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Energy Systems Environmental Restoration Program
Y-12 Environmental Restoration Program

**Remedial Investigation Work Plan for Upper East Fork Poplar Creek
Operable Unit 3 at the Oak Ridge Y-12 Plant,
Oak Ridge, Tennessee**

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OAK RIDGE Y-12 PLANT
Oak Ridge, Tennessee 37831-8169
managed by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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ACRONYMS

AAS	atomic absorption spectroscopy
ACGIH	American Conference of Governmental Industrial Hygienists
AEA	Atomic Energy Act
ALARA	as low as reasonably achievable
AOC	area of concern
ARAR	applicable or relevant and appropriate requirements
ASTM	American Society of Testing and Materials
AT	averaging time
BCV	Bear Creek Valley
bgs	below ground surface
CAMU	Corrective Action Management Unit
CAR	Corrective Action Report
CCC	criterion continuous concentration
CDB	Consolidated Data Base
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CMC	criterion maximum concentration
CMS	corrective measures study
COC	contaminant of concern
CRF	Central Records Facility
CSF	carcinogenic slope factor
CT	central
CVAA	cold-vapor atomic absorption
CWA	Clean Water Act of 1977
CWP	Comprehensive Work Plan
DCRC	Document Content and Response Committee
DMC	Data Management Coordinator
DOE	U.S. Department of Energy
DOE-ORO	U.S. Department of Energy Oak Ridge Operations Office
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
DQO	data quality objectives
EA	environmental assessment
ED	exposure duration
EDE	effective dose equivalent
EF	exposure frequency
EFPC	East Fork Poplar Creek
EML	Environmental Measurements Laboratory
Energy Systems	Martin Marietta Energy Systems, Inc.
EP	extraction procedure
EPA	U.S. Environmental Protection Agency

ER	Environmental Restoration
ES&H	Environmental Safety and Health
ESPs	Environmental Surveillance Procedures
FAA	furnace atomic absorption
FFA	Federal Facility Agreement
FFCA	Federal Facilities Compliance Agreement
FID	flame ionization detector
FRLs	final remediation levels
FS	feasibility study
FSA	field staging area
FTL	Field Team Leader
GC/MS	gas chromatograph/mass spectrophotometer
GET	general employee training
GFAA	graphite furnace atomic absorption
GM	Geiger-Muller
HA	health advisory
HAZMAT	hazardous material
HAZWOPER	Hazardous Waste Operations Emergency Response
HBC	health-based criteria
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HSL	hazardous substance list
HSWA	hazardous and solid waste amendments
IAD	Immediate Action Response Directive
ICP	inductively coupled plasma
IF	ingestion factor
IR	ingestion rate
IROD	Interim Record of Decision
LCS	laboratory control standards
LDR	land disposal restrictions
LEFPC	Lower East Fork Poplar Creek
LLW	low-level radioactive waste
M&TE	measuring and test equipment
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDA	minimum detectable activity
MDL	method detection limit
MEK	methyl ethyl ketone
MLE	most likely exposure
MS	matrix spike
MSD	matrix spike duplicate
MSDSs	material safety data sheet
NCP	National Contingency Plan
NCR	nonconformance report
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAPs	National Emission Standards for Hazardous Air Pollutants

NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
NRDA	National Resource Damage Assessment
OREIS	Oak Ridge Environmental Information System
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
OU	operable unit
OVA	organic vapor analyzer
PA	preliminary assessment
PARCC	precision, accuracy, representativeness, completeness, and comparability
PC	personal computer
PCE	polychlorinated biphenyl
PCE	tetrachloroethylene
PEF	particulate emission factor
PEL	permissible exposure limit
PGDP	Paducah Gaseous Diffusion Plant
PID	photoionization detector
PIDAS	perimeter intrusion detection assessment system
PORTS	Portsmouth Gaseous Diffusion Plant
PPE	personal protective equipment
PRGs	preliminary remediation goals
PVC	Polyvinyl chloride
QA	Quality Assurance
QAAP	Quality Assurance Administrative Plan
QAO	Quality Assurance Officer
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
QC	Quality Control
RA	remedial action
RAGs	remedial action goals
RAOs	remedial action objectives
RAS	routine analytical services
RCP	reinforced concrete pipe
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFA	RCRA Facility Assessment
RFC	reference concentrations
RFD	reference doses
RFD	request for disposal
RFI	RCRA Facility Investigation

RGO	Remedial Goal Options
RI	remedial investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RPD	relative percent difference
RSD	relative standard deviation
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SAS	special analytical services
SCBA	self-contained breathing apparatus
SDWA	Safe Drinking Water Act
SED	Site Emergency Director
SEG	Scientific Ecology Group
SEN	Secretary of Energy Notice
SHSO	Site Health and Safety Officer
SHSP	Site Health and Safety Plan
SI	site investigation
SOW	statement of work
SRR	sampling receiving report
SVOCs	semivolatile organic compounds
SWMU	solid waste management unit
TBC	to-be-considered
TCE	trichloroethylene
TCLP	toxicity characteristic leaching procedure
TDEC	Tennessee Department of Environment and Conservation
TDHE	Tennessee Department of Health and Environment
THI	target hazard index
THQ	target hazard quotient
TIC	tentatively identified compound
TR	target risk
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal
TT	treatment technology
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
UEFPC	Upper East Fork Poplar Creek
USR III	Utility System Restoration Phase 3
UST	underground storage tank
VOA	volatile organic analysis
VOCs	volatile organic compounds
VR	volatilization factor
WAC	waste acceptance criteria
WBS	Work Breakdown Structure
WCO	Waste Certification Officer
WCPF	Waste Coolant Processing Facility
WDC	Waste Disposal Coordinator
WMD	Waste Management Division

WMP
WOM
WQC
WTSD

Waste Management Plan
White Oak Mountain
water quality criterion
waste transportation, storage, and disposal

EXECUTIVE SUMMARY

The enactment of the Resource Conservation and Recovery Act (RCRA) in 1976 and the Hazardous and Solid Waste Amendments (HSWA) to RCRA in 1984 created management requirements for hazardous waste facilities. The facilities within the Oak Ridge Reservation (ORR) were in the process of meeting the RCRA requirements when ORR was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) on November 21, 1989. To ensure that all necessary steps were undertaken to protect the public health and the environment during the investigation, evaluation, and remediation of all Solid Waste Management Units (SWMUs) and Operable Units (OUs) on the ORR, the Department of Energy Oak Ridge Operations (DOE-ORO) office in Oak Ridge, Tennessee; the Tennessee Department of Environment and Conservation (TDEC); and the Environmental Protection Agency (EPA) have formulated a Federal Facility Agreement (FFA) for ORR. The FFA also outlines all deliverables, review times, and schedules to ensure that activities are undertaken in a timely manner.

UEFPC OU 3 is a source term OU composed of seven sites, and is located in the western portion of the Y-12 Plant. For the most part, the UEFPC OU 3 sites served unrelated purposes and are geographically removed from one another. The seven sites include the following: Building 81-10, the S-2 Site, Salvage Yard oil storage tanks, the Salvage Yard oil/solvent drum storage area, Tank Site 2063-U, the Salvage Yard drum deheader, and the Salvage Yard scrap metal storage area. All of these sites are contaminated with at least one or more hazardous and/or radioactive chemicals. All sites have had some previous investigation under the Y-12 Plant RCRA Program. Three other sites (the Coal Pile Trench, the Waste Coolant Processing Facility, and the Machine Coolant Storage Tanks) were originally placed in the UEFPC OU 3. These sites have been transferred from the OU to the UEFPC study areas. These sites were transferred because they are active facilities or were beneath an active facility.

The S-2 Site is about 0.7 acres and was an unlined earthen reservoir used for the disposal of unknown quantities of deteriorated chemical reagents and spent extraction raffinates. The pit was backfilled, leveled, and seeded with grass in the 1950s. The soil and groundwater at the site are known to be contaminated with metals, volatile organic compounds (VOCs), radioactive chemicals, and nitrates.

Building 81-10 is about 0.9 acres and was used to recover mercury from process waste and contaminated equipment during the late 1950s and early 1960s. Mercury-contaminated soil has also been stockpiled at the site. The soil beneath the building is known to be contaminated with mercury and other metals. The building is in a deteriorated condition and will be removed as part of site preparation activities for the RI.

The Salvage Yard area is about 11 acres and contains five separate OU 3 sites. The active scrap metal storage area occupies all of the lower half of the Salvage Yard. The oil/solvent drum storage area occupies the northeast portion of the scrap yard. This site was closed under RCRA in 1989, and contaminated soil was removed as part of closure. It is recommended that the RI for this facility focus on the completeness of closure and, if

appropriate, recommend no further investigation. The remaining Salvage Yard sites include the waste oil storage tanks, the drum deheader facility, and Tank Site 2063-U. These sites are located in the northwestern portion of the Salvage Yard. The waste oil storage tanks will be removed from the Salvage Yard as part of site preparation activities for the RI. In addition to the OU 3 sites, the abandoned acid nitric pipeline crosses through the central portion of the site, and the Rust Garage UST Site is located to the immediate west of the lower portion of the Salvage Yard.

The development of this work plan is based on the foundation set by the Data Quality Objective (DQO) process and the observational approach. The purposes of the DQO process are to ensure that data of appropriate and known quality are obtained and are adequate for their intended uses and to establish a risk-based decision framework for the RI. During the DQO process, data users were identified and were involved at the beginning of the work plan development to identify the data types and uses needed for the RI/FS. The historical data from the sites were reviewed to develop a list of potential contaminants of concern and to develop conceptual models detailing potential exposure pathways. From this preliminary work the scope of the investigation was narrowed, specific RI goals were defined, and project objectives were developed.

The approach for this RI is to perform a screening level risk assessment for the OU 3 sites using the historical data base. Upon completion of this task, confirmatory or comprehensive sampling will be conducted. The decision between confirmatory sampling or comprehensive sampling will be based on the results of a screening level risk assessment described in Sect. 6.4 and outlined in Fig. 6.1 (Chap. 6) and a qualitative assessment of the historical data. The data needs (Chap. 6) and Sampling and Analysis Plan (Chap. 7) have been developed in anticipation of further characterization being required at the S-2 Site, at Building 81-10, and at the northwest portion of the Salvage Yard and to evaluate the impact of the source term unit upon the integrator OU. After confirmatory or comprehensive sampling has been conducted, the screening level risk assessment will be conducted again, and decisions will be made following the process outlined in Sect 6.4. This approach was presented to EPA Region IV and TDEC on February 24, 1993.

The goals of this RI are to define the nature and extent of contamination so that the impact of leachate, surface water runoff, and sediment from the OU 3 sites upon the integrator OU can be evaluated, the risk to human health can be defined, and the general physical characteristics of the subsurface can be determined so that remedial alternatives can be screened. The overall project objective of this work plan is to provide a justifiable rationale and guidance for the collection and analysis of environmental data to obtain the goals of this RI. Specific objectives to meet these goals are the following:

- to quantify the contaminant concentrations for the soil column to determine spatial distributions and population statistics for potential contaminants of concern,
- to assess the contribution of contaminated soils to the concentrations of potential contaminants of concern in dissolved and particulate phases in the groundwater and surface water medium,
- to provide input into the overall assessment of the UEFPC groundwater and surface water regime thereby facilitating the investigation of OU 1,

- to support the FS in the screening of appropriate alternatives during the remedy selection, and
- to quantify the risk to human health for on-site workers.

The OU 3 RI Work Plan was prepared following the *Remedial Investigation Work Plan Annotated Outline DOE/OR/01-1077, Rev 0*. This work plan contains summaries of geographical, historical, operational, geological, and hydrological information specific to each OU 3 site. The potential for release of contaminants to receptors through the various media is addressed, and a sampling and analysis plan is presented to obtain objectives for the RI. Proposed sampling activities are contingent upon the screening level risk assessment, which includes shallow soil sampling, soil borings, monitoring well installation, groundwater sampling, and surface water sampling. Data from the site characterization activities will be used to meet the above objectives. A Field Sampling Investigation Plan, Health and Safety Plan, and Waste Management Plan are also included in this work plan.

1. INTRODUCTION

1.1 REGULATORY INITIATIVE

The Oak Ridge Reservation (ORR) is composed of three major installations: the Oak Ridge National Laboratory (ORNL), the Oak Ridge Y-12 Plant, and the Oak Ridge K-25 Site [formerly referred to as the Oak Ridge Gaseous Diffusion Plant (ORGDP)]. These installations were constructed in the early to mid-1940s by the Atomic Energy Commission [predecessor of the U.S. Department of Energy (DOE)] as research, development, and process facilities in support of the Manhattan Project. These installations, along with the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky, and the Portsmouth Gaseous Diffusion Plant (PORTS) in Piketon, Ohio, are currently administered by the DOE Oak Ridge Operations (DOE-ORO) in Oak Ridge, Tennessee.

During the construction and operation of these research, development, and process facilities, the associated decontamination, maintenance, and fabrication processes resulted in the generation of various hazardous and radioactive waste by-products. Hazardous waste treatment, storage, and disposal (TSD) facilities were constructed at each of the DOE-ORO facilities to handle such by-products. Some of these facilities continue to receive hazardous wastes, while others have been decommissioned. All DOE-ORO TSD facilities are currently subject to the requirements of several laws:

- ***Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also referred to as Superfund)***—created in 1980 to establish a program to identify sites [operable units (OUs)] from which environmental releases of hazardous substances might occur or have occurred. At such sites, Superfund promotes the evaluation of damage to natural resources, ensures cleanup by the responsible party or the government, and creates a claims procedure for parties involved in site cleanup and natural resource reclamation. Sites identified by CERCLA are evaluated and then placed on the National Priorities List (NPL), if appropriate. The ORR was listed on the NPL in the December 1989 *Federal Register* (54 FR 48184).
- ***Resource Conservation and Recovery Act (RCRA)***—created in 1976 as a management system for hazardous wastes that mandates permitting currently operating TSD facilities. Under RCRA, these TSD facilities are referred to as solid waste management units (SWMUs). RCRA defines an SWMU as any discernible waste management unit at a RCRA facility from which hazardous waste or hazardous constituents might migrate, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which hazardous waste or hazardous constituents have been routinely and systematically released.
- ***Hazardous and Solid Waste Amendments (HSWA)***—amendments to RCRA (1984) that provide the U.S. Environmental Protection Agency (EPA) with the authority to enforce corrective actions by broadening the scope of the RCRA Corrective Action Program. In addition to evaluating and correcting releases to the uppermost aquifer from regulated RCRA units, HSWA promotes the cleanup of continuing releases to any media resulting from waste

management units and practices at RCRA facilities. Among the most significant provisions of the HSWA are the following:

- **Section 3004(u): Corrective Action for Continuing Releases.** Section 3004(u) states that for permits issued after November 8, 1984, corrective action is required for releases of hazardous waste or constituents from any SWMU at any TSD facility seeking permit for permanent operation, regardless of when waste was placed in the unit. Thus, corrective actions apply to releases presently occurring as well as past releases.
- **Section 3004(v): Corrective Action Beyond the Facility Boundary.** Section 3004(v) authorized EPA to require that corrective action be taken by the facility owner or operator for releases that have migrated beyond the facility boundary (off site). Such action should be taken where necessary to protect human health and the environment unless the owner/operator demonstrates to the satisfaction of the administrator that permission to undertake such action was denied.
- **Superfund Amendments and Reauthorization Act (SARA)**—created in 1986 as a 5-year extension of the Superfund/CERCLA program to clean up hazardous releases at uncontrolled or abandoned hazardous waste sites.
- **National Environmental Policy Act (NEPA)**—created in 1968, directed federal agencies to consider the impacts of their actions (e.g., construction, remediation) on the environment as a part of all decision-making processes.

In anticipation of the ORR being listed on the NPL, DOE, the Tennessee Department of Environment and Conservation (TDEC), and EPA formulated a Federal Facilities Agreement (FFA) for ORR. The FFA was designed to ensure that all necessary steps were undertaken to protect the public health and the environment during the investigation, evaluation, and remediation of all SWMUs/OU's. The FFA also outlines all deliverables, review times, and schedules to ensure that activities are undertaken in a timely manner. The FFA became effective on January 1, 1992.

DOE and TDEC have formulated an oversight agreement/agreement-in-principle. As stated in this agreement, TDEC is the lead agency for the state of Tennessee. The purposes of this agreement are (1) to ensure compliance with applicable federal, state, and local environmental laws and (2) to assure the citizens of Tennessee that their health, safety, and environment are being protected through a program of independent monitoring and oversight by the state.

Each of these agreements provides a measure of oversight for all environmental restoration at the ORR installations. PGDP and PORTS are not listed on the NPL and as such have no FFA. (They do, however, have agreements-in-principle with their respective states.)

1.2 DOE-ORO ENVIRONMENTAL RESTORATION (ER) PROGRAM

The mission of the DOE-ORO ER Program is "to eliminate or reduce to prescribed safe levels the risks to the environment or to human health and safety posed by inactive and surplus Oak Ridge-managed sites and facilities that have been contaminated by radioactive, hazardous, or mixed wastes" (Energy Systems 1991). As a result of ORR's placement on the NPL in November 1989 and the FFA, all remedial activities including characterization, alternative

selection, and implementation must meet the requirements of RCRA, CERCLA, and NEPA. Therefore, the DOE ER Program decided to address the requirements of all applicable laws in a series of "integrated" documentation for each site.

To facilitate consistency in the preparation of these integrated documents at all DOE-OR facilities, the managing and operating contractor for DOE-ORO facilities established an ER Division. Along with central staff that serve to oversee the main program areas, ER site program managers were appointed at each of the DOE-ORO facilities. These site program managers oversee the day-to-day operations of the facility-specific programs and interface with the central ER Division staff.

1.3 SITE ER PROGRAM

CERCLA, originally enacted on December 11, 1980, authorizes the federal government to clean up releases of hazardous substances—primarily at closed or abandoned sites—by conducting site investigations, performing testing and monitoring activities, and implementing remedial actions. These activities are conducted under the terms of the National Contingency Plan (NCP), as mandated by Sect. 105 of CERCLA. The NCP details the clean up procedures, including those for both immediate removal and long-term remedial action, and assigns regulatory authority to federal and state governments. CERCLA imposes strict liability on parties responsible, or potentially responsible, for hazardous waste sites and establishes funding (the "Superfund") that enables the federal government either to order the responsible parties to remediate the spill or to seek reimbursement from the responsible parties after the government has completed clean up.

CERCLA focuses primarily on the clean up of inactive disposal sites. Since May 1989, however, it has also given the federal government the authority to respond to current uncontrolled releases of hazardous and radioactive substances from all onshore and offshore facilities as well as from vessels, including over-the-road transportation vehicles.

SARA was enacted October 17, 1986. As amended by SARA, CERCLA authorizes EPA to maintain an NPL of sites requiring remedial action. Some of the most important sections of SARA discuss stricter cleanup standards, accelerated cleanup schedules, the Community Right-to-Know program, and the Leaking Underground Tank program. CERCLA/SARA emphasizes permanent on-site solutions rather than temporary treatment or transport-and-disposal alternatives, and it requires cleanups to be cost effective and site specific. The CERCLA/SARA remedial action process requires the completion of a remedial investigation (RI) and a feasibility study (FS).

The Y-12 Plant falls under CERCLA because the entire ORR and its environs are listed on the EPA's NPL. Y-12 Plant remediation planning initially began under RCRA corrective action authority. A description of most of the individual SWMUs at the Y-12 Plant is provided in a report entitled *Solid Waste Management Unit Information for the Y-12 Plant RCRA 3004(u) Facility Assessment* and its supplements (Welch and Poore 1987, Welch 1987, Wiggins and Welch 1988, Murphy 1989). Placement of the ORR on the NPL does not relieve DOE-ORO from the obligation to implement RCRA Sect. 3004(u) and 3004(v) corrective action requirements at the ORR. The CERCLA provisions for corrective actions on the ORR overlap, to some degree, the provisions of RCRA, thus creating the need for coordination of DOE-ORO's efforts to

respond to both sets of requirements. The FFA among DOE-ORO, EPA Region IV, and TDEC establishes the procedural framework and schedule for cleaning up the ORR in compliance with CERCLA/SARA, RCRA/HSWA, and the Tennessee Hazardous Waste Management Act. Specifically, the FFA establishes procedures for integrating the requirements of CERCLA and RCRA by performing integrated RI/RCRA facility investigations (RFIs) and FS/corrective measures studies (CMSs) and identifies ORR OUs, one of which is the Upper East Fork Poplar Creek (UEFPC) OU 3.

1.4 FACILITY OU STRATEGY

To effectively evaluate the cumulative impact of releases from multiple sources of contamination, a structured approach has been adopted for ORR based on studies of the groundwater and surface water separate from studies of the sources. Based on the realization of the complexity of the hydrogeologic regime of the ORR, together with the fact that there are numerous sources contributing to groundwater contamination within a geographical area, it was agreed that more timely investigations, at perhaps less cost, can be achieved by separating the sources of contamination from the groundwater and surface water for investigation and remediation. The result will be more immediate attention [Records of Decision (ROD) for interim action or removal actions] for the source control OUs while continuing to investigate longer term remediation for the hydrogeologic regimes, which are labeled as integrator OUs.

OUs designated as both source control and groundwater OUs are projected to reach a final ROD. Those identified as source control OUs only will be addressed initially in RODs for interim action. Upon completion of all proposed source control OU interim actions, sufficient monitoring data of the integrator OUs will be available to determine if the interim actions have been effective, and, if not, further remediation would be evaluated in the integrator OU final ROD.

The Y-12 Plant OUs have been grouped not only by their proximity but also by common physical and hydrogeological parameters. An extensive study of groundwater movement and its relation to contaminant transport at the Y-12 Plant indicates that groundwater can be subdivided into three distinct hydrogeological regimes: (1) UEFPC, (2) Bear Creek, and (3) Chestnut Ridge. This subdivision is based on topography, surface water drainage, and groundwater flow patterns. It offers the advantages of providing a basis for unifying monitoring efforts at the Y-12 Plant and for tailoring monitoring efforts to the hydrogeologic characterization of each regime. The strategy used to delineate boundaries of each regime is included in *Comprehensive Groundwater Monitoring Plan for the DOE Y-12 Plant, Oak Ridge, Tennessee* (Geraghty and Miller 1990). Twelve OUs have been defined at the Y-12 Plant and its surrounding environs (Table 1.1). These OUs may be redefined as investigations progress and new data become available (Energy Systems 1992a). The integrator unit for the Y-12 Plant is UEFPC OU 1. The boundaries of this unit are from the base of Chestnut Ridge to the base of Pine Ridge and from the surface water divide near the S-3 Site to the Weir at Lake Reality. Two source term OUs have been defined within the UEFPC OU 1. These are UEFPC OU 2 Abandoned Nitric Acid Pipeline and UEFPC OU 3, which includes the S-2 Site, Building 81-10, Tank Site 2063-U, Salvage Yard drum deheader, Salvage Yard waste oil storage tanks, Salvage Yard Oil/Solvent Drum Storage Area, and the Salvage Yard Scrap Metal Storage Area. UEFPC OU 3 is the focus of this work plan.

Table 1.1. Y-12 Plant OUs

OU	Type	Sites of concern
UEFPC OU 1	Integrator	Groundwater, surface water, and sediment within the Y-12 Plant
UEFPC OU 2	Source term	Abandoned Nitric Acid Pipeline
UEFPC OU 3	Source term	S-2 Site, Building 81-10, Site 2063, Salvage Yard drum deheader, Salvage Yard waste oil storage tanks, Salvage Yard oil/solvent drum storage area, and Salvage Yard scrap metal storage area
Bear Creek OU 1	Source term	S-3 Ponds, Sanitary Landfill, 1 HCDA/Boneyard/Burnyard, Oil Landfarm, Bear Creek Burial Grounds (includes Oil Retention Ponds 1 and 2)
Bear Creek OU 2	Source term	Rust Spoil Area, Spoil Area 1, SY-200 Yard
Bear Creek OU 3	Source term	Bear Creek floodplain sediments
Bear Creek OU 4	Integrator	Bear Creek groundwater and surface flow regime
Chestnut Ridge OU 1	Source term/integrator	Chestnut Ridge Security Pits Hazardous Waste Disposal Units
Chestnut Ridge OU 2	Source term/integrator	Filled Coal Ash Pond, Upper McCoy Branch
Chestnut Ridge OU 3	Source term/integrator	UNC Disposal Site
Chestnut Ridge OU 4	Source term/integrator	Rogers Quarry and Lower McCoy Branch
Lower East Fork Poplar Creek OU	Integrator	Lower East Fork Poplar Creek floodplain and creek

1.5 INTENT AND SCOPE OF THE RI WORK PLAN

The scope of this work plan has been developed using the data quality objectives (DQO) process in combination with the observational approach. The approach for this RI is to perform a screening level risk assessment for the OU 3 sites using the historical data base. Upon completion of this task, confirmatory or comprehensive sampling will be conducted. The decision between which sampling will be conducted will be based on the outcome of the screening level risk assessment described in Sect. 6.4 and outlined in Fig. 6.1. The data needs (Chap. 6) and sampling and analysis plan (Chap. 7) have been developed in anticipation of further

characterization being required at the OU 3 sites based on the outcome of the screening level risk assessment and the evaluation of the impact of the source term units upon the integrator OU.

The sampling and analysis plan (Chap. 7) has been developed based on the data gaps (Chap. 6) identified by inspection of the historical data and development of the conceptual model (Chap. 3) and from scoping meetings.

1.6 SPECIAL PROBLEMS

Parts of the Salvage Yard are located within the exclusion zone of the plant. Only Q-cleared or properly escorted personnel are allowed in the exclusion area.

The Salvage Yard Scrap Metal Storage Area is an active facility. RI activities for this facility will not be pursued as part of this RI; however, surface soil, groundwater, and surface water will be sampled at the perimeter of the Scrap Metal Storage Area to assess the potential of contaminant release to the integrator OU. The Salvage Yard Oil/Solvent Drum Storage Area was closed under RCRA (Lind 1989a). Contaminated soils were removed during closure, thus, this site will not undergo full RI activities but merely verify removal of contaminated soils.

1.7 OU 3 PROJECT OBJECTIVES

The objective of the RI is not the unobtainable goal of removing all uncertainty but rather to gather sufficient information to support an informed risk management decision remedy for a given site (EPA 1988). The goals of the RI are (1) to define the nature and extent of contamination at the individual OU 3 sites so that the impact of groundwater, surface water runoff, and sediment from the OU 3 sites upon the integrator can be evaluated (2) to define the risk to human health and environment from the OU 3 sites, and (3) to determine the general physical characteristics of the subsurface so that remedial alternatives can be screened. Site characterization activities will be followed by a screening level human health risk assessment and the FS. A screening level risk assessment will also be conducted using historical data before site characterization. The baseline risk assessment will be performed as part of the RI for the integrator OU.

The overall project objectives of this work plan are to provide a justifiable rationale and guidance for the collection and analysis of environmental data to obtain the goals of this RI and to ensure that the data to be collected are technically and legally defensible. Specific objectives of this plan are the following:

- to quantify the contaminant concentrations for the soil column to determine spatial distributions and population statistics for potential contaminants of concern (COCs),
- to assess the contribution of contaminated soils to concentrations of potential COCs in dissolved and particulate phases in the groundwater and surface water media (UEFPC OU 1),
- to provide input into the overall assessment of the UEFPC groundwater and surface water regime thereby facilitating the investigation of OU 1,

- to support the FS in the screening of appropriate remedial alternatives during the remedy selection, and
- to quantify the risk to human health for on-site workers.

1.8 DATA QUALITY OBJECTIVES

1.8.1 Statement of Problem

Seven sites at three discrete areas within the Y-12 Plant boundary have been included in OU 3 to be evaluated as contaminant source control units. Of the OU 3 sites listed below, it is anticipated that Building 81-10, the S-2 Site, and the northeast portion of the Salvage Yard will be fully investigated since they are inactive sites amenable to near-term removal actions or a ROD for interim action. Potential migration pathways (such as groundwater and surface water) will be addressed for the active Scrap Metal Storage Area. The site name, remediation unit number, and approximate size are given in Table 1.2.

The problems to be resolved during this investigation include (1) determining the nature and extent of contamination at each site, (2) determining if any site contains contaminants in the form and concentrations that adversely impact human and ecological receptors and exceed health-based criteria or applicable or relevant and appropriate requirements (ARARs), (3) determining if any of the sites act as contaminant sources that contribute to the integrator OU (i.e., via groundwater or surface water), and (4) determining potential ways to effect a source control and protection of human health and environment. The specific objectives stated in Sect. 1.7 were developed to resolve these problems. Table 1.3 presents the correlation between the identified problems and the objectives of the work plan. Table 1.4 presents the information requirements needed to satisfy the objectives. Some of the information requirements (i.e., potential COCs, geologic and hydrologic setting, migration pathways, and future land use) are satisfied within the text of this work plan. The other information requirements will be satisfied by the collection of additional data. The details of information needed to satisfy the objectives of the work plan are given in Chap. 6. Table 6.1 (in Chap. 6) discusses how the data will be used, evaluated, and interpreted to meet the RI objectives.

To evaluate the impact of these sites, an assessment must be made to determine (1) the COCs within the boundaries of each site, (2) the vertical and horizontal distribution of contaminants at each site, (3) the nature of the various contaminants, (4) the predicted mobility that can be expected of each contaminant, and (5) whether the soil medium acts as a migration pathway to potential receptors or to the groundwater medium.

A conceptual model (Sect. 3.9) has been developed to assist in the development of the DQOs. This model identifies possible COCs from previous studies, probable migration pathways, and potentially exposed receptors. Based on this model, environmental sampling and analysis has been proposed to characterize the site and fill data gaps. The conceptual model has identified the soil horizon as having the greatest potential as a transport medium. Potential exposure routes are in direct contact with contaminated soils (ingestion and dermal contact), inhalation of particulates or volatiles, external exposure to radionuclides, and contact with contaminated groundwater or surface water (inhalation, ingestion, and dermal).

Table 1.2. UEFPC OU 3 sites

Site name	Remediation unit number	Approximate size (acres)	RI investigation proposed
Building 81-10	YS-117	0.9	Yes
S-2 Site	YD-103	0.7	Yes
Salvage Yard	-	11	Yes
Drum deheader	YT-109	-	Yes
Tank Site 2063-U	YS-204	-	Yes
Oil storage tanks	YS-018	-	Yes
Oil/solvent drum storage area	YS-020	-	Yes
Scrap metal storage area	YS-111	-	No

Sampling will be conducted to characterize the nature and extent of contamination within the soil horizon. Additionally, surface water runoff will be collected to determine contaminant loading into the UEFPC, and groundwater sampling will be conducted to ascertain the contribution of contaminants from the soils at each site to the groundwater.

DQOs will not be developed to incorporate the specific concerns of an ecological risk assessment. While no quantitative ecological risk assessment will be performed, samples will be collected to determine contribution of contaminants to UEFPC and these can be used in a qualitative manner to determine ecological risk.

1.8.2 Decisions to be Made

From a scrutiny of earlier investigations, these sites have been identified as having contamination within their boundaries which might adversely impact human health or impact the integrator OU. The ultimate decision for each site, then, is whether or not it must be remediated and what might be the most effective remedial action or if a removal action is appropriate. However, several intermediate decisions must be achieved before this determination can be made. The historical data set derived from the environmental sampling of earlier investigations will be evaluated under a most likely exposure (MLE) scenario risk assessment. If the risk is determined to be excessive relative to EPA's target risk range of greater than 10^{-6} (carcinogens) and Hazard Index (HI) greater than 1 (noncarcinogens), a full remedial investigation will be performed to complement existing data. After the investigation is completed, the individual sites will again be evaluated with the MLE risk assessment to determine if remediation is warranted. See Sect. 6.4 for a detailed description of the decision-making process as it relates to the human health risk assessment.

1.8.3 Inputs to the Decision

Inputs to a decision should be derived from two broad areas (i.e., who are the users of the data obtained during the course of the RI and what are the actual uses of the data).

Table 1.3. Correlation between identified problems and objectives of the RI

Problem / Objective	Quantify the contaminant concentrations for the soil column to determine spatial distributions and population statistics for potential COCs	Assess the contribution of contaminated soils to potential COCs in dissolved and particulate phases in the groundwater and surface water.	Provide input into the overall assessment of the UEFC groundwater and surface water regime thereby facilitating the investigation of OU 1	Support the FS in the screening of appropriate remedial alternatives during the remedy selection	Quantify the risk to human health for on-site workers.
Determine the nature and extent of contamination.	•		•		
Determine if any site contains contaminants in the form and concentrations that adversely impact human and ecological receptors and exceed health based criteria on ARARs.	•	•			•
Determine if any of the sites act as contaminant sources that contribute to the integrator OU.		•	•		
Determine potential ways to effect a source control and protection of human health and environment.	•			•	

Table 1.4. Information required to satisfy the specific objectives

Objective \ Information Requirement	Vertical and Horizontal Contaminant Distribution	Concentration of Potential COCs in Groundwater	Groundwater Velocity	Thickness of Unsaturated Zone	Thickness of Saturated Zone	Background Concentrations in Soil	Background Concentrations in Groundwater	Future Land Use	Potential COCs	Geologic & Hydrologic Setting	Contaminant Mobility	Migration Pathways	Physical Properties of the Soil
Quantify the contaminant concentrations for the soil column to determine the spatial distributions and population statistics for potential COCs.	X					X			X	X	X	X	X
Assess the contribution of contaminated soils to concentrations of potential COCs in dissolved and particulate phases in the groundwater and surface water media (UEFPC OU 1)	X	X	X	X	X		X		X	X	X	X	X
Provide input into the overall assessment of the UEFPC groundwater and surface water regime thereby facilitating the investigation of OU 1.			X						X	X	X	X	
Support the FS in the screening of appropriate remedial alternatives during the remedy selection.	X	X	X			X	X	X	X	X	X		X
Quantify the risk to human health for on-site workers.	X	X	X						X	X	X	X	

- **Data users.** An RI conducted under CERCLA is designed to fill all the data gaps, allowing the subsequent participants of the process to accomplish their tasks. For instance, data on the contaminant concentrations permit the risk assessors to calculate the chronic toxicity and the risk of excess lifetime cancers under certain exposure assumptions. The same data allow the planners and engineers in the FS to screen remedial alternatives and make recommendations regarding cleanup options. The data users have been involved in the development of this work plan through a scoping meeting held on February 24, 1993, and subsequent site tours of the OU 3 sites.

For OU 3, the following is a description of the data users and their responsibilities:

- **RI Contractor**—solicits input and concurrence from the other participants for data needs and designs an investigation to obtain those data; evaluates the data and determines the nature and extent of contamination at each site as well as the potential risk to human and ecological receptors.
 - **FS Contractor**—uses the results of the RI to assess the magnitude of the cleanup task and screens the remedial alternatives in a systematic manner to make recommendations for the ROD of interim action.
 - **Integrating Contractor (Energy Systems ER Division)**—organizes the overall approach to the RI\FS remedial design (RD) and remedial actions (RA) and evaluates the results and conclusions to ensure uniformity with the FFA and regulators; coordinates the contractors for the RI, FS, Engineering Design, and Construction Management tasks.
 - **Lead Agency (DOE-ORO ER)**—has primary responsibility for the success of the environmental restoration program. Initiates and oversees the entire process while closely coordinating input and approval from the other FFA participants.
 - **FFA Participants (DOE, EPA, and TDEC)**—have the ultimate decision-making authority. DOE is the lead agency with ultimate decision making authority over approach, schedule, and budget for environmental restoration activities. EPA and TDEC are the lead agencies for their respective regulating organizations.
 - **General Public and Public Interest Groups**—participate in policy decisions by providing input into basic considerations such as the definition of acceptable risk and what constitutes a worthwhile benefit.
- **Data uses.** Data uses are defined as those data applications that allow the problems identified in Sect. 1.8.1 to be answered. At the relatively small sites that comprise OU 3, the list of variables or characteristics needed to make the decisions includes the identification of affected media and the primary COCs, the nature and extent of contaminants, and the contribution from the individual source units to the water media. Measurement of these variables will allow a risk assessment to be completed to determine if a problem exists, to assist in the assessment of a unit's impact on the water media, and to allow a selection of a remedial technology.

1.8.4 Boundaries of the Study

The boundaries of the various sites for OU 3 are defined by both the conceptual model (Sect. 3.9) and the physical facilities surrounding the site. Knowledge of processes employed at each site suggests contaminants were initially restricted to small areas within the site. For instance, spent chemicals were disposed of within the S-2 Pond, and mercury was recovered in a roasting furnace within Building 81-10. The RI will define the nature and extent of contaminants within the specific areas of known contamination at each site and progressively away from those areas to the physical limits of the sites. This approach will ensure that the main body of the contaminants will be characterized and any potential migration within and away from the site will be determined. The physical boundaries of the sites provide a limit to the investigation. Hard-top roads or the perimeter intrusion detection assessment system (PIDAS corridor) define many areas and geographic boundaries such as hillsides or paved lots mark the limits to others. The boundaries will be sampled at each site, especially the downgradient boundaries with respect to surface water and groundwater flow.

The conceptual models define the limits of investigation for the purposes of exposure assessments. The soil at each site is considered a secondary source for purposes of exposure assessment for human receptors. Thorough and extensive sampling may be necessary to characterize the vertical and horizontal distribution of contaminants. Groundwater and surface water will also be characterized at each site to assess the contribution of each source unit.

1.8.5 Decision Rule

The decision rule to be followed for cleanup of the Y-12 Plant and its related source control units and integrator operable units is described in the Oak Ridge Reservation Site Management Plan for the Environmental Restoration Program (Energy Systems 1992a). This decision rule differs somewhat from the standard CERCLA process in which an RI/FS is followed by a final ROD. In this decision-rule approach, the purpose is to provide for an early remedial action as information becomes available to support remedy selection. The intent is to achieve near-term control of contaminant sources that may be impacting the groundwater or surface water regime.

The decision-rule approach for use within the OU 3 source control unit is described in Sect. 6.4 and is outlined in Fig. 6.1. The approach will lead to a recommendation of no further investigation, or a continuation of the CERCLA process leading to a ROD of interim action or a potential removal action. Once the investigation is completed, an RI Report will be issued that presents the results of the site characterization activities as well as the risk assessment. Following the RI, a limited number of alternatives are developed in the FS for remediation of the site to ensure long-term protection of human health and the environment. A focused-alternatives analysis will then be performed using the nine criteria established by CERCLA. Based on the analysis of all alternatives studied in the FS and the evaluation of the alternatives against the nine criteria, DOE will recommend preferred alternatives for cleanup, as outlined in an Interim Proposed Plan submitted to the state and federal regulators. After review and comment on the proposed plan by the regulators and after those comments are addressed and resolved, the proposed plan will be made available for public comment. Comments will be addressed and incorporated into a ROD of interim action, followed by RD/RA.

1.8.6 Uncertainty Constraints

Two sets of data will be evaluated to make the final decisions for the various sites within OU 3. The historical data from multiple past studies will be weighed for their reliability and usefulness and incorporated into a site-specific screening-level risk assessment. Considerations that give weight to the usefulness of historic data are the degree of documentation available both for sample collection and for laboratory analysis, the physical coverage of sampling over the site, and the spectrum of analytes determined in the laboratory analysis. More recent studies (circa 1990), in general, support a broader range of uses of the data than older sampling events. Uncertainty is inherent in using any older data. Exact sampling locations and methods may not be well known, and documentation in the form of field logbooks may not be available to answer questions or support field decisions affecting sample integrity. Laboratory analysis may have been conducted under an unknown level of quality control (QC) and statement of work (SOW), thereby undermining confidence in precision, accuracy, and sensitivity levels. The approach taken for OU 3 is that if the MLE risk assessment indicates that a problem exists, then a full investigation will be conducted to fill any data gaps remaining from the historical data. If the assessment does not indicate that a problem exists, then an assessment will be made of the historical data quality in order to support a *no-further-investigation recommendation*.

Any data derived from the sampling proposed in this work plan will be collected and documented in such a manner as to be technically and legally defensible. Specific methods to ensure this defensible quality are discussed in Chap. 8, the Quality Assurance Project Plan (QAPJP). In general, however, sampling will be performed according to a set of approved procedures and documented with field logbooks and chain-of-custody records. The sampling design will be set forth to determine the nature and extent of contamination and to characterize the statistical population distribution of the contaminants. Laboratory methods will be performed according to the EPA-Contract Laboratory Program (CLP) statement of work (SOW) that identifies acceptable internal quality control limits, calibration frequencies, and so forth. Laboratory analysis will be substantiated with a data package to meet EPA Level IV requirements. However, only 10% of the data packages will undergo full validation in order to detect systemic problems. The final analytical data goal will be Level III as defined by EPA's Data Quality Objectives for Remedial Response Activities (EPA 1987).

Uncertainty constraints exist for both the historical and proposed data sets. The primary uncertainties are related to the physicochemical nature of the contamination and the transport medium. The heterogeneity of the soil medium, the mobility of specific contaminants, interaction between contaminants, and the physical media (affecting fate and transport) will impart a degree of uncertainty to the results. Two objectives will be affected the most. First, because of the heterogeneity of the soil, precise characterization of the soil contaminant concentrations is difficult. Field duplicates can estimate the variance of the soil contaminants but cannot fully compensate for it. Second, the contribution of the contaminants from the soil to the groundwater cannot be precisely known. Bench-scale leaching studies are imprecise in duplicating the environmental conditions, geochemical models cannot account for unknown/unquantified variables, and partitioning estimates based on concentrations observed in the soil and those observed in the groundwater are highly inaccurate. The results of this investigation must be considered in light of these uncertainties, and decisions must be made accordingly.

1.8.7 Design Optimization

The objectives of most sampling designs are to characterize the nature, extent, and distribution of contaminants within a site in an optimal manner. This allows an estimate of the population statistics of a contaminant to be employed in a particular exposure scenario for risk assessment purposes. It also provides the feasibility study with an approximation of affected media exceeding preliminary remediation goals (PRGs), and delineates areas to be screened during the actual cleanup operations.

Many statistically designed plans may be used to conduct a sampling program. A simple random sampling design may be the easiest to use to achieve an estimate of the contaminant population distribution. At a large site where there is little knowledge of distribution patterns, a staged investigation may employ a systematic approach (grid, interval, fixed space, etc.) followed by biased-sampling based on the results of the first stage. At a site with an historical data set, authoritative or judgmental sampling may be employed to maximize information. The latter approach has been used for the sites within OU 3. Each site comprising the narrowed scope of OU 3 occupies an area of less than an acre, and, it is known from historical studies that contamination is localized near the facility within each site. Judgmental sampling has been used to place sampling locations adjacent to each facility and at the boundary of each site. With this approach a contaminant population of the source can be derived (with the assistance of historical data), and the extent (downgradient migration) can be estimated. Both groundwater and soil sampling have embodied this method.

1.9 SCHEDULE

The schedule of the UEFPC OU 3 RI sampling and analysis activities is provided in Fig. 1.1.

1.10 QUALITY ASSURANCE (QA)

1.10.1 Program Planning and Implementation

The overall planning and implementation of QA and QC activities for the OU 3 RI are described in Chap. 8 and are governed by the *Environmental Restoration Division Quality Assurance Program Plan* (ES/ER/TM-4, Rev. 2) (Energy Systems 1992b), which incorporates the guidance in *Interim Guidelines and Specification for Preparing Quality Assurance Project Plans* (QAMS-005/80) (EPA 1980a) and the specification of the Energy Systems Quality Procedures Manual, the American Society of Mechanical Engineers document *Quality Assurance Program Requirements for Nuclear Facilities, NQA-1* (ASME 1986), and DOE order 5700.6C.

1.10.2 Project-Specific Planning

Project-specific QA planning is described in detail in Chaps. 7 and 8. All QAMS-005/80 QA/QC and ER Division QA Program Plan requirements are addressed in this work plan, either in Chaps. 7 and 8 or within other sections of the work plan. A project-specific locator page is presented in Table 1.5.

Table 1.5. Cross reference of EPA QAMS 005/80 and ES/ER/TM-4/R2 elements with UEFPC OU 3 RI work plan sections

EPA QAMS 005/80	ES/ER/TM-4/R2 element	Location in remedial investigation work plan
1. Title page	QA project plan 4.1.2 document control	Title page and Chaps. 8, 9, 10
2. Table of contents	QA project plan 4.1.2 document control	Table of contents
3. Project description	1.6.2.2.1 Project description	Executive summary
4. Project organization and responsibility	1.5 Organization and program responsibilities	Sect. 7.2
5. QA objectives	6.1.1 QA objectives for measurement data	Sects. 1.8 and 8.1
6. Sampling procedures	5.3.1 Sampling procedures 6.1.2 Sampling procedures	Sects. 7.4.1 and 8.2
7. Sample custody	5.3.2 Sample custody	Sect. 8.4
8. Calibration procedures and frequency	5.4 Control of measuring and test equipment	Sect. 8.5
9. Analytical procedures	5.3.3 Analytical procedures 6.1.6 Specific routine procedures	Sect. 8.3
10. Data reduction, validation, and reporting	6.1.3 Analytical procedures	Sect. 8.7
11. Internal QC checks	8.2 Inspection, testing, and operating status	Sect. 8.8
12. Performance and system audits	9.3 Field audits and surveillances 9.4 Analytical laboratory audits and surveillances 10.1 Audits and surveillances 10.1.3 Field and laboratory audits and surveillances	Sect. 8.10
13. Preventive maintenance	5.4 Control of measuring and test equipment	Sect. 8.6
14. Specific routine procedures used to assess data precision, accuracy, representativeness, completeness, and comparability	6.1.5 Internal quality control checks and frequency	Sect. 8.9
15. Corrective actions	3.2 Control of nonconforming items	Sect. 8.11
16. QA reports to management	1.6.2.2.2 QA reports to management 3.2 Control of nonconforming items	Sect. 8.12

Fig. 1.1. Schedule for the UEFPC OU 3 RI

FS through a ROD of interim action.

2. HISTORY AND CURRENT CONDITIONS

The UEFPC OU 3 consists of seven sites located within three distinct areas at the western end of the Y-12 Plant. This chapter summarizes the available information on the location, background, operational history, and releases for each site. The purpose of this chapter is to describe the OU 3 sites and identify those contaminants that have or may have been released from each source area.

2.1 GEOGRAPHIC INFORMATION

The DOE ORR is located within the corporate limits of the city of Oak Ridge in eastern Tennessee, ~16 km (10 miles) east of the Cumberland Mountains and 113 km (70 miles) northwest of the Great Smoky Mountains. Figure 2.1 shows the city's location approximately midway between Nashville, Tennessee, to the west; Asheville, North Carolina to the east; Lexington, Kentucky, to the north; and Atlanta, Georgia, to the south. The area is served by Interstates 40 and 75, which intersect in nearby Knoxville, Tennessee, east of Oak Ridge. The reservation, 14,300 ha (35,300 acres) of federally owned land, houses three facilities [the Oak Ridge K-25 Site, ORNL, and the Y-12 Plant] that are managed by Martin Marietta Energy Systems, Inc. (Energy Systems), for DOE.

The Y-12 Plant contains ~800 acres and is located adjacent to the corporate center of the city of Oak Ridge. The main facilities of the Y-12 Plant lie on the Bear Creek Valley (BCV) floor, with auxiliary facilities along Pine Ridge, located to the north, and Chestnut Ridge, located to the south (Fig. 2.2). The plant complex, built predominantly in the mid-1940s, is roughly divided into two portions. The western portion was previously devoted to DOE weapons-manufacturing activities, and the eastern portion is devoted to ORNL research programs, general plant operations, and maintenance activities. The majority of the industrial portion of the Y-12 Plant is located within the headwaters of UEFPC, and a small portion of the Y-12 Plant facilities is located in the Bear Creek Watershed.

2.2 BACKGROUND INFORMATION

The Oak Ridge Y-12 Plant was built by the U.S. Army Corps of Engineers in 1943 as part of the Manhattan Project. The original mission of the plant was to separate the fissionable isotope of uranium (U^{235}) using an electromagnetic separation process. After World War II, this process was replaced by the more economical gaseous diffusion process conducted at the Oak Ridge Gaseous Diffusion Plant, which is now known as the Oak Ridge K-25 Site (Welch 1989a).

Since the 1940s the Y-12 Plant has evolved into a highly sophisticated manufacturing and developmental engineering facility. Manufacturing activities at the Y-12 Plant include chemical processing of lithium and uranium compounds and precision fabrication of components from lithium, uranium, and many other materials.

Fig. 2.2. Location of the UFFPC OU 3 sites.

Each of the three source areas that together comprise UEFPC OU 3 has had its own separate and unique function during the operational history of the Y-12 Plant. Contaminants of potential concern associated with each site are listed in Table 2.1. The general contaminant types are based on a combination of disposal records and previous site-specific sampling and environmental reports. The following subsections provide descriptions for each of the source areas that are located in UEFPC OU 3.

2.2.1 S-2 Site (YD-103)

The S-2 Site is located in the southwestern portion of the main Y-12 Plant area, south of Building 9720-32, on the southern side of Third Street at the base of Chestnut Ridge (Fig. 2.3). An asphalt paved utility and access road crosses the area.

Available records indicate that the S-2 Site was an unlined earthen reservoir that was operated from ~1943 to 1951 to dispose of corrosive and toxic liquid wastes that were generated by the Y-12 Plant. Operations within the plant during this period were directed toward uranium enrichment and nuclear weapons component fabrication. There are few historical records pertaining to the design and waste disposal operations at the S-2 Site. Engineering drawings indicate the site was excavated into the hillside and diked to form a holding pond (Welch 1989b). It is estimated that the pond was 45 ft wide by 128 ft long and ~20 ft deep (Welch 1989b). Based on descriptions of the site and on historical drawings, it is estimated that the S-2 Site had an approximate volume of 200,000 gal of waste (Welch 1989b). A chronological list of events at the S-2 Site is presented in Table 2.2.

Specific records of the identity and quantity of wastes disposed of at the S-2 Site were not kept. According to past operators of the facility, the site was used primarily for the disposal of deteriorated chemical reagents and spent extraction raffinates (Welch 1989b). These wastes consisted of nitrates containing traces of copper, nickel, chromium, dimethyl ether, and pentaether; traces of nitric, hydrochloric, and sulfuric acids; minor quantities of sulfates, dibutyl carbitol and tributyl phosphates; and complexes of aluminum nitrate, hydrogen fluoride, and cadmium (Welch 1989b). Natural and enriched uranium were also disposed of at the site, and cyanide compounds also may have been disposed of at the site. These liquid wastes were transferred to the reservoir for percolation, evaporation, or neutralization. Other than neutralization, the waste was untreated, and no barriers or leachate collection systems were used at the site. The S-2 Site was closed in 1951 by neutralizing the liquids and backfilling the reservoir with soil. After the backfilling was completed, the site was covered with topsoil, leveled, and seeded with grass.

2.2.2 Building 81-10 (YS-117)

The Building 81-10 site is located within the Y-12 Plant at the northwest corner of the intersection of "G" Road and Third Street, south of UEFPC (Fig. 2.4). Included as part of the site are two sumps. One sump (Building 9822) is on the east side of "G" Road, and the other sump is 25 ft east of the northeast corner of Building 81-10. The Building 81-10 sump drains into UEFPC. In this particular area of the Y-12 Plant, the UEFPC flows through an underground 90-in. diameter reinforced concrete pipe (RCP) and receives drainage from the Building 81-10 sump. To the immediate north of the site is the PIDAS corridor.

LEGEND:

- Building
 Fence
 Rail Road
 2' Contours

SOURCE:

- 1) Data for the Effluent Pit is based on drawing No. F.S. 08407 from the Stone & Webster Corp., May 5, 1945

OAK RIDGE Y-12 PLANT
UEFPC OU 3
OAK RIDGE, TENNESSEE

FIGURE 2.3
S-2 (YD-103)
SITE MAP

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P.HOLM		01-28-93
1	P.HOLM		03-18-93

XREFERENCES	PLOT FILES
	\\93034\DWG\2508

SHT 1 OF 1	\\93034\DWG\2508	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

Table 2.1. UEFPC OU 3 potential COCs

Site	Contaminants
Building 81-10	Beryllium Mercury Uranium
S-2 Site	Arsenic Beryllium Boron Cadmium Chromium Cobalt Copper Cyanide Fluoride Gross alpha Gross beta Lead
	Mercury Methylene chloride Nickel Nitrate Nitrite Phosphate Sulfate Tetrachloroethylene (PCE) Thorium Trichloroethylene (TCE) Uranium VOCs Zinc
Salvage Yard	Beryllium
Oil storage tanks	Chromium
Oil/solvent drum storage area	Cobalt Lead
Tank Site 2063-4	Mercury
Drum deheader	Polychlorinated
Scrap metal storage area	biphenyls (PCBs) PCE Thallium TCE Uranium

Building 81-10 was built in 1943 and constructed over the original UEFPC channel (Turner 1986). The stream channel was moved to the north of Building 81-10 during the Y-12 Plant construction activities and remained as an open ditch until after 1958 when two 60-in. diameter RCPs were installed to contain water flow (Turner 1986). During the construction of the PIDAS corridor and the Utility System Restoration Phase III creek tile replacement projects during 1987-1988, the upper 5 to 15 ft of soil north of Building 81-10 were disturbed and/or removed (Wiggins 1988a), and the two 60-in. diameter RCPs were replaced with a single 90-in. diameter RCP.

Building 81-10 is identified as a tin shop on early Y-12 Plant maps. In 1957, a Nichols-Hereshoff roasting furnace was located on the site. This furnace was used to recover mercury from sludges, wastes, contaminated soils, scrap from dismantled equipment, and other similar materials used at the Y-12 Plant in the late 1950s and early 1960s. The furnace was in operation for ~5 years, closing in 1962. During its operation, an estimated 1361 kg of mercury was spilled on the concrete pad, beneath the concrete pad, and on the ground. In

Table 2.2. Chronological list of events at the S-2 Site (YD-103)

Year	List of events
1943-1951	S-2 Site was an unlined earthen reservoir used to dispose of unknown quantities of liquid waste, some of which were corrosive and toxic. The S-2 Site was reported to be used primarily for the disposal of deteriorated chemical reagents and spent extraction raffinates. The liquid waste streams were transferred by truck to the reservoir for percolation, evaporation, or neutralization. It is estimated that the S-2 Site had an approximate volume of 200,000 gal of waste (RFI Plan, June 1989). The S-2 Site was closed by neutralizing the remaining liquids and backfilling the reservoir with soil. After the backfilling was completed, the site was capped with more soil, leveled, and seeded with grass (Welch 1989b) (Y/TS-349 RI)
1986	Installation of six groundwater monitoring wells (GW-251,-252,-253,-254,-255, and -256) and seven soil borings as part of the Y-12 Plant groundwater investigation drilling program (Geraghty and Miller, Inc. 1987)
1986	Installation of three monitoring wells (GW-278,-279, and -280) at the S-2 Site as part of characterization activities for a site situated to the northwest of the S-2 Site. These wells were installed as part of the Y-12 Plant groundwater investigation drilling program and also used for site characterization activities at the S-2 Site (Gianfrancesco et al. December 1988) (Y/TS-321)
1986-1987	Collection of water level measurements for 16 months, and six quarterly water samples taken from the six groundwater monitoring wells at the S-2 Site (Welch 1989b) (Y/TS-349 RI)
9/1987	Plugging and abandonment of monitoring wells GW-254,-256,-278,-279, and -280 due to the Perimeter Intrusion Detection Assessment System (PIDAS) corridor project (Welch 1989b) (Y/TS-349 RI)
5/1988	Installation of monitoring wells GW-349 and -350 to replace the well cluster formed by wells GW-278, -279, and -280 (Welch 1989b) (Y/TS-349 RI)
12/1988	Initial summary and interpretation of hydraulic head and water chemistry data obtained from groundwater investigation wells surrounding the S-2 Site published in a preliminary assessment report of the S-2 Site. The data used were obtained from the Y-12 Plant Assessment and Remediation Program and covered a period from June 1986 to December 1987. Water quality analyses indicated levels at or above primary drinking water standards for barium, cadmium, chromium, lead, mercury, nitrate, gross alpha and beta, radium, chloroform, carbon tetrachloride, trichloroethylene, and tetrachloroethylene. Soil chemistry data obtained from three of the soil borings (SB-4, -5, and -6) taken in 1986 indicated elevated concentrations of boron, cadmium, chromium, cobalt, copper, lead, nickel, zinc, uranium, and nitrate (Gianfrancesco et al. December 1988) (Y/TS-321)
6/1989	RFI issued for the S-2 Site
1990	RFI Plan activities by Earth Technologies. Twenty-four soil samples were collected from three borings (B-1, -2, and -3) and analyzed for metals, gross alpha and beta, total uranium, isotopic uranium, thorium, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), boron, cyanide, sulfate, nitrate, and toxicity characteristic leaching procedure (TCLP) metals. Results indicated levels above preliminary action limits in soils for cadmium, chromium, lead, and mercury (RFI S-2 Volume 2, Earth Technology Corporation, January 1992)

1984, the site was used as a storage area to stockpile mercury-contaminated soil (Wiggins 1988a). Use of the site to stockpile soil was discontinued and the soil was removed; however, the date of removal is unknown. Currently the site contains a shed (a roof and support columns), the former sump located north of the building in the northeast corner of the

LEGEND:

- Building
 Fence
 Rail Road
 2' Contour

OAK RIDGE Y-12 PLANT
UEFPC OU 3
OAK RIDGE, TN.

Figure 2.4
Building 81-10
(YD-117)
Site Map

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P.Holm		1/29/93
1	P.Holm		3/18/93

XREFERENCES	PLOT FILES
/93034/XREF/BLDC /93034/XREF/D3TOPO /93034/XREF/D4TOPO /93034/XREF/RDS	93034/PLOT/250E

SHT 1 OF 1	93034/DWGS/250E	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

Table 2.3. Chronological list of events at Building 81-10 (YS-117)

Year	List of events
1943	Building 81-10 was constructed and used for a tin shop. The building was constructed over the original EFPC channel. The creek channel was moved to the north of Building 81-10 and left as an open ditch until it was filled sometime between 1958 and 1963
1957-1962	Building 81-10 was used for the operation of a roasting furnace that recovered mercury from sludges, wastes, contaminated soils, scrap from dismantled equipment, and other similar materials used at the Y-12 Plant (Union Carbide 1983). During this time, soil from spills that occurred at Building 9201-2 from 1951 to 1955, from the ramp area north of Building 9201-5 on July 17, 1956, and from an area between Buildings 9204-5 and 9201-5 in mid-1956 was processed at Building 81-10 (CERCLA Phase II Report, January 1988)
1962	The roasting furnace operation ceased (Wiggins 1988a) (Y/TS-412)
1971	Building 81-10 and its sump were cleaned to secure the mercury-contaminated materials and recover loose mercury. An estimated 91,451 kg of mercury were removed from Building 81-10 and its sump with an estimated 32,270 kg of mercury recovered and returned to Building 9201-4. The remaining quantity of mercury was unrecoverable and disposed of in drums as scrap (McAlister 1971)
1971	Three soil borings indicated evidence of mercury in subsurface (letter from P. D. Guettner to D.W. Smith, August 27, 1971)
1971-1984	Building 81-10 was used to store scrap material and drums of sludge (Wiggins 1988a) (Y/TS-412)
1983-1984	A two-phase site investigation study was conducted by ORNL to investigate subsurface mercury concentrations at Building 81-10. The investigation included installation of well nest 56-5 and the drilling and sampling of eight soil borings. Soil samples collected during the Phase I monitoring well installation process detected mercury on the order of hundreds of ppm as deep as 17 ft. During this phase small beads of visible mercury were noted in samples at 6 ft deep. Phase II soil sampling indicated that two locations (B-3 and B-4) had total mercury concentrations greater than 1000 ppm. Water samples obtained from the monitoring wells indicated that the mercury was not mobile in the aqueous phase (Rothschild et al. 1984a) (ORNL/TM-9092). These Phase I and II localities have since been excavated as part of the PIDAS and creek tile replacement project
1984	Building 81-10 was used to stockpile mercury-contaminated soil (RFI Report, November 1988). The use of Building 81-10 to stockpile soil was discontinued and the soil was removed; however, the date of removal is unknown
1987	Approximately 8400 ($\pm$ 500) yd ³ of soil (fill) material was removed from the area north of Building 81-10 between November 1987 and April 1988 for the Utility System Restoration Phase 3 (USR III) creek tile replacement and the PIDAS corridor projects. Monitoring wells 56-5 A, B, and C were plugged and abandoned due to construction (Wiggins 1988a) (Y/TS-412). In addition, boring localities B-3, B-4, B-2, and B-7 were excavated or partially excavated
1988	An RFI Plan was issued for Building 81-10
1990	The Building 81-10 RFI Work Plan was implemented. The results of the RFI activities are summarized in a site characterization prepared by Earth Technology Inc. (draft report)

2.2.3.1 Salvage Yard oil storage tanks (YS-018)

Two large carbon steel oil storage tanks are located on the site (Fig. 2.5). The northern tank, with a 5000-gal capacity, was put into service in 1980. The larger southern tank, with

concrete pad, and the current 27-ft sump (Structure 9822) that is located due east of the shed (Fig. 2.4). Table 2.3 contains a chronological list of events for the Building 81-10 site. At present, the building is in a deteriorated condition and is no longer used.

Building 81-10 and its sump (Building 9822) were cleaned in 1971, including the transfer of sludge to drums (McAlister 1971). During cleaning, an estimated total of 91,451 kg of mercury was removed from the contaminated materials in the Building 81-10 area with 1209 kg of the total mercury being removed from the sump (McAlister 1971). The majority of the mercury was unrecoverable from the material; however, ~32,270 kg of the mercury was recovered and returned to Building 9201-4. The remaining mercury contaminated material, which contained ~58,566 kg of mercury, was stored in drums as re-packaged scrap at the Building 81-10 site. The drums were removed from Building 81-10 in 1984.

2.2.3 Salvage Yard

The Salvage Yard area is located in the northwestern area of the plant, south of Bear Creek Road and north of Second Street (Fig. 2.2).

The Salvage Yard area at the Y-12 Plant has been used for storage of scrap metal and liquid hazardous wastes and for the deheading and crushing of used drums. The following sites are contained within the Salvage Yard area.

- Salvage Yard oil storage tanks (YS-018),
- Salvage Yard oil/solvent drum storage area (YS-020),
- Salvage Yard drum deheader (YT-109),
- Salvage Yard scrap metal storage area (YS-111), and
- Tank 2063-U site (YS-204).

The location of these sites is shown in Fig. 2.5. The uses and configuration of this site have changed numerous times since it began operation in 1950 as a storage area for uranium-contaminated and noncontaminated scrap metal. Plans for altering the current design and location of the Salvage Yard began in 1985 and have continued to the present.

A 6-in. diameter stainless steel nitric acid waste line, which transported wastes to the S-3 Ponds, runs underneath the Salvage Yard area (Fig. 2.5). The line may have leaked underground within the Salvage Yard area while carrying nitric acid from the uranium recovery area to the S-3 Ponds. The line was abandoned and plugged in 1983. Releases from it will be assessed in the on-going remedial investigation for UEFPC OU 2 (abandoned nitric acid pipeline remedial investigation).

In addition, DOE constructed the PIDAS corridor that divides the current Salvage Yard area (Fig. 2.5). During construction of this corridor, soil was excavated to a depth of 5 ft and was probably transported to the Chestnut Ridge Landfill. The soil was replaced with clean fill. Construction of the PIDAS has resulted in a higher level of security for the eastern half of the Salvage Yard area.

LEGEND:

- Building
- Fence
- Rail Road
- 900 2 ft. Contour
- RAD Contaminated Areas

Notes:

- 1) Western Portion of Oil/Solvent Drum Storage Area was closed under RCRA in 1986.
- 2) Eastern Portion of Oil/Solvent Drum Storage Area was closed under RCRA in 1989.
- 3) Oil/Solvent Drum Storage Area Berms were removed as part of Closure Activities.

Reference MMES Drawings:
ECV-26158, ECV-25670, C2E-29582
ECV-26159, ECV-25669, C2E-117289

OAK RIDGE Y-12 PLANT
OPERABLE UNIT NO. 3
OAK RIDGE, TENNESSEE

SALVAGE YARD SITE MAP

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P. HOLM		01-29-93
1	P. HOLM		03-18-93
2	P. HOLM	W. KEGLEY	07-13-93

XREFERENCES	PLOT FILES
	\\93034\PLT\250A.PLT

SHT 1 OF 1	\\93034\DWG\250A	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

a 6000-gal capacity, was put into service in 1978. Both tanks are contained within a rip-rap earthen dike, and storage of oils in the tanks was discontinued and their contents emptied in 1986 (Welch 1989c). The tanks are still located at the site and contain bottom sludge. A summary of activities at the Salvage Yard oil storage tanks is presented in Table 2.4.

Waste oils stored in the Salvage Yard oil storage tanks were generated by various operations within the Y-12 Plant. In the southern tank, the waste oils included many types: automotive-crankcase oils, vacuum-pump oils, hydraulic systems, and machining oils. Polychlorinated biphenyls (PCBs) at concentrations of 2100 parts per million (ppm) and chlorinated solvents at concentrations of 775 ppm have also been found in the bottom sludge of the tanks. The northern tank contained mineral oils generated from transformer oil changeout. Analyses of oils from this tank showed PCB concentrations of 86 ppm and chlorinated solvent concentrations of 850 ppm. Spills and tank leaks within the earthen dikes have been reported, suggesting the possibility of releases of PCB-contaminated oils to the soil medium (Welch 1989c).

2.2.3.2 Salvage Yard oil/solvent drum storage area (YS-020)

The Salvage Yard oil/solvent drum storage area operated from 1976 to 1989. It has since been closed under RCRA (Lind and Welch 1989). Originally, the drum storage area consisted of two compacted gravel areas on top of soil (Fig. 2.5). Each area had a dike constructed of clay and gravel on the downgradient side. The combined storage area had a capacity of up to 175,000 gal of drummed waste oils and solvents (~3500 drums). These drums sat on pallets and contained the following: waste oils contaminated with chlorinated organics, uranium, and/or beryllium; chlorinated organic solvents; and nonchlorinated flammable solvents. A summary of activities at the Salvage Yard oil/solvent drum storage area is given in Table 2.5.

In November 1986, the western diked portion was closed as described in the RCRA Closure Plan (Welch 1986), which was approved by the Tennessee Department of Health and Environment (TDHE). No soil removal was required to satisfy closure criteria. However, in preparation for PIDAS construction activities, a layer of soil ~5 ft deep was removed and replaced with clean fill. The soil that was removed was probably transported and deposited in the Chestnut Ridge Landfill.

Closure of the eastern portion began in 1988, as described in the RCRA Closure Plan for this area (Lind and Welch 1989). A Commissioner's Order on March 24, 1988, required that measures be taken to ensure that there was no release of untreated runoff from the Oil/Solvent Drum Storage Area. In response, a canvas tent was erected over the eastern portion of the drum storage area. Since that time, all waste oils and solvents stored at the site have been removed and taken to other facilities at the Y-12 Plant. The tent was removed and the soil and gravel beneath the storage area were excavated to a depth of ~1-2 ft and transported to one of the following sites between September and December 1988; Building 9811-1 RCRA Storage Facility (S-021), Waste Oil/Solvent Storage Facility (S-039); or the Interim Drum Yard (S-030) (Lind and Welch 1989). The dike was also removed. A layer of clean clay backfill was placed over the excavated area and a polyethylene membrane was placed over the clay. TDHE approved closure of the facility after reviewing soils analysis data and groundwater data from in and around the facility that showed arsenic levels below

Table 2.4. Chronological list of events for the Salvage Yard oil storage tanks (YS-018)

Year	List of events
1978	The 6000-gal southern oil storage tank was put into service. This tank was used to store waste oils contaminated with PCBs in excess of 2100 ppm (Welch 1989c) (Y/TS 365RI)
1980	The 5000-gal northern oil storage tank was placed in service. This tank was used to store oil contaminated with PCBs in concentrations of less than 100 ppm (Welch 1989c) (Y/TS 365RI)
1986	The storage of PCB-contaminated oil was banned from the Salvage Yard (Welch 1989c) (Y/TS 365RI)
1986	Both oil storage tanks were emptied; the use of the tanks was discontinued (Welch 1989c) (Y/TS 365RI)

ORR background levels and PCB levels well below the health-based criteria (HBC) values (Lind and Welch 1989).

2.2.3.3 Salvage Yard drum deheader (YT-109) and Tank 2063-U site (YS-204)

The Salvage Yard drum deheader operated from 1959 until 1989. The drum deheader was used to cut the tops off of empty drums that contained oils and solvents. The facility consists of a contained area with brick walls on three sides, a concrete floor, and a roof. A drum crusher was located in front of this building. Residual materials were present in some of the drums, resulting in the potential for releases. Figure 2.6 shows the location of the drum deheader, drum crusher, and underground tank sites that were associated with the drum deheading operations (Welch 1989c). Operation of the drum deheader ceased in March 1989, and all drums have since been removed. The drum deheader and drum crusher were removed from the site in 1991. A summary of the history of the drum deheader and associated tanks is presented in Table 2.6.

The "Tank 2063-U" site was composed of three underground tanks (Tanks 2063-U, 2328-U, and 2329-U) that were connected via drain pipes. These tanks will be considered together and will be referred to collectively as the Tank 2063-U site. The tanks were used in support of drum deheading operations.

Tank 2063-U was an underground sump, constructed of concrete and cinder blocks and open at the top. The capacity of the tank was about 130 gal and the dimensions were ~ 4 ft long, 2 ft wide, and 2 ft deep. Tank 2063-U was used in conjunction with the Salvage Yard drum deheader. Prior to deheading, residual liquid in the drums was routinely emptied into other storage drums placed in Tank 2063-U. The tank was used to contain spills and overflows that occurred when liquids were poured into the storage drums and also to collect residual liquids from a drain at the drum crusher. The contents of Tank 2063-U were transferred through a connecting drain pipe to Tanks 2328-U and 2329-U.

Tanks 2328-U and 2329-U were concrete and cinder block sumps and were located adjacent to each other separated by a rubber baffle (Fig. 2.6). Each tank was ~ 8 ft long, 4 ft

Table 2.5. Chronological list of events at the Salvage Yard oil/solvent drum storage area (YS-020)

Year	List of events
1976	The oil/solvent drum storage area was put into operation. The oil/solvent drum storage area consists of an east site and a west site (Stone 1989) (Y/TS-566)
1986	Soil samples were taken from the oil/solvent drum storage areas during RCRA closure of the west site (Welch 1989c) (Y/TS-365 RI). Collection of these soil samples was planned as Phase I and Phase II; however, both phases were implemented at the same time (Welch 1986) (Y/TS-212 RI)
11/1986	The western dike portion of the oil/solvent drum storage area was closed. This closure was approved by TDHE. No soil removal was required for closure (Welch 1989c) (Y/TS-365 RI)
1987	During PIDAS construction, a layer of soil ~5 ft deep was removed and replaced with clean fill (Welch 1989c) (Y/TS-365 RI)
1988	Closure of the east site oil/solvent drum storage area began (Welch 1989c) (Y/TS-365 RI)
3/24/1988	The Commissioner's Order required that measures be taken to ensure that there were no releases of untreated runoff from the oil/solvent drum storage area. This resulted in a canvas tent being erected over the eastern portion of the oil/solvent drum storage area in response to the Commissioner's Order (Welch 1989c) (Y/TS-365 RI)
3/1988– 6/1989	All waste oils and solvents stored at the east site oil/solvent drum storage area were removed and taken to other facilities at the Y-12 Plant. The tent was removed from the east site and the soil and gravel beneath the storage area were excavated to a depth of ~1–2 ft. The dike was removed, a layer of clean clay backfill was placed over the excavated area, and a polyethylene membrane was placed over the clay (Welch 1989c) (Y/TS-365 RI)
1989	TDHE approved closure of the east site oil/solvent drum storage area after reviewing data from the soil analysis data and groundwater data from in and around the facility (Welch 1989c) (Y/TS-365 RI)

wide, and 4 ft deep and had a total capacity of about 950 gal. A floor drain from the drum deheader and a drain pipe from Tank 2063-U was connected to these tanks. In the past, rainwater and surface water runoff occasionally collected in the tanks because the tops of the tanks were at ground level and were covered only by a metal grate. A rubber baffle between the tanks helped to separate the oils and solvents from the rainwater and runoff. Once separated, the rainwater and surface runoff in the tanks were discharged via a drainpipe to the Y-12 Plant stormwater drainage system. Oils remaining in the tanks were periodically pumped out as necessary. In 1979, the floor drain from the drum deheader was plugged, discharges to Tanks 2328-U and 2329-U ceased, and the remaining liquid was pumped out. At the same time, the metal grates covering the tanks were replaced with two metal plates, and sandbags were placed around the perimeter of the tanks to prevent surface runoff from collecting in the tanks. As a result, collection of rainwater and surface water in the tanks decreased.

In March 1989, a 24-hr hydrostatic hold test (Petro-tite tank tightness test) was conducted for each tank and all three were found to be leaking (Stone 1989). Leak rates

2-051093-000

Fig. 2.6. Schematic of the Salvage Yard drum deheader and Tanks 2063-U, 2328-U, and 2329-U.

Table 2.6. Chronological list of events for the drum deheader (YT-109) and Tanks 2063-U, 2028-U, and 2029-U (YS-204)

Year	List of events
1959	The drum deheader became operational (Stone 1989) (Y/TS-566)
1979	The floor drain was plugged, and discharge to Tanks 2328-U and 2329-U ceased (Stone 1989) (Y/TS-566)
1979	The metal grate covering Tanks 2328-U and 2329-U was replaced with two metal plates, and sand bags were placed around the perimeter of the tanks. This reduced the amount of precipitation that entered the tanks (Stone 1989) (Y/TS-566)
1987	The drain line that connected Tank 2063-U to Tank 2328-U was plugged (Stone 1989) (Y/TS-566)
1987	A curb was constructed on the north side of the shed housing the drum deheader (Stone 1989) (Y/TS-566)
3/1989	Operation of the drum deheader ceased (Stone 1989) (Y/TS-566)
3/13/1989	A leak test of tank 2063-U showed a leak rate of 0.46 gal/hr (Stone 1989) (Y/TS-566)
	A leak test of tank 2328-U showed a leak rate of 0.14 gal/hr (Stone 1989) (Y/TS-566)
	A leak test of tank 2329-U showed a leak rate of 0.14 gal/hr (Stone 1989) (Y/TS-566)
3/1989	DOE and TDHE were notified of the results of the leak tests on tanks 2063-U, 2328-U, and 2329-U (Stone 1989) (Y/TS-566)
3/17/1989	Initial soil sampling took place in the vicinity of tanks 2063-U, 2328-U, and 2329-U. Soil samples were taken from 18 locations (Stone 1989) (Y/TS-566)
4/10/1989	An abatement report for tanks 2063-U, 2328-U, and 2329-U was sent to TDHE on April 10, 1989 (Stone 1989) (Y/TS-566)
7/21/1989- 7/22/1989	Tanks 2063-U, 2328-U, and 2329-U-A strong organic odor was evident as the soil was being excavated. The soil beneath the tanks was stained (Stone 1989) (Y/TS-566)
7/21/1989- 7/22/1989	Soil beneath tanks 2063-U, 2328-U, and 2329-U was sampled (Stone 1989) (Y/TS-566)
7/31/1989	Observation well GW-190 was installed to monitor contamination from tanks 2063-U, 2328-U, and 2329-U (Stone 1989) (Y/TS-566)
8/10/1989- 8/14/1989	Well GW-190 was bailed and showed no free phase product or petroleum odors (Stone 1989) (Y/TS-566)
8/1989	A free product report was issued for tanks 2063-U, 2328-U, and 2329-U. <i>Conclusion:</i> No free phase product could be detected as a result of investigative efforts (Stone 1989) (Y/TS-566)

were 0.46 gal/hr, 0.14 gal/hr, and 0.14 gal/hr for Tank 2063-U, Tank 2328-U, and Tank 2329-U, respectively. Each of these rates exceeds the maximum allowable leak rate of 0.1 gal/hr established under federal underground storage tank (UST) regulations, 40 CFR

280.43(c) (Stone 1989). Shortly after the leak test, operation of the drum deheader ceased and interim corrective measures were taken for the tanks.

In July 1989, all three tanks were excavated. The pit created by excavation was lined with plastic, and the excavated soil was placed back in the pit. The top of the pit was covered with a plastic geomembrane. Analysis of initial abatement soil samples collected from the tanks show the highest detectable levels of volatiles, total PCBs, and arsenic were below the maximum allowable limits. In contrast, analysis of samples taken during the excavation indicated levels in at least one sample were above the maximum allowable limits for TCE (26 kg/mg), total PCBs (25 kg/mg), and for the metals cadmium, lead, and mercury (Stone 1989). The maximum allowable limits referred to here are levels at which corrective action was necessary as determined under RCRA following Chapter 8 of the RFI Guidance Document (EPA 1989a). These limits are used in this RI Work Plan for comparative purposes of the historic data at the drum deheader site.

Detailed records of the amount of liquids collected in and removed from the tanks during their operation were not kept. Consequently, the amount of liquids that may have leaked out of each sump cannot be reasonably estimated (Stone 1989).

2.2.3.4 Salvage Yard scrap metal storage area (YS-111)

The Salvage Yard scrap metal storage area (Fig. 2.5) has been in use since 1950 for the storage of scrap metal. The facility is currently in use housing several tons of scrap metal, some of which is contaminated with low levels of depleted uranium. Between 1987 and 1989 the PIDAS corridor was installed, splitting the Salvage Yard into west and east portions. During installation of the PIDAS corridor, contaminated soil was excavated to a depth of 5 ft and replaced with clean fill. The excavation was probably transported and deposited in the Chestnut Ridge Landfill. An historical summary of the Salvage Yard Scrap Metal Storage Area is presented in Table 2.7.

The Salvage Yard scrap metal storage area has been in operation since 1950. Presently, the scrap metal storage area receives materials such as electrical equipment, wires and cables, junction boxes, hydraulic equipment, transformers, stainless steel and aluminum alloys, and support steel. In the past, some scrap metals may have been contaminated with alpha and beta radiation, PCBs, asbestos, and beryllium (Welch 1989c). Mercury is also suspected to have been stored at the Salvage Yard.

Contaminated scrap materials are separated according to the type of contaminants present. For example, materials and equipment from enriched uranium processes are brought to the Salvage Yard with surface contamination and must be segregated from other contaminated scrap material. At present, the scrap metals are segregated, sheared, and packaged in land-sea transport containers for shipment to an approved smelter. Activity at the scrap metal storage area will presumably increase commensurate with decontamination and decommissioning activities within the plant.

Visual evidence of surface soil contamination has been observed during visits to the scrap metal storage area and on aerial photographs taken over the past few years. Discolored soils are scattered around the site and appear to be the result of one-time occurrences (i.e.,

Table 2.7. Chronological list of events at the Salvage Yard scrap metal storage area (YS-111)

Year	List of events
1950	Salvage Yard began operation as a storage area for uranium contaminated and noncontaminated scrap metal (Welch 1989c) (Y/TS-365 RI)
1955	A zirconium explosion occurred in the west Salvage Yard. A nearby heat source caused a wooden keg of powder zirconium to explode. In order to deactivate the remaining kegs of zirconium, a fire was built and the remaining kegs were burned (Welch 1989c) (Y/TS-365 RI)
Present (12/1992)	The site continues to be used as a staging area for scrap metal generated at the Y-12 Plant (Welch 1989c) (Y/TS-365 RI)

accidental spills, rather than continuing releases from permanent sources). The nitric acid pipeline, which crosses the Salvage Yard area ~ 5.5 ft below grade, might have contributed to subsurface soil contamination in the area if any part of it corroded and leaked (Welch 1989c).

In 1955, a zirconium explosion occurred in the west Salvage Yard with resultant injuries. A nearby source of heat caused wooden kegs of zirconium powder to explode. To deactivate the remaining kegs of zirconium, a fire was built and the kegs were burned to consume the material. Any contamination occurring may have been airborne or deposited on the surface, and any residual surface contamination has since been removed, covered, or disturbed.

2.3 OPERATIONAL INFORMATION

2.3.1 S-2 Site (YD-103)

Operational information is discussed in Sect. 2.2.1 and summarized in Table 2.2.

2.3.2 Building 81-10 (YS-117)

Operational information is discussed in Sect. 2.2.2 and summarized in Table 2.3. Future activities at Building 81-10 will include removal of the building.

2.3.3 Salvage Yard Area

The Salvage Yard area consists of five sites: the Salvage Yard oil storage tanks; the Salvage Yard Oil/Solvent Drum Storage Area; the Salvage Yard drum deheader; Tank 2063-U; and the Salvage Yard Scrap Metal Storage Area.

The Salvage Yard drum deheader and Tank 2063-U sites are one description herein because of their proximity.

2.3.3.1 Salvage Yard oil storage tanks (YS-108)

Operational information is discussed in Sect. 2.2.5.1.

2.3.3.2 Salvage Yard oil/solvent drum storage area (YS-020)

The Salvage Yard Oil/Solvent Drum Storage Area was operational from 1976 to 1989. All materials entering the area were accompanied by a completed Part I of Form UCN-2109, which identified waste composition, waste quantity, and known contaminants. This form was submitted to the Waste Transportation, Storage, and Disposal (WTSD) Department for review and approval. The materials were packaged according to WTSD requirements.

After the paperwork was reviewed, the packaging was inspected, and Part II of the UCN-2109 disposal request was completed with written disposal instructions. In addition, the drums were labeled and logged on a driver log sheet. Once the drums arrived at the Salvage Yard, they were sampled and analyzed. Following drum sampling, any discarded materials, such as sponges, wipes, gloves, or sampling tubes were gathered from the area for disposal. Based on the analytical results, the oils and solvents were either segregated or bulked together. The Salvage Yard oil/solvent drum storage area was inspected weekly, and any deficiencies were noted and reported. The western and eastern areas were closed under RCRA in 1986 and 1989, respectively, as described in Sect. 2.2.5.2. As part of closure activities, contaminated soil was removed from both the east and west sites. Soil samples were collected by Earth Technology, Inc. and analyzed for radiological parameters.

2.3.3.3 Salvage Yard drum deheader (YT-109) and Tank 2063-U site (YS-204)

Operations at the drum deheader ceased in March 1989, and all drums were removed. During active operation of the site, empty drums were brought to the Salvage Yard drum deheader from areas within the Y-12 Plant and were deheaded and beaded for reuse in various locations within the plant. Selection of drums to be deheaded, beaded, and reused was determined by the previous use and contents of the drum.

The drums were allowed to contain up to an inch of liquid. A tilting device was used to drain the residual liquid through a funnel into a drum at the drum drain station (Tank 2063-U). The top chime and drum top were cut off, and the top edge of the deheaded drum was beaded. The bead was curled against the drum wall so that no sharp edge was exposed.

Any free liquid remaining in the drum was then cleaned up with absorbent material, which was packaged for transport to the appropriate disposal facility. Improperly beaded drums were crushed with the drum crusher.

Empty drums to be crushed were checked for the presence of combustible material with a combustible gas detector. It was common for small quantities of residual liquid to leak out from the bottom of the crusher door as a drum was crushed with the ram. The crushed drum was placed in a portable scrap hopper, and the area was then cleaned of free liquid with absorbent material. Crushed drums were disposed of in the Bear Creek Burial Grounds or the sanitary landfill, according to where the drum had been used and its previous contents (Welch 1989c).

Tanks 2063-U, 2328-U, and 2329-U received residual liquids that were drained or leaked from drums during the drum deheading process. Tank 2063-U was used to receive residual liquids drained from drums, to contain spills during pouring activities, and to drain any liquids from the crushing of drums. Liquids in Tank 2063-U drained into Tanks 2328-U and 2329-U for additional storage.

Tanks 2328-U and 2329-U received residual oils, solvents, organics, and other free liquids from a floor drain at the drum deheader in addition to liquid residues from Tank 2063-U. In 1979, the drain from the drum deheader was plugged and discharges from the drum deheader to these tanks ceased.

2.3.3.4 Salvage Yard scrap metal storage area (YS-111)

The Salvage Yard scrap metal storage area is the only area within the Salvage Yard that is still in active use. Scrap metal from the Y-12 Plant is delivered to the Salvage Yard for monitoring, collection, segregation, storage, and sales as determined by WTSD Department personnel. The scrap metals are sorted and placed in separate areas depending on the levels of radioactive contamination.

In the past, uncontaminated scrap metals were sold to the public. Presently, the scrap metals are segregated, sheared, and packaged in land-sea transport containers for shipment to an approved smelter.

Because the scrap metal storage area is currently active, the site cannot be fully characterized. It is therefore recommended that RI activities not be pursued at this time for the scrap metal areas. Limited sampling will be conducted at the perimeter of the southern end of the Salvage Yard to assess potential releases.

2.4 RELEASES

2.4.1 S-2 Site (YD-103)

The S-2 Pond was designed to perform as a seepage basin; thus, the operation of the facility has resulted in contamination of surrounding soil and the groundwater. Contaminated soil at the site is still releasing hazardous substances to the groundwater environment.

2.4.2 Building 81-10 Site (YS-117)

From 1957 to 1962, the Building 81-10 site had an estimated 1361 kg of mercury spilled on the concrete pad, beneath it, and on the ground contaminating the soil and Building 81-10 and its sump, and the sump of Building 9822 (Wiggins 1988a). Also, in 1984, mercury-contaminated soils were stockpiled on the site. It is possible that the mercury contained in the stockpiled soil may have been released to the Building 81-10 site.

2.4.3 Salvage Yard

Release of hazardous chemicals from the Salvage Yard sites to the environment has occurred. These releases are verified by the presence of contamination in the surface and subsurface soils. The nature and extent of contamination resulting from these releases is discussed in Sect. 3.4.3.

2.4.3.1 Salvage Yard oil storage tanks (YS-108)

Soil contamination that resulted from leaks and spills from the Salvage Yard oil storage tanks is suspected. The RFI Work Plan (Welch 1989c) for the Salvage Yard area states that "spills and leaks within the earthen dikes have been reported, suggesting the possibility of releases of PCB and chlorinated solvent contaminated oils to the soil medium."

2.4.3.2 Salvage Yard oil/solvent drum storage area (YS-020)

Inspection of Y-12 Plant photos 216619 and 248406 indicates that releases have occurred at the oil/solvent drum storage areas. Sampling within the storage areas has verified the presence of contaminated soils. Removal of contaminated soil from the western storage area occurred during construction of PIDAS, and removal of contaminated soil from the eastern storage area occurred during RCRA closure.

2.4.3.3 Salvage Yard drum deheader (YT-109) and Tank 2063-U site (YS-204)

Release of waste oils and solvents have occurred at the drum deheader and associated Tanks 2063-U, 2328-U, and 2329-U. These releases have occurred for the most part as a result of past operational practices at the site. From 1959 to 1979, Tanks 2328-U and 2329-U were covered by a metal grate, thus allowing surface runoff to accumulate in the tanks. During periods of heavy rain, liquids contained in these tanks would overflow and drain northwest to a storm water collection basin (Fig. 2.5). Tanks 2328-U and 2329-U were separated by a rubber baffle. This baffle was used to separate water from the oil. The water was discharged via a 4-in. storm drain into the storm water collection basin located ~75 ft to the northwest of the tanks (Fig. 2.5). In addition, all three tanks have leaked into the shallow subsurface (Stone 1989). Drum crushing and deheading may have resulted in spills that could have contaminated the soil adjacent to the concrete floor of the facility.

2.4.3.4 Salvage Yard scrap metal storage area (YS-020)

Due to the nature of the materials stored and limited soil sampling, releases of radioactive and nonradioactive metals are suspected to have occurred where scrap metal piles are located.

3. CHARACTERIZATION OF THE ENVIRONMENTAL SETTING

3.1 GEOGRAPHY

A description of the geographic setting of UEFPC OU 3 is presented in Sect. 2.1.

3.2 CLIMATE

Detailed discussions of climate can be found in Sect. 4.4 of Vol. I of the RFI General Document (Welch 1989a) and in Sect. 3.1 of the *Clinch River RCRA Facility Investigation Plan* (Energy Systems 1990a). The Oak Ridge area has a temperate climate that is moderated by the Blue Ridge Mountains to the east and the Cumberland Plateau to the west.

Weather patterns in Oak Ridge are generally temperate, with warm, humid summers and cool winters. The annual mean temperature is about 15°C (58°F), with a January mean of about 3.5°C (38°F) and a July mean of about 25°C (77°F). Relative humidity in mid-afternoon averages about 55%. At night humidity is higher, averaging 85% at dawn.

The mean annual rainfall is about 136 cm (Fig. 3.1); however, during the drought of 1981-88, yearly precipitation was about 30-35 cm less than average. Winter months usually have the most rain, with another peak in July, when thunderstorms are common. Autumn is usually the season of lowest rainfall.

Prevailing winds in the area follow the general topography of the surrounding ridges (Fig. 3.2). The down-valley draft, coming from the northeast and identified with gravitational flow down local slopes and the Tennessee Valley, prevails during inversion conditions of late evening through mid-morning. Daytime up-valley flow is from the southwest when regional or synoptic flows aloft become strong enough to dominate the opposing local gravitational winds. Average wind speed for the Oak Ridge area is 4.4 mph.

3.3 DEMOGRAPHY

3.3.1 Population Information

The Y-12 Plant is located at the northeast boundary of ORR across Pine Ridge from the commercial center of Oak Ridge, which has a population of 27,310 (U.S. Department of Commerce 1991). The employment at the Y-12 Plant, as of January 1992, consisted of 6934 full-time Energy Systems employees and ~1000 on-site employees of M-K Ferguson, DOE, and ORNL. No drinking water supplies are located within the ORR boundary: a pumping station located on the north bank of Melton Hill Lake at Clinch River supplies water to the Y-12 Plant and the Oak Ridge water plant.

Fig. 3.1. Annual precipitation in the Oak Ridge area. Source: Energy Systems 1991.

Fig. 3.2. 1990 wind rose for Y-12 Plant Meteorological Tower East (east 100-m level), with 98.7% of possible data.

3.3.2 Land Use

The East Tennessee Development District, which includes Oak Ridge, is rural in character. Knoxville is the district's regional center and the only city with a population in excess of 50,000. Oak Ridge and other cities in the district are within the 7500 to 50,000 population range, are incorporated, and have a definite central core that provides major employment and trade opportunities. Of the district's 1,700,010 ha (4,200,800 acres), approximately 80% is in agricultural and forest land use (Table 3.1).

In contrast to the district's general land use patterns, the city of Oak Ridge is an urban center with minimal agricultural activities. Land not owned by the federal government consists of 5510 ha (13,615 acres) and is divided into more than 9500 parcels. Table 3.2 categorizes urban land use data for the city of Oak Ridge. Most of this land is either residential or vacant, with over 1903 ha (4700 acres) of the vacant land suitable for housing (DOE 1982).

Several categories of land use are in close proximity to the ORR. The nearest privately owned residential properties are in the Poplar Springs, Sugar Grove Valley, and Oak Ridge communities. Relative to ORR boundaries, Poplar Springs is located 2 miles west across the Clinch River, and Sugar Grove Valley is located 1.5 miles north. Other residential areas include Bradbury, Edgewood, and Lawnville. Bradbury is located across the Clinch River ~ 5 miles to the south. Edgewood and Lawnville are located immediately west-northwest of the Poplar Springs community. Agricultural use includes limited-scale private gardening; raising of tobacco, corn, wheat, and soybeans as cash crops; raising of beef cattle; and dairy farming. Some areas are also used for commercial logging.

Industrial land use includes Phyton Technologies, Inc.; Scientific Ecology Group (SEG); and IT Corporation's Bear Creek Radiological Laboratory. SEG, Phyton, and the IT Corporation laboratory are within 2 miles of the Y-12 Plant. Tennessee Valley Authority (TVA) facilities, including the Melton Hill Dam, the Bull Run Steam Plant, and the Kingston Steam Plant, are all greater than 6 miles from the Y-12 Plant.

Recreational areas in close proximity to ORR include the Watts Bar Lake Embayment/Clinch River waterway, which is used as a recreational area by both pleasure boaters and fishermen; a number of small camping areas and boat launching ramps; a small dirt-surface racetrack located ~ 4 miles south that attracts several thousand spectators during the racing season; and a public swimming area 7 miles southeast at Melton Hill Dam. There are no public recreational facilities, except the previously mentioned boat launching ramp, within 2 miles of ORR. Sport hunting of game birds and game animals occurs seasonally in the region, and deer hunting is authorized on some parts of the ORR as a conservation measure.

The ORR lies within the corporate limits of the city of Oak Ridge. A buffer zone surrounds each of the facilities to provide security, space for expansion, and isolation from the general public. Tracts totaling about 5666 ha (14,000 acres) are allocated around operating reactors, waste disposal areas, and streams that receive routine waste releases and burial ground seepages. Acreage used for high-voltage transmission lines, pipelines, transportation corridors, and security fences amounts to about 2023 ha (5000 acres) (DOE 1982).

Table 3.1. Land use data for the Eastern Tennessee Development District

Land use category	Hectares	Acres	Percent
Residential	35,074	86,670	2.1
Commercial	1,950	4,820	0.1
Industrial	20,700	51,150	1.2
Recreational	269,129	665,030	15.8
Agricultural	685,904	1,694,900	40.3
Public and quasi-public	28,430	70,250	1.7
Forest	658,823	1,627,980	38.8
TOTAL	1,700,010	4,200,800	100.0

Source: DOE 1982.

Table 3.2. Urban land use data for the city of Oak Ridge, Tennessee^a

Land Use Category	Hectares	Acres	Percent
Residential	1,640	4,050	28.9
Vacant	2,247	5,550	39.6
Recreational	749	1,850	13.2
Commercial	104	256	1.8
Industrial	47	115	0.8
Public transportation, parking	480	1,185	8.5
Private transportation	33	82	0.6
Utilities and communications	52	129	0.9
Services	314	775	5.5
TOTAL	5,666	13,992	99.9

^aExcludes federally owned lands within the corporate city limits.

Source: DOE 1982.

About 80% of the ORR is part of a comprehensive forest management program that divides the ORR into 27 compartments. These compartments range in size from 148 to 486 ha (365 to 1200 acres). Vegetational features unique to the area are excluded from timber harvest operations, and 40 individual sites are designated for environmental research.

The Y-12 Plant is situated at the eastern end of the ORR, adjacent to the commercial center of Oak Ridge, and contains ~800 acres. Land uses associated with the Y-12 Plant facility include several waste storage or disposal areas, of which (1) a parcel of ~61 ha (150 acres) serves as a sanitary waste landfill for solid wastes; (2) ~26 ha (65 acres) located west of the main plant is used as a burial ground for low-level radioactively contaminated solid wastes generated by the Y-12 Plant; and (3) ~1.6 ha (4 acres) is an abandoned quarry formerly used as a disposal and dilution basin for selected nonradioactive chemical wastes, primarily sodium, lithium, and potassium from Y-12 Plant operations.

3.4 TOPOGRAPHY, GEOLOGY, AND SOILS

The Oak Ridge Y-12 Plant is located in the Valley and Ridge physiographic province, part of the Appalachian fold and thrust belt. The area is characterized by a succession of northeast-trending ridges and valleys, which formed as a result of thrust faulting and subsequent differential erosion of the clastic and carbonate lithologies (southeast dipping, locally 45° to vertical) that make up the individual thrust sheets. The strike of the formations is between N47°E and N67°E (King and Haase 1987).

UEFPC OU 3 is located in Bear Creek Valley (BCV), which is bounded to the north and south (plant grid directions, plant grid is ~34° W of true north) by Pine Ridge and Chestnut Ridge, respectively. Maximum relief from the ridge tops to the BCV floor is ~300 ft. These ridges and valley are part of the White Oak Mountain (WOM) thrust sheet, which exposes Lower Cambrian to Ordovician rock units in the immediate area (Fig. 3.3) (Hatcher et al. 1992). The stratigraphy of the area, from oldest to youngest (and exposed from grid-north to grid-south), includes the Lower Cambrian Rome Formation (exposed on Pine Ridge), the Cambrian Conasauga Group (exposed in BCV), and the Knox Group (exposed on Chestnut Ridge).

The Conasauga Group is further divided into six formations of alternating shale and carbonate-rich lithologies. From oldest to youngest these are the Pumpkin Valley Shale, the Rutledge Limestone, the Rogersville Shale, the Maryville Limestone, the Nolichucky Shale, and the Maynardville Limestone (Table 3.3).

The strata of greatest interest, with respect to UEFPC OU 3, include the Maynardville and Nolichucky Formations of the Conasauga Group. For general descriptions of the stratigraphy of other units in the ORR, the reader is referred to Haase, Walls, and Farmer (1985) (Conasauga Group and Rome Formation) and Lee and Ketelle (1988) (Knox and Chickamauga Groups).

Maynardville Limestone. (Shevenell et al. 1992) The Maynardville Limestone is the youngest formation of the Conasauga Group and consists primarily of light-gray to tan, massive to thinly bedded limestone with subordinate amounts of dolostone. Data obtained

Fig. 3.3. Bedrock geology at the Y-12 Plant and vicinity (Geraghty and Miller 1990).

SCALE IN METERS

Table 3.3. Stratigraphy of the Y-12 Plant area (after Solomon et al. 1992)

Unit	Age	Thickness (ft)	Lithology	Hydrologic unit
Knox Group	Lower			
Mascot Dolomite	Ordovician,	246-394	Massive dolomite, siliceous dolomite,	Aquifer
Kingsport Formation	Upper	295-492	bedded chert,	
Longview Dolomite	Cambrian	130-200	limestone, some	
Chepultepec Dolomite		490-700	clastics	
Copper Ridge Dolomite		805-1100		
Conasauga Group	Middle,			
Maynardville Limestone	Upper Cambrian	230-445	Dolomitic limestone, limestone	Aquifer
Nolichucky Shale		442-550	Shale, siltstone,	Aquitard
Dismal Gap Formation (formerly Maryville Limestone)		380-400	calcareous siltstone and shale, shaly limestone, limestone	
Rogersville Shale		100-120		
Rutledge Limestone		100-120		
Pumpkin Valley Shale		320		
Rome Formation	Lower Cambrian	300-410	Shale, siltstone, sandstone, local dolomite lenses	Aquitard

from the Maynardville Exit Pathway Monitoring Program demonstrate that on the ORR, the Maynardville is more uniformly dolomitic and exhibits more subtle vertical lithologic variation than that described in the type section. In BCV, the Maynardville Formation varies in vertical thickness from 320 to 600 ft and in stratigraphic thickness from 230 to 445 ft. The Exit Pathways Program subdivided the Maynardville into six different informal lithologic zones and identified a seventh zone to mark the transition between the Maynardville Limestone and the overlying Copper Ridge Dolomite. The zones were divided based on the gamma log signatures of the individual zones and lithologic characteristics observed in cores and drill cuttings during installation of groundwater monitoring wells. The following discussion provides descriptions for each of the seven lithologic zones.

The transition zone (Zone 7) represents the contact between the Copper Ridge Dolomite and the Maynardville Limestone. The dolomitic zone is ~20 ft thick and contains lithologies that are characteristic of both the Copper Ridge Dolomite and the Maynardville Limestone. The contact is gradational and is marked by an appearance of chert in the Copper Ridge Dolomite and the appearance of vugs in the uppermost Maynardville Limestone. Zone 6 is a dolostone with coarsely crystalline saccharoidal texture and contains an increase in vugs. The zone has an average thickness of 100 ft. Zone 5 is characterized by the presence of thin shale stringers that occur throughout the ~54-ft zone. Zone 4 has an average thickness of 105 ft and is recognized as a massive, light-colored medium to coarsely crystalline sparite, with subordinate amounts of oosparite. Zone 3 averages 79 ft in thickness

and is characterized by an increase in mottling. It is described as a continuation of Zone 4 with a fine to medium-crystalline, massive to slightly mottled sparite. Zone 2 is characterized by a change from a mottled, stylolitic sparite and oosparite to a finely crystalline light-colored sparite exhibiting thin, discontinuous, wisp-like, shale partings. Although the thickness can vary considerably, the average thickness is ~ 150 ft.

In BCV, the Maynardville Limestone occurs on the northern flanks of Chestnut Ridge and extends into the valley axis. Much of the flow through the Maynardville Limestone is controlled by solutionally enlarged fractures and joint sets. Three major joint sets have been identified within the Maynardville Limestone: (1) approximately parallel to geologic strike and along bedding planes; (2) perpendicular to geologic strike and dips steeply; and (3) parallel to strike and perpendicular to bedding planes (Rothschild et al. 1984; Dreier et al. 1987). Dissolution along joint, fractures, and bedding planes in the Maynardville Limestone has formed solutionally enlarged zones and, in some cases, relatively large cavities that have greatly increased the overall permeability of the unit. The larger solution cavities generally occur in the upper part of the saturated zone (Geraghty and Miller 1985). A combination of factors, such as structure, depth, and lithology, affect the fracture and water interval distribution in the Maynardville Limestone. However, the greatest likelihood of intersecting a cavity in the Maynardville Limestone occurs within Zone 6, whereas Zone 3 appears to be the least likely to contain cavities (Shevenell et al. 1992). Most of the cavities in Zones 2 through 6 were located at depths of <100 ft, suggesting the active karst system may be relatively shallow in the Maynardville Limestone. Building 81-10, the Coal Pile Trench, and the S-2 Site are underlain by the Maynardville Limestone.

Nolichucky Shale. (Foreman et al. 1991; King and Haase 1987; Rothschild et al. 1984). In BCV, the Nolichucky Shale ranges in thickness from 422 to 550 ft (King and Haase 1987). Intraclastic limestone, thick fossiliferous limestone, and oolitic limestone interbedded with fissile shale are characteristic of the Nolichucky Shale in the WOM thrust sheet (Foreman et al. 1991). The Nolichucky Shale can be subdivided into four zones based on dominant lithologies: (1) thrombolytic limestone overlying oolitic limestone and lime mudstone occurs in the uppermost Nolichucky; (2) laminated peloidal packstone, lime mudstone, and shale are the most abundant lithologies toward the top of the Nolichucky Shale; (3) oolitic and skeletal packstone and grainstone interbedded with shale are the dominant lithologies in the middle Nolichucky Shale; and (4) intraclastic limestone interbedded with shale and calcareous siltstone are the dominant lithologies in the lower Nolichucky Shale (Foreman et al. 1991). The formation is massive to very thinly bedded and is characterized by a maroon-brown shale. The interbedded limestones typically contain limestone-pebble conglomerates and oolite-rich beds similar to those occurring in the underlying Dismal Gap Formation. Throughout much of the Nolichucky Shale, mudstone/shale and limestone lithologies alternate on a scale of 1 to 3 ft, giving the formation a thickly bedded appearance.

Structural Geology. Pine Ridge, BCV, and Chestnut Ridge all are part of the WOM thrust sheet, which is floored by the WOM thrust fault. The WOM fault is a regional thrust fault of the Valley and Ridge, which shows at least several kilometers of displacement. The fault formed during the Permian-Pennsylvanian Alleghanian Orogeny and has not been historically active. At the ORR, the fault trends parallel to regional strike (N55E) and dips steeply (45°) to the southeast (King and Haase 1987). Bedding plane dip values measured in

outcrops cluster around 45° but may steepen to vertical as a result of localized small-scale folding or faulting.

The WOM thrust fault north of Pine Ridge is very complex and is characterized by a sequence of cross-cutting imbricate splay faults that repeatedly stack the Rome Formation. Because of the complex deformation associated with the WOM thrust fault sheet, it is predicted that this region contains numerous fault-related fracture zones of enhanced permeability.

BCV is characterized by numerous cross-strike streams with a consistent northwestern trend. Such a consistent orientation suggests that the location of these creek beds is controlled by a geological structural feature, either a minor tear fault or a prominent fracture trend. Both features are possible, and in Melton Valley the White Oak Creek Tear Fault shows a similar north trend. If these structures are faults, they show minor displacement but should have an associated fracture zone.

Unconsolidated Materials. Details concerning the physical properties of the unconsolidated material within the main plant compound are complicated. The original topography of the Y-12 Plant has been greatly altered. During construction of the plant, hills were flattened, valleys were filled, and the original drainage was contained within a storm sewer system (Rothschild et al. 1984). Figure 3.4 shows areas that were filled, and shows the original UEFPC channel and tributaries. Unconsolidated material at the Y-12 Plant consists of fill, soil, saprolite, and minor amounts of alluvium. Soil background data are presented in Table 3.4. A background soil study has been conducted by researchers at ORNL. The data from this study will be available for the final work plan and will be used in this RI.

Since the 1940s there have been numerous construction projects, backfilling activities, and excavation work that disturbed and redistributed the surficial deposits. Therefore, backfilled plant areas, where no known releases have occurred, may potentially contain contaminants of concern because the fill may have been excavated from an area where releases occurred in the past. The type of fill material varies greatly. The fill may be tightly compacted or have a large number of voids (Rothschild et al. 1984). This will most likely result in highly variable hydraulic properties.

Rothschild et al. (1984) gives the following description of fill material in the subsurface at the Y-12 Plant. "Color ranges from grey to red brown to yellow brown and dark brown. Generally it contains angular gravel-sized clasts of dolomite and weathered shale up to 2 in. across mixed with clay. In some cores, pieces of asphalt, wood roots, and wire are found in the fill. The percentage of dolomite and shale clasts varies greatly and ranges up to ~90% in thin (less than 4 in.) zones. The shale clasts are often stained by manganese oxide and exhibit bedding structure. In some cores, the upper part of the fill is composed dominantly of dolomite clasts, and is highly porous and very unconsolidated. Compactness and consolidation of the fill increases with depth. At locations not overlain by asphalt, the upper part of the fill is characterized by a thin zone (less than 4 in.) of organic-rich soil and grass."

Fig. 3.4. Preconstruction d

LEGEND:

- ... FORMER LOCATION OF EFPC
 AREAS FILLED DURING PLANT CONSTRUCTION

NOTES:

- 1) Fill areas are based on a comparison of topographic maps from 1942 & 1979
MMES Drawing No.
PES/140/102990 RO

OAK RIDGE Y-12 PLANT UEFPC OU 3 OAK RIDGE, TN.

Figure 3.4 PRE-CONSTRUCTION DRAINAGE & LOCATION OF FILL AREAS

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P. Holm		1/13/93
1	P. HOLM		5/5/93

XREFERENCES	PLOT FILES
93034/XREF/PRE-CONS 93034/XREF/BLDG	93034/PLOT/2501

SHT. 1 OF 1	93034/DWGS/2501	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

Table 3.4. Soil background values for East Tennessee and BCV (all values in ppm)

Analyte	Knox Dolomite ^a	Residual Clay ^a	Residual Clay ^a	Fresh Sevier Shale ^a	Weathered Sevier Shale ^a	Bowen 1966 ^b	Davis 1980 ^c	Bear Creek ^d	Oak Ridge ^e	Mean
Aluminum	400	19,500	13,000	4,500	4,000	71,000		34,228.1	14,330	20,119.8
Antimony	3	0.3	1	1	0.3			0.3	12.3	2.6
Arsenic	10	10	2	5	10	6		6.8	20.6	8.8
Barium	90	150	300	300	300	500		149.5	49.8	229.9
Beryllium	1	1	0.1	0.1	0.1	6			1.10	1.3
Boron	0.6	20	30	60	60			3,956.0	20.6	592.5
Cadmium	1	<0.2	<0.2	<0.2	<0.2	0.06	0.2	0.2	1.0	1.2
Calcium		300	300	6.5	95,000	13,700		1,928.1	3,641	16,410.8
Chromium	3	30	50	50	30	100	100	14.7	15.2	39.4
Cobalt	8	8	8	8	8	8	25	34.8	14.0	13.5
Copper	1	20	20	20	4	20	55	21.2	15.2	25.7
Iron	12,500	15,000	42,000	19,500	19,500	38,000	6000		23,583	19,855.9
Lead	6	10	20	20	20	10	13	42.3	21.6	25.4
Lithium						30		32.0		31.0
Magnesium	11,500	1,500	1,500	5,000	7,500	5,000		4,646.3	1,525	4,771.4
Manganese						850	950		380	1,110.0
Mercury	0.009	0.015	0.016	0.04	0.031	0.03	0.08	0.2	0.17	0.1
Nickel	100	20	40	100	50	40	75		14.7	55.0
Potassium	1,500	10,000	10,000	20,500	10,000	14,000		38.1	2,075	8,514.1
Selenium	8	0.8	3	3	3	0.2		0.2706	20.6	4.9
Silver						0.1	0.07	21.7575	2.05	6.0

Table 3.4 (continued)

Analyte	Knox Dolomite ^a	Residual Clay ^a	Residual Clay ^a	Fresh Sevier Shale ^a	Weathered Sevier Shale ^a	Bowen 1966 ^b	Davis 1980 ^c	Bear Creek ^d	Oak Ridge ^e	Mean
Sodium	9	20	20	60	90	6,300			1,027	1,075.1
Thallium	<0.1	<0.1	0.4	0.4	0.5	0.1	0.45		44.9	5.9
Thorium	0.6	0.6	2	2	4	5	9.6			3.7
Uranium	0.6	0.2	2	2	1	1	2.7	2,3080		1.8
Vanadium	8	20	40	80	20	100	135	49,1821	22	50.4
Zinc	7	30	<0.3	70	200	50	70	46,3532	36.6	56.6

^aMaher 1973.^bBowen 1966.^cDavis 1990.^dTurner and Mercier 1988.^eBechtel National, Inc. 1991. Characterization report for the Elza Gate Site, Oak Ridge, Tennessee. DOE/OR/20722-278. U.S. Department of Energy, Oak Ridge, Tennessee.

Note: Information compiled by ORNL staff.

3.4.1 S-2 Site

The S-2 Site is located at the western end of the Y-12 Plant at the base of Chestnut Ridge (Fig. 3.5). A cross section through the S-2 Site is presented in Fig. 3.6. The unconsolidated zone at the S-2 Site consists primarily of fill material and residuum that is composed of a medium to high plasticity clay that is generally orange-brown, silty, and contains weathered chert fragments. Water-bearing zones were encountered at variable depths (Geraghty and Miller 1987). Depth to water table is ~8 to 15 ft below ground surface (bgs) (Fig. 3.6). The thickness of the unconsolidated zone to the top of bedrock ranges from 18.5 ft to 51 ft at the site.

The bedrock underlying the S-2 Site consists of the upper Maynardville Limestone of the Conasauga Group. The Maynardville Limestone can contain solutional cavities and other karst-related features that profoundly influence groundwater movement (Rothschild et al. 1984; Geraghty and Miller 1985). The contact between the Maynardville Limestone and the overlying Copper Ridge Dolomite of the Knox Group lies immediately to the south of the site (King and Haase 1987).

In spring 1986, monitoring wells GW-251, GW-252, GW-253, GW-254, and GW-256 were installed around the perimeter of the S-2 pond site, and soil Borings SB-1 through SB-7 were installed from both inside and outside of the pond boundaries under the supervision of Geraghty and Miller (1987) (Fig. 3.5). Construction and survey details for monitoring wells at the S-2 Site are presented in Appendix A. Continuous soil samples were collected with Shelby tubes from Borings GW-251, GW-252, GW-253, and GW-256 during the monitoring well installation and from soil Borings SB-1 through SB-7. Soil Borings SB-1 and SB-2 were drilled outside the former pit, and SB-3 to SB-7 were drilled within the former pit boundary. Boring depths extended to the top of bedrock, which ranged from 18.5 to 51.0 ft. Samples were taken at 2-ft intervals, and chemical analyses were conducted on samples from Borings SB-4, SB-5, and SB-6 (Fig. 3.5). Borings SB-1, SB-2, SB-3, and SB-7 were not analyzed. All sample splits from Boring SB-5 were analyzed, while every other sample split, starting from the lowermost sampling in the boring, was analyzed for SB-4 and SB-6. The samples were analyzed for metals, chlorides, nitrates, sulfates, and uranium (Gianfrancesco et al. 1988). Table 3.5 provides a list of sampling activities for the S-2 Site.

The groundwater wells GW-254, GW-256, GW-278, GW-279, and GW-280 were plugged and abandoned in September 1987 because of construction associated with PI 104AS. The site groundwater gradient (Welch 1989b), the terrain conductivity survey showing plume migration (Ketelle 1986), and the location of the holes GW-349 and GW-350 with respect to the S-2 Site suggest that any well analytical results should reflect the influence of the S-3 Site and the Y-12 Plant rather than the S-2 Site. Therefore, analytical parameters for these two wells will be excluded.

The analytical results for the soil samples collected in 1986 indicated elevated concentrations of boron, cadmium, chromium, cobalt, copper, lead, nickel, zinc, uranium, and nitrate at depths ranging from ~8 to 26 ft (Gianfrancesco et al. 1988). The highest concentrations of cadmium, chromium, copper, and nickel occur at the shallowest depths and within a relatively limited interval, from 6 to 16 ft bgs. Elevated concentrations of boron, cobalt, and zinc occur at somewhat greater depths and are found over a wider depth interval,

Fig. 3.5. Boring and monitoring

LEGEND:

- Building
- Fence
- Rail Road
- 2' Contours
- SECTION A-A'
- Soil Boring
- Soil Boring w/o Analysis
- Monitoring Well
- Plugged & Abandoned Well

SOURCE:

- 1) Data for the Effluent Pit is based on drawing No. F.S. 08407 from the Stone & Webster Corp., May 5, 1945
- B Borings Drilled by Earth Technology Inc. 1990
- SB Borings, from Gianfrancesco et.al, 1988, locations are approximated.

OAK RIDGE Y-12 PLANT
UEFPC OU 3
OAK RIDGE, TENNESSEE

FIGURE 3.5
BORING & MONITORING
WELL LOCATIONS AT
S-2 SITE

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P. HOLM		01-29-93
1	P. HOLM		03-17-93
2	P. HOLM		05-05-93

XREFERENCES	PLOT FILES
	\\93034\LOT\276C

SHT 1 OF 1	\\93034\DWG\276C	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

ng well locations at the S-2 Site.

Fig. 3.6. Cross-section

LEGEND:

- ▼ POTENTIOMETRIC SURFACE
- MONITORED INTERVAL OF MONITORING WELLS. DASHED LINES INDICATED WELLS THAT ARE PROJECTED INTO SECTION

NOTES:

- 1.) THE DEPTH & THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE GENERALIZED & INTERPOLATED BETWEEN THE TEST BORINGS INFO. ON ACTUAL SUBSURFACE CONDITIONS EXIST. ONLY AT THE LOC. OF THE TEST BORINGS & IT IS POSSIBLE THAT SUBSURFACE CONDITIONS BETWEEN THE BORINGS MAY VARY FROM THOSE INDICATED

SKETCH BY: TIM COFFEY

SOURCE DATA:

- 1.) ELEVATIONS & DIMENSIONS OF THE S-2 LOCATION FROM DWG. FS.08407.

OAK RIDGE Y-12 PLANT
UEFPC OU 3
OAK RIDGE, TENNESSEE

FIGURE 3.6

CROSS-SECTION THROUGH
THE S-2 SITE

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	R. BEELER		01-28-93
1	P. HOLM		03-17-93
2	P. HOLM		05-05-93

REFERENCES	PLOT FILES
	\\93034\PLT\276PROFA.PLT

SHT 1 OF 1	\\93034\DWG\276PROFA	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

Table 3.5. Sampling activities for the S-2 Site

Sampling event	Site location	Sample station	Sample media	Analytical parameter
April 1986 ^a	S-2	GW-251	Soil	
		GW-252	Soil	
		GW-253	Soil	Metals
		GW-254	Soil	SW-846
		GW-255	Soil	Method 6010
		GW-256	Soil	
		SB-4	Soil	Uranium
		SB-5	Soil	Chloride
		SB-6	Soil	Nitrate
		SB-1	Soil	Sulfate
		SB-2	Soil	
		SB-3	Soil	SB-1, SB-2, SB-3 and SB-7 were not analyzed
		SB-7	Soil	
June 1986 to Dec. 1987	S-2	GW-251	Water	Alkalinity (CO ₃) (HCO ₃)
		GW-252	Water	Total Suspended Solids
		GW-253	Water	Total Kjeldahl Nitrogen
		GW-254	Water	Ammonia
		GW-255	Water	Turbidity
		GW-256	Water	Coliform
				Fluoride
				Chloride
				Nitrate
				Nitrite
				Sulfate
				Total Organic Carbon
				Total Organic Halides
				Metals, (inductively coupled plasma [(ICP), AA]
				Mercury
				Alpha Activity
				Beta Activity
				Strontium-90
				Uranium
				% ²³⁵ U
				Radium
				Volatile Organics
				Extractible Organics
1987	S-2	GW-278	Water	
		GW-279	Water	
		GW-280	Water	
(Gianfrancesco et al. 1988) (Y/TS-321)				Both filtered and unfiltered samples have been taken. Not all parameters were analyzed for each sampling event.

Table 3.5 (continued)

Sampling event	Site location	Sample station	Sample media	Analytical parameter
Sept. 1990 ^b	S-2	B-1 B-2 B-3	Soil Soil Soil	As,Ba,Cd,Cr,Ag,Pb,Hg, and Se by atomic absorption spectroscopy (AAS), ICP Metals, Gross Alpha, Gross Beta, Total U, Isot. U, Thorium, B, Cyanide, SO ₄ ,NO ₃ , TCLP Metals

^aGianfrancesco et al. 1988 (Y/TS-321).

^bEarth Technology 1992.

from 0 to 30 ft bgs (Gianfrancesco et al. 1988). Elevated concentrations of lead and uranium occur within the interval from 8 to 26 ft, with the highest values typically occurring toward the shallower portions of that interval. Elevated nitrate concentrations occur within the interval of 8 to 34 ft bgs, with the highest nitrate concentrations found toward the bottom of this interval at depths of greater than 20 ft. The analytical data obtained from soil borings are tabulated in Gianfrancesco et al. (1988) and are presented graphically in Appendix B.

In 1990, Earth Technology, Inc., implemented the RCRA facility investigation plan (Welch 1989b) for the S-2 Site. Included in the field effort was the collection of 24 split-spoon soil samples from Boreholes B-1, B-2, and B-3 (Fig. 3.5). Samples were collected continuously to refusal. Borehole depths ranged from 25.9 ft to 40.8 ft bgs. The soil samples were analyzed for metals, gross alpha, gross beta, total uranium, isotopic uranium, thorium, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), boron, cyanide, sulfate, nitrate, and toxic characteristic leaching procedure (TCLP) metals. Borings B-1 and B-2 were drilled into the former pit, and Boring B-3 was drilled downgradient of the former pit. Analytical results from these three borings indicate that the soil contamination is greatest at shallow depths within and outside the former pit (Fig. 3.7).

Analytical data from the Earth Technology, Inc., 1990 sampling effort (Earth Technology 1992) substantiate the analytical results reported by Gianfrancesco et al. (1988). Figure 3.7 represents a contaminant versus depth profile for total copper, uranium, and trichloroethylene (TCE) from Borings B-1, B-2, and B-3. The shapes of the B-1 profiles are more or less typical for borings drilled within the confines of the former S-2 pond. Appendix B presents concentration profiles for the other potential COCs. Chemical constituents found at the site include cadmium, chromium, copper, lead, mercury, trichloroethene, tetrachloroethene, depleted and enriched uranium, silver, zinc, arsenic, and cyanide compounds. Trichloroethene and tetrachloroethene were only detected in B-1 and B-2, with the highest levels occurring in B-1 at depths between 6 ft and 14 ft. Soils from Borings B-1, B-2, and B-3 were analyzed by the TCLP. Cadmium from the 6-14 ft depth of Boring B-1 was found to exceed the regulatory limit of 1.0 mg/L. All other metals were found to be below regulatory limits listed in 40 CFR 261.24.

Fig. 3.7. Depth versus concentration for total copper, uranium, and trichloroethene from Borings B-1, B-2, and B-3 at the S-2 site.

Analytical results from Boring B-3 indicate that contamination has migrated from the former S-2 pit; however, concentrations are lower than those found in Borings B-1 and B-2. A comparison of analytical results from Boring B-3 with those from B-1 and B-2 (Fig. 3.7) indicates that trichloroethene has not migrated to the northeast from the former S-2 pit. The comparison also suggests some migration of uranium and copper from the site to the B-3 location, but the data are not conclusive as to the extent.

Table 3.6 represents an analytical summary of the potential COCs at the S-2 Site. The samples were taken from the top interval to the bottom from the Borings B-1, B-2, and B-3. All the analytical results from the three borings are combined, and the proportion of the results greater than the detection limit is given as per contaminant of concern. For each contaminant of concern, a mean and standard deviation is calculated and reported (data generated from Earth Technology 1992).

3.4.2 Building 81-10

Borings, monitoring wells, and other sampling locations at Building 81-10 are shown in Fig. 3.8. The Building 81-10 site is underlain by the Maynardville Limestone. Numerous solution cavities of various sizes have been found in the Maynardville Limestone, especially along bedding planes in the upper parts of the formation. These cavities are more prevalent adjacent to and beneath UEFPC. Solution cavities were encountered in monitoring wells 56-5C and GW-698 (Fig. 3.9). Monitoring well construction data for wells shown on Fig. 3.8 are presented in Appendix A.

Unconsolidated material at the Building 81-10 site consists of fill, soil, weathered bedrock, and possibly alluvium. A cross-section representing the shallow subsurface at Building 81-10 is shown on Fig. 3.9. Building 81-10 is situated on top of or immediately adjacent to the original UEFPC channel. The preconstruction land surface is shown on Fig. 3.9. During plant construction in 1943, the site of Building 81-10 was back-filled with material from adjacent areas. From the time of plant construction until about 1960, UEFPC flowed in an open channel immediately north of Building 81-10. Sometime between 1958 and 1963, this open drainage ditch was back-filled with soil and construction rubble taken from other areas within the Y-12 Plant, and two 60-in. RCP storm drains were installed to contain creek flow. In 1987, ~8700 (± 500) yd³ of fill were removed from the area just north of Building 81-10 as part of the creek tile replacement and PIDAS projects. The two 60-in. storm drains were abandoned in place and replaced by a single 90-in. storm drain as part of the creek tile replacement project. The area of excavation is shown on Fig. 3.8. During an inspection of this building, performed by Science Applications International Corporation (SAIC) as part of this work plan, weathered dull maroon shale chips were observed at the northeast foundation of the building. From inspection of boring logs B-5 and B-6 (Fig. 3.9) from Rothschild et al. (1984), it appears that this material underlies most of Building 81-10 to a depth of about 24 ft.

Six previous investigations have been performed at Building 81-10 (Table 3.7) to characterize the extent of contamination in the subsurface below Building 81-10. The investigations performed by Rothschild et al. (1984) and Earth Technology, Inc. (1992) are well documented and provide the most useful data. Each sampling event is discussed separately in this section.

Table 3.6. UEFPC OU 3 potential contaminants of concern in soil at the S-2 site for B1, B2, and B3 (all intervals)^a

Parameter, unit	Proportion of results > detection limit	Mean detection limit ^b	Minimum result > detection limit	Mean result > detection limit	Maximum result > detection limit	Standard deviation > detection limit	Grand mean (<DL = 0)	Radiation counting uncertainty of mean
<i>Metals</i>								
Arsenic, mg/kg	64/96	4.38	1.10	9.13	34.00	8.54	6.09	NA ^c
Beryllium, mg/kg	48/48	NA	0.22	3.78	21.30	4.72	3.78	NA
Boron, mg/kg	12/48	1.42	1.30	5.82	28.10	10.40	1.45	NA
Cadmium, mg/kg	92/96	0.195	0.71	38.30	610.00	119.00	36.70	NA
Chromium, mg/kg	96/96	NA	2.50	60.00	689.00	103.00	60.00	NA
Cobalt, mg/kg	48/48	NA	4.60	35.40	134.00	583.00	35.40	NA
Copper, mg/kg	48/48	NA	19.80	1770.00	29200.00	NA	1770.00	NA
Lead, mg/kg	96/96	NA	20.10	110.00	353.00	11.60	110.00	NA
Mercury, mg/kg	48/48	NA	0.05	0.40	5.90	1.32	0.40	NA
Nickel, mg/kg	48/48	NA	4.20	49.70	167.00	33.20	49.70	NA
Thallium, mg/kg	42/48	4.30	4.40	85.70	216.00	48.80	75.00	NA
Zinc, mg/kg	48/48	NA	24.80	13.80	401.00	89.30	138.00	NA
<i>VOCs</i>								
Methylene chloride, µg/kg	54/54	NA	3	344	7000	729	344	NA
Tetrachloroethene, µg/kg	40/52	7.17	2	21200	410000	90400	16300	NA
Trichloroethene, µg/kg	41/53	7.17	2	1290	23000	5010	999	

Table 3.6 (continued)

Parameter, unit	Proportion of results > detection limit	Mean detection limit ^b	Minimum result > detection limit	Mean result > detection limit	Maximum result > detection limit	Standard deviation > detection limit	Grand mean (<DL = 0)	Radiation counting uncertainty of mean
<i>Radiologicals</i>								
Alpha activity	48/48	NA	5.5	43	506	104	43	69.2
Beta activity	48/48	NA	14.5	46.2	198	37.6	46.2	16
Uranium, µg/kg	46/46	NA	3750	261000	248000	53000	26100	24.4
<i>Ionic</i>								
Cyanide, µg/kg	0/48	500	NA	NA	NA	72900	0	NA
Nitrate-N, µg/kg	44/48	500	1100	168000	2000000	419000	154000	NA
Sulfate, µg/kg	24/48	1500	21002	21200	55000	20200	10600	NA

^aCalculations include nondetects set to zero. Program: COCSOIL-SAS. Data source: Earth Technology Corporation.^bMean quantitative limit for results reported less than detection limit.^cNot applicable.

Fig. 3.8. Boring and monitoring w

LEGEND:

- Building
- Fence
- Rail Road
- 2' Contour
- Cross Section A-A'
- GW-698 Monitoring Well
- ⊗ 56-5C Abandoned Monitoring Well
- △ SS-1 Surface Soil Sample (Location Approximated)
- ▲ B-4 Soil Boring (Locations approximated from Rothschild et.al., 1984a. Borings B-2, B-3, B-4 have been removed as part of Pidas construction.)
- - - Excavated Area (1987)

OAK RIDGE Y-12 PLANT
UEFPC OU 3
OAK RIDGE, TENNESSEE

Figure 3.8
Building 81-10
(YD-117)
Sample Locations

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P.HOLM		01-29-93
1	P.HOLM		03-17-93
2	P.HOLM		05-05-93

REFERENCES	PLOT FILES
	\\93034\LOT\276B

SHT 1 OF 1	\\93034\DWGS\276B	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

all locations at the Building 81-10 site.

Fig. 3.9. Cross-section through the

LEGEND:

MONITORED INTERVAL OF
MONITORING WELLS.

or
Ror

NOTES:

- 1.) THE DEPTH & THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THE SECTIONS WERE GENERALIZED & INTERPOLATED BETWEEN THE TEST BORINGS INFO. ON ACTUAL SUBSURFACE CONDITIONS EXIST. ONLY AT THE LOC. OF THE TEST BORINGS & IT IS POSSIBLE THAT SUBSURFACE CONDITIONS BETWEEN THE BORINGS MAY VARY FROM THOSE INDICATED

SOURCE DATA

- 1.) PRESITE TOPOGRAPHY FROM DWG. RR 4915.
- 2.) SKETCH BY: WILL KEGLEY
- 3.) BORING LOG DATA FROM JONES ET. AL., 1992

HORIZONTAL SCALE: 1" = 30'-0"

VERTICAL SCALE: 1" = 10'-0"

VERTICAL EXAGGERATION = 3X

OAK RIDGE Y-12 PLANT
UEFPC OU 3
OAK RIDGE, TENNESSEE

FIGURE 3.9

**CROSS-SECTION THROUGH
THE EAST END OF
BUILDING 81-10 (YD-117)**

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	R. BEELER		01-20-93
1	P. HOLM		03-17-93
2	P. HOLM		05-05-93

REFERENCES	PLOT FILES
	\\93034\DWGS\276PROFB.PLT

SHT 1 OF 1	\\93034\DWGS\276PROFB	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

east end of Building 81-10 (YD-117).

Table 3.7. Sampling activities for Building 81-10 site

Sampling event	Site location	Sample station	Sample media	Analytical parameter
August 1971 (Guettner 1971)	Bldg. 81-10	#1 South of storage pad	Soil	Mercury
		#2 North of furnace area in drainage ditch	Soil	Mercury
		#3 North of storage pad	Soil	Mercury
Aug. 1983 Phase I (Rothschild et al. 1984)	Bldg. 81-10	56-5 B	Soil	Mercury
		56-5 C	Soil	Mercury
	Bldg. 81-10	56-5 A	Water	Mercury
		56-5 B	Water	Mercury
		56-5 C	Water	Mercury
Dec. 1983 Phase II (Rothschild et al. 1984)	Bldg. 81-10	56-5/B-2	Soil	Mercury
		56-5/B-3	Soil	Mercury
		56-5/B-4	Soil	Mercury
		56-5/B-5	Soil	Mercury
		56-5/B-6	Soil	Mercury
		56-5/B-7	Soil	Mercury
		56-5/B-8	Soil	Mercury
December 1985 (Turner 1986)	Bldg. 81-10	BH-1	Soil	Mercury, Uranium
		BH-2	Soil	Mercury, Uranium
		BH-3	Soil	Mercury, Uranium
		BH-4	Soil	Mercury, Uranium
1986 (Murphy 1988)	Bldg. 81-10	Soil Pile 1	Soil	Total Hg, U, % ²³⁵ U & EP Tox.
		Soil Pile 2	Soil	Total Hg, U, % ²³⁵ U & EP Tox.
		Soil Pile 3	Soil	Total Hg, U, % ²³⁵ U & EP Tox.
		Soil Pile 4	Soil	Total Hg, U, % ²³⁵ U & EP Tox.
		Soil Pile 5	Soil	Total Hg, U, % ²³⁵ U & EP Tox.
		Soil Pile 6	Soil	Total Hg, U, % ²³⁵ U & EP Tox.
November 1990 (Earth Technology 1992)	Bldg. 81-10	GW-696 (WN#5)	Soil	VOCs, ICP
		GW-697 (WN#5)	Soil	Metals, As, Ba, Pb, Hg, Se,
		GW-698 (WN#5)	Soil	Cd, Cr, Ag, gross alpha,
		GW-699 (WN#1)	Soil	and gross beta,
		GW-700 (WN#3)	Soil	total U, and isotopic U
		GW-701 (WN#2)	Soil	
		GW-702 (WN#4)	Soil	
		SS-1	Surface soil	
		SS-2	Surface soil	
		SS-3	Surface soil	
		SW-1	Surface	
		SW-2	Water/sed.	
		GW-696 (WN#5)	Surface water	
		GW-697 (WN#5)	Water	
		GW-698 (WN#5)	Water	
		GW-699 (WN#1)	Water	
		GW-700 (WN#3)	Water	
		GW-701 (WN#2)	Water	
		GW-702 (WN#4)	Water	

In 1971, core samples were taken at three locations around Building 81-10 (Fig. 3.8). The locations of the boreholes shown in Fig. 3.10 were not surveyed. Individual samples 1 to 2 ft in length were taken continuously to depths of 6 to 14 ft bgs. Boring 1 was advanced to a depth of 8 ft bgs. Slight amounts of visible mercury were evident between 3 and 5 ft bgs as reported in Guettner (1971). Inspection of the soil from Location 2 (Fig. 3.10) indicated that visible mercury contamination was present in slight amounts to a depth of 8 ft bgs and was "very much present" from 9 to 10.5 ft and from 12 to 13.5 ft bgs (Guettner 1971). Subsequent analysis for percentage of mercury in soil composited from each corehole indicated that Corehole 2 had the highest percentage of mercury, 520 ppm. No visible mercury was observed from Boring 3 (Guettner 1971). The Boring 2 location was excavated during the creek tile replacement and PIDAS construction projects (Guettner 1971). The Boring 1 location has not been altered since 1971, and the visible mercury observed at that location is expected to remain at the 3- to 5-ft depth, assuming that no further subsurface transport has taken place.

Rothschild et al. (1984) performed an extensive investigation on the mercury contamination at Building 81-10. During the investigation, monitoring well cluster 56-5 was installed along with eight soil borings (B-2 through B-9). The locations of these sampling points are shown on Fig. 3.8, and the screen zones for well cluster 56-5 are shown on Fig. 3.9. The locations of Boreholes B-2 through B-9 shown in Fig. 3.8 were not surveyed and are approximated from Rothschild et al. (1984). All the borings were sampled continuously to refusal. Appendix B contains mercury concentration profiles for Borings B-2 through B-9. Mercury was detected at levels above background in Borings B-2 through B-9. Mercury background for the Y-12 Plant is identified by Rothschild et al. (1984) as 0.2 ppm (analytical detection limit). Borings B-3 and B-4 had high mercury concentrations, with mercury values over 1000 ppm for the 3- to 7-ft interval from B-3 and over 1000 ppm for B-4 at the 10- to 12-ft interval. Both Borings B-3 and B-4 were removed along with Boring B-2 during the creek tile replacement and PIDAS construction projects. Well cluster 56-5 was also plugged and abandoned as part of the construction activities. It is not known exactly how deep the area was excavated for PIDAS and the creek tile replacement; thus, some contamination may still be present at depth.

Borings B-5 and B-6 were drilled on the south side of Building 81-10, and B-7 was drilled on the east side. In Borings B-5 and B-6, mercury was detected at over 100 ppm and 50 ppm, respectively, in the 5-ft to 6-ft intervals. Figure 3.11 shows a comparison of depth versus mercury concentration for B-5, B-6, and B-7. Mercury was detected at levels over 100 ppm from 0 to 3 ft in B-7 and at levels over 75 ppm at the 5- to 6-ft interval in B-8. The locations of Borings B-5, B-6, B-7, B-8, and B-9 have not been disturbed since the samples were taken, and any mercury observed at these locations is expected to still be present, assuming no further subsurface transport.

In 1985, four borings were drilled as part of the PIDAS and creek tile replacement projects (Turner 1986). Mercury was found at high concentrations in these borings. The boring locations were never surveyed, and their location cannot be plotted. All these borings were excavated as part of the PIDAS construction.

In 1990, Earth Technology, Inc., implemented the RFI plan (Wiggins 1988a) for Building 81-10. Three surface soil samples (SS-1, SS-2 and SS-3) and five borings were

93034\DWGS\276A

Fig. 3.10. Sampling locations for 1971 composite samples.

92-206P/072993

Method: EPA-600 4-79-020, 245.5 Reference: Rothschild et al, 1984

Fig. 3.11. Depth versus concentration for total mercury from Borings B-5, B-6, and B-7 at the Building 81-10 site.

advanced as part of this investigation. The five boreholes were completed as monitoring wells (GW-696, GW-699, GW-700, GW-701, and GW-702) and samples at 2-ft intervals to a maximum depth of 25 ft in GW-701. Sampling locations are shown in Fig. 3.8. The soils were analyzed for VOCs, metals, total uranium, and isotopic uranium. Results from this investigation indicated that the surface soil samples between Building 81-10 and the PIDAS corridor (SS-1, SS-2, and SS-3) had high metal contamination. Mercury had the most significant concentration within each surface soil sample. Mercury was detected at 53.1 ppm in SS-1, 24.3 ppm in SS-2, and 37.3 ppm in SS-3. Analytical results from samples obtained from the five boreholes are summarized in Table 3.8.

In addition to soil samples, a sediment sample from the small sump, located at the northeast corner of the building site, was taken. This sample yielded mercury at 3180 ppm, nickel at 349 ppm, lead at 254 ppm, antimony at 52.2 ppm, thallium at 73.5 ppm, and zinc at 1010 ppm.

Table 3.8. Summary of soil analytical results for Building 81-10 site soil samples from Earth Technology sampling

Sample or borehole	Chemical	Highest analytical result (ppm)
SS-1	Cr	43
	Hg	53
SS-2	Hg	243
	Sb	5.6
SS-3	Cr	62
	Hg	373
	Ni	305
	Pb	303
	Sb	14.9
GW-697	Co	53.2
	Pb	145
	Tl	75.5
GW-699	Co	34.9
GW-700	Co	27.5
	Cu	92.7
	Hg	151
	Sb	42
GW-701	Co	58.2
	Hg	64.4
	Tl	18.1

Table 3.9 presents an analytical summary of the potential COCs in the soils at the Building 81-10 site. The samples were taken from the groundwater monitoring well GW-696 and soil borings SS-1, SS-2 and SS-3. Monitoring wells GW-699, GW-700, GW-701, and GW-702 were excluded, as they are located outside the investigation site. All the analytical results from the groundwater well and soil borings are combined, and the proportion of results greater than the detection limit is given as per contaminant of concern. For each contaminant of concern, a mean and a standard deviation value are calculated and reported (data generated from Earth Technology 1992).

3.4.3 Salvage Yard

The Salvage Yard sites are underlain by gravel, fill, natural soil, and saprolite, which in turn is underlain by Nolichucky Shale. Borings and monitoring wells that have been installed in the Salvage Yard vicinity are shown in Figs. 3.12 and 3.13. Survey and construction details for these borings and wells are presented in Appendix A. A 1- to 2-ft-thick gravel layer is present over most of the Salvage Yard surface. Most of the unconsolidated material below the gravel layer consists of highly weathered tan to reddish-brown shale, which commonly displays relict bedding. Depth to bedrock is irregular and varies from 3 to 24 ft. The contact between saprolite and rock is gradational. Local strike within the Salvage Yard area varies from N 50°E to N 66°E, and dip is about 45° to the south (King and Haase 1987).

Table 3.10 presents a list of soil sampling activities that have occurred at the Salvage Yard. The soil sampling events were performed to characterize the extent of contamination in the subsurface below the Salvage Yard sites. Each sampling event is discussed below.

In 1986 the Oil/Solvent Drum Storage Area was investigated to evaluate the nature and extent of contamination in the underlying soils. Eight borings were drilled as part of the Phase I effort, and 24 borings were drilled as part of Phase II. The borings are labeled sequentially with the prefix BH, and their locations are shown on Fig. 3.13. Boring coordinates and total depth of penetration are listed in Table 3.11. The borings were drilled at the east Oil/Solvent Drum Storage Area, and the remainder were drilled at the western Oil/Solvent Drum Storage Area. The analytical results for the Phase II sampling effort are contained in Shelton and Willoughby (1986a). Table 3.12 lists the highest concentrations detected during the sampling effort. Extraction procedure (EP) toxicity tests were performed on soil samples with high metal concentrations.

Shelton and Willoughby (1986b) presented the results of verification sampling at the western Salvage Yard Oil/Solvent Drum Storage Area (S-020). The verification sampling was conducted after all the drums had been removed from the site. This sampling effort involved taking ten composite samples from ten randomly selected major grid squares (Shelton and Willoughby 1986b). The composite samples were tested for the following analytes: tetrachloroethene, methylene chloride, 1,1,1-trichloroethane, trichloroethene, benzene, toluene, methyl ethyl ketone, PCBs, freon 113, arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. All analytes were found to be below the maximum allowable limits specified in the closure plan.

Table 3.9. UEFPC OU 3 potential contaminants of concern for soils at Building 81-10
incorporating data from GW-696, SS-1, SS-2 and SS-3^a

Parameter, unit	Proportion of results > detection limit	Mean detection limit ^b	Minimum result > detection limit	Mean result > detection limit	Maximum result > detection limit	Standard deviation > detection limit	Grand mean (<DL = 0)	Radiation counting uncertainty of mean
<i>Metals</i>								
Arsenic, mg/kg	38/64	3.63	0.39	7.16	40.7	11.6	4.25	NA ^c
Beryllium, mg/kg	32/32	NA	0.11	0.637	1.1	0.275	0.637	NA
Boron, mg/kg								
Cadmium, mg/kg	6/32	0.599	0.84	4.23	10.9	5.16	0.794	NA
Chromium, mg/kg	32/32	NA	2.7	24.4	61.7	14.5	24.4	NA
Cobalt, mg/kg	32/32	NA	3.8	19.8	53.2	12.2	19.8	NA
Copper, mg/kg	32/32	NA	5.1	17.4	68.3	15.6	17.4	NA
Lead, mg/kg	62/64	3.7	3.9	34.9	303	65.4	33.8	NA
Mercury, mg/kg	28/32	0.02	0.03	48.1	373	112	42.1	NA
Nickel, mg/kg	32/32	NA	5.8	39.2	305	72.3	39.2	NA
Thallium, mg/kg	2/32	3.91	75.5	75.5	75.5	0	4.72	NA
Zinc, mg/kg	32/32	NA	21.1	108	822	200	108	NA
<i>VOCs</i>								
Methylene chloride, µg/kg	32/32	NA	4	5.19	12	2.01	5.19	NA
Tetrachloroethene, µg/kg	2/32	6	3	3	3	0	0.188	NA
Trichloroethene, µg/kg	0/32	6	NA	NA	NA	NA	0	NA

Table 3.9 (continued)

Parameter, unit	Proportion of results > detection limit	Mean detection limit ^b	Minimum result > detection limit	Mean result > detection limit	Maximum result > detection limit	Standard deviation > detection limit	Grand mean (<DL = 0)	Radiation counting uncertainty of mean
<i>Radiologicals</i>								
Alpha activity, pCi/g	32/32	NA	3.67	11.5	71.4	16	11.5	15.8
Beta activity, pCi/g	32/32	NA	15.1	52.5	272	58.4	52.5	20.5
Uranium, µg/kg	32/32	NA	2,320	39,300	521,000	127,000	39,300	51.5
<i>Ionic</i>								
Cyanide								
Nitrate-N								
Sulfate								

^aCalculations include nondetects set to zero. Program: COCSOILSAS. Data source: Earth Technology. Date: March 19, 1993.^bMean quantitative limit for results reported less than detection limit.^cNot applicable.

Fig. 3.12. Boring and monitoring

LEGEND:

- Building
- Fence
- Rail Road
- Removed Nitric Acid Line
- Soil Boring
- Monitoring Well
- Plugged & Abandoned
- Monitoring Well

NOTES:

- 1.) FOR REFERENCE DWGS. SEE
MMES DWGS: ECV-26158
ECV-26159
ECV-25670
ECV-25669
C2E-29582
C2E-129583
- 2.) BH BOREHOLE LOCATIONS
FROM 7/SUB/86-00206C/1.
- 3.) WB & EB BOREHOLE LOC.
FROM EARTH TECHNOLOGY
1992.

OAK RIDGE Y-12 PLANT
UEFPC OU 3
OAK RIDGE, TENNESSEE

SALVAGE YARD BORING & MONITORING WELL LOCATION MAP

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P. HOLM	W. KEGLEY	01-29-93
1	P. HOLM	W. KEGLEY	03-18-93
2	P. HOLM	W. KEGLEY	05-05-93

XREFERENCES	PLOT FILES
	\93034\LOT\250L.PLT

SHT 1 OF 1	\93034\DWGS\250L	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

g well locations at the Salvage Yard.

LEGEND:

- Building
- Fence
- Rail Road
- Removed Nitric Acid Line
- BH-12 Soil Boring
- GW-261 Monitoring Well
- Δ₁ Surface Soil Sample
- Surface Water Runoff
- Direction
- 2' Contour

NOTES:

- 1.) FOR REFERENCE DWGS. SEE MMES DWGS:
ECV-26158 ECV-25670
ECV-26159 ECV-25669
C2E-29582 C2E-129583
- 2.) BH BOREHOLE LOCATIONS FROM 7/SUB/86-00206C/1.
- 3.) WB & EB BOREHOLE LOC. FROM EARTH TECHNOLOGY 1992.
- 4.) SURFACE SOIL SAMPLE LOCATIONS APPROXIMATED FROM LIND & WELCH, 1989

Y-12 Plant North

OAK RIDGE Y-12 PLANT
UEFPC OU 3
OAK RIDGE, TENNESSEE

**OIL/SOLVENT
DRUM STORAGE
AREA**

REVISION	DRAWN BY:	CHKD. BY:	DATE:
0	P. HOLM		01-26-93
1	P. HOLM		03-18-93
2	P. HOLM		05-06-93

XREFERENCES	PLOT FILES
	\\93034\PLT\250L.PLT

SHT 1 OF 1	\\93034\DWGS\250M	N/A
DRAWING #	CAD FILE #	ROT. ANGLE

thern portion of the Salvage Yard.

Table 3.10. Sampling activities at the Salvage Yard

Sampling event	Site location	Sample station	Sample media	Analytical parameters
1986 Phase I (Shelton and Willoughby 1986a) Y/TS-212/3	Oil/Solvent Drum Storage Area	BH-1, BH-2, BH-3, BH-7, BH-10, BH-11, BH-12, BH-13	Soil	As, Ba, Cd, Cr, Pb, Hg, Se, Ag, Benzene, Freon 113, Methyl Ethyl Ketone, Methylene Chloride, PCBs, Tetrachloroethene, 1,1,1-Trichloroethane, Trichloroethene, Toluene
1986 Phase II (Shelton and Willoughby 1986a) Y/TS-212/5	Oil/Solvent Drum Storage Area	BH-4, BH-5, BH-6, BH-8, BH-9, BH-14, BH-15, BH-16, BH-17, BH-18, BH-19, BH-20, BH-21, BH-22, BH-23, BH-24, BH-25, BH-26, BH-27, BH-28, BH-29, BH-30, BH-31, BH-32	Soil	As, Ba, Cd, Cr, Pb, Hg, Se, Ag, Benzene, Freon 113, Methyl Ethyl Ketone, Methylene Chloride, PCBs, Tetrachloroethene, 1,1,1-Trichloroethane, Trichloroethene, Toluene
1986 West Closure Verification (Shelton and Willoughby 1986b) Y/TS-212/8	Oil/Solvent Drum Storage Area	VI-1, VI-2, VI-3, VI-4, VI-5, VI-6, VI-7, VI-8, VI-9, VI-10	Soil	(SW-846 methods) As, Ba, Cd, Cr, Se, Ag, Benzene, Freon 113, Methyl Ethyl Ketone, Methylene Chloride, PCBs, Tetrachloroethene, 1,1,1-Trichloroethane, Toluene
1988 East Closure, Phase I (Lind and Welch 1989) Y/TS-382/R2	East Oil/Solvent Drum Storage Area	13 locations 12- to 15-in. depth	Soil	(SW-846 methods) metals 3050, 6010; Hg 7471; As, Se, Cd, Pb 7000 series; U, % 235 Isotopic Dilution Mass Spectroscopy; EP Tox (As Pb); Volatiles 8240; PCBs 8080
1988 East Closure Phase II (Lind and Welch 1989) Y/TS-382/R2 Y/TS-510 (Lind 1989a)	East Oil/Solvent Drum Storage Area	13 locations 18 to 24 in.; same locations as 1988 Phase I	Soil	(SW-846 methods) metals 3050, 6010; Hg 7471; As, Se, Cd, Pb 7000 series; U, %235 Isotopic Dilution Mass Spectroscopy; EP Tox (As Pb); Volatiles 8240; PCBs 8080

Table 3.10 (continued)

Sampling event	Site location	Sample station	Sample media	Analytical parameters
March 17, 1989 Initial Abatement Sampling from the Drum Deheader Sumps (Stone 1989) Y/TS-566	Tanks 2063, 2328, 2329	18 locations adjacent to tanks	Soils	(SW-846 methods) metals, Arsenic, Cadmium, Chromium, Lead, Mercury, Selenium, volatile organic analytes, semivolatiles, pesticides, PCBs, alpha-beta activity, Total Uranium, Percent U-235
July 21-22, 1989 Drum Deheader Tanks Excavation Sampling (Stone 1989) Y/TS-566	Tanks 2063, 2328, 2329	14 soil samples taken from bottom of excavation and excavated soil piles. 1 water sample from Tank 2328-U excavation	Soil water	(SW-846 methods) metals, Arsenic, Cadmium, Chromium, Lead, Mercury, Selenium, VOAs, semivolatiles, pesticides, PCBs, alpha-beta activity, Total Uranium, Percent U- 235
1990 RFI implementation (Earth Technology 1992)	Salvage Yard Area	WB1, WB2, WB3, WB4, WB5, WB6, WB7, WB8, WB9, EB1, EB2, EB3, EB4, EB5, EB6, 38 surface soil samples	Soil	Appendix IX sweep: metals, VOA,

In 1988 shallow soil samples were taken in support of closure activities for the eastern Oil/Solvent Drum Storage Area (Lind and Welch 1989). The specific objectives of the sampling were (1) to identify organic and inorganic contaminant concentrations in the excavated soil from the Salvage Yard after excavation was complete; (2) to identify any organic or inorganic contaminants that were present within the top 12 in. of soil remaining after excavation was complete; and (3) to delineate the horizontal extent of the contamination. The sampling was conducted in two phases. In Phase I, 13 soil samples were taken to a depth of 12 in. at locations identified in Fig. 3.13. Phase II sampling was carried out after the first 12 in. of soil were excavated. Samples for Phase II were taken at the same location as was used for Phase I. Table 3.10 lists the parameters for which the samples were analyzed.

In 1989, soil samples were collected as part of the characterization and excavation activities associated with Tanks 2063-U, 2328-U, and 2329-U (Stone 1989). Sampling locations associated with this effort are shown on Fig. 3.14.

During the initial abatement (March 1989) of Tanks 2063-U, 2328-U, and 2329-U, 18 soil samples were taken in the vicinity of the tanks. Additional sampling (July 1989) was

Table 3.11. Phase I and II soil boring survey data for the oil/solvent drum storage area (Willoughby 1986)

Boring number	Drum storage area	Coordinates		Ground elevation (ft MSL)	Boring depth (ft)	Sample type ^c	Date begun and completed
		North	East				
BH-1	WEST	30,740.80	53,373.12	1,030.46	6.0	ST	05/19/86
BH-1 Redrill	WEST	30,737.98	53,373.21	1,030.40	15.8	SS, ST	05/19/86
BH-2	WEST	30,818.64	53,447.65	1,036.37	20.0	SS, ST	05/20/86
BH-3	WEST	30,734.56	53,443.93	1,030.66	24.8	SS, ST	05/21/86
BH-4	WEST	30,765.80	53,444.79	1,032.53	13.0	SS, ST	05/21/86
BH-5	WEST	30,791.26	53,445.63	1,034.94	20.4	SS	05/22/86
BH-6	WEST	30,760.03	53,505.73	1,033.69	17.4	SS	05/23/86
BH-7	WEST	30,732.19	53,504.27	1,031.19	20.4	SS	05/27/86
BH-8	WEST	30,762.90	53,371.73	1,031.24	17.4	SS	05/28/86
BH-9	WEST	30,794.80	53,373.25	1,033.24	18.4	SS	05/29/86
BH-10	WEST	30,628.53	53,679.25	1,024.00	23.4	SS	05/30/86
BH-11	WEST	30,636.90	53,607.87	1,024.64	23.4	SS	05/30/86
BH-12	WEST	30,643.20	53,572.72	1,025.32	19.8	SS	06/02/86
BH-13	WEST	30,754.29	53,624.55	1,030.58	13.3	SS	06/02/86
BH-14	WEST	30,767.58	53,580.21	1,032.13	12.0	SS	06/03/86
BH-15	WEST	30,763.36	53,540.71	1,033.49	11.3	SS	06/03/86
BH-16	WEST	30,817.85	53,376.13	1,034.67	12.0	SS	06/03/86
BH-17	WEST	30,798.01	53,353.32	1,032.99	11.3	SS	06/04/86
BH-18	WEST	30,799.62	53,508.94	1,035.42	15.4	SS	06/05/86

Table 3.11 (continued)

Boring number	Drum storage area	Coordinates		Ground elevation (ft MSL)	Boring depth (ft)	Sample type ^a	Date begun and completed
		North	East				
BH-19	WEST	30,808.46	53,512.23	1,031.68	11.3	SS	06/05/86
BH-20	WEST	30,731.19	53,539.14	1,031.06	12.0	SS	06/05/86
BH-21	WEST	30,731.19	53,539.14	1,028.47	24.0	SS	06/06/86
BH-22	WEST	30,701.07	53,539.14	1,027.52	20.0	SS	06/06/86
BH-23	WEST	30,694.86	53,443.23	1,028.32	20.0	SS	06/09/86
BH-24	WEST	30,712.54	53,500.85	1,029.01	20.0	SS	06/09/86
BH-25	WEST	30,717.63	53,372.90	1,031.66	6.0	SS	06/09/86
BH-26	WEST	30,718.10	53,502.23	1,032.20	6.0	SS	06/09/86
BH-27	WEST	30,724.70	53,335.57	1,029.15	1.0	SS	06/09/86
BH-28	WEST	30,719.18	53,334.32	1,029.18	2.0	SS	06/09/86
BH-29	WEST	30,713.77	53,333.95	1,029.21	2.0	SS	06/09/86
BH-30	WEST	30,708.31	53,335.25	1,028.79	2.0	SS	06/09/86
BH-31	WEST	30,702.15	53,338.44	1,028.53	2.0	SS	06/09/86
BH-32	WEST	30,700.34	53,347.83	1,028.63	2.0	SS	06/09/86

^aSS = split-spoon, ST = Shelby tube.

Table 3.12. Highest observed contaminant concentrations in Phase I and II soil samples at the Salvage Yard oil/solvent drum storage area (Shelton and Willoughby 1986)

Contaminant	Highest concentration in Phase I samples	Highest concentration in Phase II samples
Arsenic, mg/kg	4.8	17
Barium, mg/kg	1300	760
Cadmium, mg/kg	3.3	4.1
Chromium, mg/kg	48	57
Lead, mg/kg	95	290 ^a
Mercury, mg/kg	202 ^a	306 ^a
Selenium, mg/kg	0.6	0.6
Silver, mg/kg	0.7	5.4
Tetrachloroethene, $\mu\text{g/kg}$	740	1600
Methylene chloride, $\mu\text{g/kg}$	19	13
1,1,1-trichloroethane, $\mu\text{g/kg}$	1800	8
Trichloroethene, $\mu\text{g/kg}$	14	2
Benzene, $\mu\text{g/kg}$	ND ^b	ND
Toluene, $\mu\text{g/kg}$	29	51
Methyl ethyl ketone, $\mu\text{g/kg}$	ND	ND
PCB, $\mu\text{g/kg}$	ND	100
Freon 113, $\mu\text{g/kg}$	ND	150

^aEP Toxicity Tests were performed on the soil samples with lead and mercury concentrations greater than the preliminary action values. The lead and mercury concentrations from the Toxicity Tests did not exceed the maximum allowable limits.

^bND = not detected.

performed at depths of ~3 ft when the tanks were excavated. This effort included 14 soil samples from the bottom of the excavated pits and 1 sample taken from the excavated pile (Stone 1989).

Table 3.13 (Stone 1989) shows the analytical concentrations of the soil contaminants found during the initial abatement and excavation efforts. Table 3.14 presents contaminant concentrations in water collected during the excavation of Tanks 2063-U, 2328-U, and 2329-U.

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Fig. 3.14. Sampling locations for Tanks 2063-U, 2328-U, and 2329-U.

Table 3.13. Detected concentrations in soil collected during initial abatement and excavation of Tanks 2063-U, 2328-U, and 2329-U (Stone 1989)

Contaminant	Initial Abatement (3/17/89)		Excavation Date (7/21/89)	
	Mean ^d	(Min - Max)	Mean ^d	(Min - Max)
Volatiles ^b (µg/kg)				
Tetrachloroethene	10,000	10U - 4,700J	17,000	10U - 64,700
Methylene chloride	32	<10 - 111	390	<10- 1,640J
1,1,1-Trichloroethane	500	<10 - 3,520J	2,800	50U - 12,700J
Trichloroethene	640	<10 - 2,830J	3,700	86 - 9,170J
Benzene	---	<10 - <100	34	<10 - 38
Toluene	150	10U - 101	50	<10 - 50
Xylene	---	---	160	19 - 537
Freon 113	350	<10 - 1790J	2,080	110 - 7,740J
Total PCBs (mg/kg)	2.5	0.3 - 4.1	9	0.3 - 30
Metals (mg/kg)				
Arsenic	4.5	1.6 - 13	8.4	3.8 - 13
Barium	230	16 - 1570	197	<0.2 - 323
Cadmium	0.71	<0.01 - 4.8	3.9	<0.25 - 36
Chromium	30	15 - 50	45	17 - 70
Lead	31	9.4 - 86	58	11-150
Mercury	11	<0.02 - 81	20	<0.2 - 97

Table 3.13 (continued)

Contaminant	Initial Abatement (3/17/89)		Excavation Date (7/21/89)	
	Mean ^a	(Min - Max)	Mean ^a	(Min - Max)
Selenium	0.2	<0.2 - 0.5	---	<0.2 - <3.8
Silver	---	<2.8 - <4.2	---	<3.5 - <4
Uranium, total (mg/kg)	34	3.6 - 142.3	14.3	3.47 - 36.0
Uranium-235 (percent)	0.579	0.336 - 1.21	2.13	0.693 - 10.5
Alpha activity (pCi/g)	38	8.1 - 83	20	6.1 - 48.0
Beta activity (pCi/g)	37	11 - 72	23	5.9 - 47
Gamma, total (pCi/g)	---	---	9.3	3.0 - 17

^aCalculated using "undetected" and "less than" values at the detection limit rather than as zeros. Mean not calculated when all sample analysis is below the detection limit.

^bU = contaminant was not detected during analysis. J = estimated value.

Table 3.14. Contaminant concentrations in water collected during excavation of Tanks 2063-U, 2328-U, and 2329-U (Stone 1989)

Contaminant	Units	Tank 2063-U	Tanks 2328-U and 2329-U
Tetrachloroethene	µg/L	28,000	11,000
Methylene chloride	µg/L	110	470
1,1,1-Trichloroethane	µg/L	72,000	3,600
Trichloroethene	µg/L	2,000	32,000
Benzene	µg/L	<10	<10
Toluene	µg/L	74	95
Freon	µg/L	22,000	1,300

In 1990, 15 borings and 38 surface soil samples were taken by Earth Technology, Inc. This sampling effort was based on the RFI Plan (Welch 1989c). The boring locations are shown in Fig. 3.12, and the surface soil sample locations, broken into geographic sub-areas, are presented in Fig. 3.15. The soils were analyzed for parameters listed in Appendix C according to SW-846 methods for metals and organic compounds.

The borings were sampled continuously to refusal. The deepest boring was 13.5 ft bgs, while the shallowest was 11.5 ft bgs. Boring depth versus concentration profiles for the potential COCs (Table 2.2) are presented in Appendix B. High concentrations were detected for some contaminants; however, their distribution does not appear to be widespread. The highest concentrations of contaminants were found in the vicinity of the drum deheader and waste oil storage tanks. The following contaminants were detected from the 5- to 9-ft interval of Boring WB4: tetrachloroethene (310 ppm), trichloroethene (8.6 ppm), PCBs (2.3 ppm), and copper (90 ppm). Copper was also detected at the 9- to 11-ft interval of Boring WB4 at a concentration of 266 ppm. The following contaminants were detected from the 2- to 4-ft interval of Boring WB3: lead (131 ppm), nickel (109 ppm), and copper (331 ppm). Mercury (15.5 ppm) and lead (156 ppm) were detected in Boring WB6 from the 0- to 2-ft and 6- to 8-ft intervals, respectively.

Table 3.15 presents the soil boring analytical summary of the potential COCs at the Salvage Yard (Welch 1989c). All the analytical results are combined, with the proportion of results greater than the detection limit given as per contaminant of concern. For each contaminant of concern, a mean and standard deviation is calculated and reported (data generated from Earth Technology 1992).

Surface soil sampling locations with the COCs above the detection limit are shown on Fig. 3.15. Each surface soil sample shown is a composite sample. Figure 3.15 is broken into five geographic areas of the Salvage Yard, and the statistical analysis of the potential COCs is reported by area of occurrence in Table 3.16.

Fig. 3.15. Location of surface soil samples collected at the Salvage Yard.

Table 3.15. UEFPC OU 3 potential COCs in soil at Salvage Yard, analytical summary^a

Parameter	Proportion of results > detection limit	Mean detection limit ^b	Minimum result > detection limit	Mean result > detection limit	Maximum result > detection limit	Standard deviation > detection limit	Grand mean (<DL = 0)	Radiation counting uncertainty of mean
Arsenic, mg/kg	338/536	3.73	0.31	4.37	71.4	6.76	2.76	NA ^c
Beryllium, mg/kg	256/268	0.14	0.13	0.969	2.1	0.451	0.925	NA
Cadmium, mg/kg	134/532	0.369	0.11	0.688	2.9	0.538	0.173	NA
Chromium, mg/kg	532/532	NA	5.4	30.6	139	13.8	30.6	NA
Cobalt, mg/kg	256/268	2.6	2.4	16	81.1	12	15.3	NA
Copper, mg/kg	266/268	6.6	2.5	22.2	331	37.4	22	NA
Lead, mg/kg	528/536	3.57	0.85	23.8	1100	75.1	23.5	NA
Mercury, mg/kg	144/268	0.024 ⁴	0.02	0.652	15.5	2.05	0.35	NA
Nickel, mg/kg	264/268	2.85	3	22.9	109	14.6	22.6	NA
Thallium, mg/kg	252/268	3.74	3.4	56.4	202	36.7	53.1	NA
Zinc, mg/kg	268/268	NA	9.6	59.6	608	55.8	59.6	NA
Methylene chloride, µg/kg	276/278	6	4	34.3	2,200	190	34.1	NA
Tetrachloroethene, µg/kg	88/276	6.18	1	11,700	310,000	54,700	3,730	NA
Trichloroethene, µg/kg	50/276	12.9	1	563	8,600	2,060	102	NA
Total PCBs, µg/kg	37/1904	274	260	40,300	746,000	144,000	783	NA
Alpha activity, pCi/g	272/272	NA	2.47	8.13	53.3	5.45	8.13	12.4
Beta activity, pCi/g	272/272	NA	9.59	33.1	367	30.4	33.1	26.6
Uranium, µg/kg	272/272	NA	51.16	11,700	806,000	69,600	11,700	79.1

^aCalculations include nondetects set to zero. Program: COCSOILSAS. Data source: Earth Technology Corporation.^bMean quantitative limit for results reported less than detection limit.^cNot applicable.

Table 3.16. UEFFC OU 3 potential COCs in soil at the Salvage Yard by area^a

Parameter	Proportion of results > detection limit	Mean detection limit	Minimum result > detection limit	Mean result > detection limit	Maximum result > detection limit	Soil ID for Maximum	Standard deviation > detection limit	Grand mean (<DL = 0)
<i>Central East Location</i>								
Beryllium, mg/kg	8/8	NA ^b	0.62	0.887	1.6	EA17	0.348	0.887
Chromium, mg/kg	8/8	NA	8.1	26.1	36.1	EA17	10.4	26.1
Cobalt, mg/kg	8/8	NA	5.7	11.9	19.7	EA09	5.7	11.9
Mercury, mg/kg	7/8	0.02	0.02	0.0957	0.41	EB03	0.14	0.0837
Thallium, mg/kg	7/8	3.6	45.2	111	172	EA17	46.8	97.5
Tetrachloroethene, µg/kg	1/8	6	8	8	8	EB04	NA	1
Trichloroethene, µg/kg	0/8	5.87	NA	NA	NA		NA	0
Total PCB, mg/kg	0/24	0.177	NA	NA	NA		NA	0
Uranium, µg/kg	8/8	NA	2.31	5.49	13.7	EB03	4.08	5.49
<i>Central West Location</i>								
Beryllium, mg/kg	8/8	NA	0.41	0.95	1.4	WA26	0.307	0.95
Chromium, mg/kg	8/8	NA	7.7	27.1	41.1	WA43	10.9	27.1
Cobalt, mg/kg	7/8	2.2	8	14.7	20.8	WA41	5.19	12.8
Mercury, mg/kg	8/8	NA	0.07	0.641	2.2	WA41	0.709	0.641
Thallium, mg/kg	7/8	3.5	18.7	61	91.5	WA43	28.7	53.4
Tetrachloroethene, µg/kg	3/8	6	5	22.3	50	WA26	24.2	8.37
Trichloroethene, µg/kg	2/8	6	2	6.5	11	WA26	6.36	1.63
Total PCB, mg/kg	1/24	0.17	0.38	0.38	0.38	WA43	NA	0.016
Uranium, µg/kg	8/8	NA	3.21	5	6.37	WA34	1.08	5

Table 3.16 (continued)

Parameter	Proportion of results > detection limit	Mean detection limit	Minimum result > detection limit	Mean result > detection limit	Maximum result > detection limit	Soil ID for Maximum	Standard deviation > detection limit	Grand mean (<DL = 0)
<i>North West Location</i>								
Beryllium, mg/kg	14/15	0.12	0.33	0.882	1.4	WB05	0.302	0.823
Chromium, mg/kg	15/15	NA	6.1	23.5	47.2	WB03	10.1	23.5
Cobalt, mg/kg	15/15	NA	4.1	13.6	24.1	WB08	5.33	13.6
Mercury, mg/kg	9/15	0.0233	0.06	2.11	15.5	WB06	5.04	1.26
Thallium, mg/kg	14/15	3.5	28	62.4	92.8	WB05	20.3	58.3
Tetrachloroethene, µg/kg	8/15	6.29	3	80.4	290	WB04	104	42.9
Trichloroethene, µg/kg	5/15	6.2	2	18.8	70	WB04	29.1	6.27
Total PCB, mg/kg	5/45	0.89	0.34	140.0	350.0	WA22	191.0	15.6
Uranium, µg/kg	15/15	NA	2.43	69.4	806	WA16	206	69.4
<i>South East Location</i>								
Beryllium, mg/kg	9/10	0.12	0.13	0.499	0.94	EA41	0.318	0.449
Chromium, mg/kg	10/10	NA	8.7	20.5	30.8	EA45	7.76	20.5
Cobalt, mg/kg	9/10	2.5	3.8	11.8	28.5	EA37	8.24	10.6
Mercury, mg/kg	5/10	0.022	0.1	0.486	1.4	EA37	0.532	0.243
Thallium, mg/kg	10/10	NA	27.7	52.8	76.5	EA27	17.1	52.8
Tetrachloroethene, µg/kg	1/10	6	4	4	4	EB02	NA	0.4
Trichloroethene, µg/kg	0/10	6	NA	NA	NA		NA	0
Total PCB, mg/kg	1/30	0.17	0.26	0.26	0.26	EA38	NA	0.008
Uranium, µg/kg	10/10	NA	2.05	2.9	3.99	EA41	0.474	2.9

Table 3.16 (continued)

Parameter	Proportion of results > detection limit	Mean detection limit	Minimum result > detection limit	Mean result > detection limit	Maximum result > detection limit	Soil ID for Maximum	Standard deviation > detection limit	Grand mean (<DL = 0)
<i>South West Location</i>								
Beryllium, mg/kg	6/6	NA	0.31	0.615	0.77	WB01	0.173	0.615
Chromium, mg/kg	6/6	NA	8.9	21.9	38.5	WB01	10.8	21.9
Cobalt, mg/kg	6/6	NA	2.4	10.8	14.5	WB01	4.86	10.8
Mercury, mg/kg	5/6	0.02	0.13	0.376	1.2	WA49	0.461	0.313
Thallium, mg/kg	5/6	3.6	3.4	47.3	76.4	WA57	30.8	39.5
Tetrachloroethene, µg/kg	1/6	5.8	1	1	1	WA57	NA	0.167
Trichloroethene, µg/kg	1/6	5.8	1	1	1	WA68	NA	0.167
Total PCB, mg/kg	1/18	0.18	0.32	0.32	0.32	WA68	NA	0.018
Uranium, µg/kg	6/6	NA	2.66	7.68	27.2	WA49	9.64	7.68

^aGrand mean includes nondetects set to zero. Data source: Earth Technology Corporation. Program source: Well.sas. Date: March 22, 1993.

^bNot applicable.

The east and west scrap metal storage area has contaminants comprised mostly of metals except for the minor occurrence of tetrachloroethene, PCB 1254, and trichloroethene. The areas of Tank 2063-U, drum deheader, oil storage tanks, and oil/solvent drum storage (east and west) have a greater occurrence of PCB, tetrachloroethene, and trichloroethene than the scrap metal storage area. Metals also constitute potential COCs for these areas.

3.5 SURFACE WATER AND SEDIMENTS

There are no surface streams, ponds, or lakes at the OU 3 sites. The surface drainage within the western portion of the Y-12 Plant has been greatly altered since construction of the plant. Figure 3.4 shows the original surface drainage before plant construction. During construction of the Y-12 Plant, hills were leveled and valleys were filled, and the original drainage was contained within a storm sewer network. This storm sewer system essentially corresponds to the original headwaters of East Fork Poplar Creek (EFPC). The UEFPC channel is contained in a 90-in. storm drain that lies north of Building 81-10. UEFPC becomes an open rip-rap lined channel ~1000 ft downstream of Building 81-10. The open channel flows into Lake Reality, which is located at the eastern end of the Y-12 Plant. At the Lake Reality Weir, UEFPC becomes lower EFPC, which flows through the city of Oak Ridge and into Poplar Creek, 14.5 miles downstream from Lake Reality.

Flow to UEFPC is derived almost exclusively from the Y-12 Plant storm drain system that collects runoff from ~893 acres including the plant compound and the surrounding hillsides (Geraghty and Miller 1990). More than 95% of the flow to UEFPC is comprised of (1) once-through noncontact sanitary cooling water, (2) rain runoff, (3) condensate from steam systems and air compression or cooling, and (4) cooling tower blowdown (Geraghty and Miller 1990).

Present-day surface flow at the UEFPC OU 3 sites is limited to runoff from precipitation events. The topographic site maps (Figs. 2.3, 2.4, and 2.5) presented in Chap. 2 show the location of drainage ditches. Erosion and subsequent transport of soils into the storm sewer network occur; however, information concerning erosion and sediment transport rates for soils contained within the UEFPC OU 3 sites does not exist. UEFPC has not been classified by TDEC. Lower East Fork Poplar Creek (LEFPC) is classified as a stream suitable for fish and aquatic life, recreation, irrigation, and livestock watering and wildlife.

3.6 GROUNDWATER

The hydrologic regime underlying the Y-12 Plant and vicinity has two major flow components; a regional flow component and a local flow component.

A conceptual framework for the hydrologic system at the ORR has been developed by Solomon et al. 1992. In general, the groundwater system can be divided into two broad groups: (1) the Knox Aquifer and (2) the ORR Aquitard. The Knox Aquifer consists of the Knox Group and the Maynardville Limestone. Groundwater flow in the aquifer is primarily controlled by interconnecting solution enlarged fractures and cavities. Within the Y-12 Plant area, the ORR Aquitard consists of the Rome Formation and the lower and middle portions

of the Conasauga Group. Groundwater flow within the aquitard is primarily controlled by fractures.

Both the Knox Aquifer and the ORR Aquitard can be divided into four zones (Solomon et. al. 1992). These zones are the storm flow zone, vadose zone, groundwater zone, and aquiclude zone. The following descriptions of each zone are from Solomon et. al. 1992.

The storm flow zone is a thin region at the surface where transient, precipitation-generated flow accounts for an estimated 90% or more of the water moving through the subsurface. The storm flow zone has been shown to exist in undisturbed areas in the vicinity of ORNL. The presence of a storm flow zone has not been established for the industrialized portions of the ORR and consequently may not be applicable to the Y-12 Plant where the shallow subsurface has been greatly altered and a large portion of the surface is covered with concrete and asphalt.

The vadose zone consists of the material above the groundwater zone and is characterized by unsaturated flow. The vadose zone is relatively thick on the ridge tops (~ 40 ft) and relatively thin on the valley floor. In general, the vadose zone within the Knox Aquifer consists of cherty red clay residuum as a result of weathering of Knox Group formations and the Maynardville Limestone. The vadose zone within the aquitard is generally thinner than the Knox Aquifer vadose zone and may consist of soils, saprolite, and/or rock. Within the Y-12 Plant, the vadose zone has been disturbed by construction activities. Large areas within the Y-12 Plant have been filled. The nature of the fill material used is highly variable. The fill may be tightly compacted or contain large voids. This will most likely result in highly variable hydraulic properties for the vadose zone at the Y-12 Plant.

The groundwater zone corresponds to material that is completely saturated. The groundwater zone can be further subdivided into a water table, intermediate, and deep intervals. The water table interval consists of unconsolidated material and the underlying bedrock. Groundwater flow within the water table generally follows the topography of the ground surface and surface drainage. The base of the water table zone corresponds to the zone of transition from unconsolidated material to bedrock. Flow in this zone occurs primarily in fractures. The intermediate zone is distinguished from the deep zone by a geochemical transition from Ca-HCO_3 to Na-HCO_3 water.

The geohydrology of the Y-12 Plant is predominantly controlled by the original course of UEFPC and the related solution cavity system that has developed in the underlying Maynardville Limestone (HSW Environmental Consultants 1992). The direction of groundwater flow within the Maynardville Limestone is southeast along the valley axis. Flow within the shallow groundwater, while dominated by topography, is strongly influenced by the structural properties of the bedrock. Observations from pump tests performed in the Nolichucky Formation indicate that hydraulic conductivity in the strike-parallel direction is several times larger than hydraulic conductivity in the cross-strike direction. This anisotropy in hydraulic properties means that the direction of groundwater flow deviates somewhat from that predicted by the potentiometric contours.

The aquiclude zone occurs below the groundwater zone. Water movement within this zone probably occurs on a geologic time scale. This zone is characterized by saline water. This zone is believed to occur at depths greater than 900 ft.

The following subsections describe the hydrologic conditions at the S-2 Site and Building 81-10.

3.6.1 S-2 Site

In the spring of 1986, monitoring wells GW-251, GW-252, GW-253, GW-254, and GW-256 were installed around the perimeter of the pond site under the supervision of Geraghty and Miller (Fig. 3.5). Three additional wells, GW-278, GW-279, and GW-280, were installed later in 1986 to form a well cluster northwest of the site. After collection of water level measurements for ~ 16 months and 6 quarterly water samples, wells GW-254, GW-256, GW-278, GW-279, and GW-280 were plugged and abandoned in September 1987 (Fig. 3.5). Destruction of these wells was required by the construction activities associated with the PIDAS corridor project. In May 1988, wells GW-349 and GW-350 were installed to replace the well cluster formed by wells GW-278, GW-279, and GW-280 (Fig. 3.5).

Analysis of groundwater from the monitoring wells at the S-2 Site are discussed in detail in Gianfrancesco et al. (1988). Statistical parameters for groundwater samples taken from the S-2 Site are presented in Appendix D. Water quality analyses from Gianfrancesco et al. (1988) indicated levels at or above primary drinking water standards for barium, cadmium, chromium, lead, mercury, nitrate, gross alpha, gross beta, radium, chloroform, carbon tetrachloride, and trichloroethene. In addition to the chemical analysis, the results of a terrain conductivity survey conducted at the S-2 Site (Gianfrancesco et al. 1988) indicated that a region of anomalously high conductivity extends northward from the northeastern corner of the site and is most likely associated with the suspected contaminated plume in the shallow groundwater extending outward from the S-2 Site (Welch 1989b). Figure 3.16 shows the area of the conductivity anomaly.

A review of piezometric data (Gianfrancesco et al. 1988) from Wells GW-251 and GW-253 (Fig 3.5) indicates that head measurements in Well GW-251 are consistently 10 ft lower than head measurements from Well GW-253. Construction records (Appendix A) indicate that both of these wells are screened at the same interval and both are situated at the same surface elevation. A review of the field measurements data (HSW Environmental Consultants 1992) indicates that this head drop is not caused by improper well installation or development. This dramatic head difference suggests that these two wells are not hydraulically connected, which would indicate that the shallow groundwater system at the S-2 Site consists of two or more hydraulic units. Further review of head data from Well GW-253 (Gianfrancesco et al. 1988) indicates that the water table occurs very near the ground surface during wet seasons. A small drainage gully is located to the east of Well GW-253 (Fig. 3.5), and it is conceivable that groundwater may seep into this drainage gully during the wet season.

Fig. 3.16. Terrain conductivity map of the S-2 Site.

3.6.2 Building 81-10

Groundwater samples collected from monitoring wells 56-5A, 56-5B, and 56-5C were essentially free of dissolved mercury contamination (Wiggins 1988a). Only groundwater samples containing suspended sediments have high mercury levels, indicating that mercury is being readily adsorbed onto sediment (Rothschild et al. 1984).

Several groundwater samples show constituents with concentrations exceeding maximum contaminant levels (MCLs) (Table 3.17). Samples from GW-698 exceeded MCLs for metals and VOCs. Samples from GW-700 exceeded MCLs only for metals, and samples from GW-701 exceeded MCLs only for VOCs. Sample SW01, taken from Sump SW1, exceeded MCLs for metals only, and a sample taken from Sump 9822 had no metal levels above MCLs.

3.6.3 Salvage Yard

The Salvage Yard area is comprised of the following OU 3 sites: drum deheader, oil storage tanks, oil/solvent drum storage, scrap metal storage area, and Tank 2063-U. It is located between two former tributaries that form the headwaters of UEFPC.

Surface water runoff from the Salvage Yard is separated by PIDAS (Fig. 3.17). The runoff at the western portion of the Salvage Yard flows toward a catch basin at the northwest corner above the drum deheader area and toward two other basins at the west and southwestern side of the Salvage Yard. Runoff at the eastern portion enters ditches and drains into a catch basin ~ 100 ft east of the southeast corner of the Salvage Yard (Welch 1989c).

The saturated zone of the Salvage Yard is in two zones. The upper zone is soil, fill material, and regolith and the lower zone is bedrock. The Nolichucky Shale Formation comprises the lower zone (bedrock). Both zones have low water-transmitting characteristics and water levels in both zones respond similarly to precipitation and seasonal conditions. Therefore, both zones are considered one aquifer (Welch 1989c).

Based on the potentiometric map presented in Fig. 3.17, a horizontal gradient is calculated at 0.06 ft/ft. The water table map on Fig. 3.17 shows that the depth to water is ~ 15 ft bgs in the northern half of the Salvage Yard and roughly 5 ft bgs at the site's southern end.

Groundwater chemical analysis data are summarized in Lind (1989b) from 1986 to 1987 and Welch (1989c) from the fourth quarter 1986 to the fourth quarter 1988. Table 3.18 represents the highest concentrations observed for the potential COCs including alpha and beta activity. Analytical results shown are unfiltered groundwater samples taken during the fourth quarter of 1986 to the fourth quarter 1988 sampling period (Welch 1989c). GW-190 information, however, is from the 1991 sampling period. Statistical parameters for groundwater samples taken from the Salvage Yard are presented in Appendix D. The location of the monitoring wells is shown on Fig. 3.17, and well construction information is presented in Appendix A.

Table 3.17. Contaminants exceeding MCLs in groundwater samples and sump sample from the Building 81-10 site

Constituent	MCL	Concentration
<i>GW-698</i>		
Lead, mg/L	0.005	0.0163, ^a 0.0145 ^b
Mercury, mg/L	0.002	0.0449, ^a 0.0016 ^b
1,2 dichloroethylene, µg/L	7	160
Carbon tetrachloride, µg/L	5	13
Tetrachloroethylene, µg/L	5	510
Trichloroethylene, µg/L	5	37
Vinyl chloride, µg/L	2	5
<i>GW-700</i>		
Beryllium, µg/L	0.004 ^c	0.0064
Lead, mg/L	0.005	0.157
Mercury, mg/L	0.002	0.134
<i>GW-701</i>		
Tetrachloroethylene, µg/L	5	16
Trichloroethylene, µg/L	5	72
<i>SW1</i>		
Chromium, mg/L	0.050	0.062
Nickel, mg/L	0.010	0.570
Mercury, mg/L	0.20	7.360

^aTotal.

^bDissolved.

^cEffective January 17, 1994.

Fig. 3.17. Water table map

LEGEND:

- Building
- Fence
- Rail Road
- Removed Nitric Acid Line
- Soil Boring
- Monitoring Well
- Water Table
- Contour (5' Interval)

NOTES:

- 1.) FOR REFERENCE DWGS. SEE
MMES DWGS:
- ECV-26158
 - ECV-26159
 - ECV-25670
 - ECV-25669
 - C2E-29582
 - C2E-129583

Y-12 Plant North

OAK RIDGE Y-12 PLANT OPERABLE UNIT NO. 3 OAK RIDGE, TENNESSEE

WATER TABLE MAP OF THE SALVAGE YARD

REVISION	DRAWN BY:	CHECK BY:	DATE:
0	P. HOLM	W. REELEY	01-28-83
1	P. HOLM	R. SWANN	03-29-83

REFERENCES	PLOT FILES
	13034/PLOT/250H PLJ

SHEET 1 OF 1	13034/DWG/250H	N/A
DRAWING #	CAD FILE #	NOT. ANGLE

Table 3.18. Highest observed concentrations of potential COCs in groundwater wells, Salvage Yard area

Data from fourth quarter 1986 to fourth quarter 1988^a
(Welch 1989c)

Well Number	Tetra-chloro-ethene (µg/L)	Tri-chloro-ethene (µg/L)	Lead ^b (mg/L)	Beryllium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Mercury ^c (mg/L)	Thallium ^d (mg/L)	Uranium ^e (mg/L)	Alpha activity (pCi/L)	Beta activity (pCi/L)	PCB ^f
GW-190 ^g	170	230	<0.004 ^h	<0.003 ^h	0.046	<0.005 ^h	<0.002 ^h	NA	<0.001 ^h	2.67	5.31	NA
GW-261	12	8	0.1120	0.0011	0.0710	0.0170	0.0050	0.0100	0.0050	9.0	18.0	NA
GW-262	2	2	0.0440	0.00120	0.0750	0.0130	0.0020	0.0100	0.1320	126.1	313.2	NA
GW-263	11	0	0.0050	0.0002	0.0013	0.0550	0.0130	0.0100	0.0060	2.4	10.0	NA
GW-264	7	0	0.0080	0.0003	0.0100	0.0050	0.0072	0.0100	0.0110	13.0	19.0	NA
GW-265	390	1100	0.0050	0.0004	0.130	0.0050	0.0002	0.0100	0.0070	4.0	6.0	NA
GW-266	120	140	0.0050	0.0019	0.0250	0.0250	0.0002	0.0100	0.0040	10.0	12.0	NA
GW-267	770	65	0.0130	0.0005	0.0110	0.0050	0.0002	0.0100	0.0040	6.0	5.0	NA
GW-268	8	2	0.0550	0.0012	0.0440	0.0270	0.0004	0.0100	0.0070	10.0	26.0	NA
GW-269	5	4	0.0110	0.0005	0.0200	0.0050	0.0002	0.0100	0.0040	7.0	65.0	NA
GW-270	5	4	0.0430	0.0007	0.0430	0.0190	0.0005	0.0100	0.0120	52.0	85.8	NA
GW-271	3	4	0.0040	0.0003	0.0100	0.0050	0.0002	0.0100	0.0090	3.0	140.3	NA
GW-272	14	5	0.0150	0.0003	0.0110	0.0050	0.0002	<0.0100	0.0170	43.7	363.4	NA
GW-273	46	22	0.0820	0.0073	0.0390	0.0340	0.0002	<0.0100	0.0100	19.0	566.1	NA
GW-274	2	5	0.0220	0.0380	1.0000	0.5000	0.0020	0.0100	0.0470	458.1	1,010.7	NA
GW-275	1	0	0.0170	0.0051	0.1000	0.1500	0.0009	0.0100	0.0270	283.1	2576.9	NA

^aTotal metals reported.

^bAnalysis by Atomic Absorption Spectroscopy (AAS).

^cAnalysis by Cold Vapor Atomic Absorption (CVAA).

^dDid not test for thallium for GW-190.

^eAnalysis by Fluorimetry.

^fPCBs are not tested for in groundwater analysis under usual laboratory procedures.

^gGW-190 results are from groundwater sampling during 1991.

^hCompound analyzed but not detected at the given minimum attainable detection limit.

High concentrations of tetrachloroethene and trichloroethene in groundwater occur near the drum deheader, oil/storage tanks, and the east oil/solvent drum storage area. Dense, nonaqueous-phase liquids may be present because of the high concentration of tetrachloroethene and trichloroethene. Metal concentration levels appear to be higher in groundwater wells near and downgradient of the east and west scrap metal storage area.

3.7 ECOLOGY

UEFPC OU 3 lies within the main Y-12 Plant complex, which is part of and is surrounded by ~14,164 ha (35,000 acres) encompassing the DOE ORR. Figure 3.18 shows the general wildlife habitats on the ORR, and Appendix E lists flora and fauna found within the ORR. Although the units are part of an industrialized developed environment, they still contain environs that are typical of the undeveloped surrounding environment in BCV.

3.8 RADIOLOGICAL SURVEY

An aerial radiological survey was conducted in 1989 encompassing 440 km² that included the entire ORR and adjacent areas. Typical background exposure rates were found to vary from 7 to 11 microrentgens per hour. Preliminary data collected in a 1992 aerial radiological survey corroborate the 1989 data.

Although the survey results for BCV were found to be within background range, the data are not directly applicable to UEFPC OU 3.

3.9 SITE CONCEPTUAL MODEL

Site conceptual models of the fate and transport of contaminants associated with each of the OU 3 sites were developed to illustrate the potential migration exposure pathways and develop a conceptual site risk model. Figures 3.19 through 3.21 are schematic diagrams depicting the conceptual site risk model. A complete exposure pathway consists of the following five elements (1) a source and mechanism of contaminant release to the environment; (2) an environmental transport mechanism for the released contaminants; (3) an environmental transport medium; (4) a point of human contact with the contaminated medium; and (5) a route of entry of the contaminant into the human receptor at the exposure point. An integration of sources, releases, fate and transport mechanisms, exposure points, and exposure routes is evaluated for complete exposure pathways. If any of these elements is missing, the pathway is considered to be incomplete and will not be considered in the risk evaluation.

The principal contaminant source for each of the sites is soil that was contaminated by liquid effluent disposal, past spills, and buried materials. Subsurface soil contamination at UEFPC OU 3 is present at the S-2 Site and Building 81-10. Surface soils are contaminated at Building 81-10. In addition to soil contamination, the potential for surface water runoff exists at Building 81-10.

General Wildlife Habitats

LEGEND
HARDWOOD MIXED HARDWOOD HABITAT
PINE PLANTATION HABITAT
OLD FIELD AND GRASSLAND HABITAT
AQUATIC HABITAT
CAVE HABITAT
BUILDING HABITAT

Fig. 3.18. General wildlife habitats on the ORR.

P = Potential
 NP = No Pathway
 1 = Risk from groundwater and surface water evaluated under integrator OU
 2 = Inhalation, ingestion, and dermal

Fig. 3.19. Conceptual site model for the S-2 OU, UEFPC OU 3.

P = Potential
 NP = No Pathway
 1 = Risk from groundwater and surface water evaluated under integrator OU
 2 = Inhalation, ingestion, and dermal

Fig 3.20. Conceptual site model for the Building 81-10, UEFPC OU 3.

P = Potential
 NP = No Pathway
 1 = Risk from groundwater and surface water evaluated under integrator OU
 2 = Inhalation, ingestion, and dermal

Fig. 3.21. Conceptual site model for the Salvage Yard, UEFPC OU 3.

Contaminant release mechanisms include human activity that can mobilize contaminants or that can incur direct contact with the contaminants. Potential receptors are identified under conditions of current land use and future land use. Future land use at the Y-12 Plant is assumed to remain as light industrial/commercial.

4. POTENTIAL RECEPTORS AND EXPOSURE PATHWAYS

4.1 POTENTIAL RECEPTORS

An evaluation of each unit comprising the UEFPC OU 3 was completed in order to identify and characterize contaminant sources and release mechanisms, transport media, exposure points, exposure routes, and human receptors. Graphical representations of the site conceptual models depicting this information are shown in Sect. 3.9 of this work plan. Two categories of exposure scenarios were considered: current and future land use. In this work plan future land use at the Y-12 Plant is assumed to remain as light industrial, rather than undergo conversion to residential property. Potential receptors were identified for both the current and future land use scenarios.

4.1.1 Human Populations

UEFPC OU 3 is contained within the Y-12 Plant complex, which is a part of the surrounding DOE ORR covering ~14,164 ha (35,000 acres). The units that comprise the UEFPC OU 3 are located along the southern boundary of the Y-12 Plant. Because of security precautions, the presence of persons in the area is controlled. Consequently, the potential for human exposure to contamination is minimized. The operational period of the Y-12 Plant is projected to be 30 years, with an additional passive institutional control period of 100 years, which will continue to limit exposure to human populations.

4.1.1.1 On-site potential human receptors

Current receptors considered at UEFPC OU 3 consist of on-site workers that may be Energy Systems employees or contractor personnel. Other potential receptors include transients, who may be visitors or temporary personnel. Because the exposure frequency and duration for a transient is assumed to be a small fraction of the potential frequency and duration for an employee, only the on-site employee will be considered. The potential for exposure in the current use scenario is limited because the majority of the units in the UEFPC OU 3 have been closed and intrusive activities are limited. However, activities may occur at these sites in the future that would provide a means of exposure to on-site workers.

4.1.1.2 Off-site potential human receptors

Off-site human receptors are members of the general public who live downstream and downgradient of the site and may be exposed indirectly to waste from UEFPC OU 3. This off-site population can only be considered a receptor if it is shown that the OU 3 waste migrates into the surface water (EFPC) and groundwater (and eventually the creek and/or the Clinch River) surrounding the sources. These receptors include members of the public who may contact waste in the stream outside the plant boundary, users of water taken from the Clinch River (e.g., municipal water supply), and recreational users of the Clinch River.

Because of the nature of the source term OUs, protection of these receptors may be handled indirectly. Groundwater and surface water flow is being addressed extensively as part

of the EFPC integrator operable units. Current risks to receptors exposed to contaminants in these media off-site are addressed as part of these studies. However, these receptors still need to be considered when making decisions about the need to remediate a UEFPC source unit.

Regional Demography. The regional demography is discussed in detail in Sect. 3.3 of this work plan.

Sensitive Subpopulations. Because of the location within the access controlled Y-12 Plant, no sensitive subpopulations are believed to be potentially at risk from direct exposure to contaminants at the source units. Sensitive subpopulations outside of the facility will be addressed as part of the UEFPC.

4.1.2 Ecological Populations

The units making up the UEFPC OU 3 are part of an industrialized developed environment. This assessment considers only the individual points of release of contaminants into the environment. Ecological risk will be addressed in this RI by identifying concentrations in the sources that are or could potentially lead to unacceptable concentrations in the integrator OU.

4.2 POTENTIAL EXPOSURE PATHWAYS

A potential exposure pathway is the means by which a contaminant moves from a source to a receptor. Exposure could occur if contaminants migrate from the site to an exposure point or when a receptor comes into direct contact with waste or contaminated media at the site. A complete exposure pathway consists of the following five elements:

- a source and mechanism of contaminant release to the environment;
- an environmental transport mechanism for the released contaminant;
- an environmental transport medium (e.g., air or groundwater) for the released constituent;
- a point of potential contact with the contaminated medium; and
- a route of entry for the contaminant into the human receptor.

The integration of source, release, fate and transport mechanism, exposure point, and exposure route is evaluated for complete exposure pathways. At the UEFPC OU 3 the principal contaminant source is contaminated soil and waste materials and possibly surface water in the form of precipitation runoff occurring at the Salvage Yard and Building 81-10. Release mechanisms include human activity that can mobilize contaminants or incur direct contact with contaminants, external gamma irradiation from contaminated soil and materials, surface runoff over contaminated soil following precipitation, and leaching from contaminated surface and subsurface soil to groundwater. Transport mechanisms would be primarily groundwater or surface water. Exposure points are the points at which potential receptors may make direct or indirect contact with the wastes. Current exposure routes consist of

dermal contact, ingestion, inhalation, and direct radiation. Future exposure routes may include additional exposures depending on the assumed land use scenario.

4.2.1 Dermal Contact

Dermal contact is a potential exposure pathway at UEFPC OU 3 for modeling purposes. For modeling purposes potential exposure through dermal contact will be limited to on-site workers who may come into contact with contaminated soils. The potential for exposure through dermal contact is very low because of the implementation of site-specific health and safety plans during activities at any of the units in the UEFPC OU 3.

4.2.2 Ingestion

On-site worker exposure to contaminants through incidental ingestion of soil could occur at units with surface contamination or in the future during excavation activities. This exposure would be minimized through the implementation of health and safety plans during any intrusive activities.

4.2.3 Inhalation

The potential for exposure to volatilized contaminants by inhalation at UEFPC OU 3 is minimal for the current scenarios. The presence of soil and vegetative covers, scrap metal, concrete, and asphalt at units within UEFPC OU 3 significantly reduces the potential for inhalation exposures at undisturbed sites. The potential for inhalation of contaminated particles is likely to be greatest for on-site workers engaging in excavation or intrusive activities in which subsurface soils are disturbed. Implementation of site-specific health and safety plans during these activities will ensure that the potential for inhalation of contaminants is very low.

4.2.4 External Exposure to Radionuclides

The potential for external exposure to radionuclides at the majority of units within the UEFPC OU 3 is minimal because of the presence of soil and vegetative covers. Potential radiological exposure to on-site workers could occur from exposure to contaminated surface soils at the scrap metal yard and under future conditions at all other units with the occurrence of excavation into subsurface soils. The exposure potential is lessened by the implementation of on-site health and safety plans.

5. IDENTIFICATION OF INVESTIGATION REQUIREMENTS

5.1 IDENTIFICATION OF ARARs

CERCLA was passed by Congress and signed into law on December 11, 1980 (Public Law 96-510). This act was intended to provide for "liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive waste disposal sites." SARA, adopted on October 17, 1986 (Public Law 99-499), did not substantially alter the original structure of CERCLA but provided extensive amendments to it.

In particular, §121 of CERCLA specifies that remedial actions for cleanup of hazardous substances must comply with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate to the hazardous substances or particular circumstances at a site. Inherent in the interpretation of ARARs is the assumption that protection of human health and the environment is ensured.

The purpose of this chapter is to supply a preliminary list of available federal and state chemical- and location-specific ARARs that might be considered for the cleanup of soil at the UEFPC OU 3 sites. In addition, a table of groundwater and surface water ARARs is presented for comparison to analytical detection limits for contaminants in these media. A complete summary and analysis of all ARARs impacting the entire Reservation can be found in *Applicable or Relevant and Appropriate Requirements (ARARs) for Remedial Action at the Oak Ridge Reservation, A Compendium of Major Environmental Laws* (Etnier et al. 1992). The process of ARAR identification is an iterative one that is continually changing as the RI/FS progresses. Therefore, this list of ARARs represents a compilation of potential ARARs, of which subsets will be used or additional ARARs added as further site characterization is done.

It is understood that DOE will comply with the requirements of the NEPA as specified in DOE Order 5440.1D (*National Environmental Policy Act Compliance Program*). Further, DOE Order 5400.4 (*Comprehensive Environmental Response, Compensation, and Liability Act Requirements*) calls for integration of NEPA and CERCLA requirements for DOE remedial actions at CERCLA sites. This issue has been reaffirmed in the FFA §I(A)(3) and §III(A)(2) and Secretary of Energy Notice (SEN) of February 5, 1990 (SEN-15-90), which was issued to ensure that DOE's NEPA activities are carried out in a centralized and uniform manner. Therefore, the regulations found in NEPA will not be addressed in this report as ARARs.

Similarly, DOE addresses occupational safety in DOE Orders 5480.11 (*Radiation Protection for Occupational Workers*); 5480.4 (*Environmental Protection, Safety, and Health Protection Standards*); 5483.1A (*Occupational Safety and Health Program for Contractors at GOCO Facilities*); 5480.9 (*Construction Safety and Health Program*); and 5480.10 (*Contractor Industrial Hygiene Program*). However, ARARs apply to those federal and state regulations that are designed to protect the environment, and they do not generally apply to occupational safety regulations (40 CFR 300.150). Therefore, the DOE orders related to occupational safety, as well as the regulations promulgated by the Occupational Safety and Health

Administration (OSHA) are not addressed as ARARs; these regulations appear in the site-specific Health and Safety Plan for OU 3. (See Chap. 10.)

The following is a listing of the definitions of terms used throughout this report:

Applicable requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" (40 *CFR* 300.5).

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (40 *CFR* 300.5).

Requirements under federal or state law may be *either applicable or relevant and appropriate* to CERCLA cleanup actions, but not both. However, requirements must be *both relevant and appropriate* for compliance to be necessary. In the case where a federal and a state ARAR are available, or where there are two potential ARARs addressing the same issue, the more stringent regulation must be selected. However, CERCLA §121(d)(4) provides several ARAR waiver options that may be invoked, providing that the basic premise of protection of human health and the environment is not ignored. A waiver is available for state standards that have not been applied uniformly in similar circumstances across the state. In addition, CERCLA §121(d)(2)(C) forbids state standards that effectively prohibit land disposal of hazardous substances.

CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA §121(e) and FFA §XXII]. In order to ensure that CERCLA response actions proceed as rapidly as possible, EPA has reaffirmed this position in the final NCP (55 *FR* 8756). **Substantive requirements** pertain directly to the actions or conditions at a site, while **administrative requirements** facilitate their implementation. EPA recognizes that certain of the administrative requirements, such as consultation with state agencies, reporting, etc., are accomplished through the state involvement and public participation requirements of the NCP. These administrative requirements should be observed if they are useful in determining cleanup standards at the site (55 *FR* 8757).

In the absence of federal- or state-promulgated regulations, there are many criteria, advisories, guidance values, and proposed standards that are not legally binding but may serve as useful guidance for setting protective cleanup levels. These are not potential ARARs but are "to-be-considered" (TBC) guidance.

5.1.1 Chemical-Specific ARARs

Chemical-specific requirements set health or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants (53 *FR* 51437). These requirements generally set protective cleanup levels for the chemicals of concern in the designated media or else indicate a safe level of discharge that may be incorporated when considering a specific remedial activity.

UEFPC OU 3 includes seven sites originally identified as RCRA Sect. 3004(u) SWMUs in the *Y-12 Plant General RFI Document* (Welch 1989a). All seven sites are within the confines of the Y-12 Plant. See Sects. 2.2 and 2.3 for a complete description of the site background and operational history for each unit in OU 3. A preliminary list of COCs detected in soils at OU 3 includes heavy metals, organics, inorganics, and radionuclides (Table 2.2). Although limited in number, chemical-specific standards have been established under several statutes, including RCRA, the Safe Drinking Water Act (SDWA), and the Clean Water Act (CWA) for many of these COCs.

In the case of those units in UEFPC OU 3 containing RCRA-characteristic or RCRA-listed hazardous waste as defined in 40 *CFR* 261, RCRA regulations may be applicable to remedial activities. In addition, when promulgated, the RCRA Subpart S, "Corrective Action for SWMUs at Hazardous Waste Management Facilities," may provide ARARs (proposed rule, 55 *FR* 30798, July 27, 1990).

5.1.1.1 Groundwater and surface water

Available chemical-specific criteria that have been promulgated under federal and state law are listed in Table 5.1 for COCs that have been detected at OU 3. They are presented here for comparison to analytical detection limits for contaminants in these media. If groundwater contamination from the UEFPC OU 3 units is confirmed, cleanup of the groundwater will be addressed as a separate OU, and a detailed analysis of applicable ARARs will be addressed at that time. Although there are no surface water bodies at the UEFPC OU 3 sites, surface water runoff flows into storm drains that may be sampled during site investigation. Thus, state surface water quality criteria for fish and aquatic life, and for the consumption of aquatic organisms, are listed in Table 5.1 for a comparison to sampling results to determine the extent of any contamination. These particular criteria were chosen because EFPC, which the storm drain runoff eventually flows into, is classified for protection of fish and aquatic life and recreational uses by the Tennessee Water Quality Control Board (TDEC Rules, Chap. 1200-4-4). Where no state criterion is available for a specific chemical, a federal criterion is listed if available.

5.1.1.2 Soil/sediment

Very little legislation or guidance is available governing cleanup criteria for contaminated soils or sediments at CERCLA sites. RCRA has addressed land disposal of treated hazardous wastes in its land disposal restrictions (LDRs) (40 *CFR* 268). If disposal of any

Table 5.1. Chemical-specific federal and state regulations for protection of groundwater and surface water ($\mu\text{g/L}$)^a

Chemical	RCRA ^b MCC ^c	Safe Drinking Water Act MCLs ^c	Safe Drinking Water Act MCLGs ^d	TDEC WQC ingestion of aquatic organisms ^e	TDEC WQC fish and aquatic life CMC ^f	TDEC WQC fish and aquatic life COQ ^g
Aluminum	—	50-200 ^h	—	—	750 ^h	87 ^h
Arsenic (total)	50	50 ⁱ	—	—	360 ^j	190 ^j
Beryllium	—	4 ^k	4 ^k	1.3	—	—
Boron	—	600 ^l	—	—	—	750 ^h
Cadmium	10	5 ^m	5 ^m	—	9 ⁿ	12 ⁿ
Chromium (total)	50	100 ^m	100 ^m	—	—	100
Chromium (trivalent)	—	—	—	670,000	3,062.7 ^h	365.1 ^h
Chromium (hexavalent)	—	—	—	—	16	11
Copper	—	TT ^o	1,300 ^o	—	34 ⁿ	21 ⁿ
Cobalt	—	—	—	—	—	—
Cyanide	—	200 ^k	200 ^k	—	22	5.2
Lead	50	TT ^o	0 ^o	—	198 ⁿ	8 ⁿ
Mercury	2	2 ^m	2 ^m	0.15	2.4	0.012
Methylethyl ketone	—	—	—	—	—	—
Molybdenum	—	40 ^l	—	—	—	—
Nickel	—	100 ^k	100 ^k	4,600	2,550 ⁿ	280 ⁿ

Table 5.1 (continued)

Chemical	RCRA ^b MCC ^c	Safe Drinking Water Act MCLs ^c	Safe Drinking Water Act MCLGs ^d	TDEC WQC ingestion of aquatic organisms ^e	TDEC WQC fish and aquatic life CMG ^f	TDEC WQC fish and aquatic life CMG ^f
Nitrate (as N)	—	10,000 ^m	10,000 ^m	—	—	—
Nitrite (as N)	—	1,000 ^m	1,000 ^m	—	—	—
Nitrate + Nitrite (as N)	—	10,000 ^m	10,000 ^m	—	—	—
Polychlorinated biphenyls (total)	—	0.5 ^m	0 ^m	0.001	—	0.001
Radionuclides						
Uranium	—	30 pCi/L ^g	0 ^g	—	—	—
All other man-made radionuclides	—	4 mrem/yr ^h	0	—	—	—
Sulfate	—	400,000/500,000 ^p	400,000/500,000 ^p	—	—	—
Tetrachloroethylene	—	5 ^m	0 ^m	88	—	—
Thallium	—	2 ^m	0.5 ^m	—	—	—
Trichloroethylene	—	5 ^g	0 ^g	807	—	—
Zinc	—	5,000 ^g	—	—	210 ^m	190 ^p

^aFederally promulgated regulations under RCRA, the SDWA, and Tennessee state regulations under the CWA are included in this table. Tennessee state drinking water MCLs/MCLGs (Chapter 1200-5-1 of the Rules of the TDEC) are identical to the federal.

^bRCRA = (40 CFR 264.94).

^cMCC = maximum concentration of constituents.

^dMCLG = maximum contaminant level goal.

Table 5.1 (continued)

¹Rules of the Tennessee Department of Environment and Conservation (TDEC), Chapter 1200-4-3-.03; criteria for recreational use designation; a 10^{-5} risk factor is assumed for carcinogens. WQC = water quality criterion.

²CMC = criterion maximum concentration; CCC = criterion continuous concentration; Rules of the TDEC, Chapter 1200-4-3-.03

³Federal secondary MCL, final rule [56 *FR* 3526 (January 30, 1991)]. Level for aluminum is level recommended to prevent post-treatment precipitation in the distribution system. These values are TBC, not ARAR.

⁴Federal WQC; Tennessee does not have a fish and aquatic life criterion for this chemical. *Source*: EPA Region IV Criteria Chart (December 1992).

⁵40 *FR* 59570 (December 24, 1975).

⁶Trivalent arsenic.

⁷57 *FR* 31776 (July 17, 1992); effective January 17, 1994. Tennessee is in the process of revising their MCLs to match these federal MCLs; projected to be final in fall of 1993 (Foster 1993).

⁸EPA Office of Drinking Water lifetime Health Advisory (November 1992).

⁹56 *FR* 3526, January 30, 1991, effective July 30, 1992.

¹⁰Water hardness dependent criteria, calculated based on 200 $\mu\text{g/L}$ CaCO_3 .

¹¹TT = treatment technology; 56 *FR* 26460 (June 7, 1991, effective December 7, 1992). When "action levels" of 1300 and 15 $\mu\text{g/L}$, respectively, for copper and lead, are measured in the 90th percentile at the consumer's tap, corrosion control studies and treatment requirements are triggered. An OSWER directive (dated June 21, 1990) recommends that a final cleanup level of 15 $\mu\text{g/L}$ for lead in groundwater usable for drinking water is protective of sensitive subpopulations; this is TBC, not an ARAR.

¹²This is a **proposed** MCL/MCLG only (55 *FR* 30370, July 25, 1990). EPA has deferred setting a final MCL/MCLG for sulfate pending further study (57 *FR* 31776, July 17, 1992).

¹³52 *FR* 25690 (July 8, 1987).

¹⁴Proposed rule (56 *FR* 33050, July 18, 1991); final rule expected 1994.

¹⁵If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 mrem/year.

RCRA-characteristic or RCRA-listed wastes occurs during remedial activities, the LDRs will be applicable. This will be addressed during selection of alternatives during the RI/FS phase.

The TDEC has proposed a new Chapter 1200-1-13 (*Hazardous Substance Site Remedial Action*) to the Rules of the TDEC; the proposed rule is projected to be official by mid-1993 (Binford 1993). In this proposed rule are three approaches for the establishment of cleanup levels: (1) the use of listed soil cleanup levels for residential and industrial sites, (2) the use of a site-specific human health and environmental risk assessment, and (3) the use of background levels [1200-1-13-.08(3)(a)]. In cases where site-specific risk-based cleanup levels are proposed, the TDEC must review and approve those levels [1200-1-13-.08(3)(b)]. When promulgated this rule will be legally applicable to cleanup at OU 3.

EPA has suggested cleanup values for lead in soils based on studies of blood lead levels in exposed children. The EPA OSWER Directive 9355.4-02 (dated September 7, 1989) recommends a cleanup level for soils of 500–1000 ppm lead. These would be TBC guidance, not ARARs.

Although not an ARAR, EPA has published a Toxic Substances Control Act (TSCA) PCB spill cleanup policy (52 *FR* 10688) that recommends cleanup standards for PCBs of 25–50 ppm for sites with restricted access; a 10-ppm cleanup level is recommended for residential and unrestricted access rural areas. In this latter case, a 10-in. cap of clean soil must cover the site. In the EPA guidance report for remedial actions at Superfund sites containing PCBs, preliminary remediation goals are set at 1 ppm for residential land use (a risk of 10^{-5}) and between 10 and 25 ppm for industrial and/or remote areas (a risk of 10^{-4}) (EPA 1990a). Alternatives should reduce concentrations to these levels or limit exposures.

EPA Region IV has made available a summary of chemical-specific concentrations that may be used to flag contaminant levels of concern in sediments in the storm drains. The values that may be applicable for COCs at OU 3 are given in Table 5.2. These values have been calculated by the National Oceanic and Atmospheric Administration (NOAA) and are not intended as cleanup standards.

5.1.1.3 Other TBC guidance

In the absence of federally or state-promulgated ARARs, or in the case where ARARs are not adequately protective, EPA states a preference for reference doses (RfDs) or reference concentrations (RfCs) for systemic toxicants, and carcinogenic slope factors (CSFs) for carcinogens. The RfDs, RfCs, and CSFs are available through *IRIS* (EPA 1991a) and the *EPA Health Effects Assessment Summary Tables* (EPA 1992c).

The EPA Office of Drinking Water (ODW) has developed nonregulatory health assessments (HAs) for concentrations of noncarcinogenic contaminants in drinking water at which no adverse health effects would be expected to occur. Lifetime HAs available for those COCs at OU 3 that do not have promulgated MCLs/SMCLs are listed in Table 5.1.

Table 5.2. Summary of available NOAA action levels for contaminants in sediment (ppb)^a

Chemical	Low effects range	Median effects range	Overall apparent effects threshold	Degree of confidence
Arsenic, ppm	33	85	50	Low/moderate
Beryllium	NA ^b	NA	NA	
Cadmium, ppm	5	9	5	High/high
Chromium (total), ppm	80	145	None	Moderate/moderate
Copper, ppm	70	390	300	High/high
Lead, ppm	35	110	300	Moderate/high
Mercury, ppm	0.15	1.3	1	Moderate/high
Nickel, ppm	30	50	NSD ^c	Moderate/moderate
PCBs (total), ppb	50	400	370	Moderate/moderate
Zinc, ppm	120	270	200	High/high

^aU.S. EPA Region IV Memorandum from Catherine Fox, Coastal Programs Unit, dated April 15, 1991, *Suggested Guidance for Evaluating Sediment Concentration Data*.

^bNA = Not available.

^cNSD = Not sufficient data.

5.1.2 Radiation Protection Standards

Very few applicable standards are available for the cleanup of radioactively contaminated CERCLA sites. The Atomic Energy Act (AEA) of 1954 and its amendments delegated authority for control of nuclear energy to DOE, the U.S. Nuclear Regulatory Commission (NRC), and EPA. In addition, certain states have regulatory authority and programs for radioactive waste. EPA's regulations are derived from several other statutes as well and cover many types of activities and all types of radioactive materials. The NRC licenses the possession and use of various types of radioactive materials at certain types of facilities. Tennessee is an NRC-Agreement state and, as such, has its own authority and licensing regulations.

DOE is authorized to control all types of nuclear materials at sites under its jurisdiction and is exempt from the NRC licensing and regulatory requirements. Therefore, NRC regulations are not considered to be legally applicable to CERCLA cleanup at DOE facilities; however, all or parts of individual NRC regulations may be considered relevant and appropriate depending on the particular conditions at each operable unit. The decision as to

whether a particular section or part of an NRC requirement is relevant and appropriate or TBC guidance depends on site-specific technical evaluation of suitability and need. This evaluation will be performed during selection of remedial alternatives for OU 3.

DOE regulations for the handling and cleanup of radioactive materials are outlined in a series of internal DOE orders that are contractually binding to DOE contractors but are not considered by EPA to be ARARs. However, DOE orders are generally consistent with, and typically incorporate, NRC technical requirements that are appropriate for DOE operations and waste management. Therefore, for the purposes of development of ARARs, DOE orders will be treated as TBC guidance.

In addition to hazardous waste, the Western Exclusion Area shows evidence of possible radiological contamination with uranium and thorium. The proper definition of "mixed low-level radioactive and hazardous waste" has caused considerable debate with regard to dual jurisdiction by EPA and NRC. However, EPA has published a clarification of the problem (53 *FR* 37045, September 23, 1988), as did DOE previously [52 *FR* 15937, May 1, 1987, and DOE Order 5400.3 (*Hazardous and Radioactive Mixed Waste Program*, dated February 22, 1989)]. In effect, mixed wastes are those containing a RCRA hazardous waste as defined in 40 *CFR* 261 and a radioactive waste subject to the AEA. RCRA regulations apply to the hazardous component of the waste, and AEA regulations apply to the radioactive component. When the application of both standards is conflicting or inconsistent, RCRA yields to the AEA. Tennessee received final authorization to regulate radioactive mixed waste on July 3, 1986 (53 *FR* 37045, September 23, 1988); however, the state has not implemented any regulations or guidance related to the handling of mixed waste. In June 1992, EPA and DOE signed a Federal Facilities Compliance Agreement (FFCA) to bring mixed waste generating and storage facilities on the Reservation into compliance with environmental law. Effective immediately, the FFCA allows DOE ORR facilities to continue to generate and store mixed wastes, including solid mixed wastes, while addressing LDR mixed waste compliance issues.

EPA Regulations. EPA has promulgated MCLs for radionuclides in community water systems. These MCLs appear in two forms: concentration limits for certain alpha-emitting radionuclides (40 *CFR* 141.15) and an annual dose limit for the ingestion of certain beta- and gamma-emitting radionuclides (40 *CFR* 141.16). MCLs and MCLGs were proposed for radon and uranium and repropoed for ²²⁶Ra and ²²⁸Ra, beta, and photon emitters on July 18, 1991. Final promulgation of the concentration limits is not expected until the end of 1993. As with the chemical-specific MCLs, these may be used to compare to detection limits for contaminants in groundwater at OU 3. The proposed MCLs/MCLGs for uranium and other man-made radionuclides are listed in Table 5.1.

Table 5.3 lists EPA and DOE radiation protection standards that are described on the following page. These regulations and standards generally address specific types of activities, and will be analyzed in detail for action-specific ARARs during the remedial alternatives selection phase. General requirements are discussed below.

Subpart H of 40 *CFR* 61 addresses atmospheric radionuclide emissions from DOE facilities and may be applicable to airborne emissions during the cleanup of ORR. EPA has issued a final National Emission Standards for Hazardous Air Pollutants (NESHAP) rule (54

Table 5.3. Radiation protection standards that may be “relevant and appropriate” or “to-be-considered” guidance for the Western Exclusion Area (OU 3)

Regulation	Applicability	Exposure conditions	Standard
40 <i>CFR</i> 61	National Emission Standards for Hazardous Air Pollutants for DOE facilities	Public exposure, airborne emissions	10 mrem/year
40 <i>CFR</i> 141	Drinking water maximum contaminant levels	Community water systems, gross beta	4 mrem/year
DOE Order 5400.5	Radiation Protection of the Public and the Environment	Public exposure, all sources	100 mrem/year
		Temporary maximum exemption	500 mrem/year
		Aquatic organism exposure, absorbed dose	1 rad/d
DOE Order 5820.2A	Radioactive Waste Management	Public exposure, all sources, excluding air	25 mrem/year
		Public exposure, atmospheric releases	10 mrem/year

FR 51654, December 15, 1989) that limits emissions of radionuclides to the ambient air from DOE facilities to amounts that would not cause any member of the public to receive an effective dose equivalent of 10 mrem/year (40 *CFR* 61.92).

DOE Orders. DOE orders are not promulgated regulations and thus are not considered to be ARARs by EPA. They are, however, contractually binding between DOE and Energy Systems because of contractual agreements and would be considered TBC guidance. The radiation exposure limits defined in DOE Order 5400.5 (*Radiation Protection of the Public and the Environment*, February 8, 1990) are an effective dose equivalent (EDE) of 100 mrem/year from all exposure pathways and all DOE sources of radiation and a dose of less than 500 mrem/year as a temporary maximum exemption under specially-permitted and DOE-approved circumstances. In addition, effluent releases to surface water must not result in exposures to aquatic organisms exceeding an absorbed dose of 1 rad/day. The overriding

principle of the DOE order is that all releases of radioactive material will be as low as reasonably achievable (ALARA).

This order lists guidelines for the cleanup of residual radioactive material in soils, including a limit of 5 pCi/gm for ^{230}Th and ^{232}Th , averaged over the first 15 cm of soil below the surface, and 15 pCi/gm averaged over 15-cm-thick layers of soil more than 15 cm below the surface. Guidelines for the management of properties containing residual radioactive material will be addressed as TBC following characterization of the radionuclide contamination at OU 3 and selection of remedial alternatives.

DOE Order 5820.2A (*Radioactive Waste Management*, September 9, 1988) states that the management of low-level radioactive waste must ensure that external exposure to the waste and concentrations of radioactive material that may be released into surface water and soil does not exceed 25 mrem/year to any member of the public. Releases to the atmosphere shall not exceed 10 mrem/year. Reasonable effort should be made to maintain releases to the environment to ALARA levels. The requirements of this order will be addressed if any remedial alternatives involve disposal of low-level radioactive waste.

Other TBC Guidance for Radiological Risk Assessment. The EPA Office of Radiation Programs has derived slope and unit risk factors for radionuclides of concern at remedial sites for each of three major exposure pathways (inhalation, ingestion, and external exposure to contaminated soil). These are available in the EPA *Health Effects Assessment Summary Tables* (EPA 1992c) and would be considered TBC guidance for development of remedial action goals for COCs at OU 3.

5.1.3 Location-Specific ARARs

Location-specific requirements "set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations" (53 *FR* 51394). Major federal and state location-specific ARARs that may need to be considered for remedial actions at OU 3 are identified below.

Geologic Characteristics. There are no indications of salt-dome formations, salt-bed formations, or underground mines on or near OU 3. However, if any caves are located in areas where remedial activities may occur, the regulations found in RCRA [40 *CFR* 264.18(c)] that prohibit the placement of noncontainerized or bulk liquid hazardous waste in caves might be ARAR. The faults on ORR are ancient (pre-Holocene) and stable, and the possibility of fault movement is considered extremely unlikely (Chance 1986); therefore, seismic regulations would not be applicable.

Aquatic Resources. There are no known designated wilderness areas, wildlife refuges, or scenic rivers on the ORR or within range of the reservation such that remedial action would likely impact these resources. However, if any remedial action is taken that affects wildlife or alters EFPC, which is designated by the state of Tennessee for fish and aquatic life, recreation, irrigation, and wildlife and livestock watering, then the Fish and Wildlife Coordination Act (16 USC 661 *et seq.*), the Tennessee Water Quality Control Act of 1977 (TCA 69-3-101 *et seq.*), the Clean Water Act §404, 40 *CFR* 230 and 6.302(g), and 33 *CFR* 320-330 may be applicable.

Wetlands and Floodplains. The OU 3 sites are located outside the 100- and 500-year floodplain of EFPC (Welch 1989a). A preliminary survey of the wetlands on the ORR did not identify any wetlands on or near the OU 3 sites.

Historic Sites and Archaeological Findings. The region surrounding the ORR is rich in both archaeological and historic resources, and a number of studies have indicated the presence of abundant resources on the reservation. These surveys are summarized in Vol. 3, Appendix B, of the *Resource Management Plan for the U.S. Department of Energy Oak Ridge Reservation* (Sanders 1984). Although the surveys are not exhaustive of the entire reservation, no known historic or archaeological sites appear to be located at or near the Y-12 Plant (Sanders 1984). In the event a NEPA survey indicates the presence of archeological resources, the National Historic Preservation Act (16 USC 470a-w), the Archaeological Resources Recovery Act (16 USC 470aa-ll), the Archaeological and Historic Preservation Act (16 USC 469a-c), 43 CFR 7, and 40 CFR 6.301 may provide ARARs.

Rare, Threatened, or Endangered Species. Although there are a number of state- and federal-listed species on ORR, there appear to be no known threatened or endangered species at the OU 3 sites (Kroodsma 1987).

5.1.4 Action-Specific ARARs

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to the management of hazardous waste (52 FR 32496). Selection of a particular remedial action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals. Action-specific ARARs are established under RCRA, CAA, CWA, SDWA, and TSCA. The RCRA regulations were recently amended to allow for the creation of Correction Action Management Units (CAMUs) [58 FR 8658 (February 16, 1993)]. This change allows for the consolidation of waste management areas on the same facility, even when they are not contiguous. It should promote more economical remedies and is to be used as an ARAR in remediation actions under CERCLA. Action-specific ARARs for the Western Exclusion Area will be developed before the selection of remedial alternatives.

5.2 IDENTIFICATION OF PRELIMINARY REMEDIAL ACTION GOALS

The first step in the FS scoping process is to develop preliminary remedial action objectives (RAOs) for protecting human health and the environment. These objectives should specify contaminants and media of concern, potential exposure pathways, and PRGs. PRGs are chemical-specific concentrations in media that are based on readily available environmental or health-based ARARs or risk-based values calculated with default assumptions. As new information and data are collected, the PRGs may be modified. These goals are used throughout the RI/FS process to accomplish the following:

- first identify and help set the detection limits for general response actions and later to identify, screen, and develop remedial action alternatives;

- use for screening purposes after the first phase of sampling; and
- use in FS scoping to identify, screen, and develop remedial alternatives.

UEFPC OU 3 is designated as a source control OU and, as such, will be addressed in interim action RODs consistent with the strategy outlined in the ORR Site Management Plan for the Environmental Restoration Program (DOE/OR-1001/R2).

General RAOs for OU 3 are the following:

- to prevent current and future direct exposures to contaminants resulting in total excess cancer risk greater than 10^{-6} or a hazard index greater than 1 and
- to prevent the transport of contaminants from the sources to the groundwater or surface water that would result in unacceptable risks in the receiving water bodies (i.e., those media addressed as part of UEFPC OU 1).

PRGs that address the two objectives for OU 3 must be developed. Since few ARARs exist that address soil cleanup levels, risk-based PRGs must be developed to address the first objective. The second objective can be addressed using a simple fate and transport model developed specifically to establish soil cleanup levels based on potential migration to groundwater. Both of these methods are discussed herein.

5.2.1 Soil PRGs Based on Direct Exposure

Soil risk-based PRGs are developed using guidance from EPA, *Development of Risk-Based Preliminary Remediation Goals* (EPA 1991b). The development of initial risk-based PRGs requires the following information:

- chemicals of potential concern,
- environmental media of potential concern (soil),
- probable future land use and exposures,
- chemical-specific toxicity information, and
- target risk levels.

A preliminary list of potential COCs has been identified in previous studies and appears in Table 2.2, Chap. 2.

The most-likely future land use scenario for the Y-12 Plant is industrial; however, for completeness, PRGs will be presented for both industrial and residential land uses. Pathways evaluated for the industrial scenario include incidental soil ingestion and inhalation of volatiles and particulates. The sole pathway evaluated for the residential scenario is soil ingestion.

Toxicity data used to develop PRGs are cancer slope factors and reference doses from the IRIS data base (EPA 1991a) and Health Effects Assessment Summary Tables (HEAST) (EPA 1992c).

Finally, target risk (TR) levels must be established for carcinogens, and a target hazard quotient (THQ) and target hazard index (THI) must be established for noncarcinogens. Once these levels have been established, they can be used in conjunction with toxicity data and exposure equations to calculate PRGs. The NCP and EPA (EPA 1991a) suggest a default target risk of 10^{-6} and a cumulative site HI at less than 1.

The equations used to calculate industrial and residential exposures are from EPA 1991b. The parameters used are listed in Table 5.4. Some parameters used to determine the chemical-specific volatilization factors for volatile organics can be found in EPA 1991a.

5.2.2 Soil PRGs Based on Migration to Groundwater

The second RAO for UEFPC OU 3 is to prevent contaminants from leaching from the source to groundwater or surface water at levels that would be unacceptable in those water bodies. EPA has developed several models for use in determining soil cleanup levels based on potential contaminant migration to the groundwater (EPA 1989b). No such model is known to exist for migration to surface water at this time, but several models such as the Modified Universal Soil Loss Equation are being reviewed for use in this capacity. One model for addressing migration to the groundwater is the revised Summers Model (Summers et al. 1980; EPA 1989b). The Summers Model is described below.

The concentration of a chemical in groundwater is a function of the amount of the chemical infiltrating through the soil column to the groundwater and the amount of the chemical already present in the groundwater. The chemical concentration is also determined by the volume of water into which the leachate is dissolved. The equation for the Summers Model is as follows:

$$C_{gw} = \frac{(Q_p C_p) + (Q_a C_a)}{Q_p + Q_a}$$

where

- C_{gw} = PRG concentration in water (mg/L)
- Q_p = Volumetric flow rate of infiltration into the aquifer (ft³/day), where
- $Q_p = (V_{dz})(A_p)$
- V_{dz} = Darcy velocity in downward direction (ft/day)
- A_p = Horizontal area of spill (ft²)
- C_p = Concentrations of pollutant in the infiltration at the unsaturated-saturated zone interface (μg/L)
- Q_a = Volumetric flow rate of groundwater (ft³/day), where
- $Q_a = (V_d)(h)(W)$
- V_d = Darcy velocity in aquifer (ft/day)
- h = Aquifer thickness (ft)
- w = Width of spill perpendicular to flow direction in aquifer (ft)
- C_a = Initial or background concentration of pollutant in aquifer (mg/L)

Table 5.4. Parameters used to calculate PRGs

Parameter	Units	Industrial land use		Residential land use	
		Cancer effects	Noncancer effects	Cancer effects	Noncancer effects
Target Risk (TR)	unitless	1×10^{-6}		1×10^{-6}	
Target HI (THI)	unitless		1.0		1.0
Body Weight (BW)	kg	70	70		
Averaging Time (AT)	yr	70	25	70	30
Exposure Frequency (EF)	days/yr	250	250	350	350
Exposure Duration (ED)	yr	25	25		
Soil Ingestion Rate (IR _s)	mg/day	50	50		
Age-Adjusted Soil Ingestion Factor (IF)	mg-yr/kg-day			114	114
Inhalation Rate (IR _a)	m ³ /day	20	20		
Particulate Emission Factor (PEF)	m ³ /kg	4.63×10^9	4.63×10^9		
Volatilization Factor (VR)	m ³ /kg	Chemical specific	Chemical specific	Chemical specific	Chemical specific

The Darcy velocity in the aquifer (V_d) is estimated as follows:

$$V_d = (K)(I)$$

where

K = Hydraulic conductivity (ft/day)

I = Hydraulic gradient (unitless)

It was assumed that the background concentrations of the chemicals (C_s) were equal to zero, and equations were rearranged to solve for C_s , the PRG concentration in soil:

$$C_s = \frac{C_{gw}(Q_p + Q_s)K_d}{Q_p}$$

where

K_d = Soil/water equilibrium partitioning coefficient (mL/g)

The revised Summers Model makes the following assumptions:

- The soil/water system is at equilibrium.
- No contaminant degradation is occurring.
- The unsaturated soil zone is homogeneous down to the aquifer.
- Contaminants are mixed throughout the depth of the aquifer beneath the contaminant source.

The model does not account for any contaminant dilution or attenuation due to horizontal transport within the aquifer. Therefore, acceptable soil concentrations are determined based on the assumption that the groundwater directly beneath the source meets acceptable levels. Groundwater PRGs are being developed as part of UEFPC OU 1. In lieu of risk-based groundwater PRGs, MCLs will be used as the acceptable groundwater level. Site-specific parameters used to calculate MCL-based soil PRGs are listed in Table 5.5.

5.2.3 Soil PRGs for UEFPC OU 3

Table 5.6 presents soil PRGs for use in performing the UEFPC OU 3 RI. In keeping with the spirit of the guidance that PRGs should reflect readily available information *and* be health protective, the table presents risk-based PRGs, ARARs/TBC, and other considerations for establishing PRGs, such as background and reasonable cost-effective detection limits.

Values in Table 5.6 are presented for each of the three methods described above. Risk-based PRGs are subdivided according to two headings: direct exposures (subdivided into industrial land use and residential land use) and exposures via potential migration to the groundwater. Note that all PRGs are above CLP detection limits; thus, these detection limits should provide data that are useable in the risk assessment process. Also note that PRGs for chemicals that are relatively soluble (i.e., tetrachloroethylene and TCE) are lower than PRGs based on direct contact. On the other hand, PRGs for PCBs (Aroclors) and several metals are more stringent via direct contact pathways because of the low migration potential of these relatively insoluble compounds. Information used to develop the PRGs based on the leaching potential is preliminary and thus these values are subject to change.

There are three major uses for the PRGs in the early stages of the RI/FS process: (1) as use for helping set detection limits for the sampling program, (2) as use for an acceptable risk-based reference concentration in the data evaluation, and (3) as use in the early stages of alternative development. In using initial PRGs in the early stages of the alternative screening process, engineers should understand that PRGs may be modified and thus should make the design of alternatives flexible. Chemicals may be added or deleted from the list of chemicals of concern, or PRGs may need to be modified based on the identification or deletion of additional limiting pathways. Modified PRGs will be presented in the operable unit feasibility study report and will be reported as Remedial Goal Options (RGOs).

RGOs are refined into final remediation levels (FRLs) and presented in the ROD. Final remediation levels must meet threshold criteria of "protection of human health and the environment" and "compliance with ARARs" (EPA 1991c):

Table 5.5. Parameters used in Summer's model

Parameter	Symbol	Value	Units	Reference
Volumetric flow rate of infiltration	Q_p	21-12,198	ft ³ /day	Calculated by $Q_p = V_a \times A_p$ (EPA 1989b)
Darcy velocity in downward direction	V_a	0.0005-0.28	ft/day	Hydraulic conductivity for unsaturated zone
Horizontal area of contamination	A_p	43,566	ft ²	Average area waste units in OU 3
Volumetric flow rate of groundwater	Q_a	37-827	ft ³ /day	Calculated by $Q_a = V_d \times h \times w$ (EPA 1989b)
Hydraulic conductivity	K	0.28-2.8	ft/day	Average value for Y-12 Plant area (Solomon et al. 1992)
Hydraulic gradient	I	0.03-1	unitless	Estimated from potentiometric maps of the Y-12 Plant area
Darcy velocity in aquifer	V_d	0.0084-0.28	ft/day	Calculate by $V_d = K \times I$
Aquifer thickness	h	20-30	ft	Average thickness of shallow groundwater zone at Y-12 Plant
Perpendicular spill width	w	147.6	ft	Default value from RAGS Part B

However, the NCP also allows for modification of PRGs during final remedy selection based on the "balancing" and "modifying" criteria and factors relating to uncertainty, exposure, and technical feasibility (EPA 1991c).

It should be noted that, with the exception of recommending the inclusion of environmental ARARs in the selection of PRGs, remedial action goals (RAGS), Part B, addresses mainly human health effects, especially for soil PRGs. The potential need for ecological-based soil PRGs is being evaluated.

5.3 IDENTIFICATION OF POTENTIAL CLASSES OF REMEDIAL TECHNOLOGIES

EPA-established requirements pertaining to the remediation of CERCLA sites are listed in Sect. 300.430(a)(1)(iii) of the NCP. These requirements have been considered in developing the preliminary remedial action goals, which serve to focus the consideration of remedial action alternatives. In the FS, the remedial action alternatives will undergo a detailed analysis. The detailed analysis will include assessment against the following 11 evaluation criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) short-term effectiveness; (4) long-term effectiveness; (5) reduction of

Table 5.6. Soil preliminary remediation goals

Risk-based PRGs							
Chemical	Direct contact with soil			Protection of groundwater		Other considerations	
	Without institutional controls— EPA default residential ^b			Leaching to groundwater— Summer's Model ^c	MCL-based/ (mg/kg)		
	Toxic effects (mg/kg)						
	Cancer effects ^d (mg/kg)	Toxic effects ^e (mg/kg)	Cancer effects (mg/kg)	Toxic effects (mg/kg)	ARAR- based PRGs (mg/kg)	Background ^f (mg/kg)	CLP detection limits ^g (mg/kg)
Arsenic	3.3E+00	6.1E+02	3.7E-01	8.2E+01	11-28	7.4E+00	1.0E+00
Beryllium	1.3E+00	1.0E+04	1.5E-01	1.4E+03	1-4	8.5E-01	5.0E-01
Boron	NC	1.8E+05	NC	2.5E+04	NA	--	5.0E-01
Cadmium (food)	1.1E+04	2.0E+03	NC-O	2.7E+02	3-7	--	5.0E-01
Chromium (VI)	1.6E+03	1.0E+04	NC-O	1.4E+03	160-416	5.2E+01	1.0E+00
Cobalt	NC	5.3E+03	NC	7.1E+02	NA	9.2E+00	5.0E-01
Copper	NC	7.6E+04	NC	1.0E+04	NA	2.2E+01	2.5E-01
Cyanide	NC	4.1E+04	NC	5.5E+03	NA	--	--
Lead	NC	NE ^h	NC	NE	16-42	1.7E+01	3.0E-01
Mercury	NC	6.1E+02	NC	8.2E+01	0.02 - 0.06	1.2E-01	2.0E-02
Molybdenum	NC	1.0E+04	NC	1.4E+03	NA	7.9E-01	8.0E-01
Nickel	NC	4.1E+04	NC	5.5E+03	69-180	1.8E+01	4.0E+00
Nitrate	NC	3.3E+06	NC	4.4E+05	NA	--	--
Nitrite	NC	2.0E+05	NC	2.7E+04	NA	--	--
Thallium	NC	1.4E+02	NC	1.9E+01	3-8	8.6E+00	1.0E+00
Uranium ⁱ	NC	6.1E+03	NC	8.2E+02	0.04 - 1	1.0E+00	--
Zinc	NC	6.1E+05	NC	8.2E+04	NA	5.2E+01	2.0E+00

Table 5.6 (continued)

Risk-based PRGs								
Chemical	Direct contact with soil			Protection of groundwater		ARAR-based PRGs (mg/kg)	Other considerations	
	Without institutional controls—EPA default residential ^b			Leaching to groundwater—Summer's Model ^c	Background ^e (mg/kg)		CLP detection limits ^f (mg/kg)	
	Without institutional controls—EPA default residential ^b							
	With institutional controls—industrial worker ^a	Cancer effects ^d (mg/kg)	Toxic effects ^d (mg/kg)					
	Cancer effects ^d (mg/kg)	Toxic effects ^d (mg/kg)	Cancer effects (mg/kg)	Toxic effects (mg/kg)	MCL-based ^d (mg/kg)			
Organics								
Aroclor-1248	7.4E-01	NT	8.3E-02	NT	6-15	10-50 ^a	--	3.3E-02
Aroclor-1254	7.4E-01	NT	8.3E-02	NT	6-15	10-50	--	3.3E-02
Aroclor-1260	7.4E-01	NT	8.3E-02	NT	6-15	10-50	--	3.3E-02
Benzene	2.0E+02	8.2E+02	2.2E+01	1.1E+02	0.01 - 0.04	--	--	5.0E-03
Carbon Tetrachloride	4.4E+01	1.4E+03	4.9E+00	1.9E+02	0.05 - 0.14	--	--	5.0E-03
Chloroform	9.4E+02	2.0E+04	1.0E+02	2.7E+03	0.2 - 0.5	--	--	5.0E-03
1,2-Dichloroethane	6.3E+01	NT	7.0E+00	NT	NA	--	--	5.0E-03
Ethylbenzene	NC	5.5E+04	NC	2.7E+04	20 - 52	--	--	5.0E-03
Methylene Chloride	7.6E+02	1.2E+05	8.5E+01	1.6E+04	0.002 - 0.005	--	--	5.0E-03
Tetrachloroethylene	1.1E+02	2.0E+04	1.3E+01	2.7E+03	0.03 - 0.09	--	--	5.0E-03
Trichloroethylene	5.7E+02	NT	6.4E+01	NT	0.03 - 0.09	--	--	5.0E-03
Toluene	NC	1.6E+04	NC	5.5E+04	10 - 26	--	--	5.0E-03
Xylenes	NC	4.1E+06	NC	5.5E+05	225 - 585	--	--	5.0E-03

^aPathways evaluated for the worker exposure include incidental ingestion of soil, and inhalation of particulate and volatile emissions (EPA 1991a). Parameters used are listed in Table 5.8.

^bPathway evaluated for the residential scenario is soil ingestion (EPA 1991a). Parameters used are listed in Table 5.8.

^cPRGs based on leaching to groundwater are calculated using the Summer's Model (EPA 1989). Data required for the model are listed in Table 5.8. K_d used for clayey soils (DOE 1992).

Table 5.6 (continued)

- ^dDeveloped using above mentioned pathways and cancer slope factors from the IRIS database (EPA 1993), the Healths Effects Assessment Summary Tables (HEAST) (EPA 1991b, EPA 1992a).
- ^eDeveloped using above mentioned pathways and reference doses from the IRIS database (EPA, 1993), the Healths Effects Assessment Summary Tables (HEAST) (EPA 1991b, EPA 1992a).
- ^fSoil cleanup level is based on preventing concentrations in the groundwater from reaching MCL levels. If MCL was not available, no PRG soil value was estimated.
- ^gUnited States Geological Survey (USGS) data are reported for comparison purposes. Data represent mean value for the Eastern United States. Site-specific data will be used as it becomes available.
- ^hContract required detection limits from EPA CLP Statement of Work: Inorganics - ILM 02.0, Organics - OLM 01.8. A conversion of 1 gram to mL volume was used to convert water limit to soil limits.
- ⁱ"-" = no ARAR of TBC available. Few soil ARARs exist.
- ^jNC = Not a carcinogen; NC-O = Not an oral carcinogen; NT = Not a chemical toxicant; NA = No data available.
- ^kNE = Not estimated. EPA has requested that lead toxicity be evaluated using the EPA Lead Biokinetic/Uptake Model. Using this model, EPA estimated that acceptable lead concentrations are between 500-1000 ppm.
- ^lPRG estimated based on uranium toxicity.
- ^mFrom TSCA PCB spill cleanup policy (52 FR 10688).

contaminant toxicity, mobility, and volume; (6) implementability; (7) cost; (8) state acceptance; (9) community acceptance; (10) compliance with NEPA; and (11) compliance with National Resource Damage Assessment (NRDA). The classes of remedial technologies are summarized below.

- ***Institutional controls*** such as fences and deed restrictions may be used alone or as a supplement for engineering controls to prevent exposure to hazardous substances. Monitoring is also considered an institutional control.
- ***Containment technologies*** such as capping, vertical barriers, horizontal barriers, and dust suppression may be used, as appropriate, to control contaminated areas that pose a relatively low long-term threat and for sites where treatment is impractical.
- ***Removal technologies*** such as excavation may be used alone or in combination with treatment to remove contamination or to abate the further migration of contaminants.
- ***Treatment technologies*** such as solidification/stabilization, chemical, biological, thermal, or electrical may be used alone or in combination with any of the above technologies:
 - (1) to abate principal threats such as highly mobile or toxic substances,
 - (2) to prevent further migration of contaminants, or
 - (3) to remove contamination. (Where possible, treated material that no longer poses a threat to human health or the environment will be returned to the excavation site.)
- ***Innovative technologies*** may be considered when they offer the potential for superior treatment performance or lower costs for performance similar to that of demonstrated technologies.

As the remediation goals are revised throughout the RI/FS process, the development and evaluation of the remedial action alternatives will reflect the scope and complexity of the site problems being addressed. During the FS, alternatives will be developed to protect human health and the environment by eliminating, reducing, and/or controlling risks posed through each exposure pathway.

A preliminary range of remedial action alternatives and associated technologies for UEFPC OU 3 is presented in Table 5.7. This table is not meant to present a detailed investigation of alternatives but to make an initial determination as to which general response actions might be applied to the sites. This table will be used later during the FS process to screen process options and entire technology types as to their implementability for each site. The identification of potential technologies at this stage will help ensure that data needed to evaluate them can be collected as early as possible. Early identification of technologies will also determine whether treatability studies are needed.

The general response actions are (1) no action required, (2) institutional actions, (3) source containment, and (4) removal/treatment. The "no action" response is required by CERCLA and serves as a baseline comparison against which the other actions can be measured. Institutional controls include fencing, access restrictions, deed restrictions, and monitoring. Source containment includes prevention of surface water runoff and groundwater infiltration and dust control for airborne contaminants. Treatment/removal technologies include excavation, source removal, solidification/stabilization, dewatering, biological, physical, chemical, thermal, electrical, and groundwater collection and pumping technologies.

Table 5.7. Identification of preliminary remedial action goals, preliminary general response actions, and preliminary remedial technology types for specified media

Media	Remedial action goals	General response actions	Remedial technology type/options
Soil	For protection of human health:	No action: 1. No action	Institutional options: 1. Fence/access barriers 2. Deed restrictions
	Prevent ingestion and/or inhalation of and/or direct contact with contaminated soil	Institutional actions: 1. Access restrictions 2. Legal restrictions	Monitoring technologies: 1. Sampling and analysis
	For protection of environment:		
	Prevent migration of contaminants that would result in groundwater contamination in excess of desirable levels for the contaminants of interest	Monitoring actions: 1. Monitoring Containment actions: 1. Containment	Containment technologies: 1. Capping 2. Vertical barriers 3. Horizontal barriers 4. Dust controls
		Removal and Treatment actions: 1. Excavation/disposal 2. Excavation/treatment/disposal 3. Excavation/treatment/replacement 4. In-situ treatment	Removal technologies: 1. Excavation
			Treatment technologies: 1. Solidification/stabilization 2. Dewatering 3. Physical treatment 4. Chemical treatment 5. Biological treatment 6. Thermal treatment 7. Electrical treatment 8. In-situ treatment

Table 5.7 (continued)

Media	Remedial action goals	General response actions	Remedial technology type/options
Groundwater	For protection of human health:	No action:	Institutional options:
	Prevent ingestion and/or inhalation of and/or direct contact with vapor from groundwater tainted with the contaminants of interest in excess of desirable levels	1. No action	1. Fence/access barriers
		Institutional actions:	2. Deed restrictions
		1. Access restrictions	3. Surveillance monitoring and analysis
		2. Legal restrictions	4. Sampling
		3. Monitoring	
	For protection of environment:	Containment actions:	Containment technologies:
	Isolate the contaminated groundwater and prevent further contamination of other media	1. Containment	1. Vertical barriers
		Collection/treatment actions:	2. Horizontal barriers
		1. Collection/treatment discharge	3. Capping
		2. In-situ groundwater treatment	4. Subsurface collection drains
			5. Groundwater diversion pumping
			Extraction technologies:
			1. Groundwater collection and pumping
			2. Dewater entire site
			3. Selective alternate recovery
			Treatment technologies:
			1. Physicochemical treatment
			2. Biological treatment
			3. Electrical treatment
			4. Use existing Y-12 treatment facilities
			5. In-situ treatment

6. SITE DATA NEEDS

The purpose of this section is to identify the data needs necessary to meet the objectives of the RI identified in Sect. 1.7. As described in Sect. 1.5, the observational approach for this RI is to perform a risk assessment for the OU 3 sites using the historical data base. Upon completion of this task, confirmatory sampling or comprehensive sampling would be conducted. The decision between confirmatory or comprehensive sampling will be made based on the acceptable level of risk as outlined in Sect. 6.4. The data needs discussed in Sects. 6.1, 6.2, and 6.3 have been identified in anticipation of further characterization being required at the S-2 Site, Building 81-10, and the northwest portion of the Salvage Yard, and to provide information necessary to assess the impact of the source term OU upon the integrator OU. Information required to screen potential remedial action technologies is also identified. As described in Sect. 1.6, RI activities for the Salvage Yard Scrap Metal Storage Area and Salvage Yard Oil/Solvent Drum Storage Area will not be pursued as part of this RI; however, some limited characterization is required for the Scrap Metal Storage Area and the Oil/Solvent Drum Storage Area to assess potential releases to the integrator OU and verify completeness of past clean-up actions.

The general data needs for this RI include both soil physical property parameters and contaminant concentration data. Soil physical property data is necessary to evaluate fate and transport of contaminants through the subsurface and to establish general engineering parameters for evaluation of remedial technologies. Contaminant concentration data is needed to establish the nature and extent of contamination and to evaluate the fate and transport of contaminants in the subsurface. The general data needs for the OU 3 sites are described in Table 6.1. Data needs for OU 3 have been developed, to the extent practical, using assumptions made with the historical data described in Chap. 3.

6.1 ENVIRONMENTAL CHARACTERIZATION

6.1.1 S-2 Site

6.1.1.1 S-2 Site soils

Previous investigations indicate that soil at the S-2 Site is contaminated with metals, volatile organic compounds, and uranium. The most severe contamination appears to be limited to the subsoil of the former pit; however, one downgradient boring indicates contamination has migrated into soil adjacent to the site. A geophysical survey (Gianfrancesco et. al. 1988) also indicates a plume of contamination downgradient of the S-2 Site and to bound the limits of the former pit. Surface soil samples are needed in order to evaluate the potential for contaminant transport by runoff. Additional borings are required to fully define the nature and extent of contamination in soils downgradient of the site and to confirm historical data for soils within the former pit. Soil samples are also needed for physical property information to assess contaminant transport and aid in the screening of remedial technologies. Site specific distribution coefficients (K_d) for metals and radionuclides are also required to assess the fate and transport of contaminants in the subsurface. TCLP analysis for listed metals and organics is needed for remedial alternative screening and to define the

Table 6.1. UEFPD OU 3 RI Work Plan site data needs

Data need	Data type	Sample type or method	Media	Data use	Data evaluation and interpretation	Quality level
Physical properties	Soil grain size, permeability, void ratio, soil density, bulk density, total organic carbon content, cation exchange capacity, soil pH*	Undisturbed samples (Shelby tubes)	Unconsolidated earth materials (includes soil, fill, saprolite)	<ul style="list-style-type: none"> Evaluate release mechanisms for transport from the source to groundwater, surface water, and air pathways 	This data will be illustrated on maps and cross-sections. Data will be used in conjunction with analytical data to estimate the mass rate of contaminants transported from the source to the saturated groundwater environment	
				<ul style="list-style-type: none"> Screen Remediation Technologies 		
				<ul style="list-style-type: none"> Remediation Design 		
Hydraulic head measurements		Electronic probe graduated to 0.01 ft	Groundwater	<ul style="list-style-type: none"> Determine hydraulic gradients. Establish thickness of unsaturated zone. Establish seasonal fluctuation in water table 	Data will be illustrated as potentiometric maps, hydraulic gradients will be input into mass transport calculations. Hydrographs will also be made to establish seasonal variation in the water table	
				<ul style="list-style-type: none"> Screen Remediation Technologies 		
				<ul style="list-style-type: none"> Remediation Design 		

Table 6.1 (continued)

Data need	Data type	Sample type or method	Media	Data use	Data evaluation and interpretation	Quality level
	Standard compaction test	Undisturbed sample (Shelby tube)	Soil	<ul style="list-style-type: none"> Determine compactibility of soil, plastic and liquid limits, and compressibility Screen Remediation Technologies Remediation Design 	Volume reduction of compacted soil Soil behavior on wetting Determine load bearing capacity of soil	
Physical properties (continued)	Visually inspected soil properties, and split barrel penetration blow counts	Soil/split barrel penetration tests	Unconsolidated earth materials (includes soil, fill, and saprolite)	<ul style="list-style-type: none"> Evaluate release mechanisms for transport from the source to groundwater and surface water pathways, establish thickness and volume of unconsolidated zone with the site. This data will be used to qualitatively interpret the distribution of physical properties determined from laboratory analysis Screen Remediation Alternatives Remediation Design 	Data will be illustrated on Tables Data will be plotted on boring logs, maps, and cross-sections and will be used to establish the relative degree of heterogeneity within the unconsolidated zone	

Table 6.1 (continued)

Data need	Data type	Sample type or method	Media	Data use	Data evaluation and interpretation	Quality level
Contaminant concentration	Analytical parameters to be determined for each site to be investigated	Soil samples will be collected by hand auger or split-spoon. CLP methods will be used	Soil (source)	Define the vertical and horizontal extent of contamination within the source area. Define the boundary and volume of soil to be remediated. Data will also be input into mass transport calculations to assess the threat of release to the groundwater and surface water environments. Data will be used as input for the risk assessment.	Data will be presented on maps and cross-sections along with physical property data, qualitative correlations will be made between soil physical properties and contaminant distribution and occurrence, statistical analysis will be performed and the data presented in table format	100% Level IV Lab deliverable 10% of the data will be validated to Level IV, 90% validated to Level III
Contaminant concentration (continued)		EPA SW 846 method will be used on TCLP extract		Define the relative solubility of the contaminants	Data will be presented on tables	Level III
Kd values for metals and radionuclides		Batch method	Soil	The data will be used to quantify exposure scenarios, to model the effectiveness of the potential remedial alternatives, and to aid in the determination of preliminary action goals	The data will be presented as site-specific distribution coefficient values. The values will be used in conjunction with literature values and other site data to determine the most appropriate site values	Level III

Table 6.1 (continued)

Data need	Data type	Sample type or method	Media	Data use	Data evaluation and interpretation	Quality level
Analytical parameters are determined for each site to be investigated		Groundwater samples will be taken for a period of 4 quarters. Dissolved and unfiltered samples will be collected. CLP methods will be used	Groundwater (pathway)	Assess the influence of seasonal changes on contaminant concentrations in the groundwater. Data will be used as input for the Baseline Risk Assessment for UEPPC OU 1 and the Final ROD for UEPPC	Data will be presented on maps and cross-sections. Mass transport rates will be calculated	100% Level IV Lab deliverable 10% of data validated to Level IV, 90% validated to Level III
Analytical parameters are determined for each site investigated		Samples will be collected during storm events. CLP methods will be used for analysis. Flow rates will also be measured	Surface Water (Pathway) Sediment (Pathway)	Determine if contaminants are being transported by surface water to UEPPC	Data will be presented on tables	100% Level IV Lab deliverable 10% of data validated to Level IV, 90% validated to Level III

* If this data can be collected from nearby areas, fewer samples will be needed.

relative solubility of the contaminants. The S-2 Site soil has never been screened for PCBs, therefore, analysis for this parameter is warranted.

6.1.1.2 S-2 Site groundwater

The monitoring wells that surround the S-2 Site are screened in the weathered bedrock. Groundwater samples from these wells indicate levels at or above primary drinking water standards for barium, cadmium, chromium, lead, mercury, nitrate, gross alpha and beta, radium, chloroform, carbon tetrachloride, trichloroethylene, and tetrachloroethylene. Potentiometric surface data from these wells indicate that the water table is about 10 ft below the ground surface, however, the potentiometric head between Well GW-251 and GW-253 varies by ~ 10 ft. Thus, the groundwater gradient cannot be established with confidence. This head difference also suggests the presence of two distinct hydraulic units. Soil borings indicate contamination below the water table. An upgradient and downgradient well screened across the water table is needed to establish the horizontal gradient and to collect groundwater samples from the water table contact to evaluate the contribution of contamination from soils to the groundwater. Monitoring of these wells should be conducted for four consecutive quarters in conjunction with the existing well network to establish spatial and temporal relationships of the shallow groundwater system. Groundwater monitoring wells GW-252 and GW-255 are currently sampled quarterly for volatile organic compounds, metals, and radiological parameters as part of the Y-12 Plant Groundwater Protection Program. GW-252 and GW-255 monitoring intervals are below the water table vadose zone interface; however, an evaluation of contaminant contribution from the soils to the groundwater cannot be determined conclusively.

6.1.1.3 S-2 Site surface water

Evaluation of the piezometric surface from Well GW-253 (Sect. 3.6.1) indicates that the water table may intercept a small drainage gully during prolonged wet weather periods. The drainage gully is located to the east of Well GW-253 (Fig. 3.5). In addition, there is a potential that contaminants existing at the surface may be transported by runoff. Thus, there is a need to collect a surface water sample from the drainage gully. Because the mercury spoil pile is located at the upstream end of this gully, a sample is needed upstream and downstream of the S-2 Site.

6.1.2 Building 81-10

6.1.2.1 Building 81-10 soils

Previous soil sampling at Building 81-10 indicates that the soil at the site is contaminated with mercury, and other metals. The full nature and extent of contaminated soil needs to be determined. Specific areas needing further investigation include: the rip-rap bank area between Building 81-10 and PIDAS, the area of visible mercury contamination between the building and G-Road, and the area along the fence line south and east of the building (see Fig. 3.8). TCLP analysis for listed metals and organics are also needed for screening potential remedial alternatives and for defining the relative solubility of the contaminants. Because the soil has never been analyzed for PCBs, analysis of this parameter is warranted.

6.1.2.2 Building 81-10 groundwater

Seven monitoring wells have been installed in the vicinity of Building 81-10. Three of these wells (GW-698, GW-700, and GW-701) have been sampled for mercury, metals, VOCs and extractable organics. These wells have only been sampled once. The remaining four wells have not been sampled. Well GW-698 is located on the concrete pad where the mercury roasting operation took place, and is screened within the Maynardville Limestone. Wells GW-700 and GW-701, located 125 ft and 115 ft respectively from Building 81-10, are screened in the unconsolidated material and are probably influenced by groundwater contamination from other areas. Groundwater from well GW-698 contained concentrations of mercury, chromium, lead, tetrachloroethylene, trichloroethylene, 1,2-DCE, and chloroform above primary drinking water standards. Because there are no nearby upgradient wells screened in the Maynardville, the contribution to groundwater contamination from contaminated soils at Building 81-10 cannot be assessed. One additional monitoring well cluster should be screened upgradient of Building 81-10. This well cluster should consist of a well screened in the upper portion of the Maynardville Limestone and a well screened across the water table. This well cluster along with well cluster GW-696, GW-697, and GW-698, and well GW-699, should be sampled for four consecutive quarters to establish spatial and temporal variations in groundwater contamination at Building 81-10, and to assess the impact of contaminated soils at the site to the shallow groundwater system. Additional sampling of wells GW-700 and GW-701 is not warranted because of their distance from the facility.

6.1.2.3 Building 81-10 surface water

Surface soil samples collected from the rip-rap lined bank between Building 81-10 and PIDAS indicate surface soil is contaminated with mercury and other metals. The potential for erosion by surface runoff exists in this area. Water samples collected during wet weather are needed to assess the transport of sediment from this site.

6.1.3 Salvage Yard

The Salvage Yard consists of five sites. The currently active scrap metal storage area occupies all of the central and southern portions of the Salvage Yard. Because this site is active and contains large piles of scrap metal that prohibit sampling of the soil, RI activities will not be conducted for this portion of the Salvage Yard. Limited soil, groundwater, and surface water sampling is needed at the southern end of the Salvage Yard to assess releases occurring from the active Scrap Metal Storage Area. Shallow soil sampling should also be conducted along the western border of the site to assess the potential of release from the scrap metal piles. The Oil/Solvent Drum Storage Area has been closed under RCRA. Contaminated soil associated with this facility was excavated and removed from the site as part of closure activities. Confirmatory sampling for radiological parameters is needed to verify removal of contaminated soil. The remaining sites (Tank Site 2063, drum deheader, and the waste oil storage tanks) are located in the northwest portion of the Salvage Yard and will be the focus of activities conducted at the Salvage Yard as part of this RI.

6.1.3.1 Northwest Salvage Yard soils

The presence of solvents and metals within the soils have been confirmed in the northwest portion of the Salvage Yard. The nature and extent of contamination is unknown. Additional soil sampling is needed in the areas downgradient of the drum deheader, adjacent to the concrete pad at the drum deheader, storm runoff catch basin, and soils adjacent to the oil storage tanks. TCLP analysis for listed metals and organics are also needed for remedial alternative screening and to define the relative solubility of the contaminants.

6.1.3.2 Northwest Salvage Yard groundwater

Two wells, GW-190 and GW-265, (Fig. 3.12) are present in the northwest portion of the Salvage Yard. Groundwater from GW-190 is currently sampled for metals, mercury, uranium, specific conductivity, total suspended solids, turbidity, gross alpha and gross beta activity, VOCs, major ions, pH, total dissolved solids, and total petroleum hydrocarbons by the Y-12 Plant Groundwater Protection Program. Well GW-265 has been sampled from 1986 through 1990 for VOCs, metals, and radiological parameters. Data collected from these wells indicate the groundwater is contaminated with volatile organic compounds. One soil boring will be drilled down-gradient of the storm water catch basin and a groundwater well will be installed if the soil is contaminated. This proposed well in addition to wells GW-190 and GW-265 should be sampled for four quarters to establish spatial and temporal distributions of contaminants in the shallow groundwater system.

6.1.3.3 Northwest Salvage Yard surface water

The potential for erosion of contaminated soil by surface water runoff exists at the northwest portion of the Salvage Yard. Wet weather sampling should be conducted at the stormwater catch basin to evaluate this transport pathway.

6.2 SAMPLING AND ANALYTICAL REQUIREMENTS

6.2.1 S-2 Site

The sampling and analytical requirements for the S-2 Site are discussed in Sect. 7.4.2.

6.2.2 Building 81-10

The sampling and analytical requirements for Building 81-10 are discussed in Sect. 7.4.3.

6.2.3 Salvage Yard

The sampling and analytical requirements for the Salvage Yard are discussed in Sect. 7.4.4.

6.3 DATA EVALUATION AND INTERPRETATION

All data collected as part of this RI will be entered into a data base compatible with Oak Ridge Environmental Information Systems (OREIS). A total of 10% of the data will be validated to Level IV quality standards and the remaining 90% will be validated to Level III as discussed in Sect. 8.9. The validated data will then be used for statistical analysis and data presentation as needed to satisfy the intended data use discussed in Sects. 1.8.1 and 1.8.3 of the DQOs and identified on Table 6.1. Field observations will be used to decide which 10% of the data will be validated to Level IV.

Data generated from analysis of soil samples will be summarized statistically in data tables. The tables will contain the minimum, maximum, mean, and standard deviation for each potential contaminant of concern. These data will be used to calculate human health risk as described in Sect. 6.4 and to aid in defining the nature and extent of contamination.

Contamination by depth profiles will be generated for all data from each borehole. All values above the PRGs established in Sect. 5.2 will be graphed in a different color in order to aid in establishing preliminary remediation boundaries. Cross sections will also be prepared from selected profiles to establish the vertical and horizontal extent of contamination. Visually estimated soil characteristics will also be represented on soil logs and cross sections. Potentiometric maps and contaminant concentration maps will also be prepared. Geotechnical data will be represented on data tables.

6.4 RISK ASSESSMENT METHODOLOGY

6.4.1 Screening Level Risk Assessment for UEFPC OU 3

A screening level risk assessment will be conducted for UEFPC OU 3 to characterize potential risk to public health and the environment associated with contact of contaminated soils and surface waters at the sites within the UEFPC OU 3. Because a full PA/SI has not been performed on the OU 3 site, a screening level risk assessment will provide the basis for determining whether expedited action is required at the site, and may serve as the justification for performing a removal action. The methodology to be used in the screening level risk assessment is illustrated in Fig. 6.1. Risk estimates will be presented for hypothetical, current and future use scenarios for human receptors. Chemical intake estimates and radiological dose estimates will be based on EPA methodology presented in RAGS related guidance (EPA 1991b).

The assessment uses existing data to identify and prioritize potential COCs for future evaluation and investigation to focus sampling efforts on contaminants and pathways that are principal drivers of total potential risk. The approach will be to evaluate each site initially with a lower-bound screening using the MLE to help to rapidly identify contaminants and exposure pathways with the highest priority for further evaluation and/or remedial actions. If risk is determined, from the initial MLE, to be greater than the EPA target risk range ($>10^{-6}$, >1), a complete characterization will be performed and a revised MLE will be evaluated to determine risk. If the risk associated with the revised MLE is also determined to be greater than the EPA target risk range remedial actions will be recommended. If the revised MLE

Fig. 6.1. Screening level risk assessment flow chart.

is less than the target risk range, an upper bound assessment [reasonable maximum exposure (RME)] will be performed to assess risk. If the RME risk is less than the target range of 10^{-6} and the Hazard Index is less than 1, then a recommendation of no further investigation will be made. An exceedance of these indices will result in a recommendation of either removal actions or FS/Interim Record of Decision (IROD).

If the initially calculated MLE risk is less than the EPA target risk range ($>10^{-6}$, >1), data quality will be assessed to determine the need for confirmatory sampling. An RME will be performed on either the existing or supplemented data set to characterize risk under a conservative scenario.

6.5 FEASIBILITY STUDY

The following sections describe the tasks necessary to conduct and produce the FS report for the UEFPC OU 3 interim actions. This report will follow the format outlined in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA/540/ G-88/004) and the annotated outline developed by the DOE-ORO Document Content and Response Committee (DCRC). The FS report will be prepared to integrate NRDA and NEPA requirements. Upon approval of the FS by EPA and TDEC, a proposed plan will be submitted presenting the preferred alternative for an interim remedial action followed by an interim action ROD. A series of proposed plans and interim action RODs may result, depending upon the need for more than one interim remedial action.

6.5.1 FS Contractor Responsibilities

The FS contractor will prepare the FS and will ensure that it is prepared within project quality, cost, and scheduling goals. The FS contractor will provide engineering and technical resources to support QC efforts, provide project management, and coordinate project activities to ensure that established goals are achieved. Monthly progress reports on the FS process will be issued to DOE. FS contractor activities for UEFPC OU 3 will begin with scoping activities and will be completed upon final approval of the last interim action ROD prepared for this OU.

6.5.2 Scope and Assumptions

As stated in Sect. 5.2. the general remedial action goal for the UEFPC OU 3 interim remedial actions is to protect human health and the environment from the contaminant sources within the OU. To meet this goal, the CERCLA process will be followed and will include characterization of this source control OU to the extent necessary to identify, screen, and develop interim remedial action alternatives; select a preferred interim remedial alternative or a set of alternatives; and prepare the required decision documents.

The FS contractor will be responsible for completing the FS process for UEFPC OU 3. This process will require preparing the following milestone documents for each interim action deemed necessary: (1) the FS Report, which documents the process used to examine the remedial technologies and select the preferred remedial alternative(s) and also incorporates the requirements under NRDA and NEPA; (2) the proposed plan, which is a summary plan

for presenting the selected interim remedial alternative(s); and (3) the ROD for interim action, which is the legal document that confirms that selected remediation methods meet statutory and regulatory requirements. The FS/proposed plan/ROD for interim action process may include the following principal WBS elements:

- FS Scoping Activities
- Treatability Studies
- FS Development
- NEPA Activities
- NRDA Activities
- FS OU Coordination/Oversight
- Proposed Plan Development
- ROD for Interim Action Development

6.5.2.1 FS scoping activities

Preliminary remedial alternatives have been selected to address the general response actions for UEFPC OU 3. The general response actions are listed in Sect. 5.3. These alternatives will be screened as part of the FS process to eliminate those judged too difficult to implement based on unproven technologies, those judged not sufficient to remediate the site within a reasonable time period, or those judged to have limited application for the specific contaminant or site conditions. Those technologies judged to have a reasonable chance of success for remediation will be carried forward for more detailed development and analysis.

6.5.2.2 Treatability studies

Treatability studies will be conducted as necessary to provide data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis and to support the remedial design of a selected alternative.

6.5.2.3 FS development

The FS contractor will use the format presented in the CERCLA FS guidance document and the DOE-ORO DCRC FS annotated outline to develop the FS. As required, exceptions and modifications to the format will be made for site-specific conditions in UEFPC OU 3. Based on the information obtained during the RI, the FS will be developed in sufficient detail to allow for the selection of preferred alternatives in the proposed plan. The following criteria will be developed to assess the ability of the alternatives to meet the cleanup goals and to comply with administrative and regulatory requirements.

- Threshold criteria
 - overall protection of human health and the environment
 - compliance with ARARs
- Primary balancing criteria
 - short-term effectiveness
 - long-term effectiveness

- reduction in contaminant toxicity, mobility, and volume
- implementability
- cost
- Modifying criteria
 - state acceptance
 - community acceptance
- Compliance with NRDA

The draft FS report will be issued to EPA and TDEC for review. Submittal of the draft FS report to EPA is an FFA milestone.

6.5.2.4 NEPA activities

To comply with the federal facility requirements under NEPA, the interim remedial alternatives will be evaluated for their impact on the environment. NEPA establishes public policies and goals for protecting environmental quality and mandates procedural requirements to be considered when implementing decisions that may impact the environment. DOE Order 5400.4 requires that NEPA and CERCLA be integrated to the maximum extent possible to avoid duplication of efforts that might slow the process. NEPA issues to be addressed include rare and endangered species, archeological studies, wetlands, and floodplains. The environmental impacts of the alternatives will be considered integral to the evaluation and selection process. The appropriate level of NEPA documentation will be directed by DOE after the site investigation is completed and remedial actions are formulated.

6.5.2.5 NRDA activities

To comply with NRDA, the Natural Resource Trustees may assess damages for injuries to natural resources resulting from release of hazardous substances. The first step in the NRDA process is to perform a preassessment screen. If the screening indicates that NRDA is not appropriate, no further assessment actions will be taken. However, if the preassessment screen indicates that NRDA is appropriate, a Type B assessment will begin, requiring an Injury Determination phase, a Quantification phase, and a Damage Determination phase.

6.5.2.6 FS OU coordination/oversight

The objective of FS oversight activities is to provide review and technical input during the FS to ensure that the data and information obtained during the RI are incorporated properly into the FS report and that they are adequate to prepare a proposed plan and support the development of a ROD for interim action.

6.5.2.7 Proposed plan development

Each proposed plan for UEFPC OU 3 will be prepared to present the preferred remediation alternative(s) to the public. The proposed plan documents the investigation process, administrative and regulatory actions, and remedial alternatives. The proposed plan

is a primary milestone document made available for public comment and subject to administrative and regulatory reviews.

6.5.2.8 ROD for interim action development

The final step in the decision process for UEFPC OU 3 will be preparation of the ROD for interim action, the legal document that formally describes the preferred remediation alternative(s) and establishes the remediation schedule and monitoring plan for the site. The UEFPC OU 3 ROD for interim action will be written in accordance with the statutory requirements of CERCLA and applicable federal and state requirements. It will contain a decision summary outlining the nature and extent of the contamination and associated risks at UEFPC OU 3, the evaluation and analysis of the RA alternatives considered, and an explanation of how the selected alternative(s) will meet statutory requirements. The ROD for interim action will also contain a responsiveness summary addressing the public comments obtained during public review of the proposed plan and public examination of the administrative record. The ROD for interim action is a primary FFA milestone.

6.6 REMEDIAL DESIGN (RD) AND RA PLAN

6.6.1 RD

This section presents the scope of the RD effort required to prepare an RD Work Plan; perform any required engineering studies; prepare a Title I (30%) design package; and prepare Title II (60%, 90%, and 100%) final design reports for UEFPC OU 3 remediation.

6.6.1.1 Scope and assumptions

The scope of the RD Work Plan for the remediation of UEFPC OU 3 is to provide necessary supporting documents to implement each RA activity. These documents require approval from DOE-ORO, DOE-Headquarters, TDEC, and EPA. The following sections present details of the scope of work and assumptions associated with remediation of UEFPC OU 3.

6.6.1.2 RD Work Plan

The RD Work Plan will provide the technical and management approach for the RD work. The RD contractor will prepare a draft RD Work Plan based upon the scope and design criteria specified in the proposed plan and ROD for interim action. The RD Work Plan will include the detailed design process and schedule for the design effort and will be prepared in accordance with CERCLA and NEPA regulations. The RD contractor will incorporate comments from Energy Systems, DOE, EPA, and TDEC and submit the Final RD Work Plan for approval.

6.6.1.3 RD Work Plan oversight activities

During the preparation of the RD Work Plan, the DOE prime contractors will provide review and technical input to ensure that the scope of work is adequately defined in accordance with the criteria specified in the ROD for interim action. Review of the draft RD Work Plan will also ensure that the selected technologies do not violate the intent of the ROD for interim action and that the overall work plan meets all regulatory and administrative requirements.

6.6.1.4 RD Report Title I design

Based on the engineering studies and other information available from the RI/FS, the RD contractor will prepare a Title I (30%) design/construction drawing for remedial activities showing the extent of remedial activities, site plan, details, and outline of specifications for the work involved.

6.6.1.5 RD Report Title II design

Upon approval of the Title I design document, the RD contractor will prepare Title II engineering designs, analyses, and calculations required for all civil, structural, mechanical, and electrical construction, construction drawings, technical specifications, and cost estimates.

All documents will be submitted to Energy Systems for comment at 60% completion. Upon resolution of comments, the 90% design package will be submitted to Energy Systems and DOE for review and comments. Upon resolution of 90% comments, the final design report (100%) for remedial activities will be submitted to EPA and TDEC for review and approval. Agency comments will then be incorporated to prepare design documents certified for construction.

6.6.1.6 RD oversight activities

During the review of the Title I and II design documents at 30%, 60%, and 90%, all participants will provide their review and technical input to help submit the final design document to TDEC and EPA in the given time frame.

6.6.2 RA

This section presents the scope of the RA activities required to prepare an RA Work Plan and implement the remediation of UEFPC OU 3. The risks, uncertainties, and interfacial issues for the remedial activities are also identified in this section.

6.6.2.1 Scope and assumptions

The scope of the RA includes the RA Work Plan, construction management, Title III construction oversight activities, construction of one remediation design package, construction support, independent certification, and verification.

6.6.2.2 RA Work Plan

The RA Work Plan will (1) define the scope and objectives of the RA based upon the ROD for interim action and final RD, (2) document the specific construction components of the RA, and (3) present the RA schedule, subcontracting strategy, QA plan, health and safety plan, and RA monitoring plan.

After comments from EPA and TDEC are incorporated, the final RA Work Plan will be prepared for approval and implementation.

6.6.2.3 RA Work Plan oversight activities

The purpose of this activity is to provide technical input and review during the preparation of the RA Work Plan. During the preparation of the draft RA Work Plan, all of the DOE prime contractors will review the Work Plan. This will ensure that the proposed construction efforts will implement the selected interim remedial action consistent with the ROD for interim action and the final RD report. This oversight activity will also ensure that the bid process and implementation plans comply with administrative and regulatory requirements.

6.6.2.4 RA integration

The objective of this element is to provide construction management, independent certification, Title III services, and construction support as required.

RA integration for UEFPC OU 3 remedial activities includes the following tasks:

- Ensuring that subcontracted work is performed on schedule, in accordance with all technical requirements, and in compliance with the Environmental Safety and Health (ES&H) Program, the QA Program, the Waste Management Program, and the Security Program; and
- Performing field inspections, providing as-built drawings, approving Design Change Notices and Field Change Requests as applicable, and ensuring that construction is accomplished according to final design requirements.

7. FIELD SAMPLING PLAN

7.1 INTRODUCTION AND PURPOSE

UEFPC OU 3 is a source control unit that consists of seven sites located in three distinct areas in the western portion of the Y-12 Plant. These sites are described in detail in Chaps. 2 and 3 of this work plan. Potential COCs at each site are listed in Table 2.2. Building 81-10, S-2 Site, and the northwest portion of the Salvage Yard will be the primary focus of this RI. Sampling activities will also be conducted at the active Scrap Metal Storage Area and the RCRA closed Oil/Solvent Drum Storage Area. Table 7.1 presents the rationale for sampling the OU 3 sites. Soil, groundwater, and surface water are the media of interest for this RI work plan. This work plan has been developed in accordance with quality requirements of QAMs-005/50 and ES/ER/TM-4R2. A cross-reference locator page is presented in Table 1.3 of this work plan.

As described in Chaps. 1 and 6, the observational approach for this RI is to perform a screening level risk assessment for the OU 3 sites using the historical data base. Upon completion of this task, confirmatory sampling or comprehensive sampling would be conducted. The decision between confirmatory or comprehensive sampling will be made based on the acceptable level of risk as outlined in Sect. 6.4. The sampling plan discussed in this chapter has been developed in anticipation of further characterization being required at the S-2 Site, Building 81-10, and the northwest portion of the Salvage Yard; and to provide information necessary to assess the impact of the source OU upon the integrator OU.

The overall objectives of this RI work plan are to provide a justifiable rationale and guidance for the collection and analysis of environmental data to meet the goals of this investigation (Sect. 1.7) and to ensure that the data to be collected are technically and legally defensible.

Specific objectives of this plan are as follows:

- to quantify the contaminant concentrations for the soil column and determine the spatial distributions and population statistics for potential COCs,
- to assess the contribution of in-place contaminated soils to the concentrations of potential contaminants in dissolved and particulate phases in the groundwater medium,
- to provide input into the overall assessment of the UEFPC ground water regime thereby facilitating the investigation of UEFPC OU 1,
- to support the feasibility study in the screening of appropriate alternatives during the remedy selection, and
- to quantify the risk to human health for on-site workers.

Table 7.1. Rationale for sampling or not sampling OU 3 sites

Site name	Sampling type	Rationale
Building 81-10	Soil borings Surface soils Groundwater Surface water	Nature and extent of mercury contamination should be known. Contribution from soil contamination to groundwater should be assessed. Assess potential for contaminant transport off-site by surface runoff. Gather physical property data for FS.
S-2 Site	Surface soil Soil borings Groundwater	Define nature and extent of soil contamination downgradient of the site. Bound the limits of the former pit. Assess the potential of contaminant transport by runoff. Water quality at the water table/vadose zone interface. Gather physical property data for FS.
Salvage Yard, Scrap Metal Storage Area	Surface soils Groundwater Surface water	Assess potential releases from the scrap metal piles. Other than assessment of release, no other RI activities will be pursued at this site until it becomes inactive.
Salvage Yard, Oil/Solvent Drum Storage Area	Surface soils	Confirm removal of contaminated soils from the site. Radiological analyses only.
Salvage Yard, Waste Oil Storage Tanks, Drum Deheader, Tank Site 2063	Soil borings Surface soils Groundwater Surface water	Define the nature and extent of contamination. Assess potential for contaminant transport by surface runoff and groundwater. Gather physical property data for FS.

7.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The UEFPC OU 3 RI project organization is illustrated in Fig. 7.1. Responsibilities of Energy Systems and the RI Subcontractor are presented on Table 7.2.

7.3 PROJECT DESCRIPTION

7.3.1 History and Current Conditions

The site history and current conditions for the OU 3 sites are summarized in Chaps. 2 and 3 of the work plan.

7.3.2 Conceptual Site Model

The conceptual models for the sites under investigation are presented in Figs. 3.21 and 3.22. Because the sites are located in the industrial portion of the Y-12 Plant, only exposure pathways to human receptors were considered in the investigation. Contaminant migration pathways for the sites include air, surface runoff, and groundwater transport of dissolved and solid phases.

7.3.3 Identification of Investigation Requirements

The strategy for a source term OU at the Y-12 Plant is to reduce risk to an acceptable level based on current and future use of the facility and to stop continuing releases from the source to the surface water and shallow groundwater system. The source of contamination at the OU 3 sites to be investigated is soil. Because there are few specific ARARs for soils, the investigation requirements for OU 3 are set by the PRGs. PRGs for this RI were established by two methods. The first set of PRGs are set by health-based standards based on worker ingestion of contaminated material. PRGs calculated using this criteria were fairly high (see Table 5.6). Because setting investigation requirements using health-based calculated PRGs may be too high to effectively evaluate the contribution to the groundwater and surface water system, PRGs were also calculated using the Summers model (EPA 1989b), which calculates the level of soil contamination based on contaminant concentrations in the groundwater. To establish PRGs by this method, the Safe Drinking Water Act MCLs and MCLGs were used as an acceptable groundwater concentration and the acceptable soil concentration was back calculated using the Summers' Model. Assumptions used for the calculation of the PRGs are discussed in Sect. 5.2 of the work plan. Feasible treatment technologies are discussed in Sect. 5.3 of the work plan.

7.4 SITE ACTION PLAN

The sampling design detailed in this section is based on the RI objectives and DQOs described in Chap. 1 of the work plan. The scope of sampling activities for UEFPC OU 3 includes soil borings, shallow soil sampling, groundwater monitoring well installation and groundwater sampling, and surface water sampling. The sampling objectives for this plan are specific for each site and are discussed in the sections below. Sample location maps and sample apportionment tables are included for each site.

*numbers correspond to responsibilities shown on Table 7.2.

Fig. 7.1. UEFPC OU 3 RI Functional Organization Chart.

Table 7.2. Energy Systems and subcontractor responsibilities for Y-12 Plant ER Program Assessment

Role	Subcontractor responsibilities	Energy Systems responsibilities
Project Manager	Coordinate all project plans and activities (6)*	Identify project-specific requirements (4)
Medical Monitoring	Ensure all Subcontractor project personnel have updated yearly physicals (9)	Coordinate project activities, as necessary (4)
	Ensure all Subcontractor project personnel have updated respirator fit tests (9)	Identify to Subcontractor any additional or site-specific medical monitoring requirements (7)
Health Physics	Notify ER Division Project Manager of need for an Energy Systems HP, including time and place (8,9)	Provide an HP, when requested, for screening work areas, samples, equipment, or personnel (7)
	Provide an HP or trained designee to be on-site during field activities to screen samples, equipment, and personnel, as necessary (9)	Prepare tags to approve off-site shipment of samples (7)
Industrial Hygiene	Provide site specific health & safety plans (9)	Review/approve health & safety plans (7)
	Provide health & safety oversight or surveillance (9)	Provide health & safety audits (7)
Emergency Response	Contact the Plant Shift Supervisor in any emergency at the Y-12 Plant (3)	The Plant Shift Supervisor manages all emergency situations (2)
	Follow Plant Shift Supervisor instructions (3)	
Utilities	Alert the ER Division Project Manager of the need for a utility check (8,6)	Provide utility checks (4)
NEPA	Ensure field work is done in accordance with NEPA documentation requirements (6)	Ensures assessment activities are cross checked (4)

Table 7.2 (continued)

Role	Subcontractor responsibilities	Energy Systems responsibilities
Groundwater Protection	Provide location and design of monitoring wells (6)	Install, plug and abandon, and maintain monitoring wells (7)
Security (access)	Provide field oversight of well installation (6,8)	Sample monitoring wells (7)
Permits	Provide necessary information for badges, passes, and access (6,8)	Ensure badges, passes, and access are requested and obtained (4)
	Identify project-specific permit requirements (6,8)	Ensure permit is complete (4)
	Provide necessary permit information (8)	Submit permit to correct Y-12 Plant department (4)
Analytical Project Office		Coordinate permit approval (4)
Y-12 Plant Lab (if required)	Determine project-specific analytical requirements, number, types, and schedule of delivery for samples (12)	Coordinate ER program analytical requirements (5)
Quality Assurance (QA)	Provide the number, types, and schedule of delivery for samples (12)	Provide lab space and sample analyses (5)
	Develop project-specific QA plans (12)	Approve project-specific analytical requirements (5)
	Provide internal subcontractor assessments such as surveillances and/or audits (12)	Review and approve QA plans, QA project plans, and associated procedures/instructions (10)
		Develop ER programmatic requirements (10)
		Provide internal ER and subcontractor assessments via the surveillance process (10)
		Provide QA audits (10)

Table 7.2 (continued)

Role	Subcontractor responsibilities	Energy Systems responsibilities
Training	Maintain up-to-date training records (6)	Assist in identifying project-specific training requirements (4)
Waste Treatment	Ensure project personnel have correct training (6)	Audit training records for subcontracted personnel (10)
	Identify project-specific training requirements (6,12)	Identify, schedule, and reserve space in required Energy Systems training sessions (4)
	Develop project-specific waste management plans detailing waste treatment options (6)	Review/approve waste management plans (15)
	Provide estimates of types and quantities of waste needing treatment (6)	Arrange for waste treatment with various Y-12 Plant departments (15)
Waste Transportation	Notify appropriate Energy Systems personnel that waste transportation is needed (6,8)	Arrange for waste pick-up and disposition of waste (15)
Classification	Correctly package and label waste for transport (8)	Determine the level of classification of project-specific activities (4)
	Identify project-specific activities (6)	
Sample Transportation	Follow Energy Systems specific requirements (8,11)	Provide guidance for sample transportation (15)

*number corresponds to identified person on the functional organization chart.

7.4.1 Technical Procedures for Sample Collections

Section 8.2 discusses implementing the technical procedures that will be used as instructions on how to accomplish the sampling activities at OU 3. All sampling activities, where applicable, will follow the technical procedures established in the *Environmental Surveillance Procedures, Quality Control Program* (Kimbrough et al. 1990). The most current edition of these procedures will be utilized. The document is expected to be updated sometime in 1993. Modifications have been made to several procedures and are found in Sect. 8.2, except where otherwise noted.

7.4.1.1 Soils

The soil sampling activities include drilling and sampling of soil borings and the collection of shallow soil samples using a hand auger. The shallow soil samples will be collected in accordance with requirements specified in method ESP-303-2, Revision 0. Soil samples from the soil borings will be collected in accordance with requirements specified in method ESP-303-4, Revision 0. Soil samples will be put in containers, preserved by ice or refrigeration, and handled in accordance with methods ESP-400, ESP-500, ESP-701, and ER Division Procedure Number ER/C-P2302 (IAD) Rev. 0. During the sampling event all soils will be screened for potential volatile organics and radiological contamination following the guidelines established in methods ESP-307-6 and ESP-307-7. After each sample-collecting device is used during the sampling event, it will be decontaminated prior to its next use in accordance with method ESP-900 to prevent the potential for cross-contamination of samples.

All sampling and drilling equipment will be decontaminated according to the procedures detailed in method ESP-901.

7.4.1.2 Groundwater

The field sampling plan includes the installation of monitoring wells to evaluate the impact of groundwater contamination at the source term and to establish hydraulic gradients. The monitoring wells will be installed and sampled in accordance with method ESP-600. Prior to the installation of each well and the initiation of each groundwater sampling event, all equipment, well materials, and sampling devices will be decontaminated in compliance with ESP-900 and ESP-901. The monitoring wells will be developed, purged, and sampled in compliance with the guidelines specified in ESP-302-2 and ESP-302-3. All groundwater samples collected will be put into containers, preserved, and handled in accordance with ESP-400, ESP-500, ESP-701, and ESP-800 where not superseded by ER Division Procedure Number ER/C-P2302 (IAD) Rev. 0. Water level measurements recorded from the monitoring wells will follow the guidance specified in ESP-302-1.

7.4.1.3 Surface water/sediments

Surface water samples will be collected at Building 81-10 and the S-2 Site. It is anticipated that surface water samples will have to be collected in association with a storm event because of the intermittent flow nature of the surface drainage at the site. Surface water samples taken during storm events will be collected, as applicable, in accordance with ESP-301-1.

Prior to each surface water sampling event, all sampling equipment will be decontaminated following the guidelines established in methods ESP-900 and ESP-901. All samples collected will be put into containers, preserved, and handled in accordance with methods ESP-400, ESP-500, ESP-701, and ESP-800.

7.4.2 S-2 Site

Previous sampling at the S-2 Site indicates that soil and groundwater are contaminated with metals, VOCs, and radiologicals. The source of contamination at the S-2 Site is the soil below the former basin. Soil boring, groundwater, and surface water sampling will be conducted for the S-2 Site. Seven soil borings will be drilled at the S-2 Site (Fig. 7.2) to establish lithologic control, define the nature and extent of contamination, evaluate the contribution of soil contamination to the groundwater system, and collect geotechnical data for the FS. Monitoring wells will be completed in two of the borings. The rationale for the seven proposed boring is as follows:

- Only one previous boring has been analyzed for analytical parameters outside the former pit. In order to verify that the bulk of contamination at the S-2 Site lies within the former pit, and to establish limits for the pit boundary, four borings are needed to bound the four sides of the former pond. Geotechnical parameters for the soils surrounding the pit are also needed.
- The downgradient borings are needed to quantify soil contamination directly downgradient of the pit.
- The boring inside the pit is needed for geotechnical analysis, to verify historical data, analysis of TCLP extract, and Kd values.

The proposed boring inside the pit will only be advanced to a depth of 12 ft. Table 7.3 presents the sample apportionment and Table 7.4 presents a detailed summary of the number of samples and quality of samples to be collected. All sample locations will be surveyed by a licensed surveyor to the nearest 0.1 ft using Y-12 Plant coordinates. The elevation of the sample location will be surveyed to the nearest 0.01 ft by the surveyor.

7.4.2.1 S-2 Site soils

All soil borings located outside the former basin will be sampled to refusal (~ 40 ft) at 2-ft intervals using split spoons. Boring S2-6 is anticipated to be the least contaminated of all the planned borings, thus it will be drilled first. Boring S2-7 will be drilled within the boundary of the former pit and is suspected to encounter the most contamination, consequently it will be drilled last. The split-spoon blow count will be recorded on the soil lithology log as per ASTM Method D 1586-84 and ESP-303-4 procedures. The soil will be visually inspected and described using the Unified Soil Classification System. Munsell Color Charts will be used to describe soil color. All samples will be screened in the field with an OVA, Jerome mercury vapor analyzer, and scanned for beta and gamma radiation with a GM pancake probe. The OVA reading will be taken immediately after opening the split spoon followed by the Jerome mercury vapor analyzer and the GM pancake. The readings from these meters will be recorded for every 2-ft interval on the soil lithology log.

Fig. 7.2. S-2 Site proposed soil boring and monitoring well locations.

Table 7.3. S-2 Site sample apportionment by medium

Media	Source	Location	Number of Samples	Frequency	Analysis	Rationale
Soils	Soil borings	S2-1 through S2-7	37 ^a	Once	VOCs, metals, mercury, radiologicals ^b	Define extent of soil contamination downgradient of the site. Verify contamination within the former basin.
Soils	Soil boring	S2-7	1	Once	PCBs, ^c TCLP ^d	Establish the presence or absence of PCB contamination. Define the relative solubility of contaminants.
Soils	Soil boring	S2-4, S2-7	2	Once	Metals and radionuclides	Determine the distribution coefficient for metals.
Groundwater	Monitoring wells	S2-3, S2-4	8	4 quarters	VOCs, metals, ^e mercury, ^e radiologicals, ^e anions, and miscellaneous parameters	Assess water quality downgradient of the basin site.
Surface water	Drainage ditch		2	Once	VOCs, metals, mercury, radiologicals	Assess the potential for contaminant transport by surface water.

^a Assumes samples will be collected from 0-2 ft and every other 4-ft interval thereafter from 6 borings to a depth of about 40 ft and that one boring is sampled from the 0- to 2-ft and the 8- to 12-ft interval.

^b Radiological parameters include gross α , gross β , gamma spectroscopy, isotopic uranium, and isotopic thorium.

^c Because PCBs are relatively immobile they will only be sampled from the 8- to 12-ft interval of Boring S2-7. This interval is thought to correspond with the base of the former pit.

^d TCLP extraction method will be conducted for samples taken from the 8- to 12-ft interval from boring S2-7.

^e Filtered and unfiltered samples will be collected groundwater samples analyzed for metals, mercury, and radiological parameters.

Table 7.4. Number of samples and quality control at the S-2 Site

Media	Parameter	Number of sites	Number of				Field duplicate ^a	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
			sampling events	Number of samples	Number of samples	Number of samples					
Soil borings											
	<i>Metals (mercury)</i>	7	1	38 ^e		2		2	2		44
	<i>Radiologicals</i>	7	1	38 ^e		2		2	2		44
	Gross Alpha										
	Gross Beta										
	Gamma Spec										
	Isotopic Uranium										
	Isotopic Thorium										
	<i>Volatiles</i>	7	1	38 ^e		2	7	2	2		51
	<i>PCB</i>	1	1	1 ^f							1
	<i>TCLP (metals) (organics)</i>	1	1	1 ^g							1
	<i>Distribution coefficient (metals)</i>	2	1	2 ⁱ							2
Groundwater											
	<i>Metals (mercury)</i>	2	4	32 ^{h,j}		2		2	2		38
	<i>Radiologicals</i>	2	4	32 ^{h,j}		2		2	2		38
	Gross Alpha										
	Gross Beta										
	Gamma Spec										
	Isotopic Uranium										
	Isotopic Thorium										

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Table 7.4 (continued)

Media	Parameter	Number of sites	Number of sampling events	Number of samples	Field duplicate ^a	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
	<i>Volatiles</i>	2	4	16 ^a	2	4	2	2	26
	<i>Anions</i>	2	4	16 ^a	2		2	2	22
	Sulfate								
	Fluoride								
	Nitrate								
	Chloride								
	Cyanide								
	<i>Miscellaneous</i>	2	4	16 ^a	2		2	2	22
	Alkalinity								
	Total suspended solids								
	Total dissolved solids								
	pH								
	Specific conductance								
	Turbidity								
Surface water	<i>Metals (mercury)</i>	2	1	2	1		1	1	5
	<i>Radiologicals</i>	2	1	2	1		1	1	5
	Gross Alpha, Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								

Table 7.4 (continued)

Media	Parameter	Number of sites	Number of sampling events	Number of samples	Field duplicate ^a	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
Volatiles		2	1	2	1	1	1	1	6

^aField duplicates will be collected at a frequency of 5% of the samples collected per matrix per event (see Sect. 8.8.1.4).

^bOne trip blank is to accompany each cooler containing VOC samples (see Sect. 8.8.1.1).

^cAt a minimum, one sample for each source of water for a given sampling event will be collected for analysis. At least one set of field blanks will be collected for every five borings completed (see Sect. 8.7.1.3).

^dEquipment rinsates will be collected at a rate of 5% (see Sect 8.8.1.2).

^eAssumes samples will be collected at every other 4-ft interval from 6 borings to a depth of about 40 ft and that one boring will be sampled from 0 to 2 ft and 8 to 12 ft inside the pit boundary.

^fPCB samples will be collected from continuous samples taken at 4-ft intervals from 0 to 20 ft from boreholes S2-2 and S2-3.

^gTCCLP samples will be collected from 8- to 12-ft interval from borehole S2-7. Parameters analyzed for are: VOCs, metals, and mercury.

^hAssumes three wells will be sampled for four quarters.

ⁱDistribution coefficient samples will be analyzed for metals (mercury) and radionuclides.

^jBoth filtered and unfiltered samples will be collected.

A portion of these samples will also be collected for chemical and radiological analysis. Table 7.3 presents an estimate of the number of samples to be analyzed per media at the S-2 Site. The sample estimate presented on Table 7.3 is based on six soil borings advanced to 40 ft and sampled every other 4-ft interval and one soil boring advanced to 12 ft with one sample from 8 to 12 ft. The six borings to be drilled outside of the former pit boundary (Fig. 7.2) will be sampled from the 0-2 ft interval and every other 4-ft interval, thereafter. For example the 0-2, 4-8, 12-16, 20-24, 28-32, and 36-40 ft intervals will be analyzed. Six samples per borehole are expected to be sampled for chemical and radiological parameters. The boring to be drilled within the former pit boundary (S2-7) will be sampled for chemical and radiological parameters from 0-2, and 8-12 ft. The samples collected for chemical analysis from this boring will be analyzed for VOCs, metals, and radiological parameters. In addition, the sample collected from 8 to 12 ft from borehole S2-7 will also be analyzed for PCBs, TCLP extract for organics and metals, and metals using a batch method extract to determine the distribution coefficient.

VOC samples will be collected from the first 2 ft for each 4-ft interval sampled for chemical analysis. Because the soil will be collected with 2-ft split spoons, the remaining parameters will be composited over the entire 4-ft interval. Additional samples will be taken should the Jerome mercury vapor analyzer, organic vapor analyzer (OVA), or Geiger-Muller (GM) pancake detect contamination at twice the site background level in a soil interval not originally planned to be sampled for chemical and radiological parameters.

Four Shelby tube samples will be collected in accordance with ASTM Method D1587-83 and ESP-303-5 at the S-2 Site. The samples will be analyzed for geotechnical parameters described on Table 6.1. Three of the samples will be collected from boreholes outside the former pit boundary and one sample will be taken from 12 to 14 ft from Boring S2-7. The exact location and sample interval of the other three Shelby tubes will be determined in the field by the project geologist after inspection of soil lithology logs prepared for the first two soil borings drilled. Two of the three samples collected outside the pit boundary will be collected from the saturated zone and the other sample will be collected from the unsaturated zone. The Shelby tubes will be collected from soil intervals not planned to be sampled for analytical parameters.

Two samples will be collected to determine the distribution coefficient for metals. The distribution coefficient will be determined by the batch method using the ratio of soil concentration to water concentration as specified in EPA (1991c) of the QA plan. One sample will be obtained from the 8-12 ft interval in Boring S2-7 and the other will be collected from the 8- to 12-ft interval of Boring S2-4. The distribution coefficient values will be used in conjunction with literature values and other site data to determine the most appropriate site value.

7.4.2.2 S-2 Site groundwater and surface water

Two monitoring wells will be completed in the unconsolidated zone (Fig. 7.2) to determine the horizontal gradient and define the level of groundwater contamination at the water table interface. The wells will be installed in boreholes S2-3 and S2-4 and will be sampled for at least four consecutive quarters. The wells will be sampled for VOCs, metals, mercury, radiological parameters, anions, and miscellaneous parameters identified on

Table 7.4. Filtered and unfiltered samples will be collected for metals, mercury, and radiological analysis. All other samples will be unfiltered. Field measurements will include water depth, temperature, pH, specific conductance, and dissolved oxygen. The fine-grained soil at the site may yield water at a very slow rate making sampling events prolonged. Groundwater will be sampled for four consecutive quarters. Wells GW-255 and GW-252 are sampled quarterly by the Y-12 Plant Groundwater Protection Program. Analyses from these wells will also be used in the RI report.

Two wet weather surface water samples will be collected to assess the potential for surface water to transport contaminants from the site. One sample will be collected downstream of the S-2 Site and the other will be collected upstream. The collection points are located in Fig. 7.2. The samples will be analyzed for VOCs, metals, mercury, and radiological parameters.

7.4.3 Building 81-10

Based on the results of previous sampling, potential COCs in soil at Building 81-10 include chromium, mercury, thorium, and uranium. Groundwater potential COCs include beryllium, VOCs, and gross alpha and beta. The source of contamination at Building 81-10 is the soil which was contaminated during past operations at the facility. Building 81-10 is downgradient of much of the industrialized portion of the Y-12 Plant; thus, contaminants in the groundwater below Building 81-10 could have migrated from upgradient sources as well as migrated from soils at the building site.

Soils, groundwater, and surface water sampling will be conducted at the Building 81-10 site. Table 7.5 presents an estimate of the number of samples to be collected per medium and Table 7.6 presents the estimated number of samples and quality control samples. Figure 7.3 shows the proposed sample locations at Building 81-10. All sample locations will be surveyed by a licensed surveyor to within 0.1 ft using Y-12 Plant coordinates. The ground elevation of the sample locations will be surveyed to the nearest 0.01 ft by the surveyor. Soil sampling will include collecting shallow soil samples using hand augers and subsurface samples using split spoons.

7.4.3.1 Building 81-10 soils

Thirty shallow samples will be from 15 locations collected at the Building 81-10 site (Fig. 7.3). Eight locations will be sampled from the rip-rap bank between the building and PIDAS, and seven locations will be sampled at the boundary of the site along Third Street and G-Road. The seven shallow soil samples (9-15) will be sampled first because they are expected to contain less contamination than the eight shallow soil samples (1-8). Samples from the eight locations between the building and PIDAS will be used to define the extent of contamination in this area. Samples from the other seven sites located south and east are needed to define the extent of contamination based on gaps in the historical data. These locations are chosen at places where mercury may have migrated to the soil such as expansion joints and areas where the concrete meets the asphalt. Two samples will be collected from each of the 15 locations. These soils will be sampled from 0 to 2 ft and 3 to 5 ft. The soil will be visually inspected and described using the Unified Soil Classification System. Munsell Color Charts will be used to describe soil color. All samples will be surveyed in the field with a

Table 7.5. Building 81-10 sample apportionment by medium

Media	Source	Location	No. of Samples ^a	Frequency	Analysis ^b	Rationale
Shallow soil	Hand auger	1 through 15 (Fig. 7.1)	30 ^c	Once	metals, mercury, VOCs, radiologicals ^d	Define extent of soil contamination in area between Building 81-10 and PIDAS and along expansion joints in concrete pad near mercury roasting operation.
Shallow soil	Hand auger	1 through 15 (Fig. 7.1)	15	Once	PCB ^d	PCBs are a common contaminant found in industrialized areas. Their existence should be determined.
Shallow soil	Hand auger	6 and 8 (Fig. 7.1)	2	Once	TCLP ^e TCLP ^e — metals TCLP ^e — mercury TCLP ^e — VOCs	TCLP extraction method will be conducted to provide information for screening remedial technologies and to define the relative solubility of the contaminant.
Soils	Soil borings	B-1 through B-4 (Fig. 7.1)	20 ^f	Once	Metals, mercury, VOCs, radiologicals	Define extent of soil contamination in area of reported visible mercury contamination.
Soils	Soil borings	B-1 and B-3 (Fig. 7.1)	2	Once	TCLP ^e TCLP ^e — metals TCLP ^e — mercury TCLP ^e — VOCs	TCLP extraction method will be conducted to provide information for screening remedial technologies and to define the relative solubility of the contaminant.

Table 7.5 (continued)

Media	Source	Location	No. of Samples ^a	Frequency	Analysis ^b	Rationale
Groundwater	Monitoring wells	GW-696 GW-699 GW-697 MW-1A GW-698 MW-1B	24 ^c	4 quarters	Metals, mercury, VOCs, radio-logicals, ionic	Assess the contribution of contaminated soils to the shallow groundwater system.
Surface water	Drainage ditch	Adjacent to PIDAS (Fig. 7.1)	1	One wet weather	Metals, mercury, VOCs, radiologicals	Assess potential for contaminant transport off-site by surface runoff.
Soils	Soil borings	Boring B-1, B-2, B-3, or B-4	2	Once	Soil physical properties	Obtain information necessary to screen remedial alternatives. Evaluate transport characteristics of the soil.

^aQuality Assurance samples are not included.

^bAnalytical methods were discussed in the Quality Assurance Project Plan.

^cAssumes two samples from 15 locations.

^dSamples for PCB collected from top interval only.

^eTCLP extraction method will be conducted for samples collected from the top interval from the shallow soil locations between the building and PIDAS.

^fAssumes samples will be collected at every other 4-ft interval to a depth of 35 ft, from four soil borings.

^gAssumes four quarters of groundwater sampling from six wells; both filtered and unfiltered samples will be collected.

^hRadiological parameters include gross α , gross β , gamma spectroscopy, isotopic uranium, and isotopic thorium.

Table 7.6. Number of samples and quality control at Building 81-10

Medium	Parameter	Number of sites	Sampling events	Number of samples	Field duplicate ^a	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
Shallow soils	<i>Metals (mercury)</i>	15	1	30	2		2	2	36
	<i>Radiologicals</i>	15	1	30	2		2	2	36
	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	<i>Volatiles</i>	15	1	30	2	7	2	2	43
	PCBs ^e	15	1	15	2		2	1	20
	TCLP ^f	8	1	4	1				5
Soil borings	<i>Metals (mercury)</i>	4	1	20	1		1	2	24
	<i>Radiologicals</i>	4	1	20	1		1	2	24
	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	<i>Volatiles</i>	4	1	20	1	4	1	2	28
Groundwater	<i>Metals (mercury)</i>	6	4	58 ^{g,h}	4		4	4	60

Table 7.6 (continued)

Medium	Parameter	Number of sites	Sampling events	Number of samples	Field duplicate ^a	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
	<i>Radiologicals</i>	6	4	58 ^{e,h}	4		4	4	60
	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	<i>Volatiles</i>	6	4	24	4	4	4	4	40
	<i>Anions</i>	6	4	24	4		4	4	36
	Sulfate								
	Fluoride								
	Nitrate								
	Chloride								
	Cyanide								
	<i>Miscellaneous</i>	6	4	24	4		4	4	36
	Alkalinity								
	Total suspended solids								
	Total dissolved solids								
	pH								
	Specific conductance								
	Turbidity								
Surface water									

Table 7.6 (continued)

Medium	Parameter	Number of sites	Sampling events	Number of samples	Field duplicate ^a	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
	<i>Metals (mercury)</i>	1	1	1	1		1	1	4
	<i>Radiologicals</i>	1	1	1	1		1	1	4
	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	<i>Volatiles</i>	1	1	1	1	1	1	1	5

^aField duplicates will be collected at frequency of 5% of the samples collected per matrix per event (see Sect. 8.8.1.4).

^bOne trip blank is to accompany each cooler containing VOC samples (see Sect. 8.8.1.1).

^cAt a minimum, one sample for each source of water for a given sampling event will be collected for analysis. At least one set of field blanks will be collected for every five borings completed (see Sect. 8.8.1.3).

^dEquipment rinsates will be collected at a rate of 5% (see Sect. 8.8.1.2).

^ePCBs will be analyzed from the first sample interval from the 15 shallow soil sample locations.

^fTCLP extraction method will be conducted on samples collected from the top interval shallow soil sample locations 6 and 8 between Building 81-10 and PIDAS.

One sample will be collected from each of boreholes B-1 and B-3. Parameters analyzed for are: VOCs, metals, and mercury.

^gAssumes wells will be sampled for four quarters.

^hBoth filtered and unfiltered samples will be collected.

Fig. 7.3 Building 81-10 proposed soil sampling locations.

Jerome mercury vapor analyzer, Organic Vapor Analyzer (OVA), and scanned for beta and gamma radiation with a GM pancake. The readings from these meters will be recorded in the field log. The shallow soils will be analyzed for VOCs, metals, mercury, and radiological parameters. PCBs will be analyzed for the 0- to 2-ft interval from all the shallow sample locations. TCLP analysis will also be conducted on two samples collected from the 0- to 2-ft interval from the sample locations 6 and 8 between the building and PIDAS and one sample will be collected from boreholes B-1 and B-3. Coring through the concrete and asphalt will be necessary for the shallow soil sample locations south and east of the building.

Four soil borings will be drilled to assess the extent of visible mercury contamination at the site and collect geotechnical data for the FS. Soil Borings B-2 and B-4 are expected to encounter lower concentrations relative to Borings B-1 and B-3 and will be drilled first. Borings B-1 and B-3 are expected to encounter higher concentrations of contamination and will, therefore, be done afterwards. The borings will be sampled at 2-ft intervals using split spoons to refusal (~35 ft). The split-spoon blow count will be recorded per ASTM Method D 1586-84 on the soil lithology log. The soil will be visually inspected and described using the Unified Soil Classification System. Munsell Color Charts will be used to describe color. All samples will be surveyed in the field with an OVA, Jerome mercury vapor analyzer, and the GM pancake probe. The readings from these meters will be recorded for every 2-ft interval on the soil lithology log.

A portion of the split-spoon samples will be collected for chemical and radiological analysis. Table 7.5 presents an estimate of the number of samples to be collected for analysis. The sample estimate presented on Table 7.6 is based on four borings advanced to 35 ft and sampled every other 4-ft interval. Two 2-ft split-spoon samples will be composited for every other 4-ft interval. For example the 0-4, 8-12, 16-20, etc. intervals will be analyzed for chemical and radiological parameters. The soil borings will be analyzed for VOCs, metals, mercury, and radiological parameters. Five samples per borehole are expected to be sampled for analytical parameters. VOC samples will be collected from the first 2 ft for each 4-ft interval sampled for chemical and radiological analysis. The remaining parameters will be composited over the entire 4-ft interval. Additional samples will be taken if the OVA, Jerome mercury vapor analyzer, or the GM pancake probe detect contamination at twice the site background level in a soil interval not originally planned to be sampled for chemical and radiological parameters.

Two Shelby tube samples will be collected at Building 81-10. These samples shall be collected in accordance with ASTM Method D1587-83 and ESP-303-5 and analyzed for geotechnical parameters described on Table 6.1. One sample will be collected in the unsaturated zone and the other sample will be collected below the water table. The exact location and sample interval of the Shelby tubes will be determined in the field by the project geologist after inspection of soil lithology logs prepared for the first two soil borings drilled. The Shelby tubes will be collected from soil intervals not planned to be sampled for chemical and radiological parameters.

7.4.3.2 Building 81-10 groundwater and surface water

Groundwater monitoring will be conducted at four existing wells and two proposed wells. Samples will be collected from the water table and shallow bedrock zones. The additional well

cluster will be installed on the west side of Building 81-10 (Fig. 7.3). This well cluster will consist of a well screened in the upper portion of the Maynardville Limestone and a well screened at the water table unsaturated zone interface. The Maynardville well will serve as an upgradient reference point and the water table well will serve to bound the western side of the site. The Maynardville well will be temporarily labeled MW-1B and the water table well will be labeled MW-1A until numbers can be assigned by the Y-12 Plant Groundwater Protection Program. The new well cluster along with well cluster GW-696, GW-697, GW-698, and well GW-699 will be sampled for four consecutive quarters to determine the horizontal and vertical gradients, establish spatial and temporal variations in the groundwater beneath Building 81-10, and to aid in evaluating the impact of contaminated soils to the shallow groundwater system. The wells will be sampled for VOC, metals, mercury, radiological parameters, anions, and miscellaneous parameters identified on Table 7.4. Field measurements will include water depth, temperature, pH, specific conductance, and dissolved oxygen.

One wet weather surface water sample will be collected to assess the potential for erosion of contaminated soil from the area between the building and PIDAS. The collection point for the surface water sampling will be the storm sewer grate located downstream of the rip-rap bank (Fig. 7.3). The sample will be analyzed for VOCs, metals, mercury, and radiological parameters.

7.4.4 Salvage Yard Sites

There are five sites located in the Salvage Yard. These sites are: Scrap Metal Storage Area, Oil/Solvent Drum Storage Area, waste oil storage tanks, drum deheader, and Tank 2063 site. The objectives for characterizing the Salvage Yard are as follows:

- characterize the releases that may be occurring from the Active Scrap Metal Storage Area;
- verify that the contamination has been removed from the Oil/Solvent Drum Storage Area; and
- characterize the nature and extent of contamination at the northwest portion of the Salvage Yard so that a screening level risk assessment can be performed, the contribution to OU 1 can be assessed, and remedial alternatives can be evaluated.

Soil, groundwater, and surface water will be investigated at the Salvage Yard. All sample locations will be surveyed by a licensed surveyor to within 0.1 ft using Y-12 Plant coordinates. The ground elevation of the sample locations will be surveyed to the nearest 0.01 ft by the surveyor. Soil sampling will include collecting shallow samples using hand augers and subsurface samples using split spoons. Table 7.7 presents the sample apportionment and rationale for sampling for the Salvage Yard sites. Table 7.8 presents a detailed summary of the number of samples and quality assurance samples.

Figure 7.4 shows the location of samples to be collected to characterize releases from the active Scrap Metal Storage Area and to verify removal of contaminated soil from the Oil/Solvent Drum Storage Area. Two soil samples (Locations 1 and 2, Fig. 7.4) will be collected from the western side of the Scrap Metal Storage Area (Fig. 3.4). The soil will be sampled 0 to 1 ft at Locations 1 and 2. These sample locations are located in areas where

Table 7.7. Salvage Yard sample apportionment by medium

Media	Source	Location	Number of Samples ^a	Frequency	Analysis ^b	Rationale
Soils	Soil borings	Northwest portion of Salvage Yard (Fig. 7.5)	40 ^c	Once	VOCs, metals, mercury, radiologicals ^d	Determine the nature and extent of contamination. Bound the limits of PCE contamination detected in previous borings.
Soils	Shallow soils	Northwest portion of Salvage Yard (Fig. 7.5)	25 ^e	Once	VOCs, metals, mercury, radiologicals ^d	Determine the presence of soil contamination in soil adjacent to the oil storage tanks, drum deheader, and the stormwater catch basin.
Soils	Shallow soils Soil borings	Northwest portion of Salvage Yard (Fig. 7.5)	9		PCBs ^f	Establish concentration range for PCBs in the surface soils at the site.
Soils	Soil borings	Northwest portion of Salvage Yard (Fig. 7.5)	2		TCLP-VOC, TCLP-metals, TCLP-mercury	
Soils	Shallow soils	Oil/Solvent drum storage area	7	Once	Radiologicals	Verify contaminated soil was removed from site during RCRA closures.
Ground-water	Monitoring wells	Northwest portion of Salvage Yard (Fig. 7.5)	12 ^g	4 quarters	VOCs, metals, mercury, radiologicals ^d	Evaluate impact of contaminated soils on groundwater.
Surface water	Stormwater catch basin and erosion channel	Salvage Yard	2	Once (wet weather)	VOCs, metals, mercury, radiologicals ^d	Assess threat of contaminant transport by surface water.
Ground-water	Monitoring wells	Southern perimeter of Salvage Yard	24 ^h	4 quarters	VOCs, metals, mercury, radiologicals ^d	Evaluate potential for release from scrap metal piles.

^aQuality assurance samples are not included.^bAnalytical methods are discussed in the Quality Assurance Project Plan^cAssume four borings advanced to 20 ft with sampling occurring at 2-ft intervals.^dRadiological parameters include gross α , gross β , gamma spectroscopy, isotopic uranium, and isotopic thorium.^eAssume five locations and five samples at each location.^fPCBs will be collected from the top interval of all sample locations in the northwest Salvage Yard.^gAssume three wells sampled for four quarters.

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Media	Parameter	Number of sites	Number of sampling events	Number of samples	Field duplicate ^a	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
Northwest portion of Salvage Yard									
Shallow soils	Metals (mercury)	5	1	25	2		1	2	30
	Radiologicals	5	1	25	2		1	2	30
	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	Volatiles	5	1	25	2	3	1	2	33
	PCBs	5	1	5	1		1	1	8
Soil borings	Metals (mercury)	4	1	15	2		2	2	21
	Radiologicals	4	1	15	2		2	2	21
	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	Volatiles	4	1	15	2	3	2	2	24
	PCBs	4	1	3					3
	TCLP	1	1	1			0	0	1
Groundwater									

Table 7.8 (continued)

Media	Parameter	Number of sites	Number of sampling events	Number of samples	Field duplicate ^e	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
	Metals (mercury)	2	4	16 ^f	1		1	1	19
	Radiologicals	2	4	16 ^f	1		1	1	19
	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	Volatiles	2	4	8	1	4	1	1	15
	Anions	2	4	8	1		1	1	11
	Sulfate								
	Fluoride								
	Nitrate								
	Chloride								
	Cyanide								
	Miscellaneous	2	4	8	1		1	1	11
	Alkalinity								
	Total suspended solids								
	Total dissolved solids								
	pH								
	Specific conductance								
	Turbidity								

Surface water

Table 7.8 (continued)

Media	Parameter	Number of sites	Number of sampling events	Number of samples	Field duplicate ^c	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
Scrap Metal Storage Area Shallow soil	Metals (mercury)	1	1	1	1		1	1	4
	Radiologicals	1	1	1	1		1	1	4
	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	Volatiles	1	1	1	1	1	1	1	5
	Metals (mercury)	2	1	2	1				3
	Radiologicals	2	1	2	1				3
Groundwater	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	Volatiles	2	1	2	1	1			4
	PCBs	2	1	2	1				3
	Metals (mercury)	7	4	56 ^{e,f}	2		2	2	62
	Radiologicals	7	4	56 ^{e,f}	2		2	2	62
	Gross Alpha								

Table 7.8 (continued)

Media	Parameter	Number of sites	Number of sampling events	Number of samples	Field duplicate ^e	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	Volatiles	7	4	28	2	3	2	2	37
	Anions	7	4	28	2		2	2	34
	Sulfate								
	Fluoride								
	Nitrate								
	Chloride								
	Cyanide								
	Miscellaneous	7	4	28	2		2	2	34
	Alkalinity								
	Total suspended solids								
	Total dissolved solids								
	pH								
	Specific conductance								
	Turbidity								
Surface water									
	Metals (mercury)	1	1	1					1
	Radiologicals	1	1	1					1
	Gross Alpha								

Table 7.8 (continued)

Media	Parameter	Number of sites	Number of sampling events	Number of samples	Field duplicate ^e	Trip blanks ^b	Field blanks ^c	Equipment rinsates ^d	Total samples
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								
	Volatiles	1	1	1					1
Oil/Solvent Drum Storage Area									
Soil	Radiologicals	7	1	7	1		1	1	10
	Gross Alpha								
	Gross Beta								
	Gamma Spec								
	Isotopic Uranium								
	Isotopic Thorium								

^aField duplicates will be collected at a frequency of 5% of the samples collected per matrix per event (see Sect. 8.8.1.4).

^bOne trip blank is to accompany each cooler containing VOC samples (see Sect. 8.8.1.1).

^cAt a minimum, one sample for each source of water for a given sampling event will be collected for analysis. At least one set of field blanks will be collected for every five borings completed (see Sect. 8.8.1.3).

^dEquipment rinsates will be collected at a rate of 5% (see Sect. 8.8.1.2).

^eAssumes groundwater samples will be collected for four quarters.

^fIncludes filtered and unfiltered samples.

Fig. 7.4. Proposed sample locations for the Scrap Metal Storage Area and Oil/Solvent Drum Storage Area.

contaminated soil may have accumulated. The two surface soil samples will be analyzed for PCBs, VOCs, metals, mercury, and radiological parameters (Table 7.8). Sample locations 3 through 9 are located at the former Oil/Solvent Drum Storage Area. These samples will be collected from the 5- to 7-ft depth and will be analyzed for radiological parameters. The data from these samples will be combined with data collected during the RCRA closure of this site and used to support a no further investigation required decision, if appropriate. Existing monitoring wells will be used to evaluate groundwater quality at the southern end of the Salvage Yard. A particular problem in evaluating groundwater from this area is that contaminants migrating from upgradient sources such as the RUST Garage and former S-3 Pond may be difficult to distinguish from contamination migrating from the Scrap Metal Area. Monitoring wells GW-271, GW-272, GW-273, GW-274, GW-275, GW-276, and GW-634 will be used to evaluate groundwater as a contaminate pathway from the Scrap Metal Storage Area. These wells will be sampled for four consecutive quarters for VOCs, metals, mercury, radiological, ionic, and miscellaneous parameters identified in Table 7.8. These data will be combined with the existing groundwater data for this area.

One wet weather surface water sample will be collected from an erosion channel at the southern boundary of the site (Fig. 7.4). The water will be analyzed for VOCs, metals (mercury), and radiological parameters identified in Table 7.8. These data will be used to assess the threat of contaminant transport from the Scrap Metal Storage Area by surface water.

7.4.4.1 Northwest portion of the Salvage Yard

The waste oil storage tanks, drum deheader, and Tank Site 2063 are located in the northwestern portion of the Salvage Yard. Soils and groundwater in this area are known to be contaminated with tetrachloroethylene and metals. The full extent of this contamination is not known. The objectives for sampling activities in the northwestern portion of the Salvage Yard are as follows:

- determine the nature and extent of contamination for input into the screening level risk assessment,
- determine if PCB and VOC contamination exists in the soils adjacent to the waste oil storage tanks,
- determine if soil/sediment is contaminated at the storm water catch basin,
- determine the extent of soil and groundwater contamination in the area downgradient of the drum deheader and Tank Site 2063,
- determine the soil physical properties for evaluation of remedial technologies and for input parameters into mass transport calculations, and
- determine if surface water is a pathway for contaminant transport.

Surface soil, soil boring, groundwater, and surface water sampling will be conducted at the northwest portion of the Salvage Yard. Figure 7.5 shows the location of sampling points for the investigation.

Fig. 7.5. Northwest Salvage Yard proposed soil and monitoring well locations.

Shallow soil samples will be collected at the waste oil storage tanks, adjacent to the drum deheader and at the storm runoff catch basin. These soils will be sampled for VOCs, metals (mercury), radiologicals, and PCBs. The shallow soil samples will be collected at 5 locations at 1-ft intervals from ground surface to a depth of 5 ft. These locations were chosen based on gaps in the historical data. Because PCBs are fairly immobile, only the top interval of the shallow surface samples will be sampled for PCBs.

Three soil borings will be advanced to refusal from ground surface. Borings B-1, B-2, and B-3 (Fig. 7.5) will be used to bound the limits of a tetrachloroethylene plume detected in soil samples from Boring WB-4 and in groundwater samples from monitoring well GW-190. The soil borings will be sampled to refusal (~20 ft) at 2-ft intervals using split spoons. Boring 2 is expected to encounter the least amount of contamination, thus it will be drilled first. Boring 1 is expected to encounter the highest levels of contamination and will be drilled last. The split-spoon blow counts will be recorded on the soil lithology log as per ASTM D-1586-84 and ESP-303-4 procedures. The soil will be visually inspected and described using the Unified Soil Classification System. Munsell Color Charts will be used to describe soil color. All samples will be screened in the field with an OVA, Jerome mercury vapor analyzer, and scanned for beta and gamma radiation with a GM pancake probe. The OVA reading will be taken immediately after opening the split-spoon, followed by the Jerome mercury vapor analyzer, and the GM pancake probe. The readings from these meters will be recorded for every 2-ft interval on the soil lithology log.

Table 7.7 presents an estimate of the number of samples to be analyzed per media at the S-2 Site. The sample estimate presented on Table 7.3 is based on 3 borings drilled to a depth of 20 ft and samples composited for each 4-ft interval. The soils will be analyzed for VOCs, metals (mercury), and radiological parameters. In addition, samples for PCB analysis will be collected from the 0-2 ft interval, and one sample will be collected to test the toxicity characteristics of the soil (following TCLP). The TCLP extract will be analyzed for VOCs, metals (mercury), and radiological parameters. Soil collected for VOC will be taken from the first split spoon of each 4-ft interval and will not be composited.

Two Shelby tube samples will be collected in the vicinity of the 3 borings to be drilled for chemical parameters. These samples shall be collected in accordance with ASTM Method D-1587-83 and ESP-303-5 and analyzed for geotechnical parameters described in Table 6.1. One sample will be collected in the unsaturated zone and the other sample will be collected below the water table. The exact location and sample interval of the Shelby tube samples will be determined in the field by the project geologist after inspection of the soil lithology logs prepared for borings 1, 2, and 3.

Monitoring wells GW-190 and GW-265 will be sampled for four quarters. Groundwater will be sampled for metals, VOCs, and radiological, ionic, and miscellaneous parameters identified on Table 7.8. Well GW-190 is currently monitored by the Y-12 Plant Groundwater Protection Department. Sampling of this well by the RI sampling team will not be necessary. A surface water sample will be collected at the storm runoff catch basin during wet weather conditions and be analyzed for metals, VOCs, and radiological parameters.

7.5 SAMPLE TRACKING AND RECORDS MANAGEMENT

The proper sample tracking and records management of technical data are critical to the overall success of this RI because (1) the data are important in determining potential environmental and human health effects, (2) the data must be legally defensible, and (3) the data collection and analysis costs are high. Sample tracking and records management represent a key part in the RI because they ensure that such activities are using proper records and data management procedures. These allow complete auditability and traceability of the data; thus, ensuring that all activities are conducted properly.

7.5.1 Objectives

The objective of an effective sample tracking and records management program is to ensure auditable, defensible, and accurate transmission of information from the RI field sampling activities through the analytical laboratory analyses to its end use in the analysis, risk assessment, and production of the RI reports. This objective will be met by using existing records management plans, information management procedures, and data base management systems.

7.5.2 Roles and Responsibilities

A Data Management Coordinator (DMC) will be designated by the RI project manager. Responsibilities of the DMC will be to acquire, store, validate, analyze, and report all field and analytical data collected in the performance of the RI. In addition, the DMC will acquire, store, analyze, and report validated data from the appropriate Y-12 Plant environmental data bases (e.g., groundwater, surface water, sediment). The DMC will be supported by a computer programmer, records manager, and data entry clerk.

The RI Field Team Leader (FTL) will be responsible for the delivery of paper copies of all field information (e.g., field results, copies of field logbooks, and field notes) to the DMC. The RI project manager will be responsible for laboratory information (e.g., analytical results, blanks, surrogates, and detection limits) required for inclusion in the RI report or as supporting documentation. If electronic versions of this information are also available, the FTL will work with the DMC to facilitate the electronic transfer of the data.

7.5.3 Data Tracking

Before mobilizing the field sample collection personnel, all technical information contained in this RI plan (i.e., sample location, sample identification codes, chemical parameters to be collected, field measurements to be taken, and chain-of-custody details) will be entered by a data entry clerk into a presampling data base. The DMC will then use this data base to preprint sample labels, sample tags, and field sampling logbook pages. The data base will also be used to track the sample and sample results as they are returned by the field teams and analytical laboratories.

The field data collected by the field team will include field sample information, details on field conditions, field instrument measurements, and any deviations from prescribed plans or procedures. The FTL will send to the DMC all required data packages (consisting of

copies of field results, field logbooks, and field notes) on the schedule specified in the RI plan.

The data received from the analytical laboratory will include the results from routine field samples, field QA/QC samples, laboratory QA/QC samples, and any data flags placed on the results by the laboratory analysts to explain any deviations from prescribed procedures or methods. The FTL will send to the DMC all required data packages (consisting of copies of analytical data results, QC documentation, and lab notes).

The DMC will track and reconcile both the field data packages and analytical data packages received from the FTL against the presampling data base to ensure that all planned sample collection activities were performed and documented. At the beginning of each week, the DMC will review for content and completeness, all data packages received the previous sampling period from the FTL. If the individual data packages are complete and arrive on schedule, the DMC will enter the final receipt date into the presampling data base and enter a "C" into the acceptance field for "complete." If, on review, it is determined that the data package was incomplete, the initial receipt date will be entered into the presampling data base and an "I" will be entered into the acceptance field for "incomplete."

For both incomplete data packages and missing data packages, the DMC will contact the FTL verbally (with a written backup record of communication) to determine the status of the missing information. After the missing data have been located and transferred to the DMC, or the issue has been resolved to the satisfaction of the FTL and the DMC, a memorandum to file will be filed explaining the problem, the process taken to resolve the problem, and the final resolution by the DMC. After the entire data package has been received, reviewed, and approved, the DMC will enter the final receipt date into the presampling data base and will enter a "C" into the acceptance field for "complete."

7.5.4 Sample Coding Procedures

A common sample coding and data structure format (Fig. 7.6) has been developed for the storage and retrieval of the field sampling and laboratory analysis data. The sample coding format used will be compatible with the Energy Systems Consolidated Data Base (CDB) for environmental compliance and restoration data.

7.5.5 Completion of Field and Laboratory Records

The field sampling data to be included in the CDB will consist of (1) details on field conditions; (2) field instrument measurements; and (3) task team activity logs, including chain-of-custody information, deviations from plan, QA concerns, and any noteworthy observations. The data collected by the field sampling team will be entered into a personal computer (PC) by a data entry operator using the verified field forms following Energy Systems procedures for data entry. All chain-of-custody documentation will be filled out in accordance with *Energy Systems Chain-of-Custody Procedure ESP-500 (January 31, 1990, Rev. 1)*. All data will be entered twice, and the resulting files will be compared. Changes will be iterated until the final correct file is produced. The actual field measurements, field observations, deviations from the sampling plan, and task team activity logs will be included in the data base. All field information will then be transferred from the PC to the Y-12 Plant Oak Ridge Environmental

<p>Sample No.: _____ Project No: _____</p> <p>Location: _____</p> <p>Station: _____</p> <p>Sample Media: _____</p> <p>Sample Type: _____</p> <p>Analysis: _____</p> <p>Preservative: _____ Volume: _____</p> <p>Rad Screen: _____ Units: _____</p> <p>Sample Date/Time ____/____/____ _____</p> <p>Comments: _____</p> <p>_____ Collector's Initials: _____</p>	
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Position 1: Site Location
A-S2
B-81-10

Position 2: Sample Type
1-Soil
2-Sediment
3-Groundwater
4-Surface water

Position 3 to 4: Sample Location
Numbers 01-99

Position 5 to 6: Sample Interval
00-Groundwater
01-Surface water
02-Sediment
05 to 20-Soil (depth in ft)

EXAMPLE: A30800

A groundwater sample would be taken from location 8 in the S-2 area.

Fig. 7.6. Sample label and identification structure.

Information system (OREIS) data base. Paper copies of all field data will be indexed, cataloged, and placed in the project file following appropriate Energy Systems Records Management Procedures.

The analytical laboratory data collected for this study will include (1) sample management and tracking data; (2) sample custody documentation; (3) analytical results from the field samples; (4) analytical results from the field QA/QC samples (duplicates, trip, equipment, and field blanks); and (5) analytical results from the laboratory QA/QC samples (e.g., spikes, duplicates, surrogates, and calibrations). Data from the analytical laboratories will be transferred electronically from a PC floppy disk prepared by the analytical laboratory to the OREIS data base. The analytical laboratory will have the responsibility of verifying the electronic data before release. Paper copies of all analytical data including QA forms will be indexed, cataloged, and placed in the project file.

7.5.6 Data Management

Data backup activities are the responsibility of the DMC. All data files that have been updated during the day will be copied to backup files on floppy disks or tape the same evening following Energy Systems procedures for data backup. On a weekly basis, all data files will be copied to backup files on floppy disk or tape and stored on-site in a fireproof safe. Each month, all data files will be copied to backup files on floppy disks or tape and will be stored in a secure, off-site location. All data bases will be archived yearly in tape format.

The data received from the field activities and the analytical laboratory will initially be scored in an unvalidated data base. After the data have passed through validation procedures, they will be updated and sorted in the validated data base. All subsequent summaries, statistical analyses, and reports will be generated from the data contained in the validated data base. All validation activities will follow Energy Systems procedures for data validation and correction.

After the data have been stored in the appropriate consolidated data base files, the DMC will perform an internal data consistency check. This check will involve the use of data validation programs designed for sorting the data and comparing the data identifiers with one another to determine whether data missing, mislabeled, or duplicated because of data transcription or data transmittal errors.

Manual data checks will then be performed to verify data entry accuracy, compare data values with field notes, and compare questionable data values with data previously collected or near the same sampling or measurement location. Data flags that qualify data values will be set as required. The accuracy and precision of the data will be determined by evaluating the trip blanks, field blanks, equipment blanks, and replicate field and laboratory samples.

All data determined to be incorrect using the previously described procedures will be reconciled. The DMC will perform all data reconciliation activities with accompanying error correction logs, document control, and data base update methods following Energy Systems data validation and correction procedures. Any changes to the data base from its receipt from the analytical laboratory or the field to its final form will be documented. All verified data inconsistencies will be corrected by recording information into an error correction log and

updating the data base with the correct value. A log of program changes will be kept in an OREIS program audit file. All changes will be annotated in the program audit file with reasons stating why changes were made. This log will specify the sample identification number, the field to be corrected, the incorrect value, the correct value, the reason for the change, and the last name of the responsible person.

After the data have passed through the verification and validation procedures, they will be updated and stored in a validated data base. All subsequent summaries, analyses, and reports will be generated from the data contained in the validated data base.

7.6 DATA ASSESSMENT AND INTERPRETATION

Data Assessment Procedures are discussed in Sect. 8.10 of the QAPjP. Data interpretation is discussed in Sect. 6.3 of the work plan.

**Environmental Restoration Program
Field/Laboratory Quality Assurance Project Plan (QAPjP)
for
UEFPC OU 3 RI Work Plan Y-12 Plant
Revision 0**

<hr/> Technical Support Contractor Program Manager	<hr/> Date
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<hr/> Technical Support Contractor Quality Assurance/Quality Control Officer Concurrence	<hr/> Date
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<hr/> DOE-ER Site Program Manager	<hr/> Date
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<hr/> DOE-ER Division QA Program Manager	<hr/> Date
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<hr/> Energy Systems ER Site Program Manager	<hr/> Date
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<hr/> Energy Systems ER Site Project Manager	<hr/> Date
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<hr/> Energy Systems ER Site Quality Assurance Specialist	<hr/> Date
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8. QA PROJECT PLAN

8.1 QA OBJECTIVES FOR DATA MEASUREMENT

A description of the site and the proposed action to be taken in this investigation can be found in Chap. 7 of this plan. The objectives for the work plan are

- to provide a justifiable rationale and guidance for the collection and analysis of environmental data that permits characterization of site contaminants and determination of the risk to human health,
- to quantify the contaminant concentrations for the soil column to determination spatial distributions and population statistics for potential COCs,
- to assess the contribution of contaminated soils to the concentrations of potential COCs in dissolved and particulate phases in the groundwater medium,
- to make a determination of whether any sites within this OU act as contaminant sources affecting the surface or groundwater media thereby qualifying those sites as potential removal action candidates,
- to provide input into the overall assessment of the UEFPC groundwater regime thereby facilitating the investigation of OU 1,
- to support the FS in the screening of appropriate alternatives during the remedy selection, and
- to provide technically and legally defensible data on which to base credible decisions regarding risk levels and remedial alternatives as appropriate.

The purpose of this chapter is to state the QA/QC procedures, including internal control and review that will ensure these objectives are met and that the analytical data are scientifically sound and technically defensible.

QA objectives for data are as follows:

- Scientific data generated will withstand scientific scrutiny.
- Data will be gathered using appropriate procedures for field sampling, COC, laboratory analyses, and data reporting.
- Data will be of known precision and accuracy.

A QC program for analytical data develops information that can be used (1) to evaluate the accuracy and precision of analytical data in order to establish the quality of the data; (2) to provide an indication of the need for corrective actions, when comparison with existing regulatory or program criteria or data trends shows that activities must be changed or monitored to a different degree; and (3) to determine the effect of corrective actions.

The QC criteria included in this report should be considered minimum requirements. When the laboratory or laboratories have been specified, the QC requirements that have been defined will be communicated to those facilities in analytical services SOWs. Any necessary changes to these requirements will be documented and approved through the variance system. Requirements for analytical documentation for the laboratory selected for this project will be similar to the documentation requirements outlined for the CLP. These CLP requirements are described in this QAPjP.

The QA objectives for all analytical data are to obtain reproducible, precise, and accurate measurements consistent with the intended use of the data and the limitations of the sampling and analytical procedures. The reasons for QC are (1) to screen out data of unacceptable precision or accuracy and (2) to obtain data that will accomplish the objectives of this project. QC will be accomplished through the assignment of measurement tasks to the appropriate analytical level (I-V) as defined in *Data Quality Objectives for Remedial Response Activities* (EPA 1987). Because of the requirements for conducting a screening risk assessment, which will be the primary element in decisions to remediate the OU 3 sites, all laboratory analyses data must be analyzed in accordance with the standards of Level IV documentation Energy Systems (ES) Level D (Energy Systems 1992b) as defined in this QAPjP, and with QA procedures in accordance with the EPA CLP SOWs (EPA 1990b and EPA 1990c). Field analytical data will be collected and analyzed in accordance with the standards of Level I documentation as defined in this QAPjP. Sample analyses will be scheduled according to site investigation needs and will be consistent with the sample holding times.

8.1.1 QC Level of Field Laboratory Analysis and Data Quality Parameters

QC Level I (ES Level A) analytical support will be used to generate field screening data, to provide real-time health & safety monitoring, to allow screening/optimization of sampling, and to acquire qualitative measurements of ambient conditions. Data quality criteria for QC Level I field screening support are specified below. Analytical parameters specified for QC Level I data collection for this study include

- measurement of ambient temperature (soil/water/air),
- measurement of electrical conductivity (soil/water),
- measurement of pH (soil/water),

- measurement of dissolved oxygen (water),
- total organic vapor concentration [photoionization detector/flame ionization detector (PID/FID)] (air/soil/gas), and
- radiological monitoring [alpha/beta/gamma] (soil/air/equipment/personnel).

Calibration of QC Level I instrumentation, in accordance with the manufacturer's instructions as appropriate for the media and analytes of concern, is required before and upon completion of daily sampling. The Health & Safety Officer, the Field Team Leader, or designee will perform positive response verification checks on these instruments for every 20 samples or every 4 h, whichever is more frequent. These checks consist of exposing the instrument to a source of analyte (e.g., exposing a PID to a volatile organic source) and verifying a response. If no response is obtained, corrective action will be taken and documented and the instrument will be recalibrated. Results of calibration and response checks will be recorded in the instrument logbook.

Representativeness of samples collected and analyzed is controlled by adhering to the sampling plan and conforming with specified technical procedures [e.g., Environmental Surveillance Procedures (ESPs) Quality Control Program].

The QA completeness objective for this project is to obtain usable results for at least 90% of the samples field screened during this effort. This means that instrument calibration and response checks are verifiable and acceptable before and after a given measurement.

Personnel responsible for using and/or maintaining particular instruments must maintain a log of calibration/response check procedures and performance. The Field Team Leader will inspect the logs, which will become part of the project records. Each operator must be trained in the proper use of the instruments, be familiar with their operation, be able to interpret data from them, and be able to produce documentation certifying these skills. This documentation will facilitate comparability between samples.

QC Level I (ES Level A) DQOs for sampling conducted during the investigation are met by the following:

- sampling procedures;
- site surveillance;
- use of standard sampling and monitoring devices;
- personnel training;
- documentation of sampling location, method, and media;

- reporting of results in appropriate units;
- consistent use of types of screening/monitoring instruments; and
- maintenance of measuring and test equipment (M&TE) and M&TE records.

8.1.2 QC Level of Analytical Laboratory and Data Quality Parameters

Analytical laboratory data will be generated for environmental samples to provide confirmed identification and quantification of organic and inorganic compounds and radionuclides in each sampled media. Analytical methods that may be used include EPA (CLP), SW-846, and others, as long as the QC information that is appropriate to DQOs is being reported and/or delivered.

8.1.2.1 QC Level III analytical support

QC Level III (ES Level C) analytical support is used to provide confirmed identification and quantification of contaminants to determine the extent of contamination, to determine the presence or absence of contaminants with required detection limits, and to confirm the results of lower QC Level (I & II) screening analysis. QC Level III may provide data of comparable quality to QC Level IV, but with less QC documentation, at a lower cost, and with a shorter turnaround time. TCLP analysis will be specified for QC Level III data collection for this RI.

QC Level III laboratory QC procedures will follow requirements specified in the appropriate EPA recommended methodologies. Laboratories performing QC Level III (ES Level C) analysis must maintain a record of instrument calibration and QA/QC results. Such records will become part of the project records. Each operator must be trained in the proper use of the instrument, be familiar with the instrument's operation, be able to interpret data from the instrument, and have documentation certifying these skills.

8.1.2.2 QC Level IV (ES Level D) analytical support

QC Level IV (ES Level D) analytical support will conform to the EPA CLP for performing routine analytical services (RAS). QC Level IV will be used to provide confirmed identification and quantification of contaminants, to determine the extent of contamination, and to determine the presence or absence of contaminants with low required detection limits. QC Level IV provides documented data for risk assessment and remedial investigations. Data quality criteria for QC Level IV laboratory analyses will conform to specified method requirements and limits. Analytical specifications and media that may require QC Level IV data analysis include:

- Hazardous Substance List (HSL) organic compounds (soil/water/air);
- priority pollutant inorganic compounds (soil/water/air); and
- chemical analysis.

QC Level IV laboratory QC procedures will follow requirements specified in the current EPA SOW revision for CLP methodologies. Methods not included in the CLP protocol will report QC documentation as a Level IV deliverable by meeting CLP-type protocol requirements and submitting all raw data (Energy Systems 1992c). QC Level IV CLP RAS protocols are very specific concerning QA/QC requirements and data package documentation. RAS deliverable packages contain information on initial and continuing calibration, gas chromatograph/mass spectrophotometer (GC/MS) tuning, surrogate percent recovery, matrix spike duplicates, and spectra for every sample and blank. External QC will be employed in the form of trip blanks, duplicate samples, and field blanks submitted with the samples.

Accuracy and precision for QC Level IV analytical support is provided by adherence to SW-846, EPA CLP, and other identified methodology.

Completeness goals have been established as identified in Sect. 8.10.

Representativeness is a qualitative parameter related to the proper design of the sampling program. Representativeness of samples collected and analyzed is controlled by adhering to the sampling plan and conforming with specified project specific technical procedures and approved analytical procedures. It will be measured by collecting field blanks and decontamination samples to determine if the field samples are being contaminated by handling and, therefore, do not represent the media as intended.

Comparability is achieved by using standard techniques for sampling and analysis. Data sets can be compared only when precision, accuracy, representativeness, and completeness of the measurements are known.

CLP RAS documentation will be maintained as part of the project records. Chemists must be trained in the proper use of the instrument, be familiar with the instrument's operation, be able to interpret data from the instrument, and be able to produce documentation certifying these skills.

8.2 SAMPLE COLLECTION PROCEDURES

A summary of the various samples to be collected during this investigation is presented in Table 8.1. Sampling data generated during all phases of this investigation must be of acceptable quality and must be comparable to similar environmental data. To ensure the quality and consistency of data, specific approved sample collection and handling procedures will be followed. Specific procedures are identified in this section.

Table 8.1. Summary of samples to be collected at OU 3*

Media	Sample method number	Method title	Revision	Applicable OU 3 sites
Shallow soils	ESP-303-2	Soil sampling with an auger	0	Building 81-10
Soils	ESP-303-4	Penetration test and split barrel sampling	0	S-2 Site, Building 81-10
Soils	ESP-303-5	Subsurface soil sampling with Shelby Tubes	0	S-2 Site, Building 81-10
Groundwater	ESP-302-1	Water level measurements using water level indicator	0	S-2 Site, Building 81-10
Groundwater	ESP-302-2	Guidelines for well purging	0	S-2 Site, Building 81-10
Groundwater	ESP-302-3 ^b	Groundwater sampling procedure: using a bailer	0	S-2 Site, Building 81-10
Groundwater	ESP-302-4 ^b	Groundwater sampling procedure: using a gas-driven piston pump	0	S-2 Site, Building 81-10
Groundwater	ESP-302-5 ^b	Groundwater sampling procedure: using a bladder pump	0	S-2 Site, Building 81-10
Groundwater	ESP-600	Well installation development and abandonment	0	S-2 Site, Building 81-10
Surface water	ESP-301-1	Water sampling using a dipper	0	Building 81-10

*Kimbrough et al., 1990, Environmental Surveillance Procedures Quality Control Program Martin Marietta Energy Systems, Inc.

^bChoice on groundwater sampling method will be based on type of parameter to be collected, well yield, and type of sampling equipment available.

8.2.1 Soil Sampling

The soil sampling activities include split-barrel sampling of soil borings and the collection of shallow soil samples using a hand auger. Soil samples from the soil borings will be collected in accordance with guidelines specified in ESP-303-4, Revision 0. Eleven modifications to ESP-303-4 are listed below:

1. Section III, Line 3, page 1 of 7: Add "or hydraulic methods" to the end of the sentence.
2. Section III, Line 6, page 1 of 7: After the fourth sentence add "If the split spoon is hydraulically driven, blow counts cannot be recorded".
3. Section V, Part C, page 2 of 7: Change "304/326" to "304/316".
4. Section V, Part D, page 2 of 7: Add another subpart "3". "Hydraulic unit - Hydraulic methods (auger rig, backhoe) may be used to push the split-spoon sampler into the ground for obtaining soil for chemical analysis only, in such cases, blow counts cannot be recorded.
5. Section VI, page 3 of 7: Second paragraph, delete the first sentence. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."
6. Section VII, page 3 of 7: Footnote the following statement: "If a hydraulic method is used to push the sampler into the ground, parts D-I do not apply, except G as modified to state: Mark the drill rods in 2- or 3- ft increments, depending on the length of the split spoon, and push the split spoon to the appropriate depth.
7. Section VII, Part I, Subpart 4, page 4 of 7: Add "or 24" after "18".
8. Section VII, page 4 of 7 add new part L: "Remove the aliquot for volatile organic analysis. Place remaining soil in a decontaminated stainless steel bowl, or a Teflon sheet, or a glass tray. Using a decontaminated stainless steel or Teflon spoon, spatula, or disposable scoop, mix or composite the soil as directed by the Sampling and Analysis Plan.
9. Section VII, page 4 of 7, relabel duplicate "H" as "M" and revise to read: "Place soil samples in compatible containers, then when appropriate, pack with ice in coolers as soon as possible. Package, label and prepare for shipment per ESP-500, ESP-701, and ESP-800 where not superseded by ER Division Procedure number ER/C-P2302 (IAD) Rev. 0. "Relabel "I" as "N".

10. Section VII, page 4 of 7, add a new part "O": "Boreholes will be backfilled with any remaining soil, or, if required, abandoned in accordance with ESP-600."

11. Section IX, Part A, page 5 of 7: "all" should be "allow".

The shallow soil samples will be collected in accordance with guidelines specified in ESP-303-2, Revision 0. Seven modifications to ESP-303-2 are listed below:

1. Section VI, Paragraph 2, page 2 of 6: Delete the first sentence of this paragraph. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."
2. Section VII, Part E, page 3 of 6: Revise "B & C" to state "C & D", change "precleaned" to "decontaminated". Add "and repeat steps A through D." at the end of the second sentence.
3. Section VII, Part F, page 3 of 6: Insert "or Teflon" after "polyethylene". Add as second and third sentences: "The top 2 to 3 in. of soil in the auger should be discarded. Remove aliquot for volatile organic analysis." In the last sentence insert "the remaining" between "composite" and "soil".
4. Section VII, Part G, page 3 of 6: Revise to read: "Using a decontaminated stainless-steel or Teflon spoon, spatula, or disposable scoop as appropriate, place soil samples in compatible containers, package, label, and prepare for shipment per ESP-500, ESP-701, and ESP-800."
5. Section VII, Part I, page 3 of 6: apply as applicable.
6. Section VII, Part K, page 3 of 6: Add "The borehole will be abandoned, if necessary, in accordance with ESP-600."
7. Attachment 1, Field Checklist: Add "Monitoring Instruments" to the checklist.

8.2.2 Groundwater Sampling

Groundwater sampling will be conducted in accordance with ESP-302 and ESP-600 methodologies. Water level measurements will be taken in accordance with ESP-302-1, Revision 0. Nineteen modifications to this procedure are listed below:

1. Section I, First Sentence, page 1 of 7: Insert "or piezometers" to the end of the sentence.
2. Section IV, Paragraph 2, page 2 of 7: Delete "with a plover".

3. Section IV, page 2 of 7: Delete the third paragraph.
4. Section V, Part B, page 2 of 7: Change "plover" to "raised markings."
5. Section VI, Second paragraph, page 3 of 7: Delete the first sentence of this paragraph.
6. Section VII, Part A, page 3 of 7: Change sentence to read "Don clean gloves, unlock and open well; note condition of well. Check the well with OVA, PID and/or Rad meters.
7. Section VII, Part C, page 3 of 7: Insert "inner" between "of" and "well".
8. Section VII, Part C, Subpart 1, page 3 of 7: Insert "inner well" between "of" and "casing".
9. Section VII, Part D, Subpart 1, page 3 of 7: Change the word "clean" to "decontaminated".
10. Section VII, Part D, Subpart 8, page 4 of 7: Insert "inner" between "of" and "casing".
11. Section VII, Part D, Subpart 11, page 4 of 7: This subpart should state "Pull M-scope from well and decontaminate."
12. Section VII, Part E, Subpart 1, page 4 of 7: Insert "decontaminated" between "Inspect" and "tape". Delete "or applied length for "plover".
13. Section VII, Part E, page 4 of 7: Add the following to the beginning of Subpart 2: "Chalk one or two feet of tape".
14. Section VII, Part E, Subpart 3, page 4 of 7: Change the word "plover" to "tape". Add another sentence that states "Note reading at measuring point on top of well."
15. Section VII, Part E, page 4 of 7: Replace Subpart 4 with " Remove tape from well and note wet cut on tape."
16. Section VII, Part E, Subpart 5, page 5 of 7: Replace "Read the tape to 0.01 ft." with "Subtract wet cut from measuring point reading". Insert "to 0.01 ft." between "measurement" and "in field."
17. Section VII, Part E, Subpart 7, page 5 of 7: Change "analytical" to "analysis".
18. Attachment 1, Field Checklist, page 7 of 7: Second entry should state "Steel or fiberglass tape

measure with raised markings".

19. Attachment 1, Field Checklist, page 7 of 7: Add another entry that states "Monitoring equipment (PID, OVA, Rad meters)."

Guidelines for well purging are presented in ESP-302-2, Revision 1. Eleven modifications to this procedure are listed below:

1. Section VI, Second paragraph, page 2 of 7: Delete the first sentence of this paragraph. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."
2. Section VII, Part C, page 3 of 7: Add "Decontaminate purging equipment according to ESP-900." after first sentence.
3. Section VII, Part E, page 3 of 7: Add "around the base of the well and donning clean gloves" to the end of the sentence.
4. Section VII, page 3 of 7: Add the following to the beginning of part "F" which states "Check the well with HNU, OVA, and/or Rad meters. Monitor the well for VOCs if applicable, using a PID.
5. Section VII, Part G, page 3 of 7: Change the word "known" to "measured".
6. Section VII, Part I, page 4 of 7: Add "to clear stagnant water which is not representative", after "required volumes", in first sentence.
7. Section VII, Part J, Subpart 1, page 4 of 7: Replace "then begin measuring field parameters once during each well volume" with "measure field parameters at end of each purge volume."
8. Section VII, Part J, Subpart 2, page 4 of 7: Delete "(or more as specified in the sampling and analysis plan)".
9. Section VII, Part L, page 5 of 7: Add "and on well purging form. The use of a purging form to record data is recommended to avoid the omission of critical data." to the end of this part.
10. Section VIII, Second sentence, page 5 of 7: Add "Purged water," to the beginning of the sentence.

11. Attachment 1, Field Checklist, page 7 of 7: Add entries "Monitoring equipment", "Cord of Approved Material", "Keys for Well Lock", "Bucket with Volume Markings", "55 Gallon Drums for Purge Water", and Funnel".

Groundwater sampling using a bailer will be conducted in accordance with ESP-302-3, Revision 0. Thirteen modifications to this procedure are listed below:

1. Section IV, Subpart A, page 1 of 7: Add another sentence that states: "The use of bailers with bottom emptying devices is highly recommended to reduce spillage and sample agitation.
2. Section VI, Second paragraph, page 3 of 7: Delete the first sentence of this paragraph. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."
3. Section VII, Part A, page 3 of 7: Replace the word "near" with "around the base of". Add "in" between "and" and "work". Add the following: "to prevent equipment from coming in contact with potentially contaminated surfaces." to the end of the sentence.
4. Section VII, Part C, page 3 of 7: Add another sentence to the beginning of this part that states "The use of a well sampling form in addition to the logbook record is recommended to avoid omission of critical data."
5. Section VII, page 3 of 7: Add the following to the beginning of Part "C": "Prior to sampling, check the well with PID, OVA, and/or Rad meters."
6. Section VII, Part D, page 3 of 7: Replace the word "clean" with "decontaminated".
7. Section VII, page 3 of 7: Add the following to the beginning of Part "E": "Select appropriate sample bottles (ESP-701) add preservative, if necessary, and place them ready for use."
8. Section VII, page 4 of 7: Add the following to the end of part "J": ", which are filled with no air present and capped."
9. Section VII, page 4 of 7: Add the following to the beginning of part "K": "Add the necessary preservatives, if any."
10. Section VII, Part I, page 4 of 7: Delete the third sentence of this part.
11. Section VII, Part L, page 4 of 7: In the first sentence change the word "practical" to "possible".

12. Figure 1, page 6 of 7: Change the middle note to state "Tubing (Teflon or Stainless Steel, 304, 316).
13. Attachment 1, Field Checklist, page 7 of 7: Add new entries: "Monitoring equipment", "Preservative", "Litmus paper", "Pipettes", "Sampling Forms", "Bucket of Known Volume", "Keys for Well Lock".

Groundwater sampling using a gas driven piston pump will follow ESP-302-4, Revision 0. Ten modifications to this procedure are listed below:

1. Section IV, page 2 of 6, paragraph 1: Add the following to the end of the first paragraph: "Only closed top Teflon bailers or peristaltic pumps/vacuum jug assemblies are recommended for collection of groundwater sample."
2. Section IV, page 2 of 6, Note: Replace the existing "Note" with the following: "Manufacturer's calibration and maintenance instructions will be kept with the equipment, not the procedure."
3. Section VI, Paragraph 2, page 2 of 6: Delete the first sentence of this paragraph.
4. Section VII, Part C, page 3 of 6: Add another sentence that states "Don clean gloves prior to any field activities."
5. Section VII, page 3 of 6: Add the following to part "D": "Check well with OVA, PID, and/or Rad meters."
6. Section VII, Part E, page 3 of 6: Insert "decontaminated" between "Lower" and "pump". Replace "desired" with "beneath the water".
7. Section VII, Part L, page 3 of 6: Delete the third sentence of this part.
8. Section VII, Part M, page 3 of 6: Replace "to overflowing" with "with no air present".
9. Section VII, Part O, page 4 of 6: Replace the word "practical" with "possible".
10. Attachment 1, Field Checklist, page 6 of 6: Add entries "Monitoring equipment", "Litmus Paper", and "Pipettes".

Groundwater sampling using a bladder pump will follow ESP-302-5, Revision 0. Twelve modifications to this procedure are listed below:

1. Section III, page 1 of 7: In the first sentence change the word "cleaned" to "decontaminated".
2. Section IV, page 2 of 7, Note: Replace the existing note with the following: "Manufacturer's calibration and maintenance instructions will be kept with the equipment, not the procedure."
3. Section VI, Second paragraph, page 2 of 7: Delete the first sentence of this paragraph. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."
4. Section VII, page 3 of 7: Add the following to the end of part "A": "Select appropriate sample containers, add preservative (per ESP-701), if necessary, and place them ready for use."
5. Section VII, Part B, page 3 of 7: Add "and to catch spills at the base of well." to the end of the sentence.
6. Section VII, Part C, page 3 of 7: Add two sentences that state "Don clean gloves prior to any field activities. Check well with OVA, PID, and/or Rad meters."
7. Section VII, Part F, page 3 of 7: Insert "decontaminated" between "Lower" and "pump". Replace the word "desired" with "below water level".
8. Section VII, Part P, page 4 of 7: Delete the third sentence of this part.
9. Section VII, Part Q, page 4 of 7: Replace "to overflowing" with "with no air present".
10. Section VII, Part S, page 4 of 7: Replace the word "practical" with "possible".
11. Section VII, page 4 of 7: Add the following to the end of part "T": "The use of field forms to record sampling/purging data is recommended to ensure that all pertinent information is recorded without omission."
12. Attachment 1, Field Checklist, page 7 of 7: Add new entries "Monitoring equipment", "Litmus Paper", and "Pipettes".

Groundwater well installation, development, and abandonment will follow ESP-600, Revision 0. Twenty modifications to this procedure are listed below:

1. Section V, Part A, Subpart 2, page 3 of 22: Add another sentence that states "Compressed drilling air must be filtered prior to injection into the well bore."

2. Section V, Part A, Subpart 3, Second Paragraph, page 3 of 22: Add another sentence that states "Compressed drilling air must be filtered prior to injection into the well bore."
3. Footnote 4, page 6 of 22: Change the word "powered" to "powdered".
4. Section V, Part C, page 7 of 22: Add a new subpart "9" which states "DOT Drums or tanks for containing development/purge water."
5. Section V, Part D, Subpart 5, page 8 of 22: Add another sentence that states "No petroleum based lubricants are allowed. All lubricants must be approved by on-site geologists prior to use."
6. Section V, Part D, page 8 of 22: Add a new Subpart "6" that states "DOT Drums for soil/rock cuttings."
7. Section VII, Part B, Subpart 1a, page 10 of 22: Add another sentence to the beginning of this subpart that states "The borehole should be advanced to one foot below the desired casing bottom and backfilled with filter pack sand to the desired setting depth."
8. Section VII, Part B, Subpart 1c, page 12 of 22: Revise the second sentence to state "The bentonite seal will be placed at a minimum height of 2 ft."
9. Section VII, Part B, Subpart 1c, page 12 of 22: Add another sentence that states: "Bentonite seals above the saturated zone should be hydrated by pouring potable water around the annulus of the well casing. The bentonite pellets/granules will be allowed to hydrate according to manufacturer's specifications prior to grouting."
10. Section VII, Part B, Subpart 1d, page 12 of 22: The word "Annular: in the title of this section is misspelled, the proper spelling is "Annular".
11. Section VII, Part B, Subpart 1d, page 12 of 22: Add another sentence that states "When placing the annular grout, care should be taken that the weight of the grout is not so great as to jeopardize the bentonite seal."
12. Section VII, Part B, Subpart 1e, page 13 of 22: Add another sentence that states: "It is recommended that the well cap be locked except when well is being tested."
13. Section VII, Part F, First Paragraph, page 19 of 22: Add another sentence to this paragraph that states "All well casing, centralizers, and screens will be decontaminated prior to use, unless they come from the manufacturer cleaned and packaged."

14. Section VII, Part B, Subpart 1g, page 13 of 22: Add another sentence that states "Label well with name/number in highly visible manner directly onto well protective casing."
15. Section VII, Part C, Second Paragraph, page 16 of 22: Add another sentence to the end of the paragraph that states "All wastes will be handled, stored, and disposed of in accordance with the site Waste Management Plan."
16. Section VII, Part D, Second Paragraph, page 19 of 22: Add another sentence to the end of the paragraph that states "Development shall follow the methods outlined in ESP-302-2 (Guidelines for Well Purging)."
17. Section VII, Part F, Third Paragraph, page 20 of 22: Revise this paragraph to state "Spent cleaning and decontamination solutions will be handled in accordance with the site Waste Management Plan."
18. Section VII, Part G, Second Paragraph, page 20 of 22: Add another sentence to this paragraph that states "A well identification tag shall be permanently affixed to the well head denoting the well name and specifications."
19. Section IX, Part A, page 21 of 22: Add "by the Environmental Surveillance Project Manager" between "authorized" and "prior".

8.2.3 Surface Water

Surface water samples will be collected in accordance with ESP-301-1, Revision 0. Twelve modifications to this procedure are tested below:

1. Section I, Third paragraph, Second sentence, page 1 of 7: Change the word "is" to "are".
2. Section IV, Second sentence, page 2 of 7: Revise this sentence to state "Sample for volatile organic analysis (VOA) should be collected first and extreme care must be taken to avoid disturbing or aerating the sample."
3. Section IV, page 2 of 7: Add another sentence that states "In this situation refer to the Sample and Analysis Plan."
4. Section V, Part A, page 2 of 7: Add another sentence "Composition of dipper should be appropriate for the nature of the sample and likely contaminants."

5. Section VI, Second paragraph, page 3 of 7: Delete the first sentence. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."
6. Section VII, Part B, Page 3 of 7: Modify this part to state "Select appropriate bottles, (see ESP-701) add preservative, if necessary, and place them ready for use."
7. Section VII, Part C, page 3 of 7: Change the word "clean" to "decontaminated". Add the following to the beginning of Part "C": "New latex gloves should be donned prior to collecting each sample. Dipper should be decontaminated prior to use as per ESP-900." Add another sentence that states "The sample must be taken upstream from where the sampler is standing and also upstream from where field personnel have been in the stream taking flow measurements."
8. Section VII, Part F, page 3 of 7: Delete the third sentence of this part.
9. Section VII, Part I, page 4 of 7: Change the last word of the first sentence from "practical" to "possible".
10. Section VII, Part J, page 4 of 7: Insert "appropriate field forms" between "logbook" and "and chain-of-custody".
11. Section VIII, page 4 of 7: Change the fourth sentence to state "Sampling personnel shall wear chemical resistant gloves when handling the water samples."
12. Attachment 1, page 6 of 7: Add "Extra sample jars/lids", "Bucket", "Pipettes", "Litmus paper", and add "and tags" after "Labels".

8.2.4 Sediment Sampling

Sediment sampling will be conducted in accordance with ESP-304-1, Revision 0. Twelve modifications to this procedure are listed below:

1. Section IV, Note, page 2 of 11: Replace with the following "The manufacturer's calibration and maintenance instruction should be attached to the equipment, not the procedure."
2. Section VI, Second paragraph, page 3 of 11: Delete the first sentence of this paragraph. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."
3. Section VII, Part A, page 3 of 11: Add "Don clean gloves prior to field activities" to the beginning of Subpart 1.

4. Section VII, Part A, Subpart 1, page 3 of 11: Insert "clean, decontaminated, or not previously used" between "Use" and "Lexan".
5. Section VII, Part A, Subpart 2, page 3 of 11: Insert "inner" between "certain" and "piston".
6. Section VII, Part A, Subpart 10, page 4 of 11: Add another sentence that states "Measure the length of core in the tube and any other observations as per the Sampling and Analysis Plan."
7. Section VII, Part A, Subpart 13, page 5 of 11: Change the last word of the first sentence from "practical" to "possible".
8. Section VII, Part B, page 5 of 11: Add a new Subpart 1 that states "Don clean gloves prior to field activities. To avoid injury keep hands and fingers away from open dredge jaws."
9. Section VII, Part B, Subpart 7, page 5 of 11: Change the last word of the first sentence from "practical" to "possible".
10. Section VII, Part C, page 5 of 11: Add a new Subpart 1 that states "Don clean gloves prior to field activities."
11. Section VII, Part C, Subpart 6, page 6 of 11: Add "as soon as possible" after "samples with ice" in the third line.
12. Section VII, Part C, Subpart 8, page 6 of 11: Change the last word of the first sentence from "practical" to "possible".

8.2.5 Field Measurement of Physical Parameters

Field measurement of physical parameters will be conducted in accordance with ESP-307 Series methodologies, Revision 0, except ESP-307-7, which is Revision 1.

Each of these field measurements will be performed in accordance with the applicable procedure. An amendment of these procedures to incorporate instrument-specific manufacturers instructions may be required. Any deviation from the applicable procedure will be documented as a field change to ensure upper tier concurrence and provide for reproducible measurements. A total of fifteen modifications to these procedures are listed below:

ESP-307-1

1. Section VII, page 3 of 5: Add a new Part "A" that states "Don clean gloves prior to field activities."

ESP-307-2

1. Section VII, Part B, page 3 of 6: Add the following to the end of Part "A": "Don clean gloves prior to use of instruments in the field."
2. Section VII, Part C, page 3 of 6: Revise the first sentence of this part to state "For pH meter without automatic temperature compensation, allow the sample and buffer to reach the same temperature, if possible."
3. Section VII, Part C, page 3 of 6: Add "using manufacturers operating instructions" to the end of this part.
4. Section VII, Part F, page 3 of 6: In the first sentence change the word "less" to "more".
5. Section VII, Part I, page 4 of 6: Add "of the day" to the end of this part.

ESP-307-6

1. Section IV, Paragraph 3, page 2 of 7: Delete the existing note and replace it with the following: "Manufacturer's calibration and maintenance instructions will be kept with the equipment in the field."
2. Section V, page 2 of 7: Add: "Logbook for calibration information - Specifically for instrument calibration use and separate from the field logbook" to the end of this section as step C.
3. Section VI, Last paragraph, page 3 of 7: Delete first sentence. Add "while performing this procedure" to the end of the second sentence.
4. Section VII, Part G, page 4 of 7: Add "after manufacturer's recommended waiting time" to the end of the second sentence
5. Section VII, Part K, page 4 of 7: Move second and third sentences to Step A.

ESP-307-7

1. Section IV, page 2 of 8: Delete the existing note and replace it with the following:
"Manufacturer's calibration and maintenance instructions will be kept with the equipment."
2. Section VI, Paragraph 2, page 5 of 8: Delete the first sentence. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."
3. Section VI, Paragraph 2, page 5 of 8: Add hyphen to "site specific", and "while performing this procedure" to the end of the second sentence.
4. Attachment 1, Field Checklist, page 8 of 8: Add "(when required by the site-specific health and safety plan)" after the entries for safety glasses, gloves, and safety shoes.

8.2.6 Sample Compositing

Sample compositing will be conducted in accordance with ESP-308-1. Four modifications to ESP-308-1 are listed below:

1. Section II, page 1 of 6: Add another Reference "G" that states "Kimbrough, C.W., L.W. Long and L.W. McMahon, eds. *Environmental Surveillance Procedures Quality Control Program*. Martin Marietta Energy Systems, Inc., September 1, 1988."
2. Section VI, Paragraph 2, page 2 of 6: Delete the first sentence. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."
3. Section VII, Part A, page 3 of 6: Add "Pyrex bowls may be substituted for stainless steel bowls. Samples will be homogenized before placing in containers except for VOA."
4. Section VIII, page 4 of 6, after the first sentence add the following lines: "For composite samples of solid matrixes, such as soil and sediment, the sampling equipment will be cleaned of any solid residue for aliquot (fraction or part) taken for the composite sample, but may not be decontaminated per ESP-900. The sampling equipment will be decontaminated per ESP-900 between each composite sample collected."

8.2.7 Field Documentation

An integral part of the QA/QC Plan for the field activities will be to maintain current, accurate, and complete field records including logbooks, COC (Sect. 8.4), and appropriate field data forms. Field logbooks will be of hardcover construction. All information pertinent to field activities will be recorded. Each page must be signed and dated. Corrections must be marked out with a single line, dated, and initialed. Entries in the logbooks or on the data forms will be made in water resistant black or blue ink and will include the information specified in ESP/500, Section VII, Part D methodology. Ten modifications to ESP-500 are listed below:

1. Section VII, Part D, number 7, page 4 of 8: Delete this part.
2. Section VII, Part D, page 5 of 8: Add a new number "22" that states "Describe whether the sample was a grab or composite and field personnel in charge of sample custody."
3. Section VII, Part D, page 5 of 8: Add a new number "23" that states "Deviations will be documented in the logbook."
4. Section VII, Part E, number 6, page 6 of 8: Add "one of the collectors must be the first person signing as relinquishing custody as stated in No. 14 of this section and part."
5. Section VII, Part E, number 8, page 6 of 8: Insert "in Remarks Section of Chain-of-Custody Record" following "if known".
6. Section VII, Part E, number 9, page 6 of 8: Insert "number of containers and method of shipment. The container type will not be specified on the Chain-of Custody Record but will be specified on the second page of each sample log sheet." after "Container type."
7. Section VII, Part E, number 10, page 6 of 8: Insert "in Remarks Section of Chain-of-Custody Record" following "on receipt".
8. Section VII, Part E, number 11, page 6 of 8: Insert "in Remarks Section of Chain-of-Custody Record" following "hazards".
9. Section VII, Part E, number 14, page 6 of 8: Add "The first person signing as relinquishing custody must be one of the collectors identified in No. 6 of this section and part."

10. Section VII, Part F, pages 6 of 8 and 7 of 8: Delete Part F because the Chain-of-Custody Record Section VII, Part E will be used as the Sample Request for Analysis Sheet as well as the Chain-of-Custody Record. A separate Sample Request for Analysis Sheet will not be used.

8.2.8 Sample Containers, Sample Preservatives, and Holding Times

The selection criteria for appropriate sample containers, sample preservatives, and holding times will be in accordance with ESP-701 methodologies. Types of sample containers and sample preservation methods used will be documented in the sampling logbook and field and laboratory records will indicate the sample holding time (Tables 8.2 through 8.5). Nine modifications to ESP-701 are listed below:

1. Section III, Part A, page 2 of 4: Revise first sentence to state "The most convenient preservative is a chemical which can be added to a sample bottle prior to or immediately following sampling."
2. Section III, Part A, page 2 of 4, Last sentence: Insert "Biochemical Oxygen Demand" between "with" and "BOD" and place parenthesis around "BOD".
3. Section III, Part B, page 2 of 4: Replace Part B with the following: "When acids or bases are used to adjust the pH of a sample for preservation purposes, the pH of a representative number of samples will be checked after the preservative is added. This is necessary because the ambient pH of the water or its buffering capacity often causes the pH of the sample not to be adjusted correctly when a "standard" amount of preservative is added. Document in the logbook that the pH was checked. The field supervisor will decide the number of samples in which to check the pH to ensure that similar types, batches, and sample groups are properly preserved. The pH paper should not be dipped into the sample, but a small amount of sample should be poured onto the pH paper."
4. Section III, Part D, page 2 of 4: Change "interfers" to "interfere".
5. Section IV, page 3 of 4: Add "Chemical preservation should not be added to concentrated waste samples."
6. Section V, page 3 of 4: The word "reagent" should be inserted on each line between "ACS" and "grade".
7. Section VII, page 4 of Table 1: under the heading "Parameter," change "Nutrients⁴" to "Nutrients⁵".
8. Section VII, page 6 of Table 1: Under the heading "Preservative", change "Acetate²" to "Acetate³".

Table 8.2. Requirements for soil samples - OU 3 Building 81-10^a

Analyte group	Approx. no. of samples ^a	Container	Minimum sample size	Preservative	Holding time
Volatile Organic ^b Compounds	53	1 - 4 oz glass jar with Teflon-lined cap (no headspace)	50 gm	Cool, 4°C	14 d
PCB ^c Compounds	17	1 - 8 oz glass jar with Teflon-lined cap	100 gm	Cool, 4°C	7 d (extraction) 40 d (analysis)
Metals ^b (other than Hg)	53	1 - 8 oz wide mouth polybottle	50 gm	Cool, 4°C	180 d
Mercury	53	use same container as other metals	10 gm	Cool, 4°C	28 d
Radionuclides ^d	53	1 - 16 oz wide mouth polybottle	500 gm	Cool, 4°C	180 d
TCLP	5				

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^aIncludes shallow soil and soil boring samples.

^bReference Table 2 in the Laboratory QAPJP

^cPCB compounds will be analyzed in the first depth layer only

^dIncludes Gross α , Gross β , Gamma Spectroscopy, Isotopic Uranium, Isotopic Thorium

*Includes duplicate samples to be collected

Table 8.3. Requirements for soil samples - OU 3 S-2 Site

Analyte group	Approx. no. of samples ^a	Container	Minimum sample size	Preservative	Holding time
Volatile Organic ^b Compounds	40	1 - 4 oz glass jar with Teflon-lined cap (no headspace)	50 gm	Cool, 4°C	14 d
PCB ^b Compounds	1	1 - 8 oz glass jar with Teflon-lined cap	100 gm	Cool, 4°C	7 d (extraction) 40 d (analysis)
Metals ^b (other than Hg)	40	1 - 8 oz wide mouth polybottle	50 gm	Cool, 4°C	180 d
Mercury	40	use same container as other metals	10 gm	Cool, 4°C	28 d
Radionuclides ^c	40	1 - 16 oz wide mouth polybottle	500 gm	Cool, 4°C	180 d
TCLP	1			Cool, 4°C	
Distribution Coefficient (metals)	2			Cool, 4°C	

^aIncludes duplicate samples to be collected

^bReference Table 2 in the Laboratory QAPjP

^cIncludes Gross α , Gross β , Gamma Spectroscopy, Isotopic Uranium, and Isotopic Thorium

Table 8.4. Requirements for soil samples - OU 3, the Salvage Yard^a

Analyte group	Approx. no. of samples ^b	Container	Minimum sample size	Preservative	Holding time
Volatile Organic ^c Compounds	47	1 - 4 oz glass jar with Teflon-lined cap (no headspace)	50 gm	Cool, 4°C	14 d
PCB ^c Compounds	11	1 - 8 oz glass jar with Teflon-lined cap	100 gm	Cool, 4°C	7 d (extraction) 40 d (analysis)
Metals ^c (other than Hg)	47	1 - 8 oz wide mouth polybottle	50 gm	Cool, 4°C	180 d
Mercury	47	use same container as other metals	10 gm	Cool, 4°C	28 d
Radionuclides ^d	55	1 - 16 oz wide mouth polybottle	500 gm	Cool, 4°C	180 d
TCLP	1				

^aIncludes shallow soil and soil boring samples.

^bIncludes duplicate samples to be collected

^cReference Table 2 in the Laboratory QAPjP

^dPCB compounds will be analyzed in the first depth layer only

Table 8.5. Requirements for surface water and groundwater sampling and field QC - OU 3 Building 81-10, S-2 Site, and the Salvage Yard Sites.

Analyte group	Approx. no. of samples ^a	Container	Minimum sample size ^b	Preservative	Holding time
Volatile Organic ^c Compounds	169	2 - 40 mL glass vials with Teflon-lined septum (no headspace)	80 mL	HCl to pH <2 Cool, 4°C	14 d
Metals ^d (other than Hg)	137	1 - 1 polybottle	500 mL	HNO ₃ to pH <2 Cool, 4°C	180 d
Mercury	137	use same container as other metals	200 mL	HNO ₃ to pH <2 Cool, 4°C	28 d
Anions ^d	103	250 mL polybottle	250 mL	Cool, 4°C	28 d
Nitrate-Nitrite	103	250 mL polybottle	100 mL	H ₂ SO ₄ to pH <2 Cool, 4°C	28 d
Radionuclides ^e	139	2 - 1 gal. plastic container	8 liters	HNO ₃ to pH <2	180 d

^aNumbers include all groundwater samples, groundwater duplicate samples, soil and groundwater field QC (equipment rinsate, field blanks and trip blanks.)

^bAdditional Sample must be collected for laboratory matrix spike/matrix spike duplicate or duplicate analysis

^cReference Table 2 in the Laboratory QAPjP

^dChloride, Sulfate, Fluoride

^eIncludes Gross α , Gross β , Gamma Spectroscopy, Total and Isotopic Uranium, Isotopic Thorium

9. Section VII, page 7 of Table 1: The containers for organics may be 40 ml vials with Teflon lined septum caps or 250 ml widemouth glass with Teflon lined septum caps.

8.2.9 Sample Packaging and Transportation

Handling, shipping, and storage of samples and data resulting from field activities will adhere to custody (Sect. 8.4) and will ensure that sample integrity for analytical purposes is maintained. Classifying, packaging, marking, labeling, and shipping for analysis of environmental samples collected during this investigation will be performed in accordance with ER Division Procedure Number ER/C-P2302 (IAD), Revision 0. Additional procedures to preserve, package, ship, handle, and store containers of environmental samples are described in ESP-800 methodologies, which will be adhered to where not superseded by ER/C-P2302 (IAD), Revision 0.

8.2.10 Decontamination of Equipment and Devices

Decontamination of sample containers and sampling devices will follow that prescribed in ESP-900. Sampling equipment will be decontaminated before use and between sampling locations/intervals. Each decontamination activity will be recorded in the field logbook. Equipment used during field activities, including drilling equipment, soil sampling equipment, and field test equipment will be decontaminated in accordance with ESP-901. A total of twenty modifications to these procedures are listed below:

ESP-900

1. Section III, page 1 of 20: In the second sentence insert, "decontaminated and allowed to air dry" after "must be cleaned". In the third sentence revise "cleaned and decontaminated" to state "cleaned, decontaminated, and allowed to air dry".
2. Section IV, Part A, page 2 of 20, number 2: Delete "Alquinox," and the comma after "Liquinox".
3. Section IV, Part A, page 2 of 20, number 7: Add to the end of the paragraph, "This water should be defined as containing no pesticides, herbicides, extractable organic compounds, and less than 50µg/l of purgeable organic compounds as measured by a low level GC/MS scan. Organic free water and alcohol should be stored in only glass or Teflon® containers and dispensed from only glass, Teflon®, or stainless steel containers.
4. Section VII, Part C, page 4 of 20: Add the sentence "Cleaned equipment should be wrapped in aluminum foil after drying," before the last sentence in the paragraph.
5. Section IX, Part C, page 5 of 20: Add the sentence "Note in the field logbook the equipment being used for the QC Rinsate." to the end of the paragraph.

6. Attachment 1, Part II, page 8 of 20, paragraph 2, last sentence: After the word "lids", add the following: "which have been solvent rinsed (if the actual sample containers were solvent rinsed)."
7. Attachment 2, Part I, number 1, page 9 of 20: The word "hot" should be replaced with the word "tap".
8. Attachment 2, Part I, page 9 of 20: Omit number 2 and 3.
9. Attachment 2, Part I, page 9 of 20: Omit number 2 and 3.
10. Attachment 2, Part I, Page 9 of 20, number 5: Replace "deionized" with organic free.
11. Attachment 2, Part I, page 9 of 20, number 6: Replace "solvent" with "pesticide grade isopropyl alcohol".
12. Attachment 2, Part I, page 9 of 20, number 6: Add the line, "If it is not possible to allow 24 hours drying time, rinse the equipment twice with organic free water."
13. Attachment 2, Part II, page 10 of 20, number 1: The word "hot" should be replaced with the word "tap".
14. Attachment 2, Part II, page 10 of 20: Omit number 2.
15. Attachment 2, Part II, page 10 of 20, number 3: replace "deionized" with "organic free."
16. Attachment 2, Part II, page 10 of 20, number 4: replace "solvent" with "pesticide grade isopropyl alcohol."
17. Attachment 2, Part II, page 10 of 20, number 4: Add the line, "If it is not possible to allow 24 hours drying time, rinse the equipment twice with organic free water."

ESP-901

1. Section II, page 1 of 11: Add another Reference "D" that states "Kimbrough, C.W., L.W. Long and L.W. McMahon, eds. *Environmental Surveillance Procedures Quality Control Program*. Martin Marietta Energy Systems, Inc., September 1, 1988."
2. Section VI, Paragraph 2, page 3 of 11: Delete the first sentence. Replace with "all field personnel will follow the site specific and/or project specific health and safety plan."

3. Table ESP-901-1, page 7 of 11: Steam cleaner should consistently generate greater than 2500 psi.

8.2.11 Sample Identification and Traceability

Each environmental sample collected during these investigations will be assigned a unique sample identifier, which will be permanently affixed to the sample container and recorded in the field logbook and COC. The identifiers used for samples will be established and maintained in accordance with ESP-500 methodologies.

Identification systems will assure traceability of samples to the appropriate source. Sample identification will be transferred to each subdivision when the sample is split.

8.2.12 Site Surveying

Site surveying will be conducted to establish location and elevation of all sampling points and monitoring well measuring points in relation to the Y-12 Plant grid. A licensed surveyor will be contracted to perform this effort.

8.2.13 Field Variance System

Procedures cannot fully encompass all conditions encountered during a field investigation. Variances from operating procedures, Work Plan, Sampling and Analysis Plan (SAP), and/or Health & Safety Plan will, therefore, likely occur and must be documented on a field change order form and/or a nonconformance report (NCR) and be noted in the appropriate logbooks. If a variance is anticipated (e.g., due to a change in field instrumentation) the applicable procedure should be modified and the change noted in the field logbooks.

The Field Team Leader or designee will initiate and chronologically maintain a field change order log and an NCR log. Field changes fall into three categories, minor, major, and other as described below.

8.2.13.1 Minor field change

A minor field change is one that does not affect the objectives of the field sampling plan and may be approved by the Field Team Leader by noting it in the field logbook. A slight change in the sampling location due to a physical obstruction is an example of a minor change.

8.2.13.2 Major field change

A major field change is one that affects the field sampling objectives and/or schedule and may require EPA, DOE, and/or state approval. The major field change must be approved by the site Project Manager. These changes may require a change in the program. An example of a major field change is the decision to significantly change the number of wells.

8.2.13.3 Other field change

Another field change falls between the minor and the major change in that it significantly affects the sampling plan without requiring a program change. It is approved by the site Project Manager and may require EPA, DOE, and/or state approval. Changing the number of samples is an example of another field change.

As appropriate, regulatory agencies will be notified of any variances that significantly affect project scope or objectives, and approval from the agencies will be obtained as necessary. Any variances from the Health & Safety Plan must be approved by the Health & Safety Officer. The project QA officer will be informed of all field changes. Copies of the field change order form will be maintained by the sampling teams until the field work is complete and will then be forwarded to the Project Manager for inclusion in the project file and the subcontractor's Central Records Facility (CRF).

8.3 ANALYTICAL PROCEDURES

Environmental samples collected for this RI will be analyzed for potential contaminants using established EPA methodology, where applicable. When non-EPA procedures for analysis are employed, a written description of the analytical procedures to be used will be approved by the APO before establishing a contract for analytical services.

The approved methods and protocols that may be used by the analytical laboratory are provided in:

- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA 1986);
- *Methods for Chemical Analysis of Waters and Wastes* (EPA 1983);
- *Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA 1980b);
- *Eastern Environmental Radiation Facility Radiochemistry Procedures Manual* (EPA 1984);
- *EPA CLP SOWs for Organic Analysis, OLM01.8* (EPA 1990b);
- *EPA CLP SOW for Inorganic Analysis, ILM02.0* (EPA 1991d);
- 40 CFR 136, Appendix A;
- 40 CFR 141.30;
- 40 CFR 136, Appendix C;

- APHA, *Standard Methods for the Analysis of Water and Wastewater*; and
- *Environmental Measurement Laboratory (EML) Procedures Manual*, HASL-300 (Krey and Beck 1990).

The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is greater than zero. The MDL actually achieved in a given analysis varies depending on instrument sensitivity and interferences. Contracts will be established with analytical laboratories to analyze environmental samples collected during these investigations. Each contract laboratory that analyzes samples will provide quantification limits for each constituent analyzed. MDL goals for this project are specified in Tables 8.6, 8.7, 8.8, and 8.9.

Laboratory QA/QC will be drawn from supporting laboratory(s) Laboratory Quality Assurance Plan(s), which have been reviewed for consistency with ES/ER/TM-16. Tables 8.5, 8.6, 8.7, and 8.8 specify Level III and/or IV (Energy Systems Level C and/or D) analytical data quality and parameters to be followed for this project.

8.4 SAMPLE CUSTODY

COC procedures require documentation of sample possession from the time of collection to time of disposal. These procedures allow the possession and handling of samples to be traced from the time of collection through analysis and final disposal. COC will be maintained in accordance with ESP-500 methodologies.

A sample is in a person's custody if:

- it is in their possession;
- it remains in their view after having been in their physical possession;
- before being secured to prevent tampering, it was in their possession; or
- it is in an area designated as secure.

Samples will be accompanied by an original and a duplicate completed COC record. Should a sample be split, another copy will remain with the sample. As the samples are transferred, the present custodian and the new custodian will complete the required sections of the record as well as noting any discrepancies. This COC record will remain with the sample from the field, while being transported to the laboratory, and will be checked upon receipt at the laboratory. The laboratory will retain one copy of the form, and the original will be sent to the designated subcontractor personnel. This original will be routed to the CRF and used in the final analytical report.

Table 8.6. Proposed analytical parameters for CLP volatiles by EPA-CLP SOW OLM01.8

CLP volatiles ^a	CAS number	Project detection limit goal water $\mu\text{g/L}$	Project detection limit goal ^b low soil/sediment ^c $\mu\text{g/Kg}$
Chloromethane	74-87-3	10	10
Bromomethane	74-83-9	10	10
Vinyl Chloride	75-01-4	10	10
Chloroethane	75-00-3	10	10
Methylene Chloride	75-09-2	5	5
Acetone	67-64-1	10	10
Carbon Disulfide	75-15-0	5	5
1,1-Dichloroethene	75-35-4	5	5
1,1-Dichloroethane	75-34-3	5	5
1,2-Dichloroethene (total)	540-59-0	5	5
Chloroform	67-66-3	5	5
1,2-Dichloroethane	107-06-2	5	5
2-Butanone	78-93-3	10	10
1,1,1-Trichloroethane	71-55-6	5	5
Carbon Tetrachloride	56-23-5	5	5
Vinyl Acetate	108-05-4	10	10
Bromodichloromethane	75-27-4	5	5
1,2-Dichloropropane	78-87-5	5	5
cis-1,3-Dichloropropene	10061-01-5	5	5
Trichloroethene	79-01-6	5	5
Dibromochloromethane	124-48-1	5	5
1,1,2-Trichloroethane	79-00-5	5	5
Benzene	71-43-2		5
trans-1,3-Dichloropropene	10061-02-6	5	5
Bromoform	75-25-2	5	5
4-Methyl-2-pentanone	108-10-1	10	10
2-Hexanone	591-78-6	10	10
Tetrachlorethene	127-18-4	5	5

Table 8.6 (continued)

CLP volatiles ^a	CAS number	Project detection limit goal water $\mu\text{g/L}$	Project detection limit goal ^b low soil/sediment ^c $\mu\text{g/Kg}$
Toluene	108-88-3	5	5
1,1,2,2,-Tetrachloroethane	79-34-5	5	5
Chlorobenzene	108-90-7	5	5
Ethyl benzene	100-41-4	5	5
Styrene	100-42-5	5	5
Xylenes (Total)	1330-20-7	5	5

^aMedium soil/sediment Contract Required Quantitation Limits (CRQL) for volatile TCL compounds are 125 times the individual low soil/sediment CRQL.

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

^cEPA 1983, 1986.

Table 8.7. Proposed analytical parameters for PCBS by EPA-CLP SOW OLM 01.8

Analyte	CAS Number	Project detection limit goal ($\mu\text{g/L}$)	Project detection limit goal ($\mu\text{g/kg}$)^a
Aroclor-1016	12674-11-2	1.0	33.0
Aroclor-1221	11104-28-2	2.0	67.0
Aroclor-1232	11141-16-5	1.0	33.0
Aroclor-1242	53469-21-9	1.0	33.0
Aroclor-1248	12672-29-6	1.0	33.0
Aroclor-1254	11097-69-1	1.0	33.0
Aroclor-1260	11096-82-5	1.0	33.0

^aThe detection limit is on a wet-weight basis.

Table 8.8. Analytical methods constituents for UEFPC OU 3 TCLP determination

Volatile Organic Constituent	Analytical method
Benzene	SW846-8240
Carbon Tetrachloride	SW846-8240
Chlorobenzene	SW846-8240
Chloroform	SW846-8240
1,2-Dichloroethane	SW846-8240
1,1-Dichloroethylene	SW846-8240
Methyl Ethyl Ketone	SW846-8240
Tetrachloroethylene	SW846-8240
Trichloroethylene	SW846-8240
Vinyl Chloride	SW846-8240
Metal Constituents	Analytical Methods
Arsenic	SW846-6010
Barium	SW846-6010
Cadmium	SW846-6010
Chromium	SW846-6010
Lead	SW846-6010
Selenium	SW846-6010
Silver	SW846-6010
Mercury	SW846-7470

Table 8.9. Analytical methods for UEFPC OU 3 Distribution Coefficient (K_d) determination

Batch Extraction	
<u>Technical Resource Document: Batch-Type Procedures For Estimating Soil Adsorption of Chemicals. April 1992</u> EPA/530/SW-87/006-F	
Metal Constituent	Analytical Method
Arsenic	SW846-7060
Barium	SW846-6010
Cadmium	SW846-6010
Chromium	SW846-6010
Lead	SW846-6010
Selenium	SW846-7740
Silver	SW846-6010
Mercury	SW846-7470/7471

8.4.1 Field Custody Procedures

Sample custody will be initiated at the time of sample collection. Field samples will be identified by sample tags and appropriate labels. Descriptions of sampling activities and sample identification data will also be recorded in a field logbook. Field COC forms containing the same information will be completed for each set of samples. A line item on the sample COC form will be completed for each sample and the sampling technician will confirm by signature the completeness of the information on the form. Each individual who assumes responsibility for the samples will sign and date the COC form. Examples of a COC form, sample label, and sample tag are presented in Figs. 8.1 and 8.2.

Field custody procedures include the following steps: •

- Before sampling begins, the QA/QC Officer, or designee, will instruct sampling personnel on the COC and sample labeling procedures, as necessary.
- A COC record will be initiated in the field for each sample and correspond to the sample identification label.
- Each time sample custody is transferred, the person relinquishing the sample and the new custodian will sign the COC record and note the date and time.
- The analyses to be performed for each sample will be recorded on the COC record.
- The Field Team Leader will confirm that proper custody procedures are followed during the field work and that results were documented in the field logbook.
- Samples transferred to analytical laboratories will be recorded in the field logbook at the end of the collection period.

8.4.2 Shipping Custody Procedures

Sample custody will be maintained by personnel until custody is transferred to a common carrier/air freight company, if applicable. Shipments sent by common carrier/air freight will have a bill of lading/air bill accompanying them with the original COC record packed in the containers. These bills will be maintained as permanent records and the air bill number will be noted on the COC record. The common carrier/air freight company delivers samples and transfers custody to particular analytical laboratories, where their intra-laboratory COC procedures will be in effect.

NO 500833

[illegible]

Fig. 8.1 Example of Custody Form.

SAIC.

Sample No.: _____ Project No.: _____
 Location: _____ Station: _____
 Sample Media: _____
 Sample Type: _____
 Analysis: _____
 Preservative: _____ Volume: _____
 Rad Screen: _____ Units: _____
 Sample Date/Time: _____ / _____ . _____
 Comments: _____
 _____ Collector: _____

Sample No.: _____ Project No.: _____
 Location: _____ Station: _____
 Sample Media: _____
 Sample Type: _____
 Analysis: _____
 Preservative: _____ Volume: _____
 Rad Screen: _____ Units: _____
 Sample Date/Time: _____ / _____ . _____
 Comments: _____
 _____ Collector: _____

Fig. 8.2. Examples of sample tag and label.

8.4.3 Laboratory Custody Procedures

Upon receipt at the laboratory, each sample identification will be compared to the information contained on the COC record. If discrepancies exist, appropriate notes (signed and dated) will be made on the COC record and the Project Manager or designated person will be notified.

At receipt and initial inspection of samples and accompanying forms, the following items will be checked:

- Seals and tapes on the transportation container are unbroken.
- Sample containers in the transportation container are intact and at correct temperature.
- Potential external activity contamination is determined by direct radiation measurements and surface smears (removable activity).
- pH of preserved samples (except VOCs).
- Identification on the sample bottles corresponds to the entire description on the COC record.
- Number of sample containers received is equal to the number of samples listed on the COC record(s).

If there are discrepancies, the project manager or designee will be called immediately to rectify them. Discrepancies will be recorded on appropriate forms and incorrect information marked out with a single line, initialed, and correct information added.

Once samples are in the possession of the laboratory, their internal COC and sample handling procedures will be followed. If samples are to be shipped from one laboratory to another, proper COC and packaging procedures will be maintained. Anticipation of reanalysis requires proper preservation of samples following analysis. Samples requiring refrigeration will remain refrigerated.

8.4.4 Sample Labeling

Sample labels and tags will contain sufficient information to identify the sample in the absence of other documentation. The label and tag will be directly affixed to the sample container, will be completed with blue or black water resistant ink, and will include the following at a minimum:

- project name,
- unique sample number,

- sample location/station,
- sample media,
- analysis to be performed,
- sampling date and time,
- signature of individual collecting the sample, and
- preservation method.

In the event samples arrive damaged or custody seals are broken, an NCR (Sect. 8.11.2) will be initiated. The Project Manager will be advised and will make a decision as to the fate of the nonconforming sample(s) and initiate corrective actions. The laboratories will retain tags in project files.

8.4.5 Sample Seals

Sample seals are used to detect tampering of samples, following sample collection prior to the time of analysis. The seal will be attached in such a way that it is necessary to break the seal in order to open the sample container. Here, "sample containers" may refer to either individual sample containers or a shipping container such as an ice chest. Seals will be affixed to the containers before they leave the custody of the sampling personnel.

Sample seals will be waterproof paper or plastic with gummed backs. All samples designated for shipment which leave the sampler's custody will have a sample seal affixed.

8.5 CALIBRATION PROCEDURES AND FREQUENCY

All M&TE will be calibrated against certified equipment and/or standards having known valid traceability to nationally recognized standards. M&TE will be calibrated, adjusted, and maintained at prescribed intervals and/or before use. If no nationally recognized standards exist, the basis for calibration will be documented.

8.5.1 Field Instrument Calibration Procedures and Frequency

A list of all M&TE to be used, along with a schedule for calibration, will be prepared before initiating field work. Field instrumentation will be calibrated according to the procedures specified in the manufacturer's operating manual, or more frequently should the conditions dictate it, for the particular instrument. At a minimum, criteria identified in Table 8.10 will be implemented. Instrument logbooks or notebooks will be established and maintained by the cognizant field team members, Field Team Leader, or the Health & Safety Officer, as appropriate.

Table 8.10. Level I instrument uses, detection limits, and calibration

Instrument	Uses	Detection limits	Calibration	Comments
Total organic vapor meters	Sample screening for VOCs	PID - 0.2 ppm benzene	1 point - PID benzene daily	Action level must be stated in Work Plan
	Soil gas screen	FID - 1.0 ppm methane	1 point - FID methane daily	Cannot differentiate naturally occurring compounds from contaminants
Radiological Monitoring	Health and safety screen	Daily calibration	Verification check every 20 samples	PID cannot detect compounds with ionization potentials >11 eV
	Beta-gamma surface, gross gamma, alpha surface contamination levels	Daily calibration check varies by equipment	Daily source check per manufacturer	Validation labels include minimum and maximum acceptable levels
pH kits (litmus paper)	Field screening - water only	N/A	Check color response w/known pH standards of 4.0, 7.0, 10.0	Not to be used on samples to be submitted for analysis One-time check for each lot of kits
pH Meters	Field screening - water and soil	N/A	2 point with standards at pH 7.0 and 4.0, or pH 7.0 and 10.0 daily	Accuracy to ± 0.5 pH units
Conductivity meter	Determine conductivity of water	N/A	1 point in 0.01 m KCl solution	Calculations and acceptance criteria must be available in the field
Dissolved oxygen meter	Determine amount of dissolved oxygen in water	N/A	To manufacturer instructions	Calculations must be available in the field

PID = Photoionization detector FID = Flame ionization detector N/A = not applicable VOCs = volatile organic compounds

8.5.2 Laboratory Instrument Calibration Procedures and Frequency

Laboratory equipment will be calibrated according to the procedures specified in the analytical methods and in the operating manual for the particular instrument. Calibration frequency will be based on the analytical methods employed, type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience. In those cases where analyses are governed by EPA CLP protocols, the calibration frequencies and procedures as designated in the CLP RAS SOW will be followed. For laboratory equipment, Class A volumetric glassware will be used to prepare calibration standards, bench standards, samples for analysis, etc. Class A glassware may be purchased with known accuracy per American Society of Testing and Materials (ASTM) specifications.

It should be noted that other nonanalytical instrumentation (such as thermometers) must be properly maintained and calibrated. The temperatures of ovens and refrigerators used in sample handling will be recorded and the control limits will also be defined. If these limits are not met, corrective action will be required. All calibration and maintenance records will be kept with the equipment if practical. Otherwise, they will be maintained by the laboratory QA personnel.

8.5.3 Calibration Failures

Scheduled periodic calibration of equipment will not relieve personnel of the responsibility of employing properly functioning equipment. If an individual suspects an equipment malfunction, he/she should remove the device from service, initiate an NCR, tag it so it is not inadvertently used, and notify project management. If equipment is found to be out of calibration, the appropriate project management personnel will evaluate and document (in the instrument logbook) the validity of previous inspection or test results and the acceptability of similar equipment previously inspected or tested. The responsible supervisor will ensure the devices that are out of calibration are (1) tagged or segregated from other equipment and (2) disposed of or not used until they are calibrated. Any equipment that is consistently found to be out of calibration will be repaired or replaced. Any such action should be recorded in the instrument logbook or notebook.

All standards used for equipment calibration will be traceable to the EPA, National Institute of Standards and Technology (NIST), or a commercially available certified standard. The source of the standard used and the lot number of the calibration gas must be documented in a calibration logbook.

8.5.4 Calibration Records

Calibration data will be recorded in the instrument logbook or notebook. The information will include the date, operator, signature, and standard that was used. Records will be prepared and maintained for each piece of calibrated equipment to indicate that established calibration procedures have been followed. The appropriate project management personnel will ensure that records of calibration data are kept current. Records for field equipment used will be maintained by the Field Team Leader and the Health

& Safety Officer and kept in the project files. Records for laboratory equipment used will be maintained by the laboratory supervisor and kept in the project files.

8.6 PREVENTIVE MAINTENANCE PROCEDURES/SCHEDULES

Any equipment (an inclusive term for tools, gauges, instruments, and other items that have specific preventive maintenance) will be serviced and documented as specified by the manufacturer's recommended schedule. Should the equipment not have a specific maintenance schedule, the operator will develop one based upon previous working experience with the equipment and on other documented maintenance that may have been developed.

All service will be performed by qualified and trained individuals. The operators are responsible for seeing that the equipment is scheduled for service, serviced, and properly maintained. Properly maintained equipment helps reduce unnecessary "downtime."

If the laboratory or field preventive maintenance schedule is more frequent than that of the manufacturer, then the laboratory or field preventive maintenance procedure will take precedence. Preventive maintenance frequency will be documented in the maintenance procedures.

A complete list of critical spare parts will be developed by the operator and the parts will be immediately available (either from the supplier/manufacturer or on-site). Having critical spare parts available minimizes "downtime."

The implementation of a preventive maintenance program depends on the specific instruments and equipment used for the field and laboratory. Each field operation and laboratory will prepare a preventive maintenance program that includes the following:

- A listing of the instruments and equipment that are included in the program including backup alternatives.
- The frequency of maintenance considering manufacturer's recommendations and/or previous experience with equipment. The listing and maintenance frequency should be provided on a schedule. Frequency should be stated in terms of monthly, quarterly, etc.
- For each instrument in the program provide:
 - a list of spare parts maintained,
 - external service contracts,
 - items to be checked and/or serviced during maintenance, and
 - directions for performing maintenance (if external service is not provided, or if not stated in manufacturer's instrument manuals).

Preventive maintenance will be documented. A file will be maintained for each instrument. The instrument file should include, at a minimum:

- spare parts list;
- external service contracts;
- checklist of items to be serviced and directions for maintenance or manufacturer's instrument manuals;
- record of periodic maintenance; and
- comments noting any replacement of parts, observed deterioration, etc.

8.7 DATA REDUCTION, VERIFICATION/VALIDATION, AND REPORTING

Data verification/validation is a 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 verification/validation consists of data screening, checking, auditing, verification, flagging, certification, and review.

Data reduction, verification/validation, and reporting will be in accordance with the ERD QPP ES/ER/TM-4/R2 and ES/ER/TM-16. Data will be entered into common standardized formats. Table 8.11 depicts data set deliverables for Level IV QA. In addition to the following field and laboratory documentation and QA/QC procedures, data may be verified using a variety of computerized checks for reasonableness. These procedures will ensure that data are entered, encoded, manipulated in a consistent way, and available in a usable format.

8.7.1 Field Data Reduction and Evaluation

Data collected during field activities will be evaluated by checking the procedures used and comparing the data to previous measurements. The QA/QC Officer and appropriate field personnel will be responsible for checking field QC sample results to ensure that field measurement and sampling protocols have been observed. These reviews will check date and time sampled, preservation, SOPs, calibration method and frequency, and COC documentation.

Reviewers are responsible for ensuring that data reduction calculations are documented and checked by qualified personnel. Written reports including reduced and summarized data may include the raw data in appendices. Specific calculations used for data reduction may also be included.

Table 8.11. Level IV deliverables

Method Requirements	Deliverables
Requirements for all methods:	
- Holding time information and methods requested	Signed chain-of-custody forms
- Discussion of laboratory analysis, including any laboratory problems	Case narratives
- LCS with results on control charts (run with each batch of samples processed)	Control charts
Organics: GC/MS analysis	
- Sample results, including TICs	CLP Form 1 or equivalent
- Surrogate recoveries	CLP Form 2 or equivalent
- Matrix spike/spike duplicate data	CLP Form 3 or equivalent
- Method blank data	CLP Form 4 or equivalent
- GC/MS tune	CLP Form 5 or equivalent
- GC/MS initial calibration data	CLP Form 6 or equivalent
- GC/MS continuing calibration data	CLP Form 7 or equivalent
- GC/MS internal standard area data	CLP Form 8 or equivalent
- Complete raw data	All chromatograms, preparation logs, run logs, calculations, etc.
Organics: GC analysis	
- Sample results	CLP Form 1 or equivalent
- Surrogate recoveries	CLP Form 2 or equivalent
- Matrix spike/spike duplicate data	CLP Form 3 or equivalent
- Method blank data	CLP Form 4 or equivalent
- Initial calibration data	CLP Form 6 or equivalent
- If calibration factors are used	A form listing each analyte, the concentration of each standard, the relative calibration factor, the mean calibration factor, and the %RSD
- Calibration curve if used	Calibration curve and correlation coefficient
- Continuing calibration data	CLP Form 9 or equivalent
- Positive identification (second column confirmation)	CLP Form 10 or equivalent
- Complete raw data	All chromatograms, preparation logs, run logs, calculations, etc.

Table 8.11 (continued)

Method Requirements	Deliverables
Metals	
- Sample results	CLP Form 1 or equivalent
- Initial and continuing calibration	CLP Form 2 or equivalent, dates of analyses and calibration curve, and the correlation coefficient factor
- Method blank	CLP Form 3 or equivalent and dates of analyses
- ICP interference check sample	CLP Form 4 or equivalent and dates of analyses
- Spike sample recovery	CLP Form 5A or equivalent
- Postdigestion spike sample recovery for ICP metals	CLP Form 5B or equivalent
- Postdigestion spike for GFAA	CLP Form 5B or equivalent
- Duplicates	CLP Form 6 or equivalent
- LCS	CLP Form 7 or equivalent
- Standard additions (when implemented)	CLP Form 8 or equivalent
- Holding times	CLP Form 13 or equivalent
- Run log	CLP Form 14 or equivalent
- Complete Raw Data	All preparation logs, run logs, instrument output, calculations, etc.
Wet Chemistry	
- Sample results	Report result
- Matrix spike recovery	%Recovery
- Matrix spike duplicate or duplicate	%Recovery and %RPD
- Method blank	Report results
- Initial calibration	Calibration curve and correlation coefficient
- Continuing calibration check	Recovery and % difference
- LCS	LCS result and control criteria
- Run log	Copy of run log
- Complete raw data	All preparation logs, run logs, instrument output, calculations, etc.

Table 8.11 (continued)

Method Requirements	Deliverables
Radiochemical Analysis	
- Sample results	Report results
- Initial calibration	Efficiency determination
- Efficiency check	% Difference from calibration
- Background determinations	Report results
- Minimum detectable activity (MDA)	Report results
- Method blank	Report results
- Spike recovery results	Spike added and %Recovery
- Internal standard results (tracers or carriers)	Standard added and %Recovery
- Duplicate results	Report results and %RPD
- Self Absorption Factors (α, β)	Report factors
- Cross-talk factors (α, β)	Report factors and control criteria
- LCS	LCS result and control criteria
- Run log	Copy of run log
- Complete raw data	All preparation logs, run logs, instrument output, calculations, etc.

CLP = contract laboratory program
 GC = gas chromatography
 GFAA = graphite furnace atomic absorption
 ICP = inductively coupled plasma emission
 LCS = laboratory control standard
 MS = mass spectrometry
 PCB = polychlorinated biphenyl
 RPD = relative percent difference
 RSD = relative standard deviation
 TIC = tentatively identified compound

The data reduction, validation, and reporting requirements are different for each type of data. The types of data include:

- descriptions of soil cores;
- monitoring and background data taken with screening instruments during sample collection activities;
- surveyed locations of data collection points; and
- maps of the areas under investigation.

8.7.2 Analytical Laboratory Data Reduction and Evaluation

The data reduction will follow guidelines of the EPA Contract Laboratory Program Statement of Work (EPA 1990b, 1990c) and the *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (EPA 1986). Generally, results must be expressed to two significant figures. Results of aqueous samples must be expressed in milligrams per liter or micrograms per liter, and results of nonaqueous samples must be expressed on a dry-weight basis in milligrams per kilogram, micrograms per kilogram, or micrograms per gram. The moisture content of samples must also be reported.

8.7.2.1 Sample receiving

Samples will be examined immediately upon receipt by the laboratory, to determine damage or loss during transport. Any problems discovered will be noted on the COC form or a sample receiving report; otherwise the COC form will be stamped "RECEIVED IN GOOD CONDITION." The sample condition will be indicated on a sample receiving report (SRR). The laboratory will record on the SRR the temperature of a single sample within the cooler upon receipt. If samples are damaged or otherwise compromised, the laboratory will immediately notify the subcontractor Quality Assurance Officer (QAO) by telephone. The QAO will notify appropriate ER personnel. The samples will be logged into the laboratory and maintained at appropriate temperatures (4°C for water samples and 4°C for soil and sediment samples) until submitted for analyses. After the appropriate laboratory information and required signatures have been added to the chain-of-custody and SRR forms, the laboratory will return signed copies to the subcontract's Project Manager and the subcontractor's QAO within 3 days. In addition, a laboratory-generated report including the field-designated sample number, laboratory sample number, temperature of a sample in each cooler upon receipt, and analyses to be performed must be provided with the chain-of-custody documentation.

8.7.2.2 Data reduction

In general, the analyst will process the data, either manually or by inputting the data into a computer.

All computerized programs used to reduce and analyze data should be in compliance with software QC (Energy Systems 1992c) and appropriate Energy Systems procedures. For manually processed data, all the steps in the computation must be provided, including equations used and the source of input parameters such as response factors, dilution factors, and calibration constants. If calculations are not performed directly on the data sheet or chromatogram, the calculations must be provided on company letterhead paper and attached to the data sheets. All pages of the calculations must be signed and dated by the analyst performing the calculations.

For data input by an analyst and processed using a computer, a copy of the input must be kept and uniquely identified with the project number and other pertinent information as necessary. The samples to which the data processing refers must be clearly stated, and the input must be signed and dated by the analyst performing the input.

When processing data acquired from instrumentation, the analyst must verify that the correct project, sample numbers, calibration constants, response factors, units, and numerical values used for detection limits are present.

Upon completion of required chemical analyses, the samples will be maintained at a temperature of 4°C for at least 2 weeks after expiration of the appropriate holding time. The laboratory will be responsible for disposal of all laboratory generated wastes. Upon written notification from the subcontractor's Project Manager at the close of the project, the laboratory will return unused sample portions to the project unless other arrangements have been made with the laboratory.

8.7.2.3 Data review

Once processed, data will be reviewed by the laboratory prior to delivery of the data package. This will review all data for the following:

- appropriateness of equations used;
- correctness of numerical input;
- numerical correctness of all calculations (this should be done by re-performing numerical calculations);
- correct interpretation of strip charts;
- traceability of samples from receipt to data reporting by the chain-of-custody and forms unique sample numbers;
- comparability of initial and continuing calibration results to method calibration criteria; if calibration criteria are not met, the affected samples must be reanalyzed;

- evaluation of matrix spike/matrix spike duplicate results for organics or matrix spike and duplicate results for inorganics;
- evaluation of method blank results;
- evaluation of surrogate recoveries; and
- evaluation of data report completeness and legibility.

8.7.2.4 Data reporting and deliverables

The format and content of the data reports for this project are included in Table 8.11.

The laboratory will deliver a complete data package and diskette consistent with QC requirements specified in the methods.

All laboratory QC sample analyses (e.g., method blanks, spikes, etc.) will be cross-referenced to the applicable environmental and field sample analyses.

All results will be reported on a dry-weight basis for soils, sediments, and sludges. The moisture percentage will be reported for all solid samples.

Routine analytical service turnaround, including QA documentation will be 30 days for CLP organic analyses (7 additional days for complete data package deliverable), and 30 days for CLP inorganic and non-CLP analyses (7 additional days for complete data package deliverables), beginning the day of sample receipt at the laboratory and ending the day of data package receipt at the data management subcontractor's office. Dates of receipt and shipment will be documented by the laboratory. Failure to meet the specified turnaround time for reporting due to circumstances within the laboratory's control may result in penalties. All analytical results will be reported following the significant figure policy outlined by current EPA CLP guidelines.

For all requested CLP analyses, the subcontract laboratory will provide completed reporting forms and other deliverables as specified in "Reporting and Deliverables Requirements" (EPA 1990b, 1990c) and those described in any future CLP statements of work. In addition, the laboratory will provide electronic data as specified in "Data Dictionary and Format for Data Deliverables in Computer-Reliable Format" (EPA 1990b).

All paper-copy reports will be certified by the laboratory QAO and must be signed and dated, stating that verification was performed. The laboratory QAO must also sign a certification that the electronic data are identical to that shown on the paper copy. Both the electronic data and the paper copy will be transmitted to the subcontractor using document control procedures (for example, transmittal and receipt forms). Prior to receipt of the first samples, a standard operating procedure will be developed by the

laboratory and approved by the subcontractor with concurrence by the ER QAS, to ensure that electronic and paper copies are identical and describe document revision procedures once the deliverables are sent to the subcontractor for inclusion in the ER Program data base. The following statement, signed by the Laboratory QAO, will be included with the report narrative:

The laboratory certifies that all methods and performance criteria used were those described in the applicable Statement of Work and QAPjP developed for this project. Furthermore, all data outside the project performance criteria have been reviewed, qualified, and identified in the case narrative. The laboratory also certifies that the diskette deliverables (electronic data transmissions) submitted with each written data package are exact copies of the data submitted on paper and no discrepancies exist between the two.

If any discrepancies exist between the written data package and the diskette, the laboratory will correct all deficiencies immediately, and at its own expense.

For requested non-CLP analyses, the laboratory will provide reports of analyses on forms supplied by the ER Program's subcontractor and in electronic format on diskettes. Supporting QC data for these analyses will be reported on forms supplied by the ER Program's subcontractor for QC analyses. These QC data will include all data required by this QAPjP.

Documentation will be included with all results to associate the field sample number and the laboratory sample number to the specific analyses performed for each of these sample identification number combinations. For each reported value, the laboratory will include in the data package all raw data used to obtain that value. This applies to all required supporting QC data, instrument standardization, and sample analysis reports.

The laboratory will provide a status report on each project on the twentieth of each month for the preceding month's activity. This status report may be in the form of an electronic spreadsheet and must contain the status of each sample received. This report will include for each sample the field sample identification number, the laboratory sample identification number, and the status of the sample as of the date of the monthly status report. The report will include a dated cover sheet that explains the contents of the columnar format of the report.

Standardized formats for the manual and electronic transfer from the analytical laboratory to the data generator of results and associated QA/QC information will be established prior to submission of analytical results. Audits and surveillances conducted before the contract for this work is awarded will ensure compliance with sample handling and analytical results reporting. Any problems encountered will be handled through nonconformance reporting.

8.7.3 Data Validation

Data validation is a 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, certification, and review (EPA 1990b, 1990c). Data validation will be conducted by the environmental contractor, not the subcontracted analytical laboratory.

All data for this project will be evaluated by QA/QC methods and internal peer review. Data reduction, verification, and reporting will be in accordance with the ER Program activities. Data will be entered into common standardized formats. Written reports that include reduced and summarized data will also include the raw data in appendixes. Specific calculations used for data reduction will also be included. Reviewers are responsible for ensuring that data reduction calculations are documented and checked by qualified personnel.

8.7.3.1 General requirements

All data packages received from the analytical laboratory will be reviewed and verified using EPA CLP Contract Compliance Screening software (or equivalent checklists for non-CLP methods). All data packages received from the analytical laboratory will then be validated using Computer Assisted Validation and Evaluation Assessment Tool software (which follows EPA's Functional Guidelines for Data Validation). The output (checklist or exception reports) from both the data verification and data validation steps will be reviewed and evaluated by the data validators. Final data usability flags based on the data validation process will be appended to each analytical result and stored in the Environmental Information Management System. These processes will be conducted by the environmental contractor, not the subcontracted analytical laboratory.

This constitutes 100% Level III validation or review of holding times, matrix spikes and matrix spike duplicates, blanks, field duplicates, and QC samples. Comprehensive Level IV validation will be performed on 10% of all sample delivery groups for this project. Chemical data will be validated according to the procedures outlined in the *Requirements for Quality Control of Analytical Data* (Energy Systems 1992c); radiological data will be validated according to SAIC Radiation Validation Procedures and those summarized in Sects. 8.6.3.1 through 8.6.3.2. In the event difficulties are discovered in the 10% Level IV validation, all sample delivery groups will be reviewed for the difficulties observed.

8.7.3.2 Gross alpha and gross beta validation guidelines

Holding Times. Currently there are no holding times associated with radionuclide analyses.

Calibration. A beta standard must be counted at the outset of each day's operation. The resulting counts must be $\pm 10\%$ of the predicted value; if not, the results must be qualified as estimated (J).

Background. A background count must be made that includes at least a portion of the 24 h preceding the use of the instrument on each day. The effects of background on the analysis of the sample should be qualified according to the following guidelines:

Background count for emitters (cpm)	Data qualification
alpha, > 1.0	unusable (R)
alpha, > 0.5	estimated (J)
beta, > 2.0	unusable (R)
beta, > 1.5	estimated (J)

8.7.3.3 Alpha spectroscopy validation guidelines

Holding Times. Currently there are no holding times associated with radionuclide analyses.

Calibration. An internal spike must be added for each sample run. If the count for the spike recovery is not at least 20%, the data must be qualified as estimated (J). If the count for the spike recovery is less than 10%, the data must be qualified as unusable (R).

Background. A background count must have been conducted within the last 45 days. If the count rate for any of the peaks of interest exceeds 0.5 cpm, the data must be qualified as unusable (R). If the count rate for any of the peaks of interest exceeds 0.1 cpm, the data must be qualified as estimated (J).

Alpha Sources. If the sum of the alpha activities exceeds the gross alpha activity for the same sample, the data must be rechecked and noted in the narrative; professional judgment must be used to determine which data qualifiers are needed.

8.7.3.4 Beta counting validation guidelines

Holding Times. Currently there are no holding times associated with radionuclide analyses.

Calibration and Background. Calibration and background counts are conducted on the same instrument using the same counting device as the gross beta counts. The calibration and background counts must have been conducted for that day and must follow the validation instructions in Sect. 8.6.3.2.

Carrier Recoveries. If the carrier recovery is less than 15% of the amount added in preparation, the data must be qualified as estimated (J). If the carrier recovery is less than 10% of the amount added in preparation, the data must be qualified as unusable (R).

Beta Sources. If the sum of the beta activities exceeds the gross beta activity for the same sample, the data must be rechecked and noted in the narrative; professional judgment must be used to determine which data qualifiers are needed.

8.7.3.5 Gamma spectroscopy

Holding Times. Currently there are no holding times associated with radionuclide analyses.

Calibration. A standard must have been counted for at least 10 min each day prior to the start of that day's analyses. If the counts exceed 8% of the predicted value, the data must be qualified as estimated (J). If the counts exceed 20% of the predicted value, the data must be qualified as unusable (R).

Efficiency Curves. An efficiency curve must have used the appropriate sample geometry.

Background. A background count must have been run within the last 3 months.

8.7.4 Data Evaluation

Field and analytical result measurements at or below the detection limits will be clearly identified in the data base with a data qualifier flag. The number of significant figures reported for raw data will reflect the true precision of the measurement technique. The distribution of the site characterization data will be tested for normality. Data values determined to be potential outliers will be corrected only if the cause of the problem can be documented. Data precision will be determined by examining field duplicate and analytical duplicate (or split) results. Data accuracy will be determined by examining matrix spike, surrogate, and interval standard results. Data representativeness will be determined by evaluating field blank, trip blank, equipment rinsate blank, and analytical laboratory blank results. Data completeness will be determined by comparing the final number of validated sample results obtained in the investigation to the number of samples required by the DQOs stated in this SAP. These evaluation processes will be conducted by the environmental contractor.

8.8 FIELD AND LAB QC

8.8.1 Field QC Checks

The number of required QC samples per site is based on a set minimum percentage. The number of QC samples to be collected may change from site to site; however, the types of field QC samples remain constant. The types of QC samples are trip blanks, equipment rinsates, field blanks, and field duplicates.

In defining the number of field blanks required, it is important to note that a sampling event is from the time sampling personnel arrive at the site until personnel leave for more than 24 h. For example, sampling personnel go to a site for 10 days, conduct soil borings, and install groundwater wells. During

this visit, soil and water samples are collected. The crew leaves the site for 2 months and later returns to collect another set of groundwater samples over a 3-day period. Two sampling events have occurred; a 10-day event and a 3-day event.

Blanks (trip blanks, equipment rinsates, and field blanks) and field duplicates are defined in the following sections.

8.8.1.1 Trip blanks

Trip blanks are used to detect contamination by VOCs during sample shipping and handling. Trip blanks are 40-ml VOA vials of ASTM Type II water that are generally filled in the laboratory, transported to the sampling site, and returned to the laboratory with VOA samples. Trip blanks are not to be opened in the field. One trip blank is to accompany each cooler containing VOA samples. Each trip blank is to be stored at the laboratory with associated samples and analyzed with those samples. Trip blanks are only analyzed for VOCs. Trip blanks are also sent with soil samples; however, because the blanks cannot be analyzed by soil methods, they are analyzed and reported as water samples.

8.8.1.2 Equipment rinsates

Equipment rinsates are samples of ASTM Type II water passed through decontaminated sampling equipment. They are used as a measure of decontamination process effectiveness. Equipment rinsates will be collected at a rate of 5 percent of the samples collected per matrix per event (i.e., 1 to 20 samples collected equals 1 equipment rinsate; 21 to 40 samples collected equals 2 equipment rinsates). Matrices for this purpose are considered to be soils, sediments, groundwater, and surface water. If more than one type of equipment is used to obtain samples for a particular matrix, a rinsate blank must be collected from each type of equipment. For example, if groundwater samples are collected by both bailer and pump, a rinsate blank will be submitted for each (one bailer and one pump). Equipment rinsates are analyzed for the same analytes as the associated samples. Equipment rinsates are reported as water samples.

Representative numbers of equipment rinsate samples will be sent to the analytical laboratory. The laboratory will receive equipment rinsates in proportion to the number of routine samples received. Log books should note the equipment for which the rinsate was taken.

8.8.1.3 Field blanks

Field blanks are samples of source water used for decontamination and steam cleaning. At a minimum, one sample for each source of water for a given event will be collected for analysis. Normally, this will be two field blanks per event: a sample of the potable water used for steam cleaning and a sample of the ASTM Type II water used for decontamination. If more than one lot number of ASTM Type II water is used or if potable water is taken from more than one location, additional field blanks will be taken since these constitute different sources.

For subsurface soil sampling, at least one set of field blanks will be collected for every five borings completed. This may, in some instances, result in more than one field blank per water source per event.

8.8.1.4 Field duplicates

Co-located field duplicates will be obtained by longitudinal dissection of the core section. VOC samples will be collected from identical depth locations from each half of the core section. The remaining material from each half will be independently homogenized, packaged, and shipped for analysis. Field duplicates for water samples will be collected at the same time. Duplicates will be sent to the laboratory responsible for analyses.

Field duplicates will be collected at a frequency of 5 percent of the samples collected per matrix per event (i.e., 1 to 20 samples collected equals 1 field duplicate; 21 to 40 samples collected equals 2 field duplicates). A matrix constitutes soil, sediment, groundwater, or surface water from a given site. Samples submitted for VOC analyses are not to be homogenized or split. Soil samples for VOC analyses must be sealed immediately and shipped to the laboratory.

8.8.2 Laboratory Quality Control

To ensure data quality, laboratory quality control samples, data review, and data validation are used to measure the quality of the sampling and analysis process. A quality control operation or component is only useful if it can be measured or documented. The following components of analytical QC are related to the analytical batch, or those samples that are analyzed together with the same method sequence, the same lots of reagents, and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch should be of similar composition. All QC data and records required by this section will be reported as part of the data deliverables package. These procedures will be performed at least once with each analytical batch with a minimum of one per 20 samples.

The types of laboratory QC samples are method blanks, LCSs (blank spikes), matrix spikes (MSs), matrix spike duplicates (MSDs), and duplicates. These samples are defined in the following sections. More detailed ER Division requirements are found in *Requirements for Quality Control of Analytical Data for the Environmental Restoration Program* (Energy Systems 1992c).

8.8.2.1 Method blank

Method blanks are used to determine the existence and magnitude of possible contamination encountered during sample preparation and analysis. They consist of ASTM Type II water for water samples and clean sand or soil for soil samples. They are carried through the entire analytical procedure with the samples. At least one method blank must be prepared with each batch of samples. A batch cannot exceed 20 samples, and is determined by the number of samples of similar matrix that can be

processed simultaneously through the entire preparation process. Analysis is performed for the same analytes as those associated with the respective environmental samples.

8.8.2.2 MS and MSDs

An MS is an aliquot of a sample spiked with known quantities of compounds and subjected to the entire analytical procedure. It is used to indicate the appropriateness of the method for the matrix by measuring recovery or accuracy. Accuracy is the nearness of a result or the mean of a set of results to the true or accepted value. An MSD is a second aliquot of the same sample as the MS with known quantities of compounds added. The purpose of the MSD, when compared to the MS, is to determine method precision. Precision is the measure of the reproducibility of a set of replicate results among themselves or the agreement among repeat observations made under the same conditions. MSs and MSDs will be performed per 20 samples of similar matrix.

8.8.2.3 Duplicate samples

Duplicate samples are identical splits of individual samples that are analyzed by the laboratory to test for method reproducibility or precision. These samples are split in the laboratory during sample preparation. Duplicates are used mainly for inorganic analysis, while MSDs are used in organics. Duplicates will be performed per 20 samples of similar matrix.

8.8.2.4 Laboratory control sample program requirements

The laboratory will employ an LCS program that monitors sample preparation and analysis. The LCS program is monitored through the use of control charts. The purpose of this program is to demonstrate that the laboratory process for sample preparation and analysis is in control. The LCS program is required for all ER Waste Management projects.

An LCS is a laboratory blank with a known amount of analyte(s) added or a commercially available standard consisting of known analyte concentrations representative of the contaminants to be determined. Analytes selected for spiking should be representative of the compound class. It is suggested that:

- For VOCs and SVOCs the method blank surrogate standards can be used as the LCS. All surrogates in the method blank must be monitored on control charts.
- For pesticides, at least two target compounds are added to a blank other than the method blank. These compounds are monitored on control charts.
- For PCBs, at least one target Aroclor is added to a blank other than the method blank. The compound is monitored on a control chart. If pesticides and PCBs are both being determined, it is recommended that a single LCS with both pesticide and PCB spikes be used.
- For metals determined by ICP, an LCS must be monitored by means of control charts for at least three metals.

- For metals determined by atomic absorption [GFAA, furnace atomic absorption (FAA), and cold-vapor atomic absorption (CVAA)], an LCS must be monitored by means of a control chart for each element.
- For wet chemical and radiochemical methods, an appropriate LCS for each method must be used (e.g., for cyanide, a control standard of sodium cyanide from a source other than that used for calibration may be spiked into water and analyzed with the water samples). The value for the control is monitored on the control chart.

It is recommended that two types of matrix blanks be employed. One type of matrix is the laboratory blank water. The second type of matrix is a laboratory soil or blank sand. This soil can be pulverized and homogenized. If the soil used is known to contain some analytes of interest, no spiking may be required. The LCS matrix should be comparable to the sample matrix (i.e., analyze water control samples when water samples are analyzed).

In the LCS, problems encountered with matrix effects and sample nonhomogeneity will be minimized through the use of blank water and well characterized soil. This information, used in conjunction with sample MS recoveries, can aid in determining whether an out-of-control condition is due to laboratory problems or matrix problems.

8.8.2.5 Cleanups

QC procedures performed by the laboratory will include documentation of sample and sample extract cleanup processes. All batches of adsorbents prepared for use will be checked for analyte recovery, elution pattern, and performance characteristics with appropriate standards. The elution pattern will be optimized for maximum recovery of analytes and maximum rejection of contaminants.

The elution pattern will be reconfirmed with a column check of standard compounds after activating or deactivating a batch of adsorbents. These compounds will be representative of each elution fraction. Recovery as specified in the methods is considered an acceptable column check. A result lower than specified indicates that the procedure is not acceptable or has been misapplied. The check blank will be run after activating or deactivating a batch of adsorbent.

8.8.2.6 Instrument calibration, tuning, and alignment

Calibration requirements and procedures are instrument- and method-specific. Analytical instruments will be tuned and aligned in accordance with requirements specific to the instrumentation procedures employed. Individual determinative procedures will be followed. Criteria for initial conditions and for continuing confirmation conditions for methods are found in the appropriate procedures. Analytical instrumentation will be calibrated in accordance with requirements specific to the instrumentation and procedures employed.

8.9 DATA MEASUREMENT ASSESSMENT PROCEDURES

The analytical data assessment objectives for laboratory analysis will produce data of known and sufficient quality to support the investigation and its resulting decisions. This section defines the goals for precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters for measurement data. Appropriate procedures and quality control checks will be employed to assess the level of acceptance of these parameters. All QC data will be reported to the project along with the sample results, when the analytical sample set is completed. QC data generated will be reviewed and evaluated to validate the information. Acceptance criteria and statistical evaluation of laboratory analytical results for the PARCC parameters will be determined according to the following outline.

8.9.1 Precision

Precision will be assessed by conducting separate analyses of duplicate samples. Analytical precision is expressed as the percentage of the difference between results of duplicate samples for a given compound or element. RPD is calculated as:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100\%$$

where

C_1 = concentration of the compound or element in a sample,

C_2 = concentration of the compound or element in the duplicate.

Precision is determined using matrix spike/matrix spike duplicate analyses conducted on samples collected. The laboratory will select one sample in 20 to split into three aliquots. The first aliquot will be analyzed routinely for the parameters of interest, while the other two aliquots will be spiked with known quantities of the parameters of interest before analysis. The RPD between the two spike results will be calculated and used as an indication of the precision of the analyses performed.

When the analyte of interest provides a measurable quantity these precision determinations can be obtained through duplicate analysis comparisons.

Analytical precision goals for the proposed radiochemical, metal, and other inorganic parameters will be ≤ 20 RPD. Goals for analytical precision for organic parameters will be those identified in the analytical methods for specific analytes. In general these range up to 25 RPD (volatile organics) and 50 RPD (semivolatile organics) in soils. In the event analytical precision goals are exceeded, a determination will be made through the data validation process relative to the usability of that information.

8.9.2 Accuracy

Accuracy will be assessed by splitting a sample into two portions, spiking (i.e., adding known quantity of the constituents of interest to one of the portions), and then analyzing both portions for these parameters. The difference in the concentration levels of the constituents of interest should be equal to the quantity of the spike added to one of the two portions. The %R is calculated as follows:

$$\% R = \frac{A_s - A_o}{A_f} \times 100\%$$

where

A_s = total compound or element concentration detected in the spiked sample,

A_o = concentration of the compound or element detected in the unspiked sample,

A_f = concentration of the compound or element added to the sample.

One hundred percent recovery is equivalent to 100% accuracy. Values < 100% may indicate a sample matrix effect and a false reading. A periodic program of sample spiking is required, e.g., 1 MS and 1 MSD per 20 samples.

The proposed radiochemical, metal, and other inorganic accuracy goals for this investigation will be 80 to 120 percent as expressed in recovery of known analytical spikes into the sample media. Analytical accuracy goals for organic parameters will be those identified in the CLP analytical methods for specific analytes.

In general volatile organic spike recoveries range between 60% and 150% in soils, while semivolatile organic spike recoveries range between 20% and 140%. In the event analytical accuracy goals are exceeded, a determination will be made through the data validation process relative to the usability of that information.

8.9.3 Representativeness

Representativeness expresses the relative degree to which the data depict the characteristics of a population, parameter, sampling point, process condition, or environmental condition. The objective of this study is to accurately represent the chemical concentrations of target analytes.

Representative samples for this investigation will be acquired through implementation of approved sampling and analytical procedures that will generate data representative of the sampling point location. Sampling procedures are designed to minimally impact the sample obtained, so that conditions representative of the sampling location will be maintained. Analytical methods are selected that will most

accurately represent the true concentration of the parameter of interest. The accumulation of quality control procedures and information (i.e., RPD values, blank QC concentrations, matrix spike percent recoveries, etc.) employed for a given analysis combine to exhibit the representativeness of the data generated.

The goal for representative sample data will therefore be met through the proper documentation of field and analytical protocols. In the event these procedures and methods are not able to be implemented, the appropriate corrective action documentation should encompass the impact on the representativeness of the information. When review of the data and documentation determines the data to be nonrepresentative, the information will be qualified in its use or will not be used by the project.

8.9.4 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability of the data produced for this investigation will be obtained through the implementation of the identified protocols for sampling and analysis of samples. Implementation of traceable reference materials as laboratory standards, expression of results in standard concentration units, and successful participation by the laboratories in external performance evaluation programs will enable the information produced through this investigation to be compared with future data sets, if required. Internally to this investigation, implementation of the defined protocols and methods will establish the comparability of the "background" sample information to that of the sample data along the pipeline.

8.9.5 Completeness

Completeness is a measure of the amount of data obtained from a measurement process that achieves the project goals, compared to the amount of data planned to be obtained by the project. Completeness is affected by unexpected conditions, during the data collection process, that reduce the usable data achieved relative to the data planned.

The following will be three measures of completeness determined for the (UEFPC OU 3) Project.

Sample Collection:

$$\text{Completeness} = \frac{\text{Number of Sample Points Sampled}}{\text{Number of Sample Points Planned}} \times 100\%$$

Field Measurements:

$$\text{Completeness} = \frac{\text{Number of Valid Measurements Made}}{\text{Number of Measurements Planned}} \times 100\%$$

Laboratory Analysis:

$$\text{Completeness} = \frac{\text{Number of Valid Data Points}}{\text{Number of Data Points Planned}} \times 100\%$$

Completeness goals established for this project for sample collection and field measurements are 95%. If this goal is not met, the necessity for re-sampling will be determined on a case-by-case basis. The completeness goal for laboratory analysis for this project is 90% overall. For the critical data points, which consist of the background sample locations, the completeness goal for sample collection, field measurements, and laboratory analysis is 100%. When review of the data and documentation determines the data to be incomplete, the impact relative to the project objectives will be assessed and documented.

To complete the intent of this project, all data will be validated versus the content of a Level III analytical data deliverable, with a minimum of 10% of the data validation being completed at Level IV, to determine its usability. For determination of completeness in this project, all data flagged as estimated by the validation process, will be considered valid.

8.9.6 Sensitivity

Procedures to attain sensitivity objectives include (1) uniform training and certification for staff; (2) standard provisions for inspection, maintenance, and repair; (3) provision of SOPs to technical staff, (4) reference of SOPs in the Sampling and Analysis Plan; and (5) field inspections by the QAS to determine compliance with the items specified in the support plans.

The goals for sensitivity are expressed as detection limit goals as defined in Tables 8.6, 8.7, 8.8, and 8.9 for each analyte of interest.

8.10 AUDITS AND SURVEILLANCE

Audits are performed to review and evaluate the adequacy of field and laboratory performance and to ascertain whether the QA/QC Plan is being completely and uniformly implemented. The following requirements are adapted from Basic Requirement 18, Audits, of *ANSI/ASME NQA-1*, (1986); SAIC audit procedures; *Quality Control Requirements for Field Methods*, (DOE 1990); *Requirements for Quality Control of Analytical Data for the Environmental Restoration Program*, (Energy Systems 1992c); and *Environmental Restoration Quality Program Plan* (Energy Systems 1992b). Planned and scheduled audits will be performed to verify compliance with all aspects of the QA program and to determine the program's effectiveness. These audits will be conducted in accordance with written procedures and checklists and will be performed by personnel who do not have direct responsibility for performing the activities being audited. Audit results will be documented and reported to and reviewed by responsible management. Follow-up action will be taken by the responsible line organization when necessary.

The objectives of performance and systems audits are:

- to ensure that the QA program developed for this project is being implemented according to the specified requirements,
- to assess the effectiveness of the QA program,
- to identify nonconformances/variances, and
- to verify that identified deficiencies are corrected.

Upon discovery of any significant deviation from the QA program, the Project Manager will be informed of the nature, extent, and corrective action taken to remedy the deviation.

An individual audit plan will be developed by the QA/QC Officer or his/her designee to provide a basis for each audit. This plan will identify the audit scope, the activities to be audited, the audit personnel, any applicable documents, and the audit schedule. Records of audits will be maintained in the Project Files. Audit files will include, at a minimum, the audit report, the reply to audit, and any supporting documents. It is the responsibility of the Project Manager to conform to audit procedures, particularly as to timely replies to audit reports and implementation of the corrective action indicated.

8.10.1 Frequency Of Audits

The QA/QC Officer is responsible for internal audits and will perform them according to a schedule that coincides with appropriate activities on the project schedule and sampling plans. Such scheduled audits may be supplemented by additional audits for one or more of the following reasons:

- when significant changes are made in the QA/QC Plan,
- when it is necessary to verify that corrective action has been taken on a nonconformance reported in a previous audit, or
- when requested by the Project Manager.

In addition to these internal audits, surveillance of selected activities may be performed on a periodic basis.

8.10.2 Systems Audits

A systems audit consists of an evaluation to determine if the components of a measurement system were properly selected and if they are being used correctly. A systems audit includes a careful evaluation of field and laboratory QC procedures to ensure that the QA/QC procedures are being adhered to. Systems audits are conducted as deemed necessary by the QA/QC Officer or a designee, normally before or shortly after systems are operational. The systems audit is reported in formal audit reports.

8.10.3 Performance Audits

A performance audit can be defined as a review of the existing project and QC data to determine the accuracy of a total measurement system(s) or a component of the system. The auditor(s) will check the logging of the samples, proper COC, and related documentation. The analysis of laboratory performance evaluation samples and the participation in scheduled inter-laboratory studies may be included as part of the performance audit. Laboratory audits are further described in QA/QC procedures for particular analytical laboratories. Any irregularities in QA procedures that are not immediately corrected will be brought to the attention of the Project Manager.

8.10.4 Surveillances

Surveillance activities include monitoring and observing documents and work activities to provide an effective real-time means of evaluating the adequacy and effectiveness of methods for achieving quality and for assessing the quality of final results. The QA/QC Officer may develop a surveillance plan to provide a basis for each field or laboratory surveillance. This plan will identify the scope, activities, and personnel to be involved, any applicable documents, and the schedule for each surveillance. Checklists may be prepared and used to conduct surveillances. They will be developed to accomplish the review of necessary items and to document the results of the surveillance. Surveillances will follow ER Procedure ER/C-P1600 and the subcontractor's QAAP.

Field and laboratory surveillances may involve an on-site visit by surveillance personnel. Items to be examined may include, but are not limited to, the availability and implementation of approved work procedures; calibration and operation of equipment; packaging, storage, shipping, and transfer of samples; documentation procedures and instructions; and nonconformance/field or laboratory change order documentation.

The records of field and laboratory operations may be reviewed to verify that field or laboratory related activities were performed in accordance with standard procedures. Items reviewed may include, but are not limited to, the calibration records of equipment, daily activity logbooks, COC records, and data resulting from field and laboratory operations.

During a surveillance and upon its completion, the surveillance personnel will discuss observed deviations with the individuals surveyed and agree on corrective actions to be initiated. A surveillance report will be completed for each surveillance activity.

Minor administrative findings that can be resolved to the satisfaction of the surveillance personnel during a surveillance are not required to be cited as items requiring corrective action. Findings that are not resolved during the course of the surveillance and findings affecting the overall quality of the project will be noted on the checklists and included in the surveillance report.

8.11 CORRECTIVE ACTION

This section identifies methods and policies for the documentation, evaluation, corrective action, and verification activities necessary when a deviation from established procedures occurs. Requirements for the documentation and implementation of corrective actions are also included.

Any deviation or nonconformance will be evaluated with respect to its possible impact on reportable data. All deviations from SOPs, equipment calibrations, or any aspect of the QA plan will be evaluated and documented on NCRs. Programmatic and/or significant deficiencies will also be documented on Corrective Action Reports (CARs).

Deviations or variances from SOPs may be necessary given that procedures properly addressing the entire range of conditions encountered during a field sampling program cannot be prepared. Requirements for issue and implementation of variances from SOPs are included.

8.11.1 Responsibilities of Project Participants

Project personnel will ensure the prompt identification, control, and disposition of nonconforming items. Each person is responsible for submitting records of all nonconformance events to the appropriate field/laboratory supervisor and/or the QA/QC Officer immediately following the initial identification and documentation of the nonconformance. The nonconformance will then be evaluated by the field/laboratory supervisor, QA/QC Officer, Project Manager, and others as is deemed relevant. This evaluation will determine the disposition of the nonconformance.

8.11.2 Nonconformance and Corrective Action Procedures

Nonconforming equipment, items, activities, conditions, and unusual incidents that could affect compliance with project requirements will be identified, controlled, reported, and resolved in a timely manner. A nonconformance is defined as a malfunction, failure, deficiency, or deviation from specified requirements. The originator of an NCR will describe the finding on the form provided for this purpose and notify the project management and the QA/QC Officer. When a nonconforming item exists, the personnel who identify the item will stop further processing or use of the item, as applicable. Each NCR will be reviewed and a disposition given for the item, activity, or condition.

The disposition of a nonconformance will be documented and approved by the QA/QC Officer. Probable cause of the nonconformance may be determined and action to prevent recurrence may be identified. Evaluation will determine if the event justifies the issuing of a CAR. The CAR will document the event, the findings of the evaluation, and the required corrective action. The disposition of a nonconformance will be documented and approved by the QA/QC Officer. Corrective actions taken will be commensurate with the importance, complexity, and safety considerations of the condition or occurrence. The corrective action should resolve the root cause of the problem.

If, in the opinion of project management and the QA/QC Officer, the nonconformance does not significantly affect the technical quality or use of the work, the work may continue pending resolution of the nonconformance. The basis for such a decision will be documented on the NCR and submitted to the QA/QC Officer for review and approval. The documentation will include the statement that the decision was made before continuing with the work. The records of nonconformances and their dispositions will be forwarded to the subcontractor's CRF and a copy sent to Y-12 ER QA for review/resolution.

8.12 QA REPORTS TO MANAGEMENT

The active participation of management in a project is fundamental to the success of this QA/QC Plan. Management will be aware of project activities and will participate in development, review, and operation of the project. Management will be informed of QA status and activities through the receipt, review, and/or approval of:

- regular quality status reports from the QA/QC Officer,
- laboratory QA/QC plans and procedures,
- post audit reports and audit closures,
- surveillance reports,
- CARs, and
- NCRs.

Copies of these reports will be distributed to appropriate management. In addition, periodic assessment of QA/QC activities and data PARCC will be conducted and reported by the analytical laboratories.

Project management will inform the QA/QC Officer, as appropriate, of the QA status of the project, especially any significant quality accomplishments and/or deficiencies. Project personnel are required

to inform the QA/QC Officer, Project Manager, or project support staff of all nonconformances or quality failures.

All QA Records concerning the project (e.g., internal and external correspondence, SAP, QAPjP, QAAPs, field logbooks and forms, COC forms, data packages, audit reports, surveillance reports, NCRs, CARs, etc.) will be submitted to the CRF for dual storage and retrieval and a copy sent to Y-12 ER Records Center.

At the conclusion of the project, the QA/QC Officer will prepare a complete report covering all aspects of QA as it pertains to the project. This will be in the final report. Included in this report will be all CARs, NCRs, documented changes to the QAPjP, as well as the detailed data validation report.

The data validation report will be a detailed accounting of the data validation process. At a minimum, the report will cover holding times, calibration checks, and QC checks as stated in Sect. 8.7. Included will be an assessment as to whether the QA objectives were met as they relate to PARCC.

**Environmental Restoration Program
Health and Safety Plan
for
UEFPC OU 3 RI Work Plan Y-12 Plant
Revision 0**

Technical Support Contractor
Program Manager

Date

Technical Support Contractor
Field Team Leader

Date

Site Health and Safety Officer

Date

Energy Systems ER Site Program Manager

Date

Energy Systems ER Site Project Manager

Date

9. HEALTH AND SAFETY PLAN

The purpose of this health and safety Plan is to develop and assign responsibilities, establish personnel protection requirements and mandatory safety procedures, and provide contingencies that may arise while operations are being conducted during the RI for UEFPC OU 3 at the Oak Ridge Y-12 Plant. This document addresses the requirements of 29 *CFR* 1910.120, Final Rule, with respect to environmental soil sampling, using a drilling rig, piezometer installation, storm event sampling, storm sewer and sump sediment sampling, and groundwater sampling. Section 9.13 contains a signature page for approval of this Health and Safety Plan by the appropriate Y-12 Plant departments. Approval by these Y-12 Plant departments must be obtained before this plan can be implemented.

This document has been developed in conjunction with the RI Work Plan for the UEFPC OU 3 site. Its purpose is designed to support the activities conducted during the implementation of the RI. The health and safety plan has been written to be included in the RI Work Plan as a supporting appendix and, therefore, cannot be separated from the RI Work Plan document for use.

9.1 SITE HEALTH AND SAFETY PERSONNEL

This project is being conducted under the direction of the Y-12 Plant ER Division. The ultimate responsibility for meeting goals and implementing this Health and Safety Plan rests with the Y-12 Plant ER Division and the designated subcontractor.

Energy Systems personnel affiliated with this project and RI subcontractor personnel involved with the implementation of field activities to be conducted during this project are listed in Table 9.1.

9.1.1 Y-12 Plant ER Program Manager Responsibilities

The Y-12 Plant ER Program is responsible for assessment efforts at the Oak Ridge Y-12 Plant, including scheduling, budgeting, project management oversight, and reporting. The Y-12 Plant ER Program Manager is responsible for overall management of Y-12 Plant ER Program personnel and activities and for providing budget and programmatic information to the Central ER Division and Y-12 Plant management.

9.1.2 Y-12 Plant ER Site Restoration Manager

The Y-12 Plant ER Site Restoration Manager manages projects that are directly involved with assessment activities. This includes environmental assessment and corrective action activities. Responsibilities include budget forecasting and resource commitments.

Table 9.1. Key project personnel and affiliations

Responsibility	Name	Telephone
Y-12 Plant ER Program Manager	M.P.F. Delozier	576-3712
Y-12 Plant ER Site Restoration Manager	J. T. Grumski	576-5706
Y-12 Plant ER Project Manager	K.M. Nelson	574-2141
Y-12 Plant ER Health and Safety Coordinator	R. Weigel	241-2487
Y-12 Plant ER Field Operations Manager	K.M. Nelson	574-2141
Y-12 Plant ER Field Coordinator	M.A. Guinn	576-5789
Y-12 Plant ER QA Specialist	H.C. Newsom	576-5810
Y-12 Plant HSE Health Physics	R. Howard	576-7870
Y-12 Plant HSE Industrial Hygiene	R. Weigel	241-2487
Y-12 Plant ER Waste Disposal Coordinator (WDC)	C. Smith	576-6526
Y-12 Plant ER Technical Coordinator	V.J. Brumback	576-8453
Y-12 Plant Groundwater Protection Program	S. Jones	
Subcontractor Site Project Manager	TBD*	
Subcontractor Site Health and Safety Officer (SHSO)	TBD*	
Subcontractor Field Team Leader	TBD*	

*To be determined

9.1.3 Y-12 Plant ER Project Manager Responsibilities

The Y-12 Plant ER Project Manager is responsible for managing and coordinating field activities associated with the environmental assessment. Development and implementation of environmental assessment activities include:

- coordinating the support personnel required for field activities;
- notifying the Shift Superintendent of plans and scheduled activities for the site;
- defining sampling and analysis parameters for investigation;
- obtaining required permits and documentation;
- ensuring that all support personnel have an up-to-date medical examination and are placed on the Respiratory Protection Program, if necessary;
- maintaining all training records of individuals involved in site activities and issuing site access badges on the basis of these records;
- overseeing field sampling activities and laboratory analyses;
- ensuring adherence to the health and safety plan throughout the field investigation;
- determining the intended use of data;
- ensuring that support personnel have received appropriate training;
- ensuring development/approval of a Comprehensive Work Plan (CWP) and a Site Health and Safety Plan (SHSP) before initiation of field activities;
- ensuring implementation of the CWP and SHSP;
- maintaining auditable project documentation of all required records;
- ensuring that a qualified Site Health and Safety Officer (SHSO) is designated; and
- maintaining a current copy of the SHSP.

9.1.4 Y-12 Plant ER Health and Safety Coordinator

The Y-12 Plant Hazardous Waste Operator (HAZWOPER) Coordinator (Y-12 HSE, Ind. Hygiene) is responsible for adequacy and approval of the project health and safety plan. The Health and Safety Coordinator is responsible for coordinating Y-12 Plant Industrial Hygiene and Health Physics support for the project.

9.1.5 Y-12 Plant ER Field Operations Manager

The Y-12 Plant ER Field Operations Manager is responsible for coordinating support for field activities with other Y-12 Plant organizations such as engineering, waste management, security, and fire protection.

9.1.6 Y-12 Plant ER Field Coordinator

The Y-12 Plant ER Field Coordinator serves as a liaison between any personnel conducting field activities and the Y-12 Plant ER Project Manager. The Field Coordinator may help in obtaining security escorts or providing equipment and services from plant functions to enable smooth field operations, and has the authority to make decisions in the field, but must maintain contact with technical staff and project management to ensure that any field decisions are consistent with project goals.

9.1.7 Y-12 Plant ER QA Specialist

The Y-12 Plant ER QA Specialist is responsible for ensuring that requirements of projects are conducted as required in all relevant documents, such as the CWP or the ER Division QA Plan. The QA Specialist conducts audits and surveillances to investigate operations that have QA requirements, and provides findings and observations that address the cause and remedy of any activities that do not conform to the requirements of the applicable QA Plans.

9.1.8 Health and Safety

9.1.8.1 Health Physics

Y-12 Plant HSE Health Physics will provide appropriate technical oversight and field monitoring support based on requirements specified in this plan and the CWP. If Y-12 Plant Health Physics employees are not available, Health Physics will obtain subcontractors to cover the work. Health Physics will be responsible for ensuring Health Physics subcontractor employees are trained and qualified to provide the support requested. Health Physics and/or Health Physics subcontractor employees will be responsible for calibration and maintenance of their own equipment. Specific Health Physics support services may include

- review and approval of health and safety plans;
- on-site auditing for compliance;
- on-site Health Physics technician support, to include monitoring of personnel, equipment, samples, and waste; collection and analysis of air samples and/or smears; and calibration of instruments;
- distribution, collection, and analysis of personnel dosimetry;
- reporting results of exposure monitoring, sample analysis, smears, etc. to ER or individual employees when requested; and
- interpretation of federal, state, and installation regulations, standards, and orders.

9.1.8.2 Industrial Hygiene

The Y-12 Plant HSE Industrial Hygiene Department will provide technical oversight of this project. Specific support Industrial Hygiene services may include

- review of health and safety plans;
- technical oversight;
- on-site surveillance for compliance;
- calibration and maintenance of instruments owned by Industrial Hygiene; and
- interpretation of federal, state, and installation regulations, standards, and orders.

9.1.8.3 Industrial Safety

The Y-12 Plant Industrial Safety Department will provide appropriate technical and field oversight support based on requirements specified in this plan and the CWP. Specific support services may include

- review of safety and health plans;
- technical oversight;

- on-site auditing for compliance; and
- interpretation of federal, state, and installation regulations, standards, and orders.

9.1.9 Y-12 Plant ER WDC

The Y-12 Plant ER WDC acts as a liaison between the Y-12 Plant ER Program and the Y-12 Plant Waste Management Division (WMD). Responsibilities include ensuring that all wastes generated as a result of field activities are handled in accordance with applicable regulations. All of these wastes are drummed and must be tested for hazardous constituents using TCLP within 90 days. Disposal of drum contents is in accordance with TCLP results.

9.1.10 Y-12 Plant ER Technical Coordinator

The job of the Technical Coordinator is to ensure that all projects conducted by the Y-12 Plant ER Program are technically defensible and meet applicable regulatory standards. Reports describing the projects must be easily understood by the technical community, and because they will go into the administrative record, they must also be written in such a way that they can be understood by members of the community. The Technical Coordinator must provide the rationale for numbers and locations of samples that are recommended for site characterization and contamination investigations.

9.1.11 Y-12 Plant Groundwater Protection Program Manager

The job of the Groundwater Protection Program Manager is to coordinate all activities pertaining to groundwater at the Y-12 Plant. This includes coordination of budget and funding projects, as well as scientifically based projects such as monitoring well installations and characterization studies. Monitoring well locations, completion designs, and screen intervals must be approved by the Groundwater Protection Program Manager before installation.

9.1.12 Site Project Manager

The Site Project Manager will oversee the UEFPC OU 3 environmental sampling and will be responsible for site accessibility, safety, and QA. This individual will delegate further responsibilities to other members of the sampling team. Specific responsibilities of the Site Project Manager are listed below:

- coordinate all project activities;
- interface with plant and project personnel;
- assist the Field Team Leader and SHSO when necessary;

- participate in on-site characterization activities, as needed;
- ensure development/approval of a CWP and a SHSP before initiation of field activities;
- ensure implementation of the CWP and SHSP;
- maintain auditable project documentation of all required records;
- ensure that a qualified SHSO is designated; and
- maintain a current copy of the SHSP.

9.1.13 SHSO

The SHSO, or a qualified designated representative, with the support of the Site Project Manager, has primary responsibility for the following:

- ensuring that personnel receive this plan and are aware of its provisions, are instructed in safe work practices, and are familiar with potential hazards and planned emergency procedures prior to initiation of site activities;
- conducting or designating personnel to conduct daily safety briefings regarding the current days planned activities;
- maintaining on-site copies of Material Safety Data Sheets (MSDSs) for applicable materials utilized at the site;
- confirming with the Technical Resources and Training Section that on-site personnel have received the health and safety training that qualifies them to work at a hazardous waste site;
- ensuring that all prospective site personnel sign and date the field logbook to verify that items one, two, and three have been fulfilled;
- reporting to the Site Project Manager any deviations from anticipated conditions.
- maintaining on-site copies of current training records for all on-site personnel, in accordance with 29 *CFR* 1910.120(e);
- maintaining on-site copies of physicians statements indicating that workers are medically qualified to perform duties at hazardous waste sites,

- ensuring that site workers have been properly trained and fitted for respiratory protection, as warranted;
- establishing site work zones and the level of protection required and establishing personal decontamination stations and instructing personnel in their use;
- establishing and making available at the site an emergency action plan, with telephone numbers and appropriate radio communication information;
- identifying key plant personnel (and alternates) who are responsible for specific safety-related areas, such as health, plant safety, health physics, and industrial hygiene, and establishing a liaison with the Shift Superintendent's organization to facilitate emergency response;
- field checking the calibration of all monitoring equipment that will be used daily, recording results in the field logbook, and recalibrating if necessary;
- ensuring that all monitoring equipment is operating according to the manufacturer's specifications and instructions and providing maintenance if warranted;
- ensuring that the penetration/excavation permit has been generated (if applicable) and that a signed copy is available on-site, prior to commencing the field work;
- ensuring that all chemicals not in original containers are in properly labeled containers in accordance with HAZCOM *CFR* 1910.1200 requirements;
- ensuring that personnel stay out from under overhead work and temporarily suspended equipment;
- ensuring that persons supervising respirator wearers shall be trained to issue the correct respirator for each application in compliance with ANSI Z88.2, Respiratory Protection Practices;
- documenting field changes in the SHSP;
- controlling visitor access to the site;
- authorizing work cessation if serious health and safety problems are encountered and authorizing work restart once the problems have been corrected; and

- conducting site-specific health and safety briefings, as necessary, on known or suspected hazards including safety precautions and emergency actions.

9.1.14 Site Field Team Leader

The Site Field Team Leader will be responsible for implementing the RI Work Plan and the SHSP in the field. This responsibility will entail

- minimizing the number of personnel and the amount of equipment in the exclusion zone, but only to the extent consistent with safe site operations;
- coordination of all site operations;
- oversight of all sampling activities including decontamination;
- on-site waste management, and;
- sample containerization and transport.

9.1.15 Field Project Personnel

Project personnel involved in on-site activities and operations are responsible for

- taking all reasonable precautions to prevent injury to themselves (including the wearing of proper personal safety equipment) and their fellow employees, and being alert to potentially harmful situations;
- performing only those tasks that they believe they can do safely and immediately reporting any accidents and/or unsafe conditions to the SHSO and the Site Project Manager;
- notifying the SHSO of any medical conditions (e.g., allergies, diabetes, pregnancy) that require special consideration. (A medical department approval and/or a physician's recommendation may be required before an individual with a medical condition can be assigned a specific field task);
- avoiding contact with potentially contaminated substances (i.e., walking through puddles, pools, and mud) and avoiding placement of monitoring/sampling equipment on a potentially contaminated surface;
- labeling containers that contain chemicals that have been transferred from their original containers;

- preventing spillage to the extent possible, but in the event that a spillage occurs, containing liquid, if possible, and notifying the Site Project Manager;
- avoiding splashing of contaminated materials;
- using their senses (*all senses*) to alert them to potentially harmful situations;
- practicing good housekeeping by maintaining order of the site, thereby reducing the likelihood of potentially harmful situations;
- being familiar with the physical characteristics of investigations, including:
 - wind direction in relation to ground zero
 - accessibility to associates, equipment, and vehicles
 - communications
 - hot zones (contamination sources or areas of known or suspected contamination)
 - site access
 - nearest site resources;
- maintaining all wastes generated during site characterization and sampling activities so that they can be disposed of in accordance with the Waste Management Plan (WMP);
- reporting all injuries, no matter how minor;
- abiding by a buddy system so that each on-site worker is responsible for keeping track of his or her partner in the event of an incident;
- reporting to the SHSO for frisking prior to egress from the contamination reduction zone; and
- being familiar with the appropriate emergency actions.

9.2 SAFETY RISK ANALYSIS

The purpose of the site task hazard analysis is to identify potential health and safety concerns that may be encountered by site personnel and the personal protective equipment (PPE) required for each site task. Personal decontamination requirements are outlined in Sect. 9.8. The SHSO may raise or lower the

level of PPE worn by the teams, depending upon the site-specific hazards encountered in the field. Donning and doffing procedures are outlined for various levels of protection in Sect. 9.8.

9.2.1 Site Requirements

The provisions of the plan are mandatory for all on-site employees and visitors engaged in hazardous material management activities, including but not limited to initial site reconnaissance, preliminary field investigations, mobilization, project operations, and demobilization. This document concerns operations related to soil and groundwater activities, environmental sampling, and radiological and organic contaminant field screening.

At the pre-entry health and safety briefing, all field investigation personnel, including representatives from the Y-12 Plant, such as Industrial Hygiene, Health Physics, the Fire Department, Safety, Security, Y-12 Plant Engineering, the Physical Plant, and ER, will be provided with a copy of this health and safety plan and will complete work in accordance with this plan. The pre-entry briefing will be held prior to the commencement of field operations so that field personnel may be familiarized with potential hazards, required field procedures, and evacuation procedures. The pre-entry briefing will be documented by requiring individuals to sign and date the field logbook, stating that each potential field person has received a pre-entry health and safety briefing, a copy of the work plan, and the health and safety plan. Documentation of all personnel training, in accordance with 29 *CFR* 1910.120(c), Final Rule, will also be required at this meeting. All personnel will provide the Site Project Manager with documentation of successful completion of training requirements. "Tailgate" meetings may periodically be called during field activities to apprise on-site personnel of any potential health and safety concerns that may change because of unplanned field conditions. Pre-entry training will address all project health and safety protection requirements including but not limited to the following:

- names of personnel and alternatives for the SHSO;
- safety, health, and other hazards present on-site; routes of exposure; signs of overexposure; and potential health effects;
- type and use of PPE, as well as donning and doffing procedures;
- personnel decontamination procedures;
- work practices to minimize risks from hazards;
- contents of the SHSP; and
- medical surveillance requirements.

Inadequate health and safety precautions on the part of any on-site personnel or the belief that personnel are or may be exposed to an immediate health hazard will be sufficient cause for the SHSO to suspend site work and require personnel to evacuate a potentially hazardous area.

9.2.2 Facility Description

Site. Oak Ridge Y-12 Plant, Oak Ridge, Tennessee UEFPC OU 3

Objective. This project will involve drilling and collecting soil samples, using hollow-stem augering that employs a continuous split-barrel sample tube system, piezometer installation, storm event sampling, storm sewer and sump sediment sampling, and groundwater sampling.

Proposed Date of Investigation. It is estimated that this assessment will begin in spring or summer of 1993. This timeframe is tentative and is dependent upon weather, funding, analytical services, and various Energy Systems approvals.

9.2.3 Suspected Contaminants

Descriptions of the suspected types of wastes and their compound characteristics (if known) are provided in this document. If additional potential contaminants are identified prior to the commencement of activities, they will be provided as an addendum to this document. A listing of the contaminants identified to date has been provided in Table 9.2. Copies of MSDSs for all hazardous chemicals suspected on-site will be maintained in the work area. MSDSs will be available to all employees for review during the work shift. Chemicals listed are based on historical investigations conducted by the Y-12 Plant ER program and existing characterization and monitoring data. Chemicals used in site decontamination activities also appear in the table.

All chemical containers received on-site (decontamination chemicals) will be inspected to ensure that they are clearly labeled as to the contents, hazard warnings, and manufacturer. All secondary containers will be labeled in the same fashion.

9.2.4 Hazard Evaluation

The chart shown on page 9-16 describes waste types, their characteristics, and suspected hazards at the UEFPC OU 3.

Table 9.2. Suspected contaminants

Contaminant	TLV/PEL/Activity or DAC/STEL/IDLH	Health effects/potential chemical hazard	Chemical and physical properties	Exposure route(s)
Arsenic	PEL: 0.010 mg/m ³ IDLH: 100 mg/m ³	Ulceration of nasal septum, GI disturbances, respiratory irritation	N/A	inhalation, absorption, contact, ingestion
Beryllium	PEL: 0.002 mg/m ³ IDLH: 10 mg/m ³	Respiratory symptoms, weakness, fatigue, weight loss	BP 4532°F MLT 2349°F	inhalation
Bis-2-ethyl Hexyl Phthalate	PEL: 5 mg/m ³ IDLH: Ca	Carcinogen, irritant	Oily liquid	inhalation, ingestion, contact
Boron (oxide)	PEL: 10 mg/m ³ IDLH: NE	Nasal irritation, erythema	BP 3380°F MLT 842°F	inhalation, ingestion, contact
Cadmium (fume)	PEL: 0.1 mg/m ³ IDLH: 9 mg/m ³	Pulmonary edema, cough, tight chest, chills, muscle aches, nausea, mild anemia	MLT 2599°F	inhalation
Chromium (total)	PEL: 0.5 mg/m ³ IDLH: NE	Sensitive skin	Varies depending on compound.	ingestion, contact
Cobalt	PEL: 0.05 mg/m ³ IDLH: 20 mg/m ³	Cough, decrease in pulmonary functions, respiratory hypersensitivity	BP 5612°F MLT 2719°F	inhalation, ingestion, contact
Copper (fume)	PEL: 0.1 mg/m ³ IDLH: NE	Chills, muscle aches, nausea, fever, cough, discoloration of skin, hair	MLT 1879°F VP 0 mm	inhalation, contact
Cyanide	PEL: 5 mg/m ³ IDLH: 50 mg/m ³	Asphyxia and death can occur, weakness, vomiting, slow respiration, irritation to skin and eyes	BP 2725°F MLT 1173/1047°F Sol. 72/58%	inhalation, absorption, ingestion, contact
Depleted Uranium Alloys	Varies depending on isotope	Genetic effects, carcinogen	varies depending on compound	inhalation, ingestion, absorption
Dichloromethane (Methylene Chloride)	PEL: 500 ppm IDLH: 5000 ppm	Carcinogen, irritant	colorless liquid	inhalation, ingestion, contact
Diethyl Ether	PEL: 400 ppm IDLH: 19000 ppm	Dizziness, irritant	B.P. = 94°F	inhalation, ingestion, contact
Fluoride	PEL: 2.5 mg/m ³ IDLH: 500 mg/m ³	Irritant to eyes, respiratory system, nausea, stiff spine, calcification of ribs and pelvis	BP 3099°F MLT 1819/1832°F Sol. 4/0.4%	inhalation, ingestion, contact

Table 9.2 (continued)

Contaminant	TLV/PEL/Activity or DAC/STEL/IDLH	Health effects/potential chemical hazard	Chemical and physical properties	Exposure route(s)
Lead	PEL: 0.05 mg/m ³ IDLH: 700 mg/m ³	Weakness, facial pallor, low weight, anemia, encephalopathy, nephropathy, hypotension	BP 3164°F MLT 621°F	inhalation, ingestion, contact
MEK				
Mercury (vapor)	PEL: 0.05 mg/m ³ IDLH: 28 mg/m ³	Cough, chest pain, bronchial pneumonia, fatigue, stomatitis, GI distress, irritant to eyes, skin	BP 674°F VP 0.0012 mm FRZ -38°F	inhalation, absorption, contact
Methanol	PEL: 200 ppm IDLH: 25,000 ppm	Eye irritant, drowsiness, light headedness, nausea, vomiting, blindness	BP 147°F VP 92 mm FRZ -144°F IP 10.84 eV FI P 52°F UEL 36% LEL 6%	inhalation, absorption, ingestion, contact
Methylene Chloride	PEL: 500 mg/m ³ IDLH: 5000 mg/m ³	Fatigue, weakness, sleepiness, light headedness, numbness, nausea, irritant to eyes, skin	BP 104°F VP 350 mm FRZ -139°F Sol. 2% IP 11.32 eV UEL 22% LEL 14%	inhalation, ingestion, contact
Molybdenum (soluble compounds)	PEL: 5 mg/m ³ IDLH: NE	(In animals) irritant to eyes, nose, and throat, dyspepsia, anemia	Varies depending on the compound.	inhalation, ingestion, contact
Nickel (metal and other compounds)	PEL: 0.1 mg/m ³ IDLH: NE	Vertigo, nausea, vomiting, cough, weakness, delirium, convulsions	BP 5139°F VP 0 mm MLT 2831°F	inhalation, ingestion, contact
PCBs	PEL: 0.5 mg/m ³ IDLH: 5 mg/m ³	Irritant, liver damage	BP 700°F VP 0.00006 mm Hg	
Tetrachloroethene	PEL 25 ppm IDLH 500 ppm	Irritant to eyes, nose, throat, nausea, vertigo, liver damage	BP 250°F VP 14 mm FRZ -2°F Sol. 0.02% IP 9.32 eV	inhalation, ingestion, contact

Table 9.2 (continued)

Contaminant	TLV/PEL/Activity or DAC/STEL/IDLH	Health effects/potential chemical hazard	Chemical and physical properties	Exposure route(s)
Thallium (soluble compounds)	PEL: 0.1 mg/m ³ IDLH: 20 mg/m ³	Nausea, abdominal pain, vomiting, chest pain, psychosis, liver and kidney damage	Varies depending on the compound.	inhalation, ingestion, absorption, contact
Thorium	Varies depending on isotope	Carcinogen	Varies depending on the compound.	inhalation, ingestion, contact
Tributyl Phosphate	PEL 0.2 ppm IDLH 125 ppm	Eyes, respiratory system, skin irritant, nausea	BP 552°F VP 127 mm FRZ -112°F Sol. 0.6% FI P 295°F	inhalation, contact, ingestion
Trichloroethene	PEL: 50 ppm IDLH: 1000 ppm	Vertigo, tremors, nausea, vomiting, irritant to eyes, cardiac arrhythmia	BP 189°F VP 58 mm FRZ -99°F Sol. 0.1% FI P 90°F IP 9.45 eV UEL 10.5% LEL 8%	inhalation, ingestion, contact

Waste types:	Possible characteristics of waste types:	Hazard associated with waste types:
Liquid	Ignitable	Chemical
Solid	Radioactive	Physical
Sludge	Volatile	Radiological
	Toxic	
	Reactive	
	Unknown	

Table 9.3 lists protective equipment expected for this project; however, the protective equipment requirements for specific activities are subject to change as site conditions warrant. Site work generally will require Level D protection unless atmospheric monitoring proves otherwise. A modified Level D protection (Level D+) may be necessary where excessive splashing or contact with potentially contaminated material is likely. Because of the potential for contamination, all personnel will exercise care not to have excessive skin contact with any water or soil while at the investigation site.

9.2.5 Site Project Manager

The Site Project Manager is responsible for the entire RI project. Because the Site Project Manager may be required to assist in any phase of the project, access to all zones (support, contamination reduction, and exclusion) will be required. The Site Project Manager will don the appropriate protective equipment required for specific activities within the area.

9.2.6 Site Field Team Leader

The Site Field Team Leader is responsible for oversight of the entire environmental sampling effort. The Site Field Team Leader is required to access all zones (support, contamination reduction, and exclusion), and, therefore, potentially may be exposed to all hazards with the site-specific duties of others. Prior to entering an area, the Site Field Team Leader will don the appropriate protective equipment required for site-specific activities within the area.

9.2.7 SHSO

The SHSO is responsible for the safety and health of all environmental sampling participants. The largest portion of the SHSO's time will be spent providing continuous monitoring for potential contaminants. The SHSO has access to all areas of the environmental sampling project and will be exposed to all potential hazards to which all site-specific personnel may be exposed. The SHSO will don the appropriate protective equipment required for site-specific activities within the area.

Table 9.3. Protective equipment for on-site activities

Activity	Level	Protective equipment^a	Monitoring required/action level
Excavating and environmental sampling, equipment decontamination ^b	D	Hard hat Safety glasses Hard-toed boots Field work clothes Face shield	Monitor ambient air for petroleum hydrocarbons/organics Action Level: < 2 ppm above background (HNU) and < PEL of any specific contaminants measured
Excavating and environmental sampling	D+	Above protection plus: Chemical-resistant polyethylene-coated clothing Chemical-resistant disposable gloves (Nitrile or PVC) Nitrile or butyl rubber outer boots	Monitor ambient air for petroleum hydrocarbons/organics Action Level: < 2 ppm above background (HNU) and < PEL of any specific contaminants measured and visible indication of splash or contamination
Excavating and environmental sampling at action levels	C	Above protection plus: Full-face respirator with organic vapor/high-efficiency dust and mist cartridge	Monitor ambient air for petroleum hydrocarbons/organics Action Level: 2-10 ppm above background (HNU) or 1-10 ppm × PEL of any measured contaminant

^aChemical resistant gloves, outer boots, and clothing may be worn by personnel to reduce the danger of potential splashing and to maintain personal hygiene. The information in this table should not be construed to mean that all personnel are required to conform to this practice. All site personnel and visitors must contact the Site Project Manager or SHSO to be granted access to the site and confirm actual personnel protection requirements prior to entering an investigation site.

^bFull-face face shields mounted on hard hats with safety glasses will be worn during the decontamination process.

9.2.8 Decontamination Personnel

Decontamination personnel involved with the efforts at UEFPC OU 3 may be exposed to a variety of hazards. Decontamination personnel will be responsible for decontaminating equipment used for groundwater sampling, sediment sampling, drilling/soil sampling, and hand-augering soil sampling. Equipment decontamination generally will require Level D+ protective equipment, specific requirements for which are outlined in Table 9.3. Individuals involved in personnel decontamination will wear the same level of PPE that field personnel are wearing. In addition, personnel decontamination procedures are outlined in Sect. 9.8 of this volume; equipment decontamination procedures will be outlined in the site-specific work plan.

Decontamination personnel may also be exposed to burns, splash, or backspray from the use of the portable hot-water washer. Use of a splash shield for the face is required for all personnel conducting decontamination operations that require use of the hot-water washer. This splash shield will be worn in combination with safety glasses, as it is not a substitute for safety glasses. Decontamination personnel will ensure that nonessential employees are not in a position where they would be sprayed by the hot-water washer.

The potential for elevated noise levels may exist near the hot-water washer. Hearing protection is required for decontamination personnel when the decontamination trough is affixed to the decontamination trailer and personnel are working within a radial distance of 10 ft from the hot-water washer. Previous monitoring results have shown that if the decontamination trough and its attendant activities are moved 10 ft from the decontamination trailer, then hearing protection is not required.

Hazards associated with inhalation of exhaust from the internal combustion engine that powers the hot-water washer may also be encountered. This potential problem may be avoided by ensuring that the exhaust always trails away from decontamination personnel.

The SHSO, at his discretion, may require decontamination personnel to wear personal monitoring equipment to measure potential site-specific contaminants/hazards. It is recommended that all personnel shower at the change house at the end of each day prior to departing for home.

9.2.9 Soil Sampling Team

The UEFPC OU 3 Soil Sampling Team will normally consist of a driller, a driller's helper, and two sampling personnel. Soil samples will be collected within the boundaries and near the vicinity of UEFPC OU 3. Primary contaminants and hazards the soil sampling team may encounter are identified in Sect. 9.2.1. Generally, soil sampling may be conducted using Level D protective clothing. Team members should exercise care at all times to prevent their skin from coming into direct contact with any of the soil sampled. In addition, members of the sampling team should shower as soon as practical after completing sampling and personal decontamination procedures in relation to UEFPC OU 3. It is

recommended that all personnel shower at the change house prior to departing for home at the end of each day.

Shallow soil samples will be taken by a sampling team using hand augers and scoops. This sampling effort may also be conducted using Level D protective clothing. The sampling team should exercise the same care as described above when using hand augers with regard to coming into contact with contaminants.

Heavy equipment (drill rigs) used in the collection of soil samples may also present a specific hazard to the Soil Sampling Team. Prudent safety measures should be adhered to when working around the drill rig. In addition to the potential hazard associated with rotating auger flights, all personnel should be aware of temporarily suspended equipment and overhead wires along the mast of the drill rig. It is imperative that the driller and the driller's helper be aware of the location of team members when they approach or work around the drill rig. The driller and the driller's helper will conduct most of their activities at the drill rig within the exclusion zone. However, the driller and his helper, perhaps aided by the Soil Sampling Team, may also be carrying heavy split-barrel sample tubes laden with soil from the exclusion zone to the contamination reduction zone.

Movement from one sampling location to another may also present a potential safety concern, because the sampling team frequently will be traveling where no roads exist. The team must exercise caution when moving the drill rig with the mast in the upward position. Operators and passengers will obey all applicable motor vehicle safety rules while traveling.

The actual bottling of the soil samples will occur in the contamination reduction zone. There is a potential for volatile concentrations in the breathing zone to be above an action level. The SHSO will be responsible for raising or lowering the level of PPE based upon site-specific sampling locations.

All sampling and field procedures, QA, sample handling and preservation, and decontamination procedures will be conducted in accordance with the applicable ESP.

9.2.10 Groundwater Well Sampling Team

The groundwater sampling team consists of at least two people who share responsibilities for sampling wells at the Y-12 Plant. Target analytes and sampling frequencies have been identified in the QAPP. All groundwater sampling activities are conducted while using Level D+ protection, although a hard hat may not be required if no overhead hazards are present when the wells are sampled. Hazards associated with sampling groundwater monitoring wells are significantly less than those associated with other site sampling activities, because groundwater samples will be collected from wells that have previously been installed. Potential hazards are associated with the presence of contaminants in the groundwater that are listed in Table 9.2. Potential hazards include splashing of contaminated groundwater and slipping or falling on wet or damp grassy areas surrounding the wells.

All field procedures, QA, sample handling and preservation, and decontamination procedures will be conducted in accordance with the applicable ESP.

9.2.11 Groundwater Well Installation Team

The team will consist of those individuals who comprised the well sampling team. Activities will be conducted using Level D+ protection, although a hard hat may not be required if no overhead hazards are present when the piezometers are installed. Potential hazards are associated with the presence of contaminants in the groundwater that are listed in Table 9.2. Potential hazards include splashing of contaminated water and slipping or falling on wet or damp grassy areas surrounding the piezometers.

9.2.12 Storm Event Sampling Team

The sampling team will consist of at least two individuals who will sample surface water and sediments in the vicinity of UEFPC OU 3 after major storm events. Activities will be conducted using Level D+ protection, although a hard hat may not be required if no overhead hazards are present. Potential hazards are associated with the presence of contaminants in surface water. Potential hazards include splashing of contaminated water and slipping or falling along surface water sources.

9.2.13 Storm Sewer/Sump Sediment Sampling Team

The sampling team will consist of at least two individuals who will sample storm sewer and sump sediments in the vicinity of UEFPC OU 3. Activities will be conducted using Level D+ protection, although a hard hat may not be required if no overhead hazards are present. Potential hazards are associated with the presence of contaminants in soils and sediments. Potential hazards include splashing of contaminated water and slipping or falling along surface water sources.

9.2.14 Waste Management Hazards

Hazards are associated with management of project-derived wastes. The potential hazards associated with wastes derived from this project are expected to be limited because of the waste management methods that will be employed. Potential hazards associated with project wastes will be limited to the chemical hazards described in Table 9.2, physical hazards associated with stockpiling soil waste on-site, and physical hazards associated with moving drums of decontamination rinsate on-site. The management of project wastes is discussed in the WMP included as Chap. 11 of this document.

All soil wastes generated from the investigation will be placed in segregated stockpiles beside each borehole pending characterization based on environmental samples. Upon characterization, the clean soils will be disposed of on-site, and the contaminated soils moved to a composite storage pile located in a designated waste storage area on-site pending remediation, along with in situ contaminated soils present at the site. Managing the chemical hazards potentially associated with soil wastes will be consistent with the practices for soil sampling described in Sect. 9.2.9. The same level of personnel protection used for soil sampling will, at a minimum, be used for managing contaminated soil wastes, unless the results of

environmental samples indicate another level of personal protection is appropriate. The physical hazards associated with handling soil wastes will be consistent with the practices of 29 *CFR* 1910.120. In addition, safe and prudent work practices will be followed to reduce physical hazards associated with moving soil stockpiles.

The monitoring well purge water and decontamination soap and water rinsate will be collected in small portable polyethylene tanks and transported to a designated on-site central waste storage area. The purge water and decontamination soap and water rinsate will be transferred into separate stationary polyethylene storage tanks at the waste storage area pending characterization based on environmental samples. The polyethylene storage tanks will be labeled in accordance with Chap. 11. After characterization, these wastes will be disposed of by the Y-12 Plant WMD. The hazards associated with managing purge water wastes will follow the health and safety criteria for groundwater sampling described in Sect. 9.2.10. The same level of personnel protection used for groundwater sampling will, at a minimum, be used for handling purge water wastes, unless the results of environmental samples indicate another level of personal protection is appropriate. The hazards associated with managing decontamination soap and water rinsate will follow the criteria for decontamination described in Sect. 9.2.8.

The decontamination rinsate derived from hexane and methanol rinses will be segregated and containerized in new 55-gal DOT 17E bung-top drums and stored on-site at the designated waste storage area. The drum containers will be packaged, labeled, and stored in accordance with the practices described in Sect. 11. These wastes will be characterized based on the known contents of the drums (e.g., hexane and methanol) and environmental samples collected during the investigation; therefore, drum sampling will not be required. The same level of personnel protection used for decontamination will be used for managing decontamination wastes. The hazards associated with managing decontamination rinsate will follow the criteria described in Sect. 9.2.8.

The hazards associated with project-derived waste containers will be managed in accordance with the requirements of 29 *CFR* 1910.120(j). Careful advanced planning will be employed using proper and certified lifting equipment when moving drum containers on-site. The SHSO will conduct thorough briefings for involved personnel on the methods to be employed when moving waste containers. All personnel will be required to stay clear of suspended loads and minimize contact with the waste containers prior to movement. In addition, measures will be taken to ensure emergency preparedness in accordance with 29 *CFR* 1910.120(j) when handling waste containers.

9.2.15 Special Hazards

The hazards of operations involving mixed wastes include physical, chemical, and radiological. All site investigation personnel may potentially be exposed to the hazards outlined below.

9.2.15.1 Heat stress

Activities being conducted at UEFPC OU 3 may be physically demanding during much of the investigative efforts. Physical demands placed upon investigative personnel may be compounded through the use of protective clothing/equipment, moderate to heavy workloads, ambient air temperatures, relative humidity, and exposure to nonionizing radiation.

Two important factors will help personnel function in hot environments: acclimatization and consumption of fluids. Acclimatization of workers to hot environmental conditions may require up to 2 weeks. During this period especially, workers should concentrate on maintaining a balanced diet, consuming plenty of fluids (while outside contaminated areas) throughout the day, and remaining aware of telltale signs of heat-related stress. Headaches, dizziness, high body temperature, and increased heart rate are all early warning signals of heat stress. It is imperative that the SHSO be informed if a worker experiences these signs.

Because measurement of deep body temperature is impractical for monitoring the workers' heat load, the use of the guidelines established by the American Conference of Governmental Industrial Hygienists (ACGIH) in their TLV handbook is to be followed. Particular emphasis should be placed on the fact PPE will be in use and will act as a factor in determining heat stress. As each worker is unique and may respond very differently to heat stress it is recommended that during the acclimatization period the SHSO check workers' pulse rates before the start of work and at subsequent rest breaks during the day to check the adequacy of the established work-rest regime and adjust rest period length and frequency accordingly.

All activities that take place at the investigative site require the use of a buddy system, and as field activities continue, all personnel should be apprised of their buddy's condition with respect to heat stress. A work/rest regimen will be instituted by the SHSO to help in combating heat-related disorders. The regimen will be developed based on the work being done, the temperature and humidity of the environment, and the protective clothing being worn, which will follow the guidelines established by the ACGIH. The SHSO may develop work/rest regimens in accordance with best professional judgment, which rely on guidelines published by the ACGIH or other recognized organizations such as the National Institute for Occupational Safety and Health (NIOSH). Physiological monitoring, such as pulse rate or oral temperature, may be conducted in conjunction with the work/rest regimen when the potential for heat-related disorders exists.

9.2.15.2 Biological stress

Field conditions may present a variety of biological stresses. It is the responsibility of investigative personnel to inform the SHSO of existing health conditions they have that may be affected by on-site biological stresses. Existing health conditions that may be affected by these stresses should be provided in the baseline medical evaluation for on-site workers. This information will be made available to

emergency and medical personnel. Examples of these stresses may be but are not limited to bee stings, ticks, poison ivy, asthmatic conditions that may be affected by exposure to certain pollens and grasses, snake bites, etc.

9.2.15.3 Illumination

Normal operating conditions at UEFPC OU 3 will involve conducting field activities during daylight hours. A minimum of 5-ft candles will be required to conduct field activities; however, actual field measurements of illumination will not be collected. A conservative guideline may be that field work will commence 15 min after sunrise and conclude 15 min prior to sunset. Adherence to the minimum 5-ft candles requirement will depend on the SHSO's best professional judgment.

9.2.15.4 Ergonomics

Potential hazards related to the interaction of personnel with their working environment may be present at this site. The primary ergonomic hazards that may exist may be lifting heavy loads, equipment vibrations, body positioning, and physical obstacles associated with traversing ditches and brush. Mechanical aids should be used when lifting extremely heavy objects whenever possible. Personnel should always position themselves properly and lift from the legs when attempting to lift equipment. Personnel should rely on their buddy to assist in lifting loads that are too heavy for one person to properly lift and carry. Back strain, the most common ergonomic hazard in the field, may be easily avoided, provided the on-site workers always ask for assistance when they need it.

A certain degree of vibration may be encountered by drilling personnel when operating the drill rig. If any tingling of digits is encountered, appropriate work/rest regimens will be employed by the SHSO within best professional judgment. If any ergonomic symptoms are encountered in the field, the SHSO should be notified immediately.

9.2.15.5 Physical sampling location hazards

These hazards may involve but are not limited to movement of equipment around the site, mechanical equipment malfunctions, unestablished roads, and potential noise hazards. Personal hazards such as tripping or falling are also potential sampling location hazards.

Prior to placing the sampling equipment at an auger hole location, the Site Project Manager or his designee will verify that the sampling equipment will not be operated when any part of the drill rig mast enters within a minimal radial distance of 15 ft from electrical transmission lines. All personnel should stay out from under overhead work and temporarily suspended or moving equipment whenever possible.

Subsurface physical hazards will be a specific concern for mechanical subsoil sampling at UEFPC OU 3. The sampling locations will be certified clear of all known underground hazards by authorized personnel (Energy Systems Civil Engineering) prior to sampling. Prior to mobilizing the field

investigation the Y-12 Plant Engineering Department will issue an excavation/penetration permit identifying the location of all utilities and certifying each boring location as clear of utilities.

9.2.15.6 Weather

Storms may periodically produce events such as lightning, rain, wind, ice, and snow that may cause site-specific hazards. It is the responsibility of the SHSO and investigative personnel to recognize potential hazards from storms, and it is the SHSO's responsibility to implement measures to eliminate the potential hazard(s). Lightning and heavy rain are the most common hazards encountered when the work involves a drilling rig. When lightning and heavy rains are threatening, drilling operations should cease until such time as deemed safe by the SHSO.

9.3 TRAINING REQUIREMENTS

All personnel who participate in any sort of work conducted during the RI of UEFPC OU 3 are subject to the following training requirements:

- 40-h HAZWOPER training;
- 8-h HAZWOPER annual refresher training; and
- 8-h HAZWOPER supervisors training (supervisors only).

Other necessary requirements are listed below.

- All personnel working on the site must have attended the pre-entry health and safety briefing, and documentation of the training must be entered in the field logbook before site access will be granted.
- All personnel working on the site must have attended the Y-12 Plant General Employee Training (GET)-Basic (Module #4745); GET-Hazard Communication & Chemical-Specific; GET-Radiological Health and Safety Training (Module #4298).
- All personnel will also be on the Energy Systems radiological dosimetry program, and those badges will be required during this project.
- All personnel working on the site must have Y-12 Plant Radiation Worker Training (Module #2039), and Urinalysis and Lung/Chest Count (Module #5241).

9.4 PPE

All PPE for site activities, tasks, and work zones is based upon potential site-specific contaminants and may involve conservative additions to personnel protection by the Site Project Manager, Y-12 Plant Industrial Hygiene, or Y-12 Plant Health Physics. Guidelines for PPE for site activities, tasks, and work zones are to be specified by the SHSO using Table 9.3 and the following list. The level of protection selected is based upon the following:

- type and measured concentration of the chemical substance in the ambient atmosphere in its toxicity;
- potential for exposure to substances in air liquids, or other direct contact with materials due to work being done; and
- knowledge of chemicals on-site along with properties such as toxicity, route of exposure, and contaminant matrix.

In situations where the type of chemical, concentration, and possibilities of contact are not known, the appropriate level of protection must be selected based on professional experience and judgment until the hazards are further evaluated.

- Level C Protective Equipment
 - full-face respirator and air purifying cartridge respirator capable of filtering out organic vapors and radionuclides
 - hooded chemical-resistant clothing with all seams and openings taped
 - gloves (chemical-resistant inside and outside)
 - steel-toed boots
 - nitrile or butyl rubber outer boots
 - hard hats
- Level D+ Protective Equipment
 - safety glasses

- nitrile or butyl rubber outer boots
- chemical-resistant (polyethylene-coated) clothing
- chemical-resistant disposable gloves (nitrile for light work, PVC for heavy work)
- steel-toed boots
- hard hat
- Level D Protective Equipment
 - safety glasses
 - hard hat
 - steel-toed boots
 - field work clothes

The level of protection provided by PPE selection shall be upgraded or downgraded based upon a change in site conditions or findings of investigations. Criteria indicating a possible need for reassessment of PPE selection include the following:

- commencement of a new work phase, such as the start of drum sampling or work that begins on a different portion of the site;
- change in job tasks;
- change of season/weather;
- hazards other than those previously identified are encountered;
- change in airborne concentration of chemical/radiological hazards;
- change in work scope that effects the degree of contact with contaminants.

Before using PPE:

- determine that the clothing is correct for the specified task at hand;
- visually inspect for:
 - imperfect seams
 - nonuniform coatings
 - tears
 - malfunctioning closures;
- hold up to light and check for pinholes;
- flex product
 - observe for cracks
 - observe for other signs of shelf deterioration;

During the work task:

- evidence of chemical attack such as discoloration, swelling, stiffening, and softening. Keep in mind, however, that chemical permeation can occur without any visible effects;
- closure failure;
- tears;
- punctures; and
- seam discontinuities.

The outer protective garment will be made of a chemical-resistant woven material that forms a protective barrier against detrimental chemicals for a specific period of time based on the chemical in question. *Each chemical has its own permeating ability, and the resistance of the protective clothing will vary with each chemical.* For some chemicals, the risk of chemical permeation increases when an outer protective garment becomes damp from soil or water contact. Based upon a consideration of the chemicals that are suspected to be present at the UEFPC OU 3 Site, a field investigator whose outer

protective suit becomes wet should replace the wet garment as soon as possible with a new chemical resistant suit.

All respiratory equipment will be approved by the National Institute for Occupational Safety and Health and the Mine Safety and Health Administration. All personnel required to use respiratory protection will have an up-to-date quantitative respirator fit test and will wear only those respirators approved by the quantitative fit test.

9.4.1 Protective Clothing Donning Procedure

The protective clothing donning procedure ensures that on-site personnel are instructed in the proper way to don protective clothing. Failure to adhere to this procedure may result in the protective clothing being ineffective against a potential contaminant. The following donning procedure is given as a *guide* and may be altered by the SHSO if improvements can be made to the procedure and if changes are warranted in the field. In addition, some articles of protective clothing/equipment detailed below may not be necessary for the particular site task. Personnel should consult the SHSO for the appropriate protective equipment combination.

- Inspect clothing and respiratory equipment before donning.
- Adjust hard hat to fit.
- Standing or sitting, place legs in suit, pull hard-toed safety boots through, gather up at the waist, place arms in sleeves, pull upper portion of the suit over the shoulders, and zip the suit closed. Tape the zipper closed to provide a seal. A tab should be provided on the tape to ease removal of the suit during decontamination procedures.
- Place boot covers over the hard-toed safety boots if required. Tape the boot covers to the leg of the suit, providing a seal, and tab the tape to aid removal.
- Don the respirator after performing the initial qualitative checks of the respirator's integrity. All personnel who may be required to wear respirators should familiarize themselves with Sect. 9.5.3 (respiratory protection).
- Perform the necessary qualitative respirator fit test under the direct supervision of the SHSO.
- Draw hood up around the respirator. Seal exposed facial areas between the suit and the respirator with duct tape.

- Don one or two pairs of chemical-resistant gloves as required by the SHSO; pull the sleeve of the suit over the cuff of the glove and seal it to the glove with tape. A tab should be provided on the tape to ease removal of gloves during decontamination procedures.

9.4.2 Protective Clothing Doffing Procedure

The protective clothing doffing procedure ensures that all on-site personnel are instructed in the removal of protective equipment. Failure to adhere to this procedure may result in unnecessary exposure to a potential on-site contaminant. The following doffing procedure is given as a *guide* and may be altered by the SHSO if improvements can be made to the procedure and the changes are warranted in the field. In addition, some protective equipment/clothing listed below may not be required for a specific site task. Personnel should consult the SHSO for the appropriate protective equipment combination.

- Step into the decontamination pan.
- Observe established step-off procedures and use step-off pads.
- Remove any extraneous disposable clothing/equipment (e.g., outer gloves, hard hat, boot covers, and tape) and dispose of it in the appropriate receptacle. Note: **Do not remove respirator.**
- Unzip protective suit.
- Remove one arm at a time from the suit, turning the suit inside out. Inner gloves should still be worn at this time.
- Sitting, if possible, remove one leg from the suit at a time, turning the suit inside out.
- Dispose of the suit in the appropriate receptacle.
- Remove respiratory equipment.
- Remove inner disposable gloves by rolling them off each hand, inside out, and dispose of them in the appropriate receptacle.

Personnel should familiarize themselves with this guidance and with the personnel decontamination procedures in Sect. 9.8, as both procedures need to work in harmony.

9.4.3 Respiratory Protection

Personnel at the UEFPC OU 3 Site will be covered by a respiratory protection program that meets the legal requirements of 29 *CFR* 1910.134, and ANSI Z88.2 by incorporating the following elements:

- a program administrator,
- standard operating procedures for selecting and using respirators,
- proper selection of respirators based on hazard,
- training of personnel in use and limitations of equipment,
- regular cleaning and maintenance of equipment,
- proper storage of equipment,
- routine monthly inspections of equipment and inspections before and after use,
- constant monitoring of work area for adverse conditions and worker stress,
- continual evaluation of respiratory compliance program, once in operation,
- determination of medical fitness of potential user, and
- use of only approved equipment and only after proper fit testing has been performed. The fit test should be used to determine the user's ability to obtain a satisfactory fit with a negative pressure, air-purifying respirator. The results of the fit test will be used to select the specific type, make, size, and model of a negative pressure, air-purifying respirator for use by the wearer.

The following policies should also be adhered to in the fitting and use of respirators:

- An employee must have passed the fit test and medical evaluation to use a respirator and must present a respirator card prior to being issued a respirator.
- If an employee cannot obtain a good respirator-to-face seal because of facial or medical characteristics, that employee will not use a respirator and/or enter an atmosphere that requires the use of a respirator.

- Facial hair such as beards, sideburns, or certain mustaches that may interfere with the fit test are not allowed.
- Persons requiring corrective lenses will be provided with specially mounted lenses inside the full-face mask. Under no circumstances will normal glasses be worn while using full-face respirators.
- A person may use only the specific make(s) and model(s) of air-purifying respirators for which he has obtained a satisfactory fit via the quantitative fit-testing procedures. Under no circumstances will a person be allowed to use any make or model respirator for which he has not passed a fit test.

The determination of medical fitness of the potential user is generally based on evaluating the individual for physiological/psychological limitations, as given in ANSI Standard Z88.6 (1984). Examples of problems that may render an employee unfit to use a respirator include:

- pulmonary problems;
- cardiovascular problems;
- skin sensitivity, diabetes, perforated eardrum, deviated septum; and
- claustrophobia, anxiety, and discomfort.

9.5 MEDICAL SURVEILLANCE

9.5.1 Objectives

Medical examinations are an important part of health and safety programs. Regulations as stated in 29 *CFR* Part 1910.120(f), Hazardous Waste Operations and Emergency Response, require medical examinations for the following personnel:

1. All employees exposed or potentially exposed to hazardous substances above the permissible exposure limit for more than 30 days per year.
2. Workers exposed above the permissible exposure limit or, if there is no permissible exposure limit above the published exposure level for these substances for the substance for 30 days or more per year.

3. Workers who wear respirators for 30 days or more per year, or as required by 29 *CFR* 1910.134, Respiratory Protection.
4. Workers who are or may be exposed to unexpected or emergency releases of hazardous wastes above exposure limits (without wearing appropriate protective equipment) or who show signs, symptoms, or illnesses that may have resulted from exposure to hazardous substances.
5. Members of hazardous material (HAZMAT) response teams.

The medical screening program has the following objectives:

1. To assess the health and safety of personnel and to identify any pre-existing conditions before work assignment to minimize the risk of injury/illness from exposure to hazardous materials and stressful activity and to determine the ability of personnel to perform similar future work assignments.
2. To ensure compliance with Occupational Safety and Health Administration (OSHA) regulations as stated in 29 *CFR* 1910.120.

9.5.2 Required Medical Procedures

The medical evaluation program shall consist of the following required physical examinations:

1. Preassignment
2. At least once every 12 months for each employee unless the attending physician believes a longer interval (not to exceed 2 years) is appropriate.
3. Post employment.
4. Post accident.

The medical exam may include plant-specific and site-specific screenings, including:

1. Complete personal, family, and environmental history.
2. Comprehensive physical examination.
3. Complete laboratory blood screen.

4. Urinalysis.
5. Chest X-ray (once every 3 years).
6. Resting electrocardiogram.
7. Pulmonary function testing.
8. Tonometry (35 years of age and older).
9. Audiometric screening.
10. Vision and color blindness testing.
11. Rectal examination.
12. Hemocult testing.

In addition to the aforementioned medical monitoring, Y-12 Plant Health Physics personnel will provide the subcontractor Health and Safety Officer with radioactivity exposure data on a quarterly basis.

9.6 MONITORING AND SAMPLING

Continuous real-time assessment of potentially hazardous chemical concentrations and surficial radiological levels will be performed while conducting operations at UEFPC OU 3. The deployment of monitoring equipment will depend upon the site-specific activities being conducted. The radiological walkover survey will require the use of radiological monitoring equipment only. Sampling activities require the use of all monitoring equipment, chemical and radiological. The specific equipment required for this program is listed below, and is included in the Field QAPjP. This monitoring program is designed to protect all on-site investigative personnel from potential chemical and radiological contaminants. Upon initial entry, representative monitoring shall be conducted to detect potential exposure to toxic gases or vapors, radiation, flammable atmospheres, and/or oxygen-deficient atmospheres.

To assist in evaluating potential site hazards, the SHSO shall use one or more of the following or equivalent:

- Foxboro-Century OVA Model 128 and/or HNu photo-ionization detector or equivalent.

- Ludlum Model 3 portable radiation survey meter with a Ludlum Model 44-9 pancake probe for the detection of beta and gamma radiation.
- Ludlum Model 12 portable radiation survey meter with a scintillation counter probe for the detection of alpha radiation.
- Portable explosimeter for the determination of flammable/explosive gases or vapors.
- Portable pH/conductivity meter to monitor drilling fluids and groundwater that may contact the skin.
- Jerome or other equivalent device for detecting mercury vapors.

If any of the following conditions are found, the SHSO may recommend a temporary or permanent upgrade of PPE until monitoring levels return to the previous state:

- organic vapor levels exceed 2 ppm above background levels for more than 5 min;
- measured concentration of any contaminant at greater than its PEL;
- significant dusting ($> 5 \text{ mg/m}^3$ which is the threshold limit value for nuisance dust) occurs anywhere in the immediate sampling area; and
- radiation levels exceed background levels in the work zone by direction of Y-12 Plant Health Physics personnel.

All readings, including breathing zone samples, will be taken at the borehole or sample location and will be documented in the field log. It should be noted that all direct-reading instruments have limitations in their ability to detect hazards and no one instrument will detect all possible hazardous compounds. Thermoluminescent dosimeter badges, which are required to be worn by all personnel working at the Y-12 Plant, provide Health Physics Department personnel with radiological exposure data. Abnormally high exposure information will be reported to the SHSO and appropriate investigations conducted as necessary.

9.7 SITE CONTROL MEASURES

The following sections will be used to determine work zones for UEFPC OU 3. These zones will be established individually at each sampling location.

9.7.1 Zone 1: Exclusion Zone

The exclusion zone is the area where the greatest potential exists for exposure to contamination (Fig. 9.1). All activities that take place at the investigation site require the use of the “buddy system.” All personnel entering the exclusion zone will wear the prescribed level of protective clothing, as determined by the SHSO. An entry and exit checkpoint will be visually defined at the periphery of the exclusion zone to regulate the flow of personnel and equipment. The entry and exit checkpoint will be delineated with the use of ropes, flags, or signs at the discretion of the Site Project Manager, the Site Field Team Leader, and/or the SHSO. Entry into the contamination reduction zone or the exclusion zone is prohibited without the approval of the Site Project Manager or SHSO.

Prohibited personnel, items, and conduct in the exclusion zone include the following:

- beards and long sideburns (if respiratory protection is required);
- drinking, eating, smoking, or chewing anything;
- personal articles (e.g., watches and rings);
- failure to inform the Site Field Team Leader or SHSO of any illness that could affect safety or cause health-related complications;
- removal of respiratory protective equipment;
- access to the exclusion zone by any individual without the required health and safety training, in accordance with OSHA regulations 29 *CFR* 1910.120(e)1 and (e)2;
- any individual who does not possess the appropriate badge to gain entrance to the site;
- any conduct or item thought to be potentially dangerous to the well-being of the field team or the drilling subcontractor; and
- application of insect spray or cosmetics, because interaction of these substances with other chemicals is possible.

9.7.2 Zone 2: Contamination Reduction Zone

As shown in Fig. 9.1, a contamination reduction zone is established outside the exclusion zone to provide a transition from and a buffer between the exclusion zone (potentially contaminated zone) and the support zone (clean zone). The contamination reduction zone provides additional assurance that the

Fig. 9.1. Diagram of site work zones showing exclusion zone, contamination reduction zone, and support zone.

physical transfer of contaminating substances on personnel or equipment or in the air is limited through a combination of decontamination, distance between exclusion and support zones, air dilution, zone restrictions, and work functions. At the boundary between the exclusion and contamination reduction zones, personnel decontamination stations will be established and constructed as detailed in Sect. 9.8. Section 9.8 also establishes equipment decontamination procedures.

9.7.3 Zone 3: Support Zone

The support zone (clean zone), shown in Fig. 9.1, will be marked and protected against contamination from the work site. Primary functions of the support zone follow:

- the entry area for personnel, material, and equipment;
- the exit area for decontaminated personnel, materials, and equipment;
- a storage area for clean safety and work equipment; and
- an area for rest breaks, consumption of food and beverage, and all other activities.

Additionally, the following policies will be implemented during sampling activities.

- Eating, drinking, chewing gum or tobacco, smoking, or applying cosmetics are prohibited in the exclusion zone and the contamination reduction zone or wherever the possibility exists for the transfer of contamination.
- Contact with potentially contaminated substances should be avoided. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling on the ground, leaning or sitting on equipment or the ground. Do not place monitoring equipment on a potentially contaminated surface (i.e., ground).
- Spillage should be prevented to the extent possible. In the event that a spillage occurs, contain the liquid, if possible, and notify the Site Project Manager.
- Splashing of contaminated materials should be prevented.
- All field crew members should use their senses (all senses) to alert them to potentially harmful situations.
- Good housekeeping should be practiced. Everything should be kept orderly and out of potentially harmful situations.

- Field crew members must be familiar with the physical characteristics of investigations, including:
 - wind direction in relation to the individual's location;
 - accessibility to associates, equipment, and vehicles;
 - communications;
 - the exclusion zone and any areas of known or suspected contamination;
 - site access; and
 - the nearest drinking water sources.
- The number of people and equipment in the exclusion zone should be minimized in accordance with workspace requirements for safe site operation.
- All waste generated during UEFPC OU 3 RI sampling activities will be disposed of in accordance with the WMP.
- All injuries should be reported, no matter how minor.
- All workers in the contamination zone will maintain verbal contact with fellow workers or maintain visual contact if site conditions make hearing difficult.
- Each person will make his/her presence known to the Site Project Manager or the Field Team Leader daily, and changes in personnel will be noted. A list of workers on the job site will be maintained in the field logbook for accountability.
- When wearing chemical-resistant clothing and/or using respiratory protective equipment, employees will take frequent breaks to avoid heat/cold stress while working in hazardous environments.
- Wear the appropriate level of protection as defined in the Health and Safety Plan or as otherwise recommended by the SHSO.
- Enter and exit through designated entrances and exits.
- Know the limitations of all PPE being used.

9.8 DECONTAMINATION PROCEDURES

9.8.1 Personnel Decontamination Procedures

Personnel decontamination procedures are designed to eliminate/limit the contaminated materials workers may encounter and to limit the spread of contaminated materials from the exclusion zone and contamination reduction zone. Decontamination procedures for C, D+, and D levels of protective equipment are included and are quite similar. The SHSO is responsible for the establishment of the exclusion, contamination reduction, and support zones. In addition, the SHSO will construct a decontamination station on-site and will instruct personnel in its proper use. Individuals involved in personnel decontamination will wear the same level of PPE as the field personnel unless otherwise instructed by the SHSO. Figures 9.2 and 9.3 depict minimum requirements of the decontamination stations.

The following procedures have been provided as **guides** for personnel decontamination and, dependent upon site conditions, may be modified by the SHSO if improvements are needed. These guides are worst-case scenarios; therefore, all personnel will check with the SHSO to determine the site-specific requirements.

9.8.1.1 Level D protection decontamination

Station 1: Segregated equipment drop.

Deposit equipment used on-site (tools, sampling devices, containers, monitoring equipment, clipboards, etc.) on a plastic drop cloth or a container with a plastic liner.

Equipment necessary:	containers
	plastic liners
	55-gal compatible waste drum

Station 2: Outer garment, boots, gloves, hard hat, safety glasses, and scrubbing and rinsing tools and agents.

Scrub outer boots and gloves with a laboratory-grade detergent (Liquinox or equivalent) and rinse with potable water. Disposable boots and gloves need not be scrubbed and may be disposed of in the compatible waste drums. Clean safety glasses and hard hat in the same fashion. All decontamination should take place while personnel are standing in large wash tubs, if decontamination of boots is required, so that all decontamination solutions can be caught and drummed in accordance with the WMP.

Fig. 9.2. Minimum decontamination requirements for Level D + protection.

EXCLUSION ZONE

Fig. 9.3. Minimum decontamination requirements for Level C protection.

Equipment necessary:	two or three wash tubs one hand-pump sprayer water detergent scrub brushes paper towels 55-gal drum with liner for paper towels and protective clothing
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Station 3: Boot, glove, safety glasses, and hard hat removal.

Boots, gloves, safety glasses, and hard hats are removed.

Station 4: Frisking.

All personnel will be frisked (a radiological screening) prior to leaving the contamination reduction zone for the support zone to ensure that no radiological contamination is transferred to the support zone.

Equipment necessary:	alpha detector beta/gamma detector
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Station 5: Field wash.

Thoroughly wash hands and face. Shower as soon as possible.

Equipment necessary:	water wash basin/bucket soap
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9.8.1.2 Level D+ protection decontamination

Follow the above steps for Level D decontamination; the only difference is the removal of the disposable chemical protective coverall at Station 3 and depositing of the coverall in a lined 55-gal compatible waste drum. Level D+ protective clothing is deemed necessary when sampling operations may produce excessive splashing of surface or subsurface materials, yet the action level does not require the use of a respirator and taped, protective chemical-resistant suits.

9.8.1.3 Level C protection decontamination

Station 1: Segregated equipment drop.

Deposit equipment used on-site (tools, sampling devices, containers, monitoring instruments, clipboards, etc.) on plastic cloths or in different containers with plastic liners. Each piece of equipment will be decontaminated to a different degree, which is the reason for separating the equipment. Segregation of the equipment at the drop site reduces the possibility of cross-contamination.

Equipment necessary:	various containers
	plastic liners
	plastic drop cloths
	55-gal lined compatible waste drum

Station 2: Outer garment, boots, and gloves scrubbing and rinsing.

Scrub used outer garment, boots, and gloves with laboratory-grade detergent and water and rinse with potable water. All wash water and rinsing solutions will be disposed of in accordance with the WMP. *Note: This station is not necessary when disposable PPE is used.*

Equipment necessary:	wash tubs
	water
	detergent
	scrub brushes
	one-hand pump sprayer

Station 3: Outer garment, boot, and glove removal.

Remove used outer garment, boots, and outer gloves with accompanying tape. Tape and disposable gloves should be placed in a plastic trash bag and disposed of in accordance with the WMP. Reusable outer garments and boots will be placed in plastic bags for screening by Health Physics. This equipment must be scanned and green-tagged before reuse is possible. *Note: This station is not necessary when disposable PPE is used.*

Equipment necessary:	plastic trash bag
	bench or stool

Station 4: Canister/cartridge change.

If a worker has left the exclusion zone for the sole purpose of changing a canister/cartridge of the respirator, this is the last step of the decontamination procedure. Once the worker's canister/cartridge has been replaced, the outer boots and gloves may be retaped so that all potential pathways to the skin are sealed. The used canister/cartridge will be placed in the plastic bag and will be disposed of in accordance with Chap. 11 of this document.

Equipment necessary:	respirator cartridges/canisters
	tape
	extra gloves
	boot covers (if worn)
	plastic trash bags

Station 5: Disposable outer garment and shoe cover removal.

Remove disposable shoe covers and outer garment, deposit them in a plastic trash bag, and dispose of them in accordance with the WMP.

Equipment necessary:	bench or stool
	plastic trash bags

Station 6: Respiratory protection and disposable inner glove removal.

The respirator is the next-to-last item for removal. The cartridges/canisters are placed in a plastic trash bag and disposed of in accordance with the WMP. The respirator is placed in a plastic bag dedicated for used respirators only. It may not be reused because of the single-use respirator policy. Respirators will be scanned and tagged by Health Physics and returned to ORNL Industrial Hygiene. Remove disposable inner gloves last and deposit them in a plastic trash bag, in accordance with the WMP.

Equipment necessary:	plastic trash bags
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Station 7: Frisking.

All personnel will be frisked (a radiological screening) prior to leaving the contamination reduction zone for the support zone to ensure that no radiological contamination is transferred to the support zone.

Equipment necessary: alpha detector
 beta/gamma detector

Station 8: Field wash.

Wash hands and face thoroughly with soap and water.

9.8.2 Equipment Decontamination

The equipment decontamination personnel at UEFPC OU 3 may be exposed to a variety of potential hazards. Some of the potential contaminants of concern are outlined in Table 9.2. This table identifies potential contaminants known at the time of publication.

Decontamination personnel will be responsible for conducting decontamination of all equipment used for the soil, water, and sediment sampling. Personnel decontamination procedures are outlined in Sect. 9.8.1. Equipment decontamination will generally require Level D+ protective equipment, including eye protection. Decontamination personnel may be exposed to splash or backspray during cleaning operations; therefore, protective clothing or a protective apron will be worn in addition to a face shield mounted on a hard hat. Because of high noise levels emitted from the hot-water washer, hearing protection will be required, as directed by the SHSO and dependent upon the location and placement of the decontamination trough during operation.

9.8.2.1 Discussion

This procedure applies to all equipment that comes in contact with surface and subsurface sample material (i.e., water dippers, sample mixing pans, scoops and trowels, continuous split-barrels, and hand augers).

9.8.2.2 Equipment

A list of equipment required for the decontamination process follows:

- PPE
- potable water;
- plastic tubs or buckets;
- scrub brushes;
- wire brush;
- disposable wipes;

- laboratory detergent (such as Liquinox or equivalent, phosphate free);
- plastic bags;
- deionized water in stainless steel sprayers;
- ultrapure isopropyl alcohol;
- hot-water washer with washing trough;
- 55-gal bung-top drums (to containerize all wash water);
- sheet plastic;
- aluminum foil; and
- Ziploc-type bags.

9.8.2.3 Procedure

All sampling equipment should either be washed in a bucket containing laboratory-grade detergent or in the decontamination trough. However, if sampling equipment is muddy, it should be rinsed with high-pressure hot water/steam prior to washing. The decontamination trough is designed to collect all spoils from sampling equipment and drain them into a containment reservoir. The wash solutions are transferred to a 55-gal drum. Steps 4 and 5 in the decontamination sequence below will be performed in a dedicated containment reservoir to segregate those solutions for waste minimization purposes. The decontamination trough is shown in Fig. 9.4.

The following sequence will be used to decontaminate sampling equipment:

- Wash and scrub equipment with laboratory-grade detergent and potable water.
- Rinse with potable or deionized water.
- Rinse with deionized water.
- Move equipment to isopropyl rinsing trough.
- Rinse with ultrapure isopropyl alcohol, at -70% concentration.
- Rinse with deionized water.

Fig. 9.4. Decontamination trough.

- Drain or capture all drilling spoils and associated solutions and transfer into a 55-gal drum. A 55-gal drum is used to contain fluids from the decontamination trough. A separate poly-lined 55-gal drum is used to contain isopropyl trough rinse water.
- Move to drying area/table and air dry.
- Wrap in aluminum foil if not immediately used.

The liquid generated by the cleaning operation must be containerized with other decontamination waste for appropriate disposal. All decontamination should take place in a separate staging area. Cleaned equipment may be temporarily placed on a polyethylene sheet away from high-traffic areas to avoid contamination. Care must be taken in the selection of the staging decontamination area to avoid fugitive dust, fuel oils, gasoline, organic solvents, or other airborne sources of contamination. All sampling equipment must be cleaned and washed prior to use. These instruments may be wrapped in aluminum foil or placed in Ziploc-type bags or plastic for protection from possible contamination prior to their use.

9.9 SITE OPERATING PROCEDURES

Operations at this site during the environmental assessment will include surface and subsurface soil sampling and groundwater sampling. The procedures for correctly conducting these operations are included in the Field QAPjP, which can be found in Chap. 8 of this report.

9.10 SPECIAL HAZARD PROCEDURES AND CONTINGENCY PLAN

The Site Shift Superintendent at the Y-12 Plant coordinates 24-h emergency response coverage from the Plant Protection and Shift Operations Division. The Shift Superintendent on duty is assisted by a well-trained plant emergency squad and is the overall coordinator responsible for directing the response to emergencies such as fires, major equipment failure, hazardous materials releases or spills, natural disasters, sabotage, etc.

9.10.1 Shift Superintendent

EMERGENCIES: Plant Phone: 911 (Site telephone number)

Off-Normal Occurrences: 574-7172 (cellular telephone number)

Radio Number: Station No. 9

Contact the Shift Superintendent first. The Shift Superintendent is the trained emergency response director.

Listed below are emergency groups and their telephone numbers. A cellular phone may be present in the field and available for use when workers are not in close proximity to a plant phone or radio.

Guard Department	574-7272
Health Physics	574-3547
Industrial Hygiene	576-7182
Medical	574-1577
Safety	574-1562

9.10.2 Emergency Preparedness

Information in this section was obtained from the Y-12 Plant Emergency Preparedness Department.

The Shift Superintendent on duty is the designated Plant Emergency Director who is responsible for coordinating and responding to all emergency situations. The SHSO or the Site Project Manager will notify or assign someone to notify the Shift Superintendent of an emergency situation as soon as possible.

9.10.2.1 Reporting an emergency

Telephone

- If a plant telephone is accessible, dial **911**. With a cellular phone, dial **574-7172**. With a plant radio, call station **9**.
- Describe the type of emergency.
- Identify the location of the emergency.
- Identify who is calling.
- Identify the number on the phone being used.
- *In case of an injury, tell whether an ambulance is needed.*
- Listen to and follow any instructions that are given.
- Do not hang up until *after* the emergency control center has hung up.

Fire Alarm Pull Boxes. Pulling a fire alarm box automatically transmits the location of the emergency to the Fire Department and the Emergency Control Center. The person pulling the alarm should remain at the alarm box and supply any needed information to the responding emergency squad.

Radio. By calling **Station 9**, the Shift Superintendent will be alerted of the emergency.

- Report the emergency.
- Report the type of emergency.
- Report the location of the emergency.
- Identify who is calling.
- Identify the radio station number.
- Listen for any instructions.

9.10.2.2 Alarm signals

Evacuation Alarms. Evacuation alarms are denoted by a steady or continuous sounding from the plant public address system. The SHSO or Site Project Manager will designate the evacuation routes. Evacuate the site or area and proceed to the assembly point defined by the SHSO or Site Project Manager to await further instructions. The assembly point will be designated during the site briefing.

Radiation Alarms. Radiation alarms are denoted by a steady sound from a clarion horn and rotating red beacon lights. Evacuate the site or area and proceed to the assembly point defined by the SHSO or Site Project Manager to await further instructions.

Take-cover Alarms. Take-cover alarms are denoted by the intermittent or wailing siren sound from the plant public address system. Seek immediate protective cover in a strong sheltered part of a building. Evacuate mobile structures to a permanent building.

Standard Alerting Tone. The standard alerting tone is a high/low tone from the plant public address system. Listen carefully; an emergency announcement will follow.

9.10.2.3 Evacuation procedures

Evacuation of nonemergency response personnel (full or partial) is ordered by the Site Emergency Director (SED) whenever it is determined that a threat to the safety of site personnel exists. Directions on the specific evacuation routes will be provided by the SED. Evacuation is generally by individually owned vehicles. The appropriate decision of a reassembly area and evacuation route is determined based upon site conditions, wind direction, and weather. Suggested evacuation routes are shown in Figs. 9.5 and 9.6.

Fig. 9.5. Evacuation routes from UEFPC OU 3 sites.

Fig. 9.6. Evacuation route to local hospital.

- The site evacuation and possible shutdown instructions will be given over the public address system. The evacuation tone signal is a steady siren over the public address system or continuous sounding of local evacuation devices.
- If the signal is sounded over the public address system, personnel should secure any classified documents for which they are responsible, evacuate buildings to the nearest assembly station, and wait for further instructions.
- If a shutdown is directed, proceed according to the appropriate department standard operating procedure.
- Those employees not responsible for shutdown activities should leave the site.
- When the shutdown is complete, personnel who participated in the shutdown should leave the site.
- The portals will be locked, and the turnstiles will be left in the exit-only mode. If any of the crash gates in the perimeter fence are used be sure they are closed after you exit.
- After a site evacuation, employees should monitor radio and TV stations. These media may be the only available to the site for communication with employees.
- When the “all-clear” announcement is made or a request is made from the company, employees should immediately report to their regular work locations.

9.10.2.4 Important reminders

- Know the telephone number of the Site Shift Superintendent, **574-7172, 911, or station 9.**
- Know how to summon an ambulance: Dial **911** and give the location. Wait to meet the arrival of the first-aid personnel.
- Know the quickest way to summon the plant emergency squad: Pull a fire alarm box and wait for the arrival of the Emergency Response Team.

9.11 SPECIAL HAZARD PROCEDURES

9.11.1 General

All accident incidents or injuries will be immediately reported to the SHSO. Additionally, the following procedures will be implemented.

- First aid or other appropriate initial action will be administered by properly trained personnel who are closest to the incident. This assistance will be conducted in a manner that ensures that those rendering assistance are not placed in a situation of unacceptable risk.
- All incidents will be reported to the SHSO. The SHSO is responsible for coordinating the emergency response in an efficient, rapid, and safe manner.
- If either the SHSO or his/her qualified designee determines that evacuation is necessary, all personnel will assemble in the support zone and will be accounted for at that time.
- Radiation incidents will be reported to the SHSO.

The following emergency equipment will be available at the site:

- Industrial first-aid kits
- ABC multipurpose dry chemical fire extinguishers
- Spill kit containing absorbent materials, booms, and absorbent cloth.

9.11.2 Response to Specific Situations

Emergency procedures for specific situations are given in the following paragraphs.

9.11.2.1 Worker injury from splash

If the injury to the worker is chemical in nature, the following first-aid procedures are to be instituted:

- Eye exposure - If solids or liquids get into the eyes, the eyes should be washed immediately using large amounts of potable water and occasionally lifting the lower and upper lids. Wash for at least 15 min. Obtain medical attention immediately.

- Skin exposure - If contaminated solids or liquids get on the skin, promptly wash the contaminated skin using soap or mild detergent and water for at least 15 min. Obtain medical attention immediately when exposed to concentrated solids or liquids.

9.11.2.2 Fire

Dry chemical ABC fire extinguishers (10 lb to 20 lb) will be provided at convenient locations on the site. If a localized fire breaks out, immediately notify the SHSO or your supervisor. Dry chemical fire extinguishers may be used to extinguish or control small fires. If necessary and feasible, a fire blanket, soil, or other inert material may be placed on the burning area to extinguish flames and to minimize the potential for spreading.

Contractor personnel are not professional fire fighters and, as such, are not expected or required to risk their health or safety in order to fight a fire.

9.11.2.3 Spills

Any spill will be immediately reported to the Shift Superintendent. The Shift Superintendent will issue instructions to contact personnel, based on the nature of the spill. A spill kit will be kept on the site at all times and utilized with consent from the Shift Superintendent. The site crew will be trained in the use of the spill kit materials. Spills to be attended by site crew will be immediately controlled and cleaned up in place using the following steps:

- Achieve containment using sorbent boom, diking material, loose or pillowed amorphous silica absorbent, or a combination of these (soil and other material may be used in an emergency but manufactured absorbent materials are preferred).
- "Spill Kits" will be kept in a close proximity to the work site.
- Pick up spilled material with appropriate absorbent.
- Decontaminate the area (if deemed necessary by the SHSO).
- Containerize sorbent/waste material in DOT/disposal site approved container.
- Arrange transportation, storage, and disposal with Energy Systems Environmental Department.
- All spills will be reported to Y-12 Plant Environmental Compliance and for the Y-12 Plant PSS.
- Spills of radioactive materials shall be reported immediately to Y-12 Plant Health Physics and Y-12 Plant PSS.

**Environmental Restoration Program
Waste Management Plan
for
UEFPC OU 3 RI Work Plan Y-12 Plant
Revision 0**

<hr/> Technical Support Contractor Program Manager	<hr/> Date
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<hr/> Technical Support Contractor Quality Assurance/Quality Control Officer Concurrence	<hr/> Date
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<hr/> DOE-ER Division Program Manager	<hr/> Date
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<hr/> Site ER Waste Management Coordinator	<hr/> Date
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<hr/> Site Health Physics Representative	<hr/> Date
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10. WASTE MANAGEMENT PLAN

10.1 SCOPE

The Waste Management Plan for the UEFPC OU 3 RI will include the management of soil, protective clothing, and decontamination water wastes. Table 10.1 outlines the Environmental Restoration Waste Management Plan for the OU 3 RI conducted by the Y-12 Plant ERD. Investigation-derived Wastes (IDW), waste types, waste categories, estimated generation volumes, and expected contaminants for each waste stream are provided. This waste management plan defines the procedures for segregating, characterizing, and controlling all IDW from the point of generation through treatment, storage, and/or disposal including (1) the processes and methods for sampling, analyzing, characterizing, and certifying IDW; (2) field staging areas (FSA), and permitted or interim status storage areas; (3) waste packaging and labeling procedures; (4) transportation routes and DOT reporting requirements; (5) proposed treatment and/or disposal methods and facilities; and (6) waste minimization and reduction techniques to be used. Waste management plans in support of these RI activities are summarized below.

A temporary decontamination facility will be established to support decontamination of equipment and reduce the potential for cross contamination during sampling activities. All equipment and personnel will be scanned for radioactive contamination before leaving a borehole location. Equipment or PPE exhibiting radioactive contamination will be decontaminated at the borehole location before being moved to another borehole location or returned to the temporary decontamination area. All equipment at each borehole location will be subjected to preliminary cleaning to remove surface dirt or mud that otherwise might be tracked to other areas of the Y-12 Plant.

All unused soil obtained during the drilling of boreholes will be returned to the borehole from which it came, in accordance with EPA guidance for management of IDW (*Guide to Management of Investigation-Derived Wastes*, U.S. Environmental Protection Agency (EPA), publication 9345.3-03RS, January 1992). Any excess soil will be spread evenly around the borehole.

Protective clothing will be scanned for radioactive contamination; if not contaminated, it will be treated as nonhazardous solid waste and will be disposed of in a dumpster provided by Y-12 Plant ERD.

All decontamination water will be contained and pumped into 55-gal drums with bung hole tops or into poly tanks provided by the Y-12 Plant Water Treatment Plant for final disposal. Analysis for process use will be run on the water by the Y-12 Plant Water Treatment Plant. The isopropyl alcohol used as a rinse during decontamination will be contained separately from the decontamination water and allowed to evaporate.

Table 10.1. Environmental Restoration Waste Management Project Plan

Environmental Restoration Waste Management Project Plan Revision No. Draft 1	
1. Project Name: OU 3 Remedial Investigation Conducted by Y-12 Plant ERD Plant: Y-12 Organization: ERD/RI Subcontractor	
2. Responsible Project Manager: TBD	
3. Expected Start/Completion Dates: FY 94	
4. Project Description (Brief): Remedial Investigations at UEFPC to collect subsurface soil samples	
5. Project Participants (for waste management interface only): Waste Generator: Y-12 Plant ERD Waste Handler: RI Subcontractor Waste Transporter: Energy Systems WTSD Interim Waste Storage: RI Subcontractor Permanent Waste Storage: WTSD Waste Treatment: Y-12 Plant Waste Treatment Organization (WTO) Waste Disposal: Y-12 Plant Sanitary Landfill and/or WTSD	

6. Waste Generation:

Waste Stream	Type	Category	Volume (ft ³ or gal)	Contaminants	Characterization Based on:	
					Process Knowledge	Sampling and Analysis
Waste Stream 1 Soil will be returned to borehole it came from. Any remainder will be kept onsite.	Soil	LLW	60 ft ³	Depleted and enriched uranium, nitrates, metals, acids, bases, VOCs	✓	
Waste Stream 2 Decontamination water to be stored in poly containers, analyzed, and returned to AOC or onsite treatment at WETF.	Decontamination water	LLW	110 gal	Depleted and enriched uranium, metals, acids, bases, VOCs	✓	✓
Waste Stream 3 Unused samples from offsite lab DOT container to be received at Y-12 Plant and placed in 90 day accumulation area at DARA facility pending lab analysis.	Solids (clothing)	Sanitary (Dumpster)	15 ft ³	Same as Waste Stream 1	✓	
Waste Stream 4 PPE	Solids (clothing)	Sanitary (Dumpster)	15 ft ³	Same as Waste Stream 1	✓	

Table 10.1 (continued)

Environmental Restoration Waste Management Project Plan
Revision No. Draft 1

7. **Waste Analysis and Characterization:** None to date
8. **Waste Staging Area:** Y/N YES
Location: Parking Lot in Y-12 Plant exclusion zone (Map with location to be included in final plan)
Special Requirements: Flagging around area to segregate drums
9. **Transport Across Public Access Roads:** N Energy Systems will be responsible for transporting drums from accumulation area
Road Involved:
DOT Regulations to be applied: N
Reportable quantities of anticipated DOT-regulated hazardous materials (if required): N/A
10. **Waste Storage Requirements:**
Field Staging Area: Y/N/NA YES - CERCLA staging area
Location: Parking lot in Y-12 Plant exclusion area
Responsible Organization: SAIC
- 90-Day Storage Area:** Y/N/NA NO
Location:
Capacity:
Waste Acceptance Criteria Requirements:
Responsible Organization: Energy Systems
- Permitted (or Interim Status) Storage:** Y/N/NA
Location:
Capacity:
Waste Acceptance Criteria Requirements:
Responsible Organization:
11. **Identification of Potential Treatment Options:** SOIL - NO; CLOTHES - NO
Location: West End Water Treatment Plant - Water
Capacity: 110 gal.
Responsible Organization: Energy Systems, Y-12 Plant WTO
Special Waste Acceptance Criteria Requirements: Analysis for process use
12. **Identification of Potential Disposal Options:**
Location:
Capacity:
Responsible Organization: Energy Systems
Special Waste Acceptance Criteria Requirements: Pass through trash monitoring station before final disposal

Table 10.1 (continued)

Environmental Restoration Waste Management Project Plan
Revision No. Draft 1

13. Waste Minimization and Reduction Techniques to be Implemented:

Segregation: ✓
 In-Field Pretreatment:
 Decontamination:
 Waste Handling (Spill Control): ✓
 Compaction: ✓
 Material Recycle (Solvents, Containers):
 Solvent Substitution:
 Materials Reuse (Solvents, Wash Waters):
 Sludge Dewatering:
 Cutting Fluids Recovery:
 Selection of PPE: ✓
 Selection of Equipment:
 Other:

Description of Special Techniques and Expected Effectiveness:

Effort will be made to minimize all waste generation. An attempt will be made to compact protective clothing that is put into drums. Soil from borings will be returned to the borehole it came from.

Prepared by:**Review:**

Plant Environmental Compliance Organization:
 Central ER Waste Management:
 ER Waste Reduction Manager:

Approvals:

Plant ER Waste Management Organization:	Date:
Plant Waste Management Organization:	Date:
Central Waste Management Organization:	Date:

10.2 GENERAL INFORMATION

Remedial investigation of the UEFPC OU 3 RI is expected to begin in FY 94.

10.3 INVESTIGATION-DERIVED WASTE POLICY

IDWs are expected to be generated during field investigations at the Y-12 Plant. Most of these investigations are expected to involve sampling environmental media containing low concentrations (parts-per-million to parts-per-billion range) of hazardous and radioactive constituents; only a small amount of work is likely to involve handling, sampling, and/or testing materials that contain high levels of contamination. This section presents an approach to decontaminating equipment and sampling devices. Decontamination of these items will be conducted at a temporary facility.

DOE Order 5400.1 requires that each facility identify and report on proposed waste minimization techniques that are technically and economically practicable. In accordance with this order, the RI subcontractor will incorporate waste minimization considerations into the design of its temporary decontamination facilities. IDW minimization considerations incorporated into the decontamination facility design are discussed below.

- The decontamination facility must be constructed in a manner that will prevent decontamination effluent from entering surface and subsurface drainage systems and that ensures that all effluent is controlled and drummed.
- Clean waste should be kept separate from contaminated waste materials that have come in contact with soil, groundwater, surface water, or sediment. The contaminated waste should be segregated according to medium and level of contamination. Liquid waste should be contained separately from soil and solid waste, and solid waste such as PPE should be contained separately from soil waste. All forms of liquid wastes should be segregated and contained separately. Decontamination water will be analyzed and returned to AOC or treated on-site at WETF.
- Sludge will be returned back to the original borehole. However, when sludge is associated with liquid waste, as in the case of steam-cleaning hollow-stem augers, dewatering should be conducted to reduce the amount of liquid in the sludge. This dewatering step could be as simple as placing the sludge in a 5-gal bucket with a very small hole in the bottom and then placing the bucket on top of a 55-gal drum and allowing the water to drain through the small hole into the 55-gal drum. The dewatered sludge would be placed in a separate container.
- Solid waste should always be compacted.
- The facility should be designed so that contamination zones are clearly identified.
- The facility must have an emergency spill response kit.

- The facility must have a containment wall to contain spray from steam-cleaning operations.
- The facility must prevent precipitation from accumulating on the pad and in the sump. For example, the facility could be covered with plastic when not in use.
- The facility should be designed so that equipment flows in only one direction (i.e., from dirty side to clean side).

10.3.1 Anticipated Decontamination Activities

Field activities conducted by the RI subcontractor on the Y-12 Plant will require decontamination of equipment, sampling devices, the outside portion of sample containers, and personnel. The subcontractor's project Health and Safety Officer will be responsible for personnel decontamination, which will not be permitted in the same wash tubs used for equipment decontamination. To decontaminate sample containers, the RI subcontractor will follow the procedures outlined in the Energy Systems Procedures, ESP-900 Part VII D. Decontamination of equipment and sampling devices will be accomplished in accordance with ESP 900 and ESP 901.

10.3.2 IDW

Liquid, soil, and solid waste resulting from decontamination activities will be managed to ensure protection of human health and the environment and comply with ARARs and placed in appropriately labeled drums. The RI subcontractor will obtain empty drums from the ER Division Project Manager. In the event that Energy Systems is unable to supply drums, they will be supplied by the drilling subcontractor.

10.3.3 Temporary Decontamination

The RI subcontractor will construct temporary decontamination facilities at each project site capable of supporting all routine decontamination activities that are expected to be required to support project field investigation activities. These areas must meet the waste minimization criteria described in Sect. 10.3. Temporary pads consisting of diked areas with plastic sheet liners will be set up to allow decontamination of small sampling devices such as hand augers and bailers. If necessary, larger temporary decontamination pads will be set up to allow steam-cleaning of auger drill rig equipment. The larger decontamination pads will contain a diked area for collecting and accumulating waste water and will be segregated from the small sampling pads to minimize potential for cross contamination caused by steam cleaner spray. The temporary pads will have a removable sediment trap and will be sloped (1/4 in./ft) toward the drain or sump to allow a collection point for wastewater. Decontamination wastes will be collected in drums or poly containers supplied by the ER Division Field Operations Coordinator, analyzed, and returned to AOC or sent for on-site treatment at WETF.

Before a temporary decontamination facility is constructed, a plan outlining the design and location will be approved by the RI subcontractor project manager and the ER Division Project Manager. The location of the temporary decontamination facility must be selected carefully to avoid fugitive dust, fuel oils, gasoline, organic solvents, or other airborne sources of contamination.

10.4 HISTORY AND EXPECTED CONTAMINANTS

Facility history and expected contaminants are presented in Chap. 2 of this report. An all-inclusive list of contaminants expected to be encountered by the RI subcontractor personnel during field activities would be unrealistic. Typical contaminants of concern include radionuclides (depleted and enriched uranium, ⁹⁹Tc), metals (Hg, Pb, Cr, Be), organics (PCBs, trichloroethene, tetrachloroethene, TCE, PERC, petroleum products), and nitrates.

10.5 APPLICABLE REFERENCE DOCUMENTS

The applicable laws governing waste management and related activities at the Y-12 Plant include the following:

- The Atomic Energy Act of 1954, Public Law (P.L.) 83-703, as amended
- The National Environmental Policy Act (NEPA) of 1969, P.L. 91-190, as amended
- The Resource Conservation and Recovery Act (RCRA) of 1976, P.L. 94-580, as amended
- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, P.L. 96-510, as amended
- The Toxic Substances Control Act (TSCA) of 1976, P.L. 94-469, as amended
- The Water Pollution Control Act (Clean Water Act) of 1972, P.L. 92-500, as amended
- The Safe Drinking Water Act of 1974, P.L. 93-523, as amended
- The Air Pollution Control Act of 1955, P.L. 84-159; the Clean Air Act of 1963, P.L. 88-206; the Air Quality Act of 1967, P.L. 90-148; Clean Air Act Amendments of 1970, P.L. 91-604; Clean Air Act of 1977, P.L. 95-190; and the Clean Air Act Amendments of 1990, P.L. 101-549; as amended
- The Occupational Safety and Health Act of 1970, Public Law 91-596, as amended
- The Transportation Safety Act of 1974, P.L. 93-633, as amended

- The State of Tennessee Water Quality Control Act, Tennessee Code, Title 69--Waters, Waterways, Drains and Levees, Chapter 3: Water Pollution Control; enacted by Tennessee Public Act of 1971, Chapter 164, as amended
- The Tennessee Solid Waste Disposal Act, Tennessee Code, Title 69--Waters, Waterways, Drains and Levees, Chapter 3; Water Pollution Control; enacted by Tennessee Public Act of 1971, Chapter 164, as amended
- The State of Tennessee Hazardous Waste Management Act, Tennessee Code, Title 68--Safety and Health, Chapter 46: Hazardous Waste Management; enacted by Tennessee Acts of 1977, Chapter 175, as amended
- The State of Tennessee Petroleum Underground Storage Tank Act, Tennessee Code, Title 68--Safety and Health, Chapter 53: Petroleum Underground Storage; enacted by Tennessee Acts of 1988, Chapter 984, as amended.

10.5.1 Regulations

Numerous federal and state regulations, including DOE Orders, derive their authority from, and provide standards for, regulation of provisions contained in the foregoing laws. Regulations relevant to various aspects of waste management at the Y-12 Plant include the following:

- DOE Order 5440.1C, "National Environmental Policy Act"
- DOE Order 5480.1A, "Environmental Protection, Safety, and Health Protection Programs for DOE Operations"
- DOE Order 5440.1B, "Implementation of the National Environmental Policy Act" canceled and replaced by: DOE Order 5440.1C, "National Environmental Policy Act", 4-9-85
- DOE Order 5480.1A, "Environmental Protection, Safety, and 6/22/82 Health Protection Programs for DOE Operations"
- DOE Order 5480.10, "Contractor Industrial Hygiene" 2/25/86
- DOE Order 5482.1B, "Environmental Safety and Health Appraisal"
- DOE Order 5483.1A, "Occupational Safety and Health Program for DOE" canceled and replaced by: DOE Order 5483.1A: Occupational Safety and Health Program for DOE, 6/24/83
- DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements" 5/5/82

- DOE Order 5500.2A, "Emergency Planning, Preparedness, and Responses for Operations" canceled and replaced by DOE Order 5500.2A "Emergency Notification, 4/13/88
- DOE-ORO Notice 5500.2A, "Procedures for the Classification, Notification, and Reporting of Emergency and Nonroutine Events"
- DOE Order 5820.2A, "Radioactive Waste Management"
- Nuclear Regulatory Commission (NRC) Regulation 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste"
- DOE Regulation 10 CFR 1021, "Compliance with the National Environmental Policy Act"
- U.S. Environmental Protection Agency (EPA) Regulation 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants"
- EPA Regulation 40 CFR 122, "National Pollutant Discharge Elimination System"
- EPA Regulation 40 CFR 136, "Regulations on Test Procedures for the Analysis of Pollutants"
- EPA Regulation 40 CFR 141, "National Primary Drinking Water Regulations"
- EPA Regulation 40 CFR 142, "National Primary Drinking Water Regulations Implementation"
- EPA Regulation 40 CFR 143, "National Secondary Drinking Water Regulations"
- EPA Regulation 40 CFR 190, "Environmental Radiation Protection Standards for Nuclear Power Operation"
- EPA Regulation 40 CFR 191, "Environmental Radiation Protection Standards for Management, and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Wastes"
- EPA Regulations, Title 40, "Protection of Environment," Subchapter I, "Solid Waste," Parts 240 through 299
- EPA Regulations, Title 40, "Protection of Environment," Subchapter I, "Superfund Programs" Parts 300 through 399
- EPA Regulations, Title 40, "Protection of Environment," Subchapter R, "Toxic Substances Control Act," Parts 700 through 799
- Council on Environmental Quality (CEQ) Regulations, Title 40, "Protection of Environment," Parts 1500 through 1508, "Regulations on Implementing National Environmental Policy Act Procedures"

- Guide to Management of Investigative-Derived Wastes, OSWER Directive 9345.3-03FS, January 1992.
- Department of Labor (DOL) Regulation 29 CFR 1910, "Occupational Safety and Health Standards"
- Department of Transportation (DOT) Regulations, Title 49, "Transportation," Subchapter C, "Hazardous Materials Regulations," Parts 171 through 179
- Tennessee Department of Environmental and Conservation (TDEC) Regulations Chapter 1200-1-11, "Hazardous Waste Management Rules"
- TDEC Regulations Chapter 1200-1-7, "Solid Waste Regulations"
- TDEC Regulations Chapter 1200-4-1, "General Regulations"
- TDEC Regulations Chapter 1200-4-3, "Water Quality Criteria"
- TDEC Regulations Chapter 1200-4-5, "Effluent Limitations and Standards"
- TDEC Regulations Chapter 1200-1-15, "Underground Storage Tank Program"

10.5.2 Energy Systems Policies, Standards, and Procedures

- ESS-EP-125 - Management of Polychlorinated Biphenyls (PCBs) (IAD)
- ESS-ENV.1 - Environmental, Safety, Health, and Waste Management Quality Assurance
- ESS-TR-101 - Transportation and Packaging Safety
- ESP-IH-161 - Worker Protection in Hazardous Waste Operations and Energy Response

10.5.3 Energy Systems Environmental Surveillance Procedures

- ESP-307 - Field Measurement Procedures
- ESP-500 - Manual Chain of Custody Procedures
- ESP-800 - Packaging Environmental Samples for Transportation
- ESP-900 - Cleaning and Decontaminating Sample Containers and Sampling Devices

- ESP-901 - Equipment Decontamination
- ESP-1000 - Waste Management

10.5.4 ER Division Procedures

- ER/C-P1300 - Reporting of Occurrences and Noncompliances for the Environmental Restoration Division
- ER/C-P1301 - Implementation of Training Program Requirements for Environmental Restoration Division Employee
- ER/C-P1719 - Controlling and Documenting Field Changes to Append Field Sampling Plans
- ER/C-P2101 - Preparation of ER Task/Project Specific Waste Management Plans
- ER/YP2102 - Waste Removal and Disposition Through the Y-12 Plant ER Program (Immediate Action Directive)
- ER/Y-P2103(IAD) - Management of Waste Generated from Field Investigation and Sampling Activities at the Y-12 Plant

10.5.5 Waste Management Division Operating Procedures

- WMD-HS-5402 - Intra-Plant Movement of Hazardous Material Old 1430.31 "Intra-Plant Movement of Hazardous Materials"
- SMD-HS-5501 - Off-Site Shipment of Hazardous Waste-Administration
- WMD-OP-2025 - Temporary Outside Storage of Waste Containers
- WSO-OP-2001 - Waste Storage Inspection Requirements
- WSO-OP-2008 - Waste Container Handling and Stacking Operations Old "Handling and Storage of Hazardous Waste"
- WSO-OP-2014 - Corrosion Inspection of Storage Containers
- WTD0-HS-5403 - Asbestos Waste Shipment Tracking and Reporting
- WTD0-HS-5404 - K-25 Site Fill Area I Operations

- WTDO-OP-2006 - Hazardous Waste Manifest and Tracking
- WTO-HS-5502 - Packaging and Verification of Lab. Pack Quantity Waste for Off-Site Old "Waste Verification and Waste Packaging"

10.5.6 Y-12 Plant Procedures and Standard Practices

10.5.6.1 Y-12 Plant Procedures

- 70-303 - Control of Industrial Wastes
- 70-903 - Transfer, Storage, or Disposal of Waste
- 50-41-WT8-2.64 - Hazardous Waste Collection, Packaging, Storage and Disposal

10.6 UEFPC OU 3 RI PROJECT CONTACTS

Project participants involved in the generation, management, and disposal of waste in association with the UEFPC OU 3 RI project are identified in Table 10.1

10.7 WASTE MANAGEMENT

The types of waste most likely to be generated during field investigations on the Y-12 Plant include decontamination fluids, well development/purge water, debris, sludge, soil, solvents/oils, PPE, trash, and miscellaneous uncontaminated solid waste. The RI subcontractor Project Manager will characterize all IDW according to the eight categories identified: (1) RCRA waste, (2) TSCA waste, (3) LLW waste, (4) LLW/RCRA waste, (5) LLW/TSCA waste, (6) LLW/RCRA/TSCA waste, (7) RCRA/TSCA waste, or (8) sanitary/industrial waste. IDW will be stored and managed in a protective manner in an FSA within the AOC until waste is characterized using analytical results.

10.7.1 Decontamination Fluids Handling

All decontamination fluids (water/isopropyl alcohol and water/soap) will be collected in polyethylene containers, 17E bung-top drums sampled and stored in AOC pending characterization from analytical results. Aqueous water/soap solutions derived from decontamination activities will be segregated from aqueous water/soap solution. All aqueous liquids will be labeled according to Sect. 10.8 of this WMP.

10.7.2 Well Development/Purge Water

Well development/purge water derived from RI activities will be segregated from other liquid waste and placed in 17E bung-top drums or polyethylene tanks, as determined by Y-12 Plant WTSD. Drums and poly tanks will be labeled according to Sect. 10.8 of this WMP.

10.7.3 PPE Management

PPE will be scanned for radioactivity by a Health Physics Technician and will be segregated accordingly to findings prior to being containerized. After scanning, sanitary (nonhazardous, non-low-level) PPE will be placed in trash bags after use and accumulated in the FSA. The bags of PPE will then be placed in new 55-gal DOT-specification 17C open-top drums. The sanitary PPE drums will be labeled in accordance with Sect. 10.8 of this WMP and will be staged in the FSA pending TSD.

After scanning, used low-level radioactive PPE will be segregated from the sanitary PPE and placed in bags and accumulated in a registered Low-Level Waste Staging Area. The Low-Level Waste Staging Area is to be approved and registered by the Y-12 Plant Environmental Management Division. Low-level wastes will be placed in B-25 boxes as determined by the K-25 ER WCO. An inventory is to be maintained of all low-level radioactive items placed into B-25 boxes. The inventory will be submitted with the disposal form to the Y-12 Plant WDC for TSD. The low-level radioactive PPE boxes will be labeled in accordance with Sect. 10.8 of this WMP.

10.7.4

Soil produced from RI activity will be returned to boring pit, or source immediately after generation. This action is in compliance with EPA IDW policy. The soil will be left onsite until a final remedial alternative is selected.

10.8 CONTAINERIZING AND LABELING REQUIREMENTS

Wastes generated by the RI subcontractor during field investigations and sampling activities may be collected, disposed of immediately, or provided some level of interim storage management. Until the IDW is positively identified as a RCRA hazardous waste, the subcontractor Field Operations Manager must manage IDW in a protective manner but not necessarily in accordance with RCRA Subtitle C requirements. Under CERCLA, IDW may be stored in a container within the area of concern (AOC) and returned to its source without meeting the specified Land Disposal Restriction (LDR) treatment standards. When IDW is disposed of offsite or is transported on public roads, DOT requirements for manifesting, containerizing, labeling, and transporting waste may apply. Samples collected and shipped for analysis are exempt from the RCRA packaging, labeling, manifesting, and transportation requirements. These samples will be managed in accordance with approved procedures.

10.8.1 Containerization

Containers used to store RCRA waste, TSCA waste, and LLW will comply with the DOT regulations specified in 49 *CFR* 171-179 for hazardous and radioactive waste as appropriate. LLW will be packaged according to DOE Order 5820.2A and 49 *CFR* 273. Each container type will be reviewed for compatibility with wastes before use. IDW will be placed only in containers approved by the Y-12 Plant Waste Management Organization.

Oak Ridge Y-12 Plant PP 70-903, "Transfer, Storage, or Disposal of Waste," contains specific instructions for selecting the type of container for the waste type being containerized. The SAIC Project Manager will coordinate with the Y-12 Plant WDC to ensure appropriate containers for the waste generated are used. Subcontractor drilling teams normally will provide containers for their field activities; however, the subcontractor Project Manager will obtain containers for supporting subcontractor field activities and the decontamination pad in the central staging area. Specific container requirements for each category of waste are identified in Table 10.2.

Empty containers that are stored in the central staging area while awaiting use must be kept on clean pallets in good condition.

Accessory equipment required includes pallets (including clean pallets for new containers), vent plugs, bung wrenches, plastic liners for open-top-drums, labels (see labeling section below), PPE, and handling equipment (such as forklifts and/or a pickup or flatbed truck with a hydraulic tailgate and tie-down straps).

10.8.1.1 RCRA hazardous waste container requirements

RCRA hazardous waste will be placed in containers or containers with liners that are compatible with the hazardous wastes being stored. Tanks containing RCRA hazardous waste will have a secondary containment system that includes a liner, a vault, or an equivalent device.

10.8.1.2 TSCA waste container requirements

PCB or TSCA waste containers will comply with the specifications of 49 *CFR* 178. Nonliquid PCB waste will be placed in containers that comply with 49 *CFR* 178.

10.8.1.3 LLW

LLW will be placed in containers that are approved in writing by the Waste Management Officer (WMO).

10.8.1.4 Mixed waste - RCRA/LLW, LLW/TSCA, and LLW/RCRA/TSCA

Mixed waste will be placed in containers compatible with the waste contents and will meet the regulatory requirements for each component of the waste characterization.

Table 10.2. Container requirements for waste categories

Package/Container	Quantity	Waste Type
Bags, boxes, fiber drums	Misc.	Classified clean solid waste
Fiber drums (subject to HP requirements)	Misc.	Classified, compactible radioactive solid waste
DOT 17C drum; DOT 17H drum; or strong, tight metal box for extended storage	Misc.	Classified, noncompactible radioactive waste
DOT 17E or DOT 6D drums	Misc.	Classified clean and radioactive liquid waste
New DOT containers for extended storage (waste and container must be compatible)	Misc.	Classified RCRA hazardous waste
DOT 17E, 55B, and 6D	53-gal	PCB liquids
New bung top spec. container	55-gal	PCB liquids
DOT 17C open top drums	55-gal	PCB solids
Bags, boxes, or fiber drums	small quantities	Compactible solid radioactive waste
Receptacles (normally dumpster pans) provided by Waste Management (WM)	large quantities	Compactible solid radioactive waste
B-25 or B-12 boxes or drums	55-gal	Noncompactible solid radioactive waste (see PP 70-903 for exception/exclusions)
Dot 17E, bung top drum, unlined mild steel	55-, 30-, and 5-gal	small quantities of radioactive liquids (oils)
DOT 6D, bung top drum, polylined	53-, 30-, and 5-gal	small quantities of radioactive liquids (corrosives, solvents)
WM provide containers	220- to 5000-gal	large quantities of radioactive liquids (see PP 70-903)
Boxes, metal drums, or WM provided containers or strapped to pallets	Max 8 × 8 × 20 ft	Radioactive scrap metal (see PP 70-903 for restrictions)
New DOT 6D, bung top, polylined	53- and 30-gal	liquid (small quantities) hazardous waste; oils, corrosives, solvents. Use vent plug for solvents and flammables. For large quantities contact WM.
DOT 17C or 17H drums with poly insert	55-gal	sludges, noncorrosive, and corrosive solids (for quantities greater than 30 cu ft contact WM)
Various special containers	Misc.	Special wastes such as asbestos, pesticides, and beryllium. See PP 70-903 for additional information

10.8.1.5 RCRA/TSCA

RCRA/TSCA waste will be contained in a DOT specification container compatible with the RCRA waste and in compliance with the DOT waste container specification for PCB waste.

10.8.1.6 Sanitary waste

Sanitary waste will be stored and handled in accordance with the generator's agreements with site-specific utilities and maintenance personnel.

10.8.1.7 Empty containers

Empty containers that are stored in the central staging area while awaiting use must be kept on clean pallets in good condition and labeled with an "Empty" label.

Accessory equipment required includes 48- by 48-in. pallets (including clean pallets for new containers), vent plugs, bung wrenches, plastic liners for open-top drums, labels PPE, and handling equipment (such as forklifts and/or a pickup or flatbed truck with a hydraulic tailgate and tie-down straps).

10.9 WASTE ANALYSIS AND CHARACTERIZATION PLAN FOR DISPOSAL

Based on professional judgment, considering the historical use of the area and its proximity to a documented location of contamination, the project manager shall select three of the following indicator parameters for analysis:

- pH (for liquid phase in soil, if < 2 or > 12.5)
- total organic carbon (TOC)
- oil and grease (presence or absence)
- total petroleum hydrocarbons (TPH > 100 ppm)
- conductivity
- total PCBs (25 ppm/2 ppm)
- total metals [concentrations greater than 20 times the Toxicity Characteristic Leaching Procedure (TCLP) criteria, 40 *CFR* 261.24]

- total volatile organic compounds (VOCs) (concentrations > 20 times the TCLP toxicity criteria, 40 *CFR* 261.24)
- total semivolatiles (concentrations > 20 times the TCLP toxicity criteria, 40 *CFR* 261.24)

10.10 WASTE MINIMIZATION

As described in Sect. 10.7, efforts will be implemented to minimize the generation of IDW and to segregate waste generated during the field investigations.

10.11 FIELD STAGING AREAS

The project manager will select an area within the AOC to serve as the FSA for the site. The project manager shall base selection of the FSA on site history and IDW volume estimates by type to be generated during the RI. The FSA will be clearly posted and adequate aisle spacing will be provided. In accordance with this same procedure, a logbook will be maintained to record weekly inspections of the containers stored in this area. Record of any leaks or spills, missing labels, tags, placards, or unusual conditions will be maintained. Inspections will be conducted weekly until completion of remediation activities.

Upon completion of RI activities, the Energy Systems project manager will decide if continued storage of the IDW is appropriate until the remedial action is implemented. Following characterization of wastes that will be transferred to a permitted TSD facility, the project manager will notify the Waste Management organization of the quantities of IDW involved (i.e., those IDW that cannot be returned within the AOC) and will make arrangements for disposition of IDW and transfer of responsibility to the Waste Management organization.

10.12 REQUIRED TRANSPORT ACROSS PUBLIC ACCESS ROADS

IDWs generated during the UEFPC investigations will remain on the Y-12 Plant Reservation and are not expected to be transferred across public access roads. Before transporting waste from the field investigation site for treatment, storage, or disposal, the Project Manager, in coordination with the Y-12 Plant WDC identifies a TSD facility; completes a request for disposal (RFD) package (using Form UCN-2109, Request for Transfer, Storage, or Disposal of Waste or WSIN CALL-IN FORM or State Identification Form--see Y-12 Plant PP 70-903, Appendix A); selects a route of transport; and performs a visual inspection of the waste containers. These activities are described in Sects. 10.11.1 through 10.11.3.

After verifying that all waste transfer requirements have been met, the Y-12 Plant WDC coordinates onsite and offsite waste transportation with Y-12 Plant waste management personnel and the Energy Systems Central Waste Management Division.

10.12.1 TSD Evaluation and RFD Documentation

The WDC prepares an RFD package that includes the original site-approved RFD, copies of analytical results, and supporting documentation (i.e., MSDSs). The WDC reviews the RFD package for technical accuracy, and determines the appropriate TSD option.

10.12.2 Visual Inspection of Waste Containers

The WDC will conduct a visual inspection of waste containers before they are removed from the project site. This review shall determine if transfer standards are met and if wastes are ready for transport. Additionally, the WDC verifies, in accordance with DOT regulations and the EPA waste manifest requirements in 40 *CFR* 262, the following:

- the container count according to the manifest (RFD form for on-site transportation and the EPA uniform Hazardous Waste Manifest for off-site transportation);
- each container is labeled properly, legibly, and in accordance with the instructions provided by the WDC on the manifest;
- the contents of each container have been characterized;
- the containers are sealed securely; and
- each container has been surveyed by health physics personnel for external gross alpha, beta, and gamma radiation and approved for transport. If approval is granted, the WDC shall sign the RFD form and waste container tags.

10.12.3 Transportation

Upon verification that all waste transfer requirements have been met, the WDC coordinates on-site and off-site waste transportation with the Site Waste Management personnel and Central Waste Management Division (CWMD). Waste scheduled for removal from the project site shall be transported on a public thoroughfare to an on-site or off-site TSD facility in accordance with all DOT regulations.

10.13 WASTE STORAGE REQUIREMENTS

Waste stored for on- or off-site disposal (outside an AOC) will be characterized, packaged, and labeled in accordance with the waste acceptance criteria (WAC) associated with the designated waste storage facility.

Under certain circumstances the PM may place IDW within the AOC by returning the waste to its source as described in the scenarios of the ER procedure for management of IDW. If IDW is determined to be a RCRA hazardous waste and subject to LDRs, "land disposal" of the IDW will be prohibited unless specified treatment standards are met. "Land disposal" applies to wastes from different AOCs that are consolidated into one AOC; wastes that are moved outside an AOC (for treatment or storage) and returned to the same or a different AOC; or wastes that are excavated, placed in a separate hazardous waste management unit, and then redeposited into the AOC. However, RCRA waste stored in a container (as defined in 40 *CFR* 260.10) within the AOC and then returned to its source is permissible without meeting the specified LDR treatment standards. This action does not constitute "land disposal" because a container does not constitute a hazardous waste management unit. Therefore, returning IDW that has been stored in containers (not tanks or other RCRA-regulated units) within the AOC will be an acceptable waste management option, as long as containers are not managed in such a manner as to constitute a RCRA storage unit as defined at 40 *CFR* 260.10.

10.14 IDENTIFICATION OF POTENTIAL DISPOSAL OPTIONS AND FACILITIES

The WDC prepares an RFD package that includes the original site-approved RFD, copies of analytical results, and supporting documentation (i.e., MSDS). The WDC reviews the RFD package for technical accuracy, and determines the appropriate TSD option.

10.15 AMENDMENTS

Amendments and revisions to the WM Plan will be documented and submitted to the ER Project Manager for approval.

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Appendix A
CONSTRUCTION AND SURVEY DETAIL

Table A. Monitoring well construction information

Well	North Y-12 Plant GRID	East Y-12 Plant GRID	Ground Elevation	TOC Elev	Total Depth	Type	Top	Bottom	Top Weathered Rock	Top Fresh Rock
56-8A	29466	56456	959.15	962.46	25.6	Screened	20.6	25.6		
56-9A	29533	56043	963.81	965.86	17.3	Screened	12.3	17.3		
GW-190	30776	53254	1030.19	1033.7	26.2	Screened	9.8	25.9	8	
GW-251	29467	53843	1001.6	1003.6	51	Screened	37.5	47.1		32.5
GW-252	29326	53920	1022.66	1024.2	49	Screened	43.8	48.8		
GW-253	29404	54057	1001.6	1004	50	Screened	37	46.6		
GW-254	29546	54132	994.19	996.7	58	screened				
GW-255	29330	53906	1024.27	1027.1	81.5	Screened	71.3	81.3		
GW-256	29542	54116	994.33	996.12	18.5	screened				
GW-261	30914	53094	1047.57	1050	23.7	Screened	18.3	23.7		23
GW-262	30913	53106	1047.32	1049.7	70.6	Screened	60.2	70.6		20
GW-263	30885	53674	1055.13	1057.7	30.8	Screened	25.5	30.8		30
GW-264	30872	53670	1055.54	1058.3	71	Screened	60.5	70.7		33
GW-265	30763	53308	1030.85	1032.7	23.1	Screened	17.5	23.1	10	22
GW-266	30699	53392	1028.87	1031.5	25	screened				
GW-267	30700	53464	1028.81	1031.5	27	screened				
GW-268	30616	53608	1024.13	1026.5	35	Screened	28.1	33.7	2.5	35
GW-269	30649	53779	1025.38	1027.8	30	Screened	23.7	29.4	10	
GW-270	30424	53236	1006.35	1009	18.4	Screened	13	18.4	5	11
GW-271	30435	53234	1006.49	1009	56.3	Screened	45.9	56.3	5	11
GW-272	30485	53737	1006.62	1009.2	16.2	Screened	10.9	16.2	5	15
GW-273	30201	53261	1001.34	1003.5	33.1	Screened	27.8	33.1	5	

Table A (continued)

Well	North Y-12 Plant GRID	East Y-12 Plant GRID	Ground Elevation	TOC Elev	Total Depth	Type	Top	Bottom	Top Weathered Rock	Top Fresh Rock
GW-274	30152	53673	992.94	995.43	35	Screened	28.5	33.9	3	35
GW-275	30151	53688	993.08	995.36	65.5	Screened	54.8	65.2	5	35
GW-508	30281	53148	1009.56	1012.5	15	Screened	2.2	12.5		
GW-617	29806	54756	982.61	985.11	18	Screened	7.3	17.6		
GW-618	29798	54738	982.64	984.94	37	Screened	26.7	37	27	
GW-631	30203	53145	1004.11	1004	16	Screened	5	15		
GW-634	30222	53257	1007.31	1007.2	15	Screened	4.8	14.8	5	
GW-696	29277	56810	969.78	969.78	32.5	Screened	22.5	32.5		
GW-697	29277	56806	969.81	969.81	21	Screened	11	21	21	
GW-698	29277	56804	970.09	970.09	75	Screened	65	75	21	42
GW-699	29168	56844	966.39	971.14	13.9	Screened	3.6	13.9		
GW-700	29452	56828	957.78	960.18	31	Screened	21	31	31	
GW-701	29461	56712	958.2	961.42	25	Screened	15	25	25	
GW-702	29429	56970	955.55	958.44	21	Screened	11	21	21	

Appendix B
SOIL BORING DATA

**Depth versus Concentration of Potential
Contaminants of Concern from the S-2 Site**

Depth versus concentration of potential contaminants of concern from the soil boring B1 at the S2 Site

B-3

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring B1 at the S2 Site

B-4

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring B2 at the S2 Site

B-5

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring B2 at the S2 Site

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring B3 at the S2 Site

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring B3 at the S2 Site

B-8

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring SB-4 at the S2 Site

Depth versus concentration of potential contaminants of concern from the soil boring SB-4 at the S2 Site

Reference: Gianfrancesco et al., 1988

Depth versus concentration of potential contaminants of concern from the soil boring SB-5 at the S2 Site

Reference: Gianfrancesco et al., 1988

Depth versus concentration of potential contaminants of concern from the soil boring SB-5 at the S2 Site

B-12

Reference: Gianfrancesco et al., 1988

Depth versus concentration of potential contaminants of concern from the soil boring SB-6 at the S2 Site

Reference: Gianfrancesco et al., 1988

Depth versus concentration of potential contaminants of concern from the soil boring SB-6 at the S2 Site

Reference: Gianfrancesco et al., 1988

**Depth versus Concentration of Potential Contaminants of Concern from the
Building 81-10 Site**

Depth versus mercury concentrations in soil borings from the Building 81-10 Site

Reference: Rothschild et al., 1984

Depth versus mercury concentrations in soil borings from the Building 81-10 Site

B-17

Reference: Rothschild et al., 1984

Depth versus mercury concentrations in soils collected from monitoring wells at the Building 81-10 Site

Reference: Earth Technology, 1992

**Depth versus Concentration of Potential
Contaminants of Concern from the Salvage Yard Site**

Depth versus concentration of potential contaminants of concern from the soil boring EB-1 at the Salvage Yard Site

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring EB-2 at the Salvage Yard Site

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring EB-3 at the Salvage Yard Site

Depth versus concentration of potential contaminants of concern from the soil boring EB-4 at the Salvage Yard Site

Depth versus concentration of potential contaminants of concern from the soil boring EB-5 at the Salvage Yard Site

Depth versus concentration of potential contaminants of concern from the soil boring EB-6 at the Salvage Yard Site

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring WB-1 at the Salvage Yard Site

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring WB-2 at the Salvage Yard Site

Depth versus concentration of potential contaminants of concern from the soil boring WB-3 at the Salvage Yard Site

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring WB-4 at the Salvage Yard Site

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring WB-5 at the Salvage Yard Site

Depth versus concentration of potential contaminants of concern from the soil boring WB-6 at the Salvage Yard Site

B-31

Reference: Earth Technology, 1992

Depth versus concentration of potential contaminants of concern from the soil boring WB-8 at the Salvage Yard Site

B-32

Reference: Earth Technology, 1992

Appendix C
ANALYTICAL PARAMETERS

APPENDIX C. Analytical parameters for the Salvage Yard RFI plan (Welch 1989c)

	Analytical Method ^a	Reporting Detection Limit ^b
ICP Metals Sweep (Total and Dissolved)		
Aluminum	6010	12 mg/kg ^c
Barium	6010	10 mg/kg ^c
Beryllium	6010	1 mg/kg ^c
Cadmium	6010	3 mg/kg ^c
Calcium	6010	100 mg/kg ^c
Chromium	6010	10 mg/kg ^c
Cobalt	6010	2 mg/kg ^c
Copper	6010	2 mg/kg ^c
Iron	6010	100 mg/kg ^c
Lead	6010	20 mg/kg ^c
Magnesium	6010	50 mg/kg ^c
Manganese	6010	2 mg/kg ^c
Nickel	6010	10 mg/kg ^c
Niobium	6010	10 mg/kg ^c
Phosphorus	6010	50 mg/kg ^c
Potassium	6010	500 mg/kg ^c
Silver	6010	4 mg/kg ^c
Sodium	6010	50 mg/kg ^c
Vanadium	6010	5 mg/kg ^c
Zinc	6010	2 mg/kg ^c
Inorganic Metals		
Arsenic	3050 (prep), 7060 ^d (analysis), 7061	0.5 mg/kg
Cadmium	3050 (prep), 7131 ^d (analysis), 7130	--
Chromium	3050 (prep), 7191 ^d (analysis), 7190	--

Appendix C (continued)

	Analytical Method ^a	Reporting Detection Limit ^b
Lead	7420, 7421 ^d	0.5 mg/kg
Mercury	7471	0.2 mg/kg
Selenium	3050 (prep), 7740 ^d (analysis), 7741	0.1 mg/kg
Volatile Organics		
Chloromethane	8240	10 µg/kg
Bromomethane	8240	10 µg/kg
Vinyl chloride	8240	10 µg/kg
Chloroethane	8240	10 µg/kg
Methylene chloride	8240	5 µg/kg
Acetone	8240	10 µg/kg
Carbon disulfide	8240	5 µg/kg
1,1-Dichloroethene	8240	5 µg/kg
1,1-Dichloroethane	8240	5 µg/kg
Trans-1,2-dichloroethene	8240	5 µg/kg
Chloroform	8240	5 µg/kg
1,2-Dichloroethane	8240	5 µg/kg
2-Butanone	8240	10 µg/kg
1,1,1-Trichloroethane	8240	5 µg/kg
Carbon Tetrachloride	8240	5 µg/kg
Vinyl acetate	8240	10 µg/kg
Bromodichloromethane	8240	5 µg/kg
1,1,2,2-Tetrachloroethane	8240	5 µg/kg
1,2-Dichloropropane	8240	5 µg/kg
Trans-1,2-dichloropropene	8240	5 µg/kg
Trichloroethene	8240	5 µg/kg
Dibromochloromethane	8240	5 µg/kg

Appendix C (continued)

	Analytical Method ^a	Reporting Detection Limit ^b
1,1,2-Trichloroethane	8240	5 µg/kg
Benzene	8240	5 µg/kg
Cis-1,3-dichloropropene	8240	5 µg/kg
2-Chloroethyl vinyl ether	8240	10 µg/kg
Bromoform	8240	5 µg/kg
2-Hexanone	8240	10 µg/kg
4-Methyl-2-pentanone	8240	10 µg/kg
Tetrachloroethene	8240	5 µg/kg
Toluene	8240	5 µg/kg
Chlorobenzene	8240	5 µg/kg
Ethyl benzene	8240	5 µg/kg
Styrene	8240	5 µg/kg
Total Xylenes	8240	5 µg/kg
Acid and Base-Neutral Extractable Organics		
N-nitrosodimethylamine	8240	330 µg/kg
Phenol	8240	330 µg/kg
Aniline	8240	330 µg/kg
Bis (2-chloroethyl) ether	8240	330 µg/kg
2-Chlorophenol	8240	330 µg/kg
1,3-Dichlorobenzene	8240	330 µg/kg
1,4-Dichlorobenzene	8240	330 µg/kg
Benzyl alcohol	8240	330 µg/kg
1,2-Dichlorobenzene	8240	330 µg/kg
2-Methylphenol	8240	330 µg/kg
Bis (2-chloroisopropyl) ether	8240	330 µg/kg
4-Methylphenol	8240	330 µg/kg

Appendix C (continued)

	Analytical Method ^a	Reporting Detection Limit ^b
N-nitroso-dipropylamine	8240	330 µg/kg
Hexachloroethane	8240	330 µg/kg
Nitrobenzene	8240	330 µg/kg
Isophorone	8240	330 µg/kg
2-Nitrophenol	8240	330 µg/kg
2,4-Dimethylphenol	8240	330 µg/kg
Benzoic acid	8240	1600 µg/kg
Bis (2-chloroethoxy) methane	8240	330 µg/kg
2,4-Dichlorophenol	8240	330 µg/kg
1,2,4-Trichlorobenzene	8240	330 µg/kg
Naphthalene	8240	330 µg/kg
4-Chloroaniline	8240	330 µg/kg
Hexachlorobutadiene	8240	330 µg/kg
4-Chloro-3-methylphenol (para-chloro-meta-cresol)	8240	330 µg/kg
2-Methylnaphthalene	8240	330 µg/kg
Hexachlorocyclopentadiene	8240	330 µg/kg
2,4,6-Trichlorophenol	8240	330 µg/kg
2,4,5-Trichlorophenol	8240	1600 µg/kg
2-Chloronaphthalene	8240	330 µg/kg
2-Nitroaniline	8240	1600 µg/kg
Dimethyl phthalate	8240	330 µg/kg
Acenaphthylene	8240	330 µg/kg
3-Nitroaniline	8240	1600 µg/kg
Acenaphthene	8240	330 µg/kg
2,4-Dinitrophenol	8240	1600 µg/kg
4-Nitrophenol	8240	1600 µg/kg
Dibenzofuran	8240	330 µg/kg

Appendix C (continued)

	Analytical Method ^a	Reporting Detection Limit ^b
2,4-Dinitrotoluene	8240	330 µg/kg
2,6-Dinitrotoluene	8240	330 µg/kg
Diethylphthalate	8240	330 µg/kg
4-Chlorophenyl phenyl ether	8240	330 µg/kg
Fluorene	8240	330 µg/kg
4-Nitroaniline	8240	1600 µg/kg
4,6-Dinitro-2-methylphenol	8240	1600 µg/kg
N-Nitrosodiphenylamine	8240	330 µg/kg
4-Bromophenyl phenyl ether	8240	330 µg/kg
Hexachlorobenzene	8240	330 µg/kg
Pentachlorophenol	8240	1600 µg/kg
Phenanthrene	8240	330 µg/kg
Anthracene	8240	330 µg/kg
Di-n-butylphthalate	8240	330 µg/kg
Fluoranthene	8240	330 µg/kg
Benidine	8240	1600 µg/kg
Pyrene	8240	330 µg/kg
Butyl benzyl phthalate	8240	330 µg/kg
3,3'-Dichlorobenzidine	8240	660 µg/kg
Benzo (a) anthracene	8240	330 µg/kg
Bis (2-ethylhexyl) phthalate	8240	330 µg/kg
Chrysene	8240	330 µg/kg
Di-n-octyl phthalate	8240	330 µg/kg
Benzo (b) fluoranthene	8240	330 µg/kg
Benzo (k) fluoranthene	8240	330 µg/kg
Benzo (a) pyrene	8240	330 µg/kg

Appendix C (continued)

	Analytical Method ^a	Reporting Detection Limit ^b
PCBs	8080	80-160 µg/kg
Radiologicals		
Gross alpha	EC-101 ^c	All Values Reported
Gross beta	EC-101 ^c	All Values Reported
Total Uranium	EC-370 ^c	0.2 mg/kg
Isotopic (% U-235)	EC-1940 ^c	0.001 wt/ %

^a Reference number from *Test Methods for Evaluating Solid Waste, Volume I, Laboratory, and Volume II, Field Manual, Physical/Chemical Methods*, EPA Publication SW-946, Third Edition (USEPA 1986) (unless noted otherwise).

^b Specific detection limits are highly matrix-dependent; the detection limits provided herein are provided for guidance and may not always be achievable. Detection limits were not available for all compounds.

^c Minimum reporting limits under CLP program.

^d Analysis conducted by furnace technique atomic absorption.

^e Reference: *Martin Marietta Energy Systems Environmental and Effluent Analysis Manual*, August, 1986.

Appendix D

STATISTICS FOR GROUNDWATER SAMPLES

Table D.1 Statistics for ARSENIC concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; AA filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-251	0/ 10	5	•	•	•	•	0	1986-90
GW-252	0/ 8	5	•	•	•	•	0	1986-90
GW-253	0/ 10	5	•	•	•	•	0	1986-90
GW-254	0/ 6	5	•	•	•	•	0	1986-87
GW-255	0/ 9	5	•	•	•	•	0	1986-90
GW-256	0/ 6	5	•	•	•	•	0	1986-87
GW-261	0/ 7	5	•	•	•	•	0	1986-90
GW-262	0/ 7	5	•	•	•	•	0	1986-90
GW-263	0/ 2	5	•	•	•	•	0	1986-90
GW-264	0/ 7	5	•	•	•	•	0	1986-90
GW-265	0/ 7	5	•	•	•	•	0	1986-90
GW-266	0/ 2	5	•	•	•	•	0	1986-87
GW-267	0/ 2	5	•	•	•	•	0	1986-87
GW-268	0/ 7	5	•	•	•	•	0	1986-90
GW-269	0/ 7	5	•	•	•	•	0	1986-90
GW-270	0/ 5	5	•	•	•	•	0	1986-87
GW-271	0/ 5	5	•	•	•	•	0	1086-87
GW-272	0/ 5	5	•	•	•	•	0	1986-87
GW-273	0/ 6	5	•	•	•	•	0	1986-88
GW-274	0/ 5	5	•	•	•	•	0	1986-87
GW-275	0/ 5	5	•	•	•	•	0	1986-87

Analysis: Element analyzed by Atomic Absorption.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.2 Statistics for ARSENIC concentrations in $\mu\text{g/L}$ in groundwater for UEFPCC OU3 site wells; AA unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-251	0/ 10	5	•	•	•	•	0	
GW-252	1/ 8	5	5	6	6	•	0.75	
GW-253	0/ 10	5	•	•	•	•	0	
GW-254	0/ 6	5	•	•	•	•	0	1986-87
GW-255	0/ 9	5	•	•	•	•	0	
GW-256	0/ 6	5	•	•	•	•	0	1986-87
GW-261	2/ 7	5	5	6	7	1.41	1.71	
GW-262	1/ 7	5	7	7	7	•	1	
GW-263	0/ 2	5	•	•	•	•	0	
GW-264	0/ 7	5	•	•	•	•	0	
GW-265	0/ 7	5	•	•	•	•	0	
GW-266	0/ 2	5	•	•	•	•	0	1986-87
GW-267	0/ 2	5	•	•	•	•	0	1986-87
GW-268	0/ 7	5	•	•	•	•	0	
GW-269	0/ 7	5	•	•	•	•	0	
GW-270	0/ 5	5	•	•	•	•	0	1986-87
GW-271	0/ 5	5	•	•	•	•	0	1986-87
GW-272	0/ 5	5	•	•	•	•	0	1986-87
GW-273	0/ 6	5	•	•	•	•	0	1986-88
GW-274	1/ 5	5	6	6	6	•	1.2	1986-87
GW-275	0/ 5	5	•	•	•	•	0	1986-87

Analysis: Element analyzed by Atomic Absorption.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.3 Statistics for ARSENIC concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; ICP filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	0/ 3	50	•	•	•	•	0	1990-90
GW-251	2/ 4	50	54	77	100	32.5	38.5	
GW-252	0/ 3	50	•	•	•	•	0	
GW-253	1/ 4	50	200	200	200	•	50	
GW-255	1/ 3	50	92	92	92	•	30.7	
GW-261	0/ 8	50	•	•	•	•	0	
GW-262	1/ 7	50	130	130	130	•	18.6	
GW-263	1/ 7	50	150	150	150	•	21.4	
GW-264	2/ 8	50	67	79.5	92	17.7	19.9	
GW-265	1/ 5	50	59	59	59	•	11.8	
GW-268	2/ 5	50	52	57	62	7.07	22.8	
GW-269	1/ 5	50	110	110	110	•	22	
GW-337	0/ 7	50	•	•	•	•	0	1989-90
GW-338	1/ 7	50	58	58	58	•	8.29	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.4 Statistics for ARSENIC concentrations in $\mu\text{g/L}$ in groundwater for UEFFC OU3 site wells; ICP unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	0/ 3	50	•	•	•	•	0	1990-90
GW-251	0/ 4	50	•	•	•	•	0	1986-90
GW-252	0/ 3	50	•	•	•	•	0	1986-90
GW-253	1/ 4	50	120	120	120	•	30	1986-90
GW-255	0/ 3	50	•	•	•	•	0	1986-90
GW-261	0/ 8	50	•	•	•	•	0	1986-90
GW-262	0/ 7	50	•	•	•	•	0	1986-90
GW-263	2/ 7	50	63	66	69	4.24	18.9	1987-90
GW-264	0/ 8	50	•	•	•	•	0	1986-90
GW-265	0/ 5	50	•	•	•	•	0	1986-90
GW-268	1/ 5	50	58	58	58	•	11.6	1986-90
GW-269	0/ 5	50	•	•	•	•	0	1986-90
GW-337	0/ 7	757	•	•	•	•	0	1989-90
GW-338	1/ 7	50	79	79	79	•	11.3	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.5 Statistics for BERYLLIUM concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; ICP filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-190	0/ 3	0.3	•	•	•	•	0	1990-90
GW-251	9/ 14	0.3	0.6	0.968	1.3	0.265	0.622	1986-90
GW-252	0/ 11	0.3	•	•	•	•	0	1986-90
GW-253	14/ 14	•	11	14.4	18	1.95	14.4	1986-90
GW-254	1/ 6	0.3	0.4	0.4	0.4	•	0.0667	1986-87
GW-255	1/ 12	0.3	1.3	1.3	1.3	•	0.108	1986-90
GW-256	6/ 6	•	2.6	6.05	12	3.38	6.05	1986-87
GW-261	0/ 14	0.3	•	•	•	•	0	1986-90
GW-262	0/ 14	0.3	•	•	•	•	0	1986-90
GW-263	0/ 9	0.3	•	•	•	•	0	1986-90
GW-264	0/ 14	0.3	•	•	•	•	0	1986-90
GW-265	0/ 12	0.3	•	•	•	•	0	1986-90
GW-266	0/ 2	0.3	•	•	•	•	0	1986-87
GW-267	0/ 2	0.3	•	•	•	•	0	1986-87
GW-268	1/ 12	0.3	1.3	1.3	1.3	•	0.108	1986-90
GW-269	2/ 12	0.3	0.3	0.45	0.6	0.212	0.075	1986-90
GW-270	0/ 5	0.3	•	•	•	•	0	1986-87
GW-271	0/ 5	0.3	•	•	•	•	0	1986-87
GW-272	2/ 5	0.3	0.5	0.55	0.6	0.0707	0.22	1986-87
GW-273	1/ 6	0.3	0.3	0.3	0.3	•	0.05	1986-88
GW-274	2/ 5	10.2	0.4	0.45	0.5	0.0707	0.18	1986-87
GW-275	1/ 5	0.3	3.9	3.9	3.9	•	0.78	1986-87
GW-337	1/ 7	0.3	0.32	0.32	0.32	•	0.0457	
GW-338	0/ 7	0.3	•	•	•	•	0	

Analysis: Element analyzed by Inductively Coupled Plasma.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.6 Statistics for BERYLLIUM concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; AA unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL} = 0$)	Years Sampled
GW-337	1/ 7	5.25	0.42	0.42	0.42	•	1.02	1989-90
GW-338	2/ 7	0.3	0.44	0.455	0.47	0.0212	0.13	1989-90

Analysis: Element analyzed by Atomic Absorption.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.7 Statistics for BERYLLIUM concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; ICP unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL}=0$)	Years Sampled
GW-190	0/ 3	0.3	•	•	•	•	0	1990-90
GW-251	11/ 14	0.3	0.3	0.977	1.9	0.457	0.768	1986-90
GW-252	2/ 11	0.3	0.3	0.4	0.5	0.141	0.0727	1986-90
GW-253	14/ 14	•	11	14.6	18	2.1	14.6	1986-90
GW-254	2/ 6	0.3	0.4	0.55	0.7	0.212	0.183	1986-87
GW-255	5/ 12	0.3	0.3	0.6	0.9	0.245	0.25	1986-90
GW-256	6/ 6	•	3.3	6.13	12	3.61	6.13	1986-87
GW-261	2/ 15	0.3	0.6	0.85	1.1	0.354	0.113	1986-90
GW-262	2/ 14	0.3	0.7	0.95	1.2	0.354	0.136	1986-90
GW-263	3/ 9	0.3	0.92	1.14	1.3	0.197	0.38	1987-90
GW-264	2/ 15	0.3	0.3	1	1.7	0.99	0.133	1986-90
GW-265	1/ 12	0.3	0.4	0.4	0.4	•	0.0333	1986-90
GW-266	1/ 2	0.3	1.9	1.9	1.9	•	0.95	1986-87
GW-267	2/ 2	•	0.6	0.6	0.6	0	0.6	1986-87
GW-268	4/ 12	0.3	0.36	0.62	1.2	0.391	0.207	1986-90
GW-269	3/ 12	0.3	0.4	0.573	0.82	0.219	0.143	1986-90
GW-270	2/ 5	0.3	0.5	0.6	0.7	0.141	0.24	1986-87
GW-271	0/ 5	0.3	•	•	•	•	0	1086-87
GW-272	0/ 5	0.3	•	•	•	•	0	1986-87
GW-273	3/ 6	0.3	0.4	1.1	2.3	1.04	0.55	1986-88
GW-274	3/ 5	15.1	0.3	12.9	38	21.8	7.72	1986-87
GW-275	1/ 5	0.3	5.1	5.1	5.1	•	1.02	1986-87
GW-337	1/ 7	5.25	0.42	0.42	0.42	•	1.02	1989-90
GW-338	2/ 7	0.3	0.44	0.455	0.47	0.0212	0.13	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.8 Statistics for BORON concentrations in $\mu\text{g/L}$ in groundwater for UEFP3 OU3 site wells; ICP filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	3/ 3	•	13	26.3	49	19.7	26.3	1990-90
GW-251	13/ 13	•	9	38.5	61	16.8	38.5	1986-90
GW-252	10/ 10	•	5.9	145	1300	406	145	1986-90
GW-253	14/ 14	•	260	324	380	41.5	324	1986-90
GW-254	5/ 5	•	45	57.6	73	10.9	57.6	1986-87
GW-255	11/ 11	•	6.9	31	67	17.3	31	1986-90
GW-256	5/ 5	•	29	64	100	31	64	1986-87
GW-261	12/ 14	4	6.8	32.5	72	21.5	27.8	1986-90
GW-262	13/ 14	4	6.3	28.8	78	21.6	26.8	1986-90
GW-263	7/ 9	4	14	19.3	30	5.82	15	1986-90
GW-264	13/ 14	4	29	46.2	68	12.9	42.9	1986-90
GW-265	11/ 12	4	7.6	24.2	64	18.7	22.2	1986-90
GW-266	2/ 2	•	7.8	18.9	30	15.7	18.9	1986-87
GW-267	2/ 2	•	10	27	44	24	27	1986-87
GW-268	10/ 12	4	10	110	950	295	91.3	1986-90
GW-269	11/ 12	4	9.8	114	990	291	104	1986-90
GW-270	5/ 5	•	53	85.6	110	22.1	85.6	1986-87
GW-271	5/ 5	•	23	55.6	91	30.1	55.6	1086-87
GW-272	4/ 5	4	48	68	95	19.7	54.4	1986-87
GW-273	1/ 6	0.3	0.3	0.3	0.3	•	0.05	1986-88
GW-274	2/ 5	10.2	0.4	0.45	0.5	0.0707	0.18	1986-87
GW-275	1/ 5	0.3	3.9	3.9	3.9	•	0.78	1986-87
GW-337	1/ 7	0.3	0.32	0.32	0.32	•	0.0457	
GW-338	0/ 7	0.3	•	•	•	•	0	

Analysis: Element analyzed by Inductively Coupled Plasma.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.9 Statistics for BORON concentrations in $\mu\text{g/L}$ in groundwater for UEFPIC OU3 site wells; ICP unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	3/ 3	•	14	22.3	38	13.6	22.3	1990-90
GW-251	13/ 14	4	21	105	920	245	97.3	1986-90
GW-252	11/ 11	•	11	27.7	76	23.2	27.7	1986-90
GW-253	14/ 14	•	270	320	380	35.7	320	1986-90
GW-254	6/ 6	•	51	66.7	99	17.3	66.7	1986-87
GW-255	12/ 12	•	14	24.5	45	8.24	24.5	1986-90
GW-256	6/ 6	•	28	58	100	30.5	58	1986-87
GW-261	11/ 15	4	14	25.8	42	9.33	18.9	1986-90
GW-262	13/ 14	4	6.1	31.5	54	16.3	29.3	1986-90
GW-263	7/ 9	4	7.7	25	44	13.2	19.4	1986-90
GW-264	14/ 15	4	30	55.6	120	22.5	51.9	1986-90
GW-265	11/ 12	4	7	27	69	19	24.7	1986-90
GW-266	2/ 2	•	28	35.5	43	10.6	35.5	1986-87
GW-267	2/ 2	•	22	35	48	18.4	35	1986-87
GW-268	11/ 12	4	6	103	770	223	94.4	1986-90
GW-269	10/ 12	4	11	123	850	258	102	1986-90
GW-270	5/ 5	•	72	103	160	39.7	103	1986-87
GW-271	5/ 5	•	8.3	44.3	75	24.8	44.3	1986-87
GW-272	5/ 5	•	8.4	63.7	150	55.8	63.7	1986-87
GW-273	6/ 6	•	15	56.5	95	32.7	56.5	1986-88
GW-274	2/ 5	136	250	395	540	205	158	1986-87
GW-275	3/ 5	4	75	275	530	232	165	1986-87
GW-337	3/ 7	103	5.2	16.1	22	9.42	6.89	1989-90
GW-338	4/ 7	4	8.9	22.2	36	11.2	12.7	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.
Sample type: Unfiltered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

Table D.10 Statistics for CADMIUM concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; AA filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	0/ 3	2	•	•	•	•	0	1990-90
GW-251	18/ 18	•	61	208	352	85.2	208	1986-90
GW-252	2/ 18	2	2	10	18	11.3	1.11	1986-90
GW-253	13/ 13	•	2	3040	6700	2630	3040	1986-90
GW-254	6/ 6	•	10	35.2	53	16	35.2	1986-87
GW-255	1/ 19	2	5	5	5	•	0.263	1986-90
GW-256	6/ 6	•	6	696	2600	971	696	1986-87
GW-261	0/ 11	2	•	•	•	•	0	1986-90
GW-262	0/ 10	2	•	•	•	•	0	1986-90
GW-263	0/ 7	2	•	•	•	•	0	1987-90
GW-264	0/ 11	2	•	•	•	•	0	1986-90
GW-265	1/ 8	2	9.8	9.8	9.8	•	1.22	1986-90
GW-268	0/ 8	2	•	•	•	•	0	1986-90
GW-269	0/ 8	2	•	•	•	•	0	1986-90
GW-270	0/ 9	2	•	•	•	•	0	1986-90
GW-271	1/ 9	2	24.7	24.7	24.7	•	2.74	1986-90
GW-272	3/ 10	2	4	10.7	17	6.51	3.2	1986-90
GW-273	0/ 3	2	•	•	•	•	0	1986-88
GW-274	9/ 10	2	2.7	62.8	210	74.6	56.5	1986-90
GW-275	5/ 10	2	5.1	85.4	140	51.8	42.7	1986-90
GW-337	0/ 7	2	•	•	•	•	0	1989-90
GW-338	0/ 7	2	•	•	•	•	0	1989-90

Analysis: Element analyzed by Atomic Absorption.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.11 Statistics for CADMIUM concentrations in $\mu\text{g/L}$ in groundwater for UEFFPC OU3 site wells; ICP filtered sample

Well	Proportion of Results		Mean Detection Limit	Minimum Result		Mean Result > Detection Limit	Maximum Result		Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
	> Detection Limit	Limit		> Detection Limit	Limit		> Detection Limit	Limit			
GW-190	0/ 3	3	•	•	•	•	•	•	•	0	
GW-251	4/ 4	•	140	225	88.9	225	350	88.9	225	225	
GW-252	2/ 3	3	3.6	5.1	2.12	5.1	6.6	2.12	3.4	3.4	
GW-253	4/ 4	•	3200	3950	714	3950	4900	714	3950	3950	
GW-255	0/ 3	3	•	•	•	•	•	•	•	0	
GW-261	2/ 14	3	4.1	4.7	0.849	4.7	5.3	0.849	0.671	0.671	
GW-262	4/ 14	3	3.8	5.4	1.45	5.4	7.2	1.45	1.54	1.54	
GW-263	2/ 9	3	4.1	9.05	7	9.05	14	7	2.01	2.01	
GW-264	0/ 14	3	•	•	•	•	•	•	•	0	
GW-265	2/ 12	3	3.6	4.95	1.91	4.95	6.3	1.91	0.825	0.825	
GW-266	0/ 2	3	•	•	•	•	•	•	•	0	1986-87
GW-267	0/ 2	3	•	•	•	•	•	•	•	0	1986-87
GW-268	0/ 12	3	•	•	•	•	•	•	•	0	
GW-269	1/ 12	3	3.5	3.5	•	3.5	3.5	•	0.292	0.292	
GW-270	0/ 5	3	•	•	•	•	•	•	•	0	
GW-271	0/ 5	3	•	•	•	•	•	•	•	0	
GW-272	1/ 5	3	5.9	5.9	•	5.9	5.9	•	1.18	1.18	
GW-273	1/ 6	3	5.6	5.6	•	5.6	5.6	•	0.933	0.933	
GW-274	4/ 5	300	3.7	10	6.68	10	18	6.68	8.03	8.03	
GW-273	6/ 6	•	9.4	49.2	23.5	49.2	73	23.5	49.2	49.2	1986-88
GW-273	1/ 5	103	220	220	•	220	220	•	44	44	1986-87
GW-275	3/ 5	4	50	223	186	223	420	186	134	134	1986-87
GW-337	5/ 7	4	8.4	23.9	11.8	23.9	38	11.8	17.1	17.1	1989-90
GW-338	6/ 7	4	11	20	10	20	38	10	17.1	17.1	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.
Sample type: Filtered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS

Table D.12 Statistics for CADMIUM concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; ICP unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-190	0/ 3	3	•	•	•	•	0	1990-90
GW-251	4/ 4	•	150	233	360	90	233	1986-90
GW-252	1/ 3	3	5.1	5.1	5.1	•	1.7	1986-90
GW-253	4/ 4	•	3200	3920	4700	634	3920	1986-90
GW-255	0/ 3	3	•	•	•	•	0	1986-90
GW-261	3/ 15	3	3.9	4.1	4.2	0.173	0.82	1986-90
GW-262	4/ 14	3	3.5	5.05	8.7	2.45	1.44	1986-90
GW-263	3/ 9	3	3.2	5.03	6.6	1.72	1.68	1987-90
GW-264	1/ 15	3	3	3	3	•	0.2	1986-90
GW-265	1/ 12	3	6.7	6.7	6.7	•	0.558	1986-90
GW-266	0/ 2	3	•	•	•	•	0	1986-87
GW-267	0/ 2	3	•	•	•	•	0	1986-87
GW-268	0/ 12	3	•	•	•	•	0	1986-90
GW-269	0/ 12	3	•	•	•	•	0	1986-90
GW-270	0/ 5	3	•	•	•	•	0	1986-90
GW-271	0/ 5	3	•	•	•	•	0	1986-90
GW-272	0/ 5	3	•	•	•	•	0	1986-90
GW-273	2/ 6	2.5	3.3	3.35	3.4	0.0707	1.12	1986-88
GW-274	3/ 5	300	4.4	12.5	19	7.42	7.48	1986-90
GW-275	0/ 5	8.4	•	•	•	•	0	1986-90
GW-337	2/ 7	3	4.8	172	340	237	49.3	1989-90
GW-338	1/ 7	3	4.9	4.9	4.9	•	0.7	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.13 Statistics for CHROMIUM concentrations in $\mu\text{g/L}$ in groundwater for UEFPC OU3 site wells; ICP filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	0/ 3	10	•	•	•	•	0	
GW-251	0/ 4	10	•	•	•	•	0	
GW-252	0/ 3	10	•	•	•	•	0	
GW-253	0/ 4	10	•	•	•	•	0	
GW-255	0/ 3	10	•	•	•	•	0	
GW-261	1/ 14	10	79	79	79	•	5.64	
GW-262	1/ 14	10	50	50	50	•	3.57	
GW-263	2/ 9	10	14	62	110	67.9	13.8	
GW-264	2/ 14	10	26	88	150	87.7	12.6	
GW-265	1/ 12	10	16	16	16	•	1.33	
GW-266	1/ 2	10	13	13	13	•	6.5	1986-87
GW-267	0/ 2	10	•	•	•	•	0	1986-87
GW-268	0/ 12	10	•	•	•	•	0	
GW-269	0/ 12	10	•	•	•	•	0	
GW-270	0/ 5	10	•	•	•	•	0	
GW-271	0/ 5	10	•	•	•	•	0	
GW-272	1/ 5	10	10	10	•	•	2	
GW-273	0/ 6	10	•	•	•	•	0	
GW-274	0/ 5	208	•	•	•	•	0	
GW-275	0/ 5	8.4	•	•	•	•	0	
GW-337	3/ 7	3	3.3	7.5	15	6.51	3.21	
GW-338	2/ 7	3	3.2	3.4	3.6	0.283	0.971	

Analysis: Element analyzed by Inductively Coupled Plasma.
Sample type: Filtered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

Table D.14 Statistics for CHROMIUM concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; AA filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL} = 0$)	Years Sampled
GW-190	0/3	10	•	•	•	•	0	1990-90
GW-251	2/18	10	10	15	20	7.07	1.67	1986-90
GW-252	3/18	10	10	15.3	24	7.57	2.56	1986-90
GW-253	11/14	10	10	16.5	30	5.84	13	1986-90
GW-254	0/6	10	•	•	•	•	0	1986-87
GW-255	5/19	10	10	12	17	2.92	3.16	1986-90
GW-256	1/6	10	30	30	30	•	5	1986-87
GW-261	0/11	10	•	•	•	•	0	1986-90
GW-262	0/10	10	•	•	•	•	0	1986-90
GW-263	0/7	10	•	•	•	•	0	1987-90
GW-264	0/11	10	•	•	•	•	0	1986-90
GW-265	0/8	10	•	•	•	•	0	1986-90
GW-268	1/8	10	23	23	23	•	2.87	1986-90
GW-269	2/8	10	11	11	11	0	2.75	1986-90
GW-270	2/9	10	13	13	13	0	2.89	1986-90
GW-271	0/9	10	•	•	•	•	0	1986-90
GW-272	0/10	10	•	•	•	•	0	1986-90
GW-273	0/3	10	•	•	•	•	0	1986-88
GW-274	1/10	10	102	102	102	•	10.2	1986-90
GW-275	5/10	2	5.1	85.4	140	51.8	42.7	1986-90
GW-337	0/7	2	•	•	•	•	0	1989-90
GW-338	0/7	2	•	•	•	•	0	1989-90

Analysis: Element analyzed by Atomic Absorption.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.15 Statistics for CHROMIUM concentrations in $\mu\text{g/L}$ in groundwater for UEFTPC OU3 site wells; ICP unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	1/3	10	11	11	11	•	3.67	1990-90
GW-251	1/4	10	14	14	14	•	3.5	1986-90
GW-252	0/3	10	•	•	•	•	0	1986-90
GW-253	3/4	10	10	16.3	22	6.03	12.2	1986-90
GW-255	0/3	10	•	•	•	•	0	1986-90
GW-261	3/15	10	15	34.3	71	31.8	6.87	1986-90
GW-262	5/14	10	11	32.2	75	26.6	11.5	1986-90
GW-263	6/9	10	16	47.5	100	29.2	31.7	1987-90
GW-264	2/15	10	26	39.5	53	19.1	5.27	1986-90
GW-265	1/12	10	13	13	13	•	1.08	1986-90
GW-266	2/2	•	14	19.5	25	7.78	19.5	1986-87
GW-267	1/2	10	11	11	11	•	5.5	1986-87
GW-268	6/12	10	13	25.3	44	12	12.7	1986-90
GW-269	5/12	10	10	15.4	24	6.31	6.42	1986-90
GW-270	3/5	10	11	28.3	43	16.2	17	1986-90
GW-271	0/5	10	•	•	•	•	0	1986-90
GW-272	1/5	10	11	11	11	•	2.2	1986-90
GW-273	2/6	10	13	26	39	18.4	8.67	1986-88
GW-274	0/5	406	•	•	•	•	0	1986-90
GW-275	0/5	28	•	•	•	•	0	1986-90
GW-337	2/7	208	11	400	790	551	114	1989-90
GW-338	1/7	10	30	30	30	•	4.29	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.16 Statistics for COBALT concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; ICP filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL} = 0$)	Years Sampled
GW-190	0/ 6	5	•	•	•	•	0	1990-90
GW-251	28/ 28	•	8.5	38.7	83	23.3	38.7	1986-90
GW-252	0/ 22	5	•	•	•	•	0	1986-90
GW-253	28/ 28	•	320	418	580	66	418	1986-90
GW-254	0/ 12	5	•	•	•	•	0	1986-87
GW-255	0/ 24	5	•	•	•	•	0	1986-90
GW-256	12/ 12	•	38	189	500	171	189	1986-87
GW-261	0/ 28	5	•	•	•	•	0	1986-90
GW-262	0/ 28	5	•	•	•	•	0	1986-90
GW-263	2/ 18	5	10	10	10	0	1.11	1987-90
GW-264	2/ 28	5	10	10	10	0	0.714	1986-90
GW-265	0/ 24	5	•	•	•	•	0	1986-90
GW-266	0/ 4	5	•	•	•	•	0	1986-87
GW-267	0/ 4	5	•	•	•	•	0	1986-87
GW-268	0/ 24	5	•	•	•	•	0	1986-90
GW-269	0/ 24	5	•	•	•	•	0	1986-90
GW-270	0/ 10	5	•	•	•	•	0	1986-87
GW-271	0/ 10	5	•	•	•	•	0	1986-87
GW-272	0/ 10	5	•	•	•	•	0	1986-87
GW-275	0/ 5	28	•	•	•	•	0	
GW-337	2/ 7	10	20	90	160	99	25.7	
GW-338	1/ 7	10	•	•	•	•	0	

Analysis: Element analyzed by Inductively Coupled Plasma.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.17 Statistics for COBALT concentrations in $\mu\text{g/L}$ in groundwater for UEFFC OU3 site wells; ICP unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	0/ 6	5	•	•	•	•	0	1990-90
GW-251	28/ 28	•	9.5	40.4	83	22.8	40.4	1986-90
GW-252	2/ 22	5	5.5	5.5	5.5	0	0.4	1986-90
GW-253	28/ 28	•	310	421	580	67.7	421	1986-90
GW-254	4/ 12	5	5.7	6.25	6.8	0.635	2.08	1986-87
GW-255	0/ 24	5	•	•	•	•	0	1986-90
GW-256	12/ 12	•	57	193	470	162	193	1986-87
GW-261	4/ 30	5	13	15	17	2.31	2	1986-90
GW-262	2/ 28	5	13	13	13	0	0.929	1986-90
GW-263	6/ 18	5	8.3	10.8	13	2.11	3.59	1987-90
GW-264	0/ 30	5	•	•	•	•	0	1986-90
GW-265	0/ 24	5	•	•	•	•	0	1986-90
GW-266	2/ 4	5	25	25	25	0	12.5	1986-87
GW-267	0/ 4	5	•	•	•	•	0	1986-87
GW-268	8/ 24	5	6.3	14.6	27	8.21	4.86	1986-90
GW-269	2/ 24	5	10	10	10	0	0.833	1986-90
GW-270	8/ 10	5	7.8	12.7	19	4.57	10.1	1986-90
GW-271	0/ 10	5	•	•	•	•	0	1986-90
GW-272	0/ 10	5	•	•	•	•	0	1986-90
GW-273	10/ 12	5	5.8	12.9	34	11.2	10.7	1986-88
GW-274	6/ 10	500	56	64	76	9.47	38.4	1986-87
GW-275	10/ 10	•	39	66.2	150	44.4	66.2	1986-87
GW-337	2/ 14	87.5	10	10	10	0	1.43	1989-90
GW-338	2/ 14	5	10	10	10	0	1.43	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.
Sample type: Unfiltered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

Table D.18 Statistics for COPPER concentrations in $\mu\text{g/L}$ in groundwater for UEFFPC OU3 site wells; ICP filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	1/ 3	4	4.6	4.6	4.6	•	1.53	1990-90
GW-251	17/ 17	•	69	670	1900	515	670	1986-90
GW-252	11/ 14	4	4.8	166	760	300	130	1986-90
GW-253	16/ 17	5,000	73,000	128,000	160,000	28,600	120,000	1986-90
GW-254	9/ 9	•	48	176	370	125	176	1986-87
GW-255	6/ 15	4	4	51.7	180	69.8	20.7	1986-90
GW-256	9/ 9	•	3,600	12,300	41,000	11,600	12,300	1986-87
GW-261	7/ 15	4	5.9	81.7	510	189	38.1	1986-90
GW-262	6/ 15	4	4.7	69	340	133	27.6	1986-90
GW-263	5/ 9	4	4.8	18.4	37	12.9	10.2	1987-90
GW-264	5/ 15	4	10	44.2	160	64.9	14.7	1986-90
GW-265	4/ 13	4	4.1	45.5	90	41.5	14	1986-90
GW-266	0/ 3	4	•	•	•	•	0	1986-87
GW-267	0/ 3	4	•	•	•	•	0	1986-87
GW-268	1/ 13	4	140	140	140	•	10.8	1986-90
GW-269	3/ 13	4	6.4	48	130	71	11.1	1986-90
GW-270	3/ 6	4	4	17.5	43	22.1	8.75	1986-87
GW-271	2/ 6	4	4.6	21.3	38	23.6	7.1	1986-87
GW-272	5/ 6	4	5.7	16.9	53	20.5	14.1	1986-87
GW-273	8/ 12	5	5.9	7.58	9.9	1.55	5.05	1986-88
GW-274	8/ 10	500	53	56.2	59	2.55	45	1986.87
GW-275	10/ 10	•	33	58	110	28.2	58	1986-87
GW-337	0/ 14	5	•	•	•	•	0	1989-90
GW-338	0/ 14	5	•	•	•	•	0	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.

Data source: Preliminary Y-12 data.

Sample type: Filtered Sample.

Program Source: S86L.SAS

Grand mean includes nondetects set to zero.

Date: 09MAR93

Table D.19 Statistics for COBALT concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; ICP unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	1/3	4	5	5	5	•	1.67	1990-90
GW-251	17/17	•	180	712	2000	484	712	1986-90
GW-252	13/14	4	4.7	91.1	340	119	84.6	1986-90
GW-253	16/17	5,000	73,000	131,000	180,000	33,800	124,000	1986-90
GW-254	8/9	4	110	470	1000	338	418	1986-87
GW-255	11/15	4	4	30.8	170	53	22.6	1986-90
GW-256	9/9	•	2,800	10,900	40,000	11,300	10,900	1986-87
GW-261	12/16	4	4.6	66.7	390	119	50	1986-90
GW-262	8/15	4	5.5	66	380	129	35.2	1986-90
GW-263	7/9	4	6.5	15.5	26	7.39	12	1987-90
GW-264	8/16	4	5.3	75.3	410	140	37.6	1986-90
GW-265	5/13	4	4.4	38.9	93	45.4	15	1986-90
GW-266	2/3	4	27	27	27	0	18	1986-87
GW-267	2/3	4	7.3	7.3	7.3	0	4.87	1986-87
GW-268	7/13	4	4	38.2	210	75.9	20.6	1986-90
GW-269	3/13	4	10	62.3	160	84.7	14.4	1986-90
GW-270	6/6	•	9	24.3	59	19.5	24.3	1986-90
GW-271	2/6	4	10	27	44	24	9	1986-90
GW-272	5/6	4	9.4	23.7	48	14.5	19.7	1986-90
GW-273	7/7	•	4.4	89.8	260	117	89.8	1986-88
GW-274	4/6	400	19	22	27	3.46	14.7	1986-87
GW-275	3/6	16	9.5	19.8	31	10.8	9.92	1986-87
GW-337	4/7	136	9.6	11.7	14	1.85	6.66	1989-90
GW-338	6/7	4	4.2	18.2	56	20.3	15.6	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.
Sample type: Unfiltered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

Table D.20 Statistics for LEAD concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; AA filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL}=0$)	Years Sampled
GW-190	1/ 3	4	7.2	7.2	7.2	•	2.4	1990-90
GW-251	5/ 18	4	4	6.66	13	3.93	1.85	1986-90
GW-252	4/ 18	4	4	6.5	11	3.32	1.44	1986-90
GW-253	13/ 13	•	4	56.2	98	33.6	56.2	1986-90
GW-254	1/ 6	4	4	4	4	•	0.667	1986-87
GW-255	4/ 19	4	5	6.65	9	1.99	1.4	1986-90
GW-256	5/ 6	4	4	6.6	10	2.3	5.5	1986-87
GW-261	1/ 15	4	6	6	6	•	0.4	1986-90
GW-262	2/ 14	4	5.1	5.55	6	0.636	0.793	1986-90
GW-263	2/ 9	4	4.9	12.9	21	11.4	2.88	1987-90
GW-264	3/ 15	4	4	5	6	1	1	1986-90
GW-265	0/ 12	4	•	•	•	•	0	1986-90
GW-266	1/ 2	4	16	16	16	•	8	1986-87
GW-267	1/ 2	4	14	14	14	•	7	1986-87
GW-268	2/ 12	4	7	7	7	0	1.17	1986-90
GW-269	3/ 12	4	4	6	8	2	1.5	1986-90
GW-270	2/ 14	4	4	5	6	1.41	0.714	1986-90
GW-271	3/ 14	4	4	5	6	1	1.07	1986-90
GW-272	1/ 14	4	13	13	13	•	0.929	1986-90
GW-275	1/ 10	10	77	77	77	•	7.7	1986-90
GW-337	1/ 7	10	18	18	18	•	2.57	1989-90
GW-338	0/ 7	10	•	•	•	•	0	1989-90

Analysis: Element analyzed by Atomic Absorption.
Sample type: Filtered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

Table D.21 Statistics for LEAD concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; AA unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL}=0$)	Years Sampled
GW-190	2/ 3	4	8.9	11.4	14	3.61	7.63	1990-90
GW-251	13/ 18	4	4.5	9.02	23	5.41	6.51	1986-90
GW-252	13/ 18	4	4.7	15.3	45	10.9	11	1986-90
GW-253	13/ 13	•	8	67.3	120	32.1	67.3	1986-90
GW-254	4/ 6	4	6	11.7	15	4.03	7.83	1986-87
GW-255	14/ 19	4	5.5	8.76	17	2.96	6.45	1986-90
GW-256	6/ 6	•	5	10.5	19	4.89	10.5	1986-87
GW-261	8/ 15	4	4.6	35.3	112	36.5	18.8	1986-90
GW-262	7/ 14	4	5	18	44	14.2	8.99	1986-90
GW-263	7/ 9	4	6.2	78.5	400	144	61.1	1987-90
GW-264	4/ 15	4	5	6.67	8	1.56	1.78	1986-90
GW-265	4/ 12	4	4	4.75	5	0.5	1.58	1986-90
GW-266	2/ 2	•	7	31	55	33.9	31	1986-87
GW-267	2/ 2	•	6	9.5	13	4.95	9.5	1986-87
GW-268	8/ 12	4	4	16.4	55	16.5	11	1986-90
GW-269	10/ 12	4	4	6.97	11	2.96	5.81	1986-90
GW-270	12/ 14	4	4.1	10.8	43	10.4	9.29	1986-90
GW-271	1/ 14	4	14	14	14	•	1	1986-90
GW-272	9/ 14	4	4	7.27	15	3.58	4.67	1986-90
GW-273	6/ 7	4	4.6	20.8	82	30.2	17.8	1986-88
GW-274	12/ 13	4	4.8	82.7	860	245	76.3	1986-90
GW-275	7/ 13	4	5	9.41	17	4.2	5.07	1986-90
GW-337	0/ 7	4	•	•	•	•	0	1989-90
GW-338	0/ 7	4	•	•	•	•	0	1989-90

Analysis: Element analyzed by Atomic Absorption.
Sample type: Unfiltered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

Table D.22 Statistics for MERCURY concentrations in $\mu\text{g/L}$ in groundwater for UEFPC OU3 site wells;
cold vapor AA filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL} = 0$)	Years Sampled
GW-190	0/ 3	0.2	•	•	•	•	0	1990-90
GW-251	2/ 18	0.2	0.3	0.3	0.3	0	0.0333	1986-90
GW-252	0/ 18	0.2	•	•	•	•	0	1986-90
GW-253	14/ 14	•	7.2	19.5	36	7.01	19.5	1986-90
GW-254	2/ 6	0.2	0.9	1.75	2.6	1.2	0.583	1986-87
GW-255	0/ 19	0.2	•	•	•	•	0	1986-90
GW-256	5/ 6	0.2	0.3	1.9	4.2	2.06	1.58	1986-87
GW-261	1/ 15	0.2	0.5	0.5	0.5	•	0.0333	1986-90
GW-262	1/ 14	0.2	0.2	0.2	0.2	•	0.0143	1986-90
GW-263	1/ 9	0.2	0.42	0.42	0.42	•	0.0467	1987-90
GW-264	1/ 15	0.2	0.2	0.2	0.2	•	0.0133	1986-90
GW-265	0/ 12	0.2	•	•	•	•	0	1986-90
GW-266	0/ 2	0.2	•	•	•	•	0	1986-87
GW-267	0/ 2	0.2	•	•	•	•	0	1986-87
GW-268	0/ 12	0.2	•	•	•	•	0	1986-90
GW-269	0/ 12	0.2	•	•	•	•	0	1986-90
GW-270	0/ 14	0.2	•	•	•	•	0	1986-90
GW-271	1/ 14	0.2	0.2	0.2	0.2	•	0.0143	1986-90
GW-272	0/ 14	0.2	•	•	•	•	0	1986-90
GW-273	0/ 7	0.2	•	•	•	•	0	1986-88
GW-274	3/ 14	0.2	0.2	0.567	0.9	0.351	0.121	1986-90
GW-275	0/ 14	0.2	•	•	•	•	0	1986-90
GW-337	0/ 7	0.2	•	•	•	•	0	1989-90
GW-338	1/ 7	0.2	0.39	0.39	0.39	•	0.0557	1989-90

Analysis: Element analyzed by Cold Vapor Atomic Absorption.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

**Table D.23 Statistics for MERCURY concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells;
cold vapor AA unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	1/ 3	0.2	0.2	0.2	0.2	•	0.0667	1990-90
GW-251	6/ 18	0.2	0.25	0.388	0.7	0.165	0.129	1986-90
GW-252	2/ 18	0.2	0.3	0.35	0.4	0.0707	0.0389	1986-90
GW-253	14/ 14	•	8	24.3	46	11.3	24.3	1986-90
GW-254	5/ 6	0.2	0.2	1.34	3.7	1.4	1.12	1986-87
GW-255	2/ 19	0.2	0.2	0.2	0.2	0	0.0211	1986-90
GW-256	6/ 6	•	1.1	2.28	5.3	1.61	2.28	1986-87
GW-261	3/ 15	0.2	0.3	0.4	0.5	0.1	0.08	1986-90
GW-262	1/ 14	0.2	0.2	0.2	0.2	•	0.0143	1986-90
GW-263	0/ 9	0.2	•	•	•	•	0	1987-90
GW-264	2/ 15	0.2	0.2	0.2	0.2	0	0.0267	1986-90
GW-265	1/ 12	0.2	0.2	0.2	0.2	•	0.0167	1986-90
GW-266	0/ 2	0.2	•	•	•	•	8	1986-87
GW-267	0/ 2	0.2	•	•	•	•	0	1986-87
GW-268	1/ 12	0.2	0.4	0.4	0.4	•	0.0333	1986-90
GW-269	0/ 12	0.2	•	•	•	•	0	1986-90
GW-270	4/ 14	0.2	0.2	0.3	0.5	0.141	0.0857	1986-90
GW-271	0/ 14	0.2	•	•	•	•	0	1986-90
GW-272	1/ 14	0.2	0.2	0.2	0.2	•	0.0143	1986-90

**Table D.24 Statistics for NITRATE-N concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells;
other methods unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	0/ 3	200	•	•	•	•	0	1990-90
GW-251	18/ 18	•	18,100	93,800	126,000	27,400	93,800	1986-90
GW-252	18/ 18	•	300	1,170	3,390	847	1,170	1986-90
GW-253	14/ 14	•	490,000	807,000	1,410,000	232,000	807,000	1986-90
GW-254	6/ 6	•	400,000	633,000	1,520,000	436,000	633,000	1986-87
GW-255	19/ 19	•	4,000	9,000	27,500	6,820	9,000	1986-90
GW-256	6/ 6	•	94,000	393,000	1,300,000	467,000	393,000	1986-87
GW-261	11/ 15	177	120	1,21E38	1,33E39	4,01E38	8,86E37	1986-90
GW-262	1/ 14	152	1,3292E39	1,33E39	1,33E39	•	9,49E37	1986-90
GW-263	8/ 9	200	200	840,000	6,720,000	2,380,000	747,000	1987-90
GW-264	0/ 15	278	•	•	•	•	0	1986-90
GW-265	1/ 12	151	120	120	120	•	10	1986-90
GW-266	0/ 2	110	•	•	•	•	0	1986-87
GW-267	2/ 2	•	230	275	320	63.6	275	1986-87
GW-268	2/ 12	176	200	250	300	70.7	41.7	1986-90
GW-269	12/ 12	•	180	226	300	38	226	1986-90
GW-270	14/ 14	•	111,000	320,000	723,000	180,000	320,000	1986-90
GW-271	12/ 14	200	150	328	740	180	281	1986-90
GW-272	14/ 14	•	630	2,230	12,000	2,960	2,230	1986-90
GW-273	7/ 7	•	185,000	358,000	790,000	198,000	358,000	1986-88
GW-274	14/ 14	•	1,087,000	10,800,000	15,800,000	4,390,000	10,800,000	1986-90
GW-275	13/ 13	•	57,000	8,380,000	19,000,000	4,910,000	8,380,000	1986-90
GW-337	0/ 7	200	•	•	•	•	0	1989-90
GW-338	7/ 7	•	200	329	500	125	329	1989-90

Analysis: Element analyzed by Other Methods.
Sample type: Unfiltered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

Table D.25 Statistics for NITRITE-N concentrations in $\mu\text{g/L}$ in groundwater for UEFPC OU3 site wells;
other methods filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL} = 0$)	Years Sampled
GW-261	0/ 10	346	•	•	•	•	0	1986-90
GW-262	0/ 10	346	•	•	•	•	0	1986-90
GW-263	0/ 6	967	•	•	•	•	0	1987-90
GW-264	0/ 10	346	•	•	•	•	0	1986-90
GW-265	0/ 10	346	•	•	•	•	0	1986-90
GW-266	0/ 1	300	•	•	•	•	0	1986-87
GW-267	0/ 1	300	•	•	•	•	0	1986-87
GW-268	0/ 10	346	•	•	•	•	0	1986-90
GW-269	1/ 10	351	300	300	300	•	30	1986-90
GW-270	1/ 4	2,330	1,100	1,100	1,100	•	275	1986-90
GW-271	0/ 4	490	•	•	•	•	0	1986-90
GW-272	0/ 4	323	•	•	•	•	0	1986-90
GW-273	1/ 6	4,530	3,300	3,300	3,300	•	550	1986-88
GW-274	1/ 5	41,600	4,600	4,600	4,600	•	920	1986-90
GW-275	1/ 5	41,600	6,500	6,500	6,500	•	1,300	1986-90

Analysis: Element analyzed by Other Methods.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.26 Statistics for SULFATE concentrations in $\mu\text{g/L}$ in groundwater for UEFP3 OU3 site wells; other methods unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-190	3/ 3	•	13,000	13,700	14,000	577	13,700	1990-90
GW-251	16/ 18	5,500	7,800	16,200	23,000	4,600	14,400	1986-90
GW-252	18/ 18	•	1,000	11,400	38,000	9,770	11,400	1986-90
GW-253	13/ 14	100,000	30,000	94,300	345,000	100,000	87,600	1986-90
GW-254	6/ 6	•	25,000	35,000	49,000	10,300	35,000	1986-87
GW-255	19/ 19	•	5,400	9,790	19,000	2,940	9,790	1986-90
GW-256	5/ 6	100,000	5,000	9,100	13,000	3,130	7,580	1986-87
GW-261	15/ 15	•	34,000	42,000	75,000	9,780	42,000	1986-90
GW-262	14/ 14	•	12,000	9,49E37	1.33E39	3.55E38	9,49E37	1986-90
GW-263	9/ 9	•	6,000	11,600	17,000	4,070	11,600	1987-90
GW-264	15/ 15	•	99,000	133,000	178,000	25,400	133,000	1986-90
GW-265	12/ 12	•	8,900	11,600	14,000	1,330	11,600	1986-90
GW-266	2/ 2	•	12,400	13,700	15,000	1,840	13,700	1986-87
GW-267	2/ 2	•	8,100	8,350	8,600	354	8,350	1986-87
GW-268	12/ 12	•	5,900	7,270	11,800	1,470	7,270	1986-90
GW-269	12/ 12	•	4,800	6,210	12,000	1,970	6,210	1986-90
GW-270	14/ 14	•	27,000	32,500	39,000	3,760	32,000	1986-90
GW-271	14/ 14	•	7,000	15,700	18,000	2,780	15,700	1986-90
GW-272	14/ 14	•	14,000	24,900	44,000	9,340	24,900	1986-90
GW-273	0/ 7	37,100	•	•	•	•	0	1986-88
GW-274	0/ 14	93,600	•	•	•	•	0	1986-90
GW-275	1/ 14	62,300	251,000	251,000	251,000	•	17,900	1986-90
GW-337	7/ 7	•	5,000	5,860	8,000	1,070	5,860	1989-90
GW-338	7/ 7	•	12,000	13,300	14,000	756	13,300	1989-90

Analysis: Element analyzed by Other Methods.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.27 Statistics for ZINC concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; ICP filtered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	3/ 3	•	7	11.6	20	7.31	11.6	1990-90
GW-251	14/ 14	•	28	113	250	69.1	113	1986-90
GW-252	10/ 11	1	5.6	29.7	86	28.1	27	1986-90
GW-253	14/ 14	•	4,600	7,090	11,000	1,690	7,090	1986-90
GW-254	6/ 6	•	27	54.8	79	23.2	54.8	1986-87
GW-255	7/ 12	1	1.7	4.1	6.9	2.22	2.39	1986-90
GW-256	6/ 6	•	590	1,710	4,000	1,390	1,710	1986-87
GW-261	12/ 14	1	1.2	10.2	27	7.36	8.71	1986-90
GW-262	8/ 14	1	2.3	10.4	16	5.19	5.95	1986-90
GW-263	7/ 9	1	5.8	21.8	59	18.2	16.9	1987-90
GW-264	6/ 14	1	3.1	9.4	21	6.87	4.03	1986-90
GW-265	10/ 12	1	3	21.1	85	24.9	17.6	1986-90
GW-266	0/ 2	1	•	•	•	•	0	1986-87
GW-267	1/ 2	1	10	10	10	•	5	1986-87
GW-268	6/ 12	1	1.5	6.82	9.8	3.28	3.41	1986-90
GW-269	10/ 12	1	1.4	9.37	21	5.52	7.81	1986-90
GW-270	4/ 5	1	6.9	16.6	27	9.92	13.3	1986-90
GW-271	3/ 5	1	3.8	5.03	7.3	1.97	3.02	1986-90
GW-272	5/ 5	•	2	12.4	36	13.6	12.4	1986-90
GW-273	3/ 7	1	2	5.33	9	3.51	2.29	1986-88
GW-274	14/ 14	•	26	31.8	57	8.02	31.8	1986-87
GW-275	14/ 14	•	3	12.9	27	7.78	12.9	1986-87
GW-337	7/ 7	•	1	1.14	2	0.378	1.14	1989-90
GW-338	3/ 7	1	1	1.33	2	0.577	0.571	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.28 Statistics for ZINC concentrations in $\mu\text{g/L}$ in groundwater for UEFPD OU3 site wells; ICP unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL} = 0$)	Years Sampled
GW-190	3/ 3	•	13	21	28	7.55	21	1990-90
GW-251	14/ 14	•	35	124	250	65.1	124	1986-90
GW-252	11/ 11	•	6.2	33.5	81	23.6	33.5	1986-90
GW-253	14/ 14	•	4,500	7,240	11,000	1,840	7,240	1986-90
GW-254	6/ 6	•	26	65.5	100	29.4	65.5	1986-87
GW-255	12/ 12	•	4.3	22.5	48	12.1	22.5	1986-90
GW-256	6/ 6	•	560	1,710	3,700	1,340	1,710	1986-87
GW-261	13/ 15	1	3.3	31.8	68	25.6	27.6	1986-90
GW-262	10/ 14	1	1.1	31.3	180	58.6	22.3	1986-90
GW-263	8/ 9	1	3	36.4	100	35.9	32.3	1987-90
GW-264	12/ 15	1	3	11.8	25	7.22	9.42	1986-90
GW-265	9/ 12	1	7.3	22.2	58	18.7	16.7	1986-90
GW-266	1/ 2	1	100	100	100	•	50	1986-87
GW-267	1/ 2	1	65	65	65	•	32.5	1986-87
GW-268	8/ 12	1	2.3	24.1	90	29.2	16.1	1986-90
GW-269	8/ 11	1	1.8	21.5	38	11.7	15.6	1986-90
GW-270	3/ 5	1	41	56.3	82	22.4	33.8	1986-87
GW-271	2/ 5	1	1.9	3.2	4.5	1.84	1.28	1986-87
GW-272	5/ 5	•	9.2	22.2	45	13.8	22.2	1986-87
GW-273	6/ 6	•	25	72.5	130	46.3	72.5	1986-88
GW-274	3/ 5	100	150	193	230	40.4	116	1986-87
GW-275	5/ 5	•	15	110	280	101	110	1986-87
GW-337	6/ 7	1	6.9	60	290	113	51.5	1989-90
GW-338	4/ 7	1	1.4	12.6	22	8.48	7.2	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma.
Sample type: Unfiltered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

Table D.29 Statistics for TETRACHLOROETHENE concentrations in $\mu\text{g/L}$ in groundwater for UEFFPC OU3 site wells; unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Year, Sampled
GW-190	6/ 6	•	6	55.7	130	58.7	55.7	1990-90
GW-251	36/ 36	•	18.8	260	800	191	260	1986-90
GW-252	10/ 36	5.38	0.9	2.98	8	2.77	0.828	1986-90
GW-253	28/ 28	•	9	736	1,000	240	736	1986-90
GW-254	12/ 12	•	70	121	210	56.2	121	1986-87
GW-255	22/ 38	5	1	2.82	7	1.74	1.63	1986-90
GW-256	12/ 12	•	210	4,540	24,200	9,190	4,540	1986-87
GW-261	10/ 30	5	1	4.6	12	4.14	1.53	1986-90
GW-262	10/ 28	5	0.6	1.1	2	0.499	0.393	1986-90
GW-263	2/ 18	5	1	1	1	0	0.111	1987-90
GW-264	4/ 30	5	0.8	3.9	7	3.58	0.52	1986-90
GW-265	22/ 22	•	10	243	390	104	243	1986-90
GW-266	4/ 4	•	100	110	120	11.5	110	1986-87
GW-267	4/ 4	•	750	760	770	11.5	760	1986-87
GW-268	4/ 24	5	2	5	8	3.46	0.833	1986-90
GW-269	22/ 24	5	0.6	4.24	11	3.16	3.88	1986-90
GW-270	4/ 28	5	3	4	5	1.15	0.571	1986-90
GW-271	10/ 28	5	2	3	4	0.943	1.07	1986-90
GW-272	8/ 28	5	3	6.5	14	4.69	1.86	1986-90
GW-273	14/ 14	•	19	35	46	8.96	35	1986-88
GW-274	12/ 28	36.2	1	2	3	0.603	0.857	1986-90
GW-275	6/ 28	27.7	0.9	3.97	10	4.67	0.85	1986-90
GW-337	14/ 14	•	760	1,000	1,300	165	1,000	1989-90
GW-338	4/ 14	5	3	4.5	6	1.73	1.29	1989-90

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.30 Statistics for TRICHLOROETHENE concentrations in $\mu\text{g/L}$ in groundwater for UEFFPC OU3 site wells; unfiltered sample

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-190	3/ 3	•	1	23.3	39	19.9	23.3	1990-90
GW-251	16/ 18	7.5	23	114	201	54.5	102	1986-90
GW-252	2/ 18	5	2	4	6	2.83	0.444	1986-90
GW-253	13/ 14	500	330	572	1,000	171	531	1986-90
GW-254	5/ 6	5	200	250	340	53.9	208	1986-87
GW-255	4/ 19	5	0.7	1.68	4	1.56	0.353	1986-90
GW-256	6/ 6	•	260	1,040	2,100	841	1,040	1986-87
GW-261	2/ 15	5	8	10.5	13	3.54	1.4	1986-90
GW-262	1/ 14	5	2	2	2	•	0.143	1986-90
GW-263	0/ 9	5	•	•	•	•	0	1987-90
GW-264	1/ 15	5	3	3	3	•	0.2	1986-90
GW-265	12/ 12	•	15	119	1,100	309	119	1986-90
GW-266	2/ 2	•	120	130	140	14.1	130	1986-87
GW-267	2/ 2	•	53	59	65	8.49	59	1986-87
GW-268	1/ 12	5	2	2	2	•	0.167	1986-90
GW-269	2/ 12	5	1	2.5	4	2.12	0.417	1986-90
GW-270	1/ 14	5	4	4	4	•	0.286	1986-90
GW-271	2/ 14	5	0.9	2.45	4	2.19	0.35	1986-90
GW-272	3/ 14	5	2	3	5	1.73	0.643	1986-90
GW-273	7/ 7	•	3	6.57	22	6.88	6.57	1986-88
GW-274	11/ 14	88.3	4	4.45	6	0.82	3.5	1986-90
GW-275	0/ 14	22.9	•	•	•	•	0	1986-90
GW-337	7/ 7	•	1,200	1,460	2,000	294	1,460	1989-90
GW-338	0/ 7	5	•	•	•	•	0	1989-90

Sample type: Unfiltered Sample.
Grand mean includes nondetects set to zero.
Data source: Preliminary Y-12 data.

Program Source: S86L.SAS
Date: 09MAR93

**Table D-31 Statistics for ALPHA ACTIVITY concentrations in PCI/L in groundwater for UEFPD OU3 site wells;
radiation counting unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-251	7/ 7	•	6.4	13	19	4.25	13	1986-87
GW-252	4/ 6	3.5	2	4.95	6.8	2.1	3.3	1986-87
GW-253	7/ 7	•	8	70.8	140	47.7	70.8	1986-87
GW-254	5/ 6	3	7	15.2	31.2	9.68	12.7	1986-87
GW-255	5/ 7	1.5	1	7.52	27	11	5.37	1986-87
GW-256	6/ 6	•	11.4	29.7	72	24.5	29.7	1986-87
GW-261	4/ 5	3	2.1	5.52	9	2.85	4.42	1986-87
GW-262	4/ 5	3	10	40	126	57.4	32	1986-87
GW-263	1/ 2	2	2.4	2.4	2.4	•	1.2	1987-87
GW-264	3/ 5	2.5	4.7	9.57	13	4.33	5.74	1986-87
GW-265	1/ 5	2.75	4	4	4	•	0.8	1986-87
GW-266	1/ 2	2	10	10	10	•	5	1986-87
GW-267	2/ 2	•	4	5	6	1.41	5	1986-87
GW-268	3/ 5	2	2	7	10	4.36	4.2	1986-87
GW-269	3/ 5	2.5	3.7	5.9	7	1.91	3.54	1986-87
GW-270	4/ 5	3	3	26.4	52	26.2	21.1	1986-87
GW-271	2/ 5	2.33	2	2	2	0	0.8	1986-87
GW-272	4/ 5	2	5.2	20	43.7	18.3	16	1986-87
GW-273	1/ 5	3	18	18	18	•	3.6	1986-88
GW-274	3/ 5	2.5	36.2	283	458	220	170	1986-87
GW-275	3/ 5	3	91	181	283	96.6	109	1986-87

Analysis: Element analyzed by Radiation Counting.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

Table D.32 Statistics for BETA ACTIVITY concentrations in PCI/L in groundwater for UEFPD OU3 site wells;
radiation counting unfiltered sample

Well	Proportion of Results >Detection Limit	Mean Detection Limit	Minimum Result >Detection Limit	Mean Result >Detection Limit	Maximum Result >Detection Limit	Standard Deviation >Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-251	7/7	•	9	13.6	17	2.92	13.6	1986-87
GW-252	5/6	1	5.4	9.02	16.9	4.91	7.52	1986-87
GW-253	7/7	•	12	234	1,190	424	234	1986-87
GW-254	6/6	•	9.6	49.2	99	32.5	49.2	1986-87
GW-255	6/7	5	3	11.3	26	9.25	9.7	1986-87
GW-256	6/6	•	5	22.4	54	17.6	22.4	1986-87
GW-261	4/5	5	5.9	10.2	18	5.7	8.18	1986-87
GW-262	5/5	•	6.8	79.6	313	131	79.6	1986-87
GW-263	2/2	•	6.6	8.3	10	2.4	8.3	1987-87
GW-264	4/5	5	2	8.37	19	7.7	6.7	1986-87
GW-265	2/5	3	4	5	6	1.41	2	1986-87
GW-266	1/2	2	12	12	12	•	6	1986-87
GW-267	1/2	2	5	5	5	•	2.5	1986-87
GW-268	3/5	3	2	14.3	26	12	8.6	1986-87
GW-269	4/5	2	19.2	33	65	21.4	26.4	1986-87
GW-270	5/5	•	3	30	85.8	34.7	30	1986-87
GW-271	3/5	3	2.1	51.2	141	77.5	30.7	1986-87
GW-272	5/5	•	2	123	363	158	123	1986-87
GW-273	5/5	•	212	384	566	139	384	1986-87
GW-274	5/5	•	1,112	3,940	10,100	3,670	3,940	1986-87
GW-275	5/5	•	87	1,010	2,580	973	1,010	1986-87

Analysis: Element analyzed by Radiation Counting.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

**Table D.33 Statistics for GROSS ALPHA concentrations in PCI/L in groundwater for UEFFPC OU3 site wells;
radiation counting unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	3/ 3	•	0.57	2.4	4.95	2.28	2.4	1990-90
GW-251	11/ 11	•	0.03	6.93	12.5	3.63	6.93	1988-90
GW-252	9/ 12	1.09	0.26	3.65	17	5.23	2.74	1988-90
GW-253	6/ 7	2	3.43	44.7	95	30.2	38.3	1988-90
GW-255	10/ 12	1.5	0	1.43	3	0.928	1.2	1988-90
GW-261	7/ 10	0.557	0.093	1.12	3	1.06	0.785	1988-90
GW-262	6/ 9	1.46	0.5	2.28	7	2.38	1.52	1988-90
GW-263	5/ 7	0.35	0.97	2.5	4	1.42	1.79	1988-90
GW-264	9/ 10	89	0.21	2.24	5	1.68	2.02	1988-90
GW-265	5/ 7	0.82	0.1	0.86	2	0.767	0.614	1988-90
GW-268	6/ 7	1	0.94	1.11	1.69	0.288	0.947	1988-90
GW-269	3/ 7	1.21	0	1.33	3	1.53	0.571	1988-90
GW-270	9/ 9	•	1	14.4	76	25	14.4	1988-90
GW-271	7/ 9	1.83	1.86	9.69	39	13.7	7.54	1988-90
GW-272	8/ 9	1	0.11	43.3	233	84	38.5	1988-90
GW-273	2/ 2	•	6	81.5	157	107	81.5	1988-88
GW-274	6/ 9	66.7	50	445	1,500	535	297	1988-90
GW-275	9/ 9	•	1.35	107	243	99	107	1988-90
GW-337	5/ 7	0.605	0.66	1.3	2	0.477	0.931	1989-90
GW-338	7/ 7	•	0.08	0.864	2.35	0.94	0.864	1988-90

Analysis: Element analyzed by Radiation Counting.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

**Table D.34 Statistics for GROSS BETA concentrations in PCI/L in groundwater for UEFPC OU3 site wells;
radiation counting unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-190	2/ 3	0.19	4.54	6.17	7.8	2.31	4.11	1990-90
GW-251	11/ 11	•	6.63	11.7	21.2	4.23	11.7	1988-90
GW-252	12/ 12	•	0.33	32.5	277	79.8	32.5	1988-90
GW-253	6/ 7	247	2	48.6	157	56.8	41.7	1988-90
GW-255	12/ 12	•	0.5	4.8	21	5.54	4.8	1988-90
GW-261	9/ 10	3.47	0.82	10.4	39	15	9.35	1988-90
GW-262	6/ 9	2.84	2	29.8	148	58.1	19.9	1988-90
GW-263	6/ 7	0.89	4.19	11.4	28	9.07	9.8	1988-90
GW-264	8/ 10	28.7	1.9	9.74	28	9.92	7.79	1988-90
GW-265	6/ 7	3.14	0.45	5.08	16	6.19	4.35	1988-90
GW-268	6/ 7	8	1	7.1	15	4.96	6.09	1988-90
GW-269	7/ 7	•	1	29.2	41	13.8	29.2	1988-90
GW-270	8/ 9	16	5.6	63.1	261	92.2	56.1	1988-90
GW-271	9/ 9	•	2	43.2	246	77.9	43.2	1988-90
GW-272	8/ 9	93	6.8	78.6	390	129	69.9	1988-90
GW-273	2/ 2	•	255	331	406	107	331	1988-88
GW-274	9/ 9	•	1,118	1,610	2,010	349	1,610	1988-90
GW-275	7/ 9	530	212	641	2,300	739	499	1988-90
GW-337	5/ 7	0.31	1.16	4.64	9	3.14	3.32	1989-90
GW-338	7/ 7	•	0.6	4.15	7.1	2.37	4.15	1989-90

Analysis: Element analyzed by Radiation Counting.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

**Table D.35 Statistics for URANIUM-235 concentrations in PCI/L in groundwater for UEFFC OU3 site wells;
radiation counting unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-252	3/ 3	•	0	0	0	0	0	1986-90
GW-253	1/ 1	•	0	0	0	•	0	1986-90
GW-255	3/ 3	•	0	2.74	8.21	4.74	2.74	1986-90
GW-261	3/ 3	•	0	0.533	1.6	0.924	0.533	1990-90
GW-262	2/ 2	•	0	0.625	1.25	0.884	0.625	1990-90
GW-263	2/ 2	•	0.41	4.26	8.11	5.44	4.26	1990-90
GW-264	3/ 3	•	0	0.14	0.42	0.242	0.14	1990-90

Analysis: Element analyzed by Radiation Counting.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

**Table D.36 Statistics for URANIUM-235 concentrations in PCI/L in groundwater for UEFPD OU3 site wells;
radiation counting filtered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-251	0/ 3	20,000	•	•	•	•	0	1986-90
GW-252	0/ 3	20,000	•	•	•	•	0	1986-90
GW-253	0/ 3	20,000	•	•	•	•	0	1986-90
GW-254	1/ 3	20,000	0.34	0.34	0.34	•	0.113	1986-86
GW-255	0/ 3	20,000	•	•	•	•	0	1986-90
GW-256	0/ 3	20,000	•	•	•	•	0	1986-86
GW-275	1/ 1	•	0.41	0.41	0.41	•	0.41	1989-89

Analysis: Element analyzed by Radiation Counting.

Sample type: Filtered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

**Table D.37 Statistics for URANIUM-234 concentrations in PCI/L in groundwater for UEFPD OU3 site wells;
radiation counting unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-252	1/ 3	8.34	0.43	0.43	0.43	•	0.143	1990-90
GW-253	1/ 1	•	0	0	0	•	0	1990-90
GW-255	2/ 3	8.21	0	1.82	3.65	2.58	1.22	1990-90
GW-261	2/ 3	8.65	0	1	2	1.41	0.667	1990-90
GW-262	2/ 2	•	0	0.42	0.84	0.594	0.42	1990-90
GW-263	2/ 2	•	0.41	4.26	8.11	5.44	4.26	1990-90
GW-264	3/ 3	•	0	0.14	0.42	0.242	0.14	1990-90

Analysis: Element analyzed by Radiation Counting.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

**Table D.38 Statistics for URANIUM-238 concentrations in PCI/L in groundwater for UEFPC OU3 site wells;
radiation counting unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL=0)	Years Sampled
GW-252	3/3	•	0	0	0	0	0	1990-90
GW-253	1/1	•	0	0	0	•	0	1990-90
GW-255	2/3	0.4	0	0	0	0	0	1990-90
GW-261	3/3	•	0	0.133	0.4	0.231	0.133	1990-90
GW-262	2/2	•	0	4.32	8.65	6.12	4.32	1990-90
GW-263	2/2	•	0	0.205	0.41	0.29	0.205	1990-90
GW-264	3/3	•	0	6.33	19	11	6.33	1990-90

Analysis: Element analyzed by Radiation Counting.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

**Table D.39 Statistics for URANIUM-238 concentrations in WT% in groundwater for UEFFC OU3 site wells;
radiation counting unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean (<DL =0)	Years Sampled
GW-275	1 / 1	•	99.59	99.6	99.6	•	99.6	1989-89

Analysis: Element analyzed by Radiation Counting.

Sample type: Unfiltered Sample.

Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.

Program Source: S86L.SAS

Date: 09MAR93

**Table D.40 Statistics for URANIUM FLUOROMETRIC concentrations in $\mu\text{g/L}$ in groundwater for UERFPC OU3 site wells;
ICP filtered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($< \text{DL}=0$)	Years Sampled
GW-190	0/ 3	1	•	•	•	•	0	1990-90
GW-251	15/ 18	1	1	3.4	5	1.3	2.83	1986-90
GW-252	11/ 18	1	1	2.55	6	1.75	1.56	1986-90
GW-253	14/ 14	•	5	7.07	10	1.77	7.07	1986-90
GW-254	6/ 6	•	4	15.2	42	13.9	15.2	1986-87
GW-255	5/ 19	1	1	2.2	4	1.3	0.579	1986-90
GW-256	5/ 6	1	3	11.6	37	14.4	9.67	1986-87
GW-261	6/ 15	1	2	3.33	5	1.37	1.33	1986-90
GW-262	9/ 14	1	1	6.56	29	9.28	4.21	1986-90
GW-263	2/ 9	1	3	3.5	4	0.707	0.778	1987-90
GW-264	10/ 15	1	1	5.6	33	9.75	3.73	1986-90
GW-265	7/ 12	1	1	1.29	2	0.488	0.75	1986-90
GW-266	2/ 2	•	2	4	6	2.83	4	1986-87
GW-267	2/ 2	•	1	2	3	1.41	2	1986-87
GW-268	7/ 12	1	1	2.14	4	1.07	1.25	1986-90
GW-269	4/ 12	1	2	3	4	0.816	1	1986-90
GW-270	11/ 14	1	1	11.6	90	26.3	9.14	1986-90
GW-271	3/ 14	1	2	4.67	8	3.06	1	1986-90
GW-272	7/ 14	1	1	16	74	26.1	8	1986-90
GW-273	6/ 7	4	7.4	24.7	46	17	21.2	1986-88
GW-274	4/ 6	202	7	16.3	38	14.6	10.8	1986-90
GW-275	1/ 6	11.2	16	16	16	•	2.67	1986-90
GW-337	5/ 7	4	4.4	7.88	11	2.67	5.63	1989-90
GW-338	5/ 7	4	5.8	9.16	16	4.37	6.54	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma
Sample type: Filtered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

**Table D.41 Statistics for URANIUM FLUOROMETRIC concentrations in $\mu\text{g/L}$ in groundwater for UEFPC OU3 site wells;
ICP unfiltered sample**

Well	Proportion of Results > Detection Limit	Mean Detection Limit	Minimum Result > Detection Limit	Mean Result > Detection Limit	Maximum Result > Detection Limit	Standard Deviation > Detection Limit	Grand Mean ($<DL=0$)	Years Sampled
GW-190	0/ 3	1	•	•	•	•	0	1990-90
GW-251	18/ 18	•	1	3.72	8	2.14	3.72	1986-90
GW-252	9/ 18	1	1	4.33	9	2.83	2.17	1986-90
GW-253	14/ 14	•	5	9.43	22	4.03	9.43	1986-90
GW-254	6/ 6	•	6	13.5	25	8.02	13.5	1986-87
GW-255	7/ 19	1	1	3.86	13	4.22	1.42	1986-90
GW-256	4/ 6	1	1	4.25	10	3.95	2.83	1986-87
GW-261	7/ 15	1	1	2.57	6	1.81	1.2	1986-90
GW-262	10/ 14	1	1	22.6	132	41.5	16.1	1986-90
GW-263	2/ 9	1	2	4	6	2.83	0.889	1987-90
GW-264	9/ 15	1	1	4.22	11	3.19	2.53	1986-90
GW-265	5/ 12	1	1	2.6	7	2.61	1.08	1986-90
GW-266	2/ 2	•	1	2.5	4	2.12	2.5	1986-87
GW-267	1/ 2	1	4	4	4	•	2	1986-87
GW-268	5/ 12	1	2	3.6	7	2.3	1.5	1986-90
GW-269	8/ 12	1	1	2	4	1.07	1.33	1986-90
GW-270	11/ 14	1	1	4.82	12	3.22	3.79	1986-90
GW-271	8/ 14	1	1	4.25	9	3.73	2.43	1986-90
GW-272	6/ 14	1	1	7.33	17	6.02	3.14	1986-90
GW-273	4/ 7	1	1	4.5	9	3.7	2.57	1986-88
GW-274	14/ 14	•	22	33.9	47	8.17	33.9	1986-90
GW-275	13/ 14	1	5	12.2	27	6.8	11.3	1986-90
GW-337	5/ 7	1	1	1	1	0	0.714	1989-90
GW-338	4/ 7	1	1	1.25	2	0.5	0.714	1989-90

Analysis: Element analyzed by Inductively Coupled Plasma
Sample type: Unfiltered Sample.
Grand mean includes nondetects set to zero.

Data source: Preliminary Y-12 data.
Program Source: S86L.SAS
Date: 09MAR93

Appendix E

FLORA AND FAUNA FOUND WITHIN THE ORR

APPENDIX E. Flora and fauna found within the ORR

Common Name	Scientific Name
FLORA	
American chestnut	<i>Castanea dentata</i>
Northern red oak	<i>Quercus borealis</i>
Chestnut oak	<i>Q. prinus</i>
Yellow Poplar	<i>Liriodendron tulipifera</i>
Shortleaf pine	<i>Pinus echinata</i>
Virginia pine	<i>P. virginiana</i>
Beech	<i>Fagus grandifolia</i>
Sugar maple	<i>Acer saccharum</i>
Magnolia	<i>Magnolia acuminata</i> and <i>M. tripetala</i>
Buckeye	<i>Aesculus glabra</i>
Willow	<i>Salix sp.</i>
Willow	<i>Salix sp.</i>
Sycamore	<i>Platanus occidentalis</i>
Boxelder	<i>Acer negundo</i>
Loblolly pine	<i>Pinus taeda</i>
Hickory	<i>Carya sp.</i>
Hemlock	<i>Tsuga canadensis</i>
White pine	<i>Pinus strobus</i>
Eastern red cedar	<i>Juniperus virginianus</i>
Redbud	<i>Cercis canadensis</i>
Sassafras	<i>Sassafras albidum</i>
Cottonwood	<i>Populus deltoides</i>
Elm	<i>Ulmus sp.</i>
Ash	<i>Fraxinus sp.</i>
Silver maple	<i>Acer saccharinum</i>
River birch	<i>Betula nigra</i>
White oak	<i>Quercus alba</i>
Black oak	<i>Q. velutina</i>

Appendix E (continued)

Common Name	Scientific Name
Scarlet oak	<i>Q. coccinea</i>
Post oak	<i>Q. stellata</i>
Black gum	<i>Nussa sylvatica</i>
Dogwood	<i>Cornus florida</i>
Basswood	<i>Tilia americana</i>
Bluestem	<i>Andropogon sp.</i>
Bluegrass	<i>Poa sp.</i>
Orchard grass	<i>Dactylis glomerata</i>
Ragweed	<i>Ambrosia artemisifolia</i>
Crabgrass	<i>Digitaria sp.</i>
Horse weed	<i>Conyza canadensis</i>
Primrose	<i>Oenothera sp.</i>
Honeysuckle	<i>Lonicera japonica</i>
Broomsedge	<i>Andropogon virginicus</i>
Trumpet creeper	<i>Campsis radicans</i>
Sumac	<i>Rhus typhina and R. copallina</i>
Persimmon	<i>Diospyros virginiana</i>
White poplar	<i>Populus alba</i>
Watercress	<i>Nasturtium sp.</i>
Cattail	<i>Typha sp.</i>
MAMMALS	
Little Brown Bat	<i>Myotis lucifungus</i>
Keen's bat	<i>Myotis keenii</i>
Silver-haired bat	<i>Lasionycteris noctivagans</i>
Eastern pipistrelle	<i>Pipistrellus subflavus</i>
Big brown bat	<i>Eptesicus fuscus</i>
Red bat	<i>Lasiurus borealis</i>
Hoary bat	<i>Lasiurus cinereus</i>

Appendix E (continued)

Common Name	Scientific Name
Virginia opossum	<i>Didelphis virginiana</i>
Least shrew	<i>Cryptotis parva</i>
Southeastern shrew	<i>Sorex longirostris</i>
Short-tailed shrew	<i>Blarina brevicauda</i>
Southern short-tailed shrew	<i>B. carolinensis</i>
Gray myotis	<i>Myotis grisescens</i>
Indiana myotis	<i>M. sodalis</i>
Eastern cottontail	<i>Sylvilagus floridanus</i>
Eastern chipmunk	<i>Tamias striatus</i>
Gray squirrel	<i>Sciurus carolinensis</i>
Fox squirrel	<i>S. niger</i>
Southern flying squirrel	<i>Glaucomys Volans</i>
Marsh rice rat	<i>Oryzomys palustris</i>
Cotton rat	<i>Sigmodon hispidus</i>
Norway rat	<i>Rattus norvegicus</i>
White-footed mouse	<i>Peromyscus leucopus</i>
House mouse	<i>Mus musculus</i>
Cotton mouse	<i>P. gossypinus</i>
Golden mouse	<i>Ochrotomys nuttali</i>
Eastern harvest mouse	<i>Reithrodontomys shomulsi</i>
Woodland (Pine) vole	<i>Microtus pennsylvanicus</i>
Eastern mole	<i>Scalopus aquaticus</i>
Muskrat	<i>Ondatra zibethica</i>
Red fox	<i>Vulpes vulpes</i>
Gray fox	<i>Urocyon cinereoargenteus</i>
Coyote	<i>Canis latrans</i>
Black bear	<i>Ursus americanus</i>
Ground hog	<i>Marmota monax</i>
Raccoon	<i>Procyon lotor</i>

Appendix E (continued)

Common Name	Scientific Name
Striped skunk	<i>Mephitis mephitis</i>
Eastern spotted skunk	<i>Spilogale putorius</i>
Long-tailed weasel	<i>Mustela frenata</i>
Mink	<i>Mustela vison</i>
Beaver	<i>Castor canadensis</i>
Mountain lion (eastern cougar)	<i>Felis concolor</i>
Bobcat	<i>Lynx rufus</i>
White-tailed deer	<i>Odocoileus virginianus</i>
BIRDS	
Sharp-shinned hawk	<i>Acciptier striatus</i>
Cooper's hawk	<i>A. cooperii</i>
Red-shouldered hawk	<i>Buteo lineatus</i>
Broad-winged hawk	<i>B. playtpterus</i>
Southern bald eagle	<i>Haliaeetus l. leucocephalus</i>
Marsh hawk	<i>Circus cyaneus</i>
Osprey	<i>Pandion haliaetus</i>
Peregrine falcon	<i>Falco peregrinus</i>
Ruffed grouse	<i>Bonasa umbellus</i>
Bobwhite	<i>Colinus virginianus</i>
Turkey	<i>Meleagris gallopavo</i>
Mourning dove	<i>Zenaida macroura</i>
Common (yellow-shafted) flicker	<i>Colaptes auratus</i>
Red-bellied woodpecker	<i>Melanerpes carolinus</i>
Hairy woodpecker	<i>Picoides villosus</i>
Downy woodpecker	<i>P. pubescens</i>
Red-cockaded woodpecker	<i>P. borealis</i>
Blue jay	<i>Cyanocitta cristata</i>
Common crow	<i>Corvus brachyrhynchos</i>

Appendix E (continued)

Common Name	Scientific Name
Carolina chickadee	<i>Parus carolinensis</i>
Tufted titmouse	<i>P. bicolor</i>
Bewick's wren	<i>Thryomanes bewickii</i>
Wood thrush	<i>Hylocichla mustelina</i>
Red-eyed vireo	<i>Vireo olivaceus</i>
Pine warbler	<i>Dendrocia pinus</i>
Ovenbird	<i>Seiurus aurocapillus</i>
Kentucky warbler	<i>Oporornis formosus</i>
Yellow-breasted chat	<i>Icteria virens</i>
Scarlet tanager	<i>Piranga olivacea</i>
Summer tanager	<i>P. rubra</i>
Cardinal	<i>Cardinalis cardinalis</i>
Rufous-sided towhee	<i>Pipilo erythrophthalmus</i>
Grasshopper sparrow	<i>Ammodramus savannarum</i>
Bachman's sparrow	<i>Aimophila aestivalis</i>
White-throated sparrow	<i>Zonotrichia albicollis</i>
REPTILES AND AMPHIBIANS	
Eastern narrowmouth toad	<i>Gastrophryne carolinensis</i>
Northern cricket frog	<i>Acris creptians</i>
Spring peeper	<i>Hyla crucifer</i>
Gray treefrog	<i>Hyla versicolor</i>
Upland chorus frog	<i>Pseudacris triseriata</i>
Bullfrog	<i>Rana catesbeiana</i>
Green frog	<i>Rana clamitans</i>
Pickerel frog	<i>Rana palustris</i>
Southern leopard frog	<i>Rana sphenoccephala</i>
American toad	<i>bufo americanus</i>
Fowler's toad	<i>B. woodhousei</i>

Appendix E (continued)

Common Name	Scientific Name
Hellbender	<i>Cryptobranchus alleganesis</i>
Northern dusky salamander	<i>Desmognathus fuscus</i>
Red-spotted newt	<i>Notophthalmus viridescens</i>
Tennessee cave salamander	<i>Gyrinophilus palleucus</i>
Mudpuppy	<i>Necturus malulosus</i>
Red-backed salamander	<i>Plethodon cinereus</i>
Slimy salamander	<i>P. glutinosus</i>
Northern red salamander	<i>Pseudotriton r. tuber</i>
Spotted salamander	<i>Ambystoma maculatum</i>
Marbled salamander	<i>Ambystoma opacum</i>
Two-lined salamander	<i>Eurycea bislineata</i>
Spring salamander	<i>Gyrinophilus porphyriticus</i>
Mud salamander	<i>Pseudotriton montanus</i>
Snapping turtle	<i>Chelydra serpentina</i>
Map turtle	<i>Graptemys geographica</i>
Eastern musk turtle	<i>Sternotherus odoratus</i>
Stripe-necked musk turtle	<i>Sternotherus minor</i>
Spiny softshell turtle	<i>Apalone spinifera</i>
Yellow-bellied turtle	<i>Chrysemys scripta</i>
Eastern box turtle	<i>Terrapene carolina</i>
Northern copperhead	<i>Agkistrodon contortrix mokasen</i>
Six-lined racerunner	<i>Cnemidophorus sexlineatus</i>
Northern black racer	<i>Coluber constrictor</i>
Timber rattlesnake	<i>X h. horridus</i>
Black rat snake	<i>Elaphe obsoleta</i>
Ground skink	<i>Scincella lateralis</i>
Five-lined skink	<i>Eumeces fasciatus</i>
Broodhead skink	<i>Eumeces laticeps</i>
Eastern hognose snake	<i>Heterodon platyrhinos</i>

Appendix E (continued)

Common Name	Scientific Name
Northern water snake	<i>Natrix s. sipedon</i>
Fence lizard	<i>Sceloporus undulatus</i>
Northern brown snake	<i>Storeria d. dekayi</i>
Eastern garter snake	<i>Thamnophis s. sirtalis</i>
Worm snake	<i>Carphophis amoenus</i>
Scarlet snake	<i>Cemophera coccinea</i>
Ringneck snake	<i>Diadophis punctatus</i>
Corn snake	<i>Elaphe guttata</i>
Mole snake	<i>Lampropeltis calligaster</i>
Milk snake	<i>Lampropeltis tringulum</i>
Common king snake	<i>Lampropeltis getula</i>
Pine snake	<i>Pituophis melanoleucus</i>
Common water snake	<i>Nerodia sipedon</i>
Rough green snake	<i>Ophedodrys aestivus</i>
Queen snake	<i>Regina septemvittata</i>
Brown snake	<i>Storeria dekayi</i>
Redbelly snake	<i>Storeria occipitomaculata</i>
Smooth earth snake	<i>Virginia valeriae</i>
FISH	
Rock bass	<i>Ambloplites rupestris</i>
Common shiner	<i>Notropis cornutus</i>
White sucker	<i>Catostomus commersoni</i>
Blacknose dace	<i>Rhinichthys atratulus</i>
Tennessee dace	<i>Phoxinos Tennesseeensis</i>
Stoneroller	<i>Camptostoma anomalum</i>
Creek chub	<i>Semotilus atromaculatus</i>
Northern Hogsucker	<i>Hypentelium nigricans</i>

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