (TDS) N/A (pH and E.C.)	Level III
Volatiles	Air	Evaluate whether constituents are present	Standard method detection limits	Level III
		Characterize nature and extent of constituents	Standard method detection limits	Level III
		Gather preliminary data for potential remedial actions	Standard method detection limits	Level III
		Perform preliminary baseline risk assessment	Standard method detection limits	Level IV

Table 1-1. Data Uses and Quality Objectives (Continued, Page 4 of 4)

Analytical Parameter	Media	Data Uses	Required Quantitation Limits To Be Met	Appropriate Quality Level
Semi-Volatiles	Air	Evaluate whether constituents are present	Standard method detection limits	Level III
		Characterize nature and extent of constituents	Standard method detection limits	Level III
		Gather preliminary data for potential remedial actions	Standard method detection limits	Level III
		Perform preliminary baseline risk assessment	Standard method detection limits	Level IV
Pesticides/ PCBs	Air	Evaluate whether constituents are present	Standard method detection limits	Level IV
		Characterize nature and extent of constituents	Standard method detection limits	Level IV
		Gather preliminary data for potential remedial actions	Standard method detection limits	Level III
		Perform preliminary baseline risk assessment	Standard method detection limits	Level IV
Metals, Cyanide	Air	Evaluate whether groundwater and/or soil constituents are present	Standard method detection limits	Level IV
		Characterize nature and extent of constituents	Standard method detection limits	Level IV
		Gather preliminary data for potential remedial actions	Standard method detection limits	Level III
		Perform preliminary baseline risk assessment	Standard method detection limits	Level IV
Explosives	Air	Evaluate source areas contribution to regional constituents	Standard method detection limits	Level III
		Evaluate whether constituents are present	Standard method detection limits	Level III
		Characterize source areas	Standard method detection limits	Level III
		Perform preliminary qualitative baseline risk assessment	Standard method detection limits	Level III

Note: E.C. = electric conductivity.
MBAS = methylene blue active substances.
COD = chemical oxygen demand.
TKN = total Kjeldahl nitrogen.
TDS = total dissolved solids.
CLP = contract laboratory program.
CRQL = contract required quantitation limit.
PAH = polynuclear aromatic hydrocarbon.
PCB = polychlorinated biphenyl.

property under the BRAC program. The first OU, designated the Surplus OU, consists of the property still owned by the U.S. Army and planned for disposal and reuse. This area is in the north end of the former Fort Sheridan and is primarily comprised of the golf course and historic district. The second OU is designated the Department of Defense OU (DOD OU). Since this area will remain the property of the U.S. Navy and Army Reserve, it includes most of the area to the south of Bartlett Ravine and the Army Reserve property and cemetery in the northwest corner of Fort Sheridan. Figure 1-13 indicates the areas assigned to each of the OUs.

1.4 SAMPLE NETWORK AND RATIONALE

The site specific investigation scopes of work are continually evolving based on the most recent data. For this reason specific sampling plans and their rationale will not be discussed here. Tables 1-3 and 1-4 summarize possible sampling and analysis plans which may be implemented at selected sites. The summary gives an indication of likely sample matrices and likely analytical parameter lists. Specific sampling programs and their rationale will be discussed in the site specific SAPs.

1.5 PROJECT SCHEDULE

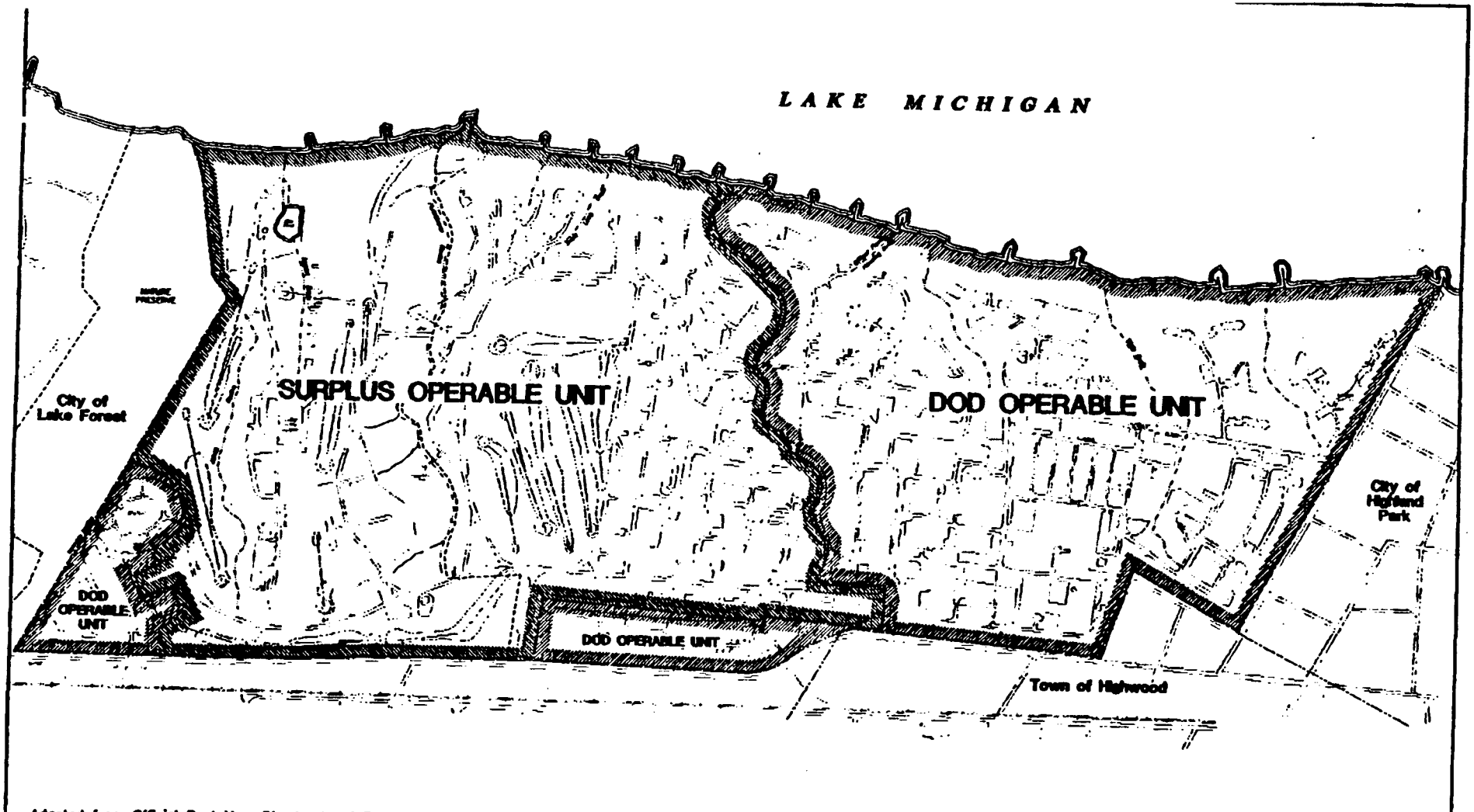
The schedule presented here is approximate and evolving, and is presented as a guide to indicate when the procedures in this OQAPP will be applied. Schedule revisions are expected to be transmitted to the Army and BCT as separate submittals rather than as updates to this OQAPP.

USAEC submits draft sampling and analysis plan and safety plan (as necessary)	MAR 95
USAEC submits final OQAPP	MAR 95
Receive regulatory comments on remaining plans	MAR 95

Table 1-2. Summary of Analytical Levels Appropriate to Data Uses

Data Uses	Analytical Level	Type of Analysis	Limitations	Data Quality
Site Characterization Monitoring During Implementation	EPA Level I	- Total organic/inorganic vapor detection using portable instruments - Field Test Kits	- Instruments respond to naturally occurring compounds	- If instruments calibrated and data interpreted correctly, can provide indication of constituent presence
Site Characterization Evaluation of Alternatives Engineering Design Monitoring During Implementation	EPA Level II	- Variety of organics by GC; inorganics by AA; XRF - Tentative ID; analyte specific - Bioassay - Detection limits vary from low ppm to low ppb	- Tentative ID - Techniques/instruments limited mostly to volatiles, metals	- Dependent on QA/QC steps employed - Data typically reported in concentration ranges
Risk Assessment PRP Determination Site Characterization Evaluation of Alternatives Engineering Design Monitoring During Implementation	EPA Level III	- Organics/inorganics using EPA procedures other than CLP can be analyte specific - RCRA characteristic tests	- Tentative ID in some cases - Can provide data of same quality as Levels IV	- Similar detection limits to CLP - Less rigorous QA/QC
Risk Assessment PRP Determination Evaluation of Alternatives Engineering Design	EPA Level IV	- TAL and TCL organics/inorganics by GC/MS; AA; ICP - Low ppb detection limit	- Tentative identification of NON-HSL parameters - Some time may be required for validation of packages	- Goal is data of known quality - Rigorous QA/QC

Source: EPA, 1987.



Adapted from Official Post Map, Directorate of Engineering and Housing, Fort Sheridan, Illinois, January 6, 1989

ESE Environmental Science & Engineering, Inc.

DVL 11/28/94 490-2087

Revised DVL 03/16/95 FS2ROP2

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Figure 1-12
Remedial Investigation Operable Units
Quality Assurance Project Plan
Fort Sheridan
Fort Sheridan, Illinois

Section 1.0
Revision 0
Date 03/16/95
Page 57 of 65

Table 1-3. Summary of Example Sampling and Analysis Program, Site-Specific Sampling and Analysis Plan, Fort Sheridan, Illinois*** (Page 1 of 5)

Sample Location	Sample Point	Sampled Media	Analytical Parameters*								
			TCL Metals (Total)	TCL Metals (Fltrd)	VOCs	SVOCs/PAH/TRPH	Pesticide/PCBs/ Herbicides	Explosives	TCLP	Cyanide	LDP Soil or SLP Water
BACKGROUND											
Background	BGS/MW-1X	Soil/Groundwater	y	y	y	y	y	y	-	y	y
Area North	BGS-5X	Soil	y	-	y	y	y	y	-	-	-
Background	BGS/MW-2X	Soil/Groundwater	y	y	y	y	y	y	-	y	y
Area East	BGS-6X	Soil	y	-	y	y	y	y	-	-	-
Background	BGS/MW-3X	Soil/Groundwater	y	y	y	y	y	y	-	y	y
Area South	BGS-7X	Soil	y	-	y	y	y	y	-	-	-
Background	BGS/MW-4X	Soil/Groundwater	y	y	y	y	y	y	-	y	y
Area West	BGS/MW-8X	Soil	y	-	y	y	y	y	-	-	-
	BGS-9X	Soil	y	-	y	y	y	y	-	-	-
Lake Michigan Bluff Area	BGS-10										
LF1MW01	LF1MW01-1	Soil	y	-	y	y	y	y	-	-	-
SURPLUS OPERABLE UNIT											
Disturbed Area	DABS-1	Soil	y	-	y	y	y	-	-	-	-
	DABS-2	Soil	y	-	y	y	y	-	-	-	-
Skeet Range	SRS-1	Soil	y	-	y	y	-	-	-	-	-
	SRS-2	Soil	y	-	y	y	-	-	-	-	-
Building 172, Potential Leak			The specific scope of work for this location will be defined in the Site-Specific SAP.								
Building 86, Drum Storage			The specific scope of work for this location will be defined in the Site-Specific SAP.								

Table 1-3. Summary of Example Sampling and Analysis Program, Site-Specific Sampling and Analysis Plan, Fort Sheridan, Illinois*** (Page 2 of 5)

Sample Location	Sample Point	Sampled Media	Analytical Parameters*								
			TCL Metals (Total)	TCL Metals (Fltrd)	VOCs	SVOCs/PAH/TRPH	Pesticide/PCBs/ Herbicides	Explosives	TCLP	Cyanide	LDP Soil or SLP Water
Potential AST Leaks			The specific scope of work for this location will be defined in the Site-Specific SAP.								
Landfill 2	LF2S-10	Soil	1	-	y	y	y	y	-	y	y
	LF2S-11	Soil	1	-	y	y	y	y	-	y	y
	LF2S-12	Soil	3	-	y	y	y	y	-	y	y
	LF2S-13	Soil	3	-	y	y	y	y	-	y	y
	LF2MW01	Groundwater	1	1	y	y	-	y	-	y	y
	LF2MW02	Groundwater	1	1	y	y	-	y	-	y	y
	LF2MW03	Groundwater	1	1	y	y	-	y	-	y	y
	LF2MW04S	Groundwater	1	1	y	y	-	y	-	y	y
	LF2MW04D	Groundwater	1	1	y	y	-	y	-	y	y
	LF2MW05S	Groundwater	y	y	y	y	-	y	-	y	y
	LF2MW05D	Groundwater	y	y	y	y	-	y	-	y	y
	LF2MW06S	Groundwater	y	y	y	y	-	y	-	y	y
	LF2MW06D	Groundwater	y	y	y	y	-	y	-	y	y
	LF2MW07S	Groundwater	y	y	y	y	-	y	-	y	y
	LF2MW07D	Groundwater	y	y	y	y	-	y	-	y	y
	LF2MW08S	Groundwater	y	y	y	y	-	y	-	y	y
	LF2MW08D	Groundwater	y	y	y	y	-	y	-	y	y
	LF2MW09S	Groundwater	y	y	y	y	-	y	-	y	y

Table 1-3. Summary of Example Sampling and Analysis Program, Site-Specific Sampling and Analysis Plan, Fort Sheridan, Illinois*** (Page 3 of 5)

Sample Location	Sample Point	Sampled Media	Analytical Parameters*								
			TCL Metals (Total)	TCL Metals (Filtrd)	VOCs	SVOCs/PAH/TRPH	Pesticide/PCBs/ Herbicides	Explosives	TCLP	Cyanide	LDP Soil or SLP Water
	LF2MW09D	Groundwater	y	y	y	y	-	y	-	y	y
Landfill 3 and Landfill 4	LF3MW01	Groundwater	y	y	y	y	-	-	-	-	y
	LF3MW02	Groundwater	y	y	y	y	-	-	-	-	y
	LF3MW03	Groundwater	y	y	y	y	-	-	-	-	y
	LF3MW04D	Groundwater	y	y	y	y	-	-	-	-	y
	LF3MW05	Groundwater	y	y	y	y	-	-	-	-	y
VES Area 1	VES1-1	Soil	y	-	y	y	-	-	-	-	-
	VES1-2	Soil	y	-	y	y	-	-	-	-	-
	VES1-3	Soil	y	-	y	y	-	-	-	-	-
VES Area 2	VES2-1	Soil	y	-	y	y	-	-	-	-	-
	VES2-2	Soil	y	-	y	y	-	-	-	-	-
	VES2-3	Soil	y	-	y	y	-	-	-	-	-
Building 126	B126MW01	Groundwater	y	y	y	y	-	-	-	-	-
Building 216	B216S-1	Soil	y	-	-	y	-	-	-	-	-
	B216S-2	Soil	y	-	-	y	-	-	-	-	-
	B216S-3	Soil	y	-	-	y	-	-	-	-	-
Bartlett Ravine Building 43	BRSS1	Sediment/Soil	y	-	y	y	-	-	-	-	-
	BRSS3	Sediment/Soil	y	-	y	y	-	-	-	-	-
	BRSS7	Sediment/Soil	y	-	y	y	-	-	-	-	-

Table 1-3. Summary of Example Sampling and Analysis Program, Site-Specific Sampling and Analysis Plan, Fort Sheridan, Illinois*** (Page 4 of 5)

Sample Location	Sample Point	Sampled Media	Analytical Parameters*								
			TCL Metals (Total)	TCL Metals (Fltrd)	VOCs	SVOCs/PAH/TRPH	Pesticide/PCBs/ Herbicides	Explosives	TCLP	Cyanide	LDP Soil or SLP Water
	BRSS15	Sediment/Soil	y	-	y	y	-	-	-	-	-
Nike Silo N	SWEEP		-	-	-	-	-	-	-	-	-
Nike Silo S	SWEEP		-	-	-	-	-	-	-	-	-
DEPARTMENT OF DEFENSE OPERABLE UNIT											
Sanitary Treatment Plant			The specific scope of work for this location will be defined in the Site-Specific SAP.								
Building 800-806 USTs			The specific scope of work for this location will be defined in the Site-Specific SAP.								
Fill Area No. 8			The specific scope of work for this location will be defined in the Site-Specific SAP.								
Building 211, Drum Storage											
Landfill 1	LF1MW01	Groundwater	y	y	y	y	-	-	-	-	y
	LF1MW02	Groundwater	y	y	y	y	-	-	-	y	y
Landfill 5	LF5MW01	Groundwater	y	y	y	y	-	-	-	-	y
	LF5MW02	Groundwater	y	y	y	y	-	-	-	-	y
	LF5MW03	Groundwater	y	y	y	y	-	-	-	-	y
	LF5MW04S	Groundwater	y	y	y	y	-	-	-	-	y
	LF5MW04D	Groundwater	y	y	y	y	-	-	-	-	y
Building 368	B368MW02	Groundwater	y	y	y	y	-	-	-	-	-
Waste Characterization	COMPOSITE	Water	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Waste Characterization	COMPOSITE	Soil	-	-	-	-	-	-	*	-	-
Waste Characterization	COMPOSITE	Water	**	**	**	**	**	**	**	**	-

Notes: LDP = Landfill design parameters.
PCB = Polychlorinated biphenyl.
SLP = Standard landfill parameters.
SVOC = Semivolatile organic compound.
TBD = To Be Determined (analytes have not been determined).
TCL = Target compound list.
TCLP = Toxicity charateristic leaching procedure.
VOC = Volatile organic compounds.

*Soil cuttings generated during the installation of monitor wells will be containerized in drums and a composite sample from every ten drums or fraction thereof will be analyzed.
**Well development and purge water will be containerized along with decontamination water. The sample(s) will be tested for the list of analytes required by the POTW before discharge.
***This is an approximate scope of future work and is provided to indicate the extent of the work that this OQAPP will govern. The scope of future field work will be developed and finalized in one or more site-specific SAPs.

Table 1-4. QA/QC Program and Sampling Rationale, Site-Specific Sampling and Analysis Plan, Fort Sheridan, Illinois (Page 1 of 2)

Sampled Media	Estimated Number of Field Samples	Analytical Parameters for Field Samples	Number of QA/QC Samples				Rationale and Comments
			Duplicates*	Field/Equipment Blanks**	Trip Blanks	Matrix Spike & M.S. Dups.**	
Soil	TBD	TCL Metals, VOCs, SVOCs, Herbicides, Pesticides/PCBs, PAH	TBD	TBD	***	TBD	Background and Disturbed Area Screening
Soil	TBD	TCL Metals, VOCs, SVOCs, PAH	TBD	TBD	***	TBD	Skeet Range screening & supplement to VES 1&2 and Barlett Ravine downstream of Building 43
Soil	TBD	TCL Metals, VOCs, SVOCs, Herbicides, Pesticides/PCBs, PAHs, Explosives, LF Design Parameters ****	TBD	TBD	***	TBD	Supplement to Landfill #2 investigation
Soil	TBD	TCL Metals, SVOCs, PAH	TBD	TBD	***	TBD	Supplement to Building 216 investigation.
Soil	TBD	TCLP	TBD	TBD	***	TBD	Waste characterization for disposal of soil cuttings generated during drilling.
Sediment	TBD	TCL Metals, VOCs, SVOCs, PAH	TBD	TBD	***	TBD	Barlett Ravine sampling downstream of Building 43.
Groundwater	TBD	TCL Metals Total & Filtered, VOCs, SVOCs, Herbicides, Pesticides/PCBs, Cyanide, PAH	TBD	TBD	***	TBD	Background screening.
Groundwater	TBD	TCL Metals Total & Filtered, VOCs, SVOCs, PAH	TBD	TBD	***	TBD	Supplement to investigations at Landfills #1, #3, #4, #5, and four additional locations to be announced.

Table 1-4. QA/QC Program and Sampling Rationale, Site-Specific Sampling and Analysis Plan, Fort Sheridan, Illinois (Page 2 of 2)

Sampled Media	Estimated Number of Field Samples	Analytical Parameters for Field Samples	Number of QA/QC Samples				Rationale and Comments
			Duplicates*	Field/Equipment Blanks**	Trip Blanks	Matrix Spike & M.S. Dups.**	
Groundwater	TBD	TCL Metals Total & Filtered, VOCs, PAH SVOCs, Herbicides, Classical Landfill Parameters*****, Explosives, Cyanide	TBD	TBD	***	TBD	Supplement to Landfill #2 investigation.
Surface Water	TBD	TCL Metals, VOCs, SVOCs, PAH, Pesticides/PCBs	TBD	TBD	***	TBD	Barlett Ravine sampling downstream of Building 43.
Radiation	TBD	Radioisotopes	N/A	N/A	N/A	N/A	Nike Missile Installation.
Waste Water	TBD******	*****	*****	*****	***	*****	Predisposal characterization of water generated during well development, sampling, and deconning.

Notes: N/A = not applicable.
TBD = to be determined.

This table cannot be completed until the scope of future field efforts is known. A completed table in this format will be included in site-specific SAPs. The guidelines to be used in determining the numbers of QA/QC samples are shown below.

*Number of duplicate samples figured as 10% of total number of samples for each media and analyte list.
**Number of field/equipment blank and matrix spike/matrix spike duplicate samples figured as 10% of total number of samples for each media and analyte list.
***Number of trip blank samples depends on sampling order and timing. A minimum of one trip blank per cooler will be analyzed.
****Landfill Design Parameters include wet and dry bulk density, specific capacity, pH, Total Organic Carbon (TOC), cation exchange capacity.
*****Classical Landfill Parameters include fluoride, nitrate, hardness, sulfate, chloride, TOC, chemical oxygen demand, boron, alkalinity, and total dissolved solids.
******Number of Waste Water samples analyzed will depend on number of containers of waste water. A minimum of one sample per 10 containers or fraction thereof will be analyzed for the analyte list required by the Publically Owned Treatment Works (POTW).

Receive regulatory concurrence on OQAPP	APR 95
Issue final revision of remaining plans	APR 95
Receive regulatory concurrence on remaining plans	MAY 95
Mobilize for background field effort	JUN 95
Initiate background field work	JUN 95
Initiate additional (Phase 1) sampling field work	JUL 95
Complete background and additional field work	AUG 95
Initiate additional (Phase 2) sampling effort (if necessary)	SEP 95
Complete additional Phase 2 sampling effort	OCT 95
Complete chemical analysis and update IRDMIS	DEC 95
Complete revised draft final remedial investigation (DFRI) report and submit for concurrent review	MAR 96

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This portion of the OQAPP addresses the Fort Sheridan project organization as it provides for QA/QC coordination and responsibilities. Figure 2-1 shows the overall project organization and its principal lines of communication and authority.

2.1 BRAC CLEANUP TEAM (BCT)

The BCT at Fort Sheridan consists of the BRAC Environmental Coordinator (BEC), IEPA BCT representative, and the EPA Region V BCT representative. The BCT, with assistance from their overall project team, should resolve global technical, operational, and administrative issues.

Specifically related to the OQAPP, the BCT should work together to solve the following types of issues:

1. How specific study areas or operable units (OUs) should be addressed,
2. Use of various methodologies and technologies,
3. Project schedules,
4. Data QA/QC analyses,
5. Data validation,
6. Data quality assessment,
7. Data management,
8. Assist in development of conceptual site models,
9. Background contaminant determination,
10. Risk assessment protocols,
11. Data gaps, and
12. Recommended No Further Response Action Planned (NFRAP) sites.

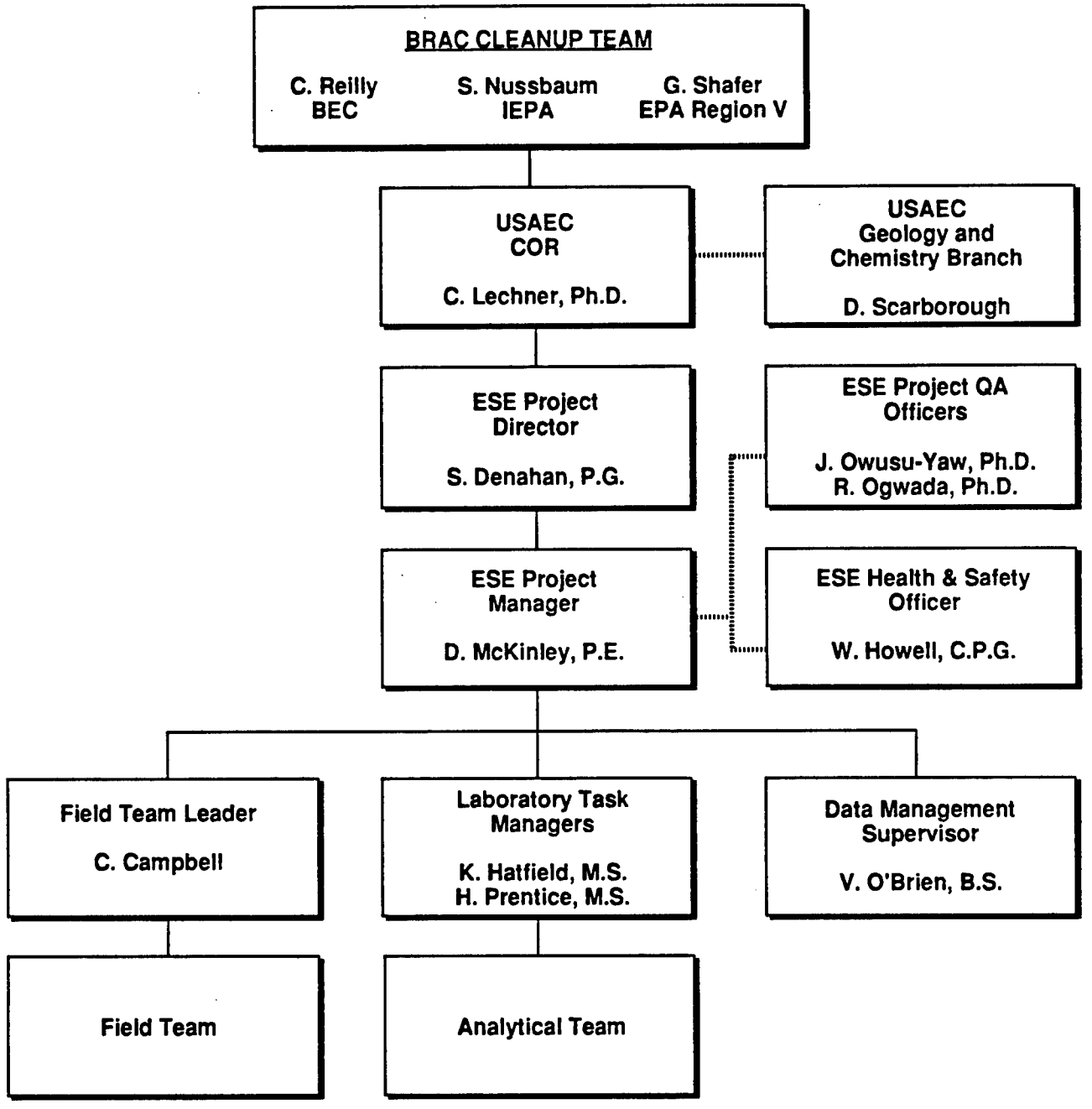


Figure 2-1
PROJECT ORGANIZATION

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

Further DOD guidance on the roles and responsibilities of the BCT is located in Appendix C of this document. (Note: For reference purposes, this guidance comes from the DOD BRAC Cleanup Plan Guidebook, Fall 1993.)

2.2 USAEC QA PROGRAM

Ultimate responsibility for QA rests with the Commander of USAEC [delegated to the USAEC Contracting Officer's Representative (COR) and the Geology and Chemistry Branch]. QA is implemented on this project through the USAEC Guidelines for Implementation of ER 1110-1-263 for USAEC Projects (May 1993) and this OQAPP. The QC requirements contained in this document adhere to the requirements of these guidelines.

2.2.1 USAEC GEOLOGY AND CHEMISTRY BRANCH, TECHNICAL SUPPORT DIVISION

The duties of the USAEC Geology and Chemistry Branch, Installation Restoration Division are as follows:

1. Advising the Commander on QA/QC practices;
2. Approving the Project QA Plan submitted by the RI/FS contractor;
3. Providing standardized analytical methods, as necessary;
4. Reviewing and recommending approval of any proposed modifications to analytical methodology;
5. Recommending validation of Contractor Laboratory analytical methods, as necessary, prior to collecting field samples;
6. Providing guidance to the USAEC COR on implementation of the QA/QC program for Fort Sheridan;
7. Providing guidance to the USAEC Project Officer on chemistry matters;
8. Evaluating the quality of data generated in this project;
9. Monitoring the effective implementation of QA/QC practices and report questionable practices to the Commander of USAEC;

10. Conducting onsite audits, if necessary;
11. Reviewing the SAP Addendum (Appendix F) and OQAPP for adequacy of analytical and sampling methods and QA/QC;
12. Coordinating data reporting requirements with the USAEC Data Management Group; and
13. Informing project agencies of any changes in the regulatory QA/QC program (SAP and OQAPP).

2.2.2 USAEC COR

The duties of the USAEC COR are as follows:

1. Acting as the principal contact between USAEC, the RI/FS contractor, and Fort Sheridan;
2. Requiring effective implementation of the USAEC QA Program;
3. Submitting requests to the Geology and Chemistry Branch to supply analytical reference materials, if necessary;
4. Forwarding Geology and Chemistry Branch review comments to the RI/FS contractor;
5. Forwarding results of the Geology and Chemistry Branch evaluation of data quality to the RI/FS contractor;
6. Providing formal notification to the Contracting Officer of unapproved deviations from the QA Program;
7. Ensuring weekly QC chart submission from the RI/FS contractor/laboratory subcontractor;
8. Informing the Geology and Chemistry Branch of difficulties and problems encountered by the RI/FS contractor in implementing the QA Program;
9. Discussing proposed changes in approved sampling and analysis procedures with the Geology and Chemistry Branch;

10. Providing OQAPPs to the Geology and Chemistry Branch for review and approval;
11. Providing any RI/FS contractor/laboratory subcontractor certification documentation to the Geology and Chemistry Branch for review and approval; and
12. Coordinating any changes in QA/QC program with regulatory agencies.

2.3 ESE QA PROGRAM

This OQAPP functions according to the USAEC QA Program. ESE and any subcontractor laboratory act as the field laboratories, which are monitored by the USAEC Geology and Chemistry Branch QA Coordinator. All chemical analyses for this project shall be performed by the ESE Gainesville laboratory, Gainesville, Florida. The project organization chart is presented on Figure 2-1. The functions of the OQAPP and QA responsibilities of each of the project participants are outlined in the following subsections.

2.3.1 PROJECT DIRECTOR

The Project Director is the primary technical reviewer of project deliverables. Responsibilities include review of work plans, schedules, costs, and technical performance, and liaison with the Project Manager to redirect resources to achieve contractual obligations.

2.3.2 PROJECT QA OFFICER

The Project QA Officer is responsible for maintaining and overseeing an effective QA/QC organization in the laboratory. The Project QA Officer directly supervises the performance of the QA/QC Coordinator and audits the performance of the laboratory to ensure that the requirements of the OQAPP are followed in sampling and analysis activities. The Project QA

Officer directs the development of the OQAPP and approves any deviations or changes to QA/QC requirements. USAEC Geology and Chemistry Branch and the COR must approve any changes to the QA/QC program. The Project QA Officers maintain liaison with the Task Team, the USAEC Geology and Chemistry Branch.

The Project QA Officer's specific responsibilities are to:

1. Provide an independent overview of QC practices within each project operation to ensure that QC requirements of the OQAPP are completed;
2. Maintain and review QC records, including control charts, and provide copies of QC records to USAEC weekly;
3. Prepare sections of interim and final project reports dealing with QC data;
4. Monitor the logging-in of samples, sample preservation, handling, subsampling, and transport throughout the project;
5. Review data batches for proper QC procedures, audit data files for correct entry of data, and approve data prior to transmittal to Level 2. Level 2 data are data transmitted from the laboratory to the USAEC database;
6. Obtain and maintain records on Standard Analytical Reference Materials (SARMs) or interim reference materials;
7. Maintain a vigil of the entire laboratory and field operation to detect conditions that might jeopardize control of the various analytical and sampling systems;
8. Ensure, by field visits, that appropriate sampling, field testing, and field analysis procedures are followed and that correct QC procedures are used;

9. Inform project management concerning nonconformance with the OQAPP and provide documentation of said nonconformance, recommend corrective actions that are to be taken, and document their completion; and
10. Maintain and update records of the qualifications of the analysts and field team members.

2.3.3 PROJECT MANAGER

The Project Manager is responsible for effective day-to-day management of the entire project staff, as well as direct communication and liaison with the USAEC COR. The Project Manager's responsibility specific to QA/QC is to design field procedures and ensure proper implementation of the field procedures by the project team.

2.3.4 LABORATORY TASK MANAGER

The Laboratory Task Manager is responsible for effective day-to-day coordination of analytical activity. He/she is responsible for review and approval of analytical data generated for the project. The Laboratory Task Manager's QA/QC responsibility is to ensure that QC requirements of the OQAPP are implemented; provide guidance and technical support in resolution of QC problems; ensure that appropriate internal QC samples are applied; and provide guidance in preparation of analytical lots to ensure efficient, comprehensive analysis of required parameters.

2.3.5 ANALYTICAL DEPARTMENT MANAGER AND FIELD TEAM LEADER

The Analytical Department Manager and Field Team Leader are responsible for provision of accurate field or laboratory data produced by analysts and sampling personnel under their supervision. They are responsible for ensuring that QC procedures are followed and documented.

2.3.6 ANALYSTS AND FIELD TEAM MEMBERS

It is the responsibility of the analysts and field team members to perform the required QA/QC procedures and to document observations and calculations in the proper notebooks or standard forms. It is the responsibility of the analyst to perform preliminary QC checks including plotting QC charts to ensure that each batch of data being generated meets all analytical criteria specified in the OQAPP. A batch or lot is defined as the maximum number of samples, including QC samples, that can be manually processed through the rate limiting step of the method during a single time period (not to exceed one day, 24 hours, as defined by the process.) The field team member or analyst must also bring any unusual observation or analytical problem to the immediate attention of his/her supervisor or the Project QA Officer. The analyst or field team member must ensure that instruments are calibrated and the calibration recorded in permanent records. Each analyst is also responsible for ensuring that sufficient quantities of reagents of adequate quality are available for the performance of the required analyses.

2.3.7 SAMPLE CUSTODIAN

The Sample Custodian is responsible for receiving samples from the field and checking to ensure that proper preservation, shipment, and chain-of-custody are maintained. The Sample Custodian also reports any unusual problems (e.g., sample breakage improper temperature) to the Laboratory Task Manager.

3.0 QUALITY ASSURANCE OBJECTIVES

3.1 INTRODUCTION

Data obtained during the investigation of Fort Sheridan are intended to define the distribution, types, and concentrations of site-related constituents; assess potential current and/or future risks to human health and the environment from exposure to these constituents; and support the evaluation of remedial alternatives in the FS. Data will be obtained under the constraints and controls of the USAEC QA Program (May 1993) and the USATHAMA Geotechnical Requirements (March 1987). These programs require production of a OQAPP and SAPs to detail the minimum standards, particularly for field and analytical data quality. The ESE Gainesville Laboratory will provide the required analytical services for this project. Analytical data will be generated by EPA methods and USAEC-approved QC criteria generated from a laboratory method validation. These procedures result in analytical data considered generally equivalent to EPA Data Quality Objective (DQO) Level III and IV data. A summary of USAEC-approved methods and equivalent EPA methods is presented in Table 3-1.

The overall QA objectives are to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide results which are legally defensible in a court of law. Specific procedures for sampling, chain-of-custody, instrument calibration/preventive maintenance, chemical analysis, internal QC, reporting data, audits, and corrective actions are described in other sections of this OQAPP. The purpose of this section is to address the specific objectives for accuracy, precision, completeness, representativeness, and comparability.

Table 3-1.

Fort Sheridan Remedial Investigation - ESE Gainesville Laboratory Analytical Methods
Page 1 of 2

Analyte	USAEC Method Numbers		Reference Analytical Method	Method Validation Required?	Associated EPA Sample Preparation Methods		EPA Sample Cleanup Method	
	Soil	Aqueous			Soil*	Aqueous*	Soil*	Aqueous*
VOCs	VMS1-SO and VMS2-SO	VMS1-WA and VMS2-WA	8240*	Yes	8240	8240	--	--
BNAs	SMV1-SO	SMV1-WA	8260*	Yes	3540	3510	3640	3640
PAHs	PAH1-SO	PAH1-WA	8310	Yes	8310	8310	8310	8310
Explosives	EXL1-SO	EXL1-WA	8330	Yes	8330	8330	8330	8330
Pesticides/PCBs	PST1-SO	PST1-WA	8080*	Yes	3540	3510	3640	3640
Herbicides	HBG1-SO	HGB1-WA	8150*	Yes	8150	8150	8150	8150
Phenols	--	--	8040*	Yes	3540	3510	3650	3650
Cyanide	CYN1-SO	CYN1-WA	9012*	Yes	--	--	--	--
Metals	ICP1-SO	ICP1-WA	6010*	Yes	3050	3005	--	--
Antimony	--	GSB1-WA	7041*	Yes	3050	3005	--	--
Arsenic	GAS1-SO	GAS1-WA	7060*	Yes	3050	7060	--	--
Lead	GPB1-SO	GPB1-WA	7421*	Yes	3050	3005	--	--
Mercury	--	HGC1-WA	7470*,**	Yes	--	7470	--	--
Mercury	HGC1-SO	--	7471*,††	Yes	7471	--	--	--
Selenium	GSE1-SO	GSE1-WA	7740*	Yes	3050	7740	--	--
Thallium	GTL1-SO	GTL1-WA	7841*	Yes	3050	3005	--	--
Vanadium	GV1-SO	GV1-WA	7911	Yes	3050	3020	--	--
Total petroleum hydrocarbons (TPH)	TPH1-SO	TPH1-WA	Modified 8015	Yes	--	--	--	--
Alkalinity	--	--	310.1†	No	--	--	--	--
Ammonia	ANA1-SO	ANA1-WA	350.1†	Yes	--	--	--	--
BOD	--	--	405.1†	No	--	--	--	--
Boron	ICP1/SO	ICP1/WA	6010*	Yes	--	--	--	--
COD	--	--	410.4†	No	--	--	--	--
Chloride	ANI1-SO	ANI1-WA	300.0†	Yes	--	--	--	--
Fluoride	ANI1-SO	ANI1-WA	300.0†	Yes	--	--	--	--

Table 3-1.

Fort Sheridan Remedial Investigation - ESE Gainesville Laboratory Analytical Methods
Page 2 of 2

Analyte	USAEC Method Numbers		Reference Analytical Method	Method Validation Required?	Associated EPA Sample Preparation Methods		EPA Sample Cleanup Method	
	Soil	Aqueous			Soil*	Aqueous*	Soil*	Aqueous*
Hardness	--	--	130.2†	No	--	--	--	--
Nitrate and Nitrite	ANA2-SO	ANI2-WA	353.2†	Yes	--	--	--	--
Hexavalent chromium	--	--	7196	Yes	--	--	--	--
pH	--	--	150.1†,**	No	--	--	--	--
pH	--	--	9045**,††	No	--	--	--	--
Specific conductivity	--	--	120.1†	No	--	--	--	--
Sulfate	ANI1-SO	ANI1-WA	300.0†	Yes	--	--	--	--
TDS	--	--	160.1†	No	--	--	--	--
TOC	--	--	9060†,††	No	--	--	--	--
TOC	--	--	415.1†,††	No	--	--	--	--
Total phenolic compounds	TPT1-SO	TPT1-WA	9066*	Yes	--	--	--	--
Total recoverable petroleum hydrocarbons	--	--	418.1	No	--	--	--	--

*Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA, SW-846, Third Edition, 1986.
†Methods of Chemical Analysis of Water and Wastes, EPA, 1983.
**Aqueous Methods.
††Soil/Sediment.

Note: -- = method not specified.

USAEC Method SOPs are in Appendix E.

Source: ESE.

3.2 REPRESENTATIVENESS

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter which is dependent upon proper design of the sampling and laboratory program. Representativeness will be satisfied by ensuring that the site-specific SAPs are followed, proper sampling techniques are used, proper analytical procedures are followed, and holding times of the samples are not exceeded. Representativeness will also be assessed by the analysis of field duplicate samples. Sample handling protocols (e.g., storage and transportation) will be selected to protect the integrity of the collected samples. Proper documentation will establish that protocols have been followed and sample identification and integrity assured.

3.3 COMPARABILITY

Comparability expresses the confidence with which one data set can be compared with another. The characteristic of comparability reflects both internal consistency of measurements made at the site and expression of results in units consistent with other organizations reporting similar data. Each value reported for a given measurement should be similar to other values within the same data set and within other related data sets. Comparability of data and measuring procedures must also be addressed. This characteristic implies operating within the calibrated range of an instrument and using analytical methodologies which produce comparable results [e.g., data obtained for total recoverable phenolics via wet chemistry are not necessarily comparable to data obtained for phenol via gas chromatography/mass spectrometry (GC/MS)].

Measurements compared to similar measurements which appear as "outliers" will be reassessed by verifying that QA/QC procedures in the field and laboratory had been followed. Units of measurement will be externally comparable by using the appropriate standard units for each measurement system.

Data will be expressed in the following units:

1. Volume in liters (L) [e.g., micrograms per liter (μg/L)] indicates an aqueous matrix. Control spikes are added into organic-free laboratory water.
2. Weight in grams (g) [e.g., micrograms per gram (μg/g)] indicates a soil/sediment matrix. Control spikes are added into a USAEC standard soil that has been chemically characterized.
3. Air units in nanograms (ng) [e.g., nanograms per cubic meter (ng/m^3), or parts per billion volume (ppbv), volume per volume].

The ESE laboratory performs the analysis for specified compounds using standardized methods and, in the process, has generated data to provide a baseline for establishing control limits (for precision, accuracy, reporting limits) for daily analyses and should therefore reflect typical performance.

3.4 COMPLETENESS

The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount that was expected to be obtained under optimal conditions. Completeness is the ratio of the valid data to the total data. The amount of valid data expected is established based on the measurements required to accomplish project objectives. The number of groundwater, soil, subsurface soil, surface water, and sediment samples to be obtained is specified for each site in the site-specific SAP. Because

sampling and waste characterization activities often rely on a field protocol, the site-specific SAP will provide an upper limit on the number of samples collected. For the background sampling, the level of completeness expected is 100 percent. However, the minimum level of completeness expected to be achieved for all analytes for the field sampling effort and laboratory analyses is 90 percent.

3.5 ACCURACY/PRECISION/REPORTING LIMITS

3.5.1 ACCURACY

Accuracy is defined as the ability to measure a value precisely and with minimal bias from the true value. Accuracy is generally measured as the percent recovery of the measured or found value versus the known value. For this project, USAEC-approved methods will require the analysis of control spikes which will be plotted on control charts according to USAEC protocol (Section 12.0). Control spikes are spikes of analytes of interest into a standard matrix (soil or water). The percent recoveries of the analytes are used to determine the precision and accuracy of the analytical method. This is achieved by the use of control charts. Details of the control spikes and construction of the control charts are provided in Section 12.0. All methods [except GC/MS and organochlorine pesticides (OCPs)] require one control spike at approximately two times the method reporting limit and replicate control spikes at the lower value of 20 times the method reporting limit or 80 percent of the upper calibration range. The same rules apply for OCPs except that there are replicate control spikes at two times the reporting limit. For GC/MS analyses, the surrogate recoveries for replicate method blanks (one per 12-hour period or two if run time is less than 12 hours) are used as control samples. Control limits for these charts are calculated and updated as described in Section 12.0. Matrix spikes/matrix spike duplicates (MS/MSDs) will be performed at one set per 20 samples

and are not used as analytical control samples but are used to evaluate whether results need to be flagged for matrix effects. Matrix effects shall be flagged based on the National Functional Guidelines. The acceptance criteria for the MS/MSD are presented in Tables 3-2 through 3-5 which represent or relate closely to Contract Laboratory Program (CLP) criteria.

3.5.2 PRECISION

Precision is defined as the ability to reproduce a measured value and is generally measured as an absolute percent difference of replicate measured values. Several types of precision will be measured and evaluated for this project. USAEC methods require control spikes as described in Section 3.0. The precision for the control spikes is plotted on control charts for replicate control spikes and single control spikes (moving average precision) as described in Section 12.0.

The precision of MS/MSD samples will be evaluated and acceptance criteria are presented in Tables 3-2 through 3-5 which represent or relate closely to CLP criteria.

The precision of field duplicates will also be evaluated to estimate sampling error or representativeness.

3.5.3 METHOD DETECTION LEVEL

Before any analytical system is used, the MDL for all analytes of interest shall be determined as follows:

1. A standard matrix sample at 1 to 5 times the estimated MDL (based on the RDL and the instrumental detection limit) shall be prepared,

Table 3-2.

Summary of Precision and Accuracy for Control Analytes for Metals

Method	Parameter	Spike Type	Aqueous Matrix Precision (Max RPD)	Aqueous Matrix Accuracy (% Recovery)	Solid Matrix Precision (Max RPD)	Solid Matrix Accuracy (% Recovery)
SW6010	Barium	MSC/QCC	20	75-125	20	75-125
	Cadmium	MSC/QCC	20	75-125	20	75-125
	Chromium	MSC/QCC	20	75-125	20	75-125
	Silver	MSC/QCC	20	75-125	20	75-125
	Lead	MSC/QCC	20	NA	20	75-125
	Sodium	MSC/QCC	20	75-125	20	75-125
	Aluminum	MSC/QCC	20	75-125	20	75-125
	Beryllium	MSC/QCC	20	75-125	20	75-125
	Boron	MSC/QCC	20	75-125	20	75-125
	Calcium	MSC/QCC	20	75-125	20	75-125
	Cobalt	MSC/QCC	20	75-125	20	75-125
	Copper	MSC/QCC	20	75-125	20	75-125
	Iron	MSC/QCC	20	75-125	20	75-125
	Magnesium	MSC/QCC	20	75-125	20	75-125
	Manganese	MSC/QCC	20	75-125	20	75-125
	Molybdenum	MSC/QCC	20	75-125	20	75-125
	Nickel	MSC/QCC	20	75-125	20	75-125
	Tin	MSC/QCC	20	75-125	20	75-125
	Zinc	MSC/QCC	20	75-125	20	75-125
SW7421/ GPB1	Lead	MSC/QCC	20	75-125	20	75-125
SW7060/ GAS1	Arsenic	MSC/QCC	20	75-125	20	75-125
SW7470/ 7471/HGC1	Mercury	MSC/QCC	20	75-125	20	75-125
SW7041/ GSB1	Antimony	MSC/QCC	20	75-125	20	75-125
SW7740/ GSE1	Selenium	MSC/QCC	20	75-125	20	75-125
SW7740/ GTL1	Thallium	MSC/QCC	20	75-125	20	75-125
EPA 9010/ CYN1	Cyanide	MSC/QCC	20	75-125	20	75-125
EPA 7911/ GV1	Vanadium	MSC/QCC	20	75-125	20	75-125

Note: MSC = matrix spike compound. This represents a spike into a sample matrix, in duplicate.
QCC = quality control check analyte. This represents a spike into a standard matrix. It is a single standard matrix spike for the methods listed in this table.
NA = not applicable.

Source: ESE.

Table 3-3.

Summary of Precision and Accuracy Criteria for Inorganics, Landfill Parameters and Radiochemistry

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Parameter	Units	Reference	Acceptance Criterion Precision (Max RPD)	Acceptance Criterion Accuracy (Percent Recovery)
Alkalinity, Total	mg/L-$CaCO_3$	EPA 310.1	25	88-110
COD, high-level	mg/L	HACH 8000	20	85-115
COD, low-level	mg/L	HACH 8000	20	85-115
Moisture	% Wet Weight	ASTM D 2216-71	23	NA
Chloride	mg/L	EPA 325.3	25	75-125
Chloride	mg/L	EPA 300	25	75-125
Nitrogen, NO_2 + NO_3	mg/L	EPA 353.2	25	75-125
Nitrogen, NO_3	mg/L-as N	EPA 300, 353.2, 9200	25	75-125
Nitrogen, NH_3 + NH_4	mg/L-as N	EPA 350.1	25	75-125
BOD, 5-day	mg/L	EPA 405.1	38	60-136
BOD, 14-day	mg/L	EPA 405.1	38	60-136
Carbon, Total	mg/L	EPA 415.1, 9060	13	87-113
Carbon, TOC	mg/L	EPA 415.1, 9060	13	87-113
Carbon, TOC, Sed	g/kg	EPA 9060 (mod)	17	82-116
Carbon, TOC, Sed	% Organic Content	ASTM D 2974	20	NA
Chlorine, Free A_v	mg/L	EPA 330.1	15	85-115
Chlorine, Total Residual	mg/L	EPA 330.1	15	85-115
Chromium (+6)	µg/L	EPA 7196	15	83-113
	µg/g	EPA 3060, 7196	15	83-113
Fluoride	mg/L	EPA 340.2	25	75-125
Fluoride	mg/L	EPA 9056, 300	25	75-125
Fluoride	µg/g	EPA 300	25	75-125
Hardness	mg/L-$CaCO_3$	EPA 130.2	25	85-115
pH	Std Units	EPA 150.1, 9040	25	NA
Phenols	µg/L	EPA 420.2, 9066	20	73-112
Phenols, Sed	µg/g	CE-81-1	25	72-122

Table 3-3.

Summary of Precision and Accuracy Criteria for Inorganics, Landfill Parameters and Radiochemistry

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Parameter	Units	Reference	Acceptance Criterion: Precision (Max RPD)	Acceptance Criterion: Accuracy (Percent Recovery)
Phosphorus, Total	mg/L	EPA 365.1	20	75-125
Phosphorus, Ortho	mg/L	EPA 365.1, 300, 9056	20	75-125
Residue, Susp. (TSS)	mg/L	EPA 160.2	34	NA
Residue, Diss., Total (TDS) 105 Deg	mg/L	EPA 160.1	19	NA
Residue, Total (TS)	mg/L	EPA 160.3	19	NA
Specific Cond.	µmhos/cm	EPA 120.1, 9050	15	NA
Temperature	°C	EPA 170.1	NA	NA
Turbidity	NTU	EPA 180.1	NA	NA
TOX	µg/L-Cl	EPA 9020	26	73-125
TOX	µg/kg	EPA 9020 (Mod)	31	66-128
Alpha, Gross	pCi/L	EPA 900.0, 9310	25	80-110
Alpha, Gross	pCi/g	EPA 3050, 9310 (Mod)	25	80-110
Beta, Gross	pCi/L	EPA 900.0, 9310	25	80-110
Beta, Gross	pCi/g	EPA 3050, 9310 (Mod)	25	80-110
Radium Alpha, Gross	pCi/L	EPA 900.1	25	70-130
Radium, 226	pCi/L	EPA 903.1, 9320	25	70-130
Radium, 226, Alpha emit	pCi/L	EPA 903.0, 9315	25	70-130
Radium, 226	pCi/g	EPA 3050, 9320 (Mod)	25	70-130
Radium, 226, Alpha emit	pCi/g	EPA 3050, 9315 (Mod)	25	70-130
Radium 228	pCi/L	EPA 904.0, 9320	25	70-130
Radium 228	pCi/g	EPA 3050, 9320 (Mod)	25	70-130
Radium, Total	pCi/L	EPA 903.0, 9315	25	70-130
Strontium 89	pCi/L	EPA 905.0	25	70-130
Strontium 90	pCi/L	EPA 905.0	25	70-130
Tritium	pCi/L	EPA 906.0	25	70-130
Uranium, Natural	pCi/L	EPA 908.0	25	70-130

Source: ESE.

Table 3-4.

Summary of Precision and Accuracy for Control Analytes and Surrogates for Organics Analysis

Method*	Parameter	Spike Type	Aqueous Matrix Precision (Max RPD)	Aqueous Matrix Accuracy (% Recovery)	Solid Matrix Precision (Max RPD)	Solid Matrix Accuracy (% Recovery)
SW 8080/PST1	PCB 1016	MSC/QCC	30	50-114	50	50-114
	PCB 1260	MSC/QCC	30	8-127	50	8-127
	Lindane	MSC/QCC	51	43-145	42	45-129
	Heptachlor	MSC/QCC	38	48-124	59	30-148
	Aldrin	MSC/QCC	45	37-127	40	53-133
	Dieldrin	MSC/QCC	43	56-142	47	46-140
	Endrin	MSC/QCC	60	35-155	37	52-126
	Decachlorobiphenyl	S	NA	12-140	NA	14-170
	Tetrachloro-m-xylene	S	NA	33-119	NA	38-130
	4,4-DDT	MSC/QCC	53	46-152	59	37-156
SW8240/VMS1	1,1-Dichloroethene	MSC/QCC	14	61-145	22	59-172
	Trichloroethene	MSC/QCC	14	71-120	24	62-137
	Benzene	MSC/QCC	11	76-127	21	66-142
	Toluene	MSC/QCC	13	76-125	21	59-139
	Chlorobenzene	MSC/QCC	13	75-130	21	60-133
	Toluene-d_8	S	NA	88-110	NA	84-138
	4-Bromofluorobenzene	S	NA	86-115	NA	59-113
	1,2-Dichloroethane-d_4	S	NA	76-114	NA	70-121
SW8270/SMV1	Acenaphthene	MSC/QCC	31	46-118	19	31-137
	2-Chlorophenol	MSC/QCC	40	27-123	50	25-102
	4-Chloro-3-methylphenol	MSC/QCC	42	23-97	33	26-103
	1,4-Dichlorobenzene	MSC/QCC	28	36-97	27	28-104
	2,4-Dinitrotoluene	MSC/QCC	38	24-96	47	28-89
	4-Nitrophenol	MSC/QCC	50	10-80	50	11-114
	N-Nitrosodi-n-propylamine	MSC/QCC	38	41-116	38	41-126
	Pentachlorophenol	MSC/QCC	50	9-103	47	17-109

Table 3-4.

Summary of Precision and Accuracy for Control Analytes and Surrogates for Organics Analysis

Method*	Parameter	Spike Type	Aqueous Matrix Precision (Max RPD)	Aqueous Matrix Accuracy (% Recovery)	Solid Matrix Precision (Max RPD)	Solid Matrix Accuracy (% Recovery)
SW8270/SMV1 (Continued)						
	Phenol	MSC/QCC	42	12-110	35	26-90
	Pyrene	MSC/QCC	31	26-127	36	35-142
	1,2,4-Trichlorobenzene	MSC/QCC	28	39-98	23	38-107
	Nitrobenzene-D5	S	NA	35-144	NA	23-120
	2-Fluorobiphenyl	S	NA	43-116	NA	30-115
	p-Terphenyl-D14	S	NA	33-141	NA	18-137
	Phenol-D5	S	NA	10-110	NA	24-113
	2-Fluorophenol	S	NA	21-110	NA	25-121
	2,4,6-Tribromophenol	S	NA	10-123	NA	19-122
SW8015/TPH1	Gasoline	MSC/QCC	59	3-121	44	43-131
	Diesel	MSC/QCC	58	37-153	55	41-151
	Pentacosane	S	NA	48-156	NA	50-152
SW8150/HBG1	2,4-D	MSC/QCC	55	9-119	48	35-131
	2,4-DB	MSC/QCC	30	84-102	50	84-102
	2,4,5-T	MSC/QCC	30	67-103	50	67-103
	2,4,5-TP/Silvex der.	MSC/QCC	51	33-135	41	61-143
	Dicamba (banvel)	MSC/QCC	47	21-115	32	57-121
	Dichlorprop	MSC/QCC	30	91-103	50	91-103
	DCAA	S	NA	32-112	NA	30-126
SW8310/PAH	Acenaphthene	MSC/QCC	37	49-123	56	30-142
	Acenaphthylene	MSC/QCC	34	45-113	48	24-120
	Anthracene	MSC/QCC	40	44-124	51	38-140
	Benzo(a)pyrene	MSC/QCC	64	10-138	60	26-146
	Benzo(b)fluoranthene	MSC/QCC	30	6-150	50	6-150

Table 3-4.

Summary of Precision and Accuracy for Control Analytes and Surrogates for Organics Analysis

Method*	Parameter	Spike Type	Aqueous Matrix Precision (Max RPD)	Aqueous Matrix Accuracy (% Recovery)	Solid Matrix Precision (Max RPD)	Solid Matrix Accuracy (% Recovery)
SW8310/PAH (Continued)						
	Benzo(k)fluoranthene	MSC/QCC	41	41-123	55	22-132
	Fluorene	MSC/QCC	35	40-110	49	25-123
	Naphthalene	MSC/QCC	50	30-130	30	46-106
	Phenanthrene	MSC/QCC	32	52-116	46	46-138
	Triphenylene	MSC/QCC	S	60-124	NA	38-154

Note: MSC = matrix spike compound. This represents a spike into a sample matrix, in duplicate.
NA = not applicable.
QCC = quality control check compound. This represents a single spike into a standard matrix compound (accuracy may be calculated and reported, but not precision).
S = surrogate.

*The methods cited are from Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition (EPA, 1986) and USAEC methods for pesticides/PCBs (PST1), volatiles (VMS1), semivolatiles (SMV1), herbicides (HBG1), and total petroleum hydrocarbons (TPH) analyses.

Source: ESE.

Table 3-5.

Analytes, Precision, and Accuracy Data for Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC), SW 8330/EXL1

Parameter	Aqueous† Precision (RPD)	Aqueous† Accuracy (% Recovery)	Solid† Precision (RPD)	Solid† Accuracy (% Recovery)
HMX††	13	84-111	18	80-116
RDX*	30	51-111	18	71-107
1,3,5-Trinitrobenzene*	28	46-102	25	65-115
1,3-Dinitrobenzene††	37	58-132	30	70-130
Methyl-2,4,6-Trinitro-phenylnitramine (Tetryl)††	21	67-109	46	65-157
Nitrobenzene*	32	44-108	24	72-120
2,4,6-Trinitrotoluene*	38	48-124	23	72-118
2,4-Dinitrotoluene*	21	60-102	19	68-106
2,6-Dinitrotoluene††	26	67-119	44	58-146
o-Nitrotoluene††	28	53-109	22	70-114
m-Nitrotoluene††	48	40-136	48	40-136
p-Nitrotoluene††	26	60-112	26	60-112
3,4-Dinitrotoluene**	NA	30-126	NA	71-143

*Matrix spike and QC check sample compound
†Accuracy and precision criteria based on ESE historical data, unless specified differently.
**Surrogate.
††Accuracy and precision criteria based on ESE method validation studies.

Source: ESE.

2. Seven aliquots of the sample shall be processed through the entire method,
3. The standard deviation shall be calculated from the results of the seven aliquots, and
4. The MDL is equal to the standard deviation times the Student's t value (3.143) for that number of measurements.

The MDL shall be equal to or less than the RDL. If the calculated MDL is lower than what the laboratory considers a practical detection level, then the MDL may be raised to the higher level. In no instance shall the MDL be lowered below the calculated level. The method documentation shall include both the calculated MDL and the request for an increased MDL. MDLs for inorganics shall be verified quarterly. MDLs for organics shall be verified annually.

Method reporting limits expected to be achieved for this project are presented in Tables 3-6 through 3-14.

Analytical methods for collected air samples are listed in Table 3-15; precision and accuracy criteria expected to be achieved for the air analyses are presented in Tables 3-16 and 3-17.

3.5.4 FIELD QUALITY CONTROL SAMPLES

Field quality control samples and their associated quality objectives are addressed in Section 4.0 of the QQAPP.

Table 3-6.
Reporting Limits for Metals Analysis in
Aqueous and Soil Matrices

Parameter	EPA/USAEC Method No.	Reporting Limit	
		Aqueous (µg/L)	Soil (µg/g)
Aluminum	6010/ICP2	40.0	150
Antimony	7041/GSB1	3.05	NA*
Arsenic	7060/GAS1	2.5	0.25
Barium	6010/ICP2	25.0	40
Beryllium	6010/ICP2	4.0	0.5
Boron	6010/ICP2	50.0	5.0
Cadmium	6010/ICP2	5.0	0.5
Calcium	6010/ICP2	100.0	100
Chromium	6010/ICP2	10.0	1.0
Cobalt	6010/ICP2	20.0	2.0
Copper	6010/ICP2	5.0	0.5
Iron	6010/ICP2	45.0	100
Lead	7421/GPB1	2.0	0.5
Magnesium	6010/ICP2	50.0	50
Manganese	6010/ICP2	5.0	4
Mercury	7040, 7041/HGC1	0.2	0.1
Molybdenum	6010/ICP2	10.0	1.0
Nickel	6010/ICP2	15.0	2.0
Potassium	6010/ICP2	550.0	100
Selenium	7740/GSE1	2.5	0.25
Silver	6010/ICP2	5.0	0.5
Sodium	6010/ICP2	100.0	50
Thallium	7841/GTL1	2.0	0.25
Tin	6010/ICP2	50.0	5.0
Vanadium	7911/GV1	5.00	0.75
Zinc	6010/ICP2	20.0	5.0

*6010/ICP2 for Sb is 5.0 µg/g.
Source: ESE.

2. Seven aliquots of the sample shall be processed through the entire method,
3. The standard deviation shall be calculated from the results of the seven aliquots, and
4. The MDL is equal to the standard deviation times the Student's t value (3.143) for that number of measurements.

The MDL shall be equal to or less than the RDL. If the calculated MDL is lower than what the laboratory considers a practical detection level, then the MDL may be raised to the higher level. In no instance shall the MDL be lowered below the calculated level. The method documentation shall include both the calculated MDL and the request for an increased MDL. MDLs for inorganics shall be verified quarterly. MDLs for organics shall be verified annually.

Method reporting limits expected to be achieved for this project are presented in Tables 3-6 through 3-14.

Analytical methods for collected air samples are listed in Table 3-15; precision and accuracy criteria expected to be achieved for the air analyses are presented in Tables 3-16 and 3-17.

3.5.4 FIELD QUALITY CONTROL SAMPLES

Field quality control samples and their associated quality objectives are addressed in Section 4.0 of the OQAPP.

Table 3-6.

Reporting Limits for Metals Analysis in Aqueous and Soil Matrices

Parameter	EPA/USAEC Method No.	Reporting Limit	
		Aqueous (µg/L)	Soil (µg/g)
Aluminum	6010/ICP1	40.0	10.0
Antimony	7041/GSB1	3.05	NA
Arsenic	7060/GAS1	2.5	0.25
Barium	6010/ICP1	25.0	5.0
Beryllium	6010/ICP1	4.0	0.5
Boron	6010/ICP1	50.0	5.0
Cadmium	6010/ICP1	5.0	0.5
Calcium	6010/ICP1	100.0	20.0
Chromium	6010/ICP1	10.0	1.0
Cobalt	6010/ICP1	20.0	2.0
Copper	6010/ICP1	5.0	0.5
Iron	6010/ICP1	45.0	10.0
Lead	7421/GPB1	2.0	0.5
Magnesium	6010/ICP1	50.0	10.0
Manganese	6010/ICP1	5.0	0.5
Mercury	7040, 7041/HGC1	0.2	0.1
Molybdenum	6010/ICP1	10.0	1.0
Nickel	6010/ICP1	15.0	2.0
Potassium	6010/ICP1	550.0	60.0
Selenium	7740/GSE1	2.5	0.25
Silver	6010/ICP1	5.0	0.5
Sodium	6010/ICP1	100.0	20.0
Thallium	7841/GTL1	2.0	0.25
Tin	6010/ICP1	50.0	5.0
Vanadium	7911/GV1	5.00	0.75
Zinc	6010/ICP1	20.0	5.0

Source: ESE.

Table 3-7.

Reporting Limit Data for Inorganics, TOX, and Radionuclides Analyses

Page 1 of 2

Parameter	Units	Reference	Reporting Limit
Alkalinity, Total	mg/L-$CaCO_3$	EPA 310.1	5.0*
COD, high-level	mg/L	HACH 8000	50†
COD, low-level	mg/L	HACH 8000	5.0†
Moisture	% Wet Wt	ASTM-D 2216-71	0.5**
Chloride	mg/L	EPA 325.3	1.0*
Chloride	mg/L	EPA 300, 9056	0.5**
Nitrogen, NO_2 + NO_3	mg/L-as N	EPA 353.2	0.010**
Nitrogen, NO_3	mg/L-as N	EPA 300, 353.2, 9056	0.010**
Nitrogen, NH_3 + NH_4	mg/L-as N	EPA 350.1	0.02**
Phosphorus, T	mg/L-as P	EPA 300, 9056	0.01**
Sulfate	mg/L	EPA 375.4	5.0**
		EPA 300, 9056	0.50**
BOD, 5-day	mg/L	EPA 405.1	1.0*
BOD, 14-day	mg/L	EPA 405.1	1.0*
Carbon, TOC	mg/L	EPA 415.1, 9060	1.0**
Carbon, TOC, Sed	g/kg	EPA 9060 (Mod)	360††
Carbon, TOC, Sed	% Organic Content	ASTM- D 2974	0.1**
Chromium (+6)	µg/L	EPA 7196	2.0
	µg/g	EPA 3060, 7196	0.05
Fluoride	mg/L	EPA 340.2	0.10**
Fluoride	mg/L	EPA 300, 9056	0.50**
Fluoride	µg/g	EPA 300	2.50
Hardness	mg/L-$CaCO_3$	EPA 130.2	1.0***
Phenols	µg/L	EPA 420.2	5.0**
Phenols, Sed	µg/g	CE-81-1, p. 3-555	100**
Residue, Diss., Total (TDS)	mg/L	EPA 160.1	10*
Residue, Susp. (TSS)	mg/L	EPA 160.2	4*
Specific Cond. Lab	µmho/cm	EPA 120.1	10**

Table 3-7.

Reporting Limit Data for Inorganics, TOX, and Radionuclides Analyses

Page 2 of 2

Parameter	Units	Reference	Reporting Limit
TOX	µg/L-Cl	EPA 9020	10**
TOX	µg/kg	EPA 9020 (Mod)	30*
TRPH	mg/L	EPA 418.1	0.17**
	µg/g	EPA 9070, 418.1	21.0**
Alpha, Gross	pCi/L	EPA 900.0	1.0†††
Alpha, Gross	pCi/g	EPA 3050, 9310 (Mod)	1.0†††
Beta, Gross	pCi/L	EPA 900.0, 9310	3.0†††
Beta, Gross	pCi/g	EPA 3050, 9310 (Mod)	3.0†††
Radium Alpha, Gross	pCi/L	EPA 900.1	1.0†††
Radium 226	pCi/L	EPA 903.1, 903.0, 9315, 9320	0.1†††
Radium 226	pCi/g	EPA 3050, 9315, 9320 (Mod)	0.1†††
Radium 228	pCi/L	EPA 904.0, 9320	2.0†††
Radium 228	pCi/g	EPA 3050, 9320 (Mod)	2.0†††
Radium, Total	pCi/L	EPA 903.0, 9315	1.0†††
Radium 226, Alpha emit	pCi/L	EPA 903.0, 9315	1.0***
Radium 226, Alpha emit	pCi/g	EPA 3050, 9315 (Mod)	1.0***

Note:
g/kg = grams per kilogram.
mg/L = milligrams per liter.
pCi/g = picocuries per gram.
pCi/L = picocuries per liter.
µg/g = micrograms per gram.
µg/L = micrograms per liter.
µmho/cm = micromhos per centimeter.

*Methods for Chemical Analyses of Water and Waste, EPA 600/4-79-020, Revised, March 1983.
†HACH instrument recommended detection limit, HACH Co., Box 389, Loveland, CO 80537.
**Based on the lowest standard that ESE routinely uses. For solids, the reporting limits are adjusted for sample weight and final volume.
††Based on MDL Study.
***Obtained from Standard Methods for the Examination of Water and Wastewater, 17th Edition, 1989.
†††Based on EPA's detection limits calculation procedure recommended for radionuclide analyses. (Reference: Carbon-14 in Aqueous Samples, Environmental Measurements Laboratory Manual, 1981.)

Source: ESE.

Table 3-8.

Reporting Limits for Volatile Organic Compounds
in Aqueous and Soil Matrices by EPA Method 8240;
USAEC Method VMS1-WA/VMS1-SO

Page 1 of 2

Parameter	Reporting Limit	
	Aqueous (µg/L)	Soil (µg/g)
Acetone	10	0.010
Benzene	2	0.010
Bromodichloromethane	2	0.010
Bromoform	2	0.010
Bromomethane	2	0.010
2 - Butanone	10	0.010
Carbon Disulfide	10	0.010
Carbon Tetrachloride	2	0.010
Chlorobenzene	2	0.010
Chloroethane	10	0.010
2-Chloroethyl Vinyl Ether	10	0.010
Chloroform	2	0.010
Chloromethane	2	0.010
Dibromochloromethane	2	0.010
1,1 - Dichloroethane	2	0.010
1,2 - Dichloroethane	2	0.010
1,2 - Dichloroethene, total	2	0.010
1,1 - Dichloroethene	2	0.010
1,2 - Dichloropropane	2	0.010
cis - 1,3 - Dichloropropene	2	0.010
trans - 1,3 - Dichloropropene	2	0.010
Ethylbenzene	2	0.010
2 - Hexanone	10	0.010
4 - Methyl - 2 - pentanone	10	0.010
Methylene Chloride	5	0.010
Styrene	2	0.010
1,1,2,2 - Tetrachloroethane	2	0.010
Tetrachloroethene	2	0.010

Table 3-8.

Reporting Limits for Volatile Organic Compounds
in Aqueous and Soil Matrices by EPA Method 8240;
USAEC Method VMS1-WA/VMS1-S0

Page 2 of 2

Parameter	Reporting Limit	
	Aqueous (µg/L)	Soil (µg/g)
1,1,1 - Trichloroethane	2	0.010
1,1,2 - Trichloroethane	2	0.010
Trichloroethene	2	0.010
Toluene	2	0.010
Vinyl Acetate	10	0.010
Vinyl Chloride	2	0.010
Xylene, total	10	0.010

Source: ESE.

Table 3-9.

Reporting Limits for Semivolatile Organic Compounds in Aqueous and Soil Matrices by EPA Method 8270; USAEC Method SMV1-WA, SVMV-S0

Page 1 of 3

Parameter	Reporting Limit*	
	Aqueous (µg/L)	Soil (µg/g)
Phenol	2.0	0.14
bis(2-Chloroethyl) ether	2.0	0.14
2-Chlorophenol	2.0	0.14
1,3-Dichlorobenzene	2.0	0.14
1,4-Dichlorobenzene	2.0	0.14
1,2-Dichlorobenzene	2.0	0.14
2-Methylphenol	2.0	0.14
2,2'-oxybis(1-chloropropane)	2.0	0.14
4-Methylphenol	2.0	0.14
N-Nitroso-di-n-propylamine	2.0	0.14
Hexachloroethane	2.0	0.14
Nitrobenzene	2.0	0.14
Isophorone	2.0	0.14
2-Nitrophenol	2.0	0.14
2,4-Dimethylphenol	2.0	0.14
Benzoic acid	20.0	1.35
bis(2-Chloroethoxy)methane	2.0	0.14
2,4-Dichlorophenol	2.0	0.14
1,2,4-Trichlorobenzene	2.0	0.14
Naphthalene	2.0	0.14
4-Chloroaniline	2.0	0.30
Hexachlorobutadiene	2.0	0.14
4-Chloro-3-methylphenol	2.0	0.14
2-Methylnaphthalene	2.0	0.14
Hexachlorocyclopentadiene	10.0	1.0
2,4,6-Trichlorophenol	2.0	0.30
2,4,5-Trichlorophenol	2.0	0.30
2-Chloronaphthalene	2.0	0.14
2-Nitrolaniline	10.0	0.67
Dimethylphthalate	2.0	0.14

Table 3-9.

Reporting Limits for Semivolatile Organic Compounds
in Aqueous and Soil Matrices by EPA Method 8270;
USAEC Method SMV1-WA, SVMV-S0

Page 2 of 3

Parameter	Reporting Limit*	
	Aqueous (µg/L)	Soil (µg/g)
Acenaphthylene	2.0	0.14
2,6-Dinitrotoluene	2.0	0.14
3-Nitroaniline	10.0	0.67
Acenaphthene	2.0	0.14
2,4-Dinitrophenol	30.0	1.35
4-Nitrophenol	20.0	1.35
Dibenzofuran	2.0	0.14
2,4-Dinitrotoluene	2.0	0.14
Diethylphthalate	2.0	0.14
4-Chlorophenyl-phenylether	2.0	0.14
Fluorene	2.0	0.14
4-Nitroaniline	10.0	0.67
4,6-Dinitro-2-methylphenol	20.0	1.35
N-nitrosodiphenylamine	2.0	0.14
4-Bromophenly-phenylether	2.0	0.14
Hexachlorobenzene	2.0	0.14
Pentachlorophenol	10.0	0.67
Phenanthrene	2.0	0.14
Anthracene	2.0	0.14
Carbazole	2.0	0.14
Di-n-butylphthalate	2.0	0.14
Fluoranthene	2.0	0.14
Pyrene	2.0	0.14
Butylbenzylphthalate	2.0	0.14
3,3'-Dichlorobenzidine	10.0	0.67
Benzo(a)anthracene	2.0	0.14
Chrysene	2.0	0.14
bis(2-Ethylhexyl)phthalate	2.0	0.14
Di-n-octylphthalate	2.0	0.14
Benzo(b)fluoranthene	2.0	0.14
Benzo(k)fluoranthene	2.0	0.14

Table 3-9.

Reporting Limits for Semivolatile Organic Compounds in Aqueous and Soil Matrices by EPA Method 8270; USAEC Method SMV1-WA, SVMV-S0

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Parameter	Reporting Limit*	
	Aqueous (µg/L)	Soil (µg/g)
Benzo(a)pyrene	2.0	0.14
Indeno(1,2,3-cd)pyrene	2.0	0.16
dibenzo(a,h)anthracene	2.0	0.16
Benzo(g,h,i)perylene	2.0	0.16

*Based on MDL studies. The reporting limits of compounds that are difficult to analyze were adjusted to a concentration that is detected more reliably. The MDL studies were conducted according to the 40 CFR 136 Appendix B protocols. MDLs are performed annually.

Source: ESE.

Table 3-10.

Reporting Limits for Explosives in Aqueous and Soil Matrices by EPA Method 8330/USAEC Method EXL1 - WA/SO

Parameter	Reporting Limit	
	Aqueous (µg/L)	Soil (µg/g)
HMX	0.2	0.5
RDX	0.2	0.5
1,3,5-Trinitrobenzene	0.1	0.25
1,3-Dinitrobenzene	0.1	0.25
Tetryl	1.0	0.5
Nitrobenzene	0.1	0.25
2,4,6-Trinitrotoluene	0.1	0.25
4-Amino-2,6-Dinitrotoluene	0.1	0.25
2-Amino-4,6-Dinitrotoluene	0.1	0.25
2,6-Dinitrotoluene	0.07	0.2
2,4-Dinitrotoluene	0.06	0.2
2-Nitrotoluene	0.2	0.5
4-Nitrotoluene	0.2	0.5
3-Nitrotoluene	0.2	0.5

Source: ESE.

Table 3-11.

Reporting Limits for Organochlorine Pesticides/PCBs
in Aqueous and Soil Matrices by EPA Method 8080/8081,
USAEC Method PST1-WA/PST1-SO

Parameter	Reporting Limit*	
	Aqueous (µg/L)	Soil (µg/g)
Aldrin	0.005	0.003
Alpha-BHC	0.005	0.003
Beta-BHC	0.005	0.003
Delta-BHC	0.005	0.003
Gamma-BHC (Lindane)	0.005	0.003
Chlordane (alpha)	0.005	0.003
Chlordane (gamma)	0.005	0.003
4,4'-DDD	0.005	0.003
4,4'-DDE	0.007	0.003
4,4'-DDT	0.007	0.003
Dieldrin	0.005	0.003
Endosulfan I	0.005	0.003
Endosulfan II	0.005	0.003
Endosulfan Sulfate	0.005	0.003
Endrin	0.005	0.003
Endrin Aldehyde	0.02	0.022+
Endrin Ketone	0.006	0.003
Heptachlor	0.005	0.003
Heptachlor Epoxide	0.005	0.003
Methoxychlor	0.009	0.003
Chlordane	0.03	0.02
Toxaphene	0.60	0.3
Arochlor 1016	0.13	0.013
Arochlor 1221	0.13	0.013
Arochlor 1232	0.13	0.013
Arochlor 1242	0.13	0.013
Arochlor 1248	0.13	0.013
Arohlor 1254	0.13	0.013
Arochlor 1260	0.13	0.013

*Based on the lowest standard routinely analyzed, taking into account the sample volume and final extract volume. The lowest standard is chosen to be within the range of 5 to 10 times the background noise of the instrument. The solid reporting limits are expressed on wet weight.

+High reporting limit due to contamination in USAEC standard soil causing coeluting peak on DB-17 column. The DB-5 column should be used for quantitation of Endrin aldehyde in soils.

Source: ESE.

Table 3-12.

Reporting Limits for Herbicides in Aqueous and Soil Matrices by EPA Method 8150; USAEC Method HBG1-WA/HBG1-SO

Parameter	Reporting Limit*	
	Aqueous (µg/L)	Soil (µg/g)
2,4-D	0.1	0.01
2,4-DB	0.1	0.01
2,4,5-T	0.1	0.01
2,4-5-TP	0.1	0.01
Dalapon	0.1	0.01
Dicamba	0.1	0.01
Dichlorprop	0.1	0.01
Dinoseb	0.1	0.01
MCPA	3.0	0.2
MCPP	3.0	0.2
DCAA*	0.04	0.004

*DCAA - 2,4-Dichlorophenyl acetic acid - Surrogate.

Source: ESE.

Table 3-13.

Reporting Limits for Total Petroleum (Fuel)
Hydrocarbons in Aqueous and Soil Matrices
EPA Method 8015 (Modified); USAEC Method TPH1-WA/TPH1-SO

Parameter	Reporting Limit	
	Aqueous (µg/L)	Soil (µg/g)
Gasoline	0.4	8.0
Diesel	0.4	8.0
Pentacosane*	0.05	1.0

*Surrogate.

Source: ESE.

Table 3-14. Method Reporting Limit (MRL) Data for PAHs, EPA 8310

Parameter	MRL Aqueous (µg/L)	MRL Solid (µg/g)
Acenaphthene	2.5	0.084
Acenaphthylene	1.5	0.044
Anthracene	0.095	0.0035
Benzo(a)anthracene	0.002	0.00005
Benzo(a)pyrene	0.004	0.0004
Benzo(b)fluoranthene	0.001	0.00002
Benzo(ghi)perylene	0.006	0.0002
Benzo(k)fluoranthene	0.001	0.00001
Chrysene	0.03	0.0008
Dibenzo(a,h)anthracene	0.004	0.00007
Fluoranthene	0.003	0.0008
Fluorene	0.25	0.01
Indeno(1,2,3-cd)pyrene	0.004	0.00015
Naphthalene	0.90	0.023
Phenanthrene	0.07	0.004
Pyrene	0.03	0.0006
1-Methylnaphthalene	1.5	0.045
2-Methylnaphthalene	1.2	0.036
Methylnaphthalene, total	3.0	0.063

Source: ESE.

Table 3-15.

Air Sample Methods for Fort Sheridan

Analyte Category	Analysis	Reference Method
Volatile Organic Compounds (VOCs)	GC/MS-SCAN	1) Compendium Method TO-14, Revision 1.0, June 1988 2) EPA CLP Draft Protocol Revision VCAA01.0, December 1991
Semivolatile Organic Compounds (BNAs)	GC/MS-SCAN	1) EPA CIP Draft Protocol Revision SVAA01.0, January 1992 2) Compendium Method TO-13 Revision 1.0, June 1988
Pesticides/PCBs	GC/ECD or GC/MS-SCAN	1) Compendium Method TO-4 Revision 1.0, April 1984 2) EPA CLP Draft Protocol Revision SVAA01.0, January 1992
Metals	ICP/MS	1) EPA CLP Draft Protocol Revision MAA01.0, December 1991 2) Compendium Method IO-1 Draft, June 1994
Explosives reference	GC/MS-SCAN HPLC/UV	1) Same as BNAs above. No specific method available. 2) Adapt AEC UW32 aqueous method to air using Porapak R cartridge as collection medium.
Mercury	CVAA	NIOSH Method 6009. NIOSH Manual of Analytical Methods. May 15, 1989.

Source: ESE.

Table 3-16.

Reporting Limits, Precision, and Accuracy for Metals in Air

Element	LD Extract (ng/mL)	LD Air (ng/m³)*	Objectives	
			Precision (RPD) ± 20	Accuracy %
Arsenic	1.0	0.2	± 20	75-125
Barium	2.0	0.4	± 20	75-125
Beryllium	0.1	0.02	± 20	75-125
Cadmium	0.25	0.05	± 20	75-125
Copper	20	4.0	± 20	75-125
Iron	150	30	± 20	75-125
Manganese	2.5	0.5	± 20	75-125
Mercury	1	0.2	± 20	75-125
Molybdenum	1.0	0.2	± 20	75-125
Nickel	5.0	1.0	± 20	75-125
Lead	2.5	0.5	± 20	75-125
Vanadium	1.0	0.2	± 20	75-125
Zinc	10	2.0	± 20	75-125

Note: LD = limit of detection.

*Assuming a nominal sample volume of 2,000m³, 40-mL final volume of digestate, and extraction of 10 percent of the total filter area.

Source: ESE.

Table 3-17.

Reporting Limits, Precision, and Accuracy for Organics in Air

Analyte*	Method	Reporting Limit	Objectives	
			Precision (RPD)	Accuracy %
SVOCs/GCMS	T013 (Modified)	0.1-1 ng/m^3	± 25	70-130
VOCs/GCMS	T014	0.1 ppbV	± 20	75-125
Pesticides/ GCMS	T013 (Modified)	0.1 ng/m^3 0.1 - 1.0	± 25	70-130
PCBs/GC-ECD	T04	.01-.1 range ng/m^3	± 25	75-125
Explosives/ HPLC/UV	EXL1	.01-.1 range ng/m^3	± 25	75-125

Note: ECD = Electron capture detector.
ng/m^3 = nanogram per meter cubed.

*The analyte list is provided in the method-specific standard operating procedure.

Source: ESE.

4.0 SAMPLING PROCEDURES

4.1 ESE GENERAL REQUIREMENTS

4.1.1 PREFIELD MEETINGS

Prefield meetings/conference calls will be held prior to field investigations. These meetings are intended to ensure that laboratory and field personnel are aware of the field activity and can plan accordingly. The Project Manager will schedule a meeting/conference call with the Project QA Officer, Field Team Leader, and Laboratory Task Manager at least 1 week in advance of the sampling effort.

4.1.2 FIELD DOCUMENTATION

Field notes will be recorded, in ink, on bound field notebooks with continuously numbered pages. Any supplementary information will be recorded, in ink, on standard field documentation forms appropriate for the activity involved. The supplementary information forms will be specifically referenced in the bound notebooks by date, time, page number, and content. Each form must provide a place for the field team member to sign and date the entries.

Field notes must be reviewed and approved by the Field Team Leader, documented by either signing each field notebook page or completing a daily field trip log and activity time log (Figures 4-1 and 4-2), which states the notes were reviewed. The review must be completed during the field site visit, preferably daily, to ensure that timely corrective actions can be implemented, if necessary. As a minimum, documentation and validity of the following items should be verified:

1. Correct study area designation and sample numbers,
2. Date and time (24-hour system recordings), and

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Daily Field Trip Log

Client _____ ESE Project _____
Site Location _____ ESE Project No. _____
ESE Field Team Leader _____ ESE Project Manager _____

Date _____ Day of Week _____ Page _____ of _____

Purpose of Trip _____

Field Team Members (Names and Initials) _____ _____
_____ _____
_____ _____

Contacts _____

Work Completed This Date _____

Samples Collected

Field Group	Sample I.D.	Sample Location	Matrix	Time	Interval (Soils Only)	Field Crew

Signatures:

Field Team Leader _____ Date _____

Reviewer _____ Date _____

Reviewer Title _____

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Figure 4-1
DAILY FIELD TRIP LOG

SOURCE: ESE.

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Activity Time Log Sheet

Sheet ___ of ___

Activity Location_____

Client_____ ESE Project_____
Site Location_____ ESE Project No._____
ESE Field Team Leader_____ ESE Project Manager_____

Date	Time (Military)	Activity

Signatures:

Crew Leader_____ Date_____

Reviewer_____ Date_____

Reviewer Title_____

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Figure 4-2
ACTIVITY TIME LOG SHEET

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

3. Complete entries on each form (no blank spaces).

4.2 STUDY AREA DESCRIPTION

The following individual study areas or study area groups are addressed in site-specific SAPs and have been or will be sampled during the RI/FS investigations according to work orders:

1. Landfill Nos. 1 through 7
2. Coal Storage Area Nos. 1 through 4
3. USTs at Buildings 115, 125, and 208
4. VES Area Nos. 1, 2, 4, 5, 6, 7, and 9
5. Storage area behind Buildings 137X, 137, and 139
6. Storage area at Building 122
7. Yards at Buildings 126, 128, 216, 368, 377, and 902
8. Missile silos and missile fueling point
9. Buildings 43, 70, 122, 137, 142, and 361
10. Storm drainage system and ravines
11. Pole-mounted transformers
12. Asbestos-containing materials in buildings
13. Sanitary Treatment Plant
14. Fill Area 8
15. Miscellaneous Storage and Distribution Areas

4.3 BACKGROUND SAMPLING

Background sampling was performed during previous onsite activities; however, the number of background samples collected is insufficient to establish background levels of constituents at Fort Sheridan with a 95% upper confidence limit. To enable this degree of statistical confidence to be established and to support the BRA, additional unaffected areas of the installation will be sampled. These data will then be combined with

previously collected validated data to establish a benchmark with which to compare analytical data from known or potentially affected areas.

Areas for the collection of background samples were selected by the BCT during a site visit on July 19, 1994. These areas were selected because there is no indication that they have been affected by activities at Fort Sheridan based on a review of available site records and aerial photographs.

Background soil samples will be collected at locations and intervals as described in the Background SAP (ESE, 1995). Specific soil and ground water sample collection methodologies are described in Sections 4.4 and 4.5, respectively.

4.4 SOIL SAMPLING PROCEDURES

The following sections establish soil sample collection techniques for the various collection mechanisms and analytes included in the sampling program at Fort Sheridan. Unless specifically noted in the site-specific SAPs, protocols established in this OQAPP will be strictly adhered to during activities conducted at Fort Sheridan. Decontamination of the sample collection devices discussed herein will be performed according to procedures established in Section 4.12.

To maximize the representative nature of the samples, when VOC analysis is to be performed and sample portions for the various analytes are to be collected separately, the following collection order will be adhered to:

1. Sample for laboratory VOC analysis,
2. Portion for field headspace screening,
3. Sample for laboratory SVOC analysis,

4. Additional sample portions including metals, PCBs/Pesticides,...etc., and
5. Unified Soil Classification System (USCS) description of the soil. Note that steps 4 and 5 may be reversed if a limited amount of soil is available for USCS description.

As with any of the sampling procedures described in this section, every effort will be made to keep the sampling devices and containers from coming into contact with potentially affected soils, waters, sediments, or surfaces. The recommended way of achieving this is to isolate the sampling equipment from exposure with a piece of plastic sheeting. A new piece of plastic should be used at each sample location and the used one should be disposed of appropriately.

4.4.1 TEST PITS

Test pits will be excavated at selected locations to examine subsurface conditions and to assess the vertical and horizontal distribution of affected shallow soil (i.e., at approximately 0 to 15 ft-bgs). A backhoe will be used to excavate the test pits. The backhoe bucket will be steam-cleaned between test pits and immediately before sample collection to prevent cross-contamination. Soils, stratigraphy, groundwater conditions, and evidence of affected media will be logged by the field team. Soils will be logged using the USCS. A minimum of two soil samples per test pit will be submitted for laboratory chemical analysis. Excavated soil will be backfilled into the pit from which it came to the extent possible. Soil samples for laboratory analysis will be selected based on field monitoring results [i.e., elevated photoionization detector (PID) readings] and visual indications of affected soil.

4.4.2 SOIL BORINGS

Soil borings will be conducted in areas where exploration depths are to be above the water table (estimated to be 1 to 15 ft-bgs) and where test pits are not feasible. If conditions are encountered where the hollow-stem auger drilling method is not appropriate (e.g., because of large cobbles, boulders, or demolition rubble), other investigation techniques such as rotary drilling with water or air may be used. Where appropriate, hand auger borings may be used to augment test pit or drill rig soil boring efforts. Equipment will be steam-cleaned between borings and handwashed between samples to minimize the potential for cross-contamination. The borings will be sampled either continuously or at 5-foot intervals using a split-spoon, California, or Laskey sampler, depending on site-specific data needs. With the exception of those background locations exhibiting no sustained PID/OVM readings above background, soils from the boreholes will be drummed in 55-gallon DOT-approved drums or put into a roll-off container and labeled in accordance with USATHAMA Geotechnical Requirements. The drum labels will include borehole identifications. Drums of soil cuttings will be sampled, stored, and disposed of as described in Section 4.15.

Samples will be collected and logged by field personnel using the USCS. At a minimum, two soil samples will be collected for laboratory chemical analysis. Analytical samples will be selected based on field screening results (see Section 4.4.3 and visual indication of affected soil. Upon completion, borings in areas other than background areas that are not equipped with monitor wells will be backfilled to the ground surface with 20:1 cement-bentonite grout. The bentonite used will be organic-free, moderate pH, and high solids specifically designed to seal environmental monitor wells and boreholes. A maximum of 8 gallons of approved water per 94-pound bag of cement will be used. Specifications for grout preparation are described in

USATHAMA's Geotechnical Requirements. Background soil borings will be backfilled with a mixture of soil cuttings and hydrated, pelletized bentonite.

Air quality in the breathing zone will be monitored using a PID during borehole advancement. Personal protective equipment will be used as prescribed in the HASP (ESE, 1994).

4.4.3 HEADSPACE ANALYSIS

Headspace analysis (field screening) will be performed to facilitate the selection of samples for laboratory analysis, or in the case of background samples, to screen the location for possible unanticipated environmental effects. The sample portion to be screened will be collected from either the soil cuttings or a portion of the discrete sample interval, depending on the objective of the field screening. The field screening objective for each location will be defined in the respective site-specific SAP.

The screening procedure will consist of placing 2 to 4 ounces of soil in a clean glass jar. The jar opening will immediately be covered with aluminum foil. The contents of the jar will be allowed to equilibrate for approximately 15 minutes, at which time the probe of the PID or OVM will be inserted into the jar through the foil. The sustained PID or OVM reading will be noted in the drilling log. A sustained reading is defined as the reading observed approximately 4 to 10 seconds after insertion of the meter probe into the jar. However, some discretion will be allowed the site geologist base on site conditions (i.e., soil moisture, atmospheric conditions).

A background PID or OVM reading will be established for each boring and recorded in the field notes. The background reading will be defined as the highest reading displayed by the screening device when it is exposed to the

ambient air of the sampling location. This reading will be determined for each location before drilling begins and collected upwind of the sampling location. These data regarding the presence of VOCs will be used to qualitatively evaluate whether the soils at each location have been affected by mission activities and/or as a basis for selecting soils for laboratory analysis.

4.4.4 SOIL SAMPLING FOR VOLATILE ORGANICS

Soil samples for VOC analysis will be collected as follows:

1. Samples will be collected with 18-inch long by 3-inch diameter split-barrel sampler with metal tube inserts or California samplers at least 6 inches in length.
2. Using a properly decontaminated sampler (refer to Section 4.12 of this document), the sampler will be pushed or driven to obtain a representative soil sample.
3. The sample will not be removed from the sample tube in the field. The laboratory will remove the sample from the sampling tube.
4. Clay or other cohesive material (i.e., wetted bentonite) will immediately be added to the ends of the sample to eliminate headspace, if necessary.
5. Both ends of the sampler will be covered with aluminum foil. The aluminum foil will be covered with a cap.
6. The sample will be immediately placed in storage at 4°C ± 2°C.
7. The temperature of the shipping container will be measured and attainment of 4°C ± 2°C documented prior to sealing for transportation to the laboratory under chain-of-custody documentation.

8. Soil samples to be tested for VOCs will not be composited or homogenized because of the volatilization that would result from either of these procedures.

When sampling soils, the middle of the three metal tube inserts from either the split-spoon or California sampler will be retained as indicated above for analysis. The sample volume is adequate to supply a sample portion for each anticipated analysis. An aliquot for each analysis will be extracted from the sealed insert in the laboratory. The top and bottom inserts will be used for field headspace screening and USCS description of soils.

If it is necessary, due to sample volume requirements, to containerize portions for each analysis separately, the VOC samples will be placed in the appropriate sample container (see Table 4-1) so as to minimize the headspace and surface area of the sample. This means that cohesive soils should be packed in large pieces from which the laboratory can extract a core for analysis. A single large piece of sample minimizes the surface area and decreases volatilization.

4.4.5 SOIL SAMPLING FOR TARGET COMPOUNDS AND ANALYTES

As indicated in Section 4.4.4, the volume and mass of soil retained in one 3-inch diameter split-spoon insert or one 4-inch diameter California sampler insert is sufficient to provide aliquots for each of the analytes. Consequently, samples for target analyte list (TAL) and target compound list (TCL) analysis will be collected using the same protocol used for VOCs.

4.5 GROUNDWATER SAMPLING

To collect groundwater samples, monitor wells will be installed at Fort Sheridan. Monitor well construction materials have been evaluated in light

of what is known about the Fort Sheridan project in terms of both the proposed analyte list and the hydrogeologic setting. Published literature on the subject has been consulted for information on design criteria and material performance. The following discussion summarizes this evaluation.

Section II of IEPA Administrative Procedure #11 (AP#11) specifically addresses monitoring well casing and screen design. In this document, two criteria for rejecting polyvinyl chloride (PVC) as a well construction material are discussed. The first, which is primarily concerned with the resistance of the well to degradation in affected or unaffected environments, states that PVC must not be used in investigations involving high concentrations of organics. The definition of "high concentrations" is not included in AP#11; however, the organic compounds of interest at Fort Sheridan have not been observed at concentrations high enough to degrade PVC. Generally, concentrations of greater than 1 percent (100,000 mg/l) are required to affect the structural integrity of PVC well material (Nielson, 1991). The majority of organic constituents are not soluble in groundwater at these concentrations. Free-phase organic constituents have not been observed at Fort Sheridan. Based on the available information, PVC cannot be rejected as the well construction material of choice based on structural concerns.

The second criterion is concerned with maintaining the chemical integrity and representative nature of groundwater samples collected from the wells and protecting unaffected groundwater. Section II, C, states. "...materials must not interfere with groundwater sample integrity, with respect to the analytes of concern, as a result of their sorbing, desorbing, or leaching of analytes." Bullet 1 of Section II, C, states that PVC may be used when it can be shown that its potential to sorb/desorb the constituent of concern is extremely low (i.e., nanograms). Numerous articles have been published on

the selection of well materials and the consensus is that PVC cannot be shown to be a threat to groundwater or sample quality either from a sorptive or desorbtive standpoint (GWMR, 1987; GWMR, 1994). In fact, where metals are constituents of concern, PVC is favored over stainless steel and considered equivalent to polytetrafluoro-ethylene (PTFE). Where organics are of concern, PVC is favored over PTFE. Given that both of these categories of chemicals are of interest at Fort Sheridan, PVC is the well material of choice that will be used.

4.5.1 MONITOR WELL INSTALLATION

Groundwater monitor wells will be installed to provide groundwater samples for chemical analyses, monitor groundwater elevations, and measure in-situ hydraulic permeability of saturated sediments. Most of the proposed monitor wells will be shallow, with screens that intercept the water table. A smaller number of monitor wells will be installed as deep wells to: (1) monitor deeper groundwater quality within the till, and (2) collect potentiometric data to investigate vertical gradients.

Well locations will be selected based on expected groundwater gradients to provide either upgradient or downgradient monitoring points. Upgradient wells will provide information to characterize the quality of groundwater entering the site, and downgradient wells will provide information to characterize the quality of water leaving the site. Comparison of upgradient and downgradient data will permit evaluation of possible effects on groundwater.

Monitor wells will be constructed of 4-inch ID, Schedule 40, flush-threaded, PVC screen and riser. Screen slot size will be selected to retain 80% of the filter pack material. The filter pack material will be selected to retain 80% of

the screened formation based on previously conducted grain-size distribution analyses for the strata encountered. Each well screen will be machine-slotted or wire-wrapped and will have a solid bottom. Well screens and risers will be steam-cleaned by the drilling contractor before installation. The annular space around each well screen will be backfilled with a clean silica sand, compatible with the screen slot size. Space allowing, the filter pack will extend from a maximum of 3 ft below the bottom of the well screen to 5 ft above the top. If conditions permit, a 5-ft bentonite pellet seal will be installed above the sandpack in the shallow wells. The filterpack and pelletized bentonite seal materials will be poured into the annular space and tamped into place to prevent bridging.

If, as anticipated, the water table is shallow (less than 12 ft-bgs), USAEC requirements for a minimum 5-ft bentonite pellet seal and 5 ft of sand above the top of the well screen cannot be implemented. In this case, approval for alternate specifications will be sought from USAEC. For the water table wells, grout will be trimmed into place above the bentonite pellet seal, extending to the ground surface. For the deep wells, if bentonite pellets cannot be placed at the required depth, a bentonite slurry seal will be trimmed into place. Water for mixing grouts and slurry seals will be obtained from a preapproved (by USAEC and BCT) source which has been tested and evaluated with regard to the presence of the constituents of concern at Fort Sheridan. The monitor well screen and sandpack will be developed before sampling to remove fines and improve the hydraulic connection with natural soils.

Each of the wells will be developed no sooner than 48 hours after completion. Monitor wells will be developed to remove sediment and establish a hydraulic connection to the aquifer by alternately pumping and

surging. Development will be accomplished by purging the well a minimum of five well volumes, plus five times the annular volume (assuming 30 percent porosity in the sandpack) as described in the USATHAMA geotechnical requirements. Wells will generally be developed for at least 1 hour, or until the field geologist determines the water is clear and free of fines and the pH has stabilized. For those wells where the borehole was made or enlarged with the use of drilling fluid (mud and/or water), a minimum of five times the measured amount of total fluids lost while drilling, plus five times the well and annular volume will be removed.

Monitor wells will have either flush-mounted or aboveground protective casings installed and sealed into the ground over the well riser. The optimal stickup for wells finished above-ground will be 30 inches. Variations from this height will be allowed to avoid wasting materials. Protective steel casings will be equipped with locking covers. Wells will be equipped with keyed-alike locks across the entire post. A cement seal and gravel base will be placed at the ground surface around each protective casing to secure the casing, prevent surface runoff from entering the borehole, and direct runoff away from the casing. Where required, bollards will be placed around the well to protect it from damage. The aboveground portions of both the well riser and protective casing will be vented. The protective casing will have a weep hole near ground level to allow water to drain from inside the casing. Wells will be permanently and properly identified in the field. Flush-mounted monitor wells will be protected from flooding by watertight caps and a sloped concrete pad to divert water.

Artesian wells installed in affected areas or zones will be sealed with a pneumatic or mechanical packer to prevent potentially affected groundwater from discharging to the ground around the well. Artesian wells shown

through analysis to be unaffected, or installed in areas where the groundwater is not likely to be affected, will be allowed to drain through a weep hole at the base of the protective casing. Drilling will be conducted under the supervision of an ESE geologist. ESE's standard forms for documenting the drilling and construction of monitor wells are presented in Figures 4-3 and 4-4. Figure 4-4 is used to record information for soil if soil samples are collected during drilling of the monitor wells. A monitor well development and sampling documentation form is provided in Figure 4-5 (a and b). Notes documenting field activities will be recorded in bound notebooks. These forms are presented as an example of the type of information that will be collected during these activities.

4.5.2 PERMEABILITY TESTING

Permeability testing will be conducted in selected wells, located in areas deemed representative of the formation, no sooner than 2 weeks after well development. Rising- or constant-head permeability tests will be performed, depending on the hydraulic conductivity of the medium being tested. Only rising-head tests will be performed on wells straddling the water table. Using a pressure transducer and data logger, or a water level meter, water level changes will be measured as a function of time as the water level returns to its equilibrated level. The number of monitor wells to be tested will be determined in the site-specific SAPs. A minimum of two tests per well will be conducted to assess variations associated with each test, evaluate inertial effects associated with each well, and provide quality control. The primary criterion for selecting monitoring wells for permeability testing is determining the hydrogeologic properties of specific formations for the purpose of evaluating risks and selecting remedies. However, to the extent practicable, to minimize disposal of potentially affected water and minimize health and safety risks, the wells will be selected from upgradient

SOIL SAMPLING REPORT FORM — **ESE** ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

BORING NO.: _____ PAGE ____ OF ____

BORING LOCATION: _____ DATE: _____

_____ CONTRACTOR: _____

SAMPLER(S): _____ DRILLER: _____

SAMPLING METHOD: _____ DRILL TYPE: _____

SAMPLE NO.	DEPTH (FEET)	LITHOLOGIC DESCRIPTION	HNU (ppm)	STANDARD PENETRATION BLOW COUNT	NOTES

87554.1

Figure 4-3
SOIL SAMPLING REPORT FORM

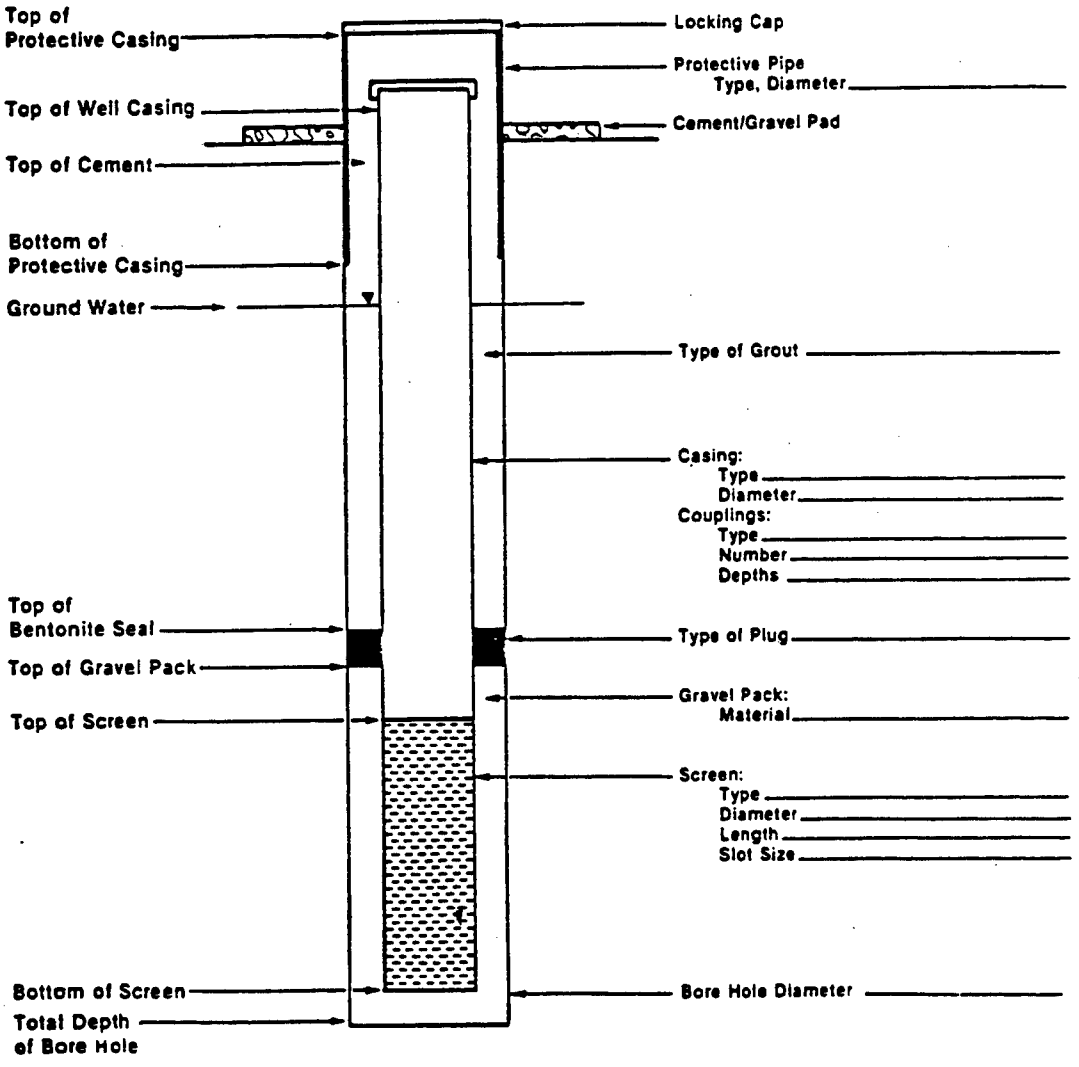
SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

OBSERVATION WELL CONSTRUCTION

Logged By: _____ Client: _____
Drilling Contractor: _____ Location: _____
Driller's Name: _____ Job Number: _____
Well Number: _____ Date/Time: Start _____ Finish _____
Comments (Lost circulation interval, Water level changes, Hole collapse interval, etc.):

Depths in Reference to Ground Level



NOT TO SCALE

Figure 4-4
OBSERVATION WELL CONSTRUCTION

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

Well Sampling Data Form

Well No._____

Client_____ ESE Project_____
Site Location_____ ESE Project No._____
ESE Field Team Leader_____ ESE Project Manager_____

Well Depth_____ Well Casing Diameter_____
Boring Diameter_____ Annular Space Length_____
Date_____ Time_____ Stickup_____

WATER LEVEL

Held_____
Cut_____
DTW_____ Top of Casing

COLUMN OF WATER IN WELL

Casing Length_____
DTW Top of Casing_____
Column of Water in Well_____

VOLUME TO BE REMOVED

Gallons per foot of A.S. (from chart)	= _____
Column of Water or Length of A.S. (whichever is less)	× _____
Volume of Annular Space	= _____
Gallons per foot of Casing	= _____
Column of Water	× _____
Volume of Casing	= _____
Total Volume (Volume of A.S. + Volume of Casing)	= _____
Number of Volumes to be Evacuated	× 3 to 5
Total Volume to be Evacuated	= _____ to _____

Method of Purging (pump, bailer, etc.)_____

FIELD ANALYSES

	Start	Mid	End
Time			
pH			
Conductivity			
Temperature			

Total Volume Purged_____ gallons
Sample Time/Date_____ Sample Number_____

FRACTIONS

VP VP VP EC MS MS MS N C S

COMMENTS_____

Signatures:

Crew Leader_____ Date_____
Reviewer_____ Date_____
Reviewer Title_____

F.001 Environmental Science & Engineering, Inc.

Figure 4-5a
WELL SAMPLING DATA FORM
PAGE 1 OF 2

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

Gallons Per Foot of Saturated Annual Space (A.S.) Using 30 Percent Porosity

Well Casing Diameter (inches)	Bore-Hole Diameter (inches)				
	4	6	8	10	12
2	0.15	0.39	0.73	1.17	1.71
4	0	0.24	0.59	1.03	1.57
6	0	0	0.34	0.78	1.32

Gallons Per Linear Foot of Casing

Casing Diameter (inches)	Gallons per Foot of Casing
2	0.1632
3	0.3672
4	0.6528
5	1.0200
6	1.4688

F.001

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Figure 4-5b
WELL SAMPLING DATA FORM
PAGE 2 OF 2

SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

areas relative to their respective sites, or in areas anticipated to contain low levels of site-specific constituents. The collected time/drawdown data will be analyzed using one of several generally accepted methods which will be selected based on the location conditions.

4.5.3 GROUNDWATER SAMPLING PROCEDURES

Groundwater samples are typically obtained from existing or newly installed monitor wells.

The following procedures will be used in the collection of groundwater samples:

1. Immediately prior to collecting a sample, the depth to water below the top of the well casing will be measured with a steel water-level tape, electric water-level tape, or acoustic well sounder and recorded in the field notebook. The point from which water levels are measured (typically the high point of the casing) will be marked by the ESE geologist as soon as practical after well installation for future water level measurement reference.
2. Whenever feasible, wells expected to be unaffected will be sampled first, followed by wells with increasing levels of constituents.
3. Prior to collecting a groundwater sample, the volume of water in the screen, well casing, and saturated annulus will be purged. Purging is considered complete if one of these following criteria are satisfied:
    a. Three well volumes are purged and subsequent stabilization of field parameters (pH, conductivity, and temperature). Stabilization of field parameters is defined as "consecutive readings within 5 percent taken at least 5 minutes apart."

b. Purging is considered complete at five well volumes even if field parameters have not stabilized.
c. At least one fully dry purge with verifying water level measurements noted in the field notes. In the event of a dry purge, the groundwater sample should be collected as soon as an adequate volume of water has entered the well to meet sample requirements.

Monitor well purge volumes will be calculated using the form depicted in Figure 4-5 (a and b) and information obtained from the site monitor well drilling records. Purging may be accomplished by:

a. Using a decontaminated Teflon® bailer for manual bailing,
b. Using a decontaminated Teflon® or stainless steel drop pipe with a motor-driven centrifugal lift pump,
c. Using a dedicated PVC drop pipe is allowed on a site-specific basis, or
d. Using a decontaminated submersible pump and appropriately decontaminated tubing.

Purging should begin from just below the top of water level in a well, and the purging device lowered to follow the water level as it falls. Stabilization of field parameters is interpreted as meaning two consecutive measurements of pH, conductivity, and temperature taken at least 5 minutes apart and within 5 percent of each other.

Wells shall be sampled within 6 hours of purging except "slow recovery" wells. "Slow recovery" wells or wells that purge

completely dry may be sampled as soon as sufficient recharge water is available or up to 24 hours after purging. Wells that have not recovered sufficiently within 24 hours will not be sampled unless specified by the client and/or regulatory agency.

The amount of fluid purged will be measured and recorded by using a graduated bucket and counting the number of buckets purged, or by using a stopwatch and measuring the flow-rate of the pump versus elapsed times.

4. The standard well sampling technique will be through the use of a separate precleaned Teflon® bailer or a disposable high density polyethylene (HDPE) bailer for each well.

   A new braided nylon or polypropylene cord is typically used for bailers. A separate piece of cord is used for sampling each well, and is discarded after one use. Since bottom-filling bailers are used, the bailer cord does not contact the sample. Reusable lanyards (monofilament, stainless steel, or Teflon®-coated) are not typically used in any well other than as part of a dedicated bailer system. Reusable lanyards are decontaminated using the same methods described earlier (see in-field decontamination).

5. HDPE bailers will be constructed with stainless steel screws and a Teflon® check ball, and no glue will be used.
6. Sampling equipment will be kept off potentially affected soil to prevent sample cross contamination (e.g., equipment will be placed on disposable polyethylene plastic sheeting).
7. The bailer, as well as all sample containers (except those for oil and grease, TPH, VOCs, microbiological samples, and any pre-preserved containers), will be rinsed once with well water prior to

collecting a sample. When collecting samples from the well, especially for VOC analysis, care should be taken not to drop the bailer into the well allowing it to splash into the water. The bailer should be lowered into the water gently to reduce agitation of the sample.

8. The first samples collected will be those for VOC analysis by decanting an aliquot into the appropriate sample jars. This will be done so as to minimize sample agitation and exposure to the atmosphere. Samples may be collected in any order after the VOCs with the exception that the sample for filtered metals should be collected last according to procedures described in Subsection 4.11.4.
9. The turbidity of the recovered sample should be measured during the well sampling. It is recommended that turbidity be evaluated using a portion of the sample for the metals analysis, preferably the unfiltered sample. Turbidity will be measured in national turbidity units (NTUs) using a portable turbidity meter that will be calibrated at each sampling location.
10. Following collection, each sample container will be labeled, preserved as required, unless prepreserved, and placed in a cooler of wet ice at 4°C ± 2°C. Just prior to shipping, meltwater will be removed and wet ice and blue ice will be added. The temperature inside the cooler will be measured and attainment of 4°C ± 2°C documented prior to sealing the cooler for transportation to the laboratory under chain-of-custody documentation.

During the sampling of each monitor well, information regarding the sampling will be kept in a field notebook (Figures 4-1 and 4-6). The following data will be collected:

1. Well number;
2. Date;
3. Time;
4. Static water level [to ± 0.01 foot (ft)];
5. Depth of well and depth of siltation;
6. Radius of well;
7. Radius of borehole;
8. Calculated well volume;
9. Number of bailer volumes removed or pumping rate, if applicable;
10. Time (duration) of pumping, if applicable;
11. Total volume of water evacuated from well;
12. Water quality measurements of pH, specific conductance, and temperature;
13. Other pertinent observations of water samples (color, turbidity, odor, etc.);
14. Fractions sampled and preservation method;
15. Weather conditions and/or miscellaneous observations;
16. Signature of sampler and date, and
17. Bailer inventory number, if pre-cleaned bailers are used.

4.6 SURFACE WATER SAMPLING

This protocol outlines procedures and equipment for the collection of representative liquid samples from: (1) flowing streams, rivers, channels, sewers, and leachate seeps; and (2) standing lakes, ponds, and lagoons.

1. Rivers, streams, and creeks:
   a. Each field sampler must understand the reason for collecting the samples to ensure that representative samples are collected. Sufficient field observations (stream stage, unexpected confluent tributaries, beaver dams, etc.) should be

made to aid in interpreting the analytical data. Documentation will be provided in the daily field trip log (Figure 4-1),

b. Unless otherwise specified in the SAP, grab samples will be collected at midstream and mid-depth where lateral mixing is complete, whenever possible.

c. Unless otherwise specified in the SAP, the surface (air-water interface) will not be sampled.

d. Care must always be taken not to disturb sediments (by wading, sediment sampling, etc.) prior to or during sampling.

e. When wading to collect a sample, the sampler should approach the station from downstream and collection should be made upstream of the sampler.

f. Unless otherwise specified in the SAP, samples must be taken in areas of the stream where good vertical and horizontal mixing occurs (good current velocity and turbulence).

g. Samples should be taken upstream of culverts (culverts tend to trap materials and debris moving downstream).

h. At small bridges, it may be necessary to move upstream when sampling to avoid garbage and debris commonly thrown off bridges by local residents.

i. When sampling downstream of an effluent discharge, the sampler must be aware of the location of the mixing zone and where samples are to be taken relative to the mixing zone (specified in the SAP).

j. Near the confluence of two streams, samples must be collected at a sufficient distance downstream to ensure adequate mixing and at a sufficient distance upstream to avoid backwater from the other stream.

k. If taken from a motor-propelled boat, surface water samples should be taken from the bow or upwind and/or upstream from the motor.

l. Field measurements of temperature, pH, conductivity, and turbidity should be collected and recorded to document the conditions at the time of sample collection.

2. Lakes, ponds, and impoundments:

a. Vertical and horizontal sampling locations will be specified in the site-specific SAP.

b. Wading to collect samples is not recommended as disturbed sediments may enter the overlying water column to be sampled.

c. When boats are used to sample lakes, care must be taken that no oil or gasoline leakage from the boat motor (if used) enters the water being sampled. Samples should be taken from the bow and/or upwind from the motor.

d. Composite samples should be collected, unless homogeneous mixing can be demonstrated.

e. Field measurements of temperature, pH, conductivity, and turbidity should be made and recorded to document the conditions at the time of sample collection.

The sampling of surface water, sewers, and leachate seeps is generally accomplished through the use of the following samplers:

1. Laboratory-cleaned sample bottle by immersing the inverted bottle with gloved hands or by an extension rod with a stainless steel clamp and then re-righting the bottle into the direction of the current (where applicable),
2. Kemmerer or Van Dorn Sampler,

3. Niskin-Flow Bottle, and
4. Sequential or composite type automatic samplers.

Sampling will be accomplished using the following procedures:

1. Surface water samples will be collected from 6 to 12 inches below the surface of the water body to be sampled with an appropriately decontaminated sample recovery device as defined in Section 4.12.
2. The sample recovery device will be a bottle or jar, 1 to 2 L in size, made of glass, Teflon®, or stainless steel.
3. A newly decontaminated sample recovery device will be used at each study area; however, it may be used repeatedly at each location.
4. From the recovered sample device, an aliquot will be decanted into the appropriately preserved sample containers, with the exception of the filtered metals samples which will be filtered prior to containerization.
5. Following collection, each sample container will be labeled, preserved as required, and placed in a cooler of wet ice at 4°C ± 2°C. Just prior to shipping meltwater will be removed and wet ice and blue ice will be added. The temperature inside the cooler will be measured and attainment of 4°C ± 2°C documented prior to sealing the cooler for transportation to the laboratory under chain-of-custody documentation.

4.7 SEDIMENT SAMPLING

Sediment sampling refers to the collection of subaqueously deposited unconsolidated detritus which is either still in that state or is located in a

drainageway which is now dry. The sampling protocol differs depending on whether the sediment is still under water.

4.7.1 SUBAQUEOUS SEDIMENT SAMPLING

1. Sediment samples will be collected with either a core barrel sampler or a slide hammer depending on the depth of the water over the sediment to be sampled. Both of the sampling devices will be equipped with metal tube inserts. Regardless of the method used, the disposition of the sample will be the same once it is recovered.
2. An appropriately decontaminated sampling device will be used. A newly decontaminated sample recovery device will be used at each study area; however, it may be used repeatedly at each location.
3. The recovered sample in the metal tube insert will be capped and sealed using the same procedure described for VOC soil sampling. If inadequate sample volume is recovered, additional portions should be collected from as close to the same location and depth as the first as possible.
4. The sample containers will then immediately be placed in the sample cooler at 4°C ± 2°C. Just prior to shipping, meltwater will be removed and wet ice and blue ice will be added. The temperature inside the cooler will be measured and attainment of 4°C ± 2°C documented prior to sealing the cooler for transportation to the laboratory under chain-of-custody documentation.

4.7.2 SUBAERIAL SEDIMENT SAMPLING

1. Sediment samples will be collected with either a stainless steel hand trowel or a hand auger with metal tube inserts depending on the depth of the sediment to be sampled.
2. An appropriately decontaminated sampling device will be used. A newly decontaminated sample recovery device will be used at each study area; however, it may be used repeatedly at each location only after it has been decontaminated with a detergent scrub and tap water prior to reuse.
3. The recovered sample in the metal tube insert will be capped and sealed using the same procedure described for VOC soil sampling. If inadequate sample volume is recovered, additional portions should be collected from as close to the first location as possible.
4. The samples collected with the hand trowel will be transferred immediately to appropriate containers. The portion to be analyzed for VOCs will be packed in a sample jar so as to minimize the headspace in the jar.
5. The sample containers will then immediately be placed in the sample cooler at 4°C ± 2°C. Just prior to shipping, meltwater will be removed and wet ice and blue ice will be added. The temperature inside the cooler will be measured and attainment of 4°C ± 2°C documented prior to sealing the cooler for transportation to the laboratory under chain-of-custody documentation.

4.8 RADIOISOTOPE SCREENING

1. Surfaces within the areas of interest will be screened with both a gross gamma scintillation detector and a Geiger counter.
2. Prior to initiating the survey, a background reading will be obtained.
3. The probe of the instruments will be passed over the surface at a distance of not more than 6 inches.
4. If sustained readings above the aforementioned background reading are detected on either of the instruments, the location will be marked and recorded along with the strength of the reading.
5. The information collected will be evaluated to determine if additional investigation and assessment are warranted.
6. Personnel conducting the surveys will be monitored for radiation exposure and records will be kept of this information along with the installation HASP.

Samples to be screened in the laboratory for the presence of radioisotopes will be divided into two groups based on field radiation screening measurements. Samples that yield total beta and gamma radiation counts during the field screening of less than 1,000 counts per minute (cpm) will be packed separately from those that yield greater than 1,000 cpm.

After the samples are sealed in the shipping ice chest, each ice chest will be screened using the Geiger Mueller counter for radiation levels as per Federal DOT regulation. If the levels exceed 0.5 milliroentgen per hour (mR/hr), as stated in the regulation, the cooler will not be shipped offsite. If the cooler

meets the DOT requirements of less than 0.5 mR/hr (1,000 cpm), it will be shipped to the laboratory.

4.9 AIR TOXICS SAMPLING

4.9.1 VOC SAMPLING WITH SUMMA® ELECTROPOLISHED STAINLESS STEEL CANISTERS USING METHOD TO-14

General--The following is a synopsis of procedures which should be strictly adhered to for the cleanup and use of Summa® canisters in sampling air for VOCs. This summary is adapted from Method TO-14 of the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.

The following procedures must be followed in the preparation and use of Summa® canisters for sampling VOCs.

1. All new Summa® canisters must be individually checked for contamination by the ESE laboratory before use. One of each batch of 10 Summa® canisters that are subsequently cleaned must be analyzed to check for contamination.
2. Each sampler tubing, fittings, and wetted parts of valves must be solvent washed in hexane and heated to more than 100°C. These parts should then be assembled and flushed with nitrogen for at least 8 hours prior to use in the sample train or in the canister cleanup apparatus.
3. Each canister's valve and fitting will be inspected for damage before cleaning. Any damaged valve will be replaced with a previously cleaned (see procedure above) valve. After replacing any valve, the canister will be cleaned and analyzed to verify that it is free of contamination.
4. If any canister is used to sample a high concentration source, it must be cleaned and analyzed to verify it is free of contamination before it can be used again.

5. Chain-of-custody must be maintained for each sample.

SUMMA® Canister Cleanup--The following cleanup procedure will be followed for the preparation of each Summa® canister:

The canisters should initially be pressurized to more than 2 atmospheres (atm) with humidified nitrogen* then evacuated to 1 atm absolute. This filling and evacuation sequence shall be repeated five times to dilute any residual contaminants. The addition of the water from the humidified nitrogen may also displace some of the more reactive contaminants that could adhere to active sites on the wall of the canister. After the fifth evacuation to 1 atm, the vacuum pump will be valved on and left on for a minimum of 3 hours or until a vacuum of more than 150 millitorr is reached. The identification number of the canister, the date, and the final vacuum will be recorded in the canister cleanup logbook. After cleaning, the canister's valve should be capped with a Swagelok® plug. A label will then be affixed to the canister denoting the date it was cleaned and the name of the person who performed the cleaning.

*The nitrogen should be certified 99.999 percent pure by the manufacturer. A molecular sieve scrubber should be attached to the nitrogen line after the regulator to remove any trace impurities.

Sample Collection--Two types of VOC samples can be collected with Summa® canisters. The canister can be opened and allowed to fill rapidly to obtain a grab sample or filled slowly by using a flow controller to collect a time integrated sample. With either type of sample, the following general procedures should be followed:

1. Pre-numbered sample tag should be tied to the handle of the Summa® canister prior to sampling.

2. A chain-of-custody record should be completed detailing time of sampling, sampling interval, and signed by the person taking the sample.
3. After the sample has been collected, the Summa® canister should be capped, the pre-numbered tag should be completed, and the canister should be placed in a shipping container with a copy of the chain-of-custody record and sealed with sample custody tape.

Grab Sample Collection--Before a grab sample for VOC analysis is collected in a Summa® canister, the canister inlet valve should be fitted with a pre-cleaned stainless steel particulate filter. At the sample collection location, the main valve should be opened and the canister allowed to fill. After about 1 minute (when no audible sound of rushing gas can be heard), close and cap the main valve of the Summa® canister.

Time-Integrated Sample Collection--This sample collection method involves the use of a flow controller or a sampler containing a flow controller to slowly meter the flow of air entering a Summa® canister. With this method, a sample is collected over a longer period of time than with a grab sample. If a constant flowrate was maintained, the resulting sample will have a VOC content that is the average of the VOC concentrations for the sampling interval (a time integrated sample).

The following procedures should be followed to collect time integrated samples:

1. Each sampler system should be checked for contamination prior to use or after any major repair. This is accomplished by metering zero air or nitrogen to the inlet of the sampler. Excess zero air or nitrogen flow should be vented with a Swagelok® tee from the

sampler inlet to atmosphere. The evacuated canister should then be filled at the normal sampling rate with the zero gas.

2. Initial flowrates will be determined with a mass flow meter. The initial flowrate and initial vacuum (at least 29 inches of mercury) should be recorded on the sample data sheet. Adjust the flowrate so that at the end of the sampling interval the ending pressure of the canister is approximately 0.9 atm.
3. Final flowrates should also be determined with a mass flow meter. Final flowrate and final vacuum should be recorded on the sample data sheets. The final vacuum should be between 5 inches and 1 inch of mercury. The final flowrate should be at least 1 standard cubic centimeter per minute (scc/m).

After sample collection, all canisters should be double checked to verify that it has an EPA pre-numbered tag with all information filled out. Place the canister in a shipping container and seal the container with EPA sample custody tape.

4.9.2 SVOC SAMPLING WITH HIGH VOLUME PUF SAMPLERS USING METHODS TO-4 & TO-13

General--The following is a synopsis of procedures that should be strictly adhered to for use of the high volume polyurethane foam (PUF) sampling method for sampling SVOC including pesticides and polychlorinated biphenyls. This summary is adapted from Method TO-4 (pesticides and PCBs) and TO-13 (polynuclear aromatic compounds) of the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air.

The following procedures must be followed in preparation of PUF sampling media and using the High Volume PUF method for sampling for SVOCs:

1. Each PUF sampling medium should be pre-cleaned, loaded into High Volume PUF sample cartridges and sealed in solvent washed cans by the extraction laboratory prior to use.
2. Chain-of-custody shall be maintained for each sample.

PUF Cleaning--PUF media should be specified as not containing any fire retardants. It should be stored in the dark to prevent photo-oxidation. It should be less than 2 years old, and should be stored in a pesticide free environment.

Care should be exercised in cutting the PUF. It should be thoroughly wet with tap water prior to cutting. A drill press and stainless steel PUF cutting die should be used. The drill press area should be free of oil and a polyethylene cutting block should be used to stop the die at the bottom of the drill press stroke (do not use wood). Water should be sprayed on the die as the PUF is cut to help prevent snagging. After the plugs are cut, they should be rinsed with tap water and followed by a rinse with deionized water. Finally, the excess water should be squeezed out.

The rinsed PUF plugs should be placed in a polyethylene plastic bag and delivered to the laboratory for preparation of the PUF/XAD-2 cartridges. The cleaned PUF/XAD-2 cartridges should be wrapped in aluminum foil and packed in metal cans cushioned by cleaned PUF to prevent breakage during shipment. Prepared PUF/XAD-2 sample cartridges that are prepacked in solvent washed metal cans will be obtained from the laboratory prior to sampling. The cans should be packed for shipment inside coolers lined with PUF.

Sample Collection--The following procedures will be followed for High Volume PUF sampling.

Nylon gloves will be used when handling each PUF cartridge and quartz particulate pre-filters. Confirm that the red silicon upper and lower gaskets, located in the cartridge housing, are in place. Then remove the PUF cartridge from the shipping can, remove from the foil and insert the cartridge into the High Volume PUF Sampler's chamber. The pre-filter should be installed in the filter holder using caution not to over tighten the fittings. The foil should be sealed back in the shipping can. The can should be labeled with site ID, operators name, and sample date, and placed in the High Volume PUF sampler enclosure until the sample is collected.

The High Volume PUF sampler should be turned on and allowed to run for 2 minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.

The operator should collect the sample as soon as possible after the sampling period ends. The sampler should be manually turned on and allowed to run for 2 minutes. A final flowrate should be recorded on the sample data sheet. The final flowrate should be at least 150 liters per minute (Lpm). The PUF cartridge should be removed, and the quartz pre-filter folded and placed in the top of the PUF cartridge. The PUF cartridge and pre-filter should be re-wrapped in the original aluminum foil and placed back in the shipping can. The can should be tightly sealed. Complete the sample data sheet and Chain-Of-Custody Sheet and seal the shipping can with a sample custody seal. Finally, the shipping can containing the sample should be placed in a cooler containing frozen eutectic salt packs (at a nominal temperature of approximately 4°C ± 2°C). When each sample is

collected from each location, the cooler should be sealed with sample custody tape for transport back to the laboratory.

4.9.3 SAMPLING FOR METALS USING THE HIGH VOLUME SAMPLER

General--The following is a synopsis of procedures that should be followed for the sampling of metals in air. This summary is adapted from 40 CFR, PART 50, APPENDIX B - Reference Method For The Determination Of Suspended Particulate Matter In The Atmosphere (High Volume Method), and 40 CFR, PART 50, APPENDIX G - Reference Method For The Determination Of Lead In Suspended Particulate Matter Collected From Ambient Air.

The following procedures must be followed in preparation for collecting samples for metals analyses with the High Volume sampler.

1. Prior to use, each filter will be checked for pinholes, and desiccated at 15°C - 30°C, ± 3°C, and less than 50 percent relative humidity, ± 5 percent, for at least 24 hours.
2. A filter field blank will be taken to the field, but not exposed. Filter field blanks will be analyzed by the laboratory to determine the background metals concentration. The number of filter blanks will be determined based on the number of samples collected, or one blank for each ten samples collected.
3. Chain-of-custody must be maintained for each sample.

Sample Collection Procedures--Samples will be collected using the High Volume sampler as described, and operated in accordance with 40 CFR, PART 50, APPENDIX B:

1. Each flow calibration orifice will be traceable to a Primary Standard Rootsmeter. Flows will be corrected to EPA Standard Temperature and Pressure [25°C and 760 millimeters of mercury (mmHg)].
2. Digital manometers used to determine flow rates will be checked against a U-Tube water manometer prior to use in each study.

Integrated Sample Collection--The following procedures should be followed to collect time-integrated samples:

1. Initial and final flowrates will be determined with a calibrated orifice and a digital manometer.
2. After the sample has been collected, the filter will be folded lengthwise and placed in a filter holder. The filter holder is then placed in an envelope and the envelope sealed.
3. A chain-of-custody record should be completed which includes the time of sampling, the sampling interval, and the signature of the person taking the sample.

4.9.4 SAMPLING FOR MERCURY USING SOLID SORBENT TUBE

General--The following is a synopsis of procedures that should be followed for the sampling of mercury in air. This summary is adapted from NIOSH Method 6009 in NIOSH Manual of Analytical Methods (May 15, 1989).

Sample Collection Procedures--Samples will be collected using a Solid Sorbent Tube (Hydrar in single section, 200 mg), as described in the NIOSH manual.

1. Each personal sampling pump will be calibrated with a representative sampler in line.
2. Immediately prior to sampling, the ends of the sampler will be broken and the sampler will be attached to a flexible tubing.
3. Sampling will then be performed at a known flow rate of 0.15 to 0.25 L/min for a sample size between 2 to 100 L.
4. The sampler will be capped and packed securely for shipment.
5. A minimum of three unopened sampling tubes from the same lot as the samples will be used as media blanks.

4.10 FIELD QC MEASURES

Field QC samples will include trip blanks, equipment blanks, and field duplicates.

4.10.1 TRIP BLANK

Trip blanks are collected to demonstrate that no volatile compound exposure occurs during the transport of samples both to and from the sampling site, or during shipment to the laboratory. Trip blanks are required for aqueous volatile organic samples only and consist of sample bottles filled in the laboratory with organic-free water; the sample bottles are then sent to the sampling location with the sampling kits. The trip blanks are returned from the sampling location with every shipment of aqueous samples and analyzed. Trip blanks are required at a rate of 1 per cooler of shipped aqueous VOC samples.

4.10.2 EQUIPMENT BLANK

Equipment blanks (rinsate blanks) are a means of proving that sampling equipment is thoroughly decontaminated. This demonstrates that no cross contamination is occurring. Rinsate samples are processed by rinsing

decontaminated sampling equipment (soil samplers, bailers, etc.) with ultrapure water obtained from the laboratory. The rinse water is collected in sample containers, preserved, and handled in the same manner as the samples. Rinse blanks are required at a rate of 1 per day or per ten samples per equipment type decontaminated (whichever is greater).

4.10.3 FIELD DUPLICATES

Collection and analysis of field duplicate samples provide an overall estimate of precision associated with sample collection and analysis. The field duplicate samples will be identified on the labels and chain-of-custody forms as "DUP," without further information as to the source of the replicate. The source information will be recorded in the field notes and the chain-of-custody by the field team at the time of collection. The source information will be known to the Chemistry Task Manager. The identity of the duplicates will not be given to the analysts. Field duplicates are required at a rate of 1 per 10 samples (10 percent).

4.10.4 MATRIX SPIKE (MS) AND MATRIX SPIKE DUPLICATE (MSD)

Matrix spikes provide information about the effect of the sample matrix on extraction/digestion and measurement methodology. All matrix spikes are performed in duplicate. MS/MSD samples are designated/collected for aqueous organic samples only. Aqueous MS/MSD samples are collected at triple the volume for VOCs and double the volume for extractable organics. MS and MSD will be run at a frequency of 1 for every 20 samples. Note: USAEC is performing MS/MSDs in an effort to be cooperative with the regulatory agencies. It is this Center's belief that EPA has no regulation requiring the use of MS/MSDs and USAEC has not been provided adequate technical justification for this requirement.

4.11 METHODS OF SAMPLE PREPARATION

4.11.1 HOMOGENIZATION

The homogenization of soil/sediment samples (except VOCs) is the process of mixing individual grab samples in order to minimize any bias of sample representativeness introduced by the natural stratification of constituents within the sample.

To homogenize a sample of a soil/sediment matrix, rocks, twigs, leaves, and other debris should be removed if they are not considered part of the sample. The soil/sediment should be removed from the sampling device and placed in a stainless steel pan and thoroughly mixed using a stainless steel spoon. The sediment in the pan should be scraped from the sides, corners, and bottom of the pan, rolled to the middle of the pan, and initially mixed. The sample should then be quartered and moved to the four corners of the pan. Each quarter of the sample should be mixed individually, and then rolled to the center of the container and the entire sample mixed again.

Homogenization of an aqueous sample in the field is only necessary if specified in the work plan and stratification of constituents is anticipated. Where unanticipated stratification occurs, the sampling team will collect the most representative/proportioned sample possible. In most cases, any stratification of sample material will be recorded in the field notes and if homogenization is required, it will be done under controlled conditions in the laboratory. Any field homogenization would be performed by mixing in a stainless steel bowl.

4.11.2 COMPOSITING

Sample compositing is performed to obtain an average concentration of contaminants over a certain number of sampling points. When compositing

is performed, the concentration of contaminant in individual grab samples is diluted proportionally to the number of samples taken. Not only is the contaminant diluted, the detection limits for each individual sample are raised proportionally to the number of samples added to the composite. For instance, if a sampler wishes to composite two discrete samples into one, and the method detection limit for a target compound is 330 parts per billion (ppb), the detection limit for the target compound does not change for the composite. However, the detection limit for the compound in the individual sample constituting the composite is two times the normal detection limit (2 x 330 = 660 ppb), and that contaminant would not be quantified or possibly even identified due to the effective dilution of the contaminant concentration in the composite. This concept should be taken into account when determining the data quality objectives of a composite sampling event to ensure that useful data are collected. It is advisable that if positive identification is made in the course of analyzing a composite sample, the discrete samples should be analyzed individually to determine the true contaminant distribution throughout each component of the composite.

Compositing of a solid matrix is accomplished by mixing equal volumes of grab samples in stainless steel pans with stainless steel spoons. Compositing is never performed on samples for volatile organics analysis.

4.11.3 SPLIT AND DUPLICATE SAMPLES

Split samples allow the comparison of analytical results from separate laboratories. Split samples are obtained as subsamples from the same parent sample and are divided into two (or three) segments for analysis in separate laboratories. Discrepancies in analytical data from split samples can serve as an index for investigating laboratory or sampling performance.

Soil/sediment samples taken for volatile organics analysis cannot be split. In this case, samples must be taken as collocated grabs, whereby a large quantity of material is collected and used to fill the remaining containers. Enough sample must be collected at one time to fill all the necessary sample containers.

When splitting aqueous samples, homogenization of the sample is only necessary if heterogeneity is suspected (VOC samples must not be homogenized). It is not generally necessary to homogenize groundwater or surface water samples when splitting, and it is generally unnecessary to divide a bailer's contents among several bottles.

Duplicates (for water) are collected by sampling from successively collected volumes (i.e., samples from the next bailer of sample water). Field duplicate samples, trip blanks, and field equipment (rinsate) blanks must be included as part of those samples which are split between the two or more laboratories involved. Field duplicate soil/sediment samples will be collected using the same methods described in the paragraph for soil/sediment sample splitting. A split soil/sediment sample should be considered a duplicate and not a split sample.

4.11.4 FIELD FILTRATION OF SAMPLES

Typically, water samples collected for total metals analysis are not filtered, because a filtered sample does not accurately reflect the total metals concentration (dissolved plus suspended) of the matrix. When sampling and analysis for dissolved metals is required, a filtered and unfiltered fraction are collected using the filtering procedures and equipment described in the following section.

Filtration of trace metal and nutrient samples must be performed in the field using one of the following filtering procedures.

Clean, noncontaminated tubing will be attached to a valve at the bottom of a bottom-discharge type bailer containing sample water. The tubing will be connected to a peristaltic pump with a clean disposable inline filter [0.45 micrometer (μm) opening] attached to the tubing on the discharge (positive pressure) side of the pump. The filtered sample will be collected directly into the sample container from the filter discharge. Inline pre-filters will be used ahead of the 0.45 μm filter as required for turbid samples. Both the filtered and unfiltered fractions will be preserved with acid and chilled to 4°C ±2°C prior to packaging for shipment/transport to the laboratory. Filtration tubing and filters will be used once and then discarded. Equipment blanks of the tubing, filter, and/or pre-filter will be collected as necessary.

For wells where the water level is deeper than approximately 25 ft, a bladder-type or Grundfos submersible pump (or equivalent) can be used to bring the sample to the surface through clean tubing. There, following the purge cycle, the flowrate will be reduced and a new inline 0.45 μm filter will be attached to the end of the tubing. The filtered sample will be collected directly into the sample container from the filter discharge. Inline pre-filters will be used ahead of the 0.45 μm filter as required for turbid samples. Both the filtered and unfiltered fractions will be preserved with acid and chilled with wet ice prior to packaging for shipment/transport to the laboratory. Filtration tubing and filters will be used once and then discarded.

4.12 FIELD EQUIPMENT DECONTAMINATION

The following decontamination procedures are for equipment that contact sample matrices:

1. Organic compounds and trace metal analyses:
   a. Clean with Liquinox® and tap water (a higher grade of water may always be substituted for tap water), using a brush, if necessary, to remove particulate matter and surface films;
   b. Rinse thoroughly with tap water;
   c. Rinse with 10 percent HNO_3;
   d. Rinse thoroughly with deionized (DI) water;
   e. Rinse twice with pesticide-grade isopropanol;
   f. Allow to air-dry; and
   g. For overnight storage, wrap in new aluminum foil, if appropriate, to prevent contamination.
2. Groundwater purging and monitoring equipment:
   a. Rinse water level tapes and slugs (slug testing) with tap water followed by DI water, and place in a polyethylene bag to prevent contamination during storage or transit;
   b. Rinse the downhole well tubing, hoses, and submersible pumps with copious amounts of tap water followed by DI water; and
   c. If the inside of the tubing/hoses cannot be rinsed adequately, tap water and DI water should be pumped through the tubing.
3. Drilling tools:
   a. Drilling equipment will be steam cleaned prior to shipment to a site.
   b. Between borings, drilling tools will be steam cleaned using tap water to remove traces of soil, rock, or other constituents. In addition, downhole tools will be rinsed with DI water followed by pesticide-grade isopropanol, and air-dried.

Except for between-sampling cleaning, these decontamination procedures shall be performed in the laboratory to ensure capture of all wastes generated. The effectiveness of the decontamination procedures will be assessed by collecting equipment blanks according to the protocol established in Section 4.10.2.

4.13 SAMPLE CONTAINERS, HOLDING TIMES AND PRESERVATION

4.13.1 CONTAINERS AND SAMPLE HOLDING TIMES

For field sampling, the Field Team Leader is responsible for proper sampling, labeling of samples, preservation, and shipment of samples to the laboratory to meet required holding times.

Table 4-1 identifies the proper containers, preservation techniques, and maximum holding times established by EPA (40 CFR Part 136). The maximum holding times in Table 4-1 apply to water and soils as noted.

4.13.2 SAMPLE PRESERVATION

Trial preservation may be necessary for concentrated hazardous/industrial wastes to ensure adequate preservation, and if reactions are suspected, the volume of preservative added should be recorded in the field notes. For example, acidification of some wastes may liberate toxic gases (e.g., cyanide gas) or result in foaming. In such cases, preservation should be omitted, samples should be shipped to the laboratory as soon as possible, and appropriate comments must be included on the sample chain-of-custody logsheet (see Section 5.0).

The preservative bottles are stored in their appropriate U.S. DOT containers with absorbent packing between use. The contaminant-free eyedroppers

Table 4-1.
Required Containers, Preservation Techniques, and Holding Times

Page 1 of 2

Parameter	Container*	Preservation	Maximum Holding Times (Aqueous and Soils)
Aqueous/Leachates			
Metals	One 1-liter polyethylene container	HNO_3 to pH <2	6 months (except for Hg which is 28 days)
Organochlorine Pesticides/PCBs/ Herbicides	One 1-liter amber glass bottle, Teflon™-lined cap	Cool, 4°C	7/40 days†
Explosives	One 1-liter amber glass bottle, Teflon™-lined cap	Cool, 4°C	7/40 days†
Volatile Organics	Two 60-mL amber glass bottle, w/Teflon™-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$ HCl to pH<2	14 days or 7 days unpreserved††
Semivolatile Organics/PAH	One 1-liter amber glass bottle, Teflon™-lined cap	Cool, 4°C	7/40 days†
Hexavalent Chromium	1 liter amber glass	Cool 4°C	24 hours
Landfill Parameters			
Alkalinity	1-liter plastic	Store at 4°C	14 days
Ammonia	1-liter plastic	Cool 4°C, H_2SO_4, pH<2	28 days
Biochemical oxygen demand (BOD)	1-liter plastic	Store at 4°C	48 hours
Boron	1-liter amber glass	HNO_3, pH<2	6 months
Chemical oxygen demand (COD)	1-liter amber glass	Add H_2SO_4 (pH<2), store at 4°C	28 days
Chloride	1-liter plastic	Store at 4°C	28 days
Fluoride	1-liter plastic	Store at 4°C	28 days
Hardness	1-liter plastic	HNO_3, pH<2	6 months
Nitrate	1-liter plastic	Cool, 4°C	48 hours
pH	1-liter plastic		Measure immediately
Specific conductivity	1-liter plastic		Measure immediately
Sulfate	1-liter plastic	Store at 4°C	28 days
Total dissolved solids (TDS)	1-liter plastic	Store at 4°C	7 days
Total organic carbon (TOC)	1-liter amber glass	Add H_2SO_4 (pH<2); store at 4°C	28 days
Total phenolic compounds	1-liter amber glass	Add H_2SO_4 (pH<2); store at 4°C	28 days
Nitrate/Nitrite	1-liter plastic	Cool, 4°C (pH<2)	28 days
TSS	1-liter plastic	Cool, 4°C	7 days
TOX	1-liter amber glass	Cool, 4°C (pH<2)	7 days
Phosphorus (T)	1-liter amber glass	Cool, 4°C, H_2SO_4 (pH<2)	28 days
Radiological	1-liter amber glass	Cool, 4°C	6 months
Soils			

Table 4-1.
Required Containers, Preservation Techniques, and Holding Times

Page 2 of 2

Parameter	Container*	Preservation	Maximum Holding Times (Aqueous and Soils)
Volatile Organics	Two 60-mL amber glass bottle, w/Teflon™-lined septum	Cool, 4°C	14 days
Semivolatile Organics/PAH	One 16-ounce amber glass jar	Cool, 4°C	14/40 days**
Organochlorine Pesticides/PCBs/ Herbicides	One 16-ounce amber glass jar	Cool, 4°C	14/40 days**
Metals	One 16-ounce amber glass jar	Cool, 4°C	6 months (except for Hg which is 28 days)
Explosives	One 16-ounce amber glass jar	Cool, 4°C	14/40 days**
TCLP VOCs SVOCs Pesticides/PCBs Metals (Extraction)	One 16-ounce amber glass jar	Cool, 4°C	14 days
Hexavalent Chromium	250 mL amber glass	Cool 4°C	24 hours
Radiological Tests Alpha, beta, Ra-226, -228, and Sr-90; Uranium	250-mL amber glass jar 250-mL amber glass jar	HCl, HNO_3 to pH<2 None	6 months 6 months
Ammonia	250-mL amber glass	Cool, 4°C	28 days
Boron	250-mL amber glass	Cool, 4°C	28 days
Chloride	250-mL amber glass	Cool, 4°C	28 days
Fluoride	250-mL amber glass	Cool, 4°C	28 days
Nitrate	250-mL amber glass	Cool, 4°C	48 hours
pH	250-mL amber glass	Cool, 4°C	Measure immediately
Sulfate	250-mL amber glass	Cool, 4°C	6 months
TOC	250-mL amber glass	Cool, 4°C	14 days
Total phenolic compounds	250-mL amber glass	Cool, 4°C	28 days
TOX	250-mL amber glass	Cool, 4°C	7 days
Moisture	250-mL amber glass	Cool, 4°C	160 days
Air	Canisters, filters	Cool, 4°C	6 months

*Containers for soil samples are glass with Teflon™-lined caps.
†7/40 = 7 days until extraction; 40 days from extraction until analysis.
**14/40 = 14 days until extraction; 40 days from extraction until analysis.
††Holding time of 7 days for unpreserved volatile organics is based on USAEC Method VMS1/VMS2.

Source: ESE.

used for adding preservative to samples are stored with the preservatives in sealed plastic bags.

Preservation of samples is performed as follows: Vials for VOC fractions are sent to the field with premeasured preservatives already placed into each container. For samples (including equipment blanks) requiring pH adjustment, the reagents (acids or base) for each fraction are added to each container with a clean eyedropper, using care not to contact the sample or sample container with the dropper. The same amount of acid is added to the appropriate equipment blank. Once the reagent is added and the cap is replaced, the container is inverted to ensure adequate mixing, and the pH is checked using full-range colorimetric pH sticks. The container is opened, an aliquot of sample is poured into the cap, and then poured from the cap onto the pH stick without the cap contacting the stick. If the pH adjustment is adequate, the sample is capped and placed in the cooler. If additional adjustment is required, the previous steps are repeated until the desired pH is reached, or until reagent has been added to the sample to a maximum of 5 percent of the original sample volume. If the sample cannot be adjusted to the desired pH using this method, it is noted on the sample custody logsheet. To avoid possible chemical interferences, the pH sticks are never introduced into the sample container to check pH.

With hazardous samples, rinsing the outer portion of sample containers with DI water prior to packaging for shipment may be necessary. The latest DOT shipping procedures of environmental samples will be used in all cases.

4.14 SAMPLE SHIPPING FROM THE FIELD TO THE LABORATORY

The field crew will package each sample container to ensure its integrity inside the shipping container. This packaging may include packing materials such as Bubble Wrap® or styrofoam fillers.

Sample containers will be shipped by bonded courier to the ESE Gainesville laboratory. Samples are shipped by overnight delivery as soon as possible after collection (usually daily), with receiving signature required. Sample receipt and check-in at the ESE laboratory is performed by the sample custodian, as described in Section 5.0.

Samples are usually organized by sample location in each shipping container with all of the fractions collected from a given station grouped together. A possible exception to this procedure would include the collection of large quantities of samples for VOC analyses.

If the samples require chilling/freezing, the sample containers will be isolated from the chilling/freezing materials using appropriate, waterproof materials such as plastic garbage bags. Typically, only wet ice is used to chill the samples.

The chain-of-custody logsheet for the samples in each shipping container is sealed in a plastic Ziploc® bag and taped to the inside of the container. ESE's policy requires sealing all sample shipping containers with evidence tape prior to shipping.

4.15 DISPOSAL OF INVESTIGATION DERIVED WASTE

Each field investigation will generate some amount of waste material, especially groundwater investigations. Boring, developing, purging, sampling

monitor wells, and field decontamination will generate soils, waters, soap solutions, calibration fluids, and spent reagents that must be handled in a way that will not spread or increase contamination at the installation.

Investigation derived wastes (IDW) from potentially affected areas will be containerized pending results from the laboratory to determine the proper disposal procedures required. This determination will be made as shown in Figure 4-6.

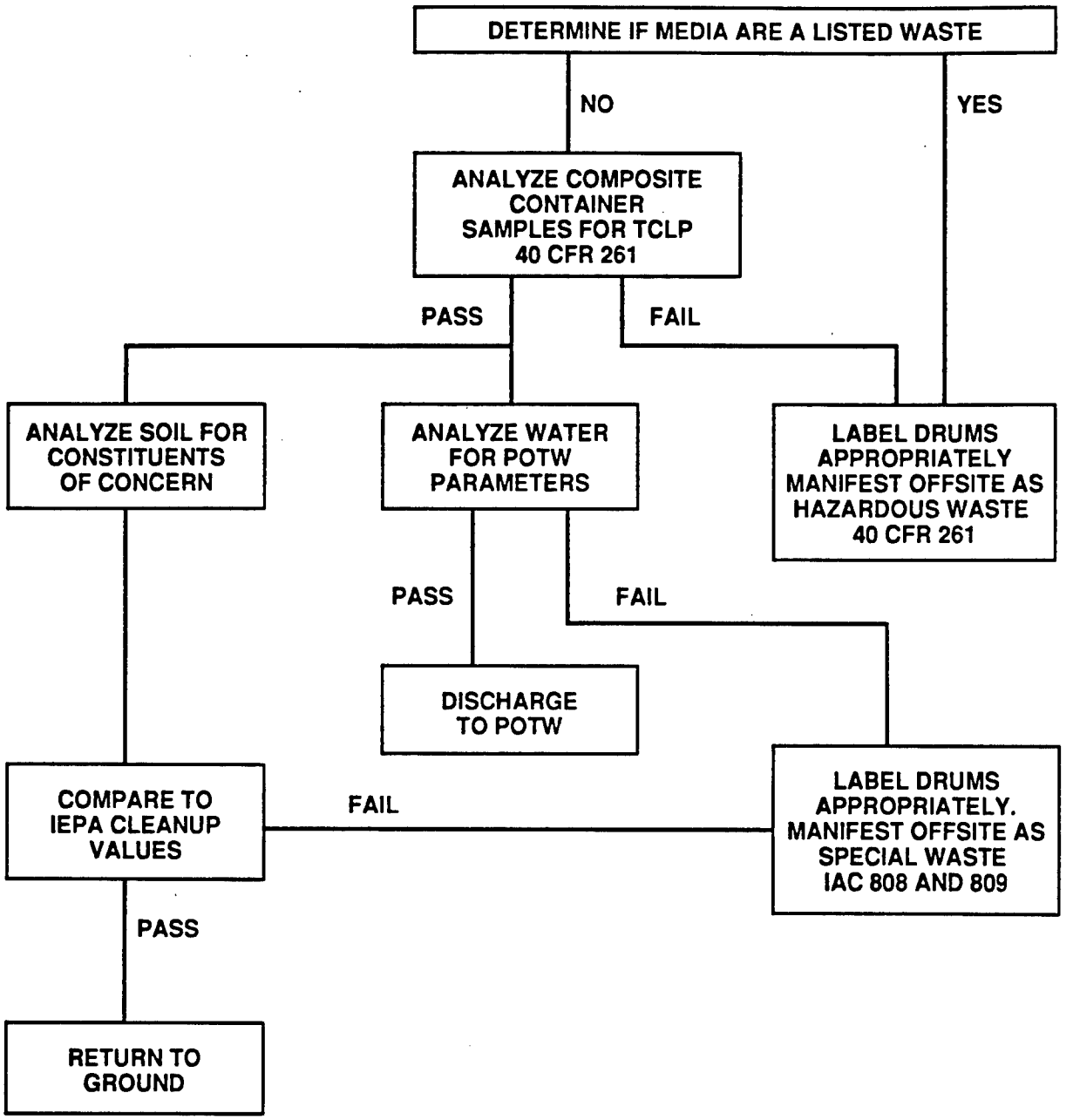


Figure 4-6
DECISION TREE FOR HANDLING IDW-SOIL (DOES NOT APPLY TO INITIAL DEVELOPMENT AND PURGE WATER FROM BACKGROUND WELLS AND SOIL CUTTINGS GENERATED DURING BACKGROUND SAMPLING WITH NO PID READINGS ABOVE BACKGROUND)
SOURCE: ESE.

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.

5.0 SAMPLE CUSTODY

5.1 DEFINITION OF SAMPLE CUSTODY

The primary objective of sample custody is to create an accurate, written, verified record that can be used to trace sample possession and handling from the moment of collection until receipt by the laboratory. Adequate sample custody is achieved by means of approved field and analytical documentation. A sign-in and sign-out sheet is provided at the laboratory.

A sample for this project is defined to be in someone's custody if:

1. It is in one's actual physical possession;
2. It is in one's view, after being in one's physical possession;
3. It is in one's physical possession and then locked or otherwise sealed so that tampering will be evident; or
4. It is kept in a secure area, restricted to authorized personnel only.

5.2 SAMPLE NUMBERING

The field team will be supplied with sample bottles and preprinted sample labels from the laboratory. ESE's Chemical Laboratory Analysis and Scheduling System (CLASS™) assigns the laboratory and field IDs prior to each field sampling effort. The laboratory ID uses an alphanumeric name. For example, this laboratory ID will be assigned as follows:

FSNM1*#

where: FSN = Fort Sheridan will be the same for all samples,
M = matrix (i.e., SW - surface water, SB - soil boring, SD - sediment, WA - water, SO - soil, AR - air, PT - plant biota, TC - TCLP, WI - wipe, TR - transformer oil, SS - surface soil, GW - groundwater),

1 = round of sampling, and

= sequence number.

For example, FSNGW1*1 represents the Fort Sheridan project groundwater sample number one, from the first round of sampling.

Also, FSNSS1*3 represents the Fort Sheridan project surficial soil sample number 3, from the first round of sampling. In the Army database, this sample will be designated by S, for soil, and keyed to the appropriate depth to indicate subsurficial samples.

5.2.1 Field IDs will be assigned as follows:

LLLLTT##Dx

Where: LLLL = The location of the sampling point, e.g., LF1 = Landfill No. 1, B216 = Building 216, CSA4 = Coal Storage Area 4, BGE = Background Area East

TT##D = The type of sample point/sample. Abbreviations include: SB01 = soil boring 1, MW09 = monitor well 9, SS12 = surface soil 12, SD05 = sediment 5, SW14 = surface water 14. The numbering of sample points (e.g., soil borings, monitor wells) will begin where the most recent round of field work left off. For example, at Landfill No. 5 if the highest number assigned to a well is 4D, the next well installed under a

subsequent phase of work would be 5S or D, depending on the depth. As indicated, for monitor wells, a D or S may be added in the case of nested wells to indicate which is the deep or shallow well.

X = The relative depth of the sample in the case of a soil boring (i.e., 1 would be the shallowest sample below the surface and 2 would be the next deepest). A soil sample collected from 0 - 0.5 ft at a soil boring location will be identified as a surface soil sample (SS).

In the case of a groundwater sample, this unit will indicate the number of the sampling episode. For example, if one round of groundwater samples has been collected from a monitor well, the next round will be designated Round 2.

The descriptor for a groundwater sample from Landfill No. 7, monitor well MW05D collected during the second sampling episode would be LF7MW05D2. The descriptor B377SB024 would be unique to the fourth soil sample from the surface from the second soil boring installed at Building 377. This does not include a surface sample collected at this location, which would be designated B377SS02.

This system will be used by the sample collector to identify the samples in the field. It is a continuation of the method used during the previous site work. Using it will result in less confusion when trying to relate data from

different phases of work and the designation will be interpretable when evaluating the data.

5.2.2 This system is referred to as the field group name and sequence number. Each sample is assigned a unique field name and sequence number combination which the laboratory uses for tracking samples. During sampling, both the field sample ID number and the laboratory number will be recorded in the field notebook and on the chain-of-custody forms.

5.2.3 QC samples can have the following notations as the modifiers:

SPL = field QC (sample split for USACE QA laboratory),
QCBL = QC blank,
QCDP = QC duplicate,
QCFB = QC field blank,
QCMB = QC method blank,
QCNP = QC natural matrix spike,
QCRB = QC rinse blank,
QCSP = QC standard matrix spike, and
QCTB = QC trip blank.

5.2.4 Once the expected number of samples for each study area for each parameter per each matrix is known, the ESE laboratory will generate sample numbers to be sent with the appropriate containers and preservatives to the field. The ESE sample numbers are linked to the study area IDs, which in turn are linked to the map files (coordinates of the sampling location). The sampling date, time of sampling, sample type, sample matrix, and depth information are then entered on the chain-of-custody forms and linked to the laboratory sample number.

All this information is entered into the USAEC and laboratory databases so that samples can be tracked easily. The ESE QA officer verifies that the field information recorded in the database matches the information on the chain-of-custody forms and ESE sample numbers before the data are downloaded into the USAEC IRDMIS. If additional samples are to be taken, the round number of sampling may be changed to 1A, 1B, 1C, etc., which in turn is keyed to the sampling date for easy verification.

5.3 PREPARING SAMPLES AND FIELD DOCUMENTATION PROCEDURES

Field procedures are designed to minimize sample handling and transfers. During sampling, the field crew will record the following information in field notebooks and field chain-of-custody logsheets (Figures 5-1 and 5-2), using indelible ink:

1. The unique sample number as obtained from the sample label,
2. Source of sample (including name, location, and sample type),
3. Date and time of sample collection,
4. Preservatives used,
5. Name(s) of collector(s), and
6. Field measurements (pH, temperature, turbidity, and specific conductance).

Each sample will be identified by affixing the pressure-sensitive, gummed label produced by the laboratory data management prefield setup (PFS) program. Each label will have a unique combination of field group name and sequence number, a standardized sample preservation code (i.e., C for chilled, N for nitric acid), and the station ID. Each label also will have spaces for the Field Team Members to write in the date and time of sample collection, sampler's initials, and a new station ID if different from the original station ID. A new station ID may be necessary due to changes in

Environmental Science & Engineering, Inc. 12-23-92 *** FIELD LOGSHEET *** FIELD GROUP: EXAMPLE
PROJECT NUMBER 3924000V 0000 PROJECT NAME: COMPANY XXX LAB COORD. PORTIA PISIGAN

ESE #	SITE/STA	HAZ?	FRACTIONS(CIRCLE)	DATE	TIME	PARAMETER LIST
*1	MW-1		EC EC VP VP VP			W610LC
*2	MW-2		EC EC VP VP VP			W610LC
*3	MW-3		EC EC VP VP VP			W610LC
*4	MW-4		EC EC VP VP VP			W610LC
*5	MW-5		EC EC VP VP VP			W610LC
*6	MW-6		EC EC VP VP VP			W610LC
*7	MW-7		EC EC VP VP VP			W610LC
*8	MW-8		EC EC VP VP VP			W610LC
*9	MW-9		EC EC VP VP VP			W610LC
*10	MW-10		EC EC VP VP VP			W610LC

NOTE -CHANGE OR ENTER SITE ID AS NECESSARY; UP TO 9 ALPHANUMERIC CHARACTERS MAY BE USED
-CIRCLE FRACTIONS COLLECTED. ENTER DATE,TIME,FIELD DATA (IF REQUIRED), HAZARD CODE AND NOTES
-HAZARD CODES: I-IGNITABLE C-CORROSIVE R-REACTIVE T-TOXIC WASTE H-OTHER ACUTE HAZARD; IDENTIFY SPECIFICS IF KNOWN
-PLEASE RETURN COMPLETED LOGSHEETS WITH SAMPLES TO Environmental Science & Engineering, Inc.

RELINQUISHED BY: (NAME/ORGANIZATION/DATE/TIME)	VIA:	REC'D BY (NAME/ORGANIZATION/DATE/TIME)
1		
2		
3		

SAMPLER: Shipped on Ice? Yes/No; I anticipate shipping ____(#) more samples on ___/___
SAMPLE CUSTODIAN: Custody Seals Used? Yes/No; If Yes, Seals Intact? Yes/No Interior Temp? ___Deg C
Preservatives Audited? Yes/No Any Problems? Yes/No; If Yes, describe:

Figure 5-1
CHAIN-OF-CUSTODY FIELD LOGSHEET

SOURCE: ESE.

Prepared for:
U.S. Army Environmental Center
Aberdeen Proving Ground, Maryland

ESE KEY TO FRACTION CODES 5/92

	CODE	PRESERVATIVE	CONTAINER	ANALYSIS TYPE	HOLDING TIMES
AIR:	AA	4 °C	Various	Various	Various
	AO	Exclude Light	Sorbent	Organic	14 Days
	AV	Exclude Light	Charcoal	Volatiles	14 Days
	FL	Keep Upright	Cassette	Various	Various
SOILS:	SS	4 °C	G, 500 mL	All excluding VOAs	7-28 Days
	SV	4 °C	G, 60 mL	Volatiles	7-14 Days
WATER:	AL	4 °C (T)	G, 2x60 mL*	Carbamates,EPA531	14 Days
	B	4 * C; NaOH, pH>12	P, 1-4 L**	Cyanides	14 Days
	C	4 * C	P, 1-4 L	Various Inorganics	1-28 Days
	CL	4 * C	G, 1-4 L	Chlorophyll	1 Day
		(Preferred Filtered & Frozen at <0-Deg-C)			
	EC	4 * C (T)	G, 1 L	Chlorinated Pesticides	7 Days
	ED	4 * C (T)	G, 2x60 mL*	EDB, DBCP	14 Days
	F	-	P, 4 L	Collection prior to Field Filtering	
	FI	4 * C (T)	G, 1 L	GC/FI Organic	7 Days
	FM	Formaldehyde	P/G, 500mL	"Quats"	28 Days
	FP	4 * C (T)	G, 3x60 mL*	GC/FP Organic	14 Days
	H	Zn Acetate;NaOH,pH>10	P, 1 L	Sulfides	7 Days
	HB	4 * C (T)	G, 1 L	Chlorinated Herbs	7 Days
	IC	4 * C	G, 1 L	IMPA	40 Days
	LC	4 * C	G, 1 L	HPLC Organics	7 Days
	M	4 * C (T),excl. light	P, 250 mL	Bacteriologic	6 Hours
	MS	4 * C (T)	G, 1 L	GCMS-SVOCs	7 Days
	N	HNO_3, pH<2	P, 1 L	Metals (Total)	180 Days
				Mercury (Total)	28 Days
	NF	HNO_3, pH<2	P, 1 L	Metals (Dissolved)	180 Days
				Mercury (Dissolved)	28 Days
	NC	4 * C	G, 1 L	Nitrocellulose	7 Days
	NP	4 * C	G, 1 L	GC/NP Organic	7 Days
	O	4 * C; H_2SO_4, pH<2	G, 1 L	Oil & Grease, TRPH	28 Days
	OC	4 * C; H_2SO_4, pH<2	G, 250 mL	TOC (USATHAMA)	28 Days
	OD	4 * C	G, 1 L	Odor	2 Days
	R	HNO_3, pH<2	P, 1-4 L	Radionuclides	180 Days
	S	4 * C; H_2SO_4, pH<2	P, 1 L	Nutrients; TOC	28 Days
	(UP)	4 * C (T)	G, 1 L	Pest (Antiquated)	7 Days
	V	4 * C (T)	G, 4x60 mL*	VOCs,excl. Aromatics	14 Days
	VP	4 * C; HCL, pH<2(T)	G, 4x60 mL*	VOCs,incl. Aromatics	14 Days
	(W)	4 * C (T)	G, 1 L	GC/FPD Organics	7 Days
	X	4 * C (S)	G, 2x250mL*	TOX(USATHAMA)	7 Days
	XP	4 * C; H_2SO_4, pH<2(S)	G, 2x250mL*	TOX	7 Days
	Z	4 * C; H_2SO_4, pH<2	G, 1 L	Total Phenols	28 Days
OTHER:	OL	None	G, 10-100mL	Organic-Oil	14 Days
	TS	-20-* C	Various	Frozen Tissue	Various
	BK	None	Various	Asbestos, Bulk	NA

ESE KEY TO FRACTION CODES 5/92

FOOTNOTES: (T) - Add Sodium Thiosulfate ($Na_2S_2O_3$), if residual chlorine present (0.25g/L)
(S) - Add Sodium Sulfite (Na_2SO_3), if residual chlorine present (0.1M, 1 mL/L).
* - Volatiles Bottles (VOAs) with Teflon-Lined Rubber Septa.
** - Test for presence of sulfide and follow EPA procedures (below) as necessary.

INSTRUCTIONS FOR SAMPLING AND SHIPPING

-Plastic (P) containers may be rinsed with sample; Do not rinse Glass (G)
-Fill completely, especially for volatiles (fill these slowly; achieve positive meniscus; cap; invert; check for air bubbles; top off if needed.
-Preserve with reagents provided as instructed above (VP's are pre-preserved)
-Special cyanide preservations: When presence of sulfide is indicated by a positive spot test with lead acetate paper, preservation consists of: 1) precipitation with cadmium nitrate until a negative test is obtained; 2) filtration of the precipitate; and 3) addition of NaOH to pH > 12.
-Fill-out logsheet/chain-of-custody. Indicate: Sample Number (*) and fractions collected; dates/times of collection & shipment; appropriate field notes; Be sure to sign and date the bottom of each page where and as indicated.
-Ship with bagged ice in ice-chest by express carrier to lab coordinator's attention.

Figure 5-2
STANDARDIZED SAMPLE PRESERVATION CODES

SOURCE: ESE.

Prepared for:
U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

field and/or sampling conditions that require substitution of sampling stations. Changes in station ID will be clearly noted in permanent ink on the sample label and logsheet and must be approved by the Project Manager. The samples will be wrapped in bubble wraps and then placed in a cooler cooled to 4 $\pm$ 2°C. Sufficient bubble wrap will be used to prevent breakage. Samples will be shipped in waterproof coolers.

Information regarding sampling activities will be kept in a bound field notebook. The following data will be documented:

1. Study area number or location;
2. Date;
3. Time (24-hour system);
4. Static water level [to $\pm$0.01 ft, if applicable];
5. Depth of well/soil;
6. Number of bailer volumes removed or pumping rate, if applicable;
7. Time of pumping, if applicable;
8. Total volume of water evacuated from well;
9. Water quality measurements of pH, specific conductance, and temperature;
10. Other pertinent observations of samples (color, turbidity, odor, depth, evidence of constituents, etc.);
11. Fractions sampled and preservation method;
12. Weather conditions and/or miscellaneous observations;
13. Bailer inventory number, if pre-cleaned bailers are used;
14. Description of photographs taken at each sampling location, if applicable;
15. Organic vapor detector readings, if applicable; and
16. Signature of sampler and date.

Additional documentation is provided in Section 4.0.

Each collected sample fraction contained in the cooler will be specified on the logsheet by circling the appropriate fraction code (Figures 5-1 and 5-2). Other field information, such as sample type, sample collection time and date, new station code (if different from tentative station ID), and field analysis results (e.g., pH, temperature), will also be entered onto the logsheet. The shipment method will be entered on the bottom of the logsheet, and the sampler will sign and date the logsheet. The logsheet will be placed in a waterproof container, taped to the inside of the lid of the cooler, and sealed in the cooler along with its samples. The cooler seal or lock will not be opened until the samples arrive in the analytical laboratory and are checked in by the sample custodian. The ESE Project Manager will alert the analytical task manager to pertinent shipping information at the end of each sampling day.

The following is the laboratory contact person and the address:

Hugh Prentice
ESE Laboratory
14220 Newberry Rd.
Gainesville, FL 32607
(904) 332-3318.

5.4 LABORATORY SAMPLE DOCUMENTATION

Upon arrival in the laboratory, samples will be checked in by the analytical task manager and sample custodian. All samples contained in the shipment will be compared to the logsheet(s) to ensure that all samples designated on the logsheet have been received. Any changes in station ID from the originally established station ID will be noted. The sample custodian will note any special remarks concerning the shipment, indicate an analysis due date, and deliver the logsheet to the sample control center. Any sample

received that has a temperature greater than 6°C, or with visible icing, shall not be analyzed without USAEC approval.

Samples will be placed in appropriate storage areas in the laboratory, depending on storage requirements. Samples requiring immediate analysis to meet holding times will be delivered directly to the appropriate analytical departments. The department managers will be notified that the samples have arrived through the distribution of arrival notices. The majority of the samples will be stored in the main coldroom, with the temperature maintained at 4°C ± 2°C. The coldroom will be kept locked when not being used. The water samples for metals analysis (fraction N and NF) will be stored in a separate, air-conditioned storage room located near the metals sample preparation area. This room will also be kept locked when not in use. The samples in the coldroom and metals storage room will be arranged alphabetically in the shelves by field group. The sample location list will be posted at the doors of each storage room. Access to samples will be limited to authorized personnel, and a sample check-out and check-in list will be maintained.

The VOC samples will be delivered directly to the GC/MS department by the Sample Custodian and will be stored in the department's refrigerators designated for sample storage (only), to avoid cross contamination.

5.5 DOCUMENT CONTROL

Document control will include maintaining project files. Project files will be maintained by the ESE Project Manager. Documents will be kept in project files. Project personnel may keep their own files. However, official and original documents will be placed in the official project file.

ESE will keep laboratory records, including batch forms, logsheets, and computerized worksheets, in a batch file in the sample control center.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

6.1 FIELD INSTRUMENTS

Field analytical equipment will be calibrated immediately prior to use in the field. The calibration procedures will follow standard manufacturers' instructions to ensure that the equipment is functioning within tolerances established by the manufacturers. A copy of the instrument user manuals will be placed in a 3-ring notebook and brought to the field by the Field Team Leader. A record of the instrument calibration will be maintained in the field notebook by the Field Team Leader.

6.1.1 HYDROLAB

For field measurement of in situ analytical parameters, ESE will use a digital automatic temperature compensating multimeter (Hydrolab 4041 or Hydrolab Surveyor II). The Hydrolab instruments contain sensors for temperature, pH, and specific conductance in one compact sonde. The Hydrolab uses the measured temperature of the sample to automatically compensate the pH and conductivity readings for temperature-dependent variations. The following sections describe the calibration procedures for the Hydrolab. Calibration data will be recorded daily on the field logbook.

6.1.1.1 pH Calibration

Hydrolab field calibration of pH is performed at the start of each sampling day using National Institute of Standards and Technology (NIST)-traceable standard buffer solutions which bracket the pH range expected in samples. At least two buffer standards (typically pH 4.0 and 7.0 at 25 °C) are used for calibration. The sonde is rinsed twice with the standard solution prior to obtaining readings by filling the sonde calibration cup half full with the standard, installing the cap, shaking for approximately 10 seconds, then

pouring out the liquid and repeating this step. The standard is then allowed to reach thermal equilibrium. The zero calibration control is used to adjust the reading to correspond to the standard. The sonde is then rinsed twice with the second standard. The second standard is added, allowed to equilibrate, and the slope control is used to adjust the reading to the corresponding standard. The meter will be checked from one well to another by rereading at least one standard. If the readings of the standard during checks vary more than ±0.3 pH unit, the instrument will be recalibrated. The days-end calibration is identical to the beginning calibration except that only the readings are recorded and the meter is not adjusted; therefore, meter drift due to sensor fouling during the day can be determined. If the drift in readings is significant, the sensors must be cleaned according to the operator's manual prior to recalibrating the meter the next day.

6.1.1.2 Conductivity Calibration

Hydrolab calibration for the conductivity meter will be performed at the start of each sampling day using potassium chloride (KCl) standard solutions prepared in the ESE laboratory prior to each field trip. The analyst preparing the solutions will verify the standard solution against a laboratory conductivity bridge. At least two standard solutions will be chosen which are within the anticipated range of the samples to be measured. The Hydrolab conductivity sensor will be calibrated using the following procedure:

1. Rinse the sonde twice with the higher range standard as described for pH, and add the standard slowly to the calibration cup, ensuring that no air bubbles are trapped on the electrodes, and that the electrodes are fully covered.

2. After allowing the sensors to reach thermal equilibrium (temperature and conductivity readings are stable), adjust the conductivity calibration or slope control until the reading matches the standard.

Rinse the sonde twice with the second (low range) standard, add the standard, and allow to reach equilibrium. The reading of the second standard should be within ±1 percent for the meter range being used on the Hydrolab. For example, if the 0 to 2K scale is used for the second standard, the reading should be correct to within ±20 microSiemens per centimeter (μS/cm). If not, the calibration is repeated. Midday checks and days-end calibrations will be performed at the same time and in the same way as for pH.

6.1.1.3 Temperature Calibration

The Hydrolab temperature sensor will be factory calibrated and is accurate to ±0.2°C. No user calibration adjustment of the temperature will be performed. The equipment manager checks the temperature system against an NIST thermometer as part of the prefield calibration. If the temperature sensor does not perform to the manufacturer's specifications, that unit will be taken out of service and sent to the manufacturer for repair.

Each piece of field sampling equipment requiring calibration will be calibrated prior to each day's use. Data are recorded in a bound field notebook. The procedures described in the following subsections apply to the specific instrument noted. If other instruments are used, the manufacturer's calibration procedures will be followed.

6.1.2 YELLOW SPRINGS INSTRUMENTS SALINITY CONDUCTIVITY TEMPERATURE METER

6.1.2.1 Temperature Probe

1. Using an NIST-approved thermometer, immerse both probes into a beaker of water and note any differences for the field probe.
2. Recalibrate as necessary.

6.1.2.1 Specific Conductance Meter

1. Calibrate meter and probe using the calibration control and the red-line on the meter dial [Yellow Springs Instruments Salinity Conductivity Temperature (YSI S-C-T) Meter, Model No. 33].
2. Turn the function switch to read conductivity x 10 and then depress the cell test button, noting the deflection. If the needle falls more than 2 percent of the reading, clean the probe and retest.
3. Using at least two solutions of different ionic strength, which will most likely bracket the expected values for conductivity, note accuracy of the water and probe and clean probe if necessary.

6.1.3 SPECIFIC ION METER - pH PROBE

1. Place electrodes and buffer solutions in a water bath at the temperature of the water to be sampled. After temperature equilibration, measure temperature and adjust the temperature compensation knob for this temperature.
2. If using refillable probes, remove electrode cap and check to ensure that filling solution is above the filling mark.
3. Immerse the probe in the pH 7 buffer solution and adjust the calibration control to read the appropriate pH. Check the pH buffer solution for correct pH value at the equilibrated temperature.

4. Remove the probe, rinse with distilled water, and immerse in either the pH 4 or pH 10 buffer solution, depending on the expected pH of the sample.
5. If the meter does not register the correct pH for that buffer solution, adjust the calibration knob on the back of the instrument to obtain the pH of the buffer.
6. After rinsing, insert the pH probe into the flow cell and allow the probe to come to equilibrium with the sample water.
7. Store the pH probe either in ambient air or a buffer solution overnight, according to the manufacturer's specifications.

6.1.4 PHOTOIONIZATION METERS

6.1.4.1 HNU

With the probe attached to the instrument, turn the function switch to the battery check position. The needle on the meter should read within or above the green battery area on the scale plate. If the needle is in the lower position of the battery arc, the instrument should be recharged prior to any calibration. If red LED comes "ON," the battery should be recharged. Next, turn the function switch to the "ON" position. In this position, the ultraviolet (UV) light source should be on.

To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the zero potentiometer produces an upscale deflection, while counterclockwise rotation yields a downscale deflection. If the span adjustment setting is changed after zero is set, the zero should be rechecked and adjusted if necessary. Wait 15 to 20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero. The instrument is now

ready for calibration by switching the function switch to the proper measurement range.

Using nontoxic analyzed gas (isobutylene) mixtures available from the manufacturer in pressurized containers, connect the cylinder with the analyzed gas mixture to the end of the probe with a piece of tubing. Open the valve of the pressurized container until a slight flow is indicated and the instrument draws in the volume of sample required for detection. Now adjust the span potentiometer so that the instrument is reading the stated value of the calibration gas.

If the instrument span setting is changed, the instrument should be turned back to the standby position and the electronic zero should be readjusted if necessary. If the instrument does not calibrate, it may be necessary to clean the probe or the lamp connection.

6.1.4.2 Photovac TIP

The name of this instrument is derived from the fact that it measures total ionizables present (TIP). Turn power switch to "ON" by first pulling knob out and then up. Allow TIP to warm up for 5 minutes prior to use. Turn span knob to max (9) and zero knob to zero. Attach "zero air" cylinder to TIP inlet using PVC tubing. Zero instrument using zero knob only. (TIP is very sensitive so stable reading of absolute zero is difficult and not necessary to achieve.) Next, attach isobutylene cylinder to TIP inlet. Use the span knob to adjust TIP reading to the concentration number on the isobutylene cylinder [usually 60 parts per million (ppm)]. Remove cylinder. TIP is now calibrated and ready for use. (Calibration should be checked often because TIP has tendency to drift.) When finished, turn power off by

pulling switch out and down. Recharge instrument overnight. (Battery charger must be pushed into place and then screwed into bottom of TIP.)

6.1.5 TURBIDITY METER

The instrument is calibrated by the manufacturer and all maintenance shall follow the manufacturer's specification.

1. On a quarterly basis, the instrument is calibrated with a Formazin Primary Tubidity Standard.
2. Before each use, measure standards in the range for which measurements are to be made with the secondary tubidity standards (Gelex).
3. Recalibrate the secondary standards with the primary standard each time a lamp or photocell is replaced.

6.2 LABORATORY INSTRUMENTS

Calibration of laboratory instruments will be performed for each analytical method based on the four USAEC method classes:

1. Class 1: Methods for the analysis of inorganic and organic parameters, with the exception of GC/MS methods and pesticides/ PCBs by gas chromatography (GC). For this project, Class 1 methods will be used for metals, explosives, and landfill parameters (anions).
2. Class 1M: GC/MS methods, both for the analysis of volatile organics and semivolatiles [base-neutral and acid extractables (BNAs)].
3. Class 1P: Methods for the analysis of pesticides and PCBs by GC.
4. Class 2: Reserved for screening type methods which give only a qualitative result or noncertified methods like radiochemistry.

Each instrument will be calibrated in a manner consistent with the method requirements and shall be documented in a parameter notebook or the analyst's notebook. Specific procedures to be used for calibration of laboratory equipment are described in the USAEC-performance demonstrated methods and summarized in the following paragraphs.

6.2.1 GC/MS TUNING AND CALIBRATION

Calibration procedures will be specified in the analytical method; the calibration shall also include additional QC requirements for USAEC's Class 1M methods.

6.2.1.1 GC/MS Instrument Tuning

Instruments will be tuned every 12 hours while in operation to ensure that the instrument is calibrated and in proper working condition with the desired sensitivity. When analyzing semivolatiles (BNAs), the GC/MS will be tuned every 12 hours with decafluorotriphenylphosphine (DFTPP), and bromofluorobenzene (BFB) for volatile organics. The mass intensity specifications for DFTPP and BFB are presented in Table 6-1.

6.2.1.2 GC/MS Calibration

Relative response factors (RFs) for the individual compounds will be determined as:

$$RF = \frac{A_c/Q_c}{A_{is}/Q_{is}} = \frac{A_c\, Q_{is}}{A_{is}\, Q_c} \qquad (6\text{-}1)$$

where: A = integrated area taken from the extracted ion current profile,
Q = quantity of material,
c = compound, and
is = internal standard.

Table 6-1.

Mass Intensity Specifications for DFTPP and BFB

Key Ions	Ion Abundance Criterion
For DFTPP	
51	30.0 - 80.0 percent of mass 198
68	Less than 2.0 percent of mass 69
69	Present
70	Less than 2.0 percent of mass 69
127	25.0 - 75.0 percent of mass 198
197	Less than 1.0 percent of mass 198
198	Base peak, 100 percent relative abundance
199	5.0 - 9.0 percent of mass 198
275	10.0 - 30.0 percent of mass 198
365	Greater than 0.75 percent of mass 198
441	Present but less than mass 443
442	40.0 - 110. percent of mass 198
443	15.0 - 24.0 percent of mass 442
For BFB	
50	8.0 - 40.0 percent of mass 95
75	30.0 - 66.0 percent of mass 95
95	Base peak, 100 percent relative abundance
96	5.0 - 9.0 percent of mass 95
173	Less than 2.0 percent of mass 174
174	50.0 - 120.0 percent of mass 95
175	4.0 - 9.0 percent of mass 174
176	93.0 - 101.0 percent of mass 174
177	5.0 - 9.0 percent of mass 176

Source: EPA Contract Laboratory Program Statement of Work for Organic Analysis. Document Number OLM01.8. 1990.

Initial calibration, using a minimum of five levels of the compound, will be used to determine the instrument linearity. The average RF will be calculated for each compound. The response factors for the system performance check compounds (SPCC) will be ≥ 0.05 for BNAs and ≥ 0.30 for volatiles. The percent RSD of the calibration check compounds (CCCs) in the initial calibration must be < 30 percent.

A 1-point calibration using a midlevel standard from the initial calibration will be used daily for all subsequent analysis. The RFs of the CCCs in the continuing calibration standard should be within ± 20 percent difference from the average RFs in the initial calibration.

QC evaluation criteria and corrective actions taken if the QC criteria for calibration are not met will be as follows:

1. If the DFTPP or BFB tuning criteria in Table 6-1 are not met, the instrument will be retuned until within criteria.
2. Percent RSD of the RF of the initial CCCs must be ≤ 30 percent. Rerun calibration standards; if still out of criteria, prepare new standards and rerun.
3. 1-point daily calibration RFs of CCCs must be within 25 percent of the average RFs in the initial calibration. Rerun standards; if still out of control limits, rerun the initial calibration.

6.2.2 GAS CHROMATOGRAPHY/HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY (GC/HPLC) CALIBRATION

Calibration will be specified in the analytical method; the calibration for the analyses of pesticides/PCBs will also meet the Class 1P methods calibration to accommodate additional USAEC QC requirements.

Initial calibration standard solutions will be prepared by sequential dilution of a single stock standard solution to cover the analytical working range of the method. These may be either composite standards of more than one analyte or single-analyte solutions. The concentrations will be adjusted to account for the instrumental and certified reporting limit. A minimum of five working standard concentrations covering the working range and a blank will be prepared and analyzed.

The initial calibration is performed daily for some methods while others require an initial calibration check daily. The initial calibration standards and the blank will be analyzed before starting an analytical run. The initial calibration curve will be produced by plotting the response for each standard versus the concentration of each standard from the initial calibration run.

For methods not requiring initial calibration to be performed daily, one high-level calibration standard will be analyzed prior to and after sample analyses. If the instrument fails the calibration check criteria, each standard in the initial calibration will be prepared and reanalyzed.

A check standard (from EPA) will also be run at the completion of calibration. If the method requires daily run of initial standards, a check standard will be required once a week. If the results of the calibration standard are not acceptable, immediate reanalysis of the calibration check standard will be required.

QC acceptance criteria and corrective action for calibration will be as follows:

1. The initial calibration curve and recalibrations curve possess a minimum of five points and a blank, or possess the number of calibration standards specified by the method.
2. The correlation coefficient of the curve is 0.995 or greater. Rerun the calibration curve if lower; if still out of control, prepare new calibration standards and recalibrate the instruments.
3. The calibration curve brackets the response for each sample. Dilute and reanalyze samples to be within the calibration range.
4. Continuing calibration standards must be within 20 percent of the same initial calibration standard for GC (25 percent for NP detector) and within 10 percent of the same initial calibration standard for HPLC. Unless specified otherwise, analysis of continuing calibration standards shall be performed at minimum intervals of every 10 samples.
5. The calibration curve brackets the response for each sample. Dilute and reanalyze samples to be within the calibration range.
6. For pesticides/PCBs, the laboratory shall analyze a blank every 12 hours. Every 12 hours the laboratory shall also alternately analyze a Performance Evaluation Mixture (PEM) or Standard Mixture consisting of CLP Mix A, CLP Mix B, Toxaphene, and PCBs 1016 and 1260. The response of the daily lot calibration must be within the limits of acceptability of ±20 percent.
7. When analyzing the PEM for pesticides/PCBs, the breakdown of DDT and Endrin shall be less than 20 percent, and the combined breakdown of DDT and Endrin shall be less than 30 percent.

6.2.3 GAS CHROMATOGRAPH (GC-VOLATILE ORGANICS) CALIBRATION

Calibration standard solutions will be prepared as needed by sequential dilution of a single stock standard solution (which is prepared every

2 months) to cover the analytical working range of the method. These may be either composite standards of more than one analyte or single-analyte solutions. The concentrations will be adjusted to account for the instrumental and method detection limit. A minimum of three calibration standard concentrations, or the number of standards specified by the method covering the working range and a blank, will be prepared and analyzed. The calibration standards and the blank will be analyzed before starting an analytical run. At least one calibration standard will be analyzed at the beginning of every analytical run and repeated at the end of the run to ensure constant instrument response. During extended runs covering more than 12 hours, this same continuing calibration standard should also be analyzed at minimum intervals of every 10 samples.

QC evaluation criteria and corrective action for calibration will be as follows:

1. The initial calibration curve and recalibrations curve possess a minimum of five points and a blank or possess the number of calibration standards specified by the method.
2. The correlation coefficient of the curve is 0.995 or greater. Rerun the calibration curve if lower; if still out of control, prepare new calibration standards and recalibrate the instruments.
3. Continuing calibration standards must be within 20 percent of the same initial calibration standard for GC (25 percent for NP detector).
4. The calibration curve brackets the response for all samples. Dilute and reanalyze samples to be within the calibration range.

6.2.4 GENERAL INORGANIC AND ORGANIC PARAMETERS CALIBRATION

This section applies to those inorganic and organic analyses procedures [ion chromatography, colorimetric, spectrophotometric, potentiometric, infrared

(IR) and UV absorption, turbidimetric] that use a standard curve for calibration [except total organic carbon (TOC) and chemical oxygen demand (COD)]. Working standard solutions will be prepared by sequential dilution of a single-stock standard to bracket the analytical working range of the method. Working standard solutions may be either composite standards of more than one analyte or single-analyte solutions. The standard concentrations will be adjusted to take into account the instrument and method, upper and lower limits of linearity, and the instrumental detection limit. A minimum of three standard concentrations, or the number of standards specified by the method, covering the working range and a blank will be prepared and analyzed. The initial calibration standards and the blank will be analyzed at the beginning of the analytical run, and at least one midlevel standard, which is the continuing calibration verification (CCV) standard, will be reanalyzed at minimum intervals of every 12 hours and at the end of the run to check for constant instrument response.

The working curve will be produced by plotting the standard response for each standard versus the concentration of each standard from the initial calibration run.

QC evaluation criteria for calibration will be as follows:

1. The working curve possesses a minimum of three points, or the number of standards specified by the method, and a blank;
2. The correlation coefficient of the line is 0.995 or greater;
3. The response for the CCV analyzed at minimum intervals of every 20 samples during the run and at the end of the run is within 20 percent of true value; and
4. The calibration curve brackets the response for all samples.

6.2.5 TRACE METALS ANALYSIS CALIBRATION

6.2.5.1 Atomic Absorption Spectroscopy (AAS) Standard Curve Calibration

Initial standard solutions will be prepared to include the analytical working range of the method; these solutions may be either composite standards of more than one metal or single-metal solutions. The standard concentrations will be adjusted to account for the instrument and method, upper and lower limits of linearity, and the instrumental detection limit. A minimum of three standard concentrations, or the number of standards specified by the method, covering the working range and a blank will be prepared and analyzed. The initial standards and the blank will be analyzed at the beginning of the analytical run, and at least one midlevel standard will be analyzed at minimum intervals of every 10 samples during the run and at the end of the run to check for constant instrument response.

The calibration will be verified by the analysis of the initial calibration verification (ICV) solution. The ICV is an independent standard prepared from different stock solutions than those used to prepare the calibration standards. Typically an EPA or NIST reference is used as the ICV and is prepared according to the supplier's instructions.

The working curve will be produced by plotting the standard response for each standard versus the concentration of each standard from the initial calibration run.

QC evaluation criteria for working curves will be as follows:

1. The working curve possesses a minimum of three points, or the number of standards specified by the method, and a blank;
2. The correlation coefficient of the line is 0.995 or greater;

3. The response for the midlevel standard analyzed at minimum intervals of every 10 samples during the run and at the end of the run is within 10 percent of true value;
4. The ICV is within 10 percent of the element's true value; and
5. The calibration curve brackets the response for all samples.

The concentration of the sample is obtained by entering the response for the sample into the working curve equation and determining the sample concentration after appropriate digestate and sample dilution factors have been applied.

6.2.5.2 Inductively Coupled Argon Plasma (ICAP) Single Point Calibration

This procedure uses a single standard concentration for each element to obtain an instrument response (emission counts). A second single point, emission counts obtained when aspirating a blank solution (undigested, acidified DI water), will be used in conjunction with the standard to calibrate the instrument in concentration units.

The calibration will be verified by the analysis of an ICV solution, which is an independent standard prepared from different stock solutions than those used to prepare the calibration standards. The elemental concentrations of the calibration verification solution must be within the calibration range of the instrument and at concentrations other than those used for instrument calibration.

A multi-element interference check solution (ICS) and a method blank (acidified DI water that is carried through the digestion process) will be analyzed each day prior to analyzing the samples. The ICS is used to verify

the correction of spectroscopic interference caused by emissions adjacent to analyte emission lines.

The CCV solution will be analyzed at minimum intervals of every 10 samples during the run and at the end of the run to document constant instrument response. This solution contains one-half the concentration of each element present in the calibration standards. This solution may be prepared by dilution of an aliquot of the calibration standard or prepared as a separate solution in a manner analogous to the calibration standard preparation procedure.

QC evaluation criteria for the instrument calibration standard will be as follows:

1. A calibration standard and a calibration blank are used;
2. Each value for the ICV is within 10 percent of each element's true value;
3. Values for the ICS are 20 percent of each element's true value; and
4. The measured concentrations of the elements in the CCV solution, for which calibration was performed, are within 10 percent of their respective true values.

6.2.6 GRAVIMETRIC METHODS CALIBRATION

The following two general types of analytical balances will be used at ESE:

1. The more sensitive microanalytical balance, and
2. The top-loading balance.

The calibration of the microanalytical balances will be verified daily by weighing the following NIST-certified weights (in grams):

Weight (g)	Tolerance Limits
0.2	± 0.0005
1.0	± 0.0005
3.0	± 0.0005
5.0	± 0.0005

The calibration of the top loading balances will be verified daily by weighing the following NIST-certified weights:

Weight (g)	Tolerance Limits
5	± 0.02
20	± 0.05
50	± 0.05

The results are recorded in the instrument logbook. If these criteria are not met, the weight may be reweighed. If the criteria are not met for the second weighing, the balance is taken out of service and repaired.

The analytical balances will also be calibrated annually by qualified service personnel. The annual calibration will be documented by a tag on the instrument. A set of NIST-certified weights will be used to check the calibration daily. Results are recorded in the instrument notebook.

6.2.7 TOC CALIBRATION

The Dohrman TOC analyzer will be calibrated with a standard reference material using a single-point calibration. The linearity of the calibration will be verified with a low-level and high-level standard to bracket the sample concentration. The linearity checks must be within 5 percent.

6.2.8 TOTAL ORGANIC HALIDES (TOX) CALIBRATION

The Mitsubishi TOX analyzer will be calibrated with a standard reference material using a 3-point calibration. The linearity of the calibration will be

verified with a low-level and high-level standard to bracket the sample concentration. The linearity checks must be within 5 percent.

6.2.9 RADIOCHEMISTRY CALIBRATION

In compliance with the State of Florida Department of Health and Rehabilitative Services (DHRS) Radioactive Materials licensing regulations, control charts for efficiencies and backgrounds will be kept for each instrument used in radiochemical counting. Standards used in calibrations and QC spiking are either from NIST or EPA.

6.2.9.1 Alpha/Beta Proportional Counter

The 10-chamber, low-background alpha/beta proportional counting system will be calibrated for counting efficiencies quarterly with Am-241 and Cs-137 standards. The alpha/beta self-absorption calibration curve for each counting chamber is determined biannually.

6.2.9.2 Liquid Scintillation Counting

The Beckman Liquid Scintillation counting system will be calibrated prior to each run of samples with a set of check sources and C-14 standards provided by the manufacturer. The H Number Quench Efficiency Correction Curve is derived from check sources and applied to the data to account for counting efficiencies.

6.2.9.3 Lucas Cell Readers For RA-226 Counting

Each Lucas Cell and the 12 matching cell readers will be calibrated with a known Ra-226 standard quarterly. Readers will be cross checked for counting efficiencies with a known Ra-226 source cell quarterly. Dark count background readings will also be run quarterly.

6.2.9.4 Gamma Spectroscopy

Both the Na(I) and Ge(Li) detector systems will be calibrated before each analysis with known source standards, depending on the radionuclide to be analyzed. Source standards are counted by the detector, and the system is calibrated to the standard's known decay energy.

7.0 ANALYTICAL PROCEDURES

7.1 ANALYTICAL METHODS

Soil, sediment, surface water, groundwater, and air samples collected during field sampling activities will be analyzed by ESE's Gainesville Laboratory, 14220 Newberry Road, Gainesville, FL 32607; Phone: (904) 332-3318.

7.1.1 LABORATORY VALIDATION

Laboratory validation is a three-phase process involving an initial validation of the laboratory by the U.S. Army Corps of Engineers, Missouri River Division (MRD), the determination of method detection levels (MDLs), and the documentation of methods to the USAEC. The ESE Gainesville laboratory has demonstrated its ability to perform the analysis for specified compounds using the standardized methods. Additional compounds requiring validation shall go through the three-phase process with final approval by USAEC.

Due to the constraints of sample holding times as specified in ER 1110-1-263, collection of environmental samples shall never occur before all the required analytical methods are validated.

7.1.2 HOLDING TIMES

Analyses to be performed for this investigation must be initiated within specified time limits (sample holding times) to avoid degradation of the parameters being analyzed. Table 4-1 presents preservation and holding time requirements.

7.2 LABORATORY METHODS DOCUMENTATION

Before an analytical method can be used for this project, the laboratory shall demonstrate the ability to perform the method for the specified analytes to meet USACE-MRD validation criteria. The laboratory shall submit method standard operating procedures (SOPs) and MDL studies to the USAEC Geology and Chemistry Branch for approval. All the analytical methods to be used for this project are USAEC-approved.

Analytical methods proposed for this project shall be described by a set of written SOPs citing the basic SW-846 method, including any changes to the basic method. Additional USAEC QC requirements are included in the basic method citing the control analytes, standard matrix spikes and levels, MDLs and upper reporting limits (URLs), and acceptance criteria. The SOP shall be approved by USAEC and shall be followed throughout the entire project.

7.2.1 METHODS NOT REQUIRING APPROVAL

Methods not requiring USAEC approval, such as laboratory/field equipment calibration, will also be used in this project. These methods do not require approval because of their intended use or due to the nature of the measurements themselves. The following parameters will be analyzed by the appropriate EPA methods and do not require USAEC method validation approval:

1. Temperature,
2. pH,
3. Specific conductivity,
4. Hardness,
5. Alkalinity,
6. TOC,
7. Biochemical oxygen demand (BOD),

8. COD,
9. Total dissolved solids (TDS),
10. Total suspended solids (TSS),
11. Total solids,
12. TOX, and
13. Moisture.

7.3 LABORATORY GLASSWARE CLEANING PROCEDURES

Dirty glassware will be drained of solvents and rinsed with tap water, if soils or other residues are still remaining, before they are submitted to the ESE washroom for cleaning. Glassware from the metals department is always rinsed with tap water prior to submittal to the washroom.

A completed glassware washing request form (Figure 7-1) must accompany each box of glassware sent to the washroom for cleaning. Laboratory glassware (i.e., volumetric flasks, separatory funnels, extraction tubes, beakers, and graduated cylinders) are cleaned according to the analysis/ parameter group listed in Table 7-1. These cleaning procedures are subject to change depending on the requirements of the project. The washroom personnel perform cleaning Procedures 1 through 4 listed in the table, unless otherwise directed in writing by the Analyst via the glassware washing request form. Cleaned glassware for organic analyses are placed in boxes lined with fresh aluminum foil. The form is then initialed, dated, and type of cleaning procedures performed are specified by washroom personnel. The remaining cleaning procedures are performed by the Analyst.

7.4 REAGENT STORAGE

The procedures to be used for storage of reagents in the laboratory are presented in Table 7-2.

Glassware Washing Request Form
To Be Done

☐ Normal Wash 1) Hot soapy tap water wash
2) Tap water rinse
3) DI rinse

☐ Rinse with DI only!

☐ Other _____(be specific)

_____

_____

_____

Solvent Rinse

☐ Acetone

☐ Other _____

_____

_____

Needed by:_____
Date and Time

Special Instructions:_____

_____

_____

_____

Requested by:_____

The Following Has Been Completed

☐ Normal Wash 1) Hot soapy tap water
2) Tap water rinse
3) DI rinse

☐ Rinse with DI only!

☐ Other _____(be specific)

_____

_____

_____

Solvent Rinse

☐ Acetone

☐ Other _____

_____

_____

Completed by:_____

Date:_____

Figure 7-1
GLASSWARE WASHING REQUEST FORM

Prepared for:
U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

Table 7-1.

Glassware Cleaning Procedures

Analysis/Parameter	Cleaning Protocol*
Extractable Organics (Semi-volatiles)	1,2,3,4,5,6
Purgeable Organics (Volatiles)	1,2,3,4,7,13
HPLC Analyses	1,2,3,4,5,10
EDB, DBCP, THMS	1,2,3,4,5,8,13
Trace Metals	1,2,3,4,12
Nutrients	1,2,3,4,11
Minerals	1,2,3,4
Residues	1,2,3,4,14
Cyanide, Oil and Grease, Phenols	1,2,3,4
Petroleum Hydrocarbons	1,2,3,4,5,9
COD, BOD	1,2,3,4
Radiochemistry	1,2,3,4
Microbiology (coliforms)	1,2,3,4,14

Note: DBCP = 1,2Dibromo-3-chloropropane
EDB = 1,2-Dibromoethane
HCl = Hydrochloric acid
HNO_3 = Nitric acid
HPLC = High Performance Liquid Chromatography
THMS = Trihalomethanes

*Cleaning Procedures

1. Remove all labels using sponge or acetone.
2. Wash with hot soapy water (use Liquinox soap only) using brushes to scrub inside of glassware, stopcocks, and other small pieces if possible.
3. Rinse three times with hot tap water.
4. Rinse three times with deionized water.
5. Rinse thoroughly with pesticide grade acetone.
6. Rinse with pesticide grade Methylene Chloride.
7. Rinse with pesticide grade methanol.
8. Rinse with pesticide grade hexane.
9. Rinse with appropriate extraction solvent prior to use.
10. Rinse with pesticide grade acetonitrile and pesticide grade methanol prior to use, if needed.
11. Acid rinse with 1:1 HCl, using only metals grade HCl.
12. Acid rinse with dilute HNO_3 and then with deionized water prior to use.
13. Bake at 80°C for 3 to 4 hours.
14. Autoclave containers.

*Class A volumetric glassware should not be baked.

Source: ESE.

Table 7-2.

Reagent Storage

Reagent	Method of Storage
Solvents	The back-up solvents that are not accessible to the analyst are stored in original containers in a vented storage room. The solvents that the analysts have access to are stored in double-walled flammable liquid storage cabinets. A purchasing personnel checks the solvent cabinets daily and transfers solvents from the storage room to the storage cabinets as needed. Note: Methanol used for volatile organics analyses is stored in the GC-Volatiles and GC/MS-Volatiles analysis areas.
Inorganic acids	Stored in original containers in the ESE stockroom. Once issued from the stockroom to a department, the acids are kept in safety carriers and stored along with the carriers in the department's cabinet designated for acids only.
Organic acids	Stored in original containers in the ESE stockroom. Once issued from the stockroom to a department, the acids are kept in safety carriers and stored along with the carriers in the department's cabinet designated for acids only. Note: Organic acids are stored in separate cabinets from the inorganic acids.
Caustics	Stored in original containers in the ESE stockroom. Once issued from the stockroom to a department, the caustic reagents are kept in safety carriers and stored along with carriers in the department's cabinet designated for caustics only. Note: Caustic reagents are stored in separate cabinets from the acids.
Other reagents	Stored in the main chemical or standards storage room or stored in the designated cabinets in each department. Liquids in quantities of one gallon or more must be kept in safety carriers. Standards that require storage at 4°C or at 0°C are stored in each department's refrigerators or freezers designated for standards only.

Source: ESE.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

8.1 DATA REDUCTION

Data reduction is the process of converting measurement system outputs to an expression of the parameter which is consistent with the comparability objective.

8.1.1 FIELD DATA

Raw data from field measurements and sample collection activities will be appropriately recorded in the field log book. If the field data are used in the project reports, they will be summarized and the method of reduction will be documented in the report.

Geotechnical data supplied by field personnel will be entered by laboratory personnel. The laboratory will enter chemical data using the scheme presented in the Installation Restoration Data Management Information System (IRDMIS) user guide. Field data to be entered into the IRDMIS are formatted consistent with IRDMIS requirements and entered into a Level 1 file (see Section 8.2.1). Details relative to specific data requirements and entry procedures are provided in the IRDMIS Users Guide (USATHAMA, 1988) and the USATHAMA Geotechnical Requirements (March 1987).

Validation/acceptance of data will be through USAEC IRDMIS computer software, validation, and review by project personnel of hard copy file data versus original data records for accuracy, completeness, and reasonableness in regard to other site conditions. Files will be entered into Level 2 in the IRDMIS (see Section 8.2.1).

8.1.2 LABORATORY DATA

8.1.2.1 Laboratory Logging

Upon arrival in the laboratory, samples will be checked against the chain-of-custody to ensure that samples on the chain-of-custody are present in the cooler. Samples will then be logged in a bound laboratory notebook containing the following information as a minimum:

1. Field sample identification;
2. Date of sample arrival in the laboratory;
3. Analysis requested; and
4. Observations concerning sample conditions upon arrival (e.g., broken containers, cooler temperature, etc.).

Problems will be documented and the Laboratory Task Manager will be informed. The Laboratory Task Manager will in turn inform the Project Manager to determine further action. Communication will be documented in the project files.

8.1.2.2 Documentation of Raw Data

The ultimate repository for information concerning analyses performed in the laboratory will be the analyst's laboratory notebook and the instrument logbooks. Bound notebooks with prenumbered pages will be maintained according to good laboratory practices. Entries will be completed in blue or black ink. Corrections will be made by drawing a single line through the incorrect entry, entering the correct information, indicating a reason for the correction (error code), and initialing and dating the correction.

Laboratory notebooks will not be removed from the laboratory without permission of the Department Manager and the Task Manager. Every entry into the notebook will be dated and signed. Entries in the personal notebook

will vary depending on the role of the individual in the laboratory and the type of work being performed. At a minimum, the personal notebook shall contain:

1. A reference to, or a description of the procedures used for sample workup or analysis;
2. A summary of the samples extracted or analyzed;
3. Weighings and calculations of standard concentrations; and
4. Information on spiking procedures and observations and comments on the procedures or samples.

An instrument logbook will be maintained for required analyses. Each time an instrument is used for sample analysis, the following information is entered:

1. Date of analysis;
2. Project name and number;
3. Number of samples analyzed and type of sample;
4. Time spent on analysis (start to finish);
5. Preventive maintenance performed, if any;
6. Time spent on preventive maintenance;
7. Instrument calibration performed, if any; and
8. Name of analyst.

Additional notes are made in the instrument logs when required. These notes are particularly important when abnormal instrument or analytical performance is observed. It is the analyst's responsibility to ensure that instrument logs are properly filled out and kept up-to-date. The QA staff monitors and audits the status of instrument logbooks quarterly.

At the end of the project, logbooks containing information specific to the installation will be forwarded to USAEC, if requested. ESE corporate logbooks should be avoided; the laboratory understands that logbooks to be used for the USAEC project must not be used for any other project (mixed); however, if such logbooks are used, certified copies of relevant logbook pages will be submitted to USAEC upon request.

8.1.2.3 ESE CLASS™ System

ESE has developed the CLASS™, a data management system which integrates data from sampling through analysis and reporting in different formats. The CLASS™ data management system will be instrumental in ensuring that minimal manual entry errors and manual manipulations occur in providing a client with valid chemical data. USAEC requires the production-defined chemical data files and contractor transfer of those files to the USAEC IRDMIS database. Since ESE has a computerized database that will be used to monitor data quality, programs have been written to produce USAEC chemical transfer files automatically. Validation occurs internally at ESE and within USAEC IRDMIS at each step of the process. As a final check, printouts from IRDMIS will be obtained on computer files and verified with the existing ESE database transferred.

The ESE data management system calculates concentrations and recoveries of samples and QC samples from either raw data manual entry or computerized upload of raw data (i.e., instrument responses for calibration curves, samples, and associated QC samples). The data management system will be used to control analyses required for individual samples by grouping individual samples in field groups. Each sample will be assigned a defined analyses list, or STORET list, to ensure that the required analyses are performed. Each STORET number could have multiple method

requirements. Therefore, STORET method combinations can be defined in the STORET list to control the type and criteria for various QC required. USAEC or EPA method numbers have been used as the method code for each STORET required for analysis by that method. The type of QC and required limits will be updated and reviewed in each STORET method code. When EPA STORET numbers are not available or applicable (different units required), ESE has internally assigns STORET numbers starting with 90000.

Computerized outputs from the following instruments have been interfaced with the ESE CLASS™ system to minimize manual entry errors:

1. All metals instrumentation except mercury analyzers [inductively coupled plasma (ICP) and furnace instrument];
2. GC/MS instrumentation for VOC and BNA analyses;
3. Ion chromatography instruments and TRAACS autoanalyzer instruments; and
4. Some GC instruments.

Other methods and instrument outputs require entry of raw data responses or final concentrations and the required QC data. Verified programs in the CLASS™ system then calculate results of environmental and QC samples and compare the results to the acceptance limits. For the USAEC performance-demonstrated methods, specific data entry requirements will be documented in individual method summaries, which become part of the raw data for the lot folders.

USAEC requires lot name assignments for groups of samples requiring analysis. The analyst obtains USAEC lot name assignments when a batch of samples is grouped for analysis or extraction/digestion for analysis. The CLASS™ system assigns batch numbers when analysts begin to enter raw

data into the CLASS™ system. A separate database has been built relating ESE batch numbers and USAEC lot names for tracking purposes. This Chemtrack database allows the Chemistry USAEC Program Manager and Project Team to monitor the status and priorities for QC chart and lot folder submission and validation.

Therefore, USAEC lot folders constitute the formal documentation for data reduction, validation, and final report files to USAEC IRDMIS. Historically, lot folder documentation requirements have typically called for stand alone documentation and traceability.

8.2 DATA VALIDATION PROCEDURES

The data processed through the ESE Data Management system, where automated QC checks are performed, will be reviewed by the analyst supervisor and Laboratory Task Manager (Figure 8-1). The data package containing the computerized reports, raw data, and the appropriate USAEC Data Review Checklists will be completed and submitted to the Project QA Officer (Figure 8-2).

8.2.1 DATA PACKAGE REVIEW BY QA PERSONNEL

The Project QA Officer will be responsible for reviewing and approving data packets before transmittal of data to the USAEC IRDMIS. Data validation involves a thorough review of data documentation from the raw data to the reported results contained in the lot folders. Data will be considered complete only after they are approved by the QA staff prior to transmittal. The reviews will be done on every batch to ensure that QC checks required by the method are included in the batch. With the use of the USAEC Data Validation Checklist (Figure 8-2), a thorough package audit will be performed. Additional guidance used for in-house data validation is provided

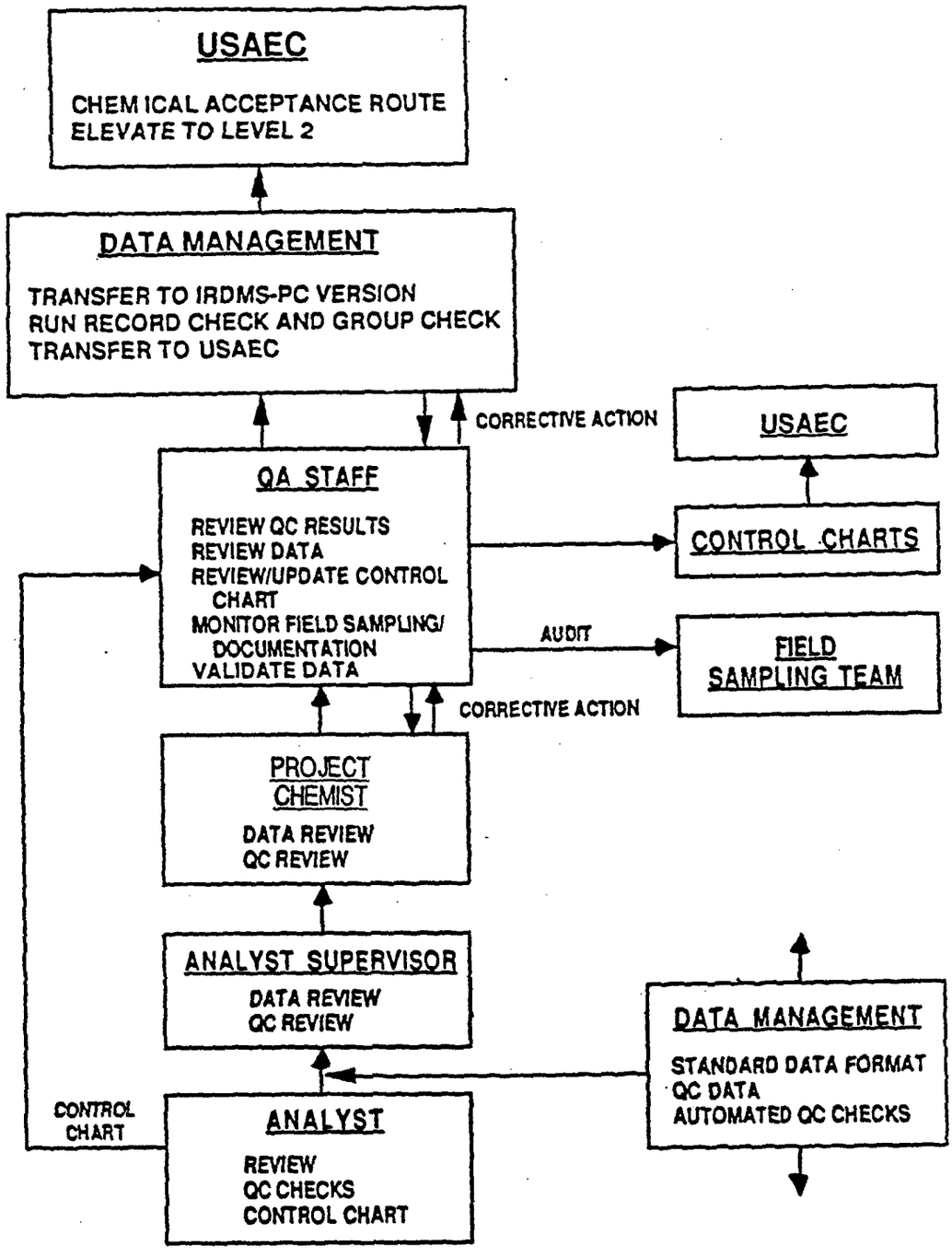


Figure 8-1
QAPP FUNCTIONS –
DATA FLOW AND QC CHECKS

SOURCE: ESE.

Prepared for:
U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

Method:	Project Name/No:
Method No:	Field Group:
Lot(s)/ESE Batch(es):	Analyte(s):

Initials Date	YES	NO	NA	COMMENTS
HOLDING TIME				
Was extraction/digestion HT met?				
Was analysis HT met?				
Were dilutions performed within HT?				
PAPER TRAIL				
Is field chain-of-custody present/complete?				
Are cooler receipt forms present and correct?				
Is lab chain-of-custody/extraction log present?				
Are all necessary forms present/complete?				
Are all notebook pages legible/signed/dated?				
Are notebook pages filled in blue/black ink?				
Are all changes made properly/initialled/dated?				
Is a case narrative present/completed/correct?				
CALIBRATION				
Standard curve for each analyte/concentrations				
Is the correlation coefficient >0.995?				
Do calibration standards bracket method range?				
Are surrogates/deuterated compounds present?				
12-hour tuning/mass calibration reports met?				
Frequency and criteria for ICV/CCV/CCB met?				
Have SPCC, RRF and CCC criteria been met?				
Was new standard curve run for reanalysis of dilutions?				

Figure 8-2
USAEC DATA REVIEW CHECKLIST
(Page 1 of 3)

Prepared for:
U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

	YES	NO	NA	COMMENTS
CONTROL SPIKES				
Are standard matrix spikes/method blank present?				
Were correct concentration levels used?				
Was a method blank and at least one spike analyzed with dilutions on different day?				
Are QC charts present with summary/signatures?				
Did QC spikes pass criteria?				
Are MS/MSD present and within criteria?				
Are field blanks/duplicates present and in criteria?				
Were all %R, %D and RPD within criteria?				
SAMPLE ANALYSIS				
Were all samples on chain-of-custody analyzed?				
Do dates in raw data match those in batch?				
Are reported concentrations within range?				
Were samples above range diluted to within range?				
Are all notebook pages legible/signed/dated?				
Are reported detection limits the MDLs (CRLs)?				
Is justification supplied for non-used data?				
Are primary and secondary columns clearly marked?				
Are reanalyzed samples marked and explained?				
Are all manual integrations justified?				
Has a TIC search been performed? (GCMS only)				

Figure 8-2
USAEC DATA REVIEW CHECKLIST
(Page 2 of 3)

Prepared for:
U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

	YES	NO	NA	COMMENTS
TRANSFER FILE				
Are units, method and lot number, installation, analyte name(s) present/correct?				
Are all QC data present?				
Are all samples present/hits confirmed?				
Are field data present and complete?				
Are corrected and uncorrected data present?				
Are non-detects reported as LT?				
Are GTs reported? If yes, consult QA Coordinator				
Are sampling/extraction/analysis dates present?				
Are data qualifiers/flagging codes present?				
CALCULATION				
For selected data points, can reported concentrations be back-calculated with available raw data?				

Figure 8-2
USAEC DATA REVIEW CHECKLIST
(Page 3 of 3)

Prepared for:
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Aberdeen Proving Ground, Maryland

in Appendix D. This includes check of the control charts, method blanks, standard matrix and sample matrix spike recoveries, surrogate recoveries, calibration data, method reporting limits (MRLs), and units. Method-specific data validation checklists which may be used are provided in Appendix D. Also included in the reviews are analyst's notebook pages, number of samples and sample identification, dilutions, percent moisture, sample weights, chain-of-custody forms, standard preparation notebooks, instrument logbooks, etc. After ensuring that these items are present and complete, the Project QA Staff reviews the raw data for precision, accuracy, and completeness. The raw data will be checked against the reported values, and the appropriate calculations are spot checked.

After ensuring that entries are correct and the QA/QC requirements will be met, Project QA Staff then initial and date the Data Validation Complete and Packet Complete portions of Figure 8-3 so that Information Services personnel can satisfactorily transmit the data to USAEC for entry into the IRDMIS.

Any discrepancies pertaining to any of the previously mentioned QA/QC checks will be directed to the Analytical Department Manager for verification, clarification, and/or correction, if necessary (Section 12.0). Other queries regarding the data transmission file (e.g., improper method codes or incomplete field data) will be addressed directly to Data Management. The questions are usually written under the "Comments" section of Figure 8-3 or on separate attachments. Once the questions are satisfactorily answered, the Project QA Staff initial and date the batch and appropriate sections of Figure 8-3. The batch folder will then be returned to Information Services for entry into IRDMIS.

Army Data Review Form

Army Lot_____ Installation_____

Data Batch_____ Method_____

Required Level Two Date_____

	Due Date	Initials	Date	Comments
Data Coordinator				
Group Leader				
Task Manager				
Data Coordinator				
QA/Coordinator (Data Validation Complete)				
(Packet Complete)				
Data Coordinator (File Transmitted)				

Comments:_____

Figure 8-3
ARMY DATA REVIEW FORM

Prepared for:
U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

The control charts will be reviewed and transmitted to USAEC weekly by the Project QA Officer. The control charts, which are the data quality information conveyed to the user, will be reviewed by the Laboratory Coordinator, Analytical Task Manager, and Project QA Staff before any data are transmitted to USAEC IRDMIS. The control charts review process is covered in detail in Section 12.0.

Three data levels will be used to indicate lot folder validation performance. Data reviewed by the ESE (or any contractor) Project QA Staff including field data and subsequently transmitted to IRDMIS are considered Validation Level 1 data.

Validation Level 2 data have been reviewed by the USAEC, but have not been transferred to the UNISYS computer (Figure 8-4). When the data are approved for transfer to UNISYS, they are considered Validation Level 3. Level 3 data containing data qualifiers and flags are available to users to create reports and graphs, but they cannot be changed by contractors.

USAEC will have an independent validation performed by a different QA group per the National Functional Guidelines for Inorganic Data Review (February 1994a) and the National Functional Guidelines for Organic Data Review (February 1994b). Data will be flagged per the guidelines. Non-CLP parameters shall be reviewed and flagged per the format of the National Functional Guidelines (1994 a and b).

8.2.2 IRDMIS RECORD AND GROUP CHECKS

After each data packet has been reviewed by key individuals and validated by Project QA Staff, the data file from the packet is loaded into the USAEC IRDMIS at ESE and will first be run through a record check and then a group

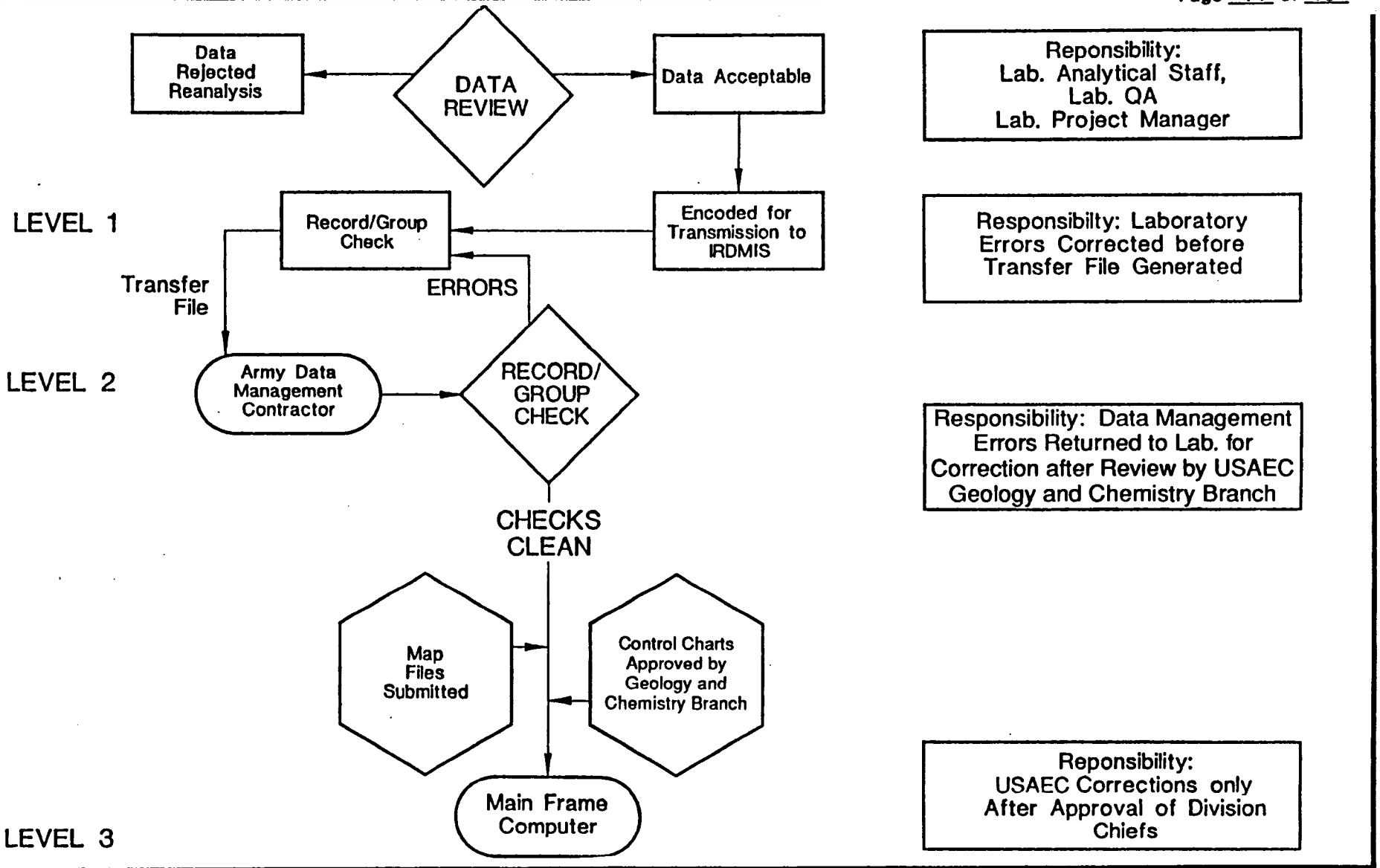


Figure 8-4
DATA VALIDATION LEVELS

Prepared for:
U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

check. Every data point will be checked using these two routines. IRDMIS record check accomplishes the following:

1. Validates file name (such as CGW, CSW) and site type (BORE, WELL);
2. Validates sampling program and technique and existence or absence of depth measurement;
3. Compares sample date, preparation/extraction date, and analysis date to determine any holding time violations;
4. Verifies test names as valid and either performance demonstrated or flagged as non-performance demonstrated, at the time of analysis or at present;
5. Determines value compliance with MRL and UCL;
6. Determines correct Boolean values, such as ND, LT;
7. Determines correct QC test, mantissa and exponent values, and uncorrected mantissa and exponent values;
8. Determines, if required, dilution mantissa, exponent, and moisture content inclusion;
9. Determines whether required flagging codes are included; and
10. Applies appropriate data qualifiers and flags.

IRDMIS group check determines the following:

1. The existence of station identifications for the lot data in the map file for the appropriate installation;
2. That test names/analytes found in the QC are present in each of the samples; and
3. That required QC spikes exist, spiking levels are valid, as determined by the methods table, and no aberrations exist in QC or sample data.

If any errors are found in the group and record check which are not addressed on the lot cover sheet (Figure 8-3) by the analysts, Task Manager, or the Project QA Officer, the lot is returned to the Task Manager so that the problem can be rectified. If changes to the analytical data are required, the lot is then resubmitted to the QA Officer, and after revalidation, it is again processed through IRDMIS to assure that any errors have been corrected. Comments affecting the quality of data will be associated with each data point as necessary by the use of flagging codes. The flagging code will be placed on the same line as the appropriate test name and data point in the lot file that is submitted to USAEC. These codes will be part of the official database and will appear with the data on reports generated from the system.

After the data in a lot have successfully passed QA validation and IRDMIS record and group checks, the transfer file of the lot is sent to USAEC via telephone line. The data are again run through record and group check by USAEC, and after passing the data checks, are elevated to Level 2.

8.3 DATA REPORTING

Numerical data will be reported in terms of the concentration in the environmental sample. Resultant found concentrations submitted for entry into the USAEC IRDMIS will remain unadjusted before being reported to USAEC. Correction factors such as dilution, percent moisture, and accuracy are maintained separately in the IRDMIS and are applied to the data in the transfer files. Values above the MDL will be reported as determined. Values will be reported as "less than" the MDL if the analyte is not detected. Values above the IDL but below the MDL will be reported as determined but will be flagged with "J" and "P" to indicate that the value is estimated.

Rounding to the correct significant figures will occur only after calculations and manipulations at the laboratory are completed. Required significant figures for the different method classes are as outlined in the following paragraphs.

8.3.1 CLASS 1 AND 1P METHODS

Sample and QC results will be reported in terms of concentrations in the original matrix and will be reported unadjusted for entry into USAEC IRDMIS. Background concentrations will not be subtracted from sample concentrations. If the results for an analyte are obtained by using the method exactly as written without dilution, the analyte concentration may be reported to three significant figures. If dilution were required for a particular analyte, the results will be reported only to two significant figures. Results of samples that cannot be diluted into the method performance-demonstrated range will be reported as greater than the upper reporting limit of the method.

8.3.2 CLASS 1M

Estimates of concentration levels in QC and actual samples for each analyte (target and surrogate) will be reported to two significant figures if the method is used without dilution. Results obtained after dilution will be reported to only one significant figure. Background concentrations will not be subtracted from sample concentrations. Estimates of concentrations of analytes that have not been subjected to the method performance demonstration procedure and for which no standards are available, as in the GC/MS screening procedure, will be reported based on the response compared to the response of a reference compound or internal standard provided that:

1. The instrumental response of the species is at least 10 percent of the response of the internal standard,
2. The estimated concentration contains only one significant figure,
3. The estimated concentration is annotated as based on the reference compound, and
4. The estimated concentration is reported as the concentration in the original matrix assuming 100-percent recovery.

Tentatively identified compounds (TICs) from the GC/MS screen will be reported to the USAEC database if the area is greater than 10 percent of the nearest internal standard. Every effort will be made to identify the compound as accurately as possible; otherwise, they will be reported as unknown hydrocarbon, unknown aldehyde, etc.

If the area of the TICs meet the $\geq$ 10 percent criteria and cannot be tentatively identified, it will be reported in the USAEC database as UNKXXX, where the XXX is keyed to the relative retention times.

The general manner in which the OQAPP functions in each laboratory in terms of data review and monitoring is shown in Figure 8-1. The analyst performs the analysis of samples and control samples and plots QC sample results on control charts. The data will then be processed through the Data Management System, where automated QC checks are performed, and the data will be presented in standard laboratory and USAEC format. The analyst Supervisor then reviews and approves the data. The Department Manager then reviews and approves the data and QC results and submits the data batch to the Project QA Staff for validation.

9.0 INTERNAL QUALITY CONTROL

9.1 FIELD QC CHECKS

9.1.1 BLANKS

Three types of QC samples will be processed: equipment blanks, trip blanks, and field blanks. The analytical data derived from these QC samples are useful for assessing field operations: constituent-free sample containers, preserving reagents, and equipment; potential onsite environmental contamination; personnel expertise in sample collection; and problems that may occur in sample storage and transport. Field duplicate samples are collected to ensure precision of the sampling and analytical processes. Requirements for field QC samples are summarized in Table 9-1.

9.1.1.1 Equipment Blanks

Aqueous equipment blanks are processed after field and/or laboratory decontamination by rinsing decontaminated sampling equipment (bailers, soil samplers, etc.) with ultra-pure water obtained from the laboratory. The rinse water is collected in sample bottles, preserved, and handled in the same manner as the samples (see Section 4.0).

Equipment blanks are prepared in the field by filling or rinsing each type of precleaned or field cleaned equipment set with analyte-free ultra-pure water. The equipment blank is collected and analyzed at a rate of one blank or 10 percent (whichever is greater) of the samples in each analyte group for all matrices.

9.1.1.2 Trip Blanks

Trip blanks for VOCs consist of sample bottles filled in the laboratory with organic-free water and any applicable preservatives or additives. They are

Table 9-1.

Frequency of Field QC Samples

QC Sample	Aqueous	Soil
Trip Blank	1 per cooler*	NR
Equipment Blank	10 percent	10 percent
Field Duplicate	10 percent per event	10 percent per event

Note: NR = not required.

All parameters must meet QC sample type and frequency requirements. Numbers calculated from specification will be rounded up to the nearest whole number(s).

*For volatile samples only.

Source: ESE.

sent to the sampling location with sampling kits and are returned unopened from the sampling location with the samples. One trip blank should be included for shipping and analysis with every cooler containing volatile samples shipped from the field. At least one trip blank for each proposed volatile organics method shall be provided and analyzed per cooler used for storing and transporting volatile sample vials (see Section 4.0).

9.1.2 FIELD DUPLICATES

Field duplicate samples are collected to assure the precision of the sampling and analytical processes (see Section 4.0). During each independent sampling event, at least one sample or 10 percent of the samples (whichever is greater) shall be collected in duplicate for analysis. This requirement applies to each parameter group and matrix sampled.

9.1.3 QC CHECKS ON FIELD MEASUREMENTS

Field instruments shall be calibrated at the beginning of each sampling day, checked with one standard at intervals not to exceed 4 hours and checked again at the end of sampling day. Instruments shall be recalibrated if these QC checks do not meet acceptance criteria. QC checks shall be recorded in the field notebook.

9.2 LABORATORY INTERNAL QC

The purpose of introducing internal QC samples is to monitor within day and day-to-day variations in routine laboratory analyses. It is essential that controls are initiated during and maintained throughout all steps, from sample preparation through sample analysis. The approach described in this OQAPP is intended to support, not replace, analytical method requirements. QC samples will be prepared from standard matrices and will be processed

through the entire method. The minimum QC requirements are summarized in Table 9-2.

The procedures outlined in this section are designed to provide both method control and individual sample control as follows:

1. Method control is provided for each method through the analysis of the appropriate standard matrix with added analytes (Class 1 and 1P methods) or with added surrogates (Class 1M methods).
2. Individual sample control is provided for Class 1P and 1M methods through the use of the SW-846 surrogate compounds spiked into each investigative and QC sample. The surrogate results will also be used to provide matrix-specific information. Individual sample control is not included for Class I methods because surrogate compounds are generally not available for the Class I method analytes.

Method blank results will be reported uncorrected, as determined on the basis of the instrument calibration response factor. Blank contamination problems must be delineated by the laboratory.

A summary of internal QC samples associated with Class 1, Class 1P, and Class 1M is presented in Table 9-2. The following subsections provide additional information regarding internal QC for each method class.

9.2.1 CLASS I METHODS

For Class 1 methods, the method blank will be followed by two standard matrix spike QC samples that contain all control analytes at 80 percent of the URL but not to exceed 20 times the MDL (Table 9-3). The concentrations of these two samples must be, to the degree possible,

Table 9-2.

Minimum QC Sample Requirements*

Analysis	Standard Matrix (QC Check Standard)		Sample Matrix†		Sample Replicate	Surrogate Spike	Filter Blank (as required)
	Blank	Spike**	Spike	Replicate Spike			
INORGANIC							
[a]All analyses except b,c,d	5%	5%	10%	10%	--	--	5%
[b]pH, residue, specific conductivity, turbidity, dissolved oxygen	5%	--	--	--	5%	--	--
[c]Radiochemistry only	5%	5%	10%	10%	--	--	5%
[d]TCLP	5%	5%	***	--	--	--	5%
ORGANIC							
[a]All analyses	5%	5%	10%	10%	--	100%††	5%
[b]TCLP	5%	5%	***	--	--	100%††	5%

Note: -- = not applicable for this analysis.

* Actual number rounded up to nearest whole number (i.e., 5% = 1QC for 1-20 samples; 2QC for 21-40, etc.).

† Sample Matrix Spike is a spike into a sample matrix which is carried through sample preparation, sample digestion, or extraction to sample analysis.

** Standard Matrix Spike (QC Check Standard) is a spike into a blank matrix which is carried through sample preparation, sample digestion or extraction to sample analysis. The blank matrix is a reagent blank for aqueous samples and a standard soil for solid matrix, if available; if standard soil is not available, spiking is done on a reagent blank. This spike is also called a QC Check Standard because the standards used to prepare the spiking solution are from a different source than those used for the calibration standards.

†† Surrogate(s) will only be spiked into all environmental and QC samples if specified by the method.

*** 5%, or one per waste type, whichever is greater.

Source: ESE.

Table 9-3.

Numbers and Concentrations of Internal QC Samples per Lot for Class 1, Class 1P, and Class 1M Methods

Number of Quality Control Samples	Types of Quality Control Samples
Class 1 - Metals, TPH, Herbicides, Phenols, Landfill Parameters*, and Nitrates	
1	Standard matrix method blank.
1	Standard matrix spike; two times MDL (approximate).
2	Standard matrix spikes; 80 percent of the URL (approximate).
All investigative samples	Natural Matrix Surrogate Spike; 80 percent URL (approximate, if possible).
Class 1P - Pesticide/PCB Analyses	
1	Standard Matrix method blank.
2	Standard matrix spikes; two times MDL (approximate).
2	Standard matrix spikes; 80 percent of the URL (approximate).
All QC and investigative samples	Standard and natural matrix surrogate spikes; 80 percent of the URL (approximate).
Class 1M - Organic Compound Analyses	
2	Standard matrix method blank/surrogate spike.
All QC and investigative samples	Standard and natural matrix surrogate spikes. Spiking level specified in the method.

*Landfill parameters include ammonia, fluoride, nitrates, hardness, sulfate, chloride, total organic carbon, chemical oxygen demand, boron, alkalinity, total dissolved solids, pH, specific conductivity, biochemical oxygen demand, and total phenolic compounds.

NOTE: MDL = method detection limit.
PCB = polychlorinated biphenyl.
QC = quality control.
TPH = total petroleum hydrocarbons.
URL = upper reporting limit.

Source: ESE.

identical. A third standard matrix spike QC sample with a concentration approximately two times the MDL will also be analyzed. Control charts will be prepared for each control analyte to evaluate system stability.

Control analytes (required analytes spiked into QC samples) shall be specified in the method SOP. For multi-analyte methods, USAEC shall designate the required control analytes, or the control analytes will be selected upon approval of the method. Those selected analytes will be used to demonstrate control of that method when analysis of all analytes is requested. The selection of control analytes will follow the USAEC guidelines (i.e., 50 percent of the target analytes with a minimum of four selected).

In addition to the QC parameters discussed, sample MS/MSD shall be analyzed. MS/MSD are generated to determine matrix effects and within day variability of the laboratory. MS/MSD samples will be analyzed at frequency of one per 10 samples of similar matrix.

9.2.2 CLASS 1P METHODS

For Class 1P methods, a standard matrix method blank will be included in each lot. In addition, four independently prepared standard matrix spike QC samples will be included in each lot. Two standard matrix spike QC samples will contain all control analytes at 80 percent of the URL (not to exceed 20 times the MDL). The spiked concentration must be the same for both samples and should be commensurate with the allowed number of reportable significant figures. The other two standard matrix spike QC samples will be prepared at approximately two times the MDL. The analysis of each lot must be completed within 48 hours. At least one QC sample will be analyzed in each 12-hour calibration period, as indicated in Table 9-3.

Control analytes (required analytes spiked into QC samples) will be specified in the method SOP. For multianalyte methods, USAEC will designate the required control analytes, or the control analytes will be selected upon approval of the method. However, control limits will be initialized for each analyte. Those selected analytes will be used to demonstrate control of that method when analysis of target analytes is requested. The selection of control analytes will follow USAEC guidelines.

In addition to the QC parameters discussed, MS and MSD shall be analyzed. MS/MSD are generated to determine matrix effects and within day variability of the laboratory. MS/MSD samples will be analyzed at frequency of one per 10 samples of similar matrix.

9.2.3 CLASS 1M METHODS

Independently prepared spiked standard and natural matrix samples shall be included in each lot of samples analyzed using Class 1M methods. Two single standard matrix QC samples (method blanks) will contain each surrogate spiked at approximately 80-percent URL. One QC sample will be analyzed in each 12-hour period, or both will be analyzed if the run is less than 12 hours. Each lot must be analyzed within 24 hours. For the purpose of method control, QC spikes obtained from the surrogates method blanks will be used for control charts. Field samples will be spiked with the control analytes at approximately 80 percent of the URL to observe matrix effects in the environmental matrix. The spike concentration must be the same for each sample. Two reportable significant figures shall be allowed for control sample results.

Control analytes will consist of those surrogates specified in the Method Documentation Package. Additional nonsurrogate target analytes may be

specified by the USAEC Project Officer for spiking (standard matrix only). Control charts will be maintained for only surrogate control analytes spiked in standard matrix samples. The minimum number of required in-control data values per lot for establishing method control for multi-analyte methods is addressed in Section 12.0.

In addition, the recoveries of the natural MS surrogate samples must be taken into account when evaluating matrix effects of specific samples. To aid in the evaluation of natural matrix surrogate recovery, the data from the natural MS surrogate recovery will be maintained on QC forms. A single form will be used for each surrogate in each lot and will become part of the data package for that lot.

In addition to the QC parameters discussed, sample MS and MSD shall be analyzed. MS/MSD are generated to demonstrate matrix effects and within day variability of the laboratory. MS/MSD samples will be analyzed at frequency of one per 10 samples of similar matrix (see Table 9-3).

9.3 MINIMUM QC

The following subsections summarize controls of the sample analysis. Precision and spike recovery checks are discussed in further detail in Section 12.0.

9.3.1 GC/MS

For GC/MS analyses, the following minimum QC checks will apply:

1. Each sample spiked with surrogates.
2. At least 5 percent spikes in sample matrix (MS) with selected analytes and surrogates will be analyzed.

3. At least 5 percent duplicate spikes in sample matrix (MSD) with selected analytes and surrogates will be analyzed.
4. At least 5 percent QC check spikes in blank matrix with selected analytes and surrogates will be analyzed.
5. At least 2 percent method blanks spiked with surrogates will be analyzed .
6. One calibration standard will be run and a daily response factor within 25 percent of initial calibration response factor for selected calibration check compounds.
7. Instrument tuning protocols will be performed and be within criteria prior to analysis.

9.3.2 GC AND HPLC

For GC-nonvolatiles, GC-volatiles, and HPLC analyses, the following minimum requirements will apply:

1. Each sample spiked with surrogate, if specified by the method.
2. At least 5 percent spikes in sample matrix (MS) with selected analytes and surrogate(s) (if applicable) will be analyzed.
3. At least 5 percent duplicate spikes in sample matrix (MSD) with selected analytes and surrogate(s) (if applicable) will be analyzed.
4. At least 5 percent QC check spikes in blank matrix with selected analytes and surrogate (if applicable) will be analyzed.
5. At least one blank spiked with surrogates (if applicable) will be analyzed.
6. At least three standards or the number of standards specified by the method will be analyzed for the standard curve.
7. Correlation coefficient of the standard curve will be equal to or greater than 0.995.
8. Samples will be within concentration range of the standards.

9. Midlevel calibration standards will be repeated at minimum intervals of every 20 samples at a frequency specified in method and at the end of a run, and response of the control analytes must be within 15 percent of initial response for GC (25 percent for NP detector) and 10 percent of initial response for HPLC.
10. Detection limits for each parameter will be determined and checked to ensure they meet limits specified for the field group.

9.3.3 TRACE METALS--ATOMIC ABSORPTION AND ICAP SPECTROSCOPY

For each batch of samples analyzed by AAS or ICAP, the following QC checks will apply:

1. At least 5 percent spikes in sample matrix (MS) with selected elements will be analyzed.
2. At least 5 percent duplicate spikes in sample matrix (MSD) with selected elements will be analyzed.
3. At least 5 percent QC check spikes in blank matrix with selected elements will be analyzed.
4. At least 5 percent method blanks will be analyzed.
5. At least three standards or the number of standards specified by the method will be analyzed as a standard curve.
6. Correlation coefficient of the standard curve will be equal to or greater than 0.995.
7. Samples will be within concentration range of the standards (or of the ICAP instrument).
8. Midlevel calibration standards will be repeated at minimum intervals of every 10 samples or at intervals specified in the method and at the end of a run, and response of the control elements must be within 10 percent (20 percent for mercury) of true value.

9. At least 5 percent filter blanks will be analyzed with each filtered sample.
10. Detection limits for each element will be determined and checked to ensure they meet limits specified for the field group.

9.3.4 MISCELLANEOUS METHODS

For each batch of samples analyzed by ion chromatographic, colorimetric, spectrophotometric, turbidimetric, IR, UV absorption, radiochemical, and titrimetric methods (except for pH, residues, specific conductivity, turbidity, and DO), the following QC checks will apply:

1. At least 5 percent QC check spikes in standard matrix will be analyzed.
2. At least 5 percent sample matrix spikes (MS) will be analyzed.
3. At least 5 percent duplicate control spikes in sample matrix (MSD) will be analyzed.
4. For radiochemistry methods, at least 10 percent sample replicates will be analyzed.
5. At least 5 percent method blanks will be analyzed.
6. At least three standards or the number of standards specified by the method will be analyzed as a standard curve.
7. Correlation coefficient of the standard curve will be equal to or greater than 0.995.
8. Samples will be within concentration range of the standards.
9. Midlevel calibration standards will be repeated at minimum intervals of one every 10 samples or as specified in the method and at the end of a run, and responses must be within 15 percent of true value.
10. At least 5 percent filter blanks will be analyzed with each filtered sample.

11. Detection limits for analytes will be determined and checked to ensure they meet limits specified for the field group.

10.0 PERFORMANCE AND SYSTEM AUDITS

Two types of audit procedures will be used to assess and document the performance of project staff: system audits and performance audits. These are performed at frequent intervals under the direction of the Project QA Officer. These audits form one of the bases for corrective action requirements and constitute a permanent record of the conformance of measurement systems to QA requirements.

10.1 SYSTEMS AUDIT

System audits include inspections of training status, records, QC data, calibrations, and conformance to SOPs without the analysis of check samples. System audits are conducted quarterly for the laboratory. Field audits may be conducted during the initial sampling activities of this project.

The system audit protocol is summarized as follows:

1. Field Operations--The Project QA Officer will periodically:
   a. Check field notebooks, logsheets, chain-of-custody forms, and report any inconsistencies and/or omissions;
   b. Check field sampling protocols, calibration of field instruments, decontamination procedures, packaging, and shipping; and
   c. Review analytical results of field QC samples (equipment blanks, trip blanks, and field duplicates).
2. Laboratory Operations--The Project QA Officer will periodically check:
   a. Parameter and/or laboratory notebooks;
   b. Instrument logbooks;
   c. Sample log-in, dispensing, and labeling for analysis;

d. Preservation procedures; and

e. Data validation.

3. Final Reports--Peer review of deliverable reports and data supporting this project will be performed by technically qualified individuals from each major discipline represented in the deliverable. Figure 10-1 is a sample of the deliverable review sheet to be used for this project. The Project QA Officer audits the project files to ensure that final reports and deliverables have gone through the peer review.

10.2 PERFORMANCE AUDIT

The ESE laboratory is participating in the following proficiency programs:

1. National Institute of Occupational Safety and Health (NIOSH) through its Proficiency Analytical Testing Program (PAT),
2. NIST proficiency testing program under the National Voluntary Laboratory Accreditation Program (NVLAP) for bulk asbestos,
3. EPA Water Pollution and Water Supply Proficiency Programs,
4. EPA Radiochemistry Intercomparison Study and Blind Performance Samples,
5. State of New York through its Environmental Laboratory Approval Program (ELAP) for public drinking water and environmental samples categories,
6. State of California Department of Health, and
7. U.S. Army Corps of Engineers (USACE).

The results of these interlaboratory studies will be evaluated periodically by the Project QA Officer during the project as part of the performance audits.

ESE | **DELIVERABLE REVIEW SHEET**

SHORT TITLE: _____ CLIENT: _____

PROPOSAL/PROJECT NUMBER: _____ DATE/TIME TO LEAVE ESE: _____

PROPOSAL/PROJECT MANAGER: _____ CLIENT DUE DATE: _____

AUTHOR(S): _____ DOCUMENT COORDINATOR: _____

_____

REVIEW CHECKLIST REVIEWER SHOULD PLACE CHECK UNDER APPROPRIATE REVIEW CATEGORY D—DRAFT F—FINAL		REQUIRED REVIEW								OPTIONAL REVIEW BY AUTHOR OR OTHER QUALIFIED INDIVIDUAL							
		① Organization/ Presentation Reviewed		① Technical Approach and Conclusions Reviewed		② Proposal Costs Reviewed (If Applicable)		② Laboratory Data Checked (If Applicable)		Tables, Figures, Text Data Checked		Critical Calculations Checked		Computer Models/ Programs Verified		Field Measurements Checked	
REVIEWER'S INITIALS	DOCUMENT/SECTION	D	F	D	F	D	F	D	F	D	F	D	F	D	F	D	F
	Document																
	SECTION(S)																

APPROVALS: _____ _____ _____ *(as appropriate)*

AUDITED BY: _____ *(QA Manager or designate)*

REMARKS: _____

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① Required review by at least one reviewer other than author in these categories.
② Required F & A review for proposals.
③ Required check by laboratory coordinator or other individual for laboratory data reports.

ORIGINAL TO PROJECT MANAGER—COPY TO QA FORM 83345

Figure 10-1
DELIVERABLE REVIEW SHEET

SOURCE: ESE.

Prepared for:
U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

Results of the internal audits will be available for review during the semiannual or quarterly USAEC external audits as a summary report, if requested.

11.0 PREVENTIVE MAINTENANCE

Preventive maintenance of field equipment, which is performed by analysts, field personnel, and sample program staging area staff, routinely precedes each sampling event; more extensive maintenance is performed by manufacturers on the basis of hours in use. Sampling crews report on the performance of the equipment after each sampling event. Critical spare parts are kept in stock. At times, it is necessary to perform routine maintenance in the field; therefore, each field instrument is provided with an operating manual and tool kit.

To minimize the occurrence of instrument failure and other system malfunction, a preventive maintenance program for field and laboratory instruments has been implemented. The preventive maintenance performed for each major piece of field and analytical equipment is addressed in the following sections.

11.1 FIELD INSTRUMENTS

The list of field instruments and their maintenance frequency are provided in Table 11-1.

11.1.1 SALINITY/CONDUCTIVITY/TEMPERATURE METER AND PROBE

1. Preventive maintenance protocol for the Yellow Springs Instruments (YSI) meter and probe involves red lining the meter to check the condition of the batteries and electronics for loose connections and cracked leads. These are checked daily before use and are replaced as needed.
2. Probe preventive maintenance involves verification of temperature readings using a mercury thermometer and verification that the

Table 11-1. Preventive Maintenance - Field

Instrument	Activity	Frequency
Dissolved oxygen meter and probe	Check battery level	Daily and replace as needed
	Check to ensure that mechanical zero is set properly	Prior to each use
	Check DO probe membrane	As needed
	Replace membrane	As needed
pH meter	Battery replacement	As needed
	Probe replacement	As needed
Conductivity meter	Battery replacement	As needed
	Check loose connections	Daily
	Replatinization	As needed
Temperature probes	Check connections	Daily
	Check against calibrated thermometer	Prior to field use
Portable organic vapor detection equipment	Clean exterior after use	Daily
	Check and recharge battery	Daily
Turbidity meter	Check battery level	Prior to each use
	Check loose connections	As needed
	Clean lens	As needed

Source: ESE.

probe does not need cleaning. A fouled probe is discovered by measuring a standard on the X100 and X10 ranges, then depressing the CELL TEST button. If the meter reading falls more than 2 percent, the probe is fouled and will be cleaned. Replacement membranes will be available.

11.1.2 pH METERS AND COMBINATION pH ELECTRODES

Preventive maintenance for the pH meter and electrodes primarily involves the proper care of the electrode. Electrodes are stored in a 1:1 solution of pH7 buffer and DI water. The hole to add internal filling solution must be plugged at all times to prevent evaporation of the solution when the electrode is not in use. When the internal filling solution has dried out, the chamber will be rinsed with DI water before the filling solution is replaced. This step prevents clogging of the probe and poor (<100 percent) slope adjustments when calibrating the electrode. When slope readings are deteriorating or a low ionic strength sample gives erroneous readings, the electrode will be treated with 1N potassium hydroxide (KOH) and 1N hydrochloric acid (HCl).

The preventive maintenance frequency is as follows:

1. The instrument batteries and electronics connections and cracks are checked daily during use.
2. Spare parts such as a replacement probe and fresh buffer solutions will be available for the system at all times and replaced as needed.

11.1.3 CONDUCTIVITY BRIDGE AND CELL

Preventive maintenance for the Beckman conductivity bridge involves keeping the rechargeable battery fully charged. Care for the conductivity cell involves storage in DI water.

The preventive maintenance frequency is as follows:

1. The instrument batteries and probe cables are checked daily during use.
2. Replatinization of the conductivity cell is performed according to when the cell response becomes erratic, a sharp endpoint cannot be obtained, or when inspection shows that any of the platinum black has flaked off.

11.1.4 DISSOLVED OXYGEN

Preventive maintenance procedures for the YSI meter involve verifying that the mechanical zero is properly set and ensuring that the batteries are fully charged to red line the instrument. The meter is shipped to the manufacturer for repair if any other problems exist. The Model 5420 BOD probe and the Model 5418 and 5419 probes are kept ready by storage in a moist atmosphere. Probe temperature readings are verified by comparison to the readings on a mercury thermometer. The DO probe membrane is replaced prior to use of the instrument in the field. The replacement of the membrane must occur at least 24 hours before use to ensure stable readings during a large number of DO analyses. Probe replacement is necessary when the probe will not calibrate properly or there are air bubbles under the membrane. Spare parts will be available for the system components most likely to experience failure.

The preventive maintenance frequency is as follows:

1. Probe membrane is checked (for deterioration) and filling solution is checked daily. Replacement is done as necessary.
2. Battery level and electronics are checked daily and replaced as necessary.

11.1.5 TEMPERATURE PROBES

1. Check connections, cables daily.
2. Check against calibrated thermometer in the laboratory prior to field use.

11.1.6 PORTABLE ORGANIC VAPOR DETECTION EQUIPMENT

1. Preventive maintenance of portable organic vapor detection equipment consists of cleaning the exterior of the equipment after use with a solution of mild detergent and rising with tap water (daily). Care should be taken not to flood the equipment; gentle wiping of the exterior is usually sufficient. No organic solvents are to be used. Care must be taken to prevent injection of water or foreign solid material into the inlets of these devices during use and cleaning.
2. Batteries must be recharged at the intervals recommended. Deep discharge of the batteries should be avoided to maximize battery life. Procedures to be followed for these preventive maintenance activities are found in the instrument manual supplied with this equipment.

11.2 GAINESVILLE LABORATORY

11.2.1 DOCUMENTATION

All maintenance performed on the instruments are documented in each instrument's maintenance logbook which is kept with the instrument. The date, initials of the analyst performing the maintenance, and the type of maintenance performed are recorded in the maintenance logbook. Receipts from the routine maintenance performed by the manufacturer's representative are kept in folders and filed in the department's file cabinets. Preventive maintenance for each major piece of laboratory equipment is listed in Table 11-2.

11.2.2 CONTINGENCY PLAN

In the event of instrument failure, every effort will be made to analyze samples within holding times by alternate means. If the redundancy in equivalent instrumentation is insufficient to handle the affected samples, efforts will be made to secure the same or equivalent analyses by a USAEC-approved laboratory. The Project Manager will be advised of any required changes in methodology or location; the Project Manager should then notify USAEC.

Table 11-2. Preventive Maintenance - Laboratory

Instrument	Activity	Frequency
Gas Chromatographs	Change septums	Weekly or as needed
	Check carrier gas	Daily
	Change carrier gas	As needed (when pressure falls below 100 psi)
	Cut off edge of a capillary column	As needed
	Replace oxygen traps used in the gas lines	Annually or as needed
	Clean ECD	Annually or as needed
	Replenish Electrolytic Conductivity Detector	Monthly or as needed
	Clean detectors	Annually or as needed
	Check system for gas leaks	At each column change
High Performance Liquid Chromatographs	Replace piston seals	Quarterly
	Replace or rebuild the the check valves	As needed (when performance of the instrument decreases)
	Clean detector flow cell	As needed
	Check pumps	As needed
	Replace guard column frits	As needed (when the HPLC system pressure increases)
	Clean detectors	Annually or as needed
Gas Chromatograph/Mass Spectrometer	Clean source and system	As needed
	Cut off ends of capillary columns	As needed
	Change columns	As needed
	Change injection point lines	Monthly or as needed
	Routine maintenance performed by the manufacturer	Annually
Atomic Absorption Spectrophotometers (Furnace and Cold Vapor)	Clean furnace windows	Daily
	Check plumbing connections	Daily
	Change graphite tubes	Daily or as needed
	Clean sample cells	Daily
	Check gases	Daily
	Check optics	Annually (on contract)
	Change graphite contact rings	As needed

Table 11-2. Preventive Maintenance - Laboratory (Continued, Page 2 of 5)

Instrument	Activity	Frequency
Inductively Coupled Plasma (ICAP)	Routine maintenance performed by the manufacturer	Annually (on contract)
	Clean the torch and nebulizer	Every six months or as needed
	Check tubing	Daily
Inductively Coupled Argon Plasma/Mass Spectroscopy (ICP/MS)	Check sample introduction system	Daily
	Routine maintenance performed by the manufacturer	Annually (on contract)
	Check cooling system	Daily
	Change pump tubing	Weekly or as needed
	Check and clean sampler and skimmer cones	Daily
	Check roughing pump oil	Weekly and change every 3 months
	Adjust ion optics	As needed
	Adjust CEM voltage	As needed
	Check mass calibration, resolution, and sensitivity	Daily
Autoanalyzers	Clean tubing	As needed
	Check tubings	Daily
	Check optics	Daily
	Clean optics	As needed
	Replace the lamp	As needed (when darkening is evident)
Colorimeter/ Turbidimeters	Check optics	Daily
	Check light source	As needed
Spectrophotometer	Routine maintenance performed by the manufacturer	Quarterly (on contract)

Table 11-2. Preventive Maintenance - Laboratory (Continued, Page 3 of 5)

Instrument	Activity	Frequency
TOX Analyzer	Clean electrodes	Daily
	Replace all solutions	Daily
	Clean absorber module and the furnace unit	Every six months or as needed
	Clean sampler boat	Monthly
	Check gases and tubing	Daily
TOC Analyzer	Check gases and tubing	Daily
	Change pump tubes	Prior to each use
	Flush digestion tubes	After each use
Ionanalyzers/Conductivity	Check probe	Daily
	Change probe solution	As needed
Ion Chromatograph	Routine maintenance performed by the manufacturer	Every six months (on contract)
	Check system for leaks	Daily prior to each run
	Check line pressure	Daily prior to each use
	Clean conductivity cells	Every six months
	Clean injection loops	Every six months
	Change columns	As needed
Ion Chromatograph (cont)	Replace tubings in the sample path	Every six months
Turbidimeter	Clean the instrument	Prior to each use
DO Meter and Probe	Check to make sure that the mechanical zero is set properly	Prior to each use
	Check DO probe membrane	Prior to each use
	Replace membrane	As needed (when tears, wrinkles, or bubbles are observed)
	Replace probe	As needed
Analytical Balances	Clean the balance	Daily
	Check alignment and balance	Daily
	Routine maintenance and calibration performed by the manufacturer	Semiannually

Table 11-2. Preventive Maintenance - Laboratory (Continued, Page 4 of 5)

Instrument	Activity	Frequency
pH Meter	Check pH probe	Prior to use
	Check internal solution	Prior to use
	Change internal solution	As needed
Specific Conductivity Meter	Clean the conductivity meter	As needed
	Replace conductivity cell	As needed (poor performance persists after cleaning)
Pensky-Martens Close-Cup Tester	Clean and dry the parts of the tester cup	Prior to use
	Check the condition and operation of the apparatus	As needed (when problem arises)
Biological Oxidizer	Clean ladle	Prior to each use
	Clean sample boats	Prior to each use
Ovens: TS, TSS, TDS	Check temperature	Prior to use
	Calibrate thermometer	Annually
Refrigerators/Freezers	Check temperature	Daily
	Calibrate thermometer	Annually
BOD Incubator	Check temperature	Prior to use
	Calibrate thermometer	Annually
Radiochemistry:		
Alpha/Beta Proportional Counter	Check gas flow	Daily
	Check counting chambers	Monthly or as needed
Liquid Scintillation Counter	Check counting system	Prior to each use
Alpha Spectrometer	Clean detectors	As needed
	Clean sample chambers	As needed
	Check vacuum	Daily
	Check voltage	Daily
Radon Flask Counters	Clean the face of the photomultiplier tube	Daily
	Check microswitch	Daily

Table 11-2. Preventive Maintenance - Laboratory (Continued, Page 5 of 5)

Instrument	Activity	Frequency
Gamma Spectroscopy	Refill liquid nitrogen in the dewar for the Ge(Li) detector	Weekly
	Check all cabling to the gamma detectors	Monthly
Biological Oxidizer	Clean ladel	Prior to each use
	Clean sample boats	Prior to each use

12.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

12.1 FIELD MEASUREMENTS

Field data will be assessed by the site QA Officer. The site QA Officer will review the field results for compliance with the established QC criteria that are specified in this OQAPP and in the site-specific SAPs. Accuracy of the field measurements will be assessed using daily instrument calibration and calibration check. Precision will be assessed on the basis of reproducibility by multiple reading of a single sample. Data completeness will be calculated using Equation 12-1.

$$Completeness = \frac{Valid\ Data\ Obtained}{Total\ Data\ Planned} X\ 100 \qquad (12\text{-}1)$$

12.2 LABORATORY DATA

Laboratory results will be assessed for compliance with required precision, accuracy, completeness, and sensitivity as described in the following paragraphs.

12.2.1 PRECISION

Precision of laboratory analysis will be assessed by the use of control charts. Additionally, by comparing the analytical results between MS/MSD for organic analysis, and laboratory duplicate analyses for inorganic analysis. The relative percent difference (RPD) will be calculated for each pair of duplicate analysis using Equation 12-2.

$$\%RPD = \frac{|S - D|}{(S + D)/2} X\ 100 \qquad (12\text{-}2)$$

where: S = First sample value (original or MS value), and

D = Second sample value (duplicate or MSD value).

12.2.2 ACCURACY

The accuracy of laboratory results will be assessed by the use of control charts, and by assessing compliance with the established QC criteria using the analytical results of method blanks, standard spikes, MS/MSD samples, and field blank. The percent recovery (%R) of matrix spike samples will be calculated using Equation 12-3.

$$\%R = \frac{A - B}{C} X\ 100 \qquad (12\text{-}3)$$

where: A = Analyte concentration determined experimentally from the spiked sample,

B = Background level determined by a separate analysis of the unspiked sample, and

C = Amount of the spike added.

12.2.3 CONTROL CHARTS

For Class 1, Class 1P, and Class 1M methods, control charts shall be used to monitor the variations in the precision and accuracy of routine analyses and detect trends in these variations. The construction of a control chart requires initial data to establish the mean and range of measurements. The QC charts are constructed from data representing performance of the complete analytical method and shall consist of tabulated data and graphical portrayals of the information described in the following paragraph. Software packages that will be used to construct charts have been provided by USAEC.

In the initial construction of the control charts, data from the laboratory analyses will be used. Data from spiked QC samples within a lot will be compared to control chart limits to demonstrate that analyses of the lot are under control, and will be used to update the charts. $\bar{X}$ - R control charts will be used.

Each control chart shall include the following information:

1. Analyte;
2. Method number;
3. Laboratory;
4. Spike concentration;
5. Matrix; and
6. Chart title - select one of the following:
   a. Single Day $\bar{X}$ Control Chart - High Spike Concentration
   b. Single Day $\bar{X}$ Control Chart - Low Spike Concentration
   c. Single Day Range Control Chart - High Spike Concentration
   d. Single Day Range Control Chart - Low Spike Concentration
   e. Three-Day $\bar{X}$ Control Chart - Low Spike Concentration
   f. Three-Day Range Control Chart - Low Spike Concentration
7. Four letter lot designation for each point, shown on the x-axis;
8. Percent Recovery (for $\bar{X}$ control charts) or Range (for R control charts) along the y-axis;
9. Upper control limit (UCL), on $\bar{X}$ and R control charts;
10. Upper warning limit (UWL), on $\bar{X}$ and R control charts;
11. Mean, on $\bar{X}$ and R control charts;
12. Lower warning limit (LWL), on $\bar{X}$ control charts; and
13. Lower control limit (LCL), on $\bar{X}$ control charts.

For some analytes specified by USAEC, warning limits on $\bar{X}$ charts will be deleted and replaced by modified control limits based on data quality specifications.

If the method is judged to be out of control (Section 12.2.3.1) and reanalysis occurs, no point from the initial analysis shall be used to update charts.

Specifics on the construction of control charts can be found in Section 12.2.4.

12.2.3.1 Out-of-Control Situations

Failure to meet calibration criteria, recordkeeping omissions, improper sampling technique, and improper storage or preservation of samples are all conditions that affect data quality and require investigation/correction. These evaluations shall be done daily so that action can be taken immediately to investigate and correct the problem.

For both duplicate spiked QC results and moving averages, a single mean (X) outside of modified limits requires immediate investigation/corrective action. When two or more successive lot means for duplicate spiked QC data are outside normal control limits but within modified limits, investigation/ corrective action shall be taken even though the data from these lots are acceptable. For moving averages, a single point outside of normal control limits but within modified limits shall require investigation/corrective action even though the data are acceptable.

12.2.4 DATA ACCURACY AND PRECISION--CONTROL CHARTS

Control charts will be used to monitor accuracy and precision of the analytical process. Control charts will be produced only for Class 1, Class 1P, and Class 1M methods. Control charts are used to monitor and graphically display trends that may affect the precision or accuracy or routine analyses.

12.2.4.1 Single Day $\bar{X}$ - R Control Charts

Accuracy and precision will be assessed using data from the duplicate spiked QC samples in each lot. Percent recovery is calculated as follows:

$$\textit{Percent recovery} = \frac{\textit{Found Concentration}}{\textit{Spiked Concentration}} \times 100 \qquad (12\text{-}4)$$

Control charts will be maintained for the duplicate spiked QC samples. To prepare control charts, the analyst will have access to the following data:

1. Percent recovery of each analyte in the two high-concentration spiked QC samples (Class 1),
2. Average ($\bar{X}$) percent recovery for the two spiked QC samples (Class 1) in each lot, and
3. Difference (R) between the percent recoveries for the two spiked QC samples (Class 1) in each lot.

The initial charts will be prepared using the first 4 days of analytical data closest to the spiking concentration used during analysis. Control limits are calculated after 4 days of analysis data are obtained. The average $\bar{X}$ ($\bar{\bar{X}}$), average range (R), and control limits for $\bar{X}$ and R will be updated after each in-control lot for the first 20 lots. Limits established after Lot 20 will be used for the next 20 lots. Control charts will be updated after each 20 lots thereafter using the most recent 40 points. When the control charts are

updated, the new data must be combined with the individual values of previous average percent recoveries and not the mean of all previous data. Only lots evaluated as in-control are applicable to the 20- and 40-lot requirements for establishing and updating control limits. Out-of-control, or outlier points, should be plotted; however, such lots are not used in lot number requirements or control limit calculations.

Two-point average control charts will be prepared for each control analyte using data from the high concentration spiked duplicate QC samples in each lot. The formulas used to establish and maintain control charts for duplicate spiked QC samples are as follows:

$$\textit{Average} = \bar{\bar{X}} = \frac{\Sigma \bar{X}}{K} \qquad (12\text{-}5)$$

$$\textit{Range} = \bar{R} = \frac{\Sigma R}{K}$$

where: $\bar{\bar{X}}$ = between-group average of the pairs (within group) average recovery,

$\bar{X}$ = average within-group recovery for data pairs,

R = within-group difference between recoveries for data pairs,

$\bar{R}$ = average range, and

K = cumulative number of pairs in the database.

From these equations, the control chart limits for paired results can be defined as follows:

$$\text{UWL on Average: } UWL_{\bar{X}} = \bar{\bar{X}} + 1.25\,\bar{R}$$

$$\text{UCL on Average: } UCL_{\bar{X}} = \bar{\bar{X}} + 1.88\,\bar{R}$$

4. Incorrect application of an analytical method.

Moving-average control charts will be maintained for each control analyte spiked in the single low-concentration spiked QC sample (Class 1). The $\bar{X}$ - R 3-point moving-average control chart will be constructed for each control analyte as follows:

1. Use percent recovery to allow for minor variations in spiking concentration;
2. The first plotted point is the average of the first three recoveries (from validation, at concentrations nearest the spiking level);
3. Subsequent points are obtained by averaging the three most recent individual recovery values (outliers excluded from calculation but not from plot);
4. The range for each point is the difference between the highest and lowest value for each group of three values; and
5. The central line, UWL, UCL, LWL, and LCL for the control charts are calculated using the following formulas:

$$Average = \bar{\bar{X}} = \frac{\Sigma \bar{X}}{K} \qquad (12\text{-}6)$$

$$Range = \bar{R} = \frac{\Sigma R}{K}$$

where: $\bar{\bar{X}}$ = between-group average of the average recovery of the three points (within group),

$\bar{X}$ = average within-group recovery for the three points,

R = within-group difference between recoveries for data sets,

$\bar{R}$ = between-group average of the three points (within-group) average range, and

K = cumulative number of pairs in the database.

$$\text{UWL on Average: } UWL_{\bar{x}} = \bar{\bar{X}} + 0.682\,\bar{R}$$

$$\text{UCL on Average: } UCL_{\bar{x}} = \bar{\bar{X}} + 1.023\,\bar{R}$$

$$\text{LWL on Average: } LWL_{\bar{x}} = \bar{\bar{X}} + 0.682\,\bar{R}$$

$$\text{LCL on Average: } LCL_{\bar{x}} = \bar{\bar{X}} + 1.023\,\bar{R}$$

$$\text{UWL on Range: } UWL_R = 2.050\,\bar{R}$$

$$\text{UCL on Range: } UCL_R = 2.575\,\bar{R}$$

$$\text{LWL on Range: } LWL_R = 0$$

$$\text{LCL on Range: } LCL_R = 0$$

Data will be plotted, whether or not the lot is in control. Plotted points represent averaged instrument measurements and not the individual measurement values. Each individual measurement value will be tested as an outlier using Dixon's test at the 98-percent confidence level (USAEC, 1993). If the datum is not classified as an outlier by the test, the point will be included in updating the control chart limits. If one of the individual measurements is an outlier, it will not be used in calculating the three-point moving average for plotting only, but the measurement is then excluded from calculations that are based on the three most recent acceptable individual points and the control chart limits determined accordingly.

After the first control chart points, control limits will be recalculated using only in-control data points. Any points falling outside of the control limits will be dropped from the calculations (but left on the charts), and the control limits recalculated using only points between the UCL and LCL. Charts will then be updated with the newly calculated control limits and all points plotted. These limits will then be used to control analysis of the next 20 lots. The control charts are now the outlier test, although individual measurements continue to be tested as outliers if they appear not to be

representative of the data set. A maximum of the 40 most recent lots will be used to recalculate control limits for 60 or more lots (40-point slide).

12.2.5 COMPLETENESS

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. A completeness of at least 90 percent for each parameter is the objective for this project. Following completion of the analytical testing, percent completeness will be calculated as follows:

$$\text{Completeness (\%) for parameter } y = \frac{\text{\# of valid } y \text{ values reported}}{\text{\# of samples collected for analysis of } y} \times 100 \qquad (12\text{-}7)$$

If completeness is less than 90 percent for any parameter(s), the ESE Project Manager will be notified immediately. The Project Manager, in coordination with the COR, are responsible for determining if resampling will be necessary to meet project objectives and will inform the Project QA Officer and Laboratory Task Manager of the decision.

13.0 CORRECTIVE ACTION

Corrective or preventive action is required when potential or existing conditions are identified that may adversely impact data quantity or quality. Corrective action could be immediate or long term. In general, any member of the project staff who identifies a condition adversely affecting quality can initiate corrective action by notifying his/her supervisor and the Project QA Officer in writing. The written communication will identify the condition and explain how it may affect data quality or quantity (Figure 13-1).

13.1 IMMEDIATE CORRECTIVE ACTION

Immediate corrective action is usually applied to spontaneous, nonrecurring problems (e.g., instrument malfunction). The individual who detects or suspects nonconformance to previously established criteria or protocol in equipment, instruments, data, or methods, will immediately notify his/her supervisor. The supervisor and the appropriate task leader will then investigate the extent of the problem and take the necessary corrective steps.

If a large quantity of data is affected, the task leader must prepare a memorandum to the Project Manager and Project QA Officer. These individuals will collectively decide how to proceed to correct the problem(s). Corrective measures will be coordinated with USAEC and any actions taken will be reported in weekly QC chart submittals. If the problem is limited in scope, the task manager will decide on the corrective action measure and document the solution in memorandum form in addition to the routing form in Figure 13-1.

QUALITY ASSURANCE CORRECTIVE ACTION REQUEST
AND ROUTING FORM

1. Identification of a Problem: CA#_____

Originator: _____ Date: _____

Nature of Problem: _____

_____

_____

_____

_____

2. Determination of Required Action:

Responsibility Assigned to: _____ Due Date:_____

Recommended Action: _____

_____

_____

_____

_____

3. Implementation of Required Action:

Responsibility Assigned to: _____ Due Date:_____

4. Assuring Effectiveness of Action:

Responsibility Assigned to: _____ Due Date:_____

Procedure to Assure Effectiveness: _____

_____

_____

_____

_____

Figure 13-1
QA CORRECTIVE ACTION
REQUEST AND ROUTING FORM

Prepared for:
U.S. Army Environmental Center

Aberdeen Proving Ground, Maryland

13.2 LONG-TERM CORRECTIVE ACTION

Long-term corrective action procedures are devised and implemented to prevent the recurrence of a potentially serious problem. The Project QA Officer will be notified of the problem and will conduct an investigation to determine the severity and extent of the problem. He/she will then file a corrective action request with the Task Manager, and Project Manager. If the corrective action will impact project budget or schedule, the action requires involvement of USAEC COR.

Corrective actions may also be initiated as a result of other activities, including:

1. Performance audits,
2. System audits,
3. Laboratory/field comparison studies, and
4. QA ongoing project audits.

The development and implementation of preventive and corrective actions will be timed, to the extent possible, so as to not adversely impact either project schedules or subsequent data generation/processing activities.

Examples of long-term corrective actions include:

1. Staff training in technical skills or in implementing the QA Program,
2. Rescheduling of laboratory routine to ensure analysis within allowed holding times,
3. Identifying vendors to supply reagents of sufficient purity, and
4. Revision of Contractor QA program or replacement of personnel.

For either immediate or long-term corrective actions, steps comprising a closed-loop corrective action system are as follows:

1. Define the problem
2. Assign responsibility for investigating the problem,
3. Investigate and determine the cause of the problem,
4. Determine a corrective action to eliminate the problem,
5. Assign and accept responsibility for implementing the corrective action,
6. Establish effectiveness of the corrective action and implement the correction, and
7. Verify that the corrective action has eliminated the problem.

Depending on the nature of the problem, the corrective action employed may be formal or informal. In either case, occurrence of the problem, corrective action employed, and verification that the problem has been eliminated must be documented. Final resolution of the problem will be documented by the signature of the Project QA Officer who shall sign the corrective action form (Figure 13-1) to indicate that the problems have been resolved.

14.0 REPORTS TO MANAGEMENT

14.1 QC REPORTS

Reports of a variety of QC activities are provided to managers at appropriate levels of the organization. QC reports are available to USAEC for review. These reports include the following:

QC Report Type	Generated By	Distributed To	Frequency
Sample data records (Sample map)	Field Crew	PM, LISM, USAEC	Per sample
Analytical QC chart documentation	LISM	LTM, QAO, USAEC	Weekly
Deliverable Review Record	TM PM	Dept. Mgr., QAM,	As needed
Project Audit	QAO	PM., QAM, USAEC	Quarterly
Corrective Action	Any Team Member	USAEC, PM, QAO	As needed

NOTES:

LISM = Laboratory Information Services Manager
LTM = Laboratory Task Manager
PM = Project Manager
QAM = Quality Assurance Manager
QAO = Quality Assurance Officer

14.2 PROJECT RECORDKEEPING

Project-specific files will be maintained in a secure manner for the duration of the project and then turned over to USAEC for maintenance. Specific logs, notebooks, and forms for each element of project activity have been described as a component of the procedures (Sections 4.0 through 14.0). These comply with USAEC requirements for project-specific bound

notebooks, filled out in ink, and signed/initialed by author and reviewer. Summary audit reports may be prepared coincident to the completion of each task to inform task staff and management of QA status. A final audit report for each project will also be prepared. The reports would include the following:

1. Periodic assessment of measurement data accuracy, precision, and completeness;
2. Results of performance audits and/or systems audits;
3. Significant QA problems and recommended solutions for future projects; and
4. Status of solutions to any problems previously identified.

Additionally, any incidents requiring corrective action will be fully documented. Procedurally, the Project QA Officer will prepare the reports to management. These reports will be addressed to the Project Manager. The summary of findings will be factual, concise, and complete. Any required supporting information will be appended to the report.

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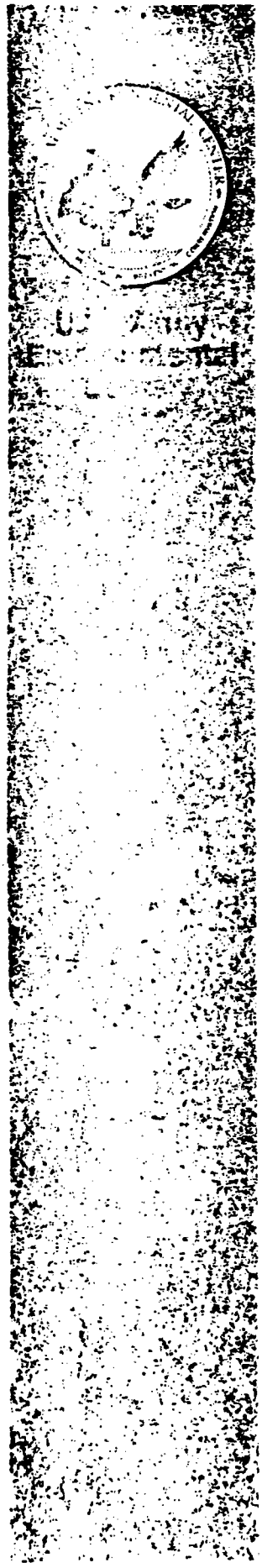
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APPENDIX A

GUIDELINES FOR IMPLEMENTATION OF ER-1110-1-263 FOR USAEC PROJECTS (MAY 1993)



U.S. Army

Environmental Center

Guidelines for Implementation

of ER 1110-1-263

for USAEC Projects

May 1993

Prepared for
U.S. Army Environmental Center
Aberdeen Proving Ground, MD 21010-5401

AEC Form 45, 1 Feb 93 replaces THAMA Form 45 which is obsolete.

U.S. ARMY ENVIRONMENTAL CENTER

GUIDELINES FOR IMPLEMENTATION OF ER 1110-1-263

FOR USAEC PROJECTS

May 1993

Prepared for

U.S. Army Environmental Center
Aberdeen Proving Ground, MD 21010-5401



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FOREWORD

This guidance document describes how ER 1110-1-263, Chemical Data Quality Management For Hazardous Waste Remedial Activities, shall be implemented for projects being performed for the U.S. Army Environmental Center (USAEC) Installation Restoration and Base Closure Projects. The Quality Assurance Project Plan submitted in fulfillment of a project requirement should be a detailed, step-by-step document implementing the procedures described herein.

The primary purpose of this document is to comply with EPA requirements. In addition, the concepts expressed in this document represent what is considered by the USAEC to be the best general approach for implementing the requirements of ER 1110-1-263.

Modifications to the requirements in this document may be made to meet program and/or project specific requirements, such as those specified by the EPA Region, or state authority. All modifications must be co-ordinated with, and approved by the USAEC Chemistry Branch through the Contracting Officer's Representative (COR)/project officer.



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NOTE ON SUBMISSIONS TO USAEC

NOTE: Whenever submission of material is required for USAEC review, decision, or approval; the contractor shall submit two copies, one to the Contracting Officer's Representative (COR) and one to Chemistry branch. In certain cases the material to be reviewed may be supplied to only one party, however, the cover letter must be supplied to both parties. The exact procedures to be followed will be determined for each project. Chemistry Branch will forward their replies through the COR/project officer. Responses are not official unless signed by the COR.



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2.0 QUALITY ASSURANCE PROJECT PLAN

2.1 INTRODUCTION

Prior to initiating field sampling and analysis of environmental samples, the Contractor Laboratory shall develop a detailed Quality Assurance Project Plan (QAPjP) for the specific project being supported. The QAPjP will be submitted to the USAEC Project Officer or the Contracting Officer's Representative, who will forward the plans to the Chemistry Branch for approval. Although ER 1110-1-263 and these guidelines outline a system for verifying and maintaining a desired level of performance quality, the QAPjP must provide laboratory-specific descriptions of how these will be implemented.

2.2 PURPOSE

The purposes of the Quality Assurance Project Plan are to:

- Be compatible with EPA and/or state requirements.
- Establish function-specific responsibilities and authorities for data quality;
- Establish procedures to ensure that all data are collected under conditions of analytical system control;
- Establish procedures for recognizing and correcting out-of-control situations;
- Establish procedures to ensure that non-laboratory activities do not compromise analytical data quality; and
- Establish record keeping procedures commensurate with project data uses.



2.3 CONTENTS

The USAEC Chemistry Branch recognizes that implementation of these guidelines will vary between laboratories. The structure of the QA/QC organization will depend not only on laboratory differences, but also on the contractor's project structure. For these reasons, the QAPjP must address laboratory-specific and project-specific situations that are not addressed by these guidelines.

The QAPjP shall include, as a minimum, the following information and descriptions in accordance with EPA QAMS 005/80:

- Title page with provision for approval signatures;
- Table of contents;
- Project description;
- Project organization and responsibility;
- QA objectives for the measurement of data in terms of precision, accuracy, completeness, representativeness, and comparability;
- Sampling procedures;
- Sample custody;
- Calibration procedures and frequency;
- Analytical procedures;
- Data reduction, validation, and reporting;
- Internal quality control checks and frequency;
- Performance and system audits and frequency;
- Preventive maintenance procedures and schedules;



- Specific routine procedures to be used to assess data precision, accuracy, and completeness of specific measurement parameters involved;

- Corrective action; and

- Quality assurance reports to management.

In addition the following information and descriptions should be included:

- A statement of adherence to or reference to ER 1110-1-263 and these guidelines;

- A detailed account of how the contractor, in conjunction with any subcontractors, will implement these guidelines;

- A description of sampling team and analyst training in technical skills, standard QC, and essential elements of theses guidelines;

- QC sample introductions and lot sizing;

- A description of applicable logs (field, instrument, sample, QC) and their use;

- Storage and use of standard analytical reference materials;

- A list of personnel responsible for data review and sequence of review prior to submittal; and

- A list of SOPs.



Not all of these items are addressed in this document, but are part of good laboratory practices and must be included in the QAPjP. Whenever possible and appropriate, names of individuals and step-by-step procedures should be provided. Any changes to an approved QAPjP must be requested in writing, approved by the USAEC Chemistry Branch, and formally coordinated through the Project Officer or Contracting Officer's Representative (COR). Written approval from USAEC must be obtained prior to implementation of the requested change. In the event that timely implementation is essential, verbal approvals may be granted on a limited basis provided the changes do not impact on resources or costs. These informal requests for changes and approvals will be formalized immediately in writing in order to document the change.



3.0 SAMPLE COLLECTION AND MANAGEMENT

3.1 INTRODUCTION

The procedures described in this section are designed so that the samples obtained will be proper representations of the matrix being sampled. Trace levels of contaminants from sources external to the sample must be eliminated through the use of good sampling techniques. Sample management and stringent documentation are the key factors in a successful QA program for sampling.

This section does not discuss sampling of air or biological matrices, or sampling for radiological constituents. When these matrices or analytes are included in a project, detailed requirements and protocols will be provided on a case-by-case basis. References are provided in the Bibliography which should be consulted when planning air or biological sampling (ASTM, 1973; EPA, 1974; EPA, 1976; EPA, 1977b; EPA, 1977c; EPA, 1978; EPA, 1983c; EPA, 1983d; U.S. Geological Survey, 1977a; and Weber, 1972).

Sampling requirements vary according to the analytes of interest and the environmental matrices sampled. These differences are discussed in Section 3.4 to 3.9. Section 3.3 discusses sample containers and Section 3.10 discusses sample preservation. References are provided in the Bibliography that discuss appropriate sampling methods in detail. These references should be consulted when preparing sampling plans (Barcelona et al., 1984; Nielson and Yeates, 1985; EPA, 1977a; EPA, 1980c; EPA, 1982a; EPA, 1982b; EPA, 1982d; EPA, 1983b; EPA, 1984a; EPA, 1984c; and U.S. Geological Survey, 1977b). The specific procedures which will be used must be described in detail in the Sampling and Analysis Plan (SAP), and the QAPjP.

NOTE: Due to variances in sample collection protocol among EPA regions and State agencies, the following collection procedures are provided as default parameters. Variances necessary to meet Regional or State requirements should be considered and identified for USAEC review and approval.

Documentation of sampling activities is described in Section 3.13.



3.2 PERSONNEL

It is the responsibility of the contractor to establish personnel qualifications and training requirements for all positions. Each member of the field team shall have the education, training, technical knowledge, and experience, or a combination thereof, to enable that individual to perform assigned functions. Personnel qualifications shall be documented in the sampling plan in terms of education, experience, and training. Training shall be provided for each team member as necessary to properly perform their functions. The suggested minimum qualifications are as follows:

- Geologist - Baccalaureate Degree in Geology, Geotechnical Engineering, or Geohydrology.

- Sampler 3 - High School Degree or equivalent plus 40 hours of OSHA training plus at least 16-hours instruction in sample collection techniques.

- Sampler 2 - All requirements for Sampler 3 plus 6-months experience (minimum participation in 3 sampling events) as Sampler 3.

- Sampler 1 (Team Leader) - All requirements of Sampler 2 plus 4-hour class in chain-of-custody procedures plus an additional 6-months experience (minimum participation in six sampling events) as Sampler 2. A Baccalaureate Degree in an Engineering or Science related subject is desirable.

3.3 CONTAINERS

Sample containers shall be chosen in accordance with Appendix F of ER 1110-1-263 and must be compatible with EPA requirements. However, for all USAEC projects 3 separate 40 ml vials shall be used for the collection of all water samples for volatile analysis.

All sample containers shall be cleaned before use according to the protocols specified by the EPA's Contract Laboratory Program (see Appendix C and S).

3.4 VOLATILES

The field sampling checklist (Appendix S) should be used to verify that all sampling is performed correctly.

3.4.1 GROUND/SURFACE WATER SAMPLES

When sampling water for volatile compounds, extra care must be exercised to prevent analyte loss by evaporation or by agitation of the sample. Precautionary measures include:

- Acquiring the sample with equipment that minimizes water gas/liquid interphase under pressure or vacuum;
- Avoiding aeration or agitation of the sample to the greatest possible extent;
- Taking triplicate samples, as a minimum;
- Filling vials to capacity, taking care that no air bubbles are trapped in the vial;
- Preserving to pH 2 or less with sodium bisulfate or HCl (NOTE - this procedure is not to be used for any sample from an area of suspected agent Mustard (HD) contamination site or any site potentially containing the Mustard breakdown product thiodiglycol. This will reduce the holding time to 7 days);
- Turning vial over and tapping gently against a hard surface or hand. If air bubbles are trapped in the vial, discard and take another sample. Repeat until triplicate samples, free of air bubbles, are obtained;
- As each vial is correctly filled, entering the applicable information on the label and then packing the vial into the shipping container. The contents of the shipping container must be kept at the required temperature at all times.
- Storing the sample at 4°C;



• Analyzing the sample as soon as possible, and never exceeding the prescribed holding time (Section 6.5);

• Never allowing a volatile sample to freeze (this includes **any** ice formation in the sample bottle); and

• Never filtering the sample.

3.4.2 TAP WATER SAMPLES

The following procedures are to be used in the sampling of water from taps located anywhere in a water supply system:

• Water should be allowed to run from the tap for 2 to 3 minutes before sampling;

• Remove the aerator from the tap, if possible;

• Slow the water flow to a trickle before filling the sample vial;

• Fill vial to the top, forming a water bulge above the rim. Add sodium thiosulfate to stop the chlorine reaction, as required. Screw on the cap without dislodging the teflon liner;

• Turn vial over and tap gently against a hard surface or hand. If air bubbles are trapped in the vial, discard and take another sample. Repeat until triplicate samples, free of air bubbles, are obtained; and

• As each vial is correctly filled, enter the applicable information on the label and then pack the vial into the shipping container. The contents of the shipping container must be kept at the required temperature at all times.

3.4.3 SOIL AND SEDIMENT SAMPLES

The sampling method for volatiles in soil or sediment will depend on the chemical analysis procedure and the nature of the soil or sediment. Portions of soil may be placed in empty vials containing the extraction solvent. In other instances, sealed cores may be shipped to the laboratory for subsampling. Acceptable materials for sealing cores must be approved by USAEC and interested regulatory agencies on a project specific basis.

The primary considerations for acquiring samples for volatiles, either in the field or in the laboratory, include the following:

- Samples stored at 4°C;
- Sample handling should be minimized;
- Sample/air contact should be minimized;
- The sample or subsample should be placed in an air-tight container immediately after collection.
- Air-tight seals on all containers used in shipment or laboratory workup.

3.5 GROUNDWATER

All groundwater sampling will occur after the wells have been developed according to the USAEC Geotechnical requirements document and/or specifications in the contract. Because drilling and well construction disturb the natural groundwater system, the maximum possible length of time (never less than two weeks, unless an waiver is obtained from the COR) shall pass between well development and sampling to allow the groundwater system to return to chemical equilibrium. The field sampling checklist (Appendix S) should be used to verify that all sampling is performed correctly.



3.5.1 MONITOR WELLS

The following procedures incorporate the necessary aspects of sampling QA and shall be used each time a monitor well is sampled:

- Measure the depth from the top of the well casing (not protective casing) to the top of the water and record the depth in the sampling logbook;

- Measure and record the depth from the top of the casing to the bottom of the sediment/water interface;

- Subtract the depth to top of the water from the depth to the bottom of the sediment/water interface to determine the height of standing water in the casing and saturated annulus. Remember to have on hand the diameter, height, and porosity of the sand pack, as recorded by the geologists during well construction;

- Obtain a sample of groundwater for temperature, conductivity, and pH measurements. Record these measurements in the sampling logbook;

- Remove a quantity of water from the well equal to 5 times the calculated volume of water in the well, including the saturated annulus;

- If the well goes dry during pumping or bailing, one is assured of removing all water which had prolonged contact with the well casing or air. If the recovery rate is rapid, allow the well to recover to its original level and purge a second time before sampling. If recovery is very slow, samples may be obtained as soon as sufficient water is available;

- Obtain samples for chemical analysis immediately after pumping or bailing is complete. For slow recovering wells, the sample shall be collected immediately after a sufficient volume is available;

- After obtaining chemical analysis samples, draw a second sample for temperature, conductivity, and pH measurement and record results in the sampling logbook;

- Filter samples, as appropriate; samples to be analyzed for VOCs should never be filtered;

• All samples must be placed in containers as specified in Appendix F of ER 1110-1-263. Except for volatiles, the sample bottle and cap shall be triple rinsed with the water being sampled before filling the bottle with the sample to be analyzed. Sample container for volatiles are never rinsed. Bottles for filtered samples shall be rinsed with filtered sample water and bottles for unfiltered samples shall be rinsed with unfiltered sample water (these requirements may be waived if it is not permitted by the regulatory agency having jurisdiction);

• Add the appropriate preservative and cap securely;

• Label samples in accordance with Section 3.13; and

• Place sample bottle(s) in a temperature controlled (4°C) chest immediately after sampling and deliver to the laboratory as soon as possible, in accordance with the chain-of-custody requirements specified in section 4.0 and Appendix E.

Note that the rinsing requirement specifically precludes adding preservative to bottles before they are shipped to the sampling site. The sampling team must have available the correct preservatives and must be trained in handling and dispensing the preservatives (Field Sampling Checklist, Appendix S).

3.5.2 WATER SUPPLY WELLS

The following procedures incorporate the necessary aspects of sampling QA and shall be used each time a water supply well is sampled:

• From existing well data or an estimated well depth, calculate the maximum possible volume of water in the well casing;

• Obtain a sample of groundwater for temperature, conductivity, and pH measurements. Record these measurements in the sampling logbook; and

• Pump to discard at least 5 times the estimated volume of water in the well.

• Filter samples, as appropriate; samples to be analyzed for VOCs should never be filtered;



• All samples must be placed in containers as specified in Appendix F of ER 1110-1-263. Except for volatile samples the sample bottle and cap shall be triple rinsed with the water being sampled before filling the bottle with the sample to be analyzed. Sample containers for volatiles are never rinsed. Bottles for filtered samples shall be rinsed with filtered sample water and bottles for unfiltered samples shall be rinsed with unfiltered sample water (these requirements may be waived if it is not permitted by the regulatory agency having jurisdiction);

• Add the appropriate preservative and cap securely;

• Label samples in accordance with Section 3.13;

• Place sample bottle(s) in a temperature controlled (4°C) chest immediately after sampling and deliver to the laboratory as soon as possible, in accordance with the chain-of-custody procedures specified in section 4.0; and

• After obtaining chemical analysis samples, draw a second sample for temperature, conductivity, and pH measurements and record results in the sampling logbook.

Note that the rinsing requirement specifically precludes adding preservative to bottles before they are shipped to the sampling site. The sampling team must have available the correct preservatives and must be trained in handling and dispensing the preservatives.

Prior to taking samples, ensure that the water to be sampled is raw (untreated) water. Under no circumstances should treated water be taken for chemical analysis to define the levels of contamination in the aquifer. If holding or pressure tanks are used in the water supply system, they should be bypassed to obtain good representative groundwater samples.

3.5.3 TAP WATER

The following procedures are to be used in the sampling of water from taps located anywhere in a water supply system:

- Water should be allowed to run from the tap for 2 to 3 minutes before sampling;

- Except for volatile samples, triple rinse sample vial with sample water (this requirement may be waived if it is not permitted by the regulatory agency having jurisdiction). Sample containers for volatiles are never rinsed;

- Each sample container must be completely filled with the water sample;

- Conductivity, pH, and temperature measurements, if required, must be performed on the water samples collected for inorganic analysis; and

- As each vial is filled, enter the applicable information on the label and then pack the vial into the shipping container. The contents of the shipping container must be kept at the required temperature (4°C) at all times.

- Ship all samples to the laboratory in accordance with the chain-of-custody procedures specified in section 4.0.

Note that the rinsing requirement specifically precludes adding preservative to bottles before they are shipped to the sampling site. The sampling team must have available the correct preservatives and must be trained in handling and dispensing the preservatives. If drinking water quality is to be determined, the sampled tap(s) must be located after any water treatment processes.



3.6 SURFACE WATER

Surface water samples may be obtained under many different circumstances. At the time of sampling, the procedures described in the Project QC Plan and Project Workplans shall be followed. These documents must have designated the appropriate techniques for the project-specific setting, as described in Section 3.1. The field sampling checklist (Appendix S) should be used to verify that all sampling is performed correctly.

Before sampling, equipment shall be rinsed downflow or away from the sampling point, taking care not to disturb sediments at the sampling point. After sampling at each location, the equipment shall be rinsed with distilled water or USAEC-approved water, as discussed in Section 3.11.

All samples shall be placed in the appropriate containers as specified in Appendix F of ER 1110-1-263. The need for sample filtration will be determined according to the requirements given in Section 6.8 or as specified in the task order. Except for volatile samples, the sample bottle and cap shall be triple rinsed with the water being sampled before filling the bottle with the sample to be analyzed. Sample containers for volatiles are never rinsed. Bottles for filtered samples shall be rinsed with filtered sample water and bottles for unfiltered samples shall be rinsed with unfiltered sample water (this requirement may be waived if it is not permitted by the regulatory agency having jurisdiction). Add the appropriate preservative and cap securely. Samples must be labeled in accordance with Section 3.13. The sample bottle(s) shall be placed in a temperature controlled (4°C) chest immediately after sampling and delivered to the laboratory as soon as possible, in accordance with the chain-of-custody procedures specified in section 4.0 and Appendix E.

Note that the rinsing requirement specifically precludes adding preservative to bottles before they are shipped to the sampling site. The sampling team must have available the correct preservatives and must be trained in handling and dispensing the preservatives (Field Sampling Checklist, Appendix S).

3.7 SOILS

The sampling team is responsible for collecting representative samples that can be analyzed as received from the field. The Program Manager, Sampling Team Leader, and Contractor QAC must train the sampling team in the types of soils to be collected, the components of interest in the samples, and how to collect the sample that will represent the matrix of interest. Specifically, the sampling team must be trained to remove all items that are not integral components of the matrix of interest.

The Quality Assurance Project Plan and Workplans must have considered appropriate sampling distributions and techniques, as described in Section 3.1. The sampling locations must have been chosen to be representative of the areas being investigated. At the time of sampling, these plans shall be followed. A large area may require collecting and compositing multiple samples into a single sample to represent the area. Individual samples may be collected and analyzed to describe the sampling points within the area. The field sampling checklist (Appendix S) should be used to verify that all sampling is performed correctly.

All sampling points must be marked with a stake that is labeled with the appropriate Site Identification. Prior to sampling, surface vegetation, rocks, pebbles, leaves, twigs, and debris will be cleared from the sample point to allow collection of a representative soil sample. After sampling each location, all equipment must be thoroughly cleaned to prevent cross-contamination of samples. Equipment shall be scrubbed and rinsed with distilled water or USAEC approved water, as described in Section 3.11.

Soil samples taken from borings shall be obtained via a split or solid barrel sampler (e.g., Split-Spoon, Dennison, Pitcher), or sampler equipped with a polybutyrate (or similar) liner. Borings shall be produced in a manner that preserves sample integrity and composition. Upon reaching the surface, the sampler shall be opened and the sample extracted, peeled, and bottled in the shortest possible time and placed in a cooler at 4°C. In the case of the polybutyrate liner, ends shall be capped and taped and placed in a cooler at 4°C. Detailed instruction on the handling of samples using these liners shall be provided in the project sampling plan if their use is required. Peeling is the process that removes the portion of sample which is in direct contact with the sampler. In addition, the ends of the sample are removed and discarded. Samples for volatiles analysis shall be peeled, bottled, and capped within 15 seconds from the time the sampler is opened.



Soil samples shall be placed in appropriate containers as specified in Appendix F of ER 1110-1-263. Samples for volatile organics shall be placed in containers appropriate for the analytical method (Section 3.4.3). Samples must be labeled in accordance with Section 3.13. Sample bottles shall be placed in a temperature controlled (4°C) chest immediately after sampling and delivered to the laboratory as soon as possible, in accordance with the chain-of-custody requirement specified in section 4.0 and Appendix E.

3.8 SEDIMENTS

The sampling team is responsible for collecting representative samples that can be analyzed as received from the field. The Program Manager, Sampling Team Leader, and Contractor QAC must instruct the sampling team in the types of sediments to be collected, the components of interest in the sample, and how to collect the sample that will represent the matrix of interest. Specifically, the sampling team must be trained to remove all items that are not integral components of the matrix of interest.

The type of sampler to be used will be dictated by the nature, as well as the accessibility, of the sediments. In addition, the type of sampler chosen should be appropriate for obtaining the desired sample, e.g., a core sampler should not be used to obtain top sediment. The Project QC Plan and Workplans should have designated appropriate sampling techniques, as described in Section 3.1. At the time of sampling, these plans must be followed. The field sampling checklist (Appendix S) should be used to verify that all sampling is performed correctly.

Prior to sampling sediments in a stream, the sampling device shall be rinsed with stream water at a point downstream from the sampling location to avoid disturbing the sediments at the sampling point. Also, sampling shall be accomplished upstream of any disturbances in the stream caused by the sampler or sampling team. Twigs, leaves, pebbles, and debris that are not integral components of the matrix of interest must be removed by the sampling team.

Prior to sampling sediments in a pond or lagoon, the sampling device shall be rinsed with water near the sampling point. However, caution must be exercised to avoid disturbing the sediments at the sampling point by the rinsing activities.

After sampling each location, all equipment must be thoroughly cleaned to prevent cross contamination of samples. Equipment shall be scrubbed and rinsed with distilled water or USAEC-approved water, as described in Section 3.11.

Sediment samples shall be collected in appropriate containers as specified in Appendix F of ER 1110-1-263. Samples must be labeled in accordance with Section 3.13. Sample bottles shall be placed in a temperature controlled (4°C) chest immediately after sampling and delivered to the laboratory as soon as possible.

3.9 SURFACE WIPE SAMPLES

Surface wipe samples shall be collected in accordance with the following guidelines:

- Wiping media (ie. filter paper, cotton balls, or gauze pads) shall be chosen to be compatible with the surface(s) being wiped. A sample(s) of the media shall be submitted each day as a media blank(s). Media blank(s) shall be analyzed for all analytes of interest sampled on that day;

- An appropriate wiping solvent shall be chosen for each class of sample to be collected. The choice of solvents shall be specified in the QAPjP (in general, a 1:4 acetone/hexane mixture should be used to wipe for organic analyses and deionized water should be used to wipe for inorganics). A solvent blank shall be submitted for each lot of solvent used and shall be analyzed for all project analytes of interest;

- Templates should be used to ensure that the area wiped is consistent from site to site. The suggested standard area (based upon industrial hygiene standard practice) is 100 square centimeters;

- Wiping should be done in a systematic fashion. The area should first be wiped horizontally from top to bottom, then vertically from left to right. After wiping is completed, the wipe shall be placed in an appropriate sample container and placed in a cooler at 4°C. No other preservation is required;

- The wiping media may be handled either with tongs or held in a gloved hand. If the media is held directly in a gloved hand then a "glove blank" shall be submitted for



analysis with each day's samples. This shall consist of wiping solvent poured over a clean pair of gloves and collected in the appropriate container. If more than one solvent is in use, a blank shall be collected for each solvent.

3.10 SAMPLE PRESERVATION

The purpose of sample preservation is to prevent or retard the degradation/modification of chemicals in samples during transit and storage prior to analysis. Efforts to preserve the integrity of the samples shall be initiated at the time of sampling and will continue until analyses are performed. Preservatives shall be added to the sample container at the time of sample collection. The recommended procedure for accomplishing this is to take premeasured volumes of the preservatives in sealed ampules to the field. Preservation and storage requirements are provided in Appendix F of ER 1110-1-263. Sample holding time requirements, as listed in Section 6.5, apply to all samples. Holding times begin on the sampling date and not the date samples are received in the laboratory. Freezing samples to extend holding times shall not be permitted.

Note that samples for volatiles and TOC which are collected from areas of suspected agent Mustard (HD) or thiodyglycol contamination are not to be preserved, due to the possibility of Mustard reformation in the presence of hydrochloric acid.

Sample storage shall only be terminated after all analytical results have been validated to level 3 in the USAEC Data Management System and approved by the USAEC Project Officer. Samples may be required to be held in storage longer to fulfill contractual requirements or as directed by the USAEC Project Officer/COR.

3.11 EQUIPMENT DECONTAMINATION

All equipment used to measure and sample the groundwater system (e.g., bailers, pumps, tapes, ropes) must be cleaned before use in each well to prevent cross contamination between wells. Equipment that is dedicated to a well site may not require cleaning between sampling events. If the well is free of inflowing sediments, thorough rinsing will be sufficient. When inflowing sediments adhere to equipment, scrubbing may be required in addition to rinsing. In no instance shall detergents, soaps, or solvents be used to routinely clean equipment in the field, without approval of USAEC Chemistry Branch through the COR/project officer. At sites where known cleaning problems exist the use of extra cleaning agents may be proposed in the QAPjP.

Water used for rinsing field equipment shall be bottled distilled water or water from a USAEC-approved source. Such USAEC-approved water should originate from an uncontaminated (background) and untreated (unchlorinated) source. The water shall be analyzed by a Missouri River Division (MRD) validated laboratory for all project specific analytes prior to collection of field samples. Water from chemical supply companies or retail merchants is acceptable, provided that analysis by an MRD validated laboratory reveals such water is free of interferences. At least one sample must be submitted to the laboratory and be analyzed for all analytes of interest prior to the first use in the field. The initial rinse water analyses may be done prior to completion of laboratory validation, provided that the analytical procedures used are identical to those to be validated. A rinse water sample shall be included with the first lot of samples during the initial and subsequent sampling excursions, defined as the time between mobilization and demobilization of the sampling team. Additional rinse water samples shall be taken, as required, to meet the DQOs of the project. Waivers to these requirements will be considered by the USAEC Chemistry Branch through the COR/project officer on a case-by-case basis.

Sampling equipment must be protected from ground surface contamination. Clean plastic sheeting spread around the well is one means of protecting the equipment. New protective sheeting should be used at each sampling location. Sampling efforts shall preclude wind-blown particles from contaminating the sample or sampling equipment.



Exceptions to this policy shall only be implemented after receipt of written approval from the Chemistry Branch of USAEC through the COR/project officer.

3.12 STANDING OPERATING PROCEDURES - FIELD

The contractor shall have written SOPs for all field procedures and methods; all procedures shall be performed as described in the SOP. Any modification of an SOP made during a data collection activity must be documented and approved by the USAEC Chemistry Branch through the COR. SOPs shall be prepared for, but not be limited to, the following areas:

- Sample management;
- Sample team training and documentation;
- Numbering and labelling of samples;
- Sample tracking;
- Sample containers;
- Sample preservation and storage;
- Holding times;
- Shipping;
- Decontamination;
- Sample collection procedures;
- Corrective actions;
- Records management;
- Chemical and sample disposal; and

- Reporting.

In addition, where analyses are performed in the field, the following additional SOPs are required:

- Reagent/standard preparation and validation;
- Equipment calibration and maintenance;
- Field analysis; and
- Data reduction and validation.

A description of the basic information required in each of the above SOPs is included in Appendix D. The contractor's SOP is not required to conform to a specific format but shall be representative of good standard field and laboratory operations, and shall give clear evidence of the contractor's ability to successfully fulfill all contract requirements.

3.13 SAMPLE MANAGEMENT

3.13.1 FIELD CHAIN-OF-CUSTODY

The necessity of having established procedures for documenting activities in the field also requires that each sample taken be delivered to the laboratory. To alleviate potential problems, the field sampling team must adequately document and identify each sample taken. This process ensures that each sample is analyzed for the requested parameters by the laboratory, and each sample requested is actually received at the laboratory. It is imperative that written procedures be not only available but followed, to ensure that an accurate record of sample collection and transfer activity is maintained. Chain-of-custody procedures are contained in Section 4.0 and Appendix E.

All required information listed in Section 4.0 shall be included on all chain-of-custody forms.



3.13.2 SAMPLE HANDLING

It is important to good custody procedures that all samples be handled by a minimum number of persons. Field records must be completed at the time a sample is collected and should include the following information as a minimum:

- Project or installation for which the sample is being taken;
- Sample date and time;
- Sample location (bore or well i.d.) or source;
- Field sample number, unique to each sample location;
- Required analyses for each container;
- Preservative used, if any;
- Field data applicable to the sample (i.e., pH, conductivity); and
- Sampler's name (the individual who actually fills the sample container).

Additional information which is required for certain samples such as wells or bore holes, would include:

- Sample depth, measured from the top of the well casing for established wells, and from ground level for bores; and
- Sample technique.

Information which is entered on the field chain of custody must match exactly the information from the field sampling log. All entries must be made in blue or black ink, and must be legible. There shall be sufficient matching information on each sample label to verify each sample against the chain of custody. As a minimum, the following information is required:

- Sample date and time;

- Sample location (bore or well i.d.) or source;

- Field sample number, unique to each container, if several analytical samples are being taken from the same source;

- Required analyses for each container;

- Preservative used, if any; and

- Sampler's name or initials.

Unused bottles, containers, and coolers which have been shipped to a sampling location are to be kept in a secured location to minimize tampering and possible contamination.

When samples are to be transferred, the custodian must sign and date the chain-of-custody form(s), as must the recipient who now becomes the sample custodian. Transfers must account for each individual sample, even when samples are transferred as a group.

Shipped packages are considered under chain-of-custody if the carrier signs a form indicative of receipt; a receipt is also generated by delivery of the samples. This receipt is attached to the original chain-of-custody forms, which shall be shipped inside of the cooler or container to prevent loss upon transfer. Custody seals should be placed across all edges of the cooler lid except for the hinge side, to ensure that no tampering has occurred.

3.13.3 SAMPLE RECEIPT

When samples are received at the analytical laboratory the coolers shall be inspected as soon as possible and the following information recorded:

- Condition of cooler, including whether custody seals are intact.

- Whether chain-of-custody documents are enclosed in the cooler and are properly filled out.



- Whether sample containers are intact and sealed with evidence tape.

- Temperature of cooler. This should be measured in a separate container (temperature blank) and not in an actual sample.

The USAEC requires that all samples be cooled to 4° C. However, samples received at up to 6° C may be analyzed. Any samples received at temperatures greater than 6° C shall not be analyzed without the approval of the USAEC project officer/COR and the USAEC Chemistry Branch. Any sample received which exhibits any signs of icing shall not be analyzed without the approval of the USAEC project officer/COR and the USAEC Chemistry Branch.

All sample receipt information shall be recorded on an appropriate form and placed in the lot data package. Whenever discrepancies are found a non-conformance report to management shall be generated, a copy of which shall be maintained in the lot data package.

4.0 CHAIN-OF-CUSTODY PROCEDURES

All work performed for the USAEC shall adhere to the chain-of-custody procedures specified in NEIC Policies and Procedures (EPA-300/9-78-001-R). See Appendix E for a summary of these requirements.

At a minimum, the following information shall be recorded on the chain-of-custody form:

- Date of Sampling
- Matrix type (3 characters)
- Site type (4 characters)
- Site Identification Number (10 characters)
- Depth (in the format XXX.X)
- Sample Technique (1 character)
- Analysis Required (should specify specific method)
- Installation (2 characters)
- Prime Contractor (2 characters)
- Sampling Program (3 characters)
- Field Sampling Number (Optional)

Figure 4-1 illustrates a chain-of-custody form which meets the above requirements.



Figure 4-1

ZYX Engineers
CHAIN OF CUSTODY RECORD - USAEC SAMPLES

Installation (1):
Sample Program (3):
Laboratory (2):

COC By: ____|____|____

ZYX Field Sampler Initials (3)	Time of Sampling (Military Clock) (4)	Site ID (10)	ZYX Field Sample ID (8)	File Type (3)	Site Type (4)	Depth Ft. (5)	Sample Techniques (1) / Sample Flag Code (1) / Sample QC Code (1) / TEST CODE / NAME																			Matrix	Number of Containers

Relinquished by: ZYX Engineers
Date: _____ Time: _____ Signature: _____
Accepted by:
Date: _____ Time: _____ Signature: _____
Accepted by:
Date: _____ Time: _____ Signature: _____

Carrier: _____ Air Bill Number _____
Relinquished by:
Date: _____ Time _____ Signature: _____
Comments:

Total No of Containers

5.0 LABORATORY VALIDATION

5.1 INTRODUCTION

Before using an analytical method to analyze environmental samples, a Contractor Laboratory must demonstrate the ability to perform the method for specific analytes, and, in the process, generate data to be used in establishing Method Detection Levels (MDLs). Standardized analytical methods shall be selected from the EPA's Contract Laboratory Program (CLP), SW-846, or from some other EPA standard method (ie. 200, 500, and 600 series). If the analyte of interest is not addressed in either of the above sources, then methodology will be provided by the USAEC, if available. The USAEC will also provide a list of the target analytes for all USAEC work and Required Detection Levels (RDLs). RDLs are defined as the lowest level required by any federal or state regulations, that is technically achievable with available instrumentation.

Laboratory validation is a three phase process involving an initial validation of the laboratory by the U.S. Army Corps of Engineers Missouri River Division (MRD), the determination of method detection levels(MDLs), and the documentation of methods to the USAEC. The laboratory shall demonstrate its ability to perform the analysis for specified compounds using the standardized methods. A normal timeframe for completion of this process is 12 to 18 weeks.

Due to the constraints of sample holding times as specified in ER 1110-1-263, collection of environmental samples shall never occur before all required analytical methods are validated.



5.2 VALIDATION PROCEDURES

5.2.1 MRD LABORATORY VALIDATION

MRD validation procedures are described in detail in Appendix C of ER 1110-1-263. To summarize, this is a 3 step process;

- The laboratory must submit its Quality Management or Quality Assurance Manual to MRD for review;

- MRD will provide the laboratory with performance audit (PA) samples, which the laboratory shall analyze according to the method specified by MRD (NOTE: This is not necessarily the method selected by the laboratory for routine use);

- Upon successful analysis of the PA samples, a representative of MRD will visit the laboratory for an on-site inspection.

5.2.2 METHOD DETECTION LEVEL

The laboratory shall determine a Method Detection Level (MDL) for all analytes of interest. MDLs shall be determined as follows:

- The laboratory shall prepare a standard matrix sample at 1 to 5 times the estimated MDL (based on the RDL and the instrumental detection limit);

- 7 aliquots of the sample shall be processed through the entire method;

- The standard deviation shall be calculated from the results of the seven aliquots;

- The MDL is equal to the standard deviation times the Student's t value (3.143) for that number of measurements.

The MDL shall be equal to or less than the Required Detection Level (RDL). If the calculated MDL is lower than what the laboratory considers a practical detection level then the MDL may be raised to the higher level. In no instance shall the MDL be lowered below the calculated level. The method documentation (section 5.2.3) shall include both the calculated MDL and the request for an increased MDL. MDLs for inorganics shall be verified quarterly. MDLs for organics shall be verified annually.

If the laboratory has verified an MDL within the timeframes specified above, it shall not be necessary for the laboratory to repeat the verification process.

This procedure is based upon 40 CFR Chapter 1, and upon the CLP inorganic Statement of Work.

All data related to determination and verification of MDLs shall be maintained at the laboratory.

5.2.3 ANALYTICAL METHODS DOCUMENTATION

An analytical method shall be described by a set of written instructions (Method Documentation Package) citing the basic method (ie. CLP or SW-846), any changes to the basic method, descriptions of analytes, sample type (matrix), MDLs and Upper Reporting Levels (URLs), and calibration standard levels, and a copy of the calibration curve used for the MDL determination. The package shall also include the laboratory SOP for the basic method and details of the preparation of **all** calibration and spiking solutions, from stocks to working standards. MDLs shall be determined as specified in Section 5.2. The URL shall be the highest value which the laboratory can report and to which the method is calibrated. The laboratory shall specify how the URL was selected. All values above the URL shall be diluted to within the reporting range. When the basic method offers a choice of options the method shall specify which option(s) was selected. The analytical method shall be followed throughout the entire project. The Method Documentation Package shall be submitted to the USAEC Chemistry Branch for approval through the COR/project officer. After approval of a method, additional deviations shall not be acceptable, unless written approval, in advance, is provided by the USAEC Chemistry Branch through the COR/project officer. In urgent cases verbal approval may be granted, however, this must be immediately followed by a written approval. Any change in the documented procedure



shall constitute a modification. The significance of the modification will be determined by the USAEC Chemistry Branch. Changes made after approval may require generation of new MDLs. Any method that offers the capability for analyte confirmation (e.g., second column confirmation for a GC method) shall have the confirmation procedure included as part of the method writeup. Determination of the MDL shall also be required for the confirmation procedure. If the Confirmation MDL is greater than the Method MDL the USAEC Chemistry Branch will decide if the results are acceptable on a case by case basis. If a method has the capability to use both columns for quantitation, then the same column shall always be used for a given compound. The column to be used for quantitation shall be specified in the method documentation package.

Methods specifically designated as Field Detection Methods should also follow the requirements of validation as described in these Guidelines and contain the necessary statements/procedures for the associated QA/QC.

5.3 METHODS NOT REQUIRING VALIDATION

Some methods, including calibration of test and measurement equipment, do not require validation, due to either the nature of the measurement or the intended use of the data. When such methods are part of a project, the USAEC will not provide a standardized method. However, laboratories must submit sufficient information in test plans, work plans, project QC plans, etc., to describe exactly the procedures to be used. A copy of the methods must be submitted to the USAEC before it is used on any project.

The following methods do not require validation:

- Temperature;
- Conductivity;
- pH;
- Oil and Grease;
- Hardness;

- Asbestos;
- Alkalinity, Carbonate/Bicarbonate/Hydroxide;
- Total Organic Carbon (TOC);
- Biochemical Oxygen Demand (BOD);
- Chemical Oxygen Demand (COD);
- Total Dissolved Solids (TDS);
- Total Suspended Solids (TSS);
- Salinity;
- Total Solids;
- Acidity;
- Total organic Halogen (TOX); and
- Dissolved organic carbon (DOC).

Other methods that may be included in this category should be brought to the attention of the Chemistry Branch for consideration.



5.4 METHOD DEVELOPMENT

In the event that analyses must be conducted for compounds for which no reliable methods exist, development of a method will be conducted by a Development Laboratory (laboratory designated to develop an analytical method). The Development Laboratory may be a contractor laboratory tasked to perform the development, or it may be a government laboratory. Documentation for Proposed Methods Development (Appendix A) shall be submitted to the USAEC Chemistry Branch for approval prior to initiation of method development.

The Chemistry Branch will evaluate the proposed approach for technical soundness and economy of effort. The Chemistry Branch will then request the Development Laboratory to proceed with the method development, either as proposed or with USAEC recommended modifications.

The Development Laboratory shall investigate the proposed procedures to be included in the method. Should any of the proposed procedures approved by the Chemistry Branch be found to be inadequate for the method, alternative procedures will be investigated after approval by the Chemistry Branch.

When testing of the analytical procedures has been successfully completed by the Development Laboratory, the method shall be fully documented.

Full documentation of the method shall be submitted to the USAEC Chemistry Branch. The Chemistry Branch will review the documentation for completeness and comprehension. Based on this review, the Development Laboratory will make any necessary modifications. After final approval by the Chemistry Branch, the method will be issued as a final method. Chemistry Branch shall inform MRD of method development initiatives.

6.0 GENERAL LABORATORY PROCEDURES

6.1 STANDING OPERATING PROCEDURES - LABORATORY

The laboratory shall have written SOPs for all procedures and methods, including sample analysis, laboratory functions, and auxiliary functions, prior to the analysis of field samples. Procedures and methods shall be performed in the laboratory as described in the SOP. Any modification of an SOP made during a data collection activity must be documented and approved in writing by the USAEC Chemistry Branch through the COR/project officer. SOPs shall be prepared for, but not limited to, those listed in Appendix G.

A description of the basic information required in each of the above SOPs is included in Appendix G. The laboratory SOP is not required to conform to a specific format but shall be representative of standard laboratory operations, and shall give clear evidence of the laboratory's ability to successfully fulfill all contract requirements.

6.2 LABORATORY PERSONNEL GUIDELINES

Guidelines to be used in the determination of personnel qualifications are as follows:

- Laboratory Director - should have earned a Baccalaureate Degree in Science or Engineering from an accredited college or university or the equivalent and have at least 5 years experience in laboratory work.

- Senior Staff - should have earned a Baccalaureate Degree in Science or Engineering from an accredited college or university or the equivalent and have at least 2 years experience at the bench level.

- Technical Staff - should have formal training in the sampling and analytical methodology and quality control as applied to the specific sample types and concentration levels of analytes which are of interest to the project.



These requirements are based upon those contained in the CLP Statements of Work.

6.3 USAEC METHOD CLASSES

USAEC divides analytical methods into 4 classes for determining the number and types of QC samples per lot, and for use in automated data validation routines. The USAEC method classes are as follows:

- CLASS 1 Methods - These are methods for the analysis of organic parameters, with the exception of GC/MS methods and pesticides/PCBs by GC, and for the analysis of inorganic parameters.

- CLASS 1M Methods - These are GC/MS methods, both for the analysis of volatiles and semivolatiles.

- CLASS 1P Methods - This class is restricted to methods for the analysis of pesticides and PCBs by GC.

- CLASS 2 Methods - This class is reserved for screening type methods, which give only a qualitative (i.e. yes/no) result.

6.4 USAEC SAMPLE IDENTIFICATION NUMBERS

The reporting of analytical results to the USAEC Installation Restoration Data Management Information System (IRDMIS) requires that each sample aliquot be assigned a unique seven character identification number. The first four characters of this number are alpha characters that represent the analytical lot. Each analytical lot is given a different series of alpha characters. For instance a group of water samples for Metals analyses by ICP could be assigned the alpha designation of AAAA. Another group of samples that contain samples for Anion analyses, some to be done by Technicon and others to be done by IC, would be given two different alpha designations. The Technicon analyses could be given a designation such as AAAB and the IC analyses could be given a designation such as AAAC. In the case of a multi-analyte method, the alpha designator assigned will be the same for each analyte



in a single sample aliquot.

The last three characters are numeric characters that represent the individual samples within the lot. The lot size must be determined before these numbers can be assigned. The lot size is defined as the number of samples that can be extracted, analyzed, or digested in a single day as controlled by the rate limiting step in the particular method (see Section 6.9). When USAEC approves a particular method write-up during the validation process, it also approves a lot size.

If the contractor laboratory uses an internal numbering system a correlation of the internal lab sample number to the USAEC lot number shall be recorded in a bound logbook.

6.5 SAMPLE HOLDING TIMES

The time that a preserved sample may be held between sampling and analysis is based on the analyte(s) of interest. Holding time limitations are intended to minimize chemical change in a sample before it is analyzed. The holding time is the maximum time allowable between sample collection and the completion of analysis, based on stability factors. The holding times specified in this document do not preclude shorter analysis and reporting requirements which may be specified in the contract. Allowable holding times (Table 6-1) apply to both solid and aqueous samples. Results reported for samples analyzed after holding times have been exceeded shall normally be considered out-of-control and unacceptable. To expedite analysis and to minimize the possibility of exceeding holding times, samples should be sent to the laboratory by an overnight courier service, as soon as possible after collection. The holding times specified in Table 6-1 are based on the most restrictive holding times required by the EPA and do not necessarily match the holding times in ER 1110-1-263.



TABLE 6-1 REQUIRED HOLDING TIMES FOR USAEC SAMPLES

Analysis	Holding Time
Volatiles - Aqueous	14 Days Preserved 7 Days Unpreserved
Volatiles - Solid	14 Days (Some EPA Regions may only allow 10 days)
Semivolatiles - Aqueous/ Solid	7 Days for Extraction 40 Days for Analysis
Pesticides/PCBs - Aqueous/ Solid	7 Days for Extraction 40 Days for Analysis
Explosives - Aqueous/ Solid	7 Days for Extraction 40 Days for Analysis
Cyanide - Aqueous/Solid	14 Days
Mercury - Aqueous/Solid	28 Days
Metals (except Mercury) Aqueous/Solid	180 Days
Anions - Aqueous/Solid	28 Days (48 Hrs for NO2/NO3 speciation)
TPHC - Aqueous/Solid	28 Days
CR(VI) - Aqueous/Solid	24 Hrs

6.6 STANDARD WATER SAMPLES

Standard water samples shall be used for standard matrix quality control spikes. Standard water samples will be prepared by adding a known quantity of target analyte to a known volume of water. The volume of water will be specified in the method being performed. All control analytes for the method will be added. ASTM Type I grade water will be used for inorganic methods (Table 6-2). ASTM Type II grade water containing 100 mg/L each of added sulfate and chloride will be used for organic methods (Table 6-2). The method and reagents used to prepare spiking solutions are specified in the standardized methods.

6.7 STANDARD SOIL SAMPLES

USAEC supplied standard soil shall be used for standard matrix quality control spikes. Standard soil samples will be prepared by adding a known quantity of the control analyte to a known weight of selectively blended standard soil as provided by the Chemistry Branch. This standard soil is provided to the Contractor Laboratory after contract award. The required amount of soil (sample weight) to be spiked will be specified in the method being tested. A minimum quantity of solvent shall be used so that the character of the sample is not changed. The normal solvent to soil ratio is 1:2 (ie. 5 ml for a 10 g sample). All control analytes for the method will be added. With the exception of volatiles, spikes must sit in contact with the soil for a minimum of 1 hour before processing of the sample continues. Spikes for volatiles shall be analyzed immediately following the spiking procedure. The method and reagents used to prepare spiking solutions are specified in the standardized methods. The Contractor Laboratory will be provided a sufficient quantity of this standard soil to last for the duration of the project or series of projects.



Table 6-2. CRITERIA FOR ASTM WATER TYPES

Grade of Water	Maximum Total Matter (mg/L)	Maximum Electrical Conductivity at 25C (umho/cm)	Minimum Electrical Resistivity at 25C (M cm)	Minimum Color Retention Time of $KMnO_4$ (min)
Type I	0.1	0.06	16.67	60
*Type II	0.1	1.0	1.0	60

* 100 mg/L Sulfate and Chloride Added. The following preparation is provided:

(1) Weigh 1.48 g of reagent grade anhydrous sodium sulfate into a 1-liter volumetric flask and dilute to mark with ASTM Type II water.

(2) Weigh 1.65 g of reagent grade anhydrous sodium chloride into a 1-liter volumetric flask and dilute to mark with ASTM Type II water.

(3) Transfer 100 ml of each solution prepared in (1) and (2) into a 1-liter flask and dilute to volume with ASTM Type II water.

6.8 SAMPLE PREPARATION/FILTRATION

Water used in the course of organic analyses shall conform to ASTM Type II grade, as defined in Table 6-2. Water used in the course of inorganic analyses shall conform to ASTM Type I grade, as defined in Table 6-2. Standard and QC samples for organic analyses shall be prepared with water which conforms to ASTM Type II grade with 100 mg/L sulfate and chloride added.

6.8.1 WATER SAMPLES

The need to filter water samples depends on whether total or dissolved contaminants are of interest. The project-specific decision must be explicitly stated in the Quality Assurance Project Plan. Assessment objectives must be considered when specifying filtration requirements, procedures, and materials in the Project Workplan.

Samples for any dissolved constituents (organic or inorganic) must be filtered in the field if a chemical additive is used for preservation. Volatile organic compounds and oil/grease are the only universal exemptions to this guideline; samples for these two analyte classes are never filtered. Samples for dissolved metals analyses must be filtered in the field, before adding chemical preservatives, to preclude extraction of contaminants from the particulate matter by the preservatives. Samples for organic analyses generally should be filtered in the laboratory. The filter material used in the field or the laboratory must be compatible with the constituents of interest. Compatibility is defined in the following way:

- The filter material is not changed by the material being filtered (and vice versa); and

- The filter material does not absorb or leach the chemical species for which the sample will be analyzed.

The compatibility requirement may necessitate filtering individual subsamples for specific analytes if a universally compatible filter material cannot be identified. Exceptions to these guidelines must be obtained in writing from the USAEC Chemistry Branch. However, if the proposed filter material(s) meet the above requirements, no additional approval is required.



6.8.2 SOIL/SEDIMENT SAMPLES

Soils and sediments are very complex mixtures with widely varying compositions, even within a single site. Recovery of analytes depends on many factors, including organic content, mineral content, particle size, and moisture content of the soil. Soil and sediment samples shall be analyzed in the as-received condition and prepared as follows:

- The sample shall be mixed as thoroughly as possible in the wide-mouth, amber-glass bottle by shaking and/or stirring. Glass or Teflon rods may be used for stirring (does not apply to samples for volatiles analysis, as no mixing may be performed on these samples).

- For each sample, an aliquot of the as-received sample shall be dried according to the procedure in ASTM D2216-71, "Laboratory Determination of Moisture Content of Soil" (Note that the calculations specified in the method do not apply; only the drying procedure itself is of interest). The calculated percent moisture for each sample shall be entered into the USAEC IRDMIS as described in Section 9.4. The determination of percent moisture is calculated as follows:

$$\frac{\text{Sample Weight (wet)} - \text{Sample Weight (dry)}}{\text{Sample Weight (wet)}} \times 100$$

- The moisture determination on a sample designated for volatiles analysis shall be performed on a duplicate of the sample and not the sample itself.

- Weighed aliquots of the mixed sample shall be obtained for each analysis. All samples will be analyzed and reported in the as-received condition.

6.9 SAMPLE ANALYSIS/LOTS

All samples shall be analyzed by lot. A lot is the maximum number of samples, including QC samples, that can be processed through the rate limiting step of the method during a single time period, not to exceed one 24 hour day, except for Class 1P methods, where the instrumental analysis may continue for 48 hours. The time period for a lot does not include the initial or daily lot calibrations, provided that sample analysis begins immediately following completion of the calibration. Analysis of samples within a lot must be as nearly continuous as possible. Lots shall not be mixed; that is, all samples for one lot, including QC samples, must be completed prior to the beginning of a new lot. Any break in the analytical sequence shall not exceed 2 times the analytical run time and must be fully documented. For methods with multi-step extractions, each subsequent step must begin immediately, or on the next normal business day. The rate of sample collection or shipment does not determine maximum lot size, although it may limit the number of samples available for analysis at a given time. A lot may consist of samples from more than one installation as long as the data quality objectives for each of the installations are the same. All samples in one lot must be completely processed through any given step in the same time period. For example, suppose a laboratory can extract 10 samples at one time, can concentrate 20 sample extracts at a time, and can instrumentally analyze 50 sample extracts at a time. The lot may only contain 10 samples because no more than 10 samples can be processed at one time during the rate limiting step, in this case the extraction step.

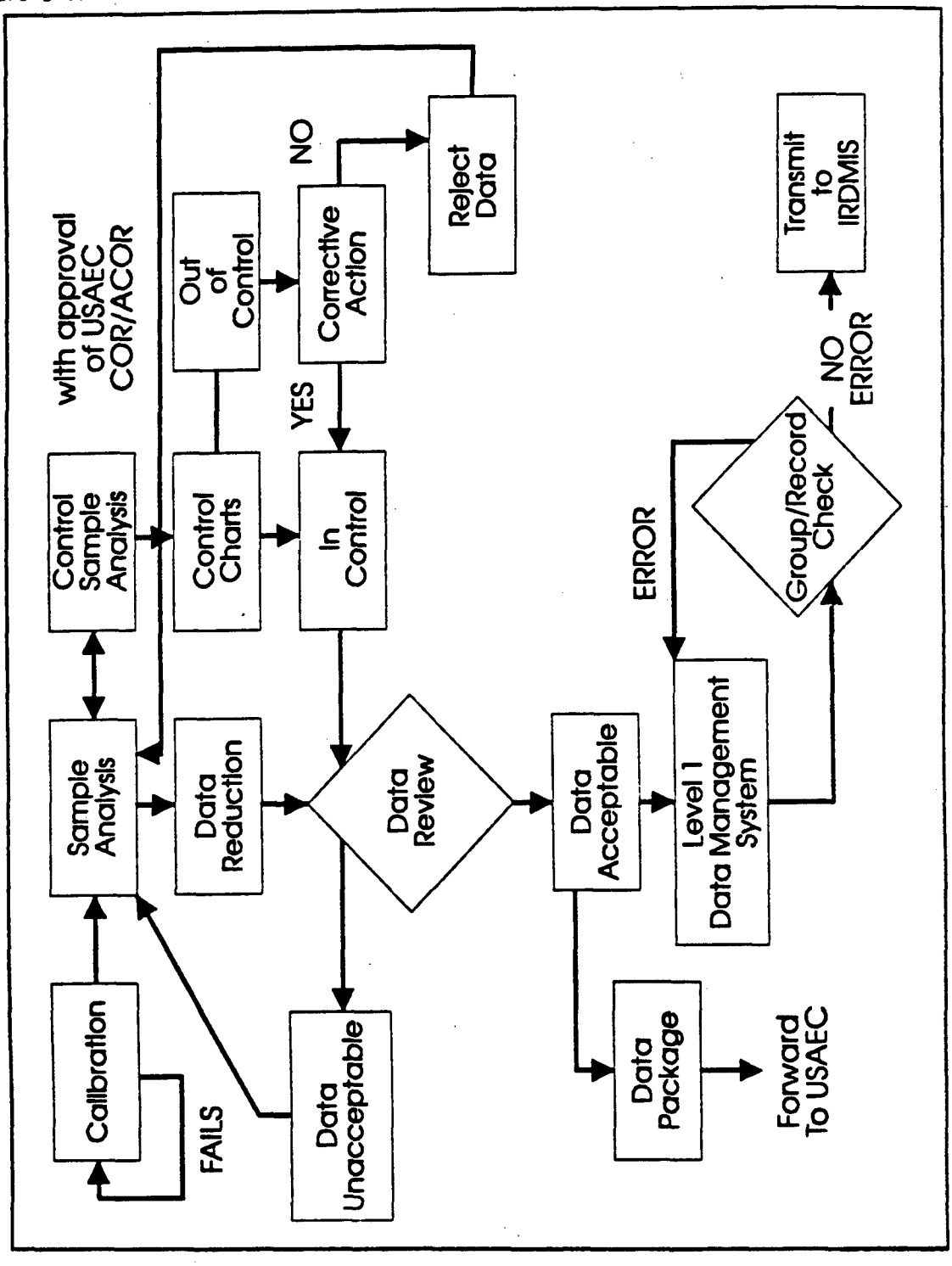
All samples must be processed through the entire analytical method, exactly as validated. Any proposed modifications to the validated method must be evaluated and approved by the USAEC Chemistry Branch through the COR/project officer before use. Any field samples with concentrations of any analyte above the URL shall be diluted within range for concentration measurement (QC samples are never to be diluted). Records of all dilutions must be maintained and the dilution factors shall be entered into the USAEC IRDMIS (Section 9.4). The method of analyte identification and quantification will be specified in the analytical methods. A typical sequence of sample analysis through data transmission is shown in Figure 6-1.

In any chromatographic method, excluding GC/MS and ion chromatography, the presence of a compound shall be confirmed (as long as confirmatory method is available) on a second column. Confirmation does not necessarily have to be



performed within holding times but must be accomplished within 10 days of sample analysis. Results of confirmatory analyses must be reported with the original data within the time specified by the contract or task order.

Figure 6-1.


Calibration
FAILS
Sample Analysis
Control Sample Analysis
with approval of USAEC COR/ACOR
Data Reduction
Control Charts
Out of Control
Data Unacceptable
Data Review
NO
YES
Corrective Action
In Control
Reject Data
Data Acceptable
Data Package
Forward To USAEC
ERROR
Level 1 Data Management System
Group/Record Check
NO ERROR
Transmit to IRDMIS

6.10 INSTRUMENT MAINTENANCE

This section establishes procedures for maintaining test and measurement equipment used to conduct analyses, in such areas as instrument maintenance, service contracts, and absolute physical or electronic calibration. Chemical calibration is discussed in Section 7.0.

The calibration policies and procedures set forth will apply to all test and measuring equipment. All test and measuring instruments fall into two general categories: those which are calibrated prior to each use and those which are calibrated on a scheduled, periodic basis.

All equipment to be calibrated will have an assigned record number permanently affixed to the instrument. A label will be affixed to each instrument showing: description, manufacturer, model number, serial number, date of last calibration or maintenance, by whom calibrated/maintained, and due date of next servicing. Calibration reports and compensation or correction figures will be maintained with the instrument. Thermometers are exempt from the labeling requirement, but not from the calibration requirement.

A written stepwise calibration procedure must be available for each piece of test and measurement equipment. Any instrument which is not calibrated to within the manufacturer's original specifications must display a red warning tag to alert the analyst that the device carries only a "limited calibration." Equipment unable to meet approved calibration specifications shall not be used for sample analysis.

It is the contractor's responsibility to maintain an adequate supply of critical spare parts to minimize instrument down-times.



6.11 CALIBRATION IDENTIFICATION

Instruments past due for calibration or maintenance must be immediately removed from service, either physically or, if this is impractical, by tagging, sealing, labeling, or other means.

The labeling and recording system extends to calibration or maintenance services provided to the Contractor Laboratory by other organizations. Certifications and reports furnished by these organizations should be filed and made a part of the required record keeping system.

Equipment in "Calibrate Before Use" (CBU) status must be administratively sequestered to avoid accidental use without calibration.

6.11.1 CALIBRATION STANDARDS

All physical or electronic measurements or calibrations (excluding chemical calibration curves) performed by or for the Contractor Laboratory must be traceable, directly or indirectly, through an unbroken chain of properly conducted calibrations (supported by reports or data sheets) to the NIST. Reports must be up-to-date for each reference standard and each subordinate standard used for calibration of test and measurement equipment. When calibration services are performed by a non-contractor laboratory organization, copies of reports, and records showing traceability to the NIST should be immediately available. These records may be inspected during laboratory audits.

6.11.2 CALIBRATION FREQUENCY SCHEDULE

At a minimum, calibration and maintenance intervals for complex or sensitive laboratory instruments must be those recommended by the respective manufacturers, unless experience dictates a shorter interval. When the manufacturer has not specified a calibration interval for its equipment, the interval will be established in writing by the calibration group servicing the laboratory. Adherence to the schedule is



mandatory. The fact that these checks may be scheduled and performed by an outside source does not exempt the laboratory from its responsibility for identifying, monitoring and controlling calibration intervals, and ensuring that checks are made on time.

6.11.3 EXAMPLES

Routine, "absolute" calibration is not the same as chemical calibration, where the relationship between instrument response and concentration is established. "Absolute" calibration ensures that the perceived instrument response corresponds to the correct physical signal that should produce that response. Examples of equipment that must be "absolutely" calibrated include, but may not be limited to, the following:

- Balances -- These are the clearest examples of equipment requiring calibration. NIST-certified weights are used to ensure the accuracy of measurements.

- Thermometers -- NIST-certified thermometers are used to verify the accuracy of measurements.

- Other Temperature Sensors and Controllers -- For analytical equipment that incorporates temperature sensing or control, the accuracy of the sensors and controllers will affect method performance. When a method specifies an injector temperature of 100°C, the analyst must be sure that the instrument settings for 100°C actually corresponds to that temperature. Oven temperatures (e.g., drying ovens, GC ovens) must be accurately known. Equipment manufacturers describe procedures for temperature calibration, using either NIST-calibrated thermometers or measured electrical signals.

- Flow Controllers -- Measuring and controlling gas and liquid flow are integral parts of many instrumental analysis systems. The devices used to measure/control must be calibrated to ensure that actual flow corresponds to instrument readings or settings. ICP, IC, GC, GC/MS, and HPLC are examples of systems that must be calibrated for flow.

- Autoinjectors -- The actual volume injected into the analytical system must correspond to the instrumental settings for the intended volume. This calibration is particularly critical when absolute analyte response (e.g., peak height) is used for

quantification (as opposed to the ratio of analyte peak height to internal standard peak height).

- Recorders -- When physical records (e.g., strip charts) are used for quantification, the recorder response must correspond to the electronic signal received. If the basis of quantification is a linear relationship between response and concentration, the recorder must exhibit linear response to linear changes in electric signals.



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7.0 CALIBRATION REQUIREMENTS

7.1 CHEMICAL CALIBRATION CURVES

Before samples are analyzed on an instrument, chemical calibration standards of each target analyte must be analyzed to establish that the instrument is functioning properly with the desired sensitivity. Economy of effort dictates that as many analytes as possible be combined in the chemical calibration standards.

Chemical instrument calibration shall be accomplished using calibration standards prepared by mixing the species to be analyzed in the solvent that is introduced into the instrument, as dictated by the analytical method. The concentrations of the chemical calibration standards will be chosen to cover the allowable reporting range of the method. That is, at least one calibration standard will have a concentration equal to the MDL and at least one calibration standard will have a concentration equal to the upper reporting limit.

Data from the chemical calibration standards shall be plotted with the instrument response indicated on the ordinate and the concentration indicated on the abscissa. When microprocessors are used to establish calibration curves, the data must nevertheless be plotted. If, after plotting, the curve is shown to be linear with acceptable variance, the microprocessor may be used to determine analyte concentrations in samples. Methods and formulae for quantification shall be as specified in the standardized methods.

Chemical instrument calibration curves shall not be used to determine the MDL. Rather, analysis of chemical calibration standards are to be used by instrument operators to establish response versus concentration relationships and to provide early warning of instrument variances.

Data from the calibration checks are to be recorded on forms (Appendix R) and maintained with the lot data package. Alternatively, if a laboratory-wide computerized data management system is available, data calibration may be generated electronically and output on forms or charts. In either case, documentation must be available to demonstrate the validity of the calibration checks.



7.1.1 INITIAL CALIBRATION, CLASS 1, CLASS 1P, AND CLASS 1M METHODS

Initial Calibration procedures shall be used whenever:

- The method detection level (MDL) is determined;
- The instrument is started up (other than daily start up and shut down);
- The instrument is used to analyze analytes different from those for which the instrument was previously calibrated; and
- The instrument fails daily or continuing calibration.

Initial calibration shall be as specified in the analytical method, however, in addition, one standard at the MDL and one standard at the URL shall be analyzed. If no calibration requirements are specified in the method, then refer to the USAEC Chemistry Branch for guidance. The concentrations of the calibration standards, in the solvent that results from all the preparation steps of the method, shall take into account any concentration steps that are part of the method. Concentrations in the solvent shall correspond to those in an environmental matrix as if the method preparation steps had been performed.

In addition to the initial calibration standards, Class 1 and 1P methods require the analysis of calibration check standards (Section 7.4). During a Class 1 or Class 1P initial calibration, a calibration check standard shall be analyzed at the completion of calibration. If the method requires what could be an initial calibration each day analysis is performed, then the calibration check standards are to be analyzed once a week rather than each day. The concentration of the calibration check standard shall be near the upper end of the Method Reporting Range (MRR) and shall contain all the analytes of interest. Calibration check standard results shall be within the limits of acceptability defined in Sections 7.4 and 7.5.



If the results of the calibration check standard are not acceptable, immediate reanalysis of the calibration check standard is required. If the results of the reanalysis still exceed the limits of acceptability the system is considered to have failed calibration. Sample analysis shall be halted and shall not resume until successful completion of initial calibration. Corrective action(s) taken to restore initial calibration shall be documented by the contractor laboratory.

7.1.2 DAILY LOT CALIBRATION, CLASS 1, CLASS 1P, AND CLASS 1M METHODS

Calibration standards shall be analyzed at the start of each lot, prior to sample analysis, to verify that instrument response has not changed from previous calibration. Daily lot calibration shall be performed in accordance with the requirements of the analytical method. If no calibration requirements are specified in the method, then contact the USAEC Chemistry Branch for guidance. **NOTE: For pesticides/PCBs it is suggested that the daily lot calibration consist of CLP Mix A, CLP Mix B, Toxaphene, and PCBs 1016 and 1260.** The response of the daily lot calibration must fall within the limits of acceptability as defined in section 7.5. If the response fails this test, the daily lot calibration shall be reanalyzed. If the response from the second analysis is not within the limits of acceptability, Initial Calibration must be performed before analyzing samples.

After sample analyses are completed for the lot an ending daily lot calibration standard, as specified in the method, shall be analyzed. If the response is not within the limits of acceptability, the daily lot calibration standard shall be reanalyzed. If the response from the second analysis is not within the limits of acceptability, the system is considered to have failed calibration. Initial Calibration must be performed and all samples analyzed since the last acceptable calibration must be reanalyzed. Note that the ending daily lot calibration may also serve as the beginning daily lot calibration for a subsequent lot, provided that there is no break in the analytical sequence.

For both the beginning and ending calibrations, if the first attempt fails to meet criteria, minor maintenance (ie. snipping the end of the GC column, cleaning the injection port, etc.) may be performed. All such activities shall be documented.

In addition, a special case exists for beginning calibrations with no preceding



analyses (ie. there has been a break since the last analysis by this method). If the second attempt to calibrate fails, then the laboratory may prepare a new daily calibration standard and reanalyze. If this third attempt fails then initial calibration shall be performed.

7.1.3 CONTINUING CALIBRATIONS

Continuing calibration, in accordance with the EPA CLP Statement of Work, shall be performed as follows:

- For inorganics, a blank and a continuing calibration standard shall be analyzed after every 10th sample, or every 2 hours, whichever is more frequent. The standard shall be near the mid-point of the method reporting range and shall meet the limits of acceptability as specified in Section 7.5.

- For GC/MS volatiles, a blank and a continuing calibration standard shall be analyzed every 12 hours. The standard shall meet the limits of acceptability as defined in Section 7.5.

- For GC/MS semivolatiles, a continuing calibration standard shall be analyzed every 12 hours. The standard shall meet the limits of acceptability as defined in Section 7.5.

- For pesticides and PCBs, the laboratory shall analyze a blank every 12 hours. In addition, every 12 hours the laboratory shall alternately analyze a Performance Evaluation Mixture (PEM) or Standard Mixtures A and B as defined in the EPA CLP requirements. All results for the PEM and Standards shall meet the limits of acceptability as defined in Section 7.5.

- For all other organic methods, the laboratory shall analyze a blank and a continuing calibration standard every 12 hours. The standard shall meet the limits of acceptability as defined in Section 7.5.

- If a continuing calibration fails to meet the limits of acceptability the laboratory shall immediately reanalyze the standard. If the first analysis fails to meet criteria, minor maintenance (ie. snipping the end of the GC column, cleaning the injection port, etc.) may be performed. All such activities shall be documented. If this reanalysis is

not acceptable then all analyses shall cease until the cause of the problem is determined and corrected. All samples analyzed since the last acceptable calibration shall be reanalyzed.

7.1.4 INITIAL CALIBRATION, CLASS 2 METHODS

The instances when Initial Calibration must be performed are the same as described in Section 7.1.1. Calibration standards shall be prepared and analyzed in triplicate at concentrations of 0 (blank) and the MDL. The spiked concentration shall correspond to the MDL in the environmental matrix. All blanks must yield negative results and all spiked samples must yield positive results for acceptable calibration.

7.1.5 DAILY LOT CALIBRATION, CLASS 2 METHODS

Before and after sample analysis of each lot, one blank and one calibration standard at the MDL shall be analyzed. If any calibration standard yields an inappropriate response (positive for a blank, or negative for the spiked standard), a second calibration standard shall be analyzed. If the second standard yields an inappropriate response, the system is considered to have failed calibration. The cause of the failure must be determined and corrected before analyses may continue.

If calibration failure occurs at the end of sample analyses, the analytical results obtained since the last satisfactory calibration are considered invalid and must be repeated. After calibration failure, the procedure for the Initial Calibration must be followed to demonstrate satisfactory performance.



SECTION 7.2 GC/MS TUNING

All GC/MS methods shall require the instrument to be tuned every 12 hours while in operation. When analyzing volatiles, bromofluorobenzene shall be used to tune the instrument, while decafluorotriphenyl phosphine shall be used for semivolatile analyses. These requirements, and the criteria for acceptability shall be as specified in the latest EPA CLP requirements.

SECTION 7.3 ICP METHOD SPECIFIC REQUIREMENTS

For all analyses conducted by ICP the following requirements from the CLP Statement of Work shall be met:

- Interelement correction factors shall be calculated annually, or whenever major maintenance is performed on the instrument.

- Interference check samples shall be run twice per lot or twice per 8 hours, whichever is more frequent.

SECTION 7.4 CALIBRATION CHECK STANDARDS

SECTION 7.4.1 REQUIREMENTS FOR USE

Calibration check standards are required for all Class 1 and 1P methods and shall be analyzed with each initial calibration. If an initial calibration is performed each day then the calibration check standard shall be analyzed once per week (once per five lots if analyses are not performed daily). The calibration check standard shall contain all analytes of interest for the method in question at a concentration near the upper end of the calibration range.

SECTION 7.4.2 SOURCES OF CHECK STANDARDS

CASE 1. A certified check standard is available from the EPA or some other source with both the true value and limits of acceptability specified by the supplier. The results must fall within the limits specified in Section 7.5 or by the supplier, whichever is less.

CASE 2. A certified check standard is available from the EPA or some other source with a true value specified but without limits of acceptability. The results must fall within the limits specified in Section 7.5.



CASE 3. If no certified check standard is available, the contractor laboratory shall prepare a check standard using a second source of reference material. This standard shall be prepared by a different analyst than the one who prepared the calibration standard. If weighing of the material is required, a different balance should be used, if possible. The results must fall within the limits specified in Section 7.5.

CASE 4. If there is only one source of reference material available, then the calibration and calibration check standards must be prepared from the same material. The standards shall be prepared by different analysts. If weighing is required, different balances should be used, if possible. The results must fall within the limits specified in Section 7.5.

7.5 LIMITS OF ACCEPTABILITY

Limits of acceptability are based upon those contained in the EPA CLP Statements of Work.

7.5.1 INORGANICS

- All metals except mercury shall be within +/- 10%.
- Mercury shall be within +/- 20%.
- Anions shall be within +/- 15%.
- All other inorganics shall be within +/- 15%

7.5.2 ORGANICS

- For GC/MS methods, 2/3 of the analytes shall be within +/- 25%, and all analytes shall be within +/- 40%.
- For all non-GC/MS organic methods all analytes shall be within +/- 25%.



• When analyzing the PEM for pesticides/PCBs the breakdown of DDT and Endrin shall be less than 20%, and the combined breakdown of DDT and Endrin shall be less than 30%.

• When response factors are used the daily and continuing standards shall be compared to the average response factor of the initial calibration.

7.6 REFERENCE MATERIAL

During chemical calibration and sample analyses, solutions containing known analytes at known concentrations must be prepared. These solutions are needed to generate method performance data, calibrate instruments, spike analytical surrogates or internal standards, prepare QC samples, and prepare performance samples, when specified. Three types of reference materials may be used to prepare standard solutions, as described in Sections 7.6.1 through 7.6.3.

Before initiating any laboratory studies, the Contractor Laboratory must submit a request to the USAEC Project Officer or Contracting Officer's Representative for reference materials. The list should include all target analytes of interest on a specific project, surrogate compounds, and internal standards. The USAEC Project Officer or Contracting Officer's Representative will forward the request to the USAEC Chemistry Branch. Samples of reference materials will be shipped to the Contractor Laboratory from the repository. Only if reference materials are not available through USAEC should the Contractor Laboratory obtain the materials from an outside source.

Reference materials for metals and non-metallic inorganics may be maintained at room temperature in a locked storage area. All other reference materials must be stored in a locked refrigerator at or below 4°C. All reference materials shall be maintained under chain-of-custody. An SOP for the use, control, and inventory of reference materials will be prepared.



7.6.1 STANDARD ANALYTICAL REFERENCE MATERIALS (SARMs)

Whenever possible, chemical analyses conducted in support of USAEC projects should be based on SARMs. These materials are labeled as SARMs and carry a SARM identification number. These materials will either be National Institute of Standards and Technology (NIST) Standard Reference Materials (SRMs) or will be traceable to NIST SRMs. The SARM Repository Program is described in Appendix F. Contractors are encouraged to use secondary standards that are referenced to SARMs and are periodically checked against SARMs. This check will be performed the first time the standard is used and at six month intervals or when the standard is replaced, whichever comes first. The use of secondary standards are encouraged as a conservation method for the more costly SARMs.

7.6.2 INTERIM REFERENCE MATERIALS (ITRMs)

ITRMs are available from two sources. Some of these materials are maintained and distributed by the USAEC and should be used if SARMs are not available. Although ITRMs are supplied through the USAEC, they are not as rigorously characterized, as are SARMs. ITRM characterization includes positive identification of the material and an estimate of purity. The SARM label on each bottle is modified by adding the word "Interim" and includes an identification number. These materials may be used as received from the USAEC. Reference materials obtained from the U.S. Environmental Protection Agency, or NIST do not require characterization by the Contractor Laboratory.

7.6.3 OFF-THE-SHELF MATERIALS

SARMs or ITRMs may not be available for some target analytes. If materials are unavailable through USAEC, Contractor Laboratories will be instructed to purchase materials from an outside supplier. These materials shall be considered as "off-the-shelf." Before using any material, regardless of source, classified as "off-the-shelf," the Contractor Laboratory must analyze the material to obtain a positive identification and estimate of purity. Where possible, characterization analyses for purity shall be conducted using at least two different methods. Off-the-shelf materials should be



compared to NIST or EPA standard material whenever possible. The characterization analyses must be performed before method validation is initiated and the results must be provided to USAEC with the Method Documentation Package. Documentation for purity and identity characterization analyses shall be kept on file at the contractor laboratory. Possible techniques for characterizing the off-the-shelf materials include, as applicable:

- Infrared spectroscopy;
- Melting point, decomposition point, or boiling point determinations;
- Mass spectrometry;
- NMR spectrometry;
- Elemental analysis;
- Gas chromatography (for purity); or
- Liquid chromatography (for purity).

This list is not exhaustive and all of the listed techniques need not be used. The Contractor Laboratory is responsible for providing positive identification and a purity estimate for each off-the-shelf material (including internal standards) to USAEC.



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8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 INTRODUCTION

In addition to the requirements discussed thus far, QC samples must be analyzed to provide quantitative evidence that the entire method is performing acceptably. It is essential that controls are initiated during and maintained throughout the analysis of samples. Data generated from the control samples are plotted on control charts, which are used to monitor day-to-day variations in routine analyses.

For multi-analyte methods, the selection of control analytes will be specified at the time the method is approved. As a rule, no less than 50 percent of the target analytes will be selected as control analytes, with the minimum number selected being 4. That is, for any method having four or fewer target analytes, all analytes will be selected as control analytes; for a method having 5 to 8 target analytes, 4 will be selected as control analytes; for each additional 1 or 2 target analytes, 1 additional control analyte will be selected. Exceptions will be specified in the appropriate standard method. Note that this rule does not apply to GC/MS or ICP methods.

For GC/MS methods, only the surrogates will be used as control analytes. The surrogates used shall be as specified in the method. For ICP water methods, due to interelement factors, all analytes must be spiked into the control samples. However, only those analytes which are to be reported need be control charted. For ICP soil methods the same rule applies, however, Al, Ba, Ca, Fe, Mg, Mn, K, and Na shall not be used as spike elements.

Note that USAEC does not normally require the matrix spikes and matrix spike duplicates required by the EPA. The EPA uses these samples to determine matrix effects and within day variability of the laboratory. In lieu of these, USAEC will perform the following:

- Matrix effects shall be determined using surrogates in each field sample, if appropriate surrogates are available. If surrogates are not available, then matrix spikes will be performed at a rate of 1 per 20 samples.

- The within day variability of the method will be determined using the USAEC



required duplicate, standard matrix, QC spikes. This will replace the matrix spike duplicates.

8.2 CONTROL SAMPLES

Control samples are those samples that are introduced into the train of environmental samples to function as monitors on the performance of the analytical method. All required QC samples shall be prepared from standard matrices (Sections 6.6 and 6.7) or actual field samples, as required, and processed through the complete analytical method. Stock solutions used to spike QC samples shall be prepared independently of stocks used for calibration standards.

Numbers and concentrations of QC samples required for different method classes, per lot of field samples, are summarized in Table 8-1. The analysis sequence for Class 1P control samples shall be as specified in Table 8-2. For Class 1M method, if the lot requires more than 12 hours for analysis then one QC sample shall be analyzed in each 12 hour period.

Routine reanalysis of QC samples is not permitted. Justification for reanalysis of QC samples must be fully documented.

8.2.1 TYPES OF CONTROL SAMPLES

The following types of QC samples shall be included in each analytical lot:

Class 1 Methods:

- Method Blank, to verify that the laboratory is not a source of sample contamination; and

- Spikes of all control analytes (required analytes spiked into QC samples) in standard matrices, to verify performance.

- Spikes of surrogates in all field samples, to observe recovery effects in the environmental matrix (if possible for the method).



Class 1P Methods:

- Method Blank, to verify that the laboratory is not a source of sample contamination; and

- Spikes of all control analytes (required analytes spiked into QC samples) in standard matrices, to verify performance.

- Spikes of surrogates in all field samples, to observe recovery effects in the environmental matrix.

Class 1M Method (GC/MS Only):

- Method Blanks/Spikes, to verify that the laboratory is not a source of sample contamination (non-surrogates) and to verify performance (surrogates); and

- Spikes of all control analytes (surrogate only) in every field sample, to observe recovery effects in the environmental matrix.

Class 2 Method:

- Method Blank, to verify that the laboratory is not a source of sample contamination; and

- Spikes of all control analytes in standard matrices, to verify method performance and to distinguish between the response of this sample and the response obtained from the blank.



Table 8-1. NUMBERS AND CONCENTRATIONS OF QC SAMPLES PER LOT

CLASS 1

1 - Standard Matrix Method Blank
3 - Standard Matrix Spikes
2 X MDL, 80% URL, 80% URL(approx)
All Field Samples - Natural Matrix Spikes
80% URL (approx.) Surrogates Only (if possible for the method)

CLASS 1P

1 - Standard Matrix Method Blank
4 - Standard Matrix Spikes
2 X MDL, 2 X MDL, 80% URL, 80% URL (approx.)
All field samples - Natural Matrix Spikes
80% URL (approx.) Surrogates Only

CLASS 1M

2 - Standard Matrix Method Blanks/Spikes
80% URL (approx.) Surrogates
All Field Samples - Natural Matrix Spikes
80% URL (approx.) Surrogates Only

CLASS 2

1 - Standard Matrix Method Blank
1 - Standard Matrix Spike
1 X MDL

NOTE 1: Wherever a spike level of 80% URL is specified this shall not exceed 20 X MDL.

NOTE 2: When a standard surrogate spiking level is specified in the method that level shall be used.

TABLE 8.2 CLASS 1P QC Spike Run Order

Number of 12 Hr. Periods	Period 1	Period 2	Period 3	Period 4
4	low	high	low	high
3	low	high high	low	---
2	low high	low high	---	---
1	all	---	---	---

8.2.2 PREPARATION OF CONTROL SAMPLES

Because QC samples are used for rapid, daily control of the analytical process, most QC samples must be identifiable by the analyst. Sample numbers for QC samples must be assigned during the logging-in and lot make-up process. However, actual preparation of the QC samples shall be performed by the person who conducts the first step of the analytical method. This person is responsible for obtaining the correct volume/weight and type of standard matrix (Sections 6.5 and 6.6) or field sample, and for spiking the matrix with the required analytes at the correct concentration (Section 8.2.1).

The spiking solvents and procedures will be specified in the approved method write-up. In general, however, the correct volume or weight of standard matrix/field sample for each method will be spiked with all control analytes using a minimum of spiking solution to prevent altering the character of the matrix. Spiked samples, excluding water samples and VOAs in soil, must be allowed to stand for one hour before continuing the analysis.

Validation of spiking solutions must be performed on a regular basis before the solution is used and not afterwards as part of a correction action. The following procedure shall be used:



Dilute working solutions will be validated against working standards before initial use and within seven days before subsequent usage. The method of validation should utilize the same technology used for measurement in environmental samples. GC/FID may be substituted for GC/MS with approval from the USAEC Chemistry Branch.

For single analyte solutions and the multi-analyte solutions used for other than GC/MS procedures, recovery must be greater than the lower warning limit in the control chart for that analyte. The control chart for the concentration closest to the solution concentration shall be used. If the same solution is used to spike water and soil, the control chart that exhibits the more stringent control limit shall be used. If a solution is suspected of deterioration at other times, it shall be tested before it is discarded to assess its status and allow judgements on spiked control samples prepared since the last solution validation.

For multi-analyte surrogate solutions for GC/MS, recovery of all surrogates shall be greater than the lower control limits on the X charts if GC/MS is used for validation. If GC/FID is used, the recovery shall be greater than the lower warning limit.

8.3 FIELD QC SAMPLES

Samples such as field blanks, trip blanks, rinse blanks, and field duplicates are collected by individuals performing sampling or contamination assessment. They must be specified when planning field activities and explicitly described in the Project Workplan. These samples should each be included at the rates indicated in Table 8-3. This table represents the general EPA requirements, and may be modified to meet site specific criteria, or additional regulatory requirements. Such field samples are not part of laboratory QC and will be treated by the laboratory simply as environmental samples. Evaluation of data from these field samples must be performed by the contractor when the final report is produced.

TABLE 8-3 FIELD QC SAMPLES

TYPE	FREQUENCY
Trip Blanks (VOAs in water only, unless required by regulatory agency)	1 per cooler shipped
Rinse Blanks (Not required for dedicated sampling equipment)	1 per day per equipment type
Field Blanks	1 per 20 samples
Field Duplicates	1 per 20 samples

Note that this table does not include the matrix spikes and matrix spike duplicates required by the EPA. The EPA uses these samples to determine matrix effects and within day variability of the laboratory. In lieu of these USAEC will perform the following:

- Matrix effects shall be determined using surrogates in each field sample, if appropriate surrogates are available. If surrogates are not available, then matrix spikes will be performed at a rate of 1 per 20 samples.

- The within day variability of the method will be determined using the USAEC required duplicate standard matrix QC spikes. This will replace the matrix spike duplicates. The use of a standard matrix ensures that any variability is done to laboratory performance, and not a result of matrix effect.

8.4 QA SPLIT SAMPLES

In addition to the QC samples listed above, the contractor (if so directed in the task order) shall provide 10 % split samples for analysis at a Corp of Engineers (COE) QA laboratory. The contractor is responsible for providing sample containers and coolers, and for the shipping of these samples to the QA laboratory. USAEC will advise the contractor where the samples are to be sent, and if any analyses are not to be split



(ie. those for which no COE laboratory has the capability to analyze for). USAEC will review the results from the splits and use this information as part of the overall data validation program.

Water samples and samples for volatiles shall be discrete, collocated samples. For all other parameters in soil the sample shall be thoroughly mixed prior to bottling of the fractions.

8.5 DATA REPORTING for QC

8.5.1 CLASS 1, CLASS 1P, and CLASS 1M METHODS

The results for each analyte in the spiked QC sample shall be determined using the same acceptable calibration curve that is used for environmental samples in the lot. Data shall be reported as "less than" the MDL if the analyte is not detected. Any values above the MDL shall be reported as determined. Values above the instrumental detection level (IDL), but below the MDL, shall be reported as determined, but must be flagged with "J" and "P" to indicate that the value is estimated. Results for QC samples shall not be corrected, except as described below. Because all spike levels must be within the reporting range, no dilutions should be required. Data shall be reported in the USAEC IRDMIS, as described in Section 9.6, using the correct number of significant figures (maximum of 3 for Class 1 and Class 1P, 2 for Class 1M and Class 2).

Each day of analysis, the analyst shall quantify each analyte in the method blank and spiked QC samples. A new lot of samples shall not be introduced into the analytical instrument until results for QC samples in the previous lot have been calculated, plotted on control charts as necessary, and the entire analytical method shown to be in control. If time is a constraint, the calculation of associated environmental sample results may be postponed until a later date. The analyst should maintain control charts by the instrument so that the results of QC samples could be hand-plotted, in order to have an early indication of problems.

Data from the method blank shall be reported as "less than" the MDL if the analyte is not detected. Any values above the MDL shall be reported as determined. Values above the instrumental detection level (IDL), but below the MDL, shall be reported as determined, but must be flagged with "J" and "P" to indicate that the value is

estimated. Corrections to the QC samples is required whenever an analyte is detected above the IDL in the method blank. The correction will be done based upon the instrument response values and not the found values calculated from a calibration curve. If the instrument response output is only available in concentration than this may be used. Entries into the USAEC IRDMIS shall be in terms of concentration. The importance attached to finding measurable concentrations in the method blank is dependent on analyte and method. In the Project QC Plan, each laboratory must describe its procedure for assessing method blank results and identifying laboratory contamination problems.

8.5.2 CLASS 2 METHODS

Method blank and dilution corrections are not performed for Class 2 analyses. The results for samples analyzed by Class 2 methods are measured in relation to the MDL (two significant figures) and reported as "less than, equal to, or greater than" the MDL. A tested concentration range is not applicable since only the MDL concentration is tested.

8.6 CONTROL CHARTS

Control charts are not used with Class 2 methods. For Class 1, Class 1P, and Class 1M methods, control charts are used to monitor the variations in the precision and accuracy of routine analyses and detect trends in these variations. The construction of a control chart requires initial data to establish the mean and range of measurements. The QC control charts are constructed from data representing performance of the complete analytical method.

Although tabulations of the various statistical parameters can be used to evaluate if a datum falls within the prescribed limits, trends are very difficult to discern from tables. Therefore, control charts shall consist of tabulated data and graphical portrayals of the information described below. Software packages that to be used to construct charts will be provided by USAEC and the use of the USAEC supplied software is required.



In the initial construction of the control charts, data from the laboratory analyses will be used. Data from spiked QC samples within a lot will be compared to control chart limits to demonstrate that analyses of the lot are under control, and will be used to update the charts. $\bar{x}$ - R control charts will be used in these guidelines.

Each control chart shall include the following information:

- Analyte;
- Method number;
- Laboratory;
- Spike concentration;
- Matrix; and
- Chart title - select one of the following:

  1) Single Day X-Bar Control Chart - High Spike Concentration

  2) Single Day X-Bar Control Chart - Low Spike Concentration

  3) Single Day Range Control Chart - High Spike concentration

  4) Single Day Range Control Chart - Low Spike concentration

  5) Three-Day X-Bar Control Chart - Low Spike Concentration

  6) Three-Day Range Control Chart - Low Spike Concentration

- Four letter lot designation for each point, shown on the x-axis;
- Percent Recovery (for $\bar{x}$ control charts) or Range (for R control charts) along the y-axis;
- Upper control limit (UCL), on $\bar{x}$ and R control charts;
- Upper warning limit (UWL)*, on $\bar{x}$* and R control charts;

- Mean, on $\bar{x}$ and R control charts;
- Lower warning limit (LWL)*, on $\bar{x}$* control charts; and
- Lower control limit (LCL), on $\bar{x}$ control charts.

* For some analytes specified by USAEC, warning limits on $\bar{x}$ charts will be deleted and replaced by modified control limits based on data quality specifications. See Appendix L for details.

If the method is judged to be out-of-control (Section 8.7) and reanalysis occurs, no point from the initial analysis may be used to update charts.

Specifics on the construction of control charts can be found in Appendix H.

8.7 OUT-OF-CONTROL SITUATIONS

Failure to meet calibration criteria, record keeping omissions, improper sampling technique, and improper storage or preservation of samples are all conditions that affect data quality and require investigation/correction. However, this section of the guidelines describes only evaluations performed by the analyst, in consultation with the QAC, to determine whether the entire analytical method is in control. These evaluations must be done daily so that action can be taken immediately to investigate and correct the problem. Failure to take immediate action may necessitate discarding large quantities of data and reacquiring, preparing, and reanalyzing samples processed after the problem was detected.

For both duplicate spiked QC results and moving averages a single mean (X) outside of modified limits requires immediate investigation/corrective action. When two or more successive lot means for duplicate spiked QC data are outside normal control limits but within modified limits, investigation/corrective action should be taken even though the data from these lots are acceptable. For moving averages, a single point outside of normal control limits but within modified limits requires investigation/corrective action even though the data are acceptable.



8.7.1 HOLDING TIMES

Any sample or sample extract held beyond the time periods specified in Section 6.5 shall be deemed out-of-control. These samples should not be analyzed unless incident-specific exception is received from USAEC. Sampling and laboratory schedules, and budgets, should be coordinated to avoid holding time violations.

8.7.2 $\bar{x}$ Control Charts

An out-of-control situation for $\bar{x}$ control charts may be indicated by:

- A value outside the control limits or classified as outlier by statistical test;
- A series of seven successive points on the same side of the central line;
- A series of five successive points going in the same direction;
- A cyclical pattern of control values; or
- Two consecutive points between the UWL and UCL or the LWL and LCL.

Note that for moving average control charts it is the individual daily recovery, not the average which must be evaluated.

Whenever one of these conditions is detected, the analyst and QAC must investigate to determine the cause and document actions taken. Data acquired concurrently with one of these conditions shall be discarded and samples reanalyzed unless the investigation of the problem proves that the analysis was in control, or modified control limits are being used to determine acceptability of data (See Appendix L). Justification for the acceptance of data must be provided with the weekly quality control submission.

The analyst will determine whether all sample analyses by a multi-analyte method should cease, in the following way:

- Plot average percent recovery ($\bar{x}$) for each analyte.

- If the points for at least two thirds (see Table 8-4) of the control analytes for a multi-analyte method are classified as in-control, based on the conditions described above, the method is in control and environmental sample data may be reported (providing that the condition of two consecutive out-of-control points has not occurred). The conditions which may have caused more than one third of the control analytes to fail the control criteria shall be investigated and corrected as necessary. All activities shall be documented. The data points indicating possible error shall be annotated with a reference to the investigation and to the fact that the method met control criteria.

- A method may be deemed out-of-control even if greater than or equal to 2/3 of the control analytes meet control criteria. Of the remaining control analytes (less than 1/3 possible out-of-control), if one analyte has two consecutive out-of-control points, as defined above, the method is out-of-control. Analyses must cease, the cause must be investigated and corrected, and a determination made by the USAEC Chemistry Branch of whether the lot must be reanalyzed.

- If data points for fewer than 2/3 of the control analytes are classified as in control (more than 1/3 meet one of the out-of-control conditions), the method is considered to be out-of-control and all work on that method (including sample preparation) must cease immediately. No data for environmental samples in that lot may be reported. Efforts must be initiated to determine the cause of the problem. If the problem is instrumental or specific only to preparation of that lot, samples prepared after the out-of-control situation occurred may be processed after the instrumental system is repaired and recalibrated, provided holding times are not exceeded. If no specific cause can be assigned, the instrument should be recalibrated and all samples prepared subsequent to the last in-control lot should be re-prepared, provided that the holding time has not expired. If the holding time has expired then USAEC must be contacted for guidance on re-sampling. In any case, the out-of-control lot shall be reanalyzed. The out-of-control situation and corrective actions taken shall be fully documented. Each point shall be annotated with a reference to the investigation and to the disposition of samples and results.

- The establishment of overall method control for analyses may not be accurate for describing a particular analyte(s). For analyses where control cannot be established for certain control analytes (i.e., loss of surrogate due to volatility), such analyte results may still be deemed as out-of-control even though the method is considered in control. The evaluation of control in such instances will be handled on a case-by-case basis.



If a lot is still out of control after reanalysis, all method-related activities shall stop immediately. A detailed laboratory-wide investigation shall be conducted to isolate and correct faulty operations. Sample security, integrity of standards, reagents, glassware, laboratory notebooks, instrument performance, and adherence to validated methods should be included in the investigation and the findings/corrective actions documented.

8.7.3 R CONTROL CHARTS

An out-of-control situation for R control charts may be indicated by:

- A value above the UCL;
- A series of five consecutive points going in an upward direction;
- A cyclical pattern of control values; or
- Two consecutive points between the UWL and UCL.

Whenever one of the conditions is detected, the analyst and QAC must investigate. Criteria for determining if a method is in control are the same as those described in Section 8.7. Out-of-control on range charts bears as much weight as out-of-control on accuracy charts.

Table 8-4. MINIMUM NUMBER OF IN-CONTROL POINTS FOR MULTI-ANALYTE METHODS

Required Control Analytes Per Method	Required Number of Data Values Falling Between the UCL and LCL
1	1
2	2
3	2
4	3
5	4
6	4
7	5
8	6
9	6
10	7
11	8
12	8
13	9
14	10
15	10
16	11
17	12
18	12
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25	17



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9.0 DATA REDUCTION, VALIDATION, AND REPORTING

Traditionally, record keeping was the primary emphasis of QA. Although the primary emphasis of this USAEC QA Program is the control of sample analysis, record keeping maintains its importance in the overall assessment of the production of quality data and is used in part to document the control of sample analysis.

The degree of rigor used in documenting sampling and analysis activities cannot be understated. All activities require extensive documentation and special handling protocols. All activities are to be performed under chain of custody procedures. Particularly in these situations, the attitude is "if you didn't write it down, you didn't do it."

For most USAEC projects, this degree of documentation is required. However, for some projects, documentation in the form of an EPA CLP package will be required. In any case, the records described below shall be maintained and will be available for inspection by USAEC.

Note that the Daily QC Report requirement of ER 1110-1-263 is replaced by the USAEC requirement to maintain daily field logbooks during sampling activities. Copies of these logbooks will be submitted in lieu of the Daily QC Reports.

9.1 RECORD KEEPING

Bound logbooks with pre-numbered pages shall be utilized for record keeping. In addition to the pre-numbered pages, each logbook or laboratory notebook shall have a unique number for ease of identification. Additional documentation, such as chromatograms, shall be referenced to the logbook or notebook, where appropriate. Loose sheets are not to be used unless permanently affixed to the logbook. The use of bound books tends to result in a chronological sequence of data insertion. Numbered pages encourages use of data in sequence and also aids in referencing data through a table of contents ordered according to time, type of analysis, type of sample, and/or identity of analyst.

Validation can be easily accomplished by requiring the sampler or analyst to date



and sign each activity or analysis prior to the end of their work shift. This validation should be further strengthened by providing space for the supervisor to witness the date and the completion of the analyses.

Logbook entries shall be completed in ink. Corrections should be made by drawing one line through the incorrect entry, entering the correct information, initialling, and dating the change. Complete information should be entered so that in an examination it can be determined what was done, by whom, when, and what the results were. At the end of each work shift, the analyst shall sign after the last entry is made.

Computerized logging systems may be used as support tools during any record keeping activities. However, bound logbooks are required for original records. If computers are used, bound logbooks must nevertheless be maintained. A computer hardcopy that has been permanently affixed in the logbook is acceptable as an original record of sampling and laboratory logging.

Separate installation logbooks or partial logbooks in other formats (e.g., analytical lot) maintained in conjunction with the installation logbook are the preferred methods for documenting appropriate information relevant to chemical analyses performed during USAEC projects. Master instrument logbooks are acceptable; however, such logbooks generally remain permanent property of the laboratory. Whatever logbook practice is utilized should minimize the duplication of records and be identified in the project QC plan submitted to USAEC. Logging, tuning, calibration, and reporting activities must be included in the logbooks. Copies of laboratory notebooks that integrate non-USAEC projects shall not be acceptable. Routine maintenance activities (Chapter 6) do not require installation-specific logbooks.

At the end of a project, all logbooks containing information specific to the installation shall be forwarded to USAEC for maintenance. Corporate controlled logbooks should be avoided; however, if such logbooks are used by the laboratory; certified copies of all relevant logbook pages shall be submitted to USAEC. A certified copy is a copy with the source documented, signed, and dated, after copying, by the Laboratory Task Manager or Quality Assurance Coordinator.

Because exact procedures vary between laboratories, an exact system for documentation will not be specified. However, the records described in the following sections must be maintained for each USAEC project.



9.2 LABORATORY

9.2.1 LABORATORY LOGGING

Upon arrival at the laboratory, samples shall be logged into a bound laboratory book, preferably installation specific. Logging the samples into a laboratory-wide sample tracking system (logbook or computer) does not supplant the need for a written project-specific log. Sample information provided in the logbook must include:

- Field sample number;
- Date of arrival at the laboratory;
- Observations concerning the conditions under which the samples arrived, e.g., broken containers, leakage, temperature of cooler upon receipt, unusual appearance of samples, etc;
- Analyses requested; and
- USAEC sample identification number (in addition to any internal laboratory sample numbers) associated with each field sample number. The USAEC sample identification numbers must be sequential, including laboratory QC samples, in the format described in Section 6.4.
- When problems are encountered with samples the sampling contractor shall be notified. Written records shall be maintained of all communications with the sampling contractor.

Prior to the analysis, samples are grouped into analytical lots, ordered and assigned a USAEC sample identification number. The laboratory may use internal laboratory sample numbers in addition to the required USAEC designation. USAEC sample identification numbers will be assigned for the QC samples to ensure inclusion of the correct number of QC samples in each lot for each analytical method (Section 8.2.1).



9.3 ANALYTICAL RECORDS

Reference Materials:

A bound logbook record shall be maintained of all reference materials (Section 7.6) used on a project. The record shall include date of receipt, source, purity, all compositional information, storage conditions, and expiration date. Data obtained during characterization of purchased materials (Section 7.6.3) shall also be included.

Working standards made from reference materials shall be labeled with complete information on preparation date, concentration of each compound, solvent, preparer's name, expiration date, and logbook where information on the standard is recorded. Reagents shall be labeled with date received and expiration date, if applicable. All of the information described above shall also be recorded in a bound logbook. Measurements made during standards preparation (e.g., from weighing operations) shall also be recorded. There should be no bottle, flask, beaker, or vial that contains a sample, sample extract, or standard solution that is not correctly labeled and properly stored.

Sample Handling:

Each person conducting any part of an analytical protocol shall maintain a record of all activities in a bound logbook. This notebook shall be specific to the operation but need not be person-specific if several individuals perform the same operation. Each day the analyst shall record the samples handled, standards used, QC samples prepared, procedures used, and resultant calculations. The logbook shall be signed and dated daily.

9.4 DATA REPORTING

All numerical results shall be reported in terms of concentration in the environmental sample. Resultant found concentrations submitted for entry into the USAEC IRDMIS must remain unadjusted before being reported to USAEC. Correction factors (e.g., percent soil moisture and dilution factor) are maintained separately in the IRDMIS. All data must have been collected during periods when calibration and control systems were used. Data shall be reported as "less than" the MDL if the analyte is not detected. Any values above the MDL shall be reported as determined. Values above the instrumental detection level (IDL), but below the MDL, shall be reported as determined, but must be flagged with "J" and "P" to indicate that the value is estimated. Specific instructions are provided in the IRDMIS User's Guide regarding the coding of entries. Flagging codes, as described in the IRDMIS User's Guide will be used, when applicable, to comment on the data. Contractor Laboratory comments on the data are mandatory.

In reporting results, rounding to the correct number of significant figures should occur only after all calculations and manipulations at the laboratory are completed. As many figures as are warranted by the analytical technique should be used in pre-reporting calculations. Premature rounding can significantly affect the final result.

Rounding will be accomplished using the following rules:

Rule 1 - In expressing an experimental quantity, retain no digits beyond the second uncertain one.

Rule 2 - In rounding numbers (i.e., in dropping superfluous digits);

- Increase the last retained digit by one if the first uncertain digit is larger than 5;

- Retain the last digit unchanged if the first uncertain digit is less than 5; and

- Retain the last digit unchanged if even, or increase it by one if odd, if the first uncertain digit is 5 and the second uncertain digit is 0.

- Increase the last retained digit by one if the first uncertain digit is 5 and the second uncertain digit is >0.



The correct number of reported significant figures, by method class, are as follows:

- Class 1 and 1P - 3 significant figures;
- Class 1M - 2 significant figures; and
- Class 2 - 2 significant figures.

The number of allowable significant figures are reduced when added uncertainties are included in the analysis, i.e., the results for samples diluted into the Method Reporting Range (MRR) allow one less significant figure due to the uncertainty added by the dilution process.

When required by contract or task order, data may have to be reported according to EPA CLP format (as specified in the CLP Statement of Work), in addition to those described above.

9.4.1 CLASS 1, CLASS 1P, AND CLASS 1M METHODS

Class 1 and 1P Methods:

If results for an analyte were obtained using the method exactly as tested, without dilution, the analyte concentration in the sample may be reported to three significant figures. If dilution was required for a particular analyte, the result may be reported to only two significant figures.

Class 1M Methods:

Results for all analytes (target and surrogate) may be reported with two significant figures if the method was used without dilution. Results obtained after dilution and results of screening for non-target analytes may be reported to only one significant figure. Any results for Class 1M methods that result from manual integration of chromatographic peaks shall be justified with copies of the specific peaks (instrument integration and manual integrations) provided in the data package.

9.4.2 CLASS 2 METHODS

The results of Class 2 methods are not adjusted for dilution. The results for samples analyzed by Class 2 methods are measured in relation to the MDL (two significant figures) and reported as "less than, equal to, or greater than" the MDL. A tested concentration range is not applicable since only the MDL concentration is tested.

9.5 DATA DELIVERABLES

In addition to those requirements of providing the results of analyses, both for analytical samples and QC samples, to the USAEC Data Management System, the contractor laboratory is responsible for maintaining and providing to USAEC the following documentation:

- Data Package - A data package contains all the data necessary to support the results of one analytical method for one lot of samples. Data packages shall be "free standing," that is, all data should be available without reference to other documents or files. The data package shall be forwarded to USAEC at the completion of the project or as otherwise specified (i.e., delivery order package or case file package). The description of the contents of a data package and the requirement for their review are contained in Section 9.5.1. A data package is basically all back-up data for a CLP data package, without the CLP report forms. Therefore, it should be possible to produce a CLP report from the data contained in the data package, if required.

- Delivery Order Package - A delivery order package consists of all the data packages associated with a specific delivery order of a contract and will be forwarded to USAEC at the completion of the analyses specified in the delivery order.

- Case File - A case file consists of the data or data packages associated with a specific case as defined in the EPA Contractor Laboratory Program. When specified, data may be required to be delivered to USAEC following EPA CLP protocols (as defined in the CLP Statement of Work), at the completion of the analysis of a case lot of samples.



• Other - As required in a contract or delivery order, data and/or data packages may be required to be delivered to USAEC at a specified frequency other than those described above.

9.5.1 DEVELOPMENT AND USAGE OF DOCUMENT CONTROL PROCEDURES

9.5.1.1. PURPOSE AND DEFINITION

Document control procedures are necessary in order to produce a litigation quality data package. A data package shall contain all the data necessary to support the results of one analytical method for one lot of samples. Data packages shall be "free standing," that is all data shall be available without reference to other documents or files.

9.5.1.2 CONTENTS OF DATA PACKAGE

In general, all data shall be maintained in two separate locations, the data package and the laboratory notebook(s).

Records to be contained in the data package shall include, but are not limited to the following:

• Original chromatograms, strip charts, or other instrument output. Note that all run data must be included, even if it is not used in determining the final result.

• Original chain of custody form and carrier transmittal documents.

• All hardcopy GC/MS output.

• Expanded scale blow-up of manually integrated peak(s).

• All data sheets or other preprinted forms used by the contractor laboratory.

• All injection logs.



• One sample per lot shall have the ICP spectra printed in hard copy, if possible, according to the instrument used.

• Copies of all relevant notebook pages. This shall include preparation of calibration and QC spiking standards (from stocks to working standards), calibration, sample appearance, sample pH, sample preparation/extraction, moisture determinations, calculations, and any other relevant comments. When any preparation or analysis step is to be performed for a specified time (ie. sonicate for 18 hours) the start and stop times of the procedure shall be recorded.

• Corrective action and non-conformance reports.

• Hard copy of the transfer file as transmitted to USAEC.

Each data package shall contain all information related to one lot for one installation. In cases where a lot has samples from more than one installation then the information shall be copied and placed in separate packages for each installation. In those packages which receive copies, the location of the original material shall be identified.

Each data package shall contain a contents and approval checklist. This list shall identify all materials which must be placed into the data package. This list shall also list reviewer's names, dates of review, provide space for comments, notes, and corrective actions.

It is the responsibility of the contractor laboratory to review data packages for both content and correctness (see Section 9.5.1.3).

Included in the data package shall be a discussion of the observations of the data contained in that package. This discussion shall include, but not be limited to, observed matrix effects, unusual sample appearance, sample pH, blank results, control problems, deviations from approved SOPs, digressions from normal practices (i.e., manual integrations) and reasons thereof, etc. The impact on the usability of the data shall be discussed. Explanations on the use of the applicable flagging codes shall be provided.



9.5.1.3 REVIEW OF DATA PACKAGES

All data packages shall be reviewed by the contractor laboratory. This review should be completed no later than 30 days after the sample analyses for the lot are completed. This review serves two primary purposes. First it ensures that all required data and documents are contained in the data package. Secondly it checks the content for record keeping errors.

Reviewer's names and dates of review shall be recorded on the data package checklist. If any corrective actions are required they shall also be noted. When corrective actions are completed the reviewer shall place his/her initials and date next to the original comment to indicate completion of the action. The responsibility for final review of all data packages resides with the Quality Assurance Officer of the contractor laboratory. The final step in any evaluation shall be the attesting, in writing, of the Quality Assurance Coordinator as to the validity of the data.

Additional reviews are performed at USAEC after receipt of the data packages. Specific procedures for the reviews are covered in USAEC Chemistry Branch internal SOPs.

9.5.1.4 NOTEBOOKS

All contractor laboratories shall use bound notebooks. Both the sewn binding and the plastic binding (i.e., 19 ring GBC plastic binders) are acceptable. Pages shall be pre-numbered prior to use. Each notebook shall be assigned a unique notebook number which shall be recorded on the cover and on each page of the notebook.

Each page shall be signed and dated by the analyst and supervisor. Corrections shall be made by drawing a single line through the incorrect entry. Each correction shall be initialled and dated and also include a brief explanation for the correction. The use of correction media is prohibited.

If material is copied for inclusion in the notebook, the copy must be legible and not reduced to an excessive degree, making it unreadable.

9.5.1.5 FORMS

If the contractor laboratory uses preprinted forms for recording of data, then the original shall be placed into the data package and a copy retained in the appropriate notebook.

Forms should be designed to be specific to a given analysis. All spaces shall be filled, either with the required data or with an N/A to signify that the item is "not applicable" to the analysis.

Corrections shall be made with a single line through the incorrect entry, initialled, dated, and with a short explanation. The use of correction media is prohibited.

9.6 DATA MANAGEMENT SYSTEM

The results for samples analyzed in support of USAEC projects shall be entered in the USAEC IRDMIS. Specific instructions for format, coding, and submission are provided in the IRDMIS User's Guide. In order to facilitate correct and efficient data submission, the information listed in the IRDMIS User's Guide should be collected, recorded, and provided to contractor data management personnel. Questions pertaining to data management should be referred to the contractor data management group. Laboratories are encouraged to interface their internal data management system (i.e., LIMS) to the IRDMIS. USAEC will provide assistance in the accomplishment of that interface. A typical sequence of Data Management activities are shown in Figure 9-1. Any problems with USAEC provided software shall immediately be reported to the USAEC Chemistry Branch. Direct contact with the Data Management Contractor is discouraged, without prior notification of USAEC Chemistry Branch. When problems are site specific and may impact project performance Chemistry Branch will notify the COR/project officer.

Laboratories shall perform group and record checks of the data before transmission to the USAEC IRDMIS. However, the prime contractor is responsible for the quality and correctness of all data. Therefore, it is recommended that the prime contractor also group and record check the data. Any errors that can be corrected by the laboratory shall be corrected before transmission; otherwise the data will be returned



unprocessed. Data that cannot be corrected by the laboratory, e.g., results outside the MRR, will be reviewed by the USAEC Chemistry Branch for acceptance into the IRDMIS.

9.7 DATA REVIEW AND VALIDATION

An integral part of any QA Program is the review of data and its subsequent validation. The primary responsibility for this review and validation rests with the laboratory performing the analyses. Each data package must be reviewed with the data being validated prior to its submission to the Data Management System. Checklists, such as the examples in Appendix P, will be used to demonstrate that the data review was accomplished.

The data review and validation at the laboratory should include, but not be limited to, the following subjects:

- Completeness of laboratory data.
- Evaluation of data with respect to reporting limits.
- Evaluation of data with respect to control limits.
- Review of holding time data.
- Correlation of laboratory data from related laboratory tests.

The specific item for data review are covered in the Data Package Review Checklists, Appendix P.

Specific items for validation shall include, but are not limited to, the following:

- Examination of chain-of-custody records to ensure that custody was properly maintained.
- Comparison of data on instrument print-outs with data recorded on worksheets or in notebooks.

- Checking to ensure that the same calibration was used for all samples within a lot.

- Examination of chromatographic outputs and documentation of the reasons for manual integrations.

- Comparison of standard and sample preparation and injection records with instrument output to ensure that each output is associated with the correct sample.

- Examination of calibration and tuning results, to ensure that requirements are met.

- Checking calculations on selected samples to ensure correctness.

- Checking that GC/MS library searches have been performed for all unknowns, as required, and that the results have been evaluated and recorded.

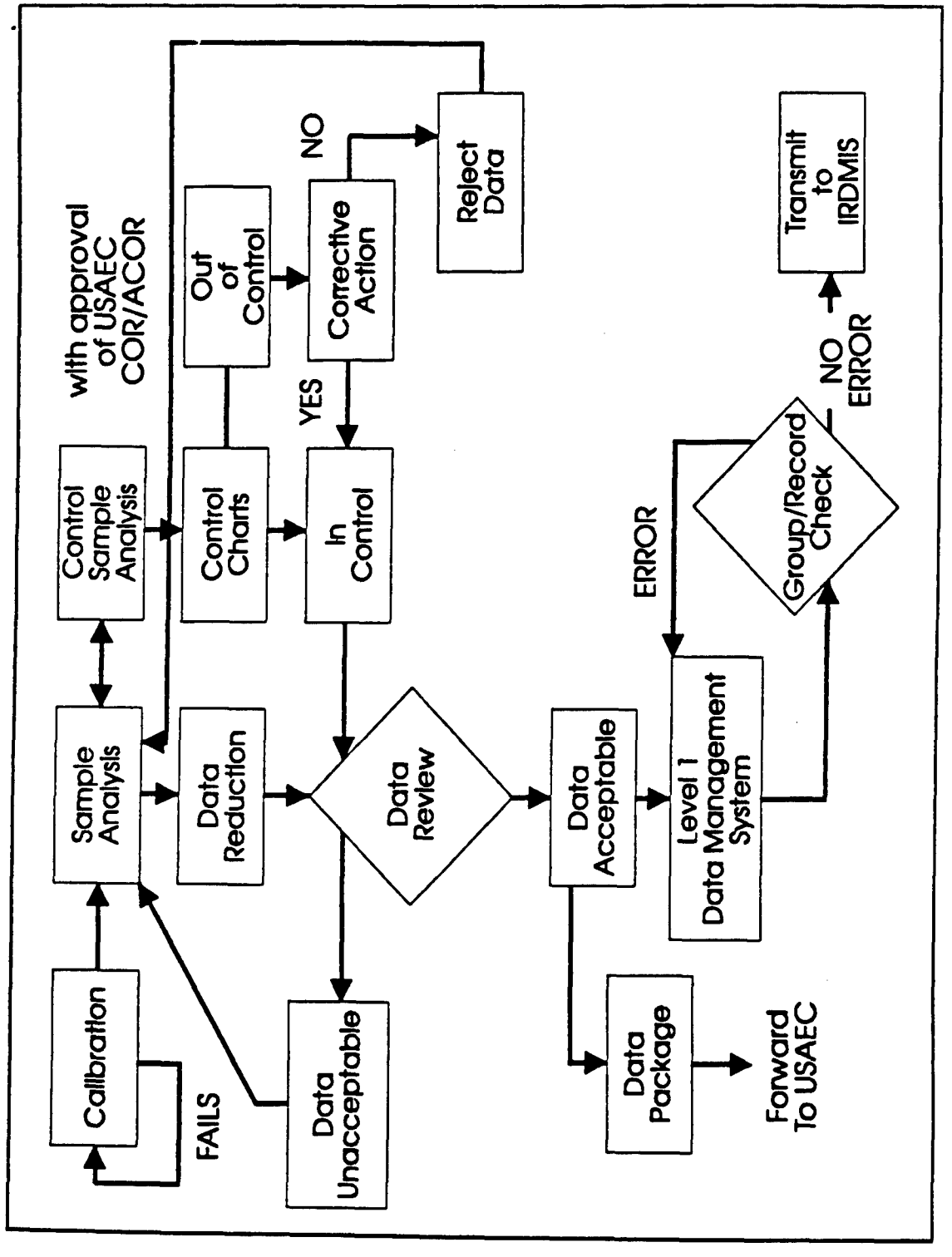
- Examination of all papers and notebooks to ensure that all pages are initialed, dated, and have sufficient explanation for the changes, and that all items are legible.

- Comparison of transfer file, record and group check results with analysis results.

Similar reviews are performed at USAEC once the data packages are received.



Figure 9-1.


with approval of USAEC COR/ACOR
Control Sample Analysis
Control Charts
Out of Control
NO
Corrective Action
Reject Data
YES
In Control
Sample Analysis
Data Reduction
Data Review
Data Acceptable
Level 1 Data Management System
ERROR
Group/Record Check
NO ERROR
Transmit to IRDMIS
Calibration
FAILS
Data Unacceptable
Data Package
Forward To USAEC

10.0 CORRECTIVE ACTIONS

When, as a result of audits or QC sample analysis, sampling or analysis systems are shown to be unsatisfactory, a corrective action shall be implemented. The Project Manager, Analytical Task Manager, QAC, and analyst shall be involved in the corrective action. If previously reported data are affected by the situation requiring correction or if the corrective action will impact the project budget or schedule, the action shall directly involve the Project Manager and the USAEC Project Officer and Project Chemist. Corrective actions are of two kinds:

- Immediate, to correct or repair nonconforming equipment and systems. The need for such an action will most frequently be identified by the analyst as a result of calibration checks and QC sample analyses.

- Long term, to eliminate causes of nonconformance. The need for such actions will probably be identified by audits. Examples of this type of action include:

  - Staff training in technical skills or in implementing these guidelines;

  - Rescheduling of laboratory routine to ensure analysis within allowed holding times;

  - Identifying vendors to supply reagents of sufficient purity; and

  - Revision of Contractor QA system or replacement of personnel.

For either immediate or long-term corrective actions, steps comprising a closed-loop corrective action system are as follows:

- Define the problem;

- Assign responsibility for investigating the problem;

- Investigate and determine the cause of the problem;

- Determine a corrective action to eliminate the problem;



- Assign and accept responsibility for implementing the corrective action;
- Establish effectiveness of the corrective action and implement the correction; and
- Verify that the corrective action has eliminated the problem.

The occurrence of the problem, corrective action employed, and verification that the problem has been eliminated must be documented.

In addition, if the corrective action results in the preparation of a new standard or calibration solution(s), then a comparison of the new versus the old solution needs to be performed and the results supplied with the weekly QC submittal as verification that the problem has been eliminated.

11.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Normal submissions to USAEC shall include the IRDMIS submissions (Section 9.6), audit reports (Section 12.0), and the results of QC activities (Section 8.0). When required in the task order, a CLP data package (as defined in the CLP Statement of Work) shall also be submitted. During those periods when analyses are being conducted, all QC charts (tabular and graphical), as described in Section 8.6, shall be submitted to the USAEC Chemistry Branch on a weekly basis. The QC report shall be provided to the Chemistry Branch NLT 5 working days after analyses for a week are completed. Analysis date shall be defined by the day the analytical instrument was run (Section 9.3). All points which indicate an out-of-control situation shall be evaluated and explained. Any corrective measures and reanalysis of samples shall be fully explained and documented, including procedural changes to prevent recurrence. Printouts generated from control chart software programs provided by USAEC shall be utilized, when available. A checklist for inclusion with each control chart submission is shown in Appendix M. In addition, for the first lot analyzed for each method, a copy of the calibration curve used for that lot shall be included.

As an appendix to the project final report, the QAC, in coordination with the Analytical Task Manager and the Project Manager, shall provide tabulation of all QC sample data, as well as specific observations delineating the control effectiveness for each analytical method. These observations will include the following:

- QC samples in each lot and how analytical results were combined to prepare control charts;

- Spike levels and rationale for choosing those levels;

- Possible effects on environmental sample results of detected concentrations in method blanks; and

- Unique matrix characteristics of environmental samples.

If at any time during the analytical effort a process was not in control, a discussion will be submitted on:

- Rationale for judging a point as in control, if it appears to satisfy an out-of-control



criterion listed in Section 8.7;

- Investigation of the out-of-control situation;
- Actions taken to bring the process back into control;
- Actions taken to ensure that the out-of-control situation did not recur; and
- Disposition of data acquired while the process was out-of-control.

12.0 PERFORMANCE AND SYSTEM AUDITS

An audit is a systematic evaluation to determine the quality of operation of some system or function. As applied in these guidelines, an audit may be external or internal.

12.1 EXTERNAL

External audits are conducted by representatives of the USAEC Chemistry Branch and prime contractors. These audits may be simultaneous or separate. After reviewing the proposed Project QC Plan, the Contractor Laboratory may be visited to discuss any weaknesses in the plan and to evaluate the laboratory's capability to implement the plan. During this visit, the USAEC representative may fill out the Audit Checklist (Appendix Q). Copies of the audit report will be provided to the USAEC Project Officer, the Contractor Project Manager, the Contractor Analytical Task Manager, the Contractor QAC, and the USAEC Chemistry Branch. If deficiencies are of a serious nature, copies will be forwarded to the Contracting Officer at Procurement for official documentation and action. The visit may occur before analyses of field samples are initiated by the laboratory.

After initiation of the analyses by the Contractor Laboratory, a USAEC representative may visit the field activities or the laboratory to evaluate the effective implementation of the Project QC Plan. Any project related activities may be evaluated during the visit (Appendix Q). Any documents or data required by the QA Program shall be eligible for inspection. Any aspect of the internal audit (as described in section 12.2) may be monitored. Findings will be reported to the USAEC Project Officer, the Contractor Project Manager, the Contractor Analytical Task Manager, the Contractor QAC, and the USAEC Chemistry Branch. If deficiencies are of a serious nature, copies may be forwarded to the Contracting Officer at Procurement for official documentation and action.

Scheduling/completion of the visits noted above does not preclude additional visits, as deemed necessary or desirable.



12.2 INTERNAL

Internal audits shall be conducted by the project QC staff (QAC or representative of the QAC) and shall include:

- Verification that standards, procedures, records, charts, magnetic tapes, etc., are properly maintained;

- Verification that actual practice agrees with written instructions; accomplished through the use of a systems audit where a selected method is monitored through all the steps of its performance. This system audit must be accomplished at least once each quarter, if the laboratory effort is long term; or once a month if the laboratory effort is short term. Methods must be selected so that all phases of a laboratory's effort is monitored, to include but not be limited to sample logging, chain of custody, sample preparation, standard preparation, extract storage and analysis and data reduction;

- Verification that QA records are adequately filed and maintained so as to assure protection and retrievability; and

- Assessment of results of QC sample analyses.

Auditing shall consist of observations and notations as to whether approved practices are followed. A formal audit report comprised of summary findings shall be distributed to the Project Manager, Analytical Task Leader, and USAEC Chemistry Branch. Deviations shall be noted and discussed with the staff member, appropriate management, and with USAEC. The audit and findings, both compliance and non-compliance, shall be documented in a bound logbook, or permanently attached and maintained as part of the QA documentation. The QA office shall maintain by project, a file(s) of audit reports and findings, copies of reports and findings that cover more than one project shall be maintained in each project file. At the conclusion of a project or task order, copies of the QA file shall be transmitted to the USAEC Chemistry Branch, along with the data packages.

12.3 FREQUENCY

Internal audits shall be conducted at least quarterly, and the results reported to USAEC within 2 weeks. Prime contractors shall conduct at least one laboratory audit per sampling event, or semiannually, whichever is greater. A written report of the audit shall be provide to USAEC within two weeks.

The USAEC will conduct audits at a frequency commensurate with the needs of the program/project.



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14.0 GLOSSARY

Accuracy -- Difference between individual analytical measurements and the true value, corresponding to the sum of systematic and random errors.

Analyte -- Chemical component for which analysis is conducted.

Analytical Method -- Set of written instructions completely defining the procedure to be adopted by the analyst in order to obtain an analytical result.

Audit -- Systematic check to determine the quality of operation of some function or activity. Audits may be of two basic types: 1) performance audits in which quantitative data are independently obtained for comparison with routinely obtained data in a measurement system; or 2) system audits of a qualitative nature that consist of an onsite review of a laboratory's quality assurance system and physical facilities for sampling, calibration, and measurement.

Chain-of-Custody -- Formalized system of creating an accurate written record which can be used to trace the possession and handling of a sample from the moment of collection through analysis and introduction of data as evidence.

Chemical Calibration Curve -- Best-fit regression curve determined from a plot of response versus calibration standard concentration.

Chemical Calibration Standard -- Solutions containing known amounts of analytes, introduced directly into the instrument to obtain the response versus concentration relationship for each analyte.

Comparability -- Confidence with which one data set can be compared to another.

Confidence Limit -- One of the end points of an interval which has a specified probability of containing a given parameter or characteristic.

Contractor Laboratory -- Analytical chemistry laboratory performing analysis of environmental samples in support of a USAEC contract. The laboratory may be part of the organization holding the contract with USAEC (prime contractor) or may be subcontracted to the prime contractor.



Control Analyte -- Analyte spiked into a QC sample. Control analytes may consist of target and/or surrogate analytes. Control charts are required for each control analyte.

Control Samples -- Samples introduced into the train of environmental samples as monitors on the performance of the analytical method (Section 8.2).

Data Package -- A data package contains all the data necessary to support the results of one analytical method for one lot of samples. Data packages shall be "free standing," that is, all data should be available without reference to other documents or files.

Data Validation -- Systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their intended use. Data validation consists of data editing, screening, checking, auditing, verification, and review.

Data Quality -- Totality of features and characteristics of a data set that bears on its ability to satisfy a given purpose.

Development Laboratory -- Laboratory designated and/or contracted to develop an analytical method.

Field Blank -- Standard matrix sample, to which no analyte of interest has been added, that is transported to the sampling site and back, to ensure that no contamination is introduced during shipment. This sample is created by pouring the distilled water used in the field into a randomly selected container at the sampling site.

Field Duplicate -- A second sample from one site taken in the field and submitted to the laboratory as a separate sample. It is usually analyzed "blind" by the laboratory, i.e., the laboratory does not know that it is a duplicate of another sample. The results act as an external check on the combined precision of sampling and analysis.

Found Concentration -- Concentration based on instrumental response of the sample compared to the instrument calibration curve.

Holding Time -- The maximum time allowable between sample collection and analysis.

IRDMIS -- Installation Restoration Data Management Information System, a USAEC computerized data submittal, storage, and retrieval system.

Lot Size, Maximum -- Number of samples, including QC samples, that can be processed through the rate limiting step of the analytical method during a single time period.

Method Blank -- Standard matrix sample to which no analyte of interest has been added that is processed in the same manner as samples, to ensure that the apparatus and reagents used are not contributing contaminants to the analysis.

Method Documentation Package -- A detailed description of the method to be performed.

Method Detection Level -- The lowest level at which an analyte may be reported.

Method Reporting Range -- The range of concentrations from which data may be reported. This is the range between the Method Detection Level and the Upper Reporting Level.

Negative Interference -- A response indicating a lesser amount of analyte than is actually present.

Outlier -- An extreme observation that is shown to have a low probability of belonging to a data population.

Percent Imprecision -- Single concentration standard deviation divided by the average found concentration; also called Relative Standard Deviation.

Percent Inaccuracy -- The difference between the found and target (true) concentration, divided by the target concentration and multiplied by 100.

Positive Interference -- A response indicating the presence of an analyte in greater amounts than actually present.

Precision -- Degree of mutual agreement among individual measurements made under prescribed conditions with a single test procedure.

Project QC Plan -- An orderly assembly of detailed and specific procedures which delineates how data of known and accepted quality are produced for a specific project.



Project Officer -- The individual responsible for the project at USAEC. The Project Officer may be the USAEC Chemistry Branch Chemist assigned to the project or the Contract COR, depending on the contract under which work is being performed.

Quality Assurance (QA) -- The total integrated program for assuring and documenting the reliability of monitoring and measurement data and for integrating quality planning, quality assessment, and quality improvement efforts to meet user requirements.

Quality Control (QC) -- The routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process.

Quality Control Sample -- Sample that is introduced into a train of environmental samples as a monitor on the performance of the analytical system.

Rank of an Observation -- The number assigned to an observation if a collection of observations is ordered from smallest to largest and each observation is given the number corresponding to its place in the order.

Recovery -- Difference between the analytical results before and after spiking, divided by known amount of spiking compound and multiplied by 100 to convert to percentage.

Representativeness -- The degree to which data accurately and precisely represent a characteristic of a populations parameter variations at a sampling point, a process condition, or an environmental condition.

Response Factor -- The change in the size of peaks of standards that are run under the same conditions. The areas and retention time of the standards should not vary.

Rinse Blank -- Analyte free water which is poured over cleaned equipment and collected for analysis. The results are used to verify the efficiency of the equipment cleaning procedures.

Scientific Notation -- A method of expressing a number with the first significant digit to the left of the decimal point, the remaining significant digits to the right of the decimal point, and multiplied by ten raised to a positive or negative integer power.

Sensitivity -- Instrument response (counts, peak area, etc.) observed for the absolute quantity of analyte introduced into the instrument at the reporting limit.

Significant Figures -- The number of digits used to express a result in scientific notation. All digits are expected to be known definitely, except the last digit, which may be in doubt.

Spiked Sample -- A sample to which a known amount of analyte is added and which is then carried through the complete analytical method.

Standard Deviation -- The positive square root of the expected value of the square of the difference between a random variable and its mean.

Standard Sample -- Sample prepared in a standard matrix as defined in Sections 6.6 and 6.7.

Standing Operating Procedure (SOP) -- A written document which details an operation, analysis or action whose mechanisms are thoroughly prescribed and which is commonly accepted as the method for performing certain routine or repetitive tasks.

Target Analyte -- Specific, validated analyte reported for every sample analyzed by a given method.

Target Concentration -- Known spiked concentration.

Traceability -- The ability to completely reconstruct all activities from the time of sampling to data reporting, including all sample handling as well as instrument maintenance, QC results, and calibration curves.

Trip Blank -- A means to determine if volatile samples are being contaminated during shipping and storage. Vials of analyte free water are prepared by the laboratory and shipped to the sampling site and stored along with the empty sample containers. One trip blank shall be included in each cooler containing field samples for volatiles.

Upper Reporting Level -- The highest concentration at which an analyte may be reported, without the use of dilutions.

Validity -- Degree to which the reported results represent that which they intend to represent.



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15.0 LIST OF ACRONYMS

AAS -- Atomic Absorption Spectroscopy

ASTM -- American Society for Testing and Materials

BC -- Base Closure

BOD -- Biochemical Oxygen Demand

CLP -- Contract Laboratory Program

COD -- Chemical Oxygen Demand

EPA -- U.S. Environmental Protection Agency

GC -- Gas Chromatograph(y)

IC -- Ion Chromatograph(y)

ICP -- Inductively Coupled Plasma-Emission Spectroscopy

IDL -- Instrument(al) Detection Level

IR -- Installation Restoration

IRDMIS -- Installation Restoration Data Management Information System

IRM -- Interim Reference Material

LCL -- Lower Control Limit

LOF -- Lack of Fit

LWL -- Lower Warning Limit

MDL -- Method Detection Level



MRR -- Method Reporting Range

MS -- Mass Spectroscopy

NIST -- National Institute of Standards and Technology

NMR -- Nuclear Magnetic Resonance

QA -- Quality Assurance

QAC -- Quality Assurance Coordinator

QC -- Quality Control

RDL -- Required Detection Level

SARM -- Standard Analytical Reference Material

SRM -- Standard Reference Material from NIST

TDS -- Total Dissolved Solids

TOC -- Total Organic Carbon

TSS -- Total Suspended Solids

TRL -- Target Reporting Limit

UCL -- Upper Control Limit

URL -- Upper Reporting Level

USAEC -- U.S. Army Environmental Center (formerly known as the U.S. Army Toxic and Hazardous Materials Agency)

UWL -- Upper Warning Limit

ZI -- Zero Intercept

APPENDIX A

DOCUMENTATION FOR PROPOSED METHOD DEVELOPMENT

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APPENDIX A

DOCUMENTATION FOR PROPOSED METHOD DEVELOPMENT

1. Organization submitting documentation.

2. Statement of the problem.

3. Description of the technical approach to include specific details on procedures, solvents, instrumentation, etc.

4. Estimate of resources required to include labor hours, funds, and schedule.



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APPENDIX B

RANK SUM TEST



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APPENDIX B

RANK SUM TEST

The following pages contain examples of the Rank Sum Test used for evaluating Class 2 method performance data. The calculations are not performed by the computer software supplied by USAEC. The Rank Sum Test calculations shall be submitted as part of the Validation Procedure for Class 2 methods.

Table B-1. Rank Sum Test, Example 1

Standard Sample	Results	Rank	Average Rank
Blank	NN	1	2.5
Blank	NN	2	2.5
Blank	NN	3	2.5
Blank	NN	4	2.5
Spike	PP	5	6.5
Spike	PP	6	6.5
Spike	PP	7	6.5
Spike	PP	8	6.5

* NN = Negative; PP = Positive

** Average Rank for Negative Results = $\frac{1 + 2 + 3 + 4}{4} = 2.5$

Average Rank for Positive Results = $\frac{5 + 6 + 7 + 8}{4} = 6.5$

Sum of Average Ranks for Blanks = 2.5 + 2.5 + 2.5 + 2.5 = 10.

The criterion for acceptability is that the sum of the average ranks of blanks be less than or equal to 10. Therefore, the results are acceptable.



Table B-2. Rank Sum Test, Example 2

Standard Sample	Results*	Rank	Average Rank**
Blank	NN	1	2
Blank	NN	2	2
Blank	NN	3	2
Blank	PP	4	6
Spike	PP	5	6
Spike	PP	6	6
Spike	PP	7	6
Spike	PP	8	6

* NN = Negative; PP = Positive

** Average Rank for Negative Results = $\frac{1 + 2 + 3}{3} = 2$

Average Rank for Positive Results = $\frac{4 + 5 + 6 + 7 + 8}{5} = 6$

Sum of Average Ranks for Blanks = 2 + 2 + 2 + 6 = 12.

Because the sum of the average ranks of blanks exceed the criterion of less than or equal to 10, the results are unacceptable, therefore,

Test an additional two blanks and two spikes:

Standard Sample	Results	Rank	Average Rank ***
Blank	NN	1	3
Blank	NN	2	3
Blank	NN	3	3
Blank-New	NN	4	3
Blank-New	NN	5	3
Blank	PP	6	9
Spike	PP	7	9
Spike	PP	8	9
Spike	PP	9	9
Spike	PP	10	9
Spike-New	PP	11	9
Spike-New	PP	12	9

*** Average Rank for Negative Results = $\frac{1 + 2 + 3 + 4 + 5}{5} = 3$

Average Rank for Positive Results = $\frac{6 + 7 + 8 + 9 + 10 + 11 + 12}{7} = 9$

Sum of Average Ranks for Blanks = 3 + 3 + 3 + 3 + 3 + 9 = 24.

Because the sum of the average ranks of blanks meet the criterion of less than or equal to 26, the results are acceptable.

Table B-3. Rank Sum Test, Example 3

Standard Sample	Results*	Rank	Average Rank**
Blank	NN	1	3
Blank	NN	2	3
Blank	NN	3	3
Blank	NN	4	3
Spike	NN	5	3
Spike	PP	6	7
Spike	PP	7	7
Spike	PP	8	7

* NN = Negative; PP = Positive

** Average Rank for Negative Results = $\frac{1 + 2 + 3 + 4 + 5}{5} = 3$

Average Rank for Positive Results = $\frac{6 + 7 + 8}{3} = 7$

Sum of Average Ranks for Blanks = 3 + 3 + 3 + 3 = 12.

Because the sum of the average ranks of blanks exceed the criterion of less than or equal to 10, the results are unacceptable, therefore,

Test an additional two blanks and two spikes:

Standard Sample	Results	Rank	Average Rank ***
Blank	NN	1	3.5
Blank	NN	2	3.5
Blank	NN	3	3.5
Blank	NN	4	3.5
Spike	NN	5	3.5
Blank-New	NN	6	3.5
Blank-New	PP	7	9.5
Spike	PP	8	9.5
Spike	PP	9	9.5
Spike	PP	10	9.5
Spike-New	PP	11	9.5
Spike-New	PP	12	9.5

*** Average Rank for Negative Results = $\frac{1 + 2 + 3 + 4 + 5 + 6}{6} = 3.5$

Average Rank for Positive Results = $\frac{7 + 8 + 9 + 10 + 11 + 12}{6} = 9.5$

Sum of Average Ranks for Blanks = 3.5 + 3.5 + 3.5 + 3.5 + 3.5 + 9.5 = 27.

Because the sum of the average ranks of blanks exceed the criterion of less than or equal to 26, the results are unacceptable. The target concentration must be increased or a different method must be used.



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APPENDIX C

SAMPLE CONTAINER CLEANING PROCEDURES

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APPENDIX C

SAMPLE CONTAINER CLEANING PROCEDURES

To ensure the integrity of aqueous and solid samples, steps must be taken to minimize contamination from the containers in which they are stored. If the analyte(s) to be determined are organic in nature, the container should be made of amber glass. If the analyte(s) are inorganic, the container should be polyethylene. When both organic and inorganic substances are expected to be present, separate samples should be taken. New sample bottles must be cleaned according to either of the procedures presented below; reuse of sample containers is expressly prohibited. The procedure that was used must be documented. Commercially cleaned containers may be utilized if cleaning procedures comply with those provided in this appendix and prior USAEC Chemistry Branch approval is obtained. The procedures for cleaning the glass and polyethylene containers and their caps are as follows:

Specified by EPA for CLP

- Amber Glass Bottles

(1) Wash containers, closures, and teflon liners in hot tap water with laboratory grade non-phosphate detergent.

(2) Rinse three times with tap water.

(3) Rinse with 1:1 nitric acid.

(4) Rinse three times with ASTM Type 1 deionized water.

(5) Rinse with pesticide grade methylene chloride.

(6) Oven dry.

(7) Remove containers, closures, and teflon liners from oven.



(8) Place teflon liners in closures and place closures on containers. Attendant to wear gloves and containers not to be removed from preparation room until sealed.

- 40 mL Borosilicate Glass Vials

(1) Wash vials, septa, and closures in hot tap water with laboratory grade non-phosphate detergent.

(2) Rinse three times with tap water.

(3) Rinse three times with ASTM Type 1 deionized water.

(4) Oven dry vials, septa, and closures.

(5) Remove vials, septa, and closures from oven.

(6) Place septa in closures, teflon side down, and place on vials. Attendant to wear gloves and vials not to be removed from preparation room until sealed.

- High Density Polyethylene Bottles

(1) Wash bottles, closures, and teflon liners with hot tap water with laboratory grade non-phosphate detergent.

(2) Rinse three times with tap water.

(3) Rinse with 1:1 nitric acid.

(4) Rinse three times with ASTM Type 1 deionized water.

(5) Air dry in contaminant-free environment.

(6) Place liners in closures and place closures on bottles. Attendant to wear gloves and bottles not to be removed from preparation room until sealed.

Documentation must be provided to the USAEC Chemistry Branch validating that the bottles are in fact "clean." Documentation may consist of the results of "bottle

blank" analysis using the method(s) that will be applied to the sample that will be placed in that bottle. QC results from the supplier of commercially cleaned containers, demonstrating that the bottle(s) are "clean," will be acceptable. The documentation must be provided before the bottles are used to collect samples in the field. This validation is to be performed or provided for each batch or "lot" of bottles cleaned together and must be provided at least once for each installation where they are used.



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APPENDIX D

STANDING OPERATING PROCEDURES
FIELD OPERATIONS

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APPENDIX D

STANDING OPERATING PROCEDURES
FIELD OPERATIONS

The organization shall have written Standing Operating Procedures (SOPs) for all procedures and methods. SOPs shall be available for the following areas and shall contain, at a minimum, the information described.

- Training -- These SOPs describe the training procedures used to ensure that field personnel are qualified to perform the required functions.

- Sample Management -- These SOPs describe the numbering and labeling system, chain-of-custody procedures, and tracking of samples from collection to shipment or relinquishment to the laboratory. Sample management also includes the specification of holding times, volume of sample required by the laboratory, preservatives, and shipping requirements.

- Numbering and Labeling -- These SOPs describe the system for numbering and labeling samples. The numbering system shall ensure that a sample from a given location is assigned a unique number, and typically involves codes that explain information about the sample, such as matrix type, location, depth, and well number. The labeling SOPs shall specify the types of labels and markers to be used, typically waterproof, and the information to be included on the label, such as sample number, date and time of collection, sampler's name, matrix type, and type of analysis required.

- Sample Tracking -- These SOPs describe the procedures used to ensure that sample integrity is maintained from sampling and shipping through receipt in the laboratory. Chain-of-custody will be maintained and, therefore, possession shall be traceable from the time the samples are collected, through analysis, and finally to disposal. Typical information recorded on the custody form includes project name, signature of sampler(s), sampling station number, date and time of collection, and grab or composite sample designation. The signature of the individual(s) involved in sample transfer (i.e., relinquishing and accepting samples) must be documented.

- Sample Containers -- SOPs shall detail the specifications, including type and



size of container and lid, for each container used in a sample collection activity. In addition, SOPs shall specify cleaning procedures to be followed prior to the use of the container to ensure that the container does not contaminate the sample. SOPs may also specify protocols for verifying the cleanliness of the containers through chemical analysis.

- Sample Preservation and Storage -- Preservation techniques are generally limited to pH control, chemical addition, refrigeration, and freezing. SOPs shall describe which preservation techniques apply to a method, how preservatives are added, the amount added, procedures associated with shipping the preservative to the site, and any special handling or safety requirements.

- Holding Times -- Many analyses have a maximum time between collection and initiation of analytical work specified by either the method or regulations. If this time is exceeded, the analytes of interest may degrade and the data may be unusable. SOPs shall list holding times, if applicable, by method and sample matrix, and describe procedures for communicating holding time requirements to field personnel so that samples can be shipped to the laboratory in a timely manner.

- Shipping -- If the laboratory and sampling site are not in close proximity, the samples must be shipped. SOPs shall specify packaging procedures that prevent spills, maintain the required temperature, and meet Department of Transportation (DOT) requirements for shipping environmental or potentially hazardous samples. Instructions shall be provided for completing shipping papers. If holding times are crucial, SOPs should specify delivery to the laboratory within 24 hours or on weekends.

- Decontamination -- These SOPs describe the procedures used to clean field equipment before and during the sample collection process. The SOPs should include cleaning materials used, the order of washing and rinsing with the cleaning materials, requirements for protecting or covering cleaned equipment, procedures for disposing of cleaning materials, and safety considerations.

- Sample Collection Procedures -- SOPs for sample collection procedures shall describe how the procedures are actually performed in the field and not be a simple reference to standard methods, unless a procedure is performed exactly as described in the published method. The SOP for sample collection procedures should include the following:

- Applicability of the procedure;
- Equipment required;
- Detailed description of procedures to be followed in collecting the samples;
- Common problems encountered;
- Precautions to be taken; and
- Health and safety considerations.

It should include a statement that every effort shall be made to collect samples during the work week with samples delivered to the laboratory that same week.

- Corrective Action -- These SOPs describe procedures used to identify and correct deficiencies in the sample collection process. These should include specific steps to take in correcting deficiencies such as performing additional decontamination of equipment, resampling, and additional training of field personnel in methods procedures. The SOP shall specify that each corrective action must be documented with a description of the deficiency, the corrective action taken, and the person(s) responsible for implementing the corrective action.

- Records Management -- These SOPs describe the procedures for generating, controlling, and archiving field records. The SOPs should describe the responsibilities for record generation and control and the policies for record retention, including type, time, security, and retrieval and disposal authorities. Records shall include:

Project-specific records related to fieldwork performed for a group of samples. Project records may include correspondence, chain-of-custody, field notes, all reports issued as a result of the work, training records, project planning documents, and procedural SOPs used.

Field operations records, which document overall field operations. These records may include equipment performance and maintenance logs, personnel files, general field SOPs, and corrective action reports.

- Chemical and Sample Disposal -- These SOPs describe the policies and procedures for disposal of neat chemicals and standard and reagent solutions used in calibration of field equipment and decontamination procedures. Disposal of all chemicals must conform to federal, state, and local regulations.

- Reporting -- These SOPs describe the process for reporting the results of field



activities.

In addition, where analyses are performed in the field, the following additional SOPs are required:

- Reagent/Standard Preparation -- These SOPs describe the procedures used to prepare and document every standard and reagent solution used in field operations. Information concerning specific grades of materials used in the preparation, appropriate glassware, containers for preparation, storage, labeling, recordkeeping for stocks and dilutions, and safety precautions to be taken should be included.

- Equipment Calibration and Maintenance -- These SOPs describe procedures used to ensure that field equipment and instrumentation are in working order. The SOPs describe calibration procedures and schedules, maintenance procedures and schedules, maintenance logs, service contractors or service arrangements for all equipment, and spare parts available in-house. Calibration and maintenance of field equipment and instrumentation shall be in accordance with manufacturers' specifications and shall be documented.

- Field Analysis -- All in situ, portable analysis, mobile labs, or other methods used in the field to determine a chemical or physical parameter shall be described by one or more SOPs. The SOPs shall incorporate applicable criteria from Appendix G.

- Data Reduction and Validation -- These SOPs describe procedures used to compute results from field measurements and to review and validate these data. They should include all formulas used to calculate results and procedures used to verify independently that field measurement results are correct.

APPENDIX E

CHAIN-OF-CUSTODY PROCEDURES

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APPENDIX E

CHAIN-OF-CUSTODY PROCEDURES

The material presented here briefly summarizes the major aspects of chain-of-custody. Reference should be made to NEIC Policies and Procedures (EPA-300/9-78-001-R) for more information.

E.1 INTRODUCTION

As in any other activity that may be used to support litigation, government agencies must be able to provide the chain-of-possession and custody of any samples which are offered for evidence or which form the basis of analytical test results introduced into evidence in any legal proceeding. It is imperative that written procedures be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed. The primary objective of these procedures is to create an accurate written record which can be used to trace the possession and handling of the sample from the moment of its collection through analysis and its introduction as evidence.

A sample is in someone's "custody" if:

- It is in one's actual physical possession;
- It is in one's view, after being in one's physical possession;
- It is in one's physical possession and then locked up so that no one can tamper with it; or
- It is kept in a secured area, restricted to authorized personnel only.



E.2 SURVEY PLANNING AND PREPARATION

The evidence-gathering portion of a survey should be characterized by the minimum number of samples required to give a fair representation of the sampled area or matrix. To the greatest extent possible, the number of samples and sampling locations should be determined prior to the survey.

All survey participants will receive a copy of the survey study plan and will be knowledgeable of its contents prior to the survey. A pre-survey briefing will be held to re-appraise all participants of the survey objectives, sample locations, and chain-of-custody procedures. After all chain-of-custody samples are collected, a debriefing will be held in the field to determine adherence to custody procedures and whether additional evidentiary samples are required.

E.3 SAMPLE COLLECTION, HANDLING, AND IDENTIFICATION

It is important that a minimum number of persons be involved in sample collection and handling. Standard field sampling techniques, such as those published by the U.S. Environmental Protection Agency, should be used for sample collection, preservation, and handling. Field records should be completed at the time the sample is collected and should be signed or initialed, including the date and time, by the sample collector(s). Field records should contain the following information:

- Unique sample or log number;
- Date and time;
- Source of sample (including name, location, and sample type);
- Preservative used;
- Analyses required;
- Name of collector(s);
- Pertinent field data (pH, temperature, depth to water, etc.); and

- Serial number of custody seals and transportation cases.

Each sample is identified by affixing a pressure sensitive gummed label or standardized tag on the container(s). This label should contain the sample identification number, date and time of sample collection, source of sample, preservative used, and the collector's initials. Analyses required should be identified. After all information has been recorded the label should be covered with water-proof tape. Where a label is not available, the same information should be affixed to the sample container with an indelible, water-proof marking pen.

The sample container should then be placed in a transportation case along with the chain-of-custody record form , pertinent field records, and analyses request form as needed. All records should be placed in a plastic, zip-lock type bag.The transportation case should then be sealed and labeled. All records should be filled out legibly in pen.

The use of the locked and sealed chests may never eliminate the need for close control of individual sample containers. Therefore, the sampler should place a custody seal around the cap of the individual sample container which would indicate tampering if removed. In addition, all edges of the cooler lid except the hinge side shall be sealed with evidence tape.

When samples are composited over a time period, unsealed samples can be transferred from one crew to the next crew. A list of samples will be made by the transferring crew and signed for by a member of the receiving crew. They will either transfer the samples to another crew or deliver them to laboratory personnel who will then acknowledge receipt in a similar manner.

Color slides or photographs taken of the sample location and of any visible pollution are recommended to facilitate identification and later recollection by the sampler. A photograph log should be made at the time the photo is taken so that this information can be written later on the back of the photo or in the margin of the slide. This log should include the signature of the photographer, time, date, site location, and brief description of the subject of the photograph. Photographs and written records, which may be used as evidence, should be handled in such a way that chain-of-custody can be established.



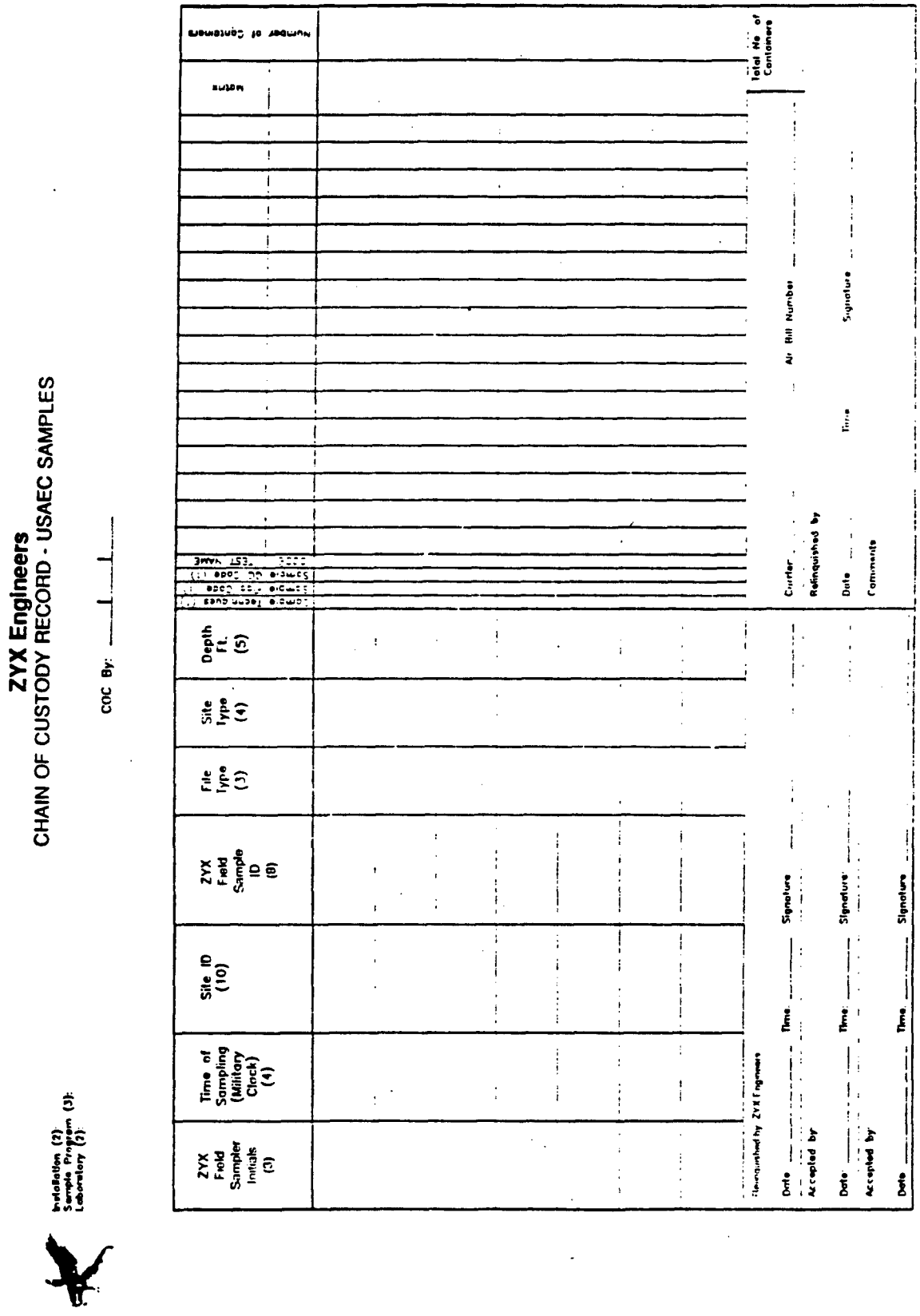
E.4 TRANSFER OF CUSTODY AND SHIPMENT

When transferring the possession of the samples, the transferee must sign and record the date and time on the chain-of-custody record. Custody transfers, if made to a sample custodian in the field, should account for each individual sample, even when samples are transferred as a group. Every person who takes custody must fill in the appropriate section of the Chain-of-Custody Record. To prevent undue proliferation of custody records, the number of custodians in the chain-of-possession should be as few as possible.

The field custodian, or field inspector if a custodian has not been assigned, is responsible for properly packaging and dispatching samples to the appropriate laboratory for analysis. This responsibility includes filling out, dating, and signing the appropriate portions of the Chain-of-Custody Record. A Chain-of-Custody Record format, containing the necessary procedural elements, is shown in Figure E-1.

All packages sent to the laboratory should be accompanied by the Chain-of-Custody Record and other pertinent forms. A copy of these forms should be retained by the originating office (either carbon or photographic copy).

Figure E-1. Sample Chain of Custody Record



Mailed packages can be registered with return receipt requested. If packages are sent by common carrier, receipts should be retained as part of the permanent chain-of-custody documentation. Any other commercial carrier transmittal documents shall also be maintained with the permanent chain-of-custody documentation.

Samples to be shipped must be so packed as not to break and the package so sealed or locked that any evidence of tampering may be readily detected. Custody seals are narrow strips of adhesive paper used to demonstrate that no tampering has occurred. They are intended for use on a sample transport container and for routine use on individual sample containers.

E.5 LABORATORY CUSTODY PROCEDURES

Chain-of-custody procedures are also necessary in the laboratory from the time of sample receipt to the time the sample is discarded. The following procedures are recommended for the laboratory:

- A specific person shall be designated custodian and an alternate designated to act as custodian in the custodian's absence. All incoming samples shall be received by the custodian, who shall indicate receipt by signing the accompanying custody forms and who shall retain the signed forms as permanent records.

- The sample custodian shall maintain a permanent log book to record, for each sample, the person delivering the sample, the person receiving the sample, the date and time received, the source of the sample, the sample identification or log number, how the sample was transmitted to the laboratory, the temperature of the cooler, and the condition received (sealed, unsealed, broken container, or other pertinent remarks). A standardized format should be established for log book entries. A sample receipt checklist (Appendix O) shall be used by the sample custodian as an aid in logging in the samples. A copy of the checklist shall be incorporated into the lot data package.

- A clean, dry, isolation room, building, and/or refrigerated space that can be securely locked from the outside shall be designated as a "Sample Storage Security Area."

- The custodian shall ensure that heat-sensitive, light-sensitive, radioactive, or other samples having unusual physical characteristics or requiring special handling, are



properly stored and maintained prior to analysis. It is recommended that samples for volatile analysis be stored separately from all other samples.

- Distribution of samples to individuals who are responsible for the laboratory performing the analysis shall be made only by the custodian.

- Laboratory personnel are responsible for the care and custody of the sample once it is received by them and shall be prepared to testify that the sample was in their possession and view or secured in the laboratory at all times from the moment it was received from the custodian until the time that the analyses were completed.

- Once the sample analyses are completed, the unused portion of the sample, together with all identifying labels, must be returned to the custodian. The returned tagged sample should be retained in the custody room until permission to destroy the sample is received by the custodian.

- Samples shall be destroyed only after all analytical results have been validated to level 3 in the USAEC Data Management System and such action is approved by the USAEC Project Officer. Samples may be required to be held in storage longer to fulfill contractual requirements or as directed by the USAEC Project Officer.

E.6 QUESTIONS/PROBLEMS CONCERNING CUSTODY RECORDS

If a discrepancy between sample tag numbers and custody record listing is found, the person receiving custody should document this and properly store the samples. The samples should not be analyzed until the problem is resolved.

The responsible person receiving custody should attempt to resolve the problem by checking all available information (other markings or sample container, type of sample, etc.). He should then document the situation on the custody record and in his project log book and notify the project manager, quality control coordinator, and USAEC by the fastest available means, followed by a written corrective action or non-conformance report.



Changes may be written in the "Remarks" section of the custody record and should be initialed and dated. A copy of this record should accompany the written notification to the project manager and quality control coordinator.

E.7 EVIDENTIARY CONSIDERATIONS

Reducing chain-of-custody procedures as well as the various promulgated laboratory analytical procedures to writing will facilitate the admission of evidence under Rule 803(6) of the Federal Rules of Evidence (PL 93-575). Under this statute, written records of regularly conducted business activities may be introduced into evidence as an exception to the "Hearsay Rule" without the testimony of the person(s) who made the record. Although preferable, it is not always possible to have the individuals who collected, kept, and analyzed samples testify in court. In addition, if the opposing party does not intend to contest the integrity of the sample or testing evidence, admission under Rule 803(6) can save a great deal of trial time. For these reasons, it is important that the procedures following in the collection and analyses of evidentiary samples be standardized and described in an instruction manual which, if need be, can be offered as evidence of the "regularly conducted business activity" followed by the laboratory or office generating any given record.

If evidence is to be used in criminal actions, special conditions apply to use of the "Hearsay Rule." It is arguable that those portions of a sampling and analysis report dealing with matters other than sampling and analysis results come within this exception. In criminal actions, records and reports of matter observed by field investigators may not be admissible and the evidence may still have to be presented in the form of oral testimony by the person(s) who made the record or report, even though the materials come within the definition of business records. In a criminal proceeding, the opposing counsel may be able to obtain copies of reports prepared by witnesses, even if the witness does not refer to the records while testifying, and if obtained, the records may be used for cross-examination purposes.

Admission of records is not automatic under either of these sections. The business records section authorizes admission "unless the source of information or the method or circumstances or preparation indicate lack of trustworthiness," and the caveat under the public records exception reads "unless the source of information or other circumstances indicate lack of trustworthiness."

APPENDIX F

SARM REPOSITORY PROGRAM

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APPENDIX F

SARM REPOSITORY PROGRAM

F.1 SARM DEVELOPMENT

Due to the limited availability of reference materials for trace organic analyses from the NIST, USAEC has initiated a program for the development of standard analytical reference materials (SARMs) for use in its programs.

Candidate methods for high purity analyses are selected and evaluated on a preliminary basis, using known materials. Appropriate standards (traceable to NIST) are selected and procured. Sufficient analyses are run to document the random and systematic errors in the analyses. The most appropriate method of high purity analysis is selected for the evaluation of the analytical standards.

Raw materials are synthesized or procured and purified to greater than 98 mole percent. Purities above 98 mole percent can be conveniently and precisely determined in many cases by differential scanning calorimetry using the premelting technique. Wet analyses are used where required. Precision and accuracy data must be presented to support each high purity analysis used to guarantee a standard. Chromatographic analyses are used to estimate impurities and thus, support an analysis by difference. Chromatographic, spectrophotometric, and NMR examination are routinely used to ensure that each material of certified high purity is indeed the correct compound.

Each SARM is subjected to an aggravated storage period to estimate its stability. Materials showing a propensity for decomposition are repurified and stabilized if practical. If repurification and stabilization are not practical, an alternate standard must be selected. SARMs should emerge from aggravated storage with purities in excess of 98 mole percent. Any standards obtained from any other source than USAEC are not considered to be SARMs.



F.1.1. CRITERIA FOR TEST RESULTS

Results of the aggravated storage tests are expressed as mole percent purity before and after the two week test. Unanticipated observations concerning the condition of the standard are noted. Test conditions are fully documented. If the purity of the standard does not fall below the 98 mole percent value and there are no conditions observed in the standard that would interfere with the analytical system, the standard passes the test.

F.1.2. TEST PROCEDURE

Liquid SARMs are sealed in glass bottles with crimp-type septum tops or glass ampules, while solid SARMs are sealed in screw top bottles. The SARMs are sealed under normal atmosphere and stored at 70°C for 2 weeks. These SARMs are then cooled and stored in a freezer until they can be analyzed. If a standard degrades below 98 mole percent, the cause is sought and special storage conditions are developed. Special storage conditions might include dark glass containers, inert atmosphere, lowered temperature, or addition of a stabilizer. If a material is found to be too unstable for storage, a new SARM is selected. The analytical technique initially used to guarantee the purity of each new SARM is repeated after aggravated storage in order to detect degradation.

F.1.3. REPORTS

The results of aggravated storage tests are submitted to the USAEC Chemistry Branch. The Chemistry Branch reviews the suitability of each material and all its supporting data for adequacy as a SARM.

F.2. SARM SURVEILLANCE PROGRAM

At six-month intervals, surveillance samples are removed from the repository and reanalyzed by the original acceptance methods.

F.2.1. PURPOSE

The purpose of this surveillance program is to confirm the integrity of each SARM by scheduled analyses.

F.2.2. CONDITIONS

All SARMs are protected from UV radiation and stored in bulk at 4°C. SARMs which have been purchased at 98 mole percent purity are stored in the manufacturer's container. Where possible, purified SARMs are stored in glass stoppered flasks which have been sealed with Parafilm. Air sensitive compounds are stored under inert atmosphere. Hygroscopic compounds are stored with desiccant in a sealed outer container.

F.2.3. TEST PROCEDURE

A specimen is withdrawn (under the appropriate atmosphere) from each SARM at prescribed intervals. Purities of these specimens are determined using the original acceptance methods.

F.2.4. CRITERIA FOR SURVEILLANCE

The standards must remain at least 98 mole percent pure through the surveillance program. If a SARM fails to meet this criterion, its use is suspended immediately and all laboratories using it are notified by the central repository by phone.



F.2.5. PROGRAM

The surveillance program for each SARM begins when the material is purified and placed in the 4°C repository. If further purification is indicated by the aggravated storage phase, the surveillance period is reinitiated upon completion of the repurification. Thus, the aggravated storage is carried out concomitantly with the first 2 weeks of the first surveillance cycle. Any required subsequent repurification of the SARM reinitiates the surveillance program. Each surveillance cycle lasts 6 months. The entire program continues for 2 years for each SARM. After 2 years, aggravated storage will be repeated on a specimen of the original materials or newly obtained material as availability and projected needs for the material at that time dictate. Materials which have been deleted from the surveys will be removed from the surveillance program at the convenience of USAEC.

F.3. USER REPORTING

The user laboratory shall report any problems with received SARMs or observed degradation of any SARM immediately to the USAEC Chemistry Branch.

APPENDIX G

STANDING OPERATING PROCEDURES
LABORATORY OPERATIONS

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APPENDIX G

STANDING OPERATING PROCEDURES
LABORATORY OPERATIONS

The laboratory shall have written standing operating procedures (SOPs) for all procedures and methods. SOPs shall be available for the following areas and shall contain, at a minimum, the information described:

- Training-- These SOPs describe the training procedures used by the laboratory to ensure that personnel are qualified to perform the required analyses.

- Sample Receipt and Logging -- These SOPs describe the precautions to be used in opening sample shipment containers, as well as procedures used to verify that chain-of-custody has been maintained, to examine samples for damage, to check for proper preservatives and temperature, to assign the testing program, and to log samples into the laboratory sample streams.

- Sample and Extract Storage -- These SOPs describe the storage conditions for all samples, procedures used to verify and document daily storage temperature, and procedures used to ensure that custody of the samples is maintained while in the laboratory.

- Sample Scheduling -- These SOPs describe the procedures and criteria used for scheduling work in the laboratory, including procedures used to ensure that holding times or contract analytical/reporting requirements, if applicable, are met.

- Preventing Sample Contamination -- These SOPs describe the procedures that will be used to prevent cross contamination or lab contamination of samples and extracts.

- Security for Laboratory and Samples -- These SOPs describe the procedures for ensuring that equipment or samples in the laboratory are not tampered with and the limit of access to authorized personnel only.

- Traceability/Equivalency of Standards -- These SOPs describe the



procedures for the obtaining of standards and their inventory and the methods to be employed for the characterization of non-SARMs and the demonstration of equivalency for secondary standards.

• Standard Solution Verification -- These SOPs detail the procedures used to prepare, verify, and document every standard and reagent solution, including reagent-grade water, used in the laboratory. Information concerning specific grades of materials used in the preparation, appropriate glassware and containers for preparation and storage, labeling and recordkeeping for stocks and dilutions, procedures used to verify concentration and purity, and safety precautions to be taken should be included in the SOPs.

• Maintaining Instrument Records and Logbooks -- These SOPs describe procedures used to ensure that laboratory equipment and instrumentation are in working order. The SOPs describe calibration procedures and schedules, maintenance procedures and schedules, maintenance logs, service contracts or service arrangements for all equipment, and spare parts available in-house. Calibration and maintenance of laboratory equipment and instrumentation shall be in accordance with manufacturers' specifications and shall be documented.

• Sample Analysis and Data Control Systems -- These SOPs describe procedures that are used for the operation of the sample analysis and data control systems.

• Glassware Cleaning -- These SOPs describe the procedures that are used in the cleaning of glassware used in the laboratory.

• Technical and Managerial Review of Laboratory Operations and Data Package Preparation -- These SOPs describe the procedures that are used to ensure that operations are being carried out according to requirements, in a timely manner and the interaction between management and the laboratory staff.

• Internal Review and Contractually Required Quality Assurance and Quality Control Data for Each Individual Data Package -- These SOPs detail the type, purpose, and frequency of QC samples analyzed in the laboratory. They should include information on the applicability of the QC sample to the analytical process, the statistical treatment of the data, and the responsibility of laboratory staff and management in generating and using the data.

• Sample Analysis, Data Handling and Reporting -- SOPs for analytical methods shall be a description of how the analysis is actually performed in the laboratory. These SOPs should include the following:

• Sample preparation and analysis procedures including applicable holding time, extraction, digestion, or preparation steps as appropriate to the method; procedures for determining the appropriate dilution to analyze; and any other information required
to perform the analysis accurately and consistently.

• Instrument standardization, including concentration and frequency of analysis of calibration standards, linear range of the method, and calibration acceptance criteria.

• Raw data recording requirements and documentation including sample identification number, analyst, data verification analyst, date of analysis and verification, and computational method(s).

• Data Reduction and Validation -- These SOPs describe the procedures used to compute analytical results from data and to review and validate the data. They should include all formulas used to calculate the results, procedures for computing and interpreting the results from QC samples, and procedures used to independently verify that the analytical results are correct. In addition, routine procedures used to monitor precision and accuracy, including evaluations of reagent, field, and trip blanks, calibration standards, control samples, duplicate and matrix spike samples, and surrogate recovery should be detailed in an SOP. The validation of data entry into the IRDMIS shall be included, i.e., check of transfer file versus input data.

• Chain-of-Custody -- These SOPs describe the procedures to be followed for controlling internal chain of custody of samples and extracts, and reporting problems of chain-of-custody from sampling contractor.

• Document Control, Including Data Package Preparation -- These SOPs describe the procedures being used to control all the data output from the analysis. They conclude the procedures for the preparation of the data package and its subsequent review.

• Corrective Action -- These SOPs describe procedures used to identify and



correct deficiencies in the analytical process. These include specific steps to take in correcting deficiencies such as preparation of new standards and reagents, recalibration and restandardization of equipment, reanalysis of samples, and additional training of laboratory personnel in methods and procedures. The SOP shall specify that each corrective action must be documented with a description of the deficiency, the corrective action taken, and the person(s) responsible for implementing the corrective action.

• Records Management -- These SOPs describe the procedures for generating, controlling, and archiving laboratory records. The SOPs should detail the responsibilities for record generation and control; policies for record retention; including type, time, security, and retrieval and disposal authorities. Records shall include:

• Project-specific records related to analyses performed for a group of samples. Project records may include an index of documents, correspondence, chain-of-custody records, request for analysis, calibration records, raw and finished analytical and QC data, data reports, and project planning documents.

• Laboratory operations records, which document the overall laboratory operation. These records may include laboratory notebooks, instrument performance and maintenance logs, software documentation, control charts, reference material certification, personnel files, laboratory SOPs, and corrective action reports.



APPENDIX H

CONTROL CHART CONSTRUCTION

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APPENDIX H

CONTROL CHART CONSTRUCTION

H.1 SINGLE DAY $\bar{x}$ - R CONTROL CHARTS

Control charts are prepared for each control analyte using data from the duplicate spiked QC samples in each lot to determine percent recovery:

$$\frac{\text{*Found Concentration}}{\text{Spiked Concentration}} \times 100$$

(* Method Blank correction addressed in Section 9.4). Use of percent recovery allows for minor variations in spiking solution concentrations.

To prepare control charts, the analyst should have access to the following data:

- Percent recovery of each analyte in the two high concentration spiked QC samples (Class 1);

- Average ($\bar{x}$) percent recovery for the two spiked QC samples (Class 1) in each lot; and

- Difference (R) between the percent recoveries for the two spiked QC samples (Class 1) in each lot.

The initial control chart shall be prepared using the first four days of analysis data closest to the spiking concentration used during analyses. The average $\bar{x}$ ($\bar{\bar{x}}$), average range (R), and control limits for $\bar{x}$ and R shall be updated after each in-control lot for the first 20 lots. Limits established after lot 20 shall be used for the next 20 lots. Control charts shall be updated after each 20 lots, thereafter, using the most recent 40 points. In interpreting the control charts developed for the initial lots (lots 1-20), the limits established from the previous lots will be used to control the current lot. When modified limits (see Appendix L) are established, data for samples will be accepted if the control data falls between the modified limits. If modified limits have not been established, data



for samples will be accepted based on the recoveries established during validation and the current performance of the method. In updating the control charts, the new data must be combined with the individual values of previous average percent recoveries and not the mean of all previous data. Only lots evaluated as in-control are applicable to the 20 and 40 lot requirements for establishing and updating control limits. Out-of-control or outlier points should be plotted; however, such lots are not utilized in lot number requirements or control limit calculations.

The formulae used to establish and maintain control charts for duplicates are as follows:

Average: $\bar{\bar{x}} = \frac{\sum \bar{x}}{K}$

Range: $\bar{R} = \frac{\sum R}{K}$

where:

$\bar{\bar{x}}$ = between group average of the pairs (within group) average recovery;

$\bar{x}$ = average within group recovery for data pairs;

R = within group difference between recoveries for data pairs; and

K = cumulative number of pairs in data base.

UWL on Average*: $UWL_{\bar{x}} = \bar{\bar{x}} + 1.25\ \bar{R}$

UCL on Average: $UCL_{\bar{x}} = \bar{\bar{x}} + 1.88\ \bar{R}$

LWL on Average*: $LWL_{\bar{x}} = \bar{\bar{x}} - 1.25\ \bar{R}$

LCL on Average: $LCL_{\bar{x}} = \bar{\bar{x}} - 1.88\ \bar{R}$

UWL on Range: $UWL_R = 2.511\ \bar{R}$

UCL on Range: $UCL_R = 3.267\ \bar{R}$

LWL on Range: $LWL_R = 0$

LCL on Range: $LCL_R = 0$

One possible format for maintaining $\bar{x}$ - R chart data in both tabulated and graphic form is shown in Figures 11-1 and 11-2. Examples of $\bar{x}$ - R data and charts are provided in Appendix L.

* See Appendix L for discussion on Modified Limits

All recoveries shall be plotted, whether or not the lot is in-control. Plotted points represent averaged instrument measurements and not the individual measurement values. Each individual recovery measurement value shall be tested as an outlier using Dixon's Test at the 98 percent confidence level (Appendix K). If the datum is not classified as an outlier by the test, the point shall be included in updating the control chart limits. If the datum is classified as an outlier, it shall not be used by the program in updating the control chart limits. Method control shall be judged according to the criteria in Section 8.7. Range data are not subject to outlier testing.

After the first 20 in-control sample lots, control limits shall be recalculated using only in-control data points. The control limits shall then be drawn backward to encompass all previous points. Any points falling outside the control limits (UCL or LCL) shall be dropped and the control limits recalculated using only points between the UCL and LCL. This practice of dropping points and recalculating limits is only performed once. Charts will then be updated with the newly calculated control limits and all points plotted. Lots associated with points outside the new control limits may require resampling and/or reanalysis as determined by the USAEC Project Officer on a case-by-case basis. These limits shall then be used to control analysis of the next 20 lots. Once 60 or more lots are analyzed by a particular method, control limits are recalculated based upon the 40 most recent in-control lots, i.e., control limits for the 60th lot are based on lots 21-60 (40-point slide).



Figure H-1. Sample $\bar{x}$ - R CONTROL CHART DATA TABULATION FORMAT

Laboratory Quality Control Worksheet -- $\bar{X}$ - R Chart

Laboratory _____ Date _____

Method of Test or Operation _____

Reference Value _____ Increment of Measurement _____

Data

Date	No.	X_1	X_2	X_3	$\bar{X}$	R

Totals $\Sigma \bar{X}$ _____ Σ R _____

X_i = observed value R = largest - smallest

K = sets of values CL = control limit

Σ = summation WL = warning limit

U = upper L = lower

D_4 = 3.267 for n = 2; 2.575 for n = 3

A_2 = 1.880 for n = 2; 1.023 for n = 3

Calculations

1. $\bar{R} = \Sigma R \div K$

   ___ = ___ ÷ ___

2. $UCL_R = D_4 \times \bar{R}$

   ___ = ___ x ___

3. $UWL_R = 2/3(D_4\bar{R} - \bar{R}) + \bar{R}$

   ___ = 2/3(___ - ___) + ___

4. $\bar{\bar{X}} = \Sigma \bar{X} \div K$

   ___ = ___ ÷ ___

5. $CL_{\bar{X}} = A_2 \times \bar{R}$

   ___ = ___ x ___

6. $WL_{\bar{X}} = 2/3 \times CL_{\bar{X}}$

   ___ = 2/3 x ___

7. $UCL_{\bar{X}} = \bar{\bar{X}} + CL_{\bar{X}}$

   ___ = ___ + ___

8. $UWL_{\bar{X}} = \bar{\bar{X}} + WL_{\bar{X}}$

   ___ = ___ + ___

9. $LWL_{\bar{X}} = \bar{\bar{X}} - WL_{\bar{X}}$

   ___ = ___ - ___

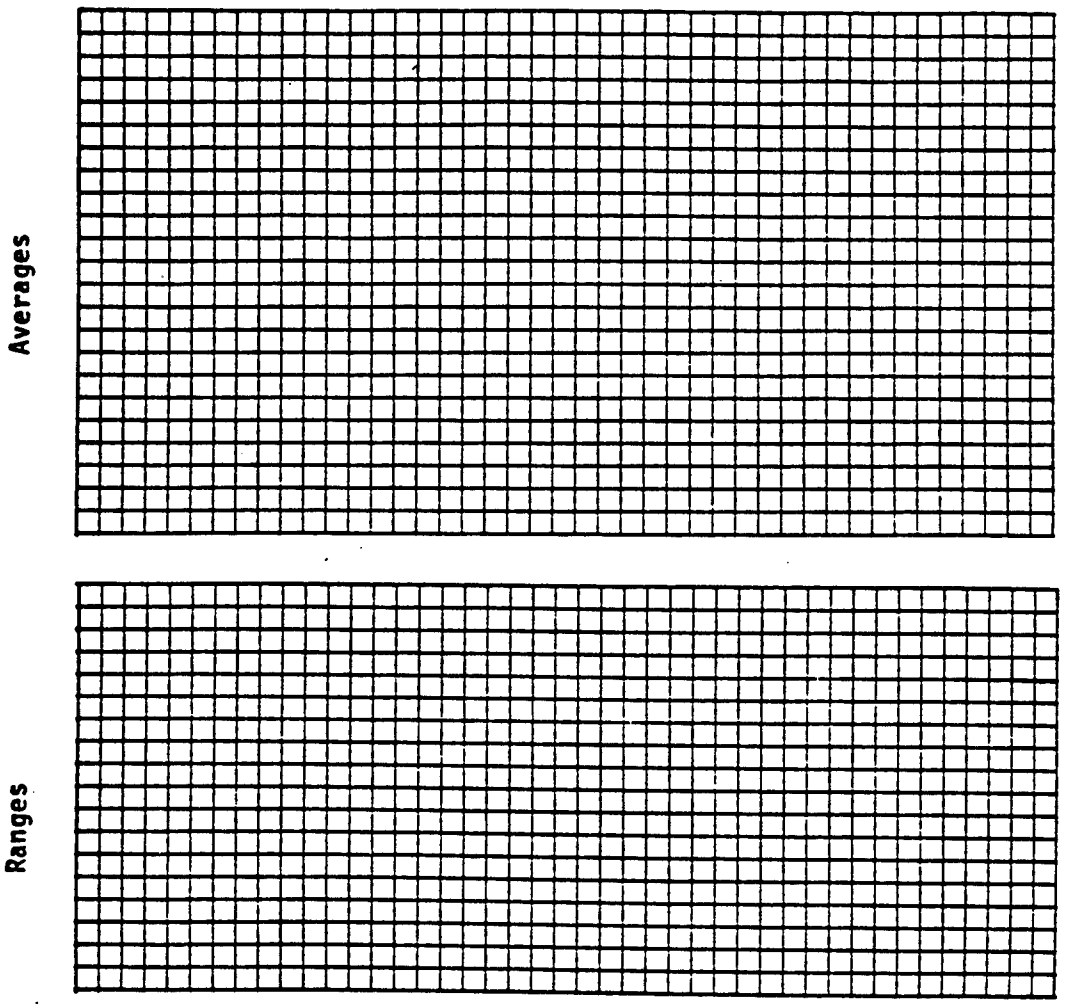
10. $LCL_{\bar{X}} = \bar{\bar{X}} - CL_{\bar{X}}$

    ___ = ___ - ___

Figure H-2. Sample $\bar{x}$ - R CONTROL CHART PLOTTING FORMAT

Laboratory Quality Control Worksheet -- $\bar{X}$ - R Chart

Operation _____ Date _____



Directions:

1. Draw $\bar{R}$ line _____
2. Draw UCL_R line _____
3. Draw UWL_R line _____
4. Plot R's as generated
5. Draw $\bar{\bar{X}}$ line _____
6. Draw $UCL_{\bar{X}}$ line _____
7. Draw $UWL_{\bar{X}}$ line _____
8. Draw $LWL_{\bar{X}}$ line _____
9. Draw $LCL_{\bar{X}}$ line _____
10. Plot $\bar{X}$'s as generated

If the method is judged to be out-of-control (Section 8.7) and reanalysis occurs, no point from the initial analysis may be used to update charts.

H.2 THREE-POINT MOVING AVERAGE CONTROL CHARTS

Moving average control charts shall be maintained for each control analyte spiked in the single low concentration spiked QC sample (Class 1) The X - R three-point moving average control chart shall be constructed for each control analyte as follows:

- Use percent recovery to allow for minor variations in spiking concentration;

- The first plotted point is the average of the first three recoveries (from certification, at concentrations nearest the spiking level);

- Subsequent points are obtained by averaging the three most recent individual recovery values (outliers excluded from calculation, but not from plot);

- The range for each point is the difference between the highest and lowest value for each group of three values; and

- The central line, UWL, UCL, LWL, and LCL for the control charts are calculated using the following formulae:

Average: $\bar{\bar{x}} = \frac{\sum \bar{x}}{K}$

Range: $\bar{R} = \frac{\sum R}{K}$

where:

$\bar{\bar{x}}$ = between group average of the three points (within group) average recovery;

$\bar{x}$ = average within group recovery for the three points;

R = within group difference between recoveries for data sets; and

$\bar{R}$ = between group average of the three points (within group) average range

K = cumulative number of sets in data base.

UWL on Average*: $UWL_{\bar{x}} = \bar{\bar{x}} + 0.682\ R$

UCL on Average: $UCL_{\bar{x}} = \bar{\bar{x}} + 1.023\ \bar{R}$

LWL on Average*: $LWL_{\bar{x}} = \bar{\bar{x}} - 0.682\ \bar{R}$

LCL on Average: $LCL_{\bar{x}} = \bar{\bar{x}} - 1.023\ \bar{R}$

UWL on Range: $UWL_R = 2.050\ \bar{R}$

UCL on Range: $UCL_R = 2.575\ \bar{R}$

LWL on Range: $LWL_R = 0$

LCL on Range: $LCL_R = 0$

All data shall be plotted, whether or not the lot is in-control. Plotted points represent averaged instrument measurements and not the individual measurement values. Each individual recovery measurement value shall be tested as an outlier using Dixon's Test at the 98 percent confidence level (Appendix I). If the datum is not classified as an outlier by the test, the point shall be used by the program to update the control chart limits. If one of the individual measurements is an outlier, it shall be used in calculating the three-point moving average for plotting only, but is then excluded from calculations which are based on the three most recent acceptable individual points and the control chart limits determined accordingly. Method control shall be judged according to the criteria in Section 8.7. Range data are not subject to outlier testing.

After the first 20 in-control sample lots, control limits shall be recalculated using only in-control data points. The control limits shall then be drawn backward to encompass all previous points. Any points falling outside the control limits (UCL or LCL) shall be dropped from the calculations (but left on the charts) and the control limits recalculated using only points between the UCL and LCL. This practice of dropping points and recalculating limits is only performed once. Charts will then be updated with the newly calculated control limits and all points plotted. Lots associated with points outside the



new control limits may require resampling and/or reanalysis as determined by the USAEC Project Officer on a case-by-case basis. These limits shall then be used to control analysis of the next 20 lots. A maximum of the 40 most recent lots will be used to recalculate control limits for 60 or more lots (40-point slide).

An example of data tabulation and plotting using moving average $\bar{x}$ - R charts is shown in Appendix K.

APPENDIX I

OUTLIER TEST



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APPENDIX I

OUTLIER TEST

An extreme observation (outlier) is a datum that appears to be different from the main data pattern. Such observations may be caused by the following:

- A measurement that was read, recorded, or transcribed incorrectly;
- A faulty instrument;
- Incorrectly prepared standards;
- Incorrect calculations;
- Incorrect application of an analytical method;
- Degradation of standard or spiking solutions;
- Environmental conditions that have changed significantly; or
- Other unidentified instrumental problems.

The principal safeguards against obtaining or using an outlier are vigilance during all operations and visual inspection of data before performing statistical analyses.

If a datum falls above or below the control limits of either the X or R control chart or if identified as an outlier by Dixon's test, the value shall be investigated. Sometimes the investigation will reveal a recording or computational mistake that can be revised to obtain the correct value. If an error is found but the correct value cannot be determined, the erroneous value shall not be used in statistical calculations. When errors are found, either correctable or uncorrectable, all analytical results for that lot must be inspected to ensure that erroneous results are not reported. If an uncorrectable error affected results of environmental samples, the lot shall be judged as out-of-control and analyses must be repeated.



DIXON'S TEST

Dixon's test expresses the gap between an outlier and the nearest value as a fraction of the range between the smallest and largest value.

The entire data set must be ordered from highest to lowest, with the highest value assigned a rank of 1 (X_1) and the lowest value a rank of n (Xn). The test criterion (r) varies with sample size, as follows:

- For less than eight measurements, reject Xn (the lowest value) if

$$\frac{Xn-X(n-1)}{Xn-X1} > r(10);$$

- For less than eight measurements, reject X1 (the highest value) if

$$\frac{X2-X1}{Xn-X1} > r(10);$$

- Between eight and ten measurements, reject Xn (the lowest value) if

$$\frac{Xn-X(n-1)}{Xn-X2} > r(11);$$

- Between eight and ten measurements, reject X1 (the highest value) if

$$\frac{X2-X1}{X(n-1)-X1} > r(11);$$

- Between eleven and thirteen measurements, reject Xn (the lowest value) if

$$\frac{Xn-X(n-2)}{Xn-X2} > r(21);$$

- Between eleven and thirteen measurements, reject x1 (the highest value) if

$$\frac{X3-X1}{X(n-1)-X1} > r(21);$$



- Over thirteen measurements, reject Xn (the lowest value) if

$$\frac{Xn-X(n-2)}{Xn-X3} > r(22);$$

- Over thirteen measurements, reject X1 (the highest value) if

$$\frac{X3-X1}{X(n-2)-X} > r(22).$$

The critical values for the test statistic at 98 percent confidence level are shown in Table I-1. If the test statistic is greater than the critical value from the Table, then the data point is an outlier. Once adequate data are available, n shall be kept constant at 20, with the 20 most recent data points being used.



Table I-1. CRITICAL VALUES FOR DIXON'S OUTLIER TEST

Number of Measurements (n)	Criterion (r)	Critical Value of r (a = 0.02)	Critical Value of r (a = 0.05)
3		0.988	0.970
4		0.889	0.829
5	r_{10}	0.780	0.710
6		0.698	0.625
7		0.637	0.568
8		0.683	0.615
9	r_{11}	0.635	0.570
10		0.597	0.534
11		0.579	0.625
12	r_{21}	0.642	0.592
13		0.615	0.565
14		0.641	0.590
15		0.616	0.568
16		0.595	0.548
17		0.577	0.531
18		0.561	0.516
19		0.547	0.503
20	r_{22}	0.535	0.491
21		0.524	0.480
22		0.514	0.470
23		0.505	0.461
24		0.497	0.452
25		0.489	0.445

APPENDIX J

$\bar{x}$ - R CHART DATA TABULATION AND GRAPHING FOR DUPLICATE SPIKE RECOVERY

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Figure J-1

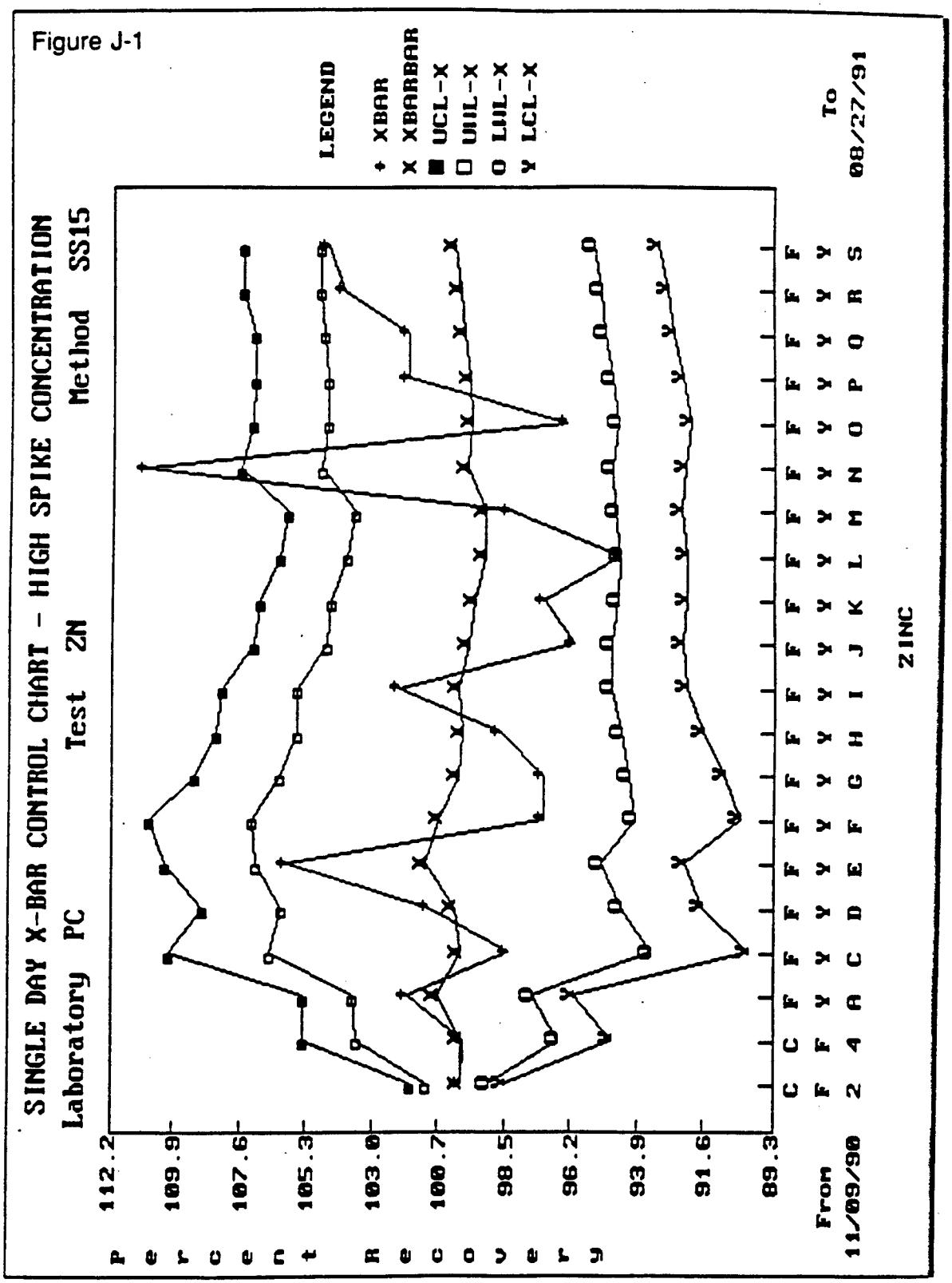

SINGLE DAY X-BAR CONTROL CHART - HIGH SPIKE CONCENTRATION
Laboratory PC Test ZN Method SS15
LEGEND
+ XBAR
X XBARBAR
UCL-X
UWL-X
LWL-X
LCL-X
From 11/09/90
To 08/27/91
ZINC
Percent Recovery
112.2
109.9
107.6
105.3
103.0
100.7
98.5
96.2
93.9
91.6
89.3

Figure J-2

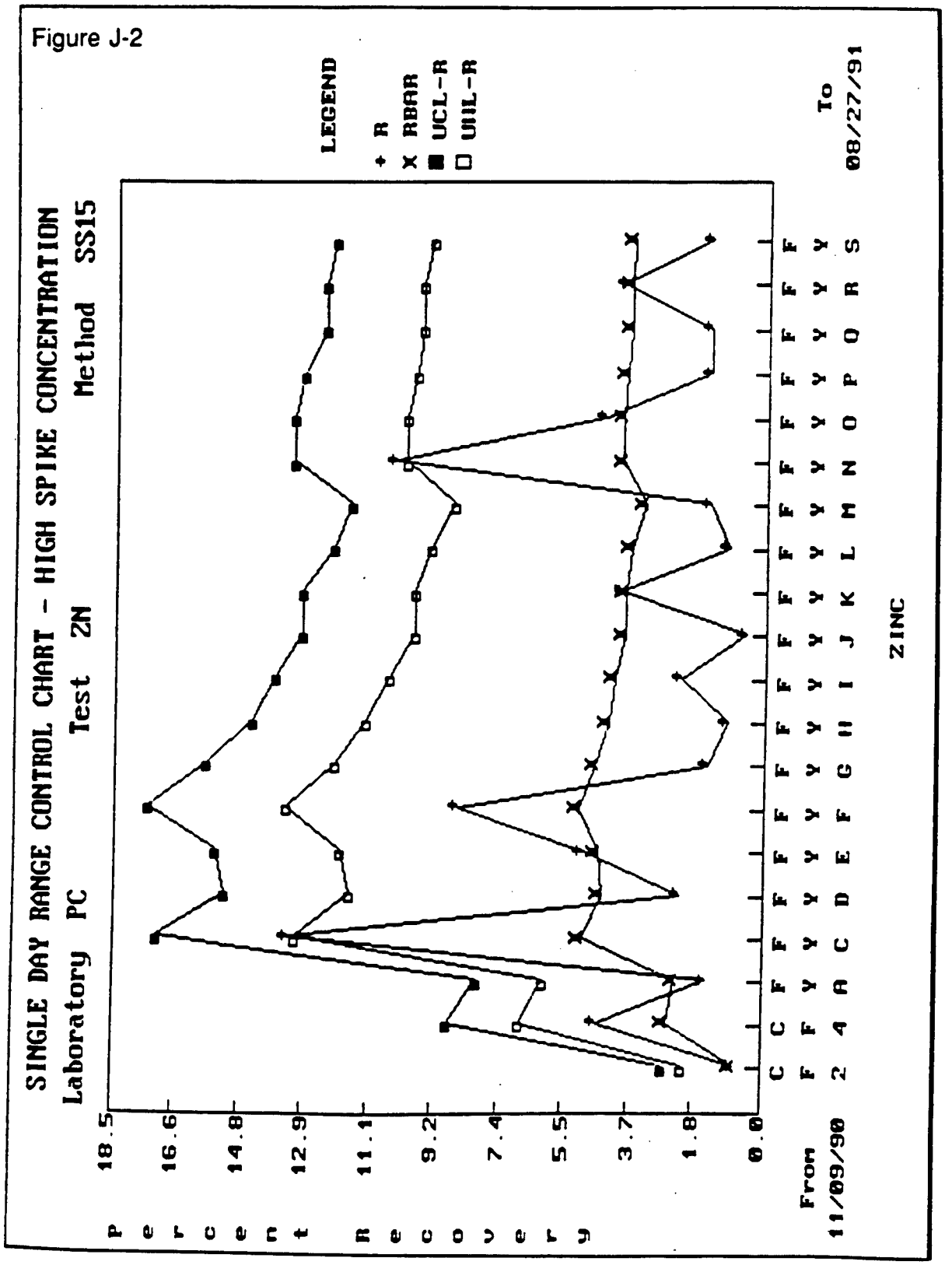

SINGLE DAY RANGE CONTROL CHART - HIGH SPIKE CONCENTRATION
Laboratory PC Test ZN Method SS15
LEGEND
+ R
X RBAR
■ UCL-R
□ UIL-R
From 11/09/90
To 08/27/91
Percent Recovery
18.5
16.6
14.8
12.9
11.1
9.2
7.4
5.5
3.7
1.8
0.0
ZINC

Figure J-3

Version 3.10

SINGLE DAY R REPORT OF PERCENT RECOVERY - HIGH CONCENTRATION
FOR ZINC

Laboratory:PC	Date:01/08/93
Method:SS15	Test Name:ZN

Date	Lot	QC Man	QC Exp	X1 Man	X1 Exp	X2 Man	X2 Exp	%X1	%X2	R	UCLR	UWLR
110990	CF2	2.00	3	2.01	3	2.00	3	100.7	99.8	0.9	2.9	2.3
110990	CF4	2.00	3	2.05	3	1.96	3	102.6	97.8	4.8	9.1	7.0
022091	FYA	1.70	3	1.75	3	1.72	3	102.9	101.2	1.8	8.2	6.3
022291	FYC	1.70	3	1.56	3	1.79	3	91.8	105.3	13.5	17.3	13.3
030691	FYD	1.70	3	1.70	3	1.74	3	100.0	102.4	2.4	15.4	11.8
031391	FYE	1.70	3	1.76	3	1.85	3	103.5	108.8	5.3	15.7	12.1
040391	FYF	1.70	3	1.58	3	1.73	3	92.9	101.8	8.8	17.6	13.6
040491	FYG	1.70	3	1.64	3	1.67	3	96.5	98.2	1.8	16.0	12.3
041191	FYH	1.70	3	1.67	3	1.69	3	98.2	99.4	1.2	14.7	11.3
041891	FYI	1.70	3	1.72	3	1.76	3	101.2	103.5	2.4	14.0	10.8
042291	FYJ	1.70	3	1.64	3	1.63	3	96.5	95.9	0.6	13.1	10.0
060391	FYK	1.70	3	1.69	3	1.62	3	99.4	95.3	4.1	13.1	10.0
060491	FYL	1.70	3	1.62	3	1.60	3	95.3	94.1	1.2	12.4	9.5
061191	FYM	1.70	3	1.66	3	1.69	3	97.7	99.4	1.8	11.8	9.0
062091	FYN	1.70	3	1.80	3	1.98	3	105.9	116.5	10.6	13.4	10.3
071991	FYO	1.70	3	1.60	3	1.68	3	94.1	98.8	4.7	13.4	10.3
072491	FYP	1.70	3	1.72	3	1.75	3	101.2	102.9	1.8	13.1	10.0
073191	FYQ	1.70	3	1.72	3	1.75	3	101.2	102.9	1.8	12.7	9.8
080691	FYR	1.70	3	1.74	3	1.81	3	102.4	106.5	4.1	12.7	9.8
082791	FYS	1.70	3	1.77	3	1.80	3	104.1	105.9	1.8	12.4	9.5

* Changes made to data



Figure J-4

Version 3.10

SINGLE DAY XBAR REPORT OF PERCENT RECOVERY - HIGH CONCENTRATION
FOR ZINC

Laboratory:PC	Date:01/08/93
Method:SS15	Test Name:ZN

Date	Lot	QC Man	QC Exp	x1 Man	x1 Exp	x2 Man	x2 Exp	%x1	%x2	XBAR	UCLX	UWLX	LWLX	LCLX	OUTLIER
110990	CF2	2.00	3	2.01	3	2.00	3	100.7	99.8	100.3	102.0	101.4	99.2	98.6	.F.
110990	CF4	2.00	3	2.05	3	1.96	3	102.6	97.8	100.2	105.6	103.8	96.8	95.0	.F.
022091	FYA	1.70	3	1.75	3	1.72	3	102.9	101.2	102.1	105.6	104.0	97.8	96.2	.F.
022291	FYC	1.70	3	1.56	3	1.79	3	91.8	105.3	98.5	110.3	106.9	93.7	90.3	.F.
030691	FYD	1.70	3	1.70	3	1.74	3	100.0	102.4	101.2	109.3	106.4	94.6	91.7	.F.
031391	FYE	1.70	3	1.76	3	1.85	3	103.5	108.8	106.2	110.4	107.4	95.4	92.4	.F.
040391	FYF	1.70	3	1.58	3	1.73	3	92.9	101.8	97.3	111.0	107.6	94.1	90.6	.F.
040491	FYG	1.70	3	1.64	3	1.67	3	96.5	98.2	97.3	109.6	106.5	94.3	91.2	.F.
041191	FYH	1.70	3	1.67	3	1.69	3	98.2	99.4	98.8	108.7	105.8	94.6	91.7	.F.
041891	FYI	1.70	3	1.72	3	1.76	3	101.2	103.5	102.4	108.5	105.8	95.0	92.3	.F.
042291	FYJ	1.70	3	1.64	3	1.63	3	96.5	95.9	96.2	107.5	105.0	95.0	92.5	.F.
060391	FYK	1.70	3	1.69	3	1.62	3	99.4	95.3	97.3	107.3	104.8	94.8	92.3	.F.
060491	FYL	1.70	3	1.62	3	1.60	3	95.3	94.1	94.7	106.5	104.2	94.7	92.3	.F.
061191	FYM	1.70	3	1.66	3	1.69	3	97.7	99.4	98.5	106.2	103.9	94.9	92.6	.F.
062091	FYN	1.70	3	1.80	3	1.98	3	105.9	116.5	111.2	107.8	105.2	95.0	92.4	.F.
071991	FYO	1.70	3	1.60	3	1.68	3	94.1	98.8	96.5	107.6	105.0	94.8	92.2	.F.
072491	FYP	1.70	3	1.72	3	1.75	3	101.2	102.9	102.1	107.5	105.0	95.0	92.5	.F.
073191	FYQ	1.70	3	1.72	3	1.75	3	101.2	102.9	102.1	107.5	105.1	95.3	92.9	.F.
080691	FYR	1.70	3	1.74	3	1.81	3	102.4	106.5	104.4	107.7	105.3	95.5	93.1	.F.
082791	FYS	1.70	3	1.77	3	1.80	3	104.1	105.9	105.0	107.7	105.3	95.8	93.5	.F.

* Changes made to data

Figure J-5

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-------------------------------------------
| SINGLE DAY XBAR CHARTS - HIGH CONCENTRATION |
-------------------------------------------

-------------------------------------------------
| Laboratory: PC | Date: 01/08/93 | Method: SS15  |
-------------------------------------------------
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NOTE: This is an abbreviated report and may not reflect the entire situation. You need to examine the charts and comment on corrective measures. This program does not test for cyclical patterns.

Number of Control Analytes: 12.

Method is out-of-control.
Less than one-third of the analytes were out-of-control.
However, of this one-third, at least one analyte contained two consecutive out-of-control points.

ANALYTE	BEGIN LOT	END LOT	NUMBER OF POINTS
SE	FYR	FYS	2

The following analytes contained points classified as outliers:

ANALYTE	LOT
BE	FYI
NI	FYQ
SE	FYQ
SE	FYR

The following analytes contained points outside the UCL:

ANALYTE	LOT	XBAR	UCL
BE	FYN	101.5	100.2
BE	FYS	103.5	100.8
BA	FYN	102.4	102.1
CR	FYS	106.9	104.3
CU	FYI	103.5	100.8
CU	FYR	101.5	100.2
SB	FYS	103.5	102.5
SE	FYN	106.0	103.1
SE	FYP	104.3	104.1
SE	FYR	136.8	104.1
SE	FYS	109.0	104.5
ZN	FYN	111.2	107.8



Figure J-6

The following analytes contained points outside the LCL:

ANALYTE	LOT	XBAR	LCL
BE	FYI	49.0	89.5
BA	FYO	87.5	89.3
CO	FYL	89.2	91.8
NI	FYQ	55.4	93.4
SB	FYG	92.9	93.1
SB	FYL	91.0	92.5
SE	FYG	93.0	94.7
SE	FYJ	92.7	94.0
SE	FYL	93.3	93.6
SE	FYQ	57.9	93.5
TL	FYO	85.7	87.5

The following analytes contained seven successive points below the central line:

ANALYTE	BEGIN LOT	END LOT	NUMBER OF POINTS
SE	FYF	FYM	8

WARNING: The following analytes contained four successive points going in an upward direction:

ANALYTE	BEGIN LOT	END LOT
BE	FYP	FYS
BA	FYP	FYS
CR	FYP	FYS
PB	FYP	FYS
SB	FYP	FYS

WARNING: The following analytes contained six successive points below the central line:

ANALYTE	BEGIN LOT	END LOT
TL	FYJ	FYO

Figure J-7

SINGLE DAY RANGE CHARTS - HIGH CONCENTRATION

Laboratory: PC | Date: 01/08/93 | Method: SS15

NOTE: This is an abbreviated report and may not reflect the entire situation. You need to examine the charts and comment on corrective measures. This program does not test for cyclical patterns.

Number of Control Analytes: 12.

Method is out-of-control.
Less than one-third of the analytes were out-of-control.
However, of this one-third, at least one analyte contained two consecutive out-of-control points.

ANALYTE	BEGIN LOT	END LOT	NUMBER OF POINTS
SE	FYQ	FYR	2

The following analytes contained points outside the UCL:

ANALYTE	LOT	XBAR	UCL
BE	FYI	98.0	10.1
NI	FYQ	90.6	11.1
SE	FYQ	94.9	9.1
SE	FYR	60.3	9.1



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APPENDIX K

$\bar{x}$ - R CHART DATA TABULATION AND GRAPHING FOR THREE-POINT MOVING AVERAGE SPIKE RECOVERY



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Figure K-1

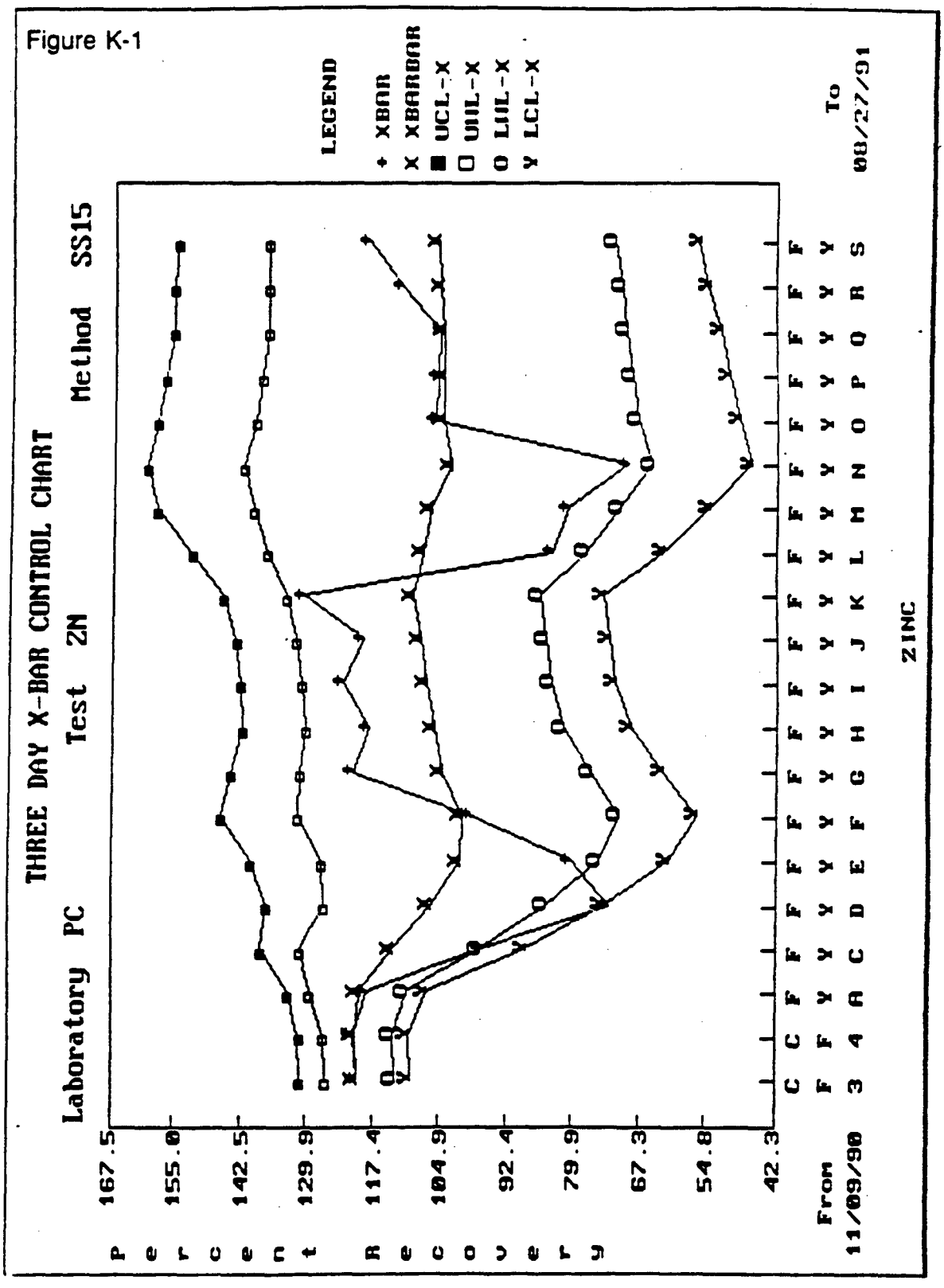

THREE DAY X-BAR CONTROL CHART
Laboratory PC Test ZN Method SS15
LEGEND
+ XBAR
X XBARBAR
■ UCL-X
□ UWL-X
O LWL-X
Y LCL-X
From 11/09/90
To 08/27/91
Percent Recovery
167.5
155.0
142.5
129.9
117.4
104.9
92.4
79.9
67.3
54.8
42.3
C C F F F

Figure K-2

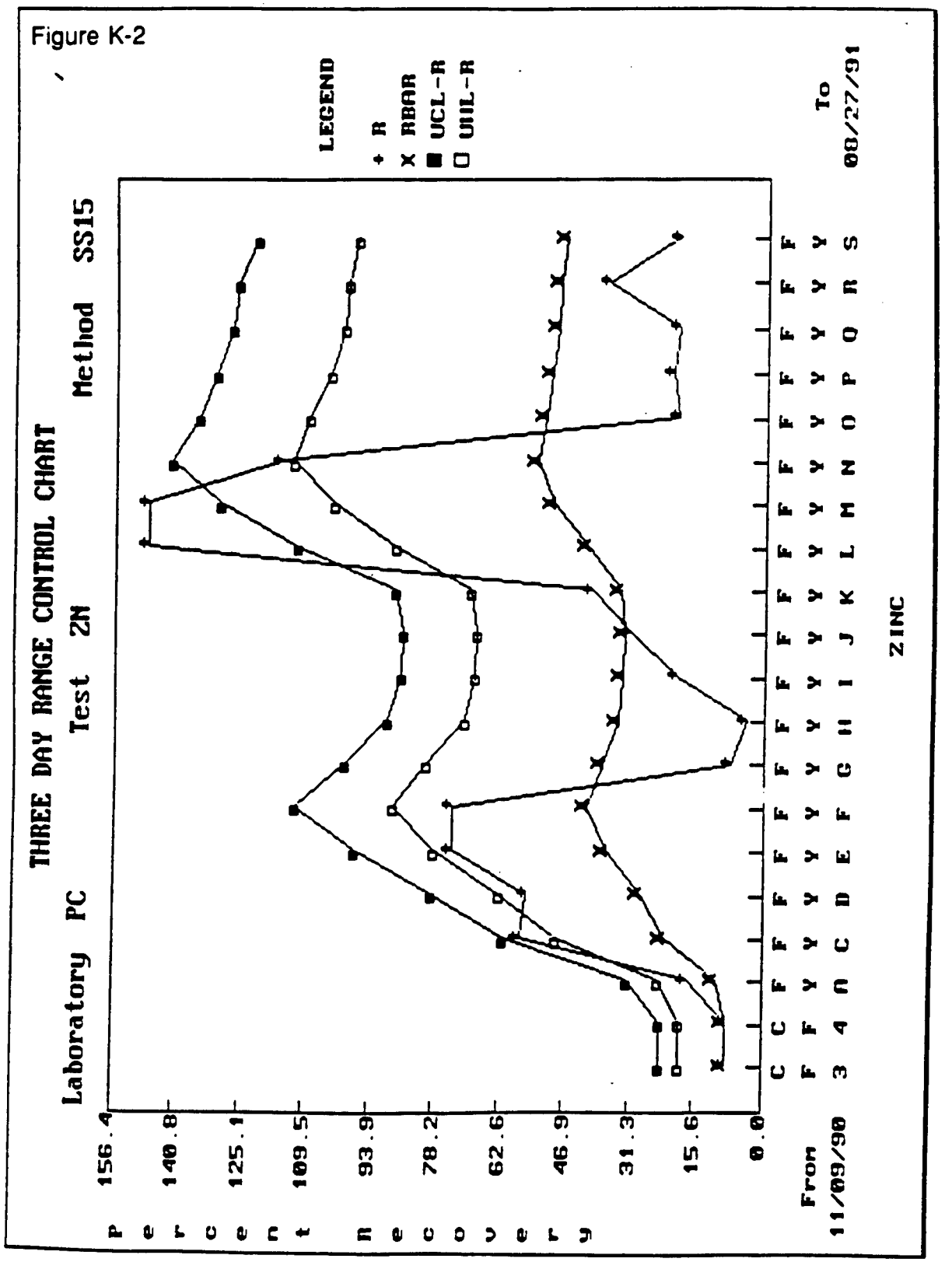

THREE DAY RANGE CONTROL CHART
Laboratory PC Test ZN Method SS15
LEGEND
+ R
X RBAR
■ UCL-R
□ UIL-R
From 11/09/90
To 08/27/91
ZINC
percent recovery
156.4
140.8
125.1
109.5
93.9
78.2
62.6
46.9
31.3
15.6
0.0

Figure K-3

Version 3.10

THREE DAY MOVING AVERAGE R REPORT OF PERCENT RECOVERY
FOR ZINC

Laboratory:PC	Date:01/08/93
Method:SS15	Test Name:ZN

Date	Lot	QC Man	QC Exp	x Man	x Exp	%X	R	UCLR	LWLR
110990	CF1	4.00	1	4.80	1	120.0	0.0	0.0	0.0
110990	CF2	4.00	1	4.70	1	117.5	0.0	0.0	0.0
110990	CF3	4.00	1	5.10	1	127.5	10.0	25.8	20.5
110990	CF4	4.00	1	4.90	1	122.5	10.0	25.8	20.5
022091	FYA	6.50	1	7.10	1	109.2	18.3	33.0	26.2
022291	FYC	6.50	1	4.10	1	63.1	59.4	62.8	50.0
030691	FYD	6.50	1	3.35	1	51.5	57.7	80.1	63.8
031391	FYE	6.50	1	8.30	1	127.7	76.1	99.4	79.1
040391	FYF	6.50	1	7.90	1	121.5	76.2	113.3	90.2
040491	FYG	6.50	1	7.70	1	118.5	9.2	102.0	81.2
041191	FYH	6.50	1	7.60	1	116.9	4.6	91.9	73.2
041891	FYI	6.50	1	9.00	1	138.5	21.6	88.3	70.3
042291	FYJ	6.50	1	6.90	1	106.2	32.3	87.8	69.9
060391	FYK	6.50	1	9.70	1	149.2	43.0	89.9	71.5
060491	FYL	6.50	1	1.00	-6	0.0	149.2	112.5	89.6
061191	FYM	6.50	1	6.20	1	95.4	149.2	131.8	105.0
062091	FYN	6.50	1	7.60	1	116.9	116.9	143.2	114.0
071991	FYO	6.50	1	7.00	1	107.7	21.5	137.8	109.7
072491	FYP	6.50	1	6.10	1	93.9	23.1	133.1	106.0
073191	FYQ	6.50	1	7.50	1	115.4	21.5	128.8	102.5
080691	FYR	6.50	1	8.60	1	132.3	38.5	127.2	101.3
082791	FYS	6.50	1	7.20	1	110.8	21.5	123.6	98.4

* Changes made to data

Figure K-4

version 3.11

THREE DAY MOVING AVERAGE XBAR REPORT OF PERCENT RECOVERY
FOR ZINC

Laboratory:PC | Date:01/08/93
Method:SS15 | Test Name:ZN

Date	Lot	QC Man	QC Exp	X Man	X Exp	%X	XBAR	UCLX	UWLX	LWLX	LCLX	OUTLIER
110990	CF1	4.00	1	4.80	1	120.0	0.0	0.0	0.0	0.0	0.0	.F.
110990	CF2	4.00	1	4.70	1	117.5	0.0	0.0	0.0	0.0	0.0	.F.
110990	CF3	4.00	1	5.10	1	127.5	121.7	131.9	128.5	114.9	111.5	.F.
110990	CF4	4.00	1	4.90	1	122.5	122.5	132.3	128.9	115.3	111.9	.F.
022091	FYA	6.50	1	7.10	1	109.2	119.7	134.4	130.0	112.6	108.2	.F.
022291	FYC	6.50	1	4.10	1	63.1	98.3	140.5	132.1	98.9	90.5	.F.
030691	FYD	6.50	1	3.35	1	51.5	74.6	139.2	128.6	86.2	75.6	.F.
031391	FYE	6.50	1	8.30	1	127.7	80.8	142.4	129.2	76.6	63.4	.F.
040391	FYF	6.50	1	7.90	1	121.5	100.3	147.6	132.6	72.6	57.6	.F.
040491	FYG	6.50	1	7.70	1	118.5	122.6	145.6	132.1	78.1	64.6	.F.
041191	FYH	6.50	1	7.60	1	116.9	119.0	143.1	130.9	82.3	70.1	.F.
041891	FYI	6.50	1	9.00	1	138.5	124.6	143.5	131.8	85.0	73.3	.F.
042291	FYJ	6.50	1	6.90	1	106.2	120.5	144.4	132.8	86.2	74.6	.F.
060391	FYK	6.50	1	9.70	1	149.2	131.3	147.0	135.1	87.5	75.6	.F.
060491	FYL	6.50	1	1.00	-6	0.0	85.1	154.0	139.1	79.5	64.6	.F.
061191	FYM	6.50	1	6.20	1	95.4	81.5	159.7	142.2	72.4	54.9	.F.
062091	FYN	6.50	1	7.60	1	116.9	70.8	161.8	142.8	67.0	48.0	.F.
071991	FYO	6.50	1	7.00	1	107.7	106.7	159.7	141.5	68.5	50.3	.F.
072491	FYP	6.50	1	6.10	1	93.9	106.1	158.0	140.4	69.8	52.2	.F.
073191	FYQ	6.50	1	7.50	1	115.4	105.6	156.3	139.2	71.0	53.9	.F.
080691	FYR	6.50	1	8.60	1	132.3	113.9	156.1	139.3	71.9	55.1	.F.
082791	FYS	6.50	1	7.20	1	110.8	119.5	155.4	139.0	73.6	57.2	.F.

* Changes made to data

Figure K-5

THREE DAY XBAR CHARTS

Laboratory: PC | Date: 01/08/93 | Method: SS15

NOTE: This is an abbreviated report and may not reflect the entire situation. You need to examine the charts and comment on corrective measures. This program does not test for cyclical patterns.

Number of Control Analytes: 12.

Method is out-of-control.
Greater than one-third of the analytes were out-of-control.

LOT	NUMBER OF ANALYTES
FYL	10

The following analytes contained points classified as outliers:

ANALYTE	LOT
BA	FYJ
BA	FYK
BA	FYL
BA	FYO
CD	FYN
CO	FYL
CR	FYL
CU	FYL
NI	FYL
PB	FYL
SB	FYL
TL	FYL

The following analytes contained points outside the UCL:

ANALYTE	LOT	RECOVERY	UCL
CD	FYN	105.0	99.3
CD	FYP	105.0	99.9
CD	FYR	105.0	101.1
TL	FYQ	105.0	99.9
TL	FYS	102.0	101.0
ZN	FYK	149.2	147.0



Figure K-6

The following analytes contained points outside the LCL:

ANALYTE	LOT	RECOVERY	LCL
BE	FYA	60.0	67.3
BE	FYC	60.0	62.0
CO	FYL	0.0	66.2
CR	FYL	0.0	64.3
CU	FYL	0.0	31.1
NI	FYL	0.0	55.4
PB	FYL	0.0	72.2
SB	FYL	0.0	68.9
SE	FYL	0.0	51.8
TL	FYL	0.0	60.9
ZN	FYL	0.0	64.6

The following analytes contained two consecutive points between the UCL and UWL:

ANALYTE	BEGIN LOT	END LOT	RECOVERY	UCL	UWL	NUMBER OF POINTS
SE	FYP	FYQ	117.3	129.1	115.2	2

The following analytes contained seven successive points above the central line:

ANALYTE	BEGIN LOT	END LOT	NUMBER OF POINTS
BE	FYM	FYS	7
CD	FYG	FYS	13
NI	FYM	FYS	7

The following analytes contained seven successive points below the central line:

ANALYTE	BEGIN LOT	END LOT	NUMBER OF POINTS
SB	FYJ	FYP	7

WARNING: The following analytes contained five successive points above the central line:

ANALYTE	BEGIN LOT	END LOT
BE	FYE	FYI
CU	FYG	FYK
PB	FYE	FYI
ZN	FYE	FYI

Figure K-7

WARNING: The following analytes contained five successive points below the central line:

ANALYTE	BEGIN LOT	END LOT
CD	FYE	FYF

WARNING: The following analytes contained six successive points above the central line:

ANALYTE	BEGIN LOT	END LOT
BA	FYE	FYI
CR	FYE	FYI
CU	FYM	FYR
SE	FYN	FYS



Figure K-8

THREE DAY RANGE CHARTS

Laboratory: PC | Date: 01/08/93 | Method: SS15

NOTE: This is an abbreviated report and may not reflect the entire situation. You need to examine the charts and comment on corrective measures. This program does not test for cyclical patterns.

Number of Control Analytes: 12.

Method is out-of-control.
Greater than one-third of the analytes were out-of-control.

LOT	NUMBER OF ANALYTES
FYL	8

The following analytes contained points outside the UCL:

ANALYTE	LOT	RECOVERY	UCL
CO	FYL	90.0	57.7
CR	FYL	95.0	60.3
NI	FYL	92.7	64.6
PB	FYL	86.5	45.8
SB	FYL	101.0	93.7
SE	FYL	111.3	92.4
SE	FYM	111.3	107.4
TL	FYL	82.5	45.8
ZN	FYL	149.2	112.5
ZN	FYM	149.2	131.8

WARNING: The following analytes contained four successive points going in an upward direction:

ANALYTE	BEGIN LOT	END LOT
CU	FYE	FYE
TL	FYN	FYQ
ZN	FYI	FYL

APPENDIX L

MODIFIED LIMITS

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APPENDIX L

MODIFIED CONTROL LIMITS (MCL) FOR $\bar{x}$ CHARTS

INTRODUCTION

The ultimate goal of control charts is to help produce results of consistent and defined quality. When methods are exceptionally precise and accurate, data quality may significantly exceed requirements for the planned and use of the results (Data Quality Objectives). For example, suppose the control mean ($\bar{x}$) is 99.5 percent with the Upper Control Limit (UCL) at 104.5 percent and the Lower Control Limit (LCL) at 94.5 percent. A lot mean of 106.0 percent would represent an out-of-control situation. However, random sampling uncertainties might suggest that recoveries between 85.0 percent and 115.0 percent would meet data quality objectives for the project. The indication of lack-of-control would not be ignored but the rejection of lot results would not be warranted.

Another important factor that applies to control charts based on duplicate spiked QC samples in each lot is that only within-day variations are reflected in the average range ($\bar{R}$) used to set upper and lower control limits on $\bar{x}$. Because lot-to-lot calibration variability is excluded from $\bar{R}$, it has been found that 10-25 percent of lot QC means will fall slightly outside of normal control limits. These minor excursions usually don't represent a true out-of-control condition and remedial action is only required when two or more successive means are outside control limits unless, of course, a mean is highly divergent.

When the average recovery differs greatly from 100 percent, many lot QC means may fail to meet data quality specifications even though reproducibility keeps these means within control limits. Alternatively, average recovery could be good but with unacceptable reproducibility. Modified Control Limits in conjunction with normal control limits on $\bar{x}$ offer a means to deal with these situations.



PROCEDURE

All previously specified steps in customary control chart establishment are followed (Appendix H). However, upper and lower warning limits are replaced by modified limits (UML $\bar{x}$ and LML $\bar{x}$) that are derived from upper and lower specification limits for individual recoveries (USL X and LSL X) using the following equations:

$$\text{UML on Average: } \text{UML } \bar{x} = \text{USL X} - M_3\bar{R}$$

$$\text{LML on Average: } \text{LML } \bar{x} = \text{LSL X} + M_3\bar{R}$$

Values for M_3 depend on the number of individual measurements in each lot mean ($\bar{x}$) and are designed to insure that each replicate measurement will be within the specification limits, except for genuine outliers. The upper and lower specification limits (USL X and LSL X) will be provided by the USAEC Chemistry Branch for those methods where a statistically valid data base has been established.

For duplicate spike QC samples (Appendix H), the equations become:

$$\text{UML } \bar{x} = \text{USL X} - 0.78\,\bar{R}$$

$$\text{LML } \bar{x} = \text{LSL X} + 0.78\,\bar{R}$$

Modified limits can also be used with moving average control charts. In contrast to duplicate spiked QC samples in each lot, $\bar{R}$ for the three-lot moving average and moving range does include lot-to-lot variability. Therefore, a high percentage of out-of-control means should not occur for measurements in a state-of-control. However, modified limits are very useful in meeting data quality specifications. For procedures with measurement capability that is superior to requirements, acceptance of lot data are facilitated for a QC moving average that is outside of control limits but within modified limits. For procedures with performance that is inadequate to meet specifications due to large $\bar{R}$ or poor accuracy, moving averages outside of modified limits command attention to improving precision and accuracy even when the averages are within current control limits.

For moving averages of n = 3 (Appendix H) the equations for modified limits are:

$$\text{UML } \bar{x} = \text{USL X} - 0.75\,\bar{R}$$

$$\text{LML } \bar{x} = \text{LML X} + 0.75\,\bar{R}$$

APPENDIX M

CONTROL CHART CHECKLIST

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APPENDIX M

CONTROL CHART CHECKLIST
(ONE WITH EACH WEEKLY SUBMISSION)

Contract/Task Number_____ Installation _____

1. The following items are included in this weekly control chart package covering method(s) _____

2. ___ Summary

3. ___ $\bar{x}$ - R Control Charts for duplicate, high or low concentration spiked QA samples, and Outlier Tests.

4. ___ $\bar{x}$ - R Three-Point Moving Average Control Charts for low concentration spiked QA samples (Class 1) and Outlier Tests.

5. ___ Observations on each chart (when applicable).

   a. ___ Trend analysis.

   b. ___ Out-of-control analysis.

   c. ___ Actions taken.

   d. ___ Demonstration of resumption of control.

6. ___ Recommendations.

7. ___ Calibration.

8. ___ Surrogate recoveries.

_____ _____
Contractor QAC Date



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APPENDIX M

INSTRUCTIONS FOR CONTROL CHART CHECKLIST

Item I. The USAEC method number(s) under which the control charts were generated that are included in this current package are to be listed in numerical order.

Item 2. A summary table shall be prepared listing the method number(s), USAEC lots, dates of analysis, and analytes that are included in this package.

Items 3 & 4. All $\bar{x}$ - R control charts generated in the control of analyses performed during this period shall be included. Each control chart shall include the following information:

- Analyte
- Method number
- Matrix
- Laboratory
- Spike concentration
- Chart title - one of the following:
  - Single Day $\bar{x}$ Control Chart
  - Single Day R Control Chart
  - Three-Point Moving Average $\bar{x}$ Control Chart
  - Three-Point Moving Average R Control Chart
- Four-letter lot designation and analysis date for each point, shown on the x-axis



- Percent Recovery (for $\bar{x}$ control charts) or Range (for R control charts) along the y-axis.
- Upper control limit (UCL), on $\bar{x}$ and R control charts
- Upper warning limit (UWL), on $\bar{x}$ and R control charts
- Mean, on $\bar{x}$ and R control charts
- Lower warning limit (LWL), on $\bar{x}$ control charts
- Lower control limit (LCL), on $\bar{x}$ control charts.

The charts must contain sufficient data so that any trends, if present, could be discerned. (Charts developed during the initial stages of any analysis shall contain all points. Charts developed after the process has been stabilized, at least 20 points, shall contain at a minimum the most recent 10 points). Any point(s) that exceed the control limits shall be flagged (by circling in red) for discussion under 5b below. Any outlier tests must be included.

Item 5. The observations made during the review of the control charts, including but not limited to the items listed, shall be submitted in writing.

Item 5a. A discussion of any trends observed, the possible start of any trend, or the lack thereof, shall be included. A trend can be defined as seven points on the same side of mean, five points going in one direction or a cyclical representation of data.

Item 5b. An analysis of any points flagged on the control chart(s) as being out-of-control shall be included. Discussion should attempt to describe the cause of the out-of-control status and whether the point(s) are to be expected due to the random statistics used to demonstrate control or are the results of a possible systematic error or bias that would affect the analytical results. The discussion should include evaluation of outlier test results.

Item 5c. Describe all actions taken to get process back into control.

Item 5d. The data generated to prove that the analysis are back in control along with the criteria used ascertaining same shall be included.

Item 6. Recommendations made as to the acceptance or rejection of the lot analysis, based on Item 5. above.

Item 7. A copy of the calibration curve used for this lot. **THIS IS FOR THE FIRST LOT ONLY.**

Item 8. Tables of % recovery of surrogates in all field samples, by lot and sample number. (i.e. AAAA003,004, etc.)



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APPENDIX N

CONTRACTOR QAC CHECKLIST



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APPENDIX N

CONTRACTOR QAC CHECKLIST

Before releasing data for transmission to permanent storage, for use by other project participants, or for submission via the USAEC IRDMIS, the Contractor QAC shall complete the attached checklist. One checklist shall be completed for each analytical lot. The QAC shall retain the checklist with the analytical data for the lot. The data, checklist file, and data package arranged by lot for each installation, may be inspected during any laboratory audit. The complete data/checklist file shall be forwarded to USAEC at the end of a project.



APPENDIX N

CONTRACTOR QAC CHECKLIST

Contract/Task Number _____ Installation _____

Method Number _____ Method _____

Analyte(s) _____ Lot Designation _____

No Yes		QA Program Reference	Comments
I.	Holding Times		
_ _	Extraction Time Met	6.5	
_ _	Analysis Time Met	6.5	
II.	Calibration		
A.	Initial		
1. _ _	Initial Calibration Performance	7.1.1	
4. _ _	Points Plotted	8.1.1	
B.	Daily		
1. _ _	Daily Calibration Performed	7.1.2	
2. _ _	Daily Criteria Met	7.1.2 7.5	

QA Program

No Yes		Reference	Comments
If II.B.2 is NO:			
_ _	Daily Standard Reanalyzed	7.1.2	
_ _	Daily Criteria Met	7.1.2	
_ _	Initial Calibration Performed	7.1.1	
_ _	Initial Criteria Met	8.1.1 or 8.1.3	
3. _ _	End of Day Calibration Performed	7.1.2	
4. _ _	End of Day Criteria Met	7.1.2	
If II.B.4 is NO:			
_ _	Standard Reanalyzed	7.1.2	
_ _	Criteria Met	7.1.2	
_ _	Sample Results Rejected	7.1.2	
_ _	Blow-up of manually Integrated peak(s) examined and commented on	10.5.1.2	
III. Quality Control			
A. _ _	Blank and Correct Spikes in Sample Lot	8.2	



QA Program

	No	Yes		Reference	Comments
B.	_	_	Data Plotted on Control Chart(s)	8.6	
C.	_	_	Control Points Within Limits	8.7	
If III.C is NO:					
1.	_	_	Outlier Test Performed	Appendix K	
2.	_	_	Acceptable Explanation Provided	8.7	
3.	_	_	Corrective Actions Implemented and Documented	10.0	
4.	_	_	Control Reestablished	8.7	
5.	_	_	Lot Reanalyzed	8.7	
IV.	Sample Analysis				
A.	_	_	Reported Concentrations within Certified Range	9.4	
If IV.A is NO:					
	_	_	Extracts Diluted within Range	10.4.1 or 10.4.2	
B.	_	_	All Results have Correct Significant Figures	9.4	

Contractor QAC _____ Date

APPENDIX O

SAMPLE RECEIPT CHECKLIST

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APPENDIX O

SAMPLE RECEIPT CHECKLIST

	Yes	No	Comment

A. Sample Cooler

1. Is evidence tape intact?
2. Chain of Custody forms provided; filled out properly/completely?
3. Blue ice (or equiv) included __; temp recorded ___.
4. Samples intact, i.e., bottles not broken, caps in place.

B. Samples

1. Bottles labelled.
2. Labels agree with chain-of-custody form.
3. Bottles correct for type of sample.
4. Sample volume adequate for required tests.
5. Preservatives added, where required.
6. Evidence tape on bottles.

C. Log in

1. Site ID/field number entered in logbook.
2. USAEC number assigned and entered.
3. Label on bottle annotated with USAEC number.



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APPENDIX P

DATA PACKAGE CHECKLISTS

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APPENDIX P

DATA PACKAGE CHECKLISTS

Each data package will have a series of checklists associated with it as an aid in the determination of its completeness and as a means of checking compliance with USAEC requirements. These checklists will include, but are not limited to:

- Data package checklist;
- Data package document inventory list;
- Data review checklist;
- Report checklist.

The final step in the review of a data package are the signing by the QAC of the checklist and the attesting to the fact that the data are correct and defensible.



APPENDIX P

DATA PACKAGE CHECKLIST

___ Lot

_____ Method Number

I have checked this report and data package to make certain that the following conditions are in compliance with USAEC requirements:

I. GENERAL

___ 1. All enclosed copies are legible and not excessively reduced.

___ 2. There are no "yellow stickies," tablet sheets, or other undocumented forms in the data package.

___ 3. All required documents, including a completed chain-of-custody form, are enclosed.

___ 4. The data block on the outside of the data package are complete, with all other relevant information included.

II. NOTEBOOK PAGES

___ 5. All copies of notebook pages are identified by notebook number and page number.

___ 6. All units ("ug/L"; "ug/g"; "mL") are clearly defined.

___ 7. Each page has been signed and dated by the analyst and reviewer.

___ 8. All written explanations have all of the necessary information included and may stand alone as written.

III. COMPUTER DATA SHEET

___ 9. The preliminary computer data sheet has been signed and dated by both the reviewer and the analyst.

IV. CHROMATOGRAMS AND STRIP CHARTS

___ 10. All enclosed chromatograms and/or strip charts have been labelled properly, signed, and dated by the analyst.

V. CHECKLISTS

___ 11. All enclosed checklists are the current version, and have either each blank initialled or the blanks checked with a signature at the bottom of the page.

VII. CORRECTIONS

___ 12. No white-out or correction tape has been used on any raw data.

___ 13. All cross-outs consist of only a single line, and have been initialled and dated.

___ 14. All cross-outs have a legitimate, sufficient explanation alongside.

_____ _____

Analyst Signature Date Checker Signature Date

Data were obtained while the analytical process was in-control and meet the agreed upon Data Quality Objectives.

_____ _____

QAC Signature Date

APPENDIX P

DATA PACKAGE DOCUMENT INVENTORY LIST

___ Lot

_____ Method Number

Analyst: If the listed document is in the data package, please initial inventory list.

____ Review sign-off sheet;
____ Chain-of-custody sheet, laboratory;
____ Chain-of-custody sheet, field;
____ Reagent blank report form;
____ Screening chromatogram - dated and initialed by analyst;
____ Unknown analyte report sheet;
____ Best fit spectra for each unknown peak;
____ NIST library search for unknowns;
____ Coding form or approved data reporting form;
____ Copy of extraction logbook pages;
____ Copy of sample preparation logbook pages;
____ Copy of analyst's notebook pages;
____ Copy of moisture logbook pages;
____ Copy of standards preparation (logbook pages);
____ Raw data output - dated and initialed by analyst (printouts, etc.);
____ DFTPP 12 hour tuning and mass calibration report(s);
____ BFB 12 hour tuning and mass calibration report(s);
____ Initial calibration data, including RIC, and quantitation reports for four standards;
____ Daily calibration data, including RIC, and quantitation report;
____ RIC and quantitation report for: field samples, QC samples, blank samples;
____ Check standard results;
____ Chromatogram or strip chart recorded output with analyte peak indicated, dated, and initialled by analyst;
____ Expanded scale blow-up of manually integrated peak;
____ Unknown report, library search, best fit spectra;
____ Raw data for quantitated analytes (when positively identified - including difference display, and enhanced and unenhanced spectra);
____ Example calculations.

NA - item not applicable to analytical procedure.

APPENDIX P

USAEC DATA REVIEW CHECKLIST

Lot ____ Method Number _____

HOLDING TIMES	YES	NO	N/A	COMMENTS
1. Was extraction/digestion holding time met for all samples?				
2. Was analysis holding time met for all extracts/digestates?				
3. Were all reported dilutions performed within holding times?				
PAPER TRAIL _____				
4. Is chain-of-custody information present and complete?				
5. Are all necessary forms present, complete, and filled out in blue or black ink?				
6. Are all changes made properly, and initialled/dated?				



DAILY CALIBRATION	YES	NO	N/A	COMMENTS
7. Was a standard curve for each analyte (as specified in the method) plus a blank analyzed with each daily lot?				
8. Was a new standard curve run on the day of reanalysis of diluted extracts, and was it used for sample calculation for that date?				
9. Do the calibration standards equal or bracket the concentration equivalent to the MDL and the URL (if appropriate)?				
10. Do the calibration standards equal or bracket the MDL and the highest sample or spike response in the daily lot (if appropriate)?				
11. Was the standard specified in the method reanalyzed at the end of each daily lot, and at the appropriate interval within that lot and did the response meet criteria?				
CONTROL SPIKES _____				
12. Were standard matrix control spikes (spiked with the appropriate analytes and at the designated levels) and a standard matrix blank extracted/digested and analyzed on the same date as the daily lot?				

	YES	NO	N/A	COMMENTS
13. If dilution and reanalysis have been performed on a different day, was at least one control spike reanalyzed with the diluted samples? Has this spike been reported with the data on the appropriate date?				
14. Did control spikes pass control chart criteria? If not, has an acceptable explanation been provided, and correction taken as necessary?				
SAMPLE ANALYSIS				
15. Are reported sample and control spike concentrations within the certified concentration range of the method?				
16. If sample concentrations above the URL are reported, were they diluted into the certified range with the dilution factors clearly indicated?				
17. Are reported detection limits the Method Detection Limits?				
18. Are justifications supplied for all non-use of data, analyses, etc.				
19. Are all reanalyzed samples clearly marked and explanation presented?				



	YES	NO	N/A	COMMENTS
20. Are all manual integration justified?				

QUALITY ASSURANCE REVIEWER ONLY

21. For randomly selected data points, can the reported concentrations be back calculated using the available raw data?				

REVIEWER'S SIGNATURE

CHEM: _____ DATE _____

SUPERVISOR: _____ DATE _____

QA: _____ DATE _____

APPENDIX P

USAEC REPORT CHECKLIST

Lot _____ Method Number _____

I have reviewed and checked the enclosed report for the following items:

Transcriptions

_____ 1. Soil weights and liquid volumes have been copied correctly.
_____ 2. All information from strip charts, chromatograms, and lab notebooks has been correctly transferred to the computer.
_____ 3. All information from the field chain-of-custody has been correctly copied onto the coding form.
_____ 4. Sample results and dilution factors derived from computer printouts or notebook calculations have been accurately copied onto the coding form.

Calculations

_____ 5. All calculations have been verified.
_____ 6. All reported values are uncorrected for moisture, dilution, or other factors.

Coding Form and QC Form

_____ 7. The mantissa and exponent for each sample result and dilution factor have been accurately entered onto the coding form.
_____ 8. The correct MDL has been used on the coding form.
_____ 9. The correct method ID has been noted on both the coding form and the outside of the data package.
_____ 10. Preparation date and analysis date on the coding form agree with those on the chain-of-custody.
_____ 11. The QC form indicating whether or not the QC spikes are within control has been completely and accurately completed.
_____ 12. Sample results are not reported below the MDL or above the highest standard.

_____ _____
Analyst Signature Date

_____ _____
Checker Signature Date

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APPENDIX Q

AUDIT CHECKLIST

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APPENDIX Q

LABORATORY AUDIT CHECKLIST

_____
EVALUATED LABORATORY

_____
SUBJECT PROJECT

QC Coordinator _____

Analytical Task Manager _____

Project Manager _____

Project Officer _____

Evaluator _____

Evaluation Date _____



APPENDIX Q

AUDIT CHECKLIST

	YES	NO	COMMENT
PRE-AUDIT			
1. Notified laboratory			
2. Notified project officer			
3. Made travel arrangements			
4. Reviewed background information/ data			
5. Requested laboratory to have data/ methods/personnel available			
6. Prepared agenda			
IN-BRIEFING			
7. Introduced participants			
8. Described goals and objectives of audit/agenda			
9. Identified specific areas for review that could require some laboratory preparation			
10. Discussed general overview/status on project			
11. Discussed problem areas			

	YES	NO	COMMENT
GENERAL			
12. a. Has detailed Project QC Plan (QAPjP) been submitted?			
b. Has individual been appointed as QAC who is independent from analysis?			
c. Have sufficient facilities, personnel, and instrumentation been provided to perform the required analyses?			
d. Does the QAC have the resources to function effectively?			
e. Are chemicals and reagents of sufficient quality so as not to compromise the analytical system?			
f. Is housekeeping commensurate with analytical techniques?			
g. Has a training plan been developed and training been documented?			
h. Is the correct version of USAEC supplied software being used?			

AUDIT	YES	NO	COMMENT
13. Samples chosen to follow through laboratory:			
Inorganic			
Organic			
14. Sample receiving:			
a. Are procedures/SOPs available?			
b. Are samples checked upon receipt?			
c. Is the sample checking documented?			
d. Is area secure?			
e. Are chain-of-custody forms filed?			
f. Are internal chain-of-custody forms generated?			
g. Are samples logged in according to SOP?			
h. Are USAEC numbers assigned?			
i. Are numbers allocated for QC samples?			

AUDIT (cont)	YES	NO	COMMENT
j. Are samples stored in refrigerator until needed?			
k. Is the temperature of refrigerator monitored?			
l. Is there a sign-out system for samples?			
m. Are VOA samples isolated from other samples?			
15. Inorganics Section:			
a. Are logbooks kept for:			
Digestion?			
Analysis?			
Instrument maintenance?			
Standard preparation?			
b. Are logbooks identified with unique number?			
c. Are pages of logbooks numbered?			
d. Are reagents/solvents/acids checked for purity, etc.?			



Inorganics (cont)	YES	NO	COMMENT
e. Are standards stored correctly?			
f. Is inventory of standards maintained?			
g. Are standard solutions labelled with date prepared?			
h. Are solution validity checks documented?			
i. Are standards traceable from receipt to use?			
j. Are samples maintained and stored according to SOP?			
k. Are procedures in place to minimize cross contamination?			
l. Are samples analyzed according to validated methods?			
m. Are results of analyses stored in data packages?			

16. Organics Section:

a. Are logbooks kept for:

Extraction?
Analysis?

Organics Section (cont)	YES	NO	COMMENT
Instrument Maintenance?			
Standard preparation?			
b. Are logbooks identified with unique number?			
c. Are pages in logbooks numbered?			
d. Are reagents/chemicals checked for purity, etc.?			
e. Are standards stored correctly?			
f. Is an inventory of standards maintained?			
g. Are standard solutions labelled with date prepared?			
h. Are solution validity checks documented?			
i. Are standards traceable from receipt to use?			
j. Are samples maintained and stored according to SOP?			
k. Are procedures in place to minimize cross contamination?			



Organics (cont)	YES	NO	COMMENT
l. Is tuning of GC/MS performed and documented every 12 hours?			
m. Are samples analyzed according to validated methods?			
n. Are results of analyses stored in data packages?			
17. Method selected is performed according to written validated method?			
18. Have problem areas been discussed and corrective actions reviewed/ recommended?			
19. Data Management:			
a. Data packages prepared for each lot of analysis?			
b. Data packages readily available for review?			
c. Representative data packages from each method reviewed?			
d. Data package checklists included in each package?			
Filled out correctly?			
e. Notebook pages signed and dated?			

Data Management (cont)	YES	NO	COMMENT
f. Computer print-outs readily identified?			
g. Data processing according to SOPs?			
h. Data transmittal to USAEC according to SOPs?			
20. Has data been validated according to USAEC internal SOP?			
OUTBRIEFING			
21. Summary given on findings, observations, conclusions reached?			
22. Responded to laboratory questions/ concerns?			
23. Provided forum to rectify differences between laboratory staff and audit team?			
24. Identified deficiencies and offered assistance in their correction?			
25. Copy of completed audit checklist provided to laboratory?			
26. Discussed future goals and objectives?			

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APPENDIX R

CALIBRATION/SURROGATE DOCUMENTATION



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APPENDIX R

INSTRUCTIONS FOR CALIBRATION/SURROGATE DOCUMENTATION

FOR CALIBRATION (DAILY AND CHECK STANDARD)

1. Compound - Record the compound being monitored.

2. Check the correct box - whether daily calibration standard or check standard.

3. Method No. - Record the method number of the method being used for the designated compound.

4. Concentration - Record the target or true concentration of the standard.

5. Units - Record the units of measurements.

6. Matrix - Record the matrix of the samples being determined by the assigned method number.

7. ID - Record the identity number of the standard being monitored and the USAEC lot number(s) for which the calibration is applicable.

8. Date - Record the date of the measurement.

9. Low Recovery - Record the recovery of the standard if it is lower than the low specification.

10. Low Specification Value - Record the low specification value (lowest acceptable value, i.e., either the 10 percent or 25 percent or 2 S.D. criteria) for the standard in question in the box at the top of the column. Record a recovery between the low specification value and the mean in this column.

11. Mean - Record the mean recovery (labelled recovery, if applicable) in the box at the top of the column.

12. High Specification Value - Record the high specification value (highest acceptable) value, i.e., either the 10 percent or 25 percent or 2

S.D.criteria) for the standard in question in the box at the top of the column. Record a recovery between the mean and the high spike in this colum ..

13. High Recovery - Record the recovery of the standard if it is greater than the high specification.

14. Comments - Record any comments on the measurement in this column.

Calibration data supporting multiple lots may be entered on the same form. A copy of the form shall be included in the data packages for the associated lots.

FOR SURROGATES:

1. Compound - Record the compound being monitored.

2. Check the box marked surr for surrogate.

3. Method Number - Record the method number of the method being used for the designated compound.

4. Concentration - Record the units of measurement.

5. Units - Record the units of measurement.

6. Matrix - Record the matrix of the samples being determined by the assigned method number.

7. ID - Record the individual sample numbers that the surrogate was spiked into.

8. Date - Record the date of the measurement.

9. Low Recovery - Record the recovery of the surrogate if it is lower than the low specification.

10. Low Specification - Record the low specification value (lowest acceptable value) for the surrogate in question in the box at the top of the column. Record a recovery between the low specification and the mean in this column.

11. Mean - Record the historical mean recovery of the surrogate in the box at the top of the column.

12. High Specification - Record the high specification value (highest acceptable value) for the surrogate in question in the box at the top of the column. Record a recovery between the mean and the high specification in this column.

13. High Recovery - Record the recovery of the surrogate if it is greater than the high specification.

14. Comments - Record any comments on the measurement in this column.

A separate form should be used of each surrogate in each lot. Only data from a single lot shall be included on a form. A copy of the form shall be included in the data package for that lot.



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APPENDIX S

FIELD SAMPLING CHECKLIST

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FIELD CHECKLIST

Signature of Auditor _____ Date of Audit _____

Project Coordinator _____ Project No. _____

Project Location _____

Type of Investigation _____
(Authority, Agency)

Briefing with Project Coordinator

Yes _ No _ N/A _ 1. Was a project plan prepared? If yes, what items are addressed in the plan?

_____
_____
_____

Yes _ No _ N/A _ 2. Were additional instructions given to project participants (i.e., changes in project plan)? If yes, describe these changes.

_____
_____
_____

Yes _ No _ N/A _ 3. Is there a written list of sampling locations and descriptions? If yes, describe where documents are.

_____
_____
_____

Yes _ No _ N/A _ 4. Is there a map of sampling locations? If yes, where is the map?

_____
_____
_____

Yes _ No _ N/A _ 5. Do the investigators follow a system of accountable documents? If yes, what documents are accountable?

_____
_____
_____

Yes _ No _ N/A _ 6. Is there a list of accountable field documents checked out to the project coordinator? If yes, who checked them out and where is this documented?

_____
_____
_____

Yes _ No _ N/A _ 7. Is the transfer of field documents (sample tags, chain-of-custody records, logbooks, etc.) from the project coordinator to the field participants documented? If yes, where is the transfer documented?

_____
_____
_____

Yes _ No _ N/A _ 8. Have the team members received the adequate training for their position? Documented?

_____
_____
_____

Yes _ No _ N/A _ 9. Have the team members received the required number of hours of OSHA training.

_____
_____
_____

FIELD CHECKLIST

FIELD OBSERVATIONS

Yes _ No _ N/A _ 1. Was permission granted to enter and inspect the facility (required if RCRA inspection)?

_____
_____
_____

Yes _ No _ N/A _ 2. Is permission to enter the facility documented? If yes, where is it documented?

_____
_____
_____

Yes _ No _ N/A _ 3. Were split samples offered to the facility. If yes, was the offer accepted or declined?

_____
_____
_____

Yes _ No _ N/A _ 4. Is the offering of split samples recorded? If yes, where is it recorded?

_____
_____
_____

Yes _ No _ N/A _ 5. If the offer to split samples was accepted, were the split samples collected? If yes, how were they identified?

_____
_____
_____

Yes _ No _ N/A _ 6. Are the number, frequency and types of field measurements, and observations taken as specified in the project plan or as directed by the project coordinator? If yes, where are they recorded?

_____
_____
_____

Yes _ No _ N/A _ 7. Are samples collected in the types of containers specified for each type of analysis? If no, what kind of sample containers were used?

_____
_____
_____

Yes _ No _ N/A _ 8. Are samples preserved as required? If no or N/A, explain.

_____
_____
_____

Yes _ No _ N/A _ 9. Are the number, frequency, and types of samples collected as specified in the project plan or as directed by the project coordinator? If no, explain why not?

_____
_____
_____

Yes _ No _ N/A _ 10. Are samples packed for preservation when required (i.e., packed in ice, etc.)? If no or N/A, explain why.

_____
_____
_____

Yes _ No _ N/A _ 11. Is sample custody maintained at all times? How?

_____
_____
_____

Yes _ No _ N/A _ 12. Is the following information completed on each chain-of-custody record?

- Sample identification number;
- Sample collector's signature;
- Date and time of collection;
- Place and address of collection;
- Waste sample description;
- Shipper's name and address;
- Name and address of organization(s) receiving sample;
- Signatures and titles of persons involved in chain-of-possession; and
- Inclusive dates of possession for each possession.

_____
_____
_____

Yes _ No _ N/A _ 13. Does a sample analysis sheet accompany all samples on delivery to the laboratory sample custodian?

_____
_____
_____

Yes _ No _ N/A _ 14. At the minimum, has the following information been completed on each sample analysis request sheet?

- Name of person receiving sample (sample custodian);
- Laboratory sample number;
- Date of sample receipt;
- Sample allocation;
- Analyses to be performed;
- Collector's name, affiliation name, address, and phone number;
- Date and time of sampling;



- Location of sampling; and
- Special handling and/or storage requirements.

_____
_____
_____

Yes _ No _ N/A _ 15. Has a field custodian been assigned for sample recovery, preservation, and storage until shipment?

_____
_____
_____

Yes _ No _ N/A _ 16. Where applicable, are sample collection containers rinsed three times with the sample material prior to collection?

_____
_____
_____

Yes _ No _ N/A _ 17. Are glass containers with Teflon-lined screw caps used to collect the following types of samples?

- Water samples for organic analyses?
- Soil and sediment samples?
- Liquid and solid hazardous waste samples (*)?

Yes _ No _ N/A _ 18. Are polyethylene bottles with solid polyethylene-lined caps used to collect the following types of samples?

- Water samples for metal analysis?
- Water samples for pH and fluoride analysis?
- Water samples for cyanide analysis?

Yes _ No _ N/A _ 19. Are amber glass or aluminum foil-wrapped glass bottles used for samples suspected of being photosensitive?

* Highly alkaline wastes and wastes known to contain hydrofluoric acid should be collected in plastic containers. If it is suspected that highly alkaline materials or hydrofluoric acid is present, a small sample should be tested to determine if it reacts with the sample container.



QUALITY ASSURANCE/QUALITY CONTROL

SAMPLE DOCUMENTATION AND CHAIN-OF-CUSTODY

Yes _ No _ N/A _ 1. Is the following information being recorded in the field log book or on data sheets?

- Project name and project number;
- Purpose of sampling (e.g., quarterly sampling, resample to confirm previous analysis, initial site assessment, etc.;
- Date and time each sample was collected;
- Date and starting/stopping times (Hr:Min) for air samples;
- Date and well bailing time for groundwater;
- Blank, duplicate and split sample identification numbers;
- Sample description including type (i.e., soil, sludge, groundwater, etc.);
- Field measurement results (i.e., conductivity, pH, dissolved oxygen, combustible gas (e.g., LEL), radioactivity, etc.);
- Preservation method for each sample;
- Type and quantity of containers used for each sample;
- Weather conditions at time of sampling;
- Photographic log identifying subject, reason for photograph, date, time, direction in which photograph was taken, number of the picture on the roll;
- Sample destination;
- Analyses to be performed on each sample;
- Reference number from all forms on which the sample is listed or labels attached to the sample (i.e., chain-of-custody, bill of lading or manifest forms, etc.);
- Name(s) of sampling personnel; and

- Signature of person(s) making entries on each page.

_____
_____
_____
_____
_____
_____

Yes _ No _ N/A _ 2. Is a chain-of-custody record completed for all samples collected?

_____
_____
_____



CHECKLIST FOR MECHANICALLY CORED SAMPLES

Yes _ No _ N/A _ 1. Was the rig set up at a staked and cleared borehole location?

_____
_____
_____

Yes _ No _ N/A _ 2. Was the location, date, time, and other pertinent information recorded on boring log form?

_____
_____
_____

Yes _ No _ N/A _ 3. Was polybutyrate core tubes cut to specification and placed into core barrel?

_____
_____
_____

Yes _ No _ N/A _ 4. Was auguring and coring conducted according to the following sequence: 0-1 ft, 1-4 ft, 4-5 ft, 5-9 ft, and 9-10 ft, etc.?

_____
_____
_____

Yes _ No _ N/A _ 5. Was the core barrel removed from the borehole and opened at the completion of each coring interval?

_____
_____
_____

Yes _ No _ N/A _ 6. Was the 12-inch sections for laboratory analysis removed, capped with Teflon film lined plastic caps, sealed with tape, and immediately placed in a cooler?

Yes _ No _ N/A _ 7. Were core sections which were previously etched length-wise taped with plastic caps to prevent opening during transport to the support facility?

Yes _ No _ N/A _ 8. Were the polybutyrate line sections marked with an arrow to the top end, the boring number, and depth interval? Was a label giving the same information as well as the project name, number, the date, and the sampler's initials attached to the core in the sample handling trailer or at the site?

Yes _ No _ N/A _ 9. Were clean polybutyrate liners placed in a clean core barrel for each additional coring increment to be drilled?

Yes _ No _ N/A _ 10. Did the boring reach a predetermined depth or encounter the water table, whichever came first?



Yes _ No _ N/A _ 11. For trench disposal areas was the coring performed to the maximum depth of observable contamination?

Yes _ No _ N/A _ 12. Were all core sections transported to the support facility for logging and sample shipment preparation?

Yes _ No _ N/A _ 13. Was the boring stake left in the ground adjacent to the borehole and a board placed over the hole until it was grouted?

Yes _ No _ N/A _ 14. Were all boreholes greater than 1 ft in depth grouted the same day of construction and the borehole location stake placed in the grout?

Yes _ No _ N/A _ 15. Were one foot deep borings backfilled with native materials available adjacent to the boring?

Yes _ No _ N/A _ 16. Were the augers, and other downhole equipment decontaminated in the field prior to moving to the next borehole location upon completion of each boring?

Yes _ No _ N/A _ 17. When all borings in a specific source were completed was the drill rig initially cleaned at the source location?

Yes _ No _ N/A _ 18. Upon completion of the initial cleaning was the drill rig transported to the decontamination pad where it was thoroughly steam-cleaned before entering another source area?

Yes _ No _ N/A _ 19. Were enough augers and core barrels available so that when one set was in use a second set was being decontaminated?

Yes _ No _ N/A _ 20. At the end of the working day did all equipment, except the drill rig, and personnel proceed to the decontamination pad where decontamination procedures were initiated?



Yes _ No _ N/A _ 21. Were all bore cuttings drummed and stored while awaiting USAEC's directions for disposal?

CHECKLIST FOR HAND CORED SAMPLES

Yes _ No _ N/A _ 1. Was a piece of Teflon film and plywood placed over the top of the polybutyrate tube and the tube pushed or driven into the ground by hand?

Yes _ No _ N/A _ 2. Was the tube removed from the ground by shovel, the tube exterior wiped clean, the ends capped with Teflon film lined plastic caps, and sealed with tape?

Yes _ No _ N/A _ 3. Were the sample tubes marked with the boring number, the depth of the interval sampled, and the upward direction?

Yes _ No _ N/A _ 4. Was a label containing the same information written on the sample tube as well as the project name, number, the date, and sampler's initials taped to the outside of the core?

Yes _ No _ N/A _ 5. Were cores logged and stored in a cooler with commercially available Blue Ice prior to and during transport to the support facility sampling area where they were logged for shipment?

FIELD CHECKLIST

DOCUMENT CONTROL

Yes _ No _ N/A _ 1. Have all unused and voided accountable documents been returned to the coordinator by the team members?

_____
_____
_____

Yes _ No _ N/A _ 2. Were any accountable documents lost or destroyed? If yes, have document numbers of all lost or destroyed accountable documents been recorded and where are they recorded?

_____
_____
_____

Yes _ No _ N/A _ 3. Are all samples identified with sample tags? If no, how are samples identified?

_____
_____
_____

Yes _ No _ N/A _ 4. Are all sample tags completed (e.g., station number, location, date, time, analyses, signatures of samplers, type, preservatives, etc.)? If yes, describe types of information recorded.

_____
_____
_____

Yes _ No _ N/A _ 5. Are all samples collected listed on a chain-of-custody record? If yes, describe the type of chain-of-custody record used and what information is recorded.

Yes _ No _ N/A _ 6. If used, are the sample tag numbers recorded on the chain-of-custody documents?

Yes _ No _ N/A _ 7. Does information on sample tags and chain-of-custody records match?

Yes _ No _ N/A _ 8. Does the chain-of-custody record indicate the method of sample shipment?

Yes _ No _ N/A _ 9. Is the chain-of-custody record included with the samples in the shipping container?

Yes _ No _ N/A _ 10. If used, do the sample traffic reports agree with the sample tags?



Yes _ No _ N/A _ 11. If required, has a receipt for samples been provided to the facility (required by RCRA)? Describe where offer or a receipt is documented.

_____
_____
_____

Yes _ No _ N/A _ 12. If used, are blank samples identified?

_____
_____
_____

Yes _ No _ N/A _ 13. If collected, are duplicate samples identified on sample tags and chain-of-custody records?

_____
_____
_____

Yes _ No _ N/A _ 14. If used, are spiked samples identified?

_____
_____
_____

Yes _ No _ N/A _ 15. Are logbooks signed by the individual who checked out the logbook from the project coordinator?

_____
_____
_____

Yes _ No _ N/A _ 16. Are logbooks dated upon receipt from the project coordinator?

_____
_____
_____



Yes _ No _ N/A _ 17. Are logbooks project-specific (by logbook or by page)?

Yes _ No _ N/A _ 18. Are logbook entries dated and identified by author?

Yes _ No _ N/A _ 19. Is the facility's approval or disapproval to take photographs noted in a logbook?

Yes _ No _ N/A _ 20. Are photographs documented in logbooks (e.g., time, date, description of subject, photographer, etc.)?

Yes _ No _ N/A _ 21. If film from a self-developing camera is used, are photos matched with logbook documentation?

Yes _ No _ N/A _ 22. Are sample tag numbers recorded? If yes, describe where they are recorded.

FIELD CHECKLIST

DEBRIEFING WITH PROJECT COORDINATOR

Yes _ No _ N/A _ 1. Was a debriefing held with project coordinator and/or other participants?

_____
_____
_____

Yes _ No _ N/A _ 2. Were any recommendations made to the project participants during the debriefing? If yes, list recommendations.

_____
_____
_____

Yes _ No _ N/A _ 3. Was a copy of the field checklist left with the project coordinator at the conclusion of the debriefing?

_____
_____
_____



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USER EVALUATION SHEET/CHANGE OF ADDRESS

USAEC undertakes a continuing effort to improve the quality of its Quality Assurance Program. Your comments will aid us in achieving our goals. (Additional sheets may be attached.)

1. Organization (The following comments are provided concerning the organization of the Program).

_____

2. Useability (The following comments are provided as to the ability to find items in the Program).

_____

3. Concepts (The following comments are provided as to the existing concepts of the Program or to recommend new or innovative concepts).

_____

4. General (The following specific comments are offered for consideration in updates to the Program).

_____



5. _____
Name

_____
Organization

Current Address _____
Address

_____
City, State, Zip

_____
Telephone

6. If indicating a change of address or address correction, please provide the new or correct address in block 5 above and the old or incorrect address below.

_____
Name

_____
Organization

Old Address _____
Address

_____
City, State, Zip

_____
Telephone

Mail completed form to:

Commander
U.S. Army Environmental Center
ATTN: ENAEC-TS-C
Aberdeen Proving Ground, MD 21010-5401

8.36 Test Name (Analyte) Nomenclature

ELEMENT IS USED IN THE FOLLOWING IR RECORDS AND DATA BASE TABLES:

IRDMIS Record		IRDMIS Data Base	
Record Type	Column(s)	DB Table(s)	DB Column
•		analytes	test_name

• Manual keyboard entry in IRDMIS Data Base

ELEMENT SIZE AND CHARACTERISTICS:

IRDMIS Data Base: 200 Alphanumeric characters, left justified

ELEMENT DESCRIPTION:

Nomenclature of the analyte or parameter being measured.

ACCEPTABLE CRITERIA:

- Nomenclature must be associated with one of the acceptable codes in Section 8.24, Test Name (Analyte) Code

ACCEPTABLE ENTRIES: (Cont.)

ACCEPTABLE ENTRIES:

(See also 8.24, Test Name (Analyte) Code, and 8.29, CAS Registry Number)

(1-Methylethyl)benzene	ISOPBZ	98-82-8
(1-Methylethyl)methylbenzene	ISOPT	
(1-Methylpropyl) benzene	1MPRB	195-98-8
(1',5-*trans*)-7-Chloro-6-hydroxy-2',4-dimethoxy-6'-methyl spiro[benzofuran-2-(3H)-1'-(2)-cyclohexene]-3, 4'-dione	SPIRO	
(1,1-Dimethylethyl) benzene	11DMEB	98-06-6
(1,3-Dimethylbutyl) benzene	13DMBB	
(2-Chloroethenyl)arsonous dichloride	L	541-25-3
(2-Chloroethoxy)ethene	2CLEVE	110-75-8
(2-Methylpropyl)benzene	2MPBZ	538-93-2
(2,4,5-Trichlorophenoxy)acetic acid	245T	93-76-5
(3β)-Stigmast-5-en-3-ol	3S5E3L	
(3β,24S)-Stigmast-5-en-3-ol	GSITOS	
(3β,5α)-Stigmastan-3-ol	STIGMA	83-45-4
(4-Chloro-2-methylphenoxy)acetic acid	MCPA	94-74-6
(4-Chloro-*o*-tolyloxy)acetic acid	MCPA	94-74-6
(all-E)-2,6,10,15,19,23-Hexamethyl-2,6,10,14,18,22-tetracosahexaene	SQUAL	111-02-4
(*E*)-2-Decenal	E2DCEA	
(*Z*)-2-Methyl-2-pentene	Z2M2PE	
(*Z*)-3-Methyl-4-nonene	Z3M4NE	
(±)-2-(4-Chloro-2-methylphenoxy)propanoic acid	MCPP	7085-19-0
α-Benzenehexachloride	ABHC	319-84-6
α-Bromotoluene	BZYLBR	100-39-0
α-Chlordane	ACLDAN	5103-71-9
α-Endosulfan	AENSLF	959-98-8

ACCEPTABLE ENTRIES: (Cont.)

α-Hexachlorocyclohexane	ABHC	319-84-6
α-Methylacrylonitrile	MTHCRN	126-98-7
α-Methylbenzyl-2-chloroacetoacetate	MBZCL	
α-Methylbenzyl acetoacetate	MBZA	
α-Methylbenzyl alcohol	MBOH	
α-Pinene	ALPHPN	80-56-8
α-Toluic acid	PHENAA	103-82-2
α-Trinitrotoluene	246TNT	118-96-7
α,α-Dichloropropionic acid	DALA	75-99-0
α,α-Dimethylbenzenemethanol	BZAL2M	
α,α-Dimethylphenethylamine	AADMP	122-09-8
β-Benzenehexachloride	BBHC	319-85-7
β-Chlordane	BCLDAN	5103-74-2
β-Endosulfan	BENSLF	33213-65-9
β-Hexachlorocyclohexane	BBHC	319-85-7
β-Isoamylene	AMYLEN	513-35-9
β-Picoline	PIC3	
β-Sitostanol	STIGMA	83-45-4
β-Sitosterol	3S5E3L	
γ-Benzenehexachloride	LIN	58-89-9
γ-Chlordane	GCLDAN	5566-34-7
γ-Hexachlorocyclohexane	LIN	58-89-9
γ-Sitosterol	GSITOS	
Δ-Benzenehexachloride	DBHC	319-86-8
Δ-Hexachlorocyclohexane	DBHC	319-86-8
0.1N Hydrochloric acid	01NHCL	
1-(2-Butoxyethoxy) ethanol	BEETO	112-34-5

ACCEPTABLE ENTRIES: (Cont.)

1-Acetyl-3-methyl-5-pyrazolone	1A3MPZ	
1-Acetyl-4-(1-hydroxy-1-methylethyl) benzene	1A4HMB	
1-Benzazine	QUINO	91-22-5
1-Benzyl-4-hydroxybenzimidazole	1BY4HB	
1-Butanol	1C4L	71-36-3
1-Butylcyclohexene	1BCHE	
1-Carbamoyl-3,5-dimethyl-2-pyrazoline	1CDMPZ	
1-Chloro-2,4-hexadiene	1CL24H	
1-Chloro-4-(methylsulfonyl)benzene	1C4MSB	
1-Chloro-4-(methylthio)benzene	1C4MTB	
1-Chlorohexane	1CH	544-10-5
1-Chloronaphthalene	1CNAP	90-13-1
1-Chlorooctadecane	1CLODC	3386-33-2
1-Dodecanol	1DODCL	112-53-8
1-Dotriacontanol	1DTCTL	
1-Eicosanol	EICOSL	629-96-9
1-Ethyl-2-methylbenzene	1E2MB	
1-Ethyl-2,4-dimethylbenzene	1E24DB	
1-Ethyl-3-methylbenzene	ET3MBZ	
1-Ethyl-4-methylbenzene	ET4MBZ	
1-Ethylhexylbenzene	1EHB	
1-Ethylidene-1H-indene	1EHIND	
1-Ethylpropylbenzene	1EPB	
1-Fluoronaphthalene	1FNAP	321-38-0
1-Heptadecanol	1HPDOL	1454-85-9
1-Hexen-3-ol	1HX3OL	4798-44-1
1-Hexene	1HXE	592-41-6
1-Hydroxy-2,3-methylene indan [M.W.146]	INDAN	496-11-7

ACCEPTABLE ENTRIES: (Cont.)

1-Isopropyl-3,5-dimethylbenzene	IPMXYL	
1-Methoxy-1-propene	1MX1PE	
1-Methoxy-4-(1-propenyl)benzene	ANTHOL	
1-Methyl-2-(2-propenyl) cyclopentane	1M2PEC	
1-Methyl-3-(1-methylethyl)cyclopentane	3I1MCP	
1-Methyl-3-propylbenzene	3PT	
1-Methyl-4-(1-methylethyl)-*cis*-cyclohexane	1M4CCX	
1-Methyl-4-(1-methylethylidene)cyclohexane	1M4MEC	
1-Methyl-7-(1-methylethyl) naphthalene	1M7MEN	
1-Methyl-9H-fluorene	1MFLRE	
1-Methylbenz[*a*]anthracene	1MBAAN	
1-Methylcyclopentene	1MCPNE	
1-Methyldecylbenzene	1MDB	
1-Methylethylcyclohexane	1MECHX	
1-Methylethylcyclopropane	1MECPR	
1-Methylindan	1MEIND	
1-Methylnaphthalene	1MNAP	90-12-0
1-Methylnonylbenzene	1MNB	
1-Methylpyrene	1MPYR	
1-Naphthalenol methylcarbamate	SEVIN	63-25-2
1-Naphthylamine	1NAPA	134-32-7
1-Nitro-2-octanone	1N2ONE	
1-Nitroheptane	1NHP	
1-Nitropropane	1NPN	108-03-2
1-Octanol	1OCTOL	111-87-5
1-Phenylnaphthalene	1PNAP	605-02-7
1-Phenylpropane	PRC6H5	103-65-1

ACCEPTABLE ENTRIES: (Cont.)

1-Propanol	1C3L	71-23-8
1-Propenylcyclohexane	1PECHX	
1-*tert*-Butylcyclohexanecarboxylic acid	1TBCHA	
1.0N Potassium chloride solution	1NKCL	
1α(E),4α-1-(1,4-Dihydroxy-2,6,6-trimethyl-2-cyclohexen-1-yl)-2-buten-1-one		
1α,2α,3β,4α,5α,6β-Hexachlorocyclohexane	DTCHBO	
10-Chloro-5,10-dihydrophenarsazine	LIN	58-89-9
10-Cyclopentylundecanoic acid methyl ester	DM	578-94-9
10-Methylundecanoic acid methyl ester	10CUDM	
10-Octadecenoic acid methyl ester	10MUDM	
10% Methanol	10OEME	
1,1-(1,2-Ethynediyl) bis[benzene]	10MEOH	677-56-1
1,1-Di-*n*-butylethene	DPETYN	501-65-5
1,1-Di-*n*-butylethylene	DNBEE	
	DNBEE	
1,1-Dichloro-1-propene	11C1PE	
1,1-Dichloroethane	11DCLE	75-34-3
1,1-Dichloroethene	11DCE	75-35-4
1,1-Dichloroethylene	11DCE	75-35-4
1,1-Dichloropropane	11C1PN	78-99-9
1,1-Dichloropropene	11DCPE	
1,1-Dimethyl-3-(α,α,α-trifluoro-*m*-tolyl)urea	FLUMET	2164-17-2
1,1-Dimethyl-3-phenylurea trichloroacetate	FENRNT	4482-55-7
1,1-Dimethylcyclohexane	11DMCH	
1,1-Dimethylcyclopentane	11MCPE	
1,1-Dimethylcyclopropane	11DMCP	
1,1-Diphenylhydrazine	11DPH	530-50-7
1,1-Thiobis[benzene]	DPSULF	139-66-2

ACCEPTABLE ENTRIES: (Cont.)

1,1'-(1,3-Phenylene)ethanone	PHYETH	
1,1'-(1,3-Propanediyl) bis[benzene]	13DPPR	
1,1'-(2,2-Dichloroethylidene)bis[4-chlorobenzene]	PPDDD	72-54-8
1,1'-(2,2,2-Trichloroethylidene)-bis[4-methoxybenzene]	MEXCLR	72-43-5
1,1'-Methylenebis[piperidine]	MEBPIP	
1,1'-Oxybis[butane]	NBUETH	142-96-1
1,1,1-Trichloro-2,2,2-trifluoroethane	TFTCLE	
1,1,1-Trichloroethane	111TCE	71-55-6
1,1,1,2-Tetrachloroethane	2TCLEA	630-20-6
1,1,2-Trichloro-1,2,2-trifluoroethane	TCLTFE	76-13-1
1,1,2-Trichloroethane	112TCE	79-00-5
1,1,2-Trifluoro-1,2-dichloroethane	TFDCLE	
1,1,2-Trimethylcyclohexane	112TCH	
1,1,2,2-Tetrachloroethane	TCLEA	79-34-5
1,1,2,2-Tetramethylcyclopropane	12TMCP	
1,1,3-Trimethylcyclohexane	113MCH	
1,1a,2,2,3,3a,4,5,5,5a,5b,6-Decachlorooctahydro-1,3,4-metheno-1*H*-cyclobuta[*cd*]pentalene	MIREX	2385-85-8
1,2-(Methylenedioxy)-4-propenylbenzene	ISOSAF	
1,2-Benzenedicarboxylic acid	PHTHA	88-99-3
1,2-Benzenedicarboxylic acid bis(2-methylethyl) ester	DIPP	
1,2-Cyclohexane oxide	CHO	
1,2-Dibromo-3-chloropropane	12DB3C	
1,2-Dibromoethane	12DBRE	106-93-4
1,2-Dichlorobenzene	12DCLB	95-50-1
1,2-Dichlorobenzene-D4	12DBD4	
1,2-Dichloroethane	12DCLE	107-06-2
1,2-Dichloroethane-D4	12DCD4	

ACCEPTABLE ENTRIES: (Cont.)

1,2-Dichloroethenes	12DCE	
1,2-Dichloroethylenes (*cis* and *trans* isomers)	12DCE	
1,2-Dichloropropane	12DCLP	78-87-5
1,2-Dichloropropene, total	12DCPE	
1,2-Dimethylbenzene	12DMB	
1,2-Dimethylcyclopentadiene	DMCPDE	
1,2-Dimethylcyclopentane	12MCPE	
1,2-Dimethylnaphthalene	12DNAP	573-98-8
1,2-Diphenylbenzene	12DPB	
1,2-Diphenylhydrazine	12DPH	
1,2-Epoxycyclohexene	12EPCH	286-20-4
1,2-Epoxyethylbenzene	12EPEB	96-09-3
12-Methyltetradecanoic acid methyl ester	12MTDM	
1,2:5,6-Dibenzanthracene	DBAHA	53-70-3
1,2,3-Benzotriazole	BZOTRZ	95-14-7
1,2,3-Propanetriol diacetate	123PDA	
1,2,3-Propanetriol trinitrate	NG	55-63-0
1,2,3-Trichlorobenzene	123TCB	87-61-6
1,2,3-Trichloropropane	123CPR	96-18-4
1,2,3-Trimethylbenzene	123TMB	526-73-8
1,2,3-Trimethylcyclohexane	123MCH	
1,2,3,4-Tetrachlorobenzene	TCB2	634-66-2
1,2,3,4-Tetrahydro-1*H*-methylnaphthalene	THMNAP	
1,2,3,4-Tetrahydronaphthalene	THNAP	119-64-2
1,2,3,4-Tetramethylbenzene	1234MB	488-23-3
1,2,3,4,4A,5,8,8A-Octahydro-1,4,5,8-dimethanol-naphthalen-2-ol	18O18D	
1,2,3,4,5-Pentahydroxycyclopentane	PHYCP	
1,2,3,5-Tetrachlorobenzene	TCB3	634-90-2

ACCEPTABLE ENTRIES: (Cont.)

1,2,3,5-Tetramethylbenzene	ISODUR	
1,2,3,5,6,7,8,8A-Octahydro-1,8A-dimethyl-1-7(1-methylethenyl)-,[1S-(1α,7α,8Aα)]-naphthalene	18ONAP	
1,2,4-Trichlorobenzene	124TCB	120-82-1
1,2,4-Trimethylbenzene	124TMB	95-63-6
1,2,4-Trimethylcyclohexane	124MCH	
1,2,4-Trimethylcyclopentane	124TMC	
1,2,4,5-Tetrachlorobenzene	TCB1	95-94-3
1,3-Benzenediol	RESO	108-46-3
1,3-Butadiene	13BDE	
1,3-Cyclopentadione	13CPDO	
1,3-Diaceto-2-myristin	13DA2M	
1,3-Dichlorobenzene	13DCLB	541-73-1
1,3-Dichlorobenzene-D4	13DBD4	
1,3-Dichloropropane	13DCP	142-28-9
1,3-Dichloropropene	13DCPE	542-75-6
1,3-Diethylbenzene	13DEB	141-93-5
1,3-Difluorobenzene	13DFB	372-18-9
1,3-Dihydro-2*H*-indol-2-one	13HIND	
1,3-Dimethyl-5-(1-methylethyl) benzene	IPMXYL	
1,3-Dimethyl-5-isopropylbenzene	IPMXYL	
1,3-Dimethylbenzene	13DMB	108-38-3
1,3-Dimethylcyclohexane	13DMCH	591-21-9
1,3-Dimethylcyclopentane	13MCPE	
1,3-Dimethylnaphthalene	13DNAP	575-41-7
1,3-Dinitrobenzene	13DNB	99-65-0
1,3-Diphenylpropane	13DPPR	
1,3-Isobenzofurandione	PHTHAN	85-44-9

ACCEPTABLE ENTRIES: (Cont.)

13-Tetradecynoic acid methyl ester	13TDAM	
1,3,5-Triazine-2,4,6-triamine	MELAM	108-78-1
1,3,5-Trimethylbenzene	135TMB	108-67-8
1,3,5-Trimethylcyclohexane	135MCH	
1,3,5-Trinitrobenzene	135TNB	99-35-4
1,3,5,7-Tetraazatricyclo[3.3.13.7]decane	HXMETA	100-97-0
1,3,7-Trimethyl-2,6-dioxopurine	CAFEIN	58-08-2
1,3,7-Trimethylxanthine	CAFEIN	58-08-2
1,4-Benzoquinone	PQUIN	
1,4-Diacetylbenzene	14DACB	1009-61-6
1,4-Dichlorobenzene	14DCLB	106-46-7
1,4-Dichlorobenzene-D4	14DBD4	
1,4-Dichlorobutane	14DCBU	110-56-5
1,4-Difluorobenzene	14DFB	540-36-3
1,4-Dihydro-1,4-methanonaphthalene	14DMNP	
1,4-Dimethoxyanthracene	14DMXA	
1,4-Dimethyl-2-ethylbenzene	14D2EB	
1,4-Dimethylbenzene	14DMB	106-42-3
1,4-Dimethylcyclohexane	14DMCH	589-90-2
1,4-Dimethylnaphthalene	14DNAP	
1,4-Dinitrobenzene	14DNB	100-25-4
1,4-Dioxane	14DIOX	123-91-1
1,4-Hexadiene	14HXDE	592-45-0
14-Methylpentadecanic acid methyl ester	14MPME	
1,4-Naphthoquinone	14NAQ	
1,4-Oxathiane	OXAT	15980-15-1
1,4,6-Trimethylnaphthalene	146TMN	

ACCEPTABLE ENTRIES: (Cont.)

1,5-Bis(1,1-dimethylethyl)-3,3-dimethylbicyclo[3.1.0]hexane-2-one	BIDBI	
1,5-Dimethylnaphthalene	15DNAP	571-61-9
15-Methylhexadecanoic acid methyl ester	15MHME	
15-Tetracosenoic acid methyl ester	TCSAME	
1,6-Dimethylindan	16DMIN	
1,6-Dimethylnaphthalene	16DNAP	
16-Methylheptadecanoic acid methyl ester	16MHME	
1,6,7-Trimethylnaphthalene	167TMN	
1,7-Dimethylnaphthalene	17DNAP	
17-Pentatriacontene	17PTCE	
1,8-Dimethylnaphthalene	18DNAP	569-41-5
1A,2,3,4,4A,5,6,7B-Octahydro-1,1,4,7-tetramethyl-[1Aα,4Aβ,7Bα]-1*H*-cycloprop[*e*]azulene	17OAZU	
1*H*-1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene	HPCL	76-44-8
1*H*-Benzotriazole	BZOTRZ	95-14-7
1*H*-Indene, octahydro-	HYDRND	
2-(1-Methylethyl)naphthalene	2MENAP	
2-(1-Methyloxy)phenol methylcarbamate	PROPXR	114-26-1
2-(2-(4-(1,1,3,3-Tetramethyl)butyl)phenoxy)ethanol	TMBPET	
2-(2-Cyanoethyl) cyclohexanone	2CECHO	
2-(2-Methoxyethoxy) ethanol	2MXEXL	111-77-3
2-(2-*n*-Butoxyethoxy) ethanol	2BEETO	
2-(2-Phenoxyethoxy) ethanol	2PXEXL	
2-(2,4-Dichlorophenoxy)propionic acid	DICP	120-36-5
2-(2,4,5-Trichlorophenoxy)propionic acid	245TP	93-72-1
2-(Cyanomethyl) cyclohexanone	2CMCHO	
2-(Dimethylamino)-*N*-[[(methylamino)carbonyl]oxy]-2-oxoethanimidothioic acid methyl ester	OXAMYL	23135-22-0
2-(*m*-Chlorophenyl)-2-(*p*-chlorophenyl)-1,1- dichloroethane	MPDDD	
2-(*o*-Chlorophenyl)-2-(*p*-chlorophenyl)-1,1- dichloroethane	OPDDD	53-19-0

ACCEPTABLE ENTRIES: (Cont.)

2-(*o*-Chlorophenyl)-2-(*p*-chlorophenyl)-1,1-dichloroethene	OPDDE	3424-82-6
2-(*o*-Chlorophenyl)-2-(*p*-chlorophenyl)-1,1,1-trichloroethane	OPDDT	789-02-6
2-(*tert*-butyl)-4-methylfuran	2B4MFU	
2-Acetylaminofluorene	2ACAMF	
2-Amino-4-nitrotoluene	2A4NT	
2-Amino-4,6-dinitroaniline	2A46DA	
2-Amino-4,6-dinitrotoluene	2A46DT	
2-Benzazine	ISOQUN	119-65-3
2-Bromo-1-chloropropane	2B1CP	3017-95-6
2-Bromohexanoic acid	2BRHXA	616-05-7
2-Butanone	MEK	78-93-3
2-Butene	2C4E	107-01-7
2-Butoxyethanol	2BUXEL	111-76-2
2-Butoxyethanol phosphate	BEP	
2-Butyl-1-octanol	2B1OOL	
2-Butyl-*N*-methylnorleucine, methyl ester	2BNMNM	
2-Butyltetrahydrofuran	2BUTHF	
2-Chloro-1-(2,4-dichlorophenyl) vinyldiethyl phosphate	SUPONA	470-90-6
2-Chloro-6-methoxy-10H-phenothiazine	2C6MPZ	
2-Chloro-*N*-(2-chloroethyl)-*N*-methylethanamine	HN	51-75-2
2-Chlorobiphenyl	2CLBP	
2-Chloroethyl vinyl ether	2CLEVE	110-75-8
2-Chloronaphthalene	2CNAP	91-58-7
2-Chlorophenol	2CLP	95-57-8
2-Chlorophenol-D4	2CLPD4	
2-Chlorotoluene	2CLT	95-49-8
2-Chlorovinyl arsonic acid	CLVRA	
2-Cresol	2MP	95-48-7

ACCEPTABLE ENTRIES: (Cont.)

2-Cyclohexen-1-ol	2CHE1L	822-67-3
2-Cyclohexen-1-one	2CHE1O	930-68-7
2-Cyclohexyl-4,6-dinitrophenol	2CH46D	131-89-5
2-Cyclopentene-1-hendecanoic acid ethyl ester	2CHAEE	
2-Diisopropylaminoethanol	KB	
2-Diisopropylaminoethyl ethyl methylphosphonate	QB	
2-Diisopropylaminoethyl methylphosphinate	QA	
2-Ethoxyethanol	EGMEE	110-80-5
2-Ethyl-1-hexanol	2E1HXL	104-76-7
2-Ethyl-1,3-dimethylbenzene	2E13XY	
2-Ethyl-1,3-dimethylcyclohexane	2EDMCH	
2-Ethyl-2-hydroxymethyl-1, 3-propanediol	2E2HPD	77-99-6
2-Ethyl-4-methyl-1-pentanol	2E4MPL	
2-Ethyl-*m*-xylene	2E13XY	
2-Ethylcyclobutanol	2ECYBL	
2-Ethylhexanoic acid	2EC6A	149-57-5
2-Ethylphenol	2EP	90-00-6
2-Fluorobiphenyl	2FBP	321-60-8
2-Fluoronaphthalene	2FNAP	
2-Fluorophenol	2FP	367-12-4
2-Furanmethanol	FURAL	98-00-0
2-Hendecanol	2HNDOL	
2-Heptanone	2C7O	110-43-0
2-Hexanone	MNBK	591-78-6
2-Hydroxybenzaldehyde	2HBNZL	90-02-8
2-Hydroxybenzoic acid	2HBZOA	69-72-7
2-Hydroxybiphenyl	2HYBP	

ACCEPTABLE ENTRIES: (Cont.)

2-Hydroxybutanedioic acid dimethyl ester	2HBDDM	
2-Methoxy-1-propene	2MX1PE	
2-Methoxy-2-methylpropane	2MXMC3	1634-04-4
2-Methoxy-2,3,3-trimethylbutane	2MXTMB	
2-Methoxy-3,6-dichlorobenzoic acid	DCAMBA	1918-00-9
2-Methyl-1-dodecanol	2M1DDL	
2-Methyl-1-pentene	2M1PNE	763-29-1
2-Methyl-1-phenylpropane	2MPBZ	538-93-2
2-Methyl-2-(methylthio)propanal *O*-[(methylamino)carbonyl] oxime	ALDI	116-06-3
2-Methyl-2-butene	AMYLEN	513-35-9
2-Methyl-2-butenediamide	2M2BDA	
2-Methyl-2-hydroxy-3-butyne	2M2H3B	
2-Methyl-2-phenylpropane	TBBEN	
2-Methyl-2-propanol	2M2C3L	75-65-0
2-Methyl-2-propenenitrile	MTHCRN	126-98-7
2-Methyl-2-propenoic acid 1,2-ethanediyl ester	2MPEAE	
2-Methyl-2,4-pentanediol	2M24P	107-41-5
2-Methyl-3-hexene	2M3HXE	
2-Methyl-3-pentanone	2M3PNO	565-61-7
2-Methyl-4-(*tert*-butyl) phenol	4TBU2C	
2-Methyl-4-chlorophenol	4CL2C	1570-64-5
2-Methyl-4,6-dinitrophenol	46DN2C	534-52-1
2-Methyl-5-(1-methylethyl)-2-cyclohexen-1-one	2MMECO	
2-Methyl-5-chlorophenol	5CL2C	
2-Methyl-6-(*tert*-butyl) phenol	6TBU2C	
2-Methylbenzyl alcohol	2MBZA	89-95-2
2-Methylbutane	2MC4	78-78-4

ACCEPTABLE ENTRIES: (Cont.)

2-Methylcyclopentanol	2MCYPL	25144-05-2
2-Methylcyclopentanone	2MCPNE	1120-72-5
2-Methyldecane	2MDEC	
2-Methyldodecane	2MDOD	
2-Methylhendecanal	MDCL	110-41-8
2-Methylheptane	2MC7	540-84-1
2-Methylhexane	2MC6	591-76-4
2-Methylnaphthalene	2MNAP	91-57-6
2-Methyloctadecanoic acid	2MEODE	
2-Methylpentane	2MEPEN	107-83-5
2-Methylpentanol	MEPOH	
2-Methylphenol	2MP	95-48-7
2-Methylpropane	2MC3	78-28-5
2-Methylpropanoic acid	2MPA1E	79-31-2
2-Methylpropanoic acid 3-hydroxy-2,4,4-trimethyl-1,3-propanediyl ester	2MPAHT	
2-Methylpropanoic acid methyl ester	2MPAME	547-63-7
2-Methylpyrene	2MPYR	
2-Methyltetradecane	2MTETD	
2-Methyltetrahydrofuran	2MTHF	96-47-9
2-Methylthio-4-hydroxypyrimidine	2MTHPM	
2-Methylundecanal	MDCL	110-41-8
2-Naphthylamine	2NAPA	91-59-8
2-Nitro-*m*-cresol	2N3C	4920-77-8
2-Nitro-*N*-nitrosodiphenylamine	2NNDPA	
2-Nitroaniline	2NANIL	88-74-4
2-Nitrobenzalazine	2NBZLZ	
2-Nitrophenol	2NP	88-75-5
2-Nitropropane	2NPN	79-46-9

ACCEPTABLE ENTRIES: (Cont.)

2-Nitrotoluene	2NT	88-72-2
2-Nonadecanone	2NODCO	
2-Pentanone	MPK	107-87-9
2-Phenanthrenol, 4B,5,6,7,8,8A,9,10-octahydro-4B,8	2PHANL	
2-Phenoxyethanol	2PHXEL	122-99-6
2-Phenylbutane	SBBEN	135-98-8
2-Phenylethanol	2PETOH	60-12-8
2-Phenylnaphthalene	2PNAP	
2-Picoline	2PICO	109-06-8
2-Propanol	2PROL	67-63-0
2-Propenylbenzene	2PEBZ	
2-Propyn-1-ol	2PY1OL	
2-*sec*-Butyl-4,6-dinitrophenol	2SB46D	
2-Undecanol	2HNDOL	
2.0N Potassium chloride solution	2NKCL	
2,10-Dimethylundecane	210DMU	
2,2-Bis(chlorophenyl)chloroethylene (DDT related)	BCPHCE	
2,2-Bis(ethylmercapto) diethyl ether	2BEMDE	
2,2-Bis(methylmercapto) propane	2BMMPR	
2,2-Bis(*p*-chlorophenyl)-1,1-dichloroethane	PPDDD	72-54-8
2,2-Bis(*p*-chlorophenyl)-1,1-dichloroethene	PPDDE	72-55-9
2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane	PPDDT	
2,2-Bis(*p*-chlorophenyl)-2-phenyl-1,1-dichloroethene	PPTDE	
2,2-Bis[(nitrooxy)methyl]-1,3-propanediol dinitrate (ester)	PETN	78-11-5
2,2-Dichloropropane	22DCP	
2,2-Dichloropropanoic acid	DALA	75-99-0
2,2-Dimethyl-1-acetylcyclohexane	DM1ACH	
2,2-Dimethyl-1-propanol	TBCARB	75-84-3

ACCEPTABLE ENTRIES: (Cont.)

2,2-Dimethyl-5-(1-methylpropyl) tetrahydrofuran	DMPTHF	
2,2-Dimethylbutane	22DMC4	75-83-2
2,2-Dimethylhexane	22DMHX	
2,2-Dimethylpentane	2DMPEN	590-35-2
2,2-Oxybis[ethanol]	DEGLYC	111-46-6
2,2'-Ethylenedioxybis(ethanol)	TEGLYC	112-27-6
2,2'-Oxybis(1-chloropropane)	B2CIPE	108-60-1
2,2'-Thiobis[acetic acid]	TDGCLA	123-93-3
2,2'-Thiodiethanol	TDGCL	111-48-8
2,2'-[1,2-Ethanediylbis(oxy)]bisethanol	TEGLYC	112-27-6
2,2',3,3',4,4',5,5'-Octachlorobiphenyl	25OCCB	
2,2',3,4,4',5,6-Heptachlorobiphenyl	26HPCB	
2,2',3,4,5,5'-Hexachlorobiphenyl	25HXCB	
2,2',3,4,5,5',6-Heptachlorobiphenyl	25HPCB	
2,2'4,5,5'-Pentachlorobiphenyl	245PCB	
2,2',5-Trichlorobiphenyl	225TCB	
2,2',5,5'-Tetrachlorobiphenyl	2255CB	
2,2,3,3-Tetramethylpentane	23TMP	
2,2,4-Trimethyl-1,3-pentanediol	24T13P	144-19-4
2,2,4,4,7,7-Hexamethyloctahydro-1*H*-indene	247HOI	
2,2,6-Trimethyloctane	226TMO	
2,2,7,7-Tetramethyl-4,5-octadien-3-one	TMODEO	
2,3-Benzopyrrole	INDOLE	120-72-9
2,3-Dichloro-1-propene	23C1PE	78-88-6
2,3-Dichlorophenol	23DCLP	576-24-9
2,3-Dihydro-1*H*-indene	INDAN	496-11-7
2,3-Dihydro-2,2-dimethyl-7-benzofuranol methylcarbamate	CARBOF	1563-66-2

ACCEPTABLE ENTRIES: (Cont.)

2,3-Dihydrobenzofuran	COUMRN	496-16-2
2,3-Dimethyl-1-butene	23DM1B	
2,3-Dimethyl-2-hexanol	23D2HL	
2,3-Dimethylbutane	23DMC4	79-29-8
2,3-Dimethylnaphthalene	23DNAP	581-40-8
2,3-Dimethyloctane	23DMO	
2,3-Dimethylpentane	23DMC5	565-59-3
2,3-Dimethylphenol	23DMP	576-75-0
2,3,3-Trimethyl-1,4-pentadiene	233TMP	
2,3,4-Trimethyl-3-pentanol	TM3PL	
2,3,4-Trimethyl-4-tetradecene	TRMTDE	
2,3,4-Trimethylpentane	234TMP	
2,3,4,5-Tetrachlorobiphenyl	2345CB	
2,3,4,6-Tetrachlorophenol	2346CP	58-90-2
2,3,5-Trichlorophenol	235TCP	933-78-8
2,3,5-Trimethyldecane	235TMD	
2,3,5,6-Tetrachloro-1,4-benzenedicarboxylic acid dimethyl ester	DCPA	1861-32-1
2,3,5,6-Tetrachlorophenol	2356CP	935-95-5
2,3,6-Trichlorophenol	236TCP	
2,3,6-Trimethylnaphthalene	236TMN	
2,3,7-Trimethyloctane	237TMO	
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	TCDD	1746-01-6
2,3,7,8-Tetrachlorodibenzodioxin, C13 isomeric	ITCDD	
2,3,7,8-Tetrachlorodibenzofuran	TCDF	30402-14-3
2,3,7,8-Tetrachlorodibenzofuran, C13 isomeric	ITCDF	
2,3,7,8-Tetrachlorodibenzo[*b*,*e*][1,4]dioxin	TCDD	1746-01-6
2,4-Bis(isopropylamino)-6-methoxy-1,3,5-triazine	PROMET	1610-18-0

ACCEPTABLE ENTRIES: (Cont.)

2,4-D	24D	94-75-7
2,4-DB	24DB	94-82-6
2,4-Dichlorophenol	24DCLP	120-83-2
2,4-Dichlorophenoxyacetic acid	24D	94-75-7
2,4-Dichlorophenylacetic acid	DCAA	19719-28-9
2,4-Dihydroxybenzoic acid tris[trimethysilyl]	DBATTS	
2,4-Dimethyl-2-pentanol	24M2PL	
2,4-Dimethyldecane	24DMD	
2,4-Dimethylhexane	24DMHX	
2,4-Dimethylpentane	24DMC5	108-08-7
2,4-Dimethylphenol	24DMPN	105-67-9
2,4-Dinitro-6-*sec*-butylphenol	DINO	88-85-7
2,4-Dinitrophenol	24DNP	51-28-5
2,4-Dinitrophenol-D3	24NPD3	
2,4-Dinitrotoluene	24DNT	121-14-2
2,4'-Dichlorobiphenyl	24DCB	
24α-Ethylcholestanol	STIGMA	83-45-4
2,4,5-Trichlorophenol	245TCP	95-95-4
2,4,5,6-Tetrachlorometaxylene	CL4XYL	
245T	245T	93-76-5
245TP	245TP	93-72-1
2,4,6-Tribromophenol	246TBP	118-79-6
2,4,6-Trichloroaniline	246TCA	634-93-5
2,4,6-Trichlorophenol	246TCP	88-06-2
2,4,6-Trimethyloctane	246TMO	
2,4,6-Trimethylpyridine	246MPY	108-75-8
2,4,6-Trinitrobenzaldehyde	ATNBA	
2,4,6-Trinitrophenol	246TNP	88-89-1

ACCEPTABLE ENTRIES: (Cont.)

2,4,6-Trinitrophenol ammonium salt	NH4PIC	131-74-8
2,4,6-Trinitroresorcinol	246TNR	82-71-3
2,4,6-Trinitrotoluene	246TNT	118-96-7
2,4,7-Trimethyloctane	247TMO	
2,5-Cyclohexadien-1,4-dione	25C14D	106-51-4
2,5-Dichlorophenol	25DCLP	583-78-8
2,5-Diethyltetrahydrofuran	25ETHF	
2,5-Dimethylphenanthrene	25DMPA	
2,5-Dimethylphenol	25DMP	95-87-4
2,5-Dimethyltetrahydrofuran	25DTHF	1003-38-9
2,5,6-Trimethyldecane	256TMD	
2,5,8,11,14-Pentaoxapentadecane	TGLYME	143-24-8
2,6-Bis(1,1-dimethylethyl)-2,5-cyclohexadiene-1,4-dione	26BCHD	
2,6-Di-*tert*-butyl-4-cresol	26DBMP	128-37-0
2,6-Di-*tert*-butyl-4-methylphenol	26DBMP	128-37-0
2,6-Dichlorophenol	26DCLP	87-65-0
2,6-Dimethyl-2-octene	26DM2O	
2,6-Dimethylheptadecane	26DMHD	
2,6-Dimethyloctane	26DMO	
2,6-Dimethyloctene	26DMOE	
2,6-Dimethylphenol	26DMP	576-26-1
2,6-Dimethylstyrene	26DMST	
2,6-Dimethylundecane	26DMUD	
2,6-Dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)benzenamine	TREFLN	1582-09-8
2,6-Dinitroaniline	26DNA	606-22-4
2,6-Dinitrotoluene	26DNT	606-20-2
2,6,10,14-Tetramethylheptadecane	2TMHPD	
2,6,10,14-Tetramethylpentadecane	2TMPD	1921-70-6

ACCEPTABLE ENTRIES: (Cont.)

2,6,11-Trimethyldodecane	2611MD	
2,7-Dimethylnaphthalene	27DNAP	582-16-1
2,7-Dimethyloctane	27DMO	
2,9-Dimethylundecane	29DMUD	
3-(1-Methylethyl)-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one-2,2-dioxide	BTAZON	
3-(2,2-Dimethylpropoxy) cyclohexene	DMPCHE	
3-(3,4-Dichlorophenyl)-1-methoxy-1-methylurea	LINRN	330-55-2
3-(3,4-Dichlorophenyl)-1,1-dimethylurea	DIURON	330-54-1
3-(Chloromethyl) cyclohexene	3CMCH	
3-(Hydroxymethyl)-4,4-dimethylpentanal	3HDMPL	
3-(*p*-Chlorophenyl)-1,1-dimethylurea	MONRN	150-68-5
3-(*p*-Chlorophenyl)-1,1-dimethylurea trichloroacetate	MNRNTC	140-41-0
3-(*tert*-Butyl)-pentane	3E22MP	
3-(*tert*-Butyl) phenol	3TBUP	
3-Amino-2,5-dichlorobenzoic acid	CAMBEN	
3-Butenyl pentyl ether	3BPETH	
3-Chloro-1-propene	3C1C3E	107-05-1
3-Chlorooctane	3CO	
3-Chlorophenol	3CLP	108-43-0
3-Chloropropionitrile	3CLPRN	
3-Chlorotoluene	3CLT	108-41-8
3-Cresol	3MP	108-39-4
3-Cyclohexyldecane	3CHXD	
3-Ethyl-1,4-hexadiene	3EHXDE	
3-Ethyl-2,2-dimethylpentane	3E22MP	
3-Ethyl-2,5-dimethyl-3-hexene	3E25DH	
3-Ethyl-4-methyloctane	EMFUR	

ACCEPTABLE ENTRIES: (Cont.)

3-Ethyl-5-(2-ethylbutyl) octadecane	3EEBOD	
3-Ethyl-5-methylheptane	3E5MHP	
3-Ethylphenol	3EP	620-17-7
3-Hexen-2-one	3HXE2O	
3-Hydroxy-2,7-dimethyl-4-[3*H*]-pteridinone	3HDMPT	
3-Hydroxybenzaldehyde	3HYBA	100-83-4
3-Hydroxycarbofuran	3HCFRN	
3-Isopropyl-1-methylcyclopentane	3I1MCP	
3-Methoxy-2-cyclopenten-1-one	3M2C1O	
3-Methoxyimidazole	3MXIMZ	
3-Methoxytoluene	3MXT	
3-Methyl-1-pentanol	3M1PL	589-35-5
3-Methyl-2-cyclohexen-1-one	3M2CHO	
3-Methyl-2-hexanol	3M2HXL	
3-Methyl-2-nitrophenol	2N3C	4920-77-8
3-Methyl-2-pentene	3M2C5E	922-61-2
3-Methyl-4-chlorophenol	4CL3C	
3-Methyl-5-propylnonane	3M5PNN	
3-Methyl-6-chlorophenol	6CL3C	
3-Methylbiphenyl	3MBP	
3-Methylbutanoic acid	ISOVAL	
3-Methylbutanoic acid 3,7-dimethyl-2,4,6-octatrienyl ester	MBADOE	
3-Methylcholanthrene	3MCA	56-49-5
3-Methylchrysene	3MCHRY	
3-Methylcyclohexene	3MCHXE	
3-Methyldecane	3MDEC	
3-Methylhexane	3MC6	598-34-4

ACCEPTABLE ENTRIES: (Cont.)

3-Methylpentane	3MEPEN	96-14-0
3-Methylphenanthrene	3MPANR	
3-Methylphenol	3MP	108-39-4
3-Methylpyridine	PIC3	
3-Methylundecane	3MUND	
3-Nitroaniline	3NANIL	99-09-2
3-Nitrotoluene	3NT	99-08-1
3-Octanol	3OCTOL	20296-29-1
3-Oxo-3-phenylpropanoic acid ethyl ester	3OPPAE	
3-Phenyl-1,1-dimethylurea	FENRN	101-42-8
3-Phenylpropanol	EDBDAS	
3-Phenylpropanoyl chloride	3PC3AC	
3-Picoline	PIC3	
3-Propyltoluene	3PT	
3-Quinuclidinyl benzilate	BZ	1619-34-7
3-[(Dimethoxyphosphinyl)oxy]-2-butenoic acid methyl ester	MEVIN	7786-34-7
3,3-Dimethylhexane	33DMHX	
3,3-Dimethylpentane	33DMPN	562-49-2
3,3'-Dichlorobenzidine	33DCBD	91-94-1
3,3'-Dimethoxybenzidine	33DMBP	
3,3'-Dimethoxybiphenyl	33DMBP	
3,3'-Dimethylbenzidine	33DMEB	
3,3'-Dimethylbiphenyl	33DMEB	
3,3',4,4'-Tetrachlorobiphenyl-D6	34CBD6	
3,3,6-Trimethyl-1,5-heptadien-4-one	TMHPDO	
3,4-Benzofluoranthene	BBFANT	205-99-2
3,4-Benzphenanthrene	BZCPAN	195-19-7
3,4-Dichlorophenol	34DCLP	95-77-2

ACCEPTABLE ENTRIES: (Cont.)

3,4-Dihydro-2*H*-1-benzopyran	DHBZPY	
3,4-Dimethyl-1-decene	34D1DE	
3,4-Dimethylphenol	34DMP	95-65-8
3,4-Dinitrotoluene	34DNT	610-39-9
3,4-Epoxy-3-ethyl-2-butanone	3EE2BO	
3,4,4-Trimethyl-2-hexene	344TMH	
3,4,4-Trimethyl-2-pentene	344TPE	
3,4,5-Trimethyl-1-hexene	345T1H	
3,4,5,6-Tetramethylphenanthrene	36TMPA	
3,5-Dichloro-*N*-(1,1-dimethyl-2-propynyl)benzamide	PRONA	23950-58-5
3,5-Dimethyl-2-cyclohexen-1-one	3DCHEO	1123-09-7
3,5-Dimethyl-3-hexanol	35M3HL	
3,5-Dimethyl-4-(methylthio) phenol methylcarbamate	METHCB	2032-65-7
3,5-Dimethylcumene	IPMXYL	
3,5-Dimethylphenol	35DMP	108-68-9
3,5-Dinitroaniline	35DNA	618-87-1
3,5-Dinitrophenol	35DNP	
3,5-Dinitrotoluene	35DNT	
3,5,24-Trimethyltetracontane	TMTCON	
3,5,5-Trimethyl-1-hexanol	TMHXL	
3,5,5-Trimethyl-2-cyclohexen-1-one	3TCHEO	
3,6-Dichlorofluoren-9-one	36DF9O	
3,6-Dimethyloctane	36DMO	
3,7-Dihydro-1,3,7-trimethyl-1*H*-purine-2,6-dione	CAFEIN	58-08-2
3,7-Dimethylnonane	37DMNN	
3,7,11-Trimethyl-2,6,10-dodecatrien-1-ol	FARN	4602-84-0
3,7,7-Trimethyl-bicyclo[4,1,0]heptane	377TBH	
3,8-Dimethylundecane	38DMUD	

ACCEPTABLE ENTRIES: (Cont.)

4-(1-Methylethyl)-*N*-phenylaniline	4MENPA	
4-(1-Methylethyl)heptane	41MEHP	
4-(1-Methylethyl)toluene	PCYMEN	99-87-6
4-(1,1-Dimethylethyl)benzoic acid	DMEBZO	
4-(2-Aminoethyl) pyrocatechol	DOPAM	51-61-6
4-(2,4-Dichlorophenoxy)butyric acid	24DB	94-82-6
4-(Dimethylamino)-3-methylphenol methylcarbamate	AMINCR	2032-59-9
4-(Dimethylamino)-3,5-dimethylphenol methylcarbamate (ester)	MXCRBT	315-18-4
4-Acetylmorpholine	4AMORP	1696-20-4
4-Allyl-1,2-methylenedioxybenzene	SAFROL	94-59-7
4-Amino-2-nitrotoluene	4A2NT	
4-Amino-3,5-dinitrotoluene	4A35DT	
4-Amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4*H*)-one	MBZ	21087-64-9
4-Aminobiphenyl	4ABP	92-67-1
4-Bromofluorobenzene	4BFB	460-00-4
4-Bromophenyl phenyl ether	4BRPPE	
4-Butoxy-3-penten-2-one	4B3P2O	
4-Chloro-2-butyl *m*-chlorocarbanilate	BARBAN	101-27-9
4-Chloro-2-cresol	4CL2C	1570-64-5
4-Chloro-3-cresol	4CL3C	
4-Chloro-3-methyl-1-butene	4C3MBE	
4-Chloro-3-methylphenol	4CL3C	
4-Chloro-*m*-cresol	4CL3C	
4-Chloroaniline	4CANIL	106-47-8
4-Chlorocyclohexanol	4CCHXL	
4-Chlorophenyl phenyl ether	4CLPPE	
4-Chlorotoluene	4CLT	106-43-4

ACCEPTABLE ENTRIES: (Cont.)

4-Cresol	4MP	106-44-5
4-Dimethylamino-3,5-xylyl methylcarbamate	MXCRBT	315-18-4
4-Ethyl-2-methylhexane	4E2MHX	
4-Ethyl-2-octene	4E2OCE	
4-Ethyl-2,2,6,6-tetramethylheptane	4ETMHP	
4-Fluoroaniline	4FANIL	371-40-4
4-Fluorotoluene	4FT	352-32-9
4-Hydroxy-3-(3-oxo-1-phenylbutyl)-2*H*-1-benzopyran-2-one	WARFRN	81-81-2
4-Hydroxy-3-methoxybenzaldehyde	4H3MBA	121-33-5
4-Hydroxy-3,5-dimethoxybenzaldehyde	4H35BA	134-96-3
4-Hydroxy-4-methyl-2-pentanone	DIACAL	123-42-2
4-Hydroxyazobenzene	4HAZOB	1689-82-3
4-Hydroxybenzaldehyde	4HYBA	123-08-0
4-Hydroxybenzoic acid	4HBZOA	99-96-7
4-Iodomethylquinuclidine	4IOMQU	
4-Methoxycyclohexanol	4MXCHL	
4-Methoxyphenol	4MXP	150-76-5
4-Methyl-1-(1-methylethyl)-bicyclo[3.1.0]hex-2-ene	4MMBHE	
4-Methyl-1,4-hexadiene	4M14HX	
4-Methyl-2-pentanol	MIBCOH	108-11-2
4-Methyl-2-pentanone	MIBK	108-10-1
4-Methyl-2-propyl-1-pentanol	4M2PPL	
4-Methyl-3-penten-2-one	MESTOX	141-79-7
4-Methyl-9*H*-fluorene	4MFLRE	
4-Methylbenzene sulfonamide	4MBSA	
4-Methylbiphenyl	4MBP	644-08-6
4-Methyldecane	4MDEC	

ACCEPTABLE ENTRIES: (Cont.)

4-Methyldibenzofuran	4MDBFU	
4-Methylheptane	4MC7	589-53-7
4-Methylphenanthrene	4MPANR	
4-Methylphenol	4MP	106-44-5
4-Methylpyrene	4MPYR	
4-Nitroaniline	4NANIL	100-01-6
4-Nitrophenol	4NP	100-02-7
4-Nitroquinoline-1-oxide	4NQU1O	
4-Nitrotoluene	4NT	99-99-0
4-*tert*-Butyl-2-cresol	4TBU2C	
4-*tert*-Octylphenol	4TOP	140-66-9
4,4-Difluorobenzophenone	44DFBZ	345-92-6
4,4-Dimethyl-2-pentanol	4DM2PL	6144-93-0
4,4-Dimethyl-2-pentene	44DMPE	
4,4-Dimethylundecane	44DMUD	
4,4'-Dichlorobenzophenone	44DCBZ	90-98-2
4,4'-Methylenebis(2-chloroaniline)	44MB2C	
4,5-Dimethyl-2,6-bis(trimethylsiloxy) pyrimidine	DBTSPY	
4,5,6,7,8,8A-Hexahydro-8A-methyl-2-[1*H*]-azulene	HXHMAZ	
4,6-Dinitro-2-cresol	46DN2C	534-52-1
4,6,8-Trimethyl-1-nonene	468T1N	
4,7-Dimethylundecane	47DMUD	
4,8-Dimethylhendecane	48DMHD	
5-(1-Propenyl)-1,3-benzodioxole	ISOSAF	
5-(2-Propenyl)-1,3-benzodioxole	SAFROL	94-59-7
5-Chloro-*o*-cresol	5CL2C	
5-Ethyl-2-methylheptane	5E2MHP	
5-Ethyl-5-methyldecane	5E5MD	

ACCEPTABLE ENTRIES: (Cont.)

5-Methyl-2-hexanone	5M2HXO	
5-Methyl-5-hydroxyhexanoic acid lactone	5M5HAL	
5-Methylbenzo[*c*]acridine	MBZCAC	
5-Nitro-*o*-toluidine	5NOTOL	
5-Norboren-2-ol	5N2OL	13080-90-5
5-Propyltridecane	5PTRID	
50% 1M NaOH - 50% Methanol	NAOHME	
50% Hexane - 50% acetone	50H50A	
50% Methylene chloride - 50% acetone	50M50A	
50% Water - 25% Methanol - 25% acetonitrile	50WMAN	
5,7-Dichloro-2-methylbenzofuran	DCMBF	
6-Aminohexanoic acid lactam	CAPLCT	105-60-2
6-Chloro-3-cresol	6CL3C	
6-Chloro-*N,N'*-diethyl-1,3,5-triazine-2,4-diamine	SIMAZ	122-34-9
6-Ethyl-6-methylfulvene	6E6MFV	
6-Methoxy-*N,N'*-bis(1-methylethyl)-1,3,5-triazine-2,4-diamine	PROMET	1610-18-0
6-Methyl-1-heptanol	6M1HPL	
6-Methyl-3-heptanol	6M3HPL	
6-Methyldodecane	6MDOD	
6-Methylpurine	6MEPUR	2004-03-7
6-Methyltridecane	6MTRID	
6-*tert*-Butyl-2-cresol	6TBU2C	
6,7,8,9-Tetrahydro-5*H*-tetrazolo[1,5-*a*]azepine	MTRZL	54-95-5
7-Hydroxynorbornadiene	HYNB	
7-Methyltridecane	7MTRID	
7,12-Dimethylbenz[*a*]anthracene	712DMA	57-97-6
7*H*-Benz[*de*]anthracen-7-one	BENZA	82-05-3
8-Methyl-1,8-nonanediol	8MNNDL	

ACCEPTABLE ENTRIES: (Cont.)

8-Methyldecanoic acid methyl ester	C12AMM	
9-Anthracenecarbonitrile	ANTRCN	1210-12-4
9-Fluorenone	9FLENO	486-25-9
9-Methoxyanthracene	9MXANT	
9-Methylbenz[*a*]anthracene	9MBAAN	
9,10-Anthracenedione	ANTRQU	84-65-1
9,10-Benzphenanthrene	TRPHEN	217-59-4
9,10-Dihydro-9,9-dimethylacridine	DHDMAC	
9*H*-Carbazole	CARBAZ	86-74-8
9*H*-Fluoren-9-one	9HFLRE	
9*H*-Fluorene	FLRENE	86-73-7
Acenaphthene	ANAPNE	83-32-9
Acenaphthene-D10	ACND10	
Acenaphthylene	ANAPYL	208-96-8
Acetic acid	ETHACD	
Acetic acid cyclohexyl ester	AACHXE	622-45-7
Acetic acid ethyl ester	C2AEE	141-78-6
Acetic acid vinyl ester	C2AVE	108-05-4
Acetone	ACET	67-64-1
Acetonitrile	CH3CN	75-05-8
Acetophenone	ACPHN	98-86-2
Acetylene tetrachloride	TCLEA	79-34-5
Acid volatile sulfide	AVS	
Acidity	ACIDIT	
Acids (high molecular weight)	ACDHMW	
Acrolein	ACROLN	107-02-8
Acrylonitrile	ACRYLO	107-13-1

ACCEPTABLE ENTRIES: (Cont.)

Actinium 228	AC228	
Adamsite	DM	578-94-9
Alachlor	ALACL	15972-60-8
Alcohols (high molecular weight)	ALHMW	
Aldehydes	ALDEHY	
Aldicarb	ALDI	116-06-3
Aldicarb sulfone	ALDISN	
Aldicarb sulfoxide	ALDISX	
Aldrin	ALDRN	309-00-2
Algylen	TRCLE	79-01-6
Aliphatic alcohols	ALAL	
Aliphatic hydrocarbons	ALHC	
Alkalinity	ALK	
Alkalinity - bicarbonate	ALKBIC	
Alkalinity - carbonate	ALKCAR	
Alkalinity - hydroxide	ALKHYD	
Alkalinity - phenolphthalein	ALKPHE	
Alkanes	ALKN	
Alkron	PRTHN	56-38-2
Alleron	PRTHN	56-38-2
Alltox	TXPHEN	8001-35-2
Allyl alcohol	ALYLOL	
Allyl chloride	3C1C3E	107-05-1
Allyl ether	AYLETH	557-40-4
Allylcatechol methylene ether	SAFROL	94-59-7
Allyldioxybenzene methylene ether	SAFROL	94-59-7
Alpha gross	ALPHAG	

ACCEPTABLE ENTRIES: (Cont.)

Alpha gross-field	ALPGF	
Alpha gross-lab	ALPGL	
Alpha gross-soluble acid fraction	ALPGLA	
Alpha gross-soluble water fraction	ALPGLW	
Aluminum	AL	7429-90-5
Amenable cyanide	CYNAM	
Americium 241	AM241	
Aminocarb	AMCARB	
Aminoguanidine	AMGD	79-17-4
Ammonia	NH3	7664-41-7
Ammonia nitrogen	NH3N2	
Ammonium	NH4	12125-02-9
Ammonium carbazoate	NH4PIC	131-74-8
Ammonium dihydrogen phosphate	ADHP	7722-76-1
Ammonium nitrate	NH4NIT	6484-52-2
Ammonium picrate	NH4PIC	131-74-8
Amosite asbestos	AMOS	12172-73-5
Amylene	AMYLENE	513-35-9
Anethole	ANTHOL	
Aniline	ANIL	62-53-3
Anion elutent	ANELNT	
Anise camphor	ANTHOL	
Ankilostin	TCLEE	127-18-4
Anprolene	ETOX	75-21-8
Anthocyanin	ANTCYA	
Anthophyllite asbestos	ANPHO	
Anthracene	ANTRC	120-12-7

ACCEPTABLE ENTRIES: (Cont.)

Anticholinesterase	ACHE	
Antimony	SB	7440-36-0
Antimony-124	SB124	
Antimony-125	SB125	
Aphamite	PRTHN	56-38-2
Aquacare	UREA	57-13-6
Aquadrate	UREA	57-13-6
Arachic acid	ARACHA	
Arachidic acid	ARACHA	
Aramite	ARAMT	140-57-8
Aromatics, hydroxylated	HYDARO	
Arsenic	AS	7440-38-2
Arsenic extractable	ASEXT	
Arsenic total	ASTOT	
Arylam	SEVIN	63-25-2
Asbestos	ASBEST	
Ash, total	TOTASH	
Athraquinone	ANTRQU	84-65-1
Atrazine	ATZ	1912-24-9
AVS:SEM ratio (unitless)	AVSSEM	
Azacylononane	AZACN	
Azinphos methyl	AZM	86-50-0
Azodrin	MNCRPH	
Barban	BARBAN	101-27-9
Barium	BA	7440-39-3
Barium-133	BA133	
Barium-140	BA140	
Basodexan	UREA	57-13-6

ACCEPTABLE ENTRIES: (Cont.)

Baygon	PROPXR	114-26-1
Bentazon	BTAZON	
Benzal chloride	BAC	98-87-3
Benzaldehyde	BENZAL	100-52-7
Benzanthrone	BENZA	82-05-3
Benzene	C6H6	71-43-2
Benzene-D6	C6D6	
Benzeneacetic acid	PHENAA	103-82-2
Benzenephosphonic acid	BZPA	
Benzenethiol	BTHIOL	
Benzfluoranthene	BZFANT	
Benzidine	BENZID	92-87-5
Benzobifluoroanthene	BF2ANT	
Benzoic acid	BENZOA	65-85-0
Benzoic acid ammonium salt	BZONH4	1863-63-4
Benzoic acid methyl ester	BZOAME	93-58-3
Benzothiazole	BTZ	95-16-9
Benzotrichloride	BTC	98-07-7
Benzo[*a*]anthracene	BAANTR	56-55-3
Benzo[*a*]phenanthrene	BZAPAN	
Benzo[*a*]pyrene	BAPYR	50-32-8
Benzo[*b*]fluoranthene	BBFANT	205-99-2
Benzo[*b*]fluorene	BBFLRE	
Benzo[*b*]naphtho[1,2-*D*]thiophene	BBNTHP	239-35-0
Benzo[*b*]naphtho[2,3-*D*]furan	BBNFN	
Benzo[*b*]pyridine	QUINO	91-22-5
Benzo[*b*]thiophene	BZOTHP	95-15-8

ACCEPTABLE ENTRIES: (Cont.)

Benzo[*b*]triphenylene	BZOTRP	
Benzo[*c*]phenanthrene	BZCPAN	195-19-7
Benzo[*c*]pyridine	ISOQUN	119-65-3
Benzo[*def*]phenanthrene	PYR	129-00-0
Benzo[*e*]pyrine	BEPYR	192-97-2
Benzo[*ghi*]fluoranthene	BGHIFA	
Benzo[*ghi*]perylene	BGHIPY	191-24-2
Benzo[*h*]quinoline	BZHQUN	230-27-3
Benzo[*j*]fluoranthene	BJFANT	205-82-3
Benzo[*k*]fluoranthene	BKFANT	207-08-9
Benzyl alcohol	BZALC	100-51-6
Benzyl bromide	BZYLBR	100-39-0
Benzyl chloride	BZYLCL	100-44-7
Beryllium	BE	7440-41-7
Beryllium 7	BE7	
Beta gamma gross	BEGAG	
Beta gross	BETAG	
Beta gross-field	BETGF	
Beta gross-lab	BETGL	
Beta gross-soluble acid fraction	BETGLA	
Beta gross-soluble water fraction	BETGLW	
BHC - nonspecific	BHC	
Bicarbonate	HCO3	71-52-3
Bicyclohexyl	BICYHX	92-51-3
Bicyclo[2,2,1]hepta-2,5-diene	BCHPD	121-46-0
Bicyclo[3,1,0]hexane	BCY3HX	
Bifex	PROPXR	114-26-1

ACCEPTABLE ENTRIES: (Cont.)

Binaphthyl	BINAP	
Biological oxygen demand	BOD	
Birlane	SUPONA	470-90-6
Bis(1-methylethyl) carbamothioic acid *S*-(2,3-dichloro-2-propenyl) ester	DIALAT	2303-16-4
Bis(2-chloroethoxy) methane	B2CEXM	111-91-1
Bis(2-chloroethyl) ether	B2CLEE	111-44-4
Bis(2-chloroethyl) sulfide	HD	505-60-2
Bis(2-chloroisopropyl) ether	B2CIPE	108-60-1
Bis(2-diisopropylaminoethyl) methylphosphonate	LT-A	
Bis(2-diisopropylaminoethyl) methylphosphonite	LT	
Bis(2-ethylhexyl) phthalate	B2EHP	117-81-7
Bis(carboxymethyl) sulfone	BCMSO2	
Bis(carboxymethyl) sulfoxide	BCMSO	
Bis(chloromethyl) ether	BCLME	542-81-1
Bis(diisopropylaminoethyl) disulfide	DIADS	
Bis(diisopropylamino) ethanethiol	DIAET	
Bis(diisopropylamino) ethanol	DIAEL	
Bis(diisopropylamino) ethylsulfide	DIAS	
Bis(diisopropylamino) ethylsulfonate	DIASO2	
Bis(hydroxyethyl)sulfide	TDGCL	111-48-8
Bis(pentafluorophenyl) phenyl phosphine	C185FP	5074-71-5
Bis(trimethylsilyl) oxalic acid	BTMSOA	
Bismuth	BI	7440-69-9
Bismuth 212	BI212	
Bismuth 214	BI214	
Bladex	BLDX	21725-46-2
Blattanex	PROPXR	114-26-1
Bolstar	BOLS	35400-43-2

ACCEPTABLE ENTRIES: (Cont.)

Bonoform	TCLEA	79-34-5
Boron	B	7440-42-8
Bromacil	BRMCIL	314-40-9
Bromchlophos	NALED	300-76-5
Bromex	NALED	300-76-5
Bromide	BR	
Bromobenzene	BRC6H5	108-86-1
Bromochloromethane	BRCLM	74-97-5
Bromodichloromethane	BRDCLM	75-27-4
Bromoethane	ETHBR	74-96-4
Bromoform	CHBR3	75-25-2
Bromomethane	CH3BR	74-83-9
Butane	C4	106-97-8
Butanedioic acid dimethyl ester	BDADME	106-65-0
Butanoic acid 1-hexyl ester	BAHXE	
Butter yellow	PDMAB	60-11-7
Butyl ethyl ether	BUEETH	628-81-9
Butyl stearate	C18ABE	123-95-5
Butylbenzene	BUC6H5	104-51-8
Butylbenzyl phthalate	BBZP	85-68-7
Butylmethyl phthalate	BMP	
Butylphthalyl butylglycolate	BPBG	85-70-1
C17 alkane	C17A	
C18 alkane	C18A	
C18H30O Unknown	C18UNS	
C22H40O Unknown	C22UNS	
C8 alkane	C8A	
Cadmium	CD	7440-43-9

ACCEPTABLE ENTRIES: (Cont.)

Cadmium, simultaneously extracted	CDSX	
Caffeine	CAFEIN	58-08-2
Calcium	CA	7440-70-2
Calcium carbonate solution	CACO3S	471-34-1
Calculated Hardness	CHARD	
Californium 252	CF252	
Camphechlor	TXPHEN	8001-35-2
Camphor	CAMP	464-49-3
Canex	ROTEN	83-79-4
Caproic acid	HEXAC	142-62-1
Caprolactam	CAPLCT	105-60-2
Captan	CAPTAN	133-06-2
Carbamic acid methyl ester	CAME	
Carbamide	UREA	57-13-6
Carbaryl	SEVIN	63-25-2
Carbazole	CARBAZ	86-74-8
Carbofuran	CARBOF	1563-66-2
Carbolic acid	PHENOL	108-95-2
Carbon 14	CARB14	
Carbon dioxide	CO2	124-38-9
Carbon disulfide	CS2	75-15-0
Carbon monoxide	CMONOX	630-08-0
Carbon tetrachloride	CCL4	56-23-5
Carbonate	CO3	
Carbonic acid dimethyl ester	C1ADME	616-38-6
Carbonyl chloride	CG	75-44-5
Carbonyldiamide	UREA	57-13-6

ACCEPTABLE ENTRIES: (Cont.)

Carbophenothion	TRITN	786-19-6
Cardiazole	MTRZL	54-95-5
Carylderm	SEVIN	63-25-2
Catechol	CATOL	120-80-9
Cation exchange capacity	CEC	
Cellon	TCLEA	79-34-5
Cellosolve	EGMEE	110-80-5
Cerium	CE	7440-45-1
Cerium 141	CE141	
Cerium 144	CE144	
Cesium	CS	7440-46-2
Cesium 134	CS134	
Cesium 137	CS137	
Chemical oxygen demand	COD	
Chinoleine	QUINO	91-22-5
Chloramben	CAMBEN	
Chlorate	CLO3	
Chlordane	CLDAN	57-74-9
Chlordecone	KEP	143-50-0
Chlordene	CLDEN	
Chlorfenvinphos	SUPONA	470-90-6
Chloride	CL	
Chlorinated benzenes	CLXB	
Chlorinated camphene	TXPHEN	8001-35-2
Chlorinated naphthalenes	CLXNAP	
Chlorine	CL2	7782-50-5
Chlorine demand	CLD	

ACCEPTABLE ENTRIES: (Cont.)

Chloroacetaldehyde	CAAH	107-20-0
Chloroacetic acid	CLC2A	79-11-8
Chloroacetophenone	CN	532-27-4
Chlorobenzene	CLC6H5	108-90-7
Chlorobenzene-D5	CLC6D5	
Chlorobenzilate	CLBZL	510-15-6
Chlorocyclohexane	CLCYHX	542-18-7
Chlorodibromomethane	DBRCLM	124-48-1
Chlorodifluoromethane	CCLF2	75-45-6
Chlorodinitrobenzene isomer	CDNBIS	
Chloroethane	C2H5CL	75-00-3
Chloroethene	C2H3CL	75-01-4
Chlorofluoromethane	CCLF	
Chloroform	CHCL3.	67-66-3
Chloroform-D	CDCL3	
Chloromethane	CH3CL	74-87-3
Chloromethyl methyl ether	CMME	107-30-2
Chloromethyloxirane	EPCLHD	106-89-8
Chloronaphthalenes	CLNAP	
Chlorophenols	CLP	
Chlorothalonil	CLTHL	1897-45-6
Chlorotoluene	CT	25168-05-2
Chlorpropham	CLPRPM	101-21-3
Chlorpyrifos	CPYR	2921-88-2
Chlorylen	TRCLE	79-01-6
Cholestane	CHOLA	481-21-0
Chromate	CRO4	
Chromium	CR	7440-47-3

ACCEPTABLE ENTRIES: (Cont.)

Chromium 51	CR51	
Chromium, hexavalent	CRHEX	
Chromium III	CR3	16065-83-1
Chrysene	CHRY	218-01-9
Chrysene-D12	CYSD12	
Chrysotile asbestos	CHRYS	12001-29-5
Cinnamene	STYR	100-42-5
Cinnamol	*STYR*	*100-42-5*
cis-1-Bromo-2-chlorocyclohexane	CBCCH	
cis-1-Ethyl-2-methylcyclohexane	C1E2MC	
cis-1,2-Diacetoxycyclohexane	CDACH	
cis-1,2-Dichloroethene	C12DCE	156-59-2
cis-1,2-Dichloroethylene	C12DCE	156-59-2
cis-1,3-Dichloropropene	C13DCP	
cis-1,3-Dichloropropylene	C13DCP	
cis-1,4-Dichloro-2-butene	CDCBU	1476-11-5
cis-2-Methyl-2-pentene	Z2M2PE	
cis-3-Methyl-4-nonene	Z3M4NE	
cis-4-Hexen-1-ol	C4HX1L	
cis-Chlordane	CCLDAN	
Clinicide	SEVIN	63-25-2
Clionasterol	GSITOS	
Co-eluting compounds QA and LT (q.v.)	QALT	
Co-eluting compounds YL, QL and DEMP (q.v.)	YLQLTR	
Co-Rax	WARFRN	81-81-2
Cobalt	CO	7440-48-4
Cobalt 57	CO57	
Cobalt 58	CO58	

ACCEPTABLE ENTRIES: (Cont.)

Cobalt 60	CO60	
Color	COLOR	
Columbium	NB94	
Columbium	NB95	
Copper	CU	7440-50-8
Copper extractable	CUEXT	
Copper, simultaneously extracted	CUSX	
Copper total	CUTOT	
Corrositivity (tendency to corrode)	CORRTY	
Cotoran	FLUMET	2164-17-2
Cottonex	FLUMET	2164-17-2
Coumaphos	COUMA	56-72-4
Coumaran	COUMRN	496-16-2
Cresols	CSOL	
Crocidolite asbestos	CROCO	
Crotonaldehyde	CRTALD	123-73-9
Cryoflex	CRYOF	
Cumene	ISOPBZ	98-82-8
CVP	SUPONA	470-90-6
Cyanide	CYN	57-12-5
Cyanide, free form	CYNF	
Cyanide, reactive	RECN	
Cyanogen chloride	CK	506-77-4
Cyclododecane	CYDODC	
Cyclohexane	CYHX	110-82-7
Cyclohexanol	C6HOH	108-93-0
Cyclohexanone	CHONE	108-94-1

ACCEPTABLE ENTRIES: (Cont.)

Cyclohexene	CYHXE	110-83-8
Cyclohexene oxide	12EPCH	286-20-4
Cyclohexyl chloride	CLCYHX	542-18-7
Cyclohexylamine	CYHXA	
Cyclohexylbenzene	CYHXB	827-52-1
Cyclonite	RDX	121-82-4
Cyclooctatetraene	CYOCTE	629-20-9
Cyclopentadiene	CYPD	542-92-7
Cyclopentanecarboxaldehyde	CPCXAL	
Cyclopentanone	CPO	120-92-3
Cyclopentene	CYPNE	142-29-0
Cyclotetramethylenetetranitramine	HMX	2691-41-0
Cymene	ISOPT	
Cynem	ZINPHS	297-97-2
D(-)-Pantoyl lactone	DPNTLL	599-04-2
Dacthal	DCPA	1861-32-1
Dalapon	DALA	75-99-0
DCAA	DCAA	19719-28-9
DCPA	DCPA	1861-32-1
DDVP	DDVP	62-73-7
Decachlorobiphenyl	CL10BP	
Decafluorobiphenyl	F10BP	434-90-2
Decahydro-2-methylnaphthalene	DH2MN	
Decamethylcyclopentasiloxane	DCMPSX	541-02-6
Decane	C10	124-18-5
Decylbenzene	DECYLB	104-72-3
Deionized water	DIH2O	

ACCEPTABLE ENTRIES: (Cont.)

Demeton-O	DEMO	298-03-3
Demeton-S	DEMS	126-75-0
Demeton total	TDEMET	
Derbac	SEVIN	63-25-2
Dermaton	SUPONA	470-90-6
Di-*n*-butyl phthalate	DNBP	84-74-2
Di-*n*-octyl phthalate	DNOP	117-84-0
Di-*n*-octyl phthalate-D4	DNOPD4	
Di-*n*-pentyl phthalate	DNPP	
Diacetone alcohol	DIACAL	123-42-2
Diallate	DIALAT	2303-16-4
Diazinon	DIAZ	333-41-5
Dibenzofuran	DBZFUR	132-64-9
Dibenzofurans - nonspecific	FURANS	
Dibenzothiophene	DBZTHP	132-65-0
Dibenzo[*ae*]pyrene	DBAEPY	
Dibenzo[*ah*]pyrene	DBAHPY	
Dibenzo[*al*]pyrene	DBAIPY	
Dibenz[*ab*]anthracene	DBABA	
Dibenz[*ah*]anthracene	DBAHA	53-70-3
Dibenz[*aj*]acridine	DBAJA	224-42-0
Dibrom	NALED	300-76-5
Dibromochloromethane	DBRCLM	124-48-1
Dibromochloropropane	DBCP	
Dibromodichloromethane	DBRDCM	
Dibromomethane	DBRM	74-95-3
Dibutyl adipate	HXADBE	105-99-7
Dibutylchlorendate	DBUCLE	1770-80-5

ACCEPTABLE ENTRIES: (Cont.)

Dicamba	DCAMBA	1918-00-9
Dicarbam	SEVIN	63-25-2
Dichloran	DCLRN	102-30-7
Dichloricide aerosol	STROBN	8001-50-1
Dichloricide mothproofer	STROBN	8001-50-1
Dichloro(2-chlorovinyl)arsine	L	541-25-3
Dichloroacetonitrile	CL2ACN	
Dichlorobenzalkonium chloride	DCLRN	102-30-7
Dichlorobenzene - nonspecific	DCLB	25321-22-6
Dichlorobenzenes	CL2BZ	
Dichlorobenzophenone	DCBPH	
Dichlorobiphenyls	CL2BP	
Dichlorobutane	DCBUT	
Dichlorodifluoromethane	CCL2F2	75-71-8
Dichloroethyl arsine	ED	
Dichlorofluoromethane	FREON	75-43-4
Dichloroformoxime	CX	
Dichloroiodomethane	CHCL2I	
Dichloromethane	CH2CL2	75-09-2
Dichloronaphthalenes	CL2NAP	
Dichlorophenlactic	DCPL	
Dichlorophenols	DICLP	
Dichlorophenyl arsine	PD	696-28-6
Dichlorophos	DDVP	62-73-7
Dichloroprop	DICP	120-36-5
Dichlorvos	DDVP	62-73-7
Dicofol	DICOF	115-32-2
Dicyclohexyl phthalate	DCHP	84-61-7

ACCEPTABLE ENTRIES: (Cont.)

Dicyclopentadiene	DCPD	77-73-6
Didakene	TCLEE	127-18-4
Dieldrin	DLDRN	60-57-1
Diesel fuel	DIESEL	
Diethanolamine	CHNO2	111-42-2
Diethion	ETHION	563-12-2
Diethyl ether	DEETH	60-29-7
Diethyl methylphosphonate	TRO	683-08-9
Diethyl methylphosphonite	DEMP	15715-41-0
Diethyl phthalate	DEP	84-66-2
Diethyl phthalate-D4	DEPD4	
Diethylamine	DEA	109-89-7
Diethylcyclohexane	DECHX	
Diethyldimethyl diphosphonate	DEDMP	
Diethylene glycol	DEGLYC	111-46-6
Diethylene glycol monomethyl ether	2MXEXL	111-77-3
Diethylene oxide	THF	109-99-9
Dihydro-3-hydroxy-4*H*-dimethyl-2(3*H*)-furanone	DPNTLL	599-04-2
Dihydro-β-sitosterol	STIGMA	83-45-4
Diisobutyl carbinol	DISBCB	108-82-7
Diisobutyl phthalate	DIBP	84-69-5
Diisooctyl phthalate	DIOP	27554-26-3
Diisopropyl ether	DIPETH	108-20-3
Diisopropyl ketone	DIPK	565-80-0
Diisopropyl methylphosphonate	DIMP	
Diisopropyl phthalate	DIPP	
Diisopropyl urea	DIPUR	

ACCEPTABLE ENTRIES: (Cont.)

Diisopropyldimethyl diphosphonate	DIDDP	
Diisopropylthiocarbamic acid *S*-2,3-dichloroallyl ester	DIALAT	2303-16-4
Dimethicone	PDMSLX	9016-00-6
Dimethoate	DMOATE	60-51-5
Dimethoxydimethylsilane	DMXDMS	
Dimethoxytetraethylene glycol	TGLYME	143-24-8
Dimethyl-(E)-1-methyl-2-methylcarbamoylvinyl phosphate	MNCRPH	
Dimethyl-2-propanone	DIPK	565-80-0
Dimethyl-2,3,5,6-trichloropicolinic acid	PCLORM	
Dimethyl adipate	HXADME	627-93-0
Dimethyl arsenic acid	ME2AEA	
Dimethyl disulfide	DMDS	624-92-0
Dimethyl dithiocarbonate	DMCAR	
Dimethyl ether	DMETH	115-10-6
Dimethyl isophthalate	DMIP	1459-93-4
Dimethyl mercury	ME2HG	593-74-8
Dimethyl methylphosphate	DMMP	
Dimethyl phenol	DMPHEN	1300-71-6
Dimethyl phthalate	DMP	131-11-3
Dimethyl sulfate	SUADME	77-78-1
Dimethylaniline	NNDMA	121-69-7
Dimethylcyclopentane - nonspecific	DMCP	
Dimethylhydroxy benzene	DMPHEN	1300-71-6
Dimethylnaphthalenes	ME2NAP	
Dimethylpoly siloxane	PDMSLX	9016-00-6
Dimethylsulfide-α,α'-dicarboxylic acid	TDGCLA	123-93-3
Dimethylundecanes	ME2C11	

ACCEPTABLE ENTRIES: (Cont.)

Dinitrotoluene isomer	DNTISO	
Dinoseb	DINO	88-85-7
Dioctyl adipate	DOAD	103-23-1
Dioctyl azelate	DOAZ	103-24-2
Dioctyl ether	DOETH	629-82-3
Dioxin	TCDD	1746-01-6
Dioxolane	DIOXOL	646-06-0
Diphenyl	DPHNY	92-52-4
Diphenyl ether	DPETH	101-84-8
Diphenyl sulfide	DPSULF	139-66-2
Diphenyl sulfoxide	DPSO	945-51-7
Diphenylacetylene	DPETYN	501-65-5
Diphenylamine	DPA	122-39-4
Diphenylethyne	DPETYN	501-65-5
Diphenylhydrazines - nonspecific	DPH	
Diphosphoric acid tetraethyl ester	TEPP	
Diseleno diindole	DSEDIN	
Dissolved organic carbon	DOC	
Dissolved oxygen	DO	
Distilled mustard	HD	505-60-2
Disulfoton	DSTON	298-04-4
Disulfur dichloride	S2CL2	10025-67-9
Dithiane	DITH	
Dithio	SFOTEP	3689-24-5
Dithione	SFOTEP	3689-24-5
Dithiophos	SFOTEP	3689-24-5
Diuron	DIURON	330-54-1
Divinylene sulfide	TPH	110-02-1

ACCEPTABLE ENTRIES: (Cont.)

dl-2-(3-Hydroxyphenyl) glycine	DL2HPG	
DMN	NNDMEA	62-75-9
DMNA	NNDMEA	62-75-9
DMS	SUADME	77-78-1
DNTP	PRTHN	56-38-2
Dodecane	C12	112-40-3
Dodecanoic acid	LAURIC	143-07-7
Dodecylbenzene	DODECB	
Dolcymene	PCYMEN	99-87-6
Dopamine	DOPAM	51-61-6
Dursban	CPYR	2921-88-2
DXYA12	DXYA12	
Dybar	FENRN	101-42-8
Ectoral	RON	299-84-3
Eicosane	C20	112-95-8
Eicosanoic acid	ARACHA	
Endosulfan I	AENSLF	959-98-8
Endosulfan II	BENSLF	33213-65-9
Endosulfan sulfate	ESFSO4	1031-07-8
Endrin	ENDRN	72-20-8
Endrin aldehyde	ENDRNA	7421-93-4
Endrin ketone	ENDRNK	53494-70-5
Epichlorohydrin	EPCLHD	106-89-8
EPN	EPN	
Essence of mirbane	NB	98-95-3
Ethanedioic acid	OXAL	144-62-7
Ethanoic acid	ETHACD	
Ethanol	ETOH	64-17-5

ACCEPTABLE ENTRIES: (Cont.)

Ethanolamine	CHNO	141-43-5
Ethenylbenzene	STYR	100-42-5
Ether - nonspecific	ETHER	
Ethinyl trichloride	TRCLE	79-01-6
Ethoprophos	ETHOPR	13194-48-4
Ethyl 2-diisopropylaminoethyl methylphosphonite	QL	
Ethyl-2,2-bis(4-chlorophenyl) glycolate	EBCPGL	
Ethyl acetate	C2AEE	141-78-6
Ethyl acetone	MPK	107-87-9
Ethyl bromide	ETHBR	74-96-4
Ethyl dibromide	12DBRE	106-93-4
Ethyl methacrylate	ETMACR	97-63-2
Ethyl methanesulfonate	EMS	62-50-0
Ethyl methylphosphinate	YL	
Ethyl methylphosphonate	EMPA	
Ethyl methylphosphonic acid	EMPA	
Ethyl *n*-hexyl ether	ENHETH	
Ethyl-*N*,*N*-dimethyl phosphoramidocyanidate	GA	77-81-6
Ethyl phenol	EPHEN	
Ethyl phosphate	TEPO4	78-40-0
Ethyl stearate	C18AE	111-61-5
Ethylbenzene	ETC6H5	100-41-4
Ethylbenzene-D10	ETBD10	
Ethylcyclohexane	ETCYHX	1678-91-7
Ethylene chlorohydrin	CL2ETH	107-07-3
Ethylene glycol monoethyl ether	EGMEE	110-80-5
Ethylene oxide	ETOX	75-21-8

ACCEPTABLE ENTRIES: (Cont.)

Ethylene tetrachloride	TCLEE	127-18-4
Ethylhydroxy benzene	EPHEN	
Ethylmethyl benzene	ETMEBZ	
Etilon	PRTHN	56-38-2
Etrolene	RON	299-84-3
Europium	EU	7440-53-1
Explosive spray	XPLOSV	
Extraction procedure toxic organics	EPTOX	
Famophos	FAMPHR	52-85-7
Famphur	FAMPHR	52-85-7
Farnesol	FARN	4602-84-0
Fatty alcohols	FATAL	
Fecal coliform	COLI	
Fecal streptococci	FSTREP	
Fenchlorphos	RON	299-84-3
Fenoprop	245TP	93-72-1
Fensulfothion	FST	115-90-2
Fenthion	FNT	55-38-9
Fenuron	FENRN	101-42-8
Fenuron TCA	FENRNT	4482-55-7
Fiberglass	FIBGLS	
Fibrous glass	FIBGLS	
Flash point	FLASH	
Fluometuron	FLUMET	2164-17-2
Fluoranthene	FANT	206-44-0
Fluorene	FLRENE	86-73-7
Fluoride	F	16984-48-8

ACCEPTABLE ENTRIES: (Cont.)

Fluoroacetic acid	FC2A	144-49-0
Fluorotrimethylsilanol	FTMSIO	
Foaming agents	MBAS	
Folidol	PRTHN	56-38-2
Formaldehyde	FORM	50-00-0
Formic acid β-phenylethyl ester	FABPEE	
Formic acid cyclohexyl ester	FACHXE	
Fosferno	PRTHN	56-38-2
Freon	FREON	75-43-4
Freon 112	FRN112	
Fucostanol	STIGMA	83-45-4
Fuel oil no. 1	FOIL1	
Fuel oil no. 2	DIESEL	
Fuel oil no. 6	FOIL6	
Furfuryl alcohol	FURAL	98-00-0
Gallium	GALM	7440-55-3
Gamma gross	GAMAG	
Gamma scan	GAMMAS	
Gamma screen	GAMMAS	
Gardona	STIR	22248-79-9
Garrathion	TRITN	786-19-6
Gasoline	GAS	8006-61-9
Gasoline, regular	GAS	8006-61-9
GC-MS dye scan	DYSCAN	
GC-MS organic scan	MSSCAN	
Gemalgene	TRCLE	79-01-6
Genephene	TXPHEN	8001-35-2
Germalgene	TRCLE	79-01-6

ACCEPTABLE ENTRIES: (Cont.)

Germanium	GE	7440-56-4
Gesatop	SIMAZ	122-34-9
Glyphosate	GLPHST	
Gold	AU	7440-57-5
Green dye	GRNDY	
Guanidine nitrate	GUNIT	506-93-4
Guaranine	CAFEIN	58-08-2
Halowax 1013	HWX013	
Halowax 1099	HWX099	
Hendecane	C11	1120-21-4
Heneicosane	C21	629-94-7
Heptachlor	HPCL	76-44-8
Heptachlor epoxide	HPCLE	1024-57-3
Heptachlorobiphenyls	CL7BP	
Heptachlorodibenzodioxin - nonspecific	HPCDD	
Heptachlorodibenzofuran - nonspecific	HPCDF	
Heptachloronorbornadienes	CL7NB	
Heptachloronorbornene	C7NB1	
Heptadecane	C17	629-78-7
Heptadecanoic acid methyl ester	C17AM	
Heptane	C7	142-82-5
Heptanoic acid	C7A	111-14-8
Hexachloro-1,3-butadiene	HCBD	87-68-3
Hexachlorobenzene	CL6BZ	118-74-1
Hexachlorobiphenyls	CL6BP	
Hexachlorobutadiene	HCBD	87-68-3
Hexachlorocyclopentadiene	CL6CP	77-47-4
Hexachlorodibenzodioxin - nonspecific	HXCDD	

ACCEPTABLE ENTRIES: (Cont.)

Hexachlorodibenzofuran - nonspecific	HXCDF	
Hexachloroethane	CL6ET	67-72-1
Hexachloronorbornadiene	HCNB	
Hexachlorophene	HCPHEN	
Hexachloropropene	HXCPEN	
Hexacosane	HXCOS	630-01-3
Hexadecane	C16	544-76-3
Hexadecanoic acid	C16A	57-10-3
Hexadecanoic acid bis(2-ethylhexyl) ester	C16AEH	
Hexadecanoic acid butyl ester	C16ABE	
Hexadecanoic acid dimethyl ester	C16ADM	
Hexadecanoic acid methyl ester	C16AME	
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX	121-82-4
Hexahydropyridine	PIPER	110-89-4
Hexamethylcyclotrisiloxane	HXMTSX	541-05-9
Hexamethyldisiloxane	HMDSIX	
Hexamethylene tetramine	HXMETA	100-97-0
Hexane	HEXANE	110-54-3
Hexanedioic acid bis(2-ethylhexyl) ester	HXAB2E	
Hexanedioic acid dibutyl ester	HXADBE	105-99-7
Hexanedioic acid dimethyl ester	HXADME	627-93-0
Hexanedioic acid dioctyl ester	DOAD	103-23-1
Hexanoic acid	HEXAC	142-62-1
Hexatriacontane	C36	630-06-8
Hexavalent chromium	CRHEX	
Hexogen	RDX	121-82-4
Holmium	HO	7440-60-0

ACCEPTABLE ENTRIES: (Cont.)

HPLC-grade water	HPLH2O	
Hyanit	UREA	57-13-6
Hydrazine	HYDRZ	302-01-2
Hydrindane	HYDRND	
Hydrindene	INDAN	496-11-7
Hydrocarbons (all molecular weights)	CALLMW	
Hydrocinnamyl chloride	3PC3AC	
Hydrocyanic acid	AC	74-90-8
Hydrogen cyanide	AC	74-90-8
Hydrogen sulfide	H2S	7783-06-4
Hydrolyzable phosphate	HPO4	
Hydroxybenzene	PHENOL	108-95-2
Hydroxybenzoic acid	HBZOA	
Hydroxylated aromatics	HYDARO	
Hypochlorite	HTH	
Ignitability	IGNIT	
Indan	INDAN	496-11-7
Indene	INDENE	95-13-6
Indeno[1,2,3-*C,D*]pyrene	ICDPYR	193-39-5
Indium	IN	7440-74-6
Indole	INDOLE	120-72-9
Indonaphthene	INDENE	95-13-6
Insecticide 3960-X14	STROBN	8001-50-1
InvisiGard	PROPXR	114-26-1
Iodine (as I)	I	7553-56-2
Iodine 131	I131	
Iodomethane	CH3I	

ACCEPTABLE ENTRIES: (Cont.)

IPC	PROPHM	122-42-9
Iron	FE	7439-89-6
Iron 59	FE59	
Isobutane	2MC3	78-28-5
Isobutanol	2M1C3L	
Isobutyl alcohol	2M1C3L	
Isobutylbenzene	2MPBZ	538-93-2
Isobutyric acid	2MPA1E	79-31-2
Isochrysene	TRPHEN	217-59-4
Isodrin	ISODR	465-73-6
Isodurene	ISODUR	
Isoheptane	2MC6	591-76-4
Isooctane	2MC7	540-84-1
Isopentane	2MC4	78-78-4
Isophorone	ISOPHR	
Isopropene cyanide	MTHCRN	126-98-7
Isopropyl-1,3-dimethylbenzene	IPMXYL	
Isopropyl carbanilate	PROPHM	122-42-9
Isopropyl *m*-chlorocarbanilate	CLPRPM	101-21-3
Isopropyl-*m*-xylene	IPMXYL	
Isopropyl methylphosphonate	IMPA	
Isopropyl methylphosphonic acid	IMPA	
Isopropyl methylphosphonofluoridate	GB	107-44-8
Isopropylacetone	MIBK	108-10-1
Isopropylamine	IPA	75-31-0
Isopropylbenzene	ISOPBZ	98-82-8
Isopropyltoluene	ISOPT	
Isoquinoline	ISOQUN	119-65-3

ACCEPTABLE ENTRIES: (Cont.)

Isosafrole	ISOSAF	
Isovaleric acid	ISOVAL	
Kepone	KEP	143-50-0
Keralyt	2HBZOA	69-72-7
Keratinamin	UREA	57-13-6
Ketoendrin	KEND	
Kloben	NEBRN	55-37-3
Korlan	RON	299-84-3
Lactic acid cyclic butaneboronate	LACYBB	
Lanex	FLUMET	2164-17-2
Lanthanum	LA	7439-91-0
Lanthanum 140	LA140	
Lauric acid	LAURIC	143-07-7
Lead	PB	7439-92-1
Lead 211	PB211	
Lead 212	PB212	
Lead 214	PB214	
Lead, organic	PBORG	
Lead, simultaneously extracted	PBSX	
Lead styphnate	PBSTY	63918-97-8
Lead, tetraethyl	PBTE	78-00-2
Leucoline	QUINO	91-22-5
Levinstein mustard	H	
Lewisite	L	541-25-3
Lewisite oxide	LO	
Lignin	LIGNIN	
Lindane	LIN	58-89-9
Linuron	LINRN	330-55-2

ACCEPTABLE ENTRIES: (Cont.)

Lipids, percentage	LIPID	
Lithium	LI	7439-93-2
Lorsban	CPYR	2921-88-2
Lysodren	OPDDD	53-19-0
m-Allylpyrocatechin methylene ether	SAFROL	94-59-7
m-Cresol	3MP	108-39-4
m-Dihydroxybenzene	RESO	108-46-3
m-Pròpyltoluene	3PT	
m-Xylene	13DMB	108-38-3
Magnesium	MG	7439-95-4
Malathion	MLTHN	121-75-5
Malononitrile	MALO	109-77-3
Manganese	MN	7439-96-5
Manganese 54	MN54	
MCPA	MCPA	94-74-6
MCPP	MCPP	7085-19-0
Mechlorethamine	HN	51-75-2
Mecoprop	MCPP	7085-19-0
Melamine	MELAM	108-78-1
Mercaptodiacetic acid	TDGCLA	123-93-3
Mercury	HG	7439-97-6
Mercury extractable	HGEXT	
Mercury total	HGTOT	
Merphos	MERP	150-05-5
Mesityl oxide	MESTOX	141-79-7
Methacrylonitrile	MTHCRN	126-98-7
Methanal	FORM	50-00-0

ACCEPTABLE ENTRIES: (Cont.)

Methane	CH4	74-82-8
Methanesulfonic acid methyl ester	MMS	66-27-3
Methanol	MEOH	67-56-1
Methapyrilene	MEPYRI	
Methioarb	METARB	
Methiocarb	METHCB	2032-65-7
Methomyl	MTHMYL	16752-77-5
Methoxy-DDT	MEXCLR	72-43-5
Methoxychlor	MEXCLR	72-43-5
Methyl-2-heptanols	ME2HPL	
Methyl-2-heptanones	ME2HPO	
Methyl aldehyde	FORM	50-00-0
Methyl arsonic acid	MEAOA	124-58-3
Methyl benzoate	BZOAME	93-58-3
Methyl carbitol	2MXEXL	111-77-3
Methyl ethyl ketone	MEK	78-93-3
Methyl isobutyl carbinol	MIBCOH	108-11-2
Methyl isobutyl ketone	MIBK	108-10-1
Methyl isopropyl ketone	MIPK	563-80-4
Methyl mercury	MEHG	
Methyl mercury chloride	MEHGCL	
Methyl methacrylate	PLEXI	
Methyl methanesulfonate	MMS	66-27-3
Methyl *n*-butyl ketone	MNBK	591-78-6
Methyl-*N*-(3,4-dichlorophenyl)carbamate	SWEP	1918-18-9
Methyl *N'*,*N'*-dimethyl-N-{(methylcarbamoyl)oxy}-1-amylacetate	OXAMYL	23135-22-0
Methyl pentyl ketone	2C7O	110-43-0

ACCEPTABLE ENTRIES: (Cont.)

Methyl propianoic acid	METPRO	
Methyl propionate	C3AME	554-12-1
Methyl propyl ketone	MPK	107-87-9
Methyl stearate	C18AME	112-61-8
Methyl succinate	BDADME	106-65-0
Methyl sulfide	MES	75-18-3
Methyl trithion	MTRITN	
Methyl yellow	PDMAB	60-11-7
Methylcyclobutane	MECYBU	
Methylcyclodecane	MECYDC	
Methylcyclohexane	MECC6	108-87-2
Methylcyclopentane	MECYPE	96-37-7
Methylene blue active substance	MBAS	
Methylene bromide	CH2BR2	74-95-3
Methylene chloride	CH2CL2	75-09-2
Methylene chloride-D2	CD2CL2	
Methylene oxide	FORM	50-00-0
Methylethyl phenol	MEPHEN	
Methylethylhydroxy benzene	MEPHEN	
Methylhydrazine	MHYDRZ	60-34-4
Methylnaphthalenes	METLAP	
Methyloxirane	PROPOX	75-56-9
Methylphenols	MP	
Methylphosphonic acid	MPA	13590-71-1
Methyltheobromine	CAFEIN	58-08-2
Metrazole	MTRZL	54-95-5
Metribuzin	MBZ	21087-64-9
Mevinphos	MEVIN	7786-34-7

ACCEPTABLE ENTRIES: (Cont.)

Mexacarbate	MXCRBT	315-18-4
Milli-Q-filtered water	MQFH2O	
Mineral wool	MINWOL	
Mirex	MIREX	2385-85-8
Mitotane	OPDDD	53-19-0
MMS	MMS	66-27-3
Mocap	ETHOPR	13194-48-4
Molinate	MLNAT	2212-67-1
Molybdenum	MO	7439-98-7
Molybdenum 99	MO99	
Monasirip	ANTHOL	
Monochlorobenzene	CLC6H5	108-90-7
Monocron	MNCRPH	
Monocrotophos	MNCRPH	
Monomethyl mercury	MEHG	
Monuron	MONRN	150-68-5
Motox	TXPHEN	8001-35-2
Myristic acid	C14A	544-63-8
n-Butyl ether	NBUETH	142-96-1
n-Butylacetate	NBACET	
n-Dibutylamine	DBA	109-73-9
n-Propylbenzene	PRC6H5	103-65-1
N-(2-Hydroxyethyl)-decanamide	NHEDCA	
N-(2-Methylcyclohexyl)-*N'*-phenylurea	SIDRN	1982-49-6
N-(4-Chlorophenyl)-3-phenyl-2-propenamide	NCPPPA	
N-(4-Ethoxyphenyl)acetamide	PHENA	62-44-2
N-Butyl-1-butanamine	DBA	109-73-9
N-Butyl-4-methylbenzenesulfonamide	NBMBSA	

ACCEPTABLE ENTRIES: (Cont.)

N-Butyl-*N'*-(3,4-dichlorophenyl)-*N*-methylurea	NEBRN	55-37-3
N-Ethyl-2-propenamide	NE2PEA	
N-Ethylcyclohexylamine	NECHXA	5459-75-5
N-Methyl-*N*-nitrosoaniline	NMNSOA	
N-Methyl-*N*-nitrosomethanamine	NNDMEA	62-75-9
N-Methyl-*N*,2,4,6-tetranitroaniline	TETRYL	479-45-8
N-Methyl-*N*,2,4,6-tetranitrobenzenamine	TETRYL	479-45-8
N-Methylaniline	NMANIL	100-61-8
N-Methylbenzenamine	NMANIL	100-61-8
N-Methylcarbamic acid 1-naphthyl ester	NMCANE	
N-Nitrodihexylamine	NDHXA	
N-Nitroso-4-hydroxyproline	NN4HPL	
N-Nitrosodi-*n*-butylamine	NNDNB	924-16-3
N-Nitrosodi-*n*-propylamine	NNDNPA	621-64-7
N-Nitrosodiethylamine	NNDEA	
N-Nitrosodimethylamine	NNDMEA	62-75-9
N-Nitrosodimethylamine-D6	NDMAD6	
N-Nitrosodiphenylamine	NNDPA	86-30-6
N-Nitrosomethylethylamine	NNMEA	
N-Nitrosomorpholine	NNMORP	
N-Nitrosopentylisopentylamine	NNPIPA	
N-Nitrosopiperidine	NNPIP	100-75-4
N-Nitrosopyrrolidine	NNPYRL	
N-Pentamide	PENAMD	
N-[[(Methylamino)carbonyl]oxy]ethanimidothioic acid methyl ester	MTHMYL	16752-77-5
N'-(3,4-Dichlorophenyl)-*N*-methoxy-*N*-methylurea	LINRN	330-55-2
N,4-Dimethylbenzenesulfonamide	NDMBSA	

ACCEPTABLE ENTRIES: (Cont.)

Naled	NALED	300-76-5
Nankor	RON	299-84-3
Naphthalene	NAP	91-20-3
Naphthalene-D8	NAPD8	
Naphthoquinone	NPQ	
Neburon	NEBRN	55-37-3
Nema	TCLEE	127-18-4
Nemafos	ZINPHS	297-97-2
Neoamyl alcohol	TBCARB	75-84-3
Neodymium	ND	7440-00-8
Neopentanol	TBCARB	75-84-3
Neopentyl alcohol	TBCARB	75-84-3
Nialate	ETHION	563-12-2
Nickel	NI	7440-02-0
Nickel 63	NI63	
Nickel, simultaneously extracted	NISX	
Niobium	NIOB	7440-03-1
Niobium 94	NB94	
Niobium 95	NB95	
Niran	PRTHN	56-38-2
Nitramine	TETRYL	479-45-8
Nitrate	NO3	
Nitrate as nitrogen	NO3N	
Nitrite	NO2	
Nitrite, nitrate - nonspecific	NIT	
Nitroaromatics	NITARO	
Nitrobenzene	NB	98-95-3

ACCEPTABLE ENTRIES: (Cont.)

Nitrobenzene-D5	NBD5	
Nitrocellulose	NC	
Nitrocellulose 12%N	NC1	
Nitrocellulose 13.4%N	NC2	
Nitrogen by Kjeldahl Method	N2KJEL	
Nitrogen dioxide	NDIOX	10102-44-0
Nitrogen mustard	HN	51-75-2
Nitroglycerine	NG	55-63-0
Nitroguanidine	NQ	
Nitrosodi-*n*-propylamine	NDNPA	
N,*N*-Bis(2-hydroxyethyl)dodecanamide	HEDODA	
N,*N*-Dibutyl-1-butanamine	TBA	102-82-9
N,*N*-Diethyl-3-methylbenzamide	DEMBZA	134-62-3
N,*N*-Diethyl-*m*-toluamide	DEMBZA	134-62-3
N,*N*-Dimethyl-1-octadecanamine	NNDMOD	
N,*N*-Dimethyl-1,2-ethanediamine	DMETDA	
N,*N*-Dimethyl-4-(phenylazo)benzenamine	PDMAB	60-11-7
N,*N*-Dimethyl-*N*-phenylurea	FENRN	101-42-8
N,*N*-Dimethyl-*N*-phenylurea trichloroacetate	FENRNT	4482-55-7
N,*N*-Dimethylaniline	NNDMA	121-69-7
N,*N*-Dimethylbenzenamine	NNDMA	121-69-7
N,*N*,4-Trimethylbenzenesulfonamide	NTMBSA	
Nonacosane	C29	
Nonadecane	C19	629-92-5
Nonadecanoic acid	C19A	646-30-0
Nonane	C9	111-84-2
Nonanedioic acid dimethyl ester	NNADME	
Nonpurgeable organic halides	NPOX	

ACCEPTABLE ENTRIES: (Cont.)

Nonyl phenol (any isomer)	NONPHE	25154-52-3
Nortricyclanol	NCLN	
Nutraplus	UREA	57-13-6
Nuvacron	MNCRPH	
o-Chlorobenzaldehyde	CBA	89-98-5
o-Chlorobenzoic acid	CBOA	118-91-2
o-Chlorobenzylidine malononitrile	2CBMN	
o-Cresol	2MP	95-48-7
o-Toluidine	OTOLDN	
o-Xylene	12DMB	
O-Ethyl methylphosphonate	OEMP	
O-Ethyl-*S*-(2-diethylaminoethyl) methylphosphonothiolate	VM	
O-Ethyl-*S*-(2-diisopropylaminoethyl) methylphosphonothiolate	VX	
Octachlorodibenzodioxin - nonspecific	OCDD	
Octachlorodibenzofuran, C13 isomeric	IOCDF	
Octachlorodibenzofuran - nonspecific	OCDF	
Octadecamethylcyclononasiloxane	ODMNSX	556-71-8
Octadecane	C18	593-45-3
Octadecanoic acid	ODECA	57-11-4
Octadecanoic acid (2-phenyl-1,3-dioxolan-4-yl) methyl ester	ODAPDM	
Octadecanoic acid butyl ester	C18ABE	123-95-5
Octadecanoic acid ethyl ester	C18AE	111-61-5
Octadecanoic acid methyl ester	C18AME	112-61-8
Octadecanoic acid octadecyl ester	C18AOD	
Octadecyl stearate	C18AOD	
Octahydro-2-methylpentalene	OH2MPL	
Octamethylcyclotetrasiloxane	OMCTSX	556-67-2
Octanal	C8AL	

ACCEPTABLE ENTRIES: (Cont.)

Octane	C8	111-65-9
Octanedioic acid dimethyl ester	OCADME	
Octanoic acid methyl ester	C8AME	
Odor	ODOR	
Oil & grease	OILGR	
Oil of mirbane	NB	98-95-3
Onychomal	UREA	57-13-6
O,O-Diethyl *O*-2-pyrazinyl phosphorothioate	DE2PYP	
opDDD	OPDDD	53-19-0
Organic fibers	ORGFIB	
Organophosphates	OPO4	
Orthophosphate	PO4ORT	
Osmium	OS	7440-04-2
Oxacyclononane	OXCN	
Oxalic Acid	OXAL	144-62-7
Oxamyl	OXAMYL	23135-22-0
Oxirane	ETOX	75-21-8
Oxitol	EGMEE	110-80-5
Oxomethane	FORM	50-00-0
Oxybenzene	PHENOL	108-95-2
Oxybis[chloromethane]	BCLME	542-81-1
Oxygen	O2	7782-44-7
Oxymethylene	FORM	50-00-0
Ozone	OZONE	10028-15-6
p-Benzoquinone	PQUIN	
p-Chlorophenylmethyl sulfide	CPMS	
p-Chlorophenylmethyl sulfone	CPMSO2	

ACCEPTABLE ENTRIES: (Cont.)

p-Chlorophenylmethyl sulfoxide	CPMSO
p-Cresol	4MP 106-44-5
p-Cymene	PCYMEN 99-87-6
p-Dimethylaminoazobenzene	PDMAB 60-11-7
p-Hydroxybenzoic acid	4HBZOA 99-96-7
p-Phenylenediamine	PPDIAM
p-Toluenesulfonic acid heptyl ester	TSAHPE
p-Xylene	14DMB 106-42-3
Palmitic acid	C16A 57-10-3
Pantolactone	DPNTLL 599-04-2
Paraoxon	PAD4NE 311-45-5
Paraphos	PRTHN 56-38-2
Parathion	PRTHN 56-38-2
Parathion methyl	MPRTHN 298-00-0
Particulate matter	PARTIC
Particulates measured by filter	PARTIC
Pastaron	UREA 57-13-6
PCB 1016	PCB016 12674-11-2
PCB 1221	PCB221 1104-28-2
PCB 1232	PCB232 11141-16-5
PCB 1242	PCB242 53469-21-9
PCB 1248	PCB248 12672-29-6
PCB 1254	PCB254 11097-69-1
PCB 1260	PCB260 11096-82-5
PCB 1262	PCB262
PCNB	PCNB 82-68-8
Penphene	TXPHEN 8001-35-2

ACCEPTABLE ENTRIES: (Cont.)

Pentachlorobenzene	CL5B	608-93-5
Pentachlorobiphenyls	CL5BP	
Pentachlorodibenzodioxin - nonspecific	PCDD	
Pentachlorodibenzofuran - nonspecific	PCDF	
Pentachloroethane	CL5ET	76-01-7
Pentachlorohexane	PCH	
Pentachloronitrobenzene	PCNB	82-68-8
Pentachlorophenol	PCP	87-86-5
Pentacosane	C25	629-99-2
Pentadecane	C15	629-62-9
Pentadecanoic acid	C15A	1002-82-4
Pentaerythritol tetranitrate	PETN	78-11-5
Pentafluorophenol	PFP	771-61-9
Pentane	PENTAN	109-66-0
Pentanoic acid	C5A	109-52-4
Pentanoic acid 2-methylbutyl ester	PA2MBE	
Pentatriacontane	C35	
Pentylenetetrazole	MTRZL	54-95-5
Perchloroethylene	TCLEE	127-18-4
Perchloropropene	HXCPEN	
Perclene	TCLEE	127-18-4
Perthane	PERTHN	
Perylene-D12	PYLD12	
PETN	PETN	78-11-5
Petroleum distillates	PETDIL	8002-05-9
pH	PH	
pH as tested in the field	PH-F	
Phenacetin	PHENA	62-44-2

ACCEPTABLE ENTRIES: (Cont.)

Phenacide	TXPHEN	8001-35-2
Phenanthrene	PHANTR	85-01-8
Phenanthrene-D10	PHAD10	
Phenarsazine chloride	DM	578-94-9
Phenatox	TXPHEN	8001-35-2
Phenic acid	PHENOL	108-95-2
Phenol	PHENOL	108-95-2
Phenol-D5	PHEND5	
Phenol-D6	PHEND6	
Phenolics - nonspecific	PHENLC	
Phenoxyacetic acid	PHXAA	122-59-8
Phenyl hydroxide	PHENOL	108-95-2
Phenylacetic acid	PHENAA	103-82-2
Phenylcarbamic acid 1-methylethyl ester	PROPHM	122-42-9
Phenylcyclohexane	CYHXB	827-52-1
Phenylethylene	STYR	100-42-5
Phenylic acid	*PHENOL*	*108-95-2*
Phenylphosphonothioic acid *O*-ethyl *O*-(4-nitrophenyl) ester	EPN	
Phorate	PHOR	298-02-2
Phosgene	CG	75-44-5
Phosgene oxime	CX	
Phosphate	PO4	
Phosphoric acid	H3PO4	7664-38-2
Phosphoric acid 1,2-dibromo-2,2-dichloroethyl dimethyl ester	NALED	300-76-5
Phosphoric acid 2-chloro-1-(2,4-dichlorophenyl)ethenyl diethyl ester	SUPONA	470-90-6
Phosphoric acid 2-chloro-1-(2,4,5-trichlorophenyl)ethanyl dimethyl ester	STIR	22248-79-9
Phosphoric acid 2,2-dichloroethenyl dimethyl ester	DDVP	62-73-7
Phosphoric acid diethyl-4-nitrophenyl ester	PAD4NE	311-45-5

ACCEPTABLE ENTRIES: (Cont.)

Phosphoric acid dimethyl [1-methyl-3-(methylamino)-3-oxo-1-propenyl] ester	MNCRPH	
Phosphoric acid octyldiphenyl ester	PAODPE	
Phosphoric acid triethyl ester	TEPO4	78-40-0
Phosphoric acid triphenyl ester	PATPE	115-86-6
Phosphoric acid tris[3-methylphenyl] ester	PAT3MP	
Phosphorodithioic acid *O*-ethyl *S*,*S*-dipropyl ester	ETHOPR	13194-48-4
Phosphorodithioic acid *O*,*O*-diethyl *S*-[(ethylthio)methyl] ester	PHOR	298-02-2
Phosphorodithioic acid *O*,*O*-diethyl *S*-[2-(ethylthio)ethyl] ester	DSTON	298-04-4
Phosphorodithioic acid *S*-[[(4-chlorophenyl)thio]methyl] *O*,*O*-diethyl ester	TRITN	786-19-6
Phosphorodithioic acid *S*,*S*'-methylene *O*,*O*,*O*',*O*'-tetraethyl ester	ETHION	563-12-2
Phosphorothioic acid *O*-[4-[(dimethylamino)sulfonyl]phenyl] *O*,*O*-dimethyl ester	FAMPHR	52-85-7
Phosphorothioic acid *O*,*O*-diethyl *O*-(3,5,6-trichloro-2-pyridinyl) ester	CPYR	2921-88
Phosphorothioic acid *O*,*O*-diethyl *O*-(4-nitrophenyl) ester	PRTHN	56-38-2
Phosphorothioic acid *O*,*O*-diethyl *O*-pyrazinyl ester	ZINPHS	297-97-2
Phosphorothioic acid *O*,*O*-diethyl *O*-[4-(methylsulfinyl)phenyl] ester	FST	115-90-2
Phosphorothioic acid *O*,*O*-dimethyl *O*-(2,4,5-trichlorophenyl) ester	RON	299-84-3
Phosphorothioic acid *O*,*O*-dimethyl *O*-(4-nitrophenyl) ester	MPRTHN	298-00-0
Phosphorothioic acid *O*,*O*-dimethyl *O*-[3-methyl-4-(methylthio)phenyl ester	FNT	55-38-9
Phosphorus	P4	7723-14-0
Phosphorus, dissolved (as P)	DISP	
Phosphorus, dissolved hydrolyzable (as P)	PDHYD	
Phosphorus, dissolved organic (as P)	PDORG	
Phosphorus, total hydrolyzable (as P)	PHYDR	108-99-6
Phosphorus, total organic (as P)	PORG	
Phthalates	PHTHL	
Phthalazinone	PTHZ	119-39-1
Phthalic acid	PHTHA	88-99-3

ACCEPTABLE ENTRIES: (Cont.)

Phthalic anhydride	PHTHAN	85-44-9
Picloram	PCLORM	
Picric acid	246TNP	88-89-1
Picrylmethylnitramine	TETRYL	479-45-8
Picrylnitromethylamine	TETRYL	479-45-8
Pinacolyl methylphosphonofluoridate	GD	96-64-0
Piperidine	PIPER	110-89-4
Platinum	PT	7440-06-4
Plexiglass	PLEXI	
Plutonium 238 isotope	PU238	
Plutonium 239 isotope	PU239	
Plutonium 240 isotope	PU240	
Polydimethyl siloxane	PDMSLX	9016-00-6
Polyethyleneglycol ethers	PEGE	
Polynuclear aromatic hydrocarbons	PAH	
Potassium	K	7440-09-7
Potassium 40	K40	
ppDDD	PPDDD	72-54-8
Primatol	PROMET	1610-18-0
Primatol S	SIMAZ	122-34-9
Princep	SIMAZ	122-34-9
Prometon	PROMET	1610-18-0
Promulsin	ODECA	57-11-4
Pronamid	PRONA	23950-58-5
Propanedinitrile	MALO	109-77-3
Propanoic acid 2-hydroxydecyl ester	PA2HDE	
Propanoic acid 2-methylbutyl ester	C3A2MB	

ACCEPTABLE ENTRIES: (Cont.)

Propanoic acid methyl ester	C3AME	554-12-1
Propanoic acid *tert*-butyl ester	PATBUE	
Propham	PROPHM	122-42-9
Propionic acid	PROACD	
Propionitrile	PROPCN	
Propoxur	PROPXR	114-26-1
Propyl methylphosphonic acid	PMPA	
Propylbenzene	PRC6H5	103-65-1
Propylene oxide	PROPOX	75-56-9
Propylidene chloride	11C1PN	
Propyon	PROPXR	114-26-1
Propyzamide	PRONA	23950-58-5
Protactinium 234	PA234	
Prothiophos	TOKU	34643-46-4
Proviscol wax	ODECA	57-11-4
Purgeable organic carbon	POC	
Purgeable organic halogen	POX	
Pyrene	PYR	129-00-0
Pyrene-D10	PYRD10	
Pyridine	PYRDIN	110-86-1
Pyrinex	CPYR	2921-88-2
QL	QL	
Quinoline	QUINO	91-22-5
Quinone	25C14D	106-51-4
Quintozene	PCNB	82-68-8
Rabon	STIR	22248-79-9
Radium	RA	7440-14-4
Radium 223	RA223	

ACCEPTABLE ENTRIES: (Cont.)

Radium 224	RA224	
Radium 226	RA226	
Radium 228	RA228	
Radon	RN	10043-92-2
Radon 226	RN226	
Ravyon	SEVIN	63-25-2
RDX	RDX	121-82-4
Reactive cyanide	RECN	
Reactive sulfide	RESF	
Reactivity	REACTY	
Red dye	REDDY	
Resin acids	RESACI	
Resistivity	RESIST	
Resorcin	RESO	108-46-3
Resorcinol	RESO	108-46-3
Rhenium	RE	7440-15-5
Rhodiatox	PRTHN	56-38-2
Rhodium	RO	7440-16-6
Rhodium 106	RO106	
Rhothane	PPDDD	72-54-8
Rodex	WARFRN	81-81-2
Ronnel	RON	299-84-3
Rotenone	ROTEN	83-79-4
Rubidium	RB	7440-17-7
Ruthenium	RU	7440-18-8
Ruthenium 103	RU103	
Ruthenium 106	RU106	
S-2-Diisopropylaminoethyl methylphosphonic acid	EA2192	

ACCEPTABLE ENTRIES: (Cont.)

S-Diisopropylaminoethyl methylphosphonothioate	DIAEP	
S-Methyl-*N*-[(methylcarbamoyl)oxy]thioactimidate	MTHMYL	16752-77-5
Safrole	SAFROL	94-59-7
Salicylaldehyde	2HBNZL	90-02-8
Salicylic acid	2HBZOA	69-72-7
Saline	SALINE	
Salinity	SALINI	
Sapecron	SUPONA	470-90-6
Sarin	GB	107-44-8
Saturated hydrocabons (C16)	C16SAT	
Scandium	SC	7440-20-2
sec-Butylbenzene	SBBEN	135-98-8
Seffein	SEVIN	63-25-2
Selenium	SE	7782-49-2
Sendran	PROPXR	114-26-1
Settleable solids	SSOL	
Sevin	SEVIN	63-25-2
Siduron	SIDRN	1982-49-6
Silica	SI	7631-86-9
Silicic anhydride	SI	7631-86-9
Silicon	SILCON	7440-21-3
Silicon dioxide	SI	7631-86-9
Silicone	SIL	
Silver	AG	7440-22-4
Silver 110 (metastable)	AG110M	
Silvex	245TP	93-72-1
Simanex	SIMAZ	122-34-9

ACCEPTABLE ENTRIES: (Cont.)

Simazine	SIMAZ	122-34-9
Simethicone	PDMSLX	9016-00-6
Simultaneously extracted cadmium	CDSX	
Simultaneously extracted copper	CUSX	
Simultaneously extracted lead	PBSX	
Simultaneously extracted nickel	NISX	
Simultaneously extracted zinc	ZNSX	
Sodium	NA	7440-23-5
Sodium 22	NA22	
Sodium chloride	NACL	
Sodium hypochlorite	NACLO	7681-52-9
Sodium phosphate	NAPO4	
Soman	GD	96-64-0
Specific conductivity	COND	
Specific conductivity as tested in the field	COND-F	
Spinacene	SQUAL	111-02-4
Squalene	SQUAL	111-02-4
Stearic acid	ODECA	57-11-4
Steladone	SUPONA	470-90-6
Steroids	STERO	
Stigmastenol	STIGMA	83-45-4
Stirophos	STIR	22248-79-9
Strobane	STROBN	8001-50-1
Strobane-T	TXPHEN	8001-35-2
Strontium	SR	7440-24-6
Strontium 90	SR90	
Styphnate ion	STYPH	

ACCEPTABLE ENTRIES: (Cont.)

Styphnic acid	246TNR	82-71-3
Styrene	STYR	100-42-5
Styrene oxide	12EPEB	96-09-3
Styrol	STYR	100-42-5
Styrolene	STYR	100-42-5
Sulfate	SO4	
Sulfide	SULFID	
Sulfide, acid volatile	AVS	
Sulfide, reactive	RESF	
Sulfite	SO3	
Sulfotep	SFOTEP	3689-24-5
Sulfotepp	SFOTEP	3689-24-5
Sulfur	S	7704-34-9
Sulfur chloride	S2CL2	10025-67-9
Sulfur dioxide	SO2	7446-09-5
Sulfur monochloride	S2CL2	10025-67-9
Sulfur subchloride	S2CL2	10025-67-9
Sulfuric acid dimethyl ester	SUADME	77-78-1
Sulfurous anhydride	SO2	7446-09-5
Sulfurous oxide	SO2	7446-09-5
Suncide	PROPXR	114-26-1
Super tropical bleach	STB	
Supona	SUPONA	470-90-6
Supraene	SQUAL	111-02-4
Swep	SWEP	1918-18-9
sym-Dichloromethyl ether	BCLME	542-81-1
Tabun	GA	77-81-6
Tannin	TANNIN	

ACCEPTABLE ENTRIES: (Cont.)

Tannin and lignin combined	TINNIN	
Tantalum	TA	7440-25-7
Tar camphor	NAP	91-20-3
Taste	TASTE	
TCDBD	TCDD	1746-01-6
TCDD	TCDD	1746-01-6
TDE	PPDDD	72-54-8
TEDP	SFOTEP	3689-24-5
Tellurium	TE	13494-80-9
Temperature	TEMP	
Temperature as tested in the field	TEMP-F	
Temur	TMUR	632-22-4
TEPP	TEPP	
Terpene polychlorinates	STROBN	8001-50-1
Terphenyl-D14	TRPD14	
tert-Butanol	2M2C3L	75-65-0
tert-Butylbenzene	TBBEN	
tert-Butylcarbinol	TBCARB	75-84-3
tert-Butylmethyl ether	2MXMC3	1634-04-4
tert-Dodecanethiol	TDODTL	25103-58-6
Tetracap	TCLEE	127-18-4
Tetrachlorobenzenes	TCB	
Tetrachlorobiphenyls	CL4BP	
Tetrachlorocyclopentene	TETPT	
Tetrachlorodifluoroethane	FRN112	
Tetrachloroethane	TCLEA	79-34-5
Tetrachloroethene	TCLEE	127-18-4
Tetrachloroethylene	TCLEE	127-18-4

ACCEPTABLE ENTRIES: (Cont.)

Tetrachlorometaxylene	CL4XYL	
Tetrachloronaphthalenes	CL4NAP	
Tetrachlorophenol	TTCP	
Tetrachlorvinphos	STIR	22248-79-9
Tetracosane	TCOS	646-31-1
Tetradecamethylhexasiloxane	TDMHSX	107-52-8
Tetradecane	C14	629-59-4
Tetradecanoic acid	C14A	544-63-8
Tetradecanoic acid methyl ester	C14AME	
Tetraethyl pyrophosphate	TEPP	
Tetraethyldithiopyrophosphate	TEDTPP	
Tetraethylene glycol dimethyl ether	TGLYME	143-24-8
Tetraethyllead	PBTE	78-00-2
Tetraethylplumbane	PBTE	78-00-2
Tetraglyme	TGLYME	143-24-8
Tetrahydrofuran	THF	109-99-9
Tetrahydropyranyl-2-methanol	THP2ML	
Tetralin	THNAP	119-64-2
Tetralite	TETRYL	479-45-8
Tetramethylene oxide	THF	109-99-9
Tetramethylphenanthrene	TMPHAN	
Tetramethylurea	TMUR	632-22-4
Tetranap	THNAP	119-64-2
Tetrazene	TETR	
Tetropil	TCLEE	127-18-4
Tetryl	TETRYL	479-45-8
Thallium	TL	7440-28-0

ACCEPTABLE ENTRIES: (Cont.)

Thallium 208	TL208	
Thein	CAFEIN	58-08-2
Thianaphthene	BZOTHP	95-15-8
Thinocarb	THNCRB	
Thiobencarb	THBNC	
Thiobismethane	MES	75-18-3
Thiobutyric acid *S*-decyl ester	TBASDE	
Thiocyanate	SCN	
Thiodiethylene glycol	TDGCL	111-48-8
Thiodiglycol	TDGCL	111-48-8
Thiodiglycolic acid	TDGCLA	123-93-3
Thiodiphosphoric acid tetraethyl ester	SFOTEP	3689-24-5
Thiofuran	TPH	110-02-1
Thiofurfuran	TPH	110-02-1
Thiole	TPH	110-02-1
Thionazin	ZINPHS	297-97-2
Thiophene	TPH	110-02-1
Thiophos	PRTHN	56-38-2
Thiotepp	SFOTEP	3689-24-5
Thiotetrole	TPH	110-02-1
Thorium	TH	7440-29-1
Thorium 227	TH227	
Thorium 228	TH228	
Thorium 230	TH230	
Thorium 232	TH232	
Thorium 234	TH234	
Tin	SN	7440-31-5

ACCEPTABLE ENTRIES: (Cont.)

Titanium	TI	7440-32-6
TMU	TMUR	632-22-4
Tokuthion	TOKU	34643-46-4
Tolan	DPETYN	501-65-5
Toluene	MEC6H5	108-88-3
Toluene-D8	MEC6D8	
Total ash	TOTASH	
Total coliform	TOTCOL	
Total cyanide	TCYN	
Total dissolved solids	TDS	
Total extractable hydrocarbons	TEHC	
Total gravimetric, acid fraction	TOTGAF	
Total hardness	HARD	
Total heptachlorodibenzo-*p*-dioxins	THPCDD	
Total heptachlorodibenzofurans	THPCDF	
Total hexachlorodibenzo-*p*-dioxins	THCDD	
Total hexachlorodibenzofurans	THCDF	
Total inorganic carbon	TIC	
Total mercury	TOTHG2	
Total mononitrotoluenes	TMNT	
Total octachlorodibenzofurans	TOCDF	
Total octochlorodibenzo-*p*-dioxins	TOCDD	
Total organic carbon	TOC	
Total organic content, 444° C (ASTM)	TORC	
Total organic halogens	TOX	
Total PCBs	TOTPCB	
Total pentachlorodibenzo-*p*-dioxins	TPCDD	
Total pentachlorodibenzofurans	TPCDF	

ACCEPTABLE ENTRIES: (Cont.)

Total petroleum hydrocarbons	TPHC	
Total petroleum hydrocarbons, aviation gasoline fraction	TPHAVG	
Total petroleum hydrocarbons, diesel fraction	TPHDSL	
Total petroleum hydrocarbons, gas fraction	TPHGAS	
Total phosphates	TPO4	
Total solids	TSOLID	
Total sulfur	TS	
Total suspended solids	TSS	
Total tetrachlorodibenzo-*p*-dioxins	TTCDD	
Total tetrachlorodibenzofurans	TTCDF	
Total toxic organics	TTO	
Total uranium	TU	
Total value of all DDT, DDE, DDD isomers	TOTDDT	
Total volatile hydrocarbons	TVHC	
Total volatile solids	TVS	
Toxakil	TXPHEN	8001-35-2
Toxaphene	TXPHEN	8001-35-2
TR	DEMP	15715-41-0
Tramolite-actinolite asbestos	TREACT	
trans-1-Bromo-2-butylcyclopropane	T1B2BC	
trans-1,2-Cyclohexandiol, cyclic sulfite	TCHDCS	
trans-1,2-Dichloroethene	T12DCE	156-60-5
trans-1,2-Dichloroethylene	T12DCE	156-60-5
trans-1,3-Dichloropropene	T13DCP	
trans-1,3-Dimethylcyclohexane	T13DMC	
trans-1,4-Dichloro-2-butene	TDCBU	110-57-6
trans-2-Butenal	CRTALD	123-73-9
trans-2-Decenal	E2DCEA	

ACCEPTABLE ENTRIES: (Cont.)

trans-2-Decene	T2DEC	
trans-Chlordane	TCLDAN	
trans-Octahydro-1*H*-indane	TOH1HI	
Treflan	TREFLN	1582-09-8
Trethylene	TRCLE	79-01-6
Tri	TRCLE	79-01-6
Tri-*m*-cresyl phosphate	PAT3MP	
Tri-*m*-tolyl phosphate	PAT3MP	
Triacontanoic acid methyl ester	C30AME	
Tributyl phosphate	TBP	126-73-8
Tributylamine	TBA	102-82-9
Trichloran	TRCLE	79-01-6
Trichloren	TRCLE	79-01-6
Trichlorobenzenes	TRIBZ	
Trichlorobiphenyls	CL3BP	
Trichlorocyclopentene	TRIPT	
Trichloroethene	TRCLE	79-01-6
Trichloroethylene	TRCLE	79-01-6
Trichlorofluoromethane	CCL3F	75-69-4
Trichloromethanethiol	TCMTHO	
Trichloronaphthalenes	CL3NAP	
Trichloronate	TCN	327-98-0
Trichlorophenols	CL3P	
Trichloropropane	TCP	
Trichloropropenes	CL3C3E	
Trichlorostyrenes	TCST	
Trichlorotrifluoroethane	TTCTFE	

ACCEPTABLE ENTRIES: (Cont.)

Triclene	TRCLE	79-01-6
Tridecane	C13	692-50-5
Trielene	TRCLE	79-01-6
Triethyl phosphate	TEPO4	78-40-0
Triethylene glycol	TEGLYC	112-27-6
Triethylene glycol, methyl ether	TEGLME	
Trifluoroacetic acid 1,5-pentanediyl ester	TFAAPE	
Trifluorochloromethane	CCLF3	
Trifluralin	TREFLN	1582-09-8
Triflurex	TREFLN	1582-09-8
Trihalomethanes	TRXMET	
Trilene	TRCLE	79-01-6
Triline	TRCLE	79-01-6
Trimar	TRCLE	79-01-6
Trimethyl phosphate	TMP	512-56-1
Trimethyl phosphite	TMPO3	121-45-9
Trimethylbenzenes	TRIMBZ	
Trimethyldecanes	ME3C10	
Trimethylethylene	AMYLEN	513-35-9
Trimethylhexanes	ME3C6	
Trimethylnaphthalenes	ME3NAP	
Trimethyloctane	TMO	
Trimethylphosphonate	TMPO	
Trimethylsilanol	TMSIOH	
Trimethylundecanes	ME3C11	
Trinitrobenzene isomer	TNBISO	
Trinitrotoluene isomer	TNTISO	

ACCEPTABLE ENTRIES: (Cont.)

Trioxone	245T	93-76-5
Triphenyl phosphate	PATPE	115-86-6
Triphenylene	TRPHEN	217-59-4
Tris[2,3-dibromopropyl] phosphate	T23DBP	
Trithion	TRITN	786-19-6
Tritium	TRITIU	10028-17-8
Trolene	RON	299-84-3
Tungsten	W	7440-33-7
Tupersan	SIDRN	1982-49-6
Turbidity	TURBID	
Undecane	C11	1120-21-4
Unden	PROPXR	114-26-1
Unknown compound, XXX = 001 thru 999.	UNKXXX	
Unsymmetrical dimethyl hydrazine	UDMH	
Uranium	U	7440-61-1
Uranium 234	U234	13966-29-5
Uranium 235	U235	
Uranium 238	U238	
Urea	UREA	57-13-6
Ureaphil	UREA	57-13-6
Ureophil	UREA	57-13-6
Urepearl	UREA	57-13-6
Urob	FENRNT	4482-55-7
Valeric acid	C5A	109-52-4
Vanadium	V	7440-62-2
Vanillin	4H3MBA	121-33-5
Vapona	DDVP	62-73-7
Various hydrocarbons with increasing M.W.	VARHY	

ACCEPTABLE ENTRIES: (Cont.)

Verrugon	2HBZOA	69-72-7
Vinyl acetate	C2AVE	108-05-4
Vinyl chloride	C2H3CL	75-01-4
Vinyl formate	VFA	
Vinylbenzene	STYR	100-42-5
Viozene	RON	299-84-3
Warbex	FAMPHR	52-85-7
Warfarin	WARFRN	81-81-2
Water	H2O	
Weedone	245T	93-76-5
Westrosol	TRCLE	79-01-6
White phosphorus	WP	
XXCC3	CC3	
Xylenes	XYLEN	
Xylenes, total combined	TXYLEN	
Xylenol	DMPHEN	1300-71-6
Yellow dye	YELDY	
Ytterbium	YB	7440-64-4
Yttrium	Y	7440-65-5
Zinc	ZN	7440-66-6
Zinc 65	ZN65	
Zinc, simultaneously extracted	ZNSX	
Zinophos	ZINPHS	297-97-2
Zirconium	ZR	7440-67-7
Zirconium 95	ZR95	
[2*R*-(2α,6aα,12aα]-1,2,12,12a-Tetrahydro-8,9-dimethoxy-2-(1-methylethenyl)-[1]benzopyrano[3,4-*b*]furo [2,3-*h*][1]benzopyran-6-(6a*H*)-one	ROTEN	83-79-4

APPENDIX B

USATHAMA GEOTECHNICAL REQUIREMENTS

APPENDIX F

GEOTECHNICAL REQUIREMENTS

FOR

DRILLING, MONITOR WELLS, DATA ACQUISITION, AND REPORTS

MARCH 1987

DEPARTMENT OF THE ARMY

U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY

ABERDEEN PROVING GROUND, MD 21010-5401

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I. OBJECTIVE.

The objective of these requirements is to set forth the geotechnical criteria and procedures of the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). These requirements are used in technical support of the Contracting Officer for geotechnical exploration and reporting. The application of geotechnology to environmental programs should begin with project conception. The Geotechnical Requirements join this application during the design of the field program, after the initial magnitude of the study has been determined and tentative well sites selected. The application of these requirements is intended to provide acceptable technical data and tracking procedures to accurately obtain, describe, and evaluate representative samples of the subsurface environment in terms of geology, hydrology, and groundwater chemistry. This sample-specific data can be merged with site-operational knowledge to characterize and appraise the contaminant potential of the site.

II. GENERAL POLICY.

A. The Geotechnical Requirements shall be a part of and attached to each Request for Proposal or Quotation (RFP/RFQ) involving subsurface exploration and resulting contracts and/or task orders. A verbatim copy of these Requirements, modified by only the initial contract or task order and subsequent amendments, shall be made part of and attached to the contractor's Technical Plan (or equivalent document).

B. The Geotechnical Requirements were written as a generalized document. Application to a specific contract or task is likely to generate obvious or subtle conflicts. When conflicts exist between the Geotechnical Requirements and specific contractual documents; i.e., the RFP/RFQ, contract, task order, or contractual amendments, the latest contractual documents shall take precedence.

C. Technically, the Contracting Officer is the only Governmental agent who has the authority to change a given contract. Some administrative aspects of this authority are usually delegated in writing to certain USATHAMA personnel serving as Contracting Officer's Representatives (COR). These aspects include the approval for use of specified items; e.g., the drilling water, granular filter pack, bentonite, etc., as discussed in the Geotechnical Requirements. USATHAMA's approval of these items is performed through and under the authority of the Contracting Officer. Therefore, the contractor's requests for approval of, variance from, or notification of problems with the technical items within these Geotechnical Requirements shall be directly sent from the contractor to the USATHAMA COR responsible for that contract or task.

D. Any deviation from the contract shall be requested of and approved by the Contracting Officer. Deviations approved for a given contract or task shall not be applicable to any other contract or task unless specified in the approval.

E. These requirements will be updated as required incorporating new technology, experience, and policy.

III. SPECIFIC ELEMENTS.

A. Drilling Operations.

1. Drilling Methods.

a. The object of drilling method selection is to use that technique which:

(1) Minimizes subsurface contamination or cross contamination.

(2) Provides representative data.

(3) Minimizes drilling costs.

b. To this end, the following drilling methods are typically used:

(1) Hollow-stem augers.

(2) Water/mud rotary.

(3) Cable tool/churn drill.

(4) Air rotary.

c. Of these, air rotary is the least desirable and is further discussed in section III.A.2. Other methods, like reverse circulation, may have applicability in certain cases. Unless specified in the RFP/RFQ, the drilling method shall be suggested and described by the contractor in his RFP/RFQ response and/or technical plan, for the Contracting Officer's consideration and approval.

2. Air Rotary.

a. Air systems, including bottled gas, shall not be used for drilling, well installation, well development, presample purging, or sampling unless specified in the statement of work. However, when alternative bids or proposals are allowed, the contractor may present as part of the bid/proposal package an alternative using an air system(s) for a given operation(s). The contractor's alternative shall include:

(1) Situation.

(2) Recommendation.

(3) The effect of usage upon groundwater and soil chemical analyses.

(4) Alternatives with cost savings or increases, as appropriate.

b. The above item shall be quantified, costed (in the appropriate section of the bid/proposal package), and shall incorporate the

appropriate criteria discussed in paragraph III.A.2.c. below. Consideration and a recommendation by USATHAMA will be made during the course of bid/proposal evaluation, prior to contract award.

c. In general, air system plans shall:

(1) Specify the type of air compressor and lubricating oil and require a pint sample of each oil be retained by the contractor, along with a record of oil loss (on the boring log), for evaluation in the event of future problems. The oil sample(s) may be disposed of upon contract/task completion.

(2) Require an air line oil filter and that the filter be changed per manufacturer's recommendation during operation with a record kept (on the boring log) of this maintenance. More frequent changes shall be made if oil is visibly detected in the filtered air.

(3) Prohibit the use of any additive except approved water (III.A.10.b.) for dust control and cuttings removal.

(4) Detail the use of any downhole hammer/bit with emphasis upon those procedures to be taken to preclude residual groundwater sample contamination caused by the lubrication of the downhole equipment.

d. Air usage shall be fully described in the log or associated geotechnical report to include equipment description(s), manufacturer(s), model(s), air pressures used, frequency of oil filter change, and evaluations of the system performance, both design and actual.

3. Recirculation Tanks and Sumps. Portable recirculation tanks are suggested for mud/water rotary operations and similar requirements. The use of dug sumps/pits (lined or unlined) is expressly prohibited.

4. Site Geologist. A geologist shall be present and responsible at each operating drill rig for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of that rig. Each geologist shall be responsible for only one operating rig. Each geologist shall have onsite sufficient tools and professional equipment in operable condition to efficiently perform his/her duties as outlined in these Geotechnical Requirements and other contractual documents. Items in the possession of each geologist shall include, as a minimum: a copy of the geotechnical portion of the statement of work, the USATHAMA-approved Technical Plan (or equivalent) which incorporates these Geotechnical Requirements, the approved Safety Plan (approved after contract award), a 10X (minimum) hand lens, and a weighted (with steel or iron) tape(s), long enough to measure the deepest well within the contract, heavy enough to reach that depth, and small enough to readily fit within the annulus between the well and drill casing. Each geologist shall also have onsite a water level measuring device, preferably electrical.

5. Permits, Rights-of-Entry, and Licenses. The contractor shall be responsible for securing and complying with any and all boring or well drilling permits and/or procedures required by state or local authorities and

for determining and complying with any and all state or local regulations with regard to the submission of well logs, samples, etc. Submission of these items to state or local authorities shall be coordinated through USATHAMA. The contractor shall telephonically notify USATHAMA immediately in the event of any apparent discrepancy between contractual and state or local requirements. Notification shall include the nature of the discrepancy; the name, agency, and telephone number of the person noting the discrepancy; and the current status. Any rights-of-entry (for off-post drilling) will be obtained for and supplied to the contractor by the Contracting Officer. The contractor shall ensure that all drilling of boreholes, well installation, and topographic surveying is accomplished by companies appropriately licensed in the project State. A copy of each current license (denoting expiration date) shall be provided in the contractor's Technical Plan. If the project State does not require a licensed driller for this project, then a statement to that effect shall be included in the technical plan.

6. Drilling Safety and Underground Utility Detection. The contractor shall be responsible for determining and complying with any and all (to include host installation) regulations, requirements, and permits with regard to drilling safety and underground utility detection. The contractor shall include a discussion of his actions with regard to these items in his proposal and Safety Plan (also see III.A.12.b., III.A.12.d., and III.G.).

7. Lubricants. Only petroleum jelly, teflon tape, lithium grease, or vegetable-based lubricants shall be used on the threads of downhole drilling equipment. Additives containing lead or copper shall not be used. Any hydraulic or other fluids in the drilling rig, pumps, or other field equipment/vehicles shall NOT contain any polychlorinated biphenyls (PCBs).

8. Surface Runoff. Surface runoff; e.g., precipitation, wasted or spilled drilling fluid, and miscellaneous spills and leaks, shall not enter any boring or well either during or after drilling/well construction. To help preclude this, the use of starter casing, recirculation tanks, berms about the borehole, and surficial bentonite packs, as appropriate, are suggested.

9. Antifreeze. If antifreeze is added to any pump, hose, etc., in an area in contact with drilling fluid, this antifreeze shall be completely purged prior to the equipment's use in drilling, mud mixing, or any other part of the overall drilling operation. Only antifreeze without rust inhibitors and/or sealants shall be used. The contractor shall note on the boring log the dates, reasons, quantities, and brand names of antifreeze per above.

10. Materials.

a. Bentonite is the only drilling fluid additive allowed. No organic additives shall be used. Exception is usually made for some high yield bentonites to which the manufacturer has added a small quantity of polymer. The use of any bentonite must be approved by the Contracting Officer prior to the arrival onsite of the drilling equipment (rigs). This includes bentonites (powders, pellets, etc.) intended for drilling mud, grout, seals, etc. The following data, III.A.10.a.(1)-(5), shall be submitted in writing (see Figure 1) through USATHAMA to the Contracting Officer as part of the approval request. Allow six working days from the time of receipt by USATHAMA for request evaluation and recommendation.

III.A.10.a.

(1) Brand names(s).

(2) Manufacturer(s).

(3) Manufacturer's address(es) and telephone number(s).

(4) Product description(s) from package label(s)/manufacturer's brochure(s).

(5) Intended use(s) for this product.

b. Water.

(1) The source of any water to be used in drilling, grouting, sealing, filter placement, well installation, or equipment washing must be approved by the Contracting Officer prior to arrival of the drilling equipment onsite. Parameters for approval include:

(a) A deep aquifer origin (ideally, greater than 200 feet below ground surface).

(b) Well head upgradient of potential contaminant sources.

(c) Free of survey-related contaminants by virtue of pretesting (sampling and analysis) by the contractor using a laboratory certified by or in the process of being certified by USATHAMA for those contaminants. Pretesting shall be conducted on duplicate samples, each analyzed at a different time, using separate lots.

(d) The water to be non-treated and non-filtered.

(e) The tap to have 24-hour per day, 7-day per week access with plumbing sufficient to allow the filling of a 500 gallon tank in less than 20 minutes.

(f) The use of only one designated tap for access.

(2) Periodic testing of the approved water source may be required when the water is used to clean the sampling equipment after well installation. A detailed discussion of these requirements is provided in the USATHAMA Quality Assurance Program.

(3) Surface water bodies shall not be used, if at all possible.

(4) If a suitable source exists onsite, the contractor shall be directed to that source. If no onsite water is available, the contractor shall locate a potential source and submit the following data, III.A.10.b.(4)(a)-(h), in writing to USATHAMA (see Figure 2) for the Contracting Officer's approval prior to the arrival of any drilling equipment onsite. Allow three calendar weeks from the time of receipt by USATHAMA for request evaluation and recommendation.

III.A.10.b.(4)

(a) Owner/address/telephone number.

(b) Location of tap/address.

(c) Type of source (well, pond, river, etc.). If a well, specify static water level (depth), date measured, well depth, and aquifer description.

(d) Type of treatment and filtration prior to tap (chlorination, fluoridation, softening, etc.).

(e) Time of access (24-hours per day, 5-days per week, etc.).

(f) Cost per gallon charged by Owner/Operator.

(g) Results and dates of all available chemical analyses over past two years. Include the name(s) and address(s) of the analytical laboratory(s)

(h) Results and date(s) of duplicate chemical analysis (see III.A.10.b.(1)(c)) for project contaminants by a laboratory certified by or in the process of being certified by USATHAMA for those contaminants.

(5) The contractor has the responsibility to procure, transport, and store the water required for project needs in a manner to avoid the chemical contamination or degradation of the water once obtained. The contractor is also responsible for any heating, thermal insulation, or agitation of the water to maintain the water as a fluid for its intended uses.

(6) The contractor shall enter the chemical and geotechnical data for the approved water source into the Data Management System.

c. Grout.

(1) Materials. Grout, when used in monitor well construction or well abandonment, shall be composed by weight of 20 parts cement (Portland cement, type II or V) up to 1 part bentonite with a maximum of 8 gallons of approved water per 94 pound bag of cement. Neither additives nor borehole cuttings shall be mixed with the grout. Bentonite shall be added after the required amount of cement is mixed with water.

(2) Equipment. All grout materials shall be combined in an above-ground rigid container or mixer and mechanically (not manually) blended onsite to produce a thick, lump-free mixture throughout the mixing vessel. The mixed grout shall be recirculated through the grout pump prior to placement. Grout shall be placed using a grout pump and tremie. The grout pump for recirculation and placement shall be a commercially available product specifically manufactured to pump cement grouts. The tremie pipe shall be of rigid, not flexible, construction. Drill rods, rigid polyvinyl chloride (PVC) or metal pipes are acceptable tremies. Hoses and flexible PVC are unacceptable. Grout placement, via gravity and the grout head, using an elevated grout tank is expressly prohibited.

(3) Grout shall be placed in the monitor wells as follows:

(a) When a bentonite seal is used as shown in Figures 5 or 6:

(i) Prior to exposing any portion of the borehole above the seal by the removal of any drill casing (to include hollow-stem augers), the annulus between the well casing and drill casing shall be filled with grout.

(ii) The grout shall be placed from within a rigid tremie pipe, located just over the top of the seal.

(iii) The grout shall be pumped through this pipe to the bottom of the open annulus until undiluted grout flows from the annulus at ground surface, forming a continuous grout column from the seal to ground surface. The grout shall not penetrate the well screen or granular filter pack. Disturbance of the bentonite seal should be minimal.

(iv) The drill casing shall then be removed and more grout immediately added to compensate for settlement.

(v) If drill casing (to include hollow-stem auger) was not used, proceed with grouting to ground surface in one, continuous operation.

(vi) After 24 hours, the contractor shall check the site for grout settlement and that day add more grout to fill any settlement depression.

(vii) Repeat this process until firm grout remains at ground surface.

(viii) Incremental quantities of grout added in this manner shall be recorded as added and the data submitted to the Contracting Officer through USATHAMA on the well diagram (or addendum).

(b) When no bentonite seal is used (unusual occurrence requiring specific Contracting Officer approval):

(i) The contractor shall mix, place, monitor, and report grout usage as described above: III.A.10.c.(1) to (3)(a)(viii), but position the rigid tremie pipe just above the granular filter pack.

(ii) Place the grout so as to avoid grout penetration into the underlying granular filter pack and screen.

(4) If field conditions permit, the contractor may incrementally place grout and remove drill casing so as to constantly maintain 10 feet of grout (minimally) within the casing yet to be removed from the ground. Using this method requires at least 20 feet of grout to be within the casing before removing 10 feet of casing.

III.A.10.c.

(5) For grout placement at depths less than ten feet in a DRY hole, the grout may be poured in place from ground surface.

d. Granular Filter Pack. For this discussion, refer to section III.C.5.

e. Well Screens, Casings, and Fittings. For a discussion of these materials, see section III.C.2.

f. Well Caps and Centralizers. These items are discussed in sections III.C.3. and 4, respectively.

g. Well Protection. Elements of well protection are covered in section III.C.8.

h. Tracers, dyes, or other substances shall not be used or otherwise introduced into borings, wells, grout, backfill, groundwater, or surface water unless specifically required by contract.

i. Summarize the usage of these and any other drilling/well construction materials which potentially could have a bearing on subsequent interpretation of the analytical results. Include this summary within the geotechnical report. An example summary is provided at Table 1.

11. Abandonment. Abandonment is that procedure by which any boring or well is permanently closed. Abandonment procedures shall preclude any current or subsequent discharges from entering the abandoned boring or well and thereby terminate access to the subsurface environment.

a. The abandonment of any borings or wells not scheduled for abandonment per contract, must be approved by the Contracting Officer prior to any casing removal, sealing, or backfilling. Abandonment requests shall be submitted telephonically through USATHAMA to the Contracting Officer with the following data, III.A.11.a.(1)-(3), plus recommendation. Allow four consecutive hours from the time of receipt by USATHAMA for request evaluation and decision. Frequently, resolution is made within minutes. Infrequent circumstances may preclude a four-hour resolution. A written followup memorandum shall be submitted by the contractor within five working days of the telephonic request. This document shall be forwarded through USATHAMA to the Contracting Officer and contain the following data:

(1) Designation of well/bore in question.

(2) Current status (depth, contents of hole, stratigraphy, water level, etc.).

(3) Reason for abandonment.

(4) Action taken, to include any replacement boring or well.

b. Each boring or well to be abandoned shall be sealed by grouting from the bottom of the boring/well to ground surface. This shall be done by placing a grout pipe to the bottom of the boring/well (i.e., to the maximum depth drilled/bottom of well screen) and pumping grout through this

pipe until undiluted grout flows from the boring/well at ground surface. Any open or ungrouted portion of the annular space between the well casing and borehole shall be grouted in the same manner also. Grout composition, equipment, and placement procedures are covered in section III.A.10.c.

c. After 24 hours, the contractor shall check the abandoned site for grout settlement. That day, any settlement depression shall be filled with grout and rechecked 24 hours later. This process shall be repeated until firm grout remains at ground surface.

d. Normally an abandoned well shall be grouted with the well screen and casing in place. However, a lack of data concerning well construction or other factors may dictate the removal of the well materials and a partial or total hole redrilling prior to sealing the well site.

e. For each abandoned boring/well, a record shall be prepared to include the following, III.A.11.e.(1)-(13), as applicable. Report all depths/heights from ground surface. The original record shall be submitted to USATHAMA within three working days after abandonment is completed.

(1) Boring/well designation.

(2) Location with respect to the replacement boring or well (if any); e.g., 20 feet north and 20 feet west of Well 14.

(3) Open depth prior to grouting and depth to which grout pipe placed. This includes the depth of open hole, open depth to the bottom of the well, and the open depth in the well-borehole annulus.

(4) Casing left in hole by depth, composition, and size.

(5) Copy of the boring log.

(6) Copy of construction diagram for abandoned well.

(7) Drilled and sampled depth prior to decision to abandon site.

(8) Items left in hole by depth, description, and composition.

(9) Description and total quantity of grout used initially.

(10) Description and daily quantities of grout used to compensate for settlement.

(11) Dates of grouting.

(12) Water or mud level (specify) prior to grouting and date measured.

(13) Remaining casing above ground surface: height above ground, size, and composition.

f. Ideally, replacement wells/borings (if any) will be offset at least 20 feet from any abandoned site in a presumed up- or cross-gradient groundwater direction. Site-specific conditions may necessitate variation to this placement.

12. Soil Samples.

a. Unless otherwise specified in the contract, intact soil samples for physical descriptions, retention, and potential physical analyses shall be taken and retained every five feet or at each major change of material, whichever occurs first. The contractor may propose an alternate sampling frequency in his technical plan. These samples shall be representative of their host environment and are to be obtained with driven (e.g., split spoon), pushed (e.g., thin wall), or rotary (e.g., Denison) type samplers. Auger flight or wash samples will not satisfy this requirement.

b. At the detection of any unusual odors off the auger turnings or intact samples, drilling shall cease for an evaluation of their nature and crew safety. After the field crew completes this evaluation and implements any appropriate safety precautions, drilling shall resume. If the odors are judged by the field crew to be contaminant-related, intact samples shall be continuously taken until the odors are no longer detected in the samples. At that time, normal sampling shall resume. Specific procedures shall be detailed in the contractor's proposal and Safety Plan.

c. Representative soil samples from each sampler shall be placed in half- or one-pint glass jars with air-tight, screw-type lids (canning jars). These jars shall be stored in individual compartments in cardboard boxes. A single box shall not contain more than 24 one-pint jars or 48 half-pint jars. For thin wall (shelby) samples, retain a sample from each tube as described above. The remaining portion may be wasted or sealed in the tube, as per testing requirements. Minimum information on each sample container shall include the boring and sample number. No geotechnical data shall appear on the container that is not specified on the boring log. Jars and tubes shall be kept from freezing.

d. Physical soil testing shall be conducted on ten (10) to twenty (20) percent of the soil samples using procedures and equipment described in the current U.S. Army Corps of Engineers Manual, EM 1110-2-1906: Laboratory Soils Testing, or current Annual Book of ASTM Standards, American Society of Testing and Materials, Part 19. Tested samples shall be representative of the range and frequency of soil types encountered. In addition, they shall be obtained from borings that cover the geographic and geologic range within the study area of the host Army installation. The contractor shall select the particular samples. Tests shall include Atterberg Limits, sieve grain size distribution, and assignment of Unified Soil Classification System symbols. Laboratory and summary sheets shall be submitted to the COR within ten working days of final test completion. The contractor shall address any contaminant-related safety precautions for the physical analysis of these samples in his proposal and Safety Plan.

e. Soil samples for chemical analysis taken from borings shall be obtained in a manner to provide intact specimens; using a split spoon or

solid barrel sampler, Denison sampler, etc. These samples shall be extracted from their host environment in as near an intact, undisturbed condition as technically practical. Once at the surface, the sampler shall be opened, sample extracted, peeled, and bottled in as short a time as possible. "Peeling" is a process whereby that portion of the sample which was in direct contact with the sampler, as well as the ends of the sample, are removed and discarded. Samples for volatile analysis shall be peeled, bottled, and capped within fifteen (15) seconds from the time of opening the sampler. Additional acquisition, preservation, and handling criteria for the chemical analysis of soils are found in the current Quality Assurance Program.

f. All soil samples, except those for physical and/or chemical analysis and reference shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

13. Rock Core. The preferred method of drilling bedrock is through coring. This method, using a diamond or carbide studded bit, produces a generally intact sample of the bedrock lithology, structure, and physical condition. The use of a gear-bit, tricone, etc., to penetrate bedrock should only be considered for the confirmation of the "top of rock" (where penetration is limited to a few feet), the enlargement of a previously cored hole, or the drilling of highly fractured intervals.

a. The coring of bedrock or any firm stratigraphic unit shall be conducted in a manner to obtain at least 90% intact recovery. The physical character of the bedrock; i.e., fractures, poor cementation, weathering, or solution cavities, may lessen the desired recovery, even with the best of drillers and equipment.

b. While drilling in bedrock, and especially while coring, drilling fluid pressures shall be adjusted to minimize drilling fluid losses and hydraulic fracturing.

c. Rock cores shall be stored in covered wooden boxes in such a manner as to preserve their relative position by depth. Intervals of lost core shall be noted in the core sequence with annotated wooden blocks. Boxes shall be marked inside and out to provide boring number, cored interval, and box number in cases of multiple boxes. The weight of each fully loaded box shall not exceed 75 pounds. No geotechnical data shall appear on or within the box that is not specified on the boring log. As a minimum, the estimated number of boxes required for each boring shall be on hand prior to coring that site.

d. The core within each completed box shall be photographed after the core surface has been cleaned/peeled and wetted. Photos shall be taken using color film (ASA as appropriate), 35mm camera, 55mm (minimum) lens, light meter, with one box per frame. Each photo shall be in sharp focus and contain both a legible scale in feet and tenths of feet (or centimeters) and a USATHAMA-supplied photographic color chart for color comparison. The core shall be oriented so that the top of the core is at the top of the photo. One set of 3 x 5 inch glossy color prints plus all negatives shall be sent to USATHAMA via registered mail within 2 weeks of the last coring. Each photo shall be annotated on the back as to the bore/well designation, box number, and cored

depths denoted in the photograph. The photos shall be used to enhance the interpretation of core sketches and corresponding narrative descriptions.

e. All rock core, except that for analysis and reference, shall remain onsite, neatly stored at a USATHAMA-designated location. The disposition of these samples will be arranged between USATHAMA and the host installation.

14. Drilling in Contaminated Areas. Many borings and wells are drilled in areas that are clean relative to the deeper horizons of interest. However, circumstances do arise which require drilling where the overlying soils or shallow aquifer may be contaminated relative to the underlying environment. This situation requires the placement of, at least, double casing: an outer permanent (or temporary) casing sealed in place and cleaned of all previous drill fluids prior to proceeding into the deeper, "cleaner" environment. These situations shall be addressed by the contractor on a case-by-case basis in the technical plan.

15. Equipment Cleaning. The steam cleaning of all drilling equipment to include rigs, water tanks (inside and out), augers, drill casings, rods, samplers, tools, recirculation tanks, etc., shall be done prior to project site (installation) arrival followed by onsite steam cleaning with approved water (III.A.10.b.) upon site arrival and between boring/well sites. Prior to use onsite, all casings, augers, recirculation and water tanks, etc., shall be devoid both inside and out of any asphaltic, bituminous, or other encrusting or coating materials, grease, grout, soil, etc. Paint, applied by the equipment manufacturer, need not be removed from drilling equipment. To the extent practical, all cleaning shall be performed in an area that is remote from and surficially cross- or downgradient from any site to be sampled.

16. Work Area Restoration, Disposal of Borehole Cuttings and Well Water. All work areas around the wells and/or borings installed as part of this contract shall be restored to a physical condition equivalent to that of preinstallation. This includes cuttings removal or spreading and rut removal. Borehole cuttings, drilling fluids, and water removed from a well during installation, development, aquifer testing, and presample purging shall be disposed of in a manner approved by the Contracting Officer and the host installation. The contractor shall suggest a disposal procedure and location(s) as part of his technical plan.

17. Physical Security.

a. On Post: While physical security measures are present on most Army properties, the contractor has the ultimate responsibility for securing his own equipment. The contractor shall address any special needs to the onsite installation personnel and include these items in his technical plan.

b. Off Post: For any operations off post, the contractor is totally responsible for his own physical security.

B. Borehole Logging. Each boring log shall fully describe the subsurface environment and the procedures used to gain that description.

1. Format. The format of the boring log shall be determined by the contractor. A suggested format is presented in Figure 4.

III.B.

2. Submittal. Each original boring log shall be submitted directly from the field to the Contracting Officer's designated office within three working days after the boring is completed. In those cases where a monitor well or other instrument is to be inserted into the boring, both the log for that boring and the installation diagram must be submitted within three working days after the instrument is installed.

3. Originals. Only the original boring log (and diagram) shall be submitted from the field to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice.

4. Time of Recording. Logs shall be recorded directly in the field without transcribing from a field book or other document. This technique reduces offsite work hours for the geologist, lessens the chance for errors of manual copying, and allows the completed document to be field-reviewed closer to the time of drilling.

5. Routine Entries. In addition to the data desired by the contractor and uniquely required by contract, the following information shall be routinely entered on the boring log or attached to the log:

a. Depths/heights shall be recorded in feet and fractions thereof (tenths or inches). Metric measurements are acceptable if typically used by the geologist. The DMS does not accept entries in inches.

b. Soil classifications shall be in accordance with the Unified Soil Classification System (equivalent to ASTM D 2487-69).

c. Soil classifications shall be prepared in the field at the time of sampling by the geologist and are subject to change based upon laboratory tests and/or subsequent review. The mere difference between laboratory and field classification is not sufficient to change the field classification. Additional factors to consider before changing a field determination include the expertise of the field geologist and laboratory personnel, representative character of the tested sample, labeling errors, etc. Any changes made after this consideration shall be discussed and incorporated in the project report(s). The contractor shall also initiate any subsequent corrections to the Data Management System.

d. Each soil sample taken (see III.A.12.) shall be fully described on the log. The descriptions of intact samples shall include the following parameters:

PARAMETER	EXAMPLE
Classification	Sandy Clay
Unified Soil Classification Symbol	CL
Secondary Components and Estimated Percentages	Sand: 25% (Fine sand 5%, Coarse sand 20%)
Color (using Munsell Soil or Geological	Gray: 7.5 YR 5.0 (Munsell)

Society of America (GSA) Rock Color Chart), give both narrative and numerical description and note which chart used.	
Plasticity	Low Plasticity
Consistency (cohesive soil)	Stiff
Density (non-cohesive soil)	Loose
Moisture Content. Use relative term. Do not express as a percentage unless a value has been measured.	Dry, moist, wet, etc.
Texture/Fabric/Bedding and Orientation	No apparent bedding: numerous vertical, iron-stained, tight fractures
Grain Angularity	Rounded
Depositional Environment and Formation, if named	Glacial till, Twin Cities Formation

e. In the field, visual numeric estimates shall be made of secondary soil constituents; e.g., "silty sand with 20 percent fines" or "sandy gravel with 40 percent sand." If such terms as "trace," "some," "several," etc., are used, their quantitative meaning is to be defined on each log or within a general legend.

f. When used to supplement other sampling techniques, disturbed samples; e.g., wash samples, cuttings, and auger flight samples, shall be described in terms of the appropriate soil/rock parameters to the extent practical. "Classification" shall be minimally described for these samples, along with a description of drill action and water losses/gains for the corresponding depth.

g. Rock core shall be visually described for the following parameters:

PARAMETER	EXAMPLE
Classification	Limestone, Sandstone, Granite
Lithologic Characteristics	Shaly, Calcareous, Siliceous, Micaceous
Bedding/Banding Characteristics	Laminated, Thin bedded, Massive, Cross bedded, Foliated
Color (using Munsell Soil or GSA Rock Color Chart), give both narrative and numerical description and note which chart was used.	Mod. brown: 5 YR 3/4 GSA

III.B.5.g.

Hardness	Soft, Very hard
Degree of Cementation	Poorly cemented, Well cemented
Texture	Dense, Fine-, Medium-, Coarse-grained, Glassy, Porphyritic, Crystalline
Structure and Orientation	Horizontal bedding, Dipping beds at 30°, Highly fractured, Open vertical joints, Healed 30° faults/ fractures, Slickensides at 45°, Fissile
Degree of Weathering	Unweathered, Badly weathered
Solution or Void Conditions	Solid, Cavernous, Vuggy with partial infilling by clay
Primary and Secondary Permeability, include estimates and rationale	Low primary: Well cemented High secondary: Several open joints
Lost Core, interval and reason for loss	50-51', noncemented sandstone likely

h. For rock core, provide a scaled graphic sketch of the core on or with the log denoting by depth the location, orientation, and nature (natural or coring-induced) of all core breaks. Note also the intervals by depth of all lost core and hydrologically significant details. This sketch shall be prepared at the time of core logging, concurrent with drilling.

i. Record the brand name and amount of any bentonite used for each boring along with the reason for and start (by depth) of this use.

j. The drilling equipment used shall be generally described either on each log or in a general legend. Record such information as rod size, bit type, pump type, rig manufacturer and model.

k. Each log shall record the drilling sequence; e.g.:

(1) Opened hole with 8" auger to 9'.

(2) Set 8" casing to 10'.

(3) Cleaned out and advanced hole with 8" roller bit to 15' (clean water, no water loss).

(4) Drove standard sampler to 16.5'.

III.B.5.k.

(5) Advanced with 8" roller bit to 30', 15 gallon water loss.

(6) Drove standard sampler to 31.5'.

(7) Hole heaved to 20'.

(8) Mixed 25 pounds of ABC bentonite in 100 gallons of water for hole stabilization and advanced with 8" roller bit to 45', etc.

l. Record all special problems and their resolution on the log; e.g., hole squeezing, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, unrecovered tools in hole, lost casings, etc.

m. The dates for the start and completion of borings shall be recorded on the log along with notation by depth for drill crew shifts and individual days.

n. Each sequential boundary between the various soils and individual lithologies shall be noted on the log by depth. When depths are estimated, the estimated range shall be noted along the boundary.

o. The depth of first encountered free water shall be indicated along with the method of determination; e.g., "37.6' from direct measurement after drilling to 40.0';" or "40.1' from direct measurement in 60' hole when boring left overnight, hole dry at end of previous shift;" or "25.0' based on saturated soil sample while sampling 24-26'." Allow the first encountered water to partially stabilize (5 to 10 minutes) and record this secondary level and time between measurements before proceeding. Also describe any other distinct water level(s) found below the first.

p. The estimated interval by depth for each sample taken, classified, and/or retained shall be noted on the log. For each driven (split spoon), thin wall (shelby), and cored sample, record the length of sampled interval and length of sample recovery. Record the sampler type and size (diameter and length).

q. Record the blow counts, hammer weight, and length of hammer fall for driven samplers. For thin wall samplers, indicate whether the sampler was pushed or driven. Blow counts shall be recorded in half foot increments when standard (1 3/8" ID by 2" OD) samplers are used. For penetration less than a half foot, annotate the count with the distance over which the count was taken.

r. When drilling fluid is used, quantitatively record fluid losses and/or gains and the interval over which they occur. Adjust fluid losses for spillage and intentional wasting (e.g., recirculation tank cleaning) to more accurately estimate the amount of fluid lost to the subsurface environment.

s. Record the pumping pressures typically used during all rotary drilling operations.

t. Note the total depth of drilling or sampling, whichever is deeper, on the log.

III.C.1.

c. Once begun, well installation shall not be interrupted due to the end of the contractor's/driller's work shift, darkness, weekend, or holiday.

d. The contractor shall ensure that all materials and equipment for drilling and installing a given well are available and onsite prior to drilling that well. The contractor shall have all equipment and materials onsite prior to drilling and installing any well if the total well drilling and installation effort is scheduled to take 14 consecutive days or less. ("Consecutive days" refers to the continuous combination of "working" and "nonworking days;" i.e., "calendar days."). For longer schedules, the contractor shall ensure that the above materials needed for at least 14 consecutive days of operation are onsite prior to well drilling. The balance of materials shall be either on order or in transit prior to well drilling.

2. Screens, Casings, and Fittings.

a. Typically, only polyvinyl chloride (PVC), polytetrafluoroethylene (PTFE), and/or stainless steel shall be used. All PVC screens, casings, and fittings shall conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage (or American Society for Testing and Materials (ASTM) equivalent) and bear the appropriate rating logo. If a contractor uses a screen and/or casing manufacturer or supplier who removes or does not apply this logo, the contractor shall include in the Technical Plan a written statement from the manufacturer/supplier (and endorsed by the contractor) that the screens and/or casing have been appropriately rated by NSF/ASTM. Specific materials will be specified in the RFP/RFQ or proposed by the contractor in his RFP/RFQ response for the Contracting Officer's approval. All materials shall be as chemically inert with respect to the site environment as technically possible and practical.

b. All well screens shall be commercially fabricated, slotted or continuously wound, and have an inside diameter equal to or greater than the well casing. For PVC and PTFE screens, their schedule/thickness shall be the same as that of the well casing. Stainless steel screens may be used with PVC or PTFE well casing. No fitting shall restrict the inside diameter of the joined casing and/or screen. All screens, casings, and fittings shall be new.

c. All well screens and well casings shall be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and washed with approved water prior to use. Pipe nomenclature stamped or stenciled directly on the well screen and/or blank casing within and below the bentonite seal shall be removed (via SANDING). Solvents shall NOT be used for marking removal. Washed screens and casings shall be stored in plastic sheeting or kept on racks prior to insertion.

d. Well screens shall be placed no more than three feet above the bottom of the drilled borehole.

e. All screen bottoms shall be securely fitted with a threaded cap or plug of the same composition as the screen. This cap/plug shall be within 0.5' of the open portion of the screen (see Figures 5 and 6). No solvents or glues shall be permitted for attachment.

f. Silt traps (also called "cellars") shall not be used. A silt trap is a blank length of casing attached to and below the screen. Their use fosters a stagnant environment which could influence analytical results for trace concentrations.

g. Joints within and between the casing and screen shall be compatibly threaded. Thermally welded joints or couplings shall not be used. This prohibition includes threaded or slip joint couplings thermally welded to casing by the manufacturer or in the field. Solvent welded joints may be used only to make casing repairs or to adjust casing height. Any glue or solvent usage shall be described on the log or well diagram. During these repairs or adjustments which require solvent/glue usage, a clean rag should be tightly fit into the intact well casing to catch any glue spillage. This rag shall be attached to a strong twine for ease of rag removal and to preclude rag loss down the well. The rag and twine shall be removed upon repair completion.

h. Gaskets shall not be used on monitor wells.

i. The top of each well installed under these Requirements shall be level such that the difference in elevation between the highest and lowest part of the well casing/riser shall be less than or equal to 0.02'.

3. Caps and Vents. The tops of all well casings shall be telescopically capped with loosely fitting PVC, PTFE, or stainless steel covers. These covers shall be constructed to preclude binding to the well casing due to tightness of fit, unclean surface, or frost and secure enough to preclude debris and insects from entering the well. No vents shall be placed in these caps (or well risers/stickup). Therefore, the caps shall be loose enough to allow pressure equalization between the well and atmosphere.

4. Centralizers. Well centralizers, when used, shall be of PVC, PTFE, or stainless steel and attached to the casing via stainless steel fasteners or strapping. Centralizers shall not be attached to the well screen or to that part of the well casing exposed to the granular filter or bentonite seal.

5. Granular Filter Pack.

a. All granular filters must be approved by the Contracting Officer prior to drilling. A one-pint representative sample of each proposed granular filter pack, accompanied by the data below, III.C.5.a.(1)-(6), shall be submitted by the contractor to the Contracting Officer through USATHAMA for consideration prior to drilling. Allow eight working hours for evaluation and recommendation once all of the above data are received by USATHAMA. Each sample shall be described, in writing (see Figure 3), in terms of:

(1) Lithology.

(2) Grain size distribution.

(3) Brand name, if any.

(4) Source, both manufacturing company and location of pit or quarry of origin.

III.C.5.a.

(5) Processing method; e.g., pit run, screened and unwashed, screened and washed with water from well/river/pond, etc.

(6) Slot size of intended screen.

b. Granular filter packs shall be chemically and texturally clean (as seen through a 10X hand lens), inert, siliceous, and of appropriate size for the well screen and host environment.

c. The filter pack shall extend above the top of the screen by at least five feet, unless otherwise specified in the statement of work.

d. The final depth to the top of the granular filter shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed filter.

6. Bentonite Seals.

a. Bentonite seals shall be composed of commercially available pellets. Pellet seals shall be a minimum of five feet thick as measured immediately after placement, without allowance for swelling.

b. Slurry seals shall be used only as a last resort, as when the seal location is too far below water to allow for pellet or containerized-bentonite placement or within a narrow well-borehole annulus. Slurry seals shall have a thick, batter-like (high viscosity) consistency with a placement thickness of five feet maximum.

c. In wells designed to monitor bedrock, the top of the bentonite seal shall be located at least three feet below the top of firm bedrock, as may be determined by drilling. "Firm bedrock" refers to that portion of solid or relatively solid, moderately to unweathered bedrock where the frequency of loose and fractured rock is markedly less than in the overlying, highly weathered bedrock. The interval between the top of the bentonite seal and the top of the highly weathered bedrock shall be filled with grout. Figure 6 denotes the seal location.

d. The final depth to the top of the bentonite seal shall be directly measured (via tape or rod) and recorded. Final depths are not to be estimated; as, for example, based on volumetric measurements of placed bentonite.

7. Grouting. Grout mix design and placement are detailed in paragraph III.A.10.c.

8. Well Protection.

a. Protective casing shall be installed around each monitor well the same day as initial grout placement around that well. Any annulus formed between the outside of the protective casing and borehole shall be filled to ground surface with grout as part of the grouting procedure. Requests for exceptions in usage, design, and timing of placement will be considered on a case-by-case basis by the Contracting Officer. Request in writing shall be made prior to drilling. Include in the request the well(s) involved, reason for

request, cost savings, recommendation, and alternatives. Allow six working days for evaluation and recommendation after the request is received by USATHAMA.

b. All protective casing shall be steam cleaned prior to placement, free of extraneous openings, devoid of any asphaltic, bituminous, encrusting, and/or coating materials (except the black paint or primer applied by the manufacturer).

c. Minimum elements of protection design include:

(1) A 5-foot minimum length of new, black iron/steel pipe extending about 2.5 feet above ground surface and set in grout (see Figures 5, 6 and 7).

(2) An 8" protector pipe for 5" wells.

(3) A 6" protector pipe for 4" wells.

(4) A 5" protector pipe for 3" wells.

(5) A 4" protector pipe for 2" wells.

(6) A hinged cover or loose fitting telescoping cap to keep direct precipitation and cover runoff out of the casing.

(7) All protective casing covers/caps secured to the casing by means of a padlock from the date of protective casing installation.

(8) All padlocks at a given site (Army installation) opened by the same key. The contractor shall provide two of these keys to a Contracting Officer's designated representative at the installation and two keys to USATHAMA upon the conclusion of well placement.

(9) No more than .2' from the top of protective casing to the top of well casing. This, or a smaller spacing, is critical for subsequent water level determination via acoustical equipment.

(10) The outside only of the protective casing, hinges (if present), and covers/caps painted orange with a paint brush (not aerosol can). Painting required to be completed and dry prior to initially sampling that well. Any color deviations will be conveyed to the contractor by the COR.

(11) The painting of the well designation on the outside of the protective casing, using white paint and a brush. The identification shall be done after the casing is painted as described above. Painting required to be completed and dry prior to initially sampling that well.

(12) The erection of four steel pickets, each radially located 4 feet from each well, placed 2 to 3 feet below ground surface, having 3 feet minimally above ground surface with flagging in areas of high vegetation (see Figure 7). The pickets shall be painted orange, using a brush. Installation and painting shall be completed (and dry) prior to sampling the well.

III.C.8.c.

(13) The above pickets (III.C.8.c.(12)) shall be supplemented with three-strand barbed wire in livestock grazing areas. Installation required prior to sampling.

(14) The placement of an internal mortar collar within the well-protective casing annulus from ground surface to 1/2 foot above ground surface with a 1/4" diameter hole (drainage port) in the protective casing centered 1/8" above this level (see Figures 5 and 6). The mortar mix shall be (by weight) 1 part cement to 2 parts sand (the granular filter used around the well screen), with minimal water for placement. Placement required at least 48 consecutive hours prior to well development.

(15) The application of an approximately .5' thick coarse gravel (3/4" to 3" particle size) blanket extending 4' radially from the protective casing (see Figure 8 for layout and dimensions). Application required prior to development.

(16) Unique specifications for flood protection, if applicable, will be covered on a case-by-case basis.

9. Drilling Fluid Removal. When a borehole, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the borehole fluid should be removed or displaced with approved water (section III.A.10.b.). This removal is intended to remove or dilute the thick fluid and thus allow the proper placement of casing, screen, granular filter, and seal. Fluid losses in this operation shall be initially recorded on the well diagram or boring log and later on the well development record (also see III.D.6., 11., and 14.). Any fluid removal prior to well placement is contingent upon the driller's and the geologist's evaluation of hole stability long enough for the desired well and seal placement.

10. Drilling Fluid Losses in Bedrock. For an option to remove drilling water from bedrock prior to well insertion, see paragraph III.D.11.

11. Schematic Well Construction. Figures 5 and 6 depict schematic well construction. Specific contract requirements described in the statement of work may alter some of the components and/or values shown.

12. Well Construction Diagrams.

a. Each installed well shall be depicted in a well diagram. This diagram shall be attached to the bore log for that installation and shall graphically denote, by depth from ground surface (unless otherwise specified):

(1) The bottom of the boring (that part of the boring most deeply penetrated by drilling and/or sampling) and boring diameter(s).

(2) Screen location.

(3) Joint locations.

(4) Granular filter pack.

(5) Seal.

(6) Grout.

(7) Cave-in.

(8) Centralizers.

(9) Height of riser without cap/plug above ground surface (stickup).

(10) Protective casing detail.

(a) Height of protective casing without cap/cover (above ground surface).

(b) Base of protective casing.

(c) Drainage port location and size.

(d) Internal mortar collar location.

(e) Gravel blanket height and extent.

(f) Picket configuration.

b. Describe on the diagram or on an attachment thereto:

(1) The actual quantity and composition of the grout, seals, and granular filter pack used for each well.

(2) The screen slot size (in inches), slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer.

(3) The outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing.

(4) The joint design and composition.

(5) Centralizer design and composition.

(6) Protective casing composition and nominal inside diameter.

(7) The use of solvents, glues, and cleaners to include manufacturer and type (specification).

(8) Special problems and their resolutions; e.g., grout in wells, lost casing and/or screens, bridging, etc.

(9) Dates for the start and completion of well installation.

c. Each diagram shall be attached to the boring log and submitted from the field to the Contracting Officer's designated office within three

working days after well installation. Do not delay this submission until all elements of well protection have been installed. Submit a supplemental diagram for well protection elements to the same designated office within three working days after all elements of well protection are installed.

d. Only the original well diagram and log shall be submitted to fulfill the above requirement. Carbon, typed, or reproduced copies shall not suffice. A legible copy of the well diagram may be used as a base for the supplemental protection diagram.

e. For abbreviations in the diagrams, see section III.B.5.v.

D. Well Development and Presample Purging.

1. Development: Definition and Purpose. As used herein, "well development" is that process by which one restores the aquifer's hydraulic conductivity and removes well drilling fluids, solids, and other mobile particulates from within and adjacent the newly installed well. "Development" can also refer to that process whereby one removes sediment or other built-up materials from a "clogged," older well. The resulting inflow should be as physically and chemically representative of the host aquifer as the following procedures allow for a newly installed well.

2. Timing and Record Submittal. The development of monitor wells shall be initiated not sooner than 48 consecutive hours after nor longer than 7 calendar days beyond internal mortar collar placement. The record of well development (see section III.D.14.) shall be submitted to the COR within three working days after development.

3. Pump and Bailer Usage. Development shall be accomplished with a pump and may be supplemented with a bottom discharge/filling bailer (for sediment removal) and surge block. A bottom discharge/filling bailer may be used in lieu of a pump in 2-inch wells. Bailers shall not be left inside the wells after development is completed.

4. Development Criteria. Development shall proceed in the manner described herein and continue until all the following are met:

a. The well water is clear to the unaided eye.

b. The sediment thickness remaining within the well is less than 1% of the screen length.

c. The conditions of paragraph III.D.5. (below) are met.

5. Volumetric Removal. In addition to minimally removing five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30% porosity), the following apply:

a. For those wells where the boring was made by the use of cable tool, auger, or air rotary methods and without the use of drilling fluid (mud and/or water), only the five volumes plus five times any water used in granular filter pack placement need be minimally removed. Should recharge be so slow that the required volume cannot be removed in 48 consecutive hours, the water

remains discolored, or excess sediment remains after the five volume removal; contact the Contracting Officer's designated office for guidance.

b. For those wells where the boring was made or enlarged (totally or partially) with the use of drilling fluid (mud and/or water), remove five times the measured amount of total fluids lost while drilling plus five times the combined amount of standing water,annular water, and that used in filter pack placement as above. The same procedures apply here as above with respect to slow recharge, discoloration, and sediment thickness.

c. See sections III.C.9., III.D.6., and III.D.11. for optional procedures and the requirements if these options are used.

6. Water Additions and Wells with Thick Fluids. Water shall not be added to a well as part of development once the initial seal is placed. However, when a bore, made with or without the use of drilling fluid, contains an excessively thick, particulate-laden fluid which would preclude or practically hinder contractual well installation, the contractor should purge or dilute this fluid with clean water from the approved source (also see III.C.9.). A record of purging fluid losses shall be made on both the log or diagram and well development record (III.D.14.). Five times the volume of this loss shall be added to the other volumetric removal requirements for well development.

7. Agents and Additives. No dispersing agents, acids, disinfectants, or other additives shall be used during development or at any other time introduced to the well.

8. Development-Sampling Break. Well development shall be completed at least fourteen consecutive days before well sampling.

9. Pump/Bailer Movement. During development, water shall be removed throughout the entire water column by periodically lowering and raising the pump intake (or bailer stopping point).

10. Development Water Sample. For each well, a one-pint sample of the last water to be removed during development shall be obtained and given to the installation environmental coordinator (or USATHAMA-specified individual) for disposition, within three working days of developing that well. No preservation of these samples is required. However, the contractor shall ensure that these samples do not freeze while in his possession.

11. Partial Bedrock Development. If large drilling water losses occur in bedrock and if the hole is cased to bedrock, the contractor may remove at least five times this volumetric loss prior to well insertion. The intent here is to allow the placement of a larger pump in the borehole than otherwise possible in the well casing thereby reducing the development time and removing the lost water closer to the time of loss. Development of the completed well could then be reduced by a volume equal to that which was removed as above. However, the requirement shall still remain to remove at the time of well development at least five times the combination of standing water, water in the saturated annulus, plus that which was added during filter pack placement. Record the amount removed per above on the well diagram and in the well development record (III.D.14.).

III.D.

12. Well Washing. Part of well development shall be the washing of the entire well cap and the interior of the well casing above the water table using only water from that well. The result of this operation shall be a well casing free of extraneous materials (grout, bentonite, sand, etc.) inside the riser, well cap, and blank casing between the top of the well casing and the water table. This washing shall be conducted before and/or during development, not after development.

13. Problems. If problems are encountered during development, contact the COR within 24 consecutive hours for guidance.

14. Well Development Record Requirements. The following data shall be recorded as part of development and submitted per section III.D.2.:

a. Well designation.

b. Date(s) of well installation.

c. Date(s) of well development.

d. Static water level from top of well casing before and 24 consecutive hours after development.

e. Quantity of mud/water:

(1) Lost during drilling.

(2) Removed prior to well insertion (III.D.11.).

(3) Lost during thick fluid displacement (III.C.9. and III.D.6.).

(4) Added during granular filter placement.

f. Quantity of fluid in well prior to development.

(1) Standing in well.

(2) Contained in saturated annulus (assume 30% porosity).

g. Field measurement of pH before, twice during, and after development using an electrometric device (EPA 150.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020).

h. Field measurement of specific conductance (electrical conductivity) before, twice during, and after development using a conductivity meter (EPA 120.1-Methods for Chemical Analysis of Water and Wastes, EPA 600/4 - 79-020). Obtain conductance and pH readings concurrently.

i. Depth from top of well casing to bottom of well (from diagram).

j. Screen length (from diagram).

III.D.14.

k. Depth from top of well casing to top of sediment inside well, before and after development.

l. Physical character of removed water, to include changes during development in clarity, color, particulates, and odor.

m. Type and size/capacity of pump and/or bailer used.

n. Description of surge technique, if used.

o. Height of well casing above ground surface.

p. Typical pumping rate.

q. Estimated recharge rate.

r. Quantity of fluid/water removed and time for removal (present both incremental and total values).

15. Presample Purging: Definition and Purpose. "Presample purging" refers to the removal of water from a well IMMEDIATELY prior to sample acquisition. This ensures a fresh and representative sample for analysis. In general, the USATHAMA Installation Restoration Program, Quality Assurance Program requires five times the calculated volume of water in the well and saturated well annulus to be removed immediately prior to sampling. Therefore, any water removed from a well as part of "development" shall not be counted toward the volumetric removal required in presample purging. Additional presample purging requirements are discussed in the current USATHAMA Quality Assurance Program.

E. Water Levels.

1. Measurement and Datum. The depth to groundwater shall be measured from the highest point on the rim of the well casing or riser (not protective casing). This same point on the well casing shall be surveyed for vertical control (see III.I.2). The depths to groundwater shall be converted to elevations for report usage. To enter the depths into the Data Management System, the well riser height above ground surface (stickup) must be subtracted from the above measured depth.

2. Contour Requirements. For contouring and reporting purposes, at least one complete set of static water level measurements shall be made over a single, consecutive 10-hour period for all wells (newly installed and specified) in the project. Static levels in borings not converted to wells shall be included if practical and technically appropriate.

3. Ground and Surface Water. Determine and report the elevations, to within $\pm$ 0.1 foot, of any streams, lakes, or open water bodies (natural and man-made), within 300 feet of monitor wells used in this contract or task. Use these data for the refinement of the groundwater contours in the vicinity of surface water if a hydrological connection is believed to exist.

F. Well and Boring Acceptance Criteria.

III.F.

1. Well Criteria. Wells must be acceptable to the Contracting Officer. Well acceptance shall be on a case-by-case basis. The following criteria shall be used along with individual circumstances in the evaluation process.

a. The well and material placement shall meet the construction and placement specifications of these Geotechnical Requirements as modified, if at all, by the contract/task.

b. Wells/boreholes shall not contain portions of drill casing or augers unless they are contractually required as permanent casing.

c. All well casing and screen materials shall be free of any unsecured couplings, ruptures or other physical breakage/defects before and after installation.

d. The annular material (filter pack, bentonite, and grout) surrounding each installed well shall form a continuous and uniform structure, free of any fractures or cracks.

e. Any casing or screen deformation or bending shall be minimal to the point of allowing the insertion and retrieval of the pump and/or bailer optimally designed for that size casing (e.g., a 4-inch pump in a 4-inch schedule 40, PVC casing is optimal; a 2-inch pump in a 4-inch casing is not optimal).

f. All joints shall be constructed to provide a straight, nonconstricting, and water-tight fit.

g. Installed wells (fully or partially cased) shall be free of extraneous objects or materials (e.g., tools, pumps, bailers, packers, excessive sediment thickness, grout, etc.).

h. For those monitor wells where the screen depth was determined by the contractor, the well shall have sufficient free water at the time of water level measurement (III.E.2.) to obtain a representative groundwater level for that site. These same wells shall have sufficient free water, at the time of initial sampling, which is representative of the desired portion of the aquifer for the intended chemical analysis.

i. Data for all required geotechnical files in the Data Management System shall be acceptably entered and verified by the contractor.

2. Abandoned Borings and Wells. Borings not completed as wells shall be abandoned per section III.A.11. and the data therefrom acceptably entered and verified by the contractor into the Data Management System.

3. Well and Boring Rejection. Wells and borings not meeting these criteria are subject to rejection by the Contracting Officer.

G. Geophysics. The use of geophysical techniques, if required, will be specified in the RFP/RFQ. In the absence of this specification, the contractor should consider these techniques for site-specific applicability to enhance the technical acuity and cost-effectiveness of his efforts. Special applications

may be useful in unexploded ordnance detection, disturbed area delineation, contaminant detection, depth to bedrock, buried drum detection, borehole and well logging, etc. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), resolution, and accuracy. The contractor shall also address the safety aspects of geophysical applications in his proposal and Safety Plan, especially for those areas where induced electrical currents or seismic waves could detonate unexploded ordnance or other explosive materials. If geophysical techniques are used, the same topics shall be addressed in the geotechnical report.

H. Vadose Zone Monitoring. Data acquisition from the vadose (unsaturated) zone shall be addressed on a case-by-case basis. The use of lysimeters in a silica flour matrix, soil-gas monitors, and analysis of bulk soil samples are mechanisms which may be employed by the contractor. When proposed for Contracting Officer approval, the contractor shall include the purpose, particular method(s) and equipment, selection rationale, methods and procedural assumptions, limitations (theoretical and site-specific), and analytical variances from the current USATHAMA Quality Assurance Program.

I. Topographic Survey.

1. Horizontal Control. Each boring and/or well installed under this contract shall be topographically surveyed by a licensed surveyor to determine its map coordinates using a Universal Transverse Mercator (UTM) or State Planar grid to within $\pm$ 3' ($\pm$ 1 meter).

2. Vertical Control. Elevations for the natural ground surface (not the top of the coarse gravel blanket) and the highest point on the rim of the uncapped well casing (not protective casing) for each bore/well site shall be surveyed by a licensed surveyor to within $\pm$ 0.05' ($\pm$ 1.5 centimeters) using the National Geodetic Vertical Datum of 1929.

3. Field Data. The topographic survey shall be completed as near to the time of last well completion as possible, but no longer than five weeks after well installation. Survey field data (as corrected), to include loop closure for survey accuracy, shall be included within the geotechnical or final report. Closure shall be within the horizontal and vertical limits given above. These data shall clearly list the coordinates (and system) and elevation (ground surface, top of well, and protective casings) as appropriate, for all borings, wells, and reference marks. All permanent and semipermanent reference marks used for horizontal and vertical control (bench marks, caps, plates, chiseled cuts, rail spikes, etc.) shall be described in terms of their name, character, and physical location.

J. Data Management System.

1. Usage of the Data Management System (DMS) is a means to record and monitor contract performance; store, compare, and evaluate data; and provide cost-efficient, report quality tables and graphics. The System is thereby useful to both administrative and technical users.

2. The geotechnical data acceptably entered in the computer shall be regarded as having the technically best quality for evaluation and decision making. Any deviation from the field data shall be specified and discussed by the contractor in the geotechnical report (see III.B.5.c. and III.K.3.j.(6)).

3. To computerize all of the field-generated data would be neither useful nor cost-effective for most projects. Therefore, only those items specified in III.J.6. shall be acceptably entered on a routine basis by the contractor for each contract or task. These data shall be entered for new borings, wells, and other sampling points; e.g., existing wells, surface water, sediment, and soils, specified in the contract or task. If the contractor wishes to use additional geotechnical files or entries, the contractor shall first receive COR's approval.

4. The items selected for DMS entry shall be entered in one or more of four geotechnical files:

a. Map File (GMA).

b. Field Drilling File (GFD).

c. Well Construction File (GWC).

d. Groundwater Stabilized File (GGS).

5. These files, and others, along with data entry procedures are fully described in Sections 3 and 4 of the Installation Restoration Data Management User's Guide. Additional geotechnical files are available but are not routinely used. The contract or task will specify additional files to be completed, if required.

6. The following lists, arranged by file, denote those items which the contractor shall acceptably enter and verify. Consult the DMS User's Guide for specific coding.

a. Map File (GMA).

(1) Installation.

(2) Site Type.

(3) Site Identification/Site Number.

(4) Coordinates and Coordinate System.

(5) Ground Surface Elevation.

(6) Source and Accuracy of Mapping Data.

(7) Aquifer.

(8) Pointer Information (cross reference for each boring and associated well(s)).

III.J.6.a.

(9) Source of Data (company and individual).

b. Field Drilling File (GFD).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to First Encountered Water.

(5) Depth to Bedrock.

(6) Depth to Deepest Part of Boring.

(7) Unified Soil Classification System Symbol (expanded for bedrock lithologies).

(8) Lithologic Intervals (by depth and thickness).

(9) Source of Data (company and individual).

(10) Dates.

c. Well Construction File (GWC). The abbreviations in parentheses which follow are the "Action Measurements," as explained in the User's Guide.

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Stickup (STKUP).

(5) Bentonite Seal Interval (BSEAL).

(6) Blank Well Casing Interval (CASE).

(7) Well Casing Diameter (CASED).

(8) Length of Overburden Casing (CSEAL).

(9) Overburden Casing Diameter (CASES).

(10) Total Depth of Boring (DPTOT).

(11) Filter Pack Interval (GFILT).

(12) Grout Interval (GROUT).

(13) Screen Interval (SCREN).

(14) Dates.

(15) Source of Data (company and individual).

d. Groundwater Stabilized File (GGS).

(1) Installation.

(2) Site Type.

(3) Site Identification.

(4) Depth to Water (from ground surface).

(5) Date(s) Measured.

(6) Source of Data (company and individual).

7. Figures 11 to 15 are provided as examples of completed DMS coding sheets for each of the above files using the example boring log and well diagram (Figures 4 and 6, respectively). Additional data required for coding but not shown on Figures 4 or 6 follow:

a. Abbreviations:

GP = General AAP
PALEO = Code used for aquifer at General AAP.

b. Field Data:

(1) Surveyed coordinates for boring in UTM system are:

X : 54321 centimeters
and Y : 99876 centimeters.

(2) Surveyed ground surface elevation for boring is 4321 centimeters, using National Geodetic Vertical Datum of 1929.

(3) Well 87-14 is located in the same hole made by boring 87-14.

(4) Cement grout proportioned per these Requirements (cement:bentonite = 20:1).

(5) Well screen: 4" PVC, Schedule 40, .01 inch slot.

(6) Well installed 8 Nov 87.

(7) Water levels recorded by Mr. Smith after development were as follows:

Date	Depth from Top of Riser (ft)
12 Nov 87	9.0

20 Dec 87 9.7
04 Jan 88 11.4

K. Geotechnical Reports.

1. General. Requirements of the geotechnical report are discussed herein along with required guidelines for the technical writing style. When a separate geotechnical report is not required per contract, the elements herein shall be incorporated into the final contract/task report(s).

2. Report Contents. The geotechnical report shall contain as a minimum:

a. Title page.

b. Disclaimer.

c. DD Form 1473.

d. Abstract.

e. Table of Contents.

f. Background.

g. Regional Geology.

h. Site Geology.

i. Methodology.

j. Significant Conclusions.

k. Geotechnical Analysis.

l. Recommendations.

m. References.

n. Bibliography.

o. Appendices.

(1) Boring Logs.

(2) Well Diagrams.

(3) Well Development.

(4) Water Levels.

(5) Special Problems and Resolution.

(6) Aquifer Testing and Hydraulic Parameters.

(7) Geophysical Data.

(8) Vadose Zone Monitoring data.

(9) Physical Analyses.

(10) Topographic Survey Data.

p. Distribution List.

3. Content Details. Details of the above items are listed below:

a. Title Page. The title page contains the following:

(1) Title.

(2) Author(s).

(3) Company (prime contractor).

(4) Report Date.

(5) Report/Contract Number (provided by USATHAMA).

(6) Distribution Statement (statement indicating the agency authorized to release the report, provided by USATHAMA).

(7) Organization(s) for which report was prepared (typically a Department of the Army installation and USATHAMA).

(8) USATHAMA Address.

b. Disclaimer. The following "DISCLAIMER" shall immediately follow the title page:

"DISCLAIMER"

"The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other documentation.

The use of trade names in this report does not constitute an official endorsement or approval of the use of such commercial products. This report may not be cited for purposes of advertisement."

c. Department of Defense (DD) Form 1473. This form shall be completed by the contractor. The data for blocks 1, 2, 3, 5, and 20 will be furnished by USATHAMA. A blank form is shown in Figure 9.

d. Abstract. The abstract is a summary of purpose, setting, and significant conclusions. This abstract should be more detailed than that given on the DD Form 1473.

e. Table of Contents. This item shall contain:

(1) Major Headings.

(2) Page Numbers.

(3) Figures, Tables, Plates (separately listed).

f. Background. Provide the objective of the geotechnical effort and a discussion of the contractor's corporate involvement within total survey.

g. Regional Geology. Include a discussion of the following topics for adjacent counties and states (as appropriate).

(1) Setting. Include maps and graphics for:

(a) Topography.

(b) Geomorphology.

(c) Physiography.

(d) Drainage.

(2) Stratigraphy. Include a complete, ideal sequence.

(3) Structure and Seismic Activity. Include cross sections.

(4) Hydrology. Include a discussion of surface and groundwater occurrences, drainage area, cross sections, and contour plots of potentiometric surfaces.

h. Site Geology. Discuss site specifics and how the site conforms and/or departs from the regional discussion based upon the knowledge gained from this study.

(1) Setting. Include local aspects of the regional setting.

(2) Stratigraphy. Discuss the sequence encountered.

(3) Structure and Seismic Activity. Include cross sections and local seismic history.

(4) Hydrology. Include hydrostratigraphic cross sections, contour plots, and a discussion of the relationship(s) between surface water and each aquifer encountered.

i. Methodology.

(1) Geotechnical Approach. Discuss literature and field considerations, provide boring and well placement rationale for each drilling site, note drilling locations on a detailed installation map and the largest scale U.S. Geological Survey topographic map depicting the installation.

(2) Drilling techniques. Specify the equipment, water source, procedures, and contractor.

(3) Borehole logging. Describe the procedures and specify the contractor.

(4) Well installation. Describe the materials (casing, screen, bentonite, cement, water, filter pack, etc. (see Table 1), construction procedures, and contractor.

(5) Well development. Specify the equipment, procedures, and contractor.

(6) Geophysical techniques. Provide the purpose, methods and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific), resolution, accuracy, and contractor(s).

(7) Vadose Zone Monitoring. Provide the purpose, particular method(s) and equipment, selection rationale, method and procedural assumptions, limitations (theoretical and site-specific) and contractor(s).

(8) Topographic surveying. Specify the equipment, control systems, procedures, and contractor.

(9) Aquifer Tests. Specify the type of tests, literature reference, equipment, general procedure, and contractor.

(10) Physical Analyses. Provide the type of tests, literature references, and contractor.

j. Geotechnical Analysis.

(1) Provide indepth discussions of those geotechnical areas which were significant to the development of the report's conclusions. Describe any uncertainties or extrapolations of data and their relative importance to the conclusions drawn. Provide the data base, references, and actual calculations (in an appendix if over three pages) for quantitative discussions.

(2) Detail the integration of potential contaminant source locations, geologic, hydrologic, and available chemical data. Include how known or estimated groundwater velocities, directions, and chemical quality correspond to known or suspected up-, down-, and cross-gradient contaminant locations. For example, evaluate the occurrence of contaminants at a down-gradient well in terms of most likely up-gradient source, groundwater velocity and direction known or estimated in that area.

(3) Discuss each contaminant site in terms of the geologic, hydrologic, and (when available) chemical data generated by this study. Combine these individual site presentations into a total installation environmental discussion. Relate the installation environmental setting to the regional level. This site to regional development shall be done graphically with narratives to cover key and subtle points.

(4) Present and evaluate the results of any geophysical efforts in terms of design versus actual results, and actual results versus confirmatory/ground truth data; e.g., water levels, chemical analyses, borehole stratigraphy, etc.

(5) Discuss and evaluate the results of any vadose zone monitoring.

(6) Specify and discuss any soil classifications and any other geotechnical data which were changed from the original field descriptions (see III.B.5.c.).

k. Significant Conclusions. Provide summary discussions of those project results which bear upon the intended survey objectives and related areas. Avoid quantitative conclusions based upon qualitative data. Highlight the limitations imposed upon the extrapolation of quantitative conclusions.

l. Recommendations. In addition to any specific recommendations requested within the Statement of Work, the contractor shall recommend those actions (if any) to refine or fill key data gaps and areas of uncertainty relative to the project objective. Additional recommendations should be made for those areas where a change in technique, methodology, or approach could result in a technical or cost benefit in any future efforts at the installation. The COR will specify whether the recommendations shall be included as part of the geotechnical or final report or be provided under a separate cover.

m. References. List by author, title, publication, volume, date, etc., those sources specifically referenced within the geotechnical report.

n. Bibliography. List as above those sources which provided or could provide general project-related data.

o. Appendices. Include data too bulky to be presented within the main body of the report; e.g., extensive tables or figures, or groups of data covering more than three pages. Where these data are in the DMS, they shall be presented in tabular and/or graphic form by the contractor directly from this System. The contractor shall coordinate with the COR to accomplish this requirement.

(1) Boring Logs. Provide legible copies of the "as submitted" field logs, uncorrected by office review and any lab analyses.

(2) Well Diagrams. Provide a detailed graphical presentation for each well with data per contract, to include hole depth, locations of screen, joints, centralizers, top of riser, top of protective casing, cave-in, granular filter pack, bentonite, grout, etc. Include an adjacent staff with appropriate Unified Soil Classification Symbols/rock classification for the entire length of drilled hole. Also graphically detail the protective measures at the well head; protective casing, pickets, caps, locks, etc. Key these sketches to both ground surface (depths below/heights above) and elevation (National Geodetic Vertical Datum of 1929).

(3) Well Development. Provide contractual data in tabular form.

(4) Water Levels. Provide, in tabular form, a listing of water levels (depths and elevations) for each well to include: well number, ground surface elevation, riser height above ground surface (stickup), riser elevation, first encountered water, initial 24-hour level after development, and subsequent static levels measured during the course of the contract. Each level must be annotated as to date of measurement and point from which measured. At least one complete set of static level measurements must be made and included for all project wells over a ten-hour period.

(5) Special Problems and Resolution. Discuss any special geotechnical problems and their resolution. This topic may be addressed in a separate letter to the COR.

(6) Aquifer Testing and Hydraulic Parameters. For the procedures and parameters required by contract, provide a detailed discussion of methodology used, assumptions made, and accuracy measured. Discuss how field conditions varied from those assumed in the method used. Evaluate the values measured against values reported in similar environments and against the setting and manner in which the values of this study were measured. Include references, field data, graphs of field data (e.g., time vs. drawdown plots), sample calculations for each parameter, and a graphical sketch of the relation between field and equation parameters. Present results in tabular form.

(7) Geophysical Data. Provide the data obtained during the study and any lengthy discussions better suited for an Appendix rather than in the main text.

(8) Vadose Zone Monitoring. Provide the data from any monitoring and any detailed discussions more appropriate for Appendices.

(9) Physical Analyses. Provide the references for all tests run. Include the method and procedures for any permeameter tests. Present the results in tabular form. Also, include grain-size graphs. Provide a discussion of these analyses with respect to permeability, both alone and as a comparison with aquifer test results.

(10) Topographic Survey Data. Provide a corrected, legible copy of the field topographic data; and in tabular form, the corrected coordinates and elevation of each surveyed and key feature, including, bores and wells, bench marks, key control points, etc. For each well, include the elevations of the top of the well riser, protective casing, and ground surface. See paragraph III.I. for more guidance. Provide a statement of closure, indicating the amount of error (in feet) to be expected for each set of coordinates and elevations.

p. Distribution List. This list will be provided by the Contracting Officer.

4. Technical Writing Style.

III.K.4.

a. Be quantitative. Use single, numerical values or ranges to convey magnitude, size, extent, etc. When ranges are used, denote the most probable value or a narrower, subrange of most probable occurrence. If qualitative terms must be used, define them within a numerical range.

b. Express confidence. Discuss the degree of confidence within the quantitative values generated. This confidence may be a function of field or lab conditions, technique, equipment, practice vs. theory, experience, personal bias, etc. Quantify the degree of confidence for key parameters such as elevations, velocities, permeabilities, porosities, gradients, etc. This shall be done through the use of (a) ranges with a most probable value, or (b) a single number with a plus-or-minus value attached.

c. For each point raised, provide a complete discussion. Do not leave the reader with unanswered questions which could have been naturally anticipated.

d. For maps, cross sections, boring staffs, well sketches, contour plots, etc., provide graphic scales (both vertical and horizontal) and a north arrow, as appropriate. Orient maps, contour plots, etc., with north toward the top of the page/sheet and orient the legend in the same manner as the map. Orient each graphic and its legend so that both can be easily read without rotating the graphic. Expand the graphics to cover the full paper size. Make all graphics fully and easily legible. Avoid any color coding on graphics. Provide vertical scales on both sides of each cross section and a horizontal scale along the base.

e. Adjust groundwater contours for topography (hills and valleys), streams (discharging, recharging), impermeable bedrock, and other obvious expressions of or alterations to the plotted groundwater contours.

f. Number all pages and denote those intentionally left blank.

g. Make sure separate graphics containing similar data agree. Make sure the field data, as corrected, agree with the graphical, tabular, and narrative presentations. Specify and discuss any changes made to the field data.

h. Address the four dimensional aspects of groundwater flow (X, Y, Z components and time) for each aquifer. The use of flow nets to supplement groundwater profiles and contours is desired.

i. Based on presurvey and survey data, provide hydrogeologic cross sections for the installation. These sections should include boring staffs with Unified Soil (and rock) Classification Symbols, summary well diagrams (with screen and seal locations noted), estimated stratigraphic correlation between borings, and estimated groundwater profiling.

j. <u>USE TABULAR FORMATS WHEREVER PRACTICAL</u>.

k. Provide literature/source credits for all data used or modified by the contractor. Credits shall appear in the text, on graphics, and in the list of references.

III.

L. Summary Lists.

1. Procedural and Material Summary. Table 2 denotes those geotechnical procedures and materials requiring specific USATHAMA-COR approval prior to their usage and the expected times for geotechnical evaluation and recommendations.

2. Document Submission Summary. In addition to those items to be submitted for approval per III.L.1., various documents and items discussed in these Geotechnical Requirements are to be submitted to the COR designated office (typically USATHAMA) after a particular action is completed. These materials and their submission times are summarized in Table 3.

III.

M. FIGURES

BENTONITE APPROVAL REQUEST

Army Installation for Intended Use:

1. Bentonite Brand Name:

2. Bentonite Manufacturer:

3. Manufacturer's Address and Telephone Number:

4. Product Description (from package label or attach brochure):

5. Intended Use:

SUBMITTED BY:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL: (check one)

Project Officer/Date: A D

Project Geologist/Date: A D

BENTONITE APPROVAL REQUEST
FIGURE 1

WATER APPROVAL REQUEST

Army Installation for Intended Use:

1. Water source:

   Owner:

   Address:

   Telephone Number:

2. Water tap location:

   Operator:

   Address:

3. Type of source:

   Aquifer:

   Well depth:

   Static water level from ground surface:

   Date measured:

4. Type of treatment prior to tap:

5. Type of access:

6. Cost per gallon charged by Owner/Operator:

WATER APPROVAL REQUEST
FIGURE 2

7. Attach results and dates of chemical analyses for past two years. Include name(s) and address(s) of analytical laboratory(s).

8. Attach results and dates of duplicate chemical analyses for project analytes by the laboratory certified by, or in the process of being certified by, USATHAMA for those analytes.

SUBMITTED BY:

Company:

Person:

Telephone Number:

Date:

USATHAMA APPROVAL/DISAPPROVAL:	(check one)	
Project Officer:	A	D
Project Geologist/Date:	A	D
Project Chemist/Date:	A	D

WATER APPROVAL REQUEST
FIGURE 2

GRANULAR FILTER PACK APPROVAL REQUEST

Army Installation for Intended Use:

1. Filter Material Brand Name:

2. Lithology:

3. Grain Size Distribution:

4. Source:

   Company that made product:

   Location of pit/quarry of origin:

5. Processing Method:

6. Slot Size of Intended Screen:

Submitted by:

Company:

Person:

Telephone:

Date:

USATHAMA APPROVAL/DISAPPROVAL: (check one)

Project Officer Name/Date: A D

Project Geologist Name/Date: A D

GRANULAR FILTER PACK APPROVAL REQUEST

FIGURE 3

BORING LOG GENERAL DATA

Project: GENERAL AAP Boring: 87-14 Page: 1 of 3

Driller & Company: JACK JONES OF ACME Co

Geologist/Logger & Company: J. SMITH OF ACE Co Signature: J Smith

Date Boring Started: 7 NOV 87 Completed: 8 NOV 87

Water Levels (from Ground Surface) Drilling Rig: ABC 20

First Encountered: 7.0' Date: 8 NOV 87

While Drilling: 7.0 Date: 8 NOV 87

At Boring Completion: NOT MEAS. Date: 8 NOV 87

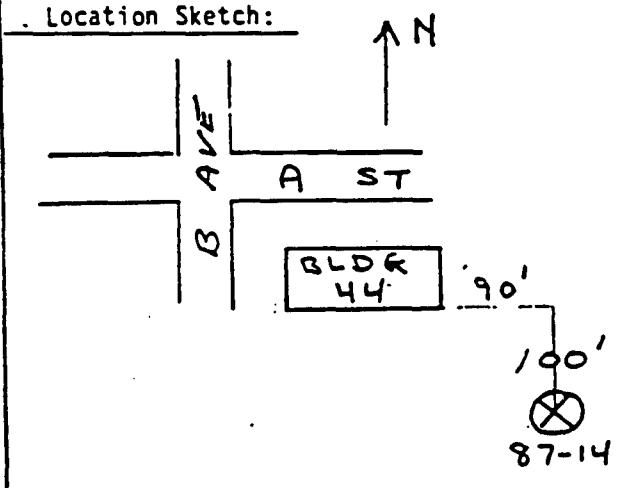
Drilling Shifts:

Date 1987	Time Start	Time End	Depth of Drilling Per Shift Start	Depth of Drilling Per Shift End	Date	Time Start	Time End	Depth of Drilling Per Shift Start	Depth of Drilling Per Shift End
7 NOV	1500	1700	0	5					
8 NOV	0800	1700	5	18.5					

Abbreviations:

Abbr	Meaning
3X3 1/2 } 2X2 1/2 }	ID & OD OF SPL BBL SAMPLER
STD	1 3/8 X 2 STANDARD SAMPLER
R	RECOVERY
C/B	CORING INDUCED BREAK
N B	NATURAL BREAK
LC	LOST CORE
3X	3X3 1/2 SAMPLER
2X	2X2 1/2 SAMPLER

Location Sketch:



BORING LOG FORMAT

FIGURE 4

Project: GENERAL AAP	Boring: 87-14	Page: 2 of 3

Depth/ Elevation (FT)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		GROUND SURFACE			
0	OL	ORG CLAY, SANDY DK RED BRN 5YR 3/4 (MUNSELL) V MOIST, L PLAST ROOTMAT, TOPSOIL	S#1 .8	3x3½ 3	NOTES: 1. ALL SAMPLERS DRIVEN BY 140LB HAMMER, FALLING 30"
.8		TRANSITIONAL .8 - 1.5'		2 R1.5	2. ALL DEPTHS & RECOVERIES IN FT
1	SM	SILTY SAND 20% FINES F-M SAND — 60% F — 20% M MOIST, LOOSE YEL BRN 10YR 5/4 FAINTLY BEDDED FLAT LYING & X-BEDDED <5% SILTY CLAY (CL) LAMINAE FLUVIAL	1.5 S#2 3.0	2x2½ 4 6 R1.5	3. DEPTHS FROM GROUND SURFACE NOTE 0' 1. DROVE 3X TO 1.5' 2. DROVE 2X TO 3.5' 3. DROVE STD TO 5' 4. SET HSA W/PLUG TO 5', PULLED PLUG (HSA: 3¼" ID, 7" OD)
2					
3					
4			3.5 S#3 4.6	STD 2 4	
.6		SHARP			
5	SP	SAND <5% FINES F-C SAND { 60% C 10% M 25% F V MOIST - SAT NO APPARENT BEDDING LOOSE LT RED BRN 5YR 6/4 V MOIST SAT FLUVIAL	5.0	5 R1.5	END 7 NOV 87
6			S#4 6.0	3X 10	START 8 NOV NOTE 5' 1. HOLE DRY + OPEN TO 5'
			6.5	5 R1.0	2. DROVE 3X TO 6.5'
7			S#5 7.5	2X 8	3. DROVE 2X TO 8.5' 4. FREE WATER ON SAMPLER & IN SAMPLE 5. MEAS. WATER AT 7.0 W/ELEC TAPE. AFTER 5 MIN, STILL AT 7.0
8		SHARP		10	6. DRIVE STD TO 10'
	GP	SANDY GRAVEL 20% F-C SAND 80% F GRAVEL LT RED BRN 5YR 6/4 MED DENSE SAT, NO APP BED FLUVIAL	8.5 S#6 9.8	R1.0 STD 2 4 8	7. SET HSA W/ PLUG TO 10', PULL PLUG
9					
10					

BORING LOG FORMAT

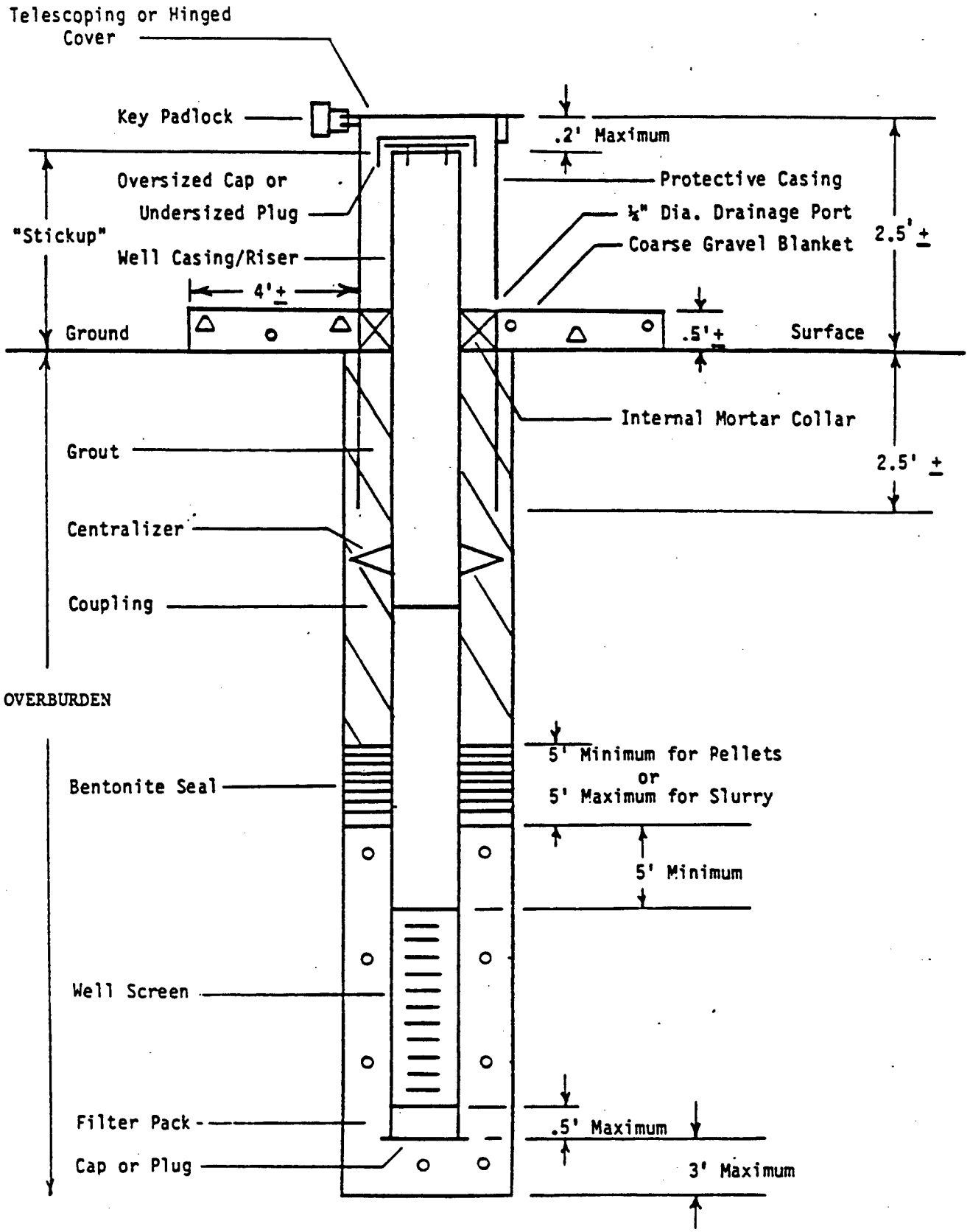
FIGURE 4

Project: GENERAL AAP	Boring: 87-14	Page: 3 of 3

(ft) Depth/ Elevation	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
10	GP	SANDY GRAVEL (CONT'D)	S#7 10-6	3X 100 R-5 10.9	NOTE 10' 1. DROVE 3X TO 10.9' (REFUSAL) 2. PULLED ALL HSA SET 6" CSG TO 11.5' 3. DRILLED W/ ROLLER BIT (6") TO 12.0. WATER LOSS 30 GAL 11.5'-12.0'
11	L C	APPROXIMATE TOP OF WEATHERED ROCK LIMESTONE (LM) BASED ON CUTTINGS 1.1' LOST DUE TO DRILLING METHOD			
12	L C	LM, .5 LOST DUE TO WEATHERING & FRACTURES	12.5	12.0	
13	C1B	TOP OF SL. WEAT. ROCK LIMESTONE SANDY (SILICEOUS) FOSSILIFEROUS, NUMEROUS CORALS &		RUN #1 R1.5 14.0	NOTE 12 1. START CORE RUN #1 AT 12' W/ 4" DOUBLE TUBE & DIAM. BOT. DISCH. BIT 2. RUN #1 40 GAL LOST 12-12.5 0 LOST 12.5-14 SOUNDED, HOLE 14.0'
14	C1B	GASTROPODS THIN, HORIZONTAL BEDDING	BOX 1 OF 1		
15	N B	YEL BRN 10YR 5/4 HARD		RUN #2	
16	N B	WELL CEMENTED DENSE - COARSE GRAINED			
17	N B	SCAT (<5%) TIGHT 45° FRACTURES NO STAINING			NOTE 14 1. RUN #2, COMPLETE, WATER LOSS 18-18.5 (50 GAL)., SH 18.5 NOTE 18.5 1. TOO FRACTURED TO CORE, USE GEAR BIT TO 30', 2. LOST 500 GALS 3. HOLE OPEN TO 30' 4. SET WELL, PULLED ALL CASING END 8 NOV 87
18	C1B	SOLID, LOW PRIMARY & SECONDARY PERM. ST. GEORGE FM	18.0	R4.5 18.5	
.5	L C	.5' LOST LM BADLY FRACTURED	18.5		
		11.5' LOST, HIGHLY FRAC. LM (CUTTINGS) V. ROUGH DRILLING	S# 8		
30		BOTTOM OF HOLE 30.0			

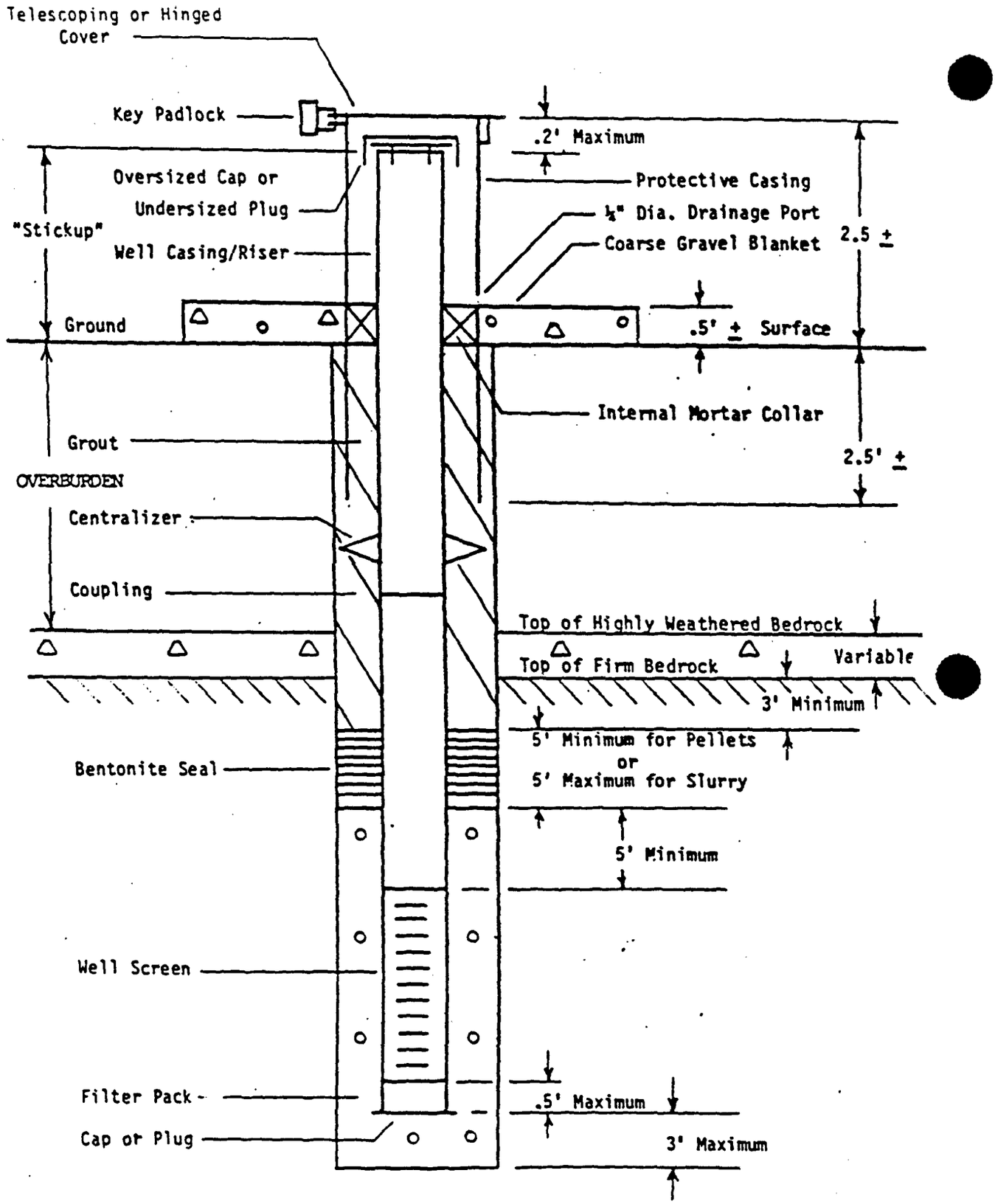
BORING LOG FORMAT

FIGURE 4



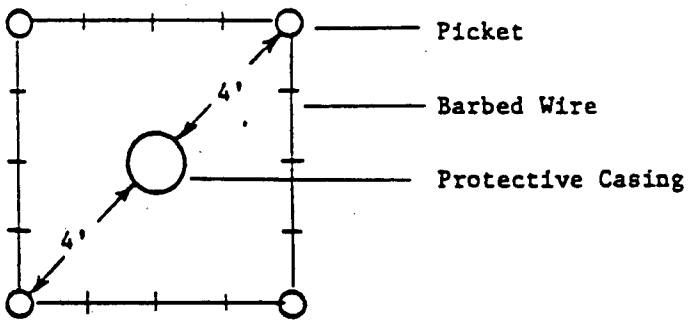
SCHEMATIC CONSTRUCTION OF OVERBURDEN WELL

FIGURE 5

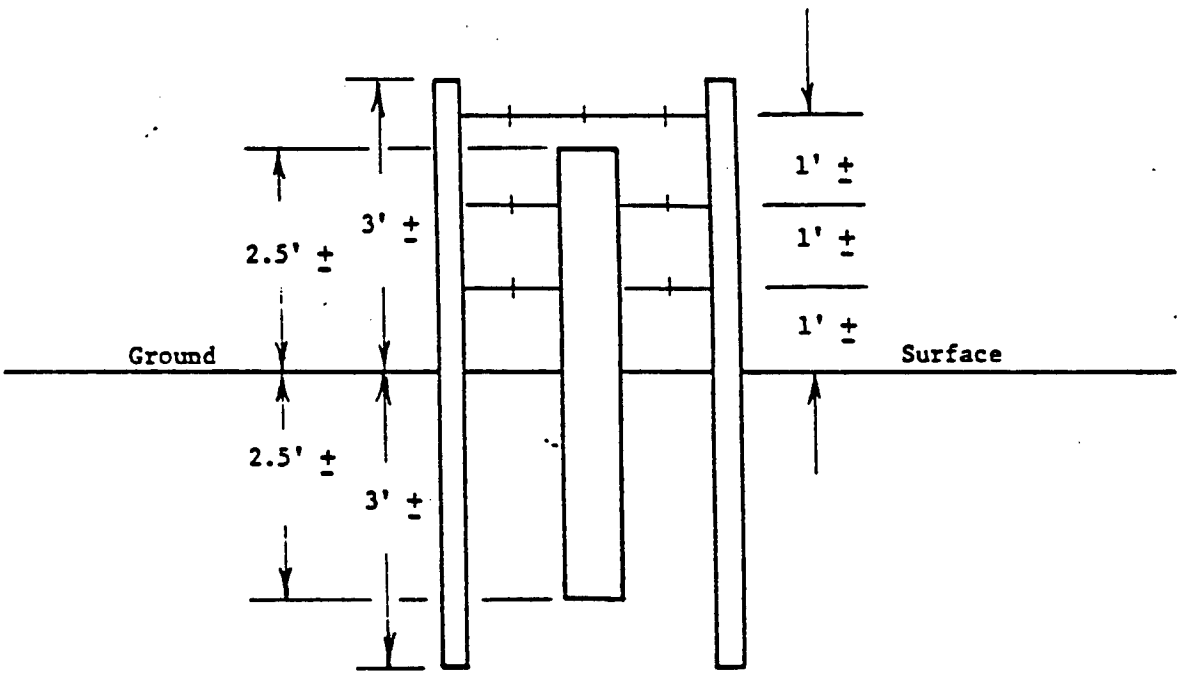


SCHEMATIC CONSTRUCTION OF BEDROCK WELL

FIGURE 6

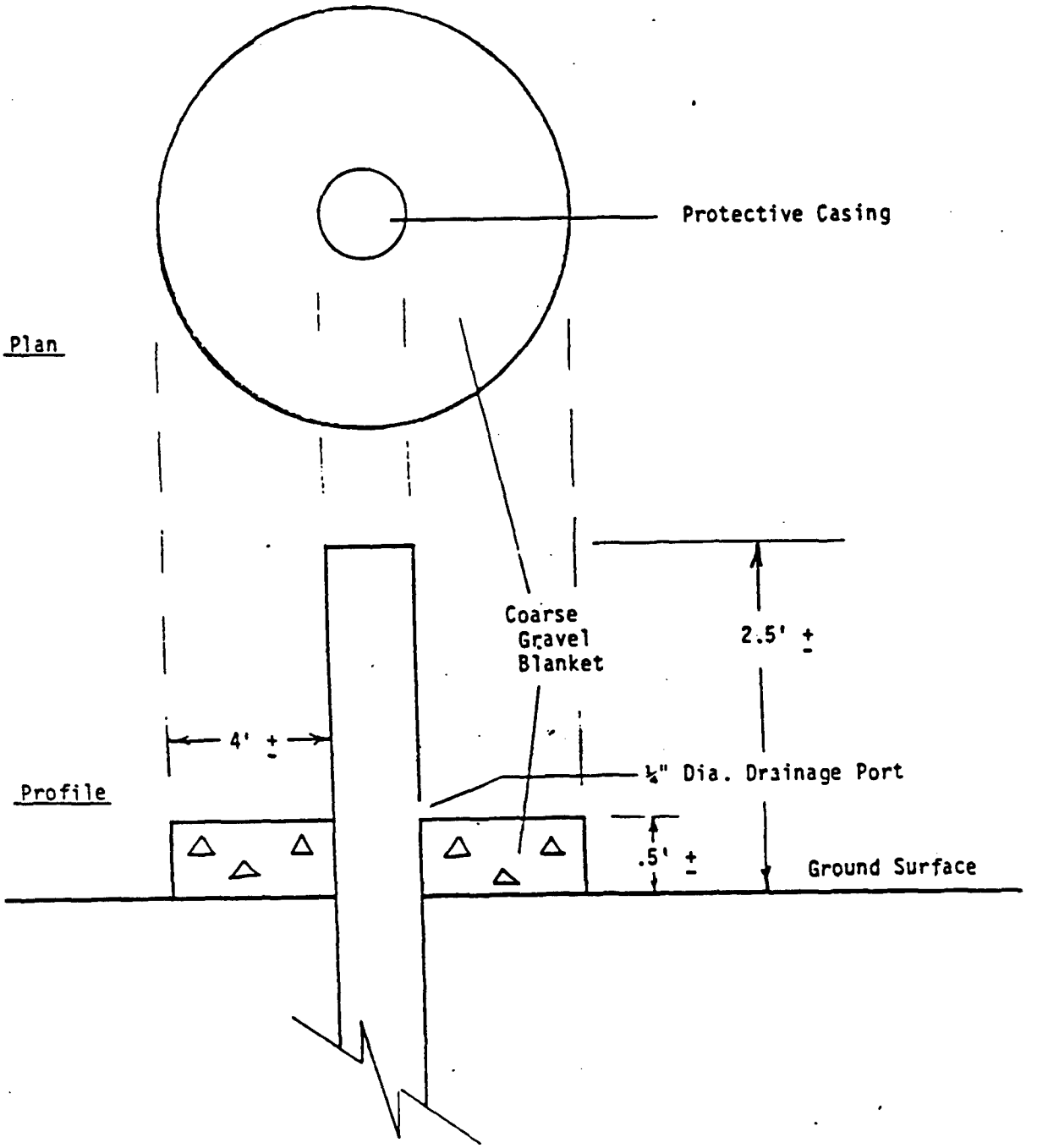


Plan



Profile

PICKET PLACEMENT AROUND WELLS
FIGURE 7



COARSE GRAVEL BLANKET LAYOUT

FIGURE 8

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION		1b. RESTRICTIVE MARKINGS	
2a SECURITY CLASSIFICATION AUTHORITY		3 DISTRIBUTION / AVAILABILITY OF REPORT	
2b DECLASSIFICATION / DOWNGRADING SCHEDULE			
4 PERFORMING ORGANIZATION REPORT NUMBER(S)		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a NAME OF PERFORMING ORGANIZATION	6b OFFICE SYMBOL *(If applicable)*	7a. NAME OF MONITORING ORGANIZATION	
6c. ADDRESS (*City, State, and ZIP Code*)		7b. ADDRESS (*City, State, and ZIP Code*)	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION	8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (*City, State, and ZIP Code*)		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO.	PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11 TITLE (*Include Security Classification*)

12 PERSONAL AUTHOR(S)

13a. TYPE OF REPORT	13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (*Year, Month, Day*)	15. PAGE COUNT

16. SUPPLEMENTARY NOTATION

17 COSATI CODES			18. SUBJECT TERMS (*Continue on reverse if necessary and identify by block number*)
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT (*Continue on reverse if necessary and identify by block number*)

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FIGURE 9

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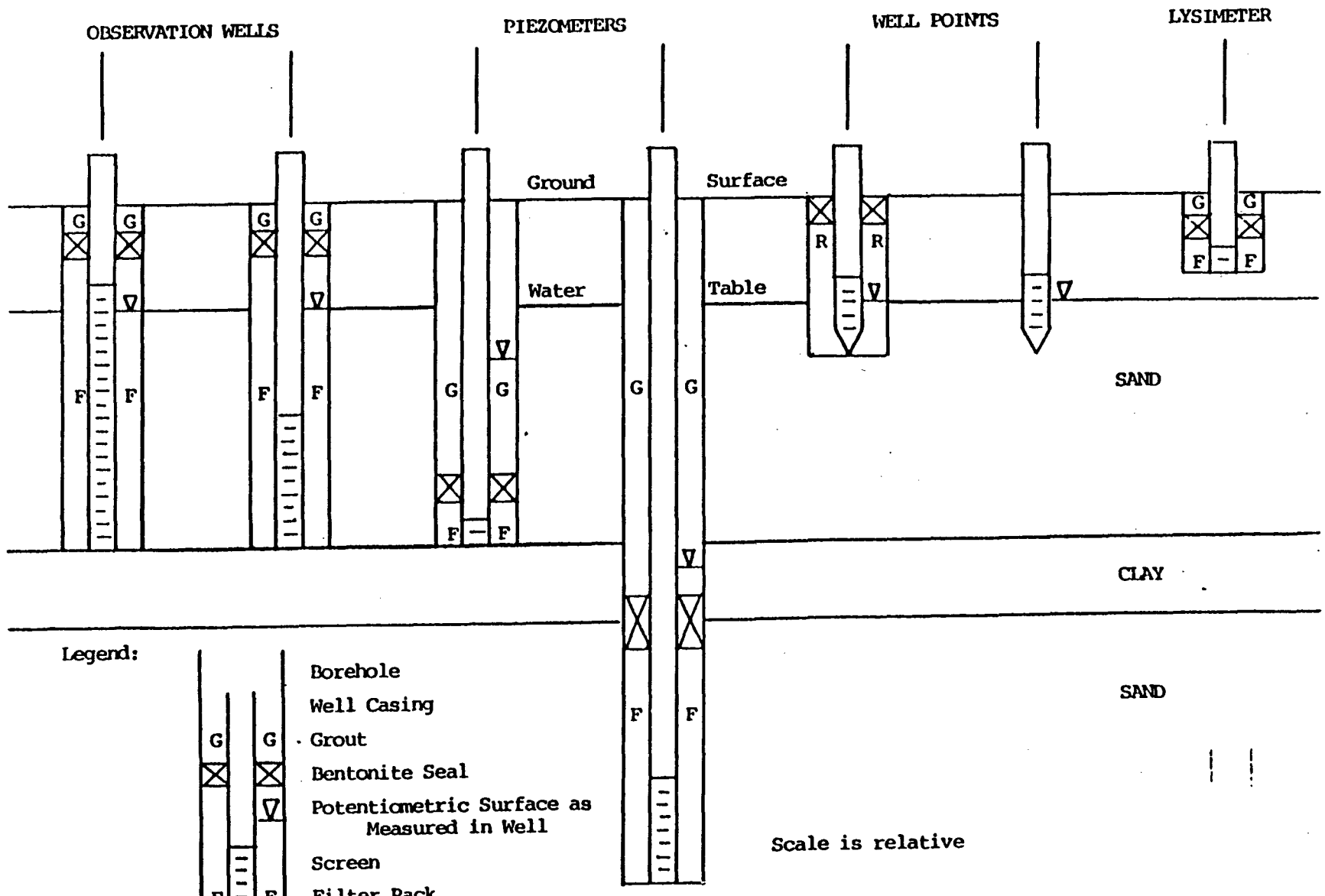
20 DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (*Include Area Code*) / 22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

DD FORM 1473

FIGURE 9

Page 2 of 2



MONITOR WELLS
FIGURE 10

MAP CODING FORM

Installation GP Site Type BORE Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: WELL
Pointer Site Id: 87-14
Aquifer id: PALEO

Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y		X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM
Accuracy Source Code: S
Exponent: Ø
Coordinate — X 54321 Y 98765

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø
Elevation: 4321

MAP FILE CODING SHEET (BORE)
FIGURE 11

MAP CODING FORM

Installation GP Site Type WELL Site Id 87-14

Description Information :

Pointer Information:
Pointer Site Type: BORE Pointer Site Id: 87-14
Aquifer Id: PALEO
Area Information:
Coord Sys: Acc Source Code: Exp: No.Points:

Coordinate	X	Y		X	Y
1			10		
2			11		
3			12		
4			13		
5			14		
6			15		
7			16		
8			17		
9			18		

LSMP Information:
Coordinate System: UTM Accuracy Source Code: S Exponent: Ø
Coordinate — X 54321 Y 99876

Elevation Information:
Elevation Source: S
Elevation Accuracy: Ø 4321
Elevation:

MAP FILE CODING SHEET (WELL)

FIGURE 12

INST	FILE TYPE	LAB	INITIALS
GP	GFD	AC	JS

GEOTECHNICAL DATA ENTRY CODING FORM

FIELD DRILLING AND WELL CONSTRUCTION

SITE TYPE	SITE ID
BORE	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	GRDWT	01			7.0	FT	
11/08/87	DBRK	01			11.9	FT	
11/08/87	DPTOT	01			30.0	FT	
11/07/87	USCS	01	0.0	.8		FT	OL
11/07/87	USCS	01	0.8	3.8		FT	SM
11/08/87	USCS	01	4.6	3.4		FT	SP
11/08/87	USCS	01	8.0	3.9		FT	GP
11/08/87	USCS	01	11.9	18.1		FT	LMSN
/ /							

FIELD DRILLING FILE CODING SHEET

FIGURE 13

GEOTECHNICAL DATA ENTRY CODING FORM

INST	FILE TYPE	LAB	INITIALS
GP	GWC	AC	JS

FIELD DRILLING
AND
WELL CONSTRUCTION

SITE TYPE	SITE ID
WELL	87-14

DATE	ACTION MEAS	METHOD	DEPTH	INTERVAL	VALUE	UNITS	ENTRY
11/08/87	STKUP	01			2.3	FT	
11/08/87	BSEAL	01			5.0	FT	
/ /	CASE	01			25.0	FT	
/ /	CASED	01			.33	FT	
/ /	DPTOT	01			30.0	FT	
/ /	GFILT	01			10.0	FT	
/ /	GROUT	04			15.0	FT	
/ /	SCREN	02			5.0	FT	
/ /							

WELL CONSTRUCTION FILE
CODING SHEET
FIGURE 14

GEOTECHNICAL DATA ENTRY CODING FORM

INST	FILE TYPE	LAB	INITIALS
GP	GGS	AC	JS

UNITS
FT

GROUND WATER STABILIZED *

SITE TYPE	SITE ID	DATE	DEPTH
WELL	87-14	11/12/87	6.7
WELL	87-14	12/20/87	7.4
WELL	87-14	01/04/88	9.1
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	
		/ /	

* - Depth measured from ground surface

GROUNDWATER STABILIZED FILE CODING SHEET

FIGURE 15

III.

N. TABLES

TABLE 2

PROCEDURAL AND MATERIAL APPROVAL SUMMARY

Items Requiring Approval	Reference Section	Time for Approval	Turn Around Time for Geotechnical Evaluation and Recommendation
Drilling Method	III.A.1.c.	Prior to contract/task award	During Proposal/ Bid Evaluation
Air Usage	III.A.2.	Prior to contract/task award	During Proposal/ Bid Evaluation
Bentonite	III.A.10.a.	Prior to drilling equipment arrival onsite	6 Working Days
Water	III.A.10.b.	Prior to drilling equipment arrival onsite	3 Calendar Weeks
Abandonment	III.A.11.	Prior to casing removal or backfilling	4 Consecutive Hours
Borehole Fluids, Cuttings, and Well Water Disposal	III.A.16.	Prior to technical plan acceptance	During Plan Evaluation
Time of Well Installation	III.C.1.	Prior to drilling	3 Working Days
Well Screen and Casing Materials	III.C.2.a.	Prior to contract/task award	During Proposal/ Bid Evaluation
Granular Filter Pack	III.C.5.a.	Prior to drilling	8 Working Hours
Protective Casing, Exceptions	III.C.8.a	Prior to drilling	6 Working Days
Geophysical Procedures	III.G.	Prior to use	Time not specified
Vadose Zone Monitoring	III.H.	Prior to use	Time not specified

TABLE 3 (Cont'd)

Document/Item	Reference Section	Submission Time	Submission To
Well development record	III.D.2.	Within 3 working days after development	USATHAMA-COR
Well development water sample	III.D.10.	Within 3 working days after developing that well	USATHAMA-designated individual
Geotechnical Report(s)	III.K.	As required per contract or task	Contracting Officer through USATHAMA

APPENDIX C

DEPARTMENT OF DEFENSE GUIDANCE DOCUMENT

DOD GUIDANCE ON ESTABLISHING BASE REALIGNMENT AND CLOSURE CLEANUP TEAMS

I. PURPOSE

This guidance implements the President's plan to expedite the disposal and reuse of closing military bases by creating partnerships and accelerating environmental cleanup activities. It establishes a Base Realignment and Closure (BRAC) Cleanup Team (BCT) for each Department of Defense (DoD) closing or realigning base where property is available for transfer to the community and empowers the team with the authority, responsibility, and accountability for environmental cleanup programs at these installations, emphasizing those actions which are necessary to facilitate reuse and redevelopment.

II. APPLICABILITY AND SCOPE

This policy applies to all DoD installations slated for closure or realignment where property is available for transfer to the community pursuant to the Base Closure and Realignment Act of 1988 (P.L. 100-526) (BRAC 88) or the Defense Base Closure and Realignment Act of 1990 (P.L. 101-510) (BRAC 91, 93, and 95). The policy's scope includes environmental cleanup programs and activities that support the lease or transfer of real property at affected installations under applicable statutes, regulations, and authorities, including but not limited to the following:

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)
- Resource Conservation and Recovery Act (RCRA)
- National Environmental Policy Act (NEPA)
- Executive Order 12580, Superfund Implementation
- Community Environmental Response Facilitation Act (CERFA)
- National Contingency Plan (NCP)
- Defense Environmental Restoration Program (DERP)

The requirements of this policy shall in no way impede, or otherwise affect the continuing responsibility to achieve and maintain environmental compliance in the ongoing operation of installation facilities.

III. POLICY

Department of Defense policy is to conduct environmental cleanup actions and programs to protect human health and the environment and to facilitate the reuse and redevelopment of

closure bases as expeditiously as possible. This policy will be carried out to promote economic reuse of affected installations in support of their surrounding communities, while satisfying applicable environmental protection laws and regulations.

IV. PROCEDURES AND RESPONSIBILITIES

A. PROCEDURES

1. In conjunction with the appropriate Environmental Protection Agency (EPA) Regional Office and state environmental regulatory entity, every DoD installation slated for closure or realignment at which property will be available for transfer to the community shall form a BCT comprised of one representative from DoD, one representative from the state and, where appropriate, one representative from the U.S. EPA. The BCT will act as the primary forum in which issues affecting the execution of cleanup to facilitate reuse will be addressed.

2. The DoD representative on the BCT (to be known as the BRAC Environmental Coordinator (BEC)) will be appointed by the appropriate DoD Component responsible for the installation. The BEC appointed for each base will work for and within the DoD Component organization and will have the responsibilities and implementation authorities for environmental cleanup programs related to the transfer of the installation's real property. The BEC shall have experience commensurate with the responsibilities of the position. The regulatory entities are preparing similar policies to provide members to the BCT of comparable experience who will possess the requisite authority from their respective organizations to take the actions stipulated in this policy.

3. The BEC, in conjunction with other members of the BCT, will conduct a "Bottom Up" review of the environmental cleanup. The "Bottom Up" review will include an evaluation of the existing environmental programs such as the Installation Restoration Program, Closure Related Compliance Program, and the Asbestos Program to identify opportunities for acceleration to expedite conveyance of property. Potential areas for acceleration include, but are not limited to:

a. Review of selected technology for application of expedited solutions.

b. Implementation of immediate removal actions to eliminate "hot spots" while investigation continues.

c. Identification of clean properties.

d. Identification of overlapping phases of the cleanup process.

e. Use of improved contracting procedures.

f. Interfacing with the community reuse plan and schedule.

g. Embracing a bias for cleanup instead of studies.

h. Validation of technology of the proposed remedy selection to ensure conformance with Fast Track Cleanup objectives.

i. Identification of opportunities for application of presumptive remedies.

j. Using innovative management, coordination and communication techniques (e.g., partnering).

The product of this review will be a BRAC Cleanup Plan (BCP) which will be the road map for expeditious cleanup necessary to facilitate conveyance of property to communities for redevelopment. The BCP will be a phased plan which encapsulates and prioritizes requirements, schedules and cost of the environmental programs to be implemented by the BCT for completing environmental action in support of the cleanup, reuse and redevelopment of the base. For sites with existing Federal Facility Agreements (FFA), Interagency Agreements (IAG), or similar cleanup agreements, orders or decrees, the BEC will propose and negotiate changes needed to expedite cleanup.

B. RESPONSIBILITIES

1. For the purposes of carrying out this policy, the Secretaries of the Military Departments and the Director of the Defense Logistics Agency, through their organizations, shall be responsible for:

a. Identifying the DoD Representative (the BEC) for each installation and notifying the DUSD(ES) of the Representative's name and address by September 1, 1993.

b. Delegating to the BRAC Environmental Coordinator (BEC), to the extent permitted by applicable law, authority and responsibility for the execution of all environmental cleanup programs related to the transfer of the base or parcels within a BRAC Cleanup Plan (BCP).

c. Ensuring that all BECs are adequately trained to execute their responsibilities.

d. Making the resources (e.g., technical expertise, contracting, legal, financial) available to the BEC for executing the cleanup programs.

e. Acting on the BCP within 30 days of receipt.

f. Programming and budgeting for the resources required to execute the BCP.

g. Providing implementing instructions for this guidance.

h. Providing oversight of the BEC's actions.

2. The responsibilities of the BEC shall include:

a. In conjunction with the other members of the BCT, conducting a "Bottom-Up" review of the environmental cleanup programs and submitting the resulting BCP to the respective component by March 31, 1994.

b. Contacting the appropriate U.S. EPA Regional Office and state environmental regulatory agency and forming the BCT.

c. Implementing all environmental cleanup programs related to closure in an expeditious and cost effective manner in accordance with the BCP.

d. Negotiating appropriate cleanup and abatement actions with EPA and state BCT members.

e. Identifying resource requirements for cleanup and abatement actions.

f. Acting as the liaison/coordinator with appropriate installation and headquarters commanders with regard to closure-related environmental compliance matters.

g. Participating, in conjunction with other BCT members, as a member of the community's Restoration Advisory Board (RAB) and acting as liaison to the DoD Transition Coordinator on environmental matters affecting the leasing or conveyance of property (e.g., cleanup schedules and priorities, cleanup actions and levels, reports to community leaders on cleanup progress and/or possible impediments to a lease or conveyance).

h. Providing direction on the use of BRAC environmental funds to accomplish cleanup and abatement actions within resources available.

i. Proposing and executing changes to existing cleanup agreements, orders and decrees, and other environmental procedures to achieve timely and cost effective cleanup.

j. Serving as the Program Manager or the Remedial Program Manager where the installation has an FFA, IAG, or other regulatory cleanup agreement, order or decree.

k. Signing the Record of Decision for cleanup actions under CERCLA.

l. Signing the decision documents for corrective actions related to cleanup under RCRA once the operational mission has departed, and removal actions under CERCLA.

m. Signing the decision documents for corrective actions related to cleanup under applicable state laws, regulations and programs.

n. Signing the installation's Environmental Baseline Survey.

o. Signing uncontaminated parcel determinations under CERFA.

p. Providing input to the Finding of Suitability to Lease (FOSL) and Finding of Suitability to Transfer (FOST).

q. Establishing and maintaining the Administrative Record and Participation Procedures required under CERCLA and administrative records of all actions taken with regard to the cleanup of the installation.

r. Maintaining an awareness of the status of site activities and intervening as warranted to ensure expeditious project completion.

s. Integrating property transfer priorities into the cleanup program.

t. Certifying construction requested by lessee will not interfere with the environmental cleanup program.

V. ISSUES RESOLUTION

Issues affecting the execution of environmental cleanup programs should be resolved at the BCT level. For sites with existing FFAs, IAGs, or other agreements, orders, or decrees, issues which cannot be resolved by the BCT will be handled in accordance with existing dispute resolution procedures. For sites covered under the Defense - State Memorandum of Agreement (DSMOA) program without other agreements, orders, or decrees in place, disagreements will be resolved through the Dispute Resolution provision in the DSMOA. Where disputes arise at sites without any dispute resolution procedures in place, resolution will be made at the Component Deputy Assistant Secretary level.

APPENDIX D

DATA VALIDATION STANDARD OPERATING PROCEDURES

PROPOSAL TO PROVIDE DATA VALIDATION SERVICES FOR U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

RFP NO. 4-5052

VOLUME I TECHNICAL PROPOSAL

Prepared for:

U.S. GEOLOGICAL SURVEY

In Support of:

U.S.G.S. WATER RESOURCES DIVISION
HYDROLOGIC INVESTIGATIONS

Prepared by:

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.
Gainesville, Florida

ESE No. 319-4862-999

August 1994

Environmental
Science &
Engineering, Inc.

July 28, 1994

U.S. Geological Survey
Procurement and Contracts, MS 204A
Denver Federal Center
Denver, CO 80225
ATTN: Ms. Jean Schilling
Contracting Officer, Central Region

RE: RFP No. 4-5052

Dear Ms. Schilling:

Environmental Science & Engineering, Inc. (ESE) is pleased to submit this proposal in response to the above-referenced request for data validation services for the U.S. Geological Survey, Water Resources Division. The proposal contents consist of Volume I Technical Proposal and Volume II Business Proposal, as required in the RFP.

Thank you for giving ESE the opportunity to respond to this request for proposal. If you require any additional information or clarification of information provided, contact Dr. Richard Ogwada at (904) 332-3318, extension 1630.

Sincerely,

Environmental Science & Engineering, Inc.

Richard A. Ogwada, Ph.D.
QA Division Manager

Stephen A. Denahan, P.G.
Vice President

M/QA/RAO0726

P.O. Box 1703 Gainesville, FL 32602-1703 Phone (904) 332-3318 (800) 874-7872 Fax (904) 333-6622

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TECHNICAL

1.0 RELATED CORPORATE EXPERIENCE

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- 1.2 CORPORATE OVERVIEW
- 1.3 DATA VALIDATION CAPABILITIES AND PROJECT EXPERIENCE
- 1.4 SELECTED DATA VALIDATION PROJECT DESCRIPTIONS
- 1.5 CLIENT REFERENCES
- 1.6 RECENTLY COMPLETED PROJECTS
- 1.7 WORK IN PROGRESS
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- 2.2 PROJECT CAPACITY
- 2.3 CORPORATE COMMITMENT
- 2.4 PROJECT MANAGER ASSIGNED TO THIS SUBCONTRACT
- 2.5 PROJECT TEAM QUALIFICATIONS AND EXPERIENCE

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GC/MS VOLATILES AND SEMIVOLATILES

DATA REVIEW PROCEDURES

1. Method Specific QC Requirements

2. Data Review/Evaluation Procedure

Table 3-1a. QC Requirements for Volatile Organic Analysis Methods			
Procedure	524	624	8240
Tuning	BFB	BFB	BFB
Frequency	8 hrs.	Daily	12 hrs.
Criteria	Table 3	Table 3	Table 3
IC: Levels	3-5	3	5
Criteria (%RSD)	<20%	<35%	<30% (6)
Minimum RRF	NS	NS	0.250-0.300 (5)
CC: Frequency	8 hrs.	Daily	12 hrs.
Criteria (%D)	±30%	QC Limits	±25% (6)
IS Area	±30% of last CC or ±50% IC	NS	-50 to +100% of last CC
BLK: Frequency	12 hrs.	Daily	12 hrs.
Criteria	<MDL	In Control	In Control
SPIKES:Frequency	Daily or 5%	5%	5%
% Recovery	80 - 120%	Varies	Varies
REPLICATES: Frequency	Quarterly	NS	5%
Precision	<20% RSD	NS	Varies
HOLDING TIMES (days)	14 C*	14 C*	14 C*
INTERNAL STDS.	1 @ 2-10 µg/L	3 @ 30 µg/L	3 @ 50 µg/L
Criteria	NS	NS	NS
SURROGATES	2 @ 2-10 µg/L	3 @ 30 µg/L	3 @ 50 µg/L
Criteria	80 - 120%	NS	Table 6
ANALYTE ID	RT ± 30 sec 3 ions ±20%	RT ±30 sec 3 ions ±20%	RRT ±0.06 Ions > 10% ±20%

Table 3-1b. QC Requirements for Semivolatile Organic Analysis Methods			
Procedure	525	625	8270
Tuning	5 ng DFTPP	50 ng DFTPP	50 ng DFTPP
Frequency	8 hrs	Daily	12 hrs.
Criteria	Table 4	Table 4	Table 4
IC: Levels	6	3	5
Criteria (%RSD)	<30%	<35%	<30% (13)
Minimum RRF	NS	NS	0.050 (4)
CC: Frequency	8 hrs.	Daily	12 hrs.
Criteria (%D)	±30%	±20%	±30% (13)
IS Area	±30% of last CC or ±50% IC	NS	-50 to 100% of last CC
BLK: Frequency	1/batch	1/batch	1/batch
Criteria	<MDL	In Control	In Control
SPIKES: Frequency	Daily or 5%	5%	5%
% Recovery	80 - 120%	Varies	Varies
REPLICATES: Frequency	Quarterly	NS	5%
Precision	<20% RSD	NS	Varies
HOLDING TIMES (days)	Extract: 7 C* Analyze:30 E*	Extract:7 C* Analyze:40 E*	Extract:7-14 C* Analyze:40 E*
INTERNAL STDS.	3 @ 5 ng/μL	3	6 @ 40 ng/μL
Criteria	> 70% Recovery	NS	NS
SURROGATES	3 @ 5 μg/L	3 @ 100 μg/L	6 @ 100 - 200 μg/L
Criteria	80 - 120%	NS	Table 7
ANALYTE ID	RT ±30 sec. 3 ions ±20%	RT ±30 sec. 3 ions ±20%	RRT ±0.06 Ions > 10% ±20%

Notes: C* = Days from Collection. R* = Days from Receipt.
CC = Continuing Calibration. IC = Initial Calibration.
NS = Not Specified. E* = Days from Extraction

For more detailed information, refer to the corresponding method document.

Table 3-2a. BFB Relative Ion Abundance Criteria			
Ion Abundance Criteria	Method 524	Method 624	Method 8240
50 percent of mass 95	15 - 40%	15 - 40%	15 - 40%
75 percent of mass 95	30 - 80%	30 - 60%	30 - 60%
95	100%	100%	100%
96 percent of mass 95	5 - 9%	5 - 9%	5 - 9%
173 percent of mass 174	<2%	<2%	<2%
174 percent of mass 95	>50%	>50%	>50%
175 percent of mass 174	5 - 9%	5 - 9%	5 - 9%
176 percent of mass 174	95 - 101%	95 - 101%	95 - 101%
177 percent of mass 176	5 - 9%	5 - 9%	5 - 9%

Table 3-2b. DFTPP Relative Ion Abundance Criteria			
Ion Abundance Criteria	Method 524	Method 625	Method 8270
51 percent of mass 198	10 - 80%	30 - 60%	30 - 60%
68 percent of mass 69	<2%	<2%	<2%
70 percent of mass 69	<2%	<2%	<2%
127 percent of mass 198	10 - 80%	40 - 60%	40 - 60%
197 percent of mass 198	<2%	<1%	<1%
198	100%	100%	100%
199 percent of mass 198	5 - 9%	5 - 9%	5 - 9%
275 percent of mass 198	10 - 60%	10 - 30%	10 - 30%
365 percent of mass 198	>1%	>1%	>1%
441	<mass 443	<mass 443	<mass 443
442 percent of mass 198	>50%	>40%	>40%
443 percent of mass 442	15 - 24%	17 - 23%	17 - 23%

Table 3-3a. Volatile Surrogate Recovery Limits				
Compound	Method 524	Method 624	Method 8240 Water	Method 8240 Soil
4-Bromofluorobenzene	80 - 120%	NS	86 - 115%	74 - 121%
1,2-Dichloroethane-d4	80 - 120	NS	76 -114	70 - 121
Toluene-d8	80 - 120	NS	88 - 110	81 - 117

Table 3-3b. Semivolatile Surrogate Recovery Limits				
Compound	Method 525	Method 625	Method 8270 Water	Method 8270 Soil
Nitrobenzene-d5	80 - 120%	NS	35 - 114%	23 - 120%
2-Fluorobiphenyl	80 - 120%	NS	43 - 116	30 - 115
p-Terphenyl-d14	80 - 120%	NS	33 - 141	18 - 137
Phenol-d6	80 - 120%	NS	10 - 94	24 - 113
2-Fluorophenol	80 - 120%	NS	21 - 100	25 - 121
2,4,6-Tribromophenol	80 - 120%	NS	10 - 123	19 - 122
1,2-Dichlorobenzene-d4	80 - 120	NS	NS	NS
2,4,6-Tribromophenol	80 - 120	NS	NS	NS

GC/MS VOLATILES & SEMIVOLATILES DATA REVIEW

Project Name_____ **Batch/SDG Number**_____ **Validator**_____
Parameter Analyzed_____ **Analysis Method**_____

1. Use project (laboratory) provided criteria and/or the method specific criteria (Tables 3-1 through 3-3) to evaluate the data.
2. Tabulate all QC parameters outside the criteria (see Outlier/Action Forms).

EVALUATION PROCEDURE	Y	N	COMMENTS
1. Holding Time (Table 3-1a/3-1b)			
Has the sample preparation holding time been met?			
Has the analysis holding time been met?			
2. Tuning (Table 3-2a/3-2b)			
Volatiles: Are the enhanced bar graph spectra and mass/ charge (m/z) listings (every 12 hrs) for bromofluorobenzene (BFB) present? Semivolatiles: Are the enhanced bar graph spectra and mass/ charge (m/z) listings (every 12 hrs) for decafluorotriphenylphosphine (DFTPP) present?			
Have the ion abundance criteria been met?			
Has the correct tuning frequency been applied?			
Has the raw data been checked (mass spectral listings) to ensure that the mass is normalized to m/z 95 (VOA) or m/z 198 (semiv)?			
3. Initial Calibration (Table 3-1a/3-1b)			
Are all analytes present?			
Are correct concentration standard levels (5) been used?			
Has the correct frequency been applied?			
Have the criteria been met?			
If any sample results were calculated using an initial calibration, was the correct standard (i.e., 50 ug/L) used?			
4. Continuing Calibration (Table 3-1a/3-1b)			
Are all analytes present?			
Has the correct frequency been used?			
Have the criteria been met?			

EVALUATION PROCEDURE	Y	N	COMMENTS
5. Method Blanks (Table 3-1a/3-1b)			
Has the correct frequency been used?			
Has the criteria been met?			
6. Surrogates (Table 3-1, 3-3a/3-3b or Lab Limits)			
Have the required surrogates been used?			
Are recoveries within criteria?			
7. Spikes (Table 3-1a/3-1b)			
Are all analytes present?			
Has the correct spiking frequency been applied?			
Has the correct concentration been used?			
Has the recovery criteria been met?			
8. Laboratory Control Samples (Table 3-1a/3-1b)			
Were the LCS run at the required frequency and results provided?			
Are reported recoveries within the required QC limits?			
Were LCS recoveries calculated correctly?			
9. Internal Standards (Table 3-1a/3-1b)			
Are all internal standard area counts within a factor of two (-50 to +100%) from the associated calibration standards?			
Are all retention times of the internal standards with $\pm$30 seconds from the retention time of the associated calibration standard?			
Have the raw data (e.g., chromatograms and quantitation lists) been checked to verify the IS areas and RTs reported on the summary forms?			
10. Target Compound Identification (Table 3-1a/3-1b)			
Are the relative retention times (RRTs) of reported compounds within $\pm$0.06 RRT units of the CC standard RRT?			
An instrument blank must be run after samples in which a target analyte ion(s) saturates the detector. Has the possibility of sample carryover been checked- if cross contamination has affected any positive compound identification?			

EVALUATION PROCEDURE	Y	N	COMMENTS
Have all the major peaks been identified as target compounds, TICs, surrogates or internal standards?			
11. Laboratory Quantitation Limits			
Are the laboratory reporting limits been adjusted to reflect all sample dilutions and dry weight factors that are not accounted for by the method?			
12. Tentatively Identified Compounds (TICs)			
Has the raw data been checked to verify that the lab has generated a library search for all required peaks in the chromatograms for samples and blanks?			
Have the blank chromatograms been examined to verify that that the TIC peaks present in samples are not for common lab artifacts/contaminants in the blank?			
Are the major ions (> 10% relative intensity) in the reference spectrum present in the sample spectrum?			
Do the ralative intensities of the major ions agree within ±20% between the sample and the reference spectra?			
Are the molecular ions present in the reference spectrum also present in the sample spectrum?			
13. Field Duplicate Samples			
Are field duplicates reported in this analysis? If present tabulate the RPD of all positive results in the report.			
14. Field Blanks			
Have all field blanks been identified in this batch? For each category of field blank tabulate all positive results in the report.			
15. Data Reduction			
Do reported summarized results agree with raw data?			
Have the correct units been used?			
Are reported results free of transcription errors?			
16. Data Package Completeness			
Has the data batch package contents been reviewed and found complete?			
REVIEWED BY:		DATE:	

ORGANOCHLORINE PESTICIDES/PCBs

DATA REVIEW PROCEDURES

1. Method Specific QC Requirements

2. Data Review/Evaluation Procedure

Table 3-4a. QC Requirements for Pesticide/PCB Analysis Methods			
Procedure	508	608	8080
IC: Levels	3 - 5	3	5
Criteria (% RSD)	<20%	<20%	<20%
DDT/Endrin Breakdown	<20%	NS	<20%
Resolution	NS	NS	NS
CC: Frequency	Beg. and end	Daily	Daily
Criteria (RPD)	±20%	±15%	±15
RT	NS	NS	NS
BLK: Frequency	1/batch	1/batch	1/batch
Criteria	<MDL	In Control	In Control
SPIKES: Frequency	10%	10%	5%
% Recovery	Avg % Rec. ±3S	Varies	Varies
REPLICATES: Frequency	Quarterly	NS	5%
Precision	<20% RSD	NS	Varies
HOLDING TIME (days)	Extract: 7 C* Analyze: 14 E*	Extract:7 C* Analyze:40 E*	Extract: 7 - 14 C Analyze: 40 E*
SURROGATES	1 @ 25 µg/L	NS	2 @ 1 µg/L
Criteria	70 - 130% Recovery	NS	Lab QC limits
ANALYTE ID	RT within 3xSD std. RT window	RT within 3XSD std. RT window	RT within 3XSD std. RT window
Confirmation	2nd column or detector for positive ID	2nd column for unknown samples	2nd column for positive ID

Table 3-4b. Pesticide Surrogate Recovery Limits			
Compound	Method 508	Method 608	Method 8080
4,4-Dichlorobiphenyl	70 - 130%	NS	NS
Tetrachloro-m-xylene	NS	NS	Lab Limits
Decachlorobiphenyl	NS	NS	NS
Dibutylchlorendate	NS	NS	Lab Limits

Notes: C* = Days from Collection CC = Continuing Calibration E* = Days from Extraction.
IC = Initial Calibration NS = Not Specified. R* = Days from Receipt.
For more detailed information, refer to the corresponding method document.

ORGANOCHLORINE PESTICIDES/PCBs DATA VALIDATION PROCEDURE

Project Name_____ **Batch/SDG Number**_____

Parameter Analyzed_____ **Analysis Method**_____

Laboratory_____ **Validator**_____

1. Use project (laboratory) provided criteria and/or the method specific criteria (Tables 3-4) to evaluate the data.
2. Tabulate all parameters outside the QC criteria (see Outlier/Action Forms).

EVALUATION PROCEDURE	Y	N	COMMENTS
1. Holding Time			
Has the preparation holding time been met?			
Has the analysis holding time been met?			
2. Initial Calibration			
Are all analytes present?			
Has the retention time (RT) window been established from the RT of three standards of the initial calibration of single component analytes?			
Have the correct standard levels been used and calibration factors calculated?			
Are the %RSD for the calibration factors for each single component compound (less than or equal to 20%) and surrogates (less than or equal to 30%) within criteria?			
Have the retention time windows been established for the multicomponent target compounds (Toxaphene, Aroclor)?			
Is the resolution between any two adjacent peaks within required criteria?			
Is the breakdown of DDT less than or equal to 20.0 percent on both columns?			
Is the breakdown of Endrin less than or equal to 20.0 percent on both columns?			
Is the combined breakdown of DDT and Endrin less than or equal to 30.0 percent on both columns?			

EVALUATION PROCEDURE	Y	N	COMMENTS
2. Continuing Calibration			
Is continuing calibration verification analysis frequency met?			
Is the retention time for each of the single component pesticides and surrogates within retention time window?			
Is the %RPD of the calculated amount and the true amount for each of the single component pesticides and surrogates within criteria?			
3. Method Blanks			
Has the correct frequency been used?			
Has the criteria been met (contamination)?			
4. Surrogate Recovery			
Were surrogates added to samples as required?			
Are the surrogate recoveries within QC limits?			
Are retention time values for surrogates within QC limits?			
5. Laboratory Control Samples			
Were the LCS run at the required frequency and results provided?			
Are reported recoveries within the required QC limits?			
Were LCS recoveries calculated correctly?			
6. Matrix Spike (MS)/Matrix Spike Duplicate (MSD)			
Were MS and MSD samples analyzed as required?			
Are the % recoveries within QC limits?			
Are the RPDs within QC limits?			
7. Replicates			
Were laboratory sample replicates run as required?			
Are the %RSD within QC limits?			
8. Florisil Cartridge Check			
Are the percent spike recoveries for florisil cartridge check within QC limits?			

EVALUATION PROCEDURE	Y	N	COMMENTS
9. Gel Permeation Chromatography (GPC) Calibration			
Are the percent spike recoveries for GPC within QC limits?			
10. Compound Identification			
Is compound identification summary complete for every sample in which a pesticide or PCB was detected?			
Are the retention times of sample compounds within the calculated RT windows for both the quantitation and confirmation analyses?			
Was a second confirmation column/detector used for positive ID?			
11. Data Reduction			
Do reported summarized results agree with raw data?			
Have the correct units been used?			
Are reported results free of transcription errors?			
12. Reporting Limits			
Have the data been checked for transcription/calculation errors?			
Are the reporting limits adjusted to reflect sample dilutions and, for soils, sample moisture?			
13. Field Duplicates			
Were field duplicates run in this batch? Summarize the hits and RPDs.			
14. Field Blanks			
Were field blanks run in this batch? Summarize the contaminants in the blanks			
15. Data Package Completeness			
Has the data batch package contents been reviewed and found complete?			
REVIEWED BY: DATE:			

METALS (ICP, GFAA, CVAA)

DATA REVIEW PROCEDURES

1. Method Specific QC Requirements

2. Data Review/Evaluation Procedure

Table 3-5a. QC Requirements for EPA Metals Analysis Methods by ICP		
Procedure	Method 6010	Method 200.7
Initial Calibration	Cali. and check with 2 stds. and blk	Cali. with 1 std (min) and a blk
Frequency	Daily	Daily
Criteria	NS	NS
Calibration Verification	Mid-range standard	Mid-range standard
Frequency	Every 10 samples and at end	Every 10 samples
Criteria	90 - 110% Recovery	95 - 105% Recovery
Other Standards	Highest mixed std.	Highest mixed std.
Frequency	Before sample analyses	Before sample analyses
Criteria	95 - 105% Recovery	95 - 105% Recovery
Calibration Blanks		
Frequency	Every 10 samples and at end	Every 10 samples
Criteria	$\pm$3 SD of mean value	$\pm$2 SD of mean value
Prep. Blk: Frequency	1/batch	1/batch
Criteria	NS	NS
Laboratory Control Samples		
Frequency	Each IC and weekly	Each IC and weekly
Criteria	90 - 110% Recovery	95 - 105% Recovery
Matrix Spike Samples		
Frequency	5% or 1/batch	New sample matrix
Criteria	75 - 125% Recovery	90 - 110% Recovery
Duplicate Samples		
Frequency	5% or 1/batch	NS
Criteria	$\pm$20% RPD for values >10x IDL	NS
Interference Check Sample		
Frequency	Beg., & end of @ run or 2 per 8 hour shift	Beg., end & periodic intervals
Criteria	80 - 120% Recovery	$\pm$1.5 x SD of mean value
Serial Dil.: Frequency	New sample matrix	New sample matrix
Criteria	4x Dil. within $\pm$10%	Dilution within $\pm$5%

Note: NS = Not specified.

Table 3.5b. QC Requirements for EPA Metals Analysis Methods by AA		
Procedure	Method 7000	Section 200.0
Initial Calibration	4:blank and 3 standards	4:blank and 3 standards
Frequency	Daily	Daily
Criteria	±10% of true value	NS
Calibration Verification	Mid-range standard	At or near MDL
Frequency	Every 10 samples	Every 20 samples
Criteria	80 - 120% Recovery	90 - 110% Recovery
Other Standards	NS	NS
Frequency	NS	NS
Criteria	NS	NS
Calibration Blanks		
Frequency	After each calibration	After each calibration
Criteria	NS	NS
Preparation Blanks		
Frequency	Each digestion batch	Each digestion batch
Criteria	NS	NS
Laboratory Control Samples		
Frequency	After each calibration	NS
Criteria	90 - 110% Recovery	NS
Matrix Spike Samples		
Frequency	5% or 1/batch	NS
Criteria	85 - 115% Recovery	NS
Duplicate Samples		
Frequency	5% or 1/batch	10% or 1/batch
Criteria	NS	±20% RPD
Furnace QC		
Frequency	NS	NS
Criteria	NS	NS

Note: NS = Not specified.

METALS ICP, GFAA, AND CVAA DATA VALIDATION PROCEDURES

ProjectName_____ **Batch/SDGNumber**_____

Parameter Analyzed_____ **Analysis Method**_____

Laboratory_____ **Validator**_____

1. Use project (laboratory) provided criteria and/or the method specific criteria (Tables 3-5a/3-5b) to evaluate the data.
2. Tabulate all parameters outside the QC criteria (see Outlier/Action Forms).

EVALUATION PROCEDURE	Y	N	COMMENTS
METHOD QUALITY CONTROL REVIEW			
1. Initial Calibration			
Are all analytes present?			
Have the correct standard levels been used (for ICP/AA)			
Has the correct frequency been applied?			
Have the criteria been met?			
2. Continuing Calibration			
Are all analytes present?			
Has the correct frequency been used?			
Have the criteria been met?			
3. Verification of Instrument Parameters			
Are instrument detection limits (quarterly) reported?			
Are ICP interelement correction factors (annually) reported?			
Are ICP linear ranges (quarterly) reported?			
4. Other Standards			
Has one mid-level standard been run at the beginning, end, every 10 samples?			
Has the criteria been met?			
5. Method Blanks			
Has the correct frequency been used?			
Has the criteria been met?			

EVALUATION PROCEDURE	Y	N	COMMENTS
6. Matrix Spike Sample Analysis			
Has the correct spiking frequency been applied?			
Has the correct concentration been used?			
Has the recovery criteria been met?			
7. Duplicate Sample Analysis			
Has the correct frequency been applied?			
Has the precision criteria been met?			
8. Laboratory Control Standard			
Has the required frequency been used?			
Has the required criteria been met?			
9. Interference Check Sample			
Has the required frequency been used?			
Has the required criteria been met?			
SAMPLE QUALITY CONTROL REVIEW			
10. Holding Time			
Has the preparation holding time been met?			
Has the analysis holding time been met?			
11. ICP Serial Dilution			
Has the required frequency been used?			
Has the required criteria been met?			
12. Furnace AA QC			
Were duplicate injections and post-digestion spikes performed?			
Have the accuracy and precision criteria been met?			
13. Data Reduction			
Are reported summarized results agree with raw data?			
Have the correct units been used?			
Are all calculations correct?			

EVALUATION PROCEDURE	Y	N	COMMENTS
14. Lab Reporting Limits			
Are the reported concentrations within range?			
Do reported data agree with raw data?			
Are the reporting limits adjusted to reflect sample dilutions and, for soils, sample moisture?			
15. Field Duplicates			
Were field duplicates run in this batch? Summarize the hits and RPDs.			
16. Field Blanks			
Were field blanks run in this batch? Summarize the contaminants in the blanks.			
17. Data Package Completeness			
Has the data batch package contents been reviewed and found complete?			
REVIEWED BY: DATE:			

OTHER ORGANIC METHODS
DATA VALIDATION PROCEDURES

Data Review/Evaluation Procedure

OTHER ORGANIC METHODS DATA VALIDATION PROCEDURES

Project Name_____ **Batch/SDG Number**_____

Parameter Analyzed_____ **Analysis Method**_____

Laboratory_____ **Validator**_____

1. For each parameter, read the analytical method and evaluate data according to the method and/or project QC criteria.

2. Tabulate all QC parameters outside the required QC criteria (see Outlier/Action Forms)

EVALUATION PROCEDURE	Y	N	COMMENTS
1. Holding Time			
Has the preparation holding time been met?			
Has the analysis holding time been met?			
2. Initial Calibration			
Are all analytes present?			
Have the correct standard levels been used and calibration factors calculated?			
Has the criteria been met?			
3. Continuing Calibration			
Are all analytes present?			
Have the correct standard levels been used and calibration factors calculated?			
Has the criteria been met?			
4. Method Blanks			
Has the correct frequency been used?			
Has the criteria been met (contamination)?			
5. Surrogate Recovery			
Were surrogates added to samples as required?			
Are the surrogate recoveries within QC limits?			

EVALUATION PROCEDURE	Y	N	COMMENTS
6. Matrix Spike (MS)/Matrix Spike Duplicate (MSD)			
Are required analytes present?			
Are the % recoveries within QC limits?			
Are the RPDs within QC limits?			
7. Replicates			
Were laboratory sample replicates run as required?			
Are the %RSD within QC limits?			
8. Lab Control Sample			
Are LCS run at required frequency?			
Are the recoveries within QC limits?			
9. Internal Standard			
Are the area counts within QC limits?			
Are the RRTs within QC limits			
10. Found Target Analytes			
Have the data been checked for transcription/calculation errors?			
Are concentrations within range?			
11. Data Reduction			
Do reported summarized results agree with raw data?			
Have the correct units been used?			
12. Laboratory Reporting Limits			
Are the reporting limits adjusted to reflect sample dilutions and, for soils, sample moisture?			
13. Field Duplicates			
Were field duplicates run in this batch? Summarize the hits and RPDs.			

EVALUATION PROCEDURE	Y	N	COMMENTS
14. Field Blanks			
Were field blanks run in this batch? Summarize the contaminants in the blanks			
Completeness			
Using the data package checklist, is the batch package complete?			
Reviewed By: DATE:			

INORGANIC ANIONS/RADIOCHEMISTRY/OTHER METHODS

DATA REVIEW PROCEDURES

Data Review/Evaluation Procedure

INORGANIC ANIONS/RADIOCHEMISTRY/OTHER METHODS
DATA VALIDATION PROCEDURES

Project Name_____ **Batch/SDG Number**_____

Parameter Analyzed_____ **Analysis Method**_____

Laboratory_____ **Validator**_____

1. For each parameter, read the analytical method and evaluate data according to the method and/or project QC criteria.

2. Tabulate all QC parameters outside the required QC criteria (see Outlier/Action Forms)

EVALUATION PROCEDURE	Y	N	COMMENTS
1. Holding Time			
Has the preparation holding time been met?			
Has the analysis holding time been met?			
2. Initial Calibration			
Are all analytes present?			
Have the correct standard levels been used and calibration factors calculated?			
Has the criteria been met?			
3. Continuing Calibration			
Are all analytes present?			
Have the correct standard levels been used and calibration factors calculated?			
Has the criteria been met?			
4. Method Blanks			
Has the correct frequency been used?			
Has the criteria been met (contamination)?			
5. Surrogate Recovery			
Were surrogates added to samples as required?			
Are the surrogate recoveries within QC limits?			

EVALUATION PROCEDURE	Y	N	COMMENTS
6. Matrix Spike (MS)/Matrix Spike Duplicate (MSD)			
Are required analytes present?			
Are the % recoveries within QC limits?			
Are the RPDs within QC limits?			
7. Replicates			
Were laboratory sample replicates run as required?			
Are the %RSD within QC limits?			
8. Lab Control Sample			
Are LCS run at required frequency?			
Are the recoveries within QC limits?			
9. Internal Standard			
Are the area counts within QC limits?			
Are the RRTs within QC limits			
10. Found Target Analytes			
Have the data been checked for transcription/calculation errors?			
Are concentrations within range?			
11. Data Reduction			
Do reported summarized results agree with raw data?			
Have the correct units been used?			
12. Laboratory Reporting Limits			
Are the reporting limits adjusted to reflect sample dilutions and, for soils, sample moisture?			
13. Field Duplicates			
Were field duplicates run in this batch? Summarize the hits and RPDs.			

EVALUATION PROCEDURE	Y	N	COMMENTS
14. Field Blanks			
Were field blanks run in this batch? Summarize the contaminants in the blanks			
Completeness			
Using the data package checklist, is the batch package complete?			
Reviewed By: DATE:			