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**OAK RIDGE
Y-12
PLANT**

LOCKHEED MARTIN



**EVALUATION OF CALENDAR YEAR 1997
GROUNDWATER AND SURFACE WATER
QUALITY DATA FOR THE
UPPER EAST FORK POPLAR CREEK
HYDROGEOLOGIC REGIME
AT THE
U.S. DEPARTMENT OF ENERGY Y-12 PLANT,
OAK RIDGE, TENNESSEE**

September 1998

Prepared by

**AJA TECHNICAL SERVICES, INC.
Under Subcontract No. 70Y-KDS15V**

for the

**Water Compliance Department
Environment, Safety, and Health Organization
Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831**

Managed by

**LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the U.S. Department of Energy
Under Contract No. DE-AC05-84OR21400**

**MANAGED BY
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY**

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List of Acronyms and Abbreviations

ASO	Analytical Services Organization
Bear Creek Regime	Bear Creek Hydrogeologic Regime
BCV	Bear Creek Valley
bgs	below ground surface
BT	buried tributary
CY	calendar year
DNAPL	dense, nonaqueous phase liquids
DOE	U.S. Department of Energy
DQO	data quality objective
East Fork Regime	Upper East Fork Poplar Creek Hydrogeologic Regime
ETTP	East Tennessee Technology Park
ft	feet
LRSPW	Lake Reality Spillway (sampling station)
MCL	maximum contaminant level (for drinking water)
MDA	minimum detectable activity
µg/L	micrograms per liter
mg/L	milligrams per liter
msl	mean sea level
mV	millivolts
ORR	Oak Ridge Reservation
PCE	tetrachloroethene
pCi/L	picoCuries per liter
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
REDOX	oxidation-reduction potential
RI	Remedial Investigation
RPD	relative percent difference
SDWA	Safe Drinking Water Act
TCE	trichloroethene
TDS	total dissolved solids
TSS	total suspended solids
UEFPC	Upper East Fork Poplar Creek
UTL	upper tolerance limit
VOC	volatile organic compound
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCE	1,2-dichloroethene (total)
cis-1,2-DCE	cis-1,2-dichloroethene
trans-1,2-DCE	trans-1,2-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
⁹⁹ Tc	technetium-99
²³⁴ U	uranium-234
²³⁸ U	uranium-238

1.0 INTRODUCTION

This report presents an evaluation of the groundwater quality monitoring data reported in: *Calendar Year 1997 Annual Groundwater Monitoring Report for the Upper East Fork Poplar Creek Hydrogeologic Regime at the U.S. Department of Energy Y-12 Plant, Oak Ridge, Tennessee* (AJA Technical Services, Inc. 1998), which is hereafter referenced as the Annual Monitoring Report. Section 2.0 presents background information for the Upper East Fork Poplar Creek Hydrogeologic Regime (East Fork Regime) that is relevant to data evaluation, including brief descriptions of the geology, the groundwater flow system, the contaminant source areas, and the extent of groundwater contamination in the regime. Section 3.0 provides an overview of the groundwater sampling and analysis activities performed during calendar year (CY) 1997, including monitoring well locations, sampling frequency and methods, and laboratory analyses. Evaluation and interpretation of the monitoring data, described in Section 4.0, is generally focused on an overview of data quality assurance/quality control (QA/QC), long-term concentration trends for selected inorganic, organic, and radiological contaminants, and consistency with applicable site-specific conceptual contaminant transport models described in: *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (U.S. Department of Energy 1998), which is referenced hereafter as the Remedial Investigation (RI) Report. Findings of the data evaluations are summarized in Section 5.0 and a list of technical reports and regulatory documents cited for more detailed information (Section 6.0) concludes the report. All of the illustrations (maps and trend graphs) and data summary tables referenced in the text are presented in Appendix A and Appendix B, respectively. Appendix C provides a summary of the analytical results that meet applicable data quality objectives (DQOs) of the Y-12 Plant Groundwater Protection Program.

2.0 BACKGROUND INFORMATION

The East Fork Regime encompasses numerous sources of groundwater contamination located within industrialized areas of the U.S. Department of Energy (DOE) Y-12 Plant in Bear Creek Valley (BCV) southeast of Oak Ridge, Tennessee (Figure 1); unless otherwise noted, directions are in reference to the Y-12 Plant administrative grid. For the purposes of this report, the East Fork Regime is divided into the Western Plant Area (west of the Y-12 Plant grid coordinate easting 55,000), the Central Plant Area (between grid coordinate eastings 55,000 and 62,000), and the Eastern Plant Area (east of grid coordinate easting 62,000) (Figure 2).

2.1 Topography and Bedrock Geology

Bear Creek Valley is flanked to the north by Pine Ridge and to the south by Chestnut Ridge. Ground elevations range from about 1,300 feet (ft) above mean sea level (msl) on the ridge crests to 900 ft msl along the axis of BCV in the exposed channel of Upper East Fork Poplar Creek (UEFPC). The most prominent local topographic feature is the gap in Pine Ridge cut by UEFPC northeast of the Y-12 Plant (Figure 2). This gap roughly corresponds with a less prominent divide in Chestnut Ridge to the southeast of the plant and may indicate some type of structural or stratigraphic discontinuity in the vicinity of Scarboro Road.

Alternating sequences of clastic and carbonate strata that form the distinctive topography of the Valley and Ridge Physiographic Province characterize the bedrock geology in the East Fork Regime. Shale and siltstone beds of the Rome Formation form Pine Ridge to the north, limestone and shale formations of the Conasauga Group form BCV, and the primarily dolostone formations of the Knox Group form Chestnut Ridge to the south (Figure 2). Strike and dip of bedding are generally N 55°E and 45°SE, respectively (as referenced to true north). Bedrock is overlain by up to 40 ft of several unconsolidated materials, including man-made fill, alluvium, colluvium, fine-grained residuum from the weathering of the bedrock, and saprolite (weathered bedrock). Where undisturbed, the saprolite often retains primary textural features of the unweathered bedrock, including fractures (Solomon *et al.* 1992).

Extensive cut-and-fill areas within the Y-12 Plant have substantially altered the shallow subsurface throughout much of the East Fork Regime (Figure 3). Most of the fill, which contains many voids and generally consists of a heterogeneous mixture of building debris and recompacted soil/residuum, was placed in the tributaries and main channel of UEFPC (Sutton and Field 1995). The numerous voids, heterogeneous composition, and varying thickness (5 to 25 ft) significantly influence shallow groundwater flow directions and contaminant migration patterns.

Surface water in the East Fork Regime is drained by UEFPC, which was extensively modified during construction of the Y-12 Plant. The headwaters and several thousand feet of the main channel in the upper reach of the creek, including all the northern tributaries of the creek in the Western Plant Area and Central Plant Area (Figure 3), were filled and replaced with an extensive network of underground storm drains. For reference purposes, each buried tributary (BT) of UEFPC is designated with a value representing the tributary number counted downstream from the headwaters (e.g., BT-1).

2.2 Groundwater System

On the Oak Ridge Reservation (ORR) in the vicinity of BCV, the Rome Formation, the Conasauga Group, and the Knox Group comprise two basic hydrogeologic units: (1) the Aquifer, consisting of the Maynardville Limestone (upper Conasauga Group) and Knox Group, and (2) the Aquitard, consisting of the remaining Conasauga Group formations (Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone, and Pumpkin Valley Shale) and the Rome Formation (Figure 2). The Aquifer (Maynardville Limestone) functions as a hydrologic drain in BCV, and provides the principal avenues for contaminant transport in the East Fork Regime. The Aquitard formations underlie many of the contaminant source areas in the regime and are hydraulically upgradient of the Aquifer.

The extensive network of sumps, storm drains, process lines, pipes, and outfalls in the shallow subsurface throughout much of the East Fork Regime strongly influences the movement and discharge of shallow groundwater, as well as the migration of groundwater contaminants. For instance, operation of sumps to suppress the local water table below the basement floor of Buildings 9204-4, 9201-5, and 9204-1 (Figure 3) strongly influence local groundwater flow and contaminant

transport patterns in both the shallow and deeper flow system in the Aquitard (U.S. Department of Energy 1998).

Fractures provide the primary groundwater flowpaths in the Aquitard and the Aquifer, but dissolution of carbonates in the Aquifer has enlarged fractures and produced solution cavities and conduits that greatly enhance its hydraulic conductivity relative to the Aquitard. Although negligible in both units, flow through the rock matrix plays an important role in contaminant migration because of matrix diffusion processes. Most of the flow in both units is primarily parallel to bedding (along strike and dip), which in the Aquitard may or may not coincide with the direction of maximum horizontal hydraulic gradient inferred from groundwater elevation isopleths. In the Aquitard, the bulk of flow occurs within the shallow bedrock interval less than 70 ft below ground surface (bgs). Flow tangent to bedding occurs primarily along permeable zones formed by cross-cutting fractures or fracture zones (and possibly small faults). Some of these cross-cutting structures may act as barriers to lateral flow, causing groundwater from deeper intervals to upwell and discharge to the shallower flow system in each hydrogeologic unit. Others may serve as preferential pathways for migration of contaminants from the Aquitard into the Aquifer.

Most groundwater flow in the Aquifer occurs at shallow depths, typically less than 100 ft bgs in an extensively interconnected karst network of solution conduits and cavities. Flow in the shallow karst network is relatively rapid, and during rainfall, may occur as "quickflow" recharge/discharge toward springs or nearby surface drainage features (Shevenell 1994). Below the shallow karst network, fractures provide the primary flowpaths, and there are important lithologic controls on groundwater flow (Goldstrand 1995). Lithologic characteristics differentiate seven distinct stratigraphic zones (numbered from bottom to top) in the Maynardville Limestone. The more permeable zones lie at the bottom (Zone 2) and top (Zone 6) of the formation (Shevenell *et al.* 1993). Because of vugular porosity related to dissolution of gypsum nodules, Zone 6 is the most permeable interval and probably transmits the bulk of the groundwater in the Maynardville Limestone (Goldstrand 1995).

In both the Western Plant Area and Central Plant Area, groundwater generally flows south (across-strike) from the Aquitard toward the Aquifer (Maynardville Limestone) and eastward along strike in the Maynardville Limestone toward the east end of the Y-12 Plant (Figure 4). Flow

directions in the shallow interval diverge from this general pattern near New Hope Pond in the Eastern Plant Area. In the Aquitard, flow is more directly east (along strike) toward UEFPC, and in the Aquifer, flow components are north toward the water gap in Pine Ridge and east along strike toward Union Valley. Seasonal water table fluctuations, which are greatest (>10 ft) in wells located along the steep northern flank of Chestnut Ridge, do not significantly alter the directions of groundwater flow in the East Fork Regime.

2.3 Contaminant Source Areas

Sources of groundwater contamination in the East Fork Regime, most of which is heavily industrialized and highly congested, include: hazardous and nonhazardous waste treatment, storage, or disposal sites; bulk product transfer, storage, and use areas; petroleum-fuel underground storage tanks and associated dispensing facilities; industrial process buildings; waste and product spill areas; and the many process pipelines, effluent drains, and utilities associated with the industrial operations at the Y-12 Plant. Also, operation of the S-3 Ponds, a closed Resource Conservation and Recovery Act (RCRA)-regulated surface impoundment located in the Bear Creek Hydrogeologic Regime (Bear Creek Regime) near the west end of the Y-12 Plant, emplaced a large reservoir of contamination in the Western Plant Area. It is more difficult to conclusively identify other sources of groundwater contamination elsewhere in the regime because of extensive intermingling of contaminants, but the RI Report identifies the groundwater contaminant signatures (i.e., specific contaminants or distinct groups of contaminants) in the UEFPC characterization area (i.e., the East Fork Regime) that can be related to one or more of the source areas listed on Table 1; locations of these source areas are shown on Figure 5.

2.4 Extent of Groundwater Contamination

The RI Report provides a comprehensive description of the extent of groundwater and surface water contamination in the East Fork Regime. The principal groundwater contaminants in the regime are inorganic compounds (primarily nitrate); trace metals (notably boron and uranium); volatile organic compounds (VOCs), including chlorinated solvents and petroleum hydrocarbons; and several radionuclides, chiefly technetium-99 (^{99}Tc) and uranium isotopes. Intermingling of

contaminants from multiple source areas has produced an extensive, essentially continuous groundwater contaminant plume of varying composition that extends from the Western Plant Area through the southern part of the Central and Eastern plant areas and into Union Valley east of the ORR (Figure 5).

A plume of nitrate contamination originating from the S-3 Ponds extends vertically in the Aquitard at least 150 ft bgs, and laterally at least 5,000 ft into the Western Plant Area. Nitrate (as N) concentrations (hereafter synonymous with "nitrate" concentrations) within the plume exceed 10,000 milligrams per liter (mg/L). Because it is chemically stable and highly mobile in groundwater, nitrate probably traces the overall migration pattern for other groundwater contaminants from the S-3 Ponds. The geometry of the nitrate plume indicates two principal migration pathways: (1) short migration along shallow pathways (<30 ft bgs) that typically terminate in storm drains or other utilities, building sumps, and the buried tributaries and original mainstem of UEFPC; and (2) longer-term migration along strike-parallel pathways at greater depths in the bedrock toward basement sumps in Buildings 9204-4, 9201-5, and 9204-2 (U.S. Department of Energy 1998).

The low pH groundwater within the contaminant plume adjacent to the S-3 Ponds contains a diverse mix of metal ions and/or ion-complexes (beryllium, cadmium, cobalt, manganese, mercury, and nickel) that are usually not mobile (or are more readily attenuated) in less acidic groundwater, as well as metals that are mobile under a wider range of groundwater pH conditions (barium, boron, strontium, and uranium). Some of these metals were entrained in the acidic wastes disposed at the site (e.g., uranium) and others were dissolved from the underlying saprolite and bedrock (e.g., barium). Trace metal concentrations within the plume exceed applicable maximum contaminant levels (MCLs) for drinking water by an order of magnitude or more. Similarly elevated concentrations of several other trace metals (including boron, cadmium, cobalt, copper, mercury, and uranium) occur in the groundwater elsewhere in the East Fork Regime, notably the S-2 Site, but available data do not indicate that extensive plumes of metal ions and/or ion-complexes have developed in the groundwater beyond the immediate vicinity of these sites.

Volatile organic compounds are the most pervasive groundwater contaminants in the East Fork Regime. Chloroethenes, primarily tetrachloroethene (PCE), trichloroethene (TCE), and

dichloroethene isomers, are the principal components of dissolved VOC plumes in the Western Plant Area and the Central Plant Area. Chloromethanes (primarily carbon tetrachloride and chloroform) are primary plume components in the Eastern Plant Area. Concentrations of individual plume constituents in the Aquitard near several source areas, notably the Waste Coolant Processing Area (Figure 5), exceed 1,000 micrograms per liter ($\mu\text{g/L}$) and indicate the presence of dense, nonaqueous phase liquids (DNAPL) in the subsurface. Data for the existing network of Aquifer monitoring wells generally define a relatively continuous plume of dissolved VOCs in the water table interval/shallow bedrock that extends eastward from the Fire Training Facility in the Western Plant Area, underneath New Hope Pond in the Eastern Plant Area, and into Union Valley at least 2,000 ft east of the ORR boundary (Figure 5).

Groundwater with radiological contamination occurs primarily in the Aquitard east of the S-3 Ponds, at Tank 0134-U, and Buildings 9204-4, 9201-5, and 9201-4; and in the Aquifer near the S-2 Site and upgradient of New Hope Pond (wells GW-605/606 and the former Oil Skimmer Basin (Figure 5)). The S-3 Ponds are confirmed sources of uranium isotopes — primarily uranium-234 (^{234}U) and uranium-238 (^{238}U) — and ^{99}Tc ; the migration of ^{99}Tc generally mirrors that of nitrate from the site. Limited influx into the Aquifer (or extensive dilution) is indicated by the greatly decreased gross alpha, gross beta, and isotopic uranium activity in the groundwater downgradient of confirmed source areas (e.g., S-2 Site and the former Oil Skimmer Basin), which suggests that the alpha activity in the groundwater at Aquifer wells GW-605/606 and the area upgradient of New Hope Pond reflect similarly limited migration of uranium isotopes from relatively nearby upgradient source areas.

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3.0 SAMPLING AND ANALYSIS SUMMARY

Groundwater and surface water sampling in the East Fork Regime during CY 1997 was performed in accordance with the *Sampling and Analysis Plan for Groundwater and Surface Water Monitoring at the Y-12 Plant during Calendar Year 1997* (AJA Technical Services, Inc. 1996), as modified by applicable addenda. The following sections provide an overview of the sampling locations and frequency; sample collection, transportation, and chain of custody control; and field measurements and laboratory analytes.

3.1 Sampling Locations and Frequency

Groundwater samples were collected from 41 monitoring wells and surface water samples were collected from the Lake Reality Spillway (LRSPW) during CY 1997 (Figure 6). Sampling was performed during each quarter of the year (March 4 - 18; April 7- May 22; July 28 - August 13; and October 30 - December 10, 1997). Depending upon the frequency specified by the governing monitoring program, samples were collected from each location for RCRA post-closure corrective action monitoring, DOE Order 5400.1 exit pathway/perimeter monitoring, and DOE Order 5400.1 surveillance monitoring (Table 2). Most of the monitoring wells were sampled in compliance with DOE Order 5400.1.

3.2 Sample Collection, Transportation, and Chain-of-Custody Control

Personnel from the Sampling and Environmental Support Department of the Analytical Services Organization (ASO) located at the East Tennessee Technology Park (ETTP), formerly the Oak Ridge K-25 Site, were responsible for collection, transportation, and chain-of-custody control of the groundwater and surface water samples. Sampling was performed in accordance with the *Technical Procedure for Groundwater Sampling* (Lockheed Martin Energy Systems, Inc. 1997), a revised version of which was issued in April 1997. The revised version of this procedure describes the methods for: (1) conventional sampling, whereby groundwater samples are obtained after purging at least three well-volumes of groundwater from the well (if it does not purge dry), and (2) low-flow minimal drawdown sampling (hereafter referenced as low-flow sampling), whereby

groundwater samples are obtained immediately after field measurements show stable values (minimal variation over four consecutive readings) in groundwater purged from the well at a very low flow rate (<300 milliliters per minute) with minimal water level drawdown in the well (less than 0.1 foot per quarter-hour). All of the wells except well GW-722, which is equipped with a dedicated multi-port sampling system, were sampled in accordance with the low-flow minimal drawdown method during the fourth quarter of CY 1997 (Table 2).

Dedicated bladder pumps (Well Wizard™), dedicated multi-port sampling equipment (Westbay™), portable gas-piston pumps (Bennet Pump™), and disposable bailers were used to collect groundwater samples from the monitoring wells. The applicable sampling equipment was used to obtain filtered and unfiltered samples from each well. Samples collected with a Well Wizard™ or a Bennet Pump™ were filtered in the field using in-line 0.45 micron filters; samples collected from the Westbay™ monitoring system in well GW-722 were filtered in the field with a special filtering vessel; surface water samples, which were collected using grab sample bottles, and groundwater samples collected with bailers were filtered in the laboratory. All samples were collected in appropriate containers, labeled, logged, placed in ice-filled coolers, and transported to the appropriate analytical laboratory in accordance with chain-of-custody control requirements.

A total of 44 laboratory blanks, 58 trip blanks, six equipment rinsate samples, and three field blanks were analyzed for QA/QC purposes. Laboratory blanks were samples of deionized water analyzed along with several associated groundwater and/or surface water samples. Trip blanks were samples of deionized water transported in each cooler containing groundwater and surface water samples to be analyzed for VOCs. Field blanks were samples of deionized water prepared when groundwater samples were collected from selected monitoring wells. Equipment rinsates were samples of the deionized water used to decontaminate the portable groundwater sampling equipment, and were collected after a sampling team had completed sampling at a site or finished each administrative well group (a series of sampling locations grouped for data tracking and management purposes). If more than one sampling pump was used, an equipment rinsate sample was collected from each pump. In addition to these blank samples and equipment rinsates, duplicate groundwater samples were collected for QA/QC purposes from nine monitoring wells (Table 2), including at least one well in each administrative well group.

3.3 Field Measurements and Laboratory Analytes

Field personnel measured the depth to water before purging and sampling groundwater in each monitoring well. Sampling personnel also recorded field measurements of pH, temperature, specific conductance, dissolved oxygen, and oxidation-reduction potential (REDOX) for each sampling location.

All of the groundwater and surface water samples were analyzed for the following standard suite of laboratory analytes: (1) major cations (calcium, magnesium, potassium, and sodium) and anions (carbonate and bicarbonate alkalinity, chloride, fluoride, nitrate, and sulfate); (2) trace metals (the term used hereafter to differentiate metals that are typically minor constituents in groundwater from those that are major ionic species); (3) VOCs; (4) gross alpha activity and gross beta activity; and (5) pH, specific conductance, total dissolved solids (TDS), total suspended solids (TSS), and turbidity (Table 3). Unfiltered groundwater samples were analyzed for all of these analytes, and filtered samples were analyzed only for the major cations and trace metals.

Each laboratory blank, trip blank, field blank, and equipment rinsate sample was analyzed for VOCs. Selected equipment rinsates were also analyzed for inorganics (major ions and trace metals), radionuclides, and several miscellaneous analytes (e.g., TDS). Duplicate groundwater samples were analyzed for the constituents and parameters specified for the well from which they were collected.

Inorganic and miscellaneous laboratory analyses were performed by the ASO laboratories at the ETTP, and analyses for organics and radiochemical parameters were performed by the Y-12 Plant ASO laboratories. Laboratory analyses were performed in accordance with the analytical methods listed in Table 3.

4.0 DATA EVALUATION

The following sections present an evaluation of the monitoring data reported for the network of CY 1997 sampling locations. This evaluation is based on the results that meet the applicable DQOs defined in: *Y-12 Plant Groundwater Protection Program - Groundwater Monitoring Program Data Management Plan* (Martin Marietta Energy Systems, Inc. 1993). Analytical results that do not meet applicable DQOs, summarized below, were either replaced with a surrogate value (Appendix C) or were considered qualitative for evaluation purposes.

- Duplicate dissolved (filtered) lead results reported for well GW-769 (May 1997) were replaced with a missing value (i.e., no analytical result) because they differ by more than an order of magnitude.
- Total and dissolved lead results reported for well GW-782 (May 1997), and total and dissolved zinc results reported for well GW-207 (December 1997) were replaced with missing values because the dissolved concentrations exceed the corresponding total concentrations by an order of magnitude.
- Major ion data for groundwater samples collected from wells GW-108 (August 1997), GW-620 (May and December 1997), GW-722-06 (November 1997), and GW-722-14 (July 1997) were considered qualitative because the relative percent difference (RPD) between the summed milliequivalent concentrations of the anions and cations (i.e., the ion charge balance) exceed $\pm 20\%$.
- A total of 141 VOC results reported for 81 samples from 50 sampling locations were considered false positives and replaced with missing values based on the types and concentrations of the compounds detected in the associated laboratory and/or trip blank samples.
- Gross alpha activity for wells GW-380 (December 1997) and GW-746 (April 1997) were replaced with missing values. Although these results exceed the specified minimum detectable activity (MDA), they are less than the associated counting error (i.e., the statistic that expresses the degree of analytical uncertainty).

The Annual Monitoring Report provides a detailed description of the DQO criteria and associated data screening process (AJA Technical Services, Inc. 1998). A summary of the CY 1997 groundwater monitoring data qualified by the applicable DQO criteria is provided in Appendix C.

As in previous years, false-positive VOC results associated with contamination of the QA/QC samples account for the bulk of the CY 1997 groundwater quality data that do not meet applicable DQOs. One or more of 20 VOCs were detected in 32 (73%) of the laboratory blanks, 50 (86%) of the trip blanks, and all the equipment rinsate samples and field blanks, with acetone, 2-butanone, 2-hexanone, and methylene chloride accounting for most (about 70%) of these results (Table 4). The frequent detection of these common laboratory reagents indicates contamination during analysis and/or storage in the laboratory. Also, VOC results for the laboratory blanks reflect the change in the ASO laboratory that performed the analyses during CY 1997. For example, acetone was detected in only 14% of the laboratory blanks analyzed by the ETTP ASO during CY 1996 compared to 68% of the laboratory blanks analyzed by the Y-12 Plant ASO during CY 1997.

Chloroform was detected in one of the three field blanks, five (83%) of the six equipment rinsate samples, and 18 (31%) of the trip blanks, but was not detected in any of the laboratory blanks (Table 4). The lack of chloroform in the laboratory blanks discounts contamination during analysis of the samples. Contamination during transportation and storage seems unlikely because chloroform was not detected in the groundwater samples associated with these QA/QC samples. Also, improper equipment decontamination is not indicated because chloroform was detected in rinsate samples associated with wells that monitor uncontaminated groundwater. Chloroform was most likely present in the deionized water that was used to prepare trip blanks and field blanks and to decontaminate sampling equipment. Chloroform contamination of the source of deionized water used for similar QA/QC purposes has occurred during previous years, and false positive chloroform results are a DQO concern because chloroform is a component of dissolved VOC plumes in the East Fork Regime, particularly the carbon tetrachloride-dominated plume in the Eastern Plant Area.

In addition to chloroform, several other components of the dissolved VOC plumes present in the groundwater in the East Fork Regime were detected in trip blanks, laboratory blanks, and equipment rinsate samples (Table 4). Potential contamination during sample transportation may account for the detection of PCE and cis-1,2-dichloroethene (cis-1,2-DCE) in the trip blank and the associated groundwater sample collected from well GW-817 in December 1997. Concentrations in the trip blank and the groundwater sample range from 1 µg/L (cis-1,2-DCE) to 6 µg/L (PCE), with the results for the groundwater sample screened as false positives (i.e., replaced with a missing value). False-positive results for these compounds are somewhat problematic because well GW-817,

which has no previous history of VOC contamination, is potentially downgradient of the dissolved plume of chloroethenes (including PCE and cis-1,2-DCE) in the groundwater near New Hope Pond.

4.1 Major Ions

The major ion data for most of the monitoring wells sampled during CY 1997 are consistent with historical results and generally reflect the respective geochemical characteristics of the calcium-magnesium bicarbonate and sodium-bicarbonate groundwater in the Aquitard (Figure 7), and calcium-magnesium-bicarbonate groundwater in the Aquifer (Figure 8). Results for groundwater samples from the majority of wells are typically characterized by: (1) calcium, magnesium, and bicarbonate concentrations above 75, 10, and 200 mg/L, respectively; (2) low molar proportions (<10%) of chloride, potassium, sodium, and sulfate; (3) nitrate and fluoride below 1 mg/L; and (4) carbonate alkalinity below the analytical reporting limit (see Appendix C). However, the major ion data for several Aquitard and Aquifer wells are generally distinguished by atypically high molar proportions (>15% of total anions or cations) of chloride, nitrate, sodium, and sulfate (Table 5). Some of these results reflect the natural geochemical heterogeneity in each hydrogeologic unit, but most of the unusually high ion proportions reflect groundwater contamination in the Western Plant Area (GW-108, GW-251, GW-617, and GW-618), the Central Plant Area (GW-770, GW-775, GW-776, GW-783, and GW-792), and the Eastern Plant Area (GW-148, GW-153, GW-380, GW-383, GW-606, GW-746, and GW-763). Atypical ion concentrations reported for some wells (e.g., GW-108 and GW-251) reflect "legacy" contamination from past waste management activities whereas the elevated ion concentrations reported for other wells, notably GW-148, GW-746, GW-770, GW-775, and GW-776, indicate contamination from current plant operations.

4.1.1 Western Plant Area

In the East Fork Regime, nitrate contamination from the S-3 Ponds is most severe in the Aquitard near the southern end of the Y-12 Plant Salvage Yard, as evident from the extremely high nitrate concentrations (>15,000 mg/L) reported for the groundwater samples collected from well GW-108 during CY 1997. This well yields highly contaminated groundwater from a total depth of about 59 ft bgs in the Nolichucky Shale approximately 800 ft along strike to the east of the S-3

Ponds (Figure 6). Although dominated by nitrate, groundwater samples from this well are also distinguished by very high levels of calcium (>10,000 mg/L), magnesium (>900 mg/L), sodium (>400 mg/L), and chloride (>100 mg/L), which probably reflect dissolution of saprolite and bedrock by the highly acidic waste disposed at the S-3 Ponds. Historic data for the well show that nitrate concentrations are typically lowest during seasonally high groundwater flow (winter and spring) and have clearly decreased since the late 1980s (Figure 9). The downward trend probably reflects significantly reduced flux of nitrate (and other contaminants) following closure of the S-3 Ponds in 1984, installation of a low permeability cap in 1989, and flushing of nitrate by seasonal recharge/discharge cycles (U.S. Department of Energy 1998). During seasonally low groundwater flow (summer and fall), however, historical data indicate a more stable long-term nitrate concentration trend and a more positive relationship between nitrate concentrations and presampling water level elevations, which have clearly increased since the late 1980s (Figure 9). This suggests that nitrate concentrations may be increasingly attributable to upward migration from a secondary reservoir of contamination emplaced more than 400 ft bgs in the Nolichucky Shale during operation of the S-3 Ponds (U.S. Department of Energy 1998). Moreover, if the qualitative nitrate result (19,700 mg/L) reported for the sample collected in August 1997 (the ion charge balance RPD exceeds $\pm 20\%$) is confirmed by future sampling, an increasing long-term concentration trend may become apparent. Increasing long-term nitrate concentration trends are evident in several wells in the Bear Creek Regime to the west of the S-3 Ponds which intercept strike-parallel flowpaths in the upper Nolichucky Shale that potentially subcrop beneath the site (U.S. Department of Energy 1998).

The S-2 Site is the most likely source of the elevated nitrate (>40 mg/L) and sulfate (>15 mg/L) levels in the groundwater at Aquifer well GW-251, which is completed at a depth of 51 ft bgs in the upper Maynardville Limestone about 100 ft west of the site (Figure 6). Nitrate and other contaminants from the site probably leach directly into the shallow groundwater in the Maynardville Limestone and are transported via karst flow downgradient (along strike) to the east and west. However, dilution during transport in the Aquifer, which is indicated by the frequently inverse relationship between nitrate concentrations and presampling water level elevations in well GW-251 (Figure 10), and discharge from the shallow karst system into UEFPC combine to substantially reduce contaminant concentrations in the groundwater downgradient of the site (U.S. Department of Energy 1998). Although wide (dilution-related) seasonal fluctuations are evident,

which tend to hinder identifying potential inconsistencies with the low-flow sampling results obtained from well GW-251 during November 1997, historical (conventional sampling) nitrate data suggest a relatively steady if not slightly decreasing long-term concentration trend (Figure 10).

Aquifer well GW-617 yields moderately contaminated calcium-magnesium-bicarbonate groundwater from a depth of 18 ft bgs in the lower Maynardville Limestone about 700 ft northeast (across geologic strike) of the S-2 Site (Figure 6). Groundwater samples obtained from the well using conventional and low-flow sampling methods are characterized by atypically high molar proportions of sulfate and unusually low concentrations of calcium (<15 mg/L), magnesium (<5.5 mg/L), and bicarbonate alkalinity (<60 mg/L). The results for these samples also show that nitrate concentrations remain well below the 10 mg/L MCL and continue to exhibit a strongly positive relationship with presampling water level elevations in the well; sulfate concentrations likewise mirror the water level fluctuations (Figure 11). This relationship suggests advective groundwater transport of nitrate and sulfate. Shallow groundwater containing nitrate and other similarly mobile components of the contaminant plume originating from the S-3 Ponds discharges into the extensive network of subsurface drains located in the subwatersheds of UEFPC that drain the Western Plant Area (U.S. Department of Energy 1998). A major east-west oriented section of subsurface drain is located immediately north (upgradient) of well GW-617, and recharge of contaminated water leaked from the drain seems a likely source of the nitrate and sulfate in the shallow groundwater at the well. Recharge of surface runoff, potable water, and/or process water with low TDS may also explain the unusually low calcium, magnesium, and bicarbonate levels characteristic of the groundwater samples from well GW-617.

Aquifer well GW-618, which is paired with well GW-617 (Figure 6), yields moderately contaminated calcium-magnesium-bicarbonate groundwater from the shallow bedrock (37 ft bgs) in the lower Maynardville Limestone. Although nitrate levels frequently exceed 1 mg/L (but remain below the MCL), groundwater samples from this well are better distinguished by unusually high chloride concentrations (>20 mg/L) compared to most other shallow Aquifer wells in the East Fork Regime, including well GW-617 (<10 mg/L). Also, in contrast to nitrate and sulfate levels in well GW-617, nitrate and chloride concentrations in well GW-618 do not show any consistent relationship with presampling water level elevations in the well; moreover, nitrate levels have remained relatively stable since the early 1990s while chloride levels have steadily decreased

(Figure 12). The disparity between nitrate and chloride concentrations and their respective long-term concentration trends potentially indicates separate sources of these ions, both of which are highly mobile and chemically stable in groundwater. Migration from the S-3 Ponds contamination plume is the most likely source of the nitrate, whereas chloride concentrations in the well may be at least partially attributable to biodegradation of dissolved chloroethenes in the groundwater (see Section 4.3.1).

Although qualitative because of the ion charge balance errors, total and dissolved potassium concentrations reported for the groundwater samples collected from well GW-620 in May (10 mg/L) and December 1997 (11 mg/L) are substantially higher than typical of samples from all the other Aquifer wells in the East Fork Regime. Completed at a depth of 75 ft bgs in the upper Maynardville Limestone about 100 ft east (downgradient) of the Fire Training Facility (Figure 6), this well consistently yields geochemically distinctive groundwater samples with unusually low calcium (<70 mg/L), magnesium (<5 mg/L), and bicarbonate alkalinity (<1 mg/L), atypically high carbonate alkalinity (>20 mg/L) and pH (>10), and significant ion charge balance errors (samples collected during 16 of the 28 sampling events since May 1990 have ion charge balance RPDs that exceed $\pm 20\%$). Excluding results for samples with significant RPDs (which excludes all results obtained since December 1995), historical data for the well show that potassium concentrations decreased sharply during 1990, but have generally fluctuated below 20 mg/L since then, with seasonal recharge of potassium-enriched groundwater indicated by the direct relationship between potassium concentrations and presampling water level elevations in the well (Figure 13). The source of the potassium may be ash and/or inorganic flame retardants that may have been used to extinguish fires at existing and former burn areas in the western part of the Fire Training Facility, which are the likely source of dissolved VOCs in the groundwater at the well (see Section 4.3.1).

4.1.2 Central Plant Area

Elevated chloride and/or sulfate concentrations reported for the groundwater samples collected from Aquitard wells GW-770, GW-775, GW-776, GW-783, and GW-792 during CY 1997, summarized in the following table, probably reflect groundwater contamination in the Central Plant Area.

Well Number	Monitored Interval Depth (ft bgs)	Aquifer Zone		CY 1997 Concentration (mg/L)			
		Water Table Interval	Bedrock Interval	Chloride		Sulfate	
				2nd Qtr.	4th Qtr.	2nd Qtr.	4th Qtr.
GW-770	7.5 - 19.0	●		.	.	23.6	32.2
GW-775	45.0 - 56.4		●	42.9	39.36	34.0	28.3
GW-776	10.6 - 23.0	●		54.4	51.7	43.3	48.3
GW-783	3.6 - 16.3	●		21.1	20.3	20.6	24.6
GW-792	17.0 - 29.0	●		22.8	47.2	25.3	21.5

Note: "." = Typical concentration, not elevated (see Appendix C).

Leaking industrial process lines, sanitary sewers, or subsurface drains may be the source(s) of the chloride and sulfate in the shallow groundwater at these wells, particularly wells GW-770 and GW-783, which are completed with monitored intervals beginning only 7.5 ft and 3.6 ft bgs, respectively. As noted in Section 4.1, atypical ion concentrations in the groundwater at wells GW-770, GW-775, and GW-776 potentially reflect contamination related to current industrial operations rather than contamination from past waste management practices.

Although elevated chloride concentrations in the shallow groundwater elsewhere in the East Fork Regime may be at least partially attributable to degradation of dissolved chloroethenes, this is not completely clear from the data for wells GW-775, GW-776, and GW-792. For instance, well GW-792 is paired with a deeper (71 ft bgs) well (GW-791) and both monitor a plume of dissolved PCE in the Aquitard that probably originates from Building 9212 (see Section 4.3.2). Inorganic chloride accumulates during anoxic dechlorination of PCE (McCarty 1996), but the chloride concentrations in well GW-791, which monitors deeper groundwater flowpaths where anoxic conditions are more likely to occur, are within the range of background levels in the Aquitard (<10 mg/L). Additionally, the intermediate products of PCE dechlorination (e.g., TCE and cis-1,2-DCE) are infrequently detected at low concentrations in the groundwater at both wells. Moreover, historical chloride data for well GW-792 show an increasing long-term concentration trend that generally coincides with a sharp rise in the groundwater elevation in well (Figure 14), whereas PCE results show decreased concentrations (see Section 4.3.2). These results suggest a leaking utility line, subsurface drain, industrial process line, and/or sanitary sewer as the source(s) of the elevated chloride concentrations in the groundwater at the well.

Regardless of the source of the chloride, the elevated concentrations in the shallow groundwater at Aquitard wells GW-776 and GW-783 show a reasonably strong relationship with elevated chromium and/or nickel concentrations. For instance, generally concurrent long-term increasing concentration trends are indicated by historical chloride and nickel data for well GW-776, whereas generally concurrent long-term decreasing concentration trends are indicated by historical chloride and chromium data for well GW-783 (Figure 15). The apparent association between elevated chloride, nickel, and chromium concentrations in these and other shallow wells in the regime (e.g., GW-380) is conspicuous and potentially indicates corrosion of the stainless steel well casing and screen. Although the chloride concentrations in the groundwater at these wells seem too low to be corrosive to stainless steel, both wells may be exposed to other corrosive geochemical conditions, such as dissolved oxygen above 2 mg/L (Driscoll 1986).

4.1.3 Eastern Plant Area

Chloride, sodium, and/or sulfate concentrations reported for the groundwater samples collected during CY 1997 from Aquitard wells GW-746 and GW-763 and Aquifer wells GW-148, GW-153, GW-380, GW-383, GW-606 probably reflect groundwater contamination in the Eastern Plant Area. Results for these wells are summarized below.

Well Number	Aquifer Zone Monitored Interval Depth (ft bgs)	CY 1997 Concentration (mg/L)					
		Chloride		Sodium		Sulfate	
		1st/2nd Qtr.	3rd/4th Qtr.	1st/2nd Qtr.	3rd/4th Qtr.	1st/2nd Qtr.	3rd/4th Qtr.
GW-148	4.6 - 11.1	76.0	39.0	.	.	.	.
GW-153	45 - 60.0	14.2	39.0	.	.	.	.
GW-380	2.8 - 15.5	90.3	45.2	70	37	.	.
GW-383	16.6 - 23.6	29.6	38.7	.	.	.	.
GW-606	13.5 - 171	51.9	41.5	.	.	.	.
GW-746	3.2 - 15.2	34.4	25.2	.	.	22.1	18.2
GW-763	4.0 - 16	47.9	66	.	.	.	.

Note: "." = Typical concentration, not elevated (see Appendix C).

Atypically high concentrations of these ions probably reflect transport in groundwater and surface water from sources in the Y-12 Plant upgradient of New Hope Pond, particularly considering that New Hope Pond lies in the discharge area for groundwater and surface water exiting the Y-12 Plant. Additionally, results for well GW-148 suggest that the elevated ion concentrations in the groundwater at the well are related to current industrial operations in the plant instead of past waste management activities.

Elevated chloride concentrations in the groundwater at several of the wells in the Eastern Plant Area are probably at least partially attributable to natural attenuation of dissolved chloroethenes in the groundwater. For example, as illustrated by the CY 1997 data for Aquifer well GW-383 and Aquitard well GW-763 summarized below, several geochemical parameters for these wells are within the optimum range for biodegradation of chlorinated solvents (Wilson *et al.* 1996).

Geochemical Parameter/ Optimum Range	GW-383		GW-763	
	May 1997	Dec 1997	May 1997	Nov 1997
Nitrate < 1 mg/L	<0.028 mg/L	<0.028 mg/L	<0.028 mg/L	<0.028 mg/L
Iron (II) > 1 mg/L	<1 mg/L*	<1 mg/L*	15 mg/L*	24 mg/L*
Sulfate < 20 mg/L	24 mg/L	18 mg/L	2.68 mg/L	2.34 mg/L
REDOX < 50 millivolts (mV)	20 mV**	-55 mV**	-79 mV**	-60 mV**
pH 5 < pH < 9	7.5**	7.2**	7**	6.6**

Note: *Results are for total iron; **Field measurement

Whatever the source(s) of chloride, sulfate, and sodium in the groundwater near New Hope Pond, migration patterns are likely controlled primarily by hydraulic interaction between surface water in UEFPC and the shallow karst network in the Maynardville Limestone and are influenced by the underdrain system beneath the concrete diversion channel of UEFPC west and northwest of New Hope Pond and intermittent operation of the Lake Reality Sump (U.S. Department of Energy 1998).

4.3 Trace Metals

The following evaluation of the CY 1997 trace metal data is focused on total concentrations that meet applicable DQO criteria and exceed the applicable upper tolerance limit (UTL) reported in *Determination of Reference Concentrations for Inorganic Analytes in Groundwater at the Department of Energy Y-12 Plant, Oak Ridge, Tennessee* (HSW Environmental Consultants, Inc.

et al. 1995). The UTLs for each metal were determined from statistical analysis of historical (1986 - 1993) data for specific groups of wells (i.e., clusters) differentiated by similar geochemical characteristics, and they represent the maximum concentrations expected in the groundwater monitored by the wells comprising each cluster. Applicable UTLs are exceeded by the total concentrations of 17 trace metals reported for 59 unfiltered groundwater samples from 34 monitoring wells and two surface water samples from the LRSPW. However, most of these elevated trace metal concentrations probably reflect extraneous bias, such as preservation of highly turbid unfiltered samples, rather than groundwater contamination. Moreover, the change from conventional sampling during the first three quarters of 1997 to low-flow sampling during the fourth quarter of the year (see Section 3.2) is clearly reflected by the trace metal data for several wells. Fewer of the trace metal results obtained using the low-flow sampling method exceed UTLs and many of the results are an order-of-magnitude or more lower than historical data (which were obtained from conventional sampling) for each applicable sampling location. In light of these considerations, the following discussion is focused on the elevated trace metal concentrations reported for Aquitard well GW-108 and Aquifer wells GW-251, GW-618, and GW-605. Based on weight of evidence from historical data, results for these sampling locations consistently reflect contamination.

Acidic groundwater within the plume of contamination originating from the S-3 Site contains a diverse mix of metal ions (e.g., barium) and/or ion-complexes that are mobile under a wide range of pH conditions as well as other metals that are relatively immobile in less acidic groundwater (e.g., cobalt). Some of these metals (e.g., uranium) were entrained in the acidic wastes disposed at the site, whereas others (e.g., manganese) were probably dissolved from the underlying saprolite and bedrock. Analytical results reported for the samples collected from Aquitard well GW-108 in March and August 1997 are consistent with historical data showing elevated concentrations of boron (0.22 - 0.34 mg/L), cobalt (0.16 mg/L), nickel (0.26 mg/L), and uranium (0.015 mg/L) coupled with extremely high levels of barium (92 - 100 mg/L), manganese (97 - 110 mg/L), and strontium (34 - 39 mg/L). Also, both of these samples were diluted in the laboratory, and the higher analytical reporting limits may mask elevated concentrations of other trace metals in the groundwater at the well. As with nitrate levels in the groundwater at well GW-108, the very high trace metal concentrations reflect eastward groundwater transport along strike-parallel flowpaths in the

Nolichucky Shale from the S-3 Ponds, combined with upward migration from the reservoir of contamination deeper in the Aquitard.

A diverse mixture of trace metals also occurs in the groundwater at the S-2 Site. The CY 1997 results for Aquifer well GW-251 are generally consistent with historical data for the well and illustrate the bias often caused by preservation of turbid unfiltered samples as well as differences between the results obtained from conventional sampling and low-flow sampling. As shown in the following data summary, applicable UTLs are exceeded by the total concentrations of aluminum, beryllium, cadmium, cobalt, copper, lead, manganese, and zinc reported for the turbid (TSS = 55 mg/L) unfiltered sample collected using the conventional sampling method, but only cadmium and copper concentrations exceed respective UTLs in the much less turbid (TSS = 8 mg/L) unfiltered sample obtained using the low-flow sampling method.

AQUIFER WELL GW-215					
Metal	Cluster 1 UTL (mg/L)	Unfiltered (Total)/Filtered (Dissolved) Concentration (mg/L)			
		Conventional Sampling May 1997		Low-Flow Sampling November 1997	
		Total	Dissolved	Total	Dissolved
Aluminum	2.4	5.6	0.08	0.22	0.02
Beryllium	0.00045	0.0011	0.00057	0.0004	0.0003
Cadmium	0.002	0.17	0.16	0.066	0.064
Cobalt	0.014	0.036	0.029	0.0079	0.0083
Copper	0.012	0.57	0.42	0.18	0.15
Manganese	1.7	5.3	4.7	1.6	1.6
Lead	0.0096	0.016	0.00059	0.0021	<0.0005
Zinc	0.041	0.099	0.072	0.023	0.022

Comparison of the total and dissolved concentrations shows that the conventional sampling results for several of these metals (notably aluminum) were directly or indirectly biased by preservation (i.e., acidification) of the sample. Moreover, the disparity between the conventional sampling and low-flow sampling results for other trace metals that do not appear to have been influenced by sample preservation (notably cadmium and cobalt), if confirmed by additional low-flow sampling results, suggests that the historical data obtained using the conventional sampling method may overstate the severity of trace metal contamination in the groundwater at well GW-251. Nevertheless, the low-

flow sampling results for cadmium (total and dissolved) are consistent with historic data showing a frequently direct relationship with presampling water-level elevations in the well (cadmium concentrations are typically greatest when groundwater elevations are highest) and long-term decreasing concentration trends (Figure 16). The positive relationship with groundwater elevations potentially indicates transport of cadmium (and other trace metals) in colloidal suspension. If so, conventional sampling results may not be representative because purging the well may mobilize colloids that would otherwise remain immobile. Additionally, numerical source leachate modeling for the S-2 Site predicts increasing long-term concentration trends for several trace metals (e.g., uranium) that did not exceed UTLs in the CY 1997 samples (U.S. Department of Energy 1998), although increasing concentration trends are not clearly evident from the trace metal data for well GW-251.

The CY 1997 cadmium results for Aquifer well GW-618 also illustrate the sometimes substantial difference between conventional and low-flow sampling results. Cadmium was not detected (detection limit = 0.003 mg/L) in the filtered or unfiltered samples obtained using the low-flow sampling method in November 1997. Conversely, cadmium concentrations reported for the filtered (0.021 mg/L) and unfiltered (0.021 mg/L) samples obtained using the conventional sampling method in May 1997 exceed the 0.005 mg/L MCL for drinking water. Moreover, cadmium concentrations ranging from 0.014 to 0.045 mg/L were reported for every unfiltered sample previously collected from the well. If confirmed by additional low-flow sampling results, this disparity with the historical data suggests that the conventional sampling method may induce migration of cadmium into the well. Consequently, the historical cadmium data for well GW-618, which show a fluctuating but generally decreasing long-term concentration trend (Figure 16), may not accurately reflect representative total or dissolved concentrations in the groundwater.

The CY 1997 total uranium results for samples collected from Aquifer well GW-605 in March 1997 (0.24 mg/L) and August 1997 (0.23 mg/L) exceed the UTL (0.012 mg/L) by an order of magnitude. This well yields contaminated calcium-magnesium-bicarbonate groundwater from a depth of about 40 ft bgs in the upper Maynardville Limestone approximately 1,200 ft west (upstream) of New Hope Pond (Figure 6). In addition to elevated total uranium, the historical gross alpha, gross beta, and isotopic uranium data show that well GW-605 monitors a distinctive plume of radiological (uranium) contamination originating from an unidentified (but presumably nearby)

source area which, aside from the former Oil Skimmer Basin, is the only significant source of radiological contamination in the Eastern Plant Area (U.S. Department of Energy 1998). Historical (conventional sampling) results for the well show that total uranium concentrations (and presampling water level elevations) have generally increased since the early 1990s (Figure 17), and this increasing trend coincides with generally increasing levels of gross alpha and gross beta activity in the groundwater at the well (see Section 4.4). Increasing uranium concentrations, groundwater elevations, and radioactivity levels suggest an increase in the overall flux of total and isotopic uranium.

4.3 Volatile Organic Compounds

As noted in Section 2.4, VOCs are the most pervasive groundwater contaminants in the East Fork Regime, with historical data for the available monitoring well network indicating commingled plumes of dissolved chloromethanes, chloroethenes, chloroethanes, and petroleum hydrocarbons originating from several sources areas in the Western, Central, and Eastern plant areas. As part of this evaluation of the VOC results for the network of CY 1997 sampling locations, less-than-reporting-limit results were assumed to equal zero, which likewise served as the surrogate value for false-positive VOC results.

4.3.1 Western Plant Area

Excluding false-positive results, one or more of the following VOCs were detected in at least one groundwater sample collected from Aquitard well GW-108 and Aquifer wells GW-251, GW-617, GW-618, and GW-620 (Appendix C): carbon tetrachloride, chloroform, dimethylbenzene, methylene chloride, PCE, TCE, cis-1,2-DCE, trans-1,2-dichloroethene (trans-1,2-DCE), 1,1-dichloroethene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), 1,1,1-trichloroethane (1,1,1-TCA), and toluene. Maximum summed VOC concentrations range from 6 µg/L (GW-617) to 879 µg/L (GW-251), and as shown in the following summary, the maximum concentrations of PCE (GW-251 and GW-620), TCE (GW-251, GW-618, and GW-620), cis-1,2-DCE (GW-620), vinyl chloride (GW-618), methylene chloride (GW-108), and carbon tetrachloride (GW-251) exceed applicable MCLs for drinking water.

Monitoring Well	Maximum CY 1997 Concentration and MCL (µg/L)					
	PCE	TCE	cis-1,2-DCE	Vinyl Chloride	Carbon Tetrachloride	Methylene Chloride
	5	5	70	2	5	5
GW-108	<5	(2)	<5	<10	<5	48
GW-192	(3)	(3)	17	<10	<5	<5
GW-251	600	240	8	<10	18	<5
GW-617	<5	<5	6	<10	<5	<5
GW-618	(3)	8	30	(5)	<5	<5
GW-620	110	32	94	<10	<5	<5

Note: () = Estimated concentration below the reporting limit; Bold = Exceeds MCL

The presence of dissolved VOCs in the groundwater at these wells reflects migration from the following source areas: the S-3 Ponds (GW-108), the Oil/Solvent Drum Storage Area and/or Salvage Yard Drum Deheader (GW-192), the S-2 Site (GW-251), the Fire Training Facility (GW-620), and a combination of VOC source areas (e.g., Waste Coolant Processing Area) in the Western Plant Area (GW-617 and GW-618).

Summed concentrations of VOCs detected in the groundwater samples collected from well GW-108 in March (83 µg/L) and August 1997 (64 µg/L) illustrate the substantially lower concentrations of VOCs compared to other components (e.g., nitrate) of the contaminant plume originating from the S-3 Ponds (Appendix C). Relatively low VOC concentrations probably reflect a combination of the smaller volume of organic wastes disposed at the site and lower relative mobility in the groundwater (U.S. Department of Energy 1998).

The Oil/Solvent Drum Storage Area and/or Salvage Yard Drum Deheader is the suspected source of the dissolved chloroethenes in the groundwater at well GW-192 (U.S. Department of Energy 1998). This water-table interval well (17 ft bgs) is located on the east side of the Beta-4 Security Pits (Figure 6) and comprises a well cluster with shallow bedrock well GW-191 (60 ft bgs). Presampling groundwater elevations in these wells indicate vertically upward hydraulic gradients from the shallow bedrock (Maryville Limestone) to the water table interval during seasonally high and low groundwater flow conditions. Considering the lack of VOCs in the groundwater at well GW-191 and the upward hydraulic gradients, the presence of dissolved chloroethenes in the groundwater at well GW-192 suggests strike-parallel transport in the water table interval toward discharge areas in the upper reach of BT-1 (Figure 3) (AJA Technical Services, Inc. 1997).

Moreover, the apparent preponderance of cis-1,2-DCE relative to PCE and TCE suggests natural biodegradation. As shown in the following summary of CY 1997 data, several geochemical characteristics of the groundwater are within the optimum range for anaerobic reductive dechlorination of PCE (Wilson *et al.* 1996).

Geochemical Parameter	Optimum Range	Well GW-192	
		April 1997	October 1997
Nitrate	< 1 mg/L	<0.028 mg/L	<0.028 mg/L
Iron (II)	> 1 mg/L	3 mg/L*	11 mg/L*
Sulfate	< 20 mg/L	2.85 mg/L	1.78 mg/L
REDOX	< 50 mV	43 mV**	-86 mV**
pH	5 < pH < 9	6.9**	6.6**

Note: *Results are for total iron; **Field measurement

Under anaerobic conditions, reductive dechlorination of PCE occurs according to the following sequence: PCE → TCE + Cl → DCE isomers + 2Cl → vinyl chloride + 3Cl → ethene + 4Cl (Hinchee *et al.* 1995). Several factors influence this process, including the availability of electron donors (e.g., hydrogen or carbon), and the efficiency of the process differs under methanogenic, sulfate-reducing, iron-reducing, and nitrate-reducing conditions (Chapelle 1996). The apparent lack of vinyl chloride in the groundwater at well GW-192 suggests that the strongly-reducing (methanogenic) conditions necessary to transform 1,2-dichloroethene (1,2-DCE) to vinyl chloride either do not occur or that the vinyl chloride is oxidized to carbon dioxide (Wilson *et al.* 1996). In either case, natural biodegradation probably at least partially explains the decreasing long-term VOC concentration trend indicated by historical data for the well (Figure 18).

Summed concentrations of VOCs detected in the groundwater samples collected from well GW-251 during CY 1997 (Appendix C) are generally consistent with historical data showing several dissolved chloroethenes (primarily PCE and TCE) and chloromethanes (carbon tetrachloride and chloroform) in the shallow groundwater at the S-2 Site. Historical data for the well show strongly seasonal VOC concentration fluctuations, with higher concentrations evident during seasonally high groundwater flow conditions (winter and spring). However, the apparent seasonal concentration fluctuation indicated by the CY 1997 summed VOC results may be at least partially attributed to the

change from conventional sampling in May 1997 (summed VOCs = 879 $\mu\text{g/L}$) to low-flow sampling in November 1997 (summed VOCs = 193 $\mu\text{g/L}$). Nevertheless, results for both samples are consistent with historical data showing only trace levels of 1,2-DCE isomers relative to PCE and TCE, which may indicate relatively slow co-metabolic transformation of TCE rather than reductive dechlorination of PCE (McCarty 1996). Large relative proportions of chloroform may also indicate co-metabolic transformation of carbon tetrachloride, which is possible under a wider range of anaerobic conditions (McCarty 1996). As illustrated by historical (conventional sampling) PCE data, VOC concentrations decreased steadily during seasonally high and low flow conditions through May 1995 and September 1993, respectively, with subsequent PCE data indicating relatively stable or increasing trends during both seasonal flow conditions (Figure 19). Presampling water level elevations in the well frequently show a direct relationship with PCE concentrations during seasonally low flow conditions, which suggests advective flushing. Conversely, PCE concentrations during seasonally high flow show a more frequently inverse relationship with presampling water level elevations, which suggests dilution, although the 5.3 ft increase in the groundwater elevation between May 1996 (985.7 ft msl) and May 1997 (991 ft msl) is accompanied by a sharp increase in the PCE concentration (Figure 19).

As noted in Section 4.1.1, Aquifer well GW-620 yields geochemically distinctive groundwater from the upper Maynardville Limestone downgradient of the Fire Training Facility. This well monitors a plume of dissolved VOCs, consisting primarily of chloroethenes along with lesser amounts of chloroethanes and petroleum hydrocarbons, that originates from existing and former burn areas in the western part of the site (U.S. Department of Energy 1998). Summed concentrations of VOCs detected in the samples collected from the well during May 1997 (216 $\mu\text{g/L}$) and December 1997 (222 $\mu\text{g/L}$) are consistent with historical data for the well and indicate little if any difference between conventional sampling and low-flow sampling results.

Although several geochemical characteristics of the groundwater in the well (such as the very high pH) are not within the optimum range for reductive dechlorination of PCE, the high proportions of cis-1,2-DCE relative to PCE and TCE suggest biodegradation. During co-metabolism, for example, TCE is indirectly transformed by bacteria that use petroleum hydrocarbons as a primary substrate (Wiedemeier *et al.* 1996), and these compounds are in the groundwater at the site. Also, biodegradation may explain the relatively rapid decrease in VOC concentrations evident during both

seasonally high and low groundwater flow conditions (Figure 20); summed concentrations decreased about 1,000% between April/November 1991 (>2,000 µg/L) and May/December 1997 (>200 µg/L). Nevertheless, VOC concentrations in well GW-620 remain more than an order of magnitude higher than corresponding VOC levels in the shallower groundwater at well GW-619, which is paired with GW-620, but was not sampled during CY 1997. Lower VOC concentrations in the shallower groundwater probably reflect a more direct response to source removal actions (the burn areas were moved to a concrete pad) combined with greater dilution in the shallow flow system and discharge from the water table interval (U.S. Department of Energy 1998).

Maximum summed VOC concentrations determined from CY 1997 data for Aquifer wells GW-617 (6 µg/L) and GW-618 (46 µg/L) are generally consistent with historical data for each well (Figure 20). These wells intercept water table interval (GW-617) and bedrock interval (GW-618) migration pathways for the dissolved plume(s) of chloroethenes (primarily PCE and its degradation products) originating from one or more upgradient sources in the Western Plant Area (U.S. Department of Energy 1998). Results for both wells are also consistent with historical data showing fluctuating but clearly decreasing long-term VOC concentration trends. Decreasing concentrations of VOCs in the groundwater at these wells probably at least partially reflect natural attenuation in the Aquifer. Dilution is suggested by the frequently inverse correlation between summed VOC concentrations and presampling groundwater elevations in well GW-617; VOC concentrations are typically lowest when groundwater elevations are highest (Figure 20). This contrasts with the relationship between presampling water levels and the concentrations of nitrate and sulfate in the well (as noted in Section 4.1.1), and potentially indicates recharge of nitrate- and sulfate-contaminated water leaking from a nearby subsurface drain. In addition to dilution, biodegradation may be a significant VOC attenuation mechanism in the groundwater flowpaths intercepted by GW-618. As illustrated by the CY 1997 data for well GW-618 summarized in the following table, biodegradation is suggested by the preponderance of cis-1,2-DCE relative to PCE and TCE, the detection of vinyl chloride (note that the concentrations meet or exceed the 2 µg/L MCL), the elevated chloride levels, and the low REDOX.

AQUIFER WELL GW-618				
Parameter	Units	Conventional Sampling		Low-Flow Sampling
		May 1997	May 1997 (Duplicate)	November 1997
PCE	µg/L	(1)	(3)	(3)
TCE	µg/L	(4)	(4)	8
cis-1,2-DCE	µg/L	30	31	29
Vinyl chloride	µg/L	(2)	(1)	(5)
REDOX	mV	73*	78*	-35*
Chloride	mg/L	22.5	22	23.3

Note: () = Estimated concentration below the reporting limit; *Field Measurement

The results also indicate little if any difference between conventional sampling and low-flow sampling data with respect to the VOCs detected in each sample and the relative concentrations of each compound.

4.3.2 Central Plant Area

Excluding false-positive results, one or more chloromethanes (carbon tetrachloride, chloroform, and methylene chloride), chloroethenes (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and vinyl chloride), chloroethanes (1,1,1-TCA, 1,1-DCA, and chloroethane), or petroleum hydrocarbons (benzene, dimethylbenzene, ethylbenzene, and toluene) were detected in at least one groundwater sample collected during CY 1997 from Aquifer well GW-193 and Aquitard wells GW-769, GW-770, GW-775, GW-776, GW-781, GW-782, GW-783, GW-789, GW-791, and GW-792 (see Appendix C). Summed VOC concentrations are less than 10 µg/L in wells GW-770, GW-775, GW-776, and GW-789; range between 10 and 50 µg/L in wells GW-769, GW-781, and GW-792; range between 100 and 500 µg/L in wells GW-193, GW-781, and GW-782; and exceed 2,000 µg/L in well GW-791. As shown in the following table, the maximum concentrations of PCE, TCE, 1,1-DCE, vinyl chloride, and carbon tetrachloride exceed respective MCLs.

Monitoring Well	Maximum CY 1997 Concentration and MCL (µg/L)				
	PCE	TCE	1,1-DCE	Vinyl Chloride	Carbon Tetrachloride
	5	5	7	2	5
GW-769	(2)	(1)	(1)	<10	11
GW-781	37	8	(2)	<10	<5
GW-782	200	63	44	(3)	(4)
GW-783	36	15	(4)	<10	(2)
GW-791	2,100	7	<5	<10	<5
GW-792	9	<5	<5	<10	<5

Note: () = Estimated concentration below the reporting limit; Bold = Exceeds MCL

The extent of VOC contamination in the Central Plant Area reflects input from multiple sources, including potential DNAPL in the subsurface at several sites (e.g., Waste Coolant Processing Area), intermixing in the groundwater system, and the substantial hydrologic influence exerted by subsurface drains and building sumps (U.S. Department of Energy 1998). Suspected sources of the VOCs detected in the network of wells sampled during CY 1997 include the Building 9212 vicinity (GW-791 and GW-792); several potential sites in the vicinity of Buildings 9204-2 and 9731 (GW-781, GW-782, GW-783, and possibly GW-789); Tank 2331-U (GW-193); and one or more unspecified source areas (GW-769, GW-770, GW-775, and GW-776).

The production complex in the vicinity of Building 9212 is the suspected source of the dissolved PCE plume in the groundwater at shallow bedrock well GW-791 (71 ft bgs) and water table well GW-792 (29 ft bgs). Maximum PCE concentrations in well GW-791 exceed 1,000 µg/L, which is more than 1% of maximum solubility and suggest the presence of DNAPL in the subsurface (U.S. Department of Energy 1998), whereas maximum PCE levels in the shallower groundwater at well GW-792 are typically below 30 µg/L. As shown by CY 1997 results (Appendix C), the overall lack of PCE degradation products (particularly cis-1,2-DCE) in samples from wells GW-791 and GW-792 indicates little if any natural biodegradation of the DNAPL, possibly because of aerobic conditions (dissolved oxygen >1 mg/L) and low concentrations of native and/or anthropogenic carbon in the groundwater (Weidemeier *et al.* 1996).

Because presampling groundwater elevations show upward hydraulic gradients from the bedrock (GW-791) to the water table interval (GW-792) during seasonally high and low flow conditions, the conventional and low-flow sampling results for these wells indicate that PCE

dissolved from the DNAPL in the bedrock migrates upward into the shallow flow system. Historical (conventional sampling) results for well GW-791 show a generally inverse relationship between PCE concentrations and presampling water levels during seasonally high and low flow conditions (Figure 21). Conversely, historical results for well GW-792 show that PCE concentrations are typically $<10 \mu\text{g/L}$ during seasonally high flow and exhibit a strongly inverse relationship with presampling water levels, indicating dilution from seasonal recharge, whereas PCE concentrations are typically $>10 \mu\text{g/L}$ during seasonally low flow and exhibit a more direct relationship with presampling water levels, indicating seasonal flux from the bedrock (Figure 21). Additionally, data for both wells show a fairly abrupt rise (>2 ft) in groundwater elevations after November 1995 that generally coincides with decreased PCE concentrations in each well; a particularly sharp concentration decrease is evident in well GW-791 (Figure 21). As noted in Section 4.1.2, the rise in the water level in well GW-792 also coincides with increased chloride concentrations in the well (Figure 14), suggesting inflow of water leaking from a nearby utility line, industrial process line, storm drain, or sanitary sewer. Local recharge to the bedrock may also be the reason for the rise in groundwater elevations in well GW-791. If the recharge produces greater upward flux of PCE dissolved from the DNAPL, increasing PCE concentrations may become evident in well GW-792, particularly during seasonally low flow conditions.

Aquitard wells GW-781, GW-782, and GW-783 monitor a plume of dissolved VOCs containing a mixture of chloroethenes, chloroethanes, and chloromethanes that is believed to originate from sources in the vicinity of Building 9204-2 and Building 9731 (U.S. Department of Energy 1998). These wells are completed in the upper Nolichucky Shale at depths of about 63 ft, 36 ft, and 16 ft bgs, respectively, about 100 ft west of Building 9731 (Figure 6). The CY 1997 VOC results for these wells, summarized in the following table, are consistent with respective historical data showing higher VOC concentrations in well GW-782 compared to deeper well GW-781 and shallower well GW-783.

VOC and Associated Reporting Limit (µg/L)	Concentration (µg/L)					
	Conventional Sampling May 1997			Low-Flow Sampling November 1997		
	GW-781	GW-782	GW-783	GW-781	GW-782	GW-783
PCE 5	(4)	190	36	37	200	7
TCE 5	(2)	52	15	8	63	.
cis-1,2-DCE 5	.	15	20	.	14	5
trans-1,2-DCE 5	.	7	12	.	5	.
Vinyl chloride 10	.	(3)	.	.	(3)	.
1,1,1-TCA 5	(2)	20	(2)	.	(3)	(1)
1,1-DCA 5	13	150	15	.	110	.
1,1-DCE 5	(2)	44	(4)	.	33	.
Chloroethane 10	.	(5)	.	.	(2)	.
Carbon Tetrachloride 5	.	(4)	(2)	.	.	.
Chloroform 5	.	(2)	.	.	.	.

Note: "." = Not detected; () = Estimated concentration below the reporting limit

Data for wells GW-781 and GW-783 also show significant differences between the conventional and low-flow sampling results, with greatest disparity evident for well GW-783 (if confirmed by additional low-flow sampling). Nevertheless, considering the dominantly upward hydraulic gradients indicated by presampling groundwater elevations, the conventional and low-flow sampling results for all three wells suggest upward migration of dissolved VOCs into the shallow flow system (Figure 22). Very low levels of VOCs (<5 µg/L) in shallow bedrock well GW-789 (24 ft bgs), which is located about 1,000 ft east of the GW-781/782/783 well cluster (Figure 6), suggest extensive discharge of VOC-contaminated groundwater into subsurface drains and basement sumps and/or substantial attenuation of VOCs in the shallow flow system.

Several natural attenuation processes are potentially indicated by the CY 1997 results for wells GW-781, GW-782, and GW-783. Biotic and/or abiotic degradation of 1,1,1-TCA, which is the only major chlorinated solvent that can be transformed chemically in groundwater under all likely conditions (McCarty 1996), is indicated by the preponderance of 1,1-DCA and 1,1-DCE. Temperature significantly influences the rate of abiotic transformation, with the average half-life of 1,1,1-TCA being more than 12 years at 10°C, less than five years at 15°C, and less than one year at 20°C (McCarty 1996); CY 1997 field measurements show seasonal groundwater temperatures

ranging from 16.7°C (GW-782) to 19°C (GW-781). Biodegradation of PCE is indicated by the presence of one or more intermediate degradation products (cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride) along with elevated chloride levels (18.6 - 21.1 mg/L during CY 1997) in the groundwater at wells GW-782 and GW-783. Moreover, data for well GW-782, which show consistently neutral pH, sporadically low REDOX (e.g., 18 mV in November 1997), and low nitrate (<1 mg/L) and sulfate (<20 mg/L) concentrations, suggest geochemical conditions within the optimum range for reductive dechlorination (Wilson *et al.* 1996).

As illustrated by historical PCE data for wells GW-781, GW-782, and GW-783, VOC concentrations are generally lowest during seasonally high flow conditions (Figure 22), indicating dilution from seasonal recharge, with a clearly decreasing concentration trend evident in well GW-781, a fluctuating but relatively stable trend in well GW-782, and an increasing concentration trend in well GW-783.

The source(s) of dissolved chloroethenes (PCE, TCE, and cis-1,2-DCE) and/or chloromethanes (carbon tetrachloride and chloroform) in the groundwater at Aquitard wells GW-769 and GW-770, which comprise a well cluster in the Nolichucky Shale about 200 ft northeast of Building 9201-2 (Figure 6), has not been specifically identified (U.S. Department of Energy 1998). Basement sumps in Building 9201-2 locally influence groundwater flow and contaminant transport patterns from the west and southwest of the wells. Therefore, the VOC source is potentially located to the north of the wells, possibly Buildings 9202, 9203, and 9205 where large amounts of carbon tetrachloride were used to convert uranium trioxide to uranium tetrachloride (U.S. Department of Energy 1998). Wells GW-769 and GW-770 yield calcium-magnesium-bicarbonate groundwater from the shallow bedrock interval (60 ft bgs) and water table interval (19 ft bgs), respectively. As shown by the CY 1997 data for the wells (Appendix C), which indicate little difference between conventional and low-flow sampling results, concentrations of individual compounds rarely exceed 10 µg/L and maximum summed concentrations are typically higher in well GW-769 (17 µg/L) than in well GW-770 (8 µg/L).

Presampling water level elevations in wells GW-769 and GW-770 show strongly upward hydraulic gradients during seasonally high and low groundwater flow conditions (0.07 in May 1997 and 0.06 in November 1997), indicating an upward migration of dissolved VOCs from the bedrock (GW-769) to the water table interval (GW-770). Historical (conventional sampling) data for well

GW-770 show generally concurrent fluctuations in summed VOC concentrations and presampling water level elevations in the well, which suggests advective transport of VOCs along the shallow groundwater flowpaths intercepted by the well (Figure 23). Summed VOC concentrations determined from historical (conventional sampling) data for well GW-769 also show consistently concurrent concentration fluctuations during both seasonally high and low groundwater flow conditions and a steadily increasing concentration trend between November 1994 and November 1995 followed by a decreasing trend through May 1997. This apparent "pulse" of VOCs generally mirrors the presampling water levels in the well, and suggests advective transport of VOCs in the shallow bedrock (Figure 23).

A petroleum fuel underground storage tank (Tank 2331-U) that was excavated and removed in December 1988 is the source of the residual plume of dissolved petroleum hydrocarbons in the shallow groundwater at Aquifer well GW-193 (U.S. Department of Energy 1998). Summed VOC results for the groundwater samples collected from the well in March 1997 (476 µg/L) and August 1997 (319 µg/L) are consistent with historical data for the well showing steadily decreasing concentrations of petroleum hydrocarbons, although the benzene concentrations (120 - 180 µg/L) are significantly higher than the 5 µg/L MCL (Appendix C). Decreasing concentrations of dissolved petroleum hydrocarbons in the shallow groundwater also are evident at other sites in the East Fork Regime, including the Rust Garage Area in the Western Plant Area and the Building 9754-2 Fuel Facility in the Eastern Plant Area (U.S. Department of Energy 1998). Decreased concentrations in the groundwater at each of the sites reflect the effects of remedial actions and natural attenuation in the subsurface. Reduced concentrations in the shallow groundwater near Tank 2331-U also may be partially attributable to removal of contaminated groundwater via operation of the basement sumps in Building 9201-1 (U.S. Department of Energy 1998).

4.3.3 Eastern Plant Area

Excluding false-positive results, one or more chloromethanes (carbon tetrachloride, chloroform, and methylene chloride), chloroethenes (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and vinyl chloride), or chloroethanes (1,1,1-TCA and 1,1-DCA) were detected in at least one groundwater sample collected during CY 1997 from six wells located upgradient of New Hope

Pond/Lake Reality (GW-153, GW-380, GW-383, GW-605, GW-606, and GW-763) and five wells located downgradient of New Hope Pond/Lake Reality (GW-148, GW-220, GW-722, GW-733, and GW-735); trace levels (<5 µg/L) of chloroform and PCE also were detected in surface water samples collected from LRSPW (see Appendix C). Based on CY 1997 data, summed concentrations of chloromethanes (carbon tetrachloride and chloroform) exceed 1,000 µg/L in bedrock interval wells upgradient (e.g., GW-606) and downgradient (e.g., GW-722) of New Hope Pond (Appendix C), whereas summed concentrations of chloroethenes exceed 100 µg/L only in the water-table interval wells (GW-383 and GW-763) upgradient of the site. As shown in the following summary, maximum concentrations of carbon tetrachloride, PCE, TCE, cis-1,2-DCE, and vinyl chloride exceed respective MCLs for drinking water.

Well	CY 1997 Maximum Concentration and MCL (µg/L)				
	PCE 5	TCE 5	cis-1,2- DCE 70	Vinyl Chloride 2	Carbon Tetrachloride 5
Upgradient of New Hope Pond					
GW-153	7	(2)	<5	<10	200
GW-383	350	180	130	(4)	(2)
GW-605	7	(2)	5	<10	170
GW-606	5	16	<5	<10	810
GW-763	35	8	170	24	<5
Downgradient of New Hope Pond					
GW-148	<5	<5	11	<10	<5
GW-220	45	10	(3)	<10	610
GW-722-10	12	(3)	(2)	<10	82
GW-722-14	32	5	(4)	<10	410
GW-722-17	72	11	10	<10	800
GW-722-20	58	7	7	<10	1,200
GW-722-22	44	6	5	<10	850
GW-733	(1)	<5	<5	<10	31
Note: () = Estimated concentration below the reporting limit; Bold = Exceeds MCL					

Closure of New Hope Pond and construction of Lake Reality has strongly influenced the distribution of dissolved VOCs in the Eastern Plant Area, with decreasing concentration trends generally evident in wells previously influenced by recharge from New Hope Pond and the old UEFPC stream channel,

and increasing concentration trends generally evident in wells currently influenced by the UEFPC underdrain and discharge from Lake Reality (U.S. Department of Energy 1998).

The source(s) of carbon tetrachloride in the groundwater at Aquifer wells GW-605 and GW-606, which comprise a well pair in the lower Maynardville Limestone about 1,200 ft west (upstream) of New Hope Pond (Figure 6), has not been conclusively determined. Historical records do not indicate bulk storage areas near these wells. Also, monitoring data from the vicinity of the buildings in the Central and Eastern Plant areas where large volumes of carbon tetrachloride were used for uranium processing (Buildings 9202, 9203, 9212, and 9206, none of which directly overlie the Maynardville Limestone), do not indicate extensive carbon tetrachloride contamination (U.S. Department of Energy 1998). Well GW-606 (171 ft bgs) is more than 100 ft deeper than well GW-605 (40 ft bgs), and summed concentrations of carbon tetrachloride and chloroform, as illustrated by the CY 1997 sampling results (Appendix C), are substantially higher in well GW-606 (1,020 $\mu\text{g/L}$) compared to well GW-605 (186 $\mu\text{g/L}$). These data, along with results for other Aquifer wells in the Eastern Plant Area (e.g., GW-722), suggest that a large mass of carbon tetrachloride-dominated DNAPL exists more than 500 ft bgs in the Maynardville Limestone (U.S. Department of Energy 1998).

Historical carbon tetrachloride data for well GW-606 show relatively stable if not slightly decreasing long-term concentration trends during seasonally high and low flow conditions (Figure 24). This decreasing trend may be partially attributable to biodegradation or possibly abiotic reductive transformation (McCarty 1996) of carbon tetrachloride, as indicated by the high chloroform concentrations ($>200 \mu\text{g/L}$) in the well. However, the long-term rise in the groundwater elevation in the well (Figure 24) suggests that dilution is the primary natural attenuation mechanism, particularly considering the direct hydraulic connection with UEFPC observed during installation of the well (U.S. Department of Energy 1998). Historical results for well GW-605 also show increasing groundwater elevations during seasonally high and low flow conditions along with variable and increasing carbon tetrachloride concentrations, respectively (Figure 24), and significantly lower proportions of chloroform ($<10\%$) compared to well GW-606. Increasing groundwater elevations in these wells may be at least partially related to flow augmentation in UEFPC. Since July 1996, water from the Clinch River has been pumped into the creek at a point

(Outfall 200) upstream of these wells (Figure 3) in order to regulate stream flow levels, which had decreased substantially because of reduced operations at the Y-12 Plant (U.S. Department of Energy 1998). However, the long-term rise in the groundwater elevations in these wells predate flow augmentation in UEFPC, indicating that this may be only partially responsible for the increasing water levels.

Compounds dissolved from DNAPL in the subsurface near Building 9720-6 is the suspected source of the chloroethenes in the groundwater at Aquitard well GW-383, which is located near the northwest corner of New Hope Pond (Figure 6), and Aquifer well GW-763, which is located about 500 ft west-southwest of well GW-383 (U.S. Department of Energy 1998). As shown in the following data summary, the CY 1997 conventional sampling and low-flow sampling results for well GW-383 are essentially equivalent, but the low-flow sampling results for well GW-763 differ substantially from the conventional sampling results for the well.

VOC	Concentration (µg/L)			
	Conventional Sampling April/May 1997		Low-Flow Sampling November/December 1997	
	GW-383	GW-763	GW-383	GW-763
PCE	350	35	310	<5
TCE	180	8	100	<5
cis-1,2-DCE	130	170	100	<5
trans-1,2-DCE	(2)	(3)	(1)	<5
Vinyl chloride	(4)	24	<10	(2)

Note: () = Estimated concentration below the reporting limit

The disparity between conventional sampling and low-flow sampling results for well GW-763, if confirmed by additional low-flow sampling, suggests that the historical (conventional sampling) results for the well may substantially overstate the severity of VOC contamination. In either case, however, the large proportion of cis-1,2-DCE relative to PCE and the presence of vinyl chloride in the groundwater at these wells indicate biodegradation of PCE. As noted in Section 4.1.3, elevated chloride concentrations in each well may also indicate biodegradation, and several geochemical characteristics (e.g., negative REDOX) are within the optimum range for reductive dechlorination of PCE.

Historical (conventional sampling) data for well GW-383, which is completed at a depth of about 24 ft bgs in the upper Nolichucky Shale, show generally increasing PCE concentrations during seasonally high and low flow conditions since 1989 (Figure 25). This increasing trend suggests northward migration of VOCs toward the former channel of UEFPC (U.S. Department of Energy 1998). During this same time period, concentrations of carbon tetrachloride (and chloroform) in well GW-383 decreased steadily during seasonally high flow after May 1990 and was rarely detected during seasonally low flow since August 1991 (Figure 25). The decreasing concentrations of carbon tetrachloride may be caused by an artificial hydraulic gradient created by the UEFPC underdrain system that induces inflow of shallow groundwater in the Maynardville Limestone (U.S. Department of Energy 1998).

Aquifer well GW-220 yields VOC-contaminated groundwater from the shallow bedrock interval (45 ft bgs) in the lower Maynardville Limestone about 200 ft east (downgradient) of New Hope Pond (Figure 6). The summed VOC results (Appendix C) for the groundwater samples collected from the well in May 1997 (532 $\mu\text{g/L}$) and December 1997 (682 $\mu\text{g/L}$) do not indicate significant differences between conventional and low-flow sampling results and are consistent with historical (conventional sampling) data with respect to the types of compounds and their relative concentrations.

Historical data for well GW-220 show steadily increasing carbon tetrachloride and PCE concentrations following their initial detection in August 1988 (5 $\mu\text{g/L}$) and October 1988 (2 $\mu\text{g/L}$), respectively (Figure 25). Concentrations of these compounds are typically highest during seasonally high flow, with particularly sharp concentration increases evident between May 1994 and February 1995 and generally decreased concentrations during seasonally low flow after November 1994. However, these long-term concentration trends do not exhibit any clear relationship with seasonal groundwater elevations in the well.

As noted in Section 3.2, groundwater samples were obtained with Westbay™ multiport sampling equipment from 10 depth intervals in Aquifer well GW-722, which is located about 1,000 ft east (downgradient) of New Hope Pond (Figure 6). This well monitors the carbon tetrachloride dominated plume of dissolved VOCs in the Maynardville Limestone that originates upgradient (west) of wells GW-605 and GW-606 and extends along strike beneath New Hope Pond

into Union Valley east of the ORR boundary along Scarborough Road (Figure 5). The CY 1997 VOC results for the well, summarized below, show that the lower boundary of the plume is more than 500 ft bgs and that the highest summed concentrations of chloromethanes (carbon tetrachloride and chloroform), chloroethenes (PCE, TCE, cis-1,2-DCE, and 1,1-DCE), and chloroethanes (1,1,1-TCA and 1,1-DCA) occur in water producing intervals between 300 and 400 ft bgs.

AQUIFER WELL GW-722				
Sampling Port	Depth (ft bgs)	Maximum Summed Concentration (µg/L)		
		Chloromethanes	Chloroethenes	Chloroethanes
33	90	(2)	0	0
32	110	(2)	0	0
30	153.9	0	0	0
26	218.9	(1)	(3)	0
22	315.8	888	56	(3)
20	335.8	1,257	74	7
17	387.7	867	91	9
14	427.7	445	41	(3)
10	502.6	104	17	0
06	562.6	0	0	0

Note: () = Estimated concentration(s) below the reporting limit(s)

The decrease in the carbon tetrachloride concentration from more than 1,000 µg/L (GW-722-20) to about 100 µg/L (GW-722-10) combined with the increase in the proportion of chloroform from less than 4% (GW-722-22) to more than 20% (GW-722-10) of summed chloromethanes suggest that the efficiency of abiotic and/or biotic degradation of carbon tetrachloride increases with depth. The relative proportions of PCE and 1,1,1-TCA degradation products (cis-1,2-DCE and 1,1-DCA, respectively) show similar increases with depth and likewise suggest more efficient biodegradation (PCE) and/or chemical transformation (1,1,1-TCA) in the deeper groundwater.

4.4 Radioactivity

Evaluation of groundwater quality with respect to radiological contamination was based primarily on CY 1997 analytical results for gross alpha and gross beta that exceed the associated MDA and counting error (which expresses the degree of analytical uncertainty) reported for each sample (AJA Technical Services, Inc. 1998). Results that exceed MDAs and counting errors were

used to determine the annual average gross alpha and/or gross beta activity for each applicable sampling location. Annual average gross alpha activity above the Safe Drinking Water Act (SDWA) drinking water MCL of 15 picoCuries per liter (pCi/L) and annual average gross beta activity above the SDWA threshold value of 50 pCi/L were the focus of this evaluation.

Few of the monitoring wells in the East Fork Regime that were sampled during CY 1997 yield radiologically contaminated groundwater. Gross alpha activity that exceeds the associated MDA and counting error was reported for a total of 20 groundwater samples collected from 15 monitoring wells during CY 1997 (Table 6). However, only the gross alpha results for wells GW-782 and GW-605 exceed 15 pCi/L; results for the remaining wells range from 2.1 ± 1.9 pCi/L (GW-745) to 13 ± 4.7 pCi/L (GW-251). Similarly, only the gross beta activities reported for wells GW-108, GW-251, GW-782, and GW-605 exceed associated MDAs and counting errors, and only the results for wells GW-108 and GW-605 exceed 50 pCi/L (Table 6).

As illustrated by the gross beta results for the groundwater samples collected from well GW-108 in March 1997 ($8,000 \pm 600$ pCi/L) and August 1997 ($13,000 \pm 1,100$ pCi/L), radiological contamination in the East Fork Regime is highest in the Aquitard south of the Y-12 Plant Salvage Yard. Although historical groundwater monitoring data and operational information for the S-3 Ponds indicate a diverse population of alpha- and beta-emitting radioisotopes within the plume, beta radioactivity is primarily from ^{99}Tc . Because the S-3 Ponds is the sole source of ^{99}Tc in BCV, the confirmed detection of this radionuclide provides direct evidence for groundwater/surface water transport from the plume of contamination originating from the site (U.S. Department of Energy 1998). Under oxidizing conditions, ^{99}Tc occurs as the pertechnetate anion (TcO_4^-) which is soluble and highly mobile in groundwater (Gee et al. 1983). This high mobility explains the similar distribution of gross beta activity and nitrate from the S-3 Ponds and likewise reflects strike-parallel transport of ^{99}Tc combined with upward vertical migration from the reservoir of contamination deeper in the Nolichucky Shale. Most of the historical gross beta results for well GW-108 are qualitative because of DQO problems regarding sample-specific MDAs (U.S. Department of Energy 1998), but a generally upward long-term trend is evident during seasonally high and low flow conditions (Figure 26).

Gross alpha activity reported for the groundwater sample collected from well GW-782 in May (44 ± 8 pCi/L) and November 1997 (56 ± 9.4 pCi/L) are consistent with historical data for the well and indicated little if any significant difference between conventional and low-flow sampling results. Elevated gross alpha activity (i.e., >15 pCi/L) in the groundwater at this well contrasts sharply with historical and CY 1997 data showing background levels (i.e., $<MDA$) in the shallower (GW-783) and deeper (GW-781) wells clustered with GW-782. Historical gross alpha results and presampling water levels for well GW-782 clearly show an inverse relationship during seasonally high flow conditions, including a particularly sharp activity decrease and water level increase following a 1.8-inch rainfall in March 1995 (Figure 27). This strongly suggests dilution from non-radiologically contaminated recharge. Assuming the gross alpha activity is from uranium isotopes, the low gross alpha levels reported for well GW-783 and background levels of gross alpha in the deeper groundwater at well GW-781 may indicate somewhat stratabound (strike- or dip-parallel) transport along the groundwater flowpaths intercepted by well GW-782.

As noted in Section 4.2, Aquifer well GW-605 monitors a distinctive plume of radiological contamination in the Maynardville Limestone that originates from an unidentified but presumably nearby source area (U.S. Department of Energy 1998). Historical data for this well indicate that the alpha and beta radioactivity is from uranium isotopes (^{234}U and ^{238}U) that probably occur as uranyl cations, which are prone to pH-sensitive sorption reactions and consequently are not usually highly mobile in groundwater (Fetter 1993), further indicating that the source of the uranium isotopes is probably not far from the well. Seasonally fluctuating but generally increasing alpha radioactivity in the groundwater at well GW-605 potentially reflects an increased flux of uranium isotopes in the shallow flow system (Figure 27).

5.0 CONCLUSIONS AND RECOMMENDATIONS

Groundwater and surface water quality data obtained during CY 1997 are generally consistent with previous monitoring results showing VOCs, nitrate and other inorganics (e.g., chloride), several trace metals, and radioactivity as the primary groundwater contaminants in the East Fork Regime. The bulk of the results for the network of monitoring wells sampled during CY 1997 are consistent with historical data with respect to the types of contaminants detected, the concentrations of the contaminants, and long-term contaminant concentration trends. However, the results for several of the wells show substantial differences between the types and concentrations of contaminants detected in samples obtained using the conventional sampling method, which has been used since the late 1980s, compared to results for samples obtained using the low-flow minimal drawdown sampling method. The low-flow sampling method was initiated during the fourth quarter of CY 1997 and is expected to be extensively used for groundwater sampling in the future. The contrast between the conventional and low-flow sampling results suggests that historical data may overstate the severity of contamination in the groundwater at some wells (e.g., well GW-251 at the S-2 Site). In either case, the CY 1997 groundwater monitoring data do not indicate any significant change in the extent of groundwater contamination in the East Fork Regime.

The CY 1997 and historical VOC data for several wells in the regime suggest abiotic and/or biotic anaerobic degradation of chlorinated solvents in the groundwater at several VOC source areas in the East Fork Regime (e.g., the Fire Training Facility). Conversely, the CY 1997 and historical results for several other wells with VOC-contaminated groundwater, particularly Aquitard wells GW-791 and GW-792 at Building 9212, suggest little if any natural biodegradation. However, few of the field measurements of dissolved oxygen and REDOX reported for the wells that monitor dissolved VOC plumes characterized by large proportions of degradation products (e.g., cis-1,2-DCE and chloroform) relative to parent compounds (PCE and carbon tetrachloride) are within the range under which biodegradation may occur. This suggests that the dissolved oxygen and REDOX data for many of these wells may not be representative of actual groundwater conditions.

Based on evaluation of the CY 1997 groundwater monitoring data, the following actions are recommended:

- A thorough review of the procedure and equipment used to obtain field measurements of REDOX and dissolved oxygen should be performed to more clearly determine if and why nonrepresentative results are being obtained.
- Because the effectiveness of natural biodegradation of the VOC plumes in the East Fork Regime may play a key role in remedial action decisions, selected wells that monitor VOC-contaminated groundwater in the regime should be sampled to obtain data needed to evaluate the effectiveness of biodegradation. To ensure selection of the best candidate wells for biodegradation sampling, historical VOC results and geochemical data for all VOC-contaminated wells in the regime should be reviewed. In addition to alkalinity, chloride, nitrate, sulfate, dissolved oxygen, temperature, pH, and REDOX, which are currently included in the standard suite of field and laboratory analytes, the groundwater samples from the selected wells should be analyzed for the following parameters and constituents: ammonia, iron(II), sulfide, methane, total organic carbon, carbon dioxide, hydrogen, and ethene/ethane (Wiedemeier *et al.* 1996).
- Groundwater monitoring activities in the East Fork Regime should be focused on sampling locations within the Eastern Plant Area: the exit-pathway for groundwater and surface water contaminants in the regime. Where appropriate, wells in the Western and Central plant areas should be dropped from semi-annual sampling and replaced with wells located in the vicinity of New Hope Pond and Lake Reality.
- There are sufficient historical data to enable modification of the standard suite of laboratory analytes for most of the wells in the East Fork Regime, particularly wells located in the Western and Central plant areas. For instance, analyses for gross alpha and gross beta could be discontinued for all the wells that do not have a prior history of radiological contamination.
- Collection of filtered groundwater samples could be discontinued for most of the wells in the East Fork Regime without significantly impacting the overall effectiveness of groundwater monitoring activities in the regime. Analytical results for the filtered samples are used primarily to qualify (discount) the corresponding trace metal results for turbid unfiltered samples. Because the current low-flow sampling method should presumably result in the collection of fewer turbid unfiltered samples, continued collection of filtered samples may not be warranted.

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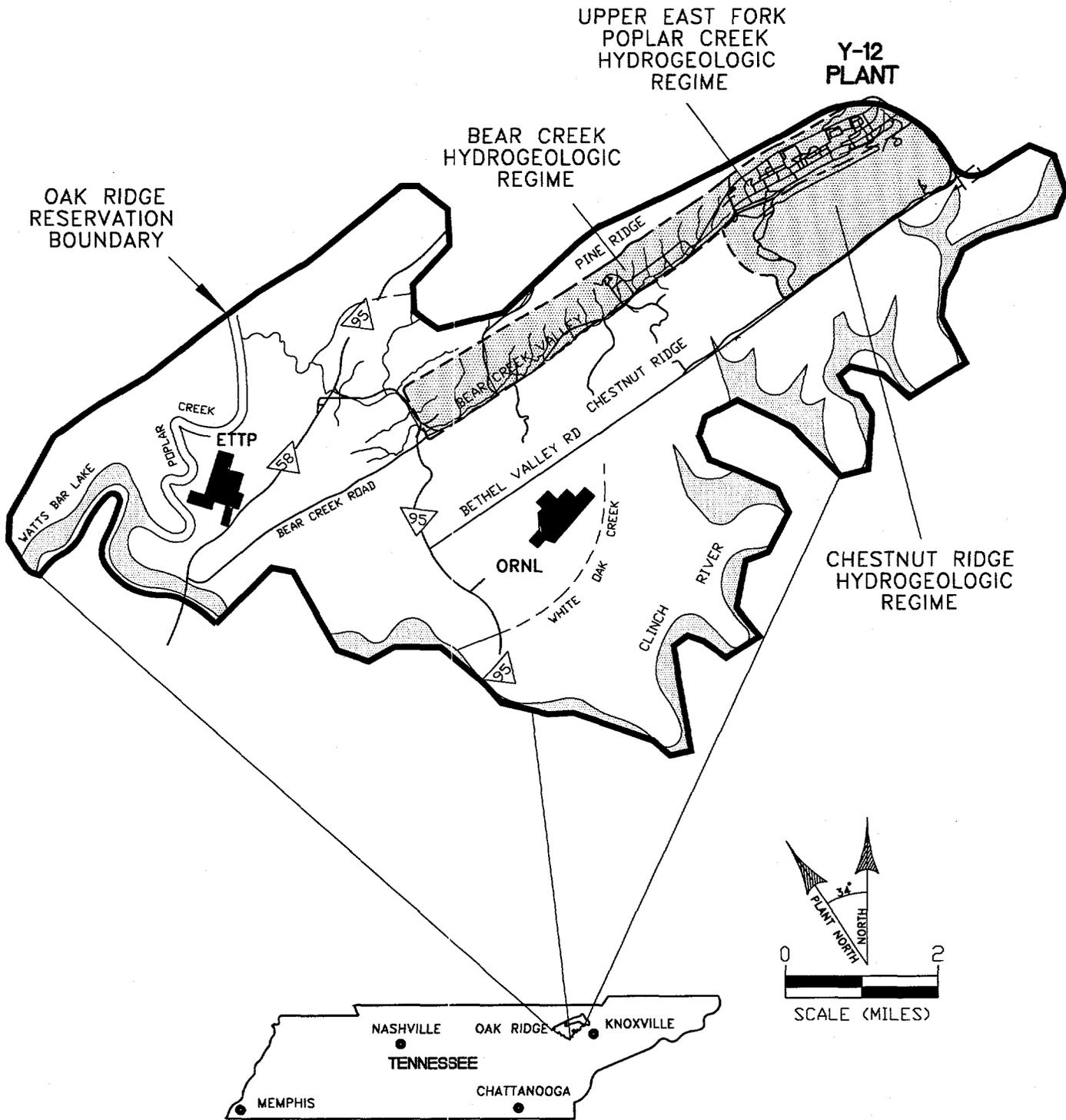
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APPENDIX A

FIGURES



PREPARED FOR:
**LOCKHEED MARTIN
ENERGY SYSTEMS, INC.**

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 1

PREPARED BY:

**AJA TECHNICAL
SERVICES, INC.**

DOC NUMBER:

MVM64V/3

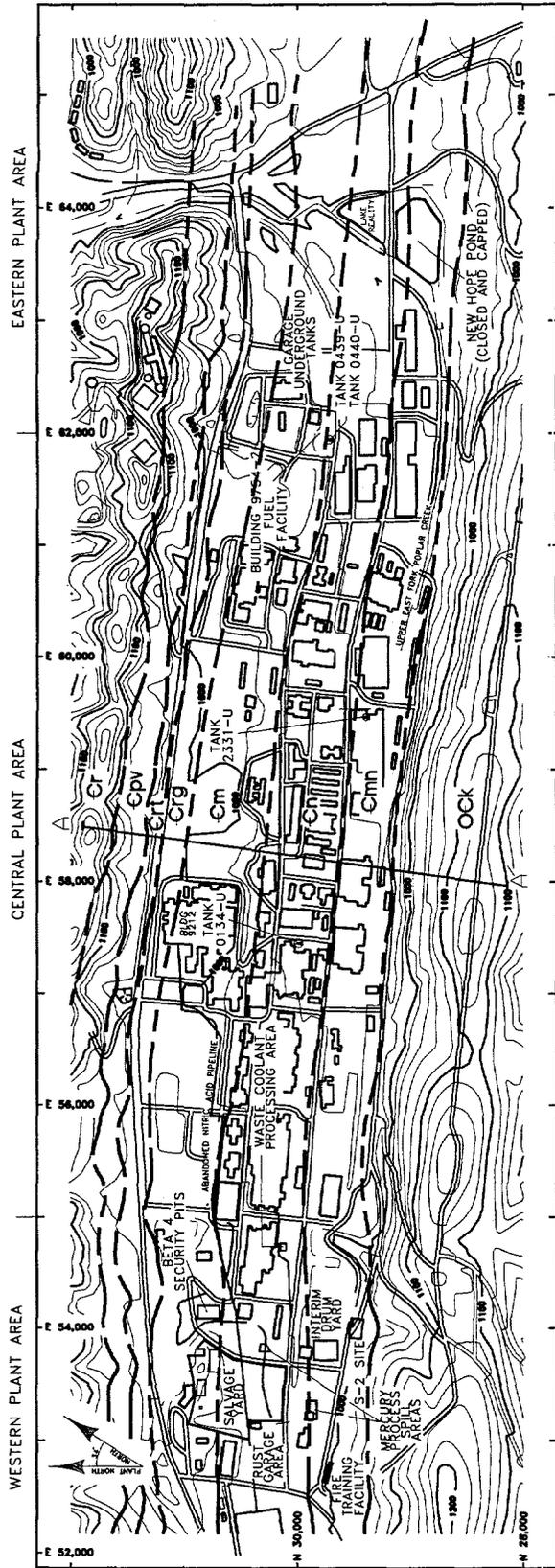
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DATE:

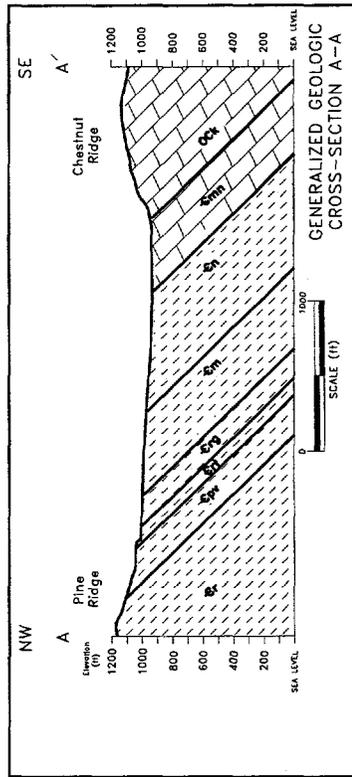
9-15-98

**HYDROGEOLOGIC REGIMES
AT THE Y-12 PLANT**



SOURCE: King and Haase, 1987

SYSTEM GROUP	HYDRO UNIT	FORMATION	MAP SYMBOL	THICKNESS (ft)
CAMBRIAN	KNOX	COPPER RIDGE DOLOMITE	Ock	NOT DETERMINED
		MAYNARDVILLE LIMESTONE	Cmn	418-450
ORR AQUITARDS	CONASAUGA	NOLICHUCKY SHALE	Cn	422-550
		MARYVILLE LIMESTONE	Cm	346-445
		ROGERSVILLE SHALE	Cr9	90-120
		RUTLEDGE LIMESTONE	Cr1	90-120
LOWER		PUMPKIN VALLEY SHALE	Cpv	260-320
MIDDLE		ROME FORMATION	Cr	NOT DETERMINED
UPPER				



PREPARED FOR:
LOCKHEED MARTIN
ENERGY SYSTEMS, INC.

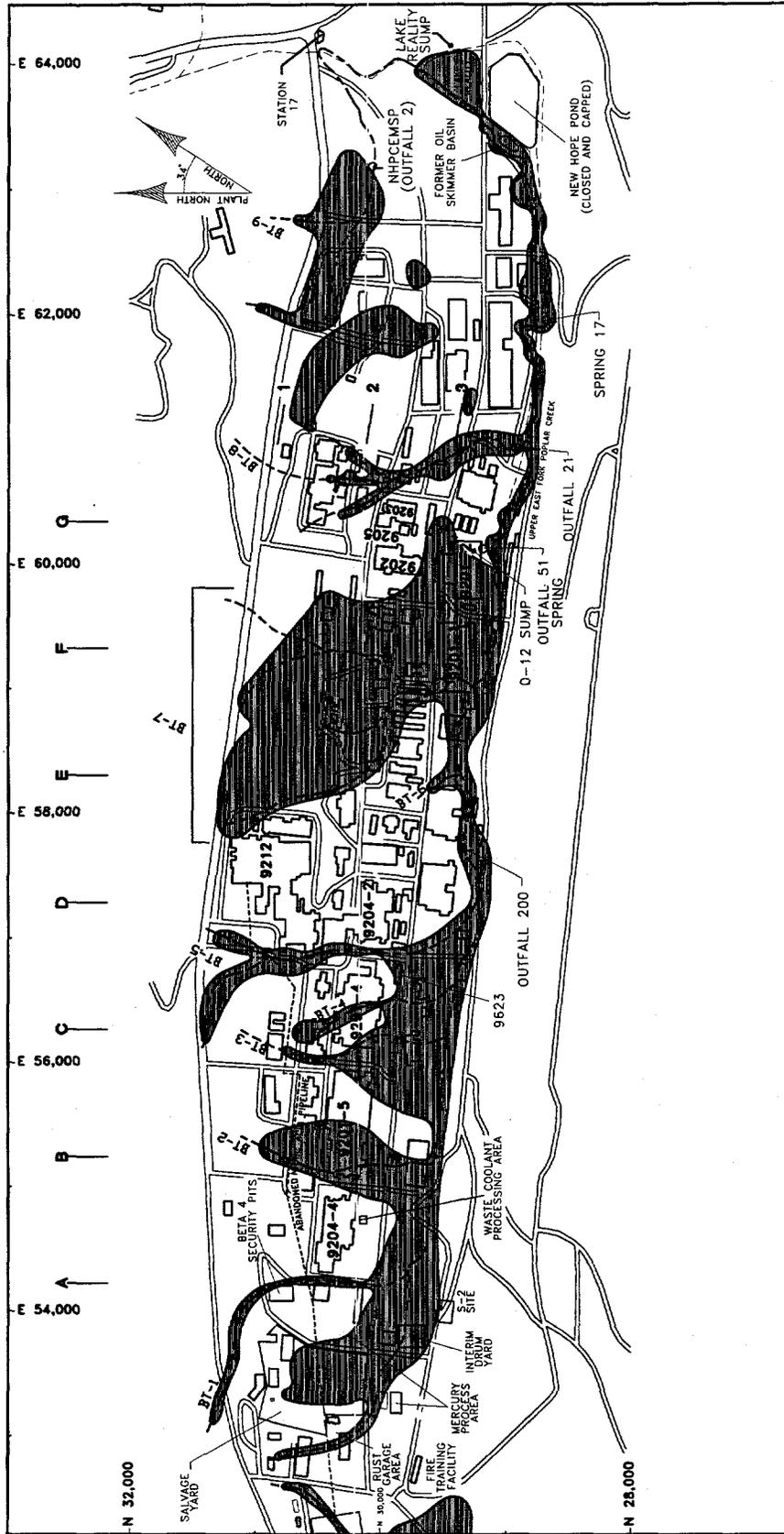
LOCATION: Y-12 PLANT
OAK RIDGE, TN.

FIGURE 2

PREPARED BY:
AJA TECHNICAL
SERVICES, INC.

DOC NUMBER: MVM64V/3
DWG ID.: 96-071
DATE: 9-15-98

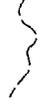
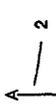
TOPOGRAPHY AND BEDROCK GEOLOGY
IN THE EAST FORK REGIME



SOURCE: Sutton and Field 1995



EXPLANATION

-  - THICKNESS GREATER THAN 5 FT
-  - BURIED TRIBUTARY (BT--)
-  - COMPREHENSIVE GROUNDWATER MONITORING GRID
-  - SPRING

PREPARED FOR:
**LOCKHEED MARTIN
 ENERGY SYSTEMS, INC.**

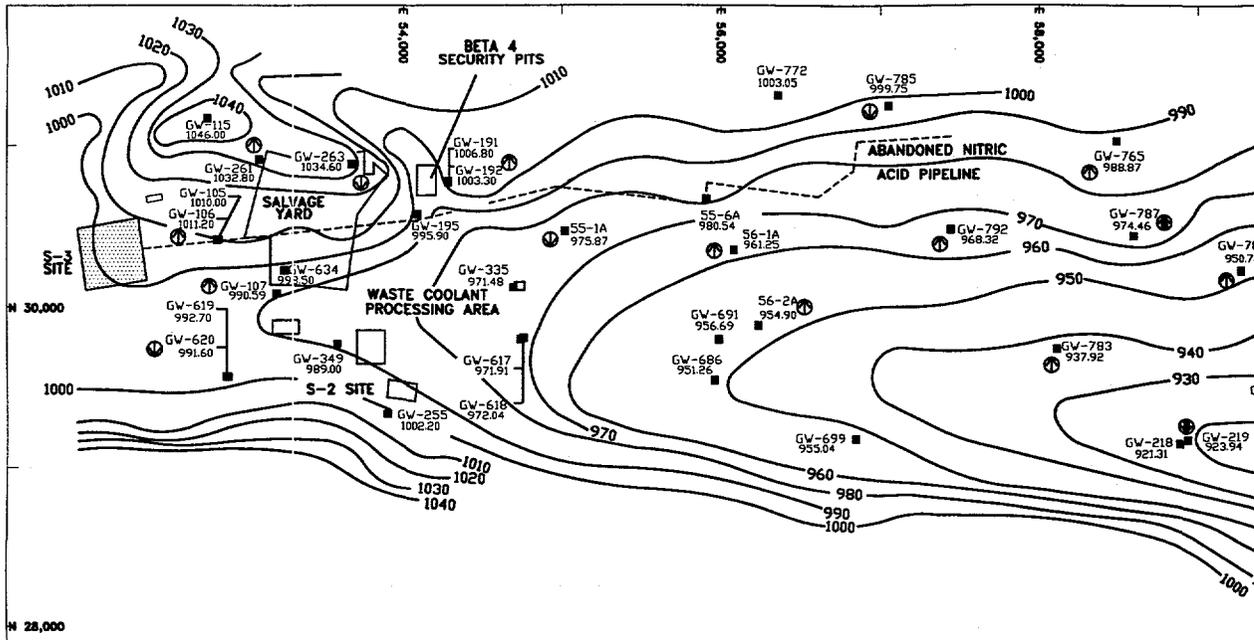
LOCATION: Y-12 PLANT
 OAK RIDGE, TN.

FIGURE 3

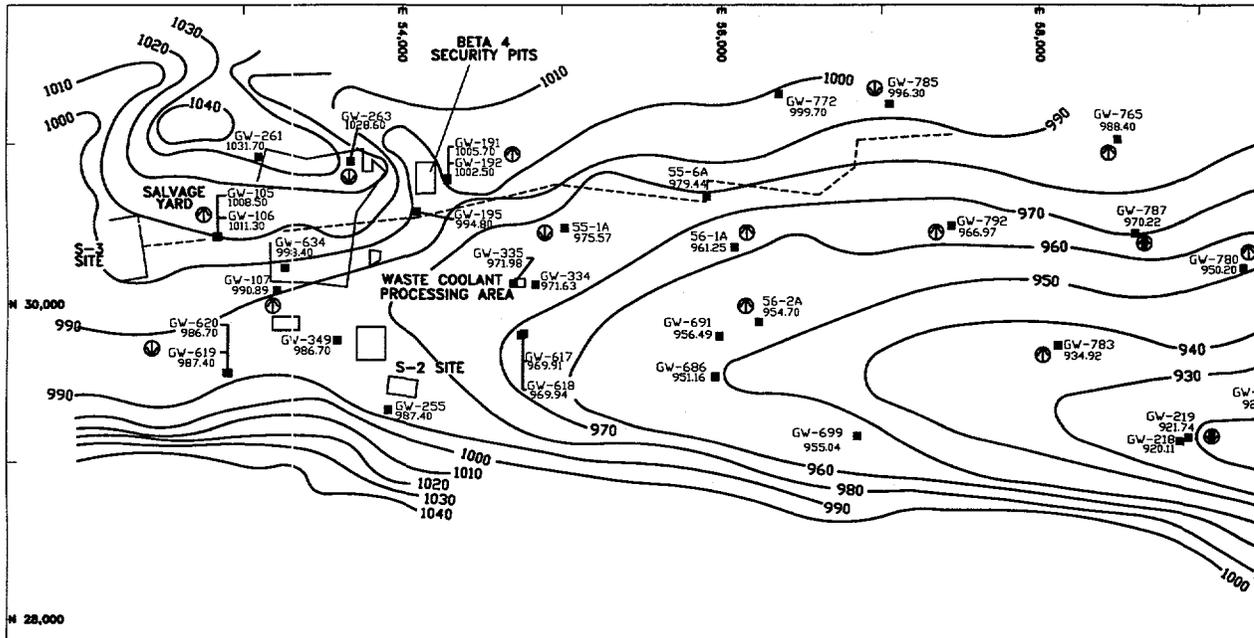
PREPARED BY:
**AJA TECHNICAL
 SERVICES, INC.**

DOC NUMBER: MVM64V/3
 DWG ID.: 96-068
 DATE: 8-15-98

FILL AREAS IN THE Y-12 PLANT
 AND PRECONSTRUCTION DRAINAGE FEATURES



MARCH 31 - APR

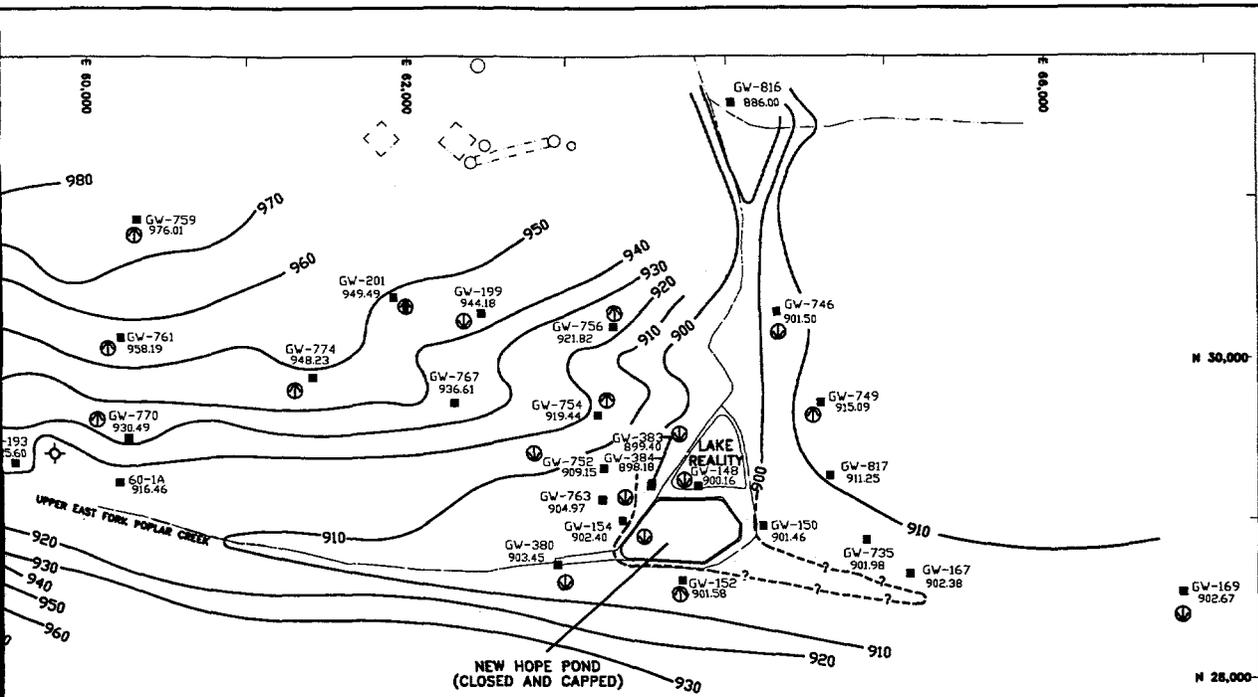


OCTOBER 8 -

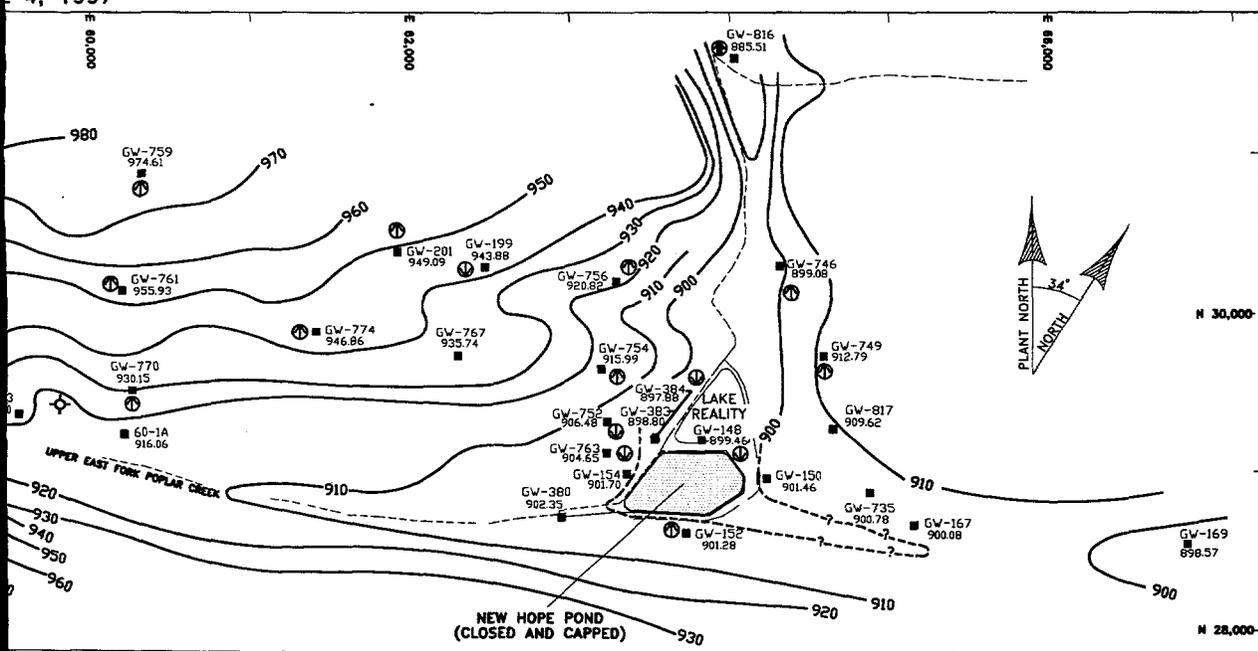


EXPLANATION

<p>GW-618 969-94</p> <p>— Water Table Monitoring Well and Water-Level Elevation (ft msl)</p> <p>— Approximate Water-Level Isopleth (ft msl)</p> <p>— Surface Drainage Feature</p> <p>◇ — 0-12 Sump (Building 9201-2)</p>	<p>Vertical Hydraulic Gradient Determined From Data For Paired Wells</p> <table border="0"> <tr> <td>0.01-0.09</td> <td>0.1-0.9</td> <td>— Less Than 0.01 was Considered Insignificant</td> </tr> <tr> <td>⊕</td> <td>⊗</td> <td>— Upward Gradient</td> </tr> <tr> <td>⊖</td> <td>⊙</td> <td>— Downward Gradient</td> </tr> </table>	0.01-0.09	0.1-0.9	— Less Than 0.01 was Considered Insignificant	⊕	⊗	— Upward Gradient	⊖	⊙	— Downward Gradient
0.01-0.09	0.1-0.9	— Less Than 0.01 was Considered Insignificant								
⊕	⊗	— Upward Gradient								
⊖	⊙	— Downward Gradient								

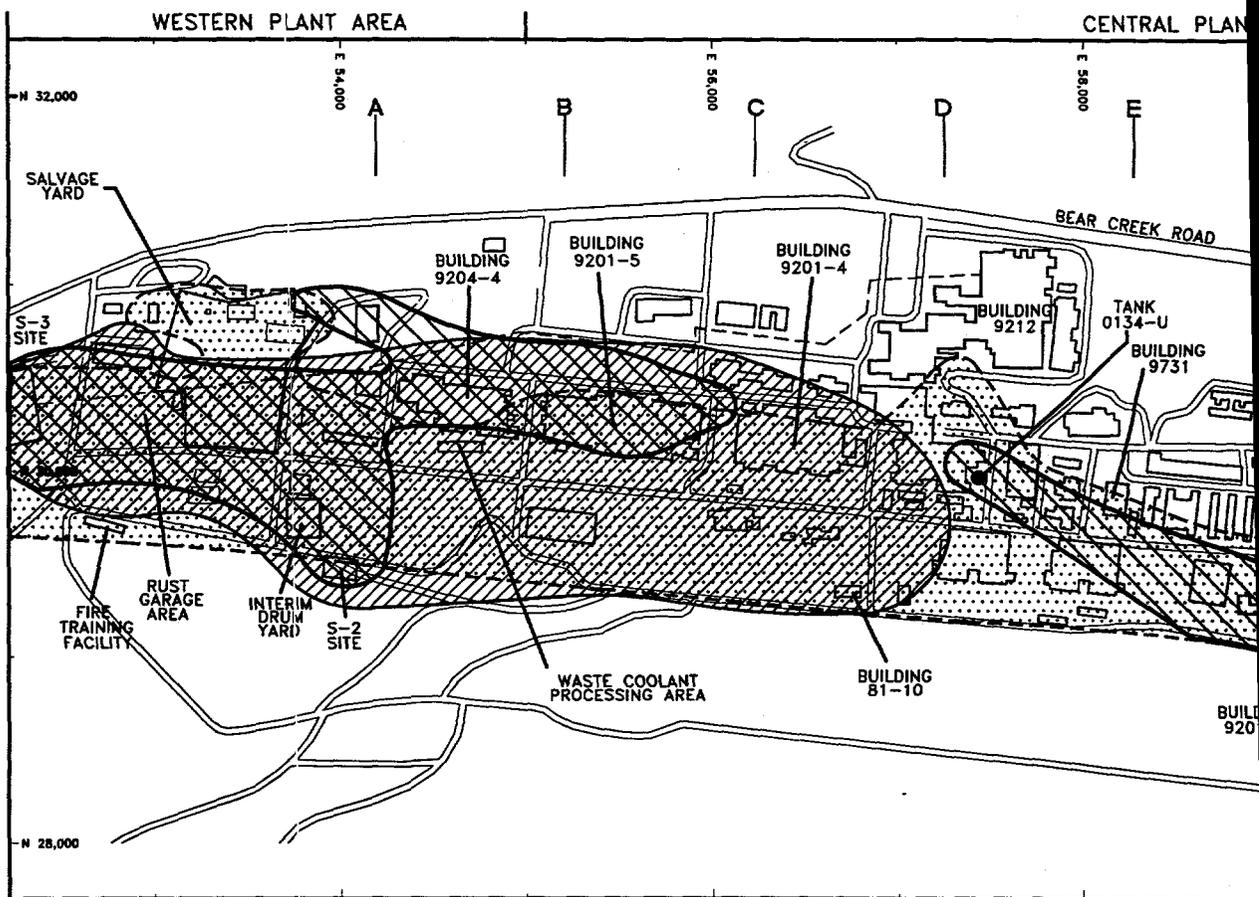


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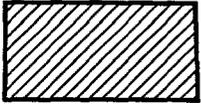
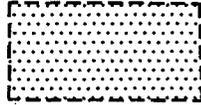
PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION: Y-12 PLANT OAK RIDGE, TN.	FIGURE 4 SEASONAL GROUNDWATER ELEVATIONS IN THE WATER TABLE INTERVAL, CY 1997
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC NUMBER: MVM64V/3	
	DWG ID.: 97-010	
	DATE: 8-15-98	



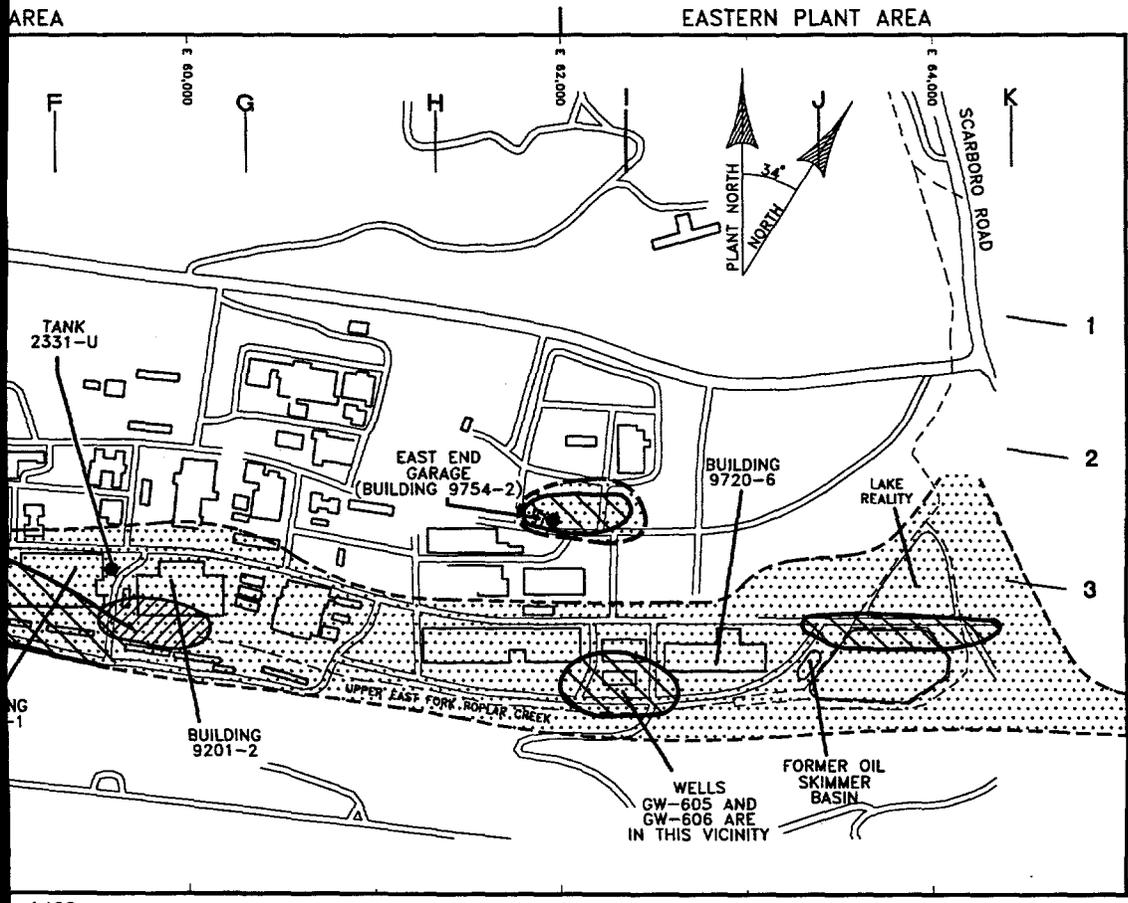
NOTE: MODIFIED FROM U.S. DEPARTMENT OF ENERGY 1998



EXPLAN

- 
2 - COMPREHENSIVE GROUND
- 
- NITRATE
- 
- VOCs
- 
- RADIOACTIVITY
(GROSS ALPHA AND GROSS BETA)

PR
F

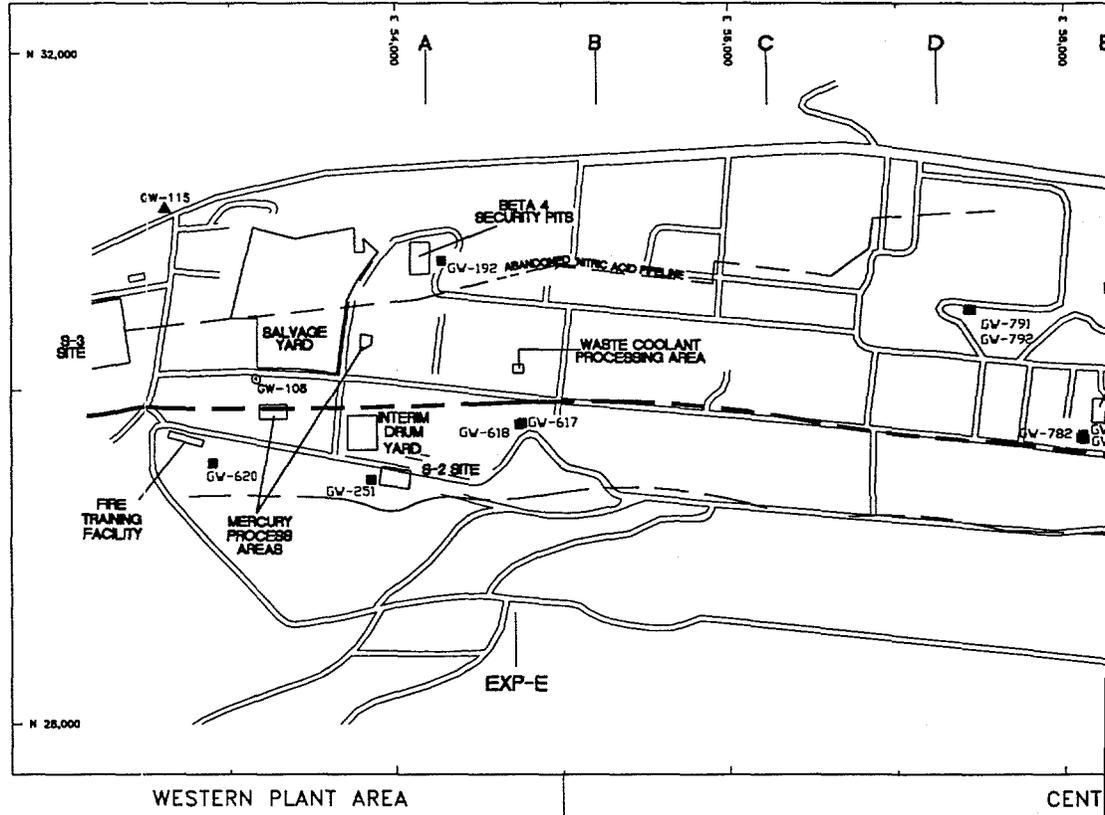


1400
 INFORMATION

WATER MONITORING GRID

SS BETA)

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 5 SOURCE AREAS AND GENERALIZED EXTENT OF GROUNDWATER CONTAMINATION IN THE EAST FORK REGIME
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC NUMBER:		MVM64V/3
	DWG ID.:	98-075	
	DATE:	8-15-98	

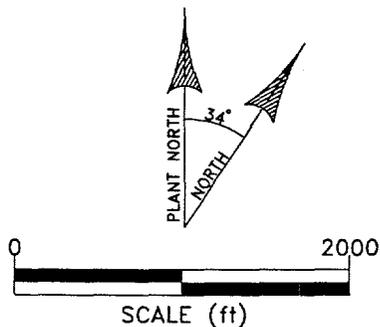
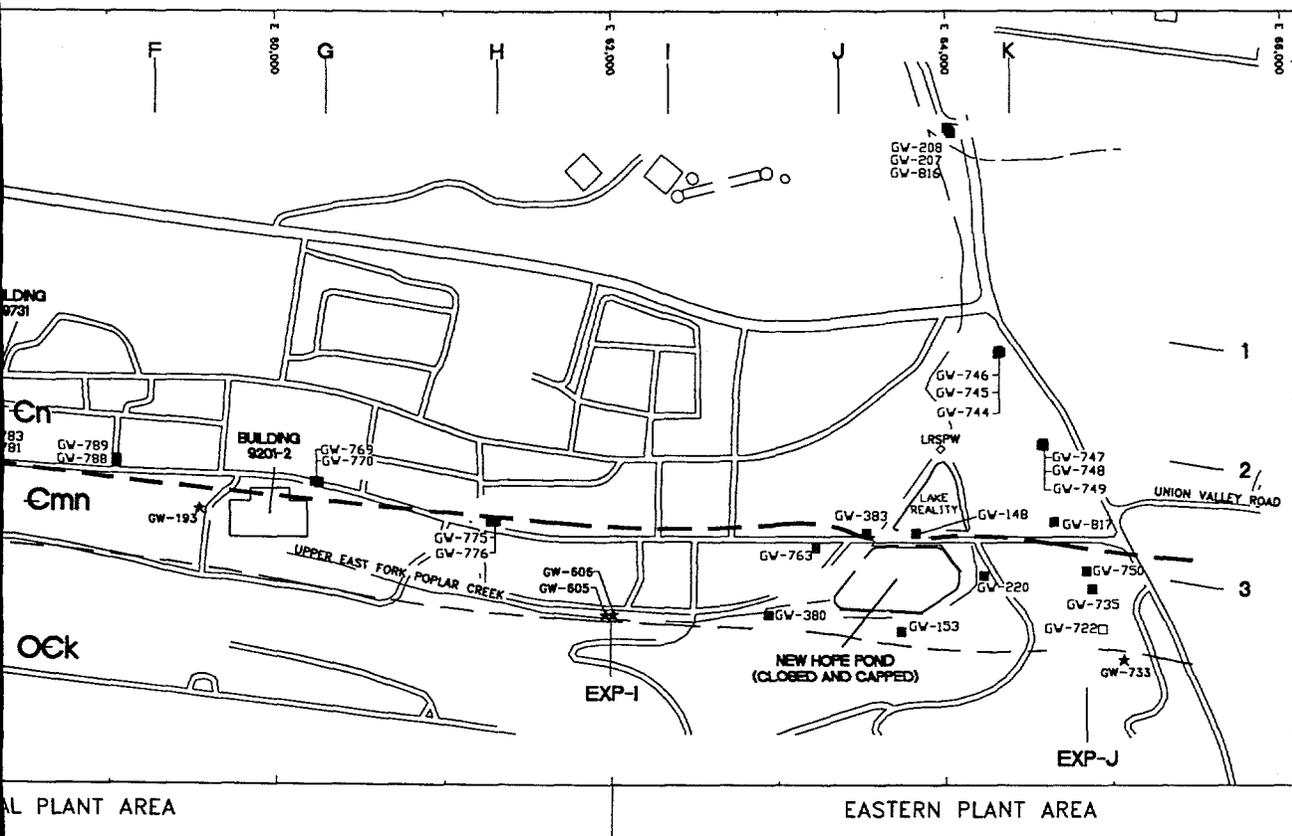


WESTERN PLANT AREA

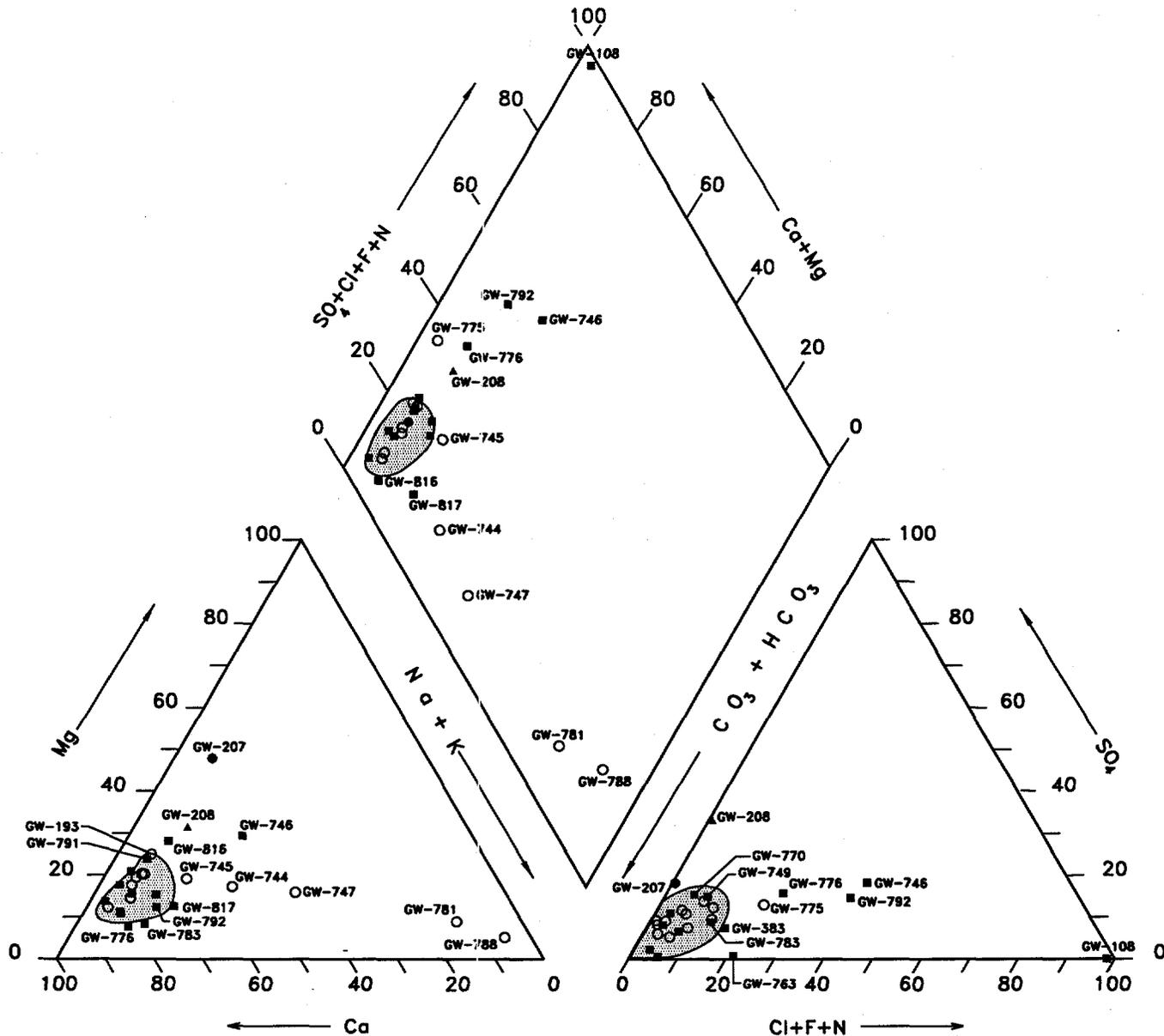
CENTRAL PLANT AREA

EXPLANATION

- — Monitoring Well
 - ▲ — RCRA Background Well
 - ⊙ — RCRA Point-of-Compliance Well
 - ★ — RCRA Plume Boundary Well
 - — Monitoring Well equipped with a Westbay Multiport Sampling System
 - LRSPW ⊙ — Lake Reality Spillway
 - EXP-J — Exit Pathway, Maynardville Limestone Pickle
- K
|
— 1 — Comprehensive Groundwater Monitoring Grid
- Cn — NOLICHUCKY SHALE ———— AQUITARD
 - Cmn — MAYNARDVILLE LIMESTONE ————
 - Ock — KNOX GROUP ———— AQUITARD



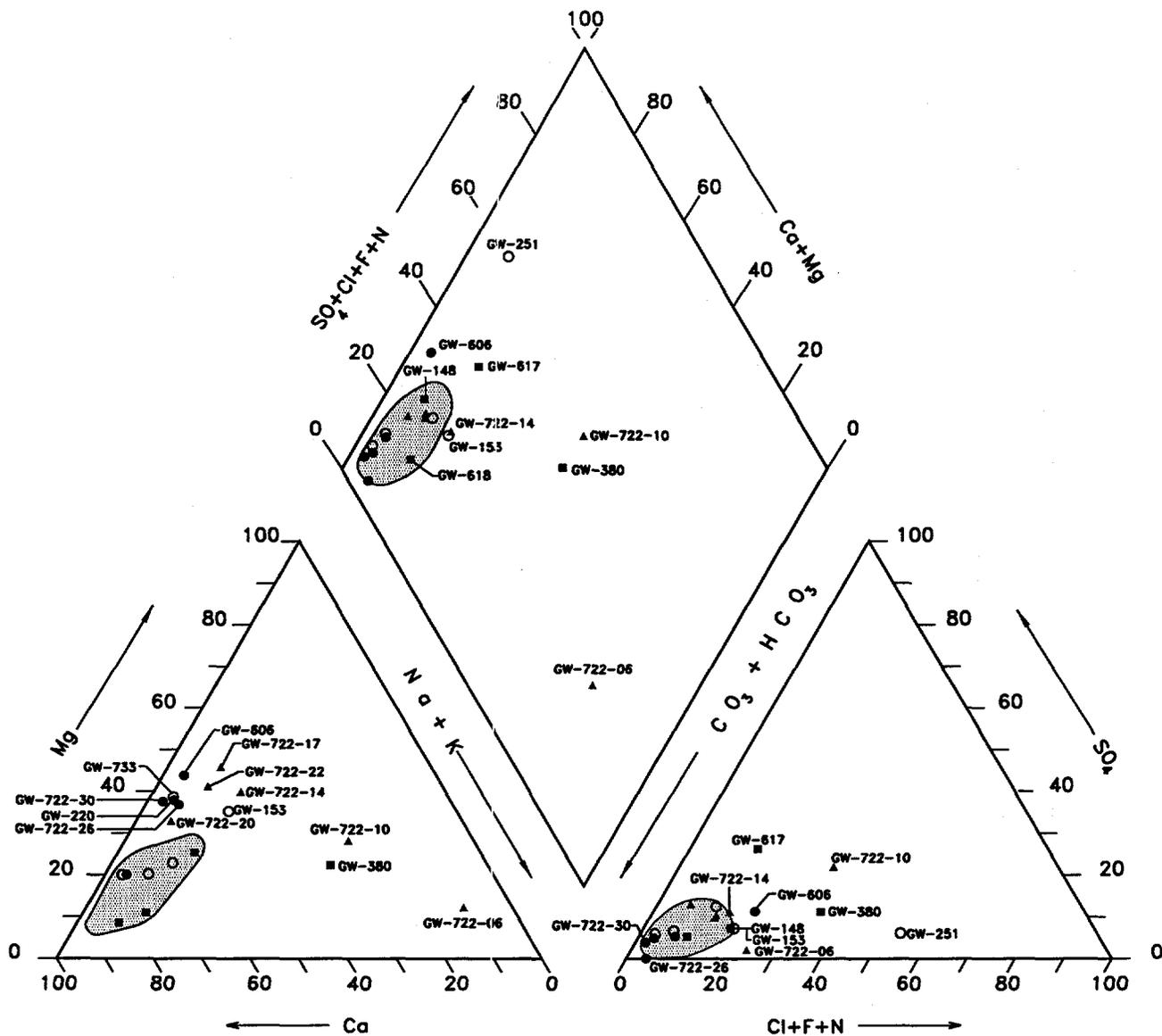
PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 6
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC NUMBER:	MVM64V/3	
	DWG ID.:	97-009	
	DATE:	8-15-98	



EXPLANATION

- GROUNDWATER COMPOSITIONS CLUSTER IN THESE AREAS, 28 SAMPLING LOCATIONS ARE PLOTTED
- WATER TABLE MONITORING WELL
- BEDROCK MONITORING WELL, LESS THAN 100 FT DEEP
- BEDROCK MONITORING WELL, 100 TO 300 FT DEEP
- BEDROCK MONITORING WELL, GREATER THAN 300 FT DEEP

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 7 MAJOR ION CHEMISTRY OF CY 1997 GROUNDWATER SAMPLES FROM AQUITARD WELLS
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC NUMBER:		MVM64V/3
	DWG ID.:	96-073	
	DATE:	8-15-98	



EXPLANATION



— GROUNDWATER COMPOSITIONS CLUSTER IN THESE AREAS
20 SAMPLING LOCATIONS ARE PLOTTED

- — WATER TABLE MONITORING WELL
- — BEDROCK MONITORING WELL, LESS THAN 100 FT DEEP
- — BEDROCK MONITORING WELL, 100 TO 300 FT DEEP
- ▲ — BEDROCK MONITORING WELL, GREATER THAN 300 FT DEEP

PREPARED FOR:
**LOCKHEED MARTIN
ENERGY SYSTEMS, INC.**

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

PREPARED BY:

**AJA TECHNICAL
SERVICES, INC.**

DOC NUMBER:

MVM64V/3

DWG ID.:

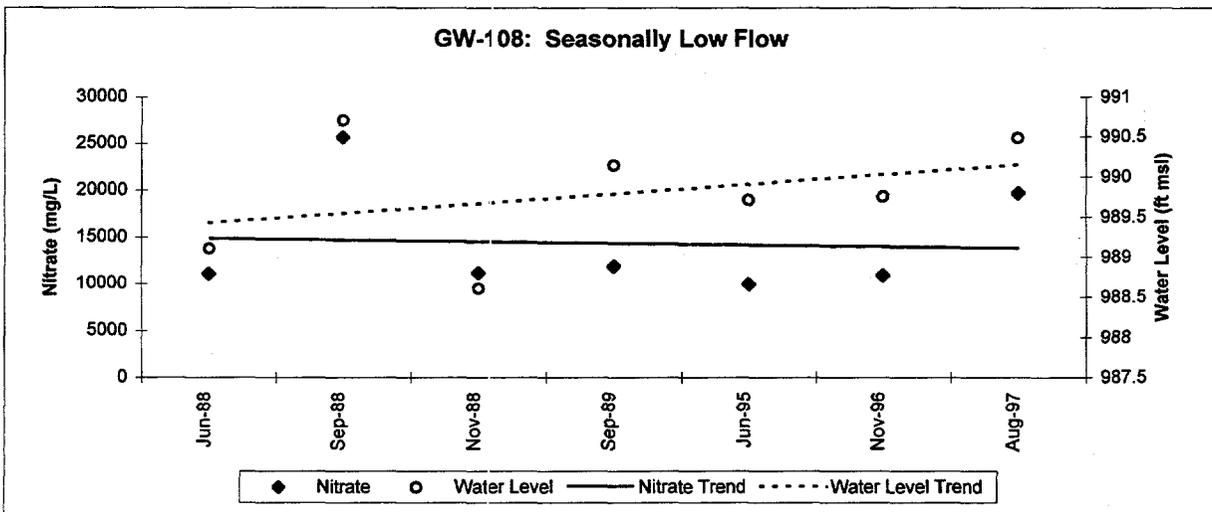
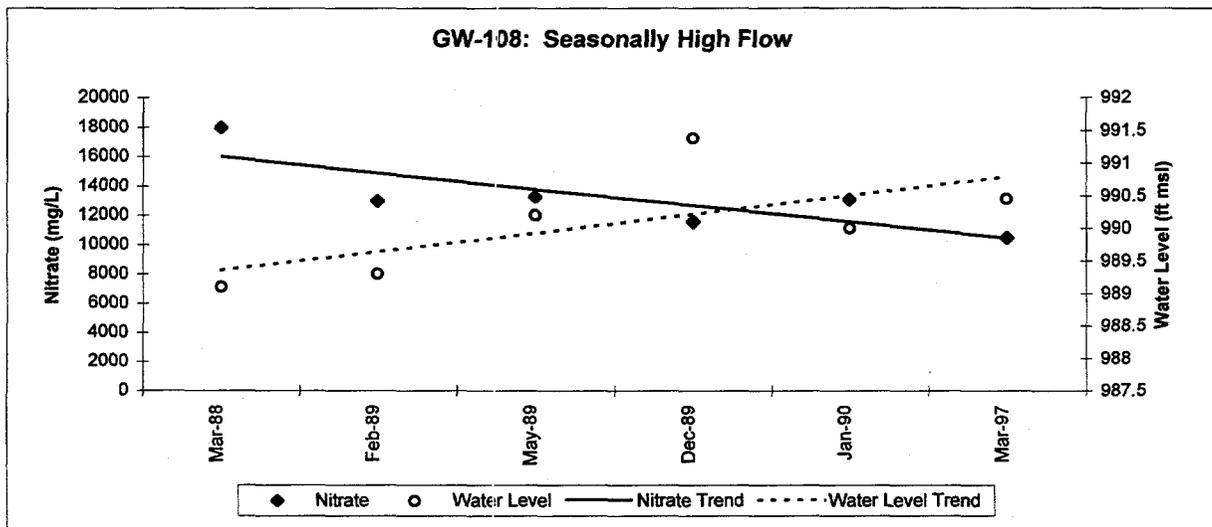
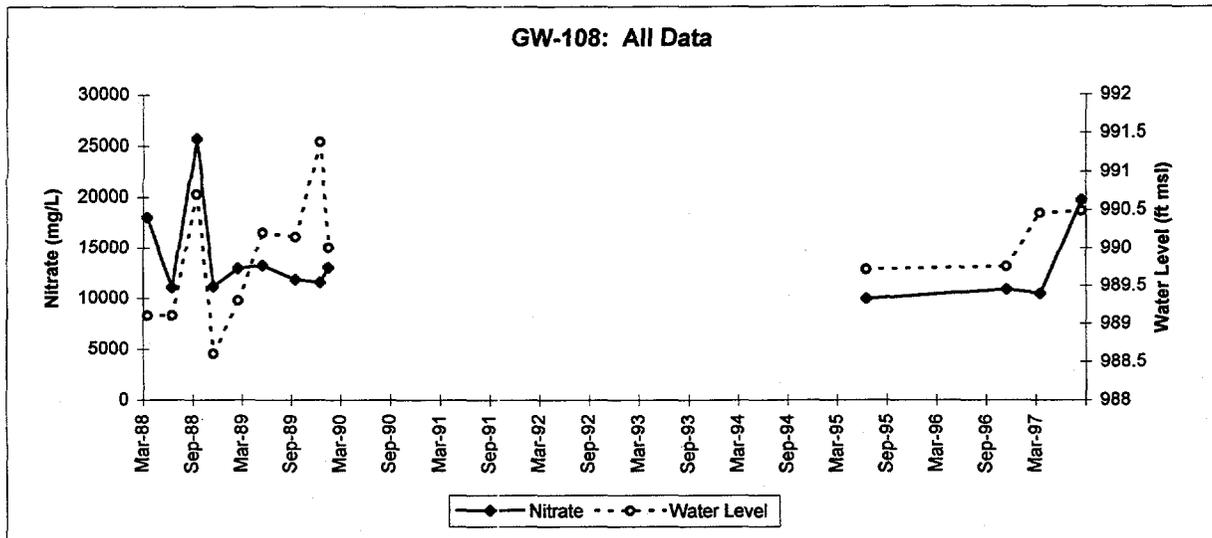
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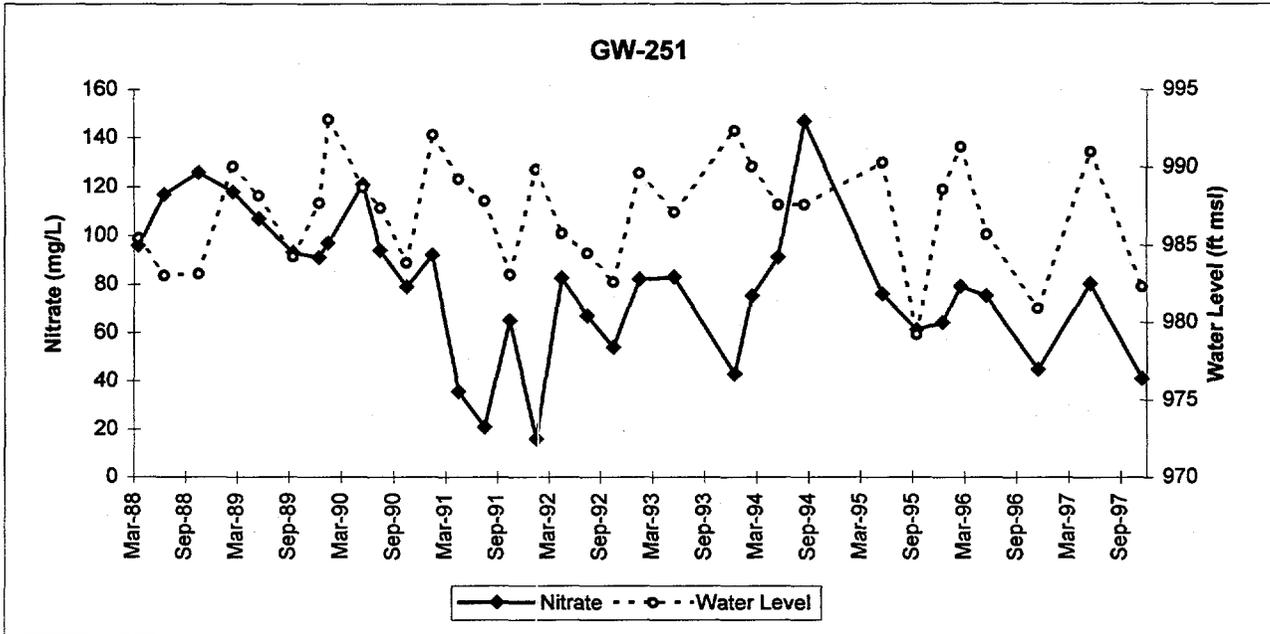
8-15-98

FIGURE 8

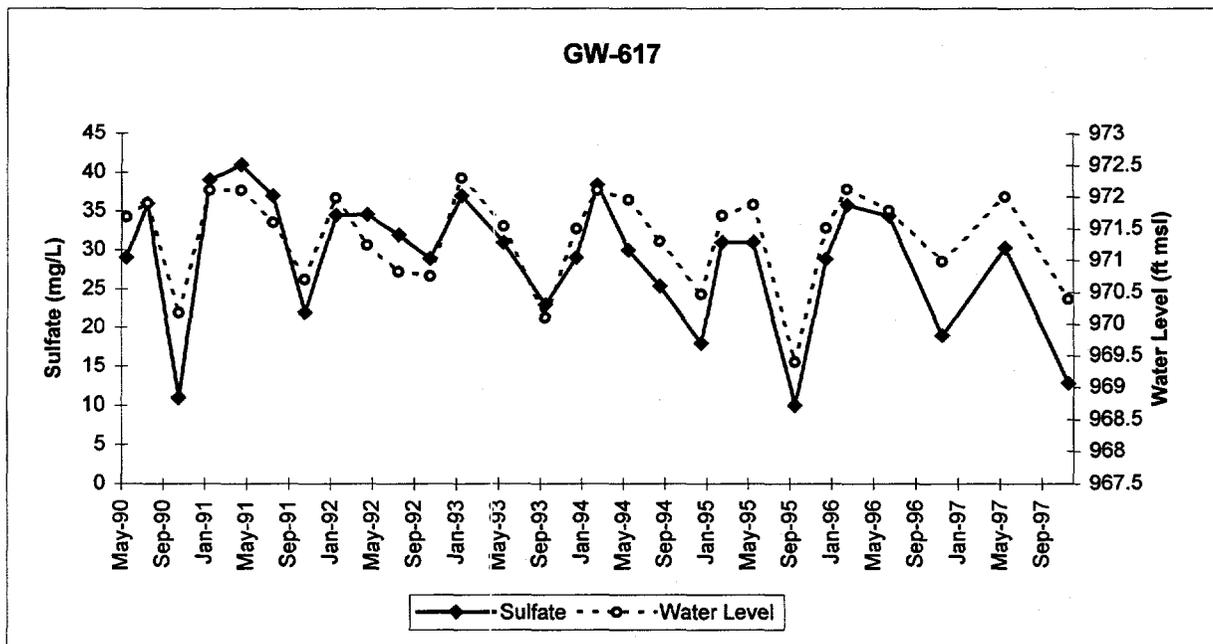
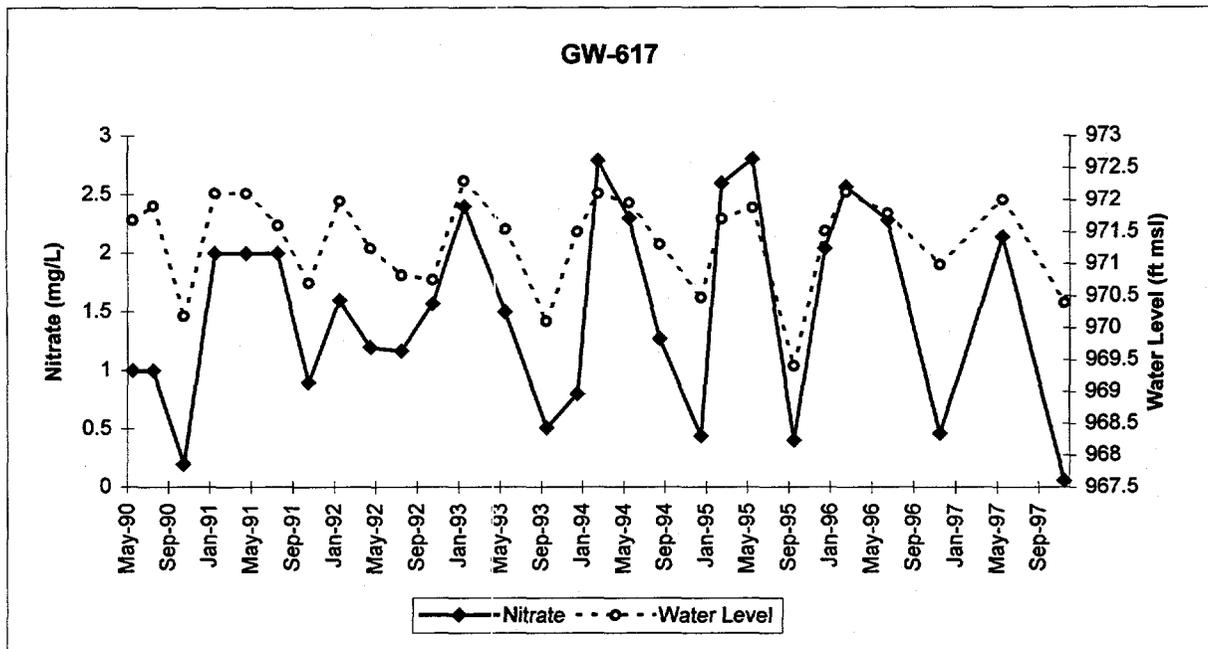
**MAJOR ION CHEMISTRY
OF CY 1997 GROUNDWATER SAMPLES
FROM AQUIFER WELLS**



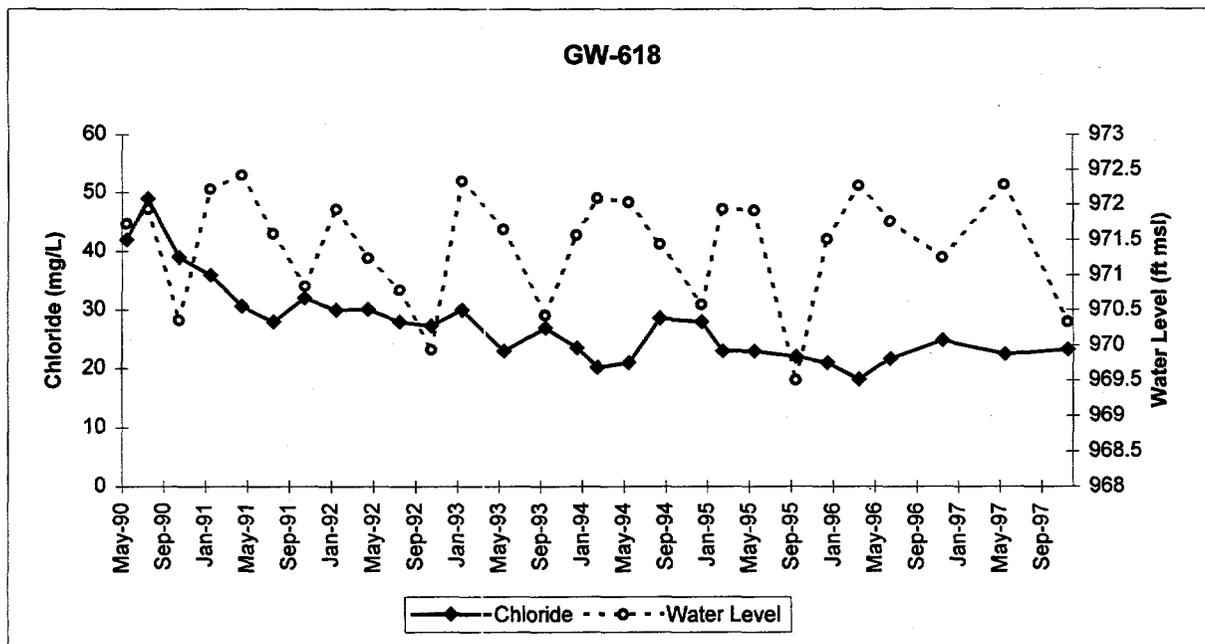
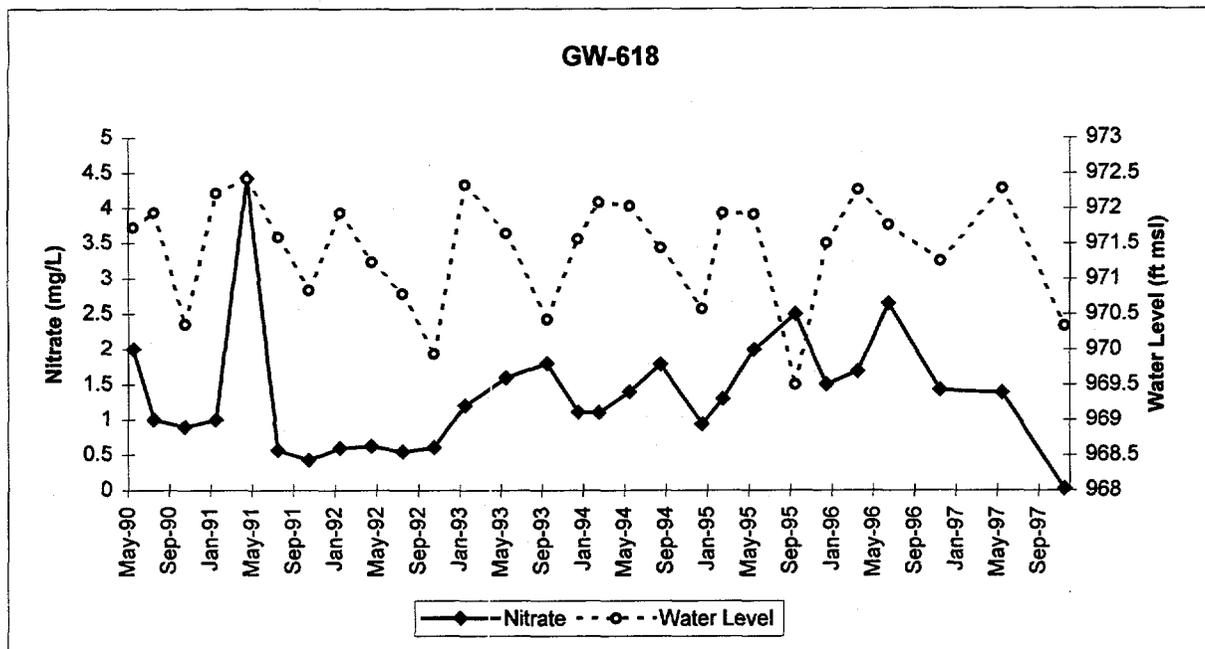
PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 9
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.: DWG ID.: DATE:	MVM64V/3 PC PT297 9/25/98	NITRATE AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELL GW-108



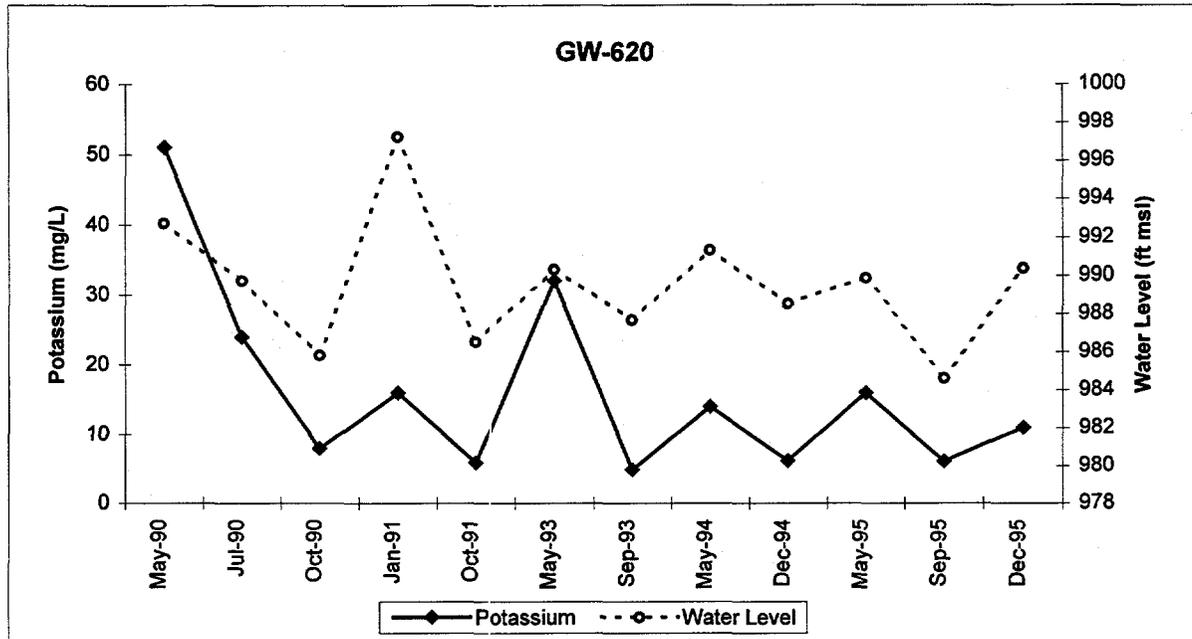
PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 10 NITRATE AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELL GW-251
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.: DWG ID.: DATE:		MVM64V/3 PC PT297 9/25/98



PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 11 NITRATE, SULFATE, AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELL GW-617
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.:		MVM64V/3
	DWG ID.:	PC PT297	
	DATE:	9/25/98	

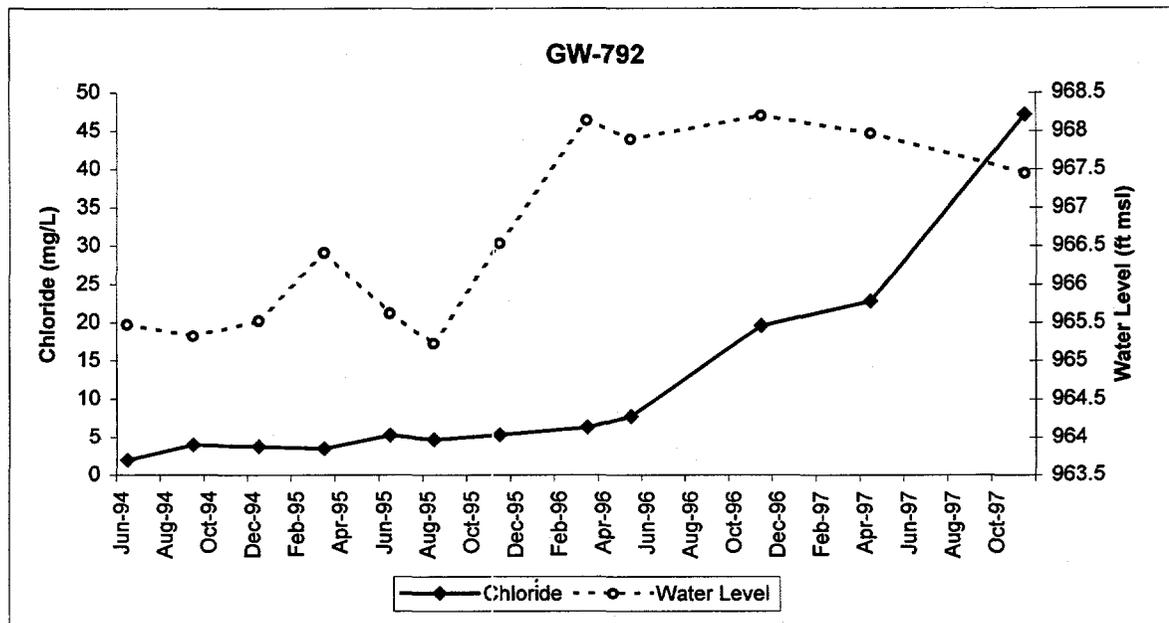


PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 12 NITRATE, CHLORIDE, AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELL GW-618
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.:		MVM64V/3
	DWG ID.:	PC PT297	
	DATE:	9/25/98	

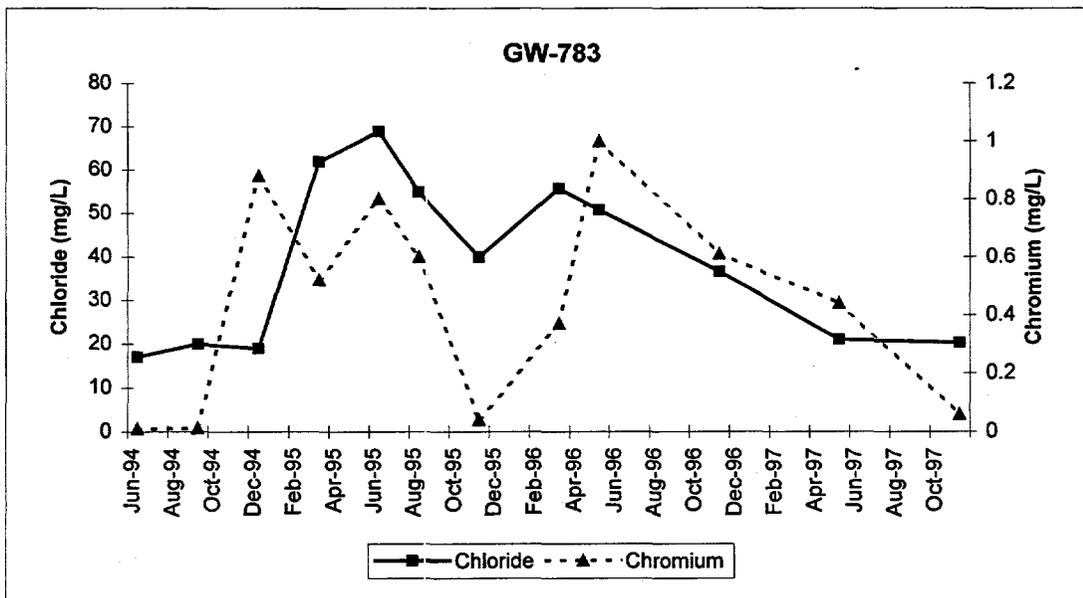
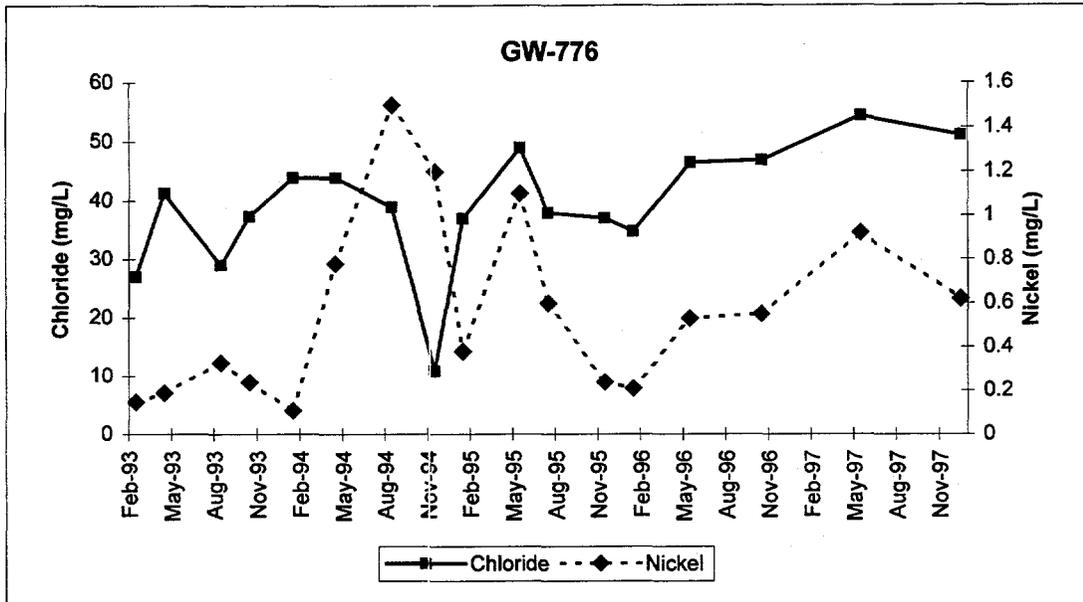


Note: Only results with acceptable ion charge balances are shown.

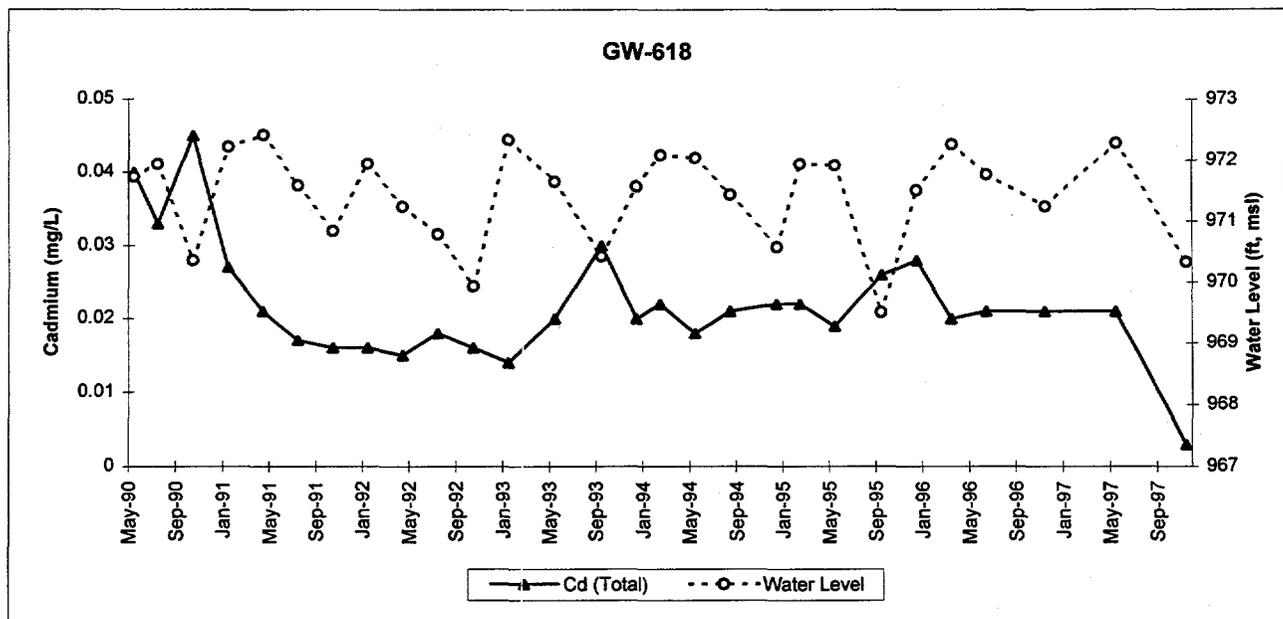
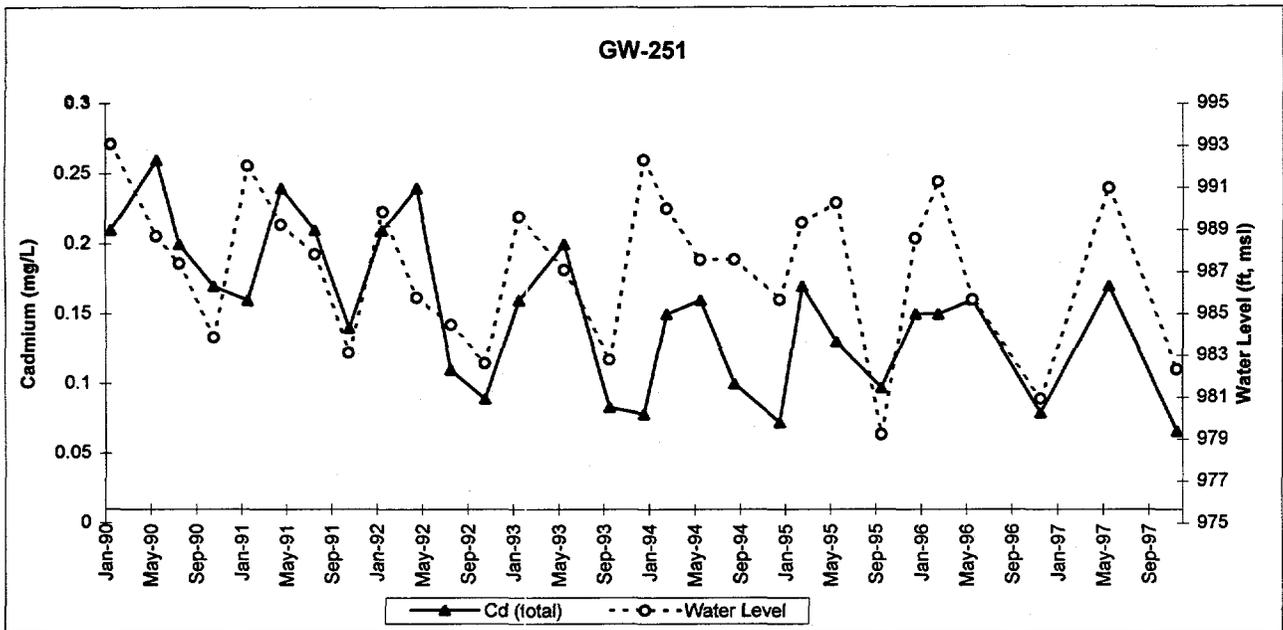
PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 13 POTASSIUM AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELL GW-620
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.: DWG ID.: DATE:		MVM64V/3 PC PT297 9/25/98



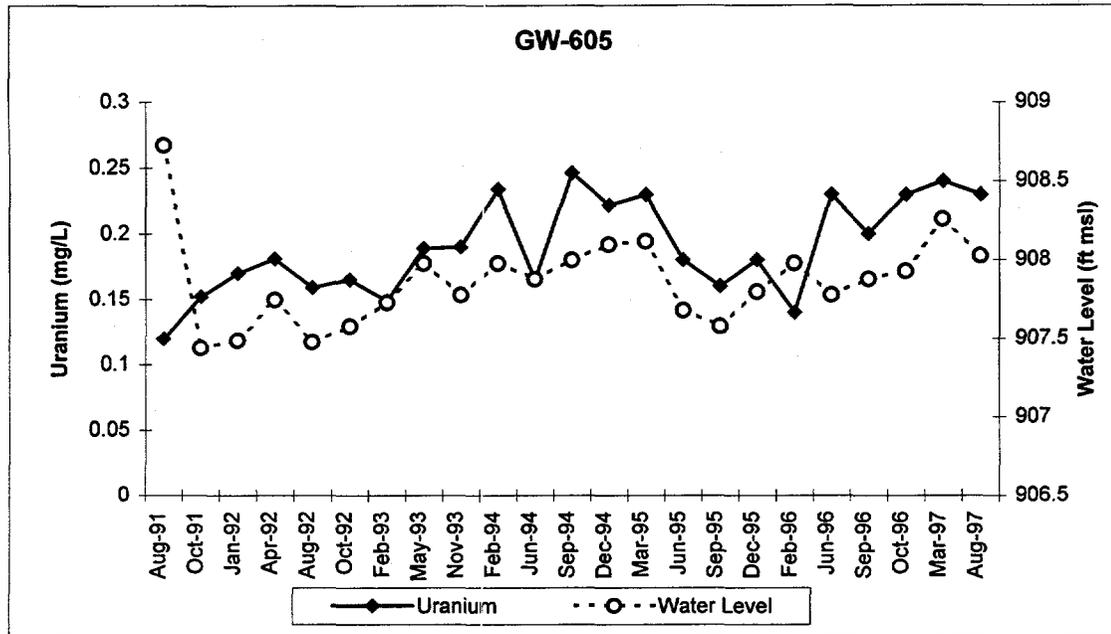
PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 14 CHLORIDE AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELL GW-792
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.: DWG ID.: DATE:		MVM64V/3 PC PT297 9/25/98



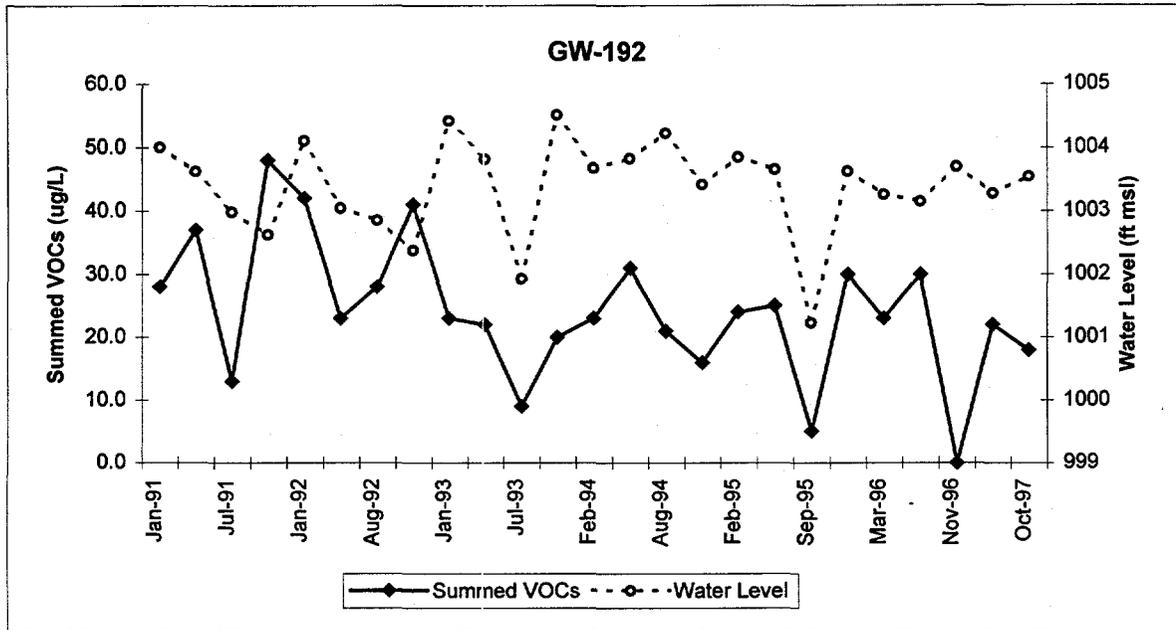
PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 15 CHLORIDE, CHROMIUM, AND/OR NICKEL CONCENTRATIONS IN WELLS GW-776 AND GW-783
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.:		MVM64V/3
	DWG ID.:	PC PT297	
	DATE:	9/25/98	



PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 16 CADMIUM AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELLS GW-251 AND GW-618
	PREPARED BY:	DOC No.:		MVM64V/3
	AJA TECHNICAL SERVICES, INC.	DWG ID.:	PC PT297
	DATE:	9/25/98	

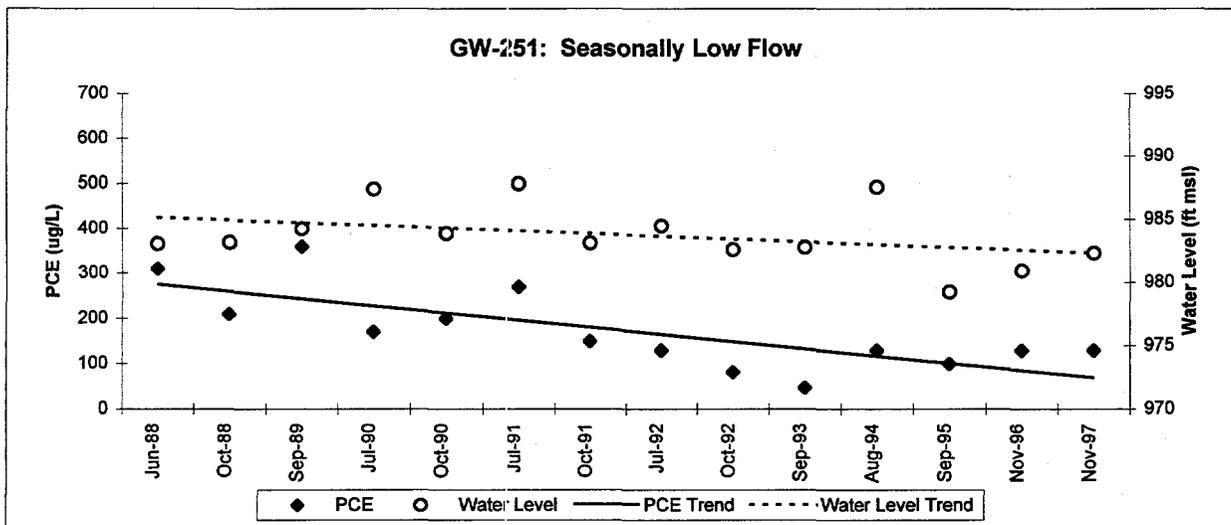
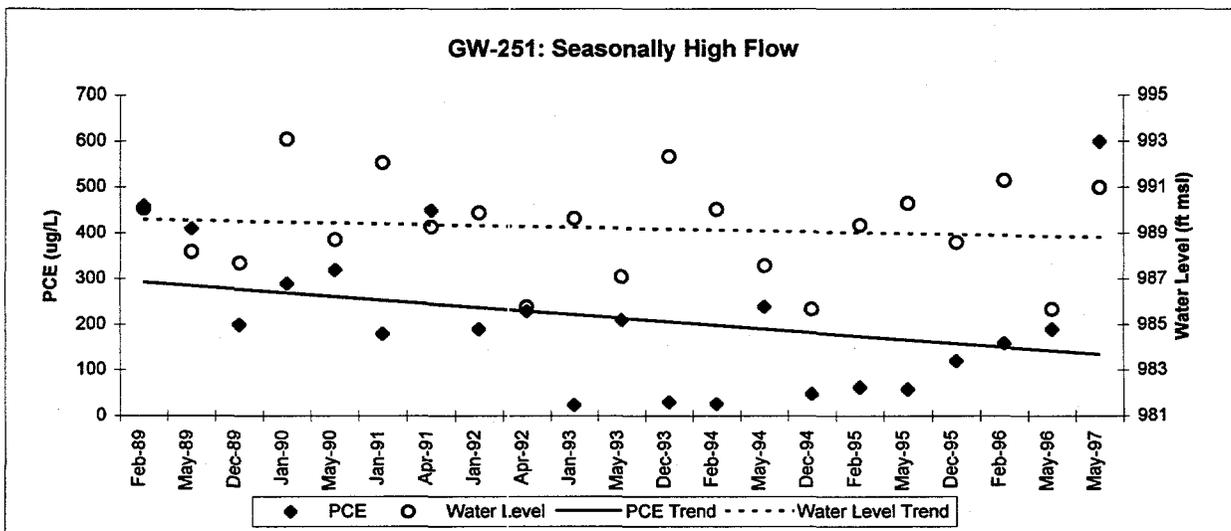
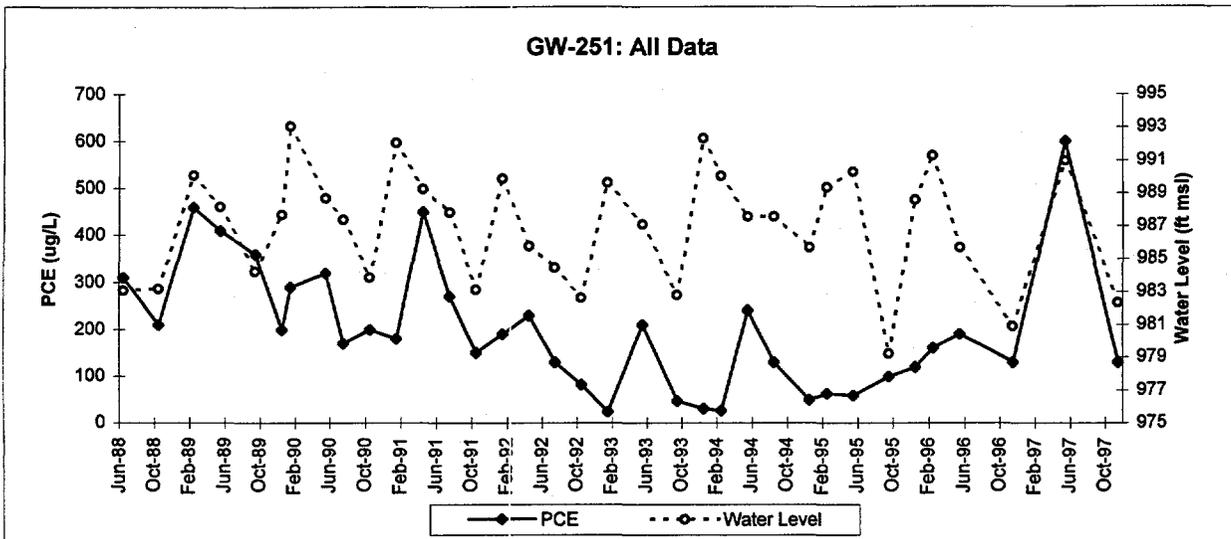


PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 17 URANIUM AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELL GW-605
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.: DWG ID.: DATE:		MVM64V/3 PC PT297 9/25/98

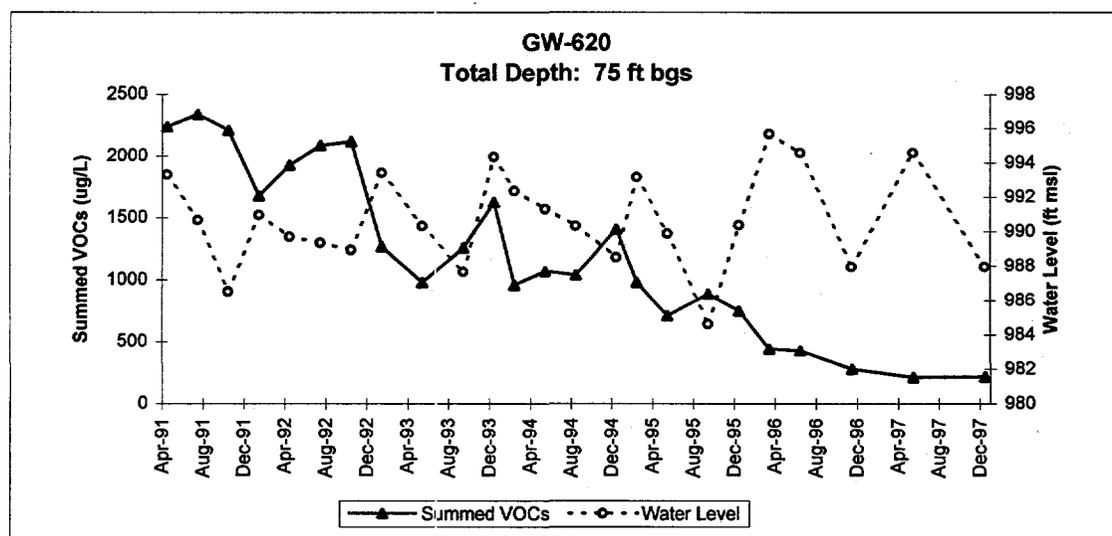
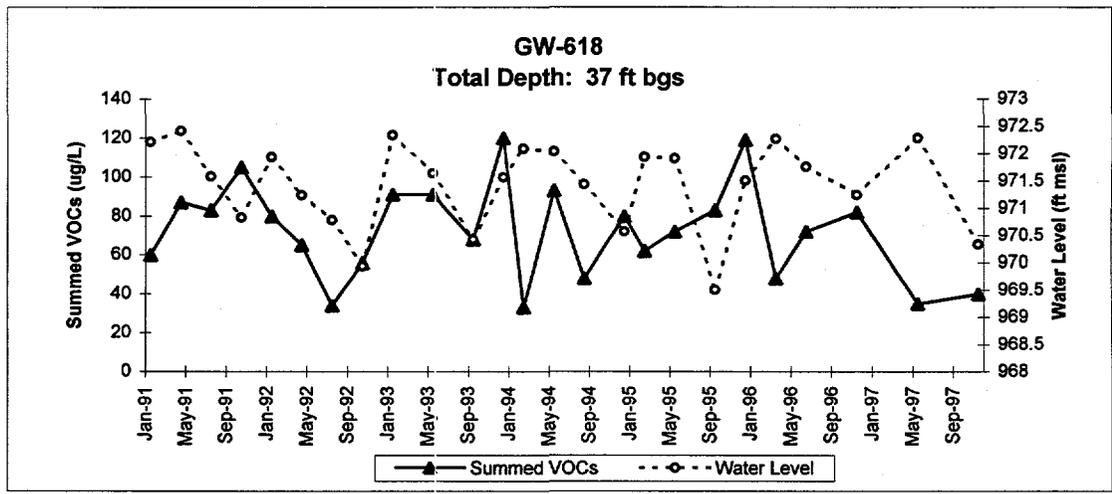
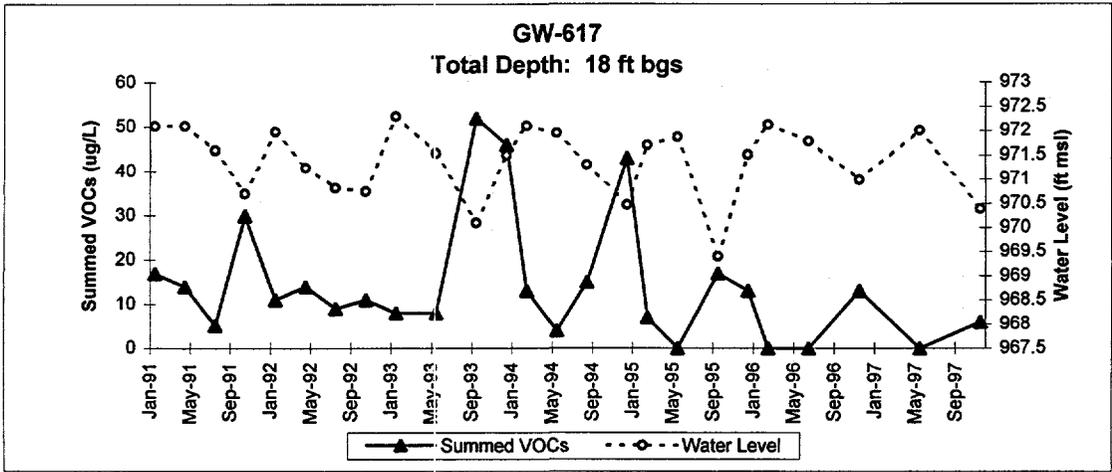


Note: Summed VOCs = summed concentration of tetrachloroethene, trichloroethene, 1,2-dichloroethene, and vinyl chloride.

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 18 SUMMED VOCs AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELL GW-192
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.: DWG ID.: DATE:		MVM64V/3 PC PT297 9/25/98

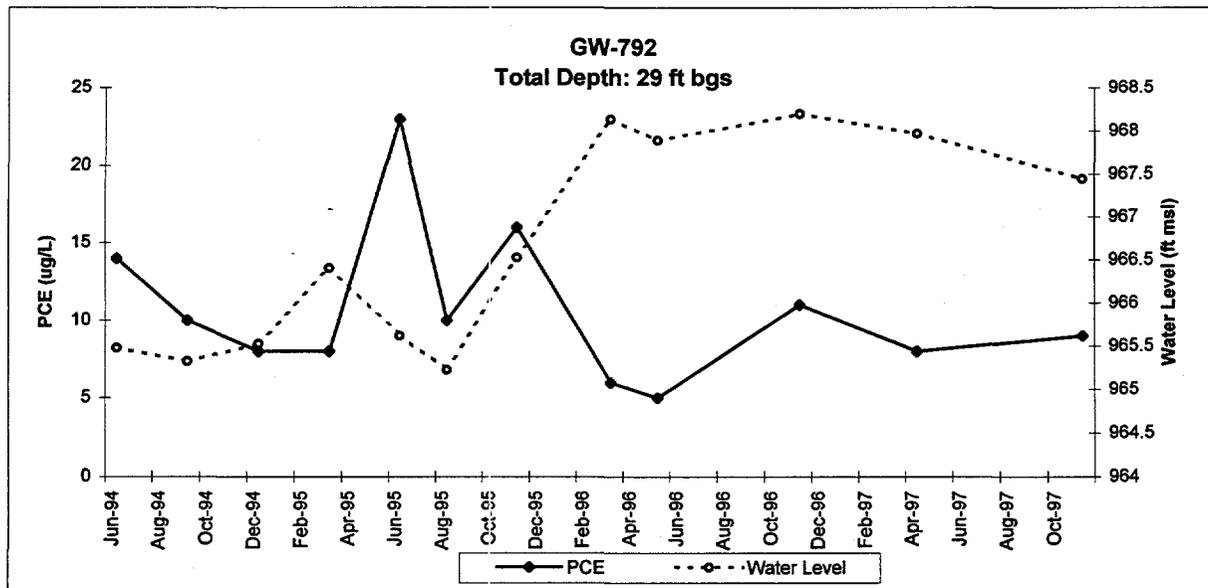
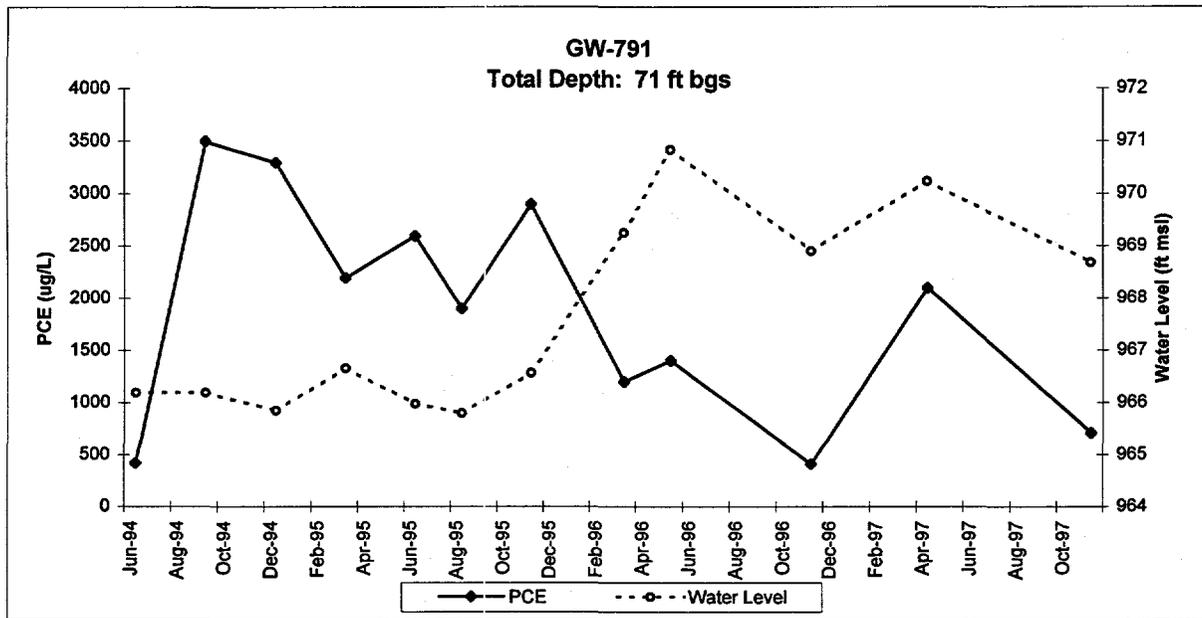


PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 19 PCE AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELL GW-251
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.:		MVM64V/3
	DWG ID.:	PC PT297	
	DATE:	9/25/98	



Note: Summed VOCs = summed concentration of tetrachloroethene, trichloroethene, and 1,2-dichloroethene.

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 20 SUMMED VOCs AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELLS GW-617, GW-618, AND GW-620
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.: DWG ID.: DATE:		MVM64V/3 PC PT297 9/25/98



PREPARED FOR:
**LOCKHEED MARTIN
ENERGY SYSTEMS, INC.**

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 21

PREPARED BY:
**AJA TECHNICAL
SERVICES, INC.**

DOC No.:

MVM64V/3

DWG ID.:

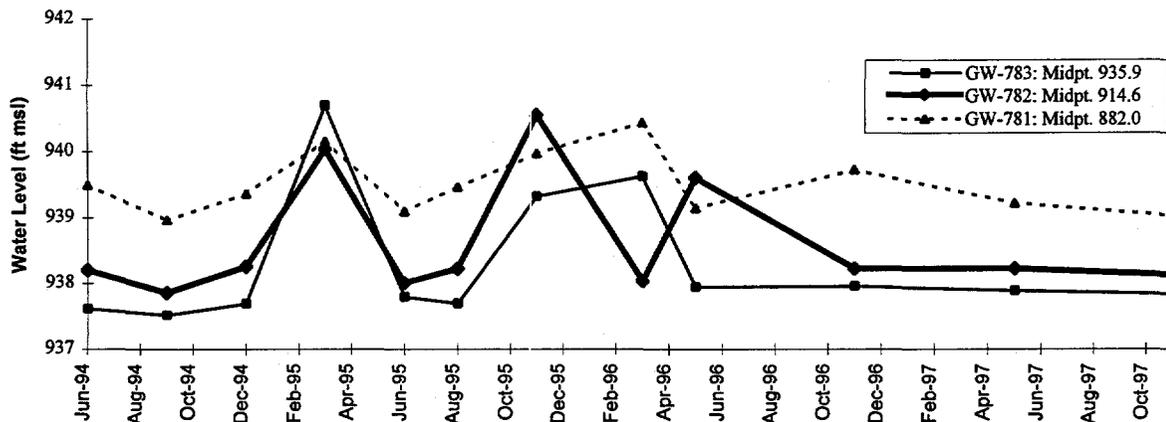
PC PT297

DATE:

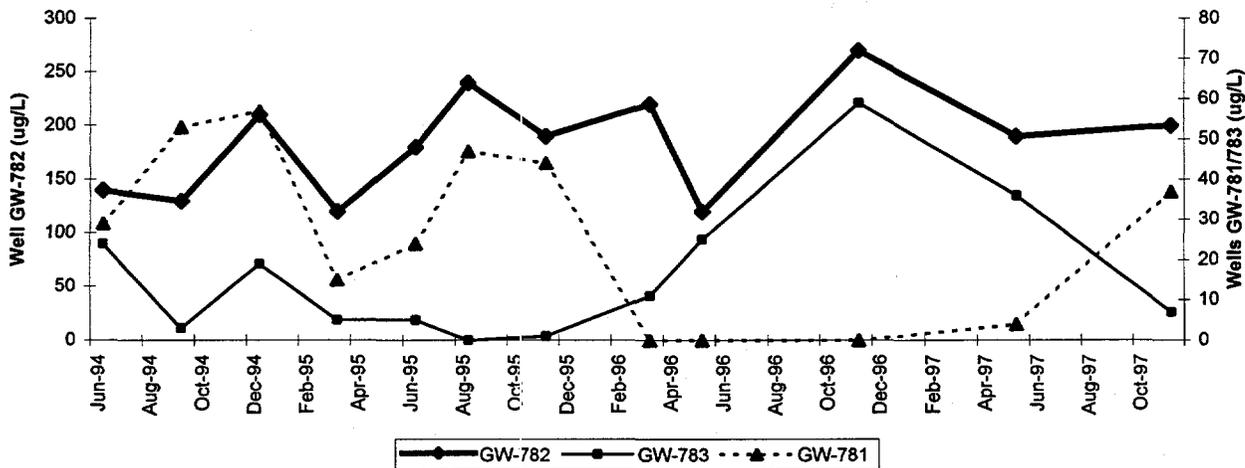
9/25/98

PCE AND PRESAMPLING GROUNDWATER
ELEVATIONS IN WELLS GW-791 AND GW-792

Groundwater Elevation/Vertical Gradient



Tetrachloroethene



PREPARED FOR:
**LOCKHEED MARTIN
ENERGY SYSTEMS, INC.**

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 22

PREPARED BY:
**AJA TECHNICAL
SERVICES, INC.**

DOC No.:

MVM64V/3

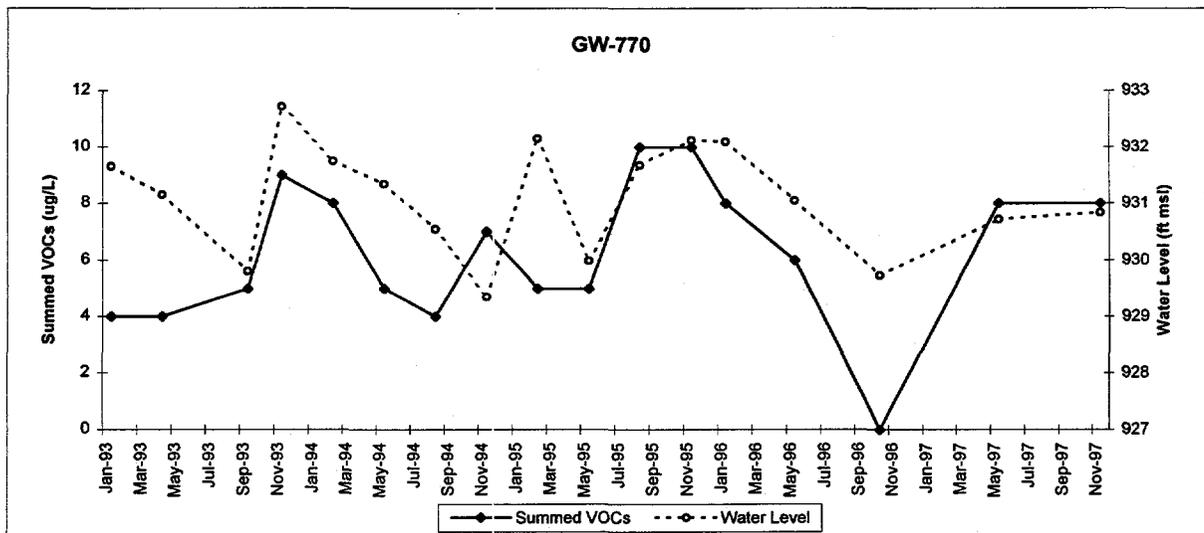
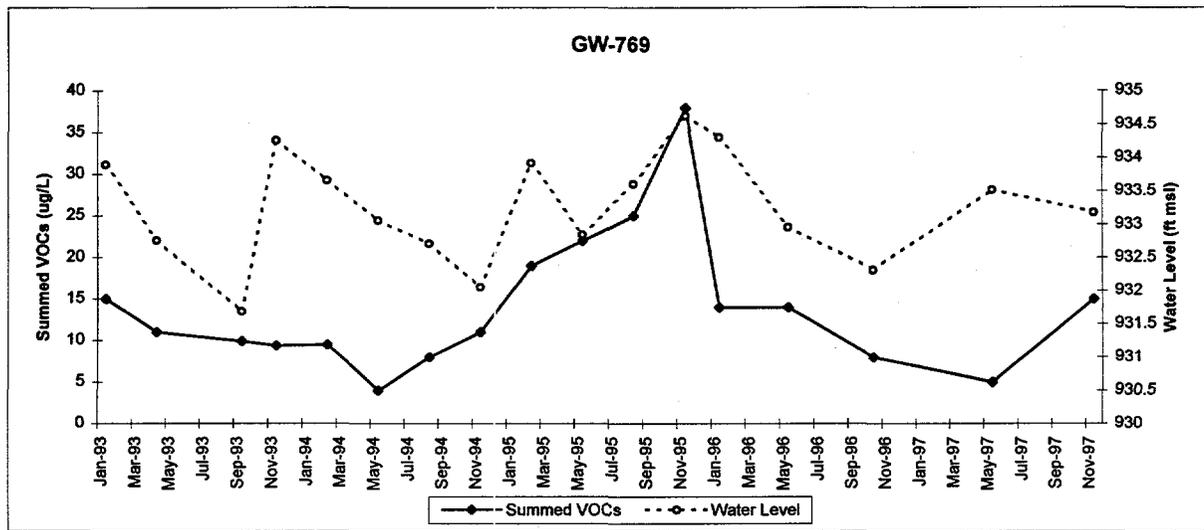
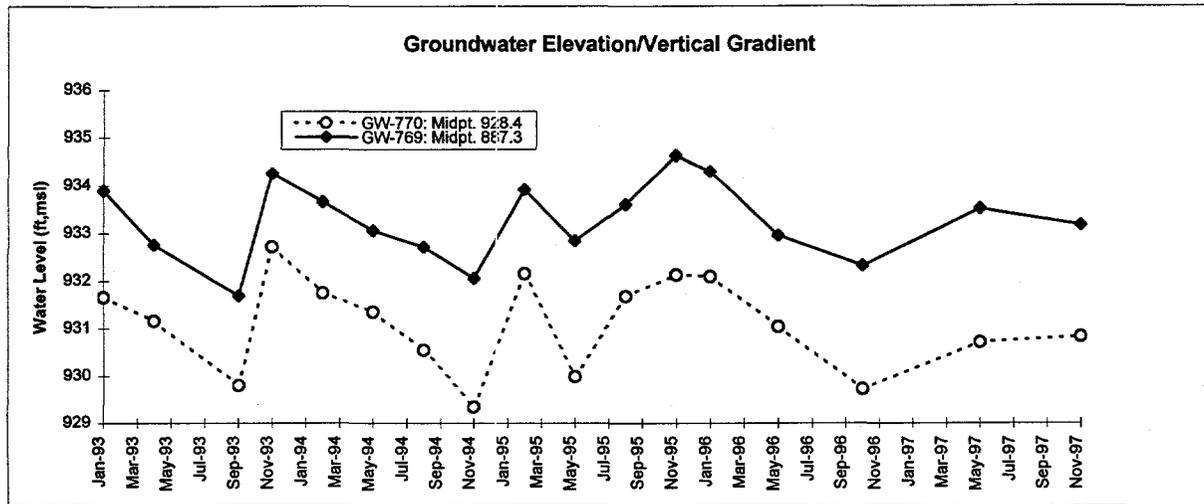
DWG ID.:

PC PT297

DATE:

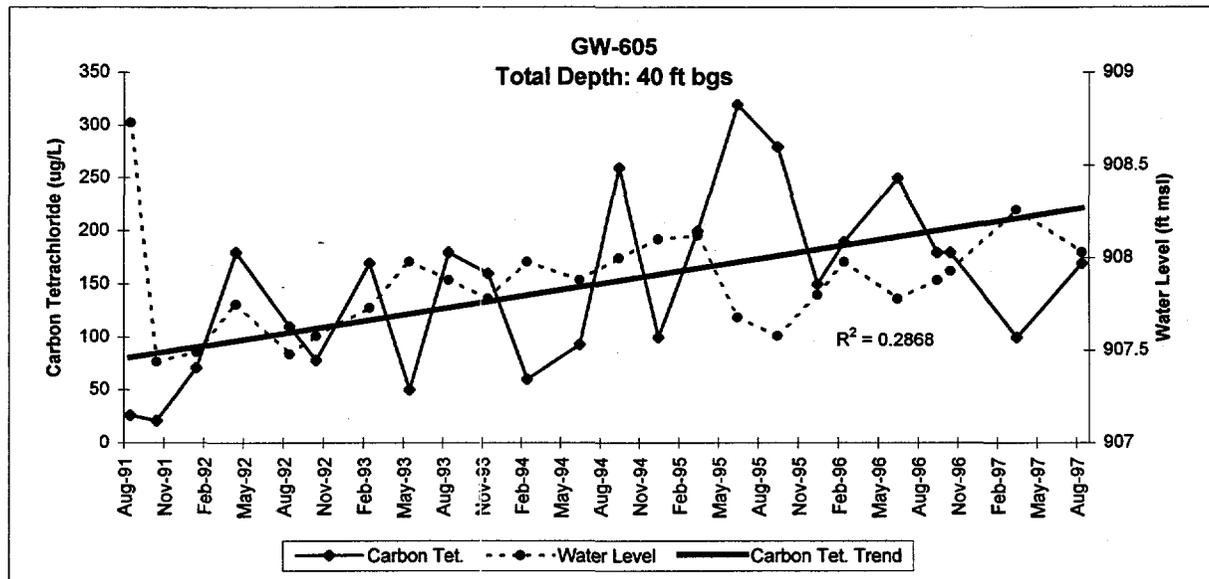
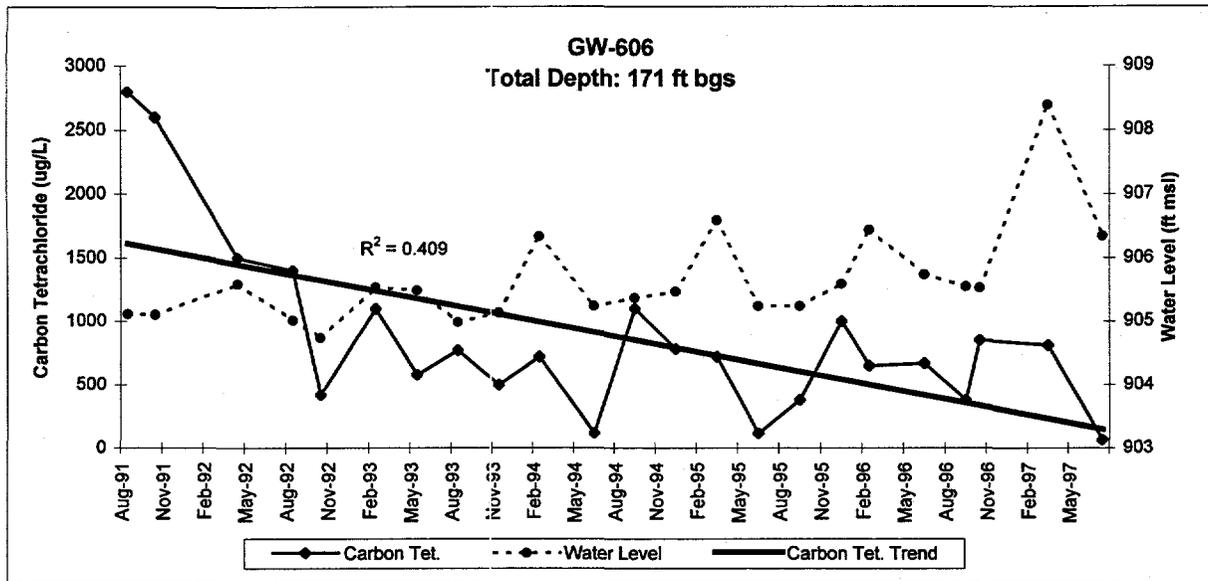
9/25/98

PCE AND PRESAMPLING GROUNDWATER
ELEVATIONS IN WELLS GW-781,
GW-782, AND GW-783



Note: Summed VOCs = summed concentrations of tetrachloroethene, trichloroethene, carbon tetrachloride, and chloroform.

PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 23 SUMMED VOCs AND PRESAMPLING GROUNDWATER ELEVATIONS IN WELLS GW-769 AND GW-770
	DOC No.:	MVM64V/3	
	DWG ID.:	PC PT297	
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DATE:	9/25/98	



PREPARED FOR:
**LOCKHEED MARTIN
ENERGY SYSTEMS, INC.**

LOCATION:

Y-12 PLANT
OAK RIDGE, TN.

FIGURE 24

PREPARED BY:
**AJA TECHNICAL
SERVICES, INC.**

DOC No.:

MVM64V/3

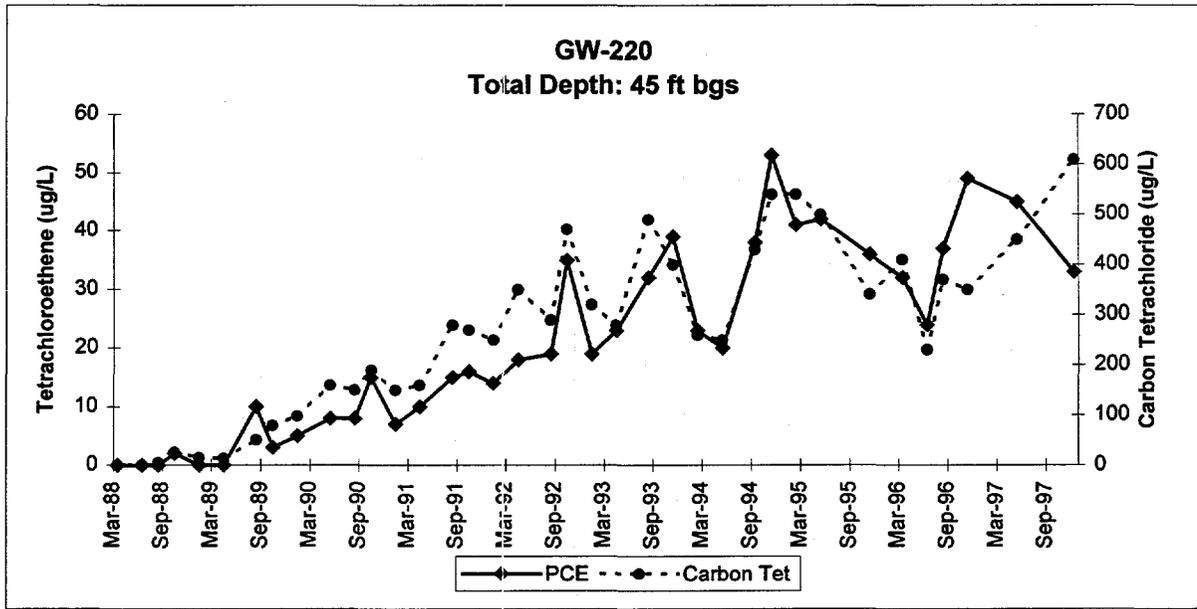
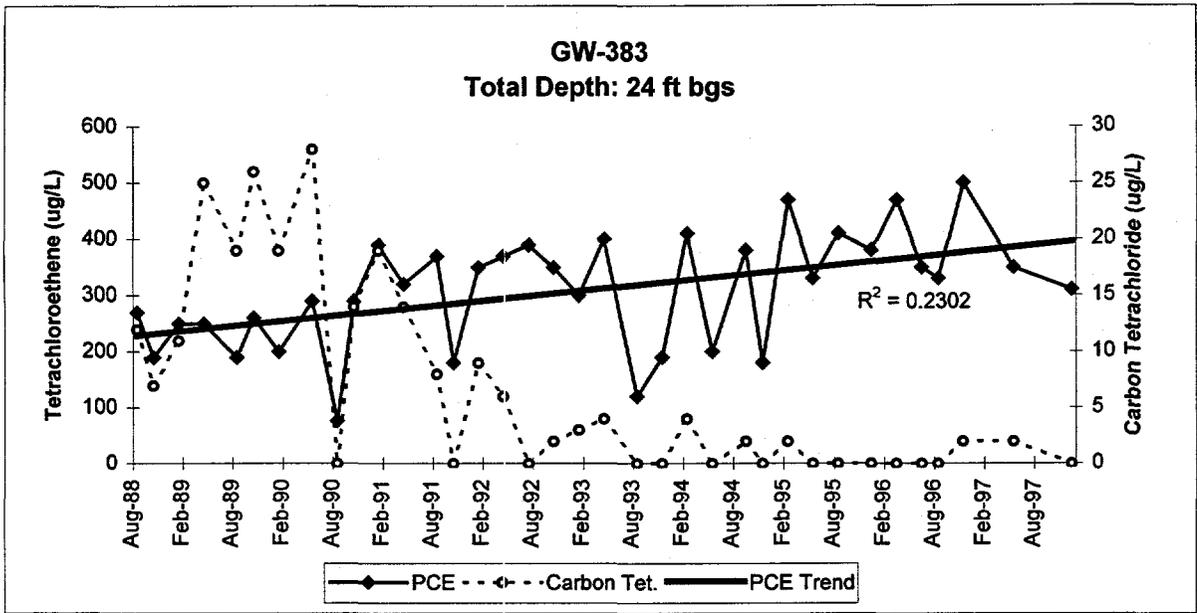
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PC PT297

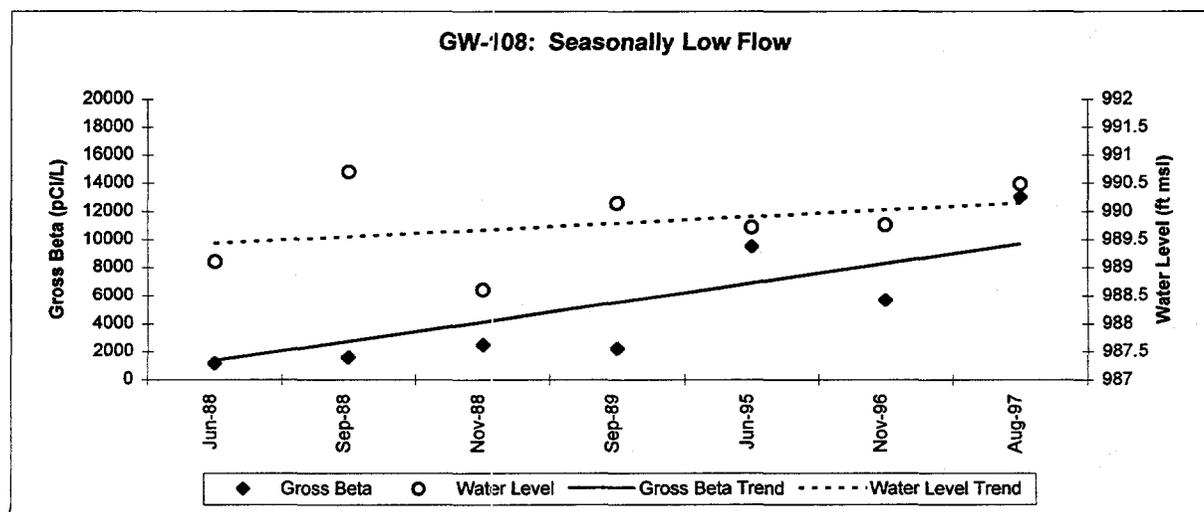
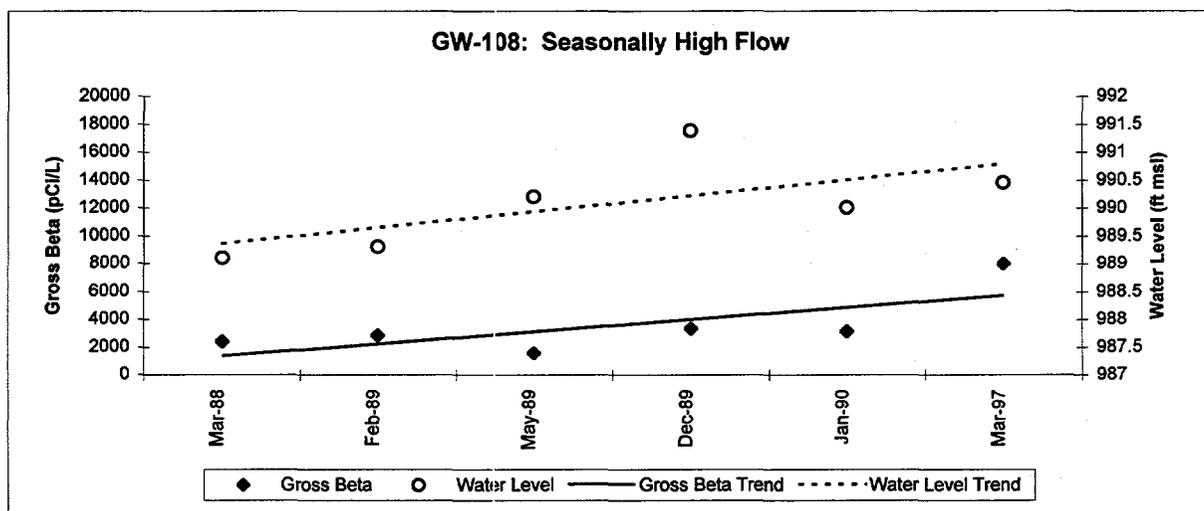
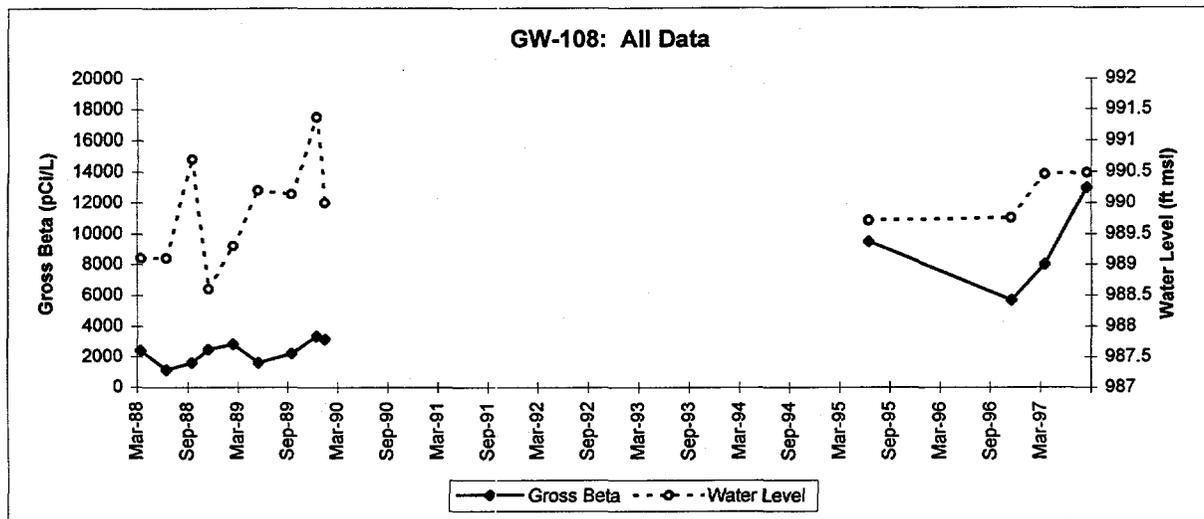
DATE:

9/25/98

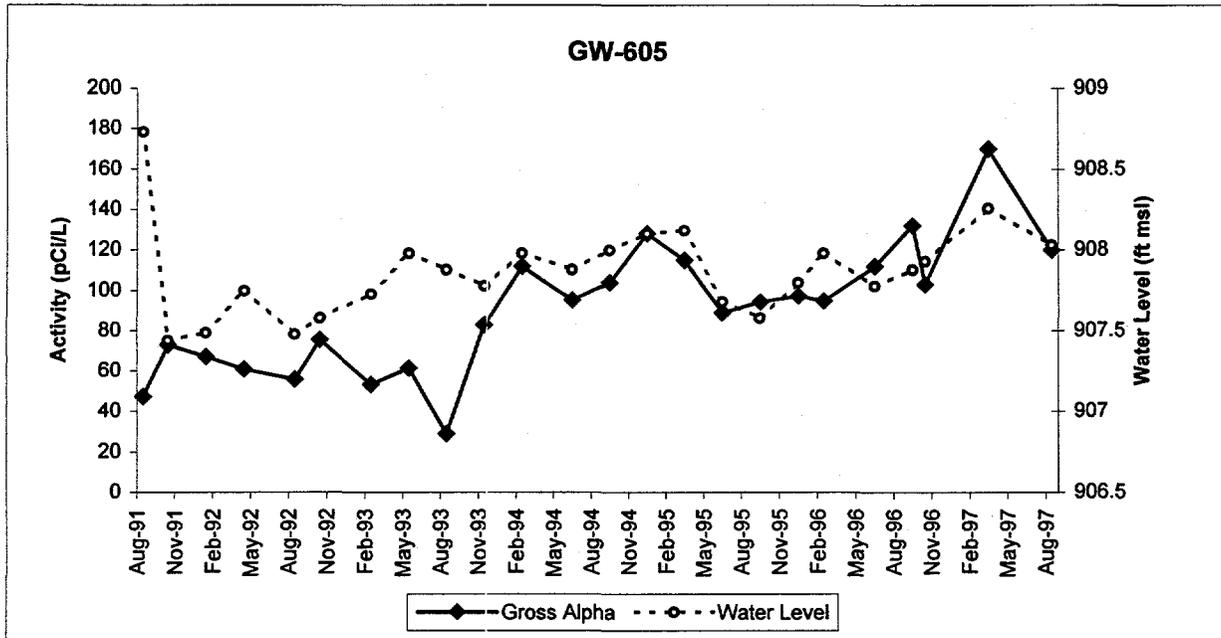
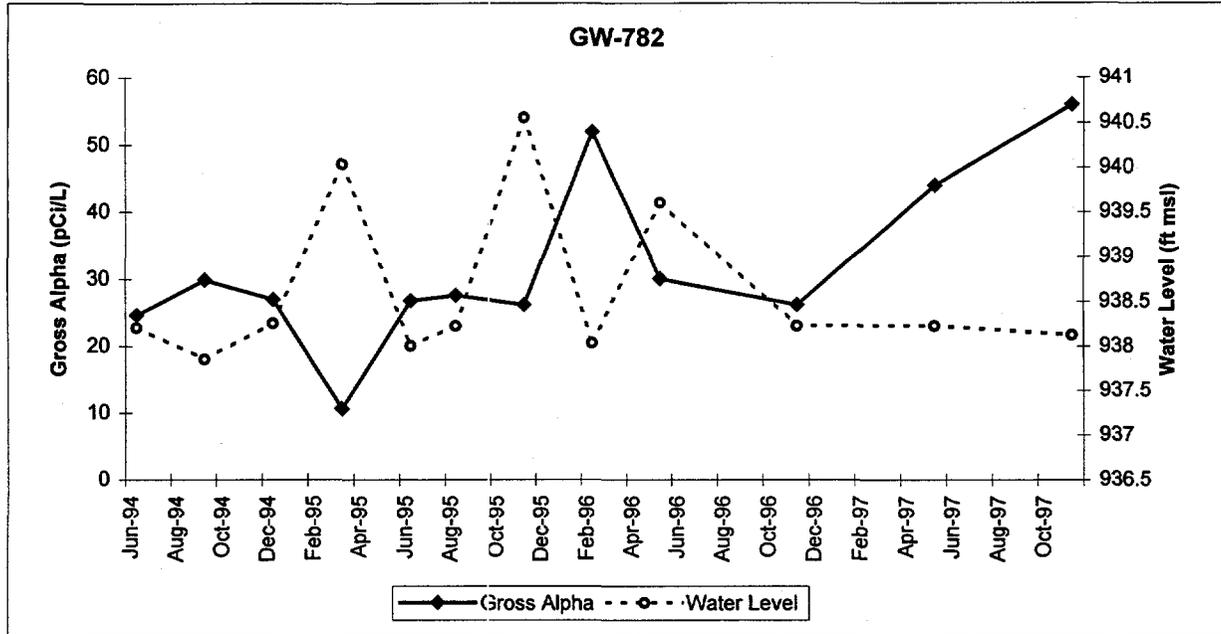
**CARBON TETRACHLORIDE AND PRESAMPLING
GROUNDWATER ELEVATIONS
IN WELLS GW-605 AND GW-606**



PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 25
PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.: DWG ID.: DATE:	MVM64V/3 PC PT297 9/25/98	CARBON TETRACHLORIDE AND PCE IN WELLS GW-220 AND GW-383



PREPARED FOR: LOCKHEED MARTIN ENERGY SYSTEMS, INC.	LOCATION:	Y-12 PLANT OAK RIDGE, TN.	FIGURE 26
	PREPARED BY: AJA TECHNICAL SERVICES, INC.	DOC No.:	MVM64V/3
	DWG ID.:	PC PT297	
	DATE:	9/25/98	



PREPARED FOR:
**LOCKHEED MARTIN
 ENERGY SYSTEMS, INC.**

LOCATION:

Y-12 PLANT
 OAK RIDGE, TN.

FIGURE 27

PREPARED BY:
**AJA TECHNICAL
 SERVICES, INC.**

DOC No.:

MVM64V/3

DWG ID.:

PC PT297

DATE:

9/25/98

GROSS ALPHA ACTIVITY AND PRESAMPLING
 GROUNDWATER ELEVATIONS
 IN WELLS GW-605 AND GW-782

APPENDIX B

TABLES

Table 1.
Sources of Groundwater Contaminant Signatures in the East Fork Regime

Confirmed and Suspected Sources of Contamination ¹	Groundwater Contaminant Signature			
	Inorganics	Organics	Metals	Radionuclides
WESTERN PLANT AREA				
S-3 Ponds	●	●	●	●
Salvage Yard		●	●	●
Rust Garage Area		●		
Waste Coolant Processing Area		●	●	●
Building 9204-4		●	●	
Fire Training Facility		●		
Interim Drum Yard Vicinity		●		
S-2 Site	●	●	●	●
CENTRAL PLANT AREA				
Buildings 9201-4 and 9201-5		●	●	
Building 9731 Vicinity		●		●
Building 9212		●		
Tank 0134-U		●	●	●
Building 81-10			●	●
Buildings 9201-1 and 9201-2		●	●	
Tank 2331-U		●	●	
EASTERN PLANT AREA				
East End Garage (Building 9754-2)		●		
Wells GW-605 and GW-606 Vicinity				●
Former Oil Skimmer Basin			●	●
East End Carbon Tetrachloride Plume		●		
Building 9720-6		●		

Note:

- 1 Modified from: *Report on the Remedial Investigation of the Upper East Fork Poplar Creek Characterization Area at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, Volume 3, Appendix D, Section D.5 - Nature and Extent of Site-Related Contaminants in Groundwater* (U.S. Department of Energy 1998).

Table 2.
CY 1997 Groundwater and Surface Water Sampling Dates

MONITORING PROGRAM		RCRA Post-Closure Corrective Action Monitoring							
		DOE Order 5400.1 Exit Pathway/Perimeter Monitoring							
		DOE Order 5400.1 Surveillance Monitoring							
		Sampling Point		Sampling Equipment ³		Sampling Date ⁴			
No. ¹	Location ²	Dedicated	Portable	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.		
GW-108	S3	●	.	03/04/97	.	08/11/97	.	.	●
GW-115	S3	●	.	03/18/97	.	08/11/97	.	.	●
GW-148	NHP	Q4	●	.	05/20/97	.	12/03/97	●	.
GW-153	NHP	Q4	●	.	05/21/97D	.	12/03/97	.	●
GW-192	B4	Q4	●	.	04/07/97	.	10/30/97	●	.
GW-193	T2331	●	.	03/05/97	.	08/13/97	.	.	●
GW-207	EXP-SR	Q4	●	.	04/08/97	.	12/02/97	.	●
GW-208	EXP-SR	Q4	●	.	04/10/97	.	12/02/97	.	●
GW-220	NHP	Q4	●	.	05/22/97	.	12/08/97	.	●
GW-251	S2	●	.	.	05/07/97	.	11/05/97	●	.
GW-380	NHP	Q4	●	.	05/21/97	.	12/02/97D	.	●
GW-383	NHP	Q4	●	.	05/22/97	.	12/04/97	●	.
GW-605	EXP-I	●	.	03/18/19D	.	08/11/97	.	.	●
GW-606	EXP-I	.	●	03/06/97	.	07/31/97D	.	.	●
GW-617	EXP-E	●	.	.	05/07/97	.	11/05/97	.	●
GW-618	EXP-E	Q4	●	.	05/06/97D	.	11/04/97	.	●
GW-620	FTF	Q4	●	.	05/06/97	.	12/01/97	●	.
GW-722-06	EXP-J	●	.	.	.	07/28/97	11/24/97	.	●
GW-722-10	EXP-J	●	.	.	.	07/29/97	11/24/97	.	●
GW-722-14	EXP-J	●	.	.	.	07/29/97	11/25/97	.	●
GW-722-17	EXP-J	●	.	.	.	07/30/97	11/25/97	.	●
GW-722-20	EXP-J	●	.	.	.	07/30/97	12/02/97	.	●
GW-722-22	EXP-J	●	.	.	.	07/31/97	12/02/97	.	●
GW-722-26	EXP-J	●	.	.	.	08/04/97	12/02/97	.	●
GW-722-30	EXP-J	●	.	.	.	08/04/97	12/04/97	.	●
GW-722-32	EXP-J	●	.	.	.	08/05/97	12/04/97	.	●
GW-722-33	EXP-J	●	.	.	.	08/05/97D	.	.	●
GW-733	EXP-J	Q3	●	03/05/97	.	07/30/97	.	.	●
GW-735	EXP-J	●	.	.	04/15/97	.	12/03/97D	.	●
GW-744	GRIDK1	●	.	.	04/16/97	.	12/08/97	●	.
GW-745	GRIDK1	●	.	.	04/17/97	.	12/09/97	●	.
GW-746	GRIDK1	●	.	.	04/17/97	.	12/09/97	●	.
GW-747	GRIDK2	●	.	.	04/17/97D	.	12/09/97	●	.
GW-748	GRIDK2	●	.	.	04/17/97	.	12/10/97	●	.
GW-749	GRIDK2	●	.	.	04/17/97	.	12/10/97	●	.
GW-750	EXP-J	Q4	●	.	04/14/97	.	12/03/97	.	●
GW-763	GRIDJ3	Q4	●	.	05/20/97	.	12/02/97	●	.

Table 2 (cont'd)

MONITORING PROGRAM		RCRA Post-Closure Corrective Action Monitoring							
		DOE Order 5400.1 Exit Pathway/Perimeter Monitoring							
		DOE Order 5400.1 Surveillance Monitoring							
		Sampling Point		Sampling Equipment ³		Sampling Date ⁴			
No. ¹	Location ²	Dedicated	Portable	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.		
GW-769	GRIDG3	Q4	●	.	05/13/97D	.	11/17/97	●	.
GW-770	GRIDG3	Q4	●	.	05/12/97	.	11/17/97	●	.
GW-775	GRIDH3	Q4	●	.	05/12/97	.	11/19/97	●	.
GW-776	GRIDH3	Q4	●	.	05/12-13/97	.	12/02/97	●	.
GW-781	GRIDE3	Q4	●	.	05/15/97	.	11/19/97	●	.
GW-782	GRIDE3	●	.	.	05/14/97	.	11/24/97	●	.
GW-783	GRIDE3	Q4	●	.	05/15/97	.	11/25/97	●	.
GW-788	GRIDF3	Q4	●	.	05/13/97	.	11/18/97	●	.
GW-789	GRIDF3	Q4	●	.	05/14/97	.	11/18/97	●	.
GW-791	GRIDD2	Q4	●	.	04/08/97	.	11/20/97	●	.
GW-792	GRIDD2	Q4	●	.	04/08/97	.	11/20/97	●	.
GW-816	EXP-SR	●	.	.	04/16/97	.	12/04/97	.	●
GW-817	GRIDK3	●	.	.	04/17/97	.	12/04/97	●	.
LRSPW	EXP-SW	.	●	.	04/22-23/97	.	12/01/97	.	●

Notes:

- Locations of monitoring wells and surface water station (LRSPW) shown on Figure 6. See Table 3 for a complete list of field measurements and laboratory analytes.
- B4 - Beta-4 Security Pits
 - EXP - Exit Pathway (Maynardville Limestone) monitoring location
 - -E, -I, or -J: Maynardville Limestone Picket monitoring well.
 - -SW: Onsite spring or surface water station
 - -SR: Along Scarboro Road in the gap through Pine Ridge
 - FTF - Fire Training Facility
 - GRID - Comprehensive Groundwater Monitoring Plan Grid Location
 - NHP - New Hope Pond
 - S2 - S-2 Site
 - S3 - S-3 Ponds Site
 - T2331 - Tank 2331-U
- Dedicated: Well Wizard™ (bladder pump that remains in the well) or Westbay™ (multiport sampling equipment; GW-722 only); Q3 = only third quarter samples collected with a Well Wizard™; Q4 = only fourth quarter samples collected with a Well Wizard™.
 - Portable: Bennet Pumps™ and disposable bailers (monitoring wells); grab sample bottles (surface water).
- "D" used to denote sampling locations from which duplicate samples were collected on the specified sampling date.

Table 3.
Laboratory Analytes and Field Measurements for CY 1997
Groundwater and Surface Water Samples

MONITORING PROGRAM		RCRA Post-Closure Corrective Action Monitoring ¹				
		DOE Order 5400.1 Monitoring ²				
MAJOR IONS	Analytical Method ³	GWPS Constituent ⁴	Sample Type ⁵			
			Filtered	Unfiltered		
Alkalinity - HCO3	EPA-310.1	.	.	●	●	●
Alkalinity - CO3	EPA-310.1	.	.	●	●	●
Calcium	EPA-6010A	.	●	●	●	●
Chloride	EPA-300.0	.	.	●	●	●
Fluoride	EPA-340.2	.	.	●	●	●
Magnesium	EPA-6010A	.	●	●	●	●
Nitrate (as N)	EPA-300.0	●	.	●	●	●
Potassium	EPA-6010A	.	●	●	●	●
Sodium	EPA-6010A	.	●	●	●	●
Sulfate	EPA-300.0	.	.	●	●	●
TRACE METALS	Analytical Method	GWPS Constituent	Sample Type			
			Filtered	Unfiltered		
Aluminum	EPA-6010A	.	●	●	●	●
Antimony	EPA-6010A	.	●	●	●	●
Arsenic	EPA-200.8	.	●	●	●	●
Barium	EPA-6010A	●	●	●	●	●
Beryllium	EPA-6010A	.	●	●	●	●
Boron	EPA-6010A	.	●	●	●	●
Cadmium	EPA-6010A	●	●	●	●	●
Chromium	EPA-6010A	●	●	●	●	●
Cobalt	EPA-6010A	.	●	●	●	●
Copper	EPA-6010A	.	●	●	●	●
Iron	EPA-6010A	.	●	●	●	●
Lead	EPA-200.8	●	●	●	●	●
Lithium	EPA-6010A	.	●	●	●	●
Manganese	EPA-6010A	.	●	●	●	●
Mercury	EPA-7470	●	●	●	●	●
Molybdenum	EPA-6010A	.	●	●	●	●
Nickel	EPA-6010A	●	●	●	●	●
Selenium	EPA-6010A	.	●	●	●	●
Silver	EPA-6010A	.	●	●	●	●
Strontium	EPA-6010A	.	●	●	●	●
Thallium	EPA-200.8	.	●	●	●	●
Thorium	EPA-6010A	.	●	●	●	●

Table 3 (cont'd)

MONITORING PROGRAM		RCRA Post-Closure Corrective Action Monitoring ¹				
		DOE Order 5400.1 Monitoring ²				
TRACE METALS (cont'd)	Analytical Method ³	GWPS Constituent ⁴	Sample Type ⁵			
			Filtered	Unfiltered		
Uranium	EPA-200.8	●	●	●	●	●
Vanadium	EPA-6010A	.	●	●	●	●
Zinc	EPA-6010A	.	●	●	●	●
VOLATILE ORGANIC COMPOUNDS	Analytical Method	GWPS Constituent	Sample Type			
			Filtered	Unfiltered		
Acetone	EPA-8260	.	.	●	●	●
Acrolein	EPA-8260	.	.	●	●	●
Acrylonitrile	EPA-8260	.	.	●	●	●
Benzene	EPA-8260	●	.	●	●	●
Bromochloromethane	EPA-8260	.	.	●	●	●
Bromodichloromethane	EPA-8260	.	.	●	●	●
Bromoform	EPA-8260	●	.	●	●	●
Bromomethane	EPA-8260	.	.	●	●	●
2-Butanone	EPA-8260	.	.	●	●	●
Carbon disulfide	EPA-8260	.	.	●	●	●
Carbon tetrachloride	EPA-8260	●	.	●	●	●
Chlorobenzene	EPA-8260	.	.	●	●	●
Chloroethane	EPA-8260	.	.	●	●	●
2-Chloroethyl vinyl ether	EPA-8260	.	.	●	●	●
Chloroform	EPA-8260	●	.	●	●	●
Chloromethane	EPA-8260	.	.	●	●	●
Dibromochloromethane	EPA-8260	.	.	●	●	●
1,2-Dibromo-3-chloropropane	EPA-8260	.	.	●	●	●
1,2-Dibromoethane	EPA-8260	.	.	●	●	●
Dibromomethane	EPA-8260	.	.	●	●	●
1,2-Dichlorobenzene	EPA-8260	.	.	●	●	●
1,4-Dichlorobenzene	EPA-8260	.	.	●	●	●
1,4-Dichloro-2-butene	EPA-8260	.	.	●	●	●
trans-1,4-Dichloro-2-butene	EPA-8260	.	.	●	●	●
Dichlorodifluoromethane	EPA-8260	.	.	●	●	●
1,1-Dichloroethane	EPA-8260	.	.	●	●	●
1,2-Dichloroethane	EPA-8260	.	.	●	●	●
1,1-Dichloroethene	EPA-8260	●	.	●	●	●
1,2-Dichloroethene	EPA-8260	.	.	●	●	●
cis-1,2-Dichloroethene	EPA-8260	.	.	●	●	●
trans-1,2-Dichloroethene	EPA-8260	●	.	●	●	●
1,2-Dichloropropane	EPA-8260	.	.	●	●	●

Table 3 (cont'd)

MONITORING PROGRAM		RCRA Post-Closure Corrective Action Monitoring ¹				
		DOE Order 5400.1 Monitoring ²				
VOLATILE ORGANIC COMPOUNDS (cont'd)	Analytical Method ³	GWPS Constituent ⁴	Sample Type ⁵			
			Filtered	Unfiltered		
cis-1,3-Dichloropropene	EPA-8260	.	.	●	●	●
trans-1,3-Dichloropropene	EPA-8260	.	.	●	●	●
Dimethylbenzene	EPA-8260	.	.	●	●	●
Ethanol	EPA-8260	.	.	●	●	●
Ethylbenzene	EPA-8260	.	.	●	●	●
Ethyl methacrylate	EPA-8260	.	.	●	●	●
2-Hexanone	EPA-8260	.	.	●	●	●
Iodomethane	EPA-8260	.	.	●	●	●
4-Methyl-2-pentanone	EPA-8260	.	.	●	●	●
Methylene chloride	EPA-8260	.	.	●	●	●
Styrene	EPA-8260	.	.	●	●	●
1,1,1,2-Tetrachloroethane	EPA-8260	.	.	●	●	●
1,1,2,2-Tetrachloroethane	EPA-8260	.	.	●	●	●
Tetrachloroethene	EPA-8260	●	.	●	●	●
Toluene	EPA-8260	.	.	●	●	●
1,1,1-Trichloroethane	EPA-8260	●	.	●	●	●
1,1,2-Trichloroethane	EPA-8260	.	.	●	●	●
Trichloroethene	EPA-8260	●	.	●	●	●
Trichlorofluoromethane	EPA-8260	.	.	●	●	●
1,2,3-Trichloropropane	EPA-8260	.	.	●	●	●
Vinyl acetate	EPA-8260	.	.	●	●	●
Vinyl chloride	EPA-8260	.	.	●	●	●
RADIOLOGICAL ANALYTES	Analytical Method	GWPS Constituent	Sample Type			
			Filtered	Unfiltered		
Gross Alpha Activity	EPA-900.0	●	.	●	●	●
Gross Beta Activity	EPA-900.0	●	.	●	●	●
Technetium-99	Y/P65-7154	●	.	●	●	●
MISC. LABORATORY ANALYTES	Analytical Method ³	GWPS Constituent ⁴	Sample Type ⁵			
			Filtered	Unfiltered		
pH	EPA-150.1	.	.	●	●	●
Conductivity	EPA-129.1	.	.	●	●	●
Total Dissolved Solids	EPA-160.1	.	.	●	●	●
Total Suspended Solids	EPA-160.2	.	.	●	●	●
Turbidity	EPA-180.1	.	.	●	●	●

Table 3 (cont'd)

MONITORING PROGRAM		RCRA Post-Closure Corrective Action Monitoring ¹				
		DOE Order 5400.1 Monitoring ²				
FIELD MEASUREMENTS	Analytical Method ³	GWPS Constituent ⁴	Sample Type ⁵			
			Filtered	Unfiltered		
Depth-to-Water	ESP 302-1	.	.	.	●	●
Water Temperature	ESP 307-1	.	.	●	●	●
pH	ESP 307-1	.	.	●	●	●
Conductivity	ESP 307-1	.	.	●	●	●
Dissolved Oxygen	ESP 307-3	.	.	●	●	●
Oxidation-Reduction Potential	ESP 307-5	.	.	●	●	●

Notes:

- 1 Monitoring per the requirements of the Resource Conservation and Recovery Act (RCRA) Post-Closure Permit for the East Fork Regime (Permit No. TNHW-089). Samples from well GW-115 were analyzed for additional isotopes (not listed on this table) to meet requirements of the RCRA Post-Closure Permit for the Bear Creek Regime (Permit No. TNHW-087). Results for these isotopes are presented in the annual monitoring report for the Bear Creek Regime (AJA Technical Services, Inc. 1998).
- 2 Surveillance monitoring and exit pathway/perimeter monitoring per the requirements of U.S. Department of Energy (DOE) Order 5400.1.
- 3 Organics analyses were performed using method EPA-8240 during the first quarter sampling event; method EPA-8260 was used for the rest of the year. Analytical/field methods/procedures from:
 - *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* (U.S. Environmental Protection Agency 1986)
 - *Methods for Chemical Analysis of Water and Wastes* (U.S. Environmental Protection Agency 1983)
 - *Environmental Surveillance Procedures Quality Control Program* (Lockheed Martin Energy Systems, Inc. 1988)
 - Lockheed Martin Energy Systems ASO radiological methods
- 4 Groundwater protection standard (GWPS) constituent specified in the RCRA Post-Closure Permit for the East Fork Regime.
- 5 Groundwater samples for metals analysis collected with dedicated sampling equipment or portable Bennet Pumps™ were filtered in the field; samples collected with bailers and surface water samples were filtered in the laboratory.

Table 4.
Summary of VOC Results for CY 1997 QA/QC Samples

Compounds ¹	Number of Detected Results by Sample Type			
	Lab Blanks	Trip Blanks	Rinsates	Field Blanks
Groundwater Artifacts				
Acetone	30	43	6	3
2-Butanone	18	23	4	2
Carbon disulfide	2	0	0	0
Miscellaneous Compounds				
Acrolein	0	1	0	0
1,2-Dichlorobenzene	1	0	0	0
1,2-Dichloroethane	0	7	0	0
2-Hexanone	6	0	2	1
4-Methyl-2-pentanone	2	1	0	1
Plume Constituents				
Acrylonitrile	1	1	0	0
Carbon tetrachloride	0	1	0	0
Chloroform	0	18	5	1
Chloromethane	0	2	0	0
1,2-Dichloroethene	0	1	0	0
cis-1,2-Dichloroethene	0	1	0	0
Dimethylbenzene	1	1	1	0
Ethylbenzene	2	1	0	0
Methylene chloride	5	4	2	0
Tetrachloroethene	1	1	0	0
Toluene	0	4	1	0
Trichloroethene	0	2	1	0
Total Number of Samples	44	58	6	3
Samples With VOCs²	32	50	6	3
Percent Contaminated	73	86	100	100

Notes:

- 1 Groundwater artifacts were commonly introduced into groundwater samples from the laboratory environment and screened as false positives.
Miscellaneous compounds were never detected in groundwater samples.
Plume constituents were consistently detected in groundwater samples from at least one well located downgradient of a source area.
- 2 Some samples had more than one compound detected.

Table 5.
Atypical Proportions of Chloride, Nitrate, Sodium, and Sulfate in
CY 1997 Groundwater and Surface Water Samples

Well Number	Well Depth (ft bgs)	Hydrogeologic Unit		Ion Proportions > 15% \sum Cations or \sum Anions			
		Aquitard	Aquifer	Chloride	Nitrate	Sodium	Sulfate
GW-108	58.6	●	.	.	●	.	.
GW-148	11.1	.	●	●	.	.	.
GW-153	60.0	.	●	●	.	●	.
GW-207	109.6	●	.	.	.	.	●
GW-208	412.8	●	.	.	.	.	●
GW-251	51.0	.	●	.	●	.	●
GW-380	15.5	.	●	●	.	●	.
GW-383	23.6	●	.	●	.	.	.
GW-606	171.0	.	●	●	.	.	.
GW-617	18.0	.	●	.	.	.	●
GW-618	37.0	.	●	●	.	.	.
GW-722-06	562.6	.	●	●	.	●	.
GW-722-10	502.6	.	●	●	.	●	●
GW-722-14	427.7	.	●	.	.	●	.
GW-744	69.5	●	.	.	.	●	.
GW-745	32.8	●	.	.	.	●	.
GW-746	15.2	●	.	●	.	●	●
GW-747	79.6	●	.	.	.	●	.
GW-763	16.0	●	.	●	.	.	.
GW-770	19.0	●	.	.	.	.	●
GW-775	56.4	●	.	●	.	.	●
GW-776	23.0	●	.	●	.	.	●
GW-781	69.3	●	.	.	.	●	.
GW-783	16.3	●	.	●	.	.	●
GW-788	67.8	●	.	.	.	●	.
GW-792	29.0	●	.	●	.	.	.
GW-817	23.0	●	.	.	.	●	.

Table 6.
CY 1997 Gross Alpha and Gross Beta Activities
that Exceed MDAs and Counting Errors

Sampling Point	Location ¹	Sampling Date	Activity ² (pCi/L)	
			Gross Alpha	Gross Beta
WESTERN PLANT AREA				
GW-108	S3	03/04/97	.	8,000 ± 600
		08/11/97	.	13,000 ± 1,100
GW-251	S2	05/07/97	13 ± 4.7	14 ± 4.6
		11/05/97	8 ± 3.7	.
GW-618	EXP-E	11/04/97	4.5 ± 3.1	.
GW-620	FTF	05/06/97	2.6 ± 1.9	.
CENTRAL PLANT AREA				
GW-193	T2331	03/05/97	7.6 ± 3.8	.
		08/13/97	4.4 ± 2.8	.
GW-770	GRIDG3	05/12/97	3.3 ± 2.2	.
GW-782	GRIDE3	05/14/97	44 ± 8	.
		11/24/97	56 ± 9.4	18 ± 5.2
GW-783	GRIDE3	11/25/97	3.5 ± 2.4	.
EASTERN PLANT AREA				
GW-605	EXP-I	03/18/97	170 ± 22	80 ± 13
		08/11/97	120 ± 39	.
GW-606	EXP-I	03/06/97	8.5 ± 3.6	.
		07/31/97	5.5 ± 3.1	.
GW-722-06	EXP-J	07/28/97	2.5 ± 2.2	.
GW-722-26	EXP-J	08/04/97	4.2 ± 2.8	.
GW-733	EXP-J	03/05/97	2.4 ± 1.8	.
GW-744	GRIDK1	12/08/97	4.2 ± 2.6	.
GW-745	GRIDK1	12/09/97	2.1 ± 1.9	.
GW-817	GRIDK3	04/17/97	4.2 ± 3.4	.

Notes:

- 1 EXP - Exit Pathway monitoring well:
 Maynardville Limestone Picket E, I, or J
 FTF - Fire Training Facility
 GRID - Comprehensive Groundwater Monitoring Plan Grid Location
 S2 - S-2 Site
 S3 - S-3 Ponds Site
 T2331 - Tank 2331-U

- 2 Activity and associated error in picoCuries per liter (pCi/L). Results shown in **bold** exceed drinking water standards.
 . - Result less than the associated MDA or counting error.

APPENDIX C
SUMMARY OF CY 1997 DATA
THAT MEET APPLICABLE DQOs

EXPLANATION

LOCATION:

- B4 - Beta-4 Security Pits
- EXP - Exit Pathway (Maynardville Limestone) monitoring location
 - -E, -I, or -J: Maynardville Limestone Picket monitoring well
 - -SW: Lake Reality Spillway (LRSPW)
 - -SR: Along Scarboro Road in the gap through Pine Ridge
- FTF - Fire Training Facility
- GRID - Comprehensive Groundwater Monitoring Plan Grid Location
- NHP - New Hope Pond
- S2 - S-2 Site
- S3 - S-3 Ponds Site
- T2331 - Tank 2331-U

UNITS:

- ft - feet (water-level elevation is in feet above mean sea level)
- mg/L - milligrams per liter
- ug/L - micrograms per liter
- pCi/L - picoCuries per liter

DATA QUALIFIERS:

- . - Not detected or not analyzed.
- TOT < DIS - Total concentration (unfiltered sample) is at least an order of magnitude less than the dissolved concentration (filtered sample).
- FP - False-positive VOC result, screened by data from the associated laboratory blank (FP1) or trip blank (FP2) sample.
- <MDA - Reported activity is less than the minimum detectable activity.
- <CE - Reported activity is greater than the MDA, but less than the associated counting error.

NOTES:

Only unfiltered results that meet data quality objectives of the Y-12 Plant Groundwater Protection Program for the constituents most often detected in CY 1997 are presented in this appendix. Results for some organics (acetone, bromochloromethane, and 2-butanone) and metals (arsenic, beryllium, molybdenum, and vanadium) are not included in this appendix because these compounds are probably sampling/analytical artifacts that were rarely detected. Although a contaminant of concern in the regime, mercury was not detected in any CY 1997 groundwater or surface water samples. All of the analytical results for groundwater and surface water samples collected in 1997 are available in the Annual Groundwater Monitoring Report (AJA Technical Services, Inc. 1998).

EXPLANATION (cont'd)

Miscellaneous:

TSS - Total Suspended Solids

Major Ions:

The relative percent difference (RPD) between summed positive and negative charges (Charge Balance) is used to evaluate the accuracy of the data. Results for major ions are considered qualitative if the Charge Balance RPD is greater than 20 or less than -20.

Trace Metals:

The Cluster Designation reflects a group (summarized below) based on similar geochemical characteristics assigned to each sampling location (HSW Environmental Consultants, Inc. 1995).

Cluster	Description
1	Shallow groundwater with variable calcium-magnesium-bicarbonate geochemistry.
2	Shallow calcium-magnesium-bicarbonate groundwater with very low TDS.
3	Shallow groundwater with fairly uniform calcium-magnesium-bicarbonate.
4	Calcium-magnesium bicarbonate groundwater with equal or nearly equal proportions of calcium and magnesium.
6	Intermediate depth sodium-bicarbonate groundwater.
10	Deep sodium-chloride bicarbonate groundwater with very high TDS.

Data for wells that comprise clusters 5, 7, 8, and 9 were excluded from upper tolerance level (UTL) calculations because groundwater from these wells had elevated nitrate concentrations and may include contamination from the S-3 Site metals plume. For comparison to UTLs, wells that comprise clusters 5, 7, 8, and 9 were assigned to one of the above clusters as a "surrogate" group based on selected well construction information and water quality data. The following table provides the UTLs that represent trace metal background levels for the wells in clusters (1, 2, 3, and 4) that apply to CY 1997 monitoring locations in the East Fork Regime.

EXPLANATION (cont'd)

Trace Metal	Upper Tolerance Limit (mg/L)			
	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Aluminum	2.4	6.1	2.4	2.4
Antimony	0.05	0.05	0.05	0.05
Arsenic	0.05	0.05	0.05	0.05
Barium	0.71	0.68	0.79	0.34
Beryllium	0.00045	0.00045	0.00045	0.00045
Boron	0.12	0.028	0.041	0.028
Cadmium	0.002	0.002	0.002	0.002
Chromium	0.029	0.041	0.041	0.029
Cobalt	0.019	0.019	0.019	0.019
Copper	0.012	0.012	0.012	0.012
Iron	8.7	8.7	8.7	4.6
Lead	0.0096	0.0096	0.0096	0.0096
Manganese	1.7	1.7	1.7	0.13
Mercury	0.0003	0.0003	0.0003	0.0003
Molybdenum	0.018	0.018	0.018	0.018
Nickel	0.06	0.06	0.02	0.02
Selenium	0.05	0.05	0.05	0.05
Silver	0.006	0.006	0.006	0.006
Strontium	4.4	0.079	0.92	0.079
Thorium	0.2	0.2	0.2	0.2
Uranium	0.012	0.004	0.005	0.005
Vanadium	0.005	0.005	0.005	0.005
Zinc	0.041	0.043	0.041	0.041

All metals analyses were performed using the inductively coupled plasma spectroscopy method unless otherwise noted.

PMS - Plasma Mass Spectroscopy

Organics:

Bromoform, bromomethane, and iodomethane were detected (< 5 ug/L) only in samples from well GW-108, so these compounds are not included in this appendix. Total 1,2-dichloroethane is not included in this appendix, but is equal to the sum of the isomers (cis- and trans-).

ND - Summed VOCs are not determined (all results not detected).

EXPLANATION (cont'd)

Isotopic Data:

Isotopic data for CY 1997 consisted of results for technetium-99 in samples from six wells. Technetium-99 was detected only in samples from well GW-108 at the S-3 Site: $18,000 \pm 1,800$ pCi/L and $14,000 \pm 1,400$ pCi/L in the first and third quarter samples, respectively.

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point Location	GW-108		GW-148		GW-153		GW-192	
	S3		NHP		NHP		B4	
Date Sampled	03/04/97	08/11/97	05/20/97	12/03/97	05/21/97	12/03/97	04/07/97	10/30/97
MISCELLANEOUS								
Water-Level Elevation	990.46	990.49	899.71	898.84	901.41	901.21	1003.28	1003.55
Water in Well (ft)	53.45	53.48	6.28	5.41	42.88	42.68	14.78	15.05
TSS (mg/L)	9	13	5	.	4	.	5	12
pH (Field)	5.8	5.4	6.9	6.5	7.9	8	6.9	6.6
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)	-7.5	-34.1	-1.5	7	1	1.3	-0.6	1
Calcium	11000	12000	160	160	41	41	120	150
Magnesium	1100	950	11	10	19	18	14	22
Potassium	.	24	2.4	2.8	2.6	3	1	1.3
Sodium	460	430	18	18	12	23	7	7.5
Alkalinity-HCO3	622	620	354	330	168	158	352	450
Alkalinity-CO3	.	.	.	.	.	.	.	.
Chloride	103	120	76	39	14.2	39.9	19.1	14.7
Fluoride	.	.	.	0.12	0.19	0.21	0.2	0.32
Sulfate	.	.	31.8	33.4	11.9	13.9	2.85	1.78
Nitrate-N	10500	19700	.	.	0.855	1.01	.	.
METALS (mg/L)								
CLUSTER DESIGNATION	3	3	1	1	1	1	3	3
Aluminum	.	0.98	0.31	0.025	0.78	0.046	0.036	.
Barium	100	92	0.3	0.29	0.05	0.046	0.17	0.26
Boron	0.22	0.34	0.036	0.039	0.023	0.015	0.015	0.019
Cadmium	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	.	.
Cobalt	.	0.16	.	.	.	.	0.0095	.
Copper	.	.	.	.	.	.	.	.
Iron	0.61	.	0.36	0.029	0.75	0.035	3	11
Lead (PMS)	0.0018	0.0017	0.00092	.	0.0036	.	0.00091	.
Lithium	0.4	0.34	0.0059	0.0069	0.012	0.0081	0.012	0.0069
Manganese	110	97	0.27	0.043	0.037	0.0012	2.5	2.7
Nickel	.	0.26	.	.	.	.	.	.
Strontium	39	34	0.57	0.57	0.16	0.16	0.23	0.34
Thallium (PMS)	.	0.0017	.	.	.	.	0.00052	.
Uranium (PMS)	0.015	0.015	0.0015	0.0012	0.0017	0.0017	.	.
Zinc	.	0.071	0.0078	0.0061	0.0077	.	0.0091	0.0028
ORGANICS (ug/L)								
SUMMED VOCs	83	64	11	8	209	ND	24	19
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	.	.	.	.	.	.	.	.
Carbon tetrachloride	.	.	.	.	200	.	.	.
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	29	22	.	.	FP2	.	.	.
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	2	1
1,1-Dichloroethene	.	.	.	.	.	.	.	.
cis-1,2-Dichloroethene	.	.	11	8	.	.	17	12
trans-1,2-Dichloroethene	.	.	.	.	.	.	.	.
Dimethylbenzene	.	.	.	.	.	.	.	.
Ethylbenzene	.	.	.	.	.	.	.	.
Methylene chloride	48	38	.	.	.	.	.	.
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	.	7	.	2	3
Toluene	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.
Trichloroethene	FP2	2	.	.	2	.	3	3
Trichlorofluoromethane	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	8000	13000	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point	GW-193		GW-207		GW-208		GW-220	
	T2331		EXP-SR		EXP-SR		NHP	
Date Sampled	03/05/97	08/13/97	04/08/97	12/02/97	04/10/97	12/02/97	05/22/97	12/08/97
MISCELLANEOUS								
Water-Level Elevation	926.39	925.62	898.36	.	897.72	.	900.32	899.69
Water in Well (ft)	13.68	12.91	113.35	.	416.14	.	32.78	32.15
TSS (mg/L)	.	.	.	.	.	1	7	1
pH (Field)	7.8	7.4	7.6	7.47	7.4	7.57	7.5	7.4
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)								
Calcium	64	89	58	58	77	80	69	59
Magnesium	14	18	38	38	25	26	25	26
Potassium	5.5	7.5	2.9	3	2.7	2.9	2.7	2.9
Sodium	3.9	4.7	10	10	15	16	4.1	5
Alkalinity-HCO3	202	272	268	274	234	228	250	228
Alkalinity-CO3	.	.	.	.	.	.	.	.
Chloride	5.42	4.43	1.08	1.03	1.28	1.56	10.6	12.2
Fluoride	0.63	0.6	0.2	0.22	0.3	0.32	.	.
Sulfate	25.8	32.2	60.3	56.2	111	111	14.6	14.6
Nitrate-N	.	.	.	.	.	.	1.14	0.82
METALS (mg/L)								
CLUSTER DESIGNATION	1	1	1	1	1	1	1	1
Aluminum	0.1	0.03	.	0.027	0.027	.	0.42	0.098
Barium	0.078	0.11	0.046	0.046	0.041	0.041	0.11	0.1
Boron	0.073	0.11	0.12	0.11	0.22	0.22	0.046	0.055
Cadmium	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	0.011	.
Cobalt	.	.	.	.	.	.	.	.
Copper	.	.	.	.	.	.	.	.
Iron	0.17	0.024	0.21	0.22	0.73	1.1	0.63	0.053
Lead (PMS)	0.0012	.	0.00088	.	0.0019	.	0.0013	.
Lithium	.	.	0.031	0.032	0.03	0.032	0.0052	0.0051
Manganese	0.25	0.39	0.0096	0.0093	0.016	0.021	0.021	0.0083
Nickel	.	.	.	.	.	.	.	.
Strontium	0.38	0.49	0.54	0.54	1.5	1.5	0.44	0.43
Thallium (PMS)	.	.	.	.	.	.	.	.
Uranium (PMS)	0.012	0.0042	.	.	.	.	0.00057	.
Zinc	0.0036	0.0039	.	TOT<DIS	1.4	1.2	0.0032	0.0033
ORGANICS (ug/L)								
SUMMED VOCs	476	319	ND	ND	ND	ND	532	682
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	180	120	.	.	.	.	.	.
Carbon tetrachloride	.	.	.	.	.	.	450	610
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	4	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	24	29
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.
cis-1,2-Dichloroethene	.	.	.	.	.	.	3	3
trans-1,2-Dichloroethene	.	.	.	.	.	.	.	.
Dimethylbenzene	120	52	.	.	.	.	.	.
Ethylbenzene	140	130	.	.	.	.	.	.
Methylene chloride	.	.	.	.	.	.	.	.
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	.	.	.	45	33
Toluene	36	13	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	.	10	6
Trichlorofluoromethane	.	.	.	.	.	.	.	1
Vinyl chloride	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	7.6	4.4	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point Location Date Sampled	GW-251		GW-380		GW-383		GW-605	
	S2		NHP		NHP		EXP-I	
	05/07/97	11/05/97	05/21/97	12/02/97	05/22/97	12/04/97	03/18/97	08/11/97
MISCELLANEOUS								
Water-Level Elevation	991.00	982.35	903.52	902.16	899.05	898.97	908.26	908.03
Water in Well (ft)	40.4	31.75	5.36	4	16.65	16.57	31.19	30.96
TSS (mg/L)	55	8	7	7	7.5	7.2	7.1	3
pH (Field)	6.5	6.8	7.2	7	7.5	7.2	7.1	6.8
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)	-9.6	-8.9	-0.9	-13.3	-2.3	1.1	-6	-5.3
Calcium	120	86	36	30	79	92	77	77
Magnesium	19	15	16	12	11	11	16	15
Potassium	4.8	2.5	1	0.96	2.8	2.9	2.8	2.8
Sodium	19	10	70	37	18	14	18	14
Alkalinity-HCO3	178	174	180	138	234	224	248	250
Alkalinity-CO3	.	.	.	.	.	.	.	.
Chloride	10.5	5.88	90.3	45.2	29.6	38.7	36.2	22.6
Fluoride	1.44	1.58	0.16	0.23	0.11	0.12	.	.
Sulfate	25.8	15.4	7.14	55.9	24.4	18	33.3	38.1
Nitrate-N	80.2	40.9	0.68	1.5	.	.	0.221	0.28
METALS (mg/L)								
CLUSTER DESIGNATION	1	1	1	1	1	1	1	1
Aluminum	5.6	0.22	0.13	.	0.046	0.029	0.04	0.058
Barium	0.13	0.065	0.032	0.023	0.55	0.6	0.057	0.054
Boron	0.033	0.012	0.025	0.034	0.13	0.094	0.14	0.14
Cadmium	0.17	0.066	0.0032	.	.	.	.	.
Chromium	0.015	.	0.26	0.048	.	.	.	.
Cobalt	0.036	0.0079	0.0064	.	.	.	.	.
Copper	0.57	0.18	0.008	.	.	.	.	.
Iron	4.4	0.097	3.3	0.11	0.84	0.39	0.08	0.046
Lead (PMS)	0.016	0.0021	0.00063	.	.	.	.	.
Lithium	0.0099	.	.	.	0.017	0.015	.	.
Manganese	5.3	1.6	0.071	0.058	0.16	0.12	0.45	0.53
Nickel	0.057	0.011	0.25	0.13	.	.	.	.
Strontium	0.24	0.15	0.041	0.033	0.43	0.43	0.17	0.17
Thallium (PMS)	0.0034	0.0014	.	.	.	.	0.00076	.
Uranium (PMS)	0.0088	0.0036	0.0012	0.0014	.	.	0.24	0.23
Zinc	0.099	0.023	0.0058	0.0068	.	0.0048	0.0024	0.003
ORGANICS (ug/L)								
SUMMED VOCs	879	193	ND	2	671	515	107	200
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	.	.	.	.	.	.	.	.
Carbon tetrachloride	18	2	.	.	2	.	100	170
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	13	9	.	2	FP2	.	FP2	16
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	3	3	.	.
cis-1,2-Dichloroethene	8	2	.	.	130	100	3	5
trans-1,2-Dichloroethene	.	.	.	.	2	1	.	.
Dimethylbenzene	.	.	.	.	.	.	.	.
Ethylbenzene	.	.	.	.	.	.	.	.
Methylene chloride	FP1	.	.	.	.	.	.	.
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	600	130	.	.	350	310	3	7
Toluene	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.
Trichloroethene	240	50	.	.	180	100	1	2
Trichlorofluoromethane	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	4	.	.	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	13	8	<MDA	< CE	<MDA	<MDA	170	120
Gross Beta	14	<MDA	<MDA	<MDA	<MDA	<MDA	80	<MDA

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point	GW-606		GW-617		GW-618		GW-620	
	EXP-I	EXP-I	EXP-E	EXP-E	EXP-E	EXP-E	FTF	FTF
Date Sampled	03/06/97	07/31/97	05/07/97	11/05/97	05/06/97	11/04/97	05/06/97	12/01/97
MISCELLANEOUS								
Water-Level Elevation	908.39	906.35	972.01	970.40	972.29	970.34	994.62	987.99
Water in Well (ft)	162.41	160.37	7.4	5.79	26.65	24.7	56.82	50.19
TSS (mg/L)	.	4	.	8	3	.	27	.
pH (Field)	7.7	6.9	6.2	5.4	6.8	6.7	10.6	11.5
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)	-3.2	-0.3	0.2	-6.6	-2.9	-0.3	26	-38
Calcium	68	66	23	15	95	110	62	18
Magnesium	35	33	5.2	4.5	8.9	9.7	3	0.43
Potassium	3	2.6	0.83	1.2	3.2	4.3	10	11
Sodium	4.9	4.9	5.2	5.2	15	24	2	2.2
Alkalinity-HCO3	234	222	44	58	266	346	.	.
Alkalinity-CO3	.	.	.	.	.	.	28	24
Chloride	51.9	41.5	5.14	6.02	22.5	23.3	1.85	2.08
Fluoride	0.23	0.2	.	.	0.27	0.25	0.12	0.11
Sulfate	37	36	30.3	12.8	21.9	15.2	4.55	4.89
Nitrate-N	1.05	1.14	2.14	0.06	1.39	.	1.28	1.44
METALS (mg/L)								
CLUSTER DESIGNATION	1	1	1	1	1	1	3	3
Aluminum	.	0.04	.	.	.	.	0.23	0.06
Barium	0.093	0.087	0.03	0.046	0.051	0.06	0.028	0.036
Boron	0.042	0.044	0.34	0.22	0.12	0.14	0.017	0.023
Cadmium	.	.	.	.	0.021	.	.	.
Chromium	.	.	.	.	.	.	.	.
Cobalt	.	.	.	0.0066	.	.	.	.
Copper	.	.	.	.	0.019	.	.	.
Iron	0.054	0.13	0.049	3.2	0.27	1.3	0.0084	.
Lead (PMS)	0.00058	0.0016	0.00056	.	0.00068	.	0.0027	.
Lithium	0.0098	0.0089	.	.	.	.	0.011	0.018
Manganese	0.011	0.0096	0.0083	3.4	1.7	1.8	.	.
Nickel	.	.	.	0.01	.	.	.	.
Strontium	0.51	0.46	0.043	0.036	0.19	0.22	0.22	0.37
Thallium (PMS)	.	.	.	.	.	.	.	.
Uranium (PMS)	0.0068	0.0074	.	.	0.00058	.	.	.
Zinc	0.0028	0.0039	.	0.0032	0.0046	.	.	.
ORGANICS (ug/L)								
SUMMED VOCs	1036	139	ND	6	37	46	216	222
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	.	.	.	.	.	.	.	.
Carbon tetrachloride	810	67	.	.	.	.	.	.
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	210	66	.	.	.	.	1	.
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.
cis-1,2-Dichloroethene	.	.	.	6	30	29	74	94
trans-1,2-Dichloroethene	.	.	.	.	.	.	.	.
Dimethylbenzene	.	.	.	.	.	.	2	.
Ethylbenzene	.	.	.	.	.	1	.	.
Methylene chloride	.	1	.	.	FP1	.	.	.
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	.	5	.	.	1	3	110	93
Toluene	.	.	.	.	.	.	.	1
1,1,1-Trichloroethane	.	.	.	.	.	.	.	2
Trichloroethene	16	.	.	.	4	8	29	32
Trichlorofluoromethane	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	2	5	.	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	8.5	5.5	<MDA	<MDA	<MDA	4.5	2.6	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point Location	GW-722-06		GW-722-10		GW-722-14		GW-722-17	
	EXP-J		EXP-J		EXP-J		EXP-J	
Date Sampled	07/28/97	11/24/97	07/29/97	11/24/97	07/29/97	11/25/97	07/30/97	11/25/97
MISCELLANEOUS								
Water-Level Elevation	.	.	.	.	.	.	.	.
Water in Well (ft)	.	.	.	.	.	.	.	.
TSS (mg/L)	6	9	4	.	27	1	10	7
pH (Field)	7.8	7.74	8.05	7.07	8.6	7.28	7.42	7.06
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)	18.4	27.8	18.6	7.9	-80.4	0.9	-1.8	3.2
Calcium	22	27	26	43	28	53	53	53
Magnesium	14	16	16	29	12	29	31	31
Potassium	4.8	7	1.9	4.1	0.85	2.3	2.4	2.3
Sodium	160	200	37	68	8.2	19	12	12
Alkalinity-HCO3	262	270	30	208	214	208	206	204
Alkalinity-CO3	.	.	.	.	.	.	.	.
Chloride	58.9	167.349	59.3	53.163	14.5	23.653	15.8	16.884
Fluoride	0.4	1.04	0.46	0.61	0.13	0.39	0.28	0.31
Sulfate	6.74	26.173	34.2	73.25	8.64	30.313	24.9	24.558
Nitrate-N	.	.	0.27	0.353	0.69	2.934	3.67	3.137
METALS (mg/L)								
CLUSTER DESIGNATION	1	1	1	1	1	1	1	1
Aluminum	0.086	0.11	0.05	.	0.17	0.094	0.11	0.091
Barium	0.067	0.13	0.066	0.069	0.078	0.068	0.073	0.066
Boron	0.71	0.68	0.14	0.24	0.04	0.074	0.075	0.066
Cadmium	.	.	.	.	.	.	.	.
Chromium	0.01	.	.	0.014	0.017	0.015	.	.
Cobalt	.	.	.	.	.	.	.	.
Copper	.	.	0.0057	.	0.0059	.	.	.
Iron	0.38	0.26	0.42	0.47	0.65	0.22	0.28	0.19
Lead (PMS)	0.0023	0.0008	0.0041	0.0009	0.029	0.001	0.0019	.
Lithium	0.12	0.14	0.027	0.051	0.0077	0.016	0.012	0.013
Manganese	0.025	0.028	0.025	0.019	0.017	0.0075	0.0079	0.0069
Nickel	0.016	0.053	0.02	0.016	0.026	0.013	.	.
Strontium	4.2	5	1.5	3.7	0.38	0.9	1	1.1
Thallium (PMS)	.	.	.	.	.	.	.	.
Uranium (PMS)	.	.	.	.	.	.	.	.
Zinc	0.1	0.043	0.43	0.025	0.98	0.022	0.12	0.034
ORGANICS (ug/L)								
SUMMED VOCs	7	2	122	69	465	492	791	982
Acrylonitrile	6	.	.	.	.	.	.	.
Benzene	.	.	.	.	.	.	.	.
Carbon tetrachloride	.	.	82	36	380	410	620	800
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	.	.	22	22	39	35	58	67
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	1	2	2
1,1-Dichloroethene	.	.	.	.	.	1	4	4
cis-1,2-Dichloroethene	.	.	2	2	4	4	9	10
trans-1,2-Dichloroethene	.	.	.	.	.	.	.	.
Dimethylbenzene	.	.	.	.	.	.	.	.
Ethylbenzene	.	1	.	.	.	.	.	.
Methylene chloride	.	.	1	.	.	.	.	.
Styrene	1	1	.	.	.	.	.	.
Tetrachloroethene	.	.	12	7	32	30	72	66
Toluene	.	.	.	.	.	.	1	.
1,1,1-Trichloroethane	.	.	.	.	2	2	6	7
Trichloroethene	.	.	3	2	5	4	8	11
Trichlorofluoromethane	.	.	.	.	3	5	11	15
Vinyl chloride	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	2.5	<MDA	<MDA	<MDA	1.4	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point	GW-722-20		GW-722-22		GW-722-26		GW-722-30	
	EXP-J		EXP-J		EXP-J		EXP-J	
Location	EXP-J		EXP-J		EXP-J		EXP-J	
Date Sampled	07/30/97	12/02/97	07/31/97	12/02/97	08/04/97	12/03/97	08/04/97	12/04/97
MISCELLANEOUS								
Water-Level Elevation	.	.	.	.	.	.	.	.
Water in Well (ft)	.	.	.	.	.	.	.	.
TSS (mg/L)	500	5	22	4	12	4	13	6.7
pH (Field)	6.72	6.89	7.66	7.2	7.56	7.21	7.72	7.43
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)	12.4	-0.2	0.3	-0.1	-5.9	-2.6	-1.1	1.3
Calcium	560	55	66	52	59	58	39	37
Magnesium	78	27	28	24	23	23	15	14
Potassium	7	3.5	1.5	2	2.9	3.1	1.3	3.4
Sodium	21	11	12	11	4.3	4.1	1	1.2
Alkalinity-HCO3	544	212	214	206	246	244	160	148
Alkalinity-CO3	.	.	.	.	.	.	.	.
Chloride	18.9	18.1	17.6	18.6	5.2	5.11	2.47	1.83
Fluoride	0.58	0.41	0.29	0.32	1.25	1.31	0.24	0.2
Sulfate	92	24.7	28.9	24.9	.	.	4.89	7.37
Nitrate-N	0.17	2.73	3.26	2.85	.	.	.	.
METALS (mg/L)								
CLUSTER DESIGNATION	1	1	1	1	4	4	4	4
Aluminum	6.2	0.17	0.16	0.064	0.066	.	0.59	0.13
Barium	0.25	0.077	0.093	0.097	0.32	0.33	0.053	0.094
Boron	0.25	0.049	0.068	0.05	0.062	0.07	0.0087	0.021
Cadmium	.	.	.	.	.	.	.	.
Chromium	0.013	0.014	.	.	.	.	.	.
Cobalt	0.012	.	.	.	.	.	.	.
Copper	0.036	0.0045	.	0.0049	.	.	.	.
Iron	43	0.59	0.79	0.29	2.2	2.2	1.1	0.48
Lead (PMS)	0.047	0.0017	0.0022	0.0027	0.0012	.	0.0017	0.001
Lithium	0.039	0.013	0.013	0.012	0.0092	0.0094	0.0059	0.0052
Manganese	0.43	0.012	0.012	0.008	0.14	0.14	0.021	0.02
Nickel	0.027	0.014	0.012	0.01	.	.	.	0.021
Strontium	4.3	0.73	0.73	0.64	2.2	2.4	0.09	0.21
Thallium (PMS)	.	.	.	.	.	.	.	.
Uranium (PMS)	0.00087	.	0.00069	.	.	.	.	.
Zinc	0.28	0.14	0.06	0.42	0.14	0.093	0.042	0.061
ORGANICS (ug/L)								
SUMMED VOCs	222	1350	953	7	37	44	2	ND
Acrylonitrile	49	.	.	.	26	20	2	.
Benzene	.	.	.	.	1	2	.	.
Carbon tetrachloride	120	1200	850	7	.	1	.	.
Chlorobenzene	.	.	.	.	.	4	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	28	57	38	.	.	.	.	.
Chloromethane	2	.	.	.	.	.	.	.
1,1-Dichloroethane	.	1	.	.	.	.	.	.
1,1-Dichloroethene	.	2	1	.	.	2	.	.
cis-1,2-Dichloroethene	2	7	5	.	.	.	.	.
trans-1,2-Dichloroethene	.	.	.	.	.	.	.	.
Dimethylbenzene	.	.	.	.	1	2	.	.
Ethylbenzene	.	.	.	.	3	.	.	.
Methylene chloride	5	.	.	.	.	.	.	.
Styrene	.	.	.	.	3	3	.	.
Tetrachloroethene	12	58	44	.	.	.	.	.
Toluene	.	.	.	.	3	9	.	.
1,1,1-Trichloroethane	1	6	3	.	.	.	.	.
Trichloroethene	2	7	6	.	.	1	.	.
Trichlorofluoromethane	1	12	6	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	<MDA	<MDA	<MDA	<MDA	4.2	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

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APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point Location Date Sampled	GW-722-32		GW-722-33		GW-733		GW-735		GW-744
	EXP-J		EXP-J		EXP-J		EXP-J		GRIDK1
	08/05/97	12/04/97	08/05/97	03/05/97	07/30/97	04/15/97	12/03/97	04/16/97	
MISCELLANEOUS									
Water-Level Elevation	.	.	.	908.10	903.19	901.33	866.06	900.62	
Water in Well (ft)	.	.	.	208.91	204	59.19	23.92	65.07	
TSS (mg/L)	24	5.7	8	17	25	3	1.2	.	
pH (Field)	7.56	6.82	7.63	7.8	7.6	7.3	7.89	7.6	
MAJOR IONS (mg/L)									
CHARGE BALANCE (RPD)	-6.8	1.1	1.7	-6.1	-0.5	-2.4	0.7	-2.1	
Calcium	72	81	73	43	43	120	39	57	
Magnesium	11	13	11	17	17	8.9	18	9.4	
Potassium	1.9	2.8	1.4	1.6	1.2	2.4	3.1	2.9	
Sodium	3.2	3.6	3.3	3.5	3.8	4.2	3.9	29	
Alkalinity-HCO3	210	236	212	180	164	316	158	224	
Alkalinity-CO3	.	.	.	.	.	.	.	.
Chloride	4.05	3.89	4.05	8.82	9.31	17.6	9.07	7.59	
Fluoride	.	.	.	0.29	0.25	.	0.26	0.12	
Sulfate	10.7	12.3	10.8	11	9.46	24.9	9.49	22.2	
Nitrate-N	0.82	0.74	0.79	0.366	0.38	0.142	.	.	
METALS (mg/L)									
CLUSTER DESIGNATION	3	3	3	3	3	1	1	3	
Aluminum	2	0.67	0.063	0.03	0.13	0.26	0.022	0.049	
Barium	0.042	0.047	0.033	0.027	0.031	0.33	0.025	0.19	
Boron	.	0.0068	.	0.021	0.021	0.025	0.011	0.053	
Cadmium	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	.	.
Cobalt	.	.	.	.	.	.	.	.
Copper	0.0053	.	.	.	0.0043	.	.	.	
Iron	2.3	1	0.15	8.8	12	0.24	1.9	0.27	
Lead (PMS)	0.004	0.0011	0.00084	0.0019	0.0042	0.0011	.	0.0012	
Lithium	0.0083	0.0068	.	0.0059	0.0048	.	0.0057	0.025	
Manganese	0.042	0.02	0.0032	0.066	0.066	0.28	0.16	0.16	
Nickel	.	.	.	.	.	.	.	.
Strontium	0.071	0.082	0.068	0.12	0.12	0.28	0.1	1.1	
Thallium (PMS)	.	.	.	.	.	.	.	.
Uranium (PMS)	.	.	0.00052	0.0008	0.00088	.	.	.	
Zinc	0.071	0.032	0.034	0.003	0.022	0.0036	0.0022	0.008	
ORGANICS (ug/L)									
SUMMED VOCs	2	2	2	34	28	2	ND	ND	
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	.	.	.	.	.	.	.	.
Carbon tetrachloride	.	.	.	31	26	.	.	.	
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	2	2	2	2	2	2	FP2	.	
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.
cis-1,2-Dichloroethene	.	.	.	.	.	.	.	.
trans-1,2-Dichloroethene	.	.	.	.	.	.	.	.
Dimethylbenzene	.	.	.	.	.	.	.	.
Ethylbenzene	.	.	.	.	.	.	.	.
Methylene chloride	.	.	.	.	.	.	.	.
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	1	.	.	.	.
Toluene	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	.	.	.
Trichlorofluoromethane	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)									
Gross Alpha	<MDA	<MDA	<MDA	2.4	<MDA	2.9	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

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APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point	GW-744		GW-745		GW-746		GW-747		GW-748
Location	GRIDK1		GRIDK1		GRIDK1		GRIDK2		GRIDK2
Date Sampled	12/08/97	04/17/97	12/09/97	04/17/97	12/09/97	04/17/97	12/09/97	04/17/97	
MISCELLANEOUS									
Water-Level Elevation	900.38	901.25	900.85	900.93	902.07	914.97	916.31	913.82	
Water in Well (ft)	64.83	29.77	29.37	11.87	13.01	76.24	77.58	22.13	
TSS (mg/L)	.	.	.	2	1	.	.	.	.
pH (Field)	8.11	6.9	6.79	5.9	5.88	7.7	7.8	7.6	
MAJOR IONS (mg/L)									
CHARGE BALANCE (RPD)	0.5	-4.1	-0.7	-7.8	0	-4.9	0.6	-4.3	
Calcium	55	64	75	23	19	42	33	87	
Magnesium	10	11	13	8	7.3	8.7	6.6	8.7	
Potassium	3.5	2.8	3.3	1.6	2.2	1.8	1.8	0.79	
Sodium	32	19	22	9.7	11	32	48	9.9	
Alkalinity-HCO3	220	200	222	52	44	204	200	236	
Alkalinity-CO3	.	.	.	.	.	.	.	.
Chloride	5.76	24.8	21	34.4	25.2	3.15	1.26	19.1	
Fluoride	.	0.11	0.1	.	.	0.2	0.21	.	
Sulfate	16.4	29.3	29.8	22.1	18.2	19.7	15.1	37.1	
Nitrate-N	.	.	.	1.26	0.79	.	0.17	.	
METALS (mg/L)									
CLUSTER DESIGNATION	3	1	1	3	3	3	3	1	
Aluminum	.	.	.	0.023	0.027	.	0.024	.	
Barium	0.22	0.14	0.19	0.14	0.17	0.13	0.13	0.11	
Boron	0.058	0.038	0.047	0.0095	0.015	0.068	0.1	0.012	
Cadmium	.	.	.	.	.	.	.	.
Chromium	.	.	.	0.13	0.14	.	.	.	
Cobalt	.	.	.	.	.	.	.	.
Copper	.	.	.	0.0054	.	.	.	.
Iron	0.045	0.23	0.31	0.92	0.99	0.057	0.028	0.021	
Lead (PMS)	0.0008	.	0.0005	.	0.0005	.	.	.	
Lithium	0.028	0.023	0.027	.	.	0.015	0.023	0.0068	
Manganese	0.12	0.64	1.1	0.036	0.03	0.015	0.0085	0.0035	
Nickel	.	.	0.066	0.34	0.65	.	.	.	
Strontium	1.2	0.69	0.8	0.097	0.086	0.52	0.43	0.23	
Thallium (PMS)	.	.	.	.	.	.	.	.
Uranium (PMS)	.	.	.	.	.	.	.	.
Zinc	.	0.0033	0.0021	0.0033	0.0078	.	0.0022	.	
ORGANICS (ug/L)									
SUMMED VOCs	ND	ND	ND	ND	ND	ND	ND	ND	
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	.	.	.	.	.	.	.	.
Carbon tetrachloride	.	.	.	.	.	.	.	.
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	.
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.
cis-1,2-Dichloroethene	.	.	.	.	.	.	.	.
trans-1,2-Dichloroethene	.	.	.	.	.	.	.	.
Dimethylbenzene	.	.	.	.	.	.	.	.
Ethylbenzene	.	.	.	.	.	.	.	.
Methylene chloride	.	.	.	.	.	.	.	.
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	.	.	.	.	.
Toluene	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	.	.	.
Trichlorofluoromethane	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)									
Gross Alpha	4.2	<MDA	2.1	< CE	<MDA	<MDA	<MDA	<MDA	
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point	GW-748	GW-749	GW-750	GW-763	GW-769			
Location	GRIDK2	GRIDK2	EXP-J	GRIDJ3	GRIDG3			
Date Sampled	12/10/97	04/17/97	12/10/97	04/14/97	12/03/97	05/20/97	12/02/97	05/13/97
MISCELLANEOUS								
Water-Level Elevation	915.82	914.17	917.19	906.24	906.09	904.73	904.19	933.52
Water in Well (ft)	24.13	11.88	14.9	62.98	62.83	9.35	8.81	52.29
TSS (mg/L)	.	1	1	.	1.2	40	39	.
pH (Field)	7.4	7.2	7	7.6	7.04	7	6.6	7.4
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)	0.1	-5.8	0.6	-4.1	-0.1	-2.5	-4.1	-0.9
Calcium	93	100	82	78	79	120	100	75
Magnesium	9.9	8.6	6.7	11	12	13	14	10
Potassium	1	1.1	1.9	4.3	5.6	1.6	1.2	2.7
Sodium	11	9.4	7.6	5	6.4	10	14	6.2
Alkalinity-HCO3	232	262	190	242	244	324	272	202
Alkalinity-CO3	.	.	.	.	.	.	.	.
Chloride	20.3	25.3	11.3	4.62	5.02	47.9	66	20.3
Fluoride	.	0.14	0.1	.	.	0.16	0.29	.
Sulfate	35.5	44.3	40.5	20.3	16.5	2.68	2.34	18.8
Nitrate-N	.	.	0.071	.	.	.	.	0.04
METALS (mg/L)								
CLUSTER DESIGNATION	1	1	1	1	1	1	1	1
Aluminum	0.026	.	0.053	0.024	0.022	1.1	0.024	.
Barium	0.14	0.12	0.12	0.7	0.8	0.098	0.047	0.42
Boron	0.016	0.0088	0.0097	0.084	0.1	0.034	0.02	0.043
Cadmium	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	.	.
Cobalt	.	.	.	.	.	.	.	.
Copper	.	0.0048	.	.	.	.	.	.
Iron	0.056	0.077	0.26	0.29	0.64	15	24	0.15
Lead (PMS)	0.0007	.	.	0.00083	.	0.01	.	0.00055
Lithium	0.0093	.	.	0.011	0.011	.	.	0.016
Manganese	0.0059	0.76	0.32	0.047	0.05	1.1	0.81	0.014
Nickel	.	.	.	.	.	.	.	.
Strontium	0.25	0.23	0.17	0.68	0.85	0.27	0.2	0.44
Thallium (PMS)	.	.	.	.	.	0.00072	.	.
Uranium (PMS)	.	0.0017	0.0018	.	.	.	.	.
Zinc	0.0097	.	0.0075	0.015	.	0.0086	.	.
ORGANICS (ug/L)								
SUMMED VOCs	ND	ND	ND	ND	ND	246	2	5
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	.	.	.	.	.	.	.	.
Carbon tetrachloride	.	.	.	.	.	.	.	3
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	.	.	.	.	.	.	.	FP2
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	2	.	.
1,1-Dichloroethene	.	.	.	.	.	4	.	.
cis-1,2-Dichloroethene	.	.	.	.	.	170	.	.
trans-1,2-Dichloroethene	.	.	.	.	.	3	.	.
Dimethylbenzene	.	.	.	.	.	.	.	.
Ethylbenzene	.	.	.	.	.	.	.	.
Methylene chloride	.	.	.	.	.	.	.	FP1
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	.	.	.	.	.	35	.	2
Toluene	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.
Trichloroethene	.	.	.	.	.	8	.	.
Trichlorofluoromethane	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	24	2	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point	GW-769		GW-770		GW-775		GW-776	
	GRIDG3	GRIDG3	GRIDG3	GRIDG3	GRIDH3	GRIDH3	GRIDH3	GRIDH3
Date Sampled	11/17/97	05/12/97	11/17/97	05/12/97	11/19/97	05/12/97	05/13/97	12/02/97
MISCELLANEOUS								
Water-Level Elevation	933.18	930.72	930.84	918.07	916.05	916.03	.	915.13
Water in Well (ft)	51.95	8.05	8.17	42.99	40.97	7.59	.	6.69
TSS (mg/L)	1	.	.	.	.	4	.	1
pH (Field)	7.25	7.1	6.85	7.6	7.34	7.4	.	7.39
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)	-4.3	0.7	-4.1	-3.1	-1.2	.	.	-1.6
Calcium	79	57	62	88	90	.	99	100
Magnesium	10	4.4	5.4	7.2	7.3	.	5.3	6.2
Potassium	2.8	2.1	2.8	2.3	2.7	.	3.1	3
Sodium	6.7	4.4	4.7	4.5	4.5	.	13	14
Alkalinity-HCO3	210	142	156	180	184	200	.	192
Alkalinity-CO3	.	.	.	.	.	.	.	.
Chloride	27.4	4.58	6.2	42.9	39.36	54.4	.	51.2
Fluoride	.	0.2	0.21	.	.	.	.	.
Sulfate	23.6	23.6	32.2	34	28.3	43.3	.	48.3
Nitrate-N	0.279	0.72	0.828	0.7	0.706	1.61	.	1.1
METALS (mg/L)								
CLUSTER DESIGNATION	1	3	3	3	3	1	1	1
Aluminum	0.023	0.29	.	.	0.025	.	0.6	.
Barium	0.43	0.057	0.069	0.18	0.19	.	0.09	0.094
Boron	0.031	0.026	0.033	0.022	0.014	.	0.02	0.019
Cadmium	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	3.8	0.043
Cobalt	.	.	.	.	.	.	0.016	.
Copper	.	.	.	.	.	.	0.03	0.0045
Iron	0.068	0.28	0.0069	0.024	0.008	.	20	0.66
Lead (PMS)	0.00064	0.0006	.	.	.	.	0.00075	0.0013
Lithium	0.017	.	.	0.0083	0.0097	.	.	0.0047
Manganese	0.012	0.012	.	0.0014	.	.	0.12	0.034
Nickel	.	.	.	.	.	.	0.92	0.62
Strontium	0.43	0.08	0.093	0.24	0.24	.	0.17	0.19
Thallium (PMS)	.	.	.	.	.	.	.	.
Uranium (PMS)	.	0.001	0.0018	.	.	.	.	.
Zinc	0.0057	0.0025	.	.	0.0038	.	0.0058	0.024
ORGANICS (ug/L)								
SUMMED VOCs	17	8	8	6	4	5	.	4
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	.	.	.	.	.	.	.	.
Carbon tetrachloride	11	5	4	.	.	.	.	.
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	2	3	4	1	.	.	.	.
Chloromethane	.	.	.	.	.	FP2	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.
1,1-Dichloroethene	1	.	.	.	.	.	.	.
cis-1,2-Dichloroethene	2	.	.	.	.	.	.	.
trans-1,2-Dichloroethene	.	.	.	.	.	.	.	.
Dimethylbenzene	.	.	.	.	.	.	.	.
Ethylbenzene	.	.	.	.	.	.	.	.
Methylene chloride	.	.	.	.	.	.	.	.
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	FP1	.	.	.	.	2	.	1
Toluene	.	.	.	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.
Trichloroethene	1	.	.	5	4	3	.	3
Trichlorofluoromethane	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	<MDA	3.3	<MDA	<MDA	<MDA	<MDA	.	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	.	<MDA

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point Location	GW-781		GW-782		GW-783		GW-788	
	GRIDE3		GRIDE3		GRIDE3		GRIDF3	
Date Sampled	05/15/97	11/19/97	05/14/97	11/24/97	05/15/97	11/25/97	05/13/97	11/18/97
MISCELLANEOUS								
Water-Level Elevation	939.22	939.03	938.23	938.13	937.89	937.84	936.17	936.16
Water in Well (ft)	63.86	63.67	29.65	29.55	8.38	8.33	70.13	70.12
TSS (mg/L)	2	2	2	2	7	7	18	18
pH (Field)	8.4	8.59	7.5	7.4	7.4	7.6	8.7	9.18
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)	0.2	-0.1	-8.9	-1.4	-0.6	-0.5	-2.3	-4.3
Calcium	13	12	85	82	85	78	11	5.9
Magnesium	4.1	4.2	15	15	6.2	4.3	3.1	3
Potassium	4.6	5.7	4.5	4.9	1.7	1.3	5.3	6
Sodium	75	76	9.7	10	15	19	120	120
Alkalinity-HCO3	200	200	248	254	216	202	270	222
Alkalinity-CO3	.	.	.	.	.	.	.	36
Chloride	9.53	10.624	18.9	18.607	21.1	20.353	9.65	12.4
Fluoride	.	.	.	.	0.1	0.15	1.68	1.25
Sulfate	8.82	8.786	17.7	17.95	20.6	24.622	22.2	36.8
Nitrate-N	0.05	0.178	0.231	0.309	0.82	1.315	0.4	1.256
METALS (mg/L)								
CLUSTER DESIGNATION	3	3	1	1	1	1	1	1
Aluminum	0.2	0.043	.	.	0.14	.	2.9	0.06
Barium	0.34	0.34	0.59	0.69	0.12	0.095	0.12	0.11
Boron	0.49	0.47	0.11	0.12	0.037	0.044	1.4	1.1
Cadmium	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	0.44	0.059	0.011	.
Cobalt	.	.	.	.	.	.	.	.
Copper	.	.	.	.	0.027	.	0.0078	.
Iron	0.16	0.028	0.71	0.76	5.7	0.34	1.9	0.041
Lead (PMS)	0.00076	0.0007	TOT<DIS	.	0.0006	.	0.0014	.
Lithium	0.061	0.058	0.018	0.021	.	.	0.083	0.072
Manganese	0.01	0.0091	0.042	0.061	0.034	0.0054	0.047	0.0014
Nickel	.	.	0.013	.	0.24	0.045	.	.
Strontium	0.69	0.66	1	1.1	0.21	0.15	0.49	0.51
Thallium (PMS)	.	.	.	.	.	.	.	.
Uranium (PMS)	.	.	0.0012	0.002	0.0014	0.0014	0.00095	0.0016
Zinc	0.0044	0.0038	.	0.0036	0.0055	.	0.0055	0.0024
ORGANICS (ug/L)								
SUMMED VOCs	23	45	492	443	106	13	ND	ND
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	.	.	.	2	.	.	.	.
Carbon tetrachloride	.	.	4	.	2	.	.	.
Chlorobenzene	.	.	.	4	.	.	.	.
Chloroethane	.	.	5	2	.	.	.	.
Chloroform	.	.	2	.	.	.	.	.
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	13	.	150	110	15	.	.	.
1,1-Dichloroethene	2	.	44	33	4	.	.	.
cis-1,2-Dichloroethene	.	.	15	14	20	5	.	.
trans-1,2-Dichloroethene	.	.	7	5	12	.	.	.
Dimethylbenzene	.	.	.	.	.	.	.	.
Ethylbenzene	.	.	.	.	.	.	.	.
Methylene chloride	FP1	.	FP1	.	.	.	.	.
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	4	37	190	200	36	7	.	.
Toluene	.	.	.	4	.	.	.	.
1,1,1-Trichloroethane	2	.	20	3	2	1	.	.
Trichloroethene	2	8	52	63	15	.	.	.
Trichlorofluoromethane	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	3	3	.	.	.	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	<MDA	<MDA	44	56	<MDA	3.5	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	18	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point	GW-789		GW-791		GW-792		GW-816	
	GRIDF3		GRIDD2		GRIDD2		EXP-SR	
Date Sampled	05/14/97	11/18/97	04/08/97	11/20/97	04/08/97	11/20/97	04/16/97	12/04/97
MISCELLANEOUS								
Water-Level Elevation	933.55	933.30	970.24	968.69	967.97	967.45	886.00	885.53
Water in Well (ft)	22.98	22.73	52.33	50.78	7.37	6.85	7.24	6.77
TSS (mg/L)	37	.	.	.	1	.	27	16
pH (Field)	7.5	7.67	7.9	7.31	6.4	6.21	7	6.8
MAJOR IONS (mg/L)								
CHARGE BALANCE (RPD)								
Calcium	-1.6	-3.3	-0.8	-1.8	-4.4	-6.8	-13.2	-2.9
Magnesium	66	62	66	67	43	46	48	53
Potassium	9.7	9.8	14	14	4.2	4.7	15	12
Sodium	3.4	3.3	2	1.7	0.87	1.4	5.5	6
Alkalinity-HCO3	5.8	6.1	7.2	7.3	8.3	9.6	3.9	5
Alkalinity-CO3	186	184	226	228	86	70	236	204
Chloride	.	.	.	.	.	.	.	.
Fluoride	6.39	7.4	5.91	7.112	22.8	47.162	4.81	5.65
Sulfate	0.11	0.11	.	.	0.12	.	0.1	0.1
Nitrate-N	19.8	24.9	12	11.16	25.3	21.504	9.86	0.36
	0.722	0.853	.	.	2.78	4.937	.	.
METALS (mg/L)								
CLUSTER DESIGNATION	3	3	1	1	2	2	4	4
Aluminum	1.5	0.037	0.04	.	0.066	.	0.036	0.029
Barium	0.33	0.33	0.26	0.26	0.092	0.1	0.38	0.5
Boron	0.065	0.053	0.021	0.017	0.012	.	0.027	0.016
Cadmium	.	.	.	.	.	.	.	.
Chromium	.	.	.	.	.	.	.	.
Cobalt	.	.	.	.	.	.	.	.
Copper	0.0063	.	.	.	0.0047	.	.	.
Iron	1.2	0.028	0.28	0.058	0.25	0.063	22	19
Lead (PMS)	0.0016	.	0.022	0.0006	0.00089	.	0.00062	.
Lithium	0.013	0.011	0.014	0.013	0.0092	0.0092	.	.
Manganese	0.14	0.0024	0.034	0.02	0.014	0.02	1.8	1.5
Nickel	0.011	.	.	.	0.021	0.048	.	.
Strontium	0.3	0.3	0.38	0.42	0.082	0.091	0.11	0.12
Thallium (PMS)	.	.	.	.	.	.	.	.
Uranium (PMS)	0.0005	.	.	.	.	.	.	.
Zinc	0.0039	.	0.0036	.	0.013	.	0.0042	0.015
ORGANICS (ug/L)								
SUMMED VOCs	3	6	2107	710	8	18	ND	ND
Acrylonitrile	.	.	.	.	.	.	.	.
Benzene	.	.	.	.	.	2	.	.
Carbon tetrachloride	.	.	.	.	.	.	.	.
Chlorobenzene	.	.	.	.	.	.	.	.
Chloroethane	.	.	.	.	.	.	.	.
Chloroform	2	2	.	.	.	.	.	.
Chloromethane	.	.	.	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.	.	.	.
cis-1,2-Dichloroethene	.	.	.	.	.	.	.	.
trans-1,2-Dichloroethene	.	.	.	.	.	.	.	.
Dimethylbenzene	.	1	.	.	.	.	.	.
Ethylbenzene	.	.	.	.	.	.	.	.
Methylene chloride	.	.	.	.	.	4	.	.
Styrene	.	.	.	.	.	.	.	.
Tetrachloroethene	.	FP1	2100	710	8	9	.	.
Toluene	.	.	.	.	.	3	.	.
1,1,1-Trichloroethane	.	.	.	.	.	.	.	.
Trichloroethene	1	3	7	.	.	.	.	.
Trichlorofluoromethane	.	.	.	.	.	.	.	.
Vinyl chloride	.	.	.	.	.	.	.	.
RADIOACTIVITY (pCi/L)								
Gross Alpha	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Gross Beta	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA

(CONTINUED)

APPENDIX C
Summary of CY 1997 Data That Meet Applicable DQOs

Sampling Point	GW-817		LRSPW		
	GRIDK3		EXP-SW		
Date Sampled	04/17/97	12/04/97	04/22/97	04/23/97	12/01/97
MISCELLANEOUS					
Water-Level Elevation	910.33	911.12	.	.	.
Water in Well (ft)	18.72	19.51	.	.	.
TSS (mg/L)	21	78.4	6	.	1
pH (Field)	8.3	7.19	7.9	.	7.6
MAJOR IONS (mg/L)					
CHARGE BALANCE (RPD)	-4.9	1.1	.	.	0
Calcium	64	73	.	35	39
Magnesium	7.6	8	.	7.6	9.8
Potassium	2.7	3.2	.	2.5	1.7
Sodium	20	15	.	8.1	7
Alkalinity-HCO3	228	208	94	.	114
Alkalinity-CO3	.	.	.	.	.
Chloride	3.83	4.4	21.4	.	9.26
Fluoride	0.18	0.15	0.2	.	0.36
Sulfate	22.9	15.5	16.2	.	23.9
Nitrate-N	0.108	0.54	2.21	.	1.45
METALS (mg/L)					
CLUSTER DESIGNATION	3	3	3	3	3
Aluminum	1.6	2.3	.	0.11	0.097
Barium	0.19	0.25	.	0.082	0.036
Boron	0.013	0.018	.	0.022	0.018
Cadmium	.	.	.	.	.
Chromium	.	.	.	.	.
Cobalt	.	.	.	.	.
Copper	.	0.0054	.	.	.
Iron	0.85	0.9	.	0.47	0.087
Lead (PMS)	0.0005	0.0009	.	0.0046	.
Lithium	0.0073	0.014	.	.	0.011
Manganese	0.036	0.044	.	0.13	0.033
Nickel	.	.	.	.	.
Strontium	0.17	0.2	.	0.21	0.093
Thallium (PMS)	.	.	.	0.00066	.
Uranium (PMS)	0.0023	0.0014	.	0.0057	0.0062
Zinc	0.0088	0.022	.	0.0027	0.026
ORGANICS (ug/L)					
SUMMED VOCs	ND	ND	1	.	4
Acrylonitrile	.	.	.	.	.
Benzene	.	.	.	.	.
Carbon tetrachloride	.	.	.	.	.
Chlorobenzene	.	.	.	.	.
Chloroethane	.	.	.	.	.
Chloroform	.	.	1	.	3
Chloromethane	.	.	.	.	.
1,1-Dichloroethane	.	.	.	.	.
1,1-Dichloroethene	.	.	.	.	.
cis-1,2-Dichloroethene	.	FP2	.	.	.
trans-1,2-Dichloroethene	.	.	.	.	.
Dimethylbenzene	.	.	.	.	.
Ethylbenzene	.	.	.	.	.
Methylene chloride	.	.	FP1	.	.
Styrene	.	.	.	.	.
Tetrachloroethene	.	FP2	.	.	1
Toluene	.	.	.	.	.
1,1,1-Trichloroethane	.	.	.	.	.
Trichloroethene	.	.	.	.	.
Trichlorofluoromethane	.	.	.	.	.
Vinyl chloride	.	.	.	.	.
RADIOACTIVITY (pCi/L)					
Gross Alpha	4.2	<MDA	<MDA	.	<MDA
Gross Beta	<MDA	<MDA	<MDA	.	<MDA