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Y-12 NATIONAL SECURITY COMPLEX

Y-12 GROUNDWATER PROTECTION PROGRAM CALENDAR YEAR 2000 GROUNDWATER MONITORING DATA EVALUATION REPORT FOR THE CHESTNUT RIDGE HYDROGEOLOGIC REGIME AT THE U.S. DEPARTMENT OF ENERGY Y-12 NATIONAL SECURITY COMPLEX, OAK RIDGE, TENNESSEE

September 2001

Prepared by

AJA TECHNICAL SERVICES, INC.
Under Subcontract No. 4300006512

for the

Environmental Compliance Department
Environment, Safety, and Health Organization
Y-12 National Security Complex
Oak Ridge, Tennessee 37831

Managed by

BWXT Y-12, L.L.C.
for the U.S. Department of Energy
Under Contract No. DE-AC05-00OR22800

MANAGED BY
BWXT Y-12, L.L.C.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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List of Acronyms and Abbreviations

AJA	AJA Technical Services, Inc.
BCV	Bear Creek Valley
bgs	below ground surface
BJC	Bechtel Jacobs Company LLC
BWXT Y-12	BWXT Y-12, L.L.C.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Chestnut Ridge Regime	Chestnut Ridge Hydrogeologic Regime
CY	calendar year
DOE	U.S. Department of Energy
DQO	data quality objective
FCAP	Filled Coal Ash Pond
ft	feet
ft/d	feet per day
GWMR	Groundwater Monitoring Report
GWPP	Groundwater Protection Program
HSW	HSW Environmental Consultants, Inc.
MCK	McCoy Branch Kilometer
MCL	Maximum Contaminant Level
MDA	minimum detectable activity
µg/L	micrograms per liter
mg/L	milligrams per liter
MIC	microbiologically induced corrosion
msl	mean sea level
NPDES	National Pollution Discharge Elimination System
OF	outfall
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PCE	tetrachloroethene
pCi/L	picoCuries per liter
PCP	post closure permit (RCRA)
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
SCR	South Chestnut Ridge
Security Pits	Chestnut Ridge Security Pits
Sediment Disposal Basin	Chestnut Ridge Sediment Disposal Basin
SWDF	solid waste disposal facility
TCE	trichloroethene
TCFM	trichlorofluoromethane
TDEC	Tennessee Department of Environment and Conservation
TDS	total dissolved solids
UTL	upper tolerance limit
VOC	volatile organic compound
WRRP	Water Resources Restoration Program
Y-12	Y-12 National Security Complex
11DCA	1,1-dichloroethane
11DCE	1,1-dichloroethene
c12DCE	cis-1,2-dichloroethene
111TCA	1,1,1-trichloroethane

1.0 INTRODUCTION

This report presents an evaluation of the groundwater and surface water monitoring data obtained during calendar year (CY) 2000 from sampling locations in the Chestnut Ridge Hydrogeologic Regime (Chestnut Ridge Regime). The Chestnut Ridge Regime encompasses several hazardous and nonhazardous waste management facilities associated with the U.S. Department of Energy (DOE) Y-12 National Security Complex (hereafter referenced as Y-12) southeast of Oak Ridge, Tennessee (Figure A.1). Prepared by the Y-12 Groundwater Protection Program (GWPP), this monitoring data evaluation report addresses applicable provisions of DOE Order 5400.1 — *General Environmental Protection Program* — that require: (1) an evaluation of the quantity and quality of groundwater in areas that are, or could be, impacted by Y-12 operations, (2) an evaluation of the quality of surface water and groundwater where contaminants from Y-12 facilities are most likely to migrate beyond the DOE Oak Ridge Reservation (ORR) property line, and (3) an evaluation of long-term trends in groundwater quality at Y-12. The following sections of this report contain relevant background information (Section 2.0); describe the results of the respective data evaluations required under DOE Order 5400.1 (Section 3.0); summarize significant findings of each evaluation (Section 4.0); and list the technical reports and regulatory documents cited for more detailed information (Section 5.0). Illustrations (maps and trend graphs) and data summary tables referenced in each section are presented in Appendix A and Appendix B, respectively.

2.0 BACKGROUND INFORMATION

The following discussion presents background information regarding the Chestnut Ridge Regime, including an overview of the groundwater monitoring programs and associated CY 2000 sampling and analysis activities; a brief description of topography and bedrock geology in the regime; an overview of the hydrogeologic characteristics and groundwater flow patterns in the Knox Aquifer; and a short description of surface water drainage features.

2.1 MONITORING PROGRAMS AND CY 2000 SAMPLING AND ANALYSIS ACTIVITIES

Groundwater and surface water monitoring in the Chestnut Ridge Regime during CY 2000 was performed primarily in accordance with the requirements of : (1) the Resource Conservation and Recovery Act (RCRA) post-closure permit (PCP) for the Chestnut Ridge Regime (permit no. TNHW-088); (2) the Tennessee Department of Environment and Conservation (TDEC) regulations governing operation and management of nonhazardous solid waste disposal facilities (SWDFs); and (3) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) decision documents (Table B.1). As specified in the RCRA PCP for the Chestnut Ridge Regime, corrective action monitoring was implemented at the Chestnut Ridge Security Pits (Security Pits) and detection monitoring was implemented at the Chestnut Ridge Sediment Disposal Basin (Sediment Disposal Basin) and Kerr Hollow Quarry. Detection monitoring in accordance with the corresponding conditions of the site-specific operating permit issued by the TDEC was performed at Industrial Landfills II, IV, and V, and Construction/Demolition Landfills VI and VII . Monitoring was performed to comply with applicable provisions of the CERCLA Record of Decision (ROD) for the United Nuclear Corporation Site, Kerr Hollow Quarry, and the Filled Coal Ash Pond (FCAP). Groundwater and surface water monitoring results obtained in the Chestnut Ridge Regime during CY 2000 have been reported in accordance with: (1) RCRA post-closure permit requirements (Bechtel Jacobs Company LLC [BJC] 2001); (2) TDEC SWDF permit requirements (BJC 2000a and BJC 2000b); and CERCLA baseline and remedial effectiveness monitoring requirements (DOE 2001).

Aside from the programs described above, additional monitoring also was performed as needed to address specific DOE Order 5400.1 data evaluation requirements. The following discussion provides a brief overview of the CY 2000 sampling and analysis activities in the Chestnut Ridge Regime, including the organizations responsible for monitoring at Y-12; the sampling locations, dates, and methods; and the field measurements and laboratory analyses. Complete details regarding these sampling and analysis activities are presented in the CY 2000 Groundwater Monitoring Report (GWMR) issued by the GWPP in March 2001 (AJA Technical Services, Inc. [AJA] 2001).

The Y-12 GWPP, which was managed by Lockheed Martin Energy Systems, Inc. until November 2000 when management was taken over by BWXT Y-12, L.L.C. (hereafter referenced as BWXT Y-12), implemented the groundwater sampling and analysis activities in the Chestnut Ridge Regime that were needed to support the monitoring data evaluations specified under applicable provisions of DOE Order 5400.1. The Water Resources Restoration Program (WRRP), which is managed by BJC, implemented the sampling and analysis activities associated with the RCRA groundwater monitoring programs specified in the PCP, the detection monitoring programs specified in the operating permit for each non-hazardous SWDF, and the CERCLA monitoring required under the applicable ROD. Although performed separately, the respective CY 2000 sampling activities planned by the GWPP and WRRP for Y-12 were coordinated to achieve mutual programmatic objectives, including the use of functionally equivalent groundwater sampling procedures and laboratory analytical methods. Accordingly, the monitoring results obtained by the GWPP and the WRRP are suitable to the purposes of each organization.

Forty-two monitoring wells, eight springs, and three surface water stations in the Chestnut Ridge Regime were sampled during CY 2000 for the purposes of the one or more monitoring programs listed above; Figure A.2 shows the location of each well, spring, and surface water station. As illustrated by the following data summary (Table 1), the bulk of the sampling locations in the Chestnut Ridge Regime are associated with the ongoing RCRA and SWDF monitoring programs.

Table 1. CY 2000 sampling locations in the Chestnut Ridge Regime

Monitoring Driver	Monitoring Wells	Springs	Surface Water Stations
DOE Order 5400.1	5	5	0
SWDF permit	22	1	0
RCRA PCP	13	0	0
CERCLA	6	2	3
Totals:	**42**	**8**	**3**
Note: Several wells serve multiple monitoring purposes			

Samples were collected at least semiannually from all of the monitoring wells and springs; semiannual sampling was performed during seasonally wet (winter/spring) and seasonally dry (summer/fall) flow conditions (Table B.2). Note that four replicate samples were collected during each sampling event from each of the wells used for RCRA post-closure detection monitoring at the Sediment Disposal Basin and Kerr Hollow Quarry. Also, one or more additional samples were collected from wells GW-305, GW-560, GW-562, GW-564, and GW-798 during the fourth quarter of the year. Samples of surface water also were collected semiannually from the outfall (OF) of Kerr Hollow Quarry (OF 301) and two sampling points in McCoy Branch located downstream of the FCAP (Figure A.2). The McCoy Branch stations, based on the McCoy Branch Kilometer (MCK) value measured upstream from the confluence of McCoy Branch and Melton Hill Reservoir, are designated MCK 2.0 and MCK 2.05.

Low-flow minimal drawdown sampling methods (hereafter referenced as low-flow sampling) were used to collect groundwater samples from all of the monitoring wells. Under low-flow sampling, which is intended to obtain representative groundwater samples that do not include stagnant water in the well casing, field personnel first pump the well at a flow rate that is low enough (<300 milliliters per minute) to minimize drawdown of the water level in the well (<0.1 feet [ft] per quarter-hour) and regularly check the pH, conductivity, temperature, oxidation-reduction potential, and dissolved oxygen in the groundwater pumped from the well. Samples of the groundwater are collected immediately after the field measurements for each parameter show minimal variation over four consecutive readings. Additionally, filtered and unfiltered groundwater samples were collected for the monitoring purposes of the Y-12 GWPP; only unfiltered groundwater samples were collected for the monitoring purposes of the WRRP.

Groundwater and surface water samples obtained for the Y-12 GWPP and the WRRP were shipped to the designated analytical laboratories where they were analyzed for: (1) miscellaneous laboratory analytes, including pH, conductivity, turbidity, total suspended solids, and total dissolved solids (TDS); (2) inorganics, including trace metals such as cobalt (i.e., metals that are typically minor constituents in groundwater) as well as other metals that are usually major ionic species (e.g., magnesium); (3) volatile organic compounds (VOCs); and (4) gross alpha and gross beta activity. Additionally, groundwater samples collected from five wells in the Chestnut Ridge Regime (GW-203, GW-302, GW-305, GW-339, and GW-521) were evaluated for evidence of microbial activity (iron-related, slime-forming, and sulfate-reducing bacteria) as part of a supplemental hydrogeologic study implemented by the Y-12 GWPP for the purposes of DOE Order 5400.1. Complete details regarding the laboratory analytes for each sampling location in the Chestnut Ridge Regime are presented in the CY 2000 GWMR (AJA 2001).

2.2 TOPOGRAPHY AND BEDROCK GEOLOGY

The Chestnut Ridge Regime encompasses a section of Chestnut Ridge bordered by Y-12 in Bear Creek Valley (BCV) to the north, Scarboro Road to the east, Bethel Valley Road to the south, and an unnamed surface drainage feature to the west (Figure A.3). The northern flank of the ridge forms a steep slope rising more than 200 ft above the floor of BCV. The ridge crest slopes toward the east from an elevation of about 1200 ft above mean sea level (msl) southwest of Y-12 to about 1060 ft above msl east of the Sediment Disposal Basin. A series of prominent hills dominates the central part of the broad southern flank of Chestnut Ridge, which gently slopes toward Bethel Valley and is dissected by several tributaries, including McCoy Branch.

Bedrock geology in the vicinity of the Chestnut Ridge Regime is generally characterized by thrust-faulted sequences of southeast-dipping, clastic (primarily shale and siltstone) and carbonate (limestone and dolostone) strata of Lower Cambrian to Upper Ordovician age. Interbedded limestone and shale formations of the Conasauga Group directly underlie Y-12 in BCV, primarily dolostone strata of the Knox Group form Chestnut Ridge, and the argillaceous limestones and interbedded shales of the Chickamauga Group underlie Bethel Valley (Figure A.3). Strike and dip of bedding in the area is generally N55^{N}E and 45^{N}SE, respectively (as referenced to true north).

Many waste sites in the Chestnut Ridge Regime are directly underlain by red-brown to yellow-orange residuum overlying the Knox Group. The residuum is characteristically acidic, predominantly composed of clays and iron sesquioxides, and contains semicontinuous, relict beds of fractured chert and other lithologic heterogeneities (such as silt bodies) that provide a weakly connected network through which saturated flow can occur (Solomon et al. 1992). The residuum is thin or nonexistent near karst features such as dolines (sink holes), swallets (sinking streams), and solution pan features (Ketelle and Huff 1984). Depth to bedrock varies throughout the Chestnut Ridge Regime but is usually less than 100 ft below ground surface (bgs).

Residuum throughout all but the southernmost portion of the Chestnut Ridge Regime is underlain by the Knox Group (Figure A.3). The Knox Group, which consists of about 2600 to 3300 ft of gray to blue-gray, thin- to thick-bedded cherty dolostone with interbedded limestone, is divided into five formations (listed from oldest to youngest): Copper Ridge Dolomite, Chepultepec Dolomite, Longview Dolomite, Kingsport Formation, and Mascot Dolomite (Figure A.3). Topographic and stratigraphic relationships suggest that the Copper Ridge Dolomite underlies the steep northern flank of the ridge, the Longview Dolomite forms the series of prominent hills across the middle of the southern flank of the ridge, and the Mascot Dolomite disconformably underlies the Chickamauga Group along the southern boundary of the regime (Hatcher et al. 1992).

The most pervasive structural features in the Chestnut Ridge Regime are extensional, hybrid, and shear fractures (Solomon et al. 1992). Three major fracture orientations are evident: one that roughly parallels bedding, one steeply dipping set that parallels geologic strike, and one steeply dipping set oriented perpendicular to strike (Dreier et al. 1987). Most fractures are short, ranging from tenths of inches to a few feet in length (Solomon et al. 1992). Dissolution of carbonates along fractures has produced many surface karst features on Chestnut Ridge, including a series of sinkholes along the crest of the ridge that show a prominent alignment parallel to strike. This linear trend may result from dissolution along a bedding plane or fracture set (Ketelle and Huff 1984; Smith et al. 1983).

2.3 GROUNDWATER SYSTEM

The Knox Aquifer, consisting of the Knox Group and the underlying Maynardville Limestone formation (Conasauga Group), is the principal hydrogeologic unit in the Chestnut Ridge Regime. Overall, groundwater flow in the Knox Aquifer is characterized by conduit flow that discharges at springs located along drainage features. The groundwater flow system in the Knox Aquifer generally consists of three vertically gradational subsystems: (1) the stormflow zone, (2) the vadose zone, and (3) the groundwater zone. The subsystems are distinguished by groundwater flux, which decreases with depth (Solomon et al. 1992).

Although detailed studies have not been conducted in the Chestnut Ridge Regime, investigations on Chestnut Ridge approximately 4000 ft west of the regime in the Walker Branch watershed show that groundwater occurs intermittently above the water table in a shallow "stormflow zone" that extends to a depth of about 8 ft bgs (Wilson et al. 1990). Macropores and mesopores provide the primary channels for lateral flow in the stormflow zone, which lasts only a few days or weeks after rainfall. Most groundwater within the stormflow zone is either lost to evapotranspiration or recharge to the water table, and the remaining water discharges at nearby seeps, springs, or streams (Moore 1989).

The vadose zone occurs between the stormflow zone and the water table, which typically occurs near the bedrock/residuum interface. Soil moisture content in the vadose zone is below the saturation limit except in the capillary fringe above the water table and within wetting fronts during periods of vertical percolation from the stormflow zone (Moore 1989). Most recharge through the vadose zone is episodic and occurs along discrete permeable fractures that become saturated, although surrounding micropores remain unsaturated (Solomon et al. 1992). Moore (1988) determined a geometric mean hydraulic conductivity of about 0.006 feet per day (ft/d) for residuum on Chestnut Ridge near the Oak Ridge National Laboratory (ORNL). The residuum is hydrologically heterogeneous with quickflow via dolines to conduits in the subsurface.

Groundwater below the vadose zone occurs within orthogonal sets of permeable, planar fractures that form water-producing zones within an essentially impermeable matrix. Dissolution of bedrock carbonates has enlarged fractures and produced an interconnected conduit-flow system characteristic of karst aquifers. Because the occurrence of solution features and the frequency, aperture, and connectivity of permeable fractures decrease with depth, the bulk hydraulic conductivity of the groundwater zone is vertically gradational. Most groundwater flux occurs within the transitional horizon between residuum and unweathered bedrock (water table interval); lower flux (and longer solute residence times) occurs at successively greater depths in the bedrock (Solomon et al. 1992).

The water table in the Chestnut Ridge Regime is a subdued replica of surface topography and occurs at the greatest depth (>100 ft bgs) along the crest of Chestnut Ridge, which is a groundwater flow divide and a recharge area. Groundwater generally flows from west to east parallel to the flow divide across the northern part of the regime, with radial components of flow north into BCV and south toward tributary headwaters on the southern flank of the ridge (Figure A.4). The central part of the regime is characterized by radial flow directions from local groundwater flow divides along hilltops between tributaries. Groundwater flow directions in the southern part of the regime are generally south toward Melton Hill Reservoir. The overall directions of groundwater flow throughout the Chestnut Ridge Regime do not significantly change during seasonal groundwater flow conditions (Figure A.4). Horizontal hydraulic gradients throughout the year are highest along the steep northern flank of Chestnut Ridge (i.e., across geologic strike) and in the upper reaches of tributaries on the southern ridge flank, and are nearly flat along the southern boundary of the regime.

Available data show that hydraulic conductivity in the Knox Group varies over multiple orders of magnitude, which is typical of karst aquifers. Results of straddle packer tests in core holes indicate hydraulic conductivity ranging from 0.0002 to 3.1 ft/d at depths generally less than 600 ft bgs in the lower Knox Group (King and

Haase 1988). Hydraulic conductivity values calculated from results of 122 falling-head slug tests performed between July 1994 and October 1997 in 17 monitoring wells completed at shallow depths (60 to 195 ft bgs) in the middle Knox Group range from about 0.003 to 14 ft/d (GW-560) (Jones 1998). Results of a preliminary dye-tracer test at the Security Pits indicate flow rates of about 100 to 300 ft/d (Geraghty & Miller, Inc. 1990). Although not confirmed by a second test using different tracers (Science Applications International Corporation 1993), these findings are supported by the range of flow rates (490 to 1250 ft/d) indicated by results of a dye-tracer test performed on Chestnut Ridge near ORNL (Ketelle and Huff 1984).

The geochemistry of the groundwater in the Knox Aquifer is fairly homogeneous. Most wells yield calcium-magnesium bicarbonate groundwater with pH of 7.5 to 8.0; TDS above 150 milligrams per liter (mg/L); equal or nearly equal molar concentrations of calcium and magnesium; low proportions (<5%) of chloride, sodium, sulfate, and potassium; and very low (i.e., <1 mg/L) carbonate alkalinity and nitrate (as N) concentrations. Some wells yield groundwater with enriched chloride and sulfate concentrations that probably reflect the geochemical influence of locally disseminated sulfides (e.g., pyrite) or evaporites (e.g., gypsum). Additionally, groundwater within low permeability (matrix) intervals in the upper Knox Group (e.g., Mascot Dolomite), as indicated by data for several wells at Kerr Hollow Quarry, often exhibits greater proportions of sulfate and potassium and higher trace metal concentrations (e.g., strontium) than typical of the groundwater from low yield intervals within the lower Knox Group formations (e.g., Copper Ridge Dolomite). These geochemical differences potentially reflect corresponding differences between carbonate mineralogies in the upper and lower sections of the Knox Group or the proximity to and types of disseminated secondary minerals (AJA 1996).

2.4 CONTAMINANT SOURCE AREAS

Monitoring data obtained since the mid-1980s indicate that groundwater contamination is fairly limited in the Chestnut Ridge Regime and that VOCs are the most common groundwater contaminants. Dissolved VOCs (primarily chloroethanes and chloroethenes) have been detected in the groundwater samples collected from monitoring wells downgradient from the Security Pits, Industrial Landfill IV, and Kerr Hollow Quarry. However, a clearly distinct plume of dissolved VOCs is indicated only by the data for wells at the Security Pits.

The Security Pits are located on the crest of Chestnut Ridge directly south of the central portion of Y-12 (Figure A.2), and consist of two areas, each containing a series of east-west oriented trenches that are about 8 to 10 ft wide, 10 to 18 ft deep, and 700 to 800 ft long. This site was used for disposal of hazardous waste until December 1984, and for disposal of nonhazardous waste until the site was closed in November 1988. Data obtained from monitoring wells at the Security Pits indicate that a narrow, elongated plume of dissolved VOCs extends parallel with geologic strike for at least 2,600 ft downgradient to the east, and perpendicular to strike for at least 500 ft downgradient to the north and south. The primary components of the plume are 1,1-dichloroethene (11DCE), 1,1-dichloroethane (11DCA), and 1,1,1-trichloroethane (111TCA) in the western trench area; and tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (c12DCE) in the eastern trench area.

Data obtained since the early 1990s indicate very low concentrations (1 to 2 micrograms per liter [µg/L]) of 111TCA in the groundwater at two wells downgradient of the western disposal trenches at the Security Pits: well GW-796, located at Industrial Landfill V about 400 ft south of the disposal trenches, and well GW-514, located at the FCAP about 900 ft south of the disposal trenches. Although the concentrations are estimated (i.e., less than the analytical reporting limit), the repeated detection of this compound in the groundwater samples from both wells probably reflects southward migration from the Security Pits, possibly along “quickflow” conduits oriented perpendicular to geologic strike.

Industrial Landfill IV, located along the crest of Chestnut Ridge in the northwest corner of the regime (Figure A.2), has received waste since October 1989 and is a suspected source of 111TCA, 11DCA, 11DCE, and boron. Elevated total boron concentrations have consistently been reported in samples from a well located downgradient to the east of the site (GW-217), while VOCs have been reported in samples from a well located south of the eastern portion of the site (GW-305). These results indicate groundwater transport along permeable flowpaths from the unlined portion (about 150 ft X 150 ft) at the eastern end of Industrial Landfill IV. Although the source of these contaminants has not been formally confirmed, no other waste management facility is located upgradient of these wells.

Kerr Hollow Quarry is located in the southeast corner of the Chestnut Ridge Regime (Figure A.2) and served as a source of stone construction material until it filled with water and was abandoned in the late 1940's. From the early 1950s until November 1988, the quarry was used for the disposal of reactive materials from Y-12 and ORNL. Wastes were removed from the quarry between mid-1990 and late 1993 to obtain certified clean-closure status from the TDEC, but the site was finally closed with some wastes remaining in place. Low levels (<5 µg/L) of several VOCs, primarily carbon tetrachloride, chloroform, and PCE, occur in the groundwater at monitoring wells located to the south (GW-144) and southeast (GW-142) of Kerr Hollow Quarry. Each of these VOCs are probably present at low concentrations in the groundwater downgradient of the site, possibly as a consequence of wastes being disturbed during attempts to obtain clean closure of the site.

2.5 SURFACE WATER SYSTEM

Surface streams in the Chestnut Ridge Regime include five primary drainage basins on the southern flank of Chestnut Ridge: two unnamed tributaries located west and east of Industrial Landfill II in the western part of the regime; the McCoy Branch drainage basin in the central part of the regime; and two unnamed drainage basins in the eastern part of the regime (Figure A.3). The drainage features located on South Chestnut Ridge (SCR) have informally been numbered from west to east (SCR1 through SCR5, see Figure A.2). These tributaries, which are mainly intermittent at elevations higher than 900 ft above msl, receive flow via surface runoff, stormflow discharge, and groundwater baseflow. Baseflow contributions increase downstream along the length of the streams, and spring discharge represents substantial contributions to the total flow in most of the tributaries. All of the tributaries flow south toward Bethel Valley and discharge into Melton Hill Reservoir (Clinch River) south of the Chestnut Ridge Regime.

3.0 DOE ORDER 5400.1 MONITORING DATA EVALUATIONS

The following sections present an evaluation of the monitoring data for the network of CY 2000 groundwater and surface water sampling locations in the Chestnut Ridge Regime. Each section addresses a corresponding requirement of DOE Order 5400.1. Section 3.1 (*Surveillance Monitoring Data*) contains an evaluation of groundwater quality in areas within the Chestnut Ridge Regime that are, or could be, affected by Y-12 operations. Section 3.2 (*Exit Pathway/Perimeter Monitoring Data*) provides an evaluation of surface water/groundwater quality where contaminants are most likely to exit the Chestnut Ridge Regime. Section 3.3 (*Contaminant Concentration Trends*) presents a review of long-term trends in groundwater quality near Y-12, as illustrated by data for selected CY 2000 sampling locations in the Chestnut Ridge Regime. Each evaluation is based on historical data (if available) and CY 2000 results that meet the applicable data quality objectives (DQOs) of the Y12 GWPP. Descriptions of the DQO criteria and associated data screening process, along with summaries of the CY 2000 data that do not meet applicable DQOs, are provided in the CY 2000 GWMR.

3.1 SURVEILLANCE MONITORING DATA EVALUATION

Monitoring results for the network of wells in the Chestnut Ridge Regime that were sampled during CY 2000 show that most of the wells continue to yield uncontaminated, calcium-magnesium-bicarbonate groundwater from the Knox Aquifer that is unaffected by operations at Y-12. However, based on evaluation of the CY 2000 groundwater monitoring data with respect to the surveillance monitoring purposes of DOE Order 5400.1, one or more groundwater contaminants potentially associated with operations at Y-12 were detected in at least one of the groundwater samples collected from the following monitoring wells in the Chestnut Ridge Regime:

Table 2. Types of groundwater contaminants detected during CY 2000

Well Number and Monitored Interval Depth (ft bgs)				Contaminant Type		
				Inorganics	VOCs	Radioactivity
1090	unknown	-	96.7	!	.	.
GW-145	86.0	-	110.0	.	!	.
GW-205	154.0	-	164.0	.	.	!
GW-217	165.2	-	180.0	!	.	.
GW-302	121.5	-	134.8	!	.	.
GW-305	165.3	-	179.6	!	!	.
GW-339	101.0	-	114.0	!	.	.
GW-609	256.4	-	269.0	.	!	.
GW-757	134.0	-	166.7	!	.	.
GW-796	122.9	-	136.5	.	!	.
GW-798	122.0	-	135.4	.	!	.

These monitoring wells are the focus of the following DOE Order 5400.1 surveillance monitoring data evaluation, which is organized into separate discussions of the respective CY 2000 results for inorganic contaminants, VOCs, and radioactivity.

3.1.1 Inorganic Contaminants

The concentrations of some trace metals and major ions reported for several of the monitoring wells exceed ambient (background) levels expected in the Knox Aquifer, as defined by the respective 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. [HSW] et al. 1995). Additionally, elevated concentrations of two trace metals (chromium and nickel) reported for several wells also exceed the respective Maximum Contaminant Level (MCL) for drinking water. Based on an evaluation of these results with respect to historical data, the elevated concentrations of boron, chloride, chromium, nickel, potassium, and sodium potentially reflect groundwater contamination in the wells listed below.

Table 3. CY 2000 maximum concentrations of inorganic groundwater contaminants

Well	Maximum Concentration (mg/L)					
	Boron	**Chloride**	**Chromium**	**Nickel**	**Potassium**	**Sodium**
1090	.	21.4	.	.	.	9.76
GW-205	.	.	.	.	79	11.7
GW-217	0.114	.	.	.	.	.
GW-302	.	33.9	**0.34**	**0.154**	.	13
GW-305	.	.	.	**0.23**	.	.
GW-339	.	21.9	.	**0.246**	.	11.5
GW-757	.	.	.	.	16.7	26.7
UTL (mg/L)	0.028	2	0.029	0.02	5.0	9.7
MCL (mg/L)	NA	NA	0.1	0.1	NA	NA

Note: "." = Less than UTL; NA = Not applicable; BOLD = Exceeds MCL

Contamination of the groundwater at these wells potentially reflect: (1) migration of boron wastes (or waste constituents) from the Industrial Landfill IV (GW-217); (2) groundwater recharge impacted by dissolved road de-icing salts (1090, GW-302, and GW-339); (3) localized grout contamination (GW-205 and GW-757); and (4) corrosion of the stainless steel well casing and screen (GW-302, GW-305, and GW-339).

Monitoring results obtained during CY 2000 show that the total boron concentrations in the groundwater at well GW-217, as indicated by the boron levels reported for the groundwater samples collected from the well in February (0.114 mg/L) and July 2000 (0.094 mg/L), remain well above the applicable UTL (0.028 mg/L). These results are consistent with historical data and show a generally decreasing concentration trend since 1994 (see Section 3.3). This well is hydraulically downgradient (along geologic strike) of Industrial Landfill IV (Figure A.4), approximately 100 ft east of an unlined portion (about 22,500 ft^2) at the east end of the landfill that began receiving waste in October 1989. Because the significant boron solute species are uncharged, they are probably not extensively absorbed onto mineral surfaces and are therefore highly mobile in groundwater (Hem 1985). Results of falling head hydraulic conductivity tests indicate that the monitored interval in well GW-217 intercepts moderately permeable (0.01 - 0.2 ft/d) flowpaths 165 ft to 180 ft bgs (Jones 1998). These hydraulic conductivity values generally support advective transport of boron to well GW-217 within the time period between initial disposal of wastes in October 1989 and a conspicuous concentration "spike" (0.69 mg/L) in January 1992 (see Section 3.3). Moreover, historical data show that three of the four lowest boron concentrations (i.e., #0.0074 mg/L) were reported for samples collected from the well before Industrial Landfill IV began receiving wastes in October 1989. Based on these considerations, the elevated concentrations of boron in the groundwater at well GW-217 may reflect migration of boron from wastes disposed in the landfill.

The elevated concentrations of chloride (>20 mg/L) and sodium (>10 mg/L) reported for wells 1090, GW-302, and GW-339 during CY 2000 are characteristic of the groundwater samples from these wells, which are all located downgradient of the United Nuclear Corporation Site (Figure A.2). Chloride and sodium concentrations in the groundwater at these wells may reflect local recharge of surface water containing dissolved salt used to de-ice the South Patrol Road and Mt. Vernon Road; well 1090 is located at the intersection of these roads, and wells GW-302 and GW-339 are immediately south of the South Patrol Road (Figure A.2). Because road salt is applied sporadically during winter months and sodium and chloride concentrations at these wells have remained fairly steady since 1990, the elevated salt concentrations may reflect steady dissolution of locally (stratigraphically) distributed evaporite deposits. Additionally, elevated chloride levels in the groundwater at wells GW-302 and GW-339 may play a role in maintaining the elevated trace metal concentrations in the samples from each well because chloride may combine with available metal cations to form complexes that significantly reduce adsorption of the metals (McLean and Bledsoe 1992).

Elevated concentrations of potassium (>10 mg/L) and sodium (>30 mg/L) relative to other wells in the Knox Aquifer, along with unusually high pH (>9.0), were reported for each of the groundwater samples collected during CY 2000 from well GW-757, which is located about 300 ft southwest (hydraulically downgradient) of Industrial Landfill II (Figure A.2). These elevated potassium, sodium, and pH results potentially reflect localized contamination from cement grout circulated into fractures and solution features in the surrounding bedrock during the installation of the well. Moreover, as shown in the following data summary (Table 4), respectively sharp increases in the levels of potassium, sodium, and pH apparently coincide with the change from a "conventional" sampling method, which involves purging a targeted amount (at least three well volumes) of groundwater before collecting samples from the well, to a low-flow sampling method, which involves minimal groundwater purging before sampling the well (see Section 2.1).

Table 4. Potassium, sodium, and pH in well GW-757, 1996-2000

Analyte	Concentration (mg/L)									
	Conventional Sampling			Low-Flow Sampling						
	Apr. 1996	Nov. 1996	Apr. 1997	Oct. 1997	Apr. 1998	Oct. 1998	Apr. 1999	Oct. 1999	Feb. 2000	Aug. 2000
Potassium	1.3	3.1	6.2	9.1	14	15.8	8.28	14.0	16	16.7
Sodium	2.1	5.8	6.7	14	26	35.3	16.7	26.7	31.4	35.1
Field pH (standard units)	8.13	8.3	7.9	9	9.44	9.41	9.39	9.94	9.72	9.67

These results suggest that the conventional sampling method may induce flow of fresh groundwater into the well, which dilutes the grout-contaminated groundwater near the well screen; thus lowering the pH, potassium, and sodium concentrations. Nevertheless, considering that the well was installed in April 1992, the low-flow sampling results obtained during CY 2000 indicate that the localized grout contamination is a persistent, chronic problem with respect to obtaining representative groundwater samples from the well. Accordingly, well GW-757 should be extensively purged (i.e., redeveloped) prior to low-flow sampling, or a conventional sampling method should be used in order to ensure collection of minimally grout-contaminated groundwater samples from the well. Alternatively, well GW-757 should not be used to monitor groundwater quality.

Very high concentrations of potassium were reported for the groundwater samples collected from well GW-205 in February (79 mg/L) and August 2000 (76 mg/L); similar levels of potassium were detected in the samples collected from the well in February 1999 (49.4 mg/L) and August 1999 (63.5 mg/L). In addition to the high potassium concentrations, the CY 2000 monitoring results also confirm other unusual chemical characteristics of the groundwater samples that were collected from the well during CY 1999, including atypically low concentrations of calcium and magnesium, elevated levels of sodium, and increasingly basic pH. As shown in the following data summary (Table 5) and Figure A.5, these unusual geochemical characteristics generally coincide with the change from conventional sampling to low-flow sampling.

Table 5. Calcium, magnesium, potassium, sodium, and pH in well GW-205, 1991-2000

Analyte	Concentration (mg/L)								
	Conventional Sampling					Low-Flow Sampling			
	July 1991	May 1993	Oct. 1994	Oct. 1995	April 1997	Feb. 1999	Aug. 1999	Feb. 2000	Aug. 2000
Calcium	31	35	20	24	38	1.45	1.32	1.35	1.26
Magnesium	17	19	18	19	22	13.6	12.6	9.96	8.7
Potassium	0.74	0.87	19	4.9	<0.6	49.4	63.5	79	76
Sodium	0.68	0.56	2.9	1.3	0.74	7.79	10	11.6	11.7
Field pH (std. units)	7.7	7.8	8.8	8.1	7.9	9.3	9.7	10.37	10.16

The unusual geochemistry of the samples collected from the well since February 1999 suggest grout contamination, and as noted previously with well GW-757, the distinctive difference between the low-flow sampling and conventional sampling results suggest that the latter sampling method is more likely to induce inflow of less grout-contaminated groundwater into the well. Accordingly, either well GW-205 should be redeveloped prior to low-flow sampling or the conventional sampling method should be used to ensure that the most representative groundwater samples (i.e., the least grout-contaminated) are obtained from the well. Alternatively, well GW-205 should be considered unsuitable for groundwater quality monitoring.

As shown in preceding summary of CY 2000 monitoring data (Table 3), the maximum chromium concentration reported for well GW-302 and the maximum nickel concentrations reported for wells GW-302, GW-305, and GW-339 exceed the respective MCL for drinking water (0.1 mg/L). Elevated chromium and nickel concentrations are characteristic of the groundwater samples from each of these wells, but none of the wells are located near known or suspected sources of chromium or nickel. Thus, corrosion of the stainless steel well casing and screen in the wells is the suspected source of the elevated chromium and/or nickel concentrations. Geochemical conditions that are corrosive to stainless steel (e.g., dissolved oxygen >1 mg/L; Driscoll 1986) are evident in each of these wells (HSW 1995; AJA 1998). Additionally, the sampling results obtained in November 1999 indicate that the groundwater in well GW-305 contains microorganisms (including iron-related bacteria, slime-forming bacteria, and sulfate-reducing bacteria) which may induce corrosion of the stainless steel (Sarouhan et al. 1998), although direct visual evidence (e.g., nodular formations) of microbiologically-induced corrosion (MIC) was not observed during a borehole camera survey of the well casing and screen (Jones 1999). Two unidentified cylindrical objects were observed at the bottom of the well, and if either of these objects is metallic (the composition of the objects could not be determined from the camera survey; Jones 1999), then galvanic corrosion also may be occurring in well GW-305.

To evaluate the potential for MIC of the stainless steel monitoring well casing and screen, microbiologic sampling was performed during CY 2000 in the Chestnut Ridge Regime to determine what types of bacteria (if any) were present in the groundwater in selected wells. The qualitative bacterial counts are estimates based on the appearance of the sample after an eight- to nine-day growth period. As shown in the following data summary (Table 6), microbial activity was determined at wells where corrosion of the stainless steel well casing and screen corrosion is suspected (GW-302, GW-305, and GW-339) and at wells where corrosion is not suspected (GW-203 and GW-521).

Table 6. Biological testing results, CY 2000

Well Number	Well Construction Material	Indication of Corrosion	Maximum Bacteria Count (colony forming units per milliliter)		
			Iron-Related	**Slime-Forming**	**Sulfate-Reducing**
GW-203	Polyvinyl Chloride	No	5,000	50,000	<100
GW-302	Stainless Steel	Yes	<100,000	<50,000	<100
GW-305	Stainless Steel	Yes	5,000	500,000	100
GW-339	Stainless Steel	Yes	5,000	50,000	<100
GW-521	Stainless Steel	No	<100	<100	>100

Note that the sample from well GW-521, which is located hydraulically upgradient of all waste management sites in the regime (Figure A.2), had negligible microbial activity while all of the other wells had much higher counts of iron-related and slime-forming bacteria. Also note that the samples from well GW-203, which is not constructed with stainless steel, had a high bacterial count but nickel and chromium were undetected. The occurrence of these types of bacteria, which may cause MIC of stainless steel, supports the possibility that the elevated concentrations of nickel and/or chromium in the groundwater samples from these wells reflect corrosion artifacts.

3.1.3 Volatile Organic Compounds

Excluding false-positive results for common laboratory reagents (e.g., methylene chloride), one or more of the following VOCs were detected in at least one of the groundwater samples collected during CY 2000 from five monitoring wells located downgradient of waste management sites in the Chestnut Ridge Regime: 111TCA, 11DCA, 11DCE, PCE, TCE, c12DCE, trichlorofluoromethane (TCFM), and chloromethane. As shown in the following data summary (Table 7), at least one of these compounds was detected in the groundwater sample(s) collected from monitoring wells located at Kerr Hollow Quarry (GW-145), Industrial Landfill IV (GW-305), the Security Pits (GW-609), Industrial Landfill II (GW-796), and Construction/Demolition Landfill VII (GW-798).

Table 7. CY 2000 maximum concentrations of VOCs

Monitoring Well	Maximum Concentration (µg/L)							
	111TCA	**11DCA**	**11DCE**	**PCE**	**TCE**	**c12DCE**	**TCFM**	**Chloromethane**
GW-145	.	.	.	.	.	.	.	(1)
GW-305	26	11	(4.3)	.	.	.	.	.
GW-609	.	.	.	(2)	.	.	.	.
GW-796	(1.2)	.	.	.	.	.	.	.
GW-798	(2)	(1)	(1.7)	(2.6)	(0.29)	(2.2)	(4.4)	.
MCL (µg/L)	**200**	**NA**	**7**	**5**	**5**	**70**	**NA**	**NA**

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

Note that all but two of these results are estimated values below the respective analytical reporting limit for each compound. Also, the maximum concentrations of 111TCA, 11DCE, PCE, TCE, and c12DCE are less than the respective MCL for drinking water. Despite the low concentrations, however, these results reflect contamination in the groundwater downgradient of the Security Pits (GW-609, GW-796, and GW-798), Industrial Landfill IV (GW-305), and Kerr Hollow Quarry (GW-145).

Monitoring results obtained from the network of monitoring wells at the Security Pits generally define a narrow, elongated plume of dissolved chloroethanes and chloroethenes extending parallel with geologic strike for at least 2600 ft to the east, and perpendicular to strike for at least 500 ft downgradient to the north and south. The primary components of the plume include 11DCE, 11DCA, and 111TCA in the western trench area and PCE, TCE, and c12DCE in the eastern trench area. The apparent distribution of the plume constituents relative to the respective source areas and elongation of the plume along the axis of Chestnut Ridge, despite steeper hydraulic gradients toward the ridge flanks, suggest primarily eastward strike-parallel horizontal transport in the groundwater. The maximum depth of vertical transport has not been conclusively determined; however, available monitoring data show that VOCs occur at least 150 ft bgs in the western trench area, 250 ft bgs near the middle of the site, and 270 ft bgs downgradient of the eastern trench area (AJA 1997).

The CY 2000 monitoring results for well GW-609, which is located about 800 ft east (along geologic strike) of the Security Pits (Figure A.2), are consistent with historical data and show that this well continues to yield calcium-magnesium-bicarbonate groundwater containing low concentrations of dissolved PCE. Assuming that the VOC results obtained using the conventional sampling method do not reflect significant volatilization during sampling, the data for well GW-609 show a generally decreasing long-term concentration trend that began after the disposal trenches at the Security Pits were closed and capped in the mid to late 1980s (see Section 3.3).

Very low (estimated) concentrations of 111TCA were detected in the groundwater samples collected from well GW-796 in January (1.2 µg/L) and July 2000 (0.94 µg/L). These results are consistent with historical data for the well, in that similarly low levels of 111TCA (2 µg/L or less) have been detected in 16 of the 18 samples collected from the well since it was first sampled in May 1993. Well GW-796, which serves as an upgradient/background well for SWDF detection monitoring at Industrial Landfill V and as a downgradient point of compliance well for RCRA post-closure corrective action monitoring at the Security Pits, is completed with a screened monitored interval 122-136 ft bgs in the Copper Ridge Dolomite about 500 ft directly south (across geologic strike) of the Security Pits (Figure A.2). Because the western trench area at the Security Pits is hydraulically upgradient of the well and is the only confirmed source of 111TCA in the Chestnut Ridge Regime, the repeated detection of this compound in well GW-796 probably reflects downgradient transport from his source, possibly along the “quickflow” conduits described by Shevenell (1994). This interpretation is supported by the consistently low TDS in the samples from the well (110 mg/L in January 2000 and 124 mg/L in July 2000), which implies short groundwater residence time, and the relatively high hydraulic conductivity (1.2 - 4.2 ft/d) of the groundwater flowpaths intercepted by the monitored interval, as indicted by falling head permeability tests in the well (Jones 1998). Moreover, considering that the Security Pits first received wastes in 1973, the travel time estimated for 111TCA to migrate into well GW-796 (120 to 450 days) is clearly within the range of possibility assuming: (1) unimpeded advective transport in the groundwater (i.e., ignoring vapor-phase transport in the vadose zone and natural attenuation in the subsurface); (2) a migration pathway length of 516 ft, as determined from a simple algebraic calculation (i.e., $a^2 + b^2 = c^2$) based on the horizontal distance (500 ft) from the western trench area at the Security Pits and the depth to the monitored interval midpoint (129 ft); and (3) the range of hydraulic conductivity values from the falling head permeability tests in the well.

Monitoring results obtained during CY 2000 reflect the first-time detection of dissolved chloroethanes (111TCA and 11DCA), chloroethenes (PCE, TCE, 11DCE, and c12DCE), and TCFM in well GW-798. This well is located about 1,500 ft east-southeast of the Security Pits (Figure A.2), which is the only known source of these VOCs that is hydraulically upgradient of the well. As shown in the preceding data summary (Table 7), only trace levels (<5 µg/L) of these VOCs were detected in GW-798, but review of the available data for the well indicates that these trace levels probably are not sampling artifacts. The use of dedicated sampling equipment discounts the potential for cross contamination of the well. Additionally, these VOC results probably are not analytical artifacts because each of these compounds were detected in the groundwater samples that were collected separately for RCRA monitoring and SWDF monitoring and were analyzed by two different commercial laboratories (AJA 2001). Moreover, historical data show that these compounds also are in the groundwater at two monitoring wells (GW-174 and GW-608) that are located directly between the Security Pits and well GW-798. Therefore, the presence of dissolved chloroethenes and chloroethanes in the groundwater at well GW-798 is most likely attributable to groundwater transport (or possibly vapor-phase transport) from the dissolved plume of VOCs originating from the Security Pits (BJC 2001).

As shown in the preceding data summary (Table 7), the CY 2000 monitoring results show that well GW-305, which is located directly south (hydraulically downgradient) of the eastern (unlined) portion of Industrial Landfill IV (Figure A.4), continues to yield groundwater samples containing dissolved VOCs, including 111TCA, 11DCE, and 11DCA. Along with the historical data for the well, which has been sampled continuously on a quarterly or semiannual basis since March 1990, the CY 2000 data show that: (1) 111TCA concentrations steadily increased following the initial detection in January 1992 (0.6 µg/L) to a peak of 26 µg/L in July 2000; (2) 11DCA concentrations increased following the initial detection in July 1996 (1 µg/L) to a peak of 11 µg/L in May and July 2000; and (3) 11DCE concentrations increased following the detection in January 1997 (1 µg/L) to a peak of 4.3 µg/L in May 2000. These results suggest the breakthrough of a dissolved VOC plume, beginning with the arrival of the parent compound (111TCA), followed by the arrival of potential degradation products (11DCA and 11DCE) several years later. Although 111TCA, 11DCE, and 11DCA are components of the VOC plume originating from the disposal trenches at the Security Pits, well GW-305 is more than one mile west of the Security Pits; seasonal groundwater elevations in well GW-305 are more than 10 ft higher than in any of the wells at the Security Pits (Figure A.4); and the elongated geometry of the dissolved VOC plume originating from the Security Pits suggests primarily eastward (downgradient) rather than westward (upgradient) strike-parallel migration in the groundwater (AJA 1996). Thus, the Security Pits are an unlikely source of the dissolved VOCs in the groundwater at well GW-305.

Industrial Landfill IV is the suspected source of the VOCs detected in well GW-305 because this landfill is the only potential contaminant source area that is hydraulically upgradient of the well, and the monitored interval for the well (165.3 - 179.6 ft bgs) potentially intercepts dip-parallel groundwater flowpaths that subcrop below the unlined eastern portion of the landfill. Industrial Landfill IV initially received wastes in October 1989; however none of the documentation for the site indicates disposal of 111TCA or related wastes. Also, assuming rapid migration to the saturated zone and unimpeded advective transport in the groundwater, the range of hydraulic conductivity values (0.025 - 0.028 ft/d) indicated by falling head tests in well GW-305 (Jones 1998) do not support transport of 111TCA to the well within the time period between the initial disposal of waste at Industrial Landfill IV (October 1989) and the first-time detection of 111TCA on January 4, 1992 (795 to 825 days). Moreover, the low hydraulic conductivity values also do not support vertical migration from the water table (about 120 ft bgs) to the monitored interval in the well GW-305 during this time frame. Therefore, the repeated detection of 111TCA (and the associated degradation products) despite the apparently low permeability of the flowpaths intercepted by the well suggest: (1) 111TCA was present in the well before January 1992 but was not detected in the samples collected from the well, perhaps because purging the well for conventional sampling volatilized the compound; (2) the hydraulic conductivity test results do not account for stratigraphic and lithologic features (e.g., chert layers) in the residuum which could provide more permeable pathways from the landfill to the water table; (3) the hydraulic conductivity test results are representative and the presence of VOCs reflect migration from an unknown source area located very close to the well; or (4) the hydraulic conductivity test results are representative and the presence of VOCs reflect migration from Industrial Landfill IV via a combination of mechanisms (e.g., vapor phase transport), possibly including migration as dense nonaqueous phase liquid (which may occur independent of groundwater flow), that greatly increase the relative rate of transport to the well.

Trace levels of chloromethane (1 µg/L) were detected in one of the replicate groundwater samples collected in October 2000 well GW-145, which is located hydraulically downgradient from Kerr Hollow Quarry. Detection of chloromethane in well GW-145 is generally consistent with historical data for the well, which show detection of chloromethane in one sample collected in CY 1999 and sporadic detection of very low concentrations (less than respective reporting limits) of several other VOCs (PCE, TCE, and chloroform). Because the concentrations are so low, the apparently sporadic detection of VOCs, particularly in previous samples collected using the conventional sampling method, potentially reflects volatilization during sample collection and handling rather than the absence of the compounds in the groundwater at the well. Moreover, historical RCRA interim status detection monitoring results show that VOCs (particularly carbon tetrachloride) were detected most frequently in the groundwater samples collected from wells at the site between the first quarter of 1990 and the fourth quarter of 1993, which correlates with the closure activities performed at Kerr Hollow Quarry during that time (HSW 1995).

3.1.4 Radioactivity

Historical monitoring data show that most of the monitoring wells in the Chestnut Ridge Regime do not typically yield groundwater samples with radiological contamination (based on results for gross alpha and gross beta activity). The CY 2000 monitoring results are consistent with these historical findings; respective gross alpha and gross beta results reported for just over half (26) of the monitoring wells sampled during CY 2000 exceed the corresponding minimum detectable activity (MDA), and the bulk of these results have large proportional counting errors (i.e., a high degree of analytical uncertainty) and reflect very low levels of alpha and beta radioactivity that do not indicate contamination.

Gross beta activity reported for the groundwater samples collected from well GW-205 at the United Nuclear Corporation Site in February 2000 (74.4 ± 3.1 picoCuries per liter [pCi/L]) and in August 2000 (81.2 ± 3.5 pCi/L) exceed the Safe Drinking Water Act screening level of 50 pCi/L and are the highest gross beta values reported for any of the monitoring wells in the Chestnut Ridge Regime that were sampled during CY 2000. As noted in Section 3.1.1, the groundwater samples obtained from this well have distinctive geochemical signatures, including unusually high pH (>9) and potassium concentrations (>50 mg/L), which suggest localized grout contamination. Of particular interest is the apparent correlation between the sharp increases in potassium concentrations and gross beta activity following initial use of the low-flow sampling method in October 1997 (Figure A.5). Assuming that (1) more grout-contaminated samples are obtained with the low-flow sampling method, (2) potassium is a component of grout (bentonite, deposited as volcanic ash, contains potassium), and (3) potassium-40 (a beta-emitting isotope commonly found in volcanic rocks) comprises a portion of the total potassium concentration, then the increasingly elevated gross beta values may be analytical artifacts related to the increasingly elevated potassium levels in the samples. Alternatively, the gross beta values reported for well GW-205 may reflect contamination from the United Nuclear Corporation Site, which contains radioactive waste and is hydraulically upgradient of the well. However, this would not explain the apparent correlation between the initial use of the low-flow sampling method and the coincident increase in potassium levels and gross beta activity. Moreover, the CY 2000 results and historical data for well GW-757 at Industrial Landfill II, which also yields grout-contaminated groundwater samples (see Section 3.1.1), likewise exhibit elevated potassium levels (e.g., 16.7 mg/L in August 2000) and gross beta activity (e.g., 17.1 ± 2.1 pCi/L in August 2000) that are coincident with the change to the low-flow sampling method (Figure A.5).

3.2 EXIT PATHWAY/PERIMETER MONITORING DATA EVALUATION

The CY 2000 monitoring results reported for samples collected from eight springs, two surface water sampling stations in McCoy Branch, and OF301 at Kerr Hollow Quarry were evaluated for DOE Order 5400.1 exit pathway/perimeter monitoring purposes. Evaluation of these monitoring results is required to determine the quality of groundwater and surface water as it exits the Chestnut Ridge Regime (and the ORR).

Six of the springs are located in surface drainage features that traverse the Chestnut Ridge Regime, exit the ORR, and discharge into the Melton Hill Reservoir south of Bethel Valley Road (Figure A.2), including unnamed drainage features about 750 ft south-southwest (SCR1.25SP) and 1,000 ft south-southeast (SCR2.1SP) of Industrial Landfill II; McCoy Branch about 1,500 ft downstream of the FCAP (SCR3.4SP) and 750 ft upstream of Rogers Quarry (SCR3.5SP); an unnamed drainage feature about 1,250 ft south of Construction/Demolition Landfill VII (SCR4.3SP); and an unnamed drainage feature about 3,000 ft upstream of Kerr Hollow Quarry (SCR5.1SP). The two remaining springs are located in Bethel Valley (Figure A.2), one about 2000 ft west of Rogers Quarry (SCR2.2SP) and one about 1,500 ft south of Kerr Hollow Quarry (SCR5.4SP). The two surface water sampling stations (MCK2.0 and MCK2.05) are located along the main channel of McCoy Branch directly downstream of the FCAP, and OF 301 is located where Kerr Hollow Quarry discharges into an unnamed drainage feature (SCR5) north of Bethel Valley Road in the southeast part of the Chestnut Ridge Regime (Figure A.2).

Grab samples were collected semiannually during CY 2000 from each spring and surface water sampling station (Table B.2), and the samples were analyzed for inorganics (major ions and trace metals), VOCs, gross alpha and gross beta activity, and several miscellaneous field (e.g., water temperature) and laboratory analytes (e.g., TDS). Analytical results are reported in the CY 2000 GWMR (AJA 2001).

Each of the springs that were sampled during CY 2000 discharge calcium-magnesium-bicarbonate groundwater characterized by: (1) a wide range of calcium:magnesium ratios; (2) variable but generally low molar proportions (<10%) of chloride, potassium, sodium, and sulfate; (3) nitrate concentrations below 1 mg/L; (4) carbonate alkalinity and fluoride concentrations below respective analytical reporting limits; (5) low total concentrations (<0.5 mg/L) of barium, strontium, and iron; and (6) TDS below 200 mg/L. Few potential groundwater contaminants were detected in samples from any of the springs. For example, nitrate concentrations that exceed the groundwater UTL (2.7 mg/L), but are less than the drinking water MCL (10 mg/L), were reported for the duplicate samples collected from spring SCR5.4SP in August 2000 (4.24 mg/L and 4.31 mg/L). This spring discharges into an unnamed tributary directly east (along strike) from a sewer sludge application site (Upper Hayfield) located northwest of Kerr Hollow Quarry, and the elevated nitrate concentrations in the spring may therefore reflect groundwater transport of nitrate leached from the sludge at this site. Samples collected during CY 2000 (March and November) from a National Pollution Discharge Elimination System (NPDES) station (S17) located downstream of Kerr Hollow Quarry near Bethel Valley Road (Figure A.2) had nitrate concentrations (0.793 - 2.60 mg/L) slightly lower than the upstream results.

Analytical results for the surface water samples collected from MCK2.0 and MCK2.05 during CY 2000 are consistent with CY 1999 data and indicate contamination in McCoy Branch downstream of the FCAP. Samples from these locations in McCoy Branch are distinguished by elevated concentrations of arsenic, sulfate, boron, and magnesium. Although rarely detected in groundwater or surface water samples in the regime, arsenic concentrations in all of the samples from both MCK2.0 and MCK2.05 have been significantly above the reporting limit (0.005 mg/L). Arsenic concentrations in samples collected during CY 2000 ranged from 0.0159 mg/L (MCK2.0) to 0.117 mg/L (MCK2.05), which exceeds the arsenic MCL (0.05 mg/L). Sulfate levels exceed the UTL for groundwater in the Knox Group (19 mg/L), with the highest concentrations reported for samples collected from MCK2.0 (22.7 mg/L) and MCK 2.05 (23.8 mg/L) in August 2000. Boron concentrations range from 0.205 mg/L (MCK2.05) to 0.241 mg/L (MCK2.0), which is almost an order of magnitude above the groundwater UTL (0.028 mg/L). Manganese concentrations likewise exceed the groundwater UTL (0.13 mg/L) by almost an order of magnitude, with the highest concentration (1.22 mg/L) reported for the sample collected from MCK2.05 in February 2000. These monitoring results suggest that the quality of surface water in McCoy Branch at MCK2.0 and MCK2.05 reflects the inflow of surface drainage (including groundwater discharge) enriched with arsenic, sulfate, boron, and manganese leached from the FCAP. Results for samples collected during CY 2000 from NPDES station S19, located where surface water exits Rogers Quarry (Figure A.2), show that the concentration of these constituents decrease before exiting the ORR. Although the arsenic reporting limit for these samples (0.2 mg/L) is too high to confirm a decrease in concentration, the boron (<0.1 mg/L), manganese (<0.2 mg/L), and sulfate (<15 mg/L) concentrations are consistently lower than the upstream concentrations, and the manganese and sulfate concentrations are below respective groundwater UTLs.

Volatile organic compounds were detected only in the samples collected during CY 2000 from one of the springs used for the exit pathway/perimeter monitoring purposes of DOE Order 5400.1. Acetone (8.5 µg/L) was detected in the sample collected from spring SCR4.3SP in February 2000 and methylene chloride (1.5 µg/L) was detected in the sample collected from this spring in July 2000. Spring SCR4.3SP is located almost a mile south-southeast of the Security Pits (Figure A.2), which is the nearest confirmed upgradient source of VOCs, and neither acetone nor methylene chloride are components of the dissolved VOC plume originating from the site. Accordingly, the acetone and methylene chloride (common laboratory reagents) results are probably analytical artifacts.

Gross alpha and/or gross beta above the associated MDA was reported for at least one sample collected during CY 2000 from OF 301, surface water stations MCK2.0 and MCK2.05, and springs SCR1.25SP, SCR2.1SP, SCR3.5SP, and SCR5.1SP. All of the gross alpha results that exceed the MDA are less than 5 pCi/L, are generally characterized by large proportional counting errors, and are substantially below the MCL for drinking water (15 pCi/L). Similarly, all of the gross beta results that exceed the associated MDA are below 10 pCi/L, have large proportional counting errors, and are substantially below the SDWA screening level (50 pCi/L). These results are consistent with historical data, which do not indicate radiological contamination at any of the sampling locations used for the purposes of exit pathway/perimeter monitoring in the regime.

Based on the preceding evaluation of the CY 2000 exit-pathway/perimeter monitoring data, Y-12 operations have not extensively impacted the quality of surface water in drainage features that traverse the Chestnut Ridge Regime.

3.3 CONTAMINANT CONCENTRATION TREND EVALUATION

As noted in Section 2.4, monitoring data obtained since the mid-1980s indicate that groundwater contamination is fairly limited in the Chestnut Ridge Regime and, as indicated by the CY 2000 monitoring results, contaminant concentrations in most wells reflect decreasing or indeterminate long-term trends. Decreasing concentration trends probably reflect a combination of several factors, including compliance with waste management regulations, waste minimization and source control measures, natural attenuation in the Knox Aquifer, and, in some cases, changes in sampling procedures and analytical methods. Indeterminate trends are evident if insufficient data are available, the trend is fairly stable, or the concentrations fluctuate with no apparent linear trend over time. For the purposes of DOE Order 5400.1 requirements, the following discussion is focused on long-term contaminant concentration trends in wells GW-217 (boron), GW-305 (VOCs), and GW-609 (PCE).

As noted in Section 3.1.1, boron concentrations in the groundwater at well GW-217 substantially exceed the applicable UTL (0.028 mg/L) and are more than an order of magnitude higher than evident in most monitoring wells in the Chestnut Ridge Regime. Historical boron results for this well show a steadily increasing trend that peaked in October 1994 (0.22 mg/L) and slowly decreased thereafter until July 2000 (0.094 mg/L), when the boron concentration dropped below 0.1 mg/L for the first time since January 1993 (Figure A.6). These results potentially reflect a “pulse” of boron-enriched groundwater that may coincide with one or more disposals of boron wastes at Industrial Landfill IV.

Historical results for well GW-305 show that the concentration of 111TCA increased from 0.6 µg/L in January 1992 to 26 µg/L in July 2000, then dropped slightly to 14 µg/L in November 2000 (Figure A.7). A similar pattern of initial detection and subsequent concentration increase also is evident for 11DCA and 11DCE (Figure A.7). The sequential detection of 111TCA (January 1992), 11DCA (July 1996), and 11DCE (January 1997) and the subsequent increases in the concentration of each compound potentially reflect eastward (parallel with geologic strike) migration of the center of mass of a dissolved VOC plume comprised primarily of 111TCA, with 11DCA and 11DCE present as degradation products. Biotic degradation of 111TCA is supported by the biological testing results obtained in CY 1999 and CY 2000 which indicate that the groundwater in this well contains a complex bacterial consortium dominated by slime forming and iron related bacteria.

Historical data for well GW-609 show clearly decreasing long-term concentrations trends. Decreasing concentrations trends probably reflect reduced flux of VOCs following closure of the Security Pits combined with natural attenuation in the subsurface. Concentrations of PCE, for example, decreased from more than 50 µg/L in April 1991 to 5 µg/L in June 1993, steadily increased to almost 40 µg/L in May 1994, and then subsequently decreased and remained below 5 µg/L since January 1999 (Figure A.8). This overall trend suggests that a “pulse” of PCE, possibly related to correspond disposal(s) of chlorinated solvents in the eastern trench area during operation of the Security Pits, may have passed the well during the peak concentration in April 1991 (BJC 2001).

4.0 CONCLUSIONS AND RECOMMENDATIONS

Monitoring data obtained in the Chestnut Ridge Regime during CY 2000 are generally consistent with historical results regarding the known sources of groundwater contamination in the regime, the primary types of groundwater contaminants, and the extent of contaminant transport in the Knox Aquifer.

Based on the evaluation of CY 2000 monitoring results in accordance with the surveillance monitoring purposes of DOE Order 5400.1, potential groundwater contamination is indicated by results for 11 monitoring wells in the Chestnut Ridge Regime. However, groundwater contaminants in five of these wells probably reflect sampling artifacts from grout contamination or corrosion of the stainless steel well casing and screen. Only the groundwater contaminants present in wells downgradient of Industrial Landfill IV (GW-217 and GW-305), the Security Pits (GW-609, GW-796, and GW-798), and Kerr Hollow Quarry (GW-145) reflect impacts from Y-12 operations on groundwater quality in the Chestnut Ridge Regime.

Based on CY 2000 monitoring results that were evaluated for the exit pathway/perimeter monitoring purposes of DOE Order 5400.1, anthropogenic contaminants are present in the surface drainage features that traverse the Chestnut Ridge Regime and ultimately exit the ORR. Elevated nitrate levels in the samples from spring SCR5.4SP, which discharges into an unnamed surface drainage feature in Bethel Valley about 1,500 ft upstream of Kerr Hollow Quarry, may reflect migration from a nearby sewage sludge disposal site. Also, the elevated arsenic, boron, manganese, and sulfate concentrations evident in McCoy Branch at MCK2.0 and MCK2.05 probably reflect the localized impact of the FCAP. In both instances, samples from downstream NPDES surface water stations located where surface water in each drainage feature exits the Chestnut Ridge Regime, concentrations of these contaminants are lower than the upstream concentrations. However, reporting limits for the NPDES samples are not low enough to confirm that the concentrations of all of these contaminants are below groundwater UTLs (e.g., boron) or MCLs (e.g., arsenic).

Based on review of the CY 2000 monitoring data, the following actions are recommended:

- Wells GW-205 and GW-757 remain contaminated by the cement grout that was circulated into the surrounding formation during their installation. Because grout contamination is a chronic problem for both wells when sampled using the low-flow method, the conventional sampling method may be the only method appropriate for obtaining the most representative samples from either well. Another option would be to modify the low-flow sampling method to specify that the field measurement of pH is below 9 before samples are collected from these wells. Alternatively, both wells should be considered unuseable for groundwater quality monitoring purposes.

- A formal network of surface water sampling locations should be established to serve the purposes of DOE Order 5400.1 exit pathway/perimeter monitoring in the Chestnut Ridge Regime. At a minimum, this network should include a baseline series of surface water sampling stations, one located in each of the five major south Chestnut Ridge drainage features: SCR1, SCR2, McCoy Branch (SCR3), SCR4, and SCR5. The surface water sampling station in each drainage feature should be located as far downstream as practical to provide information regarding the quality of surface water that exits the regime (i.e., passes beneath Bethel Valley Road and discharges into Melton Hill Reservoir). For example, baseline surface water sampling stations in SCR1, SCR2, and SCR4 could be located immediately upstream of Bethel Valley Road (initiated by the GWPP during CY 2001), and sampling stations in McCoy Branch and SCR5 could be located upstream of where these drainage features discharge into Rogers Quarry and Kerr Hollow Quarry, or at existing NPDES monitoring locations. In addition to the baseline surface water sampling stations, a variable number of upstream springs that discharge into the drainage features could be included in the exit pathway/perimeter monitoring network defined for each CY. Sampling should continue to be performed semiannually, but should be more directly tied to precipitation, with sampling during the seasonally wet flow conditions performed immediately after significant rainfall.

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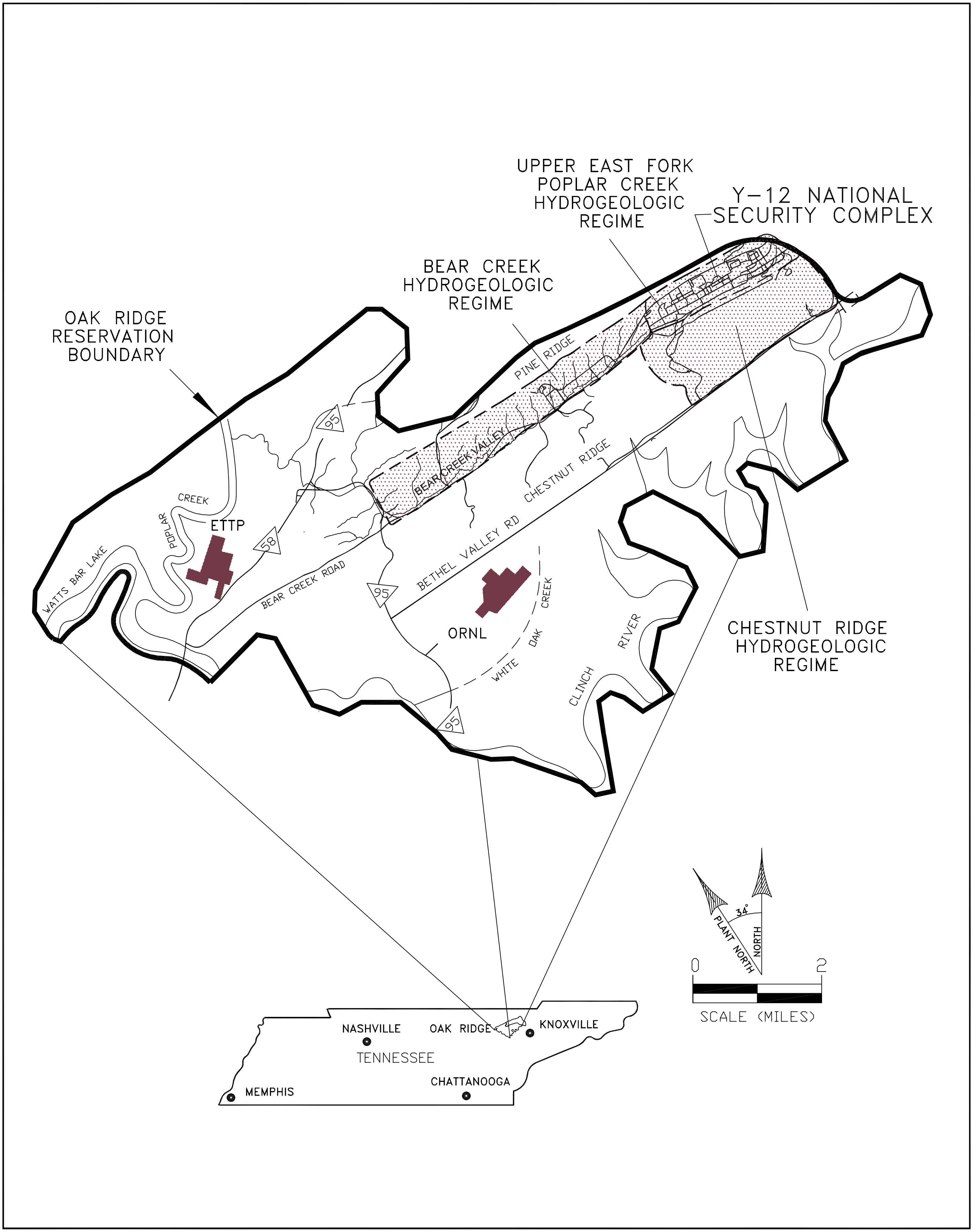
APPENDIX A

FIGURES



CROODER_01.DWG

Fig. A.1. Hydrogeologic regimes at the Y-12 National Security Complex.

CROODER_02.DWG

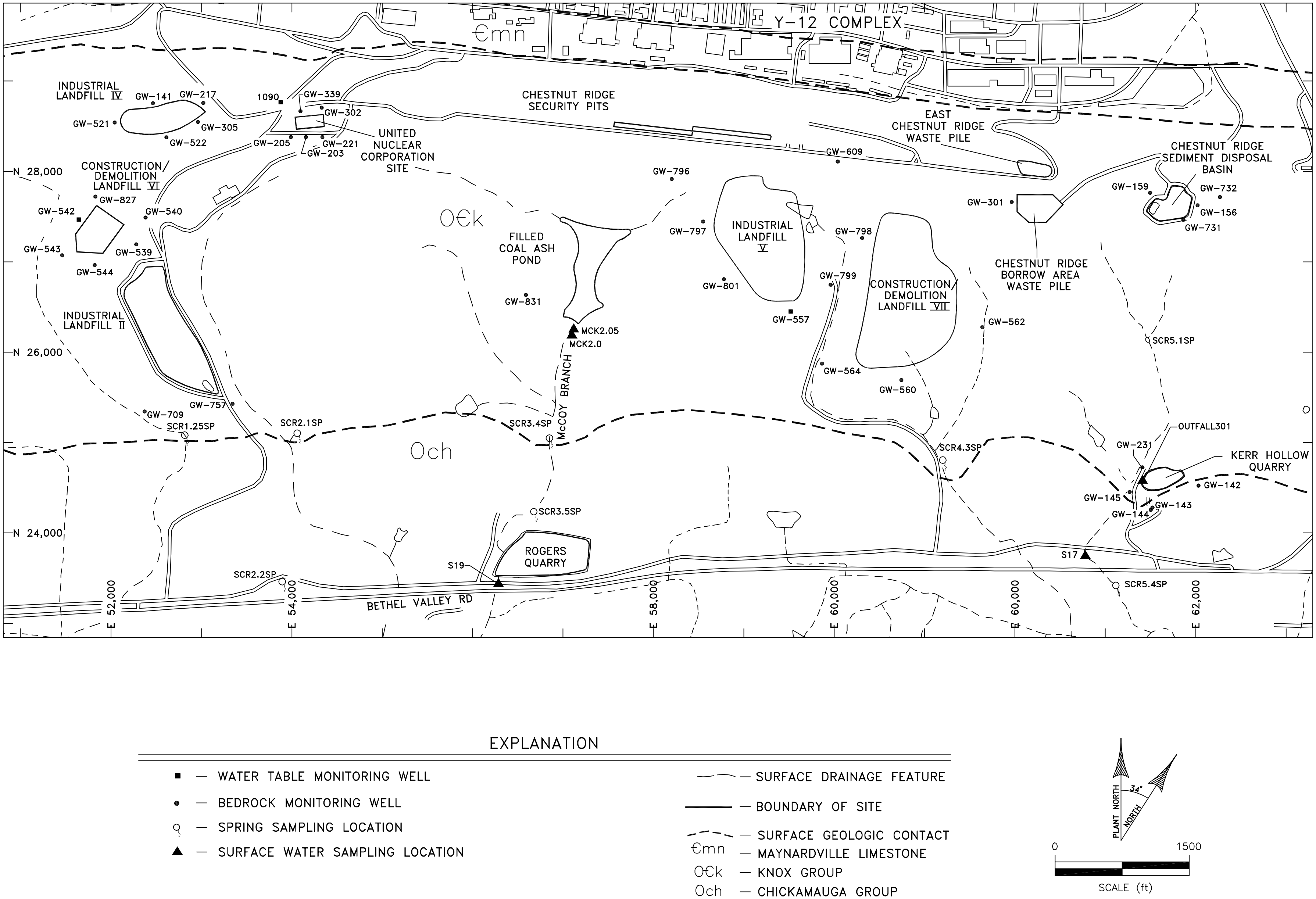
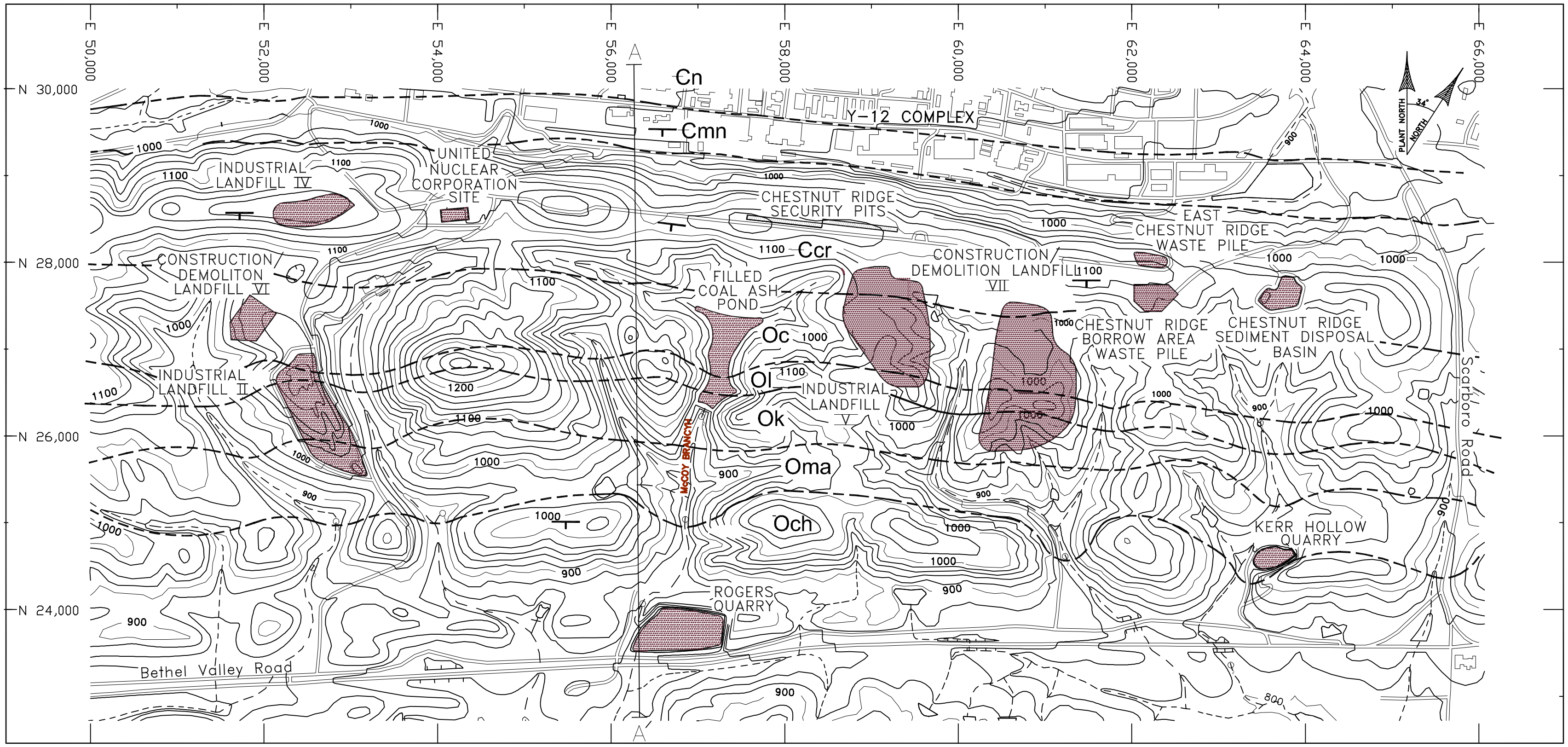
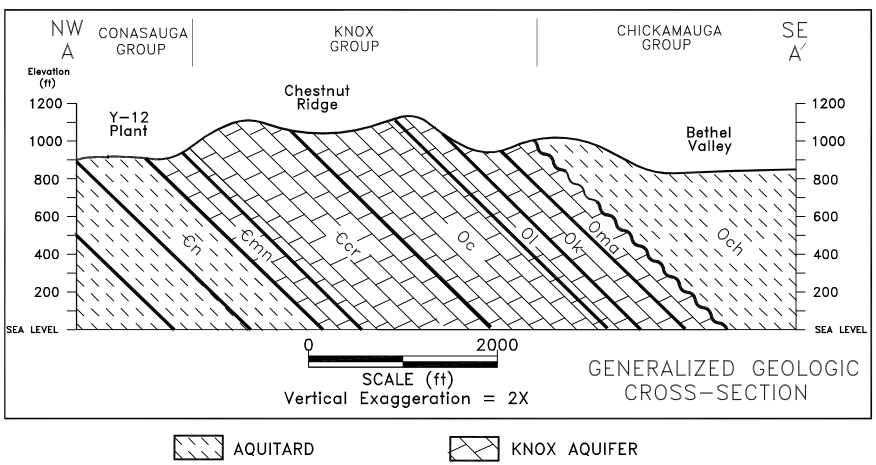


Fig. A.2. CY 2000 sampling locations in the Chestnut Ridge Hydrogeologic Regime.



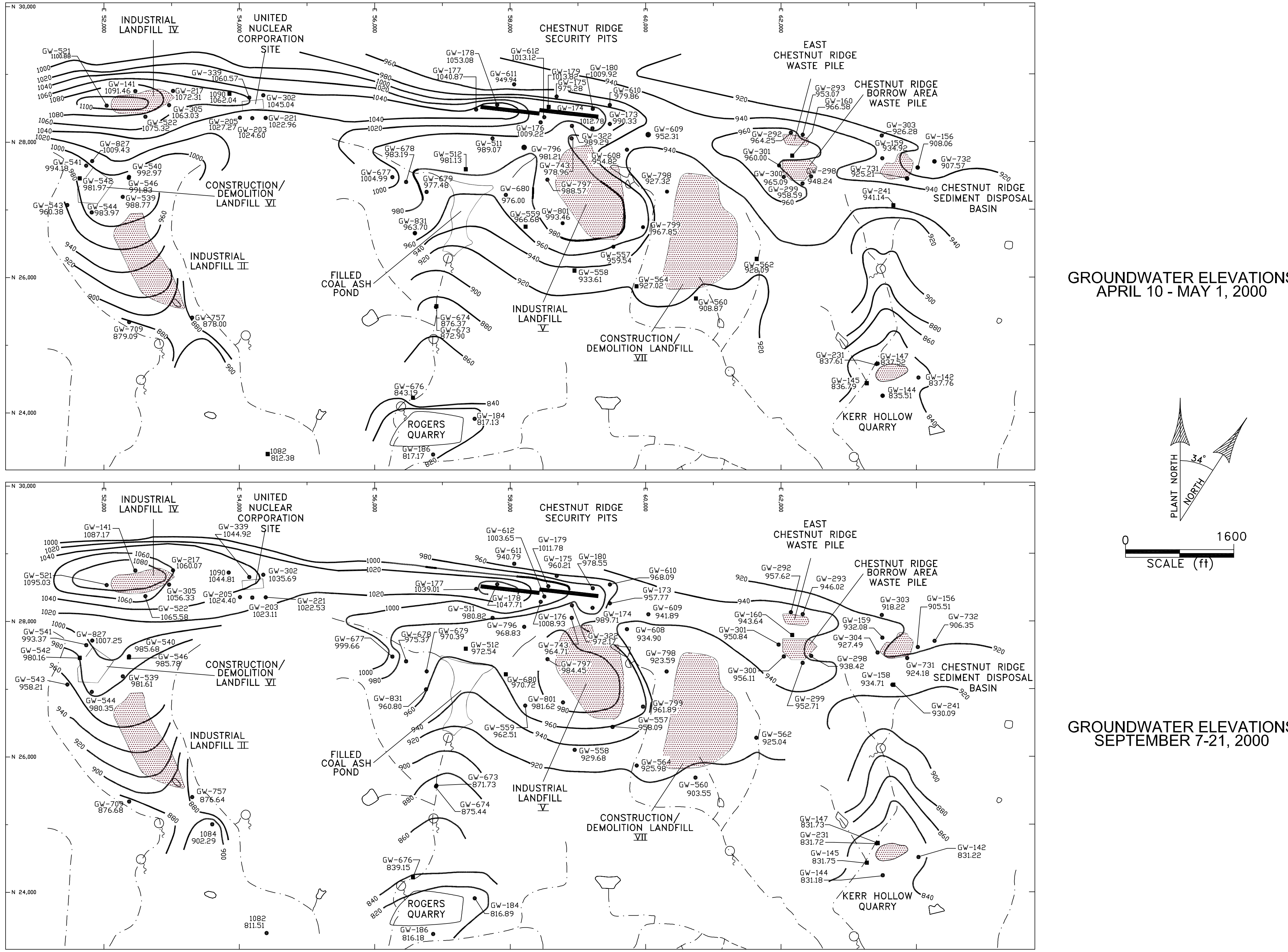
SOURCES: King and Haase, 1987
Hatcher et al. 1992

0 2000
SCALE (ft)



SYSTEM		HYDRO UNIT	GROUP	FORMATION	MAP SYMBOL	THICKNESS (FT)
ORDOVICIAN	UPPER	AQUITARD	CHICKAMAUGA	UNDIFFERENTIATED	Och	1500 TO 2000
ORDOVICIAN	MIDDLE	KNOX AQUIFER	KNOX	MISSING SECTION (Subaerial Erosion)		
ORDOVICIAN	LOWER	KNOX AQUIFER	KNOX	MASCOT DOLOMITE	Oma	250–400
ORDOVICIAN	LOWER	KNOX AQUIFER	KNOX	KINGSPORT FORMATION	Ok	300–500
ORDOVICIAN	LOWER	KNOX AQUIFER	KNOX	LONGVIEW DOLOMITE	Ol	130–200
ORDOVICIAN	LOWER	KNOX AQUIFER	KNOX	CHEPULTEPEC DOLOMITE	Oc	500–700
CAMBRIAN	UPPER	KNOX AQUIFER	KNOX	COPPER RIDGE DOLOMITE	Ꞓcr	800–1,100
CAMBRIAN	UPPER	KNOX AQUIFER	CONASAUGA	MAYNARDVILLE LIMESTONE	Ꞓmn	418–450
CAMBRIAN	MIDDLE	AQUITARD	CONASAUGA	NOLICHUCKY SHALE	Ꞓn	490–590

Fig. A.3. Topography and bedrock geology in the Chestnut Ridge Hydrogeologic Regime.

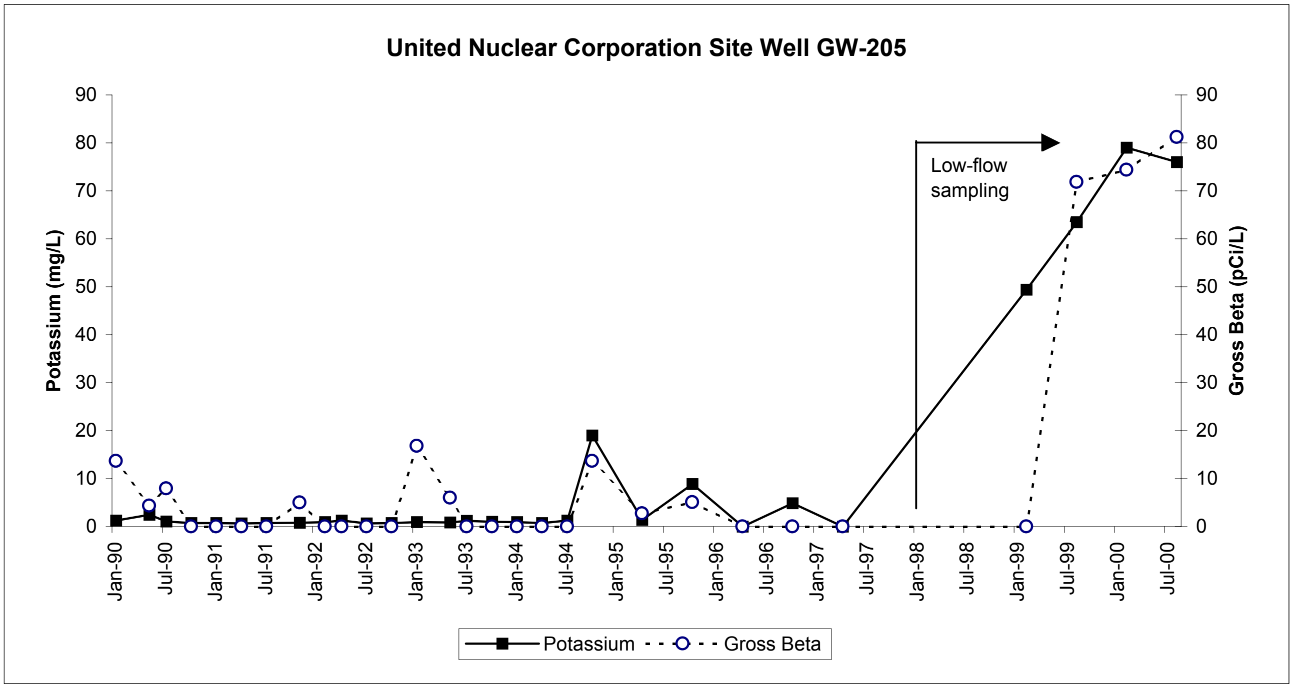


EXPLANATION

- ■ WATER TABLE INTERVAL MONITORING WELL
- • BEDROCK INTERVAL MONITORING WELL
- 920 WATER-LEVEL ISOPLETH (ft msl)
- SURFACE DRAINAGE FEATURE
- SPRING

CROODER_4.DWG

Fig. A.4. Seasonal groundwater elevations in the Chestnut Ridge Hydrogeologic Regime, 2000.



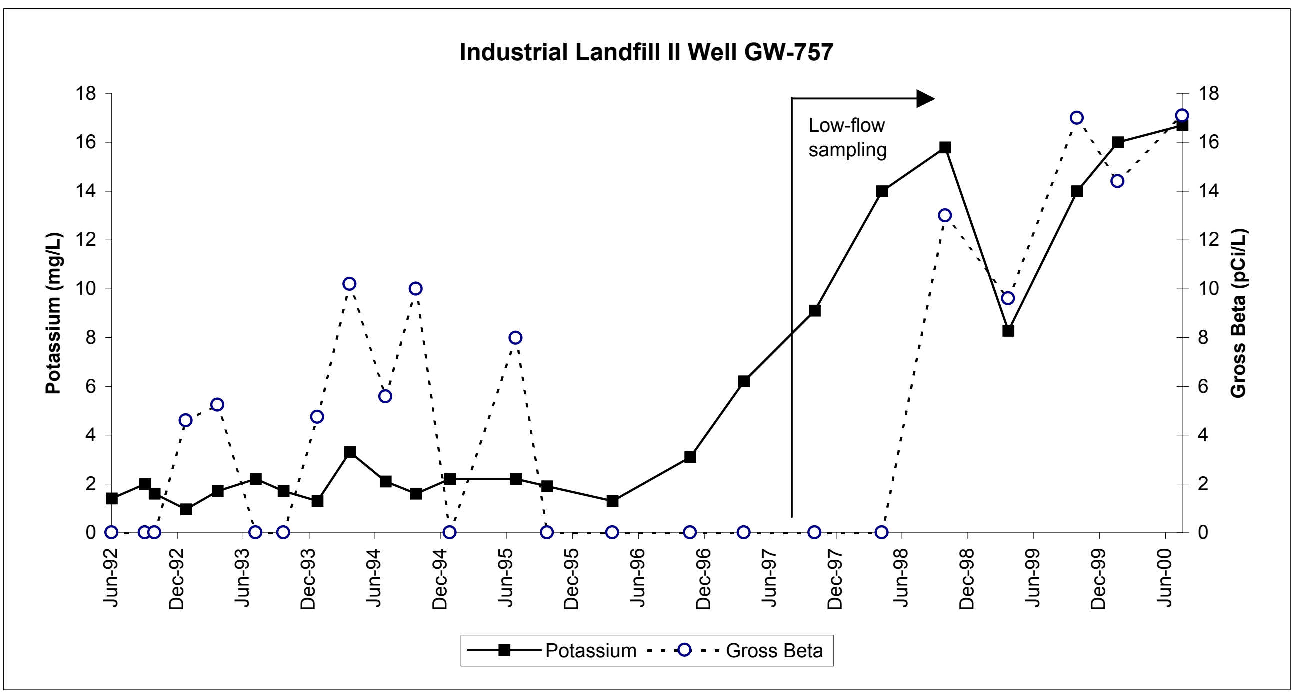


Fig.A.5. Potasium concentrations and gross beta activities in wells GW-205 and GW-757.

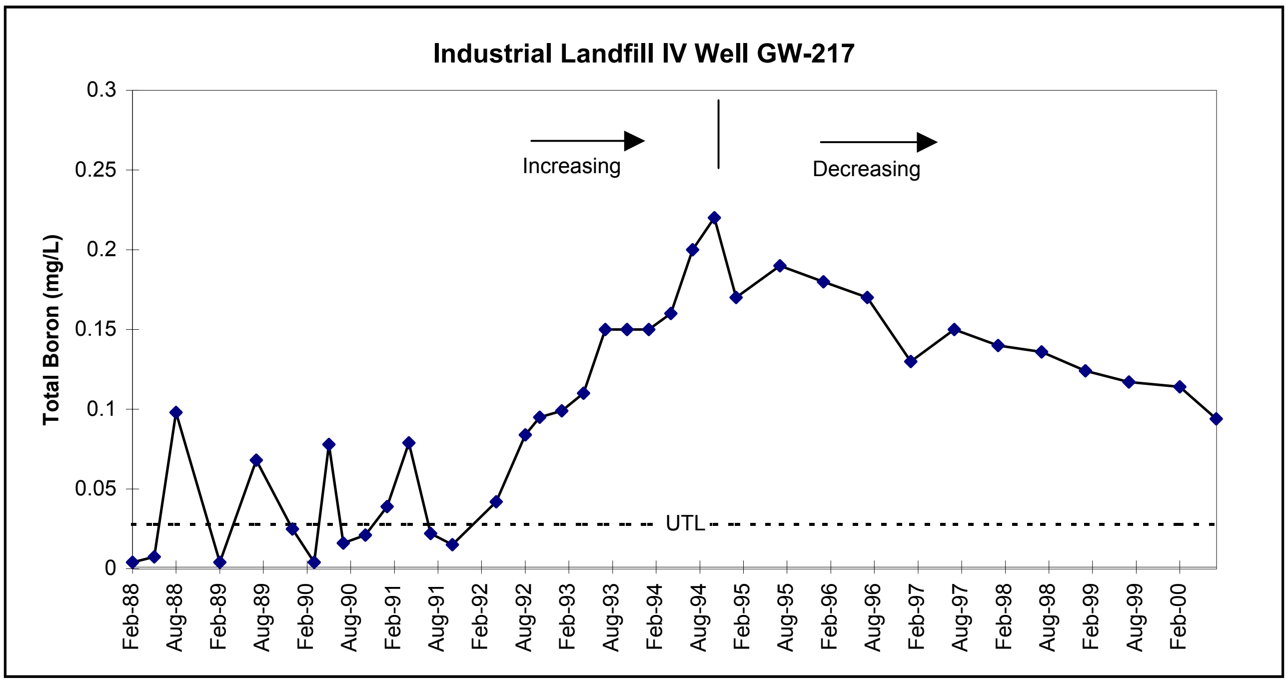
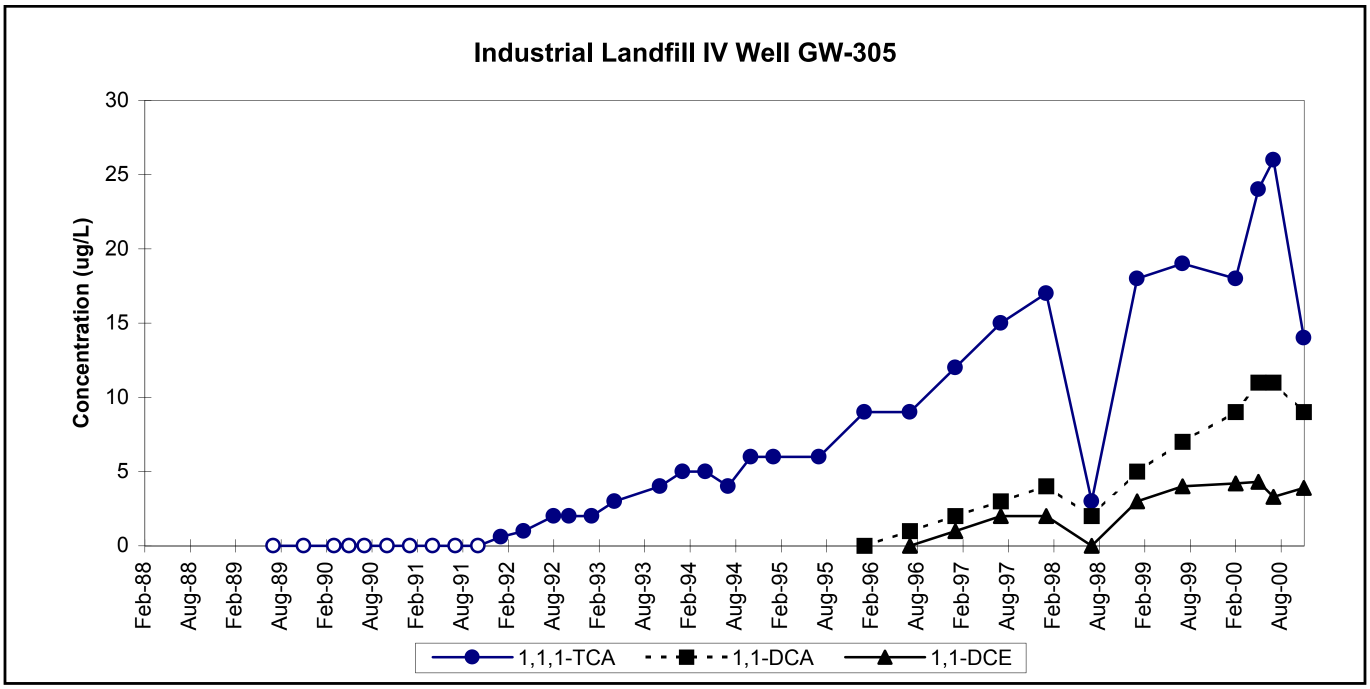


Fig.A.6. Boron concentrations in well GW-217.



Note: 1,1,1-TCA MCL = 200 ug/L; 1,1-DCE MCL = 7 ug/L.

Fig.A.7. VOC concentrations in well GW-305.

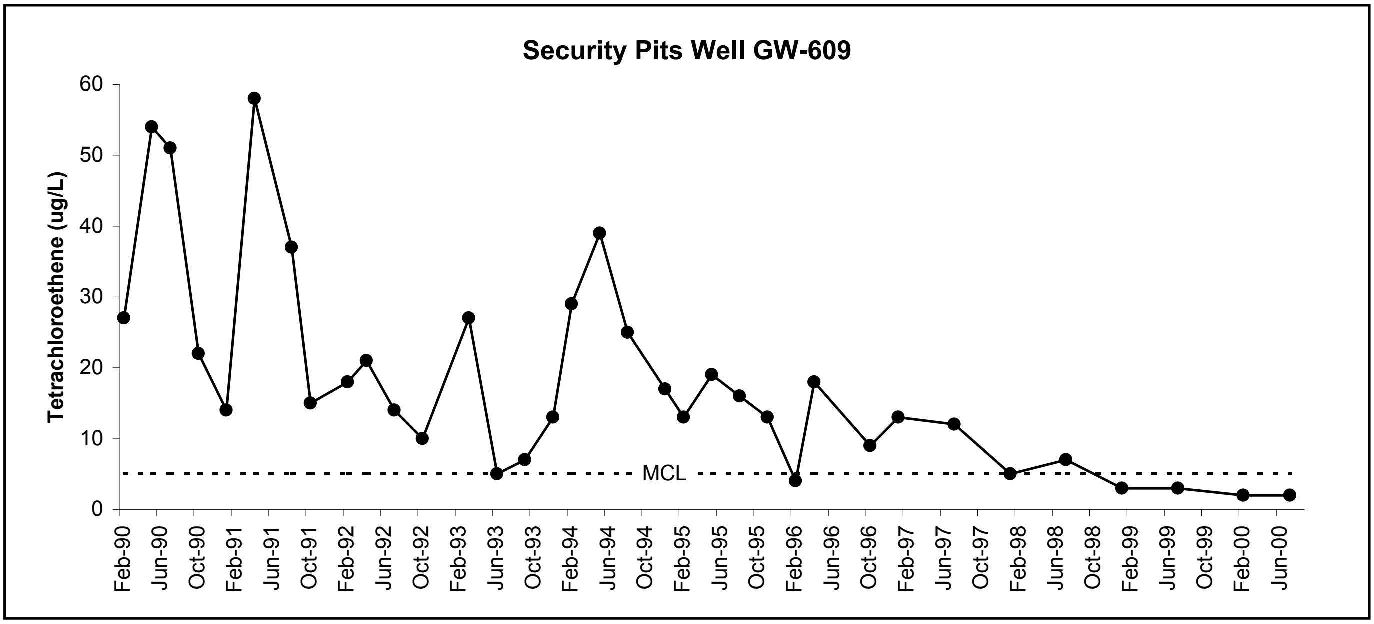


Fig.A.8. PCE concentrations in well GW-609.

APPENDIX B

TABLES

Table B.1. Waste management sites and associated groundwater monitoring programs in the Chestnut Ridge Hydrogeologic Regime

GROUNDWATER MONITORING PROGRAM			Status			DOE Order 5400.1A Monitoring [5]	CERCLA Monitoring [4]	SWDF Detection Monitoring [3]	RCRA Post-closure Detection Monitoring [2]	RCRA Post-closure Corrective Action Monitoring [1]
Waste Management Site	**Regulatory Classification**	**General Waste Inventory**	**Operation**	**Active**	**Closed**					
Chestnut Ridge Sediment Disposal Basin	RCRA/ CERCLA	Approximately 11,100 yd^3 of sediments and soils from the Y-12 Plant containing heavy metals; approximately 100,000 gallons of methanol-brine waste (70/30% water/methyl alcohol); and 55-110 gallons of toluene.	1973-1987		Ž				M	
East Chestnut Ridge Waste Pile	RCRA/ CERCLA	Contaminated soil from Y-12.	1987							
Kerr Hollow Quarry	RCRA/ CERCLA	Approximately 50 tons of water-reactive materials (alkali metals, metal hydrides); unstable organic materials (picric acid, ethers, peroxides, and hydrazone); reactive metals (phosphorous and magnesium); potentially explosive materials (e.g., gas cylinders); ammonia; and inorganic acids.	1951-1988		M		M		M	
Chestnut Ridge Security Pits	RCRA/ CERCLA	Metals (lead); reactive materials (lithium hydride, lithium deuteride, zirconium); corrosive materials (acids); ignitable materials (alcohols); and chlorinated solvents.	1973-1988		M					M
Filled Coal Ash Pond (formerly the Ash Disposal Basin)	CERCLA	Coal fly-ash slurry from the Y-12 Steam Plant.	1955-1967		M		M			
United Nuclear Corporation Site	CERCLA	Approximately 11,000 drums (55-gallon) of sludge fixed in cement, 18,000 drums of contaminated soil, and 288 boxes of contaminated process and demolition material.	1982-1992		M		M			

Table B.1 (continued)

GROUNDWATER MONITORING PROGRAM

Waste Management Site	Regulatory Classification	General Waste Inventory	Status: Operation	Status: Active	Status: Closed	DOE Order 5400.1A Monitoring [5]	CERCLA Monitoring [4]	SWDF Detection Monitoring [3]	RCRA Post-closure Detection Monitoring [2]	RCRA Post-closure Corrective Action Monitoring [1]
Rogers Quarry	CERCLA	Coal fly-ash slurry that bypassed the Filled Coal Ash Pond via spillway into McCoy Branch.	1967-1993		M	M				
Chestnut Ridge Borrow Area Waste Pile	CERCLA	Soils removed from the Oak Ridge Civic Center properties and the Oak Ridge Sewer Line Beltway contaminated with mercury and other metals, and possibly some organic compounds that originated from Y-12. All soil was removed from the site in CY 2000.	Mid-1980s							
Industrial Landfill II	SWDF	Combustible and decomposable solid waste and construction spoil material including scrap metal, glass, paper products, plastics, wood, organic garbage, textile products, asphalt roofing materials, and special wastes such as asbestos and beryllium oxide.	1983-1996		M			M		
Industrial Landfill IV	SWDF	Approximately 12,000 ft^3 per year of non-hazardous, nonradioactive industrial wastes including cardboard, plastics, rubber, scrap metal, wood, paper, and special waste.	1989-	M				M		
Industrial Landfill V	SWDF	Combustible/decomposable solid wastes.	1994-	M				M		
Construction/Demolition Landfill VI	SWDF	Construction spoil: concrete, wood, metal, plastic, roofing materials, and soil.	1994-	M				M		
Construction/Demolition Landfill VII	SWDF	No wastes emplaced during CY 2000. On standby until Construction/Demolition Landfill VI is closed.	1994-					M		

Table B.1 (continued)

GROUNDWATER MONITORING PROGRAM			Status			DOE Order 5400.1A Monitoring [5]	CERCLA Monitoring [4]	SWDF Detection Monitoring [3]	RCRA Post-closure Detection Monitoring [2]	RCRA Post-closure Corrective Action Monitoring [1]
Waste Management Site	**Regulatory Classification**	**General Waste Inventory**	**Operation**	**Active**	**Closed**					
Receptor Media	Not Regulated	Groundwater and surface water exiting the Chestnut Ridge Hydrogeologic Regime.	Not Applicable			**M**	**M**			

Notes:

1 Resource Conservation and Recovery Act (RCRA) post-closure corrective action monitoring in accordance with the requirements specified in the RCRA post-closure permit for the Chestnut Ridge Regime (Permit No. TNHW-088).

2 RCRA post-closure detection monitoring in accordance with the applicable requirements of the RCRA post-closure permit for the Chestnut Ridge Regime (Permit No. TNHW-088).

3 Detection monitoring in accordance with operating permits issued by the Tennessee Department of Environment and Conservation (TDEC) for the specified non-hazardous solid waste disposal facility (SWDF) and applicable TDEC solid waste management regulations. Groundwater monitoring has been suspended at Construction/Demolition Landfill VII until the site begins accepting waste.

4 Monitoring in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Record of Decision for the specified facility or for baseline (pre-remediation) monitoring.

5 Monitoring performed in accordance with U.S. Department of Energy Order 5400.1A.

Table B.2. CY 2000 groundwater and surface water sampling locations and dates in the Chestnut Ridge Hydrogeologic Regime

EVALUATION PURPOSE [2]						Surveillance Monitoring	Exit Pathway/Perimeter Monitoring	Contaminant Trend [1]
Sampling Point [3]	Sampling Location [4]	CY 2000 Sampling Date [5] 1st Quarter	2nd Quarter	3rd Quarter	4th Quarter			
1090	UNCS	02/22/00	.	08/09/00	.	!		
GW-141	LIV	02/07/00	.	07/26/00	.	!		
GW-142	KHQ	.	04/03-06/00 REP	.	10/02-05/00 REP	!		
GW-143	KHQ	.	**04/03-06/00 REP**	.	**10/02-05/00 REP**	!		
GW-144	KHQ	.	**04/03-06/00 REP**	.	**10/02-05/00 REP**	!		
GW-145	KHQ	.	04/03-06/00 REP	.	10/02-05/00 REP	!		
GW-156	CRSDB	.	**04/24-27/00 REP**	.	**10/09-12/00 REP**	!		
GW-159	CRSDB	.	04/24-27/00 REP	.	10/09-12/00 REP	!		
GW-203	UNCS	02/23/00	.	08/15/00	.	!		
GW-205	UNCS	02/23/00	.	08/10/00	.	!		!
GW-217	LIV	02/07/00	.	07/27/00	.	!		!
GW-221	UNCS	02/22/00	.	08/09/00	.	!		
GW-231	KHQ	.	04/03-06/00 REP	.	10/02-05/00 REP	!		
GW-301	CRBAWP	**01/31/00 D**	.	**07/19/00 D**	.	!		
GW-302	UNCS	02/23/00	.	08/14/00	.	!		
GW-305	LIV	02/07/00	05/23/00	07/27/00	11/06/00	!		!
GW-339	UNCS	**02/23/00 D**	.	**08/14/00 D**	.	!		
GW-521	LIV	1/31/00	.	7/25/00	.	!		
GW-522	LIV	02/07/00	.	07/25/00	.	!		
GW-539	LII	02/02/00	.	08/01/00	.	!		
GW-540	LII/CDLVII	02/02/00	.	07/26/00	.	!		
GW-542	CDLVI	02/01/00	.	07/27/00	.	!		
GW-543	CDLVI	02/02/00	.	07/31/00	.	!		
GW-544	CDLVI	02/02/00	.	07/31/00	.	!		
GW-557	LV	**01/26/00 D**	.	**07/20/00 D**	.	!		
GW-560	CDLVII	.	.	07/27/00	10/30, 11/28, 12/11	!		
GW-562	CDLVII	.	.	07/25/00	10/31, 11/28, 12/12	!		
GW-564	CDLVII	.	.	07/26/00	10/30, 11/27, 12/11	!		
GW-609	CRSP	02/01/00	.	07/19/00	.	!		!
GW-709	LII	02/02/00	.	08/01/00	.	!		
GW-731	CRSDB	.	04/24-27/00 REP	.	10/09-12/00 REP	!		
GW-732	CRSDB	.	**04/24-27/00 REP**	.	**10/09-12/00 REP**	!		
GW-757	LII	02/02/00	.	08/01/00	.	!		!

Table B.2 (continued)

Sampling Point [3]	Sampling Location [4]	CY 2000 Sampling Date [5]				EVALUATION PURPOSE [2]		
		1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Surveillance Monitoring	Exit Pathway/Perimeter Monitoring	Contaminant Trend [1]
GW-796	LV	01/27/00	.	07/24/00	.	!		
GW-797	LV	02/01/00	.	07/24/00	.	!		
GW-798	CDLVII	01/31/00	.	07/20/00	.	!		
GW-798	CDLVII	.	.	07/20/00	10/30, 11/27, 12/11	!		
GW-799	LV	01/27/00	.	07/25/00	.	!		
GW-801	LV	01/31/00	.	07/24/00	.	!		
GW-827	CDLVI	02/01/00	.	07/31/00	.	!		
GW-831	FCAP	01/27/00	.	07/24/00	.	!		
MCK 2.0	FCAP	02/07/00	.	08/29/00	.		!	
MCK 2.05	FCAP	02/07/00	.	**08/29/00 D**	.		!	
OF 301	KHQ	.	05/30/00	.	11/02/00		!	
SCR1.25SP	EXP	02/07/00	.	08/29/00	.		!	
SCR2.1SP	EXP	03/06/00	.	08/17/00	.		!	
SCR2.2SP	EXP	03/06/00	.	08/17/00	.		!	
SCR3.4SP	EXP	03/06/00	.	08/17/00	.		!	
SCR3.5SP	EXP	02/07/00	.	08/29/00	.		!	
SCR4.3SP	LV	02/02/00	.	07/25/00	.		!	
SCR5.1SP	EXP	**03/06/00 D**	.	08/17/00	.		!	
SCR5.4SP	EXP	03/06/00	.	**08/17/00 D**	.		!	

Notes:

1 An increasing or decreasing contaminant trend has been identified at the specified monitoring well (see Figures A.5 through A.8).

2 The DOE Order 5400.1A data evaluation purpose of the sampling location for this report, regardless of the groundwater monitoring program for which the data were obtained. A thorough description of the monitoring programs are provided in the CY 2000 GWMR (BWXT Y-12, L.L.C. 2000).

3
- GW - Groundwater monitoring well (also well number 1090)
- MCK - McCoy Branch Kilometer
- OF 301 - Outfall 301: surface water station located where water exits Kerr Hollow Quarry
- SCR - South Chestnut Ridge (tributary prefix)
- SP - Spring location (suffix)

Table B.2 (continued)

Notes: (continued)

4	CDLVI	-	Construction/Demolition Landfill VI
	CDLVII	-	Construction/Demolition Landfill VII
	CRBAWP	-	Chestnut Ridge Borrow Area Waste Pile
	CRSDB	-	Chestnut Ridge Sediment Disposal Basin
	CRSP	-	Chestnut Ridge Security Pits
	EXP	-	Exit Pathway (spring sampling location)
	FCAP	-	Filled Coal Ash Pond
	KHQ	-	Kerr Hollow Quarry
	LII	-	Industrial Landfill II
	LIV	-	Industrial Landfill IV
	LV	-	Industrial Landfill V
	UNCS	-	United Nuclear Corporation Site
5	.	-	Not Sampled.
	D	-	Duplicate sample was collected (shown in bold typeface).
	REP	-	Four replicate groundwater samples were collected from the well over the specified date range. **BOLD** indicates that duplicate groundwater samples were collected from the specified well on the following replicate sampling dates: GW-143 (April 3 and October 2); GW-144 (April 4 and October 4); GW-156 (April 27 and October 12); and GW-732 (April 25 and October10).

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