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ASSESSMENT OF THE GROUNDWATER PROTECTION PROGRAM Y-12 NATIONAL SECURITY COMPLEX, OAK RIDGE, TENNESSEE

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CONTENTS

APPENDICES:

List of Figures

List of Tables

List of Acronyms and Abbreviations

ACO	Analytical Chemistry Organization
ADMS	Analytical Data Management System
AFCEE	Air Force Center for Environmental Excellence
AOI	Area of Interest
bgs	Below Ground Surface
BJC	Bechtel Jacobs Company, L.L.C.
BWXT	BWXT Y-12, L.L.C.
CES	Cost Effective Sampling
cm/s	Centimeters per Second
CY	Calendar Year
11DCA	1,1-Dichloroethane
11DCE	1,1-Dichoroethene
12DCE	1,2-Dichloroethene
cDCE	*cis*-1,2-Dichloroethene
tDCE	*trans*-1,2-Dichloroethene
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CRSP	Chestnut Ridge Security Pits
COC	Constituent of Concern
COV	Coefficient of Variation
CTET	Carbon Tetrachloride
DOE	United States Department of Energy
DNAPL	Dense Non-Aqueous Phase Liquid
EDDs	Electronic Data Deliverables
EM	Environmental Management

EMWMF	Environmental Management Waste Management Facility
EQCAS	Environmental Quality Control and Analysis System
ft/yr	Feet per Year
GA	Gross Alpha Activity
GB	Gross Beta Activity
GIMS	Groundwater Information Management System
GIS	Geographic Information System
GSI	Groundwater Services, Inc.
GWPP	Groundwater Protection Program
HSCB	Hypothetical Statistical Compliance Boundary
LIMS	Laboratory Information Management System
LTM	Long-Term Monitoring
LTMO	Long-Term Monitoring Optimization
MAROS	Monitoring and Remediation Optimization Software
MCES	Modified Cost Effective Sampling
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
MSL	Mean Sea Level
MTBE	*tert*-Butyl Methyl Ether
NAPL	Non-Aqueous Phase Liquid
NNSA	National Nuclear Security Administration
NPDES	National Pollution Discharge Elimination System
PCE	Tetrachloroethene
PLSF	Preliminary Location Sampling Frequency

POE	Point of Exposure
PRG	Preliminary Remediation Goal
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SAIC	Science Applications International Corporation
SF	Slope Factor
SMDP	Scientific Management Decision Points
SVOCs	Semi-volatile Organic Compounds
SWDF	Solid Waste Disposal Facility
Tc-99	Technetium 99
1,1,1-TCA	1,1,1-Trichloroethane
TCE	Trichloroethene
TDEC	Tennessee Department of Environment and Conservation
UEFPC	Upper East Fork Poplar Creek
USACOE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VC	Vinyl chloride
VOC	Volatile Organic Compound
WMA	Waste Management Area
WRRP	Water Resources Restoration Program

EXECUTIVE SUMMARY

The following report contains an assessment of the Y-12 Groundwater Protection Program (GWPP) for the Y-12 National Security Complex at the Oak Ridge Reservation, Tennessee. The GWPP is administered by BWXT Y-12, L.L.C. for the purpose of groundwater surveillance monitoring. After over 20 years of extensive site characterization and delineation efforts, groundwater in the three hydrogeologic areas that comprise the Y-12 Complex requires a long-term monitoring network strategy that will efficiently satisfy surveillance monitoring objectives set forth in DOE Order 450.1. The GWPP assessment consisted of two phases, a qualitative review of the program and a quantitative evaluation of the groundwater monitoring network using the Monitoring and Remediation Optimization System (MAROS) software methodology.

The specific objective of the qualitative section of the review of the GWPP was to evaluate the methods of data collection, management, and reporting and the function of the monitoring network for the Y-12 facility using guidance from regulatory and academic sources. The results of the qualitative review are used to suggest modifications to the overall program that would be consistent with achieving objectives for long-term groundwater monitoring. While cost minimization is a consideration in the development of the monitoring program, the primary goal is to provide a comprehensive strategy to provide quality data to support site decision making during facility operations, long-term resource restoration, and property redevelopment.

The MAROS software is designed to recommend an improved groundwater monitoring network by applying statistical techniques to existing historic and current site analytical data. The MAROS methodology also considers hydrogeologic factors, regulatory framework, and the location of potential receptors. The software identifies trends and suggests components for an improved monitoring plan by analyzing individual monitoring wells in the current monitoring system as well as identifying area-wide trends.

The MAROS analysis was conducted as part of the review of the GWPP. The analysis was conducted to develop the future monitoring strategy for chlorinated solvents, radioactive constituents, metals, and nitrate affected groundwater. Because of the complicated geologic and hydrologic conditions, the MAROS method has been supplemented with results from the qualitative network assessment and decision logic methods to determine an effective monitoring strategy consistent with the unique objectives of the current GWPP.

Project Objectives

The overall objectives of the assessment of the GWPP included

- *Determine if the monitoring network is sufficient to accurately represent plume behavior;*
- *Determine if any parts of the long-term monitoring program (LTM) are redundant (i.e., do not provide new information);*
- *Determine if there are any ways to improve the accuracy and reliability of the LTM program;*

- *Determine if there any ways to reduce the life-cycle costs of the LTM program without sacrificing accuracy and protectiveness*

The qualitative assessment of the GWPP included a review of sample collection, handling, analysis and data management and reporting. Additionally the monitoring network was analyzed by applying qualitative decision logic described in a variety of long-term monitoring guidance documents such as the joint USEPA/USACOE *Roadmap to Long-Term Monitoring Optimization* (USEPA 2005) and in American Society of Civil Engineers *Long-Term Groundwater Monitoring* document (ASCE, 2003). Implementation of qualitative methods was guided by site-wide monitoring objectives and historic and current site data. The key objectives of the qualitative analysis included:

- Determining if site characterization and historic data collection efforts support the design of a long-term monitoring optimization (LTMO) process.
- Determine if data management and reporting activities comply with regulatory requirements and efficiently support site management decision making.
- Determine if analytical and well sampling techniques are appropriate and consistent with current regulatory guidance.
- Performing a qualitative evaluation (to support the quantitative evaluation) of how each sample location in the network contributes to each of the following objectives:
    - Regulatory compliance;
    - Horizontal delineation of the plume;
    - Vertical delineation of the plume;
    - Monitoring exit pathways;
    - Early detection of off-site migration or plume expansion;
    - Determination of background water quality;
    - Monitoring source behavior.

As part of the quantitative evaluation of the GWPP, the groundwater monitoring network in the vicinity of the Y-12 facility was analyzed by applying the MAROS 2.1 statistical and decision support methodology to historic and current site data. The key objectives of the analysis included:

- Determine overall stability of individual plumes through trend analysis and moment analysis;
- Evaluate individual well constituent concentration trends over time;
- Address adequate and effective sampling through reduction of redundant wells or reduction of sampling effort without information loss;
- Identify areas of higher uncertainty which should be addressed by future sampling events;
- Assess sampling frequency needed to provide sufficient plume stability information; and,
- Compare the current (2004) monitoring strategy with the improved plan suggested by the MAROS methodology combined with qualitative evaluation of the monitoring network.

Results

Qualitative Assessment

- Overall, the GWPP appears to be effectively and efficiently achieving monitoring goals set forth in Department of Energy (DOE) Order 450.1.

- Site Characterization efforts at the Y-12 Complex have an extensive history, and over 1900 sample locations are identified in the analytical database. Based on a qualitative analysis of source areas, geology and transport pathways, the monitoring network currently available is adequate to describe site-wide and off-site affected groundwater and potential transport pathways. There is sufficient data to support development of a LTMO plan.

- Groundwater sampling techniques used by the GWPP are appropriate to the size and scale of the program. The transition to low-flow techniques is supported by USEPA guidance (Puls and Barcelona, 1996) and the use of dedicated pumps and tubing at wells provides confidence in the quality of the data collected from these locations.

- Laboratory methods currently provide data that satisfy data quality objectives, meeting standards for quantization limits, quality assurance/quality control standards and documentation. High quality, reliable analytical data are generally available from 1996 to the present. The historic data set (prior to 1996), may not be entirely comparable to recent data due to changes in groundwater sampling techniques, sample handling and laboratory methods.

- The analytical data management system (ADMS) at the Y-12 Complex is efficient, well designed, and highly documented. The BWXT Groundwater Information Management System (GIMS) provides a high quality data system to support site decision making. The automated data review feature ensures possible errors or changes in plume status are identified early. The GIMS analytical database is thorough and easy to use.

- Site monitoring reports, while well written, may benefit from better quality maps and data visualization instruments. More effort should be directed toward improving the geographic information system (GIS) that links with the excellent analytical database.

Quantitative Assessment

The MAROS 2.1 sampling optimization software/methodology has been applied to the Y-12 groundwater monitoring well network for data collected during the period January 1996 through December 2004. Because the facility has three main hydrogeologic areas, several constituent classes, and multiple potential source zones, the facility was divided into 11 analysis groups, each analyzed separately. The site-wide results for 443 sample locations have been combined and are summarized below, as recommendations for the entire network.

- *COC Choice*: Priority constituents were identified in the MAROS constituents of concern (COC) Choice module. For most site areas, the volatile organic compound (VOC) constituents of greatest interest are tetrachloroethene/perchloroethylene (PCE) and trichloroethene (TCE). Priority inorganic constituents include nitrate and Gross Alpha (GA) and Gross Beta (GB) activity. Metals are a secondary but persistent concern in many areas of the Complex.

- *Moment Analysis*. The MAROS Moment Analysis module estimates the total dissolved mass (Zeroth Moment), distance of the center of mass from the source (First Moment) and distribution of mass within the plume (Second Moments). Moment analyses indicated that most plumes are classified as having "Stable" or "Decreasing" trends. Stable or decreasing plumes are good candidates for a reduced monitoring effort. Some areas have high variance in the data, indicating that more samples from a consistent set of wells would improve the statistical analysis.

- *Well Redundancy*: Due to the fractured geology and variety of depths of the wells, the Well Redundancy tool in MAROS could not be used to determine redundant locations (the redundancy tool is based on a two-dimensional analysis for diffuse flow plumes). Wells were recommended for removal from the monitoring program based on the qualitative evaluation and lines of evidence from the statistical trend evaluation and Moment analyses.

- *Well Sufficiency*: The Well Sufficiency tool was used to identify areas within the plume that may require additional monitoring due to inter-well concentration uncertainty. No new well locations are recommended. An increased monitoring effort (i.e. more frequent sampling) is suggested for some areas along the perimeter of the plume in the area of New Hope Pond and on the northern edge of the East Fork plumes.

- *Sampling Frequency*: The MAROS well sampling frequency tool uses a Modified Cost Effective Sampling (MCES) method to recommend an optimized sampling schedule for each well in the network. The results of the MCES method recommend moving from quarterly and semi-annual monitoring of all wells to an annual and biennial sampling program. Specific sampling frequency recommendations were developed using both quantitative and qualitative methods and are presented in Tables B.14-16 for each of the Regimes discussed in this document.

- Comparison of the current monitoring program (BWXT, 2004) with the MAROS recommended sampling plan indicates that MAROS suggests including more well locations, but at reduced frequency. The final recommendation includes a list of monitoring locations to review and re-evaluate after two to four years of data collection. The final number and identity of wells in the monitoring program will depend on the number of review wells to be sampled each year.

Based on the analysis of the current monitoring plan, the recommended long-term monitoring strategy results in a redirection in sampling effort from frequent sampling of a limited number of wells to less frequent sampling of a larger number of wells. This strategy examines more locations, which is consistent with the monitoring objectives articulated in DOE Order 450.1. The improved plan allows site personnel to focus attention on potential problem areas and decrease effort in areas where concentrations are shrinking or not detected. Regions of the plumes with higher rates of concentration change have been assigned higher monitoring frequencies, whereas areas of stability or concentration reduction have a reduced number of sampling points or frequency. The total number of wells can be reduced after a sufficient data set (i.e. four to six samples in a 10 year period) has been accumulated to examine the recent concentration trends.

Recommendations

Qualitative Assessment

- Data management, storage, review and reporting activities of the Y-12 GWPP are, excellent. Electronic data management is notable in its efficacy and efficiency. Reports would benefit from stronger data visualization tools. Consider developing stronger links between the analytical database and sophisticated mapping and visualization software.

- Based on examination of the GWPP analytical database, laboratory practices and analyses, particularly since the late 1990’s, provide high quality analytical data to support site management decisions. Prior to the 1990’s, some apparent outliers were detected in the analytical database, particularly for certain radioactive constituents. Consider reviewing and flagging data that may not be comparable to current sample events.

- The Y-12 Complex has been well characterized with many ‘active’ well locations, some suitable for constituent delineation and others for hydrologic investigation. Active well locations used to collect chemical analytical data should be clearly distinguished from those used for hydrogeologic data collection in the analytical database.

- The constituent 1,4-dioxane should be included in the analytical program. 1,4-Dioxane was used as a stabilizer in commercial 1,1,1-trichloroethane (111TCA) preparations. This constituent (1,4-dioxane) should be analyzed for in areas where 1,1-dichloroethene (11DCE) or 1,1-dichloroethane (11DCA) are detected.

- Sample a consistent suite of constituents at all locations. Because plumes are commingled and many constituents were used or disposed of plant-wide, analysis of all COCs provides information on the distribution of affected groundwater. Target constituents for the entire site include VOCs, metals, nitrate, Gross Alpha (GA) and Gross Beta (GB) activity, and uranium.

- Low-flow sampling techniques are recommended for groundwater sample locations across the site.

Quantitative Assessment

- The results of the analysis of the Y-12 GWPP well network indicate that the sampling frequency of most wells can be reduced from quarterly and semi-annual monitoring to annual, biennial or even greater time intervals between samples.

- By reducing sample intervals, more locations in the network can be sampled without increasing cost or effort. Sampling of more locations is important at Y-12 due to the diversity of sources and constituent classes and the complex hydrology. Increasing the diversity of sample locations while reducing the frequency of sampling will better fulfill the monitoring objectives set forth in DOE Order 450.1.

- While the current monitoring network had sufficient data to evaluate the efficacy of the network for long-term monitoring, the statistical tools used for the trend analysis could be more definitive with a larger, more consistent data set for many locations that currently have limited data. Before wells can be excluded from the sample network, sufficient data must be available to statistically support elimination of the well. The short-term recommendation is to sample wells with limited recent data for four sampling events and statistically reevaluate the contribution of each well after two years of sampling data has been obtained.

- For all analytical locations, sampling intervals should provide a minimum of four to six sample events in a 10-year time frame.

- Sample a consistent suite of constituents at all locations. Because many plumes are commingled and many constituents are distributed plant-wide, analysis of all COCs provides information on the distribution of affected groundwater. Target constituents for the entire site include VOCs, metals, nitrate, Gross Alpha (GA) and Gross Beta (GB) activity, and uranium.

- No new wells are recommended at this time.

- Evaluation of 443 sample locations resulted in a recommendation for removing 130 locations from the analytical program. Sample frequencies for 113 locations are specified under one of the regulatory orders. A well function review and possible supplemental sampling is recommended for 89 locations. No locations are recommended for quarterly sampling, while 20 locations are suggested for semi-annual sampling, 54 for annual sampling and 36 for biennial sampling.

SECTION I--QUALITATIVE ASSESSMENT

1.0 INTRODUCTION

1.1 Site Description

The U.S. Department of Energy (DOE) Y-12 National Security Complex is part of the larger Oak Ridge Reservation located in eastern Tennessee. The Complex is operated by BWXT Y-12, L.L.C. (BWXT) for the National Nuclear Security Administration (NNSA), under the broader supervision of the DOE. The facility has been engaged in research and manufacturing activities in support of security and defense missions for more than 60 years. Construction on the complex began in 1943 as part of the Manhattan Project, and Y-12 was actively involved in developing the first generation of nuclear weapons used during the Second World War. In the intervening years the primary missions of the site have evolved. Security related research and manufacturing activities have continued, and programs in basic scientific research and environmental management have been instituted at the facility.

Historic manufacturing and research operations at the facility have resulted in widespread areas of affected soil, surface water and groundwater in the Y-12 Complex. Environmental investigation and characterization activities have been conducted at the facility for over 30 years. Over 1900 surface and groundwater environmental monitoring locations are listed in the BWXT Analytical Database for locations sampled historically and currently by BWXT and Bechtel Jacobs Company, L.L.C. (BJC), the DOE environmental management (EM) contractor in Oak Ridge, TN. The Y-12 Complex within the larger Oak Ridge Reservation is regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Areas within the Complex are covered by Resource Conservation and Recovery Act (RCRA) programs as well as broader supervision by the Tennessee Department of Environment and Conservation (TDEC). Broader environmental monitoring and restoration supervision is also mandated under DOE orders for the Y-12 Complex.

1.2 Y-12 Conceptual Site Model

The groundwater and surface water monitoring program at Y-12 is guided by a detailed conceptual site model that encompasses site topography, surface water drainage, groundwater flow systems, contaminant source areas, and contaminant migration pathways. Background information regarding this conceptual site model is outlined in Section 2.0 of the *Calendar Year 2003 Groundwater Monitoring Report, Y-12 National Security Complex* (BWXT Y-12, 2004a).

The conceptual model for the Y-12 site includes three hydrogeologic regimes. The Bear Creek Regime and the Upper East Fork Poplar Creek Regime (East Fork Regime) are in Bear Creek Valley, which is bounded to the north by Pine Ridge and to the south by Chestnut Ridge. The Bear Creek Regime includes several miles of Bear Creek Valley between the west end of Bear Creek Valley and a topographic and hydrologic divide near the west end of the Y-12 industrial complex. The East Fork Regime, which includes the Y-12 industrial complex, is located east of the topographic/hydrologic divide and west of Scarboro Road.

The Chestnut Ridge Regime is located directly south of the Y-12 industrial complex and is bounded by Bear Creek Valley to the north, Scarboro Road to the east, Bethel Valley Road to the south, and Dunaway Branch to the west. The following sections describe the hydrogeology, source areas, and migration pathways for the three hydrogeologic regimes.

1.2.1 Hydrogeology

Bedrock Geology: Bedrock geology in the area consists of thrust-faulted southeast-dipping sequences of shale, siltstone, limestone, and dolostone strata of Cambrian and Ordovician age. In Bear Creek Valley the outcropping geologic units are in the Conasauga Group, which includes the Maynardville Limestone, Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone, and Pumpkin Valley Shale. Bedrock is overlain by up to 40 feet of unconsolidated materials in Bear Creek Valley, and extensive areas of fill materials typically ranging from 5 to 25 feet in thickness are present beneath the Y-12 industrial complex.

On Chestnut Ridge the formations that outcrop are carbonates of the Knox Group and overlying interbedded limestones and shales of the Chickmauga Group. Unweathered bedrock is overlain by up to 100 feet of unconsolidated residuum on Chestnut Ridge.

Surface Water Drainage: Surface water in the Bear Creek Regime flows along Bear Creek and its tributaries. Bear Creek acts as a major conduit of the shallow karst network in the Maynardville Limestone, and discharge from springs is an important component of flow in the main channel of Bear Creek. Bear Creek includes gaining reaches (i.e., groundwater discharge areas) and losing reaches. Major sections of upper and middle Bear Creek are seasonally dry.

In the East Fork Regime, surface water is drained by Upper East Fork Poplar Creek. The main channel and all the northern tributaries in the western and central portions of the East Fork Regime were filled and replaced by an extensive network of underground stormwater drain lines that were constructed during development of the Y-12 complex. A lined surface impoundment (Lake Reality) is located on the eastern side of the East Fork Regime and regulates the quantity and quality of surface water exiting Upper East Fork Poplar Creek. Lake Reality was built to replace New Hope Pond, an unlined surface impoundment that was closed and capped in 1988.

Aquifer and Aquitard Hydrogeologic Units: For the conceptual site model, geologic strata have been divided into two hydrogeologic units. The aquifer includes the Maynardville Limestone and the overlying dolomite formations of the Knox Group. The aquitard includes several formations that underlie the Maynardville Limestone, including the Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone, Pumpkin Valley Shale, and Rome Formation.

Groundwater Flow in Maynardville Limestone: The Maynardville Limestone outcrops along the axis of Bear Creek Valley. Most groundwater flow in the Maynardville Limestone is reported to occur at depths less than 100 feet below ground surface in a shallow karst network of interconnected solution conduits and cavities. In the deeper groundwater flow system within the Maynardville Limestone, fractures are the primary flow pathways.

Potentiometric surface elevations in Bear Creek Valley show a hydrologic divide near the western end of the Y-12 industrial complex. In the Bear Creek Regime, groundwater flow occurs parallel to geologic strike (i.e., along Bear Creek Valley) toward the west-southwest. In the Upper East Fork Regime, groundwater flow occurs parallel to geologic strike toward the east-southeast.

Groundwater Flow in Knox Group Formations: Groundwater flow underlying Chestnut Ridge occurs in a very shallow "stormflow zone" in the unconsolidated residuum and in fractures within unweathered bedrock of the Knox Group formations. The bedrock has enlarged fractures and other solution features characteristic of karst aquifers. Most groundwater flux occurs near the transition between the residuum and unweathered bedrock, where the water table is located.

Potentiometric surface elevations at the Chestnut Ridge Regime generally mirror surface topography. Along the crest of the ridge groundwater generally flows from west to east, parallel to geologic strike, with radial flow components to the north and south. In the central portion of the Chestnut Ridge Regime, groundwater flow is radial from local flow divides along hilltops. Groundwater flow directions in the southern part of the regime are generally toward the south.

Groundwater Flow in the Aquitard Formations: Most groundwater flow in the aquitard occurs within a permeable water table interval near the interface between unconsolidated materials and bedrock. Some groundwater flow also occurs in fractures within the bedrock. Only a small percentage of groundwater flow in the aquitard recharges deeper bedrock. In the Bear Creek Regime, it is estimated that about 94% of available water in the aquitard discharges to tributaries of Bear Creek. In the East Fork Regime, surface water infiltration and recharge to the water table interval are significantly influenced by impervious surface cover, extensive areas of fill, and subsurface networks of stormwater drains, sewer lines, and process lines. The presence of these underground utilities and operation of basement dewatering sumps strongly influences local groundwater flow patterns at some locations in the East Fork Regime.

1.2.2 Source Areas

Groundwater quality monitoring data show that the most widespread groundwater contaminants at Y-12 are nitrate, volatile organic compounds (VOCs), uranium isotopes and technetium-99 (Tc-99). Gross alpha (GA) and gross beta (GB) activity are evaluated routinely to monitor the overall uranium isotope and Tc-99 distribution across the site. GA and GB analyses are supplemented with confirmatory isotopic analyses to better define the specific constituents in groundwater. The major constituents found in groundwater at the Y-12 Complex along with the applicable screening levels are listed in Table B.1.

In the Bear Creek Regime, the primary sources of groundwater contamination include the S-3 Site located to the east, a group of sites known as the Oil Landfarm Waste Management Area (WMA), and a group of sites known as the Bear Creek Burial Grounds Waste Management Area. The principal constituents of concern (COCs) at the source areas in the Bear Creek Regime are summarized in the table below, which was developed based on descriptions in the *Calendar Year 2003 Groundwater Monitoring Report, Y-12 National Security Complex* (BWXT Y-12, 2004a).

Source Areas and COCs at the Bear Creek Regime		
	Major COCs	**Other COCs**
S-3 Site		
Former S-3 Ponds	Nitrate, Tc-99, uranium isotopes; VOCs, (with possible DNAPL); trace metals	--
Oil Landfarm Waste Management Area		
Boneyard/Burnyard	Uranium isotopes	--
Hazardous Chemical Disposal Area	VOCs	--
Oil Landfarm	111TCA; 11DCA; 11DCE; PCE; TCE; tDCE; cDCE	--
Sanitary Landfill I	11DCA; tDCE; cDCE; boron	--
Bear Creek Waste Management Area		
Burial Ground A (North)	PCE; TCE; cDCE (possible DNAPL)	Other VOCs, (including 111TCA; 1,1-DCA; and 1,2-DCA)
Burial Ground A (South)	PCE; TCE; cDCE (confirmed DNAPL)	Other VOCs (including 111TCA; 11DCA; and 12DCA); boron; uranium isotopes
Burial Ground C (East)	cDCE; vinyl chloride	Boron; uranium isotopes
Burial Ground C (West)	cDCE; vinyl chloride	Boron
Walk-In Pits	PCE (possible DNAPL)	Other VOCs

The S-3 Site is located at the eastern end of the Bear Creek Regime in the aquitard unit (Nolichucky Shale) above and north of the transmissive aquifer unit. The former S-3 ponds area is characterized by high nitrate concentrations and uranium isotopes affecting groundwater flowing in the aquitard and into the Maynardville Limestone at the base of the valley. Westward flow is occurring in the aquitard along strike (as evidenced by nitrate concentrations in GW-829, GW-537, and GW-085, see discussion Section II 3.3.1 *West S-3*). The source areas for the Oil Landfarm WMA and Bear Creek Burial Grounds are mostly underlain by the geologic formations that comprise the aquitard. VOC constituents from the Oil Landfarm WMA and Burial Grounds flow through fractures in the aquitard as well as in surface streams into affected groundwater in the Maynardville aquifer formation. The central and western areas of the Bear Creek Regime are characterized by highly commingled plumes containing diverse VOCs from the western waste management areas and nitrate and radioactive constituents from the eastern S-3 area.

In the East Fork Poplar Creek Hydrogeologic Regime (East Fork Regime), contaminant sources include waste treatment, storage, and disposal sites; bulk product transfer, storage, or use areas; industrial process buildings; waste and product spill areas; process pipelines, drains, and utilities associated with the industrial complex; the former S-3 ponds; petroleum storage tank sites. As in the Bear Creek Regime, intermingling of contaminants from the source areas has produced an extensive groundwater contamination plume beneath the Y-12 industrial complex and extending into Union Valley to the east of Scarboro Road, beyond the boundary of the Oak Ridge Reservation.

Groundwater containing nitrate and radioactive constituents from the S-3 and S-2 areas commingle with tetrachloroethene (PCE), tetrachloroethene (TCE) and carbon tetrachloride (CTET) sources in the industrial areas of the East Fork Regime. Trace metal constituents are found in some areas, but the extent of groundwater affected by metals is not as large as that of VOC or nitrate/radioactive constituents. Commingling of constituents from diverse source locations occurs along the length of the East Fork Regime. The principal constituents of concern (COCs) at the source areas in the East Fork Regime are summarized in the table below, which was developed based on descriptions in the *Calendar Year 2003 Groundwater Monitoring Report, Y-12 National Security Complex* (BWXT Y-12, 2004a).

Source Areas and COCs at the East Fork Regime		
	Major COCs	**Other COCs**
Western Y-12 Area		
Former S-3 Ponds	Nitrate, Tc-99, uranium isotopes	VOCs, Trace metals
S-2 Site,	Gross alpha and beta activity	Nitrates and trace metals
Waste Coolant Processing Area Salvage Yard, Other Processing and Manufacturing Areas	PCE; TCE; cDCE; 11DCE; vinyl chloride, metals	Other VOCs
Central Y-12 Area		
Sources in Western Y-12 Area	Gross alpha and beta activity, Nitrate	Trace metals
Building 9212 and Other Industrial Facilities	PCE; TCE; cDCE; 11DCE; vinyl chloride; 111TCA; 11DCA	Other VOCs
Eastern Y-12 Area		
Upgradient Industrial Complex	PCE, TCE, CTET	Gross alpha and beta activity, Nitrate
Building 9720-6 and Other Industrial Facilities	CTET; chloroform; dichloromethane; BTEX	Other VOCs, Trace metals

Groundwater contamination is less extensive at the Chestnut Ridge Hydrogeologic Regime, as no intensive industrial activity occurred in this area of interest (AOI). Chestnut Ridge has several legacy and current solid waste management units. VOCs are the principal groundwater constituents of concern (COCs) in this area. A distinct plume of VOCs has been identified near the Chestnut Ridge Security Pits (CRSP), and Industrial Landfill IV is a suspected source of VOC impacts. The major COCs associated with these two potential source areas are listed in the table below.

Source Areas and COCs at the Chestnut Ridge Regime	
	COCs
Chestnut Ridge Security Pits	111TCA; 11DCA; 11DCE; PCE; TCE; cDCE
Industrial Landfill IV	111TCA; 11DCA; 11DCE; boron

1.2.3 Contaminant Migration Pathways

In the Bear Creek Regime, the principal contaminant migration pathways include the following:

- Migration of COCs into the karst network of the Maynardville Limestone due to direct recharge from overlying source areas, recharge from losing reaches of Bear Creek, and inflow of shallow groundwater from the aquitard.

- Migration of COCs in deeper intervals of the Maynardville Limestone along fracture flowpaths.

- Discharge of COCs from the karst network and from deeper intervals of the Maynardville Limestone into springs and into the channel of Bear Creek in gaining reaches of the creek.

- Migration of COCs along the water table interval of the aquitard into tributaries or other surface water discharge areas that flow into Bear Creek.

- Limited migration of COCs to deeper intervals of the aquitard bedrock formations along fracture flowpaths.

In the East Fork Regime, the principal contaminant migration pathways are generally similar to those in the Bear Creek Regime, except that there is significant interaction between shallow groundwater and stormdrains, other utilities, building sumps, and buried tributaries. Another important difference is that dry weather flow in Upper East Fork Poplar Creek comes from a variety of sources, including non-contact cooling water, condensate, cooling tower blowdown, groundwater discharge, and a significant flow of water taken from the Clinch River. Water from the Clinch River is discharged into East Fork Poplar Creek for flow management in order to comply with the NPDES permit.

Five primary tributary drainage basins are located on south Chestnut Ridge. The tributaries are largely intermittent and receive flow via surface runoff, stormflow and groundwater baseflow. The tributaries run south toward Bethel Valley. Chestnut Ridge is underlain by Knox Group formations. Three hydrogeologic subsystems occur in this region: stormflow zone, vadose zone and deeper groundwater zone. Groundwater can occur intermittently above the water table in this area, forming a stormflow zone at up to eight feet below ground surface (ft bgs). Stormflow is intermittent after precipitation events. The vadose zone is defined below roughly 8 ft bgs and extends near the bedrock/residuum interface. Recharge, is episodic and occurs along saturated permeable fractures.

Deeper groundwater in the Chestnut Ridge regime occurs in permeable, planar fractures and conduits in a poorly permeable matrix. Hydraulic conductivity can vary over multiple orders of magnitude. Groundwater flow along the crest of the ridge, which functions as a recharge zone, is generally from west to east, parallel to geologic strike, with some radial flow. Groundwater flow south of the crest is generally to the south.

2.0 REGULATORY FRAMEWORK AND MONITORING OBJECTIVES

The current Y-12 Groundwater Protection Program (GWPP) is charged with fulfilling surveillance monitoring objectives as articulated in the United States Department of Energy (DOE) Order 450.1 (DOE, 2004). The Order requires that each DOE site implement an environmental management system that "provides for systematic planning, integrated execution, and evaluation of programs that ensure public health and environmental protection, pollution prevention, and compliance with DOE Directives and applicable laws and statutes" (USDOE, 2004). Sites covered under DOE Order 450.1 are charged with developing a site-wide environmental monitoring program providing data to meet regulatory requirements in the short term and to form the foundation of responsible stewardship in the long-term.

The overall groundwater monitoring program at the Y-12 National Security Complex is divided between two entities with different objectives. The Water Resources Restoration Program (WRRP), managed by the BJC, is charged with meeting the short-term regulatory requirements of RCRA, CERCLA and the State of Tennessee, while the long-term surveillance mandate is served by the Y-12 GWPP. The GWPP at Y-12, therefore, has a somewhat unique status among groundwater monitoring programs in that the primary objective of data collection is not to satisfy any one specific external regulatory requirement, but rather to provide proactive monitoring in anticipation of new threats to groundwater resources and to support responsible property management. The Y-12 GWPP serves as a watch-dog to provide management decision support for future regulatory and public health priorities, as both the site use and regulatory environments evolve.

Because of the somewhat unique status of the GWPP, many of the assumptions normally encountered in long-term groundwater monitoring evaluations must be reframed. Design criteria for the monitoring program are not entirely compliance driven and cannot be completely routine. The surveillance mission of the monitoring network means that unique, innovative or emerging issues must be addressed, which can be difficult to incorporate into a routine, fixed monitoring plan. The overall strategy of the surveillance monitoring network design still has the mandate to avoid redundancy, maintain consistent quality control and provide efficient and cost effective data. The apparently competing goals of the surveillance monitoring program provide a significant challenge in the development of an optimized monitoring network.

General objectives of Surveillance monitoring applicable to the Y-12 GWPP are provided in *Ground Water Surveillance Monitoring Guide for Use with DOE O 450.1 Environmental Protection Program* (USDOE, 2004). The surveillance monitoring network should be able to detect at the earliest possible time impacts on groundwater from facility operations using observation points located in prioritized areas of the site. Surveillance monitoring should track existing contamination in order to quantify the dimension and magnitude of affected groundwater and provide early warning of changes in concentration or extent of affected groundwater. If active remediation is underway, surveillance monitoring should provide data to support evaluation of the efficacy of the remedial action. Data from the surveillance monitoring program may be used to support diverse functions such as model development, remedial decision support or human and ecological risk evaluations.

Specific requirements of Order 450.1 require that groundwater that is or potentially could be affected by facility operations be monitored with the following objectives.

- Determine baseline groundwater quality and quantity;
- Demonstrate compliance with applicable regulations;
- Ensure early detection of affected groundwater;
- Identify and monitor sources of groundwater contamination;
- Evaluate potential for off-site migration of site constituents;
- Support site management decisions.

In essence, the specific monitoring objectives above provide the scientific questions that the data collected in the monitoring program must answer. The answers to the monitoring questions are then used to support site decisions, or in USEPA terminology, Scientific Management Decision Points (SMDPs) (USEPA, 2004a). SMDPs generally outline what actions will be taken if the weight of evidence indicates that site conditions have changed significantly and implementation of a contingency plan is warranted. In the event constituents are moving toward receptors or exceeding certain risk-based levels, contingent response actions may be implemented. Conversely, as constituent concentrations fall below screening levels, the decision may be made to change remediation strategies (i.e. reduce or turn off pumping wells) or recommend reduced frequency or removal of wells from the sampling plan.

In order to assess the current GWPP, an evaluation of how the current sample locations fulfill each of the objectives listed above has been developed. Results are tabulated in the Qualitative Evaluation section of this report and are carried through to the Quantitative Evaluation section of the report. Evaluation of the contribution of each well to the overall network forms the basis for determining the spatial and temporal sampling frequency.

The majority of regulatory compliance is tasked to the WRRP (BJC), so the qualitative (and quantitative) network analysis will center on a sampling program that satisfies the other goals set forth by the DOE. It is assumed that wells monitored by BJC to satisfy RCRA and CERCLA requirements will be sampled at the same locations and sampling frequency. However, optimized recommendations for these locations are included as part of the assessment in the event supplemental data on these wells is deemed necessary. Often, a limited suite of analytes is sampled for compliance wells, which is problematic when data are used to support modeling efforts or programs with broader goals.

This report will not specifically evaluate the SMDPs or Contingency Plans; however, these elements are essential parts of the overall monitoring program and are specifically mentioned in the DOE guidance document (USDOE, 2004).

3.0 SAMPLING, ANALYSIS AND DATA MANAGEMENT PROGRAM

The design of an efficient long-term groundwater monitoring program includes optimizing methods by which data are collected and organized as much as choosing the locations and sampling frequencies in the physical network. For any long-term monitoring program, significant efficiencies in cost and effort may be achieved by improving sample collection and analysis. For most programs significant enhancements can be achieved by improving data management and reporting. For these reasons, the sampling, analytical and data management activities of the GWPP were assessed as part of the overall evaluation.

3.1 Monitoring Program Overview

3.1.1 Well Sampling and Inspection Techniques

Due to the size and complexity of the Y-12 Complex, the well sampling program has developed several strategies to improve efficiency. Groundwater wells are grouped by location and sampling events are largely semi-annual, scheduled for alternating quarters. However, because of the number of locations, wells are sampled over many days of each quarter. By careful scheduling, the majority of data are collected by a limited number of trained personnel, providing a high degree of repeatability in data collection methods. The current program includes dedicated pumps and tubing at most locations, which is beneficial in eliminating artifacts from improperly cleaned equipment.

Responsibility for collection, transportation and chain-of-custody control for most surface and groundwater samples is assigned to the Y-12 Analytical Chemistry Organization (ACO). Preparation of bottle lists, container type, preservatives and laboratory test identification is conducted by ACO personnel. Based on the description of the sampling program in the *Y-12 GWPP Groundwater and Surface Water Sampling and Analysis Plan for Calendar Year 2005* (BWXT, 2004b), and the results in the GWPP database, no recommendations are made to improve efficiency in the aforementioned aspects of the well sampling and inspection program.

The USEPA currently recommends low-flow sampling techniques to monitor groundwater wells (Puls and Barcelona, 1996), and since 1997, low-flow techniques have been used over much of the site. Low-flow techniques reduce the time and waste generated per sample location and can dramatically reduce cost and effort associated with groundwater sampling. The Y-12 facility historically used a conventional three-well volume purge method to sample groundwater. In order to test comparability in the data sets between the two well sampling techniques, both techniques have been used at a small number of wells to collect samples. In some cases the two techniques give different results that are not necessarily predictable from well to well.

While the dual sampling provides an interesting data set, the recommendation is to commit to one technique per well, with low-flow sampling preferred. At locations where the purge technique appears to provide more representative data, the purge method should be used. Because wells where both methods have been used now have enough data to determine a statistical trend in the recent data and contrast methods with previous data, a decision should be made to collect samples using only the best method. By choosing one method, redundancy in sampling will be reduced.

Unfiltered groundwater samples are collected from all monitoring locations, which is consistent with most guidance documents. The GWPP also includes the collection of filtered groundwater samples from limited locations where three-well-volume purging sampling techniques are used. Samples are filtered in the field using a 0.45 μm filter. Filtering is indicated for locations with high turbidity in order to quantify concentrations of dissolved metals.

Formal well inspection techniques described in site reports (BWXT, 2003b) provide a good basis for evaluating and correcting any physical problems with the well locations. Well locations should also have an informal inspection during every sample event. The condition of the well, pump and tubing can be noted on the daily work log or physical water quality parameter sheet. In this way, well conditions can be monitored more frequently than is suggested in the report.

3.1.2 Laboratory Analysis

Site characterization activities have identified a large number of constituents of concern (COCs) for the Y-12 Complex (see Section 1.0 and Table B.1). Several constituent classes and geochemical parameters have been analyzed at many locations using a variety of analytical techniques. Overall, the approach has been very thorough and recent (1996 to present) laboratory analyses have produced a large, very high quality groundwater data set.

Based on the evaluation of data provided in the GWPP database and procedures outlined in the *Quality Assurance Plan for the Analytical Chemistry Organization* (BWXT, 2003c) as referenced in the *Y-12 Groundwater Protection Program Groundwater and Surface Water Sampling and Analysis Plan for Calendar Year 2005* (BWXT, 2004b), detection limits are appropriate relative to the specified screening levels. Appropriate numbers and types of duplicate samples, trip and field blanks and laboratory quality assurance/quality control (QA/QC) samples are analyzed. Laboratory and sampling methods and dates are documented and stored within the GWPP database. Data qualifiers and flags are included in the data set. As discussed above, GA and GB activity analyses are used to monitor radioactive species routinely. Confirmatory samples are analyzed periodically to identify specific isotopes and constituents in samples with GA and GB activity. The methods used to evaluate error and significance in GA and GB activity are appropriate to these types of analyses. The current laboratory analysis program and methods are supplying excellent data to support site monitoring objectives and decision making.

An examination of the analytical data indicates that the suite of constituents sampled at each location changes periodically. For example, well GW-276 in eastern Bear Creek Valley near the S-3 pits (which is regulated under an RCRA permit) has been sampled 36 times since 1986. In the GWPP database, GW-276 has 36 results for VOC's such as TCE and PCE; 32 results for Total Uranium, 29 results for Uranium, and 24 results for Nitrate as Nitrogen, 9 results for Nitrate/Nitrite, 3 results for Nitrate/Nitrite as Nitrogen and 5 results for the suite of semi-volatile organic compounds (SVOCs). Sampling location GW-526 has been sampled 37 times since 1986, with 33 results for vinyl chloride and only 10 results for nitrate as nitrogen. The varying list of constituents can make comparisons between constituent trends problematic. The diverse types of nitrate and uranium analyses, in particular, create problems in comparing nitrate results across time. The monitoring recommendation is to sample a consistent suite of basic constituents at all locations. Additional analyses, such as specific uranium isotopes can be added to the program occasionally, but the core group of constituents should be analyzed using the same methods (with the same parameter names) consistently.

A consistent set of analytes is particularly important across the Y-12 Complex because many plumes are commingled and many constituents were used or disposed of plant-wide. Analysis of all COCs provides information on the distribution and transport of affected groundwater through the complex geological formations underlying the Y-12 Complex. Target constituents for the entire site should include VOCs, metals, nitrate, Gross Alpha (GA) and Gross Beta (GB) activity, and total uranium.

One minor constituent of possible concern that should be included in the monitoring program is 1,4-dioxane. 1,4-Dioxane was a common chemical stabilizer in commercial 1,1,1-trichloroethane (111TCA) preparations, and has become a concern among the regulatory community. Federal MCLs and groundwater screening levels have not been widely established for 1,4-dioxane. Regulatory standards for drinking water vary widely by state, from 85 ppb in Michigan to 5 ppb in Florida (Mohr, 2001). California EPA has chosen a Preliminary Remediation Goal (PRG) of near 3 ppb (Spath and Alexeeff 1998) while USEPA Region IX has designated a PRG of 6.1 ppb (USEPA Region IX PRG's 2004). 1, 4-Dioxane is more mobile than the chlorinated co-constituents and should be analyzed for downgradient of areas where 111TCA, 1,1-dichloroethene (11DCE) or 1,1-dichloroethane (11DCA) are detected.

Field parameters (e.g. temperature, dissolved oxygen, conductivity, pH, redox) are important in characterizing background source water and monitoring the passage of water through various formations. Real time monitoring of field parameters during low-flow groundwater sampling is used to determine when the groundwater has stabilized and is representative of formation water. Field parameter data can be included in the site database to indicate general trends, but the accuracy of most field methods is not extremely high. Collection of data on geochemical parameters such as dissolved oxygen, sulfate, and reduced iron using more rigorous techniques can support lines of evidence confirming natural attenuation processes for a monitored natural attenuation (MNA) remedy. However, collection of large quantities of this type of data has limited utility in a routine monitoring program. The recommendation is that geochemical indicators outside of normal field parameters should be collected in support of a specific objective (like confirming MNA) in a supplemental monitoring program.

3.2 Data Management for the GWPP

The *Y-12 GWPP Data Management Plan* (BWXT, 2003a) details the process of data management for the diverse types of data collected to fulfill program objectives.

Elements of a good data management system include complete, reliable and repeatable data processing, transparent data management, fidelity (data in = data out), data connectivity and a system to question and revise the data. Based on the methods presented in the *Data Management Plan* and an interview with the GWPP data management team, the GWPP has a high quality data management system.

The laboratory performing the chemical analyses on water samples (Analytical Chemistry Organization) uses an electronic Laboratory Information Management System (LIMS) to document, track and report sample results and data flags. Electronic data deliverables (EDDs) from the laboratory are transmitted to the Analytical Data Management System (ADMS), which is managed by Science Applications International Corporation (SAIC). The ADMS functions as the master analytical data repository for GWPP and other site stakeholders. Field data from the sampling team are entered into the system. Data from both the WRRP (managed by BJC) and the GWPP are included in the ADMS.

The ADMS uses the SAS data management and statistical application to review and store the data in the site analytical database. The GWPP has instituted an automated standardized data-screening tool, the Environmental Quality Control and Analysis System (EQCAS), to identify anomalies in data points as results are delivered in electronic format from the laboratory to the GWPP personnel. In this way, environmental data can be examined immediately and outliers can be questioned and resolved before data are permanently entered into the ADMS. The data review feature is especially important in creating a high quality data set. Data from the ADMS are forwarded to GWPP for inclusion in the Y-12 Groundwater Information Management System (GIMS) managed by BWXT. The GIMS includes sampling information, water levels, well construction and geologic information, location inspection and maintenance information as well as site analytical results.

Based on the review of the analytical data for groundwater from the GIMS, the data reported since the 1996-1998 time period has achieved data quality objectives set forth in most regulatory guidance documents (USEPA, 2004a, USEPA, 1987). Sampling data are reported to GWPP personnel with QA/QC parameters, well and sample information, field parameters and analysis methods included with every record. Sample location information is included in the GIMS database, and contains information on the location, depth, geologic formation, date of installation and other pertinent sample location information. The sample location data is linked to the analytical data, creating easy access to complete sample information.

The GWPP has a model data management system, and no changes are recommended at this time. In terms of data review, historic data points that may be outliers or inaccurate should be flagged so that they can be easily removed from statistical analyses. Additionally, locations designated as 'active' should be separated into two categories, those active for hydrogeologic monitoring only, and those used for routine analytical sampling. Those locations used for hydrogeologic samples such as potentiometric surface measurements should be easy to distinguish from locations where chemical analytical data are being collected.

With the combination of quality data management and laboratory analyses and cooperation between the WRRP and GWPP, the Y-12 site has an established and powerful tool for supporting site management decisions.

3.3 Data Reporting

During review of Calendar Year 2003 Groundwater Monitoring Report, GSI identified three ways that future annual groundwater monitoring reports could be enhanced: i) prepare detailed maps for selected COCs at individual sampling locations for each hydrogeologic regime; ii) highlight exceedances of screening levels on the data tables found in Appendices D, E, and F of the report; and iii) provide more specific conclusions in Section 5.0 of the report.

Prepare Detailed Maps for Selected COCs in Each Hydrogeologic Regime: The calendar year 2003 report includes four figures (Figures. A.7, A.8, A.9, and A.10) that show the generalized extent of nitrate, VOCs, gross alpha activity, and gross beta activity, respectively, in groundwater at and near the Y-12 Complex. However, these maps do not show monitoring locations or COC concentration values at critical locations within the plume. Because of the high spatial heterogeneity of concentrations in Y-12 Complex groundwater, each monitoring location has more spatial significance than in a diffuse flow-type regime. Wells along known conduits or fractures should be highlighted. Wells with low concentrations to non-detect values can be spatially quite close to affected locations. Maps with specific locations identified would assist in communicating a more detailed picture of the extent of affected groundwater.

Future reports could be improved by including more detailed maps for selected COCs for each hydrogeologic regime. These maps would show monitoring locations and the measured COC concentration at each location. Each map would show the outline(s) of the exceedance area(s) for the COC. As an alternative to iso-concentration contour lines, different color dots or dot sizes would be used to indicate the relative magnitude of the measured concentration at each monitoring location compared to the MCL or screening value (i.e., >1X, >10X, >100X). The magnitude of concentration compared to the screening value is already used in the monitoring optimization scheme (BWXT, 2003b), and the same data can be visualized using mapping software to illustrate concentration distribution and rationale for future monitoring decisions. Examples of the 'dot map' approach to concentration distribution are shown in Figures A.2 through A.4.

The table below shows the COCs for each area that would be most useful for mapping purposes.

Hydrogeologic Regime	**Proposed Key COCs for Mapping**
Bear Creek	Nitrate, Uranium, Total VOCs, PCE, TCE, Gross Alpha Activity, Gross Beta Activity
Upper East Fork Poplar Creek	Nitrate, Uranium, Total VOCs, PCE, TCE, CTET, Benzene, Gross Alpha Activity, Gross Beta Activity
Chestnut Ridge	Total VOCs, Metals

Our review of the 2003 monitoring report indicates that MCL exceedance areas for the selected VOCs (i.e., PCE, TCE, CTET, or benzene) should in most cases encompass the exceedance areas for all other VOCs not proposed for mapping. Footnotes on the maps can be used to identify exceptions (e.g., elevated concentrations of vinyl chloride or dichloromethane detected at a few monitoring locations where none of the proposed key VOCs exceed their MCLs).

Highlight Exceedances of Screening Levels on Data Tables in Appendices D, E, and F: The tables in Appendices D, E, and F could be enhanced by highlighting screening level exceedances using bold text, cell shading, or some other type of cell formatting. This enhancement would be especially useful for trace metals and VOCs.

Provide Additional Specific Conclusions in Section 5.0 of the Report: The conclusions in Section 5.0 of the 2003 monitoring report are very general and brief. The conclusions section of future reports should mention specific areas where contaminants from Y-12 have migrated or are most likely to migrate beyond the boundaries of the Oak Ridge Reservation. The conclusion should highlight significant trend analysis results to communicate changes in concentrations at critical locations or indicate overall plume stability. Increasing or decreasing trends at individual locations can be discussed as well as plume wide trends (see Section II MAROS analysis for Moments and plume wide evaluation). It would also be very helpful to include a bullet list of key conclusions for each hydrogeologic regime. A summary of how monitoring results can be interpreted to support specific monitoring objectives outlined in DOE Order 450.1 would be useful for future site decision making.

4.0 QUALITATIVE NETWORK EVALUTION

The Y-12 Complex has over 200 known and potential sources of groundwater constituents resulting from the multiple activities including uranium enrichment, fuel and solvent storage, equipment maintenance and research activities. The concept of 'source' area at Y-12 is complicated by multiple primary and secondary sources, commingled groundwater plumes, preferential flow paths and complicated land-use patterns. The hydrogeology of the Y-12 region is further complicated by fracture flow, conduit flow, areas of diffuse flow and connection between surface water and groundwater. Straightforward quantitative techniques for monitoring network optimization do not account for the unique characteristics of the Y-12 site. For this reason, a qualitative evaluation of site wells was performed prior to and along with application of the quantitative MAROS methodology. The results of the merger of qualitative and quantitative approaches are summarized fully in the Section II of this report.

4.1 Technical Approach

The technical approach for improving the efficiency of the Y-12 GWPP monitoring strategy includes both qualitative and quantitative evaluation strategies. Steps common to most long-term monitoring optimization (LTMO) techniques have been described in a number of guidance documents including the *Roadmap to Long-Term Monitoring Optimization* (USEPA 2005), the *AFCEE Long-Term Monitoring Optimization Guide* (AFCEE, 1997) and in *Long-Term Groundwater Monitoring: The State of the Art* (ASCE, 2003). The technique used to evaluate the GWPP at Y-12 is consistent with the approach presented in these documents. Preliminary steps in the LTMO process include identifying monitoring objectives, reviewing the current monitoring program, and collecting and evaluating historic and current site data, which are detailed above. The qualitative evaluation of the monitoring network was conducted to assess the degree to which the current well network is achieving specific temporal and spatial objectives.

The qualitative hydrogeologic network evaluation involves collecting diverse site data, organizing lines of evidence and forming a decision on spatial and temporal sampling based on a weight of evidence approach. Data included in the qualitative evaluation are discussed below. The results of the qualitative hydrogeologic analysis were combined with the results of the quantitative approach to form a final monitoring recommendation.

The major products of the broader qualitative analysis include a site wide understanding of monitoring objectives, groundwater flow, major constituents, source areas and receptors, which are summarized in the material above. Factors considered for the hydrogeologic analysis for individual wells are presented in Section 4.2, and include information on how each well functions to fulfill the monitoring objectives for the various groundwater flow regimes and constituent classes. Results from the qualitative evaluation were combined with the results of the quantitative analysis in the form of a decision logic flow chart (see Figure A.10) to determine the final temporal and spatial well network.

In order to provide as thorough a review of the monitoring network as possible, all active sample locations were identified in the analytical database and included in the analysis.

Active sample locations have been designated by BWXT using decision logic detailed in the *GWPP Monitoring Optimization Report* (BWXT, 2003b). Active locations include those sampled for chemical analytical data and groundwater surface elevations as well as those locations sampled for hydrogeologic information only. The formal groundwater sampling optimization was performed for chemical analytical samples only. Collection of hydrogeologic data should continue at current active locations. Recommendations for locations to be 'removed' from the network indicate that these locations should be sampled for hydrogeologic data rather than both hydrogeologic and analytical data.

Active monitoring locations at the Y-12 Security Complex were divided into eleven different analysis groups. (Surface water sample locations and Westbay wells were not included in the groundwater network analysis.) The analysis groups are listed in Table B.2. The locations were grouped according to the three main hydrogeologic regimes and then further subdivided geographically based on common source areas and similar constituent classes. The analysis groups were formed to simplify data processing and to automate the final recommended temporal and spatial network.

4.2 Decision Logic and Location Scoring

Sample locations were categorized based on criteria discussed below as part of an overall hydrogeologic qualitative evaluation of the GWPP network. Sample locations were evaluated qualitatively for their utility to the overall program. The qualitative evaluation includes expert judgment of whether the locations provide data for horizontal or vertical delineation, source monitoring, potential exit pathways, etc. The criteria evaluated were identified as critical decision factors controlling the identity and frequency of groundwater sample locations. Many of the criteria are taken directly from monitoring objectives articulated in DOE Order 450.1. Data for criteria scoring were taken from the Y-12 GWPP GIMS (provided by BWXT, 2005) and provided by expert judgment based on the location of the well using GIS data and geological information. Results from the criteria scoring were used along with results from the MAROS analysis in recommending an optimized groundwater sampling network for the Y-12 Complex. Qualitative and quantitative results were combined using the decision logic flow chart outlined in Section II, 4.0 and illustrated in Figure A.10. Results of the qualitative scoring are summarized by sample location analysis group in Appendix D (Tables D.1.1 through D.11.1). An explanation of the decision categories identified for the qualitative evaluation is presented below.

4.2.1 RCRA/CERCLA Point of Compliance

Sample locations required under regulatory programs as points of compliance were identified from the *Monitoring Optimization Plan* and from the *Calendar Year 2003 Groundwater Monitoring Report* (BWXT, 2004). The location and sampling frequency of this group of wells is fixed by RCRA post-closure permits, CERCLA interim or final Records of Decision (ROD) or other regulatory programs (e.g. EMWMF and SWDF solid waste permits). The majority of wells identified under regulatory programs are sampled as part of the WRRP. Regulated locations were considered very high priority and their identity and sampling frequency were evaluated but not considered for changes. However, in the preliminary MAROS analysis, regulated wells were considered for reduced sampling frequency or elimination, for future reference. Backup and alternate sampling locations identified in regulatory documents were also considered high priority. Should an alternate location be included in future regulatory sampling programs, a long-term record of constituent concentrations may be necessary to support sampling frequency or remedial effectiveness decisions. The final network recommendation included primary regulated locations at their current sampling frequency.

4.2.2 Average Concentration Exceeds Screening Values

Priority Constituents were chosen for each sampling location from site analytical data (Analytical Database, BWXT, 2005). The full historic analytical record for each well was used to determine an average concentration for the well for each target constituent. The average concentration was determined conservatively using detected results with non-detects assigned a uniform detection limit corresponding to the lowest detection limit in the data set. While this approach may skew the data high, due to historic outlier detections prior to 1996 and assuming the detection limit concentration for non-detects, the approach prevents underestimating concentrations in groundwater. The representative average concentration was divided by the MCL (screening level) for each constituent and a ‘normalized’ ratio was calculated. For each well, the constituent with the highest historic normalized ratio was chosen as the Priority Constituent. Locations where the average concentration of the representative constituent is above screening levels were identified in the qualitative evaluation. Results of the priority constituent concentrations are displayed graphically for selected locations in Figures A.2 through A.4. (Note: Sample locations where groundwater is unaffected generally had trace metals or GA or GB activity at background levels, triggering these compounds as ‘priority constituents’. This artifact was taken into account during the final network analysis.)

4.2.3 Formation Type

For the purpose of the qualitative evaluation, each active sample location was assigned a water source formation type. Each location monitors either aquifer water, aquitard water or spring water. Surface water locations apart from springs were not considered in the evaluation; however, data from these surface streams can be important when identifying surface water impact to groundwater. In determining the importance of the monitoring location to the overall network, aquifer locations and springs were given priority. Springs generally discharge from the aquifer formation; however, the springs were considered to have a greater likelihood of becoming a point of exposure (POE) for human or ecological receptors, and were, therefore, considered higher priority locations. Constituents found in the aquifer formation were perceived to have greater possible mobility and access to exit pathways. As no drinking water supply wells are drilled into the aquifer formation near the Y-12 Complex, human exposure via drinking groundwater was not considered.

4.2.4 Horizontal Delineation

Wells that provide information for horizontal extent of affected groundwater were given priority in the final analysis. Highest priority was given to wells along the Y-12 property boundary. Horizontal delineation was defined using a combination of data from the analytical database and identifying the well location using ARC GIS mapping software. A well was determined to provide horizontal delineation if the well was located on the perimeter of a plume or if the well was in an area with no other wells and COCs were detected routinely at the location.

4.2.5 Vertical Delineation

Wells that provide information for vertical delineation were also prioritized. Vertical delineation was somewhat harder to determine from site data. Well construction data were used to identify wells with deep screens or with open holes below the majority of surrounding wells. Locations with high constituent concentrations for deeper locations were prioritized.

4.2.6 Exit Location

Exit pathway locations were identified using the Appendix D Tables from the Y-12 GWPP *Monitoring Optimization Plan* (BWXT, 2003b). Data from these tables were used directly to identify possible exit pathways. All spring locations were identified as exit pathways, even if they were not listed in the Optimization Plan. Exit pathway sample locations were prioritized as they represent more immediate possible exposure pathways for human or ecological receptors. Several exit pathway locations provide data on groundwater emerging as surface water, moving off-site or outside of the immediate Y-12 management area. Data collected from these locations may be used to support remedy choice or effectiveness evaluation or may be useful in supplemental ecological or human health risk evaluations.

4.2.7 Unique

The ‘unique’ category was included in the GWPP *Monitoring Optimization Plan*, and has been carried forward to this analysis, although the designation was not given high priority. Unique designations were given to locations that had no apparent redundant monitoring locations. Some unique wells provide information on deeper groundwater, potential early detection, or constituent movement, or represent isolated horizontal locations.

4.2.8 Background Concentration

Wells with metal and radioactive concentrations below MCLs and no detections of volatile organic constituents, or locations where groundwater samples have always been ‘clean’ were included in this category. As part of the mission of the GWPP is to determine background water quality, a certain number of statistically clean wells must be included in each hydrogeologic regime.

4.2.9 Early Detection

Wells that provide early detection of migration of constituents were identified by their location in transmissive groundwater formations or at spring locations. Data from both the GIMS and ARC GIS maps were used to identify wells where increases in constituent concentrations may signal movement of affected groundwater to more sensitive locations downgradient. Wells designated as ‘early detection’ points are distinguished from ‘exit locations’, generally, by a location more central to the plume or nearer the source area. Sample locations in less transmissive geology were also considered as early detection rather than exit locations.

4.2.10 Monitor Source

Wells that monitor known or potential sources were prioritized. In the final analysis, the number and position of source wells was considered when recommending sample locations and frequency after the quantitative review.

The categories described above were used to identify the function of each well in achieving monitoring objectives and were used along with the results of the MAROS evaluation in a decision logic process to recommend a final sampling network and frequency for wells in the Y-12 Complex. The decision logic flow chart and results of the final analysis are presented in Section II, 4.0.

SECTION II—QUANTITATIVE ASSESSMENT

1.0 INTRODUCTION

Long-term monitoring programs, whether applied for process control, performance measurement, or compliance purposes, require a large scale data collection effort and time commitment, making their cumulative costs very high. With the increasing use of risk-based goals and natural attenuation in recent years as well as the move toward long-term closure upon completion of cleanup activities, the need for better-designed long-term monitoring plans that are cost-effective, efficient, and protective of human and ecological health has greatly increased.

The Air Force Center for Environmental Excellence's (AFCEE's) Monitoring and Remediation Optimization System (MAROS) methodology suggests an improved monitoring network program based on historic monitoring data and location parameters within a complicated groundwater system. The MAROS method does not include a mathematical optimization in the technical sense, but does include a variety of statistical and heuristic evaluations that, when taken together, result in a 'lines of evidence' approach to streamlining a groundwater monitoring network for maximum efficacy. By applying statistical techniques to existing site analytical data, as well as considering hydrogeologic factors and the location of potential receptors, the software suggests an optimal monitoring plan. Section II summarizes the findings of an application of the MAROS 2.1 software methodology to the current Groundwater Protection Program (GWPP) for the Y-12 National Security Complex in Oak Ridge, Tennessee.

2.0 ANALYTICAL APPROACH

The Y-12 Complex has multiple primary and secondary sources of groundwater constituents resulting from site activities including uranium enrichment, manufacturing processes, fuel and solvent storage, equipment maintenance, research and historic solid waste disposal activities that have been conducted at the facility over time. The identification of discrete plumes at the Y-12 Complex is complicated by multiple source locations, preferential flow paths, commingled plumes, surface and groundwater interactions and complex land-use patterns. The MAROS method requires designation of a 'source' area for each analysis and the designation of source area wells. For the purpose of the MAROS analysis, the source area wells were designated as those near known sources, locations farthest upgradient, or with high concentrations of priority constituents.

In part due to the number of diverse sources, complicated hydrogeology, and size of the data set, the active monitoring locations at the Y-12 Security Complex were divided into eleven different analysis groups (see Figure A.1). The wells were grouped according to hydrogeologic regime and then further subdivided based on common source areas and similar constituent classes. The analysis groups are described in Table B.2 and are elaborated in the text below. Detailed descriptions from the qualitative analysis are shown in Appendix D.

Because the hydrogeology of the Y-12 vicinity is distinct from strictly diffuse flow conditions, assumptions about 'normal' plume behavior underlying the MAROS method had to be modified. For example, most areas under consideration do not have a single 'source' and 'tail' zone. Plumes are frequently co-mingled. Due to the karst geology, wells in close proximity on the surface can be unconnected hydraulically, while wells geographically separated on the surface can be connected by preferential flow paths in the subsurface. As opposed to the diffuse flow plume model, wells within the same Y-12 analysis group could have very different major constituents due to the complicated hydrogeology. For this reason, each well was considered to be more independent than in a typical MAROS evaluation. Each individual well was assigned a Priority Constituent, based on historic exceedances, and the concentration trend and recommended sampling frequency were based on that Priority Constituent.

In order to apply the MAROS methodology, several broad assumptions had to be made. These assumptions were applied in order to create general trend and constituent stability results. Many results such as the estimate of total mass in the plume (zeroth moment), should not be interpreted as precise values, but rather as estimates for the purpose of evaluating plume stability and changes over time.

2.1 Site Assumptions

- Each hydrogeologic regime (Bear Creek (BC), East Fork Poplar Creek (EF) and Chestnut Ridge (CR)) was divided into 3-4 analysis groups, roughly based on a common 'source' area and geographic proximity. Analysis groups are listed in Table B.2 and illustrated on Figure A.1 and figures summarizing the MAROS results for each group.

- Active groundwater sample locations with analytical data in the GWPP GIMS database were included in the analyses. Surface water sample locations and Westbay wells were not included in the quantitative evaluation. Locations where no analytical data were available could not be evaluated. Many groundwater wells currently used for hydrologic monitoring only were included in the quantitative evaluation as potential analytical sample locations in an attempt to provide a thorough analysis of the most effective monitoring network. In the report, some sample locations are recommended for 'removal' from the program. 'Removal' means that chemical analytical samples are not recommended for the purpose of evaluating constituent concentrations, however the well or sample location can be maintained for hydrologic sampling purposes.

- For each analysis group, wells with historically high concentrations of constituents were labeled as 'source' wells. 'Source' wells can be spread widely across an analysis area.

- Target constituents were chosen for the Y-12 facility based on historic exceedance of preliminary screening levels across the site. Target constituents along with preliminary screening levels are shown in Table B.1. The screening levels were based on USEPA MCLs for drinking water, where possible. For constituents without primary or secondary MCLs, USEPA Region IX PRGs were chosen. Historic analytical data for the listed constituents were used to prioritize constituents for each analysis group.

- Priority Constituents were chosen for each sampling location from site analytical data. The full historic analytical record for each well was used to determine an average concentration for the well for each target constituent. Non-detects were assigned a uniform detection limit corresponding to the lowest detection limit. The representative average concentration was divided by the MCL (or screening level) and a 'normalized' ratio was calculated. For each well, the constituent with the highest historic normalized ratio was chosen as the Priority Constituent.

- Groundwater flow directions are generalized for each hydrogeologic regime. The length and width of the plumes for each analysis group were estimated to be roughly the size of the analysis area. MAROS input parameters for each analysis group are shown in Appendix D under each hydrogeologic regime.

- Parameters such as the effective porosity and seepage velocity were estimated from averages of high and low numbers. The porosity was estimated as 0.1 for all locations, while a seepage velocity of 200 ft/yr (2 X 10^{-4} cm/s) was chosen for all hydrogeologic regimes.

- MAROS analyses were conducted with data acquired between January 1996 and December 2004. Historic concentrations (prior to 1996) were used to assess wells that have not been sampled recently.

- Strong connections exist between surface and groundwater in many areas of the Y-12 Complex. Precipitation, surface run-off and stream flow transport constituents to sinking locations that affect groundwater; conversely, groundwater exits to surface water bodies in many locations. Determination of seasonal influences on groundwater concentrations is part of site characterization activities, and should be well understood before LTMO occurs. The influence of seasonality in groundwater concentrations may be significant when estimating short-term exposures; however objectives of LTM networks generally involve evaluation of long-term risks and potential for change in status of the plume. For this reason, most LTMO strategies, including MAROS do not address seasonality.

- Ten multi-port Westbay wells have been installed at Y-12, but were not included in the quantitative MAROS analysis. One Westbay location, GW-722, is recommended for annual sampling to characterize groundwater constituents in the New Hope Pond area.

2.2 Analytical Methodology

Each monitoring group was evaluated for Constituent Choice and Moments for the entire plume, Statistical Trend and Sampling Frequency for each individual well and Well Redundancy and Well Sufficiency where possible. Details on the calculation and application of each of these methods are provided in Appendix C MAROS 2.1 Methodology. Further details of these methods are included in the MAROS Users Manual (AFCEE, 2003).

2.2.1 Constituent Choice

The MAROS method includes a module that evaluates and prioritizes possible constituents of concern based on their prevalence, toxicity and mobility. Concentrations of VOC, radioactive, and metal constituents from each well were entered into the software and evaluated using this tool. The USEPA MCLs as shown in Table B.2 were used as the screening values for the MAROS COC analysis. The COC risk evaluation module was run for data from each analysis group as a preliminary screening tool. Results of the COC selection can be found in Appendix D.

2.2.2 Moment Analysis

The role of moment analysis in MAROS is to provide a relative estimate of plume stability in the context of results from other MAROS modules. Stable to decreasing trend results for moments provide evidence that monitoring efforts may be reduced. Results indicating that the plume may be spreading downgradient may indicate that increased monitoring efforts are required.

The moment analysis algorithms in MAROS are simple approximations of complex calculations and are meant to estimate changes in total mass (zeroth moment), center of mass (first moment) and distribution of mass about the center (second moments) for complex well networks. Because of the complex geology at Y-12, uniform aquifer input values were used across the site. For this reason, the estimate of total mass is not as accurate in a diffuse flow type of aquifer, and the actual results are not reported, but rather the trend for the total dissolved mass is indicated in each section.

A brief explanation of the MAROS moment calculations is given in Appendix C and in the MAROS Users Manual (AFCEE, 2003). MAROS-generated summary reports on the moment analyses are located in Appendix D. Results of the Moment Trend analyses are shown in the text and estimates of the center of mass for the priority constituents are illustrated in figures for each sample group. For the Y-12 GWPP Moment analyses, one or two indicative constituents were chosen for each sample group, and data for these constituents were assumed indicative of the overall stability of the plume in a given area.

2.2.3 Statistical Trend Analysis

Within the MAROS software, statistical trend analyses are used to support a conclusion about plume stability (e.g., increasing plume, etc.). The Mann-Kendall and Linear Regression modules are explained in more detail in Appendix C of this document and in the MAROS Users Manual (AFCEE, 2003). As a rule, sample data sufficient to determine a trend with confidence would include at least two years of quarterly data (eight data events) or four years of semi-annual data, with four data points being the minimum necessary to return a statistically meaningful result. The Statistical Trend analysis was performed for the priority constituent for each individual sample location. The final statistical trend is a combination of the results of the Mann-Kendall statistical trend and the Linear Regression analysis to form an Overall Trend. Results of the Trend Analyses are interpreted as follows:

D	--	Decreasing Trend	I	--	Increasing Trend
PD	--	Probably Decreasing	PI	--	Probably Increasing
S	--	Stable Trend	NT	--	No Trend (High Variability
ND	--	Non-Detect	N/A	--	Insufficient Data

2.2.4 Well Redundancy

The goal of the well redundancy analysis is to identify wells that are redundant within the existing monitoring network and can be removed from the routine monitoring program. The approach allows elimination of sampling locations that have little impact on the long-term characterization of a contaminant plume. The sampling location module uses the Delaunay triangulation method to determine the significance of the current sampling locations relative to the overall monitoring network. The Delaunay method calculates the network area and average concentration of the plume using data from multiple monitoring wells. A slope factor (SF) is calculated for each well to indicate the significance of the well in the system (i.e. how removing a well changes the average concentration.)

Because wells in the Y-12 GWPP are not necessarily hydraulically connected when they are close to one another on the surface, the Delaunay triangulation was not useful for the site. However, the method was performed for each sample group for the dominant constituents, and no single wells were recommended for removal using this technique. All wells recommended for elimination from the program were designated based on decision logic presented below. Wells recommended for removal were reviewed qualitatively for their larger contribution to the network. Wells with significant site-specific functions, or high constituent concentrations were maintained in the program.

Wells suggested for removal from the program should not necessarily be physically removed, but removed from the current regular analytical monitoring program. Groundwater wells may be included in potentiometric surface monitoring, or as plume geometry changes, wells previously eliminated from the monitoring program may be re-incorporated into the program.

2.2.5 Well Sufficiency

The Well Sufficiency analysis, also based on the Delaunay method, can be used for recommending new sampling locations in areas where additional plume information is needed. It is designed to recommend new wells in areas within the existing monitoring network where there is high uncertainty in groundwater concentrations between established monitoring locations. Specifically, the method evaluates if concentrations at one well can be predicted from concentrations at its nearest neighbors. In many cases, new sampling locations need to be added to the existing network to enhance the spatial plume characterization. The results for determining new sampling locations are derived solely from the two-dimensional spatial configuration of the monitoring network and the spatial pattern of the contaminant plume. Therefore, new well locations needed outside the existing monitoring well network (i.e., a new sentinel well outside the existing plume network) are not assessed.

Because the hydrogeology of the Y-12 facility does not conform to the MAROS conceptual model of a two-dimensional diffuse flow plume, the interpretation of well sufficiency data is complicated. The well sufficiency module was run for each sample group and areas of high uncertainty for dominant constituents are included in the analysis; however, no new wells are suggested. The well sufficiency analysis was used to support quantitative and qualitative evaluations of well removal or sampling frequency. MAROS-generated graphical reports on well sufficiency are provided in Appendix D.

2.2.6 Sampling Frequency

The sampling frequency analysis, using the Modified Cost Effective Sampling (MCES) method, was applied to improve sampling frequency efficiency for each sampling location based on the magnitude, direction, and uncertainty of its concentration trend of recent and historical analytical data. The MCES method has both quantitative and qualitative components. Quantitatively, the trend and rate of change are determined by Mann-Kendall and Linear Regression calculations. Qualitative review is then performed to evaluate the position of the well in the network and its relationship to site specific monitoring goals. The MCES method estimates the lowest-frequency sampling schedule for a given groundwater monitoring location while still providing needed information for regulatory and remedial decision-making.

The MCES method requires four to six sample events to evaluate a sampling frequency. Locations with fewer than 4 sample events are automatically assigned a Quarterly sampling frequency until a statistically significant data set can be produced. The MAROS-recommended sampling frequency was adjusted based on the results of the qualitative well evaluation. For example, because the Y-12 GWPP data set has a large number of samples prior to the 1996-2004 analysis period and many historic sample locations, all Quarterly monitoring recommendations were reduced to Semi-annual or Annual sample frequencies. For wells with limited data, their utility to the entire network was evaluated and several wells were recommended for removal from the sampling program because they did not uniquely fulfill monitoring objectives detailed in the Qualitative Evaluation Report. Further information on the MCES method is presented in Appendix C and the MAROS Users Manual (AFCEE, 2003).

2.2.7 Data Sufficiency Analysis

In the MAROS data sufficiency analysis, statistical techniques are used to assess the sufficiency of monitoring plans for detecting the difference between the mean concentration of a constituent and the cleanup goal. The majority of the analyses are reserved for sites in the later stages of remediation. These analyses require six years of monitoring data for all relevant constituents and are not currently appropriate for wide application at the Y-12 Complex. However, many individual wells may become candidates for this type of analysis within five years. At that time, the calculations could assist site managers in eliminating 'clean' wells from routine monitoring.

2.2.8 Final Combined Analysis

Results from both the qualitative and MAROS generated quantitative analyses were combined to recommend final locations and sampling frequencies for the Y-12 Complex network. Details of the final decision logic are provided in Section II, 4.0 below.

3.0 MAROS RESULTS

Results of the MAROS analyses of Y-12 Complex groundwater monitoring locations are discussed below by hydrogeologic regime and by analysis group. Sample locations considered in each regime and analysis group are illustrated on Figures A.1 through A.4. Results from the MAROS analyses are summarized in Tables B.3-B.13 and in Figures A.5-9.

3.1 Bear Creek Hydrogeologic Regime

For the purpose of the MAROS analysis, the Bear Creek Hydrogeologic Regime (Bear Creek Regime) was divided into three analysis groups: The Western S-3 and Rust Spoils Area (West S-3), the central Oil Landfarm WMA /EMWMF/Boneyard/Burnyard (OLFA) area and the Bear Creek Burial Grounds (BCBG). Bear Creek has its headwaters in the western portion of the main Y-12 facility and flows west/southwest through Bear Creek Valley until it flows northward into the East Fork Poplar Creek. As in the other hydrogeologic regimes, the subsurface is divided into 'aquifer' group wells in the Maynardville Limestone and Knox Group and the 'aquitard' formations of the Conasauga Group and the Rome Formation, which directly underlie the areas with primary contaminant sources in the Bear Creek Regime. The aquitard areas are hydraulically upgradient of the Maynardville Limestone, and fractures provide the main flow through the unit to the aquifer. Flow from source areas occurs primarily in response to precipitation, resulting in seasonal fluctuations in contaminant transport (BWXT, 2004a).

Results from the three MAROS analyses for the Bear Creek Regime are summarized in tables below and discussed in detail in sections 3.1.1 through 3.1.3. Final network recommendations, based on both qualitative and quantitative approaches are presented in Section II, 4.0 and listed in Table B.14.

Analysis Group	MAROS Results Bear Creek Hydrogeologic Regime			
	Total Number Wells	**Number wells Above Screening Level**	**Priority COCs**	**Moment Analysis (Plume Stability Analysis)**
West S-3 Area	44	33 (75%)	GB	Variable total mass, Stable to Decreasing plume spread
			PCE	Variability in total mass and spread results
Oil Landfarm WMA	59	28 (47%)	GA	Variability in total mass and spread results
			TCE	Variability in total mass and spread results
BCBG Area	80	36 (45%)	PCE	Total mass may be Increasing, spread is Stable to Decreasing
			GB	Stable to Decreasing plume

All analysis areas in the Bear Creek Regime contained sample locations with concentrations above screening levels, with 75% of locations in the West S-3 area above screening levels. The relative number of locations above screening levels decreases across the Regime. Results from the COC Risk evaluation were used to choose representative constituents for plumes in each sample group. Representative COCs were evaluated using the Moment Analysis module in order to determine the relative stability of the plumes. Total mass estimates for plumes in each of the Bear Creek Regime analysis groups indicated variability in the data. Data variability may be the result of limited amount of data (as may be the case in West S-3), varying numbers and identities of wells sampled or actual fluctuations in groundwater concentrations. Plume spread appears to be Stable to Decreasing in the downgradient area of the Bear Creek Regime.

Results for individual sample locations trends in each sample group are tabulated below. Both the number of wells in each category and the percentage of total sample group wells in the category are indicated. Sample locations with NT (No Trend) and N/A (insufficient data) designations may benefit from additional sample collection efforts or removal from the program, if they do not provide important information. Locations with stable to decreasing trends (S, PD, D) or non-detect (ND) results may be candidates for reduced sampling effort. Locations with increasing trends (I or PI) should be monitored carefully to determine if the trend indicates an increase in the distribution of the plume.

Analysis Group	**Overall MAROS Trend Analysis Bear Creek Regime**			
	N/A, NT	**PD, D, S**	**I, PI**	**ND**
Western S-3 Area	38 (86%)	5 (11%)	1 (2%)	0
Oil Landfarm WMA	41 (69%)	9 (15%)	5 (8%)	4 (8%)
BCBG Area	50 (63%)	15 (19%)	9 (11%)	6 (7%)

Note: Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).

Preliminary sampling frequency recommendations were developed using the MAROS MCES method along with preliminary qualitative evaluation for locations with limited sample data. All wells were included in the analysis, independent of their regulatory status. By considering all wells in the network, a clearer picture of the level of effort required for the site could be developed. Preliminary results for the Bear Creek Regime are presented below, with final results detailed in Section II, 4.0. The preliminary results are compared with the sampling frequency for wells in the Bear Creek Regime from the 2004 calendar year (CY) monitoring program.

Preliminary sampling frequency results comparing the total number of samples for the 2004 program and the recommended program indicate no significant difference in total samples (150 versus 151). However, the number of wells sampled in the optimized program would be much greater than in the 2004 program (156 versus 62 locations).

Monitoring Wells	Network Frequency Analysis Bear Creek Regime		
	Sampling Frequency	**Number of Wells CY 2004**	**Number of Wells Preliminary Recommendation**
	Remove	--	27
	Quarterly	15	--
	Semi-annual	43	30
	Annual	4	57
	Biennial	0	69
Total Samples (per year)		**150**	**151**
Total Wells		62	156

* Analysis included wells regardless of regulatory status.

3.1.1 West S-3 Area (West S-3)

The eastern region of the Bear Creek Hydrogeologic Regime is dominated by the former S-3 Ponds, but includes the Rust Spoils area to the west and Spoils Area I to the south. The former S-3 Ponds were used to dispose of nitric acid containing Tc-99, uranium isotopes and various trace metals and VOCs. The S-3 site is located in the aquitard unit (Nolichucky Shale) above and north of the transmissive aquifer unit. Groundwater flow across the Regime is generally to the west, but is also characterized by fracture flow and surface water interactions resulting in southerly movement of constituents. The West S-3 Area has some of the highest constituent concentrations in the Y-12 Complex, and among the 44 wells evaluated, 33 have average concentrations above screening levels for at least one COC. Sample locations for West S-3 are listed in Table B.3 and illustrated on Figures A.1 and A.2.

Constituent Choice

The MAROS method COC Risk Evaluation module identified nitrate and Gross Beta activity (GB) as the priority COCs in the S-3 region with Gross Alpha activity (GA) also of concern. Tc-99 and uranium isotopes are likely responsible for GB and GA activity. Among the organic constituents, both PCE and TCE were identified as exceeding screening levels. Printed reports from the MAROS software, including the COC Risk Evaluation are located in Appendix D. Priority constituents were also identified for each individual sample location based on the maximum historic exceedance at that location. Among individual wells, nitrate was identified as the most common COC.

Moment Analysis

The Moment Analysis was conducted for the both GB activity and PCE in the West S-3 area to assess stability of plumes from the two main constituent source classes. Nitrate affects roughly the same area as GB activity. Results of the First Moment Analyses for GB and PCE are indicated on Figure A.5. MAROS-generated Moment Summary Reports are located in Appendix D.1. Results indicate that the total estimated dissolved mass of GB (Zeroth Moment) in the plume showed No Trend or variability (high COV) between 1996 and 2004. GB concentrations show high variability within certain wells with high overall concentrations (e.g. GW-526 ranges between non-detect and 718 pCi/L), which is reflected in the plume-wide variability in total dissolved mass. First Moment analysis (plume center of mass) indicates a Decreasing trend in the distance of the center of mass from the source, indicating a retreat of the center of mass of the plume upgradient. Estimated First Moment locations over time are illustrated on Figure A.5 (right set of panels) and indicate that the centers of mass are clustered just southwest of the former S-3 Ponds. First moment results provide evidence of stability of the GB plume in this area.

Moment Type	Gross Beta Activity Moment Trend Analysis West S-3	
	Trend	**Comment**
Zeroth	No Trend	The estimate of total dissolved mass of GB showed high variability (No Trend) during the sample period 1996-2004.
First	Decreasing	The estimated distance from the source to the center of mass showed a Decreasing trend during the sample period.
Second	Stable/ Stable	The GB plume showed Stable trends in the distribution of constituents in the direction of groundwater flow and perpendicular to groundwater flow.

Second Moments for the GB plume indicate that the distribution of mass within the plume is also stable and that mass did not redistribute from the center to the edges of the plume during the sample time frame. Stable second moments are supportive of overall plume stability. Evidence for GB plume stability supports reduced monitoring effort in this area.

Evaluation of plume stability for VOC components is based on data for PCE. Total dissolved mass of PCE in the West S-3 area showed No Trend between 1996 and 2004, indicating concentration variability in either the wells sampled or the concentrations within the wells. Likewise, there was No Trend for PCE First Moments between 1996 and 2004. However, when First Moment values derived from sample events with greater than seven sample locations are plotted (as in Figure A.5) the center of mass appears Stable between 1999 and 2004.

Moment Type	PCE Moment Trend Analysis West S-3	
	Trend	**Comment**
Zeroth	No Trend	The estimate of total dissolved PCE was found to have No Trend during the sample period 1996-2004.
First	No Trend	The estimated distance from the source to the center of mass showed No Trend during the sample period.
Second	No Trend/ Stable	The PCE plume showed No Trend (high variability) in the distribution of constituents parallel to groundwater flow, but showed a Stable trend in the direction perpendicular to groundwater flow.

Second Moments for the PCE plume show No Trend to Stable results for distribution of mass within the plume. The Moment data for PCE suggest that the VOC plume may not be as stable as the GB plume in this region, but does indicate a need for greater monitoring frequency.

Statistical Trend Results

Statistical Trend results for sample locations in the West S-3 area are shown in Table B.3 and illustrated on Figure A.5. In order to determine a statistical trend in the data, at least four sample events must be included in the time frame. Of the 44 sample locations in the West S-3 area with historic analytical data in the database, 37 wells did not have sufficient data in the 1996 to 2004 time frame to determine concentration trends. The majority of these wells (27 of 37) have historic constituent concentrations significantly above screening levels, particularly for nitrate and radioactive constituents.

Sample locations with Decreasing trends included wells GW-829, GW-311 and GW-276. Location GW-315 had a Probably Decreasing trend while spring SS-1 indicates a Stable trend for nitrate. Taken together, this group of wells monitors the western perimeter of the S-3 Ponds area. Well GW-829 is on the western edge of the analysis group close to the Oil Landfarm WMA (near GW-537), where nitrate concentrations are also Decreasing. Well GW-311 is on the southern perimeter of the plume in the Rust Spoil Area, indicating a Decreasing trend for TCE in this area. Spring SS-1 is located, roughly, between GW-829 and GW-311, in the exit pathway along Bear Creek. SS-1 shows a stable trend for nitrate, supporting Stable to Decreasing nitrate trends in the western area of the plume.

Wells GW-315 and GW-276 are on the eastern edge of the West S-3 area near the divide between Bear Creek and the East Fork Poplar Creek Regimes. GW-276 shows a Decreasing trend for the historic high uranium concentrations in the eastern area. Well GW-315 is located in the Spoils Area I, and indicates that PCE concentrations in the Spoils area are Decreasing.

The only Increasing trend was found at GW-835, located in the center of the West S-3 area. The well (piezometer) has historically high concentrations of uranium, which appear to be Increasing over time. Well GW-835 monitors constituents in the shallow zone in or near the Maynardville Limestone aquifer.

Well Sufficiency

The well sufficiency analysis, indicating areas within the plume where there is low correlation between constituent concentrations at adjacent wells, has many of the same limitations as the redundancy analysis. However, the data for the West S-3 area were examined using this tool. Well sufficiency results for PCE are indicate a VOC source area between GW-115 and GW-276 and GW-315 in the southern region (high PCE concentrations). Similarly, concentrations between wells GW-243 (high PCE) and GW-615 (low PCE) indicate a source or preferential flow path between these locations. No new wells are recommended for PCE delineation, however, locations GW-276, GW-243 and GW-315 should be monitored routinely to track concentrations in this area.. Well sufficiency data for other constituents do not indicate areas of high uncertainty

Sampling Frequency

Historic site characterization in the West S-3 area indicates high concentrations of constituents, however recent data collection efforts have been limited and insufficient data are available to determine statistical trends for roughly 80% of sampling locations. As statistical trend analysis is the basis for the sampling frequency evaluation using the MCES method, qualitative methods and historic data review were used to recommend preliminary sampling frequencies for most locations in the West S-3 area. Preliminary sampling frequencies were used as the basis for determining final sampling frequencies in the decision logic part of the analysis. Final sampling frequency recommendations for the Bear Creek Regime are presented in Table B.14 and are illustrated on Figure A.5.

Nineteen wells were recommended for Biennial sampling, largely as a result of insufficient data. The majority of wells in the Biennial sampling group may be very good candidates for removal from the network; but, the limited recent sample data make determination of trends and exceedances of screening levels difficult to evaluate. The contribution of these wells to the network was further evaluated during the decision logic step, outlined in Section II, 4.0.

Annual sampling was recommended for 14 wells. The wells in this group monitor many of the middle areas of the S-3 plume. Locations GW-122, GW-123, and GW-127 as well as GW-276 were identified in the well sufficiency analysis as requiring monitoring effort to delineate PCE concentrations. Wells GW-345 and GW-829 and spring SS-1 monitor the movement of constituents downgradient toward the Oil Landfarm WMA.

The majority of wells recommended for Semi-annual sampling monitor very high nitrate concentrations in the source area around the former S-3 site. The Increasing uranium trend at GW-835 also triggers a recommendation for Semi-annual monitoring, as does GB activity at GW-243. Monitoring source regions can provide important information supporting long-term site management decisions. While concentrations may not change rapidly in this area, developing a strong data set to support statistical or modeling analyses is important.

3.1.2 Oil Landfarm WMA (OLFA)

The Oil Landfarm Waste Management Area (OLFA) is characterized by a number of historic waste management locations. The OLFA is downgradient of the West S-3 area and upgradient of the Bear Creek Burial Grounds (BCBG). The area includes the regions known as the Oil Landfarm, Boneyard/Burnyard, the Hazardous Chemical Disposal Area (HCDA) and Sanitary Landfill I. The disposal areas are located on north of Bear Creek and the transmissive Maynardville Limestone. Constituents migrate via fracture flow and surface water to Maynardville formation. The OLFA area waste management units are suspected sources of VOC constituents, most notably TCE. Constituents such as uranium, Tc-99 and nitrate from the West S-3 area migrate into the OLFA via the aquifer, while the Boneyard/Burnyard is a source of elemental uranium GA activity. Fifty-nine monitoring locations were evaluated in the OLFA analysis group. The sample locations are listed in Table B.4 and illustrated on Figure A.2.

Constituent Choice

The MAROS method COC Risk Evaluation module identified TCE as the primary VOC constituent for overall plumes in the OLFA with vinyl chloride also of concern. Among the inorganic and radioactive constituents nitrate was identified as exceeding screening levels across the area. Reports from the MAROS software, including the COC Risk Evaluation are located in Appendix D.2. Priority constituents were also identified for each individual sample location based on the maximum historic exceedance at that location. TCE was the main COC at 19 of 59 locations. Elemental uranium (GA activity) was identified as a priority at 11 locations and GB activity was identified as the main constituents at 9 locations, but the majority of these locations had average concentrations below screening levels. Uranium isotopes were detected above screening levels at wells GW-226, GW-227 and GW-229, but the ratio of concentrations to screening levels was still below that of the VOC constituents at these locations.

Moment Analysis

The Moment Analysis was conducted for the both TCE and nitrate in the OLFA to assess stability of plumes from the two general source regions. MAROS-generated Moment Summary Reports are located in Appendix D.2 and results of First Moment estimates are shown on Figure A.5. Results indicate that the total estimated dissolved mass of TCE (Zeroth Moment) in the plume showed No Trend or variability (high COV) between 1996 and 2004. This may be due to variations in the number and identity of wells sampled during this time. First Moment analysis (plume center of mass) indicates an Increasing trend in the distance of the center of mass from the source, indicating movement of constituents downgradient. However, the estimated First Moments illustrated on Figure A.5 for sample event with >20 sample locations indicate that the center of mass has not moved significantly since 2001, when the number of wells sampled in the network stabilized. The center of mass for the TCE plume is localized just southwest of the Boneyard/Burnyard and southeast of Landfill I. The result supports relative stability of the VOC plume in this area since 2001.

Moment Type	TCE Moment Trend Analysis OLFA	
	Trend	Comment
Zeroth	No Trend	The estimate of total dissolved mass of TCE showed high variability (No Trend) during the sample period 1996-2004.
First	Increasing	The estimated distance from the source to the center of mass showed an Increasing trend during the sample period.
Second	No Trend/ Probably Increasing	The TCE plume showed No Trend in the distribution of constituents in the direction of groundwater flow and a Probably Increasing trend perpendicular to groundwater flow (mass distributing to the edges of the plume).

Second Moments for the TCE plume indicate that the distribution of mass in the plume shows high variability in the direction of groundwater flow. In the direction perpendicular to groundwater flow, mass within the plume is redistributing to the edge, with relative reduction of mass in the center of the well network.

Evaluation of Moments for the nitrate indicates that the estimate of total dissolved mass in the plume shows No Trend, similar to the TCE. High variability in total constituent concentrations may be a result of the position of the OLFA in the center of the Bear

Creek Regime, where constituents can pass into the area from the West S-3 area and out of the area to the BCBG region. Variability in data may also be due to complex hydrogeology, where surface water runoff in response to rainfall events affects concentrations.

No Trend was found for nitrate First Moments between 1996 and 2004. However, when moments are calculated for sample events with > 10 sample locations, the distribution appears very stable (Figure A.5). Second Moments for nitrate show increasing distribution of nitrate in the direction of groundwater flow and variability perpendicular to groundwater flow. The plumes in the OLFA area have less stable Moment results, with more variation in the data than those for the West S-3 BCBG areas. Variability in the data indicates that the OLFA area may benefit from consistent data collection efforts.

Moment Type	**Nitrate Moment Trend Analysis OLFA**	
	Trend	**Comment**
Zeroth	No Trend	The estimate of total dissolved nitrate was found to have No Trend during the sample period 1996-2004.
First	No Trend	The estimated distance from the source to the center of mass showed No Trend during the sample period.
Second	Increasing/ No Trend	The nitrate plume showed an Increasing trend in spread parallel to GW flow and No Trend (high variability) in the distribution of constituents perpendicular to GW flow.

Statistical Trend Results

Statistical trend analyses were conducted for constituent concentrations at each sample location between January 1996 and 2004. Trend results are listed on Table B.4 and illustrated on Figure A.5. A total of 59 sample locations at the OLFA area had historic analytical data, of these, 30 wells did not have sufficient data in the recent time frame to determine concentration trends. The function of these wells in the analytical network was reconsidered as part of the comprehensive review of the monitoring network.

Among the 29 wells with sufficient data to determine a trend, four locations had Decreasing or Probably Decreasing trends. All Decreasing locations had average concentrations above the screening level. Well GW-537, which is on-strike with GW-085 and GW-829, shows a Decreasing trend for nitrate GW-829 also has a Decreasing trend for nitrate; however, location GW-085 has a Probably Increasing trend for nitrate. Wells GW-738 and GW-740, which are located south of the waste management areas and represent potential exit pathways, show Decreasing to Probably Decreasing trends for TCE. Well GW-363 with a Probably Decreasing for GB activity does not show concentrations above the screening level and may be unaffected (7 samples since 1996, with the last 3 ND results). Five locations showed Stable trends. Four of five stable locations (GW-006, GW-226, GW-229 and GW-922) are in the Sanitary Landfill 1/Oil Landfarm source area. Stable well GW-724 monitors VOC constituents in the Maynardville formation.

Probably Increasing (PI) trends were found at five locations. The Probably Increasing trends for VOCs were found at locations GW-723 and GW-725 in the Maynardville Limestone exit pathway near Stable well GW-724. These three wells together monitor

VOC constituents in the transmissive aquifer unit, and all have average concentrations above the screening level. The three locations are recommended for Annual sampling frequency. Other wells with Probably Increasing trends delineate the upgradient northeastern sector of the Boneyard/Burnyard and Oil Landfarm. Wells GW-084 and GW-917 have concentrations well below MCLs, and the trend result is most likely an artifact of variable background concentrations of inorganic constituents and variations in detection limits.

Concentration trends with high variation in the data (NT) were found at 11 locations, but eight of these locations had average concentrations below the screening level, indicating the results may represent noise in low concentration data. Well location GW-225 displayed both high TCE concentrations and high variability in the data indicating that more sampling effort may be required in this area. Wells GW-008 and GW-098 showed lower TCE concentrations with some scatter in the data. These source area wells most likely do not require greater monitoring effort.

Well Sufficiency

Well sufficiency results for nitrate indicate that the area between well GW-225 and well GW-795 has a great deal of uncertainty. The results for nitrate are displayed graphically in Appendix D.2. Nitrate concentrations in this area drop off rapidly between GW-225 and GW-795. As the wells in the network are screened in different intervals (or represent an open hole in the case of GW-225), the variation in concentrations may represent preferential flow paths, and no new wells are recommended in the area, but continued monitoring of these locations is recommended. Well sufficiency data for other constituents do not indicate areas of high uncertainty

Sampling Frequency

MAROS-generated recommendations along with a qualitative analysis were used to develop preliminary sampling frequency recommendations that were subsequently used in the final decision logic step to recommend final sampling frequencies. Preliminary recommendations are listed in Table B.4, regardless of regulatory status of the location. Final recommended sampling frequency, accounting for regulatory and qualitative factors is listed in Table B.14 and on displayed on Figure A.5.

Nine locations were identified for removal from the routine monitoring program in the preliminary analysis. No wells were recommended for Quarterly sampling. In the MCES method, wells with less than four sample events in the time frame analyzed are given the default sampling frequency of Quarterly. However, because of the strong historical record of site characterization, reduced sampling frequency is recommended for these locations.

Preliminary recommendations for Semi-annual sampling include wells noted above with Probably Increasing trends, concentrations above screening levels or wells in areas of greater uncertainty. Wells GW-225 and GW-085 have been discussed under trend analysis and well sufficiency. Well GW-226 is adjacent to GW-225, and contributes to constituent monitoring in this area. Well GW-066 monitors the source area south of the Boneyard/Burnyard immediately north of the transmissive exit pathway in the aquifer.

Wells GW-736 and GW-737 monitor the exit pathway for nitrate, but unlike wells GW-723 and GW-724, these wells do not have sufficient data to determine a trend in the recent time frame.

Sixteen wells have preliminary recommendations for Annual sampling. Many of these wells have constituent concentrations above screening levels, but have sufficient historical sample data to determine that the rate of change of concentrations is not rapid. Many of these wells are currently being sampled at Semi-annual or Quarterly intervals. The majority of wells in the network are recommended for Biennial sampling. Many of these locations have insufficient data to determine concentration trends but have concentrations below screening levels. The recommendation for these wells is to collect four sample points in a 10-year time frame and then re-evaluate the contribution of each well to the entire network. Some wells with high average concentrations and limited sample records are recommended for Biennial sampling. Well GW-601, which has a history of exceedance of TCE screening levels, and has an open hole construction monitoring deeper levels, is recommended for Biennial sampling, which will most likely confirm Decreasing trends at this location.

3.1.3 Bear Creek Burial Grounds Area Analysis Group

The Bear Creek Burial Grounds (BCBG) analysis group includes the westernmost region of the Y-12 facility. The DOE owns the property west and downgradient of the BCBG area; consequently, affected groundwater does not, technically, extend off-site beyond the boundaries of the Oak Ridge Reservation. The BCBG area includes two major source regions with distinct constituent profiles. The BCBG are a series of waste management units below the crest of Pine Ridge containing diverse of materials. Groundwater underlying the immediate area of the BCBG is in the aquitard formation, and fracture flow conditions are present. Surface water from the streams that run through the BCBG area interact with groundwater downgradient. The predominant constituents of concern in the waste management areas include VOC compounds, most notably PCE and TCE with 11DCE and VC as secondary compounds. The second major source of constituents to the western Bear Creek Regime is affected groundwater entering from areas to the east (West S-3 and OLFA). Constituents from the BCBG area and the West S-3 area commingle in the aquifer unit.

Active monitoring locations on the western edge of the Y-12 facility were grouped together for the MAROS analysis. In the general area of the BCBG, 90 sample locations were identified as ‘active’ for both hydrologic and analytical monitoring in the Y-12 database. Of the 90 active locations identified in the database, analytical data were available for 80 locations. These 80 locations were included in the BCBG MAROS analysis group and are listed and described in Table B.5. In calendar year (CY) 2004, 27 of these locations, including groundwater wells and springs were sampled at least once.

Constituent Choice

Priority analytes were identified for the BCBG area as a whole, using the MAROS method COC Risk Evaluation module. Reports from the MAROS software, including the COC Risk Evaluation are provided in Appendix D.3. Additionally, a priority constituent was identified for each sample location based on the maximum historical exceedance at that location. The two priority constituents were chosen for the site analysis, tetrachloroethene (PCE) and Gross Beta (GB) activity. The two constituents represent the two distinct constituent classes. Plumes in the BCBG analysis group are highly commingled, with both VOC and inorganic constituents entering from upgradient sources and the BCBG contributing additional VOC.

Moment Analysis

The Moment Analysis was conducted for both PCE and GB activity in the BCBG area to determine the relative stability of groundwater concentrations in this area. Results indicate that the total estimated dissolved mass of PCE (Zeroth Moment) in the plume showed a Probably Increasing trend between 1996 and 2004. Changing trends may be due to variations in the well network sampled during this time or Increasing concentrations at specific locations. First Moment results (plume center of mass) are shown on Figure A.6 and indicate a Decreasing trend in the distance of the center of mass from the source. The source was set along the eastern edge of the BCBG for the purpose of the analysis, but precise location of a single source or sources is not possible in this area. The center of mass for the PCE plume is localized just southwest of the BCBG and does not seem to be expanding downgradient. This result supports the overall stability of the VOC plume in this area.

Moment Type	PCE Moment Trend Analysis BCBG	
	Trend	**Comment**
Zeroth	Probably Increasing	The estimate of total dissolved mass of PCE was found to be Probably Increasing during the sample period 1996-2004.
First	Decreasing	The estimated distance from the source to the center of mass showed a Decreasing trend during the sample period.
Second	Decreasing/ Probably Decreasing	The PCE plume showed Decreasing trends in the distribution of constituents (more mass in the center of the plume relative to the edges).

Generally Decreasing Second Moments for the PCE plume indicate that the distribution of mass in the plume is near the center (close to the First Moments) as opposed to expanding toward the edges. Moment results for the PCE plume indicate Stable to Decreasing plume mobility with possible Increasing total dissolved mass.

Evaluation of Moments for the GB activity indicates that the estimate of total dissolved activity in the plume is Stable between 1996 and 2004. Plume stability indicates sampling frequencies can be reduced without loss of information because the plume is not changing rapidly.

The trend of GB First Moments is also Stable between 1996 and 2004, showing some vacillation up and down the Bear Creek Regime, perhaps in response to seasonal influences. Differences in First Moment trends for GB and those for PCE reflect the difference in source areas and transport mechanisms for the two constituent classes in this region of the facility.

Second Moments for GB show greater variability in the direction of groundwater flow. This may support a seasonal component to constituent distribution in this area. Second Moments perpendicular to groundwater flow are Decreasing, supporting a narrowing of the plume in the north/south direction. Cumulative results of the Moment analyses indicate largely Stable PCE and GB plumes, with some further characterization of PCE locations required to evaluate possible mobilization of mass in this area.

Moment Type	Gross Beta Activity Moment Trend Analysis BCBG	
	Trend	**Comment**
Zeroth	Stable	The estimate of total dissolved Gross Beta Activity was found to be Stable during the sample period 1996-2004.
First	Stable	The estimated distance from the source to the center of mass showed a Stable trend during the sample period.
Second	No Trend/ Decreasing	The Gross Beta Activity plume showed No Trend (high variability) in the distribution of constituents in the direction of groundwater flow and a Decreasing trend perpendicular to groundwater flow (more mass in the center of the plume relative to the edges).

Statistical Trend Results

Trend analyses were conducted on data collected in the BCBG area between January 1996 and 2004. Concentration trend results for the Bear Creek Regime are presented in Table B.5 and Figure A.6, and are summarized at the beginning of this section. In order to determine a statistical trend for the data, at least four sample events must be available for each location. Of the 80 locations examined, 43 had insufficient analytical data in the time range examined to determine a concentration trend. These locations currently serve the primary function of hydrologic (potentiometric) data collection.

Among wells with a sufficient recent sampling history to determine a trend, six wells had either a Decreasing (D) or Probably Decreasing (PD) concentration trend for the identified priority constituent. Nine other wells had a Stable (S) trend while five wells showed ND (non-detect) for all major constituents. This indicates that 20 out of 37 wells with sufficient data had Decreasing, Stable, or non-detect concentration trends.

Increasing (I) or Probably Increasing (PI) trends were found at 9 wells, three locations each for uranium, PCE and TCE. Increasing trends for VOC constituents were found at wells GW-626, GW-627, GW-289 and GW-653 near the downgradient edge of the source area. Locations GW-082 and GW-069 had increasing trends for vinyl chloride, a degradation product of PCE and TCE. Increasing concentrations of vinyl chloride are frequently encountered in locations of active PCE or TCE degradation, and monitoring data in these locations may be used to support evidence of natural attenuation of these constituents.

Of greater concern, Increasing trends for uranium were found at downgradient and Exit Pathway locations GW-715 and SS-6E and SS-7. The average concentration exceeds the screening level at location SS-6E. The downgradient area of the plume may have been impacted by surface water influence or recent remedial actions in the BCBG area. Continued observation of this region is recommended.

Concentration trends with high variation in the data (No Trend) were found at 8 locations. Of these locations, 5 had average concentrations above the MCL, including GW-046 and GW-071 in the source area. Concentration trends indicate that many locations have Stable to Decreasing trends, and that Increasing and variable concentration trends are more common close to the BCBG waste management units.

Well Sufficiency

The well sufficiency analysis, which indicates areas within the plume of greater uncertainty in concentration, indicated an area under Burial Ground A-South as an area of high uncertainty for VOC concentrations. Analysis of landfills or waste management units using the well sufficiency tool frequently results in suggestions to add monitoring locations in the middle of the unit. No new wells are recommended for the BCBG area, but the results of the well sufficiency highlight the need to monitor the source areas carefully.

Sampling Frequency

The MAROS MCES tool was used to recommend preliminary sampling frequencies for locations in the BCBG. Preliminary sampling frequencies are listed in Table B.5. Preliminary frequencies were used in a decision logic step outlined in Section II, 4.0 to form final network recommendations. The final recommended sampling frequency is discussed in Section II, 4.0 and listed in Table B.14 and illustrated on Figure A.6.

Of the 80 locations analyzed, over half did not have the minimum four sample events in the 10-year time frame to perform the statistical trend analyses. In the case of the BCBG area, recommendations for well removal are based in large part on a qualitative analysis of the function of each well. Designation of wells to be removed is difficult for a commingled plume where different constituents dominate at different locations. The preliminary recommendation is to remove 19 locations from the routine analytical program.

Based on the strength of the historic record and general stability of the plumes, no wells were recommended for Quarterly sampling. Wells recommended for Semi-annual sampling include those with Increasing or Probably Increasing trends for VOC constituents, specifically wells GW-626, GW-627, GW-082, and GW-289. Three locations are recommended for Semi-annual sampling based on uranium concentrations: GW-061, GW-694 and the spring SS-6 (which monitors SS-6E and SS-6W).

The majority of wells in the network are recommended for Annual sampling. Locations with Increasing concentrations but average values below the screening level are recommended for Annual sampling. Eight locations recommended for Annual sampling do not meet minimum data needs to determine a trend. These locations should be sampled until a sufficient data set is established and should be re-evaluated to determine if reduction in sampling frequency is warranted.

Twenty-five wells are designated for Biennial sampling. Fourteen wells in this group have insufficient data to determine a trend, while other locations have ND trend results and may be approaching ‘clean’ status. Biennial sampling is an indication that given sufficient data, the well may be deemed redundant or unnecessary in the near future.

3.2 Upper East Fork Poplar Creek

The East Fork Poplar Creek Hydrogeologic Regime extends from the Bear Creek/East Fork divide in the west to the Union Valley area in the east. The general groundwater flow is eastward, distinct from the westward flow in the Bear Creek Regime. The East Fork Regime is characterized by intense industrial development, with the majority of current and historic manufacturing, research and processing activities taking place in the valley formed by the creek. Sources present in the East Fork Regime include the former S-3 Ponds and S-2 Site as well as numerous former underground storage tanks (USTs), the Coal Pile Trench, Scrap Yard, numerous industrial facilities, and the Fire Training Facility. The area is characterized by plumes from a number of sources containing diverse constituents.

Similar to the Bear Creek Regime analysis, the East Fork Regime was divided into four analysis areas divided roughly east to west (see Table B.2, Figure A.1). Analysis groups include the Eastern S-3 (East S-3) area, the Central Y-12 area, the Fuel Station area, and the region around New Hope Pond and Union Valley (East Y-12). As in the other hydrogeologic regimes, the subsurface is divided into 'aquifer' group wells in the Maynardville Limestone and the 'aquitard' Conasauga Group and Rome Formation. The aquitard areas are hydraulically upgradient of the Maynardville Limestone and fractures, and possibly, utility traces provide the main flow paths through the unit to the aquifer.

Results from the four MAROS analyses for the East Fork Regime are summarized in tables below and discussed in detail in sections 3.2.1 through 3.2.3. Final network recommendations, based on both qualitative and quantitative approaches are presented in Section II, 4.0 and listed in Table B.15.

Analysis Group	MAROS Results East Fork Hydrogeologic Regime			
	Total Number Wells	**Number wells Above Screening Level**	**Priority COCs**	**Moment Analysis (Plume Stability Analysis)**
East S-3 Area	49	37 (75%)	Nitrate	Variable total mass, Stable to Decreasing plume spread
			PCE	Variability in total mass and spread results
Central Y-12 Area	44	26 (59%)	Uranium	Variability in total mass and distribution results, Decreasing distance to center of mass.
			PCE	Variability in total mass and distribution results, Decreasing distance to center of mass.
Fuel Station Area	24	5 (20%)	Benzene	Decreasing total mass, but increasing distance to center of mass and distribution of constituents
New Hope Pond Area	54	20 (37%)	CTET	Probably Increasing dissolved mass (possibly due to extraction well), Decreasing trends in spread of plume

All analysis areas in the East Fork Regime contained sample locations with concentrations above screening levels, with 75% of locations in the East S-3 area (as with the West S-3 Area) above screening levels. The relative number of locations above screening levels decreases across the East Fork Regime. The Fuel Station area had the fewest number of exceedances, with many being historic. Results from the COC Risk evaluation were used to choose representative constituents for plumes in each sample group. Representative COCs were evaluated using the Moment Analysis module in order to determine the relative stability of the plumes. Total mass estimates for plumes in each of the East Fork Regime analysis groups indicated variability in the data, with the exception of the Fuel Station Area. Data variability may be the result of limited amount of data (as may be the case in East S-3), variations in the well network (i.e. number and distribution) sampled or actual fluctuations in groundwater concentrations. Plume spread appears to be Decreasing in most areas of the East Fork Regime.

Results for individual sample location trends in each sample group are tabulated below. Both the number of wells in each category and the percentage of total sample group wells in the category are indicated. Sample locations with NT (No Trend) and N/A (insufficient data) designations may benefit from additional sample collection efforts or removal from the program, if they do not provide important information. Locations with stable to decreasing trends (S, PD, D) or non-detect (ND) results may be candidates for reduced sampling effort. Locations with increasing trends (I or PI) should be monitored carefully to determine if the trend indicates an increase in the distribution of the plume.

Analysis Group	**Overall MAROS Trend Analysis East Fork Regime**			
	N/A, NT	**PD, D, S**	**I, PI**	**ND**
East S-3 Area	33 (67%)	9 (18%)	1(2%)	4 (8%)
Central Y-12 Area	25 (57%)	16 (36%)	3 (7%)	0
Fuel Station Area	15 (63%)	1 (4%)	1 (4%)	7 (29%)
New Hope Pond Area	24 (44%)	19 (35%)	6 (11%)	5 (10%)

Note: Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).

Preliminary sampling frequency recommendations were developed using the MAROS MCES method along with preliminary qualitative evaluation for locations with limited sample data. All wells were included in the analysis, independent of their regulatory status. By considering all wells in the network, a clearer picture of the level of effort required could be developed. Preliminary results for the East Fork Regime are presented below, with final results detailed in Section II, 4.0 and listed in Table B.15. The preliminary results are compared with the sampling frequency for wells in the sampled during the 2004 calendar year (CY) monitoring program.

Monitoring Wells	Network Frequency Analysis East Fork Regime		
	Sampling Frequency	Number of Wells CY 2004	Number of Wells Preliminary Recommendation
	Remove	--	27
	Quarterly	1	--
	Semi-annual	23	21
	Annual	9	63
	Biennial	0	58
Total Samples (per year)		**59**	**134**
Total Wells		34	142

Preliminary sampling frequency results comparing the total number of samples for the 2004 program and the recommended program indicate an increase in total samples (59 versus 134) and in total wells sampled (34 versus 142). The preliminary results indicate that more sampling effort may be needed, initially, to better define diverse source areas in the developed part of the Y-12 Complex. Preliminary results were carried forward as the basis for integrating qualitative and quantitative network observations into a final sampling program.

3.2.1 East S-3 Area

While the former S-3 Ponds are located in the aquitard area of the Bear Creek Hydrogeologic Regime, constituents from the site have migrated into the East Fork Regime. The S-3 site constitutes one of the major sources of groundwater contaminants in the Y-12 Complex. The East S-3 area analysis group includes data from several source areas including the S-2 Site, Beta-4 Security Pits, Rust Garage Area, Fire Training Facility, Y-12 Salvage Yard, and Waste Coolant Processing Facility (see Figure A.7. A total of 49 sample locations were considered in the evaluation of the Eastern S-3 area. Locations are listed on Table B.6 and are illustrated in Figure A.1 and A.2.

Constituent Choice

The MAROS method COC Risk Evaluation module identified many constituents as being present in the Eastern S-3 region above screening levels. Metals such as manganese and aluminum may have been mobilized by high nitrate concentrations. While metals are of concern over the site, the primary constituents chosen for site analysis were nitrate for the inorganic compounds and PCE as representative of VOC constituents. Reports from the MAROS software, including the COC Risk Evaluation are located in Appendix D. Priority constituents were also identified for each individual location based on the maximum historic exceedance at that location. Among individual wells, nitrate was identified as the priority constituent.

Moment Analysis

The Moment Analysis was conducted for both nitrate and PCE in the East S-3 area to evaluate constituents from the two main constituent classes. MAROS-generated Moment Reports are located in Appendix D.4. Results indicate that the total estimated dissolved mass of nitrate (Zeroth Moment) in the plume showed No Trend or variability between 1996 and 2004. This may be due to variations in the number and identity of wells sampled during this time or the influence of seasonal factors on groundwater flow. First Moment results (plume center of mass) show a Decreasing trend in the distance of the center of mass from the source indicating a retreat of the center of mass of the plume upgradient. The estimated First Moments are illustrated on Figure A.7 (first set of panels) and indicate that the nitrate centers of mass are retreating west. Decreasing First Moment results provide evidence of plume stability, and may indicate some plume shrinkage in this area.

Moment Type	**Nitrate Moment Trend Analysis East S-3**	
	Trend	**Comment**
Zeroth	No Trend	The estimate of total dissolved mass of nitrate showed high variability (No Trend) during the sample period 1996-2004.
First	Decreasing	The estimated distance from the source to the center of mass showed a Decreasing trend during the sample period.
Second	Stable/ No Trend	The nitrate plume showed Stable trends in the distribution of constituents in the direction of groundwater flow and No Trend perpendicular to groundwater flow.

Second Moments for the nitrate plume indicate that the distribution of mass within the plume is also stable and that mass did not redistribute from the center to the edges of the plume during the sample time frame. Some variability in mass distribution is seen in the direction perpendicular to groundwater flow. Stable second moments are supportive of overall plume stability.

Stability assessment for the VOC components of the plume is based on data for PCE. Total dissolved mass of PCE in the East S-3 area showed No Trend between 1996 and 2004, indicating variable concentrations in the wells sampled or the number of wells sampled. Likewise, there was No Trend for PCE First Moments between 1996 and 2004. First Moments appear to be moving back and forth along the axis of groundwater flow, and may be responding to seasonal effects in this location.

Moment Type	**PCE Moment Trend Analysis East S-3**	
	Trend	**Comment**
Zeroth	No Trend	The estimate of total dissolved PCE showed No Trend during the sample period 1996-2004.
First	No Trend	The estimated distance from the source to the center of mass showed No Trend during the sample period.
Second	No Trend/ No Trend	The PCE plume showed No Trend (high variability) in the distribution of constituents .

Second Moments for the PCE plume also show No Trend results for the distribution of mass within the plume. The Moment data for PCE suggest that the VOC plume may not be as stable as the nitrate plume in this region.

Statistical Trend Results

Trend results for East S-3 Area wells between January 1996 and 2004 are shown in Table B.6 and on Figure A.7. Of the 49 sample locations in the East S-3 area with historic analytical data in the database, 30 wells did not have sufficient data in the 1996 to 2004 time frame to determine concentration trends. The majority of these wells (21 of 30) have historic constituent concentrations significantly above screening levels for one or more of constituents. The limited data from the recent time period limits the quantitative approach to evaluating the monitoring network in this area.

Four sample locations showed Decreasing or Probably Decreasing trends. These included wells GW-274, GW-618, GW-620 and GW-633, which monitor locations in the center of the plume. Five additional wells showed Stable trends, including GW-251, GW-275, GW-619, GW-337 and 55-2C. Combined with the Decreasing trend wells, this group indicates that concentrations are largely Stable to Decreasing along the southern centerline of the plume.

Only two wells had Increasing or Probably Increasing trends. Well GW-253 showed a strongly Increasing trend for the metal cadmium on the southern perimeter of the area. The source of the cadmium in this small zone is nitric acid and plating waste liquids placed in the S-2 site immediately adjacent to well GW-253. The adjacent well GW-251 shows a Stable trend for PCE. The well 55-2B showed a Probably Increasing trend for PCE in the downgradient area of the plume.

No Trend results were found for nitrate in wells GW-108 and GW-109, on the western edge of the area. Concentrations of nitrate at these locations are quite high, and greater monitoring effort may be required in this area. Upgradient well GW-633, also installed in the aquitard unit, showed a Decreasing trend for both nitrate and uranium and much lower average concentrations. GW-633 is completed at shallow depth, where wells GW-108 and GW-109 are significantly deeper. (However, GW-633 showed an Increasing trend for benzene and Probably Increasing trends for 11DCE and GB activity. Well GW-633 is and example of how different constituents can return different results in locations where multiple sources are present. These results were considered in the final sampling recommendation.)

Well Sufficiency

Well sufficiency results for PCE and nitrate are illustrated graphically in Appendix D.4. Results show that PCE concentration differences between wells GW-192 in the north (low concentrations) and GW-337 in the south (higher concentrations) and GW-274 and GW-275 to the west create a zone of higher concentration uncertainty. This represents the center of the downgradient plume, and reflects the probability that GW-337 and GW-274 and 275 are hydraulically connected, while GW-192 is out of the main flow path. As the wells in this part of the network are screened in different intervals, the variation in concentrations is reasonable, and no new wells are recommended. PCE concentrations in this zone, however, may require continued monitoring effort.

Well sufficiency data for nitrate indicates some uncertainty in the northern and eastern perimeters of the plume. This result stems from higher concentrations at well 55-2C, in the center of the plume and very low concentrations at well GW-192. Very few data points are available between GW-192 and well 55-C2 to describe the change in concentration between these two points. While a new well is not suggested, a review and sampling of well 55-1A would reduce uncertainty in this area.

Sampling Frequency

The East S-3 area is heavily developed and affected by a number of diverse facility operations. Of the 49 wells evaluated, 37 have average concentrations above screening levels for at least one priority constituent. As with the Western S-3 area, there is limited recent data to evaluate concentration trends in the area. The East and West S-3 areas are source locations with consistent high concentrations located in the center of the property. For these reasons, frequent sampling has been de-prioritized. Because of the limited recent data and the diversity of depths and constituents present, wells were recommended for elimination from the program based on mainly qualitative analysis (see final recommendations in Section II, 4.0).

Preliminary sample frequency and redundancy evaluations are based on the MAROS MCES tool. Results of the preliminary frequency analysis are shown in Table B.6. Preliminary results described here were used along with the decision logic described in Section II, 4.0 of this report to develop the final sampling frequency recommendation. Eight wells were initially recommended for removal. The majority of these wells do not have concentrations above screening levels, provide redundant information with similar wells, and have not been routinely sampled recently. Ten wells are recommended for Biennial sampling, largely as a result of insufficient data or very low concentrations. The majority of wells in the Biennial sampling group may be very good candidates for removal from the network when sufficient data are available to evaluate their contribution to the network

The majority of wells have an Annual monitoring frequency recommendation. Many of these wells delineate the plume both horizontally and vertically. Of the 23 wells in the Annual category, 11 have insufficient data to determine a trend and a subsequent monitoring frequency using the MCES method. Wells recommended for Annual monitoring may be candidates for removal from the network when a sufficient number of samples are collected for statistical analysis. The majority of wells recommended for Semi-annual sampling monitor very high nitrate concentrations, although well GW-253, located in the aquifer formation, has a more frequent monitoring recommendation for cadmium concentrations.

The monitoring network in the East S-3 area functions to monitor the S-3 and S-2 source areas that may provide constituents for transport downgradient, particularly in the more transmissive Maynardville formation. Nitrate concentrations appear stable in the S-3 part of the plume, and source monitoring may require reduced effort. Wells located in the aquitard formation function is to provide information on VOC and metal constituents originating from diverse and often poorly defined sources in this area. The general monitoring suggestion for the S-3 area is to collect data at an annual frequency until the wells have sufficient data for statistical evaluation. Final recommendations specific to individual wells are detailed in Table B.15.

3.2.2 Central Y-12 Area

The Central Y-12 area is the most highly developed region of the Y-12 Complex. General groundwater flow is to the east. Affected groundwater in the Maynardville aquifer enters the area from the East S-3 region of the East Fork Regime and constituents from other sources commingle with affected groundwater entering the area. The aquifer exits the area to the east and flows into the Fuel Station and New Hope Pond and Union Valley areas. The Central Y-12 area includes the Coal Pile Trench and Uranium Oxide Vault regions. The 45 wells evaluated in this area are listed on Table B.7 and are illustrated in Figures A.1 and A.3.

Constituent Choice

The MAROS method COC Risk Evaluation module identified many constituents above screening levels in the Central Y-12 region. The VOC constituents PCE and TCE are prioritized based on toxicity, while nitrate and uranium are the inorganic constituents of greatest concern. Reports from the MAROS software, including the COC Risk Evaluation are provided in Appendix D.5. Priority constituents were also identified for each individual location based on the maximum historical exceedance at that location. Among individual wells, PCE (14 locations), GA activity (10 locations), and chromium were identified as the priority constituents.

Moment Analysis

The Moment Analysis was conducted for both uranium and PCE in the Central Y-12 area to evaluate stability of the VOC and inorganic plumes. MAROS-generated Moment Reports are located in Appendix D.5. Moment results indicate that the total estimated dissolved mass of uranium (Zeroth Moment) in the plume showed No Trend or variability between 1996 and 2004. As stated above, this result may be due to variations in the number and identity of wells sampled during this time or the influence of seasonal factors on groundwater flow. First Moment analysis (plume center of mass) indicates a Decreasing trend in the distance of the center of mass from the source, indicating a retreat of the center of mass between 1996 and 2004. First Moments for uranium are shown on Figure A.7. The estimated First Moments provide evidence of plume stability, and possible shrinkage.

Moment Type	Uranium Moment Trend Analysis Central Y-12	
	Trend	**Comment**
Zeroth	No Trend	The estimate of total dissolved mass of uranium showed high variability (No Trend) during the sample period 1996-2004.
First	Decreasing	The estimated distance from the source to the center of mass showed a Decreasing trend during the sample period.
Second	No Trend/No Trend	The uranium plume showed No Trend in the distribution of constituents.

Second Moments for uranium indicate No Trend in the data. The distribution of mass within the plume is not changing in a definite pattern.

Evaluation of Moments for the VOC components of the plume is based on data for PCE. Total dissolved mass of PCE in the Central Y-12 area showed No Trend between 1996 and 2004, indicating high variability in either the wells sampled or the concentrations within the wells. The First Moment trend for PCE shows Decreasing distance of the center of mass from the defined source area. (The designated 'source' area for both uranium and PCE is in the western portion of the Central Y-12 area, roughly near well 56-2B. While there may be other source areas within the plume, choosing a single location can still indicate relative movement or stability of the center of mass. First Moment movement back upgradient rather than downgradient generally indicates the plume is not expanding.).

Moment Type	PCE Moment Trend Analysis Central Y-12	
	Trend	**Comment**
Zeroth	No Trend	The estimate of total dissolved PCE was found to have No Trend during the sample period 1996-2004.
First	Decreasing	The estimated distance from the source to the center of mass showed No Trend during the sample period.
Second	Probably Increasing/ No Trend	The PCE plume showed No Trend (high variability) in the distribution of constituents.

Second Moments for PCE indicate that mass is becoming more dilute in the center of the plume, and higher in concentration on the perimeter in the direction of groundwater flow. Second Moments perpendicular to groundwater flow show No Trend. Moment results for PCE and uranium indicate some variation in total dissolved mass estimates and distribution of mass in the plume, but Decreasing trends in the length of the plumes.

Statistical Trend Results

Trend results for Central Y-12 area wells between January 1996 and 2004 are shown in Table B.7. Of the 44 sample locations in the Central Y-12 area with analytical data in the database, 21 wells did not have sufficient data in the 1996 to 2004 time frame to determine concentration trends. Eight of the wells with insufficient data had historic average constituent concentrations above screening levels.

Six sample locations showed Decreasing trends while three resulted in Probably Decreasing trends. Wells with Decreasing trends include centrally located aquifer wells GW-193 and GW-219, with GW-700 having a Probably Decreasing trend. Aquitard wells with Decreasing trends included GW-782 and GW-788, while aquitard well 59-1B had a Probably Decreasing trend. Decreasing trend wells GW-605 and GW-606 are in the eastern portion of the plume near the New Hope Pond and are part of the CTET plume in that area. Upgradient aquifer well GW-204 had a Probably Decreasing trend for GA activity.

An additional seven sample locations had Stable concentration trends, including the aquifer wells GW-690 and GW-218. Aquitard wells with Stable trends include 56-2C, GW-656, GW-783, GW-791 and GW-792. Combined together, these sample locations with Stable to Decreasing trends represent 16 of the 24 sample locations with defined trends, providing supporting evidence of overall stability of the plumes.

Three wells had Increasing or Probably Increasing trends. Wells GW-769 and GW-770, located in the center of the plume and screened in the aquitard formation had increasing trends for CTET. Average concentrations of CTET are not particularly high at these locations, but the source of CTET in this region of the plume is not clear. Well GW-781 shows a Probably Increasing trend for PCE in the central portion of the area.

A No Trend result indicates high variability in constituent concentrations. No Trend results were found for TCE (as well as nitrate) at aquifer well GW-698 on the southern perimeter of the area. Other wells with No Trend results include GW-787, GW-789, and GW-820. The latter well has high historic concentrations of PCE and is located on the southern edge of the plume.

Well Sufficiency

Well sufficiency results for PCE and uranium are illustrated graphically in Appendix D.5. Results show PCE concentration delineation may benefit from greater sampling effort in the region of wells GW-765, well 55-6A, and wells GW-791/792 in the north. The result is due to relatively high concentrations of PCE at the GW-791/792 cluster and low concentrations on the perimeter. While no new wells are recommended in this area, continued sampling effort in this area may be required. An additional area of PCE concentration uncertainty was identified in the region between GW-218, GW-820, and GW-770. Continued monitoring effort should be focused in this area of the plume as well.

Well sufficiency data for uranium indicates some uncertainty in the area around wells GW-788/789 and well GW-193. Uranium concentrations in this area show intermittent detections and the uncertainty may be due to variations in concentration, the presence of secondary sources, or differences in well depth.

Sampling Frequency

Preliminary sample frequency and redundancy evaluations are based on the MAROS MCES tool. Results of the preliminary frequency analysis are shown in Table B.7. Preliminary results described here were used along with the decision logic described in

Section II, 4.0 of this report to develop the final sampling frequency recommendation. Final recommendations are listed in Table B.15. Of the 44 locations evaluated, 21 locations have insufficient recent data to confirm a concentration trend, which forms the basis for the sampling frequency recommendation. Twenty-six locations have average concentrations above screening levels for at least one priority constituent.

Eight wells were initially recommended for removal. The majority of these wells do not have concentrations above screening levels, provide redundant information with similar wells, and have not been routinely sampled, recently. Seven wells are recommended for Biennial sampling due to insufficient data or the location of the well. The majority of wells in the Biennial sampling group may be very good candidates for a more reduced sampling frequency (four samples in a 10 year period) when a larger data set is available to evaluate their contribution to the network.

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The majority of wells have an Annual monitoring frequency recommendation. Many of these wells delineate the plume both horizontally and vertically. Of the 22 wells in the Annual category, six have insufficient data to determine a trend and a subsequent monitoring frequency using the MCES method. Historic trends were used to recommend frequencies at these locations. Wells recommended for Annual monitoring may be candidates for removal or reduced sampling frequency when a larger data set is available. Wells recommended for Semi-annual sampling monitor very high concentration groundwater with variable trends (GW-820 and GW-698), wells with Increasing trends (GW-769 and GW-770) and wells with insufficient data and average concentrations above the screening level.

The Central Y-12 area has many diverse sources and a large number of priority constituents as well as on-going industrial operations, which can create challenges to the monitoring program. Because inorganic concentrations appear stable to decreasing in many areas of the plume, and most wells monitor water in the aquitard formation, the main function of many of the wells is to provide information on VOC and metal constituents originating from diverse and often poorly defined sources in this area.

3.2.3 Fuel Station

The Fuel Station area of the East Fork Regime is a small area near a former fuel station where the predominant COCs are benzene and PCE/TCE. The Fuel Station area is located east of the Central Y-12 area and west of the New Hope Pond area. A group of 24 wells were included in this analysis. The wells are listed on Table A.8.

Constituent Choice

The MAROS software identified benzene, manganese and TCE/PCE as priority constituents in the Fuel Station area. While manganese is present above the secondary MCLs and lead was identified as the constituent with the highest concentration at several locations, metal contamination appears isolated and the metals do not lead the analysis. For individual wells within the network, benzene, TCE, and PCE were the most common constituents present above screening levels.

Moment Analysis

A Moment Analysis for the Fuel Station area was conducted for benzene. MAROS-generated Moment Reports are located in Appendix D.6. Moment results indicate that the total estimated dissolved mass of benzene (Zeroth Moment) in the plume showed a Decreasing trend between 1996 and 2004. A Decreasing trend for benzene is often seen in plumes with ongoing natural attenuation processes. First Moment analysis (plume center of mass) indicates an Increasing trend in the distance of the center of mass from the source. After 1998, First Moment results were determined from a limited group of monitoring wells, which may have skewed the trend.

An Increasing trend for the center of mass and Decreasing total mass indicates that benzene is degrading at the source while a dilute mass may be moving downgradient. This view of the plume is supported by the Increasing Second Moments which indicate that the plume is becoming more dilute in the center with relatively more mass present at the perimeter. These results indicate a plume shrinking in mass, but moving downgradient as a dilute footprint.

Moment Type	**Benzene Moment Trend Analysis Fuel Station**	
	Trend	**Comment**
Zeroth	Decreasing	The estimate of total dissolved mass of benzene was found to be Decreasing during the sample period 1996-2004.
First	Increasing	The estimated distance from the source to the center of mass showed an Increasing trend during the sample period.
Second	Increasing/Increasing	The benzene plume showed Increasing distribution of mass to the edge of the plume during the sample period.

Statistical Trend Results

Trend results for the Fuel Station Area wells between January 1996 and 2004 are shown in Table B.8. In order to determine a statistical trend in the data, at least four sample events must be included in the time frame. Locations that had less than four sample events between 1996 and December 2004 are indicated by an N/A in the Trend category.

Of the 24 sample locations in the Fuel area with analytical data in the database, 10 wells did not have sufficient data in the 1996 to 2004 time frame to determine concentration trends. Three of the wells with insufficient data had historic average concentrations above screening levels.

None of the wells with sufficient data had Decreasing or Probably Decreasing trends for the identified priority constituent. Well GW-776 had a Stable trend for TCE, while well GW-775 in the same cluster had No Trend, for the same compound. GW-775 had low but variable detections of TCE, triggering a No Trend result. In all, five wells showed No Trend results.

A No Trend result can indicate noise in the data, seasonal influence or as in the case of wells GW-753 and GW-754, outliers or spurious, unrepeated single detections. While wells GW-753 and GW-754 may be clean, one outlier can skew the result. Well GW-658 also had a No Trend result, but has a history of fairly high benzene concentrations that show some variability.

Seven wells in the network had no detections for the priority constituent during the 1996 to 2004 sample period. These wells are trending toward 'clean' status and are candidates for removal from the monitoring program. The trend analysis indicated that many wells had variable concentrations of priority constituents, and many locations are trending toward clean by displaying intermittent detections.

Well Sufficiency

The well sufficiency analysis, which indicates areas within the plume where there is low correlation between constituent concentrations at adjacent wells, indicated no areas of high spatial uncertainty for the priority constituents. No new wells are recommended.

Sampling Frequency

The Fuel Station area is heavily developed but is not affected by as many diverse sources and constituents as other areas of the East Fork Regime. All but one of the wells considered in this area is screened in the aquitard geologic unit, where there is reduced potential for contaminant transport. Of the 24 wells evaluated, 8 have average concentrations above screening levels for at least one priority constituent and 10 locations do not have enough data in the recent time frame to recommend a sampling frequency using the MCES method. The final recommended sampling frequency for individual wells is listed in Table B.15.

Based on the preliminary analysis, nine wells have been recommended for removal. The majority of these wells do not have concentrations above screening levels, provide redundant information with similar wells, and have not been routinely sampled recently. Ten wells are recommended for Biennial sampling. Many Biennial wells had historic exceedances of MCLs but have since dropped near or below detection limits. The majority of wells in the Biennial sampling group may be good candidates for more reduced sampling frequency (four samples over a 10-year period) or elimination from the monitoring program when a larger data set is available to evaluate their contribution to the network.

The benzene plume in the Fuel Station area has a largely Stable to Decreasing mass, with many wells trending toward 'clean' status. TCE is encountered sporadically across the site, with higher concentrations at GW-775 and GW-776, from upgradient source. Groundwater sampling in this region should be directed at collecting sufficient data to confirm natural attenuation of constituents in this area, and to delineate the extent of groundwater affected with chlorinated VOCs.

3.2.4 East Y-12 Area

The East Y-12 area, including the New Hope Pond and the Union Valley areas, represent the easternmost area of the Y-12 Complex. Affected groundwater in this region extends off of the property into the Union Valley/Scarboro Road area, and, therefore, requires greater monitoring effort in order to support management decisions protective of potential off-site receptors. In all, 54 monitoring locations in the East Y-12 area were evaluated using MAROS. The list of wells considered in this monitoring group is shown in Table B.9 and the approximate extent of the analysis area is shown in Figure A.1.

Constituent Choice

The MAROS Constituent Choice module for the entire area indicates that CTET and PCE are the main VOC constituents of concern (see MAROS COC Reports, Appendix D-7.) Manganese is found above secondary MCL levels, but is not considered a major constituent for the MAROS analysis. For the overall analysis, priority constituents for East Y-12 included CTET, PCE, GA and GB activity. The metals lead, cadmium, and chromium were also included in the analysis, but the majority of exceedances of these compounds occurred prior to 1996. Due to lower mobility, intermittent detections and overall lower concentrations relative to MCLs, metals are not considered as driving the analysis.

The detection of VOCs, metals and radioactive components in the East Y-12 area demonstrates the importance of monitoring a full suite of constituents across the site. A full set of analytes helps to delineate the commingled plumes underlying the easternmost area of the Y-12 Complex.

Moment Analysis

The Moment Analysis was conducted for the CTET plume in the East Y-12 area. Results indicate that the total estimated dissolved mass of CTET (Zeroth Moment) in the plume Increased between 1996 and 2004. This may be due to mobilization of constituent from the source zones after the installation of the extraction well GW-845 in October 2000. First Moment analysis (plume center of mass) indicates a Decreasing trend in the distance of the center of mass from the estimated source (GW-381). The estimated First Moments are illustrated on Figure A.7. Prior to 1998, the center of dissolved mass for CTET ranged between New Hope Pond and east of Scarboro Road (depending on which wells were sampled). After 2000, the center of mass has stayed relatively stationary between New Hope Pond and GW-845.

The First Moment calculations between 2000 and 2004 were performed for a fairly consistent data set including approximately 15 wells for each sample episode. The consistency of the First Moment data are the result of a very good data set for this area for the time interval evaluated. One of the criteria for a useful long-term monitoring network plan is providing a cohesive data set over a long time interval, which includes the same constituents at the same wells.

Moment Type	Carbon Tetrachloride Moment Trend Analysis East Y-12	
	Trend	**Comment**
Zeroth	Probably Increasing	The estimate of total dissolved mass of CTET was found to be Probably Increasing during the sample period 1996-2004.
First	Decreasing	The estimated distance from the source to the center of mass showed a Decreasing trend during the sample period.
Second	Decreasing/ Probably Decreasing	The CTET plume showed Decreasing trends in the distribution of constituents (more mass in the center of the plume relative to the edges).

Second Moment results indicate the relative distribution of mass within the plume. Decreasing trends for the Second Moments show the majority of dissolved mass is in the center of the plume rather than trending to the edge of the plume. With the installation of the extraction well, the plume has become stable to retreating in the New Hope Pond area, even though estimates of the total dissolved mass are Increasing.

Statistical Trend Results

Results of the Statistical Trend analysis are detailed on Table B.9 and summarized in the table above. Increasing concentration trends were found at wells GW-151, and GW-220 for CTET and PCE. These trends may be the result of constituent mobilization caused by groundwater pumping at extraction well GW-845 or shallow groundwater influence of the UEFPC Distribution channel underdrain. However, the Increasing trends in this area of the plume require consistent monitoring effort due to the proximity to the property boundary, and the location within the more transmissive Maynardville Limestone. Because of the Increasing trend in this area, monitoring effort should be focused on monitoring locations immediately downgradient of New Hope Pond and along the Y-12 property boundary adjacent to Scarboro Road.

Monitoring wells GW-750 and GW-735 delineate the northern edge of the CTET plume, downgradient from GW-151 and GW-220. The geology south of these wells is complicated, with monitoring location GW-734, drilled into a subterranean cave, providing little useful data. Well GW-722 is a multi-port Westbay well, which was not included in the MAROS analysis, but should be monitored to track concentration trends in this area of the plume. GW-733 is recommended for Annual sampling in this area, and Annual sampling of GW-722 would create a cohesive data set in this location. Monitoring GW-167 showed no detections of CTET in 1991, when it was last sampled for VOCs. Due to the position of GW-161 and the Increasing trends upgradient, this location is recommended for Annual monitoring until sufficient samples are available to determine if VOC constituents are detected at this location.

Three wells had Probably Increasing trends that did not exceed the screening level for the associated constituent. These wells included GW-385 for lead, GW-746 for chromium and GW-747 for GB activity.

Well Sufficiency

The well sufficiency analysis, which indicates areas of greater concentration uncertainty within the plume, indicated two areas with larger uncertainty. The results of the well sufficiency analysis for CTET are presented in Appendix D.7. An area of larger uncertainty is located between wells GW-747, GW-750, and GW-170. While no new wells are suggested for this area, continued monitoring of these locations and locations in the general area is recommended. The area of higher uncertainty corresponds with the property boundary between the Y-12 Complex and property in Union Valley.

The second area of higher uncertainty is located in the region of wells GW-154, GW-153, and GW-283 (and their associated nested wells). This location corresponds to the western side of the capped New Hope Pond. As mentioned above, the extraction well at GW-845 may be mobilizing constituents through this area. No new wells are recommended, but the area should be monitored regularly to determine concentration trends at these locations.

Sampling Frequency

The MAROS MCES method was use to recommend preliminary sampling frequencies for the locations in the East Y-12 area. Preliminary frequencies are listed in Table B.9 with final recommended sampling frequencies listed in Table B.15. Of the 54 locations used in the analysis, 13 have insufficient data to determine a concentration trend, which is the basis for the sampling frequency recommendation. Many wells with Biennial sampling status may be candidates for removal when sufficient data are collected to confirm that they have attained 'clean' status. The MAROS software tool has an option to evaluate if a well is statistically below MCL using an USEPA statistical protocol (see Data Sufficiency in Section 2.2). When applied to the East Y-12 area, several wells were approaching statistical cleanliness for several compounds. However, in order to establish that a well is clean, there must be a sufficiently large data set for all COCs detected at the well. Data sets with a partial suite of analytes or with large gaps in data collection can present challenges to these types of rigorous statistical evaluations. The Data Sufficiency module in MAROS may provide support for removing statistically unaffected locations from the program after approximately two more years of data are collected.

Wells recommended for Semi-annual sampling include those with Increasing trends for CTET, specifically wells GW-151, and GW-220, and wells with high but variable concentrations of PCE (GW-383). Well GW-154 has an Increasing trend for GA activity and is also recommended for Semi-annual sampling.

The preliminary recommended monitoring network in the East Y-12 area reduces the number of samples collected each year, but increases the number of wells surveyed. This recommendation is possible because the extraction well installed at GW-845 appears to have stabilized the plume substantially. By decreasing the frequency of sampling, the overall cost and effort are reduced, and by increasing the number of wells in the program, the sensitive but extensive geographical area around Scarboro Road can be evaluated.

3.3 Chestnut Ridge Hydrogeologic Regime

The Chestnut Ridge Regime is distinct from the Bear Creek and East Fork Poplar Creek Regimes in terms of both geology and source areas. The Chestnut Ridge Regime is underlain by the Knox Group formation and groundwater below the vadose zone occurs in planar fractures within an impermeable matrix. Groundwater flow in the southern area of the regime is generally to the south. Along the ridge, groundwater flow can be to the east, with radial flow in some locations.

The Chestnut Ridge Regime is one of the least developed areas of the Y-12 Complex, with low levels of VOC, metal, and radioactive constituents. The predominant source areas are a series of landfills and solid waste disposal areas, both historic and active, used to dispose of both construction and hazardous wastes. The Chestnut Ridge Regime was divided into four analysis groups based, roughly, on west to east groupings: the West Chestnut Ridge area contains the United Nuclear Corporation site, the Security Pits area along the ridge, Landfill V and VII, and the East Chestnut Ridge/ Kerr Hollow Quarry area.

Results from the four MAROS analyses for the East Fork Regime are summarized in tables below and discussed in detail in sections 3.3.1 through 3.3.3. Final network recommendations, based on both qualitative and quantitative approaches are presented in Section II, 4.0 and detailed in Table B.16.

Analysis Group	MAROS Results Chestnut Ridge Hydrogeologic Regime			
	Total Number Wells	**Number wells Above Screening Level**	**Priority COCs**	**Moment Analysis (Plume Stability Analysis)**
West Chestnut Ridge	24	3 (12.5%)	None identified by MAROS	Largely unaffected, Stable to Decreasing trends. GB and Ni in some locations.
Security Pits	29	9 (31)	PCE	Variability in total mass and spread results
Landfill V/VII	10	0	PCE	Largely unaffected, Probably Increasing total mass, Stable distribution trends
East Chestnut Ridge	26	3 (15%)	PCE	Largely unaffected, PCE results are for the off-site locations GW-841-844

Analysis areas in the Chestnut Ridge Regime contained relative few sample locations with concentrations above screening levels. The Landfill V and VII area showed no average exceedances. Overall, the Chestnut Ridge Regime is not as heavily impacted as other Y-12 Complex areas. Results from the COC Risk evaluation were used to choose representative constituents for plumes in each sample group. Representative COCs were evaluated using the Moment Analysis module in order to determine the relative stability of the plumes. Due to the low levels of constituents present at these locations, variability in data may be due to concentrations vacillating around the detection limit.

Results for individual sample location trends in each sample group are tabulated below. Both the number of wells in each category and the percentage of total sample group wells in the category are indicated. Sample locations with NT (No Trend) and N/A (insufficient data) designations may benefit from additional sample collection efforts or removal from the program, if they do not provide important information. Locations with stable to decreasing trends (S, PD, D) or non-detect (ND) results may be candidates for reduced sampling effort. Locations with increasing trends (I or PI) should be monitored carefully to determine if the trend indicates an increase in the distribution of the plume.

Analysis Group	**Overall MAROS Trend Analysis Chestnut Ridge Regime**			
	N/A, NT	**PD, D, S**	**I, PI**	**ND**
West Chestnut Ridge	5 (21%)	13 (54%)	3 (12.5%)	3 (12.5%)
CRSP	23 (79%)	4 (15%)	1 (3%)	1 (3%)
Landfills V and VII	0	1 (10%)	1 (10%)	8 (80%)
East Chestnut Ridge	15 (58%)	7 (27%)	0	4 (15%)

Note: Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).

Monitoring Wells	**Network Frequency Analysis Chestnut Ridge Regime**		
	Sampling Frequency	**Number of Wells CY 2004**	**Number of Wells Preliminary Recommendation**
	Remove	--	13
	Quarterly	2	--
	Semi-annual	56	5
	Annual	2	29
	Biennial	0	42
Total Samples (per year)		**120**	**58.5**
Total Wells		59	76

3.3.1 West Chestnut Ridge Area

The West Chestnut Ridge area extends from the crest of Chestnut Ridge in the west, south toward Bethel Valley. The analysis group includes Industrial Landfills II, IV and VI, the United Nuclear Corporation Site, Construction/Demolition Landfill VI and some Oak Ridge Sludge Farm areas. The twenty-four wells included in this analysis group are listed in Table B.10 and the approximate extent of the analysis area is indicated in Figure A.1 and well locations are identified in Figure A.4.

Constituent Choice

The MAROS Constituent Choice module for the West Chestnut Ridge area did not indicate any priority constituents above screening levels on an area-wide level. Target constituents were identified for each individual location based on historic detections. Specific locations have historically exceeded screening levels for GA and GB activity, including uranium as well as nickel and lead. Unlike areas in the Bear Creek and East Fork Regimes, no single dominant plume or plumes are located in the West Chestnut Creek area. GA activity is the primary constituent at 12 locations in the area, and was chosen for review using the Moment Analysis tool.

Moment Analysis

The Moment Analysis was conducted for GA activity in the West Chestnut Ridge area. Estimates of total dissolved activity (Zeroth Moment) Decreased between 1996 and 2004. First Moments (center of mass) for the plume were Stable during this time period. Second Moments, which describe the distribution of mass within the plume showed Stable to No Trend results. The estimate of Moments provides evidence of the overall stability of this plume.

Moment Type	**Gross Alpha Activity Moment Trend Analysis West Chestnut Ridge**	
	Trend	**Comment**
Zeroth	Decreasing	The estimate of total dissolved mass of GA was found to be Decreasing during the sample period 1996-2004.
First	Stable	The estimated distance from the source to the center of mass showed a Stable trend during the sample period.
Second	Stable/No Trend	The GA plume showed Stable to No Trend in the distribution of constituents.

Statistical Trend Results

Results of the Statistical Trend analysis are shown in Table B.10 and illustrated on Figure A.9. The statistical trend is a combination of the Mann-Kendall statistical analysis and the Linear Regression method. Of the 24 wells analyzed, only one location had insufficient data to determine a trend. A total of eight locations showed Decreasing trends for the priority constituent, and of these, none had average constituent concentrations above the screening levels. No locations showed Probably Decreasing trends.

Stable to non-detect (ND) trends were found at an additional six sample locations, including two springs analyzed (SCR2.1SP and SCR2.2SP). Fifteen of 24 sample locations showed Stable, Decreasing or non-detect results. These results support the stability of the plume, and indicate that the monitoring effort can be reduced in these locations.

Well locations GW-203 and GW-205 on the southern edge of the area showed Probably Increasing trends for GA and GB activity. Nearby location GW-221 showed No Trend for GA activity. However, these locations did not have concentrations above screening levels, and detections may not be significant. Location GW-305 showed an Increasing trend for nickel, the primary constituent, as well as 111TCA. GW-305 is located in Industrial Landfill IV area and surrounding wells did not indicate increasing nickel concentrations.

Well Sufficiency

Well sufficiency analyses were inconclusive for the West Chestnut Ridge group. As concentrations do not exceed reasonable background in many locations, no new wells are recommended and locations chosen for removal from the monitoring program were chosen by qualitative analysis.

Sampling Frequency

The MAROS recommendations along with a qualitative analysis indicate that sampling frequency can be reduced for most wells from semi-annual to annual or biennial frequency. Because many of these wells are included in regulatory programs, actual reduction in sampling frequency may not be possible. However, for the majority of the area, additional monitoring above that needed for regulatory compliance does not appear to be necessary.

Preliminary sampling frequency results are shown on Table B.10. The final recommended sampling frequency is listed in Section II, 4.0 and on Table B.16 and illustrated on Figure A.9.

The recommended level of monitoring effort in this location is essentially for Biennial sampling (30 wells). Locations recommended for Annual monitoring include those with Probably Increasing trends or with average concentrations close to screening levels.

3.3.2 Security Pits Area

The Chestnut Ridge Security Pits (CRSP) are located on the crest of Chestnut Ridge and consist of a series of trenches that received hazardous wastes until the mid-1980's. The Security Pits analysis area extends from the crest of Chestnut Ridge directly south of the Central Y-12 Complex (East Fork Regime) to the Filled Coal Ash Pond, down to Rogers Quarry. The analysis group consisted of 29 sample locations, which are listed on Table B.11 and illustrated on Figures A.1 and A.4.

Constituent Choice

The MAROS Constituent Choice module identified PCE and 1,1-DCE as priority constituents for the Chestnut Ridge Security Pit analysis group (see MAROS COC Assessment Report in Appendix D.9). However, these constituents were not detected widely (for PCE only 9 out of 29 wells exceeded the screening level) or at high concentrations.

Moment Analysis

The Moment Analysis was conducted for PCE in the Security Pit area. Estimates of total dissolved mass of PCE showed No Trend between 1996 and 2004, indicating variability in the data (high coefficient of variation). First Moments (center of mass) for the plume were Stable during this time period. The trend in First Moment locations shows that the center of mass moves around on the ridge, perhaps in response to the number and identity of wells sampled during each event or due to variability in low to non-detect concentrations encountered. Second Moments, which describe the distribution of mass within the plume showed No Trend results. Because concentrations of PCE are relatively low in the plume, small changes in concentrations can result in higher variation in the data. The estimate of Moments provides evidence of the general stability of the plume.

Moment Type	PCE Moment Trend Analysis CRSP	
	Trend	**Comment**
Zeroth	No Trend	The estimate of total dissolved mass of PCE was found to be No Trend during the sample period 1996-2004.
First	Stable	The estimated distance from the source to the center of mass showed a Stable trend during the sample period.
Second	No Trend/No Trend	The GA plume showed Stable to No Trend in the distribution of constituents.

Statistical Trend Results

Results of the Statistical Trend analysis are shown on Table B.11. The statistical trend is a combination of the Mann-Kendall statistical analysis and the Linear Regression method. Of the 29 wells analyzed, 21 locations had insufficient data to determine a trend. Based on historic data, nine locations exceeded the screening level for at least one constituent. Of locations with historic exceedances, six had insufficient recent data to determine a trend. Among the eight locations with sufficient data to determine a trend, two locations had Decreasing concentrations trends, GW-609 and GW-831. Locations GW-175 and GW-608 had Stable trends for PCE. Sample locations GW-609 and GW-175 have average concentrations above screening levels. No Trend was found at spring location SCR3.5SP, with concentrations well below screening levels, and GW-612 with concentrations above screening levels. Well GW-177 had non-detect values.

Spring location SCR3.4SP indicated a Probably Increasing trend for GA activity, but this appears to be an artifact of GA activity detection limits and background concentrations. For the data that are available, constituent trends in the Security Pit area appear to be Stable to Decreasing.

Well Sufficiency

The results of the Well Sufficiency analysis for the Security Pits indicated one area of larger uncertainty in the 11-DCE plume on the crest of Chestnut Ridge in the area of the Security Pit trenches (see MAROS Well Location Report Appendix D.9). No new wells are recommended in this area.

Sampling Frequency

The MAROS recommendations along with a qualitative analysis indicate that sampling frequency can be reduced for most locations from semi-annual to annual or biennial frequency. Because several of the wells with sufficient data are included in regulatory programs, actual reduction in sampling frequency may not be possible. However, for the majority of the area, additional monitoring above that for regulatory compliance does not appear to be necessary.

The preliminary recommended sampling frequency is listed in Table B.11. The preliminary frequency does not take regulatory status into account. The recommended changes reduce the frequency for area wells, but the number of wells monitored increases. The majority of wells with Biennial sampling frequency recommendations can be reevaluated after sufficient data have been collected and reduced in frequency or removed from the monitoring program.

3.3.3 Landfill V and VII

The Landfill V and VII analysis group encompasses monitoring locations for Industrial Landfill V, construction/Demolition Landfill VII, and South Side of Chestnut Ridge. The analysis group was small, including only 10 sample locations. Well descriptions are provided on Table B.12 with locations shown on Figure A.1.

Constituent Choice

The MAROS Constituent Choice module for the Landfill V area identified lead as the only constituent with a representative concentration over screening levels (see MAROS COC Assessment Report in Appendix D.10). Individual well constituent choice indicated that PCE has historically been present at several locations. However, in the time frame of 1996 to 2004, eight of 10 wells had non-detect results for PCE, and no detections of metals above reasonable background values. For all wells in the assessment group, none had average concentrations of the priority constituent over the screening level.

Moment Analysis

While Moment analyses were conducted for the Landfill V and VII area, concentrations are so low that there is very little change in trend to be detected. The estimate of total dissolved mass for PCE showed a Probably Increasing trend, due to increases at well GW-798, the only well with detections of PCE and an Increasing concentration trend.

Trends in estimated First and Second Moments were Stable during the time frame analyzed. This is consistent with the observation that concentrations are increasing at only one well in the network.

Moment Type	PCE Moment Trend Analysis Landfill V and VII	
	Trend	Comment
Zeroth	Probably Increasing	The estimate of total dissolved mass of PCE was found to be Probably Increasing during the sample period 1996-2004.
First	Stable	The estimated distance from the source to the center of mass showed a Stable trend during the sample period.
Second	Stable/ Stable	The PCE plume showed Stable trends in the distribution of constituents.

Statistical Trend Results

Results of the Statistical Trend analysis are shown on Table B.12. All wells included in the analysis had sufficient data to analyze trends. Eight of ten wells had no detections of priority constituents and are apparently unaffected. None of the locations had average concentrations above screening levels. Two wells had constituent detections and subsequent trends. Well GW-798, north of Construction/Demolition Landfill VII has an Increasing trend for PCE. The source of PCE in this area is most probably the Security Pits upgradient of the landfill. The second well with a detected trend was GW-797, which showed a Decreasing trend for lead.

Well Sufficiency

Due to the size of the analysis group, the Well Sufficiency module was not run on the data set.

Sampling Frequency

The MAROS preliminary recommendations along with a qualitative analysis indicate that sampling frequency can be reduced and many wells can be removed from the routine monitoring program. All sample locations in the Landfill V and VII group are currently covered by regulatory programs; however, locations were considered for modified sample frequency as part of the larger analysis. The final sampling recommendation is to sample as per permit requirements.

3.3.4 East Chestnut Ridge

The East Chestnut Ridge area includes monitoring locations in the eastern portion of the Chestnut Ridge down to Bethel Valley. The analysis group consists of 26 sample locations listed in Table B.13 and illustrated on Figure A.1.

Constituent Choice

The MAROS Constituent Choice identified TCE as the only priority COC in this area (see MAROS COC Assessment Report in Appendix D.10). TCE is found in wells south of the Y-12 Complex in the Scarboro facility wells GW-841 to GW-844. As these wells were included in the database, they were evaluated along with the Y-12 locations. Individual well Constituent Choice indicated that GA activity and lead have historically been present at several locations. A review of the data indicates that there have been some historic data outliers for uranium at two wells. Single uranium detections were not repeated in subsequent sample events. For the majority of locations, no COCs were present with average concentrations above screening levels.

Moment Analysis

Because individual constituents are not distributed widely across the East Chestnut Ridge, the Moment Analysis was not significant to the LTMO in this area. TCE, the priority constituent for East Chestnut Ridge, is found in the offsite wells GW-841 through 844, so, an analysis of this constituent would not provide the scale of information necessary to support sampling recommendations across the site.

Statistical Trend Results

Results of the Statistical Trend analysis are shown on Table B.13 and illustrated on Figure A.9. Fifteen of 26 wells included in the analysis had sufficient data to analyze trends. Of these locations, six had Decreasing concentration trends. Well GW-841, with average concentrations of TCE above screening levels, displayed a Decreasing trend. GW-841 is part of a cluster of wells near south of the Chestnut Ridge area that does not appear to be connected to source areas in the Chestnut Ridge area. Other wells in this cluster had non-detect results (GW-844), No Trend results (GW-842) and insufficient data results (GW-843). Because of the diversity of constituents and trends, wells in this area may require more monitoring attention than in other areas of Chestnut Ridge.

Monitoring locations GW-231, GW-142, and GW-143 in the Kerr Hollow Quarry area had Decreasing concentration trends, and did not exceed screening levels. Well GW-145, also in the Kerr Hollow area had a Stable concentration trend. No wells with Increasing or Probably Increasing trends are located in this area. Constituent concentrations are low to non-detect and concentration trends indicate that limited monitoring effort is required.

Well Sufficiency

Well Sufficiency analyses for the East Chestnut Ridge area did not result in locations identified as exhibiting high uncertainty. No new monitoring locations are recommended.

Sampling Frequency

The MAROS recommendations along with a qualitative analysis indicate that sampling frequency can be reduced and in the East Chestnut Ridge area. However, the majority of sample locations are included in regulatory programs. All wells that are included in regulatory programs have been retained, but the preliminary sampling frequency recommendations are listed in Table B.13 with final recommendations listed in Table B.16.

4.0 Combined Qualitative and Quantitative Analysis

Results from the qualitative well scoring detailed in Section I were combined with results from the quantitative MAROS analysis in a decision logic format to develop recommendations for sample locations and frequencies for the Y-12 Complex. The decision logic flow chart is illustrated in Figure A.10. Wells identified in RCRA post-closure permits, specified in CERCLA interim or final RODs or related decision documents, or SWDF permits have sampling frequencies that cannot be altered. These regulated wells are recommended for the sampling frequency specified in the decision document; however, a preliminary sampling frequency recommendation can be found for these locations in Tables B.3-B.13. Final recommendations by regime are detailed in Tables B.14-B.16.

Remaining sample locations were evaluated based on whether the average concentration of the priority constituent exceeds the screening level shown in Table B.1. Wells with average concentrations exceeding screening levels were separated into two groups, those with sufficient sample data to determine a concentration trend between 1996 and the present and those with insufficient data. For wells with elevated average concentrations and sufficient data for the MAROS evaluation, the preliminary MAROS sampling frequency was used as the basis for the final recommendation. For locations with less than 4 sample events since 1996, the recommendation is to review the reasons why the locations have not been sampled. Locations that do not provide useful data, either because of well construction or other issues should be removed from the analytical program. For functional sample locations, four data points after 1996 should be collected, and the trend data should be reevaluated. If constituent concentrations are stable to decreasing, or if concentrations are significantly below MCLs, then consider removing the well from the routine analytical program. Redundant source monitoring locations may also be identified and removed from the analytical program, however, fulfilling minimum requirements for trend evaluation is recommended before removal.

Sample locations with concentrations consistently below MCLs required careful consideration. The qualitative data were used to identify wells that function to monitor source areas or provide horizontal or vertical plume delineation. Low concentration wells that did not have an identified function in the network were recommended for removal from the analytical program.

Remaining sample locations with an identified function in the network were carried forward for a more quantitative function score. Locations were scored based on the formation sampled and secondary location characteristics. Springs were assigned 5 points in a scoring system, while aquifer (Maynardville Limestone) locations were assigned 3 points and aquitard wells were assigned 1 point. Exit location wells were assigned an additional 3 points. Wells with unique function and those that provide early detection for constituent mobility or information on background water quality were each assigned 1 additional point.

Sample locations with a score of 5 or more and with sufficient data (>=4 samples 1996 to present) to determine a trend with MAROS were assigned a MAROS based sampling frequency based on the preliminary sampling frequency. Locations with a score of 5 or higher with insufficient data are recommended for further evaluation or removal as described above. Sample locations with a score below 5 were considered to provide limited data to support monitoring objectives. Locations with low scores and sufficient data to determine a trend were assigned a reduced monitoring schedule based on the MAROS analysis. Locations with insufficient data and low scores were recommended for removal from the network. Most low scoring locations may be considered for removal in the future.

Results from the decision logic process are summarized below and presented in Tables B.14-B.16. Total samples per year and Total wells include those locations recommended for Quarterly, Semi-annual, Annual or Biennial sampling frequency that are not included in a regulatory program. Sample locations in these categories are recommended for inclusion in the GWPP to meet site-wide monitoring objectives. Wells in the Review category may be included in the GWPP based on their status and as budget considerations allow. Review locations with high scores (>5) and concentrations above screening levels constitute higher priority locations. Detailed recommendations for Review locations are given in Tables B.14-B.16.

Locations identified as Regulated are normally included in the WRRP monitoring program or are the responsibility of the BJC subcontractors. Individual Regulated locations may be sampled by the GWPP if supplemental information on specific groundwater areas is desired. Locations identified under the Remove category can continue as hydrologic monitoring locations and possible alternate sampling locations if plume conditions change.

Decision Results	**Sampling Frequency Results**		
	Bear Creek	**East Fork**	**Chestnut Ridge**
Remove	48	58	24
Review	52	31	6
Regulated	35	33	45
*Quarterly**	0	0	0
Semi-annual	14	6	0
Annual	24	25	5
Biennial	10	17	9
Total Samples (per year)*	**57**	**45.5**	**9.5**
Total Locations*	**48**	**48**	**14**
Total Samples CY 2005 Plan	142	64	10
Total Locations CY 2005 Plan	45	32	5

* Includes Quarterly, Semi-annual, Annual and Biennial recommendations, wells under Review will increase this number.

5.0 SUMMARY AND RECOMMENDATIONS

The current Y-12 Groundwater Protection Program (GWPP) is charged with fulfilling surveillance monitoring objectives as articulated in DOE Order 450.1 (USDOE, 2004). The Order requires that each DOE site implement an environmental management system that "provides for systematic planning, integrated execution, and evaluation of programs that ensure public health and environmental protection, pollution prevention, and compliance with DOE Directives and applicable laws and statutes" (USDOE, 2004). The current GWPP strives to achieve specific regulatory goals by monitoring a system of groundwater wells and springs on a largely semi-annual basis, maintaining an extensive database on site parameters, and documenting monitoring results in annual and supplemental reports.

5.1 Monitoring Program Evaluation

The groundwater monitoring network at the Y-12 Complex is extensive and has achieved a high level of site characterization. Based on the methods of collection, analysis and data management, and the quality and quantity of groundwater data collected, the monitoring network is sufficient to evaluate plume behaviors in the near and long term. While final remedial decisions are pending for some areas in the Y-12 Complex, the current GWPP database has sufficient data to perform a formal long-term monitoring optimization (LTMO) in order to improve data collection in support of the stated monitoring objectives and pending site management decisions. An on-going systematic and coordinated system of qualitative and quantitative analyses is applied to optimize the current monitoring network.

Groundwater sample collection and handling methods are appropriate to the scale of the Y-12 Complex network. Sample collection has been scheduled efficiently to take advantage of labor and laboratory resources. Low-flow sample techniques currently employed are appropriate for the majority of sample locations. Wells where purge techniques provide better quality data should be sampled using this method; however, dual sampling using both methods is redundant and does not directly support monitoring objectives.

The laboratory analysis program has delivered high quality data for the GWPP since approximately 1996. Current laboratory practices as articulated in site documents and as evidenced in the GWPP database meet applicable data quality objectives. While data analyzed before the mid-1990's may have met all of the data quality objectives at the time, detection limits, analytical methods and standards, as well as sampling protocols may have changed since the 1980's, in particular. Data collected before 1996 may be extremely useful, but caution should be exercised in making direct comparisons between historic and recent data sets.

Based on the objectives articulated in DOE 450.1, it is recommended that the GWPP continue to monitor the standardized suite of analytes for each sample taken. Standardizing the parameter list and analytical methods will provide consistency across the data set, and streamline plume analysis. The Y-12 Complex is underlain by numerous commingled plumes, where source and tail areas of one plume merge with elements of another. The benefit of a complete constituent list is that conservative constituents (like metals) and constituent ratios can be evaluated to support plume migration analysis, mass flux evaluations, MNA determinations and possible groundwater modeling efforts. Consistent analytical methods will help develop a data set where data from diverse sources are comparable. The benefits derived from reducing uncertainty about constituent delineation outweigh potential cost savings from a limited suite of analytes.

One minor constituent of possible concern that should be included in the monitoring program is 1,4-dioxane. 1,4-Dioxane was a common chemical stabilizer in commercial 111TCA preparations, and has become a concern among the regulatory community (Spath and Alexeeff 1998) with an PRG of near 3 ppb. 1, 4-Dioxane is more mobile than the chlorinated co-constituents and should be analyzed for downgradient of areas where 111TCA, 1,1-dichloroethene (11DCE) or 1,1-dichloroethane are detected.

Based on a review of the Y-12 GWPP Data Management Plan (BWXT, 2003a) and an interview with the data management team, the analytical data management system is of excellent quality. The current Analytical Data Management System (ADMS) and Groundwater Information Management System (GIMS) satisfy data management quality objectives articulated in the documents such as the ASCE Long-Term Groundwater Monitoring document (ASCE, 2003). Early review of data points from the laboratory using an automated system is especially important. Cooperation between the WRRP and GWPP programs in terms of data collection and management should continue.

While site reports are clear and well written, reporting activities would benefit from expanded data visualization techniques. More emphasis should be place on map development. The GWPP would benefit from improving the link between its extensive database and a geographic information system for the purpose of both data analysis and reporting.

The technical approach for improving the efficiency of the Y-12 GWPP monitoring network included both qualitative and quantitative evaluation strategies. The product of the qualitative hydrogeologic analysis for individual wells includes specific information on how each well functions to fulfill the monitoring objectives for the various groundwater flow regimes and constituent classes. Data from the qualitative approach were combined with the results of the quantitative analysis in the form of a decision logic flow chart (see Figure A.10) to determine the final temporal and spatial well network.

5.2 Quantitative Network Evaluation

The MAROS 2.1 sampling optimization methodology was applied to the groundwater monitoring network for the Y-12 Security Complex in Oak Ridge, Tennessee. The statistical analytical results of the MAROS evaluation provide the foundation for recommendations to improve the spatial and temporal groundwater monitoring network while supporting the surveillance monitoring objectives articulated in DOE Order 450.1. Results of this qualitative analysis were combined with those of the quantitative analysis to develop an optimized network sampling recommendation.

The optimization of the current monitoring network was achieved through choices in sampling frequency and sampling locations that minimized uncertainty as well as redundancy of constituent concentration information. Additionally, identified concentration trends and calculated Moments highlight areas of the plume that require greater or reduced monitoring effort.

Due to the presence of commingled plumes from diverse sources and multiple hydrogeologic regimes, the quantitative analysis was performed by dividing site locations into eleven MAROS analysis groups. Plume level priority constituents were identified by the MAROS COC Risk Evaluation module. Plume level priority COCs were used as representative compounds for evaluating overall plume stability using the Moment Analyses and Well Sufficiency tool. Plume level priority constituents included PCE, TCE, CTET, benzene, GA and GB activity, uranium and nitrate. Priority constituents of concern were identified for each monitoring location based on the magnitude of the exceedance of average constituent concentrations relative to screening levels. Individual well priority COCs were used to evaluate statistical trends and sampling frequencies for each location.

Preliminary recommendations for sample locations and frequencies were developed using the MAROS software. These recommendations were brought into a decision logic flow tool along with a location scoring system based on the qualitative well evaluation. Final location and sampling recommendations resulted from the decision logic step. Results of the quantitative and decision logic analyses for each Regime are presented below.

5.2.1 Bear Creek Hydrogeologic Regime

A total of 183 monitoring locations were evaluated in the Bear Creek Regime. The majority of these locations are in the expansive western BCBG area. The Bear Creek Regime contains two main sources of constituents, the former S-3 ponds that are the source of nitrate and radionuclides to the transmissive Maynardville Limestone, and former waste management units in the Nolichucky shale aquitard where chlorinated solvents and some radioactive migrate to the Maynardville formation. Among the 183 possible monitoring locations, 110 locations had limited recent data (fewer than 4 sample events 1996 to 2004) to determine their contribution to the monitoring network. Without a sufficient data set, no quantitative conclusions could be drawn about concentration trends, and recommendations for sample frequency could not be made using MAROS methodology.

Overview statistics (Moment and Statistical Trend analyses) for the Bear Creek regime indicate that the BCBG and West S-3 areas are largely Stable for the two main plumes. Statistical trend analysis indicates that 29 of 73 locations with sufficient data to determine a trend have Stable to Decreasing concentrations. Only one well in the heavily affected West S-3 area had an Increasing trend. Moment analyses do not indicate that plumes are trending downgradient in the recent time frame. The OLFA analysis area, located in the center of the main Bear Creek plume, shows greater variability in concentrations than both the source and tail regions. At the overview level, the plumes have largely stabilized and planning for a reduced long-term monitoring network is appropriate.

Well Sufficiency analyses for Bear Creek do not reveal any extremely large areas of uncertainty in the plume, indicating that no new wells are necessary. The frequency determination using the MCES method indicates that reduced sample frequency is appropriate for most wells.

Using the combined quantitative and qualitative approach, sampling recommendations were made for 183 locations. Locations covered by regulatory permits or agreements (35) should be sampled according to the regulatory driver (permit, ROD, etc.). However, preliminary sampling recommendations have been made for these locations in the event permits are renegotiated. Forty-eight sample locations are recommended for removal from the analytical network. These wells can be maintained as hydrogeologic monitoring locations.

Fifty-two of the 183 sample locations in the Bear Creek Regime are recommended for review. Sample locations with limited history should be reviewed for function or construction defects. Locations that do not provide quality, representative analytical data should be designated as hydrogeologic monitoring locations, moved to inactive status or plugged and abandoned. For sample locations with limited recent data or for wells that are approaching 'clean' status, the recommendation is to collect samples over the next two years to provide between 4-6 recent data points. All active analytical locations should maintain between 4-6 consistent sample events in a ten-year time frame to evaluate concentrations using statistical tools. Results of the statistical tools can be used to recommend updated sampling frequencies for these locations

No wells are recommended for quarterly sampling. Fourteen locations with Increasing trends or average concentrations above screening levels are recommended for Semi-annual sampling. Annual sampling is recommended for 24 locations. The majority of perimeter wells are recommended for Biennial (every 2 years) sampling. In all, 10 locations are recommended for Biennial sampling.

5.2.2 Upper East Fork Poplar Creek Hydrogeologic Regime

The Upper East Fork Poplar Creek Regime is the most intensely developed area of the Y-12 Complex. The region is characterized by diverse sources from historic underground storage tanks, influx from the former S-3 Ponds and current industrial activity. The western area of the regime is impacted by constituents originating in the S-3 and S-2 sites, and groundwater concentrations of nitrate and GA and GB activity (and associated isotopes) is quite high in areas. The Central Y-12 analysis area is complicated by multiple small sources of VOCs as well as impacts from the S-3 area. The East Y-12 area, including the New Hope Pond area and Union Valley analysis group represents the only area where affected groundwater migrates off-site. The presence of affected groundwater off-site raises the priority of monitoring in this location.

A network of 171 sample locations was examined quantitatively in the East Fork Regime. Of the wells analyzed, 74 locations had insufficient data to make a quantitative recommendation for sample frequency. Overview statistics for the East Fork regime indicate that the nitrate and uranium/GB activity in the western area of the plume is largely Stable. Individual well trends in the western East Fork are Decreasing to Stable with many wells trending toward non-detect status. VOC constituents in the western area of East Fork also appear to have Stable to Decreasing trends supporting the reduction in sample effort over this region. The area around the former Fuel Station also has Stable to Decreasing trends with many locations close to non-detect status.

The East Y-12 area requires careful monitoring due to the presence of affected groundwater off-site. With the installation of an extraction well in the year 2000, the VOC plume in this area has stabilized. The area just south and east of New Hope Pond has some monitoring locations with Increasing trends (GW-220, GW-151 and GW-150), but the First Moment analysis indicates that the center of mass is retreating in this area. The extraction well appears to be controlling migration of constituents downgradient.

The Well Sufficiency analysis indicated some areas of uncertainty between the region of high CTET concentration in the New Hope Pond area and the wells that monitor the property boundary. While no new well locations are recommended in this area, continued monitoring of representative property boundary wells (GW-735, GW-747, and GW-748) is recommended. The overall recommended approach of reducing the frequency of well sampling in favor of monitoring more locations should increase confidence in the delineation of constituents in these locations.

Of the 171 locations evaluated in the East Fork Regime, 33 are covered by regulatory permits. One well (GW-845) is an extraction location, and is monitored as part of the groundwater extraction remedy. Fifty-eight locations are recommended for removal from the analytical monitoring network. Thirty-one locations are recommended for review (as described under the Bear Creek Regime). Routine monitoring is recommended for 48 locations with 6 locations suggested for Semi-annual monitoring, 25 locations for Annual monitoring and 17 locations for Biennial monitoring. The multi-port Westbay well GW-722 is recommended for annual sampling.

5.2.3 Chestnut Ridge Regime

The Chestnut Ridge Regime is the least affected area at the Y-12 Complex. The ridge is underlain by the Knox Group formation which consists of groundwater flowing through fractures and solutionally enlarged conduits in an impermeable matrix. A network of 89 sample locations was examined in this area. There are very few constituents detected in this area. VOCs are detected in the Chestnut Ridge Security Pit (CRSP), but the majority of sample locations across the Regime are below screening levels.

In contrast to the other hydrogeologic regimes, wells in the Chestnut Ridge regime are very well sampled with data for as many as 20 sample events since 1996. Sampling frequency for most wells is determined by regulatory agreement or permit. The well network in Chestnut Ridge functions for detection monitoring rather than compliance monitoring. Because of the strong recent sampling record, statistical trends and MCES sampling frequencies could be determined for most locations. Statistical trend analyses indicate many locations with Decreasing, Probably Decreasing, and Stable trends in addition to those with non-detect results.

Sample frequency results indicate that the majority of locations should be sampled with reduced frequency. Forty-five of the 89 locations in the Chestnut Ridge Regime function as compliance points for regulatory programs and semi-annual sampling is mandated at most of these locations. Reduction in sample frequency at these locations may not be possible in the near term. The evaluation indicated that roughly 24 locations could be removed from the program without loss of information. Six locations are recommended for review. Biennial sampling is recommended for nine locations. Locations recommended for Annual sampling include wells in the CRSP area. No wells specific to the surveillance program are recommended for Semi-annual monitoring. The Chestnut Ridge regime appears to require limited monitoring effort relative to the other hydrogeologic regimes.

5.3 Conclusion

The monitoring network at the Y-12 Complex is very extensive and has achieved a high level of site characterization. Based on the quality and quantity of groundwater data collected, the monitoring network is sufficient to evaluate plume behaviors in the near and long term. Many active monitoring locations in the extensive network may provide redundant or irrelevant information, however, an on-going systematic and coordinated system of qualitative and quantitative analysis should be applied to eliminate redundant locations. Part of this systematic approach is to collect at least four samples in a ten-year time frame for wells targeted for future removal from the program.

The current well network appears to provide accurate and reliable information on plume behavior. However, effort should be directed at reducing the sample frequency and collecting information from a wide variety of locations in the future.

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**ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE**

Y-12 National Security Complex
Oak Ridge, Tennessee

APPENDIX A: FIGURES

LEGEND

Sample Locations by MAROS Analysis Group

Bear Creek Regime
- BCBG
- OLFA
- West S-3

Chestnut Ridge Regime
- West Chestnut Ridge
- CRSP
- Landfills V & VII
- East Chestnut Ridge

Upper East Fork Regime
- East S-3
- Central Y-12
- Fuel Station
- East Y-12

Notes:

1. BCBG = Bear Creek Burial Grounds
   OLFA = Oil Landfarm WMA
   CRSP = Chestnut Ridge Security Pits
2. Sample locations are those with analytical data from the BWXT Y-12 Analytical database (1986-2004).

SCALE (Feet)
0 1,250 2,500

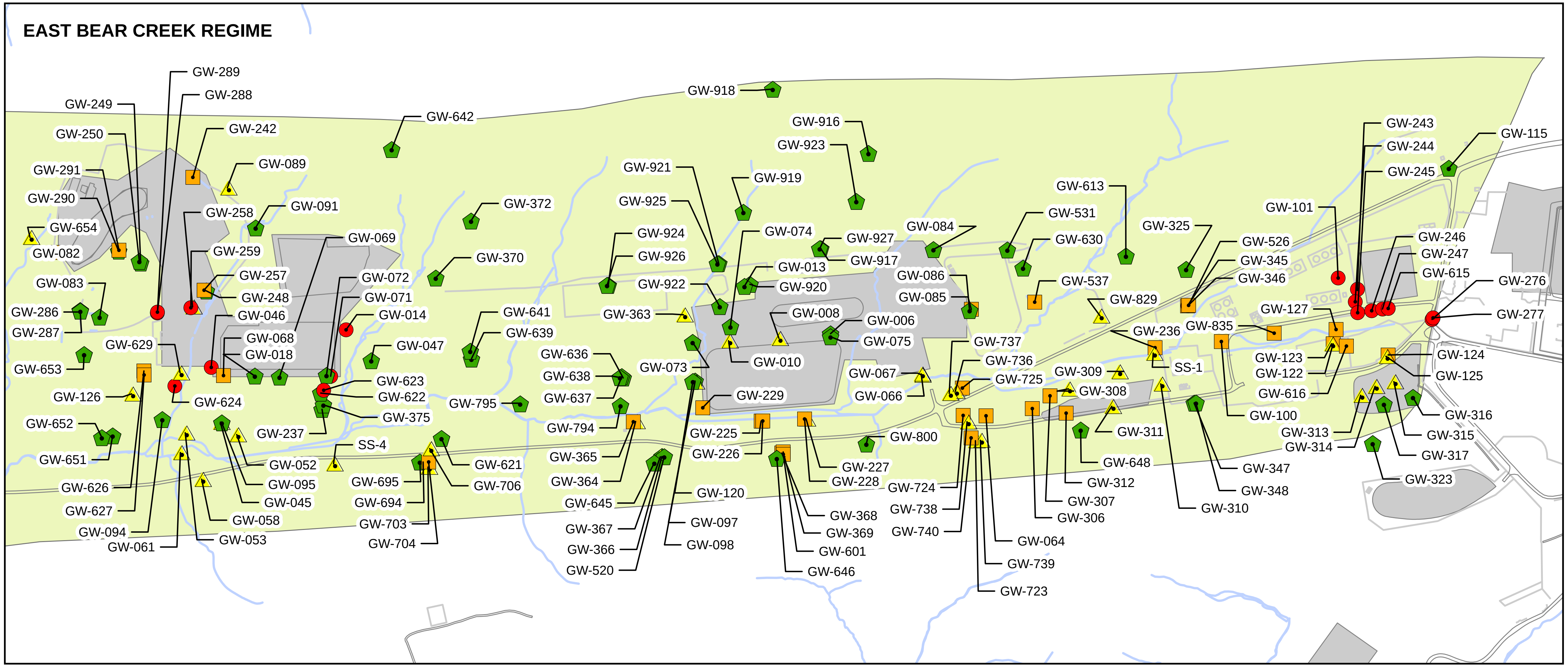
GROUNDWATER SERVICES, INC.

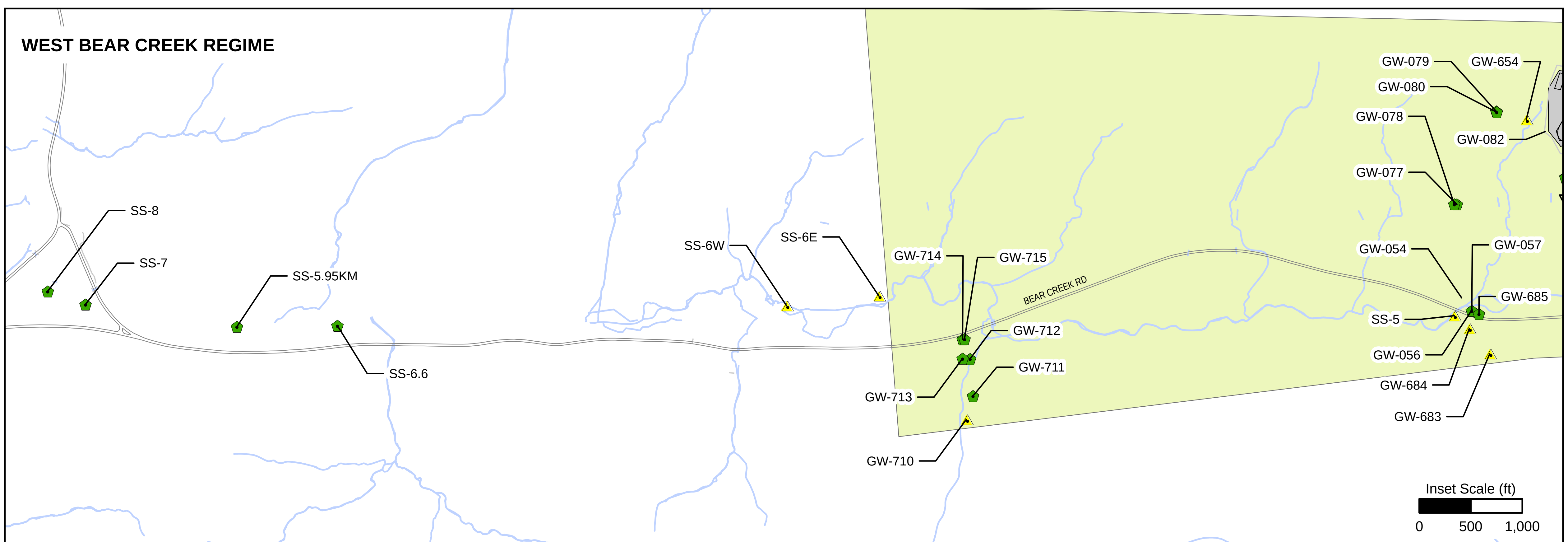
MAROS ANALYSIS SAMPLE LOCATIONS

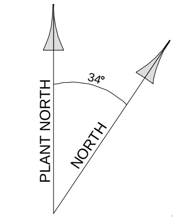
Bear Creek/Chestnut Ridge/Upper East Fork Hydrogeologic Regimes Sample Locations

Oak Ridge, Tennessee

GSI Job No:	G-3038	Drawn by:	CDM
Issued:	12/12/2005	Chk'd by:	MV
Revised:		Appv'd	MV
Scale:	As Shown		FIGURE A.1







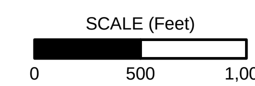
LEGEND

Priority Constituent

- > 100X MCL
- > 10X MCL
- > MCL
- > DL and < MCL
- Site Buildings, Features or Sources
- Bear Creek Regime

Note:

1. Symbols represent the highest normalized average concentration (concentration/MCL) at each active location for an individual constituent.
2. Sample locations from BWXT Y-12 Analytical Database (GIMS) for locations in the Bear Creek Hydrogeologic Regime.



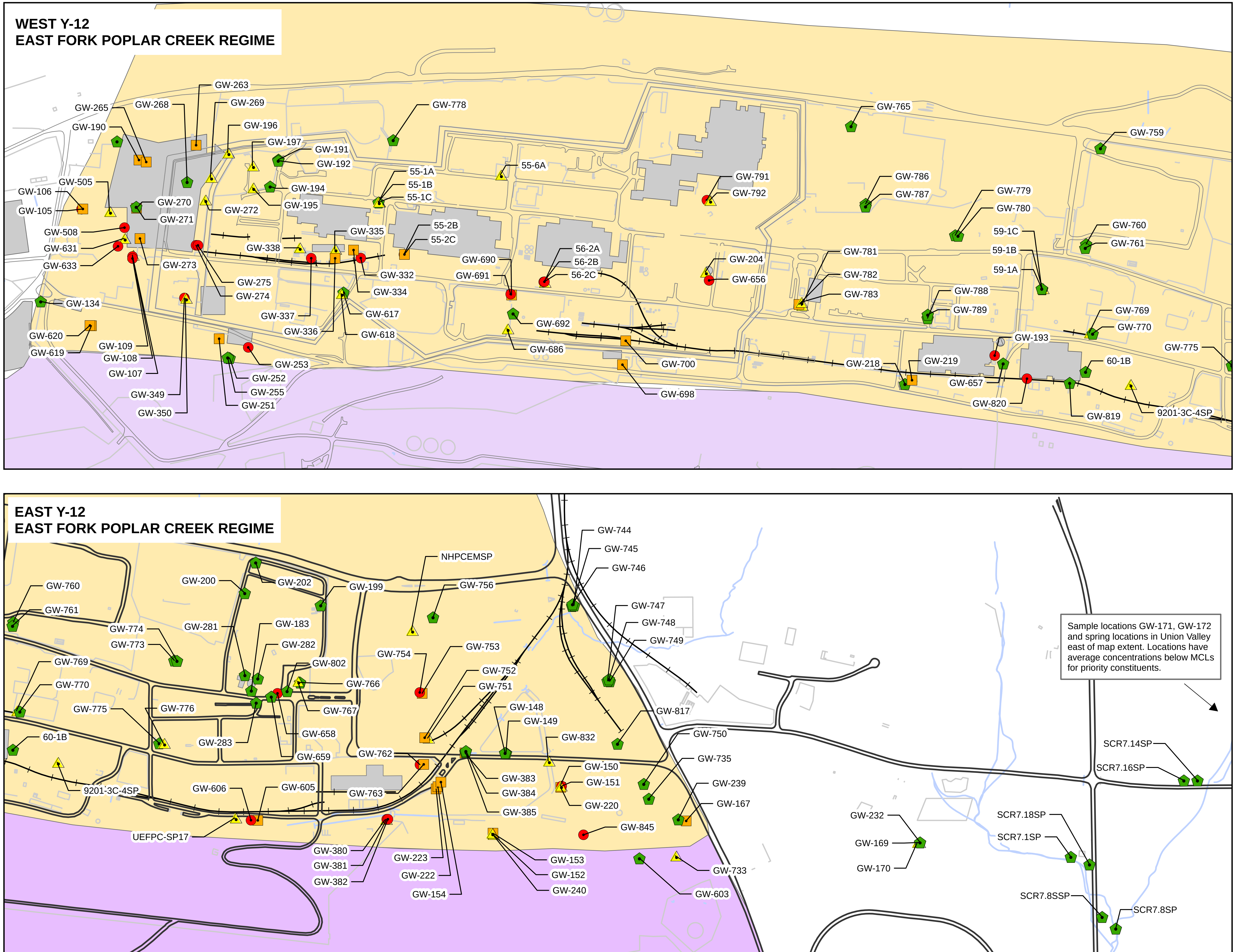
GROUNDWATER SERVICES, INC.

BEAR CREEK REGIME
EXCEEDANCE OF SCREENING LEVELS
FOR PRIORITY CONSTITUENTS

Y-12 National Security Complex

Oak Ridge, Tennessee

GSI Job No:	G-3038	Drawn by:	CDM
Issued:	12/12/2005	Chk'd by:	MV
Revised:		Appv'd	MV
Scale:	As Shown		FIGURE A.2



PLANT NORTH
NORTH
34°

LEGEND

Priority Constituent

- > 100X MCL
- > 10X MCL
- > MCL
- > DL and < MCL

- Site Buildings, Features or Sources
- Upper East Fork Regime
- ChestnutRidgeRegime

Note:

1. Symbols represent the highest normalized average concentration (concentration/MCL) at each active location for an individual constituent.
2. Sample locations from BWXT Y-12 Analytical Database (GIMS) for locations in the Upper East Fork Hydrogeologic Regime.

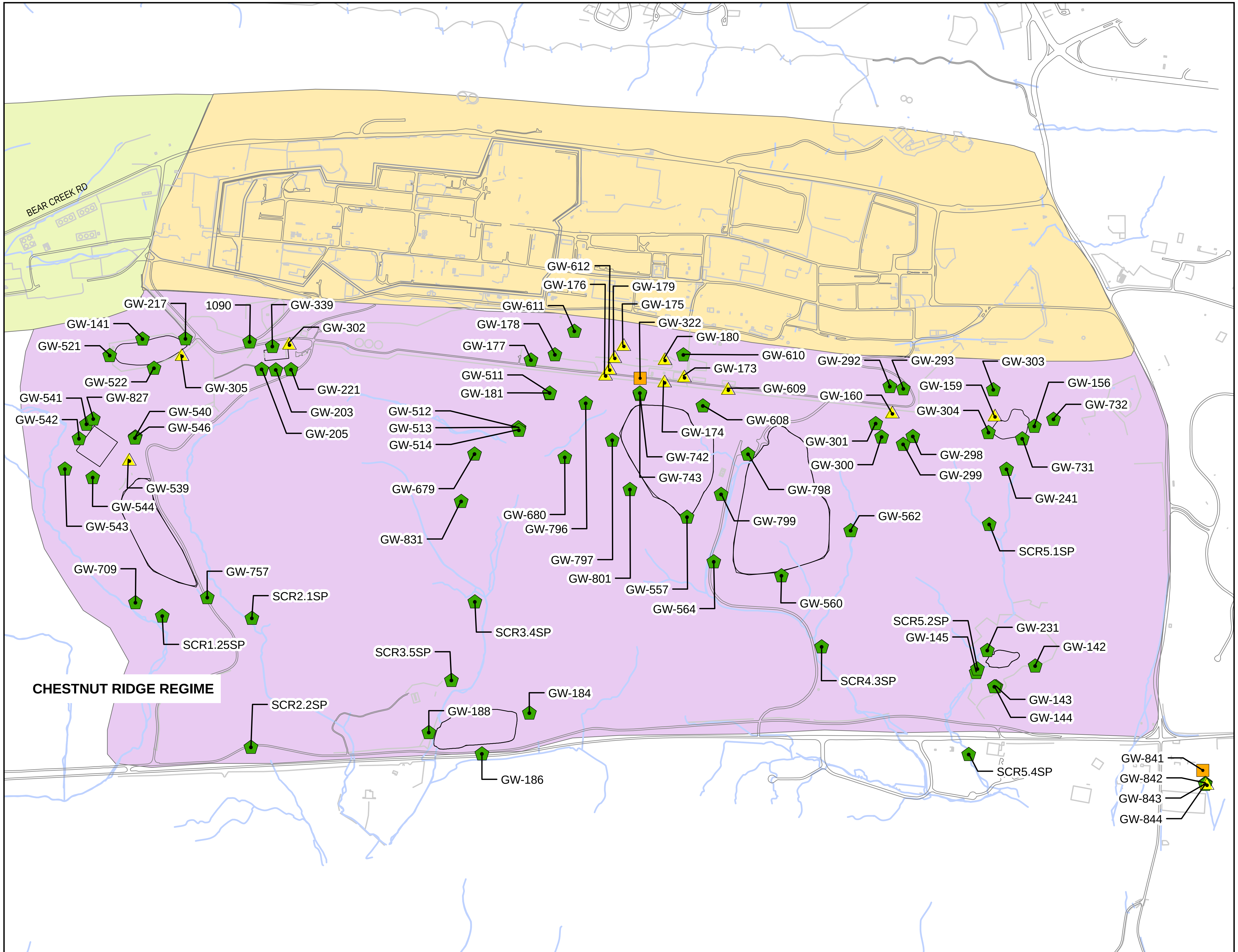
SCALE (Feet)
0 350 700

GROUNDWATER SERVICES, INC.

EAST FORK REGIME
EXCEEDANCE OF SCREENING LEVELS
FOR PRIORITY CONSTITUENTS

Y-12 National Security Complex
Oak Ridge, Tennessee

GSI Job No:	G-3038	Drawn by:	CDM
Issued:	12/12/2005	Chk'd by:	MV
Revised:		Appv'd	MV
Scale:	As Shown		FIGURE A.3



PLANT NORTH
NORTH
34°

LEGEND

Priority Constituent

- > 100X MCL
- > 10X MCL
- > MCL
- > DL and < MCL
- Site Buildings, Features or Sources
- Chestnut Ridge Regime
- UpperEastForkRegime
- BearCreekRegime

Notes:

1. Symbols represent the highest normalized average concentration (concentration/MCL) at each active location for an individual constituent.
2. Sample locations from BWXT Y-12 Analytical Database (GIMS) for locations in the Upper East Fork Hydrogeologic Regime.
3. Wells GW-841 - GW-844 are outside of the Chestnut Ridge Regime, but were included for future reference.

SCALE (Feet)
0 600 1,200

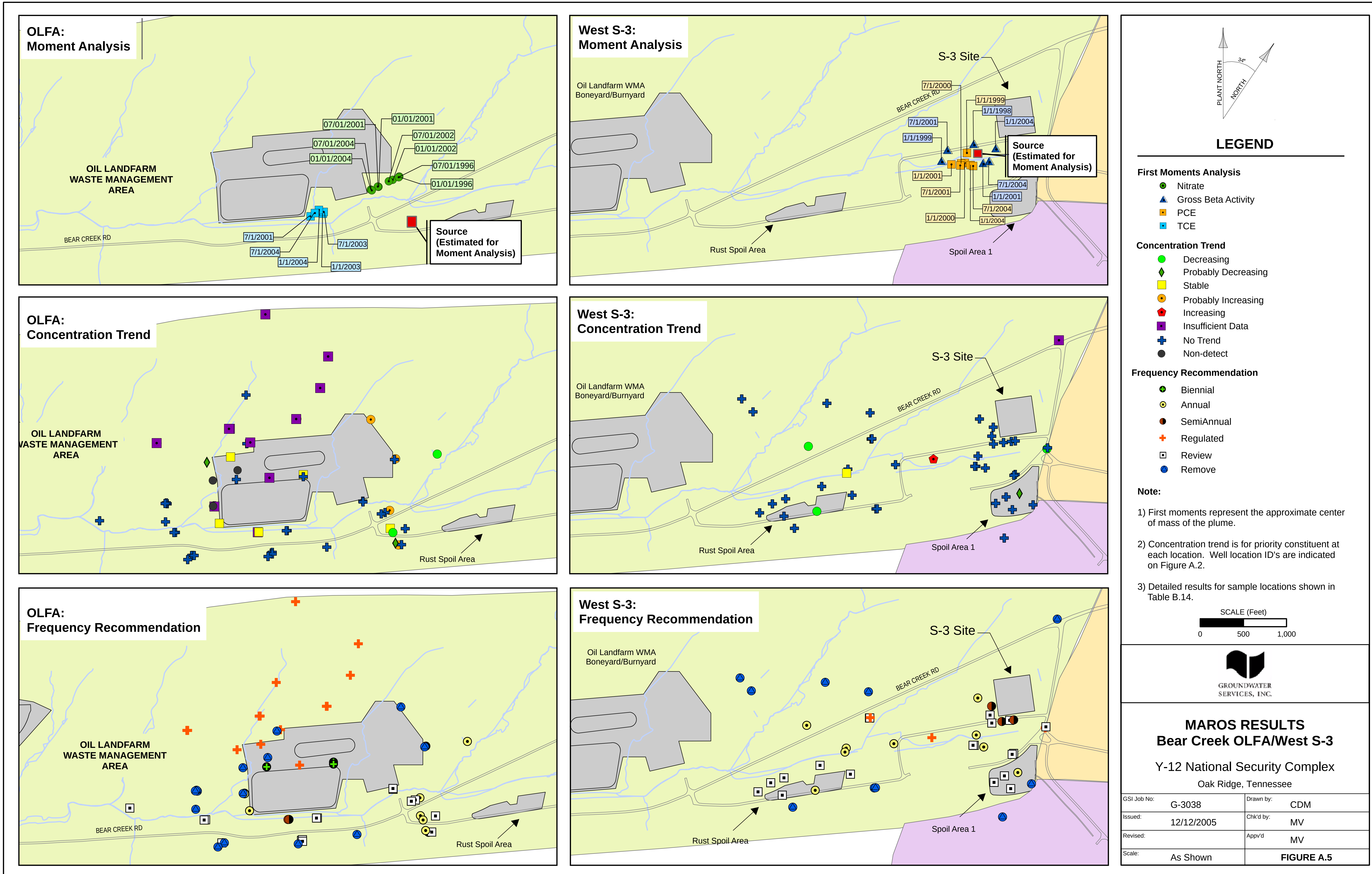
GROUNDWATER SERVICES, INC.

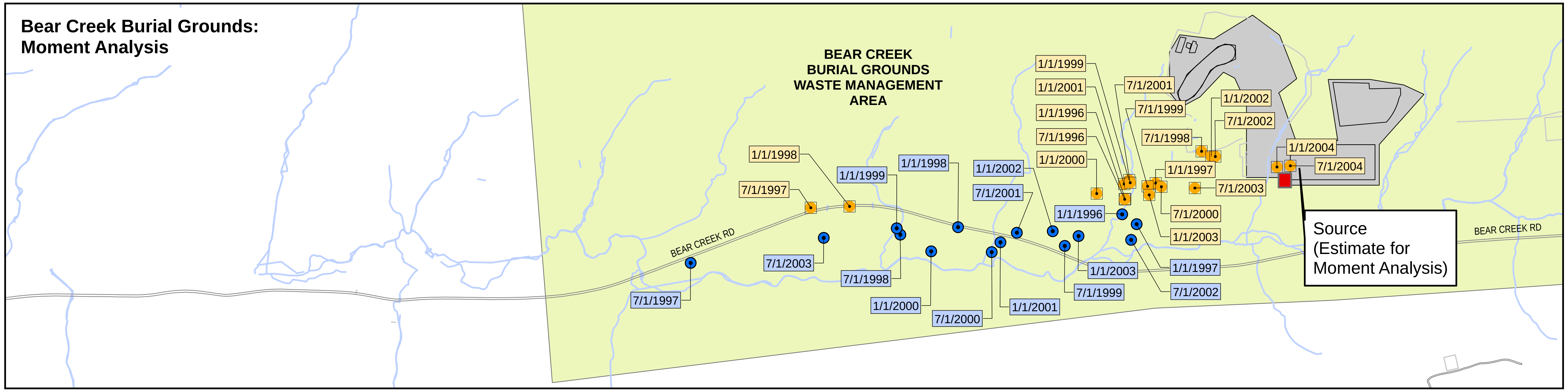
CHESTNUT RIDGE REGIME
EXCEEDANCE OF SCREENING LEVELS
FOR PRIORITY CONSTITUENTS

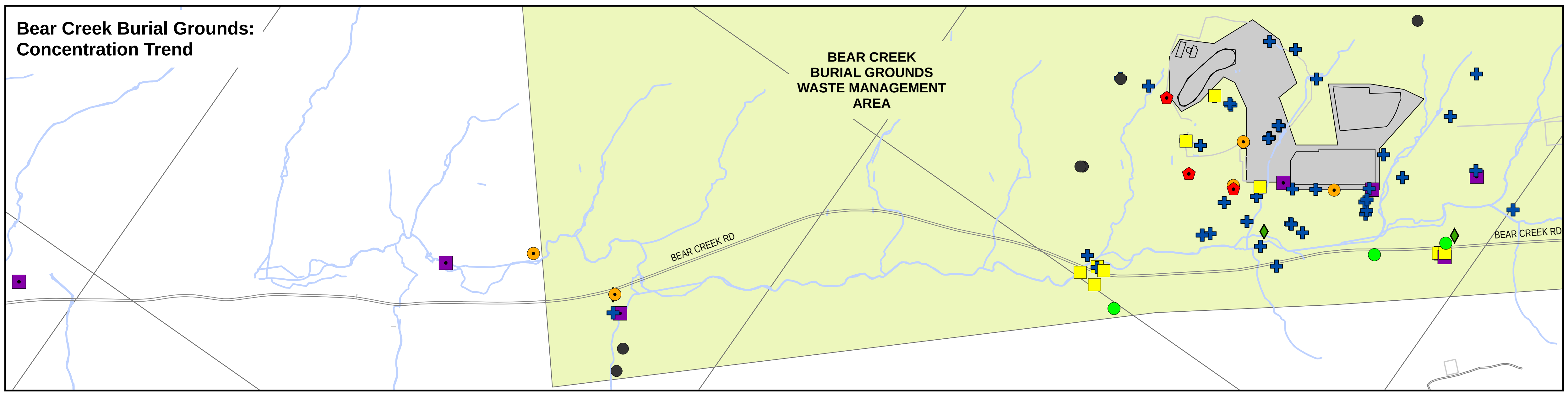
Y-12 National Security Complex

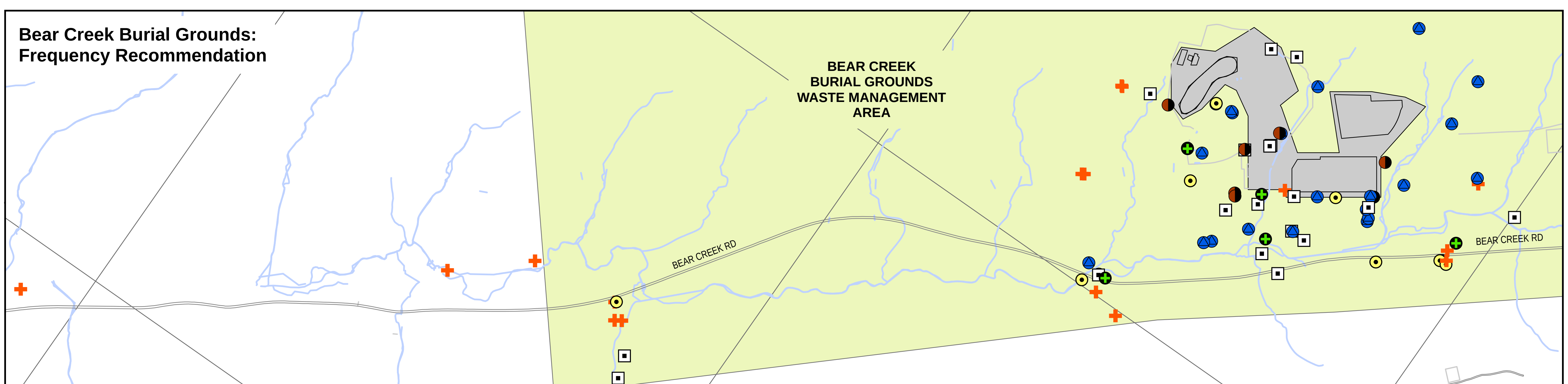
Oak Ridge, Tennessee

GSI Job No:	G-3038	Drawn by:	CDM
Issued:	12/12/2005	Chk'd by:	MV
Revised:		Appv'd	MV
Scale:	As Shown		FIGURE A.4


OLFA:
Moment Analysis
OIL LANDFARM WASTE MANAGEMENT AREA
BEAR CREEK RD
Source (Estimated for Moment Analysis)
07/01/2001
01/01/2001
07/01/2004
07/01/2002
01/01/2002
01/01/2004
07/01/1996
01/01/1996
7/1/2001
7/1/2004
1/1/2004
7/1/2003
1/1/2003
West S-3:
Moment Analysis
Oil Landfarm WMA Boneyard/Burnyard
S-3 Site
BEAR CREEK RD
Rust Spoil Area
Spoil Area 1
7/1/2000
1/1/1999
1/1/1998
1/1/2004
7/1/2001
1/1/1999
1/1/2001
7/1/2001
1/1/2000
7/1/2004
1/1/2001
7/1/2004
1/1/2004
OLFA:
Concentration Trend
OIL LANDFARM WASTE MANAGEMENT AREA
Rust Spoil Area
West S-3:
Concentration Trend
S-3 Site
Oil Landfarm WMA Boneyard/Burnyard
BEAR CREEK RD
Rust Spoil Area
Spoil Area 1
OLFA:
Frequency Recommendation
OIL LANDFARM WASTE MANAGEMENT AREA
BEAR CREEK RD
Rust Spoil Area
West S-3:
Frequency Recommendation
S-3 Site
Oil Landfarm WMA Boneyard/Burnyard
BEAR CREEK RD
Rust Spoil Area
Spoil Area 1
PLANT NORTH
NORTH
34°
LEGEND
First Moments Analysis
Nitrate
Gross Beta Activity
PCE
TCE
Concentration Trend
Decreasing
Probably Decreasing
Stable
Probably Increasing
Increasing
Insufficient Data
No Trend
Non-detect
Frequency Recommendation
Biennial
Annual
SemiAnnual
Regulated
Review
Remove
Note:
1) First moments represent the approximate center of mass of the plume.
2) Concentration trend is for priority constituent at each location. Well location ID's are indicated on Figure A.2.
3) Detailed results for sample locations shown in Table B.14.
SCALE (Feet)
0
500
1,000
GROUNDWATER SERVICES, INC.
MAROS RESULTS
Bear Creek OLFA/West S-3
Y-12 National Security Complex
Oak Ridge, Tennessee
GSI Job No: G-3038
Drawn by: CDM
Issued: 12/12/2005
Chk'd by: MV
Revised:
Appv'd MV
Scale: As Shown
FIGURE A.5







PLANT NORTH

NORTH

34°

LEGEND

First Moments Analysis

- Gross Beta Activity
- PCE

Concentration Trend

- Decreasing
- Probably Decreasing
- Stable
- Probably Increasing
- Increasing
- Insufficient Data
- No Trend
- Non-detect

Frequency Recommendation

- Biennial
- Annual
- SemiAnnual
- Regulated
- Review
- Remove

Note:

1) First moments represent the approximate center of mass of each plume over time.

2) Concentration trend is for priority constituent at each location. Sample location ID's are shown on Figure A.2.

SCALE (Feet)

0 600 1,200

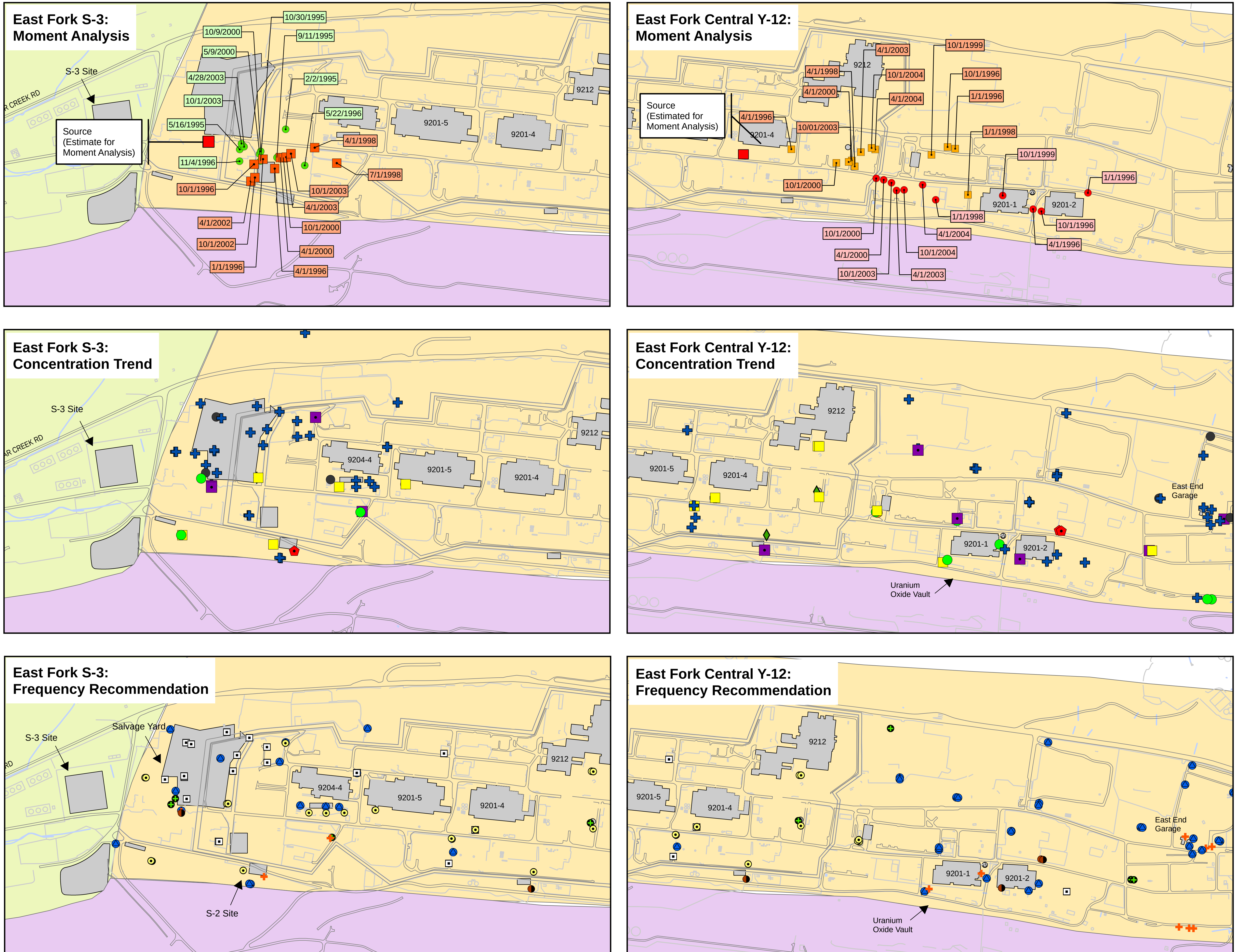
GROUNDWATER SERVICES, INC.

MAROS RESULTS
Bear Creek Burial Grounds

Y-12 National Security Complex

Oak Ridge, Tennessee

GSI Job No:	G-3038	Drawn by:	CDM
Issued:	12/12/2005	Chk'd by:	MV
Revised:		Appv'd	MV
Scale:	As Shown		**FIGURE A.6**



PLANT NORTH

34°

NORTH

LEGEND

First Moments Analysis

- Nitrate
- PCE
- Uranium

Concentration Trend

- Decreasing
- Probably Decreasing
- Stable
- Probably Increasing
- Increasing
- Insufficient Data
- No Trend
- Non-detect

Frequency Recommendation

- Biennial
- Annual
- SemiAnnual
- Regulated
- Review
- Remove

NOTES:

1) First moments represent the approximate center of mass of the plume.

2) Concentration trend is for priority constituent at each location. Sample Location ID's are shown on Figure A.3.

3) An insufficient number of wells (<6) were sampled in the East S-3 to determine First Moments for 2004 sample events.

SCALE (Feet)

0 500 1,000

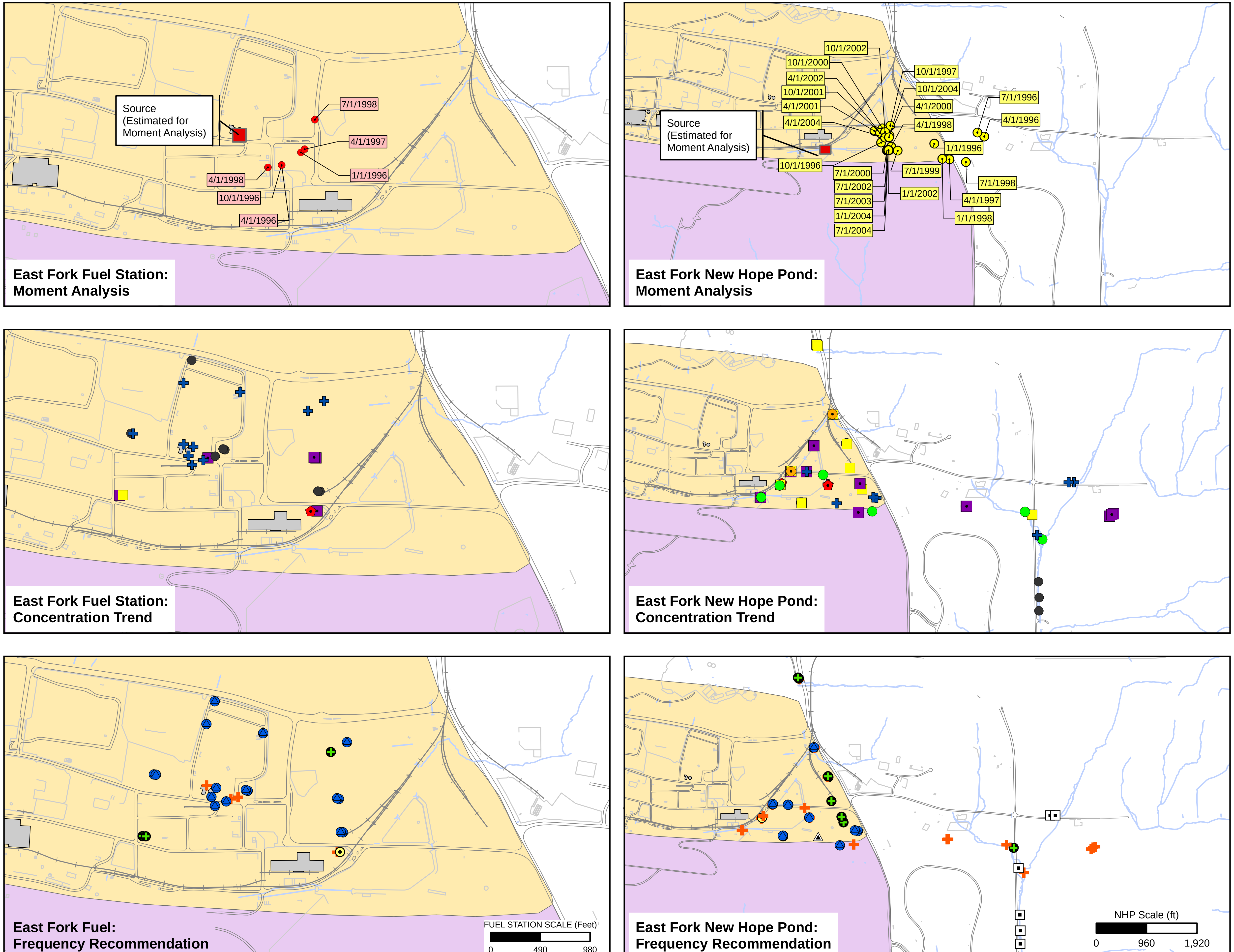
GROUNDWATER SERVICES, INC.

MAROS RESULTS
East Fork Regime
East S-3 and Central Y-12

Y-12 National Security Complex

Oak Ridge, Tennessee

GSI Job No:	G-3038	Drawn by:	CDM
Issued:	12/13/2005	Chk'd by:	MV
Revised:		Appv'd	MV
Scale:	As Shown		FIGURE A.7



PLANT NORTH
34°
NORTH

LEGEND

First Moments Analysis

- Benzene
- Carbon Tetrachloride

Concentration Trend

- Decreasing
- Probably Decreasing
- Stable
- Probably Increasing
- Increasing
- Insufficient Data
- No Trend
- Non-detect

Frequency Recommendation

- Biennial
- Annual
- SemiAnnual
- Regulated
- Review
- Remove
- Extraction Well

Note:

1) First moments represent the approximate center of mass of the plume.

2) Concentration trend is for priority constituent at each location. Sample location ID's are shown Figure A.3.

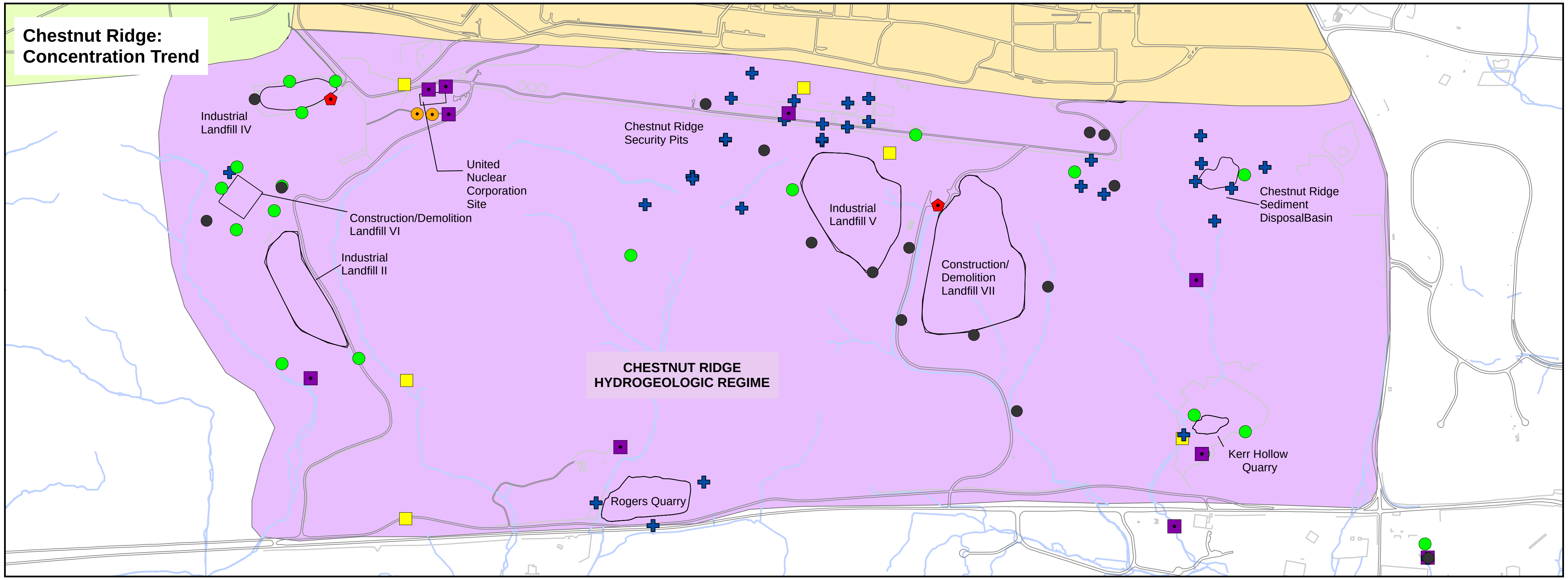
GROUNDWATER SERVICES, INC.

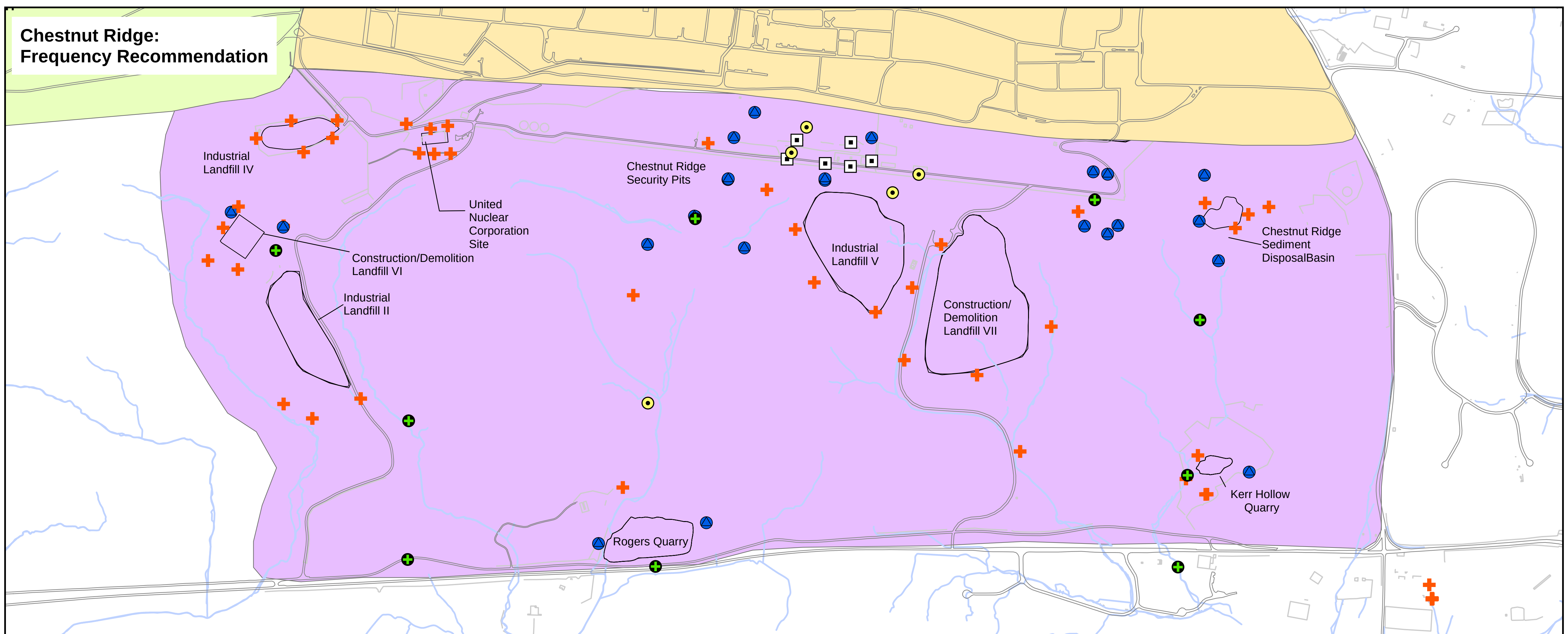
MAROS RESULTS
East ForkRegime
Fuel Station and East y-12

Y-12 National Security Complex

Oak Ridge, Tennessee

GSI Job No: G-3038		Drawn by: CDM	
Issued: 12/12/2005		Chk'd by: MV	
Revised:		Appv'd MV	
Scale: As Shown		**FIGURE A.8**	





PLANT NORTH
NORTH
34°

LEGEND

Concentration Trend

- Decreasing
- Probably Decreasing
- Stable
- Probably Increasing
- Increasing
- Insufficient Data
- No Trend
- Non-detect

Frequency Recommendation

- Biennial
- Annual
- SemiAnnual
- Regulated
- Review
- Remove

Note:

1) Concentration trend is for priority constituent at each location.

2) Sample location ID's are shown on Figure A.4.

3) First Moment analyses are not included for Chestnut Ridge Regime due to widespread non-detects, low concentrations, and large distances between areas where constituents are detcted.

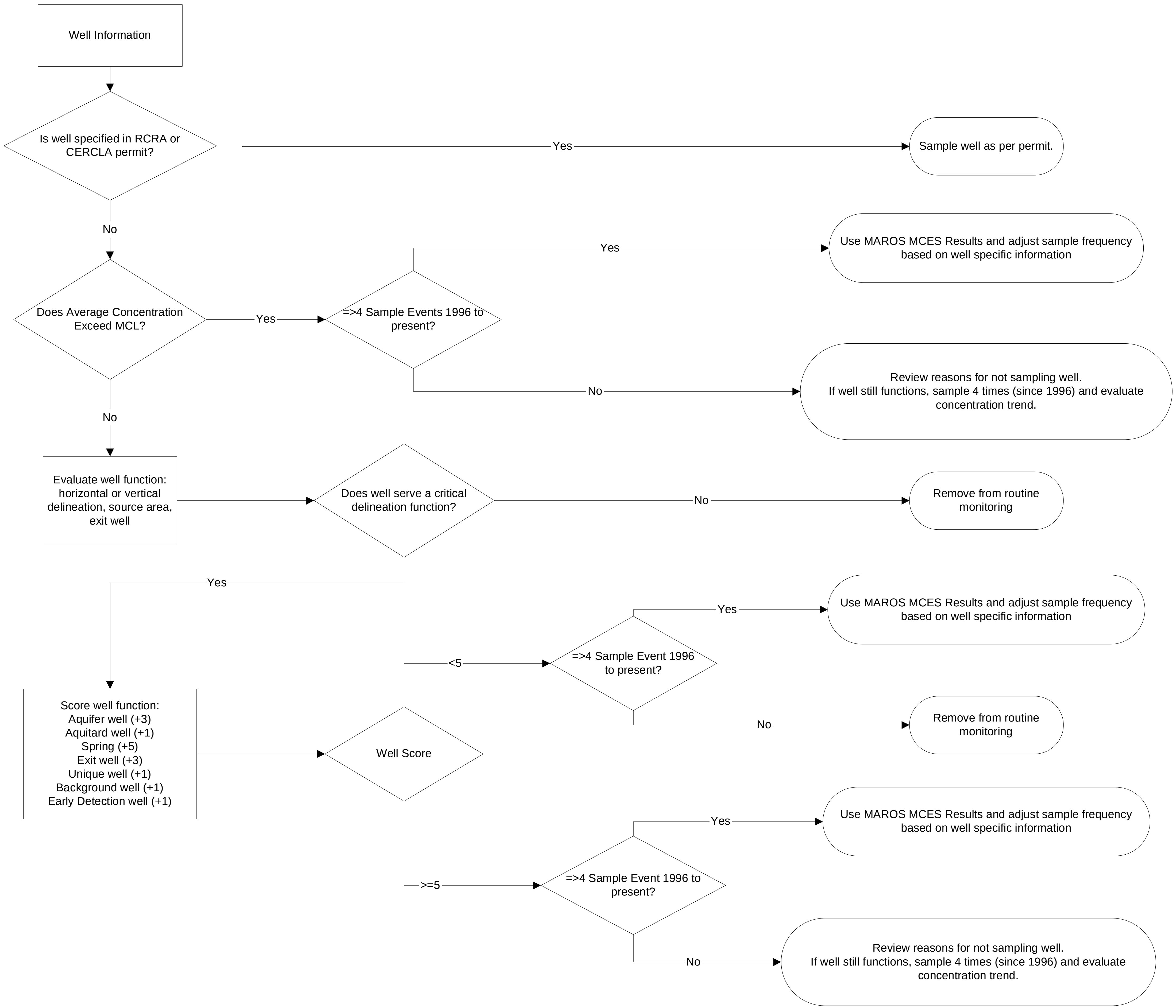
Scale (ft)
0 760 1,520

GROUNDWATER SERVICES, INC.

MAROS RESULTS
Chestnut Ridge

Y-12 National Security Complex
Oak Ridge, Tennessee

GSI Job No:	G-3038	Drawn by:	CDM
Issued:	12/10/2005	Chk'd by:	MV
Revised:		Appv'd	MV
Scale:	As Shown		FIGURE A.9



GROUNDWATER SERVICES, INC.

Well Network Decision Logic

Y-12 National Security Complex

12/12/2005	Figure A.10

ASSESSMENT OF THE GROUNDWATER PROTECTION PROGRAM Y-12 NATIONAL SECURITY COMPLEX, OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

APPENDIX B: TABLES

GROUNDWATER SERVICES, INC.

TABLE B.1
MAJOR CONSTITUENTS AND SCREENING LEVELS

Y-12 National Security Complex
Oak Ridge, Tennessee

Constituent Type	Constituent	Screening Level	Units	Source of Screening Level
INO	GROSS ALPHA ACTIVITY	15	pCi/L	MCL
INO	GROSS BETA ACTIVITY	50	pCi/L	MCL
INO	NITRATE	10	mg/L	MCL
MET	ALUMINUM	0.05	mg/L	Secondary MCL
MET	BARIUM	2	mg/L	MCL
MET	BERYLLIUM	0.004	mg/L	MCL
MET	CADMIUM	0.005	mg/L	MCL
MET	CHROMIUM	0.1	mg/L	MCL
MET	COPPER	1	mg/L	Secondary MCL
MET	LEAD	0.015	mg/L	MCL
MET	MANGANESE	0.05	mg/L	Secondary MCL
MET	MERCURY	0.002	mg/L	MCL
MET	NICKEL	0.073	mg/L	Reg 9 PRG
MET	STRONTIUM	22	mg/L	Reg 9 PRG
MET	TECHNETIUM-99	4000	pCi/L	DOE Order 5400.5
MET	URANIUM	0.03	mg/L	MCL
ORG	1,1,1-TRICHLOROETHANE	0.2	mg/L	MCL
ORG	1,1-DICHLOROETHANE	0.081	mg/L	Reg 9 PRG
ORG	1,1-DICHLOROETHENE	0.007	mg/L	MCL
ORG	1,2-DICHLOROETHANE	0.005	mg/L	MCL
ORG	BENZENE	0.005	mg/L	MCL
ORG	CARBON TETRACHLORIDE	0.005	mg/L	MCL
ORG	CHLOROFORM	0.08	mg/L	MCL (total trihalomethanes)
ORG	cis-1,2-DICHLOROETHYLENE	0.07	mg/L	MCL
ORG	TETRACHLOROETHYLENE(PCE)	0.005	mg/L	MCL
ORG	TRICHLOROETHYLENE (TCE)	0.005	mg/L	MCL
ORG	VINYL CHLORIDE	0.002	mg/L	MCL

Notes
1. MET = Metal; INO = Inorganic constituent; ORG = Organic Constituent
2. MCLs = Maximum Contaminant Levels are USEPA National Primary or Secondary Drinking Water Standards, 2005.
3. Reg 9 PRG = EPA Region IX Preliminary Remediation Goal, 2004 Values.
4. DOE Order 5400.5 = Radiation Protection of the Public and the Environment, 1/7/1993

GROUNDWATER SERVICES, INC.

TABLE B.2
LOCATION ANALYSIS GROUPS FOR MAROS EVALUATION

Y-12 National Security Complex
Oak Ridge, Tennessee

Hydrogeologic Regime	MAROS Analysis Group	Location Description	Number Sample Locations Analyzed
Bear Creek	Bear Creek Burial Grounds	Western Bear Creek Regime, Bear Creek Burial Grounds	80
	Oil Landfarm WMA	Central Bear Creek Regime includes EMWMF, Oil Landfarm WMA	59
	West S3 Area	Eastern Bear Creek Regime, S-3 Site, Rust Spoil Area, Spoil Area 1	44
Chestnut Ridge	East Chestnut Ridge	Eastern Chestnut Ridge Regime, Kerr Hollow Quarry, Sediment Basin, Borrow Area Waste Pile, Bethel Valley	26
	Landfills V and VII	Industrial Landfill V, Construction/Demolition Landfill VII, South Side Chestnut Ridge	10
	West Chestnut Ridge	Industrial Landfill II, Industrial Landfill IV, United Nuclear Corporation Site, Construction/Demolition Landfill VI, Oak Ridge Sludge Farm	24
	Chestnut Ridge Security Pits	Security Pits, Filled Coal Ash Pond, Rogers Quarry	29
East Fork Poplar Creek	East S-3	Eastern S-3 and S-2 Sites, Beta-4 Security Pits, Rust Garage Area, Fire Training Facility, Y-12 Salvage Yard, Waste Coolant Processing Facility	49
	Central Y-12	Y-12 Industrial Facility, Coal Pile Trench, Uranium Oxide Vault	44
	Fuel Station	Y-12 Fuel Station, Ravine Disposal Site	24
	East Y-12	New Hope Pond, Union Valley, Scarboro Road	54

Notes:
1. Analysis groups were formed based on geographic proximity and desired sample size.
2. The number of sample locations is the number of locations in the geographic area that had data in the Y-12 Analytical Database (BWXT Y-12, 2005).
3. Sample locations include both monitoring wells and springs. Surface water samples and Westbay wells were not included in the analysis.

GROUNDWATER SERVICES, INC.

TABLE B.3
MAROS RESULTS WEST S-3 AREA

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-100	1/22/1986	8/17/2004	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-101	1/23/1986	8/18/2004	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-115	3/9/1987	1/6/2004	WL	14	No	GROSS ALPHA ACTIVITY	NT	Annual
GW-122	12/12/1986	4/13/1991	WL	0	Yes	NITRATE	N/A	Annual
GW-123	12/23/1986	8/4/2003	WL	1	Yes	GROSS ALPHA ACTIVITY	N/A	Annual
GW-124	12/6/1986	8/9/2001	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-125	12/6/1986	9/17/1992	WL	0	Yes	GROSS BETA ACTIVITY	N/A	Annual
GW-127	12/12/1986	1/18/1990	WL	0	Yes	URANIUM	N/A	Annual
GW-236	4/5/1988	8/18/2004	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-243	12/19/1986	8/13/2002	WL	2	Yes	GROSS BETA ACTIVITY	N/A	SemiAnnual
GW-244	3/13/1987	1/18/1990	WL	0	Yes	NITRATE	N/A	Biennial
GW-245	3/10/1987	1/17/1990	WL	0	Yes	NITRATE	N/A	Biennial
GW-246	3/16/1987	8/19/2004	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-247	3/16/1987	1/17/1990	WL	0	Yes	NITRATE	N/A	Biennial
GW-276	10/29/1986	7/8/2004	WL	18	Yes	URANIUM	D	Annual
GW-277	10/29/1986	1/23/1990	WL	0	Yes	NITRATE	N/A	Annual
GW-306	2/5/1988	4/26/1991	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-307	2/6/1988	4/26/1991	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-308	2/5/1988	4/30/1991	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-309	2/9/1988	8/30/1992	WL	0	Yes	GROSS BETA ACTIVITY	N/A	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.3
MAROS RESULTS WEST S-3 AREA

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-310	2/5/1988	4/30/1991	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-311	2/5/1988	8/2/2004	WL	18	Yes	TRICHLOROETHYLENE (TCE)	D	Annual
GW-312	2/9/1988	8/6/1995	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-313	3/8/1988	8/15/1992	WL	0	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Annual
GW-314	3/7/1988	8/15/1992	WL	0	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Annual
GW-315	3/7/1988	8/2/2004	WL	18	Yes	TETRACHLOROETHYLENE(PCE)	PD	Annual
GW-316	3/7/1988	10/24/1993	WL	0	No	GROSS BETA ACTIVITY	N/A	Biennial
GW-317	3/7/1988	8/15/1995	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-323	3/8/1988	10/23/1993	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-325	12/8/1987	2/15/1994	WL	0	No	TETRACHLOROETHYLENE(PCE)	N/A	Biennial
GW-345	9/28/1988	3/9/1999	WL	1	Yes	NITRATE	N/A	Annual
GW-346	9/28/1988	3/9/1999	WL	1	Yes	NITRATE	N/A	SemiAnnual
GW-347	9/29/1988	8/15/1995	WL	0	No	GROSS BETA ACTIVITY	N/A	Biennial
GW-348	9/29/1988	8/21/1995	WL	0	No	NITRATE	N/A	Biennial
GW-526	9/28/1988	8/16/2004	WL	1	Yes	NITRATE	N/A	SemiAnnual
GW-531	12/15/1988	6/24/1991	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-613	2/9/1990	8/11/1997	WL	2	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-615	5/16/1990	8/19/2004	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-616	5/17/1990	8/9/2001	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-630	6/27/1990	8/29/1992	WL	0	No	GROSS BETA ACTIVITY	N/A	Biennial
GW-648	1/15/1991	7/23/1992	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-829	6/27/1995	8/1/2001	WL	11	Yes	NITRATE	D	Annual
GW-835	4/16/1997	8/21/2003	WL	20	Yes	URANIUM	I	SemiAnnual
SS-1	8/30/1990	7/20/2004	SP	18	Yes	NITRATE	S	Annual

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.4
MAROS RESUTLS OIL LANDFARM WMA

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-006	11/11/1998	8/2/2000	WL	8	No	TRICHLOROETHYLENE (TCE)	S	Annual
GW-008	1/26/1998	7/7/2004	WL	14	Yes	TETRACHLOROETHYLENE(PCE)	NT	Annual
GW-010	3/25/1987	2/1/1990	WL	0	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Biennial
GW-013	5/21/1990	12/19/1993	WL	0	No	CADMIUM	N/A	Remove
GW-064	11/5/1987	7/20/1998	WL	2	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-066	9/27/1995	8/13/2002	WL	2	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
GW-067	3/25/1987	3/13/1990	WL	0	Yes	LEAD	N/A	Biennial
GW-073	3/18/1987	1/30/1990	WL	0	No	GROSS BETA ACTIVITY	ND	Biennial
GW-074	5/23/1990	8/3/1992	WL	0	No	GROSS ALPHA ACTIVITY	ND	Biennial
GW-075	5/23/1990	9/8/1992	WL	0	No	CADMIUM	N/A	Biennial
GW-084	3/24/1987	8/13/1997	WL	4	No	LEAD	PI	Biennial
GW-085	11/5/1987	8/3/2004	WL	17	Yes	NITRATE	PI	SemiAnnual
GW-086	5/22/1990	10/21/1993	WL	0	No	LEAD	N/A	Remove
GW-097	3/17/1987	7/15/1998	WL	2	No	LEAD	N/A	Biennial
GW-098	3/17/1987	8/3/2004	WL	4	Yes	TRICHLOROETHYLENE (TCE)	NT	Annual
GW-120	3/26/1987	1/30/1990	WL	0	No	GROSS BETA ACTIVITY	ND	Remove
GW-225	1/12/1986	7/29/2004	WL	8	Yes	TRICHLOROETHYLENE (TCE)	NT	SemiAnnual
GW-226	1/12/1986	7/28/2004	WL	14	Yes	TRICHLOROETHYLENE (TCE)	S	SemiAnnual
GW-227	1/14/1986	9/12/1992	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Annual
GW-228	1/14/1986	9/9/1999	WL	1	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-229	1/14/1986	7/29/2004	WL	6	Yes	VINYL CHLORIDE	S	Annual
GW-363	9/21/1988	11/18/2004	WL	7	Yes	GROSS BETA ACTIVITY	PD	Biennial
GW-364	9/22/1988	8/7/2001	WL	2	Yes	TRICHLOROETHYLENE (TCE)	N/A	Annual
GW-365	9/21/1988	8/7/2001	WL	2	Yes	TRICHLOROETHYLENE (TCE)	N/A	Annual
GW-366	9/20/1988	9/7/1992	WL	0	No	LEAD	N/A	Remove
GW-367	9/19/1988	5/11/1991	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-368	9/24/1988	1/31/1990	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-369	9/22/1988	5/15/1991	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-520	9/20/1988	9/7/1992	WL	0	No	LEAD	N/A	Remove
GW-537	12/6/1989	8/3/2004	WL	17	Yes	NITRATE	D	Annual

Notes:

1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.4
MAROS RESUTLS OIL LANDFARM WMA

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-601	3/5/1990	3/8/1999	WL	1	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-636	2/11/1991	12/18/1993	WL	0	No	GROSS BETA ACTIVITY	N/A	Remove
GW-637	2/12/1991	7/19/1995	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-638	2/12/1991	12/18/1993	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-645	2/12/1991	8/2/1992	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-646	1/31/1991	8/3/1992	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-723	5/27/1992	7/23/2002	WL	4	Yes	TRICHLOROETHYLENE (TCE)	PI	Annual
GW-724	5/20/1992	7/27/2004	WL	18	Yes	TRICHLOROETHYLENE (TCE)	S	Annual
GW-725	5/21/1992	7/27/2004	WL	18	Yes	TRICHLOROETHYLENE (TCE)	PI	Annual
GW-736	5/22/1992	7/17/2002	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-737	5/22/1992	7/18/2002	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-738	5/26/1992	7/26/2004	WL	18	Yes	TRICHLOROETHYLENE (TCE)	D	Annual
GW-739	5/27/1992	7/22/2002	WL	2	Yes	TRICHLOROETHYLENE (TCE)	N/A	SemiAnnual
GW-740	6/2/1992	7/26/2004	WL	18	Yes	TRICHLOROETHYLENE (TCE)	PD	Annual
GW-794	12/3/1992	8/26/1996	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-795	12/3/1992	8/17/2004	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-800	5/11/1993	8/5/1995	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-916	4/2/2001	11/10/2004	WL	5	No	GROSS BETA ACTIVITY	NT	Annual
GW-917	4/3/2001	11/4/2004	WL	5	No	GROSS ALPHA ACTIVITY	PI	Biennial
GW-918	4/2/2001	11/10/2004	WL	5	No	GROSS BETA ACTIVITY	NT	Biennial
GW-919	12/4/2001	11/4/2003	WL	3	No	GROSS ALPHA ACTIVITY	N/A	Annual
GW-920	4/4/2001	11/9/2004	WL	5	No	GROSS BETA ACTIVITY	NT	Annual
GW-921	4/3/2001	11/4/2004	WL	5	No	GROSS BETA ACTIVITY	NT	Biennial
GW-922	4/4/2001	11/15/2004	WL	5	No	GROSS BETA ACTIVITY	S	Biennial
GW-923	4/2/2001	11/16/2004	WL	9	No	LEAD	NT	Biennial
GW-924	3/29/2001	11/17/2004	WL	5	No	VINYL CHLORIDE	ND	Biennial
GW-925	4/3/2001	11/8/2004	WL	11	No	LEAD	NT	Biennial
GW-926	4/2/2001	11/17/2004	WL	8	No	BENZENE	NT	Biennial
GW-927	4/3/2001	11/16/2004	WL	5	No	GROSS ALPHA ACTIVITY	NT	Biennial

Notes:

1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.5
MAROS RESULTS BEAR CREEK BURIAL GROUNDS

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-014	3/14/1987	8/12/2002	WL	2	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
GW-018	3/21/1991	6/20/1991	WL	0	No	VINYL CHLORIDE	N/A	Remove
GW-045	3/14/1987	2/8/1990	WL	0	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Biennial
GW-046	3/14/1987	7/8/2004	WL	14	Yes	TETRACHLOROETHYLENE(PCE)	NT	Annual
GW-047	3/23/1987	7/24/1995	WL	0	No	1,1-DICHLOROETHENE	N/A	Remove
GW-052	6/22/1990	8/16/2004	WL	2	Yes	URANIUM	N/A	Annual
GW-053	6/22/1990	7/25/2001	WL	12	Yes	VINYL CHLORIDE	PD	Annual
GW-054	6/13/1990	9/2/1992	WL	0	No	VINYL CHLORIDE	N/A	Remove
GW-056	6/9/1990	4/27/2004	WL	12	No	URANIUM	S	Biennial
GW-057	6/13/1990	8/5/1995	WL	0	No	URANIUM	N/A	Remove
GW-058	11/24/1987	9/24/1992	WL	0	Yes	URANIUM	N/A	Biennial
GW-061	8/10/1989	8/5/2002	WL	2	Yes	URANIUM	N/A	Annual
GW-068	3/18/1987	3/12/1990	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-069	6/22/1990	8/5/2002	WL	6	No	VINYL CHLORIDE	PI	Annual
GW-071	3/17/1987	8/5/2004	WL	4	Yes	TETRACHLOROETHYLENE(PCE)	NT	SemiAnnual
GW-072	3/17/1987	8/6/2002	WL	2	No	TETRACHLOROETHYLENE(PCE)	N/A	Remove
GW-077	6/13/1990	8/12/2004	WL	15	No	VINYL CHLORIDE	ND	Biennial
GW-078	6/13/1990	8/12/2004	WL	15	No	VINYL CHLORIDE	ND	Biennial
GW-079	5/31/1990	8/12/2004	WL	3	No	URANIUM	N/A	Biennial
GW-080	5/31/1990	8/12/2004	WL	17	No	VINYL CHLORIDE	ND	Biennial
GW-082	3/23/1987	8/5/2004	WL	13	Yes	VINYL CHLORIDE	I	SemiAnnual
GW-083	6/20/1990	9/2/1992	WL	0	No	VINYL CHLORIDE	N/A	Biennial
GW-089	6/19/1990	8/13/1992	WL	0	Yes	VINYL CHLORIDE	N/A	Biennial
GW-091	3/14/2002	8/8/2002	WL	2	No	URANIUM	N/A	Annual
GW-094	3/17/1987	2/15/1990	WL	0	No	URANIUM	N/A	Remove
GW-095	3/17/1987	8/27/1996	WL	2	No	TRICHLOROETHYLENE (TCE)	N/A	Remove
GW-126	3/26/1987	3/2/1999	WL	1	Yes	TRICHLOROETHYLENE (TCE)	N/A	Biennial
GW-237	4/15/1988	9/20/2004	WL	0	No	URANIUM	N/A	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. CY 2004 = Calendar year 2004. 26 of 80 locations were sampled during calendar year 2004.
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = once every 6 months; Annual = once per year; Biennial = once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.5
MAROS RESULTS BEAR CREEK BURIAL GROUNDS

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-242	11/12/1987	3/8/1999	WL	3	Yes	VINYL CHLORIDE	N/A	Annual
GW-248	2/10/1988	8/8/1995	WL	0	No	URANIUM	N/A	Remove
GW-249	3/13/1989	2/16/1990	WL	0	No	NITRATE	N/A	Remove
GW-250	11/9/1987	2/16/1990	WL	0	No	URANIUM	N/A	Remove
GW-257	5/9/1988	8/16/2004	WL	2	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
GW-258	2/6/1988	3/5/1990	WL	0	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Remove
GW-259	2/9/1988	3/5/1990	WL	0	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Annual
GW-286	3/27/1987	10/7/1993	WL	0	No	URANIUM	N/A	Remove
GW-287	3/27/1987	8/21/2000	WL	10	No	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-288	2/11/1988	8/7/2002	WL	2	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
GW-289	2/18/1988	8/8/2002	WL	4	Yes	TETRACHLOROETHYLENE(PCE)	PI	SemiAnnual
GW-290	2/16/1988	8/7/1995	WL	0	No	TETRACHLOROETHYLENE(PCE)	N/A	Biennial
GW-291	2/16/1988	8/7/2002	WL	4	Yes	TETRACHLOROETHYLENE(PCE)	S	SemiAnnual
GW-370	9/9/1988	8/8/1995	WL	0	No	URANIUM	N/A	Biennial
GW-372	9/9/1988	8/14/1997	WL	0	No	NITRATE	N/A	Remove
GW-375	9/12/1988	2/6/1990	WL	0	No	TRICHLOROETHYLENE (TCE)	N/A	Remove
GW-621	2/9/1990	7/13/2000	WL	9	No	NITRATE	PD	Annual
GW-622	2/9/1990	9/25/1992	WL	0	No	VINYL CHLORIDE	N/A	Remove
GW-623	6/27/1990	9/27/1992	WL	0	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Annual
GW-624	6/28/1990	7/15/1998	WL	2	Yes	VINYL CHLORIDE	N/A	SemiAnnual
GW-626	2/14/1990	7/25/2002	WL	4	Yes	VINYL CHLORIDE	PI	SemiAnnual
GW-627	2/13/1990	8/4/2004	WL	19	Yes	TETRACHLOROETHYLENE(PCE)	I	SemiAnnual
GW-629	6/30/1990	7/16/1998	WL	4	Yes	TETRACHLOROETHYLENE(PCE)	S	Biennial
GW-639	12/6/1990	11/11/2004	WL	8	No	BENZENE	NT	Biennial
GW-641	12/7/1990	10/14/1993	WL	0	No	VINYL CHLORIDE	N/A	Remove
GW-642	12/1/1990	8/14/1997	WL	4	No	VINYL CHLORIDE	ND	Remove
GW-651	3/23/1991	10/10/1993	WL	0	No	VINYL CHLORIDE	N/A	Remove
GW-652	3/23/1991	9/19/1995	WL	0	No	TRICHLOROETHYLENE (TCE)	N/A	Remove
GW-653	3/23/1991	8/4/2004	WL	18	No	TETRACHLOROETHYLENE(PCE)	I	Annual
GW-654	3/9/1991	12/9/1995	WL	0	Yes	URANIUM	N/A	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.5
MAROS RESULTS BEAR CREEK BURIAL GROUNDS

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-683	5/24/1991	8/16/2004	WL	17	Yes	URANIUM	D	Annual
GW-684	5/30/1991	8/16/2004	WL	18	Yes	URANIUM	S	Annual
GW-685	6/1/1991	3/14/2001	WL	10	No	NITRATE	S	Biennial
GW-694	6/19/1991	7/17/2002	WL	6	Yes	URANIUM	NT	SemiAnnual
GW-695	6/18/1991	7/21/2004	WL	18	No	TRICHLOROETHYLENE (TCE)	S	Annual
GW-703	6/18/1991	7/21/2004	WL	18	Yes	TRICHLOROETHYLENE (TCE)	NT	Annual
GW-704	6/20/1991	7/22/2004	WL	18	Yes	TRICHLOROETHYLENE (TCE)	S	Annual
GW-706	6/20/1991	7/22/2004	WL	18	Yes	URANIUM	D	Annual
GW-710	12/5/1991	7/14/2003	WL	0	Yes	NITRATE	ND	Biennial
GW-711	12/10/1991	7/14/2003	WL	6	No	VINYL CHLORIDE	ND	Annual
GW-712	12/9/1991	7/7/2004	WL	18	No	1,2-DICHLOROETHANE	NT	Biennial
GW-713	6/13/1992	7/7/2004	WL	3	No	NITRATE	N/A	Annual
GW-714	9/3/1992	7/7/2004	WL	6	No	NITRATE	PD	Annual
GW-715	9/4/1992	1/5/2004	WL	17	No	URANIUM	PI	Annual
SS-4	8/30/1990	7/20/2004	SP	18	Yes	URANIUM	D	Annual
SS-5	8/30/1990	12/8/2004	SP	19	Yes	URANIUM	S	Annual
SS-5_95KM	5/23/1995	10/26/1995	SP	0	No	VINYL CHLORIDE	N/A	Annual
SS-6_6	5/23/1995	3/2/2004	SP	12	No	URANIUM	NT	Biennial
SS-6E	8/30/1990	8/1/2000	SP	8	Yes	URANIUM	PI	SemiAnnual
SS-6W	5/23/1995	3/4/2003	SP	5	Yes	BENZENE	NT	Annual
SS-7	5/23/1995	8/19/2003	SP	13	No	URANIUM	I	Annual
SS-8	8/30/1990	8/19/2003	SP	2	No	URANIUM	N/A	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.6
MAROS RESULTS EAST S-3 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
55-1A	6/5/1996	11/16/2004	WL	3	Yes	CHROMIUM III	N/A	Annual
55-1C	6/7/1996	6/7/1996	WL	1	No	NITRATE	N/A	Biennial
55-2B	6/10/1996	11/29/2004	WL	5	Yes	TETRACHLOROETHYLENE(PCE)	PI	SemiAnnual
55-2C	6/9/1996	11/18/2003	WL	8	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-105	1/24/1986	10/2/2003	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-106	1/24/1986	10/2/2003	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-107	6/3/1986	1/19/1990	WL	0	Yes	CADMIUM	N/A	Remove
GW-108	1/29/1986	7/8/2004	WL	6	Yes	NITRATE	NT	SemiAnnual
GW-109	1/29/1986	10/6/2003	WL	5	Yes	NITRATE	NT	SemiAnnual
GW-190	6/20/1990	10/21/2003	WL	2	Yes	TETRACHLOROETHYLENE(PCE)	ND	Biennial
GW-191	3/17/1986	11/6/1996	WL	3	No	CADMIUM	ND	Biennial
GW-192	3/17/1986	10/17/2001	WL	13	No	CADMIUM	NT	Annual
GW-194	3/18/1986	11/7/1996	WL	1	No	LEAD	N/A	Remove
GW-195	3/18/1986	11/7/1996	WL	2	Yes	LEAD	N/A	Annual
GW-196	3/17/1986	2/21/1990	WL	0	Yes	LEAD	N/A	Biennial
GW-197	3/18/1986	2/3/1990	WL	0	Yes	LEAD	N/A	Biennial
GW-251	6/10/1986	10/21/2004	WL	19	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-252	6/11/1986	5/17/1995	WL	0	No	CADMIUM	N/A	Remove
GW-253	6/10/1986	10/21/2003	WL	14	Yes	CADMIUM	I	SemiAnnual
GW-255	6/5/1986	5/17/1995	WL	0	No	LEAD	N/A	Biennial
GW-261	10/28/1986	5/16/1995	WL	0	No	LEAD	N/A	Remove
GW-263	1/14/1987	5/16/1995	WL	0	Yes	NITRATE	N/A	Biennial
GW-265	10/28/1986	3/13/1990	WL	0	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Biennial
GW-268	10/28/1986	3/13/1990	WL	0	No	LEAD	N/A	Biennial
GW-269	10/28/1986	10/23/2003	WL	2	Yes	1,1-DICHLOROETHENE	N/A	Annual

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.6
MAROS RESULTS EAST S-3 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-270	10/30/1986	10/20/2003	WL	2	Yes	NITRATE	N/A	SemiAnnual
GW-271	10/30/1986	10/20/2003	WL	2	No	CADMIUM	N/A	Annual
GW-272	10/30/1986	10/23/2003	WL	2	Yes	NITRATE	N/A	Annual
GW-273	10/31/1986	10/21/2003	WL	0	Yes	NITRATE	N/A	Annual
GW-274	11/4/1986	10/22/2003	WL	5	Yes	NITRATE	PD	Annual
GW-275	11/4/1986	10/22/2003	WL	5	Yes	NITRATE	S	Annual
GW-332	5/24/1989	8/4/1998	WL	3	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Annual
GW-334	5/24/1989	4/13/1991	WL	0	Yes	TRICHLOROETHYLENE (TCE)	N/A	Remove
GW-335	6/6/1989	4/10/1991	WL	0	Yes	CHROMIUM III	N/A	Remove
GW-336	5/25/1989	11/17/2003	WL	2	Yes	TETRACHLOROETHYLENE(PCE)	N/A	Annual
GW-337	5/25/1989	11/17/2003	WL	6	Yes	TRICHLOROETHYLENE (TCE)	S	Annual
GW-338	6/8/1989	8/20/1998	WL	4	Yes	CADMIUM	ND	Biennial
GW-349	9/6/1988	10/14/2002	WL	2	Yes	CADMIUM	N/A	Annual
GW-350	9/6/1988	10/15/2002	WL	2	Yes	CADMIUM	N/A	Annual
GW-505	12/29/1988	10/6/2003	WL	3	Yes	CHROMIUM III	N/A	Annual
GW-508	12/11/1990	3/2/1994	WL	0	Yes	BENZENE	N/A	Remove
GW-617	5/14/1990	11/5/1997	WL	5	No	CADMIUM	NT	Annual
GW-618	5/14/1990	10/22/2003	WL	17	Yes	CADMIUM	D	Annual
GW-619	5/10/1990	7/21/1998	WL	5	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-620	5/10/1990	10/21/2004	WL	20	Yes	TETRACHLOROETHYLENE(PCE)	D	Annual
GW-631	3/11/1991	10/7/2003	WL	2	Yes	TETRACHLOROETHYLENE(PCE)	ND	Annual
GW-633	3/11/1991	10/26/2004	WL	7	Yes	NITRATE	D	Annual
GW-778	5/20/1994	5/18/1995	WL	0	No	LEAD	N/A	Remove

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.7
MAROS RESULTS CENTRAL Y-12 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
55-1B	4/17/2002	10/14/2002	WL	2	Yes	CHROMIUM III	N/A	Annual
55-6A	6/5/1996	11/16/2004	WL	3	Yes	LEAD	N/A	Annual
56-2A	3/23/1998	11/18/2004	WL	3	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
56-2B	3/23/1998	11/18/2004	WL	3	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
56-2C	3/24/1998	11/18/2003	WL	5	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual
59-1A	3/17/1998	10/30/2003	WL	3	No	GROSS ALPHA ACTIVITY	N/A	Remove
59-1B	3/18/1998	4/28/2004	WL	4	Yes	CHROMIUM III	PD	Annual
59-1C	3/18/1998	10/30/2003	WL	3	No	TRICHLOROETHYLENE (TCE)	N/A	Annual
60-1B	6/11/2003	10/13/2003	WL	2	No	BENZENE	N/A	Remove
9201-3C-4SP	5/18/2004	10/27/2004	SP	2	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
GW-193	6/18/1990	7/13/2004	WL	17	Yes	BENZENE	D	Biennial
GW-204	6/19/1990	10/25/2004	WL	13	Yes	BENZENE	PD	Biennial
GW-218	6/7/1996	10/30/2000	WL	4	No	CHROMIUM III	S	Annual
GW-219	9/4/1998	11/11/2004	WL	12	Yes	URANIUM	D	Annual
GW-605	8/26/1991	7/12/2004	WL	20	Yes	CARBON TETRACHLORIDE	D	Annual
GW-606	8/26/1991	7/12/2004	WL	20	Yes	CARBON TETRACHLORIDE	D	Annual
GW-656	3/7/1991	11/12/2001	WL	4	Yes	TRICHLOROETHYLENE (TCE)	S	Annual
GW-657	3/6/1991	11/15/1993	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-686	3/23/1998	11/14/2002	WL	2	Yes	LEAD	N/A	Annual
GW-690	6/8/1996	11/18/2003	WL	5	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.7
MAROS RESULTS CENTRAL Y-12 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-691	6/8/1996	11/17/2004	WL	3	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
GW-692	3/1/1996	11/17/2004	WL	3	No	TETRACHLOROETHYLENE(PCE)	N/A	Annual
GW-698	6/9/1996	11/3/2004	WL	11	Yes	TRICHLOROETHYLENE (TCE)	NT	SemiAnnual
GW-700	6/8/1996	11/10/2003	WL	5	Yes	TETRACHLOROETHYLENE(PCE)	PD	Annual
GW-759	7/26/1992	11/14/1995	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-760	7/26/1992	4/27/2004	WL	3	No	CHROMIUM III	N/A	Biennial
GW-761	7/26/1992	10/29/2003	WL	2	No	CHROMIUM III	N/A	Biennial
GW-765	7/28/1992	4/27/2004	WL	2	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-769	1/27/1993	10/28/2004	WL	19	Yes	CARBON TETRACHLORIDE	I	SemiAnnual
GW-770	1/27/1993	10/28/2004	WL	19	No	CARBON TETRACHLORIDE	I	SemiAnnual
GW-779	6/9/1994	11/7/1996	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-780	6/9/1994	11/7/1996	WL	3	No	CHROMIUM III	N/A	Biennial
GW-781	6/15/1994	10/26/1999	WL	9	Yes	TETRACHLOROETHYLENE(PCE)	PI	Annual
GW-782	6/16/1994	10/26/2004	WL	20	Yes	TETRACHLOROETHYLENE(PCE)	D	Annual
GW-783	6/16/1994	4/27/2004	WL	9	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-786	6/8/1994	10/28/2003	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-787	6/8/1994	10/28/2003	WL	5	No	CHROMIUM III	NT	Annual
GW-788	6/10/1994	10/20/1999	WL	4	No	GROSS ALPHA ACTIVITY	D	Remove
GW-789	6/15/1994	10/15/2001	WL	9	No	GROSS ALPHA ACTIVITY	NT	Annual
GW-791	6/7/1994	10/25/2004	WL	19	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-792	6/7/1994	11/28/1999	WL	9	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-819	3/26/1998	3/26/1998	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-820	3/26/1998	10/13/2003	WL	6	Yes	TETRACHLOROETHYLENE(PCE)	NT	SemiAnnual
UEFPC-SP17	3/25/1996	11/5/2003	SP	3	Yes	NITRATE	N/A	Annual

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]).
Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.8
MAROS RESULTS FUEL STATION AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-183	6/19/1990	11/16/1993	WL	0	No	BENZENE	N/A	Biennial
GW-199	3/17/1986	11/16/1995	WL	0	No	LEAD	N/A	Biennial
GW-200	3/11/1986	4/30/1988	WL	0	No	LEAD	N/A	Remove
GW-202	3/11/1986	4/30/1988	WL	0	No	LEAD	ND	Biennial
GW-281	5/4/1989	5/10/2004	WL	0	No	LEAD	N/A	Remove
GW-282	5/8/1989	7/29/1992	WL	0	No	LEAD	N/A	Remove
GW-283	5/4/1989	10/14/1993	WL	0	No	LEAD	N/A	Remove
GW-658	3/9/1991	5/10/2004	WL	6	Yes	BENZENE	NT	SemiAnnual
GW-659	3/8/1991	7/28/1998	WL	2	No	BENZENE	N/A	Biennial
GW-751	7/30/1992	11/18/1996	WL	3	No	BENZENE	ND	Remove
GW-752	7/30/1992	11/18/1996	WL	3	No	BENZENE	ND	Remove
GW-753	7/31/1992	7/29/1998	WL	5	Yes	TRICHLOROETHYLENE (TCE)	NT	Biennial
GW-754	7/31/1992	7/28/1998	WL	5	Yes	TRICHLOROETHYLENE (TCE)	NT	Biennial
GW-756	7/31/1992	7/27/1998	WL	0	No	LEAD	N/A	Remove
GW-762	8/11/1992	8/5/2004	WL	12	Yes	TETRACHLOROETHYLENE(PCE)	I	SemiAnnual
GW-763	8/11/1992	11/1/2004	WL	20	Yes	TETRACHLOROETHYLENE(PCE)	NT	Annual
GW-766	2/1/1993	10/9/1996	WL	3	No	TETRACHLOROETHYLENE(PCE)	ND	Biennial
GW-767	2/2/1993	10/9/1996	WL	3	No	TETRACHLOROETHYLENE(PCE)	ND	Biennial
GW-773	2/3/1993	11/18/1995	WL	0	No	BENZENE	ND	Remove
GW-774	2/4/1993	11/18/1995	WL	0	No	LEAD	N/A	Remove
GW-775	2/4/1993	4/28/2004	WL	11	No	TRICHLOROETHYLENE (TCE)	NT	Annual
GW-776	2/4/1993	10/31/2002	WL	11	No	TRICHLOROETHYLENE (TCE)	S	Annual
GW-802	6/22/1998	5/10/2004	WL	4	No	BENZENE	ND	Biennial
NHPCEMSP	3/11/1996	9/3/1996	SP	2	No	BENZENE	N/A	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.8
MAROS RESULTS FUEL STATION AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-183	6/19/1990	11/16/1993	WL	0	No	BENZENE	N/A	Biennial
GW-199	3/17/1986	11/16/1995	WL	0	No	LEAD	N/A	Biennial
GW-200	3/11/1986	4/30/1988	WL	0	No	LEAD	N/A	Remove
GW-202	3/11/1986	4/30/1988	WL	0	No	LEAD	ND	Biennial
GW-281	5/4/1989	5/10/2004	WL	0	No	LEAD	N/A	Remove
GW-282	5/8/1989	7/29/1992	WL	0	No	LEAD	N/A	Remove
GW-283	5/4/1989	10/14/1993	WL	0	No	LEAD	N/A	Remove
GW-658	3/9/1991	5/10/2004	WL	6	Yes	BENZENE	NT	SemiAnnual
GW-659	3/8/1991	7/28/1998	WL	2	No	BENZENE	N/A	Biennial
GW-751	7/30/1992	11/18/1996	WL	3	No	BENZENE	ND	Remove
GW-752	7/30/1992	11/18/1996	WL	3	No	BENZENE	ND	Remove
GW-753	7/31/1992	7/29/1998	WL	5	Yes	TRICHLOROETHYLENE (TCE)	NT	Biennial
GW-754	7/31/1992	7/28/1998	WL	5	Yes	TRICHLOROETHYLENE (TCE)	NT	Biennial
GW-756	7/31/1992	7/27/1998	WL	0	No	LEAD	N/A	Remove
GW-762	8/11/1992	8/5/2004	WL	12	Yes	TETRACHLOROETHYLENE(PCE)	I	SemiAnnual
GW-763	8/11/1992	11/1/2004	WL	20	Yes	TETRACHLOROETHYLENE(PCE)	NT	Annual
GW-766	2/1/1993	10/9/1996	WL	3	No	TETRACHLOROETHYLENE(PCE)	ND	Biennial
GW-767	2/2/1993	10/9/1996	WL	3	No	TETRACHLOROETHYLENE(PCE)	ND	Biennial
GW-773	2/3/1993	11/18/1995	WL	0	No	BENZENE	ND	Remove
GW-774	2/4/1993	11/18/1995	WL	0	No	LEAD	N/A	Remove
GW-775	2/4/1993	4/28/2004	WL	11	No	TRICHLOROETHYLENE (TCE)	NT	Annual
GW-776	2/4/1993	10/31/2002	WL	11	No	TRICHLOROETHYLENE (TCE)	S	Annual
GW-802	6/22/1998	5/10/2004	WL	4	No	BENZENE	ND	Biennial
NHPCEMSP	3/11/1996	9/3/1996	SP	2	No	BENZENE	N/A	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.9
MAROS RESULTS EAST Y-12 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-148	2/23/1986	11/9/1999	WL	10	No	LEAD	NT	Biennial
GW-149	2/23/1986	11/14/1996	WL	3	No	GROSS BETA ACTIVITY	N/A	Biennial
GW-150	2/20/1986	3/8/1988	WL	0	Yes	LEAD	N/A	Remove
GW-151	2/20/1986	8/10/2004	WL	19	Yes	CARBON TETRACHLORIDE	I	SemiAnnual
GW-152	2/25/1986	2/28/1990	WL	0	Yes	LEAD	N/A	Remove
GW-153	2/24/1986	11/1/2004	WL	20	Yes	CARBON TETRACHLORIDE	S	Annual
GW-154	2/23/1986	8/11/2004	WL	20	Yes	GROSS ALPHA ACTIVITY	I	SemiAnnual
GW-167	5/30/1990	2/14/1996	WL	0	Yes	LEAD	N/A	Annual
GW-169	3/1/1991	10/25/2004	WL	13	Yes	LEAD	NT	Biennial
GW-170	6/4/1990	10/25/2004	WL	27	Yes	CARBON TETRACHLORIDE	D	Annual
GW-171	9/27/1994	8/9/2004	WL	16	No	GROSS BETA ACTIVITY	NT	Biennial
GW-172	6/4/1990	8/9/2004	WL	15	No	GROSS BETA ACTIVITY	NT	Annual
GW-207	6/1/1990	11/9/2004	WL	16	No	GROSS ALPHA ACTIVITY	S	Biennial
GW-208	6/1/1990	11/9/2004	WL	16	No	GROSS ALPHA ACTIVITY	S	Biennial
GW-220	2/20/1986	11/15/2004	WL	22	Yes	CARBON TETRACHLORIDE	I	SemiAnnual
GW-222	2/23/1986	11/30/2004	WL	8	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-223	2/25/1986	8/10/2004	WL	15	Yes	TETRACHLOROETHYLENE(PCE)	D	Annual
GW-230	6/6/1990	8/9/2004	WL	14	Yes	GROSS BETA ACTIVITY	NT	Annual
GW-232	6/8/1990	10/25/2004	WL	26	No	GROSS BETA ACTIVITY	NT	Biennial
GW-239	6/14/1990	10/30/1993	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-240	2/25/1986	10/22/2001	WL	8	Yes	CARBON TETRACHLORIDE	S	Annual
GW-380	12/22/1988	8/11/2004	WL	17	Yes	CHROMIUM III	NT	Annual
GW-381	12/17/1988	11/2/2004	WL	10	Yes	CARBON TETRACHLORIDE	NT	Annual
GW-382	12/10/1988	8/11/2004	WL	11	Yes	CARBON TETRACHLORIDE	D	Annual
GW-383	8/23/1988	11/3/2004	WL	21	Yes	TETRACHLOROETHYLENE(PCE)	NT	SemiAnnual
GW-384	8/18/1988	11/21/1996	WL	4	No	GROSS ALPHA ACTIVITY	S	Biennial
GW-385	8/22/1988	11/19/1996	WL	4	No	LEAD	PI	Biennial
GW-603	2/12/1990	11/25/1996	WL	4	No	LEAD	NT	Biennial
GW-733	4/28/1992	7/8/2004	WL	21	Yes	CARBON TETRACHLORIDE	D	Annual
GW-735	4/28/1992	11/15/2004	WL	15	No	GROSS ALPHA ACTIVITY	S	Annual

Notes:

1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.9
MAROS RESULTS EAST Y-12 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-744	4/28/1992	11/10/2004	WL	15	No	GROSS ALPHA ACTIVITY	S	Biennial
GW-745	4/29/1992	12/9/1997	WL	6	No	CADMIUM	ND	Biennial
GW-746	4/29/1992	12/9/1997	WL	6	No	CHROMIUM III	PI	Annual
GW-747	8/8/1992	11/10/2004	WL	15	No	GROSS BETA ACTIVITY	PI	Biennial
GW-748	8/8/1992	12/10/1997	WL	3	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-749	8/8/1992	12/10/1997	WL	6	No	GROSS ALPHA ACTIVITY	S	Biennial
GW-750	8/9/1992	11/5/2004	WL	18	No	GROSS BETA ACTIVITY	NT	Biennial
GW-816	9/21/1994	11/9/2004	WL	20	No	GROSS BETA ACTIVITY	S	Biennial
GW-817	9/21/1994	12/4/1997	WL	6	No	GROSS ALPHA ACTIVITY	S	Biennial
GW-832	5/14/1996	8/16/2004	WL	17	Yes	CARBON TETRACHLORIDE	D	Annual
GW-845	5/21/1998	5/21/1998	WL	1	Yes	CARBON TETRACHLORIDE	N/A	Extraction
RGQWWSP	6/19/1996	4/24/1997	SP	2	No	GROSS BETA ACTIVITY	N/A	Biennial
SCR7.10SP	4/9/1997	8/27/1998	SP	4	No	CARBON TETRACHLORIDE	ND	Biennial
SCR7.14SP	3/21/1996	3/21/1996	SP	1	No	GROSS BETA ACTIVITY	N/A	Biennial
SCR7.16SP	3/21/1996	3/21/1996	SP	1	No	GROSS ALPHA ACTIVITY	N/A	Biennial
SCR7.18SP	3/21/1996	5/30/2000	SP	10	No	CARBON TETRACHLORIDE	S	Biennial
SCR7.1SP	12/13/1995	7/19/2004	SP	19	No	CARBON TETRACHLORIDE	D	Biennial
SCR7.4SP	4/9/1997	8/27/1998	SP	4	No	CARBON TETRACHLORIDE	ND	Biennial
SCR7.6SP	4/9/1997	8/27/1998	SP	4	No	CARBON TETRACHLORIDE	ND	Biennial
SCR7.7SP	4/9/1997	8/27/1998	SP	4	No	CARBON TETRACHLORIDE	ND	Biennial
SCR7.8SP	4/9/1997	7/19/2004	SP	17	No	TETRACHLOROETHYLENE(PCE)	D	Biennial
SCR7.8SSP	3/18/1996	6/20/1996	SP	1	No	GROSS ALPHA ACTIVITY	N/A	Biennial
UV8.5SP	6/19/1996	7/17/1996	SP	2	No	CARBON TETRACHLORIDE	N/A	Biennial
UV8.6SP	7/17/1996	7/17/1996	SP	1	No	CARBON TETRACHLORIDE	N/A	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.10
MAROS RESULTS WEST CHESTNUT RIDGE

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
1090	2/13/1986	8/4/2004	WL	17	No	LEAD	S	Biennial
GW-141	2/18/1988	7/15/2004	WL	17	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-203	2/6/1986	8/3/2004	WL	15	No	GROSS ALPHA ACTIVITY	PI	Annual
GW-205	2/6/1986	8/3/2004	WL	16	No	GROSS BETA ACTIVITY	PI	Annual
GW-217	2/17/1988	7/14/2004	WL	17	No	GROSS BETA ACTIVITY	D	Biennial
GW-221	2/7/1986	8/4/2004	WL	16	No	GROSS ALPHA ACTIVITY	NT	Annual
GW-302	5/16/1990	8/12/2003	WL	15	Yes	CHROMIUM III	NT	Annual
GW-305	2/18/1988	10/26/2004	WL	26	Yes	NICKEL	I	SemiAnnual
GW-339	5/15/1990	8/11/2003	WL	15	No	CHROMIUM III	NT	Biennial
GW-521	9/8/1989	7/14/2004	WL	20	No	CADMIUM	ND	Biennial
GW-522	8/30/1989	7/14/2004	WL	18	No	LEAD	D	Biennial
GW-539	3/16/1991	7/17/2002	WL	10	Yes	CHROMIUM III	D	Biennial
GW-540	3/16/1991	7/21/2004	WL	15	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-541	3/17/1991	4/15/1996	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-542	3/17/1991	7/21/2004	WL	15	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-543	3/17/1991	7/21/2004	WL	18	No	CADMIUM	ND	Biennial
GW-544	3/17/1991	7/21/2004	WL	18	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-546	3/17/1991	4/9/1996	WL	1	No	LEAD	ND	Remove
GW-709	6/19/1991	7/22/2004	WL	15	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-757	6/15/1992	7/22/2004	WL	18	No	CHROMIUM III	D	Biennial
GW-827	4/5/1995	7/20/2004	WL	16	No	GROSS BETA ACTIVITY	D	Biennial
SCR1.25SP	2/16/1999	8/17/2004	SP	12	No	GROSS ALPHA ACTIVITY	NT	Annual
SCR2.1SP	4/7/1997	7/19/2004	SP	14	No	GROSS ALPHA ACTIVITY	S	Biennial
SCR2.2SP	3/15/1995	7/19/2004	SP	14	No	LEAD	S	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.10
MAROS RESULTS WEST CHESTNUT RIDGE

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
1090	2/13/1986	8/4/2004	WL	17	No	LEAD	S	Biennial
GW-141	2/18/1988	7/15/2004	WL	17	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-203	2/6/1986	8/3/2004	WL	15	No	GROSS ALPHA ACTIVITY	PI	Annual
GW-205	2/6/1986	8/3/2004	WL	16	No	GROSS BETA ACTIVITY	PI	Annual
GW-217	2/17/1988	7/14/2004	WL	17	No	GROSS BETA ACTIVITY	D	Biennial
GW-221	2/7/1986	8/4/2004	WL	16	No	GROSS ALPHA ACTIVITY	NT	Annual
GW-302	5/16/1990	8/12/2003	WL	15	Yes	CHROMIUM III	NT	Annual
GW-305	2/18/1988	10/26/2004	WL	26	Yes	NICKEL	I	SemiAnnual
GW-339	5/15/1990	8/11/2003	WL	15	No	CHROMIUM III	NT	Biennial
GW-521	9/8/1989	7/14/2004	WL	20	No	CADMIUM	ND	Biennial
GW-522	8/30/1989	7/14/2004	WL	18	No	LEAD	D	Biennial
GW-539	3/16/1991	7/17/2002	WL	10	Yes	CHROMIUM III	D	Biennial
GW-540	3/16/1991	7/21/2004	WL	15	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-541	3/17/1991	4/15/1996	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-542	3/17/1991	7/21/2004	WL	15	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-543	3/17/1991	7/21/2004	WL	18	No	CADMIUM	ND	Biennial
GW-544	3/17/1991	7/21/2004	WL	18	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-546	3/17/1991	4/9/1996	WL	1	No	LEAD	ND	Remove
GW-709	6/19/1991	7/22/2004	WL	15	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-757	6/15/1992	7/22/2004	WL	18	No	CHROMIUM III	D	Biennial
GW-827	4/5/1995	7/20/2004	WL	16	No	GROSS BETA ACTIVITY	D	Biennial
SCR1.25SP	2/16/1999	8/17/2004	SP	12	No	GROSS ALPHA ACTIVITY	NT	Annual
SCR2.1SP	4/7/1997	7/19/2004	SP	14	No	GROSS ALPHA ACTIVITY	S	Biennial
SCR2.2SP	3/15/1995	7/19/2004	SP	14	No	LEAD	S	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

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TABLE B.11
MAROS RESULTS CHESTNUT RIDGE SECURITY PITS

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-173	2/4/1986	10/4/2004	WL	2	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
GW-174	2/4/1986	8/21/2001	WL	3	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
GW-175	8/17/1988	10/6/2004	WL	5	Yes	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-176	2/4/1986	10/7/2004	WL	2	Yes	1,1-DICHLOROETHENE	N/A	Annual
GW-177	2/4/1986	7/13/2004	WL	9	No	LEAD	ND	Biennial
GW-178	3/12/1988	10/6/2004	WL	2	No	LEAD	N/A	Annual
GW-179	2/10/1986	10/7/2004	WL	2	Yes	1,1-DICHLOROETHENE	N/A	Annual
GW-180	3/11/1988	8/21/2001	WL	2	Yes	TETRACHLOROETHYLENE(PCE)	N/A	SemiAnnual
GW-181	8/16/1988	11/6/1995	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-184	2/25/1986	4/30/1996	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-186	3/4/1986	5/1/1996	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-188	2/24/1986	4/30/1996	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-322	3/12/1988	10/11/2004	WL	3	Yes	1,1-DICHLOROETHENE	N/A	SemiAnnual
GW-511	8/16/1988	11/7/1995	WL	0	No	LEAD	N/A	Biennial
GW-512	12/6/1988	5/2/1996	WL	0	No	CADMIUM	N/A	Biennial
GW-513	12/3/1988	10/13/2004	WL	2	No	GROSS ALPHA ACTIVITY	N/A	Annual
GW-514	12/8/1988	8/16/2001	WL	2	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-608	2/10/1990	8/20/2001	WL	7	No	TETRACHLOROETHYLENE(PCE)	S	Annual
GW-609	2/14/1990	1/10/2001	WL	14	Yes	TETRACHLOROETHYLENE(PCE)	D	Annual
GW-610	2/9/1990	10/20/2004	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-611	2/9/1990	10/20/2004	WL	3	No	1,1-DICHLOROETHENE	N/A	Annual
GW-612	2/10/1990	10/5/2004	WL	5	Yes	1,1-DICHLOROETHENE	NT	Annual
GW-679	4/19/2004	10/12/2004	WL	2	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-680	6/7/2004	10/13/2004	WL	2	No	LEAD	N/A	Biennial
GW-742	4/10/1992	10/18/2004	WL	3	No	GROSS ALPHA ACTIVITY	N/A	Annual
GW-743	4/7/1992	10/18/2004	WL	2	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-831	8/27/1996	7/12/2004	WL	18	No	LEAD	D	Biennial
SCR3.4SP	4/8/1997	2/20/2001	SP	6	No	GROSS ALPHA ACTIVITY	PI	Annual
SCR3.5SP	4/8/1997	8/17/2004	SP	16	No	GROSS ALPHA ACTIVITY	NT	Annual

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

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TABLE B.12
MAROS RESULTS LANDFILLS V AND VII AREAS

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-557	5/26/1993	7/20/2004	WL	18	No	TETRACHLOROETHYLENE(PCE)	ND	Biennial
GW-560	5/26/1993	7/19/2004	WL	15	No	TETRACHLOROETHYLENE(PCE)	ND	Remove
GW-562	5/26/1993	7/19/2004	WL	15	No	TETRACHLOROETHYLENE(PCE)	ND	Remove
GW-564	5/26/1993	7/19/2004	WL	15	No	TETRACHLOROETHYLENE(PCE)	ND	Remove
GW-796	5/27/1993	7/20/2004	WL	18	No	TETRACHLOROETHYLENE(PCE)	ND	Biennial
GW-797	5/27/1993	7/15/2004	WL	18	No	LEAD	D	Biennial
GW-798	6/23/1993	7/20/2004	WL	21	No	TETRACHLOROETHYLENE(PCE)	I	Annual
GW-799	5/27/1993	7/19/2004	WL	18	No	TETRACHLOROETHYLENE(PCE)	ND	Biennial
GW-801	7/24/1993	7/15/2004	WL	18	No	TETRACHLOROETHYLENE(PCE)	ND	Biennial
SCR4.3SP	2/14/1994	7/22/2004	SP	18	No	TETRACHLOROETHYLENE(PCE)	ND	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

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TABLE B.13
MAROS RESULTS EAST CHESTNUT RIDGE

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Earliest Sample Date	Most Recent Sample Date	Location Type	Number of Samples 1996-2005	Average Concentration Exceeds Screening Level	Historic Priority Constituent	Trend for Priority Constituent 1996-2005	Preliminary Frequency
GW-142	2/27/1986	10/8/2003	WL	17	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-143	3/6/1986	10/12/2004	WL	19	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-144	2/28/1986	10/12/2004	WL	19	No	GROSS ALPHA ACTIVITY	NT	Biennial
GW-145	3/5/1986	10/12/2004	WL	19	No	GROSS ALPHA ACTIVITY	S	Annual
GW-156	2/22/1986	10/14/2004	WL	17	No	URANIUM	D	Biennial
GW-159	2/19/1986	10/13/2004	WL	2	Yes	GROSS ALPHA ACTIVITY	N/A	Annual
GW-160	2/4/1988	4/29/1996	WL	1	Yes	LEAD	N/A	Annual
GW-231	3/7/1986	10/11/2004	WL	19	No	GROSS ALPHA ACTIVITY	D	Biennial
GW-241	2/28/1986	8/16/2001	WL	2	No	LEAD	N/A	Annual
GW-292	12/22/1987	5/8/1996	WL	1	No	CADMIUM	ND	Remove
GW-293	12/22/1987	5/8/1996	WL	1	No	LEAD	ND	Remove
GW-298	2/3/1988	5/1/1996	WL	1	No	LEAD	ND	Remove
GW-299	2/3/1988	4/30/1996	WL	1	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-300	2/1/1988	10/12/2004	WL	3	No	LEAD	N/A	Annual
GW-301	2/3/1988	7/12/2004	WL	18	No	LEAD	D	Biennial
GW-303	12/17/1988	7/16/1995	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-304	12/20/1988	7/12/1995	WL	0	No	GROSS ALPHA ACTIVITY	N/A	Remove
GW-731	9/27/1991	10/13/2004	WL	2	No	LEAD	N/A	Biennial
GW-732	9/27/1991	10/14/2004	WL	2	No	GROSS ALPHA ACTIVITY	N/A	Biennial
GW-841	2/6/1997	3/2/2004	WL	8	Yes	TRICHLOROETHYLENE (TCE)	D	Annual
GW-842	2/5/1997	8/18/2004	WL	11	No	TRICHLOROETHYLENE (TCE)	NT	Annual
GW-843	2/5/1997	8/18/2004	WL	1	No	URANIUM	N/A	Annual
GW-844	2/5/1997	2/5/1997	WL	1	No	BENZENE	ND	Annual
SCR5.1SP	4/10/1997	8/15/2001	SP	4	No	GROSS ALPHA ACTIVITY	NT	Annual
SCR5.2SP	2/19/2001	8/19/2002	SP	1	No	GROSS ALPHA ACTIVITY	N/A	Annual
SCR5.4SP	4/8/1997	8/15/2001	SP	8	No	GROSS ALPHA ACTIVITY	NT	Biennial

Notes:
1. Well sample dates taken from Y-12 Analytical Database.
2. WL = Groundwater Monitoring Well; SP = Spring.
3. Trend = Insufficient Data (N/A), Decreasing (D), Probably Decreasing (PD), Stable (S), Probably Increasing (PI), and Increasing (I), No Trend (NT); and non-detect for all sample events (ND).
4. Number of samples between 1996-2005 is the count of analytical samples acquired at the location based on the BWXT Analytical Database (2005).
5. Priority Constituent is the COC with the highest average concentration from the full dataset normalized by the screening level. (e.g. MAX [Ave Conc./Screening Level]). Priority constituent indicated for wells where average concentrations do not exceed screening levels may be background level.
6. Remove = Do not sample; SemiAnnual = sample once every 6 months; Annual = sample once per year; Biennial = sample once every two years.

GROUNDWATER SERVICES, INC.

TABLE B.14
SUMMARY SAMPLING RECOMMENDATIONS BEAR CREEK REGIME

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Regulated Sample Locations						
BC	Oil Landfarm WMA	GW-008	NT	Annual	Regulated	Sample as per permit
BC	Bear Creek Burial Grounds WMA	GW-046	NT	Annual	Regulated	Sample as per permit, sample all COCs annually
BC	Bear Creek Burial Grounds WMA	GW-077	ND	Biennial	Regulated	Sample as per ROD, largely ND well, consider reduced effort
BC	Bear Creek Burial Grounds WMA	GW-078	ND	Biennial	Regulated	Sample as per ROD, largely ND well, consider reduced effort
BC	Bear Creek Burial Grounds WMA	GW-079	N/A	Biennial	Regulated	Sample as per ROD, concentrations consistent w/Biennial sampling
BC	Bear Creek Burial Grounds WMA	GW-080	ND	Biennial	Regulated	Sample as per ROD, largely ND well, consider reduced effort
BC	S-3 Site	GW-276	D	Annual	Regulated	Sample as per permit, consider annual sampling as trend is Decreasing
BC	Oil Landfarm WMA	GW-363	PD	Biennial	Regulated	Sample as alternate RCRA well, reduced frequency for Probably Decreasing trend
BC	S-3 Site	GW-526	N/A	SemiAnnual	Regulated	Sample as per ROD
BC	Bear Creek Burial Grounds WMA	GW-639	NT	Biennial	Regulated	Sample as per permit/ROD, consider reduced effort
BC	Exit Pathway - Traverse A	GW-683	D	Annual	Regulated	Sample as per ROD, consider annual sampling
BC	Exit Pathway - Traverse A	GW-684	S	Annual	Regulated	Sample as per ROD, consider annual sampling
BC	Exit Pathway - Traverse B	GW-704	S	Annual	Regulated	Sample as per ROD
BC	Exit Pathway - Traverse B	GW-706	D	Annual	Regulated	Sample as per ROD
BC	Exit Pathway - Traverse W	GW-712	NT	Biennial	Regulated	largely non-detect, consider reduced effort
BC	Exit Pathway - Traverse W	GW-713	N/A	Annual	Regulated	sampling
BC	Exit Pathway - Traverse W	GW-714	PD	Annual	Regulated	sampling
BC	S-3 Ponds	GW-835	I	SemiAnnual	Regulated	above MCL, sample at least annually
BC	EMWMF	GW-916	NT	Annual	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-917	PI	Biennial	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-918	NT	Biennial	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-919	N/A	Annual	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-920	NT	Annual	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-921	NT	Biennial	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-922	S	Biennial	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-923	NT	Biennial	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-924	ND	Biennial	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-925	NT	Biennial	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-926	NT	Biennial	Regulated	Sample as per permit, low concentrations, consider reduced effort
BC	EMWMF	GW-927	NT	Biennial	Regulated	Sample as per permit, low concentrations, consider reduced effort

See Notes End of Table

GROUNDWATER SERVICES, INC.

TABLE B.14
SUMMARY SAMPLING RECOMMENDATIONS BEAR CREEK REGIME

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
BC	Exit Pathway Spring/Surface Water	SS-6.6	NT	Biennial	Regulated	Sampled as spring location SS-6
BC	Exit Pathway Spring/Surface Water	SS-6E	PI	SemiAnnual	Regulated	Sampled as spring SS-6
BC	Exit Pathway Spring/Surface Water	SS-6W	NT	Annual	Regulated	Sampled as SS-6
BC	Exit Pathway Spring/Surface Water	SS-7	I	Annual	Regulated	Sample as per ROD, consider annual sampling
BC	Exit Pathway Spring/Surface Water	SS-8	N/A	Biennial	Regulated	Sample as per ROD
Semi-Annual Sampling						
BC	Bear Creek Burial Grounds WMA	GW-014	N/A	SemiAnnual	SemiAnnual	Sample semi-annually to annually as alternate RCRA location, evaluate trend with more data
BC	Bear Creek Burial Grounds WMA	GW-071	NT	SemiAnnual	SemiAnnual	Sample semi-annually to annually as alternate RCRA location, evaluate trend with more data
BC	Bear Creek Burial Grounds WMA	GW-082	I	SemiAnnual	SemiAnnual	Sample semi-annually to annually as alternate RCRA location, evaluate trend with more data
BC	Oil Landfarm WMA	GW-085	PI	SemiAnnual	SemiAnnual	Probably Increasing trend for Nitrate, on-strike with GW-537, GW-829
BC	Oil Landfarm WMA	GW-225	NT	SemiAnnual	SemiAnnual	Sanitary Landfill I area, historic high concentrations
BC	Oil Landfarm WMA	GW-226	S	SemiAnnual	SemiAnnual	Sanitary Landfill I area, historic high concentrations
BC	S-3 Site	GW-243	N/A	SemiAnnual	SemiAnnual	Source area well, may be redundant, Sample 4 X in 2 to 4 yrs; historic high concentrations, consider removing from program after trend established
BC	S-3 Site	GW-246	N/A	SemiAnnual	SemiAnnual	Source area well, may be redundant, Sample 4 X in 2 to 4 yrs; historic high concentrations, consider removing from program after trend established
BC	Bear Creek Burial Grounds WMA	GW-257	N/A	SemiAnnual	SemiAnnual	Sample semi-annually to annually as alternate RCRA location, evaluate trend with more data
BC	Bear Creek Burial Grounds WMA	GW-289	PI	SemiAnnual	SemiAnnual	Sample semi-annually to annually as alternate RCRA location, evaluate trend with more data
BC	S-3 Site	GW-615	N/A	SemiAnnual	SemiAnnual	Source area well, may be redundant, Sample 4 X in 2 to 4 yrs; historic high concentrations, consider removing from program after trend established
BC	Bear Creek Burial Grounds WMA	GW-626	PI	SemiAnnual	SemiAnnual	Above MCL, Probably Increasing trend
BC	Bear Creek Burial Grounds WMA	GW-627	I	SemiAnnual	SemiAnnual	Above MCL, Increasing trend
BC	Exit Pathway - Traverse B	GW-694	NT	SemiAnnual	SemiAnnual	Above MCL, high data variability

GROUNDWATER SERVICES, INC.

TABLE B.14
SUMMARY SAMPLING RECOMMENDATIONS BEAR CREEK REGIME

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Annual Sampling						
BC	Bear Creek Burial Grounds WMA	GW-069	PI	Annual	Annual	Sample annually to biennially, possible increasing VC trend in alternate RCRA well
BC	Oil Landfarm WMA	GW-098	NT	Annual	Annual	Historic exceedance, surveillance well
BC	S-3 Site	GW-100	N/A	SemiAnnual	Annual	Sample annually and evaluate trend for nitrate and beta, midpoint between SS-1 and GW-835
BC	S-3 Site	GW-101	N/A	SemiAnnual	Annual	Source area well, may be redundant, Sample 4 X in 2 to 4 yrs; historic high concentrations, consider removing from program after trend established
BC	S-3 Site	GW-127	N/A	Annual	Annual	Sample 4 X in 2 to 4 yrs; historic high concentrations of alpha and beta (not nitrate)
BC	Oil Landfarm WMA	GW-229	S	Annual	Annual	support MNA
BC	S-3 Site	GW-236	N/A	SemiAnnual	Annual	Sample annually and evaluate trend for nitrate and beta, may be redundant with SS-1
BC	Bear Creek Burial Grounds WMA	GW-291	S	SemiAnnual	Annual	Stable trend, Sample semi-annually to annually as alternate RCRA location
BC	Rust Spoil Area	GW-311	D	Annual	Annual	Monitor annually, Decreasing trend
BC	Spoil Area I	GW-315	PD	Annual	Annual	Sample annually for VOC in Spoil Area 1, Probably Decreasing trend
BC	Oil Landfarm WMA	GW-537	D	Annual	Annual	Sample as alternate CERCLA well, Decreasing nitrate trend, on strike with GW-085 and GW-829
BC	S-3 Site	GW-616	N/A	SemiAnnual	Annual	Historic nitrate exceedances, possible
BC	Bear Creek Burial Grounds	GW-653	I	Annual	Annual	Low concentration Increasing trend
BC	Exit Pathway - Traverse B	GW-695	S	Annual	Annual	Low concentration, Stable trend
BC	Exit Pathway - Traverse B	GW-703	NT	Annual	Annual	Redundant location
BC	Exit Pathway - Traverse W	GW-715	PI	Annual	Annual	Potential Exit Pathway
BC	Exit Pathway - Traverse C	GW-724	S	Annual	Annual	Historic exceedance, surveillance well
BC	Exit Pathway - Traverse C	GW-725	PI	Annual	Annual	Historic exceedance, surveillance well
BC	Exit Pathway - Traverse C	GW-738	D	Annual	Annual	Historic exceedance, surveillance well
BC	Exit Pathway - Traverse C	GW-740	PD	Annual	Annual	Historic exceedance, surveillance well
BC	S-3 Site	GW-829	D	Annual	Annual	Decreasing trend, sample annually
BC	Exit Pathway Spring/Surface Water	SS-1	S	Annual	Annual	Spring with Stable trend, sample annually
BC	Exit Pathway Spring/Surface Water	SS-4	D	Annual	Annual	Important locations, Decreasing trend
BC	Exit Pathway Spring/Surface Water	SS-5	S	Annual	Annual	Stable trend, priority location

See Notes End of Table

GROUNDWATER SERVICES, INC.

TABLE B.14
SUMMARY SAMPLING RECOMMENDATIONS BEAR CREEK REGIME

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Biennial Sampling						
BC	Oil Landfarm WMA	GW-006	S	Annual	Biennial	Low concentration, Stable trend, reduced frequency
BC	Oil Landfarm WMA	GW-010	N/A	Biennial	Biennial	Sample as alternate RCRA well
BC	Bear Creek Burial Grounds WMA	GW-053	PD	Annual	Biennial	Probably Decreasing trend, consider reducing sample frequency
BC	Exit Pathway - Traverse A	GW-056	S	Biennial	Biennial	Low concentration, Stable trend
BC	Oil Landfarm WMA	GW-075	N/A	Biennial	Biennial	Sample as alternate RCRA well, low concentrations
BC	Bear Creek Burial Grounds WMA	GW-287	S	Annual	Biennial	Low concentration, Stable trend
BC	Exit Pathway - Traverse B	GW-621	PD	Annual	Biennial	Low concentration, Probably Decreasing trend
BC	Bear Creek Burial Grounds WMA	GW-629	S	Biennial	Biennial	Low concentration, outliers 1991?
BC	Exit Pathway - Traverse A	GW-685	S	Biennial	Biennial	Low concentration, Stable trend
BC	Exit Pathway - Traverse C	GW-723	PI	Annual	Biennial	Low concentrations, may be Increasing, but redundant location, reduce frequency
Review						
BC	Bear Creek Burial Grounds WMA	GW-045	N/A	Biennial	Review	Evaluate well construction, if useful sample to determine trend, consider retaining as DTW well
BC	Bear Creek Burial Grounds WMA	GW-052	N/A	Annual	Review	Historic high uranium concentration, sample 2X and review trend
BC	Exit Pathway - Traverse A	GW-057	N/A	Remove	Review	Low concentrations, high priority but redundant location, consider removing from program
BC	Bear Creek Burial Grounds WMA	GW-058	N/A	Biennial	Review	Historic uranium hits, review location, if redundant remove from program, consider biennial sampling if unique
BC	Bear Creek Burial Grounds WMA	GW-061	N/A	Annual	Review	Historic high uranium concentration, sample 2X and review trend
BC	Oil Landfarm WMA	GW-064	N/A	Biennial	Review	Historic exceedance, review location and sample or remove
BC	Oil Landfarm WMA	GW-066	N/A	SemiAnnual	Review	Historic exceedance, review location and sample or remove
BC	Oil Landfarm WMA	GW-067	N/A	Biennial	Review	Historic exceedance, review location and sample or remove
BC	Bear Creek Burial Grounds WMA	GW-068	N/A	Biennial	Review	Historic high concentrations, review well construction and function and sample or remove from program
BC	Bear Creek Burial Grounds WMA	GW-089	N/A	Biennial	Review	Evaluate location, consider sampling for MNA support or removing from program
BC	S-3 Site	GW-122	N/A	Annual	Review	Historic high concentrations of nitrate, review function and sample 4X in 10 yrs, may be redundant w/GW-127

See Notes End of Table

GROUNDWATER SERVICES, INC.

TABLE B.14
SUMMARY SAMPLING RECOMMENDATIONS BEAR CREEK REGIME

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
BC	S-3 Site	GW-123	N/A	Annual	Review	Historic gross alpha and beta exceedances, sample 4 X in 10 yrs and consider removing from program, may be redundant w/GW-127
BC	S-3 Site	GW-124	N/A	SemiAnnual	Review	Historic beta and nitrate exceedances, review location and function, sample 4X in 10 yrs and consider removing from program
BC	S-3 Site	GW-125	N/A	Annual	Review	Review location and function or well, historic variance in data, consider removing from program
BC	Bear Creek Burial Grounds WMA	GW-126	N/A	Biennial	Review	Limited use, consider removing from program
BC	Oil Landfarm WMA	GW-227	N/A	Annual	Review	Historic exceedance, review location and sample or remove
BC	Oil Landfarm WMA	GW-228	N/A	Biennial	Review	Historic exceedance, review location and sample or remove
BC	Bear Creek Burial Grounds WMA	GW-242	N/A	Annual	Review	Historic concentrations of vinyl chloride, could support MNA remedy, consider annual or biennial sampling
BC	S-3 Site	GW-244	N/A	Biennial	Review	Source area well, may be redundant, Sample 4 X in 2 to 4 yrs; historic high concentrations, consider removing from program after trend established
BC	S-3 Site	GW-245	N/A	Biennial	Review	Source area well, may be redundant, Sample 4 X in 2 to 4 yrs; historic high concentrations, consider removing from program after trend established
BC	S-3 Site	GW-247	N/A	Biennial	Review	Source area well, may be redundant, Sample 4 X in 2 to 4 yrs; historic high concentrations, consider removing from program after trend established
BC	Bear Creek Burial Grounds WMA	GW-258	N/A	Remove	Review	Historic high concentrations, review well construction and function and sample or remove from program
BC	Bear Creek Burial Grounds WMA	GW-259	N/A	Annual	Review	Historic high concentrations, review well construction and function and sample or remove from program
BC	S-3 Site	GW-277	N/A	Annual	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program
BC	Bear Creek Burial Grounds WMA	GW-288	N/A	SemiAnnual	Review	Historic high concentrations, review well construction and function and sample or remove from program
BC	Rust Spoil Area	GW-306	N/A	Biennial	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as surveillance midpoint between GW-311 and GW-724
BC	Rust Spoil Area	GW-307	N/A	Biennial	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program
BC	Rust Spoil Area	GW-308	N/A	Biennial	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program
BC	Rust Spoil Area	GW-309	N/A	Biennial	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program

See Notes End of Table

GROUNDWATER SERVICES, INC.

TABLE B.14
SUMMARY SAMPLING RECOMMENDATIONS BEAR CREEK REGIME

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
BC	Rust Spoil Area	GW-310	N/A	Biennial	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program
BC	Rust Spoil Area	GW-312	N/A	Biennial	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program
BC	Spoil Area I	GW-313	N/A	Annual	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program
BC	Spoil Area I	GW-314	N/A	Annual	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program
BC	Spoil Area I	GW-317	N/A	Biennial	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program
BC	S-3 Site	GW-345	N/A	Annual	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program, may be redundant w/GW-526
BC	S-3 Site	GW-346	N/A	SemiAnnual	Review	Review condition and location, sample 4 X in 10 yrs or consider retaining as DTW in program, may be redundant w/GW-526
BC	Industrial Landfill I	GW-364	N/A	Annual	Review	Historic exceedance, review location and sample or remove
BC	Industrial Landfill I	GW-365	N/A	Annual	Review	Historic exceedance, review location and sample or remove
BC	Industrial Landfill I	GW-367	N/A	Biennial	Review	Historic exceedance, review location and sample or remove
BC	Industrial Landfill I	GW-368	N/A	Biennial	Review	Historic exceedance, review location and sample or remove
BC	Industrial Landfill I	GW-369	N/A	Biennial	Review	Historic exceedance, review location and sample or remove
BC	Oil Landfarm WMA	GW-601	N/A	Biennial	Review	Historic exceedance, review location and sample or remove
BC	Bear Creek Burial Grounds WMA	GW-623	N/A	Annual	Review	Sample annually to confirm trend in deep area
BC	Bear Creek Burial Grounds WMA	GW-624	N/A	SemiAnnual	Review	Historic high concentrations, review well construction and function and sample or remove from program
BC	Bear Creek Burial Grounds WMA	GW-654	N/A	Biennial	Review	Probably redundant, review location and consider removal
BC	Exit Pathway - Traverse W	GW-710	ND	Biennial	Review	Historic outlier for nitrate, reduced frequency or remove from program
BC	Exit Pathway - Traverse W	GW-711	ND	Annual	Review	Largely non-detect well; however has high function consider removing from program or sample at reduced frequency
BC	Exit Pathway - Traverse C	GW-736	N/A	SemiAnnual	Review	Historic exceedance, review location and sample or remove
BC	Exit Pathway - Traverse C	GW-737	N/A	SemiAnnual	Review	Historic exceedance, review location and sample or remove
BC	Exit Pathway - Traverse C	GW-739	N/A	SemiAnnual	Review	Historic exceedance, review location and sample or remove
BC	Above Grade Low Level Waste Storage Fac.	GW-795	N/A	Biennial	Review	Low to non-detect, consider removing from program or reduced frequency
BC	Exit Pathway Spring/Surface Water	SS-5.95KM	N/A	Annual	Review	Review location of spring, if sampling is redundant w/other locations, remove from program

See Notes End of Table

GROUNDWATER SERVICES, INC.

TABLE B.14
SUMMARY SAMPLING RECOMMENDATIONS BEAR CREEK REGIME

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Remove from Routine Monitoring						
BC	Oil Landfarm WMA	GW-013	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-018	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-047	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-054	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-072	N/A	Remove	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-073	ND	Biennial	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-074	ND	Biennial	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-083	N/A	Biennial	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-084	PI	Biennial	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-086	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-091	N/A	Annual	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-094	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-095	N/A	Remove	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-097	N/A	Biennial	Remove	Keep as DTW well
BC	S-3 Site	GW-115	NT	Annual	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-120	ND	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-237	N/A	Biennial	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-248	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-249	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-250	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-286	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-290	N/A	Biennial	Remove	Keep as DTW well
BC	Spoil Area I	GW-316	N/A	Biennial	Remove	Keep as DTW well
BC	Spoil Area I	GW-323	N/A	Biennial	Remove	Keep as DTW well
BC	S-3 Site	GW-325	N/A	Biennial	Remove	Keep as DTW well
BC	S-3 Site	GW-347	N/A	Biennial	Remove	Keep as DTW well
BC	S-3 Site	GW-348	N/A	Biennial	Remove	Keep as DTW well
BC	Industrial Landfill I	GW-366	N/A	Remove	Remove	Keep as DTW well

See Notes End of Table

GROUNDWATER SERVICES, INC.

TABLE B.14
SUMMARY SAMPLING RECOMMENDATIONS BEAR CREEK REGIME

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
BC	Bear Creek Burial Grounds WMA	GW-370	N/A	Biennial	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-372	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-375	N/A	Remove	Remove	Keep as DTW well
BC	Industrial Landfill I	GW-520	N/A	Remove	Remove	Keep as DTW well
BC	Lysimeter Demo	GW-531	N/A	Biennial	Remove	Keep as DTW well
BC	S-3 Site	GW-613	N/A	Biennial	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-622	N/A	Remove	Remove	Keep as DTW well
BC	Lysimeter Demo	GW-630	N/A	Biennial	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-636	N/A	Remove	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-637	N/A	Remove	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-638	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-641	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-642	ND	Remove	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-645	N/A	Biennial	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-646	N/A	Biennial	Remove	Keep as DTW well
BC	Rust Spoil Area	GW-648	N/A	Biennial	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-651	N/A	Remove	Remove	Keep as DTW well
BC	Bear Creek Burial Grounds WMA	GW-652	N/A	Remove	Remove	Keep as DTW well
BC	Above Grade Low Level Waste Storage Fac.	GW-794	N/A	Biennial	Remove	Keep as DTW well
BC	Oil Landfarm WMA	GW-800	N/A	Biennial	Remove	Keep as DTW well

Notes

1. Final Frequency for 183 locations:
   Regulated = Sampling location and frequency covered under RCRA post-closure permit, CERCLA interim/rinal ROD or other regulatory program.
   Semi-annual = Locations recommended for semi-annual sampling (every 6 months) based on trend, exceedance of MCL and location in network.
   Annual = Locations recommended for annual sampling (once per year) based on trend, exceedance of MCL and location in network.
   Biennial = Wells recommended for Biennial sampling (once every 2 years) based on trend, exceedance of MCL and location in network.
   Review = Review status of well, if well is in good working order, re-evaluated concentration trend for 4 sample events after 1996.
   If concentration trends are Stable to Decreasing, consider removing the well from routine monitoring program.
   Remove = Well does not provide significant data in support of monitoring objectives.
2. Well GW-012 is listed as a RCRA permit well (Oil Landfarm WMA), but no data were available in the database to evaluate this location.

TABLE B.15
SUMMARY SAMPLING RECOMMENDATIONS EAST FORK REGIME

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Regulated Sample Locations						
EF	S-3 Site	GW-108	NT	SemiAnnual	Regulated	Sample as per permit
EF	New Hope Pond	GW-151	I	SemiAnnual	Regulated	Sample as per ROD
EF	New Hope Pond	GW-154	I	SemiAnnual	Regulated	Sample as per ROD
EF	Union Valley - Exit Pathway	GW-169	NT	Biennial	Regulated	Sample as per ROD
EF	Union Valley - Exit Pathway	GW-170	D	Annual	Regulated	Sample as per ROD
EF	Union Valley - Exit Pathway	GW-171	NT	Biennial	Regulated	Sample as per ROD
EF	Union Valley - Exit Pathway	GW-172	NT	Annual	Regulated	Sample as per ROD
EF	Y-12 Plant Site	GW-193	D	Biennial	Regulated	Sample as per permit
EF	Uranium Oxide Vault	GW-219	D	Annual	Regulated	Sample as per ROD
EF	New Hope Pond	GW-220	I	SemiAnnual	Regulated	Sample as per ROD
EF	New Hope Pond	GW-223	D	Annual	Regulated	Sample as per ROD
EF	Union Valley - Exit Pathway	GW-230	NT	Annual	Regulated	Sample as per ROD
EF	Union Valley - Exit Pathway	GW-232	NT	Biennial	Regulated	Sample as per ROD
EF	S-2 Site	GW-253	I	SemiAnnual	Regulated	Semi-annual sampling for Increasing cadmium trend, or as per ROD
EF	Y-12 Fuel Station	GW-281	N/A	Remove	Regulated	Sample as per ROD
EF	New Hope Pond	GW-380	NT	Annual	Regulated	Sample as per ROD
EF	New Hope Pond	GW-381	NT	Annual	Regulated	Sample as per ROD
EF	New Hope Pond	GW-382	D	Annual	Regulated	Sample as per ROD
EF	New Hope Pond	GW-383	NT	SemiAnnual	Regulated	Sample as per ROD
EF	Exit Pathway - Traverse I	GW-605	D	Annual	Regulated	Sample as per permit or as per ROD
EF	Exit Pathway - Traverse I	GW-606	D	Annual	Regulated	Sample as per permit or as per ROD
EF	Exit Pathway - Traverse E	GW-618	D	Annual	Regulated	Sample as per ROD
EF	Y-12 Fuel Station	GW-658	NT	SemiAnnual	Regulated	Sample as per ROD
EF	Exit Pathway - Traverse J	GW-733	D	Annual	Regulated	Sample as per permit
EF	Y-12 Grid Well K1	GW-744	S	Biennial	Regulated	Sample as per ROD
EF	Y-12 Grid Well K2	GW-747	PI	Biennial	Regulated	Sample as per ROD
EF	Y-12 Grid Well J-Primary	GW-762	I	SemiAnnual	Regulated	Sample as per ROD
EF	Y-12 Fuel Station	GW-802	ND	Biennial	Regulated	Sample as per ROD
EF	Road/Pine Ridge	GW-816	S	Biennial	Regulated	Sample as per ROD
EF	New Hope Pond	GW-832	D	Annual	Regulated	Sample as per ROD
EF	Union Valley - Exit Pathway	SCR7.1SP	D	Biennial	Regulated	Sample as per ROD
EF	Exit Pathway Spring/Surface Water	SCR7.8SP	D	Biennial	Regulated	Sample as per ROD
EF	Exit Pathway Spring/Surface Water	UEFPC-SP17	N/A	Annual	Regulated	Sample as per permit

GROUNDWATER SERVICES, INC.

TABLE B.15
SUMMARY SAMPLING RECOMMENDATIONS EAST FORK REGIME

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Semi-Annual Sampling						
EF	Y-12 Grid Well B3	55-2B	PI	SemiAnnual	SemiAnnual	SemiAnnual sampling due to Increasing VOC trend in area
EF	S-3 Site	GW-109	NT	SemiAnnual	SemiAnnual	Semi-annual sampling, provides vertical data near GW-108
EF	Building 8110	GW-698	NT	SemiAnnual	SemiAnnual	Centerline of Maynardville Limestone, monitors VOC plume
EF	Y-12 Grid Well G3	GW-769	I	SemiAnnual	SemiAnnual	Increasing trend, Semi-annual monitoring recommended until trend stabilizes
EF	Y-12 Grid Well G3	GW-770	I	SemiAnnual	SemiAnnual	Increasing trend, Semi-annual monitoring recommended until trend stabilizes
EF	Building 9201-2	GW-820	NT	SemiAnnual	SemiAnnual	Centerline of Maynardville Limestone, monitors VOC plume
Annual Sampling						
EF	Y-12 Grid Well B3	55-2C	S	Annual	Annual	Sample Annually for changes in VOC plume
EF	Y-12 Grid Well C3	56-2C	S	Annual	Annual	Sample Annually to monitor PCE in center of Complex
EF	S-3 Site	GW-105	N/A	SemiAnnual	Annual	Sample Annually until sufficient data to evaluate trend, consider reducing schedule to biennial thereafter
EF	S-3 Site	GW-106	N/A	SemiAnnual	Annual	Sample Annually until sufficient data to evaluate trend, consider reducing schedule to biennial thereafter
EF	New Hope Pond	GW-153	S	Annual	Annual	Historic exceedance, sample Annually
EF	Beta-4 Security Pits	GW-192	NT	Annual	Annual	Monitor to delineate northern plume, data support MNA
EF	New Hope Pond	GW-222	S	Annual	Annual	Historic exceedance, sample Annually
EF	New Hope Pond	GW-240	S	Annual	Annual	Historic exceedance, sample Annually
EF	S-2 Site	GW-251	S	Annual	Annual	Centerline of Maynardville Limestone, supports data from GW-253 on VOC plume
EF	Y-12 Salvage Yard	GW-274	PD	Annual	Annual	Annual sampling for high nitrate
EF	Y-12 Salvage Yard	GW-275	S	Annual	Annual	Annual sampling for high nitrate
EF	Waste Coolant Processing Facility	GW-332	N/A	Annual	Annual	Sample Annually until sufficient data to evaluate trend, consider reducing schedule to biennial thereafter
EF	Waste Coolant Processing Facility	GW-336	N/A	Annual	Annual	Sample Annually until sufficient data to evaluate trend, consider reducing schedule to biennial thereafter
EF	Waste Coolant Processing Facility	GW-337	S	Annual	Annual	Historic high TCE concentrations
EF	Fire Training Facility	GW-620	D	Annual	Annual	Historic high VOC concentrations, Decreasing trend, sample Annually
EF	Y-12 Plant Site	GW-656	S	Annual	Annual	Sample Annually, historic high TCE concentrations
EF	Coal Pile Trench	GW-690	S	Annual	Annual	Sample Annually to monitor PCE in center of Complex
EF	Coal Pile Trench	GW-691	N/A	SemiAnnual	Annual	Sample Annually to monitor PCE in center of Complex
EF	Building 8110	GW-700	PD	Annual	Annual	Sample Annually to monitor PCE in center of Complex

GROUNDWATER SERVICES, INC.

TABLE B.15
SUMMARY SAMPLING RECOMMENDATIONS EAST FORK REGIME

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
EF	Y-12 Grid Well J-Primary	GW-763	NT	Annual	Annual	Trend consistent with Annual sampling
EF	Y-12 Grid Well E3	GW-781	PI	Annual	Annual	Sample Annually to monitor PCE in center of Complex
EF	Y-12 Grid Well E3	GW-782	D	Annual	Annual	Sample Annually to monitor PCE in center of Complex
EF	Y-12 Grid Well E3	GW-783	S	Annual	Annual	Sample Annually to monitor PCE in center of Complex
EF	Y-12 Grid Well D2	GW-791	S	Annual	Annual	Sample Annually to monitor PCE in center of Complex
EF	Y-12 Grid Well D2	GW-792	S	Annual	Annual	Sample Annually to monitor PCE in center of Complex
Biennial Sampling						
EF	Y-12 Plant Site	GW-204	PD	Biennial	Biennial	Sample Biennially, monitor trend for Gross Alpha
EF	Exit Pathway Scarboro Road/Pine Ridge	GW-207	S	Biennial	Biennial	Priority location, low to non-detect concentrations, sample Biennially
EF	Exit Pathway Scarboro Road/Pine Ridge	GW-208	S	Biennial	Biennial	Priority location, low to non-detect concentrations, sample Biennially
EF	Exit Pathway - Traverse E	GW-617	NT	Annual	Biennial	Sample for VOC to confirm Stable to Decreasing long-term trend
EF	Fire Training Facility	GW-619	S	Annual	Biennial	Sample occasionally to provide vertical information near GW-620
EF	Rust Garage Area	GW-631	ND	Annual	Biennial	Priority location, reduced frequency appropriate due to low concentrations and nearby wells
EF	Rust Garage Area	GW-633	D	Annual	Biennial	Priority location, reduced frequency appropriate due to Decreasing concentrations and nearby wells
EF	Exit Pathway - Traverse J	GW-735	S	Annual	Biennial	Priority location, low to non-detect concentrations, sample Biennially
EF	Y-12 Grid Well K2	GW-748	N/A	Biennial	Biennial	Priority location but very low to ND concentrations
EF	Y-12 Grid Well K2	GW-749	S	Biennial	Biennial	Priority location but very low to ND concentrations
EF	Exit Pathway - Traverse J	GW-750	NT	Biennial	Biennial	Priority location, low to non-detect concentrations, sample Biennially
EF	Y-12 Grid Well E1	GW-765	N/A	Biennial	Biennial	Occasional sampling to delineate northern extent of affected groundwater
EF	Y-12 Grid Well H3	GW-775	NT	Annual	Biennial	Sample Biennially until location statistically below detection limits for TCE
EF	Y-12 Grid Well H3	GW-776	S	Annual	Biennial	Sample Biennially until location statistically below detection limits for TCE
EF	Y-12 Grid Well K3	GW-817	S	Biennial	Biennial	Priority location but very low to ND concentrations
EF	Exit Pathway Spring/Surface Water	NHPCEMSP	N/A	Biennial	Biennial	Sample Biennially, may reduce frequency after trend is determined
EF	Union Valley - Exit Pathway	SCR7.18SP	S	Biennial	Biennial	Priority location, low to non-detect concentrations, limited monitoring schedule recommended

GROUNDWATER SERVICES, INC.

TABLE B.15
SUMMARY SAMPLING RECOMMENDATIONS EAST FORK REGIME

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Review						
EF	Y-12 Grid Well B2	55-1A	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Plant Site	55-1B	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Grid Well C2	55-6A	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Grid Well C3	56-2A	N/A	SemiAnnual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Grid Well C3	56-2B	N/A	SemiAnnual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Plant Site	9201-3C-4SP	N/A	SemiAnnual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Plant Site	GW-190	ND	Biennial	Review	Sample occasionally (Biennially or less frequently) to confirm concentrations below MCLs, monitor metal concentrations
EF	Beta-4 Security Pits	GW-195	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Beta-4 Security Pits	GW-196	N/A	Biennial	Review	Evaluate function in network, consider removing from program
EF	Beta-4 Security Pits	GW-197	N/A	Biennial	Review	Evaluate function in network, consider removing from program
EF	Y-12 Grid Well A2	GW-263	N/A	Biennial	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Salvage Yard	GW-265	N/A	Biennial	Review	Evaluate function in network, consider removing from program
EF	Y-12 Salvage Yard	GW-269	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Salvage Yard	GW-270	N/A	SemiAnnual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Salvage Yard	GW-271	N/A	Annual	Review	Evaluate function of well, consider removing from program

GROUNDWATER SERVICES, INC.

TABLE B.15
SUMMARY SAMPLING RECOMMENDATIONS EAST FORK REGIME

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
EF	Y-12 Salvage Yard	GW-272	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Y-12 Salvage Yard	GW-273	N/A	Annual	Review	Sample until 4 recent sample events (for nitrate) provide data to determine trend, consider removing from program
EF	S-2 Site	GW-349	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	S-2 Site	GW-350	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Rust Garage Area	GW-505	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Coal Pile Trench	GW-686	N/A	Annual	Review	Sample until 4 recent sample events provide data to determine trend, consider removing from program
EF	Union Valley - Exit Pathway	RGQWWSP	N/A	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended
EF	Exit Pathway Spring/Surface V	SCR7.10SP	ND	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended
EF	Union Valley - Exit Pathway	SCR7.14SP	N/A	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended
EF	Union Valley - Exit Pathway	SCR7.16SP	N/A	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended
EF	Exit Pathway Spring/Surface V	SCR7.4SP	ND	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended
EF	Exit Pathway Spring/Surface V	SCR7.6SP	ND	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended
EF	Exit Pathway Spring/Surface V	SCR7.7SP	ND	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended
EF	Union Valley - Exit Pathway	SCR7.8SSP	N/A	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended
EF	Union Valley - Exit Pathway	UV8.5SP	N/A	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended
EF	Union Valley - Exit Pathway	UV8.6SP	N/A	Biennial	Review	Priority location, low to non-detect concentrations, limited monitoring schedule recommended

GROUNDWATER SERVICES, INC.

TABLE B.15
SUMMARY SAMPLING RECOMMENDATIONS EAST FORK REGIME

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Remove from Routine Monitoring						
EF	Y-12 Grid Well B2	55-1C	N/A	Biennial	Remove	Keep as DTW location
EF	Building 9202	59-1A	N/A	Remove	Remove	Keep as DTW location
EF	Building 9202	59-1B	PD	Annual	Remove	Keep as DTW location
EF	Building 9202	59-1C	N/A	Annual	Remove	Keep as DTW location
EF	Y-12 Plant Site	60-1B	N/A	Remove	Remove	Keep as DTW location
EF	S-3 Site	GW-107	N/A	Remove	Remove	Keep as DTW location
EF	S-3 Site	GW-134			Remove	No data available
EF	New Hope Pond	GW-148	NT	Biennial	Remove	Keep as DTW location
EF	New Hope Pond	GW-149	N/A	Biennial	Remove	Keep as DTW location
EF	New Hope Pond	GW-150	N/A	Remove	Remove	Keep as DTW location
EF	New Hope Pond	GW-152	N/A	Remove	Remove	Keep as DTW location
EF	Scarboro Road	GW-167	N/A	Annual	Remove	Keep as DTW location
EF	Y-12 Fuel Station	GW-183	N/A	Biennial	Remove	Keep as DTW location
EF	Beta-4 Security Pits	GW-191	ND	Biennial	Remove	Keep as DTW location
EF	Beta-4 Security Pits	GW-194	N/A	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well I1	GW-199	N/A	Biennial	Remove	Keep as DTW location
EF	Ravine Disposal Site	GW-200	N/A	Remove	Remove	Keep as DTW location
EF	Ravine Disposal Site	GW-202	ND	Biennial	Remove	Keep as DTW location
EF	Uranium Oxide Vault	GW-218	S	Annual	Remove	Keep as DTW location
EF	Scarboro Road	GW-239	N/A	Remove	Remove	Keep as DTW location
EF	S-2 Site	GW-252	N/A	Remove	Remove	Keep as DTW location
EF	S-2 Site	GW-255	N/A	Biennial	Remove	Keep as DTW location
EF	Y-12 Grid Well A1	GW-261	N/A	Remove	Remove	Keep as DTW location
EF	Y-12 Salvage Yard	GW-268	N/A	Biennial	Remove	Keep as DTW location
EF	Y-12 Fuel Station	GW-282	N/A	Remove	Remove	Keep as DTW location
EF	Y-12 Fuel Station	GW-283	N/A	Remove	Remove	Keep as DTW location
EF	Waste Coolant Processing Facility	GW-334	N/A	Remove	Remove	Keep as DTW location
EF	Waste Coolant Processing Facility	GW-335	N/A	Remove	Remove	Keep as DTW location
EF	Waste Coolant Processing Facility	GW-338	ND	Biennial	Remove	Keep as DTW location
EF	New Hope Pond	GW-384	S	Biennial	Remove	Keep as DTW location
EF	New Hope Pond	GW-385	PI	Biennial	Remove	Keep as DTW location
EF	Rust Garage Area	GW-508	N/A	Remove	Remove	Keep as DTW location
EF	New Hope Pond	GW-603	NT	Biennial	Remove	Keep as DTW location
EF	Y-12 Plant Site	GW-657	N/A	Remove	Remove	Keep as DTW location
EF	Y-12 Fuel Station	GW-659	N/A	Biennial	Remove	Keep as DTW location
EF	Coal Pile Trench	GW-692	N/A	Annual	Remove	Keep as DTW location
EF	Y-12 Grid Well K1	GW-745	ND	Biennial	Remove	Keep as DTW location
EF	Y-12 Grid Well K1	GW-746	PI	Annual	Remove	Keep as DTW location
EF	Y-12 Grid Well J3	GW-751	ND	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well J3	GW-752	ND	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well J2	GW-753	NT	Biennial	Remove	Keep as DTW location

GROUNDWATER SERVICES, INC.

TABLE B.15
SUMMARY SAMPLING RECOMMENDATIONS EAST FORK REGIME

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
EF	Y-12 Grid Well J2	GW-754	NT	Biennial	Remove	Keep as DTW location
EF	Y-12 Grid Well J1	GW-756	N/A	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well G1	GW-759	N/A	Biennial	Remove	Keep as DTW location
EF	Y-12 Grid Well G2	GW-760	N/A	Biennial	Remove	Keep as DTW location
EF	Y-12 Grid Well G2	GW-761	N/A	Biennial	Remove	Keep as DTW location
EF	Y-12 Grid Well I2	GW-766	ND	Biennial	Remove	Keep as DTW location
EF	Y-12 Grid Well I2	GW-767	ND	Biennial	Remove	Keep as DTW location
EF	Y-12 Grid Well H2	GW-773	ND	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well H2	GW-774	N/A	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well B2	GW-778	N/A	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well F2	GW-779	N/A	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well F2	GW-780	N/A	Biennial	Remove	Keep as DTW location
EF	Y-12 Grid Well E2	GW-786	N/A	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well E2	GW-787	NT	Annual	Remove	Keep as DTW location
EF	Y-12 Grid Well F3	GW-788	D	Remove	Remove	Keep as DTW location
EF	Y-12 Grid Well F3	GW-789	NT	Annual	Remove	Keep as DTW location
EF	Building 9201-2	GW-819	N/A	Remove	Remove	Keep as DTW location

Notes

1. Final Frequency for 171 locations:
   - Regulated = Sampling location and frequency covered under RCRA post-closure permit, CERCLA interim/rinal ROD or other regulatory program.
   - Semi-annual = Locations recommended for semi-annual sampling (every 6 months) based on trend, exceedance of MCL and location in network.
   - Annual = Locations recommended for annual sampling (once per year) based on trend, exceedance of MCL and location in network.
   - Biennial = Wells recommended for Biennial sampling (once every 2 years) based on trend, exceedance of MCL and location in network.
   - Review = Review status of well, if well is in good working order, re-evaluated concentration trend for 4 sample events after 1996. If concentration trends are Stable to Decreasing, consider removing the well from routine monitoring program.
   - Remove = Well does not provide significant data in support of monitoring objectives.
   - Extraction well = Sample frequency was not considered the GW-845 extraction well.
2. Westbay well GW-722 was not evaluated, although Annual sampling is recommended.

GROUNDWATER SERVICES, INC.

TABLE B.16
SUMMARY SAMPLING RECOMMENDATIONS CHESTNUT RIDGE REGIME

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Regulated Sample Locations						
CR	United Nuclear Corporation Site	1090	S	Biennial	Regulated	Sample as per permit
CR	Industrial Landfill IV	GW-141	D	Biennial	Regulated	Sample as per permit
CR	Kerr Hollow Quarry	GW-143	D	Biennial	Regulated	Sample as per permit or as per ROD
CR	Kerr Hollow Quarry	GW-144	NT	Biennial	Regulated	Sample as per permit or as per ROD
CR	Kerr Hollow Quarry	GW-145	S	Annual	Regulated	Sample as per permit or as per ROD
CR	Chestnut Ridge Sediment Disposal Basin	GW-156	D	Biennial	Regulated	Sample as per permit
CR	Chestnut Ridge Sediment Disposal Basin	GW-159	N/A	Annual	Regulated	Sample as per permit
CR	Chestnut Ridge Security Pits	GW-177	ND	Biennial	Regulated	Sample as per permit
CR	United Nuclear Corporation Site	GW-203	PI	Annual	Regulated	Sample as per permit
CR	United Nuclear Corporation Site	GW-205	PI	Annual	Regulated	Sample as per permit
CR	Industrial Landfill IV	GW-217	D	Biennial	Regulated	Sample as per permit
CR	United Nuclear Corporation Site	GW-221	NT	Annual	Regulated	Sample as per permit
CR	Kerr Hollow Quarry	GW-231	D	Biennial	Regulated	Sample as per permit or as per ROD
CR	Chestnut Ridge Borrow Area Waste Pile	GW-301	D	Biennial	Regulated	Sample as per permit
CR	United Nuclear Corporation Site	GW-302	NT	Annual	Regulated	If dropped from CERCLA, consider Annual to Biennial sampling, low concentrations
CR	Industrial Landfill IV	GW-305	I	SemiAnnual	Regulated	Sample as per ROD
CR	United Nuclear Corporation Site	GW-339	NT	Biennial	Regulated	Sample as per permit
CR	Industrial Landfill IV	GW-521	ND	Biennial	Regulated	Sample as per permit
CR	Industrial Landfill IV	GW-522	D	Biennial	Regulated	Sample as per permit
CR	Industrial Landfill II	GW-540	D	Biennial	Regulated	Sample as per permit
CR	Construction/Demolition Landfill VI	GW-542	D	Biennial	Regulated	Sample as per permit
CR	Construction/Demolition Landfill VI	GW-543	ND	Biennial	Regulated	Sample as per permit
CR	Construction/Demolition Landfill VI	GW-544	D	Biennial	Regulated	Sample as per permit
CR	Industrial Landfill V	GW-557	ND	Biennial	Regulated	Sample as per permit
CR	Construction/Demolition Landfill VII	GW-560	ND	Remove	Regulated	Sample as per permit
CR	Construction/Demolition Landfill VII	GW-562	ND	Remove	Regulated	Sample as per permit

TABLE B.16
SUMMARY SAMPLING RECOMMENDATIONS CHESTNUT RIDGE REGIME

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
CR	Construction/Demolition Landfill VII	GW-564	ND	Remove	Regulated	Sample as per permit
CR	Industrial Landfill II	GW-709	D	Biennial	Regulated	Sample as per permit
CR	Chestnut Ridge Sediment Disposal Basin	GW-731	N/A	Biennial	Regulated	Sample as per permit
CR	Chestnut Ridge Sediment Disposal Basin	GW-732	N/A	Biennial	Regulated	Sample as per permit
CR	Industrial Landfill II	GW-757	D	Biennial	Regulated	Sample as per permit
CR	Industrial Landfill V	GW-796	ND	Biennial	Regulated	Sample as per permit
CR	Industrial Landfill V	GW-797	D	Biennial	Regulated	Sample as per permit
CR	Construction/Demolition Landfill VII	GW-798	I	Annual	Regulated	Sample as per permit
CR	Industrial Landfill V	GW-799	ND	Biennial	Regulated	Sample as per permit
CR	Industrial Landfill V	GW-801	ND	Biennial	Regulated	Sample as per permit
CR	Construction/Demolition Landfill VI	GW-827	D	Biennial	Regulated	Sample as per permit
CR	Chestnut Ridge Security Pits	GW-831	D	Biennial	Regulated	Sample as per permit
CR	South Campus Facility, Bethel Valley	GW-841	D	Annual	Regulated	Sample as per ROD
CR	South Campus Facility, Bethel Valley	GW-842	NT	Annual	Regulated	Sample as per ROD
CR	South Campus Facility, Bethel Valley	GW-843	N/A	Annual	Regulated	Sample as per ROD
CR	South Campus Facility, Bethel Valley	GW-844	ND	Annual	Regulated	Sample as per ROD
CR	Exit Pathway Spring/Surface Water	SCR1.25SP	NT	Annual	Regulated	Sample as per permit
CR	Exit Pathway Spring/Surface Water	SCR3.5SP	NT	Annual	Regulated	Sample as per ROD
CR	Industrial Landfill V	SCR4.3SP	ND	Biennial	Regulated	Sample as per permit

GROUNDWATER SERVICES, INC.

TABLE B.16
SUMMARY SAMPLING RECOMMENDATIONS CHESTNUT RIDGE REGIME

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Annual Sampling						
CR	Chestnut Ridge Security Pits	GW-175	S	Annual	Annual	Stable trend, sample Annually until trend indicates reduced frequency
CR	Chestnut Ridge Security Pits	GW-608	S	Annual	Annual	Stable trend, sample Annually until trend indicates reduced frequency
CR	Chestnut Ridge Security Pits	GW-609	D	Annual	Annual	Decreasing trend, sample Annually until trend indicates reduced frequency
CR	Chestnut Ridge Security Pits	GW-612	NT	Annual	Annual	Monitor Annually until trend indicates reduced effort is appropriate
CR	Exit Pathway Spring/Surface Water	SCR3.4SP	PI	Annual	Annual	Sample annually to biennially as detection monitoring location
Biennial Sampling						
CR	Chestnut Ridge Borrow Area Waste Pile	GW-160	N/A	Annual	Biennial	Historic lead and possible uranium detections, sample 4X in 10 yrs and reevaluate
CR	Rogers Quarry	GW-186	N/A	Biennial	Biennial	Well monitors property boundary, sample Biennially for detection monitoring
CR	Filled Coal Ash Pond	GW-514	N/A	Biennial	Biennial	Low concentrations, sample Biennial until trend determined
CR	Industrial Landfill II	GW-539	D	Biennial	Biennial	Removed
CR	Exit Pathway Spring/Surface Water	SCR2.1SP	S	Biennial	Biennial	Largely non-detect for priority COCs, sample Biennially
CR	Exit Pathway Spring/Surface Water	SCR2.2SP	S	Biennial	Biennial	Largely non-detect for priority COCs, sample Biennially
CR	Exit Pathway Spring/Surface Water	SCR5.1SP	NT	Annual	Biennial	Largely non-detect, but spring is potential point of exposure, consider biennial sampling
CR	Exit Pathway Spring/Surface Water	SCR5.2SP	N/A	Annual	Biennial	Largely non-detect, but spring is potential point of exposure, consider biennial sampling
CR	Exit Pathway Spring/Surface Water	SCR5.4SP	NT	Biennial	Biennial	Largely non-detect, but spring is potential point of exposure, consider biennial sampling
Review						
CR	Chestnut Ridge Security Pits	GW-173	N/A	SemiAnnual	Review	Sample 4X in 10 yrs and consider removing from program
CR	Chestnut Ridge Security Pits	GW-174	N/A	SemiAnnual	Review	Sample 4X in 10 yrs and consider removing from program
CR	Chestnut Ridge Security Pits	GW-176	N/A	Annual	Review	Sample 4X in 10 yrs and consider removing from program
CR	Chestnut Ridge Security Pits	GW-179	N/A	Annual	Review	Sample 4X in 10 yrs and consider removing from program
CR	Chestnut Ridge Security Pits	GW-180	N/A	SemiAnnual	Review	Decreasing historic trend, sample 4X in 10 yrs and consider removing from program
CR	Chestnut Ridge Security Pits	GW-322	N/A	SemiAnnual	Review	Sample 4X in 10 yrs and consider removing from program

GROUNDWATER SERVICES, INC.

TABLE B.16
SUMMARY SAMPLING RECOMMENDATIONS CHESTNUT RIDGE REGIME

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Regime	Functional Area	Location Name	Trend	Preliminary Frequency	Final Frequency	Recommendation
Remove from Routine Monitoring						
CR	Rogers Quarry	GW-188	N/A	Biennial	Remove	Keep as DTW well
CR	Chestnut Ridge Sediment Disposal Basin	GW-241	N/A	Annual	Remove	Limited Function Does not exceed MCL
CR	East Chestnut Ridge Waste Pile	GW-292	ND	Remove	Remove	Largely non-detect for COCs, remove from program
CR	East Chestnut Ridge Waste Pile	GW-293	ND	Remove	Remove	Largely non-detect for COCs, remove from program
CR	Chestnut Ridge Borrow Area Waste Pile	GW-298	ND	Remove	Remove	Largely non-detect for COCs, remove from program
CR	Chestnut Ridge Borrow Area Waste Pile	GW-299	N/A	Remove	Remove	Limited Function Does not exceed MCL
CR	Chestnut Ridge Borrow Area Waste Pile	GW-300	N/A	Annual	Remove	Limited Function Does not exceed MCL
CR	Chestnut Ridge Sediment Disposal Basin	GW-303	N/A	Remove	Remove	Limited Function Does not exceed MCL
CR	Chestnut Ridge Sediment Disposal Basin	GW-304	N/A	Remove	Remove	Limited Function Does not exceed MCL
CR	Chestnut Ridge Security Pits	GW-178	N/A	Annual	Remove	Keep as DTW well
CR	Kerr Hollow Quarry	GW-142	D	Biennial	Remove	Removed from RCRA program, Hydro only
CR	Rogers Quarry	GW-184	N/A	Remove	Remove	Keep as DTW well
CR	Construction/Demolition Landfill VI	GW-546	ND	Remove	Remove	Keep as DTW well
CR	Chestnut Ridge Security Pits	GW-511	N/A	Biennial	Remove	Keep as DTW well
CR	Filled Coal Ash Pond	GW-512	N/A	Biennial	Remove	Keep as DTW well
CR	Filled Coal Ash Pond	GW-513	N/A	Annual	Remove	Keep as DTW well
CR	Chestnut Ridge Security Pits	GW-610	N/A	Biennial	Remove	Keep as DTW well
CR	Chestnut Ridge Security Pits	GW-611	N/A	Annual	Remove	Keep as DTW well
CR	Filled Coal Ash Pond	GW-679	N/A	Biennial	Remove	Keep as DTW well
CR	Filled Coal Ash Pond	GW-680	N/A	Biennial	Remove	Keep as DTW well
CR	Chestnut Ridge Security Pits	GW-742	N/A	Annual	Remove	Keep as DTW well
CR	Chestnut Ridge Security Pits	GW-743	N/A	Biennial	Remove	Keep as DTW well
CR	Construction/Demolition Landfill VI	GW-541	N/A	Remove	Remove	Keep as DTW well
CR	Chestnut Ridge Security Pits	GW-181	N/A	Remove	Remove	Keep as DTW well

Notes

1. Final Frequency for 89 locations:
   Regulated = Sampling location and frequency covered under RCRA post-closure permit, CERCLA interim/rinal ROD or other regulatory program.
   Semi-annual = Locations recommended for semi-annual sampling (every 6 months) based on trend, exceedance of MCL and location in network.
   Annual = Locations recommended for annual sampling (once per year) based on trend, exceedance of MCL and location in network.
   Biennial = Wells recommended for Biennial sampling (once every 2 years) based on trend, exceedance of MCL and location in network.
   Review = Review status of well, if well is in good working order, re-evaluated concentration trend for 4 sample events after 1996.
   If concentration trends are Stable to Decreasing, consider removing the well from routine monitoring program.
   Remove = Well does not provide significant data in support of monitoring objectives.
2. No wells are recommended for Semi-annual sampling (except those under regulatory programs).
3. Well GW-564 is listed as a SWDF regulated well, but no data were available and well information table indicates that the hole is caved.

ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

APPENDIX C: MAROS 2.1 METHODOLOGY

APPENDIX C
MAROS 2.1 METHODOLOGY

Contents

MAROS METHODOLOGY

MAROS is a collection of tools in one software package that is used in an explanatory, non-linear but linked fashion. The tool includes models, statistics, heuristic rules, and empirical relationships to assist the user in optimizing a groundwater monitoring network system. The final optimized network maintains adequate delineation while providing information on plume dynamics over time. Results generated from the software tool can be used to develop lines of evidence, which, in combination with expert opinion, can be used to inform regulatory decisions for safe and economical long-term monitoring of groundwater plumes. For a detailed description of the structure of the software and further utilities, refer to the MAROS 2.1 Manual (AFCEE, 2003; http://www.gsi-net.com/software/MAROS_V2_1Manual.pdf) and Aziz et al., 2003.

1.0 MAROS Conceptual Model

In MAROS 2.1, two levels of analysis are used for optimizing long-term monitoring plans: 1) an overview statistical evaluation with interpretive trend analysis based on temporal trend analysis and plume stability information; and 2) a more detailed statistical optimization based on spatial and temporal redundancy reduction methods (see Figures C.1 and C.2 for further details). In general, the MAROS method applies to 2-D aquifers that have relatively simple site hydrogeology. However, for a multi-aquifer (3-D) system, the user has the option to apply the statistical analysis layer-by-layer.

The overview statistics or interpretive trend analysis assesses the general monitoring system category by considering individual well concentration trends, overall plume stability, hydrogeologic factors (e.g., seepage velocity, and current plume length), and the location of potential receptors (e.g., property boundaries or drinking water wells). The method relies on temporal trend analysis to assess plume stability, which is then used to determine the general monitoring system category. Since the monitoring system category is evaluated for both source and tail regions of the plume, the site wells are divided into two different zones: the source zone and the tail zone.

Source zone monitoring wells could include areas with non-aqueous phase liquids (NAPLs), contaminated vadose zone soils, and areas where aqueous-phase releases have been introduced into ground water. The source zone generally contains locations with historical high ground water concentrations of the COCs. The tail zone is usually the area downgradient of the contaminant source zone. Although this classification is a simplification of the plume conceptual model, this broadness makes the user aware on an individual well basis that the concentration trend results can have a different interpretation depending on the well location in and around the plume. The location and type of the individual wells allows further interpretation of the trend results, depending on what type of well is being analyzed (e.g., remediation well, leading plume edge well, or monitoring well). General recommendations for the monitoring network frequency and density are suggested based on heuristic rules applied to the source and tail trend results.

The detailed statistics level of analysis or sampling optimization consists of well redundancy and well sufficiency analyses using the Delaunay method, a sampling frequency analysis using the Modified Cost Effective Sampling (MCES) method and a data sufficiency analysis including statistical power analysis. The well redundancy analysis is designed to minimize monitoring locations and the Modified CES method is designed to minimize the frequency of sampling. The data sufficiency analysis uses simple statistical methods to assess the sampling record to determine if groundwater concentrations are statistically below target levels and if the current monitoring network and record is sufficient in terms of evaluating concentrations at downgradient locations.

2.0 Data Management

In MAROS, ground water monitoring data can be imported from simple database-format Microsoft® Excel spreadsheets, Microsoft Access tables, previously created MAROS database archive files, or entered manually. Monitoring data interpretation in MAROS is based on historical analytical data from a consistent set of wells over a series of sampling events. The analytical data is composed of the well name, coordinate location, constituent, result, detection limit and associated data qualifiers. Statistical validity of the concentration trend analysis requires constraints on the minimum data input of at least four wells (ASTM 1998) in which COCs have been detected. Individual sampling locations need to include data from at least six most-recent sampling events. To ensure a meaningful comparison of COC concentrations over time and space, both data quality and data quantity need to be considered. Prior to statistical analysis, the user can consolidate irregularly sampled data or smooth data that might result from seasonal fluctuations or a change in site conditions. Because MAROS is a terminal analytical tool designed for long-term planning, impacts of seasonal variation in the water unit are treated on a broad scale, as they relate to multi-year trends.

Imported ground water monitoring data and the site-specific information entered in Site Details can be archived and exported as MAROS archive files. These archive files can be appended as new monitoring data becomes available, resulting in a dynamic long-term monitoring database that reflects the changing conditions at the site (i.e. biodegradation, compliance attainment, completion of remediation phase, etc.). For wells with a limited monitoring history, addition of information as it becomes available can change the frequency or identity of wells in the network.

3.0 Site Details

Information needed for the MAROS analysis includes site-specific parameters such as seepage velocity and current plume length and width. Information on the location of potential receptors relative to the source and tail regions of the plume is entered at this point. Part of the trend analysis methodology applied in MAROS focuses on where the monitoring well is located, therefore the user needs to divide site wells into two different zones: the source zone or the tail zone. Although this classification is a simplification of the well function, this broadness makes the user aware on an individual well basis that the concentration trend results can have a different interpretation depending on the well location in and around the plume. It is up to the user to make further interpretation of the trend results, depending on what type of well is being analyzed (e.g., remediation well, leading plume edge well, or monitoring well). The Site Details section of MAROS contains a preliminary map of well locations to confirm well coordinates.

4.0 Constituent Selection

A database with multiple COCs can be entered into the MAROS software. MAROS allows the analysis of up to 5 COCs concurrently and users can pick COCs from a list of compounds existing in the monitoring data. MAROS runs separate optimizations for each compound. For sites with a single source, the suggested strategy is to choose one to three priority COCs for the optimization. If, for example, the site contains multiple chlorinated volatile organic compounds (VOCs), the standard sample chemical analysis will evaluate all VOCs, so the sample locations and frequency should based on the concentration trends of the most prevalent, toxic or mobile compounds. If different chemical classes are present, such as metals and chlorinated VOCs, choose and evaluate the priority constituent in each chemical class.

MAROS includes a short module that provides recommendations on prioritizing COCs based on toxicity, prevalence, and mobility of the compound. The toxicity ranking is determined by examining a representative concentration for each compound for the entire site. The representative concentration is then compared to the screening level (PRG or MCL) for that compound and the COCs are ranked according to the representative concentrations percent exceedence of the screening level. The evaluation of prevalence is performed by determining a representative concentration for each well location and evaluating the total exceedences (values above screening levels) compared to the total number of wells. Compounds found over screening levels are ranked for mobility based on Kd (sorption partition coefficient). The MAROS COC assessment provides the relative ranking of each COC, but the user must choose which COCs are included in the analysis.

5.0 Data Consolidation

Typically, raw data from long-term monitoring have been measured irregularly in time or contain many non-detects, trace level results, and duplicates. Therefore, before the data can be further analyzed, raw data are filtered, consolidated, transformed, and possibly smoothed to allow for a consistent dataset meeting the minimum data requirements for statistical analysis mentioned previously.

MAROS allows users to specify the period of interest in which data will be consolidated (i.e., monthly, bi-monthly, quarterly, semi-annual, yearly, or a biennial basis). In computing the representative value when consolidating, one of four statistics can be used: median, geometric mean, mean, and maximum. Non-detects can be transformed to one half the reporting or method detection limit (DL), the DL, or a fraction of the DL. Trace level results can be represented by their actual values, one half of the DL, the DL, or a fraction of their actual values. Duplicates are reduced in MAROS by one of three ways: assigning the average, maximum, or first value. The reduced data for each COC and each well can be viewed as a time series in a graphical form on a linear or semi-log plot generated by the software.

6.0 Overview Statistics: Plume Trend Analysis

Within the MAROS software there are historical data analyses that support a conclusion about plume stability (e.g., increasing plume, etc.) through statistical trend analysis of historical monitoring data. Plume stability results are assessed from time-series concentration data with the application of three statistical tools: Mann-Kendall Trend analysis, linear regression trend analysis and moment analysis. The two trend methods are used to estimate the concentration trend for each well and each COC based on a statistical trend analysis of concentrations versus time at each well. These trend analyses are then consolidated to give the user a general plume stability estimate and general monitoring frequency and density recommendations (see Figures C.1 through C.3 for further step-by-step details). Both qualitative and quantitative plume information can be gained by these evaluations of monitoring network historical data trends both spatially and temporally. The MAROS Overview Statistics are the foundation the user needs to make informed optimization decisions at the site. The Overview Statistics are designed to allow site personnel to develop a better understanding of the plume behavior over time and understand how the individual well concentration trends are spatially distributed within the plume. This step allows the user to gain information that will support a more informed decision to be made in the next level or detailed statistics optimization analysis.

6.1 Mann-Kendall Analysis

The Mann-Kendall test is a statistical procedure that is well suited for analyzing trends in data over time. The Mann-Kendall test can be viewed as a non-parametric test for zero slope of the first-order regression of time-ordered concentration data versus time. One advantage of the Mann-Kendall test is that it does not require any assumptions as to the statistical distribution of the data (e.g. normal, lognormal, etc.) and can be used with data sets which include irregular sampling intervals and missing data. The Mann-Kendall test is designed for analyzing a single groundwater constituent, multiple constituents are analyzed separately. The Mann-Kendall S statistic measures the trend in the data: positive values indicate an increase in concentrations over time and negative values indicate a decrease in concentrations over time. The strength of the trend is proportional to the magnitude of the Mann-Kendall statistic (i.e., a large value indicates a strong trend). The confidence in the trend is determined by consulting the S statistic and the sample size, n, in a Kendall probability table such as the one reported in Hollander and Wolfe (1973).

The concentration trend is determined for each well and each COC based on results of the S statistic, the confidence in the trend, and the Coefficient of Variation (COV). The decision matrix for this evaluation is shown in Table C.1. A Mann-Kendall statistic that is greater than 0 combined with a confidence of greater than 95% is categorized as an Increasing trend while a Mann-Kendall statistic of less than 0 with a confidence between 90% and 95% is defined as a probably Increasing trend, and so on.

Depending on statistical indicators, the concentration trend is classified into six categories:

- Decreasing (D),
- Probably Decreasing (PD),
- Stable (S),
- No Trend (NT),
- Probably Increasing (PI)
- Increasing (I).

These trend estimates are then analyzed to identify the source and tail region overall stability category (see Figure C.2 for further details).

6.2 Linear Regression Analysis

Linear Regression is a parametric statistical procedure that is typically used for analyzing trends in data over time. Using this type of analysis, a higher degree of scatter simply corresponds to a wider confidence interval about the average log-slope. Assuming the sign (i.e., positive or negative) of the estimated log-slope is correct, a level of confidence that the slope is not zero can be easily determined. Thus, despite a poor goodness of fit, the overall trend in the data may still be ascertained, where low levels of confidence correspond to "Stable" or "No Trend" conditions (depending on the degree of scatter) and higher levels of confidence indicate the stronger likelihood of a trend. The linear regression analysis is based on the first-order linear regression of the log-transformed concentration data versus time. The slope obtained from this log-transformed regression, the confidence level for this log-slope, and the COV of the untransformed data are used to determine the concentration trend. The decision matrix for this evaluation is shown in Table C.2.

To estimate the confidence in the log-slope, the standard error of the log-slope is calculated. The coefficient of variation, defined as the standard deviation divided by the average, is used as a secondary measure of scatter to distinguish between "Stable" or "No Trend" conditions for negative slopes. The Linear Regression Analysis is designed for analyzing a single groundwater constituent; multiple constituents are analyzed separately, (up to five COCs simultaneously). For this evaluation, a decision matrix developed by Groundwater Services, Inc. is also used to determine the "Concentration Trend" category (plume stability) for each well.

Depending on statistical indicators, the concentration trend is classified into six categories:

- Decreasing (D),
- Probably Decreasing (PD),
- Stable (S),
- No Trend (NT),
- Probably Increasing (PI)
- Increasing (I).

The resulting confidence in the trend, together with the log-slope and the COV of the untransformed data, are used in the linear regression analysis decision matrix to determine the concentration trend. For example, a positive log-slope with a confidence of less than 90% is categorized as having No Trend whereas a negative log-slope is considered Stable if the COV is less than 1 and categorized as No Trend if the COV is greater than 1.

6.3 Overall Plume Analysis

General recommendations for the monitoring network frequency and density are suggested based on heuristic rules applied to the source and tail trend results.

Individual well trend results are consolidated and weighted by the MAROS according to user input, and the direction and strength of contaminant concentration trends in the source zone and tail zone for each COC are determined. Based on

i) the consolidated trend analysis,
ii) hydrogeologic factors (e.g., seepage velocity), and
iii) location of potential receptors (e.g., wells, discharge points, or property boundaries),

the software suggests a general optimization plan for the current monitoring system in order to efficiently but effectively monitor groundwater in the future. A flow chart utilizing the trend analysis results and other site-specific parameters to form a general sampling frequency and well density recommendation is outlined in Figure C.2. For example, a generic plan for a shrinking petroleum hydrocarbon plume (BTEX) in a slow hydrogeologic environment (silt) with no nearby receptors would entail minimal, low frequency sampling of just a few indicators. On the other hand, the generic plan for a chlorinated solvent plume in a fast hydrogeologic environment that is expanding but has very erratic concentrations over time would entail more extensive, higher frequency sampling. The generic plan is based on a heuristically derived algorithm for assessing future sampling duration, location and density that takes into consideration plume stability. For a detailed description of the heuristic rules used in the MAROS software, refer to the MAROS 2.1Manual (AFCEE, 2003).

6.4 Moment Analysis

An analysis of moments can help resolve plume trends, where the zeroth moment shows change in dissolved mass vs. time, the first moment shows the center of mass location vs. time, and the second moment shows the spread of the plume vs. time. Moment calculations can predict how the plume will change in the future if further statistical analysis is applied to the moments to identify a trend (in this case, Mann Kendall Trend Analysis is applied). The trend analysis of moments can be summarized as:

- Zeroth Moment: An estimate of the total mass of the constituent for each sample event
- First Moment: An estimate of the center of mass for each sample event
- Second Moment: An estimate of the spread of the plume around the center of mass

The role of moment analysis in MAROS is to provide a relative estimate of plume stability and condition within the context of results from other MAROS modules. The Moment analysis algorithms in MAROS are simple approximations of complex calculations and are meant to estimate changes in total mass, center of mass and spread of mass for complex well networks. The Moment Analysis module is sensitive to the number and arrangement of wells in each sampling event, so, changes in the number and identity of wells during monitoring events, and the parameters chosen for data consolidation can cause changes in the estimated moments.

Plume stability may vary by constituent, therefore the MAROS Moment analysis can be used to evaluate multiple COCs simultaneously which can be used to provide a quick way of comparing individual plume parameters to determine the size and movement of constituents relative to one another. Moment analysis in the MAROS software can also be used to assist the user in evaluating the impact on plume delineation in future sampling events by removing identified “redundant” wells from a long-term monitoring program (this analysis was not performed as part of this study, for more details on this application of moment analysis refer to the MAROS Users Manual (AFCEE, 2003)).

The **zeroth moment** is the sum of concentrations for all monitoring wells and is a mass estimate. The zeroth moment calculation can show high variability over time, largely due to the fluctuating concentrations at the most contaminated wells as well as varying monitoring well network. Plume analysis and delineation based exclusively on concentration can exhibit fluctuating temporal and spatial values. The mass estimate is also sensitive to the extent of the site monitoring well network over time. The zeroth moment trend over time is determined by using the Mann-Kendall Trend Methodology. The zeroth Moment trend test allows the user to understand how the plume mass has changed over time. Results for the trend include: Increasing, probably Increasing, no trend, stable, probably decreasing, decreasing or not applicable (N/A) (Insufficient Data). When considering the results of the zeroth moment trend, the following factors should be considered which could effect the calculation and interpretation of the plume mass over time: 1) Change in the spatial distribution of the wells sampled historically 2) Different wells sampled within the well network over time (addition and subtraction of well within the network). 3) Adequate versus inadequate delineation of the plume over time

The **first moment** estimates the center of mass, coordinates (Xc and Yc) for each sample event and COC. The changing center of mass locations indicate the movement of the center of mass over time. Whereas, the distance from the original source location to the center of mass locations indicate the movement of the center of mass over time relative to the original source. Calculation of the first moment normalizes the spread by the concentration indicating the center of mass. The first moment trend of the distance to the center of mass over time shows movement of the plume in relation to the original source location over time. Analysis of the movement of mass should be viewed as it relates to 1) the original source location of contamination 2) the direction of groundwater flow and/or 3) source removal or remediation. Spatial and temporal trends in the center of mass can indicate spreading or shrinking or transient movement based on season variation in rainfall or other hydraulic considerations. No appreciable movement or a neutral trend in the center of mass would indicate plume stability. However, changes in the first moment over time do not necessarily completely characterize the changes in the concentration distribution (and the mass) over time. Therefore, in order to fully characterize the plume the First Moment trend should be compared to the zeroth moment trend (mass change over time).

The **second moment** indicates the spread of the contaminant about the center of mass (Sxx and Syy), or the distance of contamination from the center of mass for a particular COC and sample event. The Second Moment represents the spread of the plume over time in both the x and y directions. The Second Moment trend indicates the spread of the plume about the center of mass. Analysis of the spread of the plume should be viewed as it relates to the direction of groundwater flow. An Increasing trend in the second moment indicates an expanding plume, whereas a declining trend in the second moment indicates a shrinking plume. No appreciable movement or a neutral trend in the center of mass would indicate plume stability. The second moment provides a measure of the spread of the concentration distribution about the plume’s center of mass.

However, changes in the second moment over time do not necessarily completely characterize the changes in the concentration distribution (and the mass) over time. Therefore, in order to fully characterize the plume the Second Moment trend should be compared to the zeroth moment trend (mass change over time).

7.0 Detailed Statistics: Optimization Analysis

Although the overall plume analysis shows a general recommendation regarding sampling frequency reduction and a general sampling density, a more detailed analysis is also available with the MAROS 2.1 software in order to allow for further reductions on a well-by-well basis for frequency, well redundancy, well sufficiency and sampling sufficiency. The MAROS Detailed Statistics allows for a quantitative analysis for spatial and temporal optimization of the well network on a well-by-well basis. The results from the Overview Statistics should be considered along with the MAROS optimization recommendations gained from the Detailed Statistical Analysis described previously. The MAROS Detailed Statistics results should be reassessed in view of site knowledge and regulatory requirements as well as in consideration of the Overview Statistics (Figure C.2).

The Detailed Statistics or Sampling Optimization MAROS modules can be used to determine the minimal number of sampling locations and the lowest frequency of sampling that can still meet the requirements of sampling spatially and temporally for an existing monitoring program. It also provides an analysis of the sufficiency of data for the monitoring program.

Sampling optimization in MAROS consists of four parts:

- Well redundancy analysis using the Delaunay method
- Well sufficiency analysis using the Delaunay method
- Sampling frequency determination using the Modified CES method
- Data sufficiency analysis using statistical power analysis.

The well redundancy analysis using the Delaunay method identifies and eliminates redundant locations from the monitoring network. The well sufficiency analysis can determine the areas where new sampling locations might be needed. The Modified CES method determines the optimal sampling frequency for a sampling location based on the direction, magnitude, and uncertainty in its concentration trend. The data sufficiency analysis examines the risk-based site cleanup status and power and expected sample size associated with the cleanup status evaluation.

7.1 Well Redundancy Analysis – Delaunay Method

The well redundancy analysis using the Delaunay method is designed to select the minimum number of sampling locations based on the spatial analysis of the relative importance of each sampling location in the monitoring network. The approach allows elimination of sampling locations that have little impact on the historical characterization of a contaminant plume. An extended method or wells sufficiency analysis, based on the Delaunay method, can also be used for recommending new sampling locations.

Details about the Delaunay method can be found in Appendix A.2 of the MAROS Manual (AFCEE, 2003).

Sampling Location determination uses the Delaunay triangulation method to determine the significance of the current sampling locations relative to the overall monitoring network. The Delaunay method calculates the network Area and Average concentration of the plume using data from multiple monitoring wells. A slope factor (SF) is calculated for each well to indicate the significance of this well in the system (i.e. how removing a well changes the average concentration.)

The Sampling Location optimization process is performed in a stepwise fashion. Step one involves assessing the significance of the well in the system, if a well has a small SF (little significance to the network), the well may be removed from the monitoring network. Step two involves evaluating the information loss of removing a well from the network. If one well has a small SF, it may or may not be eliminated depending on whether the information loss is significant. If the information loss is not significant, the well can be eliminated from the monitoring network and the process of optimization continues with fewer wells. However if the well information loss is significant then the optimization terminates. This sampling optimization process allows the user to assess "redundant" wells that will not incur significant information loss on a constituent-by-constituent basis for individual sampling events.

7.2 Well Sufficiency Analysis – Delaunay Method

The well sufficiency analysis, using the Delaunay method, is designed to recommend new sampling locations in areas *within* the existing monitoring network where there is a high level of uncertainty in contaminant concentration. Details about the well sufficiency analysis can be found in Appendix A.2 of the MAROS Manual (AFCEE, 2003).

In many cases, new sampling locations need to be added to the existing network to enhance the spatial plume characterization. If the MAROS algorithm calculates a high level of uncertainty in predicting the constituent concentration for a particular area, a new sampling location is recommended. The Slope Factor (SF) values obtained from the redundancy evaluation described above are used to calculate the concentration estimation error for each triangle area formed in the Delaunay triangulation. The estimated SF value for each area is then classified into four levels: Small, Moderate, Large, or Extremely large (S, M, L, E) because the larger the estimated SF value, the higher the estimation error at this area. Therefore, the triangular areas with the estimated SF value at the Extremely large or Large level can be candidate regions for new sampling locations.

The results from the Delaunay method and the method for determining new sampling locations are derived solely from the spatial configuration of the monitoring network and the spatial pattern of the contaminant plume. No parameters such as the hydrogeologic conditions are considered in the analysis. Therefore, professional judgment and regulatory considerations must be used to make final decisions.

7.3 Sampling Frequency Determination - Modified CES Method

The Modified CES method optimizes sampling frequency for each sampling location based on the magnitude, direction, and uncertainty of its concentration trend derived from its recent and historical monitoring records. The Modified Cost Effective Sampling (MCES) estimates a conservative lowest-frequency sampling schedule for a given groundwater monitoring location that still provides needed information for regulatory and remedial decision-making. The MCES method was developed on the basis of the Cost Effective Sampling (CES) method developed by Ridley et al (1995). Details about the MCES method can be found in Appendix A.9 of the MAROS Manual (AFCEE, 2003).

In order to estimate the least frequent sampling schedule for a monitoring location that still provides enough information for regulatory and remedial decision-making, MCES employs three steps to determine the sampling frequency. The first step involves analyzing frequency based on recent trends. A preliminary location sampling frequency (PLSF) is developed based on the rate of change of well concentrations calculated by linear regression along with the Mann-Kendall trend analysis of the most recent monitoring data (see Figure C.3). The variability within the sequential sampling data is accounted for by the Mann-Kendall analysis. The rate of change vs. trend result matrix categorizes wells as requiring annual, semi-annual or quarterly sampling. The PLSF is then reevaluated and adjusted based on overall trends. If the long-term history of change is significantly greater than the recent trend, the frequency may be reduced by one level.

The final step in the analysis involves reducing frequency based on risk, site-specific conditions, regulatory requirements or other external issues. Since not all compounds in the target being assessed are equally harmful, frequency is reduced by one level if recent maximum concentration for a compound of high risk is less than 1/2 of the Maximum Concentration Limit (MCL). The result of applying this method is a suggested sampling frequency based on recent sampling data trends and overall sampling data trends and expert judgment.

The final sampling frequency determined from the MCES method can be Quarterly, Semiannual, Annual, or Biennial. Users can further reduce the sampling frequency to, for example, once every three years, if the trend estimated from Biennial data (i.e., data drawn once every two years from the original data) is the same as that estimated from the original data.

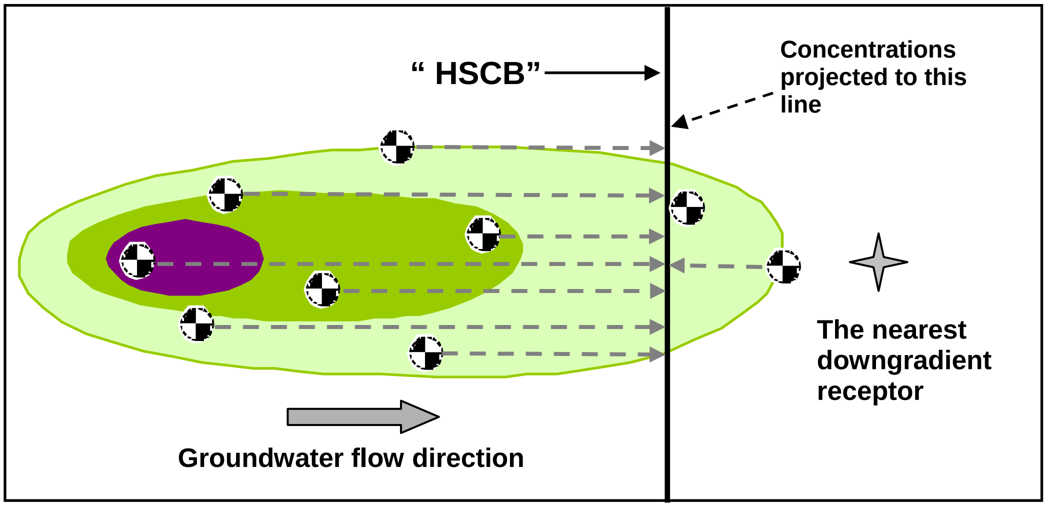
7.4 Data Sufficiency Analysis – Power Analysis

The MAROS Data Sufficiency module employs simple statistical methods to evaluate whether the collected data are adequate both in quantity and in quality for revealing changes in constituent concentrations. The first section of the module evaluates individual well concentrations to determine if they are statistically below a target screening level. The second section includes a simple calculation for estimating projected groundwater concentrations at a specified point downgradient of the plume. A statistical Power analysis is then applied to the projected concentrations to determine if the downgradient concentrations are statistically below the cleanup standard. If the number of projected concentrations is below the level to provide statistical significance, then the number of sample events required to statistically confirm concentrations below standards is estimated from the Power analysis.

Before testing the cleanup status for individual wells, the stability or trend of the contaminant plume should be evaluated. Only after the plume has reached stability or is reliably diminishing can we conduct a test to examine the cleanup status of wells. Applying the analysis to wells in an expanding plume may cause incorrect conclusions and is less meaningful.

Statistical power analysis is a technique for interpreting the results of statistical tests. The Power of a statistical test is a measure of the ability of the test to detect an effect given that the effect actually exists. The method provides additional information about a statistical test: 1) the power of the statistical test, i.e., the probability of finding a difference in the variable of interest when a difference truly exists; and 2) the expected sample size of a future sampling plan given the minimum detectable difference it is supposed to detect. For example, if the mean concentration is lower than the cleanup goal but a statistical test cannot prove this, the power and expected sample size can tell the reason and how many more samples are needed to result in a significant test. The additional samples can be obtained by a longer period of sampling or an increased sampling frequency. Details about the data sufficiency analysis can be found in Appendix A.6 of the MAROS Manual (AFCEE, 2003).

When applying the MAROS power analysis method, a hypothetical statistical compliance boundary (HSCB) is assigned to be a line perpendicular to the groundwater flow direction (see figure below). Monitoring well concentrations are projected onto the HSCB using the distance from each well to the compliance boundary along with a decay coefficient. The projected concentrations from each well and each sampling event are then used in the risk-based power analysis. Since there may be more than one sampling event selected by the user, the risk-based power analysis results are given on an event-by-event basis. This power analysis can then indicate if target are statistically achieved at the HSCB. For instance, at a site where the historical monitoring record is short with few wells, the HSCB would be distant; whereas, at a site with longer duration of sampling with many wells, the HSCB would be close. Ultimately, at a site the goal would be to have the HSCB coincide with or be within the actual compliance boundary (typically the site property line).



In order to perform a risk-based cleanup status evaluation for the whole site, a strategy was developed as follows.

- Estimate concentration versus distance decay coefficient from plume centerline wells.
- Extrapolate concentration versus distance for each well using this decay coefficient.
- Comparing the extrapolated concentrations with the compliance concentration using power analysis.

Results from this analysis can be *Attained* or *Not Attained*, providing a statistical interpretation of whether the cleanup goal has been met on the site-scale from the risk-based point of view. The results as a function of time can be used to evaluate if the monitoring system has enough power at each step in the sampling record to indicate certainty of compliance by the plume location and condition relative to the compliance boundary. For example, if results are *Not Attained* at early sampling events but are *Attained* in recent sampling events, it indicates that the recent sampling record provides a powerful enough result to indicate compliance of the plume relative to the location of the receptor or compliance boundary.

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TABLE C.1
Mann-Kendall Analysis Decision Matrix (Aziz, et. al., 2003)

Mann-Kendall Statistic	Confidence in the Trend	Concentration Trend
S > 0	> 95%	Increasing
S > 0	90 - 95%	Probably Increasing
S > 0	< 90%	No Trend
S ≤ 0	< 90% and COV ≥ 1	No Trend
S ≤ 0	< 90% and COV < 1	Stable
S < 0	90 - 95%	Probably Decreasing
S < 0	> 95%	Decreasing

TABLE C.2
Linear Regression Analysis Decision Matrix (Aziz, et. al., 2003)

Confidence in the Trend	Log-slope	
	Positive	Negative
< 90%	No Trend	COV < 1 Stable COV > 1 No Trend
90 - 95%	Probably Increasing	Probably Decreasing
> 95%	Increasing	Decreasing

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MAROS: Decision Support Tool

MAROS is a collection of tools in one software package that is used in an explanatory, non-linear fashion. The tool includes models, geostatistics, heuristic rules, and empirical relationships to assist the user in optimizing a groundwater monitoring network system while maintaining adequate delineation of the plume as well as knowledge of the plume state over time. Different users utilize the tool in different ways and interpret the results from a different viewpoint.

Overview Statistics

What it is: Simple, qualitative and quantitative plume information can be gained through evaluation of monitoring network historical data trends both spatially and temporally. The MAROS Overview Statistics are the foundation the user needs to make informed optimization decisions at the site.

What it does: The Overview Statistics are designed to allow site personnel to develop a better understanding of the plume behavior over time and understand how the individual well concentration trends are spatially distributed within the plume. This step allows the user to gain information that will support a more informed decision to be made in the next level of optimization analysis.

What are the tools: Overview Statistics includes two analytical tools:

1) **Trend Analysis:** includes Mann-Kendall and Linear Regression statistics for individual wells and results in general heuristically-derived monitoring categories with a suggested sampling density and monitoring frequency.

2) **Moment Analysis:** includes dissolved mass estimation (0^{th} Moment), center of mass (1^{st} Moment), and plume spread (2^{nd} Moment) over time. Trends of these moments show the user another piece of information about the plume stability over time.

What is the product: A first-cut blueprint for a future long-term monitoring program that is intended to be a foundation for more detailed statistical analysis.

Detailed Statistics

What it is: The MAROS Detailed Statistics allows for a quantitative analysis for spatial and temporal optimization of the well network on a well-by-well basis.

What it does: The results from the Overview Statistics should be considered along side the MAROS optimization recommendations gained from the Detailed Statistical Analysis. The MAROS Detailed Statistics results should be reassessed in view of site knowledge and regulatory requirements as well as the Overview Statistics.

What are the tools: Detailed Statistics includes four analytical tools:

1) **Sampling Frequency Optimization:** uses the Modified CES method to establish a recommended future sampling frequency.

2) **Well Redundancy Analysis:** uses the Delaunay Method to evaluate if any wells within the monitoring network are redundant and can be eliminated without any significant loss of plume information.

3) **Well Sufficiency Analysis:** uses the Delaunay Method to evaluate areas where new wells are recommended within the monitoring network due to high levels of concentration uncertainty.

4) **Data Sufficiency Analysis:** uses Power Analysis to assess if the historical monitoring data record has sufficient power to accurately reflect the location of the plume relative to the nearest receptor or compliance point.

What is the product: List of wells to remove from the monitoring program, locations where monitoring wells may need to be added, recommended frequency of sampling for each well, analysis if the overall system is statistically powerful to monitor the plume.

Figure C.1. MAROS Decision Support Tool Flow Chart

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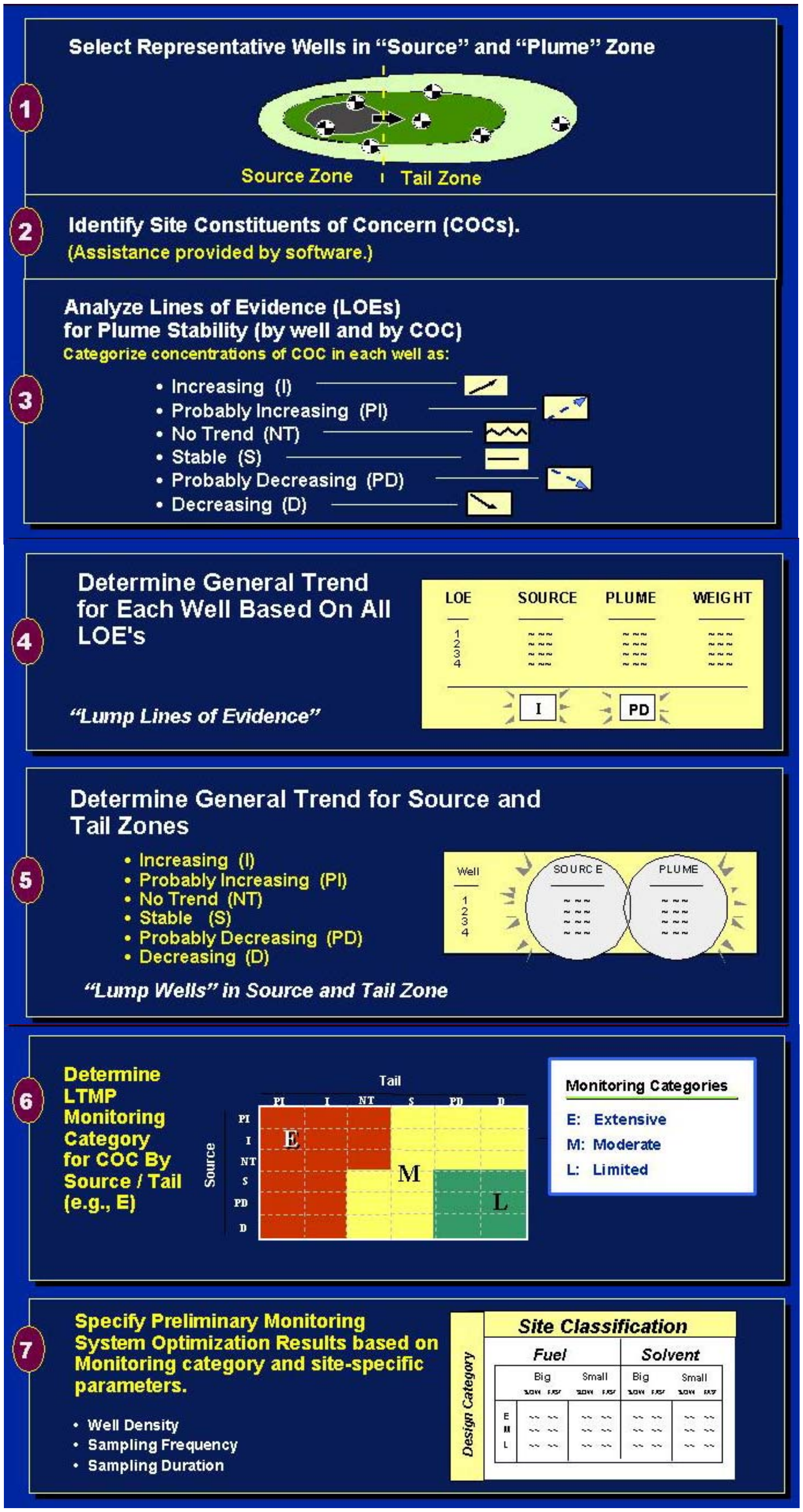

Figure C.2:
MAROS Overview Statistics Trend Analysis Methodology

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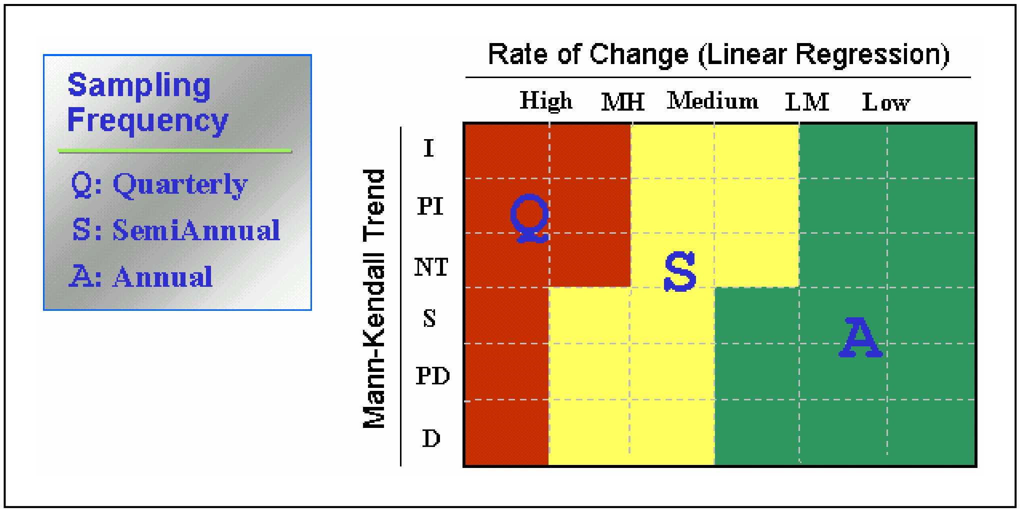

Figure C.3. Decision Matrix for Determining Provisional Frequency (*Figure A.3.1 of the MAROS Manual (AFCEE 2003*)

ASSESSMENT OF THE GROUNDWATER PROTECTION PROGRAM Y-12 NATIONAL SECURITY COMPLEX, OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

APPENDIX D: QUALITATIVE REVIEW AND MAROS REPORTS

ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.1 Bear Creek Regime West S-3

Table D.1.1	Qualitative Analysis West S-3 Area
Table D.1.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary
MAROS Chart	New Location Analysis PCE West S-3

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TABLE D.1.1
QUALITATIVE ANALYSIS WEST S-3 AREA

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-100	WL	X	Aquifer									
GW-101	WL	X	Aquitard			X						
GW-115	WL		Aquitard			X						
GW-122	WL	X	Aquifer					X			X	
GW-123	WL	X	Aquifer		X			X			X	
GW-124	WL	X	Aquifer		X						X	
GW-125	WL	X	Aquifer	X	X			X			X	
GW-127	WL	X	Aquifer			X						
GW-236	WL	X	Aquifer									
GW-243	WL	X	Aquitard			X						X
GW-244	WL	X	Aquitard			X						X
GW-245	WL	X	Aquitard			X						X
GW-246	WL	X	Aquitard			X						X
GW-247	WL	X	Aquitard			X						X
GW-276	WL	X	Aquitard			X						
GW-277	WL	X	Aquitard									
GW-306	WL	X	Aquifer	X						X		
GW-307	WL	X	Aquifer	X								
GW-308	WL	X	Aquifer	X								
GW-309	WL	X	Aquifer	X								

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figure A.1 and A.2.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
   CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.1.1
QUALITATIVE ANALYSIS WEST S-3 AREA

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-310	WL	X	Aquifer									
GW-311	WL	X	Aquifer	X								
GW-312	WL	X	Aquifer									
GW-313	WL	X	Aquifer	X								X
GW-314	WL	X	Aquifer	X								X
GW-315	WL	X	Aquifer	X								X
GW-316	WL		Aquifer									X
GW-317	WL		Aquifer	X				X				X
GW-323	WL		Aquifer	X						X		
GW-325	WL		Aquitard									
GW-345	WL	X	Aquitard									
GW-346	WL	X	Aquitard					X				
GW-347	WL		Aquifer									
GW-348	WL		Aquifer					X		X		
GW-526	WL	X	Aquitard				X					
GW-531	WL		Aquitard									
GW-613	WL		Aquitard	X						X		
GW-615	WL	X	Aquitard			X						
GW-616	WL	X	Aquifer									
GW-630	WL		Aquifer	X								
GW-648	WL		Aquifer	X						X		
GW-829	WL	X	Aquitard	X								
GW-835	WL	X		X			X				X	
SS-1	SP	X	Spring	X	X	X						

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figure A.1 and A.2.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location; CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.1.2
AQUIFER INPUT PARAMETERS

West S3 Area
Bear Creek Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	3000	ft
Maximum Plume Length	3000	ft
PlumeWidth	1400	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	5000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	Nitrate/GB/GA/VOC	--
Free NAPL Present	Yes	--
Priority COCs	**Screening Levels**	
Trichloroethene (TCE)	0.005	mg/L
1,1-Dichloroethene	0.007	mg/L
Vinyl Chloride	0.002	
Benzene	0.006	mg/L
Tetrachloroethene (PCE)	0.005	mg/L
Parameter	**Value**	
Groundwater flow direction	W/SW	200
Effective Porosity	0.1	--
Source Location near Well	GW-243	--
Source X-Coordinate	51990.37	ft*
Source Y-Coordinate	30154.79	ft*
Saturated Thickness	50	ft
Source Wells	**Value**	
GW-615, GW-243, GW-276, GW-246		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS COC Assessment

Project: Y-12 Security Complex **User Name:** MV

Location: West S-3 **State:** Tennessee

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
GROSS BETA ACTIVITY	1.8E+04	5.0E+01	36781.2%
NITRATE	9.8E+02	1.0E+01	9716.6%
URANIUM	9.7E-01	3.0E-02	3122.9%
GROSS ALPHA ACTIVITY	3.7E+02	1.5E+01	2343.3%
TETRACHLOROETHYLENE(PCE)	1.0E-01	5.0E-03	1952.1%
VINYL CHLORIDE	6.5E-03	2.0E-03	223.9%
TRICHLOROETHYLENE (TCE)	1.0E-02	5.0E-03	108.4%
TECHNETIUM-99	4.2E+03	4.0E+03	4.1%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage excedence from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Excedences	Percent Excedences	Total detects
NITRATE	INO	44	28	63.6%	40
GROSS BETA ACTIVITY	INO	44	20	45.5%	44
GROSS ALPHA ACTIVITY	INO	44	20	45.5%	44
TRICHLOROETHYLENE (TCE)	ORG	44	11	25.0%	27
TETRACHLOROETHYLENE(PCE)	ORG	44	10	22.7%	32
URANIUM	MET	44	9	20.5%	43
TECHNETIUM-99	MET	28	5	17.9%	28
VINYL CHLORIDE	ORG	44	1	2.3%	1

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total excedences (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
TECHNETIUM-99	
NITRATE	
GROSS BETA ACTIVITY	
GROSS ALPHA ACTIVITY	
VINYL CHLORIDE	0.042
TRICHLOROETHYLENE (TCE)	0.297
TETRACHLOROETHYLENE(PCE)	0.923
URANIUM	2960

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Project: Y-12 Security Complex

User Name: MV

Location: West S-3

State: Tennessee

Contaminants of Concern (COC's)

GROSS ALPHA ACTIVITY

GROSS BETA ACTIVITY

NITRATE

TETRACHLOROETHYLENE(PCE)

VINYL CHLORIDE

MAROS Plume Analysis Summary

Project: Y-12 Security Complex

User Name: MV

Location: West S-3

State: Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS ALPHA ACTIVITY											
	GW-243	S	2	2	5.1E+02	5.1E+02	No	N/A	N/A	N/A	N/A
	GW-246	S	2	2	2.8E+02	2.8E+02	No	N/A	N/A	N/A	N/A
	GW-276	S	18	18	3.2E+02	3.4E+02	No	S	NT	N/A	N/A
	GW-615	S	2	2	2.8E+02	2.8E+02	No	N/A	N/A	N/A	N/A
	GW-829	T	10	10	2.2E+00	7.7E-01	No	D	D	N/A	N/A
	GW-613	T	2	2	1.0E+00	1.0E+00	No	N/A	N/A	N/A	N/A
	GW-315	T	15	15	1.9E+00	1.7E+00	No	D	PD	N/A	N/A
	GW-124	T	2	2	4.0E+00	4.0E+00	No	N/A	N/A	N/A	N/A
	GW-616	T	1	1	3.1E+00	3.1E+00	No	N/A	N/A	N/A	N/A
	GW-345	T	1	1	1.4E+00	1.4E+00	No	N/A	N/A	N/A	N/A
	GW-123	T	1	1	1.2E+01	1.2E+01	No	N/A	N/A	N/A	N/A
	GW-115	T	14	7	1.2E+00	2.0E-01	No	NT	NT	N/A	N/A
	GW-526	T	14	8	4.0E+01	8.2E+00	No	PD	D	N/A	N/A
	SS-1	T	18	18	1.9E+01	1.9E+01	No	NT	NT	N/A	N/A
	GW-835	T	4	4	1.8E+02	1.6E+02	No	S	PD	N/A	N/A
	GW-101	T	2	2	5.3E+00	5.3E+00	No	N/A	N/A	N/A	N/A
	GW-311	T	11	11	3.6E+00	2.2E+00	No	NT	NT	N/A	N/A
	GW-236	T	3	3	4.1E+00	3.9E+00	No	N/A	N/A	N/A	N/A
GROSS BETA ACTIVITY											
	GW-276	S	17	17	5.0E+02	4.7E+02	No	D	D	N/A	N/A
	GW-246	S	2	2	1.7E+04	1.7E+04	No	N/A	N/A	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: West S-3 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS BETA ACTIVITY											
	GW-243	S	2	2	1.5E+04	1.5E+04	No	N/A	N/A	N/A	N/A
	GW-615	S	2	2	6.1E+02	6.1E+02	No	N/A	N/A	N/A	N/A
	GW-124	T	2	2	8.7E+01	8.7E+01	No	N/A	N/A	N/A	N/A
	GW-315	T	18	18	2.8E+01	3.0E+01	No	PI	NT	N/A	N/A
	GW-345	T	1	1	1.8E+00	1.8E+00	No	N/A	N/A	N/A	N/A
	GW-311	T	13	13	7.0E+00	4.4E+00	No	PD	D	N/A	N/A
	GW-526	T	14	8	9.0E+01	1.3E+01	No	NT	NT	N/A	N/A
	GW-100	T	2	2	2.1E+00	2.1E+00	No	N/A	N/A	N/A	N/A
	GW-123	T	2	2	9.5E+00	9.5E+00	No	N/A	N/A	N/A	N/A
	GW-236	T	3	3	7.0E+01	7.3E+01	No	N/A	N/A	N/A	N/A
	GW-346	T	1	1	3.8E+01	3.8E+01	No	N/A	N/A	N/A	N/A
	GW-115	T	15	13	2.6E+00	1.5E+00	No	NT	NT	N/A	N/A
	GW-101	T	2	2	4.2E+00	4.2E+00	No	N/A	N/A	N/A	N/A
	GW-835	T	4	4	2.3E+02	2.1E+02	No	S	S	N/A	N/A
	GW-616	T	1	1	6.1E-01	6.1E-01	No	N/A	N/A	N/A	N/A
	SS-1	T	18	18	4.1E+01	4.2E+01	No	I	I	N/A	N/A
	GW-613	T	2	2	4.4E+00	4.4E+00	No	N/A	N/A	N/A	N/A
	GW-829	T	12	12	5.3E+01	5.3E+00	No	NT	NT	N/A	N/A
NITRATE											
	GW-276	S	6	6	1.3E+02	1.3E+02	No	NT	NT	N/A	N/A
	GW-615	S	2	2	1.1E+04	1.1E+04	No	N/A	N/A	N/A	N/A
	GW-246	S	2	2	2.9E+03	2.9E+03	No	N/A	N/A	N/A	N/A
	GW-243	S	2	2	7.9E+03	7.9E+03	No	N/A	N/A	N/A	N/A
	GW-835	T	1	1	9.8E+01	9.8E+01	No	N/A	N/A	N/A	N/A
	SS-1	T	18	18	1.6E+01	1.6E+01	No	S	NT	N/A	N/A
	GW-100	T	2	2	5.3E+01	5.3E+01	No	N/A	N/A	N/A	N/A
	GW-311	T	17	17	3.5E-01	3.3E-01	No	S	S	N/A	N/A
	GW-123	T	2	0	2.0E-02	2.0E-02	Yes	N/A	N/A	N/A	N/A
	GW-829	T	11	11	2.7E+01	2.8E+01	No	D	PD	N/A	N/A
	GW-236	T	2	2	5.3E+01	5.3E+01	No	N/A	N/A	N/A	N/A
	GW-346	T	1	1	1.0E+03	1.0E+03	No	N/A	N/A	N/A	N/A
	GW-315	T	17	17	8.0E+00	8.0E+00	No	D	I	N/A	N/A
	GW-526	T	1	1	1.2E+03	1.2E+03	No	N/A	N/A	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: West S-3 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
NITRATE											
	GW-124	T	2	2	1.9E+01	1.9E+01	No	N/A	N/A	N/A	N/A
	GW-616	T	2	2	2.7E+02	2.7E+02	No	N/A	N/A	N/A	N/A
	GW-345	T	1	1	4.8E-01	4.8E-01	No	N/A	N/A	N/A	N/A
	GW-613	T	4	2	2.6E-02	2.5E-02	No	NT	PI	N/A	N/A
	GW-101	T	2	2	7.3E+01	7.3E+01	No	N/A	N/A	N/A	N/A
	GW-115	T	7	2	5.7E-02	2.0E-02	No	NT	PD	N/A	N/A
TETRACHLOROETHYLENE(PCE)											
	GW-276	S	18	18	1.3E-02	1.0E-02	No	D	D	N/A	N/A
	GW-615	S	6	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-243	S	2	2	4.0E+00	4.0E+00	No	N/A	N/A	N/A	N/A
	GW-246	S	2	2	1.0E-01	1.0E-01	No	N/A	N/A	N/A	N/A
	GW-115	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-123	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-100	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-101	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-124	T	2	1	5.2E-04	5.2E-04	No	N/A	N/A	N/A	N/A
	GW-236	T	3	2	5.2E-04	5.0E-04	No	N/A	N/A	N/A	N/A
	GW-835	T	20	16	1.8E-03	2.0E-03	No	I	I	N/A	N/A
	GW-613	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-616	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-346	T	1	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-829	T	12	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-345	T	1	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-526	T	11	0	5.0E-05	5.0E-05	Yes	S	I	N/A	N/A
	GW-315	T	18	18	1.1E-02	1.1E-02	No	D	S	N/A	N/A
	GW-311	T	18	1	7.5E-05	5.0E-05	No	NT	PI	N/A	N/A
	SS-1	T	18	4	2.1E-04	5.0E-05	No	D	D	N/A	N/A
VINYL CHLORIDE											
	GW-615	S	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-276	S	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-243	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-246	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: West S-3 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
VINYL CHLORIDE											
	GW-100	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-835	T	20	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-616	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-101	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-829	T	12	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-613	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-311	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-526	T	11	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-346	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-123	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-345	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-315	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-124	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	SS-1	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-236	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-115	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 Security Complex
User Name: MV
Location: West S-3
State: Tennessee

Effective Date	0th Moment: Estimated Mass (Kg)	1st Moment (Center of Mass): Xc (ft)	1st Moment (Center of Mass): Yc (ft)	1st Moment (Center of Mass): Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	2nd Moment (Spread): Sigma YY (sq ft)	Number of Wells
GROSS ALPHA ACTIVITY							
1/1/1996	5.3E+03	51,519	30,036	486	134,370	98,255	6
7/1/1996	0.0E+00						5
10/1/1996	0.0E+00						1
1/1/1997	0.0E+00						5
4/1/1997	0.0E+00						1
7/1/1997	0.0E+00						5
10/1/1997	0.0E+00						2
1/1/1998	6.2E+03	51,784	30,021	246	294,961	93,795	8
7/1/1998	1.5E+03	51,033	29,772	1,031	241,620	18,320	7
1/1/1999	2.7E+03	51,706	29,843	422	91,621	31,065	6
7/1/1999	1.5E+03	51,756	29,789	434	25,457	42,246	6
1/1/2000	2.4E+03	51,395	29,752	719	271,722	48,920	7
7/1/2000	3.7E+02	50,999	29,571	1,150	215,604	33,804	7
1/1/2001	9.4E+02	51,656	30,070	345	362,488	62,017	7
7/1/2001	1.8E+03	51,174	29,808	887	369,037	35,419	9
1/1/2002	8.1E+03	51,560	29,875	513	84,013	21,865	6
7/1/2002	1.7E+03	52,068	29,862	303	237,943	59,021	7
1/1/2003	2.6E+02	51,544	29,908	509	234,326	154,978	6
7/1/2003	0.0E+00						5
1/1/2004	4.8E+03	51,808	29,975	256	157,126	52,717	9
7/1/2004	2.4E+03	51,864	29,926	261	72,759	7,616	7
GROSS BETA ACTIVITY							
1/1/1996	1.2E+04	51,530	29,907	522	135,003	106,171	7
7/1/1996	0.0E+00						4
1/1/1997	0.0E+00						5
4/1/1997	0.0E+00						1
7/1/1997	2.4E+04	51,647	29,923	413	203,090	81,442	7
10/1/1997	0.0E+00						2
1/1/1998	1.8E+04	51,791	29,985	262	264,505	92,320	8
7/1/1998	7.6E+03	51,606	30,023	406	216,012	60,441	6
1/1/1999	1.1E+04	51,450	29,807	643	325,318	45,611	9
7/1/1999	1.0E+04	51,629	29,746	545	128,787	44,150	7
1/1/2000	3.1E+03	51,020	29,616	1,110	234,910	73,189	7
7/1/2000	2.4E+03	51,127	29,655	997	271,940	80,718	7
1/1/2001	1.7E+03	51,890	29,784	385	517,626	66,425	9
7/1/2001	2.2E+04	51,513	29,922	531	250,696	79,907	8
1/1/2002	2.2E+04	52,282	30,065	305	36,783	70,389	6
7/1/2002	3.5E+04	52,258	30,106	273	90,897	84,496	7

Project: Y-12 Security Complex

Location: West S-3

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
GROSS BETA ACTIVITY							
1/1/2003	5.3E+03	51,870	30,009	189	222,051	76,801	6
7/1/2003	4.6E+03	51,870	30,009	189	277,214	89,482	7
1/1/2004	1.6E+04	52,023	29,940	218	118,570	56,113	10
7/1/2004	9.1E+03	51,953	29,803	354	111,916	13,656	10
NITRATE							
1/1/1996	2.7E+03	51,507	29,767	619	191,119	52,565	7
7/1/1996	2.3E+03	51,504	29,745	636	190,559	37,204	7
10/1/1996	0.0E+00						1
1/1/1997	1.7E+03	51,419	29,792	676	230,021	52,475	7
7/1/1997	4.9E+02	51,521	29,976	501	154,560	55,290	6
10/1/1997	0.0E+00						1
1/1/1998	2.3E+03	51,624	29,811	502	152,202	66,757	6
7/1/1998	4.4E+03	51,581	29,855	507	397,572	68,321	7
1/1/1999	3.3E+03	51,091	29,701	1,007	27,386	5,792	7
7/1/1999	0.0E+00						1
1/1/2000	0.0E+00						4
7/1/2000	0.0E+00						4
1/1/2001	2.5E+03	50,965	29,675	1,132	153,568	15,779	6
7/1/2001	2.6E+03	50,975	29,676	1,122	167,525	15,402	6
1/1/2002	0.0E+00						4
7/1/2002	0.0E+00						4
1/1/2003	0.0E+00						4
7/1/2003	0.0E+00						4
1/1/2004	1.7E+04	51,799	29,895	322	93,692	21,036	8
7/1/2004	1.8E+04	51,804	29,902	314	89,417	20,674	8
TETRACHLOROETHYLENE(PCE)							
1/1/1996	2.3E-01	51,598	29,965	435	113,664	127,422	7
7/1/1996	6.9E-01	51,576	29,806	541	111,931	71,904	7
10/1/1996	0.0E+00						1
1/1/1997	7.1E-01	51,578	29,807	539	110,983	71,815	7
4/1/1997	0.0E+00						1
7/1/1997	3.8E-01	51,579	29,999	440	103,130	59,922	6
10/1/1997	0.0E+00						2
1/1/1998	1.4E-01	51,857	29,841	341	208,359	74,247	7
7/1/1998	1.3E-01	51,851	29,843	341	213,391	75,322	7
1/1/1999	2.1E-01	51,720	29,889	379	123,680	69,663	9
7/1/1999	2.2E-01	51,701	29,824	439	80,694	68,068	7
10/1/1999	0.0E+00						2
1/1/2000	1.2E-01	51,698	29,783	473	281,426	84,902	9
4/1/2000	0.0E+00						2
7/1/2000	1.7E-01	51,659	29,778	501	259,842	87,384	9

Project: Y-12 Security Complex

Location: West S-3

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TETRACHLOROETHYLENE(PCE)							
10/1/2000	0.0E+00						1
1/1/2001	1.3E-01	51,557	29,768	580	255,370	104,467	10
4/1/2001	0.0E+00						1
7/1/2001	1.6E-01	51,650	29,757	524	283,590	91,574	10
10/1/2001	0.0E+00						1
1/1/2002	4.1E+00	52,071	29,935	234	84,437	50,473	8
4/1/2002	0.0E+00						1
7/1/2002	4.4E+00	52,068	29,927	241	83,876	47,938	8
10/1/2002	0.0E+00						1
1/1/2003	1.6E-01	51,652	29,758	521	240,656	90,251	8
4/1/2003	0.0E+00						1
7/1/2003	1.7E-01	51,655	29,749	526	239,710	86,842	8
1/1/2004	2.8E-01	51,759	29,760	457	127,403	31,995	11
7/1/2004	2.3E-01	51,786	29,751	453	93,874	11,342	10
VINYL CHLORIDE							
1/1/1996	2.3E-01	51,403	30,071	593	248,611	140,935	7
7/1/1996	2.3E-01	51,403	30,071	593	248,611	140,935	7
10/1/1996	0.0E+00						1
1/1/1997	2.3E-01	51,403	30,071	593	248,611	140,935	7
4/1/1997	0.0E+00						1
7/1/1997	2.3E-01	51,403	30,071	593	235,146	118,852	6
10/1/1997	0.0E+00						2
1/1/1998	2.0E-01	51,477	29,999	536	330,897	109,789	7
7/1/1998	2.0E-01	51,477	29,999	536	330,897	109,789	7
1/1/1999	2.0E-01	51,477	29,999	536	306,919	121,944	9
7/1/1999	2.0E-01	51,477	29,999	536	246,220	101,260	7
10/1/1999	0.0E+00						2
1/1/2000	2.0E-01	51,477	29,999	536	376,694	117,115	9
4/1/2000	0.0E+00						2
7/1/2000	2.0E-01	51,477	29,999	536	376,694	117,115	9
10/1/2000	0.0E+00						1
1/1/2001	2.0E-01	51,477	29,999	536	376,899	109,355	10
4/1/2001	0.0E+00						1
7/1/2001	2.0E-01	51,477	29,999	536	376,899	109,355	10
10/1/2001	0.0E+00						1
1/1/2002	1.6E-01	51,638	29,983	392	281,443	133,199	8
4/1/2002	0.0E+00						1
7/1/2002	1.6E-01	51,638	29,983	392	281,443	133,199	8
10/1/2002	0.0E+00						1
1/1/2003	1.6E-01	51,638	29,983	392	274,513	111,455	8
4/1/2003	0.0E+00						1
7/1/2003	1.6E-01	51,638	29,983	392	274,513	111,455	8

Project: Y-12 Security Complex

Location: West S-3

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
VINYL CHLORIDE							
1/1/2004	1.6E-01	51,636	29,982	394	292,017	136,676	11
7/1/2004	1.0E-01	51,395	29,735	728	234,693	40,970	10

Project: Y-12 Security Complex

Location: West S-3

User Name: MV

State: Tennessee

Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	GROSS ALPHA ACTIVITY	1.23	49	92.6%	PI
	GROSS BETA ACTIVITY	0.97	38	88.3%	NT
	NITRATE	1.82	0	48.7%	NT
	TETRACHLOROETHYLENE(PCE)	2.46	-11	57.4%	NT
	VINYL CHLORIDE	0.83	-121	98.9%	D
1st Moment: Distance to Source					
	GROSS ALPHA ACTIVITY	0.55	-17	80.6%	S
	GROSS BETA ACTIVITY	0.59	-46	97.9%	D
	NITRATE	0.44	-3	56.0%	S
	TETRACHLOROETHYLENE(PCE)	0.23	7	58.9%	NT
	VINYL CHLORIDE	0.18	-73	99.7%	D
2nd Moment: Sigma XX					
	GROSS ALPHA ACTIVITY	0.54	-11	70.5%	S
	GROSS BETA ACTIVITY	0.54	-12	68.7%	S
	NITRATE	0.56	-25	97.0%	D
	TETRACHLOROETHYLENE(PCE)	0.46	9	61.7%	NT
	VINYL CHLORIDE	0.18	11	64.6%	NT
2nd Moment: Sigma YY					
	GROSS ALPHA ACTIVITY	0.72	-7	62.6%	S
	GROSS BETA ACTIVITY	0.32	-24	84.7%	S
	NITRATE	0.60	-13	82.1%	S
	TETRACHLOROETHYLENE(PCE)	0.37	-27	83.5%	S
	VINYL CHLORIDE	0.20	-43	94.4%	PD

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.

ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.2	**Bear Creek Regime Oil Landfarm WMA**
Table D.2.1	Qualitative Analysis Oil Landfarm Area
Table D.2.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary
MAROS Chart	New Location Analysis Nitrate OLFA

GROUNDWATER SERVICES, INC.

TABLE D.2.1
QUALITATIVE ANALYSIS OIL LANDFARM AREA

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-006	WL		Aquitard									X
GW-008	WL	X	Aquitard				X					X
GW-010	WL	X	Aquitard				X					X
GW-013	WL		Aquitard									
GW-064	WL	X	Aquifer									
GW-066	WL	X	Aquifer	X								X
GW-067	WL	X	Aquifer									
GW-073	WL		Aquitard						X	X		
GW-074	WL		Aquitard		X				X	X		
GW-075	WL		Aquitard		X		X					X
GW-084	WL		Aquitard							X		
GW-085	WL	X	Aquitard								X	X
GW-086	WL		Aquitard									
GW-097	WL		Aquitard									
GW-098	WL	X	Aquitard		X							X
GW-120	WL		Aquitard						X	X		
GW-225	WL	X	Aquifer		X						X	
GW-226	WL	X	Aquifer	X							X	
GW-227	WL	X	Aquifer									
GW-228	WL	X	Aquifer									
GW-229	WL	X	Aquifer									
GW-363	WL	X	Aquitard				X	X		X		
GW-364	WL	X	Aquifer	X							X	
GW-365	WL	X	Aquifer	X	X						X	
GW-366	WL		Aquifer		X				X			
GW-367	WL	X	Aquifer							X		
GW-368	WL	X	Aquifer		X					X		
GW-369	WL	X	Aquifer		X							
GW-520	WL		Aquifer									
GW-537	WL	X	Aquitard	X				X			X	X

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figure A.1 and A.2.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
   CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.2.1
QUALITATIVE ANALYSIS OIL LANDFARM AREA

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-601	WL	X	Aquifer	X	X							
GW-636	WL		Aquitard		X				X			
GW-637	WL		Aquitard	X					X	X		
GW-638	WL		Aquitard									
GW-645	WL		Aquifer	X								
GW-646	WL		Aquifer									
GW-723	WL	X	Aquifer			X					X	
GW-724	WL	X	Aquifer			X					X	
GW-725	WL	X	Aquifer	X		X					X	
GW-736	WL	X	Aquifer		X	X						X
GW-737	WL	X	Aquifer			X						X
GW-738	WL	X	Aquifer			X						
GW-739	WL	X	Aquifer			X						
GW-740	WL	X	Aquifer			X						
GW-794	WL		Aquifer	X					X	X		
GW-795	WL		Aquifer	X						X		
GW-800	WL		Aquifer	X						X		
GW-916	WL		Aquitard	X				X				
GW-917	WL		Aquitard	X				X		X		
GW-918	WL		Aquitard	X				X		X		
GW-919	WL		Aquitard					X		X		
GW-920	WL		Aquitard					X		X		
GW-921	WL		Aquitard					X				
GW-922	WL		Aquitard					X		X		
GW-923	WL		Aquitard					X				
GW-924	WL		Aquitard					X				
GW-925	WL		Aquitard		X			X				
GW-926	WL		Aquitard		X			X				
GW-927	WL		Aquitard					X		X		

Notes:

1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figure A.1 and A.2.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location; CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.2.2
AQUIFER INPUT PARAMETERS

Oil Landfarm WMA
Bear Creek Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	4000	ft
Maximum Plume Length	4000	ft
PlumeWidth	2200	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	5000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	Nitrate/GA/GB/VOC	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow direction	W/SW	200
Effective Porosity	0.1	--
Source Location near Well	GW-064	--
Source X-Coordinate	49169	ft*
Source Y-Coordinate	29195	ft*
Saturated Thickness	50	ft
Source Wells		
GW -225, GW-229, GW-064, GW-725		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS COC Assessment

Project: Y-12 Security Complex **User Name:** MV

Location: OLFA **State:** Tennessee

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
TRICHLOROETHYLENE (TCE)	2.5E-02	5.0E-03	403.7%
NITRATE	2.8E+01	1.0E+01	184.1%
VINYL CHLORIDE	4.2E-03	2.0E-03	110.4%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage excedence from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Excedences	Percent Excedences	Total detects
TRICHLOROETHYLENE (TCE)	ORG	59	23	39.0%	35
NITRATE	INO	47	12	25.5%	38
VINYL CHLORIDE	ORG	59	4	6.8%	4

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total excedences (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
NITRATE	
VINYL CHLORIDE	0.042
TRICHLOROETHYLENE (TCE)	0.297

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Contaminants of Concern (COC's)

VINYL CHLORIDE

TETRACHLOROETHYLENE(PCE)

NITRATE

MAROS Plume Analysis Summary

Project: Y-12 Security Complex

User Name: MV

Location: OLFA

State: Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
NITRATE											
	GW-725	S	17	17	3.4E+01	2.5E+01	No	D	D	N/A	N/A
	GW-064	S	1	1	3.7E+00	3.7E+00	No	N/A	N/A	N/A	N/A
	GW-229	S	6	0	2.0E-02	2.0E-02	Yes	S	D	N/A	N/A
	GW-225	S	8	8	3.4E+01	3.6E+01	No	NT	S	N/A	N/A
	GW-739	T	2	2	1.5E+00	1.5E+00	No	N/A	N/A	N/A	N/A
	GW-364	T	2	2	5.3E-01	5.3E-01	No	N/A	N/A	N/A	N/A
	GW-736	T	2	2	1.7E+01	1.7E+01	No	N/A	N/A	N/A	N/A
	GW-365	T	2	0	2.0E-02	2.0E-02	Yes	N/A	N/A	N/A	N/A
	GW-724	T	17	17	2.4E+01	2.4E+01	No	D	D	N/A	N/A
	GW-794	T	2	2	4.4E-01	4.4E-01	No	N/A	N/A	N/A	N/A
	GW-537	T	17	17	6.6E+02	6.6E+02	No	D	D	N/A	N/A
	GW-226	T	13	13	1.6E+01	1.7E+01	No	NT	NT	N/A	N/A
	GW-740	T	17	17	2.7E+00	2.4E+00	No	D	D	N/A	N/A
	GW-795	T	4	0	2.0E-02	2.0E-02	Yes	S	S	N/A	N/A
	GW-098	T	4	0	2.0E-02	2.0E-02	Yes	S	S	N/A	N/A
	GW-363	T	4	1	2.2E-02	2.0E-02	No	NT	NT	N/A	N/A
	GW-723	T	4	2	2.3E+00	1.7E+00	No	NT	D	N/A	N/A
	GW-085	T	17	17	1.6E+02	1.8E+02	No	NT	PI	N/A	N/A
	GW-006	T	1	1	2.0E+00	2.0E+00	No	N/A	N/A	N/A	N/A
	GW-084	T	4	1	5.0E-02	2.0E-02	No	NT	NT	N/A	N/A
	GW-738	T	17	17	1.4E+01	1.4E+01	No	S	S	N/A	N/A
	GW-066	T	2	2	2.6E+00	2.6E+00	No	N/A	N/A	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: OLFA **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
NITRATE											
	GW-737	T	2	2	1.3E+01	1.3E+01	No	N/A	N/A	N/A	N/A
	GW-008	T	2	0	2.0E-02	2.0E-02	Yes	N/A	N/A	N/A	N/A
	GW-601	T	1	1	1.4E+01	1.4E+01	No	N/A	N/A	N/A	N/A
TETRACHLOROETHYLENE(PCE)											
	GW-725	S	18	9	5.7E-04	2.8E-04	No	NT	NT	N/A	N/A
	GW-229	S	6	1	1.3E-04	5.0E-05	No	NT	PI	N/A	N/A
	GW-064	S	2	1	2.8E-04	2.8E-04	No	N/A	N/A	N/A	N/A
	GW-225	S	8	4	4.0E-04	2.8E-04	No	I	I	N/A	N/A
	GW-601	T	1	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-006	T	8	4	2.4E-04	2.0E-04	No	S	S	N/A	N/A
	GW-008	T	14	14	3.4E-02	2.4E-02	No	NT	NT	N/A	N/A
	GW-724	T	18	12	1.1E-03	1.5E-03	No	PI	PI	N/A	N/A
	GW-723	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-066	T	2	2	7.0E-03	7.0E-03	No	N/A	N/A	N/A	N/A
	GW-084	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-363	T	15	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-097	T	2	1	7.7E-04	7.8E-04	No	N/A	N/A	N/A	N/A
	GW-364	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-098	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-537	T	18	1	7.5E-05	5.0E-05	No	NT	PD	N/A	N/A
	GW-226	T	14	2	1.1E-04	5.0E-05	No	NT	I	N/A	N/A
	GW-228	T	1	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-365	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-085	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-919	T	5	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-916	T	11	1	2.3E-04	5.0E-05	No	NT	NT	N/A	N/A
	GW-918	T	11	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-794	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-924	T	12	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-917	T	11	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-922	T	11	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-795	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-923	T	9	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: OLFA **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TETRACHLOROETHYLENE(PCE)											
	GW-739	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-740	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-738	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-926	T	11	1	5.0E-05	5.0E-05	No	S	D	N/A	N/A
	GW-921	T	11	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-737	T	2	2	1.3E-03	1.3E-03	No	N/A	N/A	N/A	N/A
	GW-920	T	11	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-927	T	11	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-736	T	2	1	5.2E-04	5.2E-04	No	N/A	N/A	N/A	N/A
	GW-925	T	11	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
VINYL CHLORIDE											
	GW-229	S	6	6	3.1E-02	3.1E-02	No	S	PD	N/A	N/A
	GW-725	S	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-064	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-225	S	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-085	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-921	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-097	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-922	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-084	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-920	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-066	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-924	T	5	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-925	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-008	T	14	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-926	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-006	T	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-923	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-794	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-736	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-724	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-927	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-737	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: OLFA **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
VINYL CHLORIDE											
	GW-738	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-601	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-739	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-537	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-918	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-365	T	2	1	7.5E-04	7.5E-04	No	N/A	N/A	N/A	N/A
	GW-098	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-364	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-795	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-363	T	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-916	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-917	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-228	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-226	T	14	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-723	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-919	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-740	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 Security Complex
Location: OLFA
User Name: MV
State: Tennessee

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	**Estimated Mass (Kg)**	**Xc (ft)**	**Yc (ft)**	**Source Distance (ft)**	**Sigma XX (sq ft)**	**Sigma YY (sq ft)**	**Number of Wells**
NITRATE							
1/1/1996	6.4E+03	49,115	29,744	552	90,052	34,278	11
7/1/1996	5.4E+03	49,109	29,736	544	98,171	37,142	11
1/1/1997	4.9E+03	49,150	29,750	555	33,090	27,347	8
7/1/1997	4.2E+03	49,129	29,766	572	46,860	34,575	8
1/1/1998	3.7E+03	49,001	29,616	454	115,759	54,016	8
7/1/1998	3.3E+03	49,045	29,677	498	103,683	43,907	9
10/1/1998	0.0E+00						1
1/1/1999	6.9E+03	48,779	29,549	527	160,519	54,216	8
1/1/2000	7.4E+03	48,867	29,609	512	118,633	37,793	7
7/1/2000	7.0E+03	48,898	29,634	516	116,577	35,825	7
1/1/2001	6.4E+03	48,874	29,625	522	159,826	36,540	11
7/1/2001	6.6E+03	48,866	29,628	528	158,008	36,622	11
1/1/2002	6.3E+03	49,039	29,706	527	106,418	28,555	14
7/1/2002	4.7E+03	48,994	29,689	524	133,575	31,180	14
1/1/2003	7.0E+03	48,841	29,608	528	140,310	36,825	9
7/1/2003	6.9E+03	48,847	29,617	531	139,620	34,734	9
1/1/2004	9.1E+03	48,785	29,593	553	148,055	36,415	11
7/1/2004	4.7E+03	48,796	29,585	539	164,008	39,176	11
TETRACHLOROETHYLENE(PCE)							
1/1/1996	5.0E-02	47,907	29,561	1,314	465,707	63,305	11
7/1/1996	3.4E-02	47,864	29,583	1,362	448,571	67,437	11
1/1/1997	1.4E-02	48,460	29,823	947	154,611	49,616	8
7/1/1997	1.4E-02	48,460	29,823	947	154,611	49,616	8
1/1/1998	1.4E-01	48,344	29,550	898	102,213	31,358	9
4/1/1998	0.0E+00						1
7/1/1998	1.7E-01	48,190	29,537	1,037	235,391	26,161	10
10/1/1998	0.0E+00						1
1/1/1999	8.4E-02	48,378	29,477	840	157,856	39,421	10
4/1/1999	0.0E+00						1
7/1/1999	1.7E-02	48,189	29,521	1,033	267,658	34,855	10
10/1/1999	0.0E+00						1
1/1/2000	2.7E-02	48,305	29,600	954	303,162	27,620	9
4/1/2000	0.0E+00						1
7/1/2000	3.5E-02	48,104	29,571	1,130	209,280	24,714	9
1/1/2001	1.1E-01	47,803	29,693	1,454	356,038	50,364	13
4/1/2001	1.2E-02	47,370	30,742	2,373	157,502	85,700	12
7/1/2001	3.0E-01	48,114	29,719	1,178	220,928	117,764	24
10/1/2001	1.2E-02	47,370	30,742	2,373	150,226	121,117	13

Project: Y-12 Security Complex

Location: OLFA

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TETRACHLOROETHYLENE(PCE)							
1/1/2002	3.0E-01	48,180	29,585	1,063	113,254	27,331	15
7/1/2002	3.3E-01	48,202	29,587	1,044	134,010	26,355	15
1/1/2003	2.2E-01	48,095	29,723	1,197	241,619	145,143	23
4/1/2003	1.2E-02	47,370	30,742	2,373	150,226	121,117	13
7/1/2003	3.3E-01	48,107	29,756	1,201	228,978	186,099	23
10/1/2003	1.2E-02	47,370	30,742	2,373	150,226	121,117	13
1/1/2004	3.0E-01	48,020	29,644	1,234	250,390	128,151	24
4/1/2004	1.2E-02	47,355	30,740	2,383	149,308	85,476	11
7/1/2004	1.6E-01	47,905	29,725	1,371	353,310	192,891	23
10/1/2004	1.2E-02	47,370	30,742	2,373	157,502	85,700	12
VINYL CHLORIDE							
1/1/1996	2.3E-01	47,950	29,654	1,302	569,631	77,017	11
7/1/1996	2.3E-01	47,950	29,654	1,302	569,631	77,017	11
1/1/1997	1.4E-01	48,460	29,823	947	154,611	49,616	8
7/1/1997	1.4E-01	48,460	29,823	947	154,611	49,616	8
1/1/1998	1.0E-01	48,500	29,520	743	169,195	47,128	9
4/1/1998	0.0E+00						1
7/1/1998	1.2E-01	48,374	29,514	857	280,905	42,274	10
10/1/1998	0.0E+00						1
1/1/1999	1.2E-01	48,440	29,464	777	209,984	53,535	10
4/1/1999	0.0E+00						1
7/1/1999	1.0E-01	48,491	29,521	752	213,161	44,644	10
10/1/1999	0.0E+00						1
1/1/2000	1.0E-01	48,491	29,521	752	195,809	41,832	9
4/1/2000	0.0E+00						1
7/1/2000	1.0E-01	48,491	29,521	752	195,809	41,832	9
1/1/2001	2.1E-01	47,854	29,624	1,383	580,376	72,890	13
4/1/2001	1.2E-01	47,370	30,742	2,373	157,502	85,700	12
7/1/2001	4.0E-01	47,820	30,092	1,620	547,502	332,981	24
10/1/2001	1.2E-01	47,370	30,742	2,373	150,226	121,117	13
1/1/2002	1.5E-01	48,176	29,479	1,032	416,380	36,419	15
7/1/2002	1.5E-01	48,170	29,478	1,038	418,254	36,193	15
1/1/2003	1.4E-01	48,172	29,486	1,039	376,809	36,201	10
4/1/2003	1.2E-01	47,370	30,742	2,373	150,226	121,117	13
7/1/2003	1.4E-01	48,196	29,489	1,017	367,850	37,030	10
1/1/2004	2.0E-01	47,679	29,437	1,510	853,159	35,845	12
7/1/2004	1.9E-01	47,711	29,442	1,479	846,147	36,295	12

Project: Y-12 Security Complex

Location: OLFA

User Name: MV

State: Tennessee

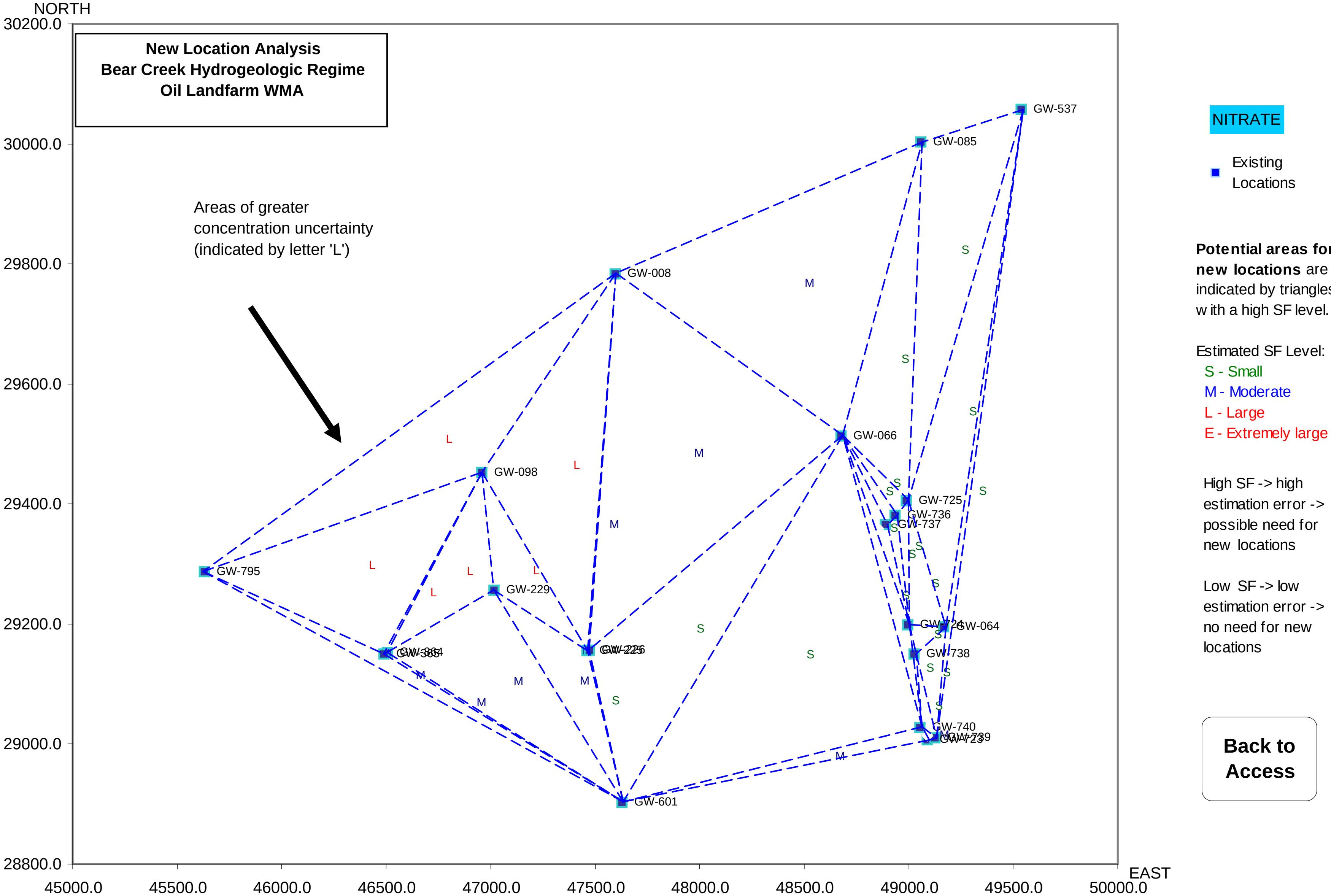
Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	NITRATE	0.36	31	87.0%	NT
	TETRACHLOROETHYLENE(PCE)	1.26	54	83.8%	NT
	VINYL CHLORIDE	0.70	59	89.8%	NT
1st Moment: Distance to Source					
	NITRATE	0.05	16	72.9%	NT
	TETRACHLOROETHYLENE(PCE)	0.40	130	100.0%	I
	VINYL CHLORIDE	0.43	62	96.8%	I
2nd Moment: Sigma XX					
	NITRATE	0.32	76	99.9%	I
	TETRACHLOROETHYLENE(PCE)	0.45	-38	81.9%	S
	VINYL CHLORIDE	0.62	28	79.0%	NT
2nd Moment: Sigma YY					
	NITRATE	0.19	2	51.6%	NT
	TETRACHLOROETHYLENE(PCE)	0.65	100	99.4%	I
	VINYL CHLORIDE	0.93	-66	97.6%	D

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.


New Location Analysis
Bear Creek Hydrogeologic Regime
Oil Landfarm WMA
NORTH
30200.0
30000.0
29800.0
29600.0
29400.0
29200.0
29000.0
28800.0
45000.0
45500.0
46000.0
46500.0
47000.0
47500.0
48000.0
48500.0
49000.0
49500.0
50000.0
EAST
Areas of greater concentration uncertainty (indicated by letter 'L')
GW-537
GW-085
GW-008
GW-066
GW-098
GW-725
GW-736
GW-737
GW-795
GW-229
GW-064
GW-738
GW-601
GW-740
NITRATE
Existing Locations
Potential areas for new locations are indicated by triangles with a high SF level.
Estimated SF Level:
S - Small
M - Moderate
L - Large
E - Extremely large
High SF -> high estimation error -> possible need for new locations
Low SF -> low estimation error -> no need for new locations
Back to Access

**ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE**

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.3	**Bear Creek Regime Bear Creek Burial Grounds**
Table D.3.1	Qualitative Analysis Bear Creek Burial Grounds
Table D.3.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary

(No Well Sufficiency areas of interest identified)

GROUNDWATER SERVICES, INC.

TABLE D.3.1
QUALITATIVE ANALYSIS BEAR CREEK BURIAL GROUNDS

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-014	WL	X	Aquitard	X			X					
GW-018	WL		Aquitard									X
GW-045	WL	X	Aquifer									
GW-046	WL	X	Aquitard				X					
GW-047	WL		Aquitard									
GW-052	WL	X	Aquifer									
GW-053	WL	X	Aquifer									
GW-054	WL		Aquifer						X			
GW-056	WL		Aquifer			X			X		X	
GW-057	WL		Aquifer			X						
GW-058	WL	X	Aquifer	X					X			
GW-061	WL	X	Aquifer									
GW-068	WL	X	Aquitard									
GW-069	WL		Aquitard				X					
GW-071	WL	X	Aquitard		X		X					
GW-072	WL		Aquitard									
GW-077	WL		Aquitard		X			X				
GW-078	WL		Aquitard					X				
GW-079	WL		Aquitard					X				
GW-080	WL		Aquitard					X		X		
GW-082	WL	X	Aquitard				X				X	
GW-083	WL		Aquitard						X			
GW-089	WL	X	Aquitard									
GW-091	WL		Aquitard									
GW-094	WL		Aquifer		X				X			
GW-095	WL		Aquifer		X				X			
GW-126	WL	X	Aquitard						X			
GW-237	WL		Aquifer									
GW-242	WL	X	Aquitard									
GW-248	WL		Aquitard						X			

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figure A.1 and A.2.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
   CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

TABLE D.3.1
QUALITATIVE ANALYSIS BEAR CREEK BURIAL GROUNDS

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-249	WL		Aquitard									
GW-250	WL		Aquitard						X			
GW-257	WL	X	Aquitard				X					
GW-258	WL	X	Aquitard									
GW-259	WL	X	Aquitard									
GW-286	WL		Aquitard						X			
GW-287	WL		Aquitard									
GW-288	WL	X	Aquitard								X	X
GW-289	WL	X	Aquitard				X				X	X
GW-290	WL		Aquitard						X			
GW-291	WL	X	Aquitard				X					
GW-370	WL		Aquitard	X								
GW-372	WL		Aquitard									
GW-375	WL		Aquifer						X			
GW-621	WL		Aquifer			X					X	
GW-622	WL		Aquitard									
GW-623	WL	X	Aquitard		X							
GW-624	WL	X	Aquitard									
GW-626	WL	X	Aquitard									
GW-627	WL	X	Aquitard									
GW-629	WL	X	Aquitard									
GW-639	WL		Aquitard	X				X				
GW-641	WL		Aquitard									
GW-642	WL		Aquitard									
GW-651	WL		Aquifer						X			
GW-652	WL		Aquifer									
GW-653	WL		Aquitard									
GW-654	WL	X	Aquitard									
GW-683	WL	X	Aquifer	X	X	X		X				
GW-684	WL	X	Aquifer		X	X		X				

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figure A.1 and A.2.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.3.1
QUALITATIVE ANALYSIS BEAR CREEK BURIAL GROUNDS

Bear Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-685	WL		Aquifer			X						
GW-694	WL	X	Aquifer			X						
GW-695	WL		Aquifer			X						
GW-703	WL	X	Aquifer			X					X	
GW-704	WL	X	Aquifer			X		X			X	
GW-706	WL	X	Aquifer			X		X			X	
GW-710	WL	X	Aquifer	X	X	X						
GW-711	WL		Aquifer	X	X	X						
GW-712	WL		Aquifer	X	X	X	X	X				
GW-713	WL		Aquifer	X	X	X	X	X				
GW-714	WL		Aquifer	X		X	X	X				
GW-715	WL		Aquifer	X		X	X					
SS-4	SP	X	Spring	X		X						X
SS-5	SP	X	Spring			X						X
SS-5_95KM	SP		Spring			X						X
SS-6_6	SP		Spring			X		X				X
SS-6E	SP	X	Spring			X		X				X
SS-6W	SP	X	Spring			X		X				X
SS-7	SP		Spring			X		X				X
SS-8	SP		Spring			X		X				X

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figure A.1 and A.2.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
   CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.3.2
AQUIFER INPUT PARAMETERS

Bear Creek Burial Grounds
Bear Creek Hydrogeologic Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	5000	ft
Maximum Plume Length	8000	ft
PlumeWidth	2500	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	9000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	Chlorinated Solvent/Nitrate/GA/GB	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow direction	W/SW	200
Effective Porosity	0.1	--
Source Location near Well	GW-046	--
Source X-Coordinate	43283.53	ft*
Source Y-Coordinate	29562.34	ft*
Saturated Thickness	50	ft
Source Wells		
GW-046, GW-014, GW-071, GW-082, GW-624, GW-623, GW-626		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS COC Assessment

Project: Y-12 Security Complex **User Name:** MV

Location: Bear Creek Burial Grounds **State:** Tennessee

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
TETRACHLOROETHYLENE(PCE)	3.4E-01	5.0E-03	6770.2%
TRICHLOROETHYLENE (TCE)	2.0E-01	5.0E-03	3946.9%
VINYL CHLORIDE	3.9E-02	2.0E-03	1831.2%
BENZENE	1.3E-02	5.0E-03	152.6%
cis-1,2-DICHLOROETHYLENE	1.3E-01	7.0E-02	83.3%
1,1-DICHLOROETHENE	1.3E-02	7.0E-03	79.6%
CARBON TETRACHLORIDE	7.8E-03	5.0E-03	55.1%
1,2-DICHLOROETHANE	7.7E-03	5.0E-03	54.9%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage excedence from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Excedences	Percent Excedences	Total detects
TRICHLOROETHYLENE (TCE)	ORG	80	19	23.8%	44
TETRACHLOROETHYLENE(PCE)	ORG	80	16	20.0%	37
VINYL CHLORIDE	ORG	80	15	18.8%	15
BENZENE	ORG	80	10	12.5%	29
1,1-DICHLOROETHENE	ORG	80	9	11.3%	20
cis-1,2-DICHLOROETHYLENE	ORG	80	8	10.0%	32
1,2-DICHLOROETHANE	ORG	80	6	7.5%	13
CARBON TETRACHLORIDE	ORG	80	5	6.3%	12

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total excedences (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
VINYL CHLORIDE	0.042
1,2-DICHLOROETHANE	0.0679
cis-1,2-DICHLOROETHYLENE	0.0724
BENZENE	0.0984
1,1-DICHLOROETHENE	0.13
CARBON TETRACHLORIDE	0.277
TRICHLOROETHYLENE (TCE)	0.297
TETRACHLOROETHYLENE(PCE)	0.923

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Project: Y-12 Security Complex **User Name:** MV

Location: Bear Creek Burial Grounds **State:** Tennessee

Contaminants of Concern (COC's)

TETRACHLOROETHYLENE(PCE)

TRICHLOROETHYLENE (TCE)

VINYL CHLORIDE

GROSS BETA ACTIVITY

NITRATE

MAROS Plume Analysis Summary

Project: Y-12 Security Complex

User Name: MV

Location: Bear Creek Burial Grounds

State: Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS BETA ACTIVITY											
	GW-624	S	2	2	3.4E+00	3.4E+00	No	N/A	N/A	N/A	N/A
	GW-071	S	1	1	3.0E+00	3.0E+00	No	N/A	N/A	N/A	N/A
	GW-082	S	11	10	5.1E+00	5.2E+00	No	I	PI	N/A	N/A
	GW-014	S	1	1	1.8E+00	1.8E+00	No	N/A	N/A	N/A	N/A
	GW-046	S	14	13	3.3E+00	3.3E+00	No	S	S	N/A	N/A
	GW-626	S	2	2	3.8E+00	3.8E+00	No	N/A	N/A	N/A	N/A
	GW-372	T	3	3	2.0E+00	2.3E+00	No	N/A	N/A	N/A	N/A
	SS-4	T	18	18	9.6E+01	8.2E+01	No	NT	NT	N/A	N/A
	GW-621	T	10	10	7.4E+00	6.4E+00	No	S	S	N/A	N/A
	GW-653	T	13	13	2.8E+00	3.1E+00	No	NT	NT	N/A	N/A
	GW-291	T	4	3	1.4E+00	1.6E+00	No	NT	NT	N/A	N/A
	GW-289	T	3	3	4.0E+00	2.3E+00	No	N/A	N/A	N/A	N/A
	GW-627	T	10	10	8.1E+00	6.7E+00	No	PI	PI	N/A	N/A
	GW-629	T	4	0	1.0E-02	1.0E-02	Yes	S	S	N/A	N/A
	GW-639	T	5	1	9.5E-01	1.0E-02	No	NT	NT	N/A	N/A
	GW-715	T	16	16	1.7E+01	3.9E+00	No	NT	NT	N/A	N/A
	GW-714	T	18	18	4.1E+00	4.2E+00	No	S	D	N/A	N/A
	GW-257	T	2	2	2.5E+00	2.5E+00	No	N/A	N/A	N/A	N/A
	GW-683	T	17	17	2.3E+01	2.0E+01	No	S	S	N/A	N/A
	GW-684	T	18	18	2.7E+01	2.6E+01	No	S	S	N/A	N/A
	GW-685	T	9	9	9.4E+00	8.0E+00	No	S	S	N/A	N/A
	GW-713	T	17	16	7.5E+00	2.6E+00	No	NT	NT	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: Bear Creek Burial Grounds **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS BETA ACTIVITY											
	GW-694	T	5	5	1.7E+01	1.4E+01	No	S	S	N/A	N/A
	GW-695	T	18	18	3.2E+01	3.0E+01	No	I	I	N/A	N/A
	GW-703	T	18	18	4.2E+01	4.6E+01	No	I	I	N/A	N/A
	GW-704	T	18	18	2.1E+01	1.6E+01	No	I	I	N/A	N/A
	GW-712	T	16	14	4.1E+00	3.0E+00	No	NT	NT	N/A	N/A
	GW-706	T	19	19	1.1E+02	8.9E+01	No	NT	PI	N/A	N/A
	GW-710	T	4	4	2.4E+01	1.4E+01	No	NT	NT	N/A	N/A
	GW-642	T	2	2	4.6E+00	4.6E+00	No	N/A	N/A	N/A	N/A
	GW-078	T	11	7	2.0E+00	6.9E-01	No	NT	NT	N/A	N/A
	SS-8	T	14	7	8.0E-01	2.4E-01	No	NT	NT	N/A	N/A
	GW-052	T	2	2	1.8E+01	1.8E+01	No	N/A	N/A	N/A	N/A
	GW-053	T	11	11	2.8E+00	2.7E+00	No	S	PD	N/A	N/A
	GW-056	T	8	8	1.1E+01	1.1E+01	No	PI	I	N/A	N/A
	GW-061	T	2	2	6.8E+01	6.8E+01	No	N/A	N/A	N/A	N/A
	SS-7	T	13	9	4.6E+00	4.4E+00	No	PI	NT	N/A	N/A
	GW-069	T	5	5	6.0E+00	6.5E+00	No	NT	PI	N/A	N/A
	GW-072	T	2	2	2.0E+00	2.0E+00	No	N/A	N/A	N/A	N/A
	GW-287	T	9	9	3.7E+00	3.1E+00	No	D	D	N/A	N/A
	GW-077	T	11	11	5.7E+00	3.0E+00	No	PD	D	N/A	N/A
	GW-711	T	1	1	1.1E+01	1.1E+01	No	N/A	N/A	N/A	N/A
	GW-095	T	2	2	3.5E+00	3.5E+00	No	N/A	N/A	N/A	N/A
	SS-5	T	19	19	3.6E+01	3.0E+01	No	NT	NT	N/A	N/A
	GW-242	T	3	3	1.8E+01	7.4E+00	No	N/A	N/A	N/A	N/A
	GW-237	T	2	2	4.7E+00	4.7E+00	No	N/A	N/A	N/A	N/A
	SS-6W	T	5	5	1.9E+01	1.2E+01	No	S	PD	N/A	N/A
	SS-6_6	T	12	11	9.1E+00	4.5E+00	No	NT	NT	N/A	N/A
	GW-079	T	13	12	2.8E+00	1.8E+00	No	S	S	N/A	N/A
	GW-091	T	2	2	3.5E+00	3.5E+00	No	N/A	N/A	N/A	N/A
	SS-6E	T	7	7	1.4E+01	9.2E+00	No	NT	NT	N/A	N/A
	GW-080	T	13	10	6.1E+00	1.3E+00	No	NT	NT	N/A	N/A
	GW-126	T	1	1	7.8E+00	7.8E+00	No	N/A	N/A	N/A	N/A
NITRATE											
	GW-071	S	4	1	2.4E-02	2.0E-02	No	S	S	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: Bear Creek Burial Grounds **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
NITRATE											
	GW-626	S	2	1	2.5E-02	2.5E-02	No	N/A	N/A	N/A	N/A
	GW-082	S	9	2	3.3E-02	2.0E-02	No	S	S	N/A	N/A
	GW-046	S	2	2	7.2E-01	7.2E-01	No	N/A	N/A	N/A	N/A
	GW-014	S	2	0	2.0E-02	2.0E-02	Yes	N/A	N/A	N/A	N/A
	GW-653	T	17	0	2.0E-02	2.0E-02	Yes	S	S	N/A	N/A
	GW-694	T	4	4	6.3E+00	4.2E+00	No	S	S	N/A	N/A
	GW-056	T	10	9	3.4E-01	3.2E-01	No	I	I	N/A	N/A
	GW-289	T	2	2	2.6E-01	2.6E-01	No	N/A	N/A	N/A	N/A
	GW-072	T	2	1	3.2E-02	3.2E-02	No	N/A	N/A	N/A	N/A
	GW-713	T	6	3	2.1E-01	6.0E-02	No	NT	NT	N/A	N/A
	SS-7	T	1	1	3.1E-01	3.1E-01	No	N/A	N/A	N/A	N/A
	GW-061	T	2	2	1.1E+01	1.1E+01	No	N/A	N/A	N/A	N/A
	GW-684	T	13	13	5.7E+00	5.2E+00	No	NT	NT	N/A	N/A
	GW-291	T	2	2	2.4E-01	2.4E-01	No	N/A	N/A	N/A	N/A
	GW-683	T	12	12	7.3E+00	7.4E+00	No	S	S	N/A	N/A
	GW-069	T	6	1	2.2E-02	2.0E-02	No	NT	PI	N/A	N/A
	GW-091	T	2	1	2.4E-02	2.4E-02	No	N/A	N/A	N/A	N/A
	GW-372	T	4	0	2.0E-02	2.0E-02	Yes	S	S	N/A	N/A
	GW-685	T	10	10	2.8E+00	2.5E+00	No	S	S	N/A	N/A
	GW-080	T	4	0	2.0E-02	2.0E-02	Yes	S	S	N/A	N/A
	SS-6E	T	6	6	1.6E+00	1.6E+00	No	NT	S	N/A	N/A
	GW-621	T	9	9	3.2E+00	2.4E+00	No	S	D	N/A	N/A
	GW-642	T	4	1	3.2E-02	2.0E-02	No	NT	NT	N/A	N/A
	GW-714	T	6	4	1.8E+00	2.0E+00	No	S	D	N/A	N/A
	SS-6W	T	1	1	3.4E+00	3.4E+00	No	N/A	N/A	N/A	N/A
	GW-288	T	2	1	5.2E-02	5.2E-02	No	N/A	N/A	N/A	N/A
	GW-079	T	4	0	2.0E-02	2.0E-02	Yes	S	S	N/A	N/A
	GW-237	T	2	2	1.8E-01	1.8E-01	No	N/A	N/A	N/A	N/A
	GW-715	T	6	6	1.1E+00	5.5E-01	No	NT	NT	N/A	N/A
	GW-627	T	17	0	2.0E-02	2.0E-02	Yes	S	S	N/A	N/A
	SS-4	T	18	18	2.6E+01	2.2E+01	No	NT	NT	N/A	N/A
	GW-257	T	2	2	2.6E-01	2.6E-01	No	N/A	N/A	N/A	N/A
	GW-710	T	6	0	2.0E-02	2.0E-02	Yes	S	S	N/A	N/A
	GW-242	T	1	0	2.0E-02	2.0E-02	Yes	N/A	N/A	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: Bear Creek Burial Grounds **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
NITRATE											
	SS-8	T	1	1	2.8E-01	2.8E-01	No	N/A	N/A	N/A	N/A
	GW-126	T	1	0	2.0E-02	2.0E-02	Yes	N/A	N/A	N/A	N/A
	GW-706	T	17	17	3.3E+01	2.7E+01	No	S	NT	N/A	N/A
	SS-5	T	18	18	8.4E+00	7.9E+00	No	NT	S	N/A	N/A
	GW-052	T	2	2	2.9E+00	2.9E+00	No	N/A	N/A	N/A	N/A
	GW-711	T	6	0	2.0E-02	2.0E-02	Yes	S	S	N/A	N/A
	GW-704	T	17	16	1.2E+01	1.5E+01	No	D	S	N/A	N/A
	GW-712	T	6	4	1.2E-01	6.1E-02	No	NT	NT	N/A	N/A
	GW-695	T	17	17	9.6E+00	9.9E+00	No	I	PI	N/A	N/A
	GW-095	T	2	1	2.5E-02	2.5E-02	No	N/A	N/A	N/A	N/A
	GW-703	T	17	17	1.6E+01	1.8E+01	No	I	NT	N/A	N/A
	GW-053	T	11	1	2.3E-02	2.0E-02	No	S	S	N/A	N/A
	SS-6_6	T	1	1	3.8E-01	3.8E-01	No	N/A	N/A	N/A	N/A
	GW-287	T	9	5	7.7E-02	3.0E-02	No	NT	NT	N/A	N/A
TETRACHLOROETHYLENE(PCE)											
	GW-626	S	4	4	3.1E-01	1.7E-01	No	NT	I	N/A	N/A
	GW-624	S	2	2	3.8E-01	3.8E-01	No	N/A	N/A	N/A	N/A
	GW-014	S	2	2	2.0E-02	2.0E-02	No	N/A	N/A	N/A	N/A
	GW-071	S	4	4	4.0E-01	3.6E-01	No	NT	NT	N/A	N/A
	GW-046	S	14	13	2.3E+00	1.4E+00	No	NT	NT	N/A	N/A
	GW-082	S	13	1	5.8E-04	5.0E-04	No	NT	NT	N/A	N/A
	GW-091	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-237	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-126	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-715	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-095	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	SS-6E	T	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SS-4	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SS-5	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-287	T	10	6	1.9E-03	1.5E-03	No	S	NT	N/A	N/A
	GW-079	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-289	T	4	4	5.3E-01	5.3E-01	No	NT	I	N/A	N/A
	GW-621	T	10	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: Bear Creek Burial Grounds **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TETRACHLOROETHYLENE(PCE)											
	GW-242	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-372	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-257	T	2	2	2.1E-01	2.1E-01	No	N/A	N/A	N/A	N/A
	GW-291	T	4	4	4.6E-01	4.1E-01	No	S	S	N/A	N/A
	SS-6_6	T	12	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-080	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-078	T	15	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-288	T	2	2	2.2E-01	2.2E-01	No	N/A	N/A	N/A	N/A
	GW-712	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-061	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-713	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-685	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-072	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-056	T	11	1	9.1E-04	5.0E-04	No	NT	D	N/A	N/A
	GW-694	T	6	1	5.8E-04	5.0E-04	No	S	S	N/A	N/A
	SS-7	T	13	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-683	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-695	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-684	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-703	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-052	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-704	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-706	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SS-8	T	14	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-710	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-711	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-053	T	12	3	5.8E-04	5.0E-04	No	S	S	N/A	N/A
	GW-642	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-629	T	4	1	4.8E-04	5.0E-04	No	S	S	N/A	N/A
	GW-077	T	15	1	5.0E-04	5.0E-04	No	S	S	N/A	N/A
	GW-653	T	18	17	4.1E-03	2.0E-03	No	I	I	N/A	N/A
	GW-627	T	19	19	3.6E-01	3.5E-01	No	I	I	N/A	N/A
	GW-069	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-639	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TETRACHLOROETHYLENE(PCE)											
	SS-6W	T	5	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-714	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
TRICHLOROETHYLENE (TCE)											
	GW-046	S	14	14	2.0E+00	1.6E+00	No	S	S	N/A	N/A
	GW-071	S	4	4	8.7E-02	8.6E-02	No	S	D	N/A	N/A
	GW-624	S	2	2	7.2E-01	7.2E-01	No	N/A	N/A	N/A	N/A
	GW-082	S	13	0	5.0E-05	5.0E-05	Yes	S	I	N/A	N/A
	GW-014	S	2	2	1.5E-01	1.5E-01	No	N/A	N/A	N/A	N/A
	GW-626	S	4	4	2.3E-01	1.0E-01	No	NT	I	N/A	N/A
	GW-095	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-078	T	15	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SS-8	T	14	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-126	T	1	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-077	T	15	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-052	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-072	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-056	T	11	1	1.4E-04	5.0E-05	No	NT	D	N/A	N/A
	GW-091	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-053	T	12	12	1.4E-03	1.5E-03	No	I	I	N/A	N/A
	GW-079	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SS-6W	T	5	0	5.0E-05	5.0E-05	Yes	S	I	N/A	N/A
	SS-6E	T	8	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SS-6_6	T	12	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-069	T	6	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-061	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-080	T	17	0	5.0E-05	5.0E-05	Yes	S	I	N/A	N/A
	SS-7	T	13	0	5.0E-05	5.0E-05	Yes	S	I	N/A	N/A
	GW-684	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-621	T	10	1	9.5E-05	5.0E-05	No	NT	NT	N/A	N/A
	GW-715	T	17	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-627	T	19	18	1.1E-01	9.2E-02	No	I	I	N/A	N/A
	GW-714	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SS-5	T	19	3	2.3E-04	5.0E-05	No	NT	NT	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: Bear Creek Burial Grounds **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TRICHLOROETHYLENE (TCE)											
	GW-639	T	11	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-642	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-653	T	18	13	2.4E-03	1.0E-03	No	I	PI	N/A	N/A
	GW-372	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-683	T	17	0	5.0E-05	5.0E-05	Yes	S	I	N/A	N/A
	GW-629	T	4	3	1.6E-03	2.0E-03	No	NT	NT	N/A	N/A
	GW-685	T	11	1	9.1E-05	5.0E-05	No	NT	NT	N/A	N/A
	GW-694	T	6	5	1.8E-03	1.5E-03	No	S	PD	N/A	N/A
	GW-712	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-695	T	18	18	5.1E-03	5.5E-03	No	S	NT	N/A	N/A
	GW-703	T	18	17	1.5E-02	1.6E-02	No	S	PI	N/A	N/A
	GW-704	T	18	17	5.5E-02	5.3E-02	No	D	NT	N/A	N/A
	GW-706	T	18	17	1.1E-02	1.1E-02	No	NT	PI	N/A	N/A
	GW-711	T	6	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-710	T	6	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-713	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-288	T	2	2	1.3E-02	1.3E-02	No	N/A	N/A	N/A	N/A
	GW-237	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-289	T	4	4	9.6E-03	1.0E-02	No	I	PI	N/A	N/A
	GW-291	T	4	4	5.1E-02	4.7E-02	No	D	PD	N/A	N/A
	GW-257	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-287	T	10	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SS-4	T	18	18	8.1E-03	7.5E-03	No	NT	NT	N/A	N/A
	GW-242	T	3	2	6.8E-04	5.0E-04	No	N/A	N/A	N/A	N/A
VINYL CHLORIDE											
	GW-046	S	14	14	5.5E-01	5.2E-01	No	S	S	N/A	N/A
	GW-082	S	13	13	1.6E-01	1.5E-01	No	I	I	N/A	N/A
	GW-624	S	2	2	4.6E-01	4.6E-01	No	N/A	N/A	N/A	N/A
	GW-071	S	4	4	1.5E-03	1.0E-03	No	NT	NT	N/A	N/A
	GW-626	S	4	2	3.1E-01	2.1E-02	No	NT	PI	N/A	N/A
	GW-014	S	2	2	8.1E-02	8.1E-02	No	N/A	N/A	N/A	N/A
	GW-685	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-257	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: Bear Creek Burial Grounds **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
VINYL CHLORIDE											
	GW-053	T	12	12	2.4E-03	2.5E-03	No	PD	PD	N/A	N/A
	GW-056	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-694	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-684	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-712	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-242	T	3	3	3.7E-02	4.2E-02	No	N/A	N/A	N/A	N/A
	GW-095	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	SS-4	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-052	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	SS-5	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-703	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SS-7	T	13	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-704	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-711	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-237	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-706	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-126	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-710	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-695	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SS-6E	T	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-291	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-080	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-372	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-079	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-715	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SS-6_6	T	12	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-621	T	10	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-289	T	4	2	1.0E-03	7.5E-04	No	NT	I	N/A	N/A
	GW-078	T	15	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SS-8	T	14	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-714	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-061	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-627	T	19	16	1.1E-02	1.1E-02	No	I	I	N/A	N/A
	GW-683	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: Bear Creek Burial Grounds **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
VINYL CHLORIDE											
	GW-072	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-288	T	2	2	3.5E-03	3.5E-03	No	N/A	N/A	N/A	N/A
	GW-287	T	10	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-639	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-642	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-713	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-069	T	6	3	8.3E-04	7.5E-04	No	NT	I	N/A	N/A
	GW-653	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SS-6W	T	5	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-629	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-091	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-077	T	15	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 Security Complex

User Name: MV

Location: Bear Creek Burial Grounds

State: Tennessee

Effective Date	0th Moment: Estimated Mass (Kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
GROSS BETA ACTIVITY							
1/1/1996	1.7E+04	41,637	29,196	1,687	4,881,980	562,033	25
7/1/1996	1.8E+04	40,841	28,784	2,564	3,925,575	295,080	18
1/1/1997	1.1E+04	41,785	29,095	1,570	3,385,632	262,211	21
4/1/1997	1.2E+03	36,076	29,360	7,211	6,971,796	58,044	9
7/1/1997	4.8E+04	37,228	28,702	6,117	13,589,404	240,779	29
1/1/1998	1.3E+04	39,960	29,065	3,361	7,262,733	186,390	29
4/1/1998	1.5E+03	43,213	30,062	504	266,509	105,378	8
7/1/1998	2.3E+04	39,371	28,989	3,955	9,757,693	196,321	36
1/1/1999	3.8E+04	39,333	29,054	3,983	5,414,673	131,814	25
7/1/1999	1.0E+04	41,051	28,874	2,336	6,163,086	83,796	23
1/1/2000	1.8E+04	39,686	28,820	3,674	14,301,235	146,380	28
7/1/2000	9.7E+03	40,305	28,811	3,073	13,354,995	97,363	27
1/1/2001	2.3E+04	40,394	28,910	2,963	9,906,867	152,169	25
4/1/2001	0.0E+00						1
7/1/2001	1.6E+04	40,562	29,009	2,778	11,652,889	141,269	23
10/1/2001	0.0E+00						1
1/1/2002	2.4E+04	40,928	29,024	2,417	12,683,266	115,526	28
7/1/2002	1.9E+04	41,729	28,935	1,677	4,575,214	204,153	24
1/1/2003	2.1E+04	41,192	28,975	2,173	7,143,977	143,175	23
4/1/2003	0.0E+00						1
7/1/2003	2.4E+04	38,589	28,956	4,734	16,043,403	160,922	24
1/1/2004	1.6E+04	40,278	28,988	3,060	8,630,375	108,076	18
7/1/2004	1.3E+04	41,606	29,022	1,762	2,853,420	127,148	19
10/1/2004	0.0E+00						1
NITRATE							
1/1/1996	1.4E+03	42,076	28,749	1,457	4,469,858	134,609	28
7/1/1996	1.4E+03	41,995	28,789	1,503	4,171,569	152,849	28
1/1/1997	1.0E+03	42,274	28,860	1,231	4,191,581	199,242	26
7/1/1997	1.8E+03	42,148	28,759	1,391	4,148,107	138,582	26
1/1/1998	1.0E+03	41,750	28,838	1,696	5,311,619	64,843	21
7/1/1998	2.2E+03	40,437	28,848	2,936	14,990,231	64,988	25
1/1/1999	1.3E+03	41,503	28,957	1,881	4,574,699	155,938	19
7/1/1999	0.0E+00						3
1/1/2000	2.3E+03	41,339	28,764	2,103	4,263,888	52,154	16
7/1/2000	1.6E+03	41,555	28,839	1,875	4,424,060	62,011	16
1/1/2001	1.5E+03	43,546	28,802	804	535,369	62,078	14
7/1/2001	1.2E+03	43,515	28,785	811	496,247	48,999	12
1/1/2002	1.9E+03	43,278	28,858	705	539,764	41,916	21

Project: Y-12 Security Complex

Location: Bear Creek Burial Grounds

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
NITRATE							
7/1/2002	9.7E+02	43,274	28,803	759	527,316	61,102	22
1/1/2003	1.3E+03	42,539	28,794	1,070	2,184,029	91,010	11
7/1/2003	7.1E+02	42,783	28,833	885	2,359,172	98,340	11
1/1/2004	6.4E+02	43,377	28,928	641	467,102	43,240	13
7/1/2004	9.4E+02	43,287	28,909	653	374,094	35,603	13
TETRACHLOROETHYLENE(PCE)							
1/1/1996	1.4E+00	41,669	29,352	1,628	4,060,693	448,338	28
7/1/1996	1.4E+00	41,663	29,349	1,635	4,177,494	457,896	28
1/1/1997	1.8E+00	41,980	29,514	1,305	3,528,668	470,550	26
4/1/1997	8.4E-01	36,215	29,371	7,072	9,545,364	68,256	9
7/1/1997	2.4E+00	38,456	29,263	4,837	14,905,657	418,237	33
1/1/1998	2.2E+00	38,852	29,276	4,441	13,885,816	175,409	30
4/1/1998	3.1E+00	42,735	30,329	943	29,269	51,710	8
7/1/1998	1.4E+01	42,449	29,838	880	5,078,223	224,670	37
1/1/1999	6.4E+00	41,708	29,546	1,576	9,541,868	173,057	31
7/1/1999	7.9E+00	41,897	29,482	1,389	7,424,966	105,016	28
1/1/2000	5.3E+00	41,378	29,408	1,913	10,167,236	119,014	27
7/1/2000	8.7E+00	42,038	29,478	1,249	6,953,004	105,734	28
1/1/2001	6.8E+00	41,658	29,505	1,627	8,122,165	120,317	26
4/1/2001	0.0E+00						1
7/1/2001	6.5E+00	41,719	29,519	1,565	8,317,844	127,533	24
10/1/2001	0.0E+00						1
1/1/2002	2.2E+01	42,549	29,785	768	2,779,875	110,516	32
7/1/2002	2.2E+01	42,590	29,784	729	2,573,110	119,491	32
1/1/2003	9.6E+00	41,913	29,395	1,381	7,781,523	185,104	27
4/1/2003	0.0E+00						1
7/1/2003	1.5E+01	42,380	29,464	910	5,461,027	152,626	26
10/1/2003	0.0E+00						1
1/1/2004	3.9E+01	43,219	29,678	133	1,038,181	37,054	26
4/1/2004	0.0E+00						1
7/1/2004	4.8E+01	43,356	29,690	147	269,327	27,694	24
10/1/2004	0.0E+00						2
TRICHLOROETHYLENE (TCE)							
1/1/1996	3.5E-01	42,709	29,109	732	2,830,510	267,991	28
7/1/1996	3.0E-01	42,778	29,110	678	3,323,005	295,148	28
1/1/1997	3.3E-01	42,390	29,227	955	2,381,818	263,366	26
4/1/1997	8.4E-02	36,215	29,371	7,072	9,545,364	68,256	9
7/1/1997	7.3E-01	41,272	29,079	2,069	11,522,169	307,474	33
1/1/1998	2.5E+00	42,987	29,280	410	3,060,235	75,876	30
4/1/1998	2.8E-01	42,804	30,010	657	29,045	169,019	8
7/1/1998	7.1E+00	43,214	29,474	113	1,404,643	183,283	37

Project: Y-12 Security Complex

Location: Bear Creek Burial Grounds

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TRICHLOROETHYLENE (TCE)							
1/1/1999	4.8E+00	43,166	29,468	151	1,928,273	153,786	31
7/1/1999	4.4E+00	43,142	29,287	310	1,849,598	62,160	28
1/1/2000	4.5E+00	43,149	29,281	312	1,817,442	62,129	27
7/1/2000	4.6E+00	43,171	29,281	303	1,793,908	61,982	28
1/1/2001	9.4E+00	43,510	29,268	372	1,117,204	67,656	26
4/1/2001	0.0E+00						1
7/1/2001	5.0E+00	43,241	29,355	211	1,749,441	84,301	24
10/1/2001	0.0E+00						1
1/1/2002	8.7E+00	43,274	29,579	20	1,303,266	82,856	32
7/1/2002	7.6E+00	43,331	29,528	58	1,537,825	111,213	32
1/1/2003	5.1E+00	43,051	29,353	313	2,025,570	100,086	27
4/1/2003	0.0E+00						1
7/1/2003	9.5E+00	43,264	29,337	226	1,172,656	71,356	26
10/1/2003	0.0E+00						1
1/1/2004	2.7E+00	43,199	29,495	108	1,648,492	78,726	26
4/1/2004	0.0E+00						1
7/1/2004	2.6E+00	43,399	29,509	126	514,065	77,892	24
10/1/2004	0.0E+00						2
VINYL CHLORIDE							
1/1/1996	1.3E+00	41,526	29,290	1,779	4,383,054	507,140	28
7/1/1996	1.3E+00	41,686	29,325	1,616	4,463,749	508,741	28
1/1/1997	1.3E+00	41,574	29,286	1,733	4,344,204	494,734	26
4/1/1997	3.3E+00	36,287	29,431	6,999	7,093,230	41,450	9
7/1/1997	3.0E+00	39,399	29,437	3,887	15,785,796	542,595	33
1/1/1998	3.1E+00	40,282	29,296	3,013	14,603,734	152,718	30
4/1/1998	3.9E-01	42,684	30,347	988	26,595	100,618	8
7/1/1998	9.8E+00	42,275	29,718	1,021	7,990,774	200,766	37
1/1/1999	1.1E+01	42,227	29,848	1,094	7,014,696	218,719	31
7/1/1999	3.6E+00	40,696	29,318	2,600	13,410,930	144,634	28
1/1/2000	3.7E+00	40,733	29,319	2,563	13,380,470	145,252	27
7/1/2000	3.0E+00	40,163	29,297	3,132	14,731,076	158,131	28
1/1/2001	9.2E+00	41,999	29,627	1,286	6,359,486	103,613	26
4/1/2001	0.0E+00						1
7/1/2001	1.1E+01	42,330	29,700	964	5,701,897	106,669	24
10/1/2001	0.0E+00						1
1/1/2002	4.9E+00	41,233	29,580	2,051	9,855,553	140,276	32
7/1/2002	3.9E+00	40,926	29,541	2,359	10,730,797	191,058	32
1/1/2003	1.0E+01	41,840	29,592	1,445	7,176,760	169,840	26
4/1/2003	0.0E+00						1
7/1/2003	1.4E+01	42,174	29,633	1,112	5,318,518	129,970	25
1/1/2004	3.2E+00	41,295	29,423	1,994	7,258,094	189,537	25
7/1/2004	2.9E+00	42,473	29,489	814	1,834,809	183,248	23

Project: Y-12 Security Complex

Location: Bear Creek Burial Grounds

User Name: MV

State: Tennessee

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	**Estimated Mass (kg)**	**Xc (ft)**	**Yc (ft)**	**Source Distance (ft)**	**Sigma XX (sq ft)**	**Sigma YY (sq ft)**	**Number of Wells**
VINYL CHLORIDE							
10/1/2004	0.0E+00						1

Project: Y-12 Security Complex

Location: Bear Creek Burial Grounds

User Name: MV

State: Tennessee

Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	GROSS BETA ACTIVITY	0.79	-26	73.0%	S
	NITRATE	0.44	-43	94.4%	PD
	TETRACHLOROETHYLENE(PCE)	1.41	62	91.0%	PI
	TRICHLOROETHYLENE (TCE)	1.06	10	57.8%	NT
	VINYL CHLORIDE	0.96	22	69.7%	NT
1st Moment: Distance to Source					
	GROSS BETA ACTIVITY	0.51	-22	75.0%	S
	NITRATE	0.48	-60	99.3%	D
	TETRACHLOROETHYLENE(PCE)	0.94	-98	99.9%	D
	TRICHLOROETHYLENE (TCE)	2.05	-102	100.0%	D
	VINYL CHLORIDE	0.67	-44	91.8%	PD
2nd Moment: Sigma XX					
	GROSS BETA ACTIVITY	0.54	38	88.3%	NT
	NITRATE	1.03	-70	99.8%	D
	TETRACHLOROETHYLENE(PCE)	0.66	-42	90.7%	PD
	TRICHLOROETHYLENE (TCE)	1.08	-94	99.9%	D
	VINYL CHLORIDE	0.55	0	48.7%	S
2nd Moment: Sigma YY					
	GROSS BETA ACTIVITY	0.62	-54	95.7%	D
	NITRATE	0.56	-68	99.8%	D
	TETRACHLOROETHYLENE(PCE)	0.78	-72	99.0%	D
	TRICHLOROETHYLENE (TCE)	0.65	-64	98.0%	D
	VINYL CHLORIDE	0.70	-36	87.0%	S

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.

ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.4 East Fork Regime East S-3 Area

Table D.4.1	Qualitative Analysis East S-3 Area
Table D.4.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary
MAROS Chart	New Location Analysis PCE East S-3

GROUNDWATER SERVICES, INC.

TABLE D.4.1
QUALITATIVE ANALYSIS EAST FORK REGIME EAST S-3 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
55-1A	WL	X	Aquitard	X								
55-1C	WL		Aquitard						X	X		
55-2B	WL	X	Aquitard	X								
55-2C	WL	X	Aquitard	X								
GW-105	WL	X	Aquitard	X								X
GW-106	WL	X	Aquitard	X								X
GW-107	WL	X	Aquitard									X
GW-108	WL	X	Aquitard		X		X				X	X
GW-109	WL	X	Aquitard		X		X					X
GW-190	WL	X	Aquifer							X		
GW-191	WL		Aquitard	X					X			
GW-192	WL		Aquitard	X								
GW-194	WL		Aquitard						X			
GW-195	WL	X	Aquitard									
GW-196	WL	X	Aquitard						X			
GW-197	WL	X	Aquitard						X	X		
GW-251	WL	X	Aquifer	X				X				
GW-252	WL		Aquifer	X					X			
GW-253	WL	X	Aquifer	X			X	X				
GW-255	WL		Aquifer	X								
GW-261	WL		Aquitard									
GW-263	WL	X	Aquitard									
GW-265	WL	X	Aquitard									
GW-268	WL		Aquitard						X	X		
GW-269	WL	X	Aquitard									

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.3.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
   CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.4.1
QUALITATIVE ANALYSIS EAST FORK REGIME EAST S-3 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-270	WL	X	Aquitard									
GW-271	WL		Aquitard						X			
GW-272	WL	X	Aquitard						X			
GW-273	WL	X	Aquitard									
GW-274	WL	X	Aquitard				X					
GW-275	WL	X	Aquitard				X					
GW-332	WL	X	Aquitard									
GW-334	WL	X	Aquitard							X		
GW-335	WL	X	Aquitard									
GW-336	WL	X	Aquitard									
GW-337	WL	X	Aquitard									
GW-338	WL	X	Aquitard						X			
GW-349	WL	X	Aquifer									
GW-350	WL	X	Aquifer						X			
GW-505	WL	X	Aquitard									
GW-508	WL	X	Aquitard									
GW-617	WL		Aquifer	X		X						
GW-618	WL	X	Aquifer	X		X		X				
GW-619	WL	X	Aquifer	X							X	
GW-620	WL	X	Aquifer	X				X			X	
GW-631	WL	X	Aquitard						X			X
GW-633	WL	X	Aquitard									X
GW-778	WL		Aquitard									
SPR14.0SP	SP		Spring	X		X				X		

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.3.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
   CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.4.2
AQUIFER INPUT PARAMETERS

East S-3
East Fork Poplar Creek Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	2500	ft
Maximum Plume Length	2500	ft
PlumeWidth	1500	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	5000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	Chlorinated Solvent/BTEX	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow direction	E/SE	0
Effective Porosity	0.1	--
Source Location near Well	GW-108	--
Source X-Coordinate	53207	ft*
Source Y-Coordinate	30070	ft*
Saturated Thickness	50	ft
Source Wells	**Value**	
GW-108, GW-109, GW-633, GW-274, GW-275, GW-107		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS COC Assessment

Project: Y-12 Security Complex **User Name:** MV

Location: East S-3 **State:** Tennessee

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
NITRATE	1.2E+03	1.0E+01	11811.7%
BENZENE	2.5E-01	5.0E-03	4951.9%
CADMIUM	2.5E-01	5.0E-03	4912.7%
TETRACHLOROETHYLENE(PCE)	1.3E-01	5.0E-03	2593.0%
VINYL CHLORIDE	4.9E-02	2.0E-03	2344.1%
TRICHLOROETHYLENE (TCE)	9.2E-02	5.0E-03	1739.2%
cis-1,2-DICHLOROETHYLENE	4.3E-01	7.0E-02	517.5%
1,2-DICHLOROETHANE	2.7E-02	5.0E-03	430.2%
CARBON TETRACHLORIDE	2.6E-02	5.0E-03	419.8%
1,1-DICHLOROETHENE	3.3E-02	7.0E-03	376.7%
NICKEL	2.5E-01	7.3E-02	241.8%
MERCURY	4.1E-03	2.0E-03	103.8%
COPPER	2.1E+00	1.3E+00	65.0%
LEAD	2.4E-02	1.5E-02	57.4%
CHROMIUM III	1.1E-01	1.0E-01	8.6%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage excedence from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Excedences	Percent Excedences	Total detects
CADMIUM	MET	39	27	69.2%	39
TETRACHLOROETHYLENE(PCE)	ORG	49	22	44.9%	39
NITRATE	INO	46	17	37.0%	46
TRICHLOROETHYLENE (TCE)	ORG	49	17	34.7%	35
LEAD	MET	43	13	30.2%	43
NICKEL	MET	45	11	24.4%	45
VINYL CHLORIDE	ORG	49	11	22.4%	11
cis-1,2-DICHLOROETHYLENE	ORG	47	10	21.3%	23
CHROMIUM III	MET	44	9	20.5%	44
1,1-DICHLOROETHENE	ORG	49	9	18.4%	20
BENZENE	ORG	49	8	16.3%	19
1,2-DICHLOROETHANE	ORG	49	5	10.2%	8
CARBON TETRACHLORIDE	ORG	49	4	8.2%	5
MERCURY	MET	29	2	6.9%	29
COPPER	MET	40	1	2.5%	40

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total excedences (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Project: Y-12 Security Complex **User Name:** MV

Location: East S-3 **State:** Tennessee

Mobility:

Contaminant of Concern	Kd
NITRATE	
VINYL CHLORIDE	0.042
1,2-DICHLOROETHANE	0.0679
cis-1,2-DICHLOROETHYLENE	0.0724
BENZENE	0.0984
1,1-DICHLOROETHENE	0.13
CARBON TETRACHLORIDE	0.277
TRICHLOROETHYLENE (TCE)	0.297
TETRACHLOROETHYLENE(PCE)	0.923
LEAD	10
CADMIUM	15
NICKEL	16
COPPER	40
MERCURY	52
CHROMIUM III	1200

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Contaminants of Concern (COC's)

GROSS BETA ACTIVITY

NITRATE

TRICHLOROETHYLENE (TCE)

TETRACHLOROETHYLENE(PCE)

GROSS ALPHA ACTIVITY

MAROS Plume Analysis Summary

Project: Y-12 National Security Complex

User Name:

Location: East S-3

State: Tennessee

Time Period: 1/1/1996 **to** 12/1/2004

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS ALPHA ACTIVITY											
	GW-633	S	8	8	3.6E+01	1.7E+01	No	NT	NT	N/A	N/A
	GW-275	S	4	4	1.1E+02	1.1E+02	No	S	NT	N/A	N/A
	GW-109	S	5	5	1.6E+02	1.1E+02	No	S	NT	N/A	N/A
	GW-108	S	17	13	2.4E+02	7.3E+01	No	NT	NT	N/A	N/A
	GW-274	S	3	3	6.7E+01	5.9E+01	No	N/A	N/A	N/A	N/A
	55-2B	T	4	2	4.1E+00	1.2E-01	No	NT	NT	N/A	N/A
	GW-505	T	3	3	3.5E+01	2.8E+01	No	N/A	N/A	N/A	N/A
	GW-619	T	3	3	2.9E+00	2.9E+00	No	N/A	N/A	N/A	N/A
	GW-332	T	1	1	9.9E-01	9.9E-01	No	N/A	N/A	N/A	N/A
	GW-336	T	1	1	1.9E+00	1.9E+00	No	N/A	N/A	N/A	N/A
	55-2C	T	8	6	2.4E+00	1.4E+00	No	NT	NT	N/A	N/A
	GW-620	T	15	15	1.8E+00	1.0E+00	No	NT	D	N/A	N/A
	GW-338	T	2	2	3.7E+00	3.7E+00	No	N/A	N/A	N/A	N/A
	GW-617	T	3	3	8.9E-01	7.6E-01	No	N/A	N/A	N/A	N/A
	GW-106	T	2	2	8.1E+01	8.1E+01	No	N/A	N/A	N/A	N/A
	GW-349	T	1	1	5.9E+00	5.9E+00	No	N/A	N/A	N/A	N/A
	GW-350	T	2	2	2.4E+00	2.4E+00	No	N/A	N/A	N/A	N/A
	GW-105	T	2	2	7.7E+01	7.7E+01	No	N/A	N/A	N/A	N/A
	GW-618	T	15	11	1.3E+00	8.6E-01	No	PD	D	N/A	N/A
	55-1C	T	1	1	3.3E+00	3.3E+00	No	N/A	N/A	N/A	N/A
	GW-195	T	2	2	3.2E+00	3.2E+00	No	N/A	N/A	N/A	N/A
	GW-251	T	19	19	7.4E+00	8.0E+00	No	D	PD	N/A	N/A

Project: Y-12 National Security Complex **User Name:**

Location: East S-3 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS ALPHA ACTIVITY											
	GW-194	T	1	1	3.1E+00	3.1E+00	No	N/A	N/A	N/A	N/A
	SPR14_0SP	T	1	1	2.6E+00	2.6E+00	No	N/A	N/A	N/A	N/A
	GW-253	T	15	15	4.7E+01	4.2E+01	No	S	S	N/A	N/A
	GW-269	T	1	1	5.2E-01	5.2E-01	No	N/A	N/A	N/A	N/A
	GW-192	T	8	8	1.4E+00	1.1E+00	No	PD	D	N/A	N/A
	GW-270	T	2	2	4.3E+00	4.3E+00	No	N/A	N/A	N/A	N/A
	GW-271	T	2	2	2.2E+00	2.2E+00	No	N/A	N/A	N/A	N/A
	GW-337	T	4	4	1.0E+00	9.6E-01	No	D	D	N/A	N/A
	55-1A	T	2	2	6.5E-01	6.5E-01	No	N/A	N/A	N/A	N/A
	GW-191	T	2	2	1.2E+00	1.2E+00	No	N/A	N/A	N/A	N/A
	GW-631	T	2	2	2.9E+00	2.9E+00	No	N/A	N/A	N/A	N/A
	GW-272	T	2	2	1.6E+01	1.6E+01	No	N/A	N/A	N/A	N/A
	GW-273	T	1	1	1.1E+00	1.1E+00	No	N/A	N/A	N/A	N/A
	GW-190	T	2	2	5.2E-01	5.2E-01	No	N/A	N/A	N/A	N/A
GROSS BETA ACTIVITY											
	GW-274	S	5	5	7.2E+03	7.8E+03	No	NT	NT	N/A	N/A
	GW-109	S	5	5	1.2E+04	1.1E+04	No	NT	I	N/A	N/A
	GW-275	S	4	4	3.5E+02	4.0E+02	No	S	S	N/A	N/A
	GW-108	S	18	18	1.0E+04	1.0E+04	No	I	I	N/A	N/A
	GW-633	S	9	9	3.3E+03	3.4E+03	No	S	I	N/A	N/A
	SPR14_0SP	T	1	1	2.6E+00	2.6E+00	No	N/A	N/A	N/A	N/A
	GW-619	T	3	3	1.2E+01	9.4E+00	No	N/A	N/A	N/A	N/A
	55-2B	T	5	5	1.2E+01	5.6E+00	No	NT	I	N/A	N/A
	GW-269	T	2	2	1.2E+01	1.2E+01	No	N/A	N/A	N/A	N/A
	GW-332	T	1	1	3.9E+00	3.9E+00	No	N/A	N/A	N/A	N/A
	GW-192	T	11	11	4.3E+00	3.8E+00	No	S	NT	N/A	N/A
	55-1C	T	1	1	4.5E+00	4.5E+00	No	N/A	N/A	N/A	N/A
	GW-620	T	17	17	1.1E+01	1.2E+01	No	NT	NT	N/A	N/A
	GW-336	T	2	2	2.3E+00	2.3E+00	No	N/A	N/A	N/A	N/A
	GW-270	T	2	2	1.1E+01	1.1E+01	No	N/A	N/A	N/A	N/A
	GW-253	T	15	15	3.0E+01	2.9E+01	No	NT	D	N/A	N/A
	GW-618	T	16	15	4.2E+00	4.6E+00	No	NT	S	N/A	N/A
	GW-271	T	2	2	2.5E+01	2.5E+01	No	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:**

Location: East S-3 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS BETA ACTIVITY											
	GW-337	T	5	5	4.7E+00	3.5E+00	No	NT	PI	N/A	N/A
	GW-349	T	2	2	2.7E+00	2.7E+00	No	N/A	N/A	N/A	N/A
	GW-505	T	3	3	1.4E+01	1.7E+01	No	N/A	N/A	N/A	N/A
	GW-350	T	1	1	1.7E+00	1.7E+00	No	N/A	N/A	N/A	N/A
	55-1A	T	2	2	9.9E+00	9.9E+00	No	N/A	N/A	N/A	N/A
	GW-631	T	1	1	3.7E+00	3.7E+00	No	N/A	N/A	N/A	N/A
	GW-191	T	3	3	6.5E+00	5.7E+00	No	N/A	N/A	N/A	N/A
	55-2C	T	8	8	1.5E+01	1.1E+01	No	I	PI	N/A	N/A
	GW-194	T	3	3	4.8E+00	6.0E+00	No	N/A	N/A	N/A	N/A
	GW-190	T	1	1	2.8E-01	2.8E-01	No	N/A	N/A	N/A	N/A
	GW-338	T	1	1	2.0E+00	2.0E+00	No	N/A	N/A	N/A	N/A
	GW-617	T	2	2	2.9E+00	2.9E+00	No	N/A	N/A	N/A	N/A
	GW-251	T	18	18	6.9E+00	5.6E+00	No	NT	NT	N/A	N/A
	GW-195	T	3	3	1.5E+01	1.0E+01	No	N/A	N/A	N/A	N/A
NITRATE											
	GW-108	S	5	5	1.3E+04	1.1E+04	No	S	NT	N/A	N/A
	GW-275	S	4	4	7.2E+03	7.2E+03	No	S	D	N/A	N/A
	GW-633	S	7	7	1.6E+03	1.5E+03	No	D	D	N/A	N/A
	GW-109	S	4	4	9.4E+03	9.3E+03	No	NT	NT	N/A	N/A
	GW-274	S	4	4	3.8E+03	3.5E+03	No	D	D	N/A	N/A
	GW-191	T	1	1	3.0E-02	3.0E-02	No	N/A	N/A	N/A	N/A
	GW-631	T	2	2	6.1E-01	6.1E-01	No	N/A	N/A	N/A	N/A
	GW-270	T	2	2	7.3E+01	7.3E+01	No	N/A	N/A	N/A	N/A
	GW-269	T	2	2	5.3E-01	5.3E-01	No	N/A	N/A	N/A	N/A
	GW-253	T	2	2	7.3E+02	7.3E+02	No	N/A	N/A	N/A	N/A
	55-1A	T	3	3	1.1E+01	1.2E+01	No	N/A	N/A	N/A	N/A
	GW-251	T	19	19	5.5E+01	5.6E+01	No	PD	S	N/A	N/A
	SPR14_0SP	T	1	1	3.2E-02	3.2E-02	No	N/A	N/A	N/A	N/A
	GW-194	T	1	1	3.0E-02	3.0E-02	No	N/A	N/A	N/A	N/A
	GW-195	T	2	2	2.2E-01	2.2E-01	No	N/A	N/A	N/A	N/A
	GW-192	T	4	4	4.5E-02	3.9E-02	No	S	S	N/A	N/A
	GW-332	T	1	1	1.8E+00	1.8E+00	No	N/A	N/A	N/A	N/A
	GW-505	T	2	2	1.4E-01	1.4E-01	No	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:**

Location: East S-3 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
NITRATE											
	GW-105	T	2	2	5.5E+02	5.5E+02	No	N/A	N/A	N/A	N/A
	55-2C	T	8	8	1.5E+02	1.4E+02	No	I	I	N/A	N/A
	GW-106	T	2	2	7.3E+02	7.3E+02	No	N/A	N/A	N/A	N/A
	GW-338	T	3	3	8.8E-01	8.3E-01	No	N/A	N/A	N/A	N/A
	GW-617	T	5	5	1.5E+00	2.1E+00	No	D	PD	N/A	N/A
	GW-336	T	2	2	1.7E+00	1.7E+00	No	N/A	N/A	N/A	N/A
	GW-618	T	8	8	1.1E+00	9.3E-01	No	D	D	N/A	N/A
	55-2B	T	5	5	1.7E+02	1.5E+02	No	I	I	N/A	N/A
	GW-272	T	2	2	3.8E+02	3.8E+02	No	N/A	N/A	N/A	N/A
	GW-190	T	2	2	5.5E-02	5.5E-02	No	N/A	N/A	N/A	N/A
	GW-619	T	3	3	9.8E-01	8.3E-01	No	N/A	N/A	N/A	N/A
	55-1C	T	1	1	2.9E+00	2.9E+00	No	N/A	N/A	N/A	N/A
	GW-620	T	19	19	1.7E+00	1.3E+00	No	D	D	N/A	N/A
TETRACHLOROETHYLENE(PCE)											
	GW-275	S	4	2	2.5E-03	5.0E-04	No	NT	NT	N/A	N/A
	GW-633	S	8	8	2.0E-01	1.9E-01	No	NT	NT	N/A	N/A
	GW-274	S	4	4	8.6E-01	8.8E-01	No	I	I	N/A	N/A
	GW-109	S	5	5	1.6E-01	1.6E-01	No	S	S	N/A	N/A
	GW-108	S	17	11	5.9E-04	5.0E-04	No	I	I	N/A	N/A
	GW-192	T	13	8	1.2E-03	1.0E-03	No	NT	NT	N/A	N/A
	GW-105	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	55-1A	T	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-106	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	55-2B	T	5	5	5.7E-01	5.5E-01	No	NT	I	N/A	N/A
	GW-194	T	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	55-1C	T	1	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-190	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-191	T	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	55-2C	T	8	8	4.8E-01	5.1E-01	No	PD	S	N/A	N/A
	GW-619	T	5	5	3.6E-02	3.3E-02	No	S	PD	N/A	N/A
	GW-349	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-505	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-338	T	4	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A

Project: Y-12 National Security Complex **User Name:**

Location: East S-3 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TETRACHLOROETHYLENE(PCE)											
	GW-617	T	5	1	7.0E-04	6.0E-06	No	NT	NT	N/A	N/A
	GW-336	T	2	2	4.8E-01	4.8E-01	No	N/A	N/A	N/A	N/A
	GW-618	T	17	17	7.1E-03	5.0E-03	No	S	S	N/A	N/A
	GW-332	T	3	3	1.0E+00	9.3E-01	No	N/A	N/A	N/A	N/A
	GW-350	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-273	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-337	T	6	6	7.3E-01	7.1E-01	No	NT	NT	N/A	N/A
	GW-272	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-271	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-253	T	14	13	5.6E-01	5.8E-01	No	NT	S	N/A	N/A
	GW-195	T	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	SPR14_0SP	T	1	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-270	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-251	T	19	19	2.0E-01	1.6E-01	No	S	S	N/A	N/A
	GW-631	T	2	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-269	T	2	2	3.3E-02	3.3E-02	No	N/A	N/A	N/A	N/A
	GW-620	T	20	20	5.1E-02	1.6E-02	No	D	D	N/A	N/A
TRICHLOROETHYLENE (TCE)											
	GW-633	S	8	8	7.1E-03	8.0E-03	No	PD	PD	N/A	N/A
	GW-109	S	5	5	3.3E-03	2.0E-03	No	D	D	N/A	N/A
	GW-108	S	17	16	1.4E-03	1.5E-03	No	I	I	N/A	N/A
	GW-275	S	4	0	5.0E-06	5.0E-06	Yes	S	S	N/A	N/A
	GW-274	S	4	4	1.1E-02	1.1E-02	No	S	I	N/A	N/A
	55-1A	T	3	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-617	T	5	1	6.0E-04	5.0E-06	No	NT	NT	N/A	N/A
	55-2B	T	5	5	2.6E-01	2.5E-01	No	PD	D	N/A	N/A
	GW-618	T	17	17	1.2E-02	1.1E-02	No	S	S	N/A	N/A
	GW-505	T	2	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-620	T	20	17	1.6E-02	7.0E-03	No	D	D	N/A	N/A
	55-1C	T	1	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-350	T	2	1	5.0E-04	5.0E-04	No	N/A	N/A	N/A	N/A
	GW-619	T	5	5	8.5E-03	9.0E-03	No	S	S	N/A	N/A
	55-2C	T	8	8	2.7E-01	2.8E-01	No	PD	S	N/A	N/A

Project: Y-12 National Security Complex **User Name:**

Location: East S-3 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TRICHLOROETHYLENE (TCE)											
	GW-631	T	2	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-272	T	2	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-195	T	3	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-192	T	13	11	2.8E-03	1.5E-03	No	NT	NT	N/A	N/A
	GW-251	T	19	19	8.8E-02	7.6E-02	No	S	S	N/A	N/A
	GW-253	T	14	13	5.0E-01	5.0E-01	No	NT	S	N/A	N/A
	GW-191	T	3	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-269	T	2	2	2.0E-03	2.0E-03	No	N/A	N/A	N/A	N/A
	GW-270	T	2	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-106	T	2	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	SPR14_0SP	T	1	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-349	T	2	1	5.0E-04	5.0E-04	No	N/A	N/A	N/A	N/A
	GW-273	T	2	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-332	T	3	3	2.6E-01	2.6E-01	No	N/A	N/A	N/A	N/A
	GW-194	T	3	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-336	T	2	2	4.9E-01	4.9E-01	No	N/A	N/A	N/A	N/A
	GW-271	T	2	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-337	T	6	6	8.1E-01	7.8E-01	No	NT	D	N/A	N/A
	GW-338	T	4	0	5.0E-06	5.0E-06	Yes	S	S	N/A	N/A
	GW-105	T	2	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-190	T	2	0	5.0E-06	5.0E-06	Yes	N/A	N/A	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 National Security Complex

Location: East S-3

User Name:

State: Tennessee

Effective Date	0th Moment: Estimated Mass (Kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
GROSS ALPHA ACTIVITY							
1/1/1996	6.2E+03	53,554	30,010	353	99,704	49,660	14
4/1/1996	9.6E+02	54,007	29,914	815	152,811	43,447	11
10/1/1996	2.5E+03	53,676	29,974	479	75,649	34,085	7
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						4
7/1/1997	0.0E+00						1
10/1/1997	0.0E+00						5
1/1/1998	0.0E+00						2
4/1/1998	2.3E+02	54,106	29,850	926	81,187	45,824	7
7/1/1998	0.0E+00						3
10/1/1998	0.0E+00						3
1/1/1999	0.0E+00						2
4/1/1999	0.0E+00						4
7/1/1999	0.0E+00						3
10/1/1999	0.0E+00						4
1/1/2000	0.0E+00						1
4/1/2000	2.7E+03	53,744	29,939	553	125,717	43,477	11
7/1/2000	0.0E+00						1
10/1/2000	1.1E+03	53,695	29,841	540	141,675	18,180	10
1/1/2001	0.0E+00						1
4/1/2001	0.0E+00						4
7/1/2001	0.0E+00						1
10/1/2001	0.0E+00						4
1/1/2002	0.0E+00						1
4/1/2002	4.9E+02	53,784	29,719	675	117,132	17,041	7
7/1/2002	0.0E+00						1
10/1/2002	0.0E+00						5
1/1/2003	0.0E+00						1
4/1/2003	2.2E+03	53,627	30,009	424	114,270	57,139	20
7/1/2003	0.0E+00						1
10/1/2003	6.7E+03	53,393	29,990	203	104,821	45,356	17
1/1/2004	0.0E+00						2
4/1/2004	0.0E+00						3
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						2
GROSS BETA ACTIVITY							
1/1/1996	3.1E+04	53,581	30,010	379	98,437	45,161	12
4/1/1996	1.8E+03	54,010	29,973	808	189,080	55,372	12

Project: Y-12 National Security Complex

Location: East S-3

User Name:

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	1st Moment (Center of Mass): Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	2nd Moment (Spread): Sigma YY (sq ft)	Number of Wells
GROSS BETA ACTIVITY							
10/1/1996	5.1E+03	53,584	29,942	398	56,835	50,616	10
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						5
7/1/1997	0.0E+00						1
10/1/1997	0.0E+00						4
1/1/1998	0.0E+00						2
4/1/1998	1.1E+03	54,002	29,932	807	141,383	31,586	7
7/1/1998	0.0E+00						4
10/1/1998	0.0E+00						4
1/1/1999	0.0E+00						2
4/1/1999	0.0E+00						4
7/1/1999	0.0E+00						4
10/1/1999	0.0E+00						5
1/1/2000	0.0E+00						1
4/1/2000	6.4E+04	53,463	30,025	259	43,319	29,157	11
7/1/2000	0.0E+00						1
10/1/2000	2.9E+04	53,437	30,009	238	74,506	36,942	11
1/1/2001	0.0E+00						1
4/1/2001	0.0E+00						5
7/1/2001	0.0E+00						1
10/1/2001	0.0E+00						5
1/1/2002	0.0E+00						1
4/1/2002	2.3E+03	53,589	29,832	450	110,900	9,061	7
7/1/2002	0.0E+00						1
10/1/2002	0.0E+00						5
1/1/2003	0.0E+00						1
4/1/2003	8.0E+04	53,591	29,986	393	36,195	30,621	14
7/1/2003	0.0E+00						1
10/1/2003	7.3E+04	53,482	29,948	301	37,184	26,325	16
1/1/2004	0.0E+00						2
4/1/2004	0.0E+00						5
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						4
NITRATE							
1/1/1996	3.0E+02	53,996	29,756	849	93,367	1,584	6
4/1/1996	1.2E+03	54,198	29,817	1,023	176,803	40,514	12
10/1/1996	6.1E+03	53,527	29,861	382	56,472	29,381	10
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						4
7/1/1997	0.0E+00						1
10/1/1997	0.0E+00						3
1/1/1998	0.0E+00						2

Project: Y-12 National Security Complex

Location: East S-3

User Name:

State: Tennessee

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	**Estimated Mass (kg)**	**Xc (ft)**	**Yc (ft)**	**Source Distance (ft)**	**Sigma XX (sq ft)**	**Sigma YY (sq ft)**	**Number of Wells**
NITRATE							
4/1/1998	4.8E+02	53,936	29,988	733	160,427	9,339	6
7/1/1998	0.0E+00						4
10/1/1998	0.0E+00						4
4/1/1999	0.0E+00						3
10/1/1999	0.0E+00						4
4/1/2000	8.7E+04	53,734	29,934	544	145,402	9,791	7
10/1/2000	6.9E+04	53,745	29,962	549	158,843	18,602	8
4/1/2001	0.0E+00						2
10/1/2001	0.0E+00						2
4/1/2002	0.0E+00						3
10/1/2002	0.0E+00						3
4/1/2003	6.0E+04	53,574	30,009	372	72,950	33,644	16
10/1/2003	6.9E+04	53,547	30,041	341	67,450	36,303	16
1/1/2004	0.0E+00						1
4/1/2004	0.0E+00						5
10/1/2004	0.0E+00						4
TETRACHLOROETHYLENE(PCE)							
1/1/1996	3.0E-01	53,738	29,862	570	76,401	2,106	10
4/1/1996	9.7E-01	53,758	29,657	689	88,725	33,432	15
10/1/1996	1.8E-01	53,608	29,756	510	197,355	10,784	11
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						5
7/1/1997	0.0E+00						1
10/1/1997	0.0E+00						5
1/1/1998	0.0E+00						2
4/1/1998	8.9E+00	54,300	30,000	1,095	242,035	54,364	9
7/1/1998	2.0E+01	54,572	29,843	1,383	26,621	480	9
10/1/1998	0.0E+00						4
1/1/1999	0.0E+00						2
4/1/1999	0.0E+00						4
7/1/1999	0.0E+00						4
10/1/1999	0.0E+00						5
1/1/2000	0.0E+00						1
4/1/2000	3.3E+01	53,946	29,898	759	217,086	54,068	11
7/1/2000	0.0E+00						1
10/1/2000	1.5E+01	53,913	29,825	747	229,781	32,536	11
1/1/2001	0.0E+00						1
4/1/2001	0.0E+00						5
7/1/2001	0.0E+00						1
10/1/2001	0.0E+00						5
1/1/2002	0.0E+00						1
4/1/2002	6.2E-01	53,623	29,574	647	52,463	20,013	7

Project: Y-12 National Security Complex

Location: East S-3

User Name:

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	1st Moment (Center of Mass): Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	2nd Moment (Spread): Sigma YY (sq ft)	Number of Wells
TETRACHLOROETHYLENE(PCE)							
7/1/2002	0.0E+00						1
10/1/2002	5.0E-01	53,653	29,615	637	72,922	25,019	7
1/1/2003	0.0E+00						1
4/1/2003	2.5E+01	54,019	29,893	831	196,369	44,513	21
7/1/2003	0.0E+00						1
10/1/2003	2.4E+01	54,070	29,931	874	207,172	55,870	21
1/1/2004	0.0E+00						2
4/1/2004	0.0E+00						5
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						5
TRICHLOROETHYLENE (TCE)							
1/1/1996	1.5E-01	53,879	29,852	707	121,197	3,635	10
4/1/1996	4.6E-01	53,837	29,678	742	119,742	32,070	15
10/1/1996	1.1E-01	53,811	29,777	671	244,598	10,759	11
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						5
7/1/1997	0.0E+00						1
10/1/1997	0.0E+00						5
1/1/1998	0.0E+00						2
4/1/1998	7.1E+00	54,265	30,013	1,059	218,580	48,443	9
7/1/1998	1.2E+01	54,511	29,837	1,325	73,382	1,372	9
10/1/1998	0.0E+00						4
1/1/1999	0.0E+00						2
4/1/1999	0.0E+00						4
7/1/1999	0.0E+00						4
10/1/1999	0.0E+00						5
1/1/2000	0.0E+00						1
4/1/2000	1.5E+01	54,326	29,904	1,131	154,361	78,746	11
7/1/2000	0.0E+00						1
10/1/2000	9.8E+00	54,405	29,915	1,208	93,663	75,707	11
1/1/2001	0.0E+00						1
4/1/2001	0.0E+00						5
7/1/2001	0.0E+00						1
10/1/2001	0.0E+00						5
1/1/2002	0.0E+00						1
4/1/2002	4.2E-01	53,720	29,571	716	64,878	15,324	7
7/1/2002	0.0E+00						1
10/1/2002	1.2E+00	53,867	29,665	775	95,961	14,615	7
1/1/2003	0.0E+00						1
4/1/2003	1.1E+01	54,347	29,839	1,163	77,143	49,349	21
7/1/2003	0.0E+00						1
10/1/2003	1.0E+01	54,347	29,865	1,158	90,041	57,489	21

Project: Y-12 National Security Complex

Location: East S-3

User Name:

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TRICHLOROETHYLENE (TCE)							
1/1/2004	0.0E+00						2
4/1/2004	0.0E+00						5
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						5

Project: Y-12 National Security Complex

Location: East S-3

User Name:

State: Tennessee

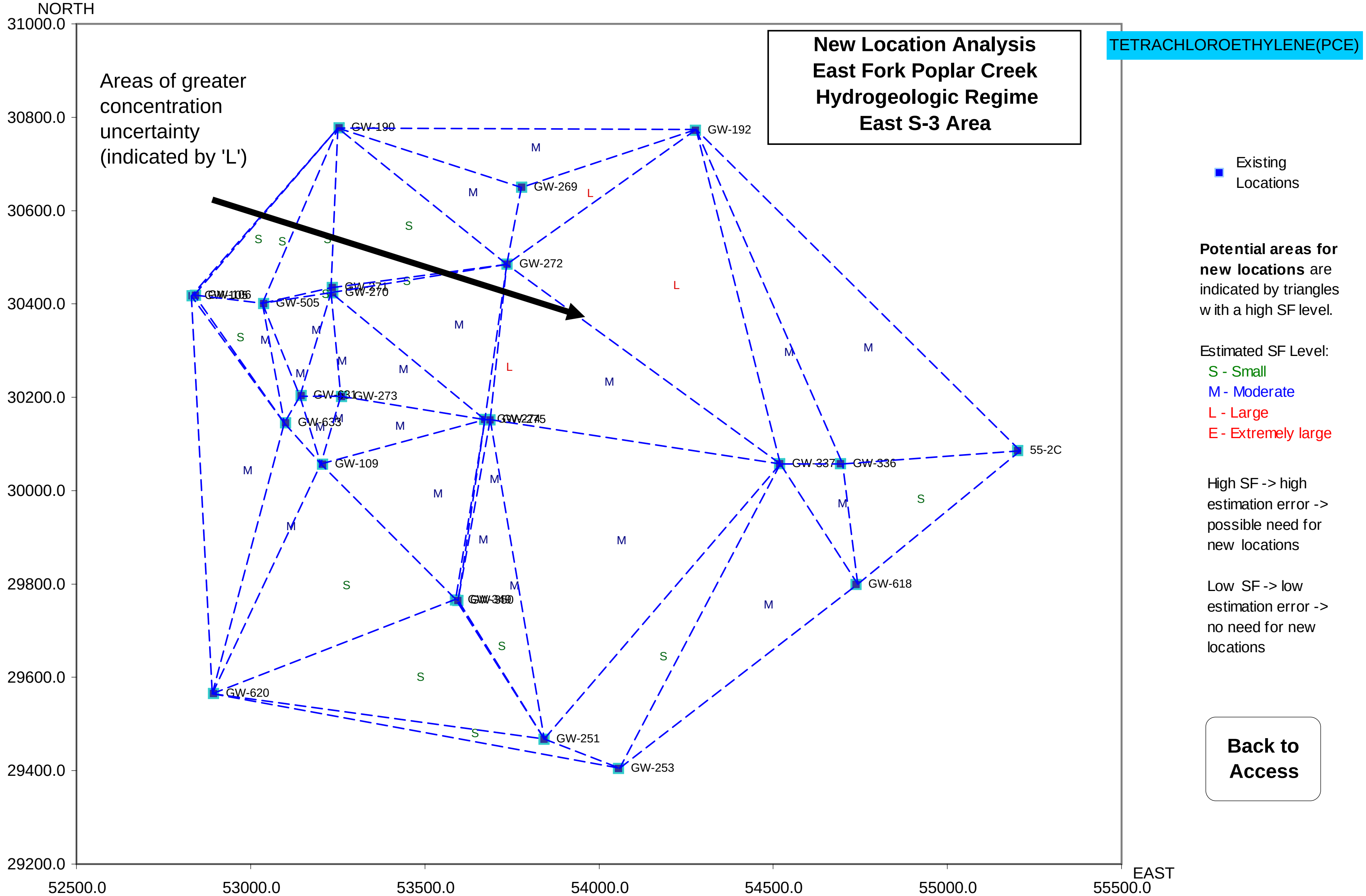
Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	GROSS ALPHA ACTIVITY	2.45	-50	75.6%	NT
	GROSS BETA ACTIVITY	2.59	-40	70.9%	NT
	NITRATE	2.24	-16	64.4%	NT
	TETRACHLOROETHYLENE(PCE)	2.34	-31	66.4%	NT
	TRICHLOROETHYLENE (TCE)	2.20	-31	66.4%	NT
1st Moment: Distance to Source					
	GROSS ALPHA ACTIVITY	0.41	-8	76.2%	S
	GROSS BETA ACTIVITY	0.48	-10	82.1%	S
	NITRATE	0.41	-18	98.4%	D
	TETRACHLOROETHYLENE(PCE)	0.32	11	77.7%	NT
	TRICHLOROETHYLENE (TCE)	0.25	19	91.8%	PI
2nd Moment: Sigma XX					
	GROSS ALPHA ACTIVITY	0.23	0	46.0%	S
	GROSS BETA ACTIVITY	0.60	-16	94.0%	PD
	NITRATE	0.42	-8	80.1%	S
	TETRACHLOROETHYLENE(PCE)	0.56	5	61.9%	NT
	TRICHLOROETHYLENE (TCE)	0.48	-23	95.7%	D
2nd Moment: Sigma YY					
	GROSS ALPHA ACTIVITY	0.35	-4	61.9%	S
	GROSS BETA ACTIVITY	0.40	-22	98.8%	D
	NITRATE	0.65	10	86.2%	NT
	TETRACHLOROETHYLENE(PCE)	0.68	17	89.1%	NT
	TRICHLOROETHYLENE (TCE)	0.80	17	89.1%	NT

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.



New Location Analysis
East Fork Poplar Creek
Hydrogeologic Regime
East S-3 Area
TETRACHLOROETHYLENE(PCE)
Areas of greater concentration uncertainty (indicated by 'L')
NORTH
EAST
31000.0
30800.0
30600.0
30400.0
30200.0
30000.0
29800.0
29600.0
29400.0
29200.0
52500.0
53000.0
53500.0
54000.0
54500.0
55000.0
55500.0
GW-190
GW-192
GW-269
GW-272
GW-271
GW-270
GW-106
GW-505
GW-631
GW-273
GW-633
GW-275
GW-109
GW-337
GW-336
55-2C
GW-618
GW-350
GW-620
GW-251
GW-253
Existing Locations
Potential areas for new locations are indicated by triangles with a high SF level.
Estimated SF Level:
S - Small
M - Moderate
L - Large
E - Extremely large
High SF -> high estimation error -> possible need for new locations
Low SF -> low estimation error -> no need for new locations
Back to Access

ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.5	**East Fork Regime Central Y-12 Area**
Table D.5.1	Qualitative Analysis East S-3 Area
Table D.5.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary

(No Well Sufficiency areas of interest identified)

TABLE D.5.1
QUALITATIVE ANALYSIS EAST FORK REGIME CENTRAL Y-12 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
55-1B	WL	X	Aquitard	X					X			
55-6A	WL	X	Aquitard									
56-2A	WL	X	Aquitard									
56-2B	WL	X	Aquitard									
56-2C	WL	X	Aquitard									
59-1A	WL		Aquitard						X	X		
59-1B	WL		Aquitard						X			
59-1C	WL		Aquitard									
60-1B	WL		Aquifer						X	X		
9201-3C-4SP	SP	X										
GW-193	WL	X	Aquifer				X					
GW-204	WL	X	Aquifer	X								
GW-218	WL		Aquifer						X			
GW-219	WL	X	Aquifer					X				
GW-605	WL	X	Aquifer	X		X	X	X			X	
GW-606	WL	X	Aquifer		X	X	X	X				
GW-656	WL	X	Aquitard									
GW-657	WL		Aquifer						X	X		
GW-686	WL	X	Aquifer									
GW-690	WL	X	Aquifer									
GW-691	WL	X	Aquifer									
GW-692	WL		Aquifer									
GW-698	WL	X	Aquifer	X							X	
GW-700	WL	X	Aquifer									
GW-759	WL		Aquitard	X						X		

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.3.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.5.1
QUALITATIVE ANALYSIS EAST FORK REGIME CENTRAL Y-12 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-760	WL		Aquitard						X			
GW-761	WL		Aquitard									
GW-765	WL		Aquitard	X								
GW-769	WL	X	Aquitard									
GW-770	WL		Aquitard									
GW-779	WL		Aquitard	X					X	X		
GW-780	WL		Aquitard	X								
GW-781	WL	X	Aquitard						X			
GW-782	WL	X	Aquitard									
GW-783	WL	X	Aquitard									
GW-786	WL		Aquitard	X					X	X		
GW-787	WL		Aquitard	X								
GW-788	WL		Aquitard						X	X		
GW-789	WL		Aquitard									
GW-791	WL	X	Aquitard									X
GW-792	WL	X	Aquitard									X
GW-819	WL								X	X		
GW-820	WL	X		X							X	
UEFPC-SP17	SP	X				X						

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.3.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location; CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.5.2
AQUIFER INPUT PARAMETERS

Central Y-12
East Fork Poplar Creek
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	5300	ft
Maximum Plume Length	5300	ft
PlumeWidth	1500	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	5000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	Chlorinated Solvent	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow direction	E	0
Effective Porosity	0.1	--
Source Location near Well	56-2B	--
Source X-Coordinate	56225.6	ft*
Source Y-Coordinate	29883.61	ft*
Saturated Thickness	50	ft
Source Wells		
-2B, GW-820, GW-791, GW-691, 56-2C, GW-656,GW-698, GW-219, GW-204, GW-60		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS COC Assessment

Project: Y-12 National Security Complex **User Name:**

Location: Central Y-12 Facility **State:** Tennessee

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
TRICHLOROETHYLENE (TCE)	2.8E-01	5.0E-03	5489.4%
TETRACHLOROETHYLENE(PCE)	2.1E-01	5.0E-03	4188.9%
BENZENE	3.5E-02	5.0E-03	607.7%
URANIUM	1.7E-01	3.0E-02	460.8%
CARBON TETRACHLORIDE	2.5E-02	5.0E-03	395.1%
NITRATE	1.2E+01	1.0E+01	23.7%
LEAD	1.6E-02	1.5E-02	4.1%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage excedence from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Excedences	Percent Excedences	Total detects
NITRATE	INO	3	2	66.7%	2
URANIUM	MET	44	21	47.7%	30
TETRACHLOROETHYLENE(PCE)	ORG	45	20	44.4%	23
TRICHLOROETHYLENE (TCE)	ORG	45	15	33.3%	23
LEAD	MET	45	11	24.4%	32
CARBON TETRACHLORIDE	ORG	45	4	8.9%	8
BENZENE	ORG	45	4	8.9%	7

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total excedences (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
NITRATE	
BENZENE	0.0984
CARBON TETRACHLORIDE	0.277
TRICHLOROETHYLENE (TCE)	0.297
TETRACHLOROETHYLENE(PCE)	0.923
LEAD	10
URANIUM	2960

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Contaminants of Concern (COC's)

TRICHLOROETHYLENE (TCE)

TETRACHLOROETHYLENE(PCE)

NITRATE

BENZENE

URANIUM

MAROS Plume Analysis Summary

Project: Y-12 National Security Complex

User Name: MV

Location: Central Y-12

State: Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
BENZENE											
	GW-820	S	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-791	S	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	56-2B	S	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-698	S	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-691	S	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	56-2C	S	5	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-605	S	20	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-219	S	12	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-656	S	4	2	7.5E-04	7.5E-04	No	NT	PI	N/A	N/A
	GW-204	S	12	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-690	T	5	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-692	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-789	T	13	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	55-1B	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-700	T	5	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-686	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-788	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-761	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-765	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-769	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-770	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-787	T	5	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: Central Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
BENZENE											
	GW-779	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-780	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-781	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-786	T	5	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-782	T	20	2	5.5E-04	5.0E-04	No	S	S	N/A	N/A
	GW-760	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-193	T	17	12	6.1E-02	2.5E-02	No	D	D	N/A	N/A
	55-6A	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	56-2A	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	UEFPC-SP17	T	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	59-1A	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	N-S PIPE	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	59-1B	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	59-1C	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-606	T	20	5	6.3E-04	5.0E-04	No	S	S	N/A	N/A
	9201-3C-4SP	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-218	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-819	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-792	T	9	1	5.6E-04	5.0E-04	No	S	D	N/A	N/A
	GW-783	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	60-1B	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
GROSS ALPHA ACTIVITY											
	GW-656	S	2	2	1.9E+00	1.9E+00	No	N/A	N/A	N/A	N/A
	GW-204	S	13	13	4.7E+01	3.7E+01	No	PD	PD	N/A	N/A
	GW-698	S	10	10	3.1E+00	2.8E+00	No	NT	NT	N/A	N/A
	GW-219	S	12	12	1.2E+02	1.2E+02	No	S	NT	N/A	N/A
	GW-691	S	2	2	2.1E+00	2.1E+00	No	N/A	N/A	N/A	N/A
	56-2C	S	4	4	1.8E+00	1.6E+00	No	NT	NT	N/A	N/A
	56-2B	S	3	3	1.2E+00	1.2E+00	No	N/A	N/A	N/A	N/A
	GW-605	S	19	19	7.0E+01	5.2E+01	No	S	PD	N/A	N/A
	GW-820	S	5	5	1.7E+00	9.0E-01	No	S	NT	N/A	N/A
	GW-791	S	11	11	2.0E+00	1.8E+00	No	S	S	N/A	N/A
	9201-3C-4SP	T	1	1	6.2E-01	6.2E-01	No	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: Central Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS ALPHA ACTIVITY											
	GW-692	T	4	4	7.3E+00	6.0E+00	No	NT	PI	N/A	N/A
	N-S PIPE	T	10	10	1.7E+01	2.0E+01	No	S	S	N/A	N/A
	GW-770	T	14	14	1.7E+00	1.5E+00	No	S	S	N/A	N/A
	GW-787	T	4	4	2.4E+00	5.8E-01	No	NT	NT	N/A	N/A
	59-1A	T	3	3	8.1E+00	6.9E+00	No	N/A	N/A	N/A	N/A
	GW-193	T	18	15	7.6E+00	2.9E+00	No	D	D	N/A	N/A
	GW-789	T	9	9	3.8E+00	1.5E+00	No	NT	NT	N/A	N/A
	GW-769	T	15	15	1.8E+00	1.3E+00	No	S	NT	N/A	N/A
	GW-819	T	1	1	3.8E-01	3.8E-01	No	N/A	N/A	N/A	N/A
	59-1B	T	3	3	4.5E+00	5.2E+00	No	N/A	N/A	N/A	N/A
	GW-788	T	4	4	3.4E+00	2.7E+00	No	D	D	N/A	N/A
	GW-765	T	2	2	1.6E+00	1.6E+00	No	N/A	N/A	N/A	N/A
	GW-760	T	2	2	9.7E-01	9.7E-01	No	N/A	N/A	N/A	N/A
	59-1C	T	2	2	1.1E+00	1.1E+00	No	N/A	N/A	N/A	N/A
	GW-700	T	5	5	2.0E+00	1.7E+00	No	S	S	N/A	N/A
	GW-792	T	4	4	1.9E+00	1.6E+00	No	S	S	N/A	N/A
	GW-783	T	8	8	2.7E+00	2.9E+00	No	NT	NT	N/A	N/A
	55-1B	T	2	2	3.4E+00	3.4E+00	No	N/A	N/A	N/A	N/A
	55-6A	T	2	2	4.1E+00	4.1E+00	No	N/A	N/A	N/A	N/A
	GW-606	T	20	19	5.9E+00	5.7E+00	No	NT	S	N/A	N/A
	GW-782	T	20	20	4.2E+01	4.4E+01	No	D	D	N/A	N/A
	GW-686	T	1	1	1.6E+01	1.6E+01	No	N/A	N/A	N/A	N/A
	56-2A	T	2	2	1.2E+00	1.2E+00	No	N/A	N/A	N/A	N/A
	GW-779	T	1	1	2.1E+00	2.1E+00	No	N/A	N/A	N/A	N/A
	GW-781	T	4	4	2.2E+00	1.6E+00	No	NT	NT	N/A	N/A
	60-1B	T	1	1	7.4E-02	7.4E-02	No	N/A	N/A	N/A	N/A
	GW-690	T	4	4	8.1E+00	5.1E+00	No	S	D	N/A	N/A
	UEFPC-SP17	T	8	8	2.4E+00	1.9E+00	No	PD	S	N/A	N/A
	GW-218	T	4	4	2.7E+00	2.7E+00	No	NT	NT	N/A	N/A
TETRACHLOROETHYLENE(PCE)											
	GW-698	S	11	10	1.1E-01	1.3E-01	No	NT	NT	N/A	N/A
	GW-219	S	12	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-204	S	12	1	1.8E-03	5.0E-04	No	NT	D	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: Central Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TETRACHLOROETHYLENE(PCE)											
	GW-691	S	3	3	8.0E-01	9.8E-01	No	N/A	N/A	N/A	N/A
	GW-656	S	4	4	5.8E-02	5.7E-02	No	S	S	N/A	N/A
	GW-820	S	6	6	4.4E+00	4.3E+00	No	NT	NT	N/A	N/A
	GW-605	S	20	19	2.6E-02	1.5E-02	No	I	I	N/A	N/A
	56-2B	S	3	3	1.0E+00	8.7E-01	No	N/A	N/A	N/A	N/A
	56-2C	S	5	5	1.4E+00	1.4E+00	No	S	PD	N/A	N/A
	GW-791	S	19	19	6.0E-01	4.1E-01	No	S	S	N/A	N/A
	GW-786	T	5	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-779	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-761	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-789	T	13	2	5.8E-04	5.0E-04	No	S	D	N/A	N/A
	GW-218	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-780	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-690	T	5	5	2.1E-01	6.6E-02	No	NT	D	N/A	N/A
	GW-792	T	9	9	6.3E-03	6.0E-03	No	S	NT	N/A	N/A
	GW-781	T	9	6	1.2E-02	5.0E-03	No	PI	I	N/A	N/A
	GW-686	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	UEFPC-SP17	T	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	55-6A	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-782	T	20	20	1.8E-01	1.9E-01	No	D	D	N/A	N/A
	55-1B	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-783	T	9	9	2.4E-02	2.4E-02	No	S	S	N/A	N/A
	56-2A	T	3	3	2.4E-02	1.3E-02	No	N/A	N/A	N/A	N/A
	GW-788	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	59-1C	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-606	T	20	17	4.8E-03	5.0E-03	No	PI	I	N/A	N/A
	60-1B	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-760	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-765	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	59-1B	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-787	T	5	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	N-S PIPE	T	6	5	2.2E-03	1.5E-03	No	NT	NT	N/A	N/A
	GW-769	T	19	18	8.9E-03	8.0E-03	No	I	I	N/A	N/A
	GW-692	T	3	2	3.5E-03	2.0E-03	No	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: Central Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TETRACHLOROETHYLENE(PCE)											
	9201-3C-4SP	T	2	1	5.7E-03	5.7E-03	No	N/A	N/A	N/A	N/A
	59-1A	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-770	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-193	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-819	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-700	T	5	5	1.9E-01	1.5E-01	No	S	D	N/A	N/A
TRICHLOROETHYLENE (TCE)											
	GW-219	S	12	1	5.4E-04	5.0E-04	No	S	S	N/A	N/A
	GW-820	S	6	6	6.6E-01	5.7E-01	No	NT	PI	N/A	N/A
	56-2B	S	3	3	6.5E-02	6.1E-02	No	N/A	N/A	N/A	N/A
	GW-605	S	20	19	2.5E-02	1.9E-02	No	I	I	N/A	N/A
	56-2C	S	5	5	5.9E-01	3.8E-01	No	S	S	N/A	N/A
	GW-204	S	12	1	5.4E-04	5.0E-04	No	S	D	N/A	N/A
	GW-791	S	19	10	1.4E-03	1.0E-03	No	NT	NT	N/A	N/A
	GW-656	S	4	4	4.3E+00	4.4E+00	No	S	S	N/A	N/A
	GW-691	S	3	3	7.2E-03	8.0E-03	No	N/A	N/A	N/A	N/A
	GW-698	S	11	11	2.8E-01	3.1E-01	No	NT	NT	N/A	N/A
	GW-786	T	5	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	59-1C	T	3	2	4.5E-03	6.0E-03	No	N/A	N/A	N/A	N/A
	55-6A	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	9201-3C-4SP	T	2	1	1.0E-03	1.0E-03	No	N/A	N/A	N/A	N/A
	GW-700	T	5	5	1.2E-02	1.0E-02	No	NT	NT	N/A	N/A
	GW-781	T	9	3	1.9E-03	5.0E-04	No	NT	NT	N/A	N/A
	60-1B	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-760	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	56-2A	T	3	3	3.2E-03	1.5E-03	No	N/A	N/A	N/A	N/A
	GW-193	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-761	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-787	T	5	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	59-1B	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-765	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	N-S PIPE	T	6	1	5.8E-04	5.0E-04	No	NT	NT	N/A	N/A
	59-1A	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: Central Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TRICHLOROETHYLENE (TCE)											
	GW-769	T	19	14	1.3E-03	1.0E-03	No	I	I	N/A	N/A
	GW-779	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-770	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-780	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-789	T	13	6	7.3E-04	5.0E-04	No	S	S	N/A	N/A
	GW-690	T	5	5	1.2E-02	7.0E-03	No	NT	NT	N/A	N/A
	55-1B	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-686	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-819	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	UEFPC-SP17	T	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-783	T	9	8	9.5E-03	1.1E-02	No	NT	S	N/A	N/A
	GW-218	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-792	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-606	T	20	1	8.8E-04	5.0E-04	No	NT	NT	N/A	N/A
	GW-692	T	3	2	6.7E-04	5.0E-04	No	N/A	N/A	N/A	N/A
	GW-782	T	20	20	5.4E-02	5.7E-02	No	D	S	N/A	N/A
	GW-788	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
URANIUM											
	GW-691	S	3	3	7.2E-04	4.7E-04	No	N/A	N/A	N/A	N/A
	GW-698	S	9	9	1.2E-03	1.2E-03	No	S	PD	N/A	N/A
	GW-204	S	12	12	5.9E-02	4.6E-02	No	D	D	N/A	N/A
	GW-791	S	19	0	1.0E-05	1.0E-05	Yes	S	S	N/A	N/A
	GW-656	S	4	1	1.9E-04	1.0E-05	No	NT	NT	N/A	N/A
	GW-820	S	6	0	1.0E-05	1.0E-05	Yes	S	D	N/A	N/A
	56-2C	S	5	0	1.0E-05	1.0E-05	Yes	S	S	N/A	N/A
	GW-219	S	12	12	3.7E-01	3.3E-01	No	D	D	N/A	N/A
	56-2B	S	3	0	1.0E-05	1.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-605	S	20	20	1.4E-01	9.8E-02	No	S	D	N/A	N/A
	GW-782	T	20	20	1.3E-03	1.3E-03	No	D	D	N/A	N/A
	GW-779	T	3	1	3.3E-03	1.0E-05	No	N/A	N/A	N/A	N/A
	55-6A	T	3	2	1.5E-03	6.8E-04	No	N/A	N/A	N/A	N/A
	56-2A	T	3	1	1.9E-04	1.0E-05	No	N/A	N/A	N/A	N/A
	55-1B	T	2	2	8.3E-04	8.3E-04	No	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: Central Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
URANIUM											
	GW-780	T	3	0	1.0E-05	1.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-781	T	9	0	1.0E-05	1.0E-05	Yes	S	I	N/A	N/A
	GW-786	T	5	0	1.0E-05	1.0E-05	Yes	S	D	N/A	N/A
	GW-783	T	10	10	1.0E-03	1.1E-03	No	NT	D	N/A	N/A
	N-S PIPE	T	10	10	7.1E-02	5.7E-02	No	NT	S	N/A	N/A
	60-1B	T	2	0	1.0E-05	1.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-686	T	2	2	7.3E-04	7.3E-04	No	N/A	N/A	N/A	N/A
	GW-789	T	13	1	2.9E-05	1.0E-05	No	NT	NT	N/A	N/A
	GW-690	T	5	1	1.8E-04	1.0E-05	No	NT	D	N/A	N/A
	GW-792	T	9	0	1.0E-05	1.0E-05	Yes	S	I	N/A	N/A
	GW-218	T	4	4	5.9E-03	6.0E-03	No	S	S	N/A	N/A
	GW-788	T	9	9	1.3E-03	1.3E-03	No	NT	NT	N/A	N/A
	GW-193	T	17	11	1.3E-02	3.9E-03	No	D	D	N/A	N/A
	UEFPC-SP17	T	6	4	1.1E-03	1.4E-03	No	PD	S	N/A	N/A
	GW-819	T	1	0	1.0E-05	1.0E-05	Yes	N/A	N/A	N/A	N/A
	59-1C	T	3	0	1.0E-05	1.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-700	T	5	4	5.6E-04	4.3E-04	No	S	S	N/A	N/A
	GW-770	T	19	16	7.5E-04	7.3E-04	No	S	NT	N/A	N/A
	GW-760	T	3	1	9.3E-05	1.0E-05	No	N/A	N/A	N/A	N/A
	GW-692	T	3	3	3.7E-04	3.3E-04	No	N/A	N/A	N/A	N/A
	GW-787	T	5	1	1.9E-04	1.0E-05	No	NT	NT	N/A	N/A
	GW-606	T	20	15	3.9E-03	5.3E-03	No	PD	S	N/A	N/A
	GW-761	T	2	0	1.0E-05	1.0E-05	Yes	N/A	N/A	N/A	N/A
	59-1B	T	4	4	4.5E-04	4.3E-04	No	S	S	N/A	N/A
	GW-765	T	3	0	1.0E-05	1.0E-05	Yes	N/A	N/A	N/A	N/A
	59-1A	T	3	3	6.6E-03	8.3E-03	No	N/A	N/A	N/A	N/A
	GW-769	T	19	0	1.0E-05	1.0E-05	Yes	S	S	N/A	N/A
	9201-3C-4SP	T	2	2	1.0E-03	1.0E-03	No	N/A	N/A	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 National Security Complex

Location: Central Y-12

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (Kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
BENZENE							
1/1/1996	1.7E-01	59,322	29,745	3,099	805,250	129,340	15
4/1/1996	4.2E-01	58,364	29,710	2,145	1,850,792	176,296	22
7/1/1996	0.0E+00						2
10/1/1996	7.0E-01	59,761	29,541	3,551	555,264	91,215	16
1/1/1997	0.0E+00						3
4/1/1997	1.0E-01	59,282	29,627	3,067	682,355	90,089	10
7/1/1997	0.0E+00						4
10/1/1997	6.8E-02	58,586	29,905	2,360	150,613	5,786	9
1/1/1998	9.3E-01	58,328	29,557	2,127	794,815	26,623	13
4/1/1998	1.4E-01	58,161	29,756	1,940	407,203	28,381	11
7/1/1998	2.8E-01	59,608	29,137	3,464	609,913	12,800	7
10/1/1998	5.4E-02	58,595	29,901	2,369	150,242	6,309	9
1/1/1999	0.0E+00						4
4/1/1999	5.5E-02	58,591	29,902	2,365	153,085	6,534	9
7/1/1999	3.0E-01	58,924	29,396	2,742	792,264	42,396	7
10/1/1999	9.2E-02	58,794	29,716	2,573	199,562	53,680	11
1/1/2000	0.0E+00						4
4/1/2000	2.6E-01	58,524	29,600	2,315	1,549,382	114,348	15
7/1/2000	0.0E+00						5
10/1/2000	2.1E-01	58,081	29,716	1,863	819,863	66,952	13
1/1/2001	0.0E+00						3
4/1/2001	1.8E-01	58,225	29,675	2,010	460,069	57,660	9
7/1/2001	0.0E+00						5
10/1/2001	1.8E-01	58,225	29,675	2,010	460,069	57,660	9
1/1/2002	0.0E+00						3
4/1/2002	2.8E-01	57,567	29,825	1,342	1,032,405	73,835	8
7/1/2002	0.0E+00						3
10/1/2002	2.9E-01	57,460	29,821	1,236	1,144,100	85,313	9
1/1/2003	0.0E+00						3
4/1/2003	3.6E-01	58,380	29,910	2,154	944,249	151,528	20
7/1/2003	0.0E+00						3
10/1/2003	3.6E-01	58,380	29,910	2,154	944,249	151,528	20
1/1/2004	0.0E+00						3
4/1/2004	2.9E-01	57,812	29,775	1,590	1,182,721	115,712	13
7/1/2004	0.0E+00						3
10/1/2004	2.9E-01	57,812	29,775	1,590	1,182,721	115,712	13
GROSS ALPHA ACTIVITY							
1/1/1996	5.2E+03	58,173	29,686	1,957	1,497,105	82,574	18

Project: Y-12 National Security Complex

Location: Central Y-12

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
GROSS ALPHA ACTIVITY							
4/1/1996	2.5E+03	58,118	29,743	1,897	1,467,993	130,967	14
7/1/1996	0.0E+00						2
10/1/1996	2.0E+03	59,340	29,303	3,168	693,538	28,420	8
1/1/1997	0.0E+00						4
4/1/1997	0.0E+00						5
7/1/1997	0.0E+00						4
10/1/1997	9.2E+02	58,175	29,775	1,952	209,391	24,025	7
1/1/1998	1.1E+03	59,175	29,449	2,981	1,193,804	54,552	11
4/1/1998	1.4E+03	57,936	29,765	1,715	238,565	22,046	8
7/1/1998	1.6E+03	59,062	29,145	2,930	734,513	12,743	6
10/1/1998	1.3E+02	58,355	29,930	2,130	143,697	10,194	9
1/1/1999	0.0E+00						4
4/1/1999	4.2E+02	58,505	29,912	2,280	141,990	4,424	8
7/1/1999	7.0E+02	59,534	29,347	3,351	314,929	21,093	6
10/1/1999	4.7E+02	59,098	29,512	2,896	185,035	33,343	9
1/1/2000	0.0E+00						3
4/1/2000	2.1E+03	58,169	29,657	1,956	873,822	89,945	13
7/1/2000	0.0E+00						4
10/1/2000	2.4E+03	57,892	29,764	1,670	451,509	64,794	11
1/1/2001	0.0E+00						3
4/1/2001	4.2E+03	58,282	29,451	2,101	300,171	11,587	7
7/1/2001	0.0E+00						5
10/1/2001	0.0E+00						4
1/1/2002	0.0E+00						3
4/1/2002	6.4E+03	58,070	29,630	1,861	712,299	69,864	8
7/1/2002	0.0E+00						4
10/1/2002	0.0E+00						5
1/1/2003	0.0E+00						5
4/1/2003	5.6E+03	58,148	29,631	1,938	559,228	68,470	17
7/1/2003	0.0E+00						3
10/1/2003	7.7E+03	58,202	29,713	1,983	475,243	54,476	15
1/1/2004	0.0E+00						3
4/1/2004	3.3E+03	58,074	29,497	1,888	539,282	15,902	8
7/1/2004	0.0E+00						3
10/1/2004	3.7E+03	57,991	29,626	1,784	766,162	85,099	12
TETRACHLOROETHYLENE(PCE)							
1/1/1996	5.1E-01	58,682	29,951	2,456	1,012,919	109,623	15
4/1/1996	6.7E+01	56,778	29,944	555	93,328	22,189	22
7/1/1996	0.0E+00						2
10/1/1996	9.5E-01	58,592	29,970	2,368	992,301	123,284	16
1/1/1997	0.0E+00						3
4/1/1997	5.9E-01	58,359	29,934	2,134	523,071	64,773	10

Project: Y-12 National Security Complex

Location: Central Y-12

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TETRACHLOROETHYLENE(PCE)							
7/1/1997	0.0E+00						4
10/1/1997	3.6E-01	58,174	30,007	1,952	202,677	22,312	9
1/1/1998	2.9E+00	58,829	29,416	2,645	541,967	52,206	13
4/1/1998	3.7E+00	57,514	29,745	1,296	171,402	8,841	11
7/1/1998	3.0E-01	58,872	29,138	2,749	788,065	15,134	7
10/1/1998	5.6E-01	58,416	29,937	2,191	182,008	10,105	9
1/1/1999	0.0E+00						4
4/1/1999	4.0E-01	58,361	29,963	2,136	225,870	16,003	9
7/1/1999	9.2E-01	59,400	29,244	3,238	496,643	32,114	7
10/1/1999	4.6E-01	58,405	29,880	2,179	225,979	41,628	11
1/1/2000	0.0E+00						4
4/1/2000	1.8E+01	57,479	29,813	1,255	1,257,100	72,768	15
7/1/2000	0.0E+00						5
10/1/2000	2.1E+01	57,300	29,786	1,078	746,686	45,149	13
1/1/2001	0.0E+00						3
4/1/2001	8.7E+00	57,724	29,649	1,517	177,849	38,561	9
7/1/2001	0.0E+00						5
10/1/2001	9.5E+00	57,740	29,661	1,530	190,938	40,915	9
1/1/2002	0.0E+00						3
4/1/2002	1.9E+01	57,755	29,881	1,529	926,358	45,719	8
7/1/2002	0.0E+00						3
10/1/2002	1.7E+01	58,383	29,894	2,158	394,210	19,126	9
1/1/2003	0.0E+00						3
4/1/2003	1.5E+01	57,585	29,910	1,359	955,299	102,081	20
7/1/2003	0.0E+00						3
10/1/2003	1.5E+01	57,444	29,797	1,221	971,408	100,340	20
1/1/2004	0.0E+00						3
4/1/2004	2.0E+01	57,752	29,943	1,527	970,186	78,097	13
7/1/2004	0.0E+00						3
10/1/2004	2.4E+01	57,710	29,959	1,485	1,030,524	79,806	13
TRICHLOROETHYLENE (TCE)							
1/1/1996	2.6E-01	59,146	29,808	2,921	883,461	116,606	15
4/1/1996	1.6E+00	57,619	29,773	1,397	1,097,124	109,399	22
7/1/1996	0.0E+00						2
10/1/1996	3.4E-01	58,873	29,888	2,647	888,268	111,023	16
1/1/1997	0.0E+00						3
4/1/1997	1.7E-01	58,855	29,747	2,633	748,489	88,035	10
7/1/1997	0.0E+00						4
10/1/1997	8.6E-02	58,553	29,900	2,327	166,626	10,081	9
1/1/1998	2.3E+00	58,716	29,534	2,515	369,248	47,434	13
4/1/1998	6.4E-01	57,722	29,724	1,504	295,681	20,645	11
7/1/1998	3.5E-01	58,881	29,131	2,760	703,094	13,438	7

Project: Y-12 National Security Complex

Location: Central Y-12

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TRICHLOROETHYLENE (TCE)							
10/1/1998	1.6E-01	58,415	29,923	2,190	144,477	5,819	9
1/1/1999	0.0E+00						4
4/1/1999	9.1E-02	58,399	29,928	2,174	160,022	7,643	9
7/1/1999	3.6E-01	59,540	29,215	3,381	495,379	28,413	7
10/1/1999	1.5E-01	58,536	29,810	2,311	230,263	48,149	11
1/1/2000	0.0E+00						4
4/1/2000	5.0E+00	57,767	29,644	1,560	1,376,946	64,802	15
7/1/2000	0.0E+00						5
10/1/2000	8.1E+00	57,399	29,693	1,188	449,030	18,594	13
1/1/2001	0.0E+00						3
4/1/2001	2.3E+01	57,511	29,611	1,314	43,240	7,934	9
7/1/2001	0.0E+00						5
10/1/2001	1.9E+01	57,505	29,615	1,307	42,039	7,496	9
1/1/2002	0.0E+00						3
4/1/2002	4.7E+00	57,573	29,689	1,361	613,257	80,424	8
7/1/2002	0.0E+00						3
10/1/2002	3.7E+00	57,975	29,620	1,768	470,859	55,411	9
1/1/2003	0.0E+00						3
4/1/2003	4.1E+00	57,891	29,666	1,679	1,324,567	85,475	20
7/1/2003	0.0E+00						3
10/1/2003	6.6E+00	57,400	29,619	1,203	948,917	53,699	20
1/1/2004	0.0E+00						3
4/1/2004	3.4E+00	57,688	29,623	1,485	550,788	75,985	13
7/1/2004	0.0E+00						3
10/1/2004	4.1E+00	57,666	29,666	1,456	621,377	88,998	13
URANIUM							
1/1/1996	1.5E-01	60,224	29,438	4,023	1,199,997	182,117	16
4/1/1996	6.0E-01	59,586	29,249	3,419	1,694,685	88,386	23
7/1/1996	0.0E+00						2
10/1/1996	2.3E+00	59,683	29,224	3,519	357,965	23,194	17
1/1/1997	0.0E+00						4
4/1/1997	9.6E-03	58,375	29,915	2,149	135,589	8,807	9
7/1/1997	0.0E+00						4
10/1/1997	1.7E-01	58,700	29,584	2,492	241,321	20,267	10
1/1/1998	6.1E-01	58,455	29,358	2,290	1,544,166	39,985	13
4/1/1998	9.9E-02	58,292	29,684	2,075	282,319	28,567	10
7/1/1998	0.0E+00						4
10/1/1998	3.5E-03	58,340	29,920	2,114	147,546	9,810	9
1/1/1999	0.0E+00						4
4/1/1999	3.4E-03	58,339	29,921	2,113	148,095	9,781	9
7/1/1999	4.5E+00	58,388	29,537	2,190	220,927	6,844	7
10/1/1999	1.4E-01	59,233	29,405	3,045	88,112	11,834	11

Project: Y-12 National Security Complex

Location: Central Y-12

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
URANIUM							
1/1/2000	0.0E+00						4
4/1/2000	2.4E-01	57,850	29,588	1,651	369,422	61,389	13
7/1/2000	0.0E+00						3
10/1/2000	3.4E-01	57,763	29,606	1,561	335,427	54,091	13
1/1/2001	0.0E+00						3
4/1/2001	1.0E+00	57,989	29,436	1,819	98,240	21,746	9
7/1/2001	0.0E+00						5
10/1/2001	8.4E-01	58,003	29,427	1,834	102,327	16,597	9
1/1/2002	0.0E+00						3
4/1/2002	1.2E+00	57,912	29,493	1,731	299,189	34,758	8
7/1/2002	0.0E+00						4
10/1/2002	7.9E-01	57,748	29,515	1,566	504,944	39,902	9
1/1/2003	0.0E+00						5
4/1/2003	1.4E+00	58,000	29,465	1,822	147,237	32,486	21
7/1/2003	0.0E+00						3
10/1/2003	5.7E-01	57,940	29,555	1,745	322,797	44,983	20
1/1/2004	0.0E+00						3
4/1/2004	8.7E-01	58,303	29,530	2,106	606,120	38,178	17
7/1/2004	0.0E+00						3
10/1/2004	6.9E-01	58,087	29,472	1,906	658,124	34,850	13

Project: Y-12 National Security Complex

Location: Central Y-12

User Name: MV

State: Tennessee

Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	BENZENE	1.26	-21	60.7%	NT
	GROSS ALPHA ACTIVITY	1.46	-12	55.9%	NT
	TETRACHLOROETHYLENE(PCE)	1.89	39	69.7%	NT
	TRICHLOROETHYLENE (TCE)	2.08	27	63.7%	NT
	URANIUM	1.89	15	57.5%	NT
1st Moment: Distance to Source					
	BENZENE	0.27	-113	99.9%	D
	GROSS ALPHA ACTIVITY	0.24	-47	94.6%	PD
	TETRACHLOROETHYLENE(PCE)	0.35	-63	96.0%	D
	TRICHLOROETHYLENE (TCE)	0.33	-103	99.8%	D
	URANIUM	0.31	-110	100.0%	D
2nd Moment: Sigma XX					
	BENZENE	0.59	65	96.5%	I
	GROSS ALPHA ACTIVITY	0.69	-13	66.1%	S
	TETRACHLOROETHYLENE(PCE)	0.63	55	93.6%	PI
	TRICHLOROETHYLENE (TCE)	0.68	-11	61.0%	S
	URANIUM	1.03	-6	55.9%	NT
2nd Moment: Sigma YY					
	BENZENE	0.68	59	94.9%	PI
	GROSS ALPHA ACTIVITY	0.75	-1	50.0%	S
	TETRACHLOROETHYLENE(PCE)	0.67	43	88.0%	NT
	TRICHLOROETHYLENE (TCE)	0.73	-7	56.6%	S
	URANIUM	1.00	12	62.9%	NT

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.

ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.6 East Fork Regime Fuel Station Area

Table D.6.1	Qualitative Analysis Fuel Station Area
Table D.6.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary

(No Well Sufficiency areas of interest identified)

GROUNDWATER SERVICES, INC.

TABLE D.6.1
QUALITATIVE ANALYSIS EAST FORK POPLAR CREEK FUEL STATION AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-183	WL		Aquifer									X
GW-199	WL		Aquitard	X								
GW-200	WL		Aquitard									
GW-202	WL		Aquitard	X								
GW-281	WL		Aquitard					X				X
GW-282	WL		Aquitard									X
GW-283	WL		Aquitard						X			X
GW-658	WL	X	Aquitard					X				X
GW-659	WL		Aquitard									X
GW-751	WL		Aquitard	X					X	X		
GW-752	WL		Aquitard	X						X		
GW-753	WL	X	Aquitard	X					X			
GW-754	WL	X	Aquitard	X								
GW-756	WL		Aquitard	X								
GW-762	WL	X	Aquitard					X				
GW-763	WL	X	Aquitard	X								
GW-766	WL		Aquitard						X			
GW-767	WL		Aquitard									
GW-773	WL		Aquitard	X					X	X		
GW-774	WL		Aquitard	X								
GW-775	WL		Aquitard									
GW-776	WL		Aquitard									
GW-802	WL		Aquitard	X				X				
NHPCEMSP	SP					X						

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.3.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location; CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report* , (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.6.2
AQUIFER INPUT PARAMETERS

Fuel Station
East Fork Poplar Creek Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	1500	ft
Maximum Plume Length	1500	ft
PlumeWidth	500	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	5000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	BTEX	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow direction	E/SE	0
Effective Porosity	0.1	--
Source Location near Well	GW-183	--
Source X-Coordinate	61954.52	ft*
Source Y-Coordinate	29658.59	ft*
Saturated Thickness	50	ft
Source Wells		
GW-183, GW-281, GW-282		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS COC Assessment

Project: Y-12 National Security Complex **User Name:** MV

Location: Fuel Station **State:** Tennessee

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
BENZENE	4.4E-01	5.0E-03	8764.7%
TETRACHLOROETHYLENE(PCE)	8.1E-02	5.0E-03	1516.8%
TRICHLOROETHYLENE (TCE)	4.5E-02	5.0E-03	795.3%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage excedence from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Excedences	Percent Excedences	Total detects
TRICHLOROETHYLENE (TCE)	ORG	22	6	27.3%	9
BENZENE	ORG	22	3	13.6%	3
TETRACHLOROETHYLENE(PCE)	ORG	22	2	9.1%	7

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total excedences (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
BENZENE	0.0984
TRICHLOROETHYLENE (TCE)	0.297
TETRACHLOROETHYLENE(PCE)	0.923

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Contaminants of Concern (COC's)

MANGANESE

TETRACHLOROETHYLENE(PCE)

TRICHLOROETHYLENE (TCE)

BENZENE

CHROMIUM III

MAROS Plume Analysis Summary

Project: Y-12 National Security Complex **User Name:** MV

Location: Fuel Station **State:** Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
BENZENE											
	GW-281	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-752	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-659	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-776	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-775	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-751	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-766	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-802	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-763	T	20	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-754	T	5	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-658	T	6	5	7.6E+00	7.8E+00	No	NT	NT	N/A	N/A
	NHPCEMSP	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-762	T	12	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-753	T	5	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-756	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-767	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
CHROMIUM III											
	GW-766	T	3	0	1.5E-04	1.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-767	T	3	0	1.5E-04	1.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-763	T	20	2	1.1E-03	1.5E-04	No	NT	NT	N/A	N/A
	GW-762	T	12	0	1.5E-04	1.5E-04	Yes	S	S	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: Fuel Station **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
CHROMIUM III											
	GW-752	T	3	1	2.1E-03	1.5E-04	No	N/A	N/A	N/A	N/A
	GW-751	T	3	1	1.8E-03	1.5E-04	No	N/A	N/A	N/A	N/A
	NHPCEMSP	T	2	0	1.5E-04	1.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-658	T	2	0	1.5E-04	1.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-775	T	12	0	1.5E-04	1.5E-04	Yes	S	S	N/A	N/A
	GW-776	T	11	11	3.5E-01	8.8E-02	No	PD	PD	N/A	N/A
LEAD											
	GW-763	T	20	7	8.4E-04	4.5E-04	No	NT	NT	N/A	N/A
	NHPCEMSP	T	2	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-658	T	2	1	2.6E-03	2.6E-03	No	N/A	N/A	N/A	N/A
	GW-752	T	3	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-767	T	3	1	5.2E-04	4.5E-04	No	N/A	N/A	N/A	N/A
	GW-776	T	11	3	5.6E-04	4.5E-04	No	S	S	N/A	N/A
	GW-762	T	12	0	4.5E-04	4.5E-04	Yes	S	S	N/A	N/A
	GW-775	T	12	3	9.1E-04	4.5E-04	No	NT	PI	N/A	N/A
	GW-766	T	3	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-751	T	3	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
TETRACHLOROETHYLENE(PCE)											
	GW-281	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-659	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-752	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-751	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-753	T	5	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-658	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-767	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	NHPCEMSP	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-756	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-802	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-762	T	12	12	2.1E+00	2.2E+00	No	I	I	N/A	N/A
	GW-763	T	20	13	1.9E-02	2.0E-02	No	NT	NT	N/A	N/A
	GW-776	T	11	4	6.4E-04	5.0E-04	No	PD	D	N/A	N/A
	GW-766	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: Fuel Station **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TETRACHLOROETHYLENE(PCE)											
	GW-754	T	5	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-775	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
TRICHLOROETHYLENE (TCE)											
	GW-281	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-802	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-776	T	11	10	1.7E-03	1.5E-03	No	S	PD	N/A	N/A
	GW-658	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-775	T	11	11	3.4E-03	2.5E-03	No	NT	NT	N/A	N/A
	GW-659	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-762	T	12	12	1.3E-01	1.4E-01	No	NT	NT	N/A	N/A
	GW-766	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-751	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-763	T	20	13	5.1E-03	2.7E-03	No	NT	NT	N/A	N/A
	NHPCEMSP	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-752	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-756	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-753	T	5	1	2.2E-01	5.0E-04	No	NT	NT	N/A	N/A
	GW-754	T	5	1	1.2E+00	5.0E-04	No	NT	NT	N/A	N/A
	GW-767	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 National Security Complex

Location: Fuel Station

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (Kg)	1st Moment (Center of Mass): Xc (ft)	1st Moment (Center of Mass): Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	2nd Moment (Spread): Sigma YY (sq ft)	Number of Wells
BENZENE							
1/1/1996	6.9E-02	62,558	29,496	624	105,764	26,911	8
4/1/1996	4.4E-02	62,368	29,374	502	64,581	726	7
7/1/1996	0.0E+00						2
10/1/1996	4.4E-02	62,368	29,374	502	64,581	726	7
4/1/1997	7.4E-02	62,595	29,528	653	19,853	31,727	6
7/1/1997	0.0E+00						3
10/1/1997	0.0E+00						5
1/1/1998	0.0E+00						3
4/1/1998	3.2E-02	62,234	29,350	415	16,089	1,910	6
7/1/1998	4.5E-02	62,695	29,819	758	38,503	2,135	6
10/1/1998	0.0E+00						3
1/1/1999	0.0E+00						1
4/1/1999	0.0E+00						3
7/1/1999	0.0E+00						1
10/1/1999	0.0E+00						3
4/1/2000	0.0E+00						2
7/1/2000	0.0E+00						1
10/1/2000	0.0E+00						1
1/1/2001	0.0E+00						1
4/1/2001	0.0E+00						1
7/1/2001	0.0E+00						1
10/1/2001	0.0E+00						1
1/1/2002	0.0E+00						1
4/1/2002	0.0E+00						4
7/1/2002	0.0E+00						1
10/1/2002	0.0E+00						4
1/1/2003	0.0E+00						1
4/1/2003	0.0E+00						4
7/1/2003	0.0E+00						1
10/1/2003	0.0E+00						1
1/1/2004	0.0E+00						1
4/1/2004	0.0E+00						4
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						1
CHROMIUM III							
1/1/1996	1.6E-01	62,304	29,389	441	30,614	5,968	8
4/1/1996	1.4E-01	62,299	29,373	447	28,934	728	7
7/1/1996	0.0E+00						2

Project: Y-12 National Security Complex **User Name:** MV

Location: Fuel Station **State:** Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
CHROMIUM III							
10/1/1996	1.3E-01	62,277	29,372	431	16,025	752	7
4/1/1997	0.0E+00						3
10/1/1997	0.0E+00						3
4/1/1998	0.0E+00						3
10/1/1998	0.0E+00						3
1/1/1999	0.0E+00						1
4/1/1999	0.0E+00						3
7/1/1999	0.0E+00						1
10/1/1999	0.0E+00						3
4/1/2000	0.0E+00						2
7/1/2000	0.0E+00						1
10/1/2000	0.0E+00						1
1/1/2001	0.0E+00						1
4/1/2001	0.0E+00						1
7/1/2001	0.0E+00						1
10/1/2001	0.0E+00						1
1/1/2002	0.0E+00						1
4/1/2002	0.0E+00						4
7/1/2002	0.0E+00						1
10/1/2002	0.0E+00						4
1/1/2003	0.0E+00						1
4/1/2003	0.0E+00						1
7/1/2003	0.0E+00						1
10/1/2003	0.0E+00						1
1/1/2004	0.0E+00						1
4/1/2004	0.0E+00						2
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						1
LEAD							
1/1/1996	6.2E-02	62,558	29,496	624	105,764	26,911	8
4/1/1996	3.9E-02	62,368	29,374	502	64,581	726	7
7/1/1996	0.0E+00						2
10/1/1996	5.3E-02	62,346	29,374	484	55,592	763	7
4/1/1997	0.0E+00						3
10/1/1997	0.0E+00						3
4/1/1998	0.0E+00						3
10/1/1998	0.0E+00						3
1/1/1999	0.0E+00						1
4/1/1999	0.0E+00						3
7/1/1999	0.0E+00						1
10/1/1999	0.0E+00						3
4/1/2000	0.0E+00						2

Project: Y-12 National Security Complex

Location: Fuel Station

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	1st Moment (Center of Mass): Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	2nd Moment (Spread): Sigma YY (sq ft)	Number of Wells
LEAD							
7/1/2000	0.0E+00						1
10/1/2000	0.0E+00						1
1/1/2001	0.0E+00						1
4/1/2001	0.0E+00						1
7/1/2001	0.0E+00						1
10/1/2001	0.0E+00						1
1/1/2002	0.0E+00						1
4/1/2002	0.0E+00						4
7/1/2002	0.0E+00						1
10/1/2002	0.0E+00						4
1/1/2003	0.0E+00						1
4/1/2003	0.0E+00						1
7/1/2003	0.0E+00						1
10/1/2003	0.0E+00						1
1/1/2004	0.0E+00						1
4/1/2004	0.0E+00						2
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						1
TETRACHLOROETHYLENE(PCE)							
1/1/1996	2.0E-01	62,425	29,414	530	75,471	13,116	8
4/1/1996	1.8E-01	62,358	29,371	495	49,795	303	7
7/1/1996	0.0E+00						2
10/1/1996	4.4E-02	62,368	29,374	502	64,581	726	7
4/1/1997	2.4E-01	62,596	29,423	683	18,476	21,442	6
7/1/1997	0.0E+00						3
10/1/1997	0.0E+00						5
1/1/1998	0.0E+00						3
4/1/1998	3.2E-02	62,234	29,350	415	16,089	1,910	6
7/1/1998	2.2E-02	62,865	29,816	923	15,885	2,745	6
10/1/1998	0.0E+00						3
1/1/1999	0.0E+00						1
4/1/1999	0.0E+00						3
7/1/1999	0.0E+00						1
10/1/1999	0.0E+00						3
4/1/2000	0.0E+00						2
7/1/2000	0.0E+00						1
10/1/2000	0.0E+00						1
1/1/2001	0.0E+00						1
4/1/2001	0.0E+00						1
7/1/2001	0.0E+00						1
10/1/2001	0.0E+00						1
1/1/2002	0.0E+00						1

Project: Y-12 National Security Complex

Location: Fuel Station

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TETRACHLOROETHYLENE(PCE)							
4/1/2002	0.0E+00						4
7/1/2002	0.0E+00						1
10/1/2002	0.0E+00						4
1/1/2003	0.0E+00						1
4/1/2003	0.0E+00						4
7/1/2003	0.0E+00						1
10/1/2003	0.0E+00						1
1/1/2004	0.0E+00						1
4/1/2004	0.0E+00						4
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						1
TRICHLOROETHYLENE (TCE)							
1/1/1996	1.3E-01	62,449	29,439	541	88,632	18,685	8
4/1/1996	1.1E-01	62,341	29,372	481	50,059	512	7
7/1/1996	0.0E+00						2
10/1/1996	1.9E-01	62,339	29,371	480	44,627	389	7
4/1/1997	1.9E-01	62,585	29,453	662	21,063	26,619	6
7/1/1997	0.0E+00						3
10/1/1997	0.0E+00						5
1/1/1998	0.0E+00						3
4/1/1998	4.0E-02	62,213	29,348	404	22,180	1,773	6
7/1/1998	2.2E-02	62,865	29,816	923	15,885	2,745	6
10/1/1998	0.0E+00						3
1/1/1999	0.0E+00						1
4/1/1999	0.0E+00						3
7/1/1999	0.0E+00						1
10/1/1999	0.0E+00						3
4/1/2000	0.0E+00						2
7/1/2000	0.0E+00						1
10/1/2000	0.0E+00						1
1/1/2001	0.0E+00						1
4/1/2001	0.0E+00						1
7/1/2001	0.0E+00						1
10/1/2001	0.0E+00						1
1/1/2002	0.0E+00						1
4/1/2002	0.0E+00						4
7/1/2002	0.0E+00						1
10/1/2002	0.0E+00						4
1/1/2003	0.0E+00						1
4/1/2003	0.0E+00						4
7/1/2003	0.0E+00						1
10/1/2003	0.0E+00						1

Project: Y-12 National Security Complex

Location: Fuel Station

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TRICHLOROETHYLENE (TCE)							
1/1/2004	0.0E+00						1
4/1/2004	0.0E+00						4
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						1

Project: Y-12 National Security Complex

Location: Fuel Station

User Name: MV

State: Tennessee

Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	BENZENE	2.31	-149	98.6%	D
	CHROMIUM III	3.12	-85	92.3%	PD
	LEAD	3.16	-83	91.8%	PD
	TETRACHLOROETHYLENE(PCE)	2.84	-157	99.0%	D
	TRICHLOROETHYLENE (TCE)	2.60	-153	98.8%	D
1st Moment: Distance to Source					
	BENZENE	0.22	3	64.0%	NT
	CHROMIUM III	0.00	0	0.0%	N/A
	LEAD	0.00	0	0.0%	N/A
	TETRACHLOROETHYLENE(PCE)	0.31	3	64.0%	NT
	TRICHLOROETHYLENE (TCE)	0.32	1	50.0%	NT
2nd Moment: Sigma XX					
	BENZENE	0.66	-11	97.2%	D
	CHROMIUM III	0.00	0	0.0%	N/A
	LEAD	0.00	0	0.0%	N/A
	TETRACHLOROETHYLENE(PCE)	0.67	-13	99.2%	D
	TRICHLOROETHYLENE (TCE)	0.68	-13	99.2%	D
2nd Moment: Sigma YY					
	BENZENE	1.36	3	64.0%	NT
	CHROMIUM III	0.00	0	0.0%	N/A
	LEAD	0.00	0	0.0%	N/A
	TETRACHLOROETHYLENE(PCE)	1.29	3	64.0%	NT
	TRICHLOROETHYLENE (TCE)	1.34	1	50.0%	NT

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.

**ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE**

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.7	**East Fork Regime East Y-12 Area**

GROUNDWATER SERVICES, INC.

TABLE D.7.1
QUALITATIVE ANALYSIS EAST FORK POPLAR CREEK EAST Y-12 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Off-Site	Monitors Background Water Quality	Early Detection	Monitor Source
GW-148	WL		Aquifer								X		
GW-149	WL		Aquifer						X				
GW-150	WL	X	Aquifer						X				
GW-151	WL	X	Aquifer	X	X			X				X	
GW-152	WL	X	Aquifer	X									
GW-153	WL	X	Aquifer	X				X					
GW-154	WL	X	Aquifer					X					
GW-167	WL	X	Aquifer	X								X	
GW-169	WL	X	Aquifer			X		X		X			
GW-170	WL	X	Aquifer	X		X		X		X			
GW-171	WL		Aquifer			X		X					
GW-172	WL		Aquifer			X		X					
GW-207	WL		Aquitard			X							
GW-208	WL		Aquitard			X							
GW-220	WL	X	Aquifer	X				X				X	
GW-222	WL	X	Aquifer										
GW-223	WL	X	Aquifer	X				X					
GW-230	WL	X	Aquifer			X		X					
GW-232	WL		Aquifer			X		X		X			
GW-239	WL		Aquifer						X		X		
GW-240	WL	X	Aquifer										
GW-380	WL	X	Aquifer					X					X
GW-381	WL	X	Aquifer					X					X
GW-382	WL	X	Aquifer	X				X					X
GW-383	WL	X	Aquitard					X					
GW-384	WL		Aquitard						X				
GW-385	WL		Aquitard						X				
GW-603	WL		Aquifer										
GW-733	WL	X	Aquifer	X		X	X						
GW-735	WL		Aquifer	X		X							

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.3.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report* , (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.7.1
QUALITATIVE ANALYSIS EAST FORK POPLAR CREEK EAST Y-12 AREA

East Fork Poplar Creek Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Off-Site	Monitors Background Water Quality	Early Detection	Monitor Source
GW-744	WL		Aquitard	X				X					
GW-745	WL		Aquitard	X					X				
GW-746	WL		Aquitard	X									
GW-747	WL		Aquitard	X	X			X			X		
GW-748	WL		Aquitard	X	X				X				
GW-749	WL		Aquitard	X	X						X		
GW-750	WL		Aquifer	X		X					X	X	
GW-816	WL		Aquitard			X		X					
GW-817	WL		Aquitard	X									
GW-832	WL	X	Aquifer	X				X					
GW-845	WL	X	Extraction										
LRSPW	SP	X	Not Used			X							
RGQWWSP	SP		Spring	X		X					X		
SCR7.10SP	SP		Spring	X		X					X		
SCR7.14SP	SP		Spring	X		X							
SCR7.16SP	SP		Spring	X		X							
SCR7.18SP	SP		Spring	X		X							
SCR7.1SP	SP		Spring	X		X							
SCR7.4SP	SP		Spring	X		X					X		
SCR7.6SP	SP		Spring	X		X					X		
SCR7.7SP	SP		Spring	X		X					X		
SCR7.8SP	SP		Spring	X		X							
SCR7.8SSP	SP		Spring	X		X							
UV8.5SP	SP		Spring	X		X					X		
UV8.6SP	SP		Spring	X		X					X		

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.3.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
   CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.7.2
AQUIFER INPUT PARAMETERS

East Y-12
East Fork Poplar Creek Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	8500	ft
Maximum Plume Length	8500	ft
PlumeWidth	1500	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	5000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	Chlorinated Solvent	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow direction	E	0
Effective Porosity	0.1	--
Source Location near Well	GW-381	--
Source X-Coordinate	62947.7	ft*
Source Y-Coordinate	28715.04	ft*
Saturated Thickness	50	ft
Source Wells		
GW-381,GW-382, GW 151, GW-223, GW-383, GW-154		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS Plume Analysis Summary

Project: Y-12 National Security Complex

User Name: MV

Location: East Y-12

State: Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
CARBON TETRACHLORIDE											
	GW-151	S	19	18	1.1E+00	1.1E+00	No	I	I	N/A	N/A
	GW-381	S	10	10	2.9E-01	2.1E-01	No	NT	NT	N/A	N/A
	GW-382	S	11	11	9.3E-01	9.3E-01	No	D	PD	N/A	N/A
	GW-383	S	21	2	1.4E-04	5.0E-05	No	NT	D	N/A	N/A
	GW-154	S	20	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-223	S	15	5	4.6E-03	5.0E-05	No	D	D	N/A	N/A
	GW-222	T	8	5	5.8E-03	1.0E-03	No	NT	D	N/A	N/A
	GW-832	T	17	17	1.8E-02	1.7E-02	No	D	D	N/A	N/A
	GW-148	T	10	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-845	T	1	1	1.6E+00	1.6E+00	No	N/A	N/A	N/A	N/A
	GW-750	T	20	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-733	T	21	21	1.5E-02	1.0E-02	No	D	D	N/A	N/A
	GW-817	T	6	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	LRSPW	T	14	11	1.4E-02	1.2E-02	No	NT	NT	N/A	N/A
	GW-230	T	17	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-816	T	20	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-232	T	26	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-240	T	8	8	6.7E-03	5.5E-03	No	NT	S	N/A	N/A
	GW-208	T	20	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-380	T	16	1	1.4E-04	5.0E-05	No	NT	NT	N/A	N/A
	GW-220	T	22	22	7.4E-01	6.6E-01	No	I	I	N/A	N/A
	GW-748	T	6	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: East Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
CARBON TETRACHLORIDE											
	GW-747	T	20	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-746	T	6	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-745	T	6	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-384	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-744	T	20	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	GW-385	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-735	T	21	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-603	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-749	T	6	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SCR7_16SP	T	1	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-153	T	20	19	1.6E-01	1.4E-01	No	PD	NT	N/A	N/A
	RGQWWSP	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	SCR7_1SP	T	19	9	7.1E-04	5.0E-05	No	D	D	N/A	N/A
	GW-169	T	22	0	5.0E-05	5.0E-05	Yes	S	I	N/A	N/A
	SCR7_7SP	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SCR7_18SP	T	10	1	2.5E-04	5.0E-05	No	NT	PD	N/A	N/A
	GW-170	T	27	27	1.7E-02	2.0E-03	No	D	D	N/A	N/A
	SCR7_6SP	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SCR7_8SP	T	17	0	5.0E-05	5.0E-05	Yes	S	I	N/A	N/A
	SCR7_4SP	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SCR7_8SSP	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-171	T	18	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	SCR7_14SP	T	1	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-172	T	17	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	SCR7_10SP	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	GW-149	T	4	0	5.0E-05	5.0E-05	Yes	S	S	N/A	N/A
	UV8_5SP	T	2	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-207	T	20	0	5.0E-05	5.0E-05	Yes	S	D	N/A	N/A
	UV8_6SP	T	1	0	5.0E-05	5.0E-05	Yes	N/A	N/A	N/A	N/A
LEAD											
	GW-383	S	21	4	8.0E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-151	S	18	1	5.9E-05	5.2E-05	No	S	S	N/A	N/A
	GW-381	S	10	3	6.0E-04	5.2E-05	No	NT	NT	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: East Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
LEAD											
	GW-382	S	11	0	5.2E-05	5.2E-05	Yes	S	S	N/A	N/A
	GW-154	S	17	6	1.4E-03	5.2E-05	No	NT	NT	N/A	N/A
	GW-223	S	15	0	5.2E-05	5.2E-05	Yes	S	S	N/A	N/A
	GW-222	T	8	1	6.8E-05	5.2E-05	No	S	S	N/A	N/A
	GW-603	T	4	2	1.7E-04	1.3E-04	No	NT	NT	N/A	N/A
	GW-207	T	20	11	1.2E-03	4.9E-04	No	NT	NT	N/A	N/A
	GW-385	T	4	2	3.6E-04	2.5E-04	No	NT	PI	N/A	N/A
	GW-148	T	10	2	1.6E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-172	T	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-384	T	4	2	2.3E-04	1.3E-04	No	NT	NT	N/A	N/A
	GW-208	T	20	16	2.2E-03	1.1E-03	No	NT	NT	N/A	N/A
	GW-240	T	8	3	2.8E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-171	T	1	1	1.4E-03	1.4E-03	No	N/A	N/A	N/A	N/A
	GW-153	T	20	10	4.0E-04	1.9E-04	No	NT	NT	N/A	N/A
	GW-170	T	15	4	2.4E-03	5.2E-05	No	NT	NT	N/A	N/A
	GW-230	T	2	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-169	T	13	1	4.4E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-232	T	14	1	2.8E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-220	T	22	6	2.3E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-380	T	17	3	1.4E-04	5.2E-05	No	NT	D	N/A	N/A
	GW-149	T	4	1	2.1E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-749	T	6	1	1.0E-04	5.2E-05	No	NT	NT	N/A	N/A
	LRSPW	T	14	6	7.0E-04	5.2E-05	No	PI	PI	N/A	N/A
	SCR7_14SP	T	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-845	T	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-733	T	20	4	5.2E-04	5.2E-05	No	PD	D	N/A	N/A
	SCR7_16SP	T	1	1	2.5E-03	2.5E-03	No	N/A	N/A	N/A	N/A
	GW-817	T	6	4	2.5E-04	2.2E-04	No	I	I	N/A	N/A
	GW-816	T	20	5	6.7E-04	5.2E-05	No	NT	NT	N/A	N/A
	SCR7_18SP	T	2	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-750	T	20	4	1.5E-04	5.2E-05	No	NT	PD	N/A	N/A
	RGQWWSP	T	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	SCR7_1SP	T	2	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-832	T	13	0	5.2E-05	5.2E-05	Yes	S	S	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: East Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
LEAD											
	GW-748	T	6	2	2.0E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-747	T	20	3	1.2E-04	5.2E-05	No	NT	PD	N/A	N/A
	GW-744	T	20	5	5.9E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-735	T	21	5	3.0E-04	5.2E-05	No	NT	PD	N/A	N/A
	SCR7_8SSP	T	2	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-746	T	6	2	1.9E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-745	T	6	2	2.3E-04	5.2E-05	No	NT	NT	N/A	N/A
TETRACHLOROETHYLENE(PCE)											
	GW-223	S	15	15	1.1E-01	4.5E-02	No	D	D	N/A	N/A
	GW-151	S	19	19	2.4E-01	1.2E-01	No	I	I	N/A	N/A
	GW-383	S	21	21	4.4E-01	4.4E-01	No	NT	NT	N/A	N/A
	GW-154	S	20	1	5.3E-04	5.0E-04	No	S	PD	N/A	N/A
	GW-381	S	10	9	3.3E-03	2.3E-03	No	S	NT	N/A	N/A
	GW-382	S	11	11	2.4E-02	1.2E-02	No	NT	NT	N/A	N/A
	RGQWWSP	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	SCR7_10SP	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	UV8_5SP	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-171	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-148	T	10	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	SCR7_8SSP	T	2	1	7.5E-04	7.5E-04	No	N/A	N/A	N/A	N/A
	SCR7_14SP	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-169	T	22	20	8.0E-04	1.0E-03	No	NT	NT	N/A	N/A
	SCR7_6SP	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR7_16SP	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-149	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR7_1SP	T	19	2	5.0E-04	5.0E-04	No	S	S	N/A	N/A
	SCR7_4SP	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-153	T	20	19	3.2E-03	2.3E-03	No	D	PD	N/A	N/A
	SCR7_7SP	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR7_18SP	T	10	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR7_8SP	T	17	4	5.9E-04	5.0E-04	No	PD	D	N/A	N/A
	GW-170	T	27	26	1.5E-03	1.0E-03	No	D	D	N/A	N/A
	GW-749	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: East Y-12 **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TETRACHLOROETHYLENE(PCE)											
	UV8_6SP	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-385	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-733	T	21	5	5.2E-04	5.0E-04	No	S	PD	N/A	N/A
	GW-384	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-735	T	21	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-744	T	20	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-745	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-746	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-380	T	16	1	5.0E-04	5.0E-04	No	S	S	N/A	N/A
	GW-747	T	20	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-240	T	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-832	T	17	17	4.1E-03	5.0E-03	No	S	S	N/A	N/A
	GW-232	T	26	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-172	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-230	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-750	T	20	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-816	T	20	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-222	T	8	8	3.6E-02	1.1E-02	No	NT	PD	N/A	N/A
	GW-817	T	6	1	1.4E-03	5.0E-04	No	NT	I	N/A	N/A
	GW-220	T	22	22	1.5E-01	7.0E-02	No	I	I	N/A	N/A
	GW-603	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-208	T	20	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-845	T	1	1	8.5E-02	8.5E-02	No	N/A	N/A	N/A	N/A
	GW-207	T	20	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	LRSPW	T	14	12	2.3E-03	1.8E-03	No	NT	NT	N/A	N/A
	GW-748	T	6	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 National Security Complex

Location: East Y-12

User Name: MV

State: Tennessee

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	**Estimated Mass (Kg)**	**Xc (ft)**	**Yc (ft)**	**Source Distance (ft)**	**Sigma XX (sq ft)**	**Sigma YY (sq ft)**	**Number of Wells**
CARBON TETRACHLORIDE							
1/1/1996	1.8E+00	65,010	28,843	2,066	1,394,861	188,908	39
4/1/1996	2.2E+00	65,962	28,977	3,025	2,943,728	285,725	36
7/1/1996	1.2E+00	65,830	29,053	2,902	8,551,303	192,789	30
10/1/1996	8.0E-01	64,000	28,863	1,062	99,894	52,374	27
1/1/1997	0.0E+00						2
4/1/1997	1.4E+00	65,299	28,547	2,357	4,461,565	489,833	32
7/1/1997	4.5E+00	65,754	28,442	2,819	560,201	204,560	14
10/1/1997	1.3E-01	64,175	29,182	1,313	74,321	131,957	18
1/1/1998	1.2E+00	65,162	28,554	2,220	1,279,377	306,647	16
4/1/1998	8.1E+00	64,192	28,785	1,246	62,800	60,173	16
7/1/1998	3.8E+00	65,612	28,492	2,673	761,754	197,217	16
10/1/1998	8.9E-01	64,094	28,933	1,167	56,540	43,818	13
1/1/1999	2.3E+00	65,317	28,721	2,369	644,397	20,021	13
4/1/1999	1.5E+00	64,115	29,148	1,245	42,523	131,060	13
7/1/1999	1.6E+01	64,314	28,710	1,366	363,886	6,025	16
10/1/1999	1.3E+00	64,112	29,132	1,236	44,828	130,670	13
1/1/2000	4.9E-02	66,915	28,301	3,989	268,031	716	10
4/1/2000	2.9E+00	64,160	28,997	1,244	456,962	112,080	28
7/1/2000	1.6E+01	64,109	28,711	1,161	125,311	5,018	16
10/1/2000	1.5E+00	64,025	29,131	1,154	157,622	122,906	17
1/1/2001	2.0E+01	64,158	28,711	1,210	152,290	3,968	13
4/1/2001	1.9E+00	63,872	29,083	995	181,869	115,116	16
7/1/2001	1.5E+01	64,154	28,715	1,206	146,163	4,290	14
10/1/2001	1.4E+00	63,982	29,044	1,085	174,617	96,295	15
1/1/2002	1.2E+01	64,151	28,716	1,203	150,707	3,425	15
4/1/2002	1.9E+00	63,980	29,047	1,084	230,309	114,442	15
7/1/2002	8.3E+00	64,144	28,719	1,196	157,818	4,057	15
10/1/2002	2.2E+00	64,074	29,060	1,178	250,454	116,137	15
1/1/2003	1.6E+01	64,071	28,730	1,124	126,249	4,751	12
4/1/2003	1.4E+00	63,932	28,964	1,015	283,953	92,077	14
7/1/2003	1.4E+01	64,114	28,718	1,166	108,685	3,073	15
10/1/2003	1.1E+00	64,074	28,958	1,152	250,589	76,881	14
1/1/2004	1.6E+01	64,134	28,716	1,186	127,815	3,115	15
4/1/2004	1.2E+00	64,074	28,956	1,151	306,954	97,107	15
7/1/2004	1.2E+01	64,139	28,716	1,191	141,238	3,393	15
10/1/2004	1.0E+00	64,150	28,961	1,227	291,673	90,121	15
LEAD							
1/1/1996	2.2E-01	66,204	29,322	3,312	1,252,059	343,419	39

Project: Y-12 National Security Complex

Location: East Y-12

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
LEAD							
4/1/1996	1.8E-01	68,088	29,391	5,184	6,020,503	227,962	34
7/1/1996	2.1E-01	63,807	29,679	1,291	160,514	289,965	28
10/1/1996	1.1E-01	64,038	29,341	1,257	195,355	357,257	27
1/1/1997	0.0E+00						2
4/1/1997	3.2E-01	63,898	29,606	1,302	109,580	331,746	18
7/1/1997	0.0E+00						1
10/1/1997	3.8E-02	64,109	29,772	1,570	117,243	283,616	18
1/1/1998	0.0E+00						2
4/1/1998	7.2E-02	63,909	29,713	1,386	141,560	236,284	14
7/1/1998	0.0E+00						2
10/1/1998	3.7E-02	63,822	29,709	1,324	118,231	294,710	13
1/1/1999	0.0E+00						4
4/1/1999	5.1E-02	63,897	29,844	1,475	100,109	265,475	13
7/1/1999	5.0E-03	63,988	28,788	1,043	70,276	13,452	7
10/1/1999	3.3E-02	63,831	29,795	1,395	118,294	246,399	13
1/1/2000	0.0E+00						1
4/1/2000	2.5E-01	63,623	29,834	1,307	51,719	127,548	19
7/1/2000	1.4E-02	63,789	28,894	860	129,927	16,881	8
10/1/2000	6.8E-02	63,890	29,851	1,475	100,938	249,604	15
1/1/2001	5.0E-03	63,988	28,788	1,043	67,683	13,184	6
4/1/2001	1.9E-01	64,009	30,197	1,822	58,465	244,847	13
7/1/2001	5.0E-03	63,988	28,788	1,043	67,683	13,184	6
10/1/2001	1.8E-01	63,875	29,628	1,301	339,688	243,683	15
1/1/2002	1.0E-02	64,659	28,750	1,711	508,266	8,175	10
4/1/2002	1.1E-01	64,144	29,875	1,667	365,763	246,665	15
7/1/2002	1.3E-02	64,474	28,807	1,529	526,298	18,079	10
10/1/2002	6.7E-01	64,533	30,190	2,165	299,447	136,862	15
1/1/2003	1.0E-02	64,659	28,750	1,711	508,266	8,175	10
4/1/2003	6.4E-02	64,376	29,535	1,646	572,821	337,417	14
7/1/2003	4.1E-02	65,186	28,721	2,238	215,903	2,291	10
10/1/2003	5.6E-02	64,472	29,548	1,737	471,136	298,348	14
1/1/2004	1.0E-02	64,679	28,750	1,732	525,855	8,048	10
4/1/2004	1.0E-01	64,862	29,341	2,014	502,822	275,863	16
7/1/2004	2.8E-02	64,921	28,761	1,973	458,427	11,747	10
10/1/2004	5.2E-02	64,572	29,462	1,787	493,136	364,659	15
TETRACHLOROETHYLENE(PCE)							
1/1/1996	1.5E+00	65,088	29,267	2,210	2,119,129	338,311	39
4/1/1996	2.8E+00	67,937	29,281	5,021	10,733,516	258,498	36
7/1/1996	2.3E+00	67,711	29,419	4,815	10,063,449	297,733	30
10/1/1996	8.2E-01	63,885	29,090	1,010	172,162	216,474	27
1/1/1997	0.0E+00						2
4/1/1997	4.5E+00	66,909	28,762	3,962	8,959,309	970,931	32

Project: Y-12 National Security Complex

Location: East Y-12

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TETRACHLOROETHYLENE(PCE)							
7/1/1997	8.9E-01	66,817	27,938	3,946	1,686,917	426,160	14
10/1/1997	1.2E+00	63,815	29,577	1,223	131,534	251,109	18
1/1/1998	9.7E-01	66,615	28,019	3,733	2,040,731	461,891	16
4/1/1998	2.3E+00	64,098	29,429	1,354	370,614	346,411	16
7/1/1998	1.2E+00	66,602	27,973	3,729	1,778,636	393,303	16
10/1/1998	1.7E+00	63,748	29,424	1,069	116,512	287,734	13
1/1/1999	6.1E-01	65,693	28,677	2,745	1,886,604	49,651	13
4/1/1999	2.3E+00	63,808	29,559	1,205	100,523	298,421	13
7/1/1999	3.0E+00	64,108	28,777	1,162	1,061,893	20,436	16
10/1/1999	2.0E+00	63,790	29,575	1,204	105,059	282,117	13
1/1/2000	1.1E-01	67,508	28,295	4,579	702,353	3,051	10
4/1/2000	4.0E+00	64,232	29,442	1,476	1,147,100	285,165	28
7/1/2000	1.9E+00	64,310	28,862	1,370	1,193,398	52,007	16
10/1/2000	5.9E+00	63,850	29,332	1,093	134,657	199,565	17
1/1/2001	1.7E+00	64,263	28,759	1,316	1,328,929	26,200	13
4/1/2001	4.5E+00	63,893	29,325	1,124	163,169	197,298	16
7/1/2001	1.8E+00	64,349	28,764	1,402	1,471,563	26,254	14
10/1/2001	5.6E+00	63,897	29,271	1,100	131,686	171,155	15
1/1/2002	1.7E+00	64,291	28,763	1,344	1,394,879	25,914	15
4/1/2002	5.1E+00	63,913	29,322	1,140	159,202	179,029	15
7/1/2002	1.8E+00	64,276	28,767	1,329	1,335,946	25,873	15
10/1/2002	5.5E+00	63,957	29,274	1,153	157,580	166,752	15
1/1/2003	3.3E+00	63,949	28,787	1,004	429,495	14,657	12
4/1/2003	6.3E+00	63,936	29,341	1,170	151,662	216,111	14
7/1/2003	2.6E+00	64,228	28,763	1,281	1,031,938	19,874	15
10/1/2003	6.2E+00	63,985	29,332	1,207	133,075	202,715	14
1/1/2004	2.8E+00	64,210	28,766	1,263	1,002,690	19,359	15
4/1/2004	5.5E+00	63,975	29,372	1,219	148,020	214,172	15
7/1/2004	2.3E+00	64,221	28,765	1,274	1,104,198	21,911	15
10/1/2004	5.8E+00	63,996	29,342	1,221	134,243	201,889	15

Project: Y-12 National Security Complex

Location: East Y-12

User Name: MV

State: Tennessee

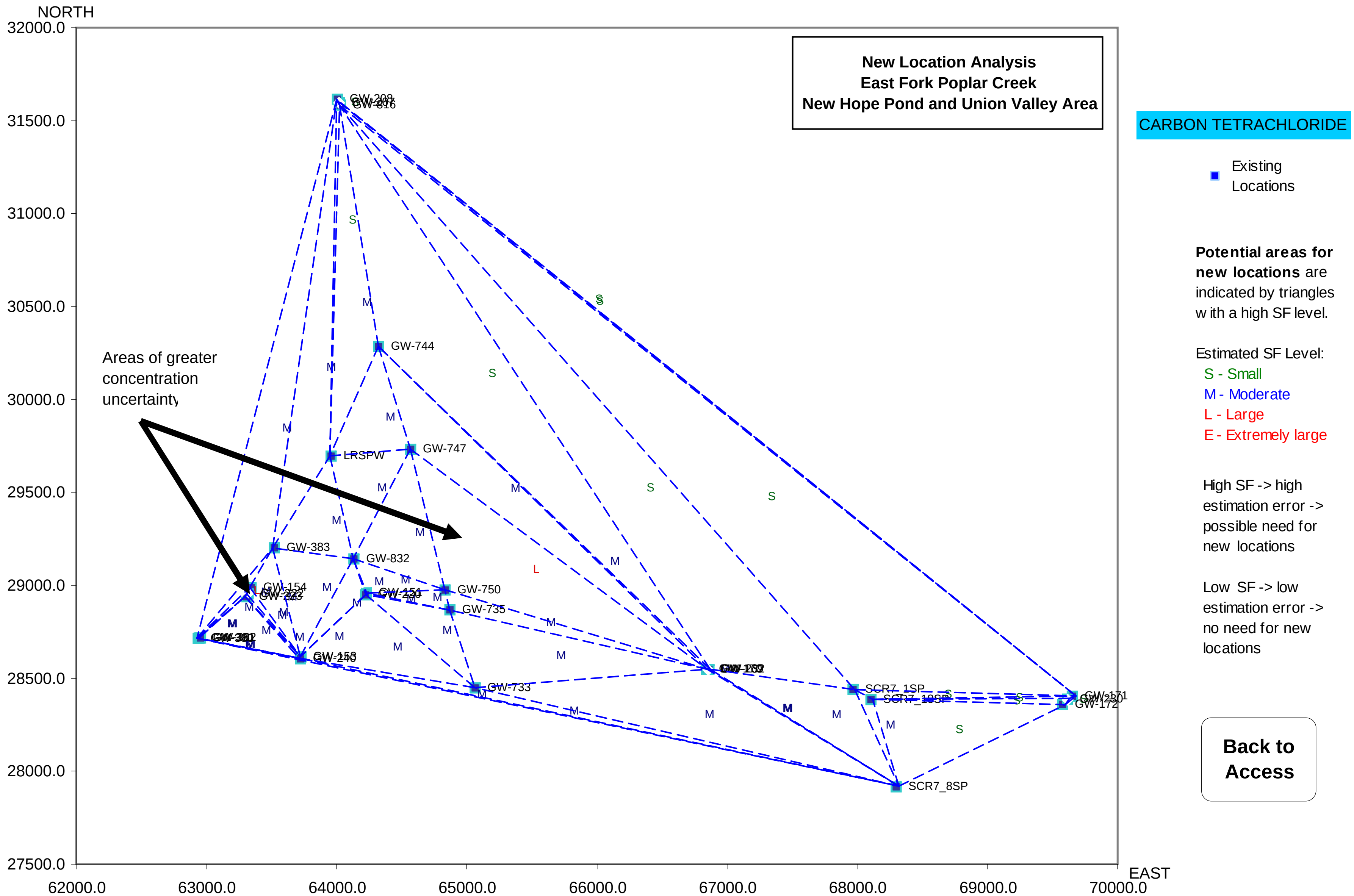
Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	CARBON TETRACHLORIDE	1.14	120	94.7%	PI
	LEAD	1.49	1	50.0%	NT
	TETRACHLOROETHYLENE(PCE)	0.66	242	100.0%	I
1st Moment: Distance to Source					
	CARBON TETRACHLORIDE	0.47	-279	100.0%	D
	LEAD	0.47	137	99.3%	I
	TETRACHLOROETHYLENE(PCE)	0.66	-185	99.6%	D
2nd Moment: Sigma XX					
	CARBON TETRACHLORIDE	2.23	-105	93.0%	PD
	LEAD	2.20	89	94.1%	PI
	TETRACHLOROETHYLENE(PCE)	1.72	-175	99.4%	D
2nd Moment: Sigma YY					
	CARBON TETRACHLORIDE	1.06	-261	100.0%	D
	LEAD	0.73	-121	98.4%	D
	TETRACHLOROETHYLENE(PCE)	0.92	-267	100.0%	D

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.



New Location Analysis
East Fork Poplar Creek
New Hope Pond and Union Valley Area
CARBON TETRACHLORIDE
Existing Locations
Potential areas for new locations are indicated by triangles with a high SF level.
Estimated SF Level:
S - Small
M - Moderate
L - Large
E - Extremely large
High SF -> high estimation error -> possible need for new locations
Low SF -> low estimation error -> no need for new locations
Back to Access
Areas of greater concentration uncertainty
NORTH
EAST
32000.0
31500.0
31000.0
30500.0
30000.0
29500.0
29000.0
28500.0
28000.0
27500.0
62000.0
63000.0
64000.0
65000.0
66000.0
67000.0
68000.0
69000.0
70000.0
GW-208
GW-816
GW-744
GW-747
LRSPW
GW-383
GW-832
GW-154
GW-222
GW-750
GW-735
GW-733
SCR7_1SP
SCR7_10SP
SCR7_8SP
GW-171
GW-172

ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.8 Chestnut Ridge Regime West Chestnut Ridge

Table D.8.1	Qualitative Analysis West Chestnut Ridge Area
Table D.8.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary

(No Well Sufficiency areas of interest identified)

GROUNDWATER SERVICES, INC.

TABLE D.8.1
QUALITATIVE ANALYSIS CHESTNUT RIDGE REGIME WEST CHESTNUT RIDGE

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source	SCORE
1090	WL		Aquifer					X					
GW-141	WL		Aquifer		X								
GW-203	WL		Aquifer		X			X					
GW-205	WL		Aquifer		X			X					
GW-217	WL		Aquifer		X								
GW-221	WL		Aquifer		X			X					
GW-302	WL	X	Aquifer		X			X					
GW-305	WL		Aquifer		X			X					
GW-339	WL		Aquifer		X			X					
GW-521	WL		Aquifer		X		X						
GW-522	WL		Aquifer		X								
GW-539	WL	X	Aquifer		X								
GW-540	WL		Aquifer		X								
GW-541	WL		Aquifer		X								
GW-542	WL		Aquifer										
GW-543	WL		Aquifer										
GW-544	WL		Aquifer		X								
GW-546	WL		Aquifer										
GW-709	WL		Aquifer										
GW-757	WL		Aquifer		X								
GW-827	WL		Aquifer		X								
SCR1.25SP	SP		Spring			X							
SCR2.1SP	SP		Spring			X							
SCR2.2SP	SP		Spring			X							

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.4.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location; CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report* , (12/01/2003).

GROUNDWATER SERVICES, INC.

TABLE D.8.2
AQUIFER INPUT PARAMETERS

West Chestnut Ridge
Chestnut Ridge Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	5500	ft
Maximum Plume Length	5500	ft
PlumeWidth	2000	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	6000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	VOC/Metals	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow direction	S	270
Effective Porosity	0.1	--
Source Location near Well	GW-205	--
Source X-Coordinate	54008.3	ft*
Source Y-Coordinate	28362.98	ft*
Saturated Thickness	50	ft
Source Wells		
GW-217, GW-205, GW-203,1090, GW-217, GW-141		

Notes:

1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS Plume Analysis Summary

Project: Y-12 National Security Complex

User Name: MV

Location: West Chestnut Ridge

State: Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
1,1,1-TRICHLOROETHANE											
	GW-205	S	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	1090	S	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-203	S	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-141	S	18	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-217	S	18	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-543	T	18	1	6.1E-05	6.0E-06	No	NT	NT	N/A	N/A
	GW-541	T	1	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-544	T	18	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-540	T	16	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-305	T	27	27	1.7E-02	1.8E-02	No	I	I	N/A	N/A
	GW-542	T	17	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-539	T	10	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-546	T	1	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-522	T	18	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-709	T	18	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-521	T	20	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-339	T	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	GW-757	T	18	1	2.3E-04	6.0E-06	No	NT	NT	N/A	N/A
	GW-827	T	18	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-302	T	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A
	SCR2_2SP	T	14	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	GW-221	T	3	0	6.0E-06	6.0E-06	Yes	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: West Chestnut Ridge **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
1,1,1-TRICHLOROETHANE											
	SCR1_25SP	T	16	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
	SCR2_1SP	T	14	0	6.0E-06	6.0E-06	Yes	S	S	N/A	N/A
GROSS ALPHA ACTIVITY											
	GW-217	S	15	5	4.0E-01	1.0E-02	No	D	D	N/A	N/A
	1090	S	16	11	9.3E-01	7.0E-01	No	NT	NT	N/A	N/A
	GW-141	S	17	7	1.8E+00	1.0E-02	No	D	D	N/A	N/A
	GW-203	S	15	11	2.2E+00	5.4E-01	No	I	NT	N/A	N/A
	GW-205	S	17	12	1.3E+00	6.1E-01	No	NT	NT	N/A	N/A
	GW-305	T	26	8	7.1E-01	1.0E-02	No	D	D	N/A	N/A
	GW-539	T	9	4	1.6E+00	1.0E-02	No	D	D	N/A	N/A
	GW-302	T	15	11	1.9E+00	8.4E-01	No	NT	NT	N/A	N/A
	GW-521	T	15	5	3.7E-01	1.0E-02	No	D	D	N/A	N/A
	GW-540	T	15	5	6.7E-01	1.0E-02	No	D	D	N/A	N/A
	GW-221	T	16	7	1.2E+00	1.0E-02	No	NT	NT	N/A	N/A
	GW-541	T	1	1	2.6E+00	2.6E+00	No	N/A	N/A	N/A	N/A
	GW-339	T	15	8	9.0E-01	4.2E-01	No	NT	NT	N/A	N/A
	GW-542	T	15	5	9.5E-01	1.0E-02	No	D	D	N/A	N/A
	GW-522	T	15	5	8.7E-01	1.0E-02	No	D	D	N/A	N/A
	GW-757	T	18	15	2.4E+00	2.0E+00	No	D	D	N/A	N/A
	GW-546	T	1	1	3.3E+00	3.3E+00	No	N/A	N/A	N/A	N/A
	GW-543	T	16	6	3.3E-01	1.0E-02	No	D	D	N/A	N/A
	GW-827	T	15	6	3.2E-01	1.0E-02	No	D	D	N/A	N/A
	SCR2_1SP	T	14	14	3.3E+00	2.8E+00	No	S	S	N/A	N/A
	SCR1_25SP	T	12	11	3.6E+00	2.1E+00	No	NT	NT	N/A	N/A
	SCR2_2SP	T	11	11	1.6E+00	1.2E+00	No	S	NT	N/A	N/A
	GW-544	T	18	11	1.5E+00	1.0E+00	No	D	D	N/A	N/A
	GW-709	T	15	7	1.1E+00	1.0E-02	No	D	D	N/A	N/A
GROSS BETA ACTIVITY											
	GW-205	S	16	15	5.0E+01	6.2E+01	No	I	PI	N/A	N/A
	GW-141	S	16	9	2.4E+00	1.0E+00	No	D	D	N/A	N/A
	GW-203	S	14	12	6.4E+00	3.0E+00	No	NT	NT	N/A	N/A
	GW-217	S	17	11	1.2E+00	9.0E-01	No	D	D	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: West Chestnut Ridge **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS BETA ACTIVITY											
	1090	S	16	11	2.7E+00	1.3E+00	No	NT	NT	N/A	N/A
	GW-305	T	24	6	9.8E-01	1.0E-03	No	D	D	N/A	N/A
	SCR1_25SP	T	12	10	1.3E+00	1.2E+00	No	I	I	N/A	N/A
	GW-302	T	14	8	2.2E+00	1.2E+00	No	NT	NT	N/A	N/A
	GW-709	T	14	9	2.0E+00	1.0E+00	No	NT	NT	N/A	N/A
	GW-339	T	13	10	5.8E+00	1.5E+00	No	NT	NT	N/A	N/A
	GW-827	T	16	9	1.8E+00	1.0E+00	No	D	D	N/A	N/A
	GW-542	T	16	13	1.9E+00	1.3E+00	No	D	PD	N/A	N/A
	GW-544	T	16	12	2.8E+00	2.2E+00	No	PD	S	N/A	N/A
	SCR2_2SP	T	9	9	2.9E+00	2.5E+00	No	NT	S	N/A	N/A
	GW-543	T	17	10	1.3E+00	1.0E+00	No	D	D	N/A	N/A
	GW-540	T	14	8	1.4E+00	1.5E+00	No	PD	PD	N/A	N/A
	GW-539	T	9	3	7.7E-01	1.0E-03	No	PD	D	N/A	N/A
	GW-221	T	16	9	1.9E+00	3.9E-01	No	NT	NT	N/A	N/A
	SCR2_1SP	T	11	10	2.0E+00	1.6E+00	No	PI	NT	N/A	N/A
	GW-522	T	14	5	8.7E-01	1.0E-03	No	D	D	N/A	N/A
	GW-546	T	1	1	5.2E-01	5.2E-01	No	N/A	N/A	N/A	N/A
	GW-757	T	18	18	1.3E+01	1.5E+01	No	I	I	N/A	N/A
	GW-521	T	15	5	1.0E+00	1.0E-03	No	D	D	N/A	N/A
LEAD											
	GW-205	S	17	2	2.4E-04	5.2E-05	No	NT	D	N/A	N/A
	GW-203	S	16	2	1.3E-04	5.2E-05	No	NT	D	N/A	N/A
	GW-217	S	18	5	1.6E-04	5.2E-05	No	D	D	N/A	N/A
	1090	S	17	2	1.2E-04	5.2E-05	No	NT	D	N/A	N/A
	GW-141	S	18	4	1.6E-03	5.2E-05	No	D	D	N/A	N/A
	SCR2_1SP	T	14	4	2.0E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-827	T	18	0	5.2E-05	5.2E-05	Yes	S	S	N/A	N/A
	SCR1_25SP	T	12	0	5.2E-05	5.2E-05	Yes	S	S	N/A	N/A
	GW-546	T	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-542	T	17	6	2.4E-04	5.2E-05	No	D	D	N/A	N/A
	GW-541	T	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-540	T	16	2	1.8E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-543	T	18	0	5.2E-05	5.2E-05	Yes	S	S	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: West Chestnut Ridge **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
LEAD											
	GW-539	T	10	3	2.1E-03	5.2E-05	No	PD	D	N/A	N/A
	SCR2_2SP	T	14	2	4.7E-03	5.2E-05	No	NT	D	N/A	N/A
	GW-544	T	18	1	6.5E-05	5.2E-05	No	S	S	N/A	N/A
	GW-521	T	20	4	2.1E-04	5.2E-05	No	PD	D	N/A	N/A
	GW-221	T	17	1	1.2E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-305	T	28	1	9.7E-05	5.2E-05	No	NT	PD	N/A	N/A
	GW-339	T	15	1	9.7E-05	5.2E-05	No	NT	NT	N/A	N/A
	GW-709	T	18	1	9.4E-05	5.2E-05	No	NT	PD	N/A	N/A
	GW-757	T	18	1	9.2E-05	5.2E-05	No	NT	PD	N/A	N/A
	GW-522	T	18	5	4.8E-04	5.2E-05	No	D	D	N/A	N/A
	GW-302	T	15	2	1.8E-04	5.2E-05	No	NT	D	N/A	N/A
NICKEL											
	GW-205	S	1	0	1.0E-04	1.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-141	S	3	3	1.1E-01	5.3E-02	No	N/A	N/A	N/A	N/A
	1090	S	1	0	1.0E-04	1.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-221	T	1	0	1.0E-04	1.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-522	T	1	1	1.2E-02	1.2E-02	No	N/A	N/A	N/A	N/A
	GW-305	T	26	26	2.8E-01	2.3E-01	No	I	I	N/A	N/A
	GW-339	T	15	15	2.3E-01	2.2E-01	No	S	PI	N/A	N/A
	GW-302	T	14	14	2.0E-01	2.0E-01	No	D	D	N/A	N/A
	SCR1_25SP	T	1	0	1.0E-04	1.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-539	T	10	10	1.6E-01	5.0E-02	No	D	D	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 National Security Complex
Location: West Chestnut Ridge
User Name: MV
State: Tennessee

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	**Estimated Mass (Kg)**	**Xc (ft)**	**Yc (ft)**	**Source Distance (ft)**	**Sigma XX (sq ft)**	**Sigma YY (sq ft)**	**Number of Wells**
1,1,1-TRICHLOROETHANE							
1/1/1996	0.0E+00						5
4/1/1996	5.7E-03	52,889	27,208	1,608	348,635	549,281	17
7/1/1996	0.0E+00						5
10/1/1996	5.7E-03	52,889	27,208	1,608	336,296	546,956	14
1/1/1997	1.6E-02	53,106	27,000	1,634	27,495	288,984	6
4/1/1997	6.1E-03	53,075	26,897	1,738	393,420	520,085	15
7/1/1997	1.5E-02	53,098	27,243	1,443	54,148	723,946	8
10/1/1997	1.6E-03	52,296	26,384	2,617	122,010	210,178	6
1/1/1998	2.6E-02	53,040	27,150	1,552	37,063	499,099	9
4/1/1998	1.9E-03	52,324	26,468	2,535	79,961	244,970	7
7/1/1998	1.0E-02	53,087	27,095	1,568	66,904	916,671	8
10/1/1998	3.2E-03	52,119	26,534	2,630	111,622	187,398	7
1/1/1999	1.6E-02	53,099	27,257	1,431	52,894	702,864	8
4/1/1999	1.2E-02	52,471	26,303	2,570	16,070	150,437	7
7/1/1999	1.6E-02	53,099	27,261	1,428	52,530	696,675	8
10/1/1999	1.9E-03	52,324	26,468	2,535	79,961	244,970	7
1/1/2000	3.3E-02	53,022	26,940	1,731	117,334	581,551	16
7/1/2000	3.7E-02	53,027	26,950	1,720	112,733	562,251	16
10/1/2000	0.0E+00						1
1/1/2001	3.5E-02	53,024	26,943	1,728	115,975	575,849	16
4/1/2001	0.0E+00						1
7/1/2001	3.4E-02	53,023	26,941	1,730	116,632	578,608	16
10/1/2001	0.0E+00						1
1/1/2002	2.2E-02	52,800	27,338	1,584	52,225	324,522	14
4/1/2002	0.0E+00						1
7/1/2002	2.1E-02	52,796	27,333	1,590	54,494	329,839	14
10/1/2002	0.0E+00						1
1/1/2003	3.5E-02	53,024	26,943	1,728	113,889	576,206	15
4/1/2003	0.0E+00						1
7/1/2003	3.5E-02	53,024	26,943	1,728	113,889	576,206	15
10/1/2003	0.0E+00						1
1/1/2004	3.2E-02	53,020	26,936	1,735	116,665	588,473	15
4/1/2004	0.0E+00						1
7/1/2004	3.2E-02	53,020	26,934	1,737	117,495	592,139	15
10/1/2004	0.0E+00						1
GROSS ALPHA ACTIVITY							
1/1/1996	0.0E+00						4
4/1/1996	2.1E+03	52,746	26,782	2,023	262,900	383,831	13

Project: Y-12 National Security Complex

Location: West Chestnut Ridge

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
GROSS ALPHA ACTIVITY							
10/1/1996	3.1E+03	52,914	27,062	1,700	199,783	473,412	13
1/1/1997	0.0E+00						4
4/1/1997	1.1E+03	52,907	26,657	2,030	275,104	588,312	11
7/1/1997	7.6E+02	53,130	26,634	1,939	39,803	841,888	7
10/1/1997	1.2E+03	52,795	26,793	1,985	286,249	353,513	12
1/1/1998	7.8E+02	53,082	26,718	1,888	87,030	1,006,974	7
4/1/1998	0.0E+00						5
7/1/1998	1.1E+03	53,528	26,883	1,556	48,143	785,185	12
10/1/1998	0.0E+00						4
1/1/1999	1.3E+03	53,165	26,779	1,795	151,515	1,254,414	14
4/1/1999	0.0E+00						5
7/1/1999	3.6E+02	53,244	26,943	1,613	128,777	419,895	11
10/1/1999	0.0E+00						5
1/1/2000	3.1E+02	53,733	26,298	2,083	148,154	582,776	22
7/1/2000	5.0E+02	53,142	25,468	3,021	395,168	1,027,840	22
10/1/2000	0.0E+00						1
1/1/2001	4.4E+02	53,650	26,863	1,542	160,130	837,462	21
4/1/2001	0.0E+00						1
7/1/2001	2.7E+02	53,508	24,871	3,527	63,037	462,299	22
10/1/2001	0.0E+00						1
1/1/2002	2.6E+02	53,666	27,352	1,067	191,840	277,866	20
4/1/2002	0.0E+00						1
7/1/2002	4.2E+02	53,580	27,263	1,180	171,107	246,993	20
10/1/2002	0.0E+00						1
1/1/2003	1.8E+03	53,646	26,225	2,168	79,277	1,219,495	21
4/1/2003	0.0E+00						1
7/1/2003	5.3E+02	53,493	25,026	3,377	71,305	592,234	21
10/1/2003	0.0E+00						1
1/1/2004	8.1E+02	53,641	26,183	2,210	85,318	973,294	19
4/1/2004	0.0E+00						1
7/1/2004	2.9E+02	53,597	26,935	1,485	536,079	633,939	18
10/1/2004	0.0E+00						1
GROSS BETA ACTIVITY							
1/1/1996	0.0E+00						3
4/1/1996	1.0E+03	53,049	27,269	1,454	271,678	511,865	9
7/1/1996	0.0E+00						2
10/1/1996	2.4E+03	52,938	27,078	1,672	223,999	189,183	9
1/1/1997	0.0E+00						4
4/1/1997	3.8E+03	52,897	26,947	1,800	135,014	358,195	8
7/1/1997	0.0E+00						4
10/1/1997	4.9E+03	52,982	27,079	1,643	244,873	382,858	12
1/1/1998	0.0E+00						5

Project: Y-12 National Security Complex

Location: West Chestnut Ridge

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
GROSS BETA ACTIVITY							
4/1/1998	0.0E+00						4
7/1/1998	4.6E+03	53,395	27,063	1,437	104,294	574,170	13
10/1/1998	8.0E+02	52,362	26,677	2,356	50,778	60,475	6
1/1/1999	1.1E+02	53,011	28,235	1,005	128,584	722,619	12
4/1/1999	9.0E+02	52,328	26,722	2,348	64,308	84,715	6
7/1/1999	4.9E+03	53,299	26,977	1,557	120,493	716,776	13
10/1/1999	1.9E+03	52,397	26,373	2,560	53,075	220,139	7
1/1/2000	4.6E+02	53,310	26,777	1,733	65,993	425,128	21
7/1/2000	4.7E+02	53,362	27,277	1,263	103,626	388,248	20
10/1/2000	0.0E+00						1
1/1/2001	2.2E+03	53,723	27,084	1,310	131,824	522,816	21
4/1/2001	0.0E+00						1
7/1/2001	1.2E+03	53,495	26,513	1,920	99,897	1,309,001	21
10/1/2001	0.0E+00						1
1/1/2002	1.5E+03	53,510	27,362	1,119	373,526	340,271	20
4/1/2002	0.0E+00						1
7/1/2002	1.7E+03	53,730	27,389	1,013	106,354	160,483	20
10/1/2002	0.0E+00						1
1/1/2003	2.6E+03	53,646	26,578	1,821	120,440	1,010,469	21
4/1/2003	0.0E+00						1
7/1/2003	2.1E+03	53,380	26,529	1,938	314,091	789,566	21
10/1/2003	0.0E+00						1
1/1/2004	6.9E+03	53,361	27,042	1,471	88,515	252,314	18
4/1/2004	0.0E+00						1
7/1/2004	2.7E+03	53,378	26,154	2,297	339,335	935,191	19
10/1/2004	0.0E+00						1
LEAD							
1/1/1996	0.0E+00						5
4/1/1996	4.9E-02	52,889	27,208	1,608	348,635	549,281	17
7/1/1996	0.0E+00						5
10/1/1996	1.5E+00	52,872	27,139	1,670	147,730	565,884	14
1/1/1997	4.5E-01	52,934	27,210	1,576	59,586	554,428	6
4/1/1997	3.5E-01	53,255	27,321	1,286	323,369	456,289	14
7/1/1997	1.6E-01	53,190	26,107	2,399	33,592	639,990	7
10/1/1997	6.9E-02	52,923	27,042	1,710	276,021	437,941	12
1/1/1998	1.4E-01	53,043	26,765	1,867	130,923	1,182,476	8
4/1/1998	2.0E-02	52,247	26,619	2,479	97,728	314,435	7
7/1/1998	4.8E-02	53,417	27,007	1,479	160,442	904,206	13
10/1/1998	1.9E-02	52,265	26,582	2,491	94,549	301,850	7
1/1/1999	1.4E-01	53,204	26,914	1,657	217,072	951,448	14
4/1/1999	4.1E-02	52,282	26,757	2,357	81,383	241,202	7
7/1/1999	5.7E-02	53,330	26,749	1,751	221,809	1,184,371	14

Project: Y-12 National Security Complex

Location: West Chestnut Ridge

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
LEAD							
10/1/1999	2.9E-02	52,453	26,851	2,168	129,804	364,966	8
1/1/2000	8.8E-02	53,226	26,515	2,007	401,198	1,355,159	22
7/1/2000	9.1E-02	53,235	26,449	2,064	388,759	1,380,651	21
10/1/2000	0.0E+00						1
1/1/2001	7.1E-02	53,104	26,714	1,881	403,426	1,270,495	22
4/1/2001	0.0E+00						1
7/1/2001	7.1E-02	53,104	26,714	1,881	403,426	1,270,495	22
10/1/2001	0.0E+00						1
1/1/2002	5.1E-02	52,886	27,219	1,602	354,277	635,920	20
4/1/2002	0.0E+00						1
7/1/2002	5.1E-02	52,886	27,219	1,602	354,277	635,920	20
10/1/2002	0.0E+00						1
1/1/2003	7.1E-02	53,104	26,714	1,881	400,075	1,266,147	21
4/1/2003	0.0E+00						1
7/1/2003	7.1E-02	53,104	26,714	1,881	400,075	1,266,147	21
10/1/2003	0.0E+00						1
1/1/2004	7.1E-02	53,095	26,697	1,900	392,921	1,246,287	19
4/1/2004	0.0E+00						1
7/1/2004	7.1E-02	53,095	26,697	1,900	392,921	1,246,287	19
10/1/2004	0.0E+00						1
NICKEL							
1/1/1996	0.0E+00						2
4/1/1996	0.0E+00						3
7/1/1996	0.0E+00						1
10/1/1996	0.0E+00						3
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						3
7/1/1997	0.0E+00						1
10/1/1997	0.0E+00						3
1/1/1998	0.0E+00						1
7/1/1998	0.0E+00						3
1/1/1999	0.0E+00						3
7/1/1999	0.0E+00						3
10/1/1999	0.0E+00						1
1/1/2000	0.0E+00						3
7/1/2000	1.3E+00	53,190	27,900	940	119,940	233,991	8
10/1/2000	0.0E+00						1
1/1/2001	0.0E+00						4
4/1/2001	0.0E+00						1
7/1/2001	0.0E+00						4
10/1/2001	0.0E+00						1
1/1/2002	0.0E+00						4

Project: Y-12 National Security Complex

Location: West Chestnut Ridge

User Name: MV

State: Tennessee

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	Estimated Mass (kg)	Xc (ft)	Yc (ft)	Source Distance (ft)	Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
NICKEL							
4/1/2002	0.0E+00						1
7/1/2002	0.0E+00						4
10/1/2002	0.0E+00						1
1/1/2003	0.0E+00						3
4/1/2003	0.0E+00						1
7/1/2003	0.0E+00						3
10/1/2003	0.0E+00						1
1/1/2004	0.0E+00						1
4/1/2004	0.0E+00						1
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						1

Project: Y-12 National Security Complex

Location: West Chestnut Ridge

User Name: MV

State: Tennessee

Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	1,1,1-TRICHLOROETHANE	1.06	34	67.9%	NT
	GROSS ALPHA ACTIVITY	1.41	-116	95.6%	D
	GROSS BETA ACTIVITY	1.33	10	55.1%	NT
	LEAD	2.38	-154	98.6%	D
	NICKEL	5.66	-3	51.3%	NT
1st Moment: Distance to Source					
	1,1,1-TRICHLOROETHANE	0.22	22	69.7%	NT
	GROSS ALPHA ACTIVITY	0.33	-1	50.0%	S
	GROSS BETA ACTIVITY	0.27	4	53.8%	NT
	LEAD	0.17	42	84.4%	NT
	NICKEL	0.00	0	0.0%	N/A
2nd Moment: Sigma XX					
	1,1,1-TRICHLOROETHANE	0.85	18	66.2%	NT
	GROSS ALPHA ACTIVITY	0.72	-9	60.9%	S
	GROSS BETA ACTIVITY	0.64	0	48.7%	S
	LEAD	0.52	118	99.9%	I
	NICKEL	0.00	0	0.0%	N/A
2nd Moment: Sigma YY					
	1,1,1-TRICHLOROETHANE	0.40	42	84.4%	NT
	GROSS ALPHA ACTIVITY	0.45	15	68.6%	NT
	GROSS BETA ACTIVITY	0.67	42	90.7%	PI
	LEAD	0.48	90	98.7%	I
	NICKEL	0.00	0	0.0%	N/A

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.

**ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE**

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.9	**Chestnut Ridge Regime Security Pits**
Table D.9.1	Qualitative Analysis Chestnut Ridge Security Pits
Table D.9.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary
MAROS Chart	New Location Analysis 11DCE Chestnut Ridge Security Pits

(No Well Sufficiency areas of interest identified)

GROUNDWATER SERVICES, INC.

TABLE D.9.1
QUALITATIVE ANALYSIS CHESTNUT RIDGE REGIME SECURITY PITS

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor Source
GW-173	WL	X	Aquifer		X							
GW-174	WL	X	Aquifer		X							
GW-175	WL	X	Aquifer	X	X		X					
GW-176	WL		Aquifer	X	X							
GW-177	WL		Aquifer	X			X					
GW-178	WL		Aquifer									
GW-179	WL		Aquifer	X								
GW-180	WL	X	Aquifer	X								
GW-181	WL		Aquifer						X			
GW-184	WL		Aquitard									
GW-186	WL		Aquitard									
GW-188	WL		Aquitard									
GW-322	WL	X	Aquifer									X
GW-511	WL		Aquifer									
GW-512	WL		Aquifer									
GW-513	WL		Aquifer						X			
GW-514	WL		Aquifer				X					
GW-608	WL		Aquifer	X			X					
GW-609	WL	X	Aquifer	X	X		X					
GW-610	WL		Aquifer	X	X							
GW-611	WL		Aquifer									
GW-612	WL		Aquifer		X							
GW-679	WL		Aquifer									
GW-680	WL		Aquifer									
GW-742	WL		Aquifer		X				X			
GW-743	WL		Aquifer		X							
GW-831	WL		Aquifer				X					
SCR3.4SP	SP		Spring			X						
SCR3.5SP	SP		Spring			X						

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.4.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.9.2
AQUIFER INPUT PARAMETERS

Security Pits
Chestnut Ridge Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	5500	ft
Maximum Plume Length	5500	ft
PlumeWidth	2000	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	6000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	VOC/Metals	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow directio	S	270
Effective Porosity	0.1	--
Source Location near We	GW-322	--
Source X-Coordinate	58912.05	ft*
Source Y-Coordinate	28240.69	ft*
Saturated Thickness	50	ft
Source Wells		
GW-322, GW-174, GW-173, GW-609, GW-180		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS COC Assessment

Project: Y-12 National Security Complex **User Name:** MV

Location: CRSP **State:** Tennessee

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
TETRACHLOROETHYLENE(PCE)	8.9E-03	5.0E-03	78.6%
1,1-DICHLOROETHENE	9.7E-03	7.0E-03	38.2%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage excedence from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Excedences	Percent Excedences	Total detects
TETRACHLOROETHYLENE(PCE)	ORG	29	9	31.0%	13
1,1-DICHLOROETHENE	ORG	29	4	13.8%	12

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total excedences (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
1,1-DICHLOROETHENE	0.13
TETRACHLOROETHYLENE(PCE)	0.923

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Contaminants of Concern (COC's)

LEAD

TETRACHLOROETHYLENE(PCE)

1,1-DICHLOROETHENE

GROSS ALPHA ACTIVITY

TRICHLOROETHYLENE (TCE)

MAROS Plume Analysis Summary

Project: Y-12 National Security Complex

User Name: MV

Location: CRSP

State: Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
1,1-DICHLOROETHENE											
	GW-173	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-322	S	3	3	1.1E-01	9.3E-02	No	N/A	N/A	N/A	N/A
	GW-174	S	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-180	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-609	S	14	1	5.4E-04	5.0E-04	No	S	S	N/A	N/A
	GW-188	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-743	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-612	T	5	5	3.5E-02	3.4E-02	No	S	S	N/A	N/A
	GW-610	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-742	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-178	T	2	2	1.3E-03	1.3E-03	No	N/A	N/A	N/A	N/A
	GW-679	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-179	T	2	2	1.8E-02	1.8E-02	No	N/A	N/A	N/A	N/A
	GW-611	T	3	1	5.0E-04	5.0E-04	No	N/A	N/A	N/A	N/A
	GW-184	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-186	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-680	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-514	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-513	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-177	T	9	9	3.6E-03	2.5E-03	No	S	NT	N/A	N/A
	SCR3_5SP	T	16	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-175	T	5	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: CRSP **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
1,1-DICHLOROETHENE											
	SCR3_4SP	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-608	T	7	1	6.4E-04	5.0E-04	No	S	PD	N/A	N/A
	GW-831	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-176	T	2	2	2.1E-02	2.1E-02	No	N/A	N/A	N/A	N/A
	GW-512	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
GROSS ALPHA ACTIVITY											
	GW-173	S	1	1	3.7E+00	3.7E+00	No	N/A	N/A	N/A	N/A
	GW-609	S	11	7	1.1E+00	8.2E-01	No	D	D	N/A	N/A
	GW-174	S	3	3	8.5E-01	6.3E-01	No	N/A	N/A	N/A	N/A
	GW-322	S	2	2	2.7E+00	2.7E+00	No	N/A	N/A	N/A	N/A
	GW-186	T	1	1	2.4E+00	2.4E+00	No	N/A	N/A	N/A	N/A
	GW-611	T	1	1	2.1E+00	2.1E+00	No	N/A	N/A	N/A	N/A
	GW-514	T	2	2	6.4E-01	6.4E-01	No	N/A	N/A	N/A	N/A
	GW-610	T	1	1	1.4E+00	1.4E+00	No	N/A	N/A	N/A	N/A
	GW-512	T	1	1	1.6E+00	1.6E+00	No	N/A	N/A	N/A	N/A
	GW-608	T	4	4	2.6E+00	2.6E+00	No	S	S	N/A	N/A
	GW-188	T	1	1	1.7E+00	1.7E+00	No	N/A	N/A	N/A	N/A
	GW-177	T	9	8	2.7E+00	3.0E+00	No	NT	NT	N/A	N/A
	SCR3_5SP	T	16	8	1.2E+00	2.9E-01	No	NT	NT	N/A	N/A
	SCR3_4SP	T	6	5	5.9E-01	6.2E-01	No	PI	PI	N/A	N/A
	GW-175	T	1	1	3.2E-01	3.2E-01	No	N/A	N/A	N/A	N/A
	GW-831	T	17	13	1.1E+00	8.3E-01	No	NT	NT	N/A	N/A
	GW-176	T	1	1	1.2E+00	1.2E+00	No	N/A	N/A	N/A	N/A
	GW-743	T	2	2	2.2E+00	2.2E+00	No	N/A	N/A	N/A	N/A
	GW-612	T	4	4	2.3E+00	1.5E+00	No	NT	PI	N/A	N/A
	GW-742	T	3	3	3.4E+00	1.6E+00	No	N/A	N/A	N/A	N/A
	GW-513	T	2	2	2.8E+00	2.8E+00	No	N/A	N/A	N/A	N/A
	GW-184	T	1	1	1.4E+00	1.4E+00	No	N/A	N/A	N/A	N/A
	GW-679	T	2	2	6.7E-01	6.7E-01	No	N/A	N/A	N/A	N/A
	GW-178	T	1	1	1.6E+00	1.6E+00	No	N/A	N/A	N/A	N/A
LEAD											
	GW-180	S	2	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: CRSP **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
LEAD											
	GW-609	S	12	4	5.8E-04	4.5E-04	No	S	S	N/A	N/A
	GW-174	S	3	2	1.8E-03	1.9E-03	No	N/A	N/A	N/A	N/A
	GW-173	S	2	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-322	S	3	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-179	T	2	1	6.0E-04	6.0E-04	No	N/A	N/A	N/A	N/A
	GW-186	T	1	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-176	T	2	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-177	T	9	0	4.5E-04	4.5E-04	Yes	S	D	N/A	N/A
	GW-188	T	1	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-175	T	5	1	4.8E-04	4.5E-04	No	NT	NT	N/A	N/A
	GW-513	T	3	1	6.3E-04	4.5E-04	No	N/A	N/A	N/A	N/A
	GW-512	T	1	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-178	T	2	1	5.0E-04	5.0E-04	No	N/A	N/A	N/A	N/A
	GW-184	T	1	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-743	T	3	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-679	T	2	2	5.8E-04	5.8E-04	No	N/A	N/A	N/A	N/A
	GW-612	T	5	5	5.4E-03	9.7E-04	No	NT	NT	N/A	N/A
	GW-680	T	2	2	6.3E-04	6.3E-04	No	N/A	N/A	N/A	N/A
	GW-611	T	3	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-742	T	3	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-610	T	3	0	4.5E-04	4.5E-04	Yes	N/A	N/A	N/A	N/A
	GW-831	T	18	6	2.3E-03	4.5E-04	No	D	PD	N/A	N/A
	GW-608	T	5	0	4.5E-04	4.5E-04	Yes	S	S	N/A	N/A
	GW-514	T	3	1	5.0E-04	4.5E-04	No	N/A	N/A	N/A	N/A
	SCR3_4SP	T	9	3	6.6E-04	4.5E-04	No	NT	S	N/A	N/A
	SCR3_5SP	T	16	0	4.5E-04	4.5E-04	Yes	NT	S	N/A	N/A
TETRACHLOROETHYLENE(PCE)											
	GW-322	S	3	3	7.3E-03	6.0E-03	No	N/A	N/A	N/A	N/A
	GW-609	S	14	13	5.1E-03	3.2E-03	No	D	D	N/A	N/A
	GW-180	S	2	2	2.0E-02	2.0E-02	No	N/A	N/A	N/A	N/A
	GW-174	S	3	3	8.0E-03	6.0E-03	No	N/A	N/A	N/A	N/A
	GW-173	S	2	2	8.5E-03	8.5E-03	No	N/A	N/A	N/A	N/A
	GW-742	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: CRSP **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TETRACHLOROETHYLENE(PCE)											
	SCR3_5SP	T	16	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-679	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-513	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-178	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-680	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-743	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	SCR3_4SP	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-176	T	2	2	1.0E-03	1.0E-03	No	N/A	N/A	N/A	N/A
	GW-179	T	2	1	5.0E-04	5.0E-04	No	N/A	N/A	N/A	N/A
	GW-175	T	5	5	1.0E-02	1.0E-02	No	S	NT	N/A	N/A
	GW-831	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-177	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-610	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-512	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-514	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-608	T	7	1	6.4E-04	5.0E-04	No	S	PD	N/A	N/A
	GW-188	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-186	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-611	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-612	T	5	3	2.4E-03	1.8E-03	No	NT	NT	N/A	N/A
	GW-184	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
TRICHLOROETHYLENE (TCE)											
	GW-180	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-173	S	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-322	S	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-174	S	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-609	S	14	4	1.3E-02	5.0E-04	No	NT	NT	N/A	N/A
	GW-743	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-513	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-512	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	SCR3_4SP	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR3_5SP	T	16	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-514	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A

Project: Y-12 National Security Complex **User Name:** MV

Location: CRSP **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
TRICHLOROETHYLENE (TCE)											
	GW-831	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-608	T	7	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-175	T	5	0	5.0E-04	5.0E-04	Yes	S	I	N/A	N/A
	GW-179	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-611	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-612	T	5	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-176	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-742	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-186	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-679	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-610	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-177	T	9	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-680	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-178	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-184	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-188	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 National Security Complex

Location: CRSP

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (Kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
1,1-DICHLOROETHENE							
1/1/1996	1.1E-01	58,851	28,357	131	340,757	24,259	8
4/1/1996	5.5E-01	57,829	25,979	2,507	387,913	670,167	7
7/1/1996	0.0E+00						3
10/1/1996	0.0E+00						2
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						4
7/1/1997	0.0E+00						5
10/1/1997	0.0E+00						1
1/1/1998	8.6E-01	58,273	27,240	1,187	312,901	455,781	6
7/1/1998	0.0E+00						5
1/1/1999	0.0E+00						4
7/1/1999	0.0E+00						4
1/1/2000	0.0E+00						4
7/1/2000	0.0E+00						4
1/1/2001	8.2E-01	57,975	27,495	1,198	307,145	774,310	11
7/1/2001	8.8E-01	57,922	27,565	1,199	186,271	721,598	9
1/1/2002	0.0E+00						3
7/1/2002	0.0E+00						3
1/1/2003	0.0E+00						3
7/1/2003	0.0E+00						3
1/1/2004	0.0E+00						3
4/1/2004	9.4E-01	58,426	28,217	487	195,385	87,130	14
7/1/2004	0.0E+00						3
10/1/2004	1.1E+00	58,439	28,240	473	183,460	80,668	14
GROSS ALPHA ACTIVITY							
1/1/1996	0.0E+00						3
4/1/1996	1.8E+03	57,842	25,993	2,489	383,906	667,855	6
7/1/1996	0.0E+00						3
10/1/1996	0.0E+00						1
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						2
7/1/1997	0.0E+00						4
1/1/1998	0.0E+00						4
7/1/1998	0.0E+00						5
1/1/1999	0.0E+00						4
7/1/1999	0.0E+00						3
1/1/2000	0.0E+00						3
7/1/2000	0.0E+00						4

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	**Estimated Mass (kg)**	**Xc (ft)**	**Yc (ft)**	**Source Distance (ft)**	**Sigma XX (sq ft)**	**Sigma YY (sq ft)**	**Number of Wells**
GROSS ALPHA ACTIVITY							
1/1/2001	6.7E+02	57,594	27,142	1,716	345,756	678,540	9
7/1/2001	4.2E+02	58,040	27,523	1,130	197,701	581,902	7
1/1/2002	0.0E+00						3
7/1/2002	0.0E+00						3
1/1/2003	0.0E+00						3
7/1/2003	0.0E+00						3
1/1/2004	0.0E+00						3
4/1/2004	3.6E+02	58,161	28,116	761	189,345	66,416	9
7/1/2004	0.0E+00						3
10/1/2004	1.1E+02	58,388	27,979	586	185,221	41,374	6
LEAD							
1/1/1996	7.8E-02	58,818	28,375	164	313,641	23,227	8
4/1/1996	4.9E-01	57,829	25,979	2,507	387,913	670,167	7
7/1/1996	0.0E+00						3
10/1/1996	0.0E+00						2
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						2
7/1/1997	0.0E+00						4
1/1/1998	5.4E-01	57,783	26,564	2,022	243,747	402,897	6
7/1/1998	0.0E+00						5
1/1/1999	0.0E+00						4
7/1/1999	0.0E+00						4
1/1/2000	0.0E+00						4
7/1/2000	0.0E+00						4
1/1/2001	7.9E-01	58,075	27,489	1,125	347,944	726,122	11
7/1/2001	4.8E-01	57,886	27,163	1,488	204,103	744,043	9
1/1/2002	0.0E+00						3
7/1/2002	0.0E+00						3
1/1/2003	0.0E+00						3
7/1/2003	0.0E+00						3
1/1/2004	0.0E+00						3
4/1/2004	1.6E-01	58,145	28,014	800	309,772	140,619	14
7/1/2004	0.0E+00						3
10/1/2004	1.9E-01	58,097	27,975	857	303,965	138,038	14
TETRACHLOROETHYLENE(PCE)							
1/1/1996	1.6E-01	58,912	28,389	148	254,511	23,487	8
4/1/1996	1.4E+00	58,102	26,318	2,086	205,430	352,982	7
7/1/1996	0.0E+00						3
10/1/1996	0.0E+00						2
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						4

Project: Y-12 National Security Complex

Location: CRSP

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TETRACHLOROETHYLENE(PCE)							
7/1/1997	0.0E+00						5
10/1/1997	0.0E+00						1
1/1/1998	5.4E-01	58,179	27,001	1,440	444,525	578,852	6
7/1/1998	0.0E+00						5
1/1/1999	0.0E+00						4
7/1/1999	0.0E+00						4
1/1/2000	0.0E+00						4
7/1/2000	0.0E+00						4
1/1/2001	7.6E-01	58,264	27,458	1,016	548,833	825,130	11
7/1/2001	6.7E-01	58,136	27,384	1,155	371,120	804,652	9
1/1/2002	0.0E+00						3
7/1/2002	0.0E+00						3
1/1/2003	0.0E+00						3
7/1/2003	0.0E+00						3
1/1/2004	0.0E+00						3
4/1/2004	3.9E-01	58,553	28,197	362	321,832	116,390	14
7/1/2004	0.0E+00						3
10/1/2004	3.2E-01	58,466	28,182	450	330,131	128,156	14
TRICHLOROETHYLENE (TCE)							
1/1/1996	8.6E-02	58,818	28,375	164	313,641	23,227	8
4/1/1996	6.4E-01	57,895	26,061	2,405	357,610	614,646	7
7/1/1996	0.0E+00						3
10/1/1996	0.0E+00						2
1/1/1997	0.0E+00						2
4/1/1997	0.0E+00						4
7/1/1997	0.0E+00						5
10/1/1997	0.0E+00						1
1/1/1998	3.5E-01	57,873	26,642	1,906	292,246	474,812	6
7/1/1998	0.0E+00						5
1/1/1999	0.0E+00						4
7/1/1999	0.0E+00						4
1/1/2000	0.0E+00						4
7/1/2000	0.0E+00						4
1/1/2001	4.9E-01	57,902	27,015	1,588	389,291	705,876	11
7/1/2001	4.6E-01	57,835	26,996	1,646	192,779	654,374	9
1/1/2002	0.0E+00						3
7/1/2002	0.0E+00						3
1/1/2003	0.0E+00						3
7/1/2003	0.0E+00						3
1/1/2004	0.0E+00						3
4/1/2004	1.7E-01	58,162	28,017	782	311,500	136,840	14
7/1/2004	0.0E+00						3

Project: Y-12 National Security Complex

Location: CRSP

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TRICHLOROETHYLENE (TCE)							
10/1/2004	1.7E-01	58,162	28,017	782	311,500	136,840	14

Project: Y-12 National Security Complex

Location: CRSP

User Name: MV

State: Tennessee

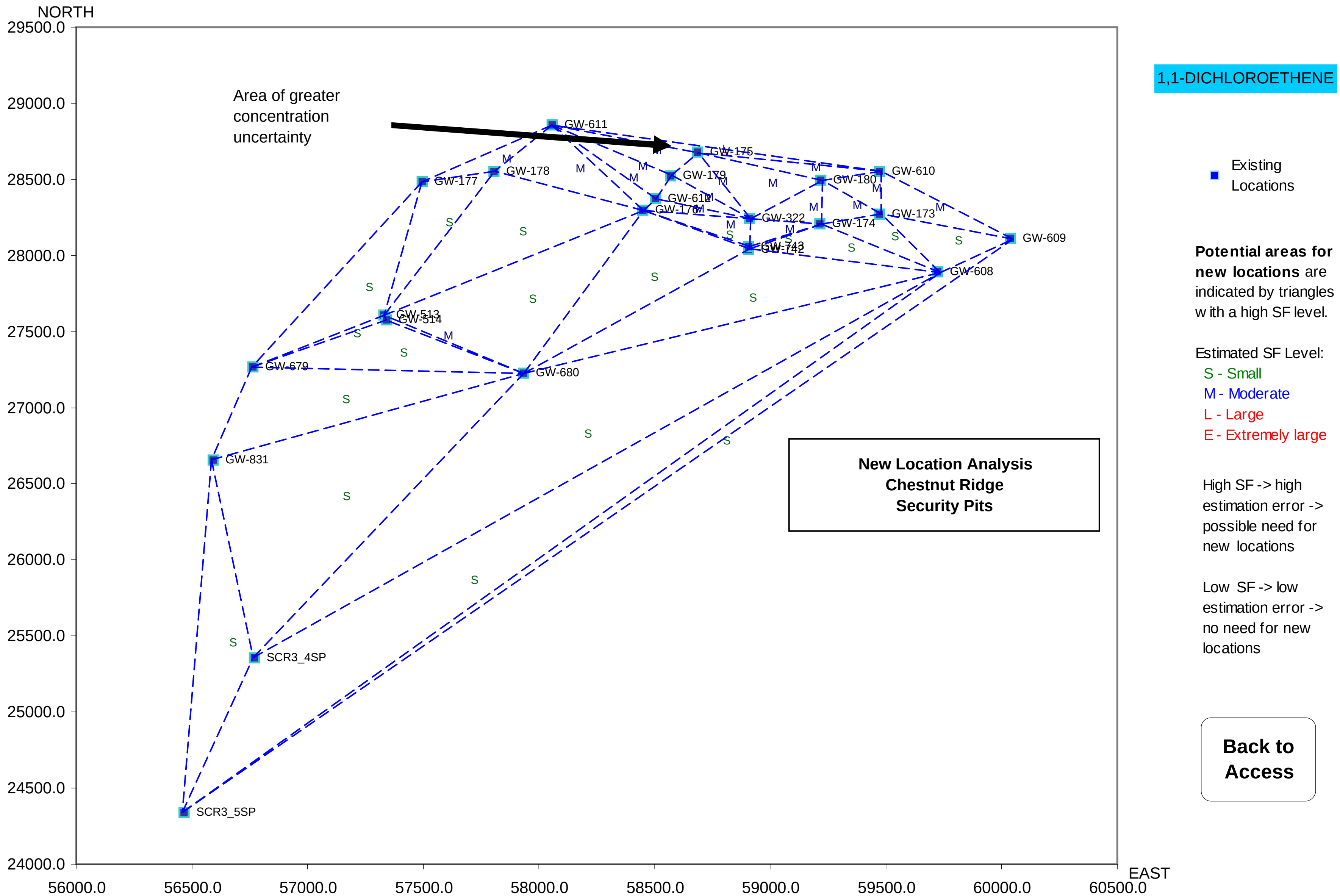
Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	1,1-DICHLOROETHENE	1.77	22	69.7%	NT
	GROSS ALPHA ACTIVITY	2.74	20	69.0%	NT
	LEAD	1.91	-1	50.0%	NT
	TETRACHLOROETHYLENE(PCE)	1.96	-2	51.0%	NT
	TRICHLOROETHYLENE (TCE)	1.91	0	49.0%	NT
1st Moment: Distance to Source					
	1,1-DICHLOROETHENE	0.76	-3	61.4%	S
	GROSS ALPHA ACTIVITY	0.58	-10	99.2%	D
	LEAD	0.62	-5	71.9%	S
	TETRACHLOROETHYLENE(PCE)	0.72	-5	71.9%	S
	TRICHLOROETHYLENE (TCE)	0.59	-5	71.9%	S
2nd Moment: Sigma XX					
	1,1-DICHLOROETHENE	0.31	-17	99.5%	D
	GROSS ALPHA ACTIVITY	0.37	-10	99.2%	D
	LEAD	0.20	-7	80.9%	S
	TETRACHLOROETHYLENE(PCE)	0.33	3	61.4%	NT
	TRICHLOROETHYLENE (TCE)	0.20	-5	71.9%	S
2nd Moment: Sigma YY					
	1,1-DICHLOROETHENE	0.83	-1	50.0%	S
	GROSS ALPHA ACTIVITY	0.80	-8	95.8%	D
	LEAD	0.76	1	50.0%	NT
	TETRACHLOROETHYLENE(PCE)	0.83	3	61.4%	NT
	TRICHLOROETHYLENE (TCE)	0.73	1	50.0%	NT

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.



NORTH
EAST
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Area of greater concentration uncertainty
GW-611
GW-175
GW-610
GW-178
GW-177
GW-179
GW-180
GW-618
GW-176
GW-322
GW-174
GW-173
GW-609
GW-743
GW-742
GW-608
GW-513
GW-514
GW-679
GW-680
GW-831
SCR3_4SP
SCR3_5SP
New Location Analysis
Chestnut Ridge
Security Pits
1,1-DICHLOROETHENE
Existing Locations
Potential areas for new locations are indicated by triangles w ith a high SF level.
Estimated SF Level:
S - Small
M - Moderate
L - Large
E - Extremely large
High SF -> high estimation error -> possible need for new locations
Low SF -> low estimation error -> no need for new locations
Back to Access

ASSESSMENT OF THE GROUNDWATER PROTECTION PROGRAM Y-12 NATIONAL SECURITY COMPLEX, OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.10	**Chestnut Ridge Regime Landfills V and VII**
Table D.10.1	Qualitative Analysis Chestnut Ridge Landfills V and VII
Table D.10.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary

(No Well Sufficiency areas of interest identified)

GROUNDWATER SERVICES, INC.

TABLE D.10.1
QUALITATIVE ANALYSIS CHESTNUT RIDGE REGIME LANDFILL V AND VII

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor source
GW-557	WL		Aquifer	X			X					X
GW-560	WL		Aquifer							X		
GW-562	WL		Aquifer							X		
GW-564	WL		Aquifer									
GW-796	WL		Aquifer	X			X					
GW-797	WL		Aquifer									
GW-798	WL		Aquifer	X			X					X
GW-799	WL		Aquifer	X			X			X		
GW-801	WL		Aquifer		X		X					
SCR4.3SP	SP		Spring			X				X		

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.4.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location; CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report*, (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.10.2
AQUIFER INPUT PARAMETERS

Landfills V and VII
Chestnut Ridge Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	5500	ft
Maximum Plume Length	5500	ft
PlumeWidth	2000	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	6000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	VOC/Metals	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow direction	S	270
Effective Porosity	0.1	--
Source Location near Well	GW-796	--
Source X-Coordinate	58206.4	ft*
Source Y-Coordinate	27923.9	ft*
Saturated Thickness	50	ft
Source Wells		
GW-796, GW-797, GW-801		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS COC Assessment

Project: Y-12 Security Complex **User Name:** MV

Location: CR_LandfillsV_VII **State:** Tennessee

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
LEAD	7.0E-03	4.0E-03	74.6%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage excedence from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Excedences	Percent Excedences	Total detects
LEAD	MET	10	10	100.0%	10

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total excedences (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
LEAD	10

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Contaminants of Concern (COC's)

LEAD

TETRACHLOROETHYLENE(PCE)

BERYLLIUM

CHROMIUM III

MAROS Plume Analysis Summary

Project: Y-12 Security Complex **User Name:** MV

Location: LandfillsV and VII **State:** Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
BERYLLIUM											
	GW-796	S	18	0	2.0E-05	2.0E-05	Yes	S	I	N/A	N/A
	GW-801	S	18	0	2.0E-05	2.0E-05	Yes	S	I	N/A	N/A
	GW-797	S	18	0	2.0E-05	2.0E-05	Yes	S	I	N/A	N/A
	GW-799	T	18	1	7.6E-05	2.0E-05	No	NT	NT	N/A	N/A
	SCR4_3SP	T	18	0	2.0E-05	2.0E-05	Yes	S	I	N/A	N/A
	GW-560	T	15	0	2.0E-05	2.0E-05	Yes	S	S	N/A	N/A
	GW-562	T	15	0	2.0E-05	2.0E-05	Yes	S	S	N/A	N/A
	GW-798	T	21	0	2.0E-05	2.0E-05	Yes	S	S	N/A	N/A
	GW-557	T	18	0	2.0E-05	2.0E-05	Yes	S	I	N/A	N/A
	GW-564	T	15	0	2.0E-05	2.0E-05	Yes	S	S	N/A	N/A
CHROMIUM III											
	GW-797	S	18	1	5.4E-04	2.6E-04	No	NT	NT	N/A	N/A
	GW-796	S	18	1	1.6E-03	2.6E-04	No	NT	NT	N/A	N/A
	GW-801	S	18	0	2.6E-04	2.6E-04	Yes	S	S	N/A	N/A
	GW-798	T	21	0	2.6E-04	2.6E-04	Yes	S	D	N/A	N/A
	GW-564	T	15	0	2.6E-04	2.6E-04	Yes	S	S	N/A	N/A
	GW-562	T	15	0	2.6E-04	2.6E-04	Yes	S	S	N/A	N/A
	GW-560	T	15	1	1.2E-03	2.6E-04	No	NT	NT	N/A	N/A
	SCR4_3SP	T	18	0	2.6E-04	2.6E-04	Yes	S	S	N/A	N/A
	GW-557	T	18	2	4.4E-03	2.6E-04	No	NT	PD	N/A	N/A
	GW-799	T	18	14	3.4E-02	3.9E-02	No	I	I	N/A	N/A

Project: Y-12 Security Complex **User Name:** MV

Location: LandfillsV and VII **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
LEAD											
LEAD											
	GW-797	S	18	5	9.9E-03	5.2E-05	No	D	D	N/A	N/A
	GW-801	S	18	1	1.3E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-796	S	18	3	2.4E-04	5.2E-05	No	NT	PD	N/A	N/A
	GW-562	T	15	3	1.1E-04	5.2E-05	No	PD	D	N/A	N/A
	SCR4_3SP	T	18	4	1.8E-04	5.2E-05	No	NT	D	N/A	N/A
	GW-557	T	18	4	3.0E-04	5.2E-05	No	NT	D	N/A	N/A
	GW-560	T	15	3	2.1E-04	5.2E-05	No	PD	D	N/A	N/A
	GW-799	T	18	2	2.1E-04	5.2E-05	No	NT	PD	N/A	N/A
	GW-798	T	21	2	7.9E-05	5.2E-05	No	NT	D	N/A	N/A
	GW-564	T	15	2	2.2E-04	5.2E-05	No	NT	D	N/A	N/A
TETRACHLOROETHYLENE(PCE)											
	GW-796	S	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-801	S	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-797	S	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-562	T	15	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-798	T	21	13	2.8E-03	2.0E-03	No	I	I	N/A	N/A
	GW-560	T	15	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-564	T	15	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-557	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR4_3SP	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-799	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 Security Complex

Location: LandfillsV and VII

User Name: MV

State: Tennessee

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	Estimated Mass (Kg)	Xc (ft)	Yc (ft)	Source Distance (ft)	Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
BERYLLIUM							
4/1/1996	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
10/1/1996	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
1/1/1997	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
7/1/1997	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
1/1/1998	8.8E-03	59,795	26,615	2,059	330,386	324,786	7
7/1/1998	8.8E-03	59,795	26,615	2,059	330,386	324,786	7
1/1/1999	8.8E-03	59,795	26,615	2,059	330,386	324,786	7
7/1/1999	8.8E-03	59,795	26,615	2,059	330,386	324,786	7
1/1/2000	2.7E-02	59,896	26,552	2,176	298,732	252,946	7
7/1/2000	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
10/1/2000	0.0E+00						4
1/1/2001	8.8E-03	59,795	26,615	2,059	330,386	324,786	7
4/1/2001	0.0E+00						4
7/1/2001	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
10/1/2001	0.0E+00						4
1/1/2002	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
7/1/2002	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
1/1/2003	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
7/1/2003	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
1/1/2004	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
7/1/2004	1.2E-02	60,145	26,465	2,427	599,576	394,724	10
CHROMIUM III							
4/1/1996	2.6E-01	59,911	26,469	2,241	469,790	251,462	10
10/1/1996	1.6E-01	60,145	26,465	2,427	599,576	394,724	10
1/1/1997	1.6E-01	60,145	26,465	2,427	599,576	394,724	10
7/1/1997	1.6E-01	60,145	26,465	2,427	599,576	394,724	10
1/1/1998	4.8E-01	59,909	26,544	2,192	293,134	243,045	7
7/1/1998	4.2E-01	59,904	26,547	2,186	295,097	246,464	7
1/1/1999	4.4E-01	59,905	26,546	2,188	294,627	245,641	7
7/1/1999	9.6E-01	59,975	26,348	2,369	212,154	203,926	7
1/1/2000	4.5E-01	59,907	26,546	2,189	294,062	244,655	7
7/1/2000	4.9E-01	59,889	26,617	2,131	359,813	240,324	10
10/1/2000	0.0E+00						4
1/1/2001	6.1E-01	59,824	26,634	2,069	343,879	299,616	7
4/1/2001	0.0E+00						4
7/1/2001	5.4E-01	59,878	26,623	2,118	347,006	232,910	10
10/1/2001	0.0E+00						4
1/1/2002	5.4E-01	59,878	26,623	2,118	347,006	232,910	10

Project: Y-12 Security Complex

Location: LandfillsV and VII

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
CHROMIUM III							
7/1/2002	8.6E-01	59,670	26,822	1,832	309,568	210,387	10
1/1/2003	4.9E-01	59,890	26,616	2,132	361,694	241,417	10
7/1/2003	5.0E-01	59,887	26,618	2,129	358,030	239,288	10
1/1/2004	4.7E-01	59,896	26,613	2,139	368,023	245,104	10
7/1/2004	5.1E-01	59,885	26,619	2,126	355,517	237,831	10
LEAD							
4/1/1996	3.2E-02	60,145	26,465	2,427	599,576	394,724	10
10/1/1996	2.2E-01	59,979	26,665	2,174	591,738	442,789	10
1/1/1997	2.3E-01	60,535	26,207	2,894	423,145	361,862	10
7/1/1997	4.6E-01	59,696	26,695	1,931	593,115	350,095	10
1/1/1998	7.0E-02	59,892	26,441	2,246	263,924	279,755	7
7/1/1998	2.3E-01	59,234	27,226	1,242	171,842	171,206	7
1/1/1999	4.8E-02	59,747	26,679	1,981	340,459	340,932	7
7/1/1999	5.7E-02	60,017	26,293	2,437	210,579	215,996	7
1/1/2000	2.3E-02	59,795	26,615	2,059	330,386	324,786	7
7/1/2000	3.2E-02	60,145	26,465	2,427	599,576	394,724	10
10/1/2000	0.0E+00						4
1/1/2001	2.3E-02	59,795	26,615	2,059	330,386	324,786	7
4/1/2001	0.0E+00						4
7/1/2001	3.2E-02	60,145	26,465	2,427	599,576	394,724	10
10/1/2001	0.0E+00						4
1/1/2002	3.2E-02	60,145	26,465	2,427	599,576	394,724	10
7/1/2002	3.2E-02	60,145	26,465	2,427	599,576	394,724	10
1/1/2003	3.2E-02	60,145	26,465	2,427	599,576	394,724	10
7/1/2003	3.2E-02	60,145	26,465	2,427	599,576	394,724	10
1/1/2004	3.2E-02	60,145	26,465	2,427	599,576	394,724	10
7/1/2004	3.2E-02	60,145	26,465	2,427	599,576	394,724	10
TETRACHLOROETHYLENE(PCE)							
4/1/1996	3.1E-01	60,145	26,465	2,427	599,576	394,724	10
10/1/1996	3.1E-01	60,145	26,465	2,427	599,576	394,724	10
1/1/1997	3.1E-01	60,145	26,465	2,427	599,576	394,724	10
7/1/1997	3.1E-01	60,145	26,465	2,427	599,576	394,724	10
1/1/1998	2.2E-01	59,795	26,615	2,059	330,386	324,786	7
7/1/1998	2.2E-01	59,795	26,615	2,059	330,386	324,786	7
1/1/1999	2.2E-01	59,795	26,615	2,059	330,386	324,786	7
7/1/1999	2.2E-01	59,795	26,615	2,059	330,386	324,786	7
1/1/2000	2.2E-01	59,795	26,615	2,059	330,386	324,786	7
7/1/2000	4.0E-01	60,145	26,545	2,379	584,633	373,618	10
10/1/2000	0.0E+00						4
1/1/2001	2.5E-01	59,802	26,643	2,047	336,585	328,165	7
4/1/2001	0.0E+00						4

Project: Y-12 Security Complex

Location: LandfillsV and VII

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TETRACHLOROETHYLENE(PCE)							
7/1/2001	4.2E-01	60,145	26,563	2,369	581,457	367,473	10
10/1/2001	0.0E+00						4
1/1/2002	4.5E-01	60,145	26,579	2,360	578,425	361,062	10
7/1/2002	5.2E-01	60,145	26,610	2,342	572,570	347,184	10
1/1/2003	5.8E-01	60,145	26,633	2,330	568,246	335,666	10
7/1/2003	5.1E-01	60,145	26,605	2,345	573,531	349,599	10
1/1/2004	4.9E-01	60,145	26,596	2,350	575,222	353,715	10
7/1/2004	4.4E-01	60,145	26,573	2,364	579,519	363,438	10

Project: Y-12 Security Complex

Location: LandfillsV and VII

User Name: MV

State: Tennessee

Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	BERYLLIUM	0.55	-15	66.2%	S
	CHROMIUM III	0.64	55	94.8%	PI
	LEAD	1.44	-81	99.3%	D
	TETRACHLOROETHYLENE(PCE)	0.56	59	96.0%	I
1st Moment: Distance to Source					
	BERYLLIUM	0.07	41	93.4%	PI
	CHROMIUM III	0.07	-87	100.0%	D
	LEAD	0.15	29	85.3%	NT
	TETRACHLOROETHYLENE(PCE)	0.07	-25	81.6%	S
2nd Moment: Sigma XX					
	BERYLLIUM	0.26	7	58.9%	NT
	CHROMIUM III	0.30	-1	50.0%	S
	LEAD	0.33	43	94.4%	PI
	TETRACHLOROETHYLENE(PCE)	0.25	-9	61.7%	S
2nd Moment: Sigma YY					
	BERYLLIUM	0.12	5	55.9%	NT
	CHROMIUM III	0.23	-69	99.6%	D
	LEAD	0.20	29	85.3%	NT
	TETRACHLOROETHYLENE(PCE)	0.08	-15	70.0%	S

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.

ASSESSMENT OF THE
GROUNDWATER PROTECTION PROGRAM
Y-12 NATIONAL SECURITY COMPLEX,
OAK RIDGE, TENNESSEE

Y-12 National Security Complex
Oak Ridge, Tennessee

Appendix D.11 Chestnut Ridge Regime East Chestnut Ridge

Table D.11.1	Qualitative Analysis East Chestnut Ridge
Table D.11.2	Aquifer Input Parameters
MAROS Report	COC Assessment
MAROS Report	Plume Summary
MAROS Report	Spatial Moment Analysis Summary

(No Well Sufficiency areas of interest identified)

GROUNDWATER SERVICES, INC.

TABLE D.11.1
QUALITATIVE ANALYSIS CHESTNUT RIDGE REGIME EAST CHESTNUT RIDGE

Chestnut Ridge Hydrogeologic Regime
Y-12 National Security Complex
Oak Ridge, Tennessee

Location Name	Location Type	Average Concentration Exceeds Screening Level	Formation Type	Horizontal Delineation	Vertical Delineation	Exit Location	RCRA	CERCLA	Unique	Monitors Background Water Quality	Early Detection	Monitor source
GW-142	WL		Aquifer	X	X		X					
GW-143	WL		Aquifer	X	X		X	X				
GW-144	WL		Aquifer	X	X		X	X				X
GW-145	WL		Aquifer	X			X	X				
GW-156	WL		Aquifer	X			X			X		
GW-159	WL	X	Aquifer	X			X					
GW-160	WL	X	Aquifer		X							
GW-231	WL		Aquifer	X			X	X				
GW-241	WL		Aquifer	X								
GW-292	WL		Aquifer		X							
GW-293	WL		Aquifer		X				X			
GW-298	WL		Aquifer		X							
GW-299	WL		Aquifer		X							
GW-300	WL		Aquifer	X								
GW-301	WL		Aquifer				X					
GW-303	WL		Aquifer		X					X		
GW-304	WL		Aquifer		X							
GW-731	WL		Aquifer	X	X		X			X		
GW-732	WL		Aquifer				X			X		
GW-841	WL	X	Aquitard	X				X				
GW-842	WL		Aquitard	X				X				
GW-843	WL		Aquitard	X				X				
GW-844	WL		Aquitard		X			X				
SCR5.1SP	SP		Spring			X				X		
SCR5.2SP	SP		Spring			X				X		
SCR5.4SP	SP		Spring			X						

Notes:
1. WL = Monitoring Well; SP = Spring
2. Well data taken from BWXT Y-12 Analytical Database. Sample locations shown on Figures A.1 and A.4.
3. RCRA indicates wells monitored as part of compliance with RCRA Post-Closure Corrective Action Monitoring or designated Alternate location;
CERCLA indicates locations monitored as part of compliance with CERCLA ROD or backup location. Data from BWXT, 2003a and BWXT 2004a.
4. Average Concentration Exceeds Screening = The average concentration over the entire sampling record for the priority constituent is above the MCL or other designated screening level as defined in Table B.1.
5. Aquifer and aquitard formations identified in Fig. A.2 from BWXT Y12, *2003 Groundwater Monitoring Report* , (12/01/2003).
6. Details of the decision criteria for each category are presented in the text.

GROUNDWATER SERVICES, INC.

TABLE D.11.2
AQUIFER INPUT PARAMETERS

East Chestnut Ridge
Chestnut Ridge Regime
Y-12 National Security Complex

Parameter	Value	Units
Current Plume Length	6500	ft
Maximum Plume Length	6500	ft
PlumeWidth	2000	ft
SeepageVelocity (ft/yr)	200	ft/yr
Distance to Receptors	6000	ft
GWFluctuations	Yes	--
SourceTreatment	None	--
PlumeType	VOC	--
Free NAPL Present	Yes	--
Parameter	**Value**	
Groundwater flow direction	S	270
Effective Porosity	0.1	--
Source Location near Well	GW-292	--
Source X-Coordinate	62146.29	ft*
Source Y-Coordinate	28140.54	ft*
Saturated Thickness	50	ft
Source Wells		
GW-292, GW-293, GW-160		

Notes:
1. Aquifer data are general values for the hydrologic regime.
2. Priority COCs defined by prevalence, toxicty and mobility.
3. ft* = Coordinates in Y-12 Plant coordinates, feet.
4. Screening Levels are USEPA MCLs, except in the case of compounds without MCLs where the level is the Region 9 PRG for tap water.
5. Effective Porosity estimated based on average high and low values for aquifer and aquitard suburfaces.

MAROS COC Assessment

Project: Y-12 Scurity Complex **User Name:** MV

Location: East Chestnut Ridge **State:** Tennessee

Toxicity:

Contaminant of Concern	Representative Concentration (mg/L)	PRG (mg/L)	Percent Above PRG
TRICHLOROETHYLENE (TCE)	6.9E-03	5.0E-03	38.0%

Note: Top COCs by toxicity were determined by examining a representative concentration for each compound over the entire site. The compound representative concentrations are then compared with the chosen PRG for that compound, with the percentage excedence from the PRG determining the compound's toxicity. All compounds above exceed the PRG.

Prevalence:

Contaminant of Concern	Class	Total Wells	Total Excedences	Percent Excedences	Total detects
TRICHLOROETHYLENE (TCE)	ORG	26	1	3.8%	12

Note: Top COCs by prevalence were determined by examining a representative concentration for each well location at the site. The total excedences (values above the chosen PRGs) are compared to the total number of wells to determine the prevalence of the compound.

Mobility:

Contaminant of Concern	Kd
TRICHLOROETHYLENE (TCE)	0.297

Note: Top COCs by mobility were determined by examining each detected compound in the dataset and comparing their mobilities (Koc's for organics, assume foc = 0.001, and Kd's for metals).

Contaminants of Concern (COC's)

TRICHLOROETHYLENE (TCE)

LEAD

CADMIUM

BENZENE

GROSS ALPHA ACTIVITY

MAROS Plume Analysis Summary

Project: Y-12 Scurity Complex

User Name: MV

Location: East Chestnut Ridge

State: Tennessee

Time Period: 1/1/1996 **to** 1/1/2005

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Average

ND Values: Specified Detection Limit

J Flag Values : Actual Value

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
BENZENE											
	GW-293	S	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-292	S	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-160	S	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-844	T	1	1	6.0E-03	6.0E-03	No	N/A	N/A	N/A	N/A
	GW-301	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-300	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-299	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-841	T	8	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-142	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-842	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-843	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-241	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-298	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-231	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-145	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-143	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR5_4SP	T	10	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-144	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR5_1SP	T	10	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR5_2SP	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
CADMIUM											

Project: Y-12 Scurity Complex **User Name:** MV

Location: East Chestnut Ridge **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
CADMIUM											
	GW-293	S	1	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-292	S	1	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-160	S	1	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-145	T	20	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	GW-241	T	2	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-301	T	18	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	GW-231	T	20	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	GW-156	T	18	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	GW-298	T	1	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-159	T	18	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	GW-143	T	20	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	GW-299	T	1	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-300	T	3	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-142	T	18	1	9.3E-05	8.0E-05	No	NT	NT	N/A	N/A
	GW-144	T	20	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	GW-732	T	18	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	GW-842	T	3	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-841	T	2	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	SCR5_4SP	T	8	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	SCR5_2SP	T	4	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
	GW-843	T	3	0	8.0E-05	8.0E-05	Yes	N/A	N/A	N/A	N/A
	GW-731	T	18	1	1.1E-04	8.0E-05	No	NT	NT	N/A	N/A
	SCR5_1SP	T	8	0	8.0E-05	8.0E-05	Yes	S	S	N/A	N/A
GROSS ALPHA ACTIVITY											
	GW-292	S	1	1	1.5E+00	1.5E+00	No	N/A	N/A	N/A	N/A
	GW-160	S	1	1	3.0E+00	3.0E+00	No	N/A	N/A	N/A	N/A
	GW-293	S	1	1	2.1E+00	2.1E+00	No	N/A	N/A	N/A	N/A
	SCR5_1SP	T	4	4	1.2E+00	1.1E+00	No	NT	NT	N/A	N/A
	GW-298	T	1	1	3.4E+00	3.4E+00	No	N/A	N/A	N/A	N/A
	GW-231	T	19	14	9.0E-01	4.9E-01	No	D	D	N/A	N/A
	GW-159	T	2	2	6.0E+01	6.0E+01	No	N/A	N/A	N/A	N/A
	GW-156	T	2	2	3.6E+00	3.6E+00	No	N/A	N/A	N/A	N/A
	GW-145	T	19	19	1.1E+01	1.1E+01	No	S	S	N/A	N/A

Project: Y-12 Scurity Complex **User Name:** MV

Location: East Chestnut Ridge **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
GROSS ALPHA ACTIVITY											
	SCR5_2SP	T	1	1	1.4E+00	1.4E+00	No	N/A	N/A	N/A	N/A
	GW-241	T	1	1	3.4E-01	3.4E-01	No	N/A	N/A	N/A	N/A
	GW-143	T	19	17	3.1E+00	2.8E+00	No	D	D	N/A	N/A
	GW-144	T	19	19	2.1E+00	2.0E+00	No	NT	NT	N/A	N/A
	GW-301	T	15	9	7.7E-01	4.9E-01	No	NT	NT	N/A	N/A
	GW-731	T	2	2	1.7E+00	1.7E+00	No	N/A	N/A	N/A	N/A
	GW-142	T	17	16	3.3E+00	1.7E+00	No	D	D	N/A	N/A
	GW-732	T	2	2	1.1E+00	1.1E+00	No	N/A	N/A	N/A	N/A
	GW-299	T	1	1	2.0E+00	2.0E+00	No	N/A	N/A	N/A	N/A
	SCR5_4SP	T	8	8	8.9E-01	6.3E-01	No	NT	NT	N/A	N/A
	GW-300	T	3	3	5.5E+00	3.2E+00	No	N/A	N/A	N/A	N/A
LEAD											
	GW-160	S	1	1	3.1E-02	3.1E-02	No	N/A	N/A	N/A	N/A
	GW-292	S	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-293	S	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	SCR5_4SP	T	8	1	1.5E-04	5.2E-05	No	NT	PD	N/A	N/A
	GW-142	T	18	5	4.7E-04	5.2E-05	No	PD	NT	N/A	N/A
	GW-159	T	18	3	3.8E-04	5.2E-05	No	D	D	N/A	N/A
	GW-156	T	18	5	5.6E-04	5.2E-05	No	D	D	N/A	N/A
	GW-843	T	3	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-145	T	20	4	1.3E-04	5.2E-05	No	D	D	N/A	N/A
	GW-143	T	20	4	7.6E-05	5.2E-05	No	D	D	N/A	N/A
	SCR5_2SP	T	4	1	5.0E-04	5.2E-05	No	NT	NT	N/A	N/A
	GW-144	T	20	4	8.3E-05	5.2E-05	No	S	D	N/A	N/A
	SCR5_1SP	T	8	1	9.2E-05	5.2E-05	No	NT	NT	N/A	N/A
	GW-842	T	3	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-732	T	18	5	3.4E-04	5.2E-05	No	D	D	N/A	N/A
	GW-298	T	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-299	T	1	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-841	T	2	0	5.2E-05	5.2E-05	Yes	N/A	N/A	N/A	N/A
	GW-731	T	18	4	2.5E-04	5.2E-05	No	D	D	N/A	N/A
	GW-241	T	2	1	5.8E-04	5.8E-04	No	N/A	N/A	N/A	N/A
	GW-300	T	3	2	4.4E-04	2.8E-04	No	N/A	N/A	N/A	N/A

Project: Y-12 Scurity Complex **User Name:** MV

Location: East Chestnut Ridge **State:** Tennessee

Constituent	Well	Source/ Tail	Number of Samples	Number of Detects	Average (mg/L)	Median (mg/L)	All Samples "ND" ?	Mann-Kendall	Linear Regression	Modeling	Empirical
LEAD											
	GW-231	T	20	4	1.8E-04	5.2E-05	No	D	D	N/A	N/A
	GW-301	T	18	4	4.9E-04	5.2E-05	No	D	D	N/A	N/A
TRICHLOROETHYLENE (TCE)											
	GW-292	S	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-293	S	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-160	S	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-142	T	17	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-300	T	3	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-143	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	SCR5_2SP	T	4	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-299	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-298	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-231	T	19	1	5.1E-04	5.0E-04	No	S	S	N/A	N/A
	GW-144	T	19	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-841	T	8	8	1.1E-01	3.0E-02	No	D	D	N/A	N/A
	GW-145	T	19	2	5.3E-04	5.0E-04	No	S	S	N/A	N/A
	SCR5_1SP	T	10	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-842	T	11	11	3.2E-03	1.5E-03	No	NT	NT	N/A	N/A
	GW-241	T	2	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	GW-301	T	18	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A
	GW-843	T	11	0	5.0E-04	5.0E-04	Yes	S	D	N/A	N/A
	GW-844	T	1	0	5.0E-04	5.0E-04	Yes	N/A	N/A	N/A	N/A
	SCR5_4SP	T	10	0	5.0E-04	5.0E-04	Yes	S	S	N/A	N/A

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Spatial Moment Analysis Summary

Project: Y-12 Scurity Complex

Location: East Chestnut Ridge

User Name: MV

State: Tennessee

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	Estimated Mass (Kg)	Xc (ft)	Yc (ft)	Source Distance (ft)	Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
BENZENE							
1/1/1996	0.0E+00						5
4/1/1996	1.7E-01	62,954	26,063	2,230	145,839	683,097	12
10/1/1996	9.7E-02	63,118	25,473	2,839	48,570	151,188	6
1/1/1997	0.0E+00						5
4/1/1997	8.0E-02	63,545	24,753	3,665	15,165	263,660	7
7/1/1997	0.0E+00						3
10/1/1997	0.0E+00						5
1/1/1998	0.0E+00						3
4/1/1998	0.0E+00						5
7/1/1998	0.0E+00						3
10/1/1998	0.0E+00						5
1/1/1999	5.1E-01	63,837	24,754	3,785	503,531	580,491	6
4/1/1999	0.0E+00						5
7/1/1999	5.1E-01	63,837	24,754	3,785	503,531	580,491	6
10/1/1999	0.0E+00						5
1/1/2000	0.0E+00						3
4/1/2000	0.0E+00						5
7/1/2000	0.0E+00						3
10/1/2000	0.0E+00						5
1/1/2001	6.5E-01	63,865	25,034	3,550	496,180	1,012,586	8
4/1/2001	0.0E+00						5
7/1/2001	6.5E-01	63,865	25,034	3,550	496,180	1,012,586	8
10/1/2001	0.0E+00						5
1/1/2002	0.0E+00						5
4/1/2002	0.0E+00						5
7/1/2002	0.0E+00						4
10/1/2002	0.0E+00						5
1/1/2003	0.0E+00						4
4/1/2003	0.0E+00						5
7/1/2003	0.0E+00						3
10/1/2003	0.0E+00						5
1/1/2004	0.0E+00						4
4/1/2004	0.0E+00						5
7/1/2004	0.0E+00						3
10/1/2004	0.0E+00						5
CADMIUM							
1/1/1996	0.0E+00						5
4/1/1996	6.3E-02	63,285	26,470	2,022	223,472	618,607	16

Project: Y-12 Scurity Complex

Location: East Chestnut Ridge

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
CADMIUM							
10/1/1996	5.8E-02	63,337	26,340	2,159	157,231	433,565	10
1/1/1997	0.0E+00						1
4/1/1997	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/1997	1.5E-02	63,118	25,473	2,839	48,570	151,188	6
10/1/1997	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
1/1/1998	0.0E+00						3
4/1/1998	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/1998	0.0E+00						3
10/1/1998	5.4E-02	63,779	26,129	2,591	37,497	431,763	9
1/1/1999	8.1E-02	63,837	24,754	3,785	503,531	580,491	6
4/1/1999	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/1999	0.0E+00						3
10/1/1999	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
1/1/2000	0.0E+00						3
4/1/2000	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/2000	0.0E+00						3
10/1/2000	4.0E-02	63,786	26,008	2,691	38,964	489,746	9
1/1/2001	0.0E+00						5
4/1/2001	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/2001	0.0E+00						5
10/1/2001	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
1/1/2002	0.0E+00						2
4/1/2002	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/2002	0.0E+00						2
10/1/2002	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
1/1/2003	0.0E+00						1
4/1/2003	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/2003	0.0E+00						1
10/1/2003	2.9E-02	63,758	26,062	2,630	41,990	517,221	9
1/1/2004	0.0E+00						4
4/1/2004	4.7E-02	63,255	26,453	2,019	97,915	321,951	9
7/1/2004	0.0E+00						3
10/1/2004	4.7E-02	63,255	26,453	2,019	97,915	321,951	9
GROSS ALPHA ACTIVITY							
1/1/1996	0.0E+00						5
4/1/1996	2.5E+03	63,197	26,783	1,717	212,358	862,900	15
10/1/1996	9.7E+02	63,421	26,160	2,356	176,327	635,407	10
1/1/1997	0.0E+00						1
4/1/1997	0.0E+00						5
7/1/1997	0.0E+00						1
10/1/1997	0.0E+00						5
1/1/1998	0.0E+00						1

Project: Y-12 Scurity Complex

Location: East Chestnut Ridge

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
GROSS ALPHA ACTIVITY							
4/1/1998	0.0E+00						5
7/1/1998	0.0E+00						2
10/1/1998	0.0E+00						5
1/1/1999	0.0E+00						2
4/1/1999	0.0E+00						5
7/1/1999	0.0E+00						2
10/1/1999	0.0E+00						5
1/1/2000	0.0E+00						3
4/1/2000	0.0E+00						5
7/1/2000	0.0E+00						3
10/1/2000	0.0E+00						5
1/1/2001	0.0E+00						4
4/1/2001	0.0E+00						5
7/1/2001	0.0E+00						2
10/1/2001	0.0E+00						5
1/1/2002	0.0E+00						1
4/1/2002	0.0E+00						5
7/1/2002	0.0E+00						2
10/1/2002	0.0E+00						5
1/1/2003	0.0E+00						1
4/1/2003	0.0E+00						5
7/1/2003	0.0E+00						1
10/1/2003	0.0E+00						5
1/1/2004	0.0E+00						1
4/1/2004	0.0E+00						5
7/1/2004	0.0E+00						1
10/1/2004	0.0E+00						5
LEAD							
1/1/1996	0.0E+00						5
4/1/1996	7.7E-02	62,939	27,057	1,343	388,564	743,005	16
10/1/1996	5.1E-01	63,250	26,529	1,953	125,762	384,340	10
1/1/1997	0.0E+00						1
4/1/1997	3.9E-01	63,780	26,286	2,472	42,291	498,833	9
7/1/1997	1.1E-01	63,107	25,560	2,754	28,288	75,226	6
10/1/1997	1.3E-01	63,798	26,170	2,571	40,663	419,897	9
1/1/1998	0.0E+00						3
4/1/1998	2.9E-02	63,810	26,085	2,645	43,847	639,701	9
7/1/1998	0.0E+00						3
10/1/1998	7.5E-02	63,790	26,143	2,587	36,941	387,976	9
1/1/1999	1.0E-01	63,813	24,783	3,749	478,574	545,780	6
4/1/1999	1.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/1999	0.0E+00						3

Project: Y-12 Scurity Complex

Location: East Chestnut Ridge

User Name: MV

State: Tennessee

Effective Date	0th Moment: Estimated Mass (kg)	1st Moment (Center of Mass): Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread): Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
LEAD							
10/1/1999	2.0E-02	63,765	26,168	2,552	40,604	638,997	9
1/1/2000	0.0E+00						3
4/1/2000	1.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/2000	0.0E+00						3
10/1/2000	1.9E-02	63,758	26,062	2,630	41,990	517,221	9
1/1/2001	0.0E+00						5
4/1/2001	1.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/2001	0.0E+00						5
10/1/2001	1.9E-02	63,758	26,062	2,630	41,990	517,221	9
1/1/2002	0.0E+00						2
4/1/2002	1.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/2002	0.0E+00						2
10/1/2002	5.3E-02	63,827	25,931	2,777	31,886	440,880	9
1/1/2003	0.0E+00						1
4/1/2003	1.9E-02	63,758	26,062	2,630	41,990	517,221	9
7/1/2003	0.0E+00						1
10/1/2003	1.9E-02	63,758	26,062	2,630	41,990	517,221	9
1/1/2004	0.0E+00						4
4/1/2004	7.0E-02	63,158	26,490	1,936	53,037	261,660	9
7/1/2004	0.0E+00						3
10/1/2004	4.8E-02	63,192	26,477	1,965	70,929	283,178	9
TRICHLOROETHYLENE (TCE)							
1/1/1996	0.0E+00						5
4/1/1996	1.7E-01	62,954	26,063	2,230	145,839	683,097	12
10/1/1996	9.7E-02	63,118	25,473	2,839	48,570	151,188	6
1/1/1997	0.0E+00						5
4/1/1997	8.1E-02	63,541	24,749	3,667	15,643	264,710	7
7/1/1997	0.0E+00						3
10/1/1997	0.0E+00						5
1/1/1998	0.0E+00						3
4/1/1998	0.0E+00						5
7/1/1998	0.0E+00						3
10/1/1998	0.0E+00						5
1/1/1999	3.2E+00	64,244	24,321	4,357	148,168	181,055	6
4/1/1999	0.0E+00						5
7/1/1999	3.0E+00	64,238	24,327	4,350	155,130	188,824	6
10/1/1999	0.0E+00						5
1/1/2000	0.0E+00						3
4/1/2000	0.0E+00						5
7/1/2000	0.0E+00						3
10/1/2000	0.0E+00						5
1/1/2001	1.6E+00	64,147	24,735	3,950	285,398	780,760	8

Project: Y-12 Scurity Complex

Location: East Chestnut Ridge

User Name: MV

State: Tennessee

Effective Date	0th Moment Estimated Mass (kg)	1st Moment (Center of Mass) Xc (ft)	Yc (ft)	Source Distance (ft)	2nd Moment (Spread) Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
TRICHLOROETHYLENE (TCE)							
4/1/2001	0.0E+00						5
7/1/2001	1.9E+00	64,187	24,692	4,007	242,866	733,622	8
10/1/2001	0.0E+00						5
1/1/2002	0.0E+00						5
4/1/2002	0.0E+00						5
7/1/2002	0.0E+00						4
10/1/2002	0.0E+00						5
1/1/2003	0.0E+00						4
4/1/2003	0.0E+00						5
7/1/2003	0.0E+00						3
10/1/2003	0.0E+00						5
1/1/2004	0.0E+00						4
4/1/2004	0.0E+00						5
7/1/2004	0.0E+00						3
10/1/2004	0.0E+00						5

Project: Y-12 Scurity Complex

Location: East Chestnut Ridge

User Name: MV

State: Tennessee

Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	BENZENE	2.47	-81	87.1%	NT
	CADMIUM	1.04	-26	63.8%	NT
	GROSS ALPHA ACTIVITY	4.54	-63	80.9%	NT
	LEAD	2.12	-126	96.2%	D
	TRICHLOROETHYLENE (TCE)	2.84	-91	89.9%	NT
1st Moment: Distance to Source					
	BENZENE	0.18	9	88.1%	NT
	CADMIUM	0.15	-22	75.0%	S
	GROSS ALPHA ACTIVITY	0.00	0	0.0%	N/A
	LEAD	0.18	28	80.7%	NT
	TRICHLOROETHYLENE (TCE)	0.22	11	93.2%	PI
2nd Moment: Sigma XX					
	BENZENE	0.74	5	71.9%	NT
	CADMIUM	1.28	20	72.9%	NT
	GROSS ALPHA ACTIVITY	0.00	0	0.0%	N/A
	LEAD	1.42	-18	70.7%	NT
	TRICHLOROETHYLENE (TCE)	0.65	13	96.5%	I
2nd Moment: Sigma YY					
	BENZENE	0.54	11	93.2%	PI
	CADMIUM	0.22	-28	80.7%	S
	GROSS ALPHA ACTIVITY	0.00	0	0.0%	N/A
	LEAD	0.31	-24	77.0%	S
	TRICHLOROETHYLENE (TCE)	0.68	7	80.9%	NT

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.10 **Saturated Thickness:** Uniform: 50 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.

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