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Y-12 NATIONAL SECURITY COMPLEX

GROUNDWATER PROTECTION PROGRAM MANAGEMENT PLAN FOR THE U.S. DEPARTMENT OF ENERGY Y-12 NATIONAL SECURITY COMPLEX, OAK RIDGE, TENNESSEE Revision 2

Issue Date: September 2009

Prepared by

ELVADO ENVIRONMENTAL LLC
Under Subcontract No. 430054638

and the

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

Managed by

Babcock & Wilcox Technical Services Y-12, LLC
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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ACRONYMS AND ABBREVIATIONS

ADMS	Analytical Data Management System
ACO	Analytical Chemistry Organization
B&W Y-12	Babcock & Wilcox Technical Services Y-12, LLC (formerly BWXT)
BCBG	Bear Creek Burial Grounds
Bear Creek Regime	Bear Creek Hydrogeologic Regime
BCV	Bear Creek Valley
bgs	below ground surface
BJC	Bechtel Jacobs Company, L.L.C.
BWXT	BWXT Y-12, L.L.C.
CA	characterization area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Chestnut Ridge Regime	Chestnut Ridge Hydrogeologic Regime
CRSDB	Chestnut Ridge Sediment Disposal Basin
CRSP	Chestnut Ridge Security Pits
CY	calendar year
DOE	United States Department of Energy
DQO	data quality objective
East Fork Regime	Upper East Fork Poplar Creek Hydrogeologic Regime
ECD	Environmental Compliance Department
EMMIS	Environmental Monitoring Management Information System
EMP	Environmental Monitoring Plan
EMS	environmental management system
EMWMF	Environmental Management Waste Management Facility
EPA	United States Environmental Protection Agency
ES&H	Environment, Safety, and Health (Division)
FCAP	Filled Coal Ash Pond
FFA	Federal Facility Agreement
FS	feasibility study
ft	feet
GIMS	Groundwater Information Management System
GWDC	Groundwater Monitoring Data Evaluation Compendium
GWDER	Groundwater Data Evaluation Report
GWMR	Groundwater Monitoring Report
GWPP	Groundwater Protection Program
GWPS	Groundwater Protection Standard
ISMS	Integrated Safety Management System
IWQP	Integrated Water Quality Program
KHQ	Kerr Hollow Quarry
LMES	Lockheed Martin Energy Systems, Inc.
M&O	management and operation
MAROS	Monitoring and Remediation Optimization System (software)
MOP	Monitoring Optimization Plan
MOU	Memorandum of Understanding
OREIS	Oak Ridge Environmental Information System

ACRONYMS AND ABBREVIATIONS (continued)

ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OU	operable unit
P&A	plugging and abandonment
PCP	post-closure permit
POC	point of compliance
QA	quality assurance
QC	quality control
QAP	Quality Assurance Plan
QPP	Quality Program Plan
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	record of decision
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
S/RID	Standard/Requirement Identification Document
SWDF	Solid Waste Disposal Facility (nonhazardous waste)
TDEC	Tennessee Department of Environment and Conservation
TSD	treatment, storage, and disposal
UIC	underground injection control
UNCS	United Nuclear Corporation Site
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WRRP	Water Resources Restoration Program
Y-12	Y-12 National Security Complex

1.0 INTRODUCTION

This document presents the Groundwater Protection Program (GWPP) management plan for the U.S. Department of Energy (DOE) Y-12 National Security Complex (hereafter referenced as Y-12). The Y-12 GWPP functions as the primary point-of-contact for groundwater-related issues at Y-12, provides stewardship of the extensive network of groundwater monitoring wells at Y-12, and serves as a resource for technical expertise, support, and historical data for groundwater-related activities at Y-12. These organizational functions each serve the primary programmatic purpose of the GWPP, which is to ensure that groundwater monitoring activities within areas under Y-12 administrative control provide representative data in compliance with the multiple purposes of applicable state and federal regulations, DOE orders, and the corporate policies of Babcock & Wilcox Technical Services Y-12 LLC(hereafter referenced as B&W Y-12), the Y-12 management and operations (M&O) contractor for DOE. B&W Y-12 is a new corporate name, assumed in January 2007, for the company formerly known as BWXT Y-12, L.L.C., hereafter referenced as BWXT).

This GWPP management plan addresses the requirements of DOE Order 450.1A *Environmental Protection Program* (hereafter referenced as DOE O 450.1A), which emphasize a site-wide approach for groundwater protection at each DOE facility through implementation of groundwater surveillance monitoring. Additionally, this plan addresses the relevant and applicable GWPP elements and goals described in the DOE O 450.1A technical guidance documents issued in June 2004 (DOE 2004) and May 2005 (DOE 2005).

This GWPP management plan is a "living" document that is reviewed annually, revised and reissued every three years, and is formatted to provide for updating individual sections independent of the rest of the document. Section 2 includes a short description of the groundwater system at Y-12, the history of groundwater monitoring at Y-12 and the corresponding evolution of the GWPP, and an overview of ongoing Y-12 groundwater monitoring activities. Section 3 describes the key elements of the GWPP management strategy. Organizational roles and responsibilities of GWPP personnel are outlined in Section 4. Section 5 presents an overview of the GWPP project plans for applicable programmatic elements. Section 6 lists the reports, plans, and documents that are referenced for technical and administrative details.

2.0 BACKGROUND INFORMATION

The area under Y-12 administrative control is divided into three hydrogeologic regimes for the purposes of groundwater monitoring (Figure 1). The Bear Creek Hydrogeologic Regime (Bear Creek Regime) encompasses a section of Bear Creek Valley (BCV) between Old Bear Creek Road on the west end of Y-12 and the west end of the valley at State Route 95 (directions are in reference to the Y-12 grid system). The Upper East Fork Poplar Creek Hydrogeologic Regime (East Fork Regime) encompasses industrial facilities and support structures located between Scarboro Road at the east end of Y-12 and Old Bear Creek Road at the west end of Y-12. The Chestnut Ridge Hydrogeologic Regime (Chestnut Ridge Regime) encompasses a section of Chestnut Ridge west of Scarboro Road and east of Dunaway Branch southwest of Y-12. The following sections provide background information regarding the groundwater system at Y-12, the history of groundwater quality monitoring in each hydrogeologic regime, and the status of ongoing groundwater monitoring activities. This information establishes the framework underlying the GWPP management strategy described in Section 3.

2.1 HYDROGEOLOGIC FRAMEWORK

The following discussion provides a generalized overview of the complex hydrogeologic system at Y-12.

The geology in the vicinity of Y-12 is generally characterized by sequences of southeast-dipping, fractured clastic (primarily shale and siltstone) and carbonate (limestone and dolostone) strata of Lower Cambrian to Lower Ordovician age (Figure 2). Strike and dip of bedding is generally N 55°E and 45°SE, respectively. BCV is underlain by the interbedded limestone and shale formations of the Conasauga Group (Figure 2). The Maynardville Limestone, the uppermost formation of the Conasauga Group, subcrops along the axis of BCV at the base of Chestnut Ridge and the underlying formations of the Conasauga Group, (the Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone, and Pumpkin Valley Shale) subcrop successively to the north toward Pine Ridge (Figure 2). Shale and siltstone beds of the underlying Rome Formation from Pine Ridge to the north, and the primarily dolostone strata of the overlying Knox Group from Chestnut Ridge to the south (Figure 2).

Bedrock near Y-12 area is overlain by any of several materials, including alluvium, colluvium, man-made fill, fine-grained residuum from the weathering of the bedrock, saprolite (a transitional mixture of fine residuum and bedrock remnants), and weathered bedrock. In many areas, the saprolite retains primary textural features of the bedrock, including fractures.

The most pervasive bedrock structural features near Y-12 are extensional, hybrid, and shear fractures. Three major joint sets are generally evident, one that roughly parallels strike and dip of bedding, one steeply dipping set that parallels geologic strike but is perpendicular to dip, and one steeply dipping set that trends perpendicular to strike. Fracture densities ranging from about 1 to 60 per foot (ft) have been observed in rock outcrops near the Oak Ridge National Laboratory (ORNL), and most fractures are short, ranging from tenths of an inch to a few feet in length. Within a fracture, groundwater may flow either downdip, laterally, or in both directions. Changes in flow direction may occur at fracture splits, truncations, and intersections and groundwater flow paths may locally resemble stairsteps in both plan and sectional views. Dissolution of carbonates along fractures, particularly in the Maynardville Limestone and the Knox Group, has produced solution-enlarged features ranging from less than an inch to tens of feet in diameter. Solution cavities occur throughout the Maynardville Limestone, but most frequently in two of six stratigraphic zones, one at the top and one at the bottom of the formation.

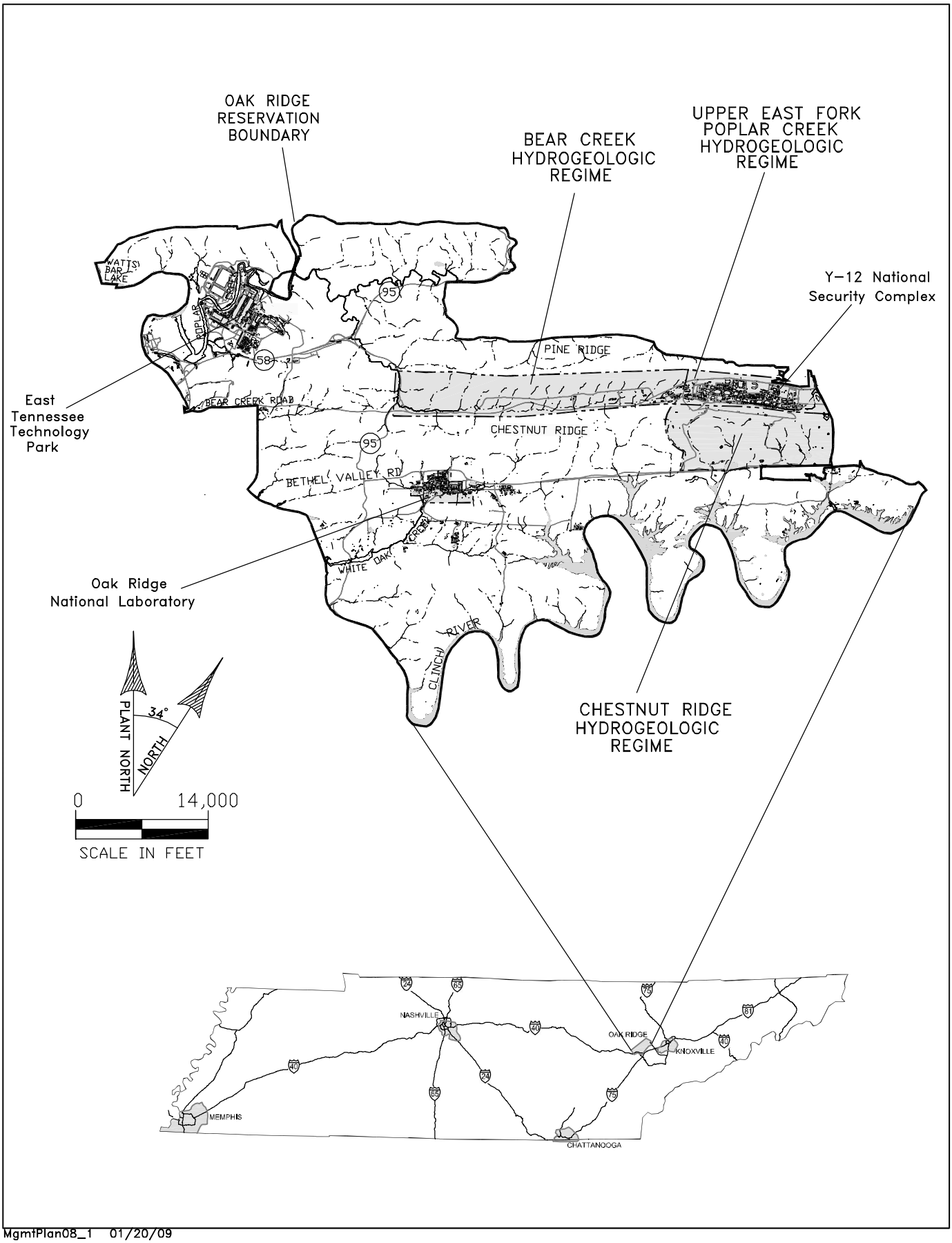

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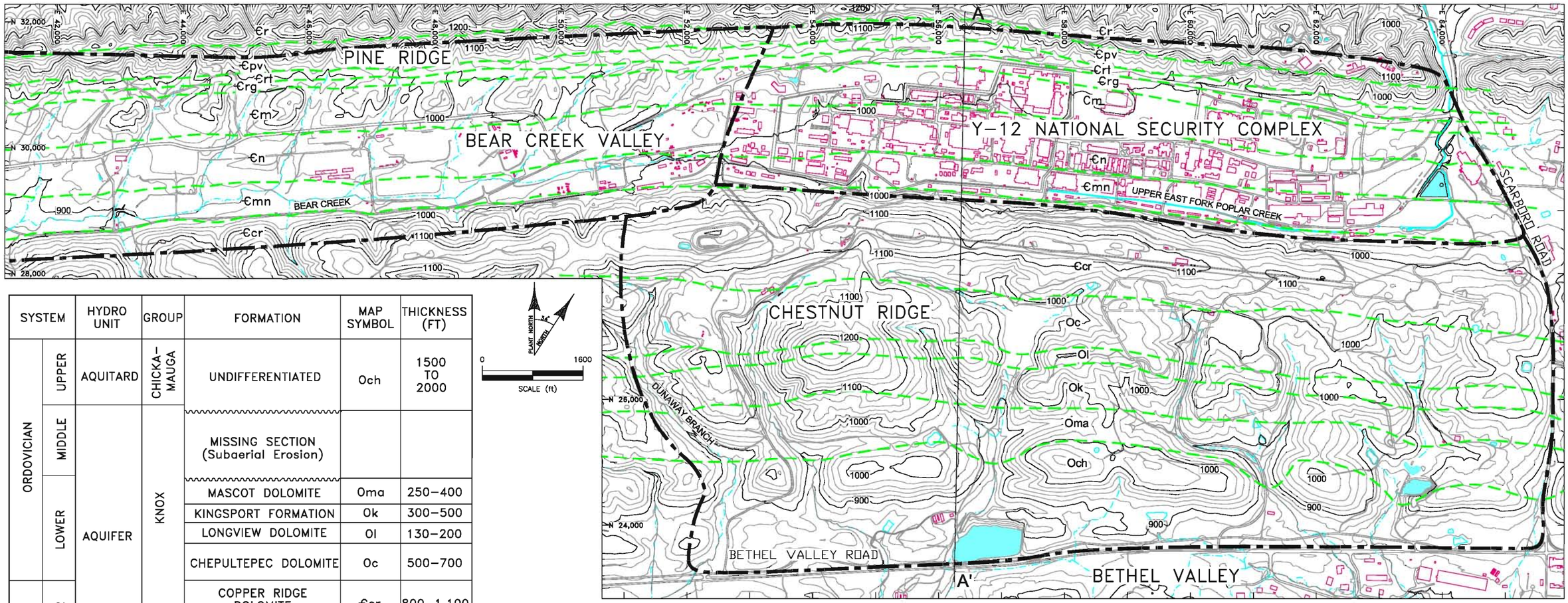
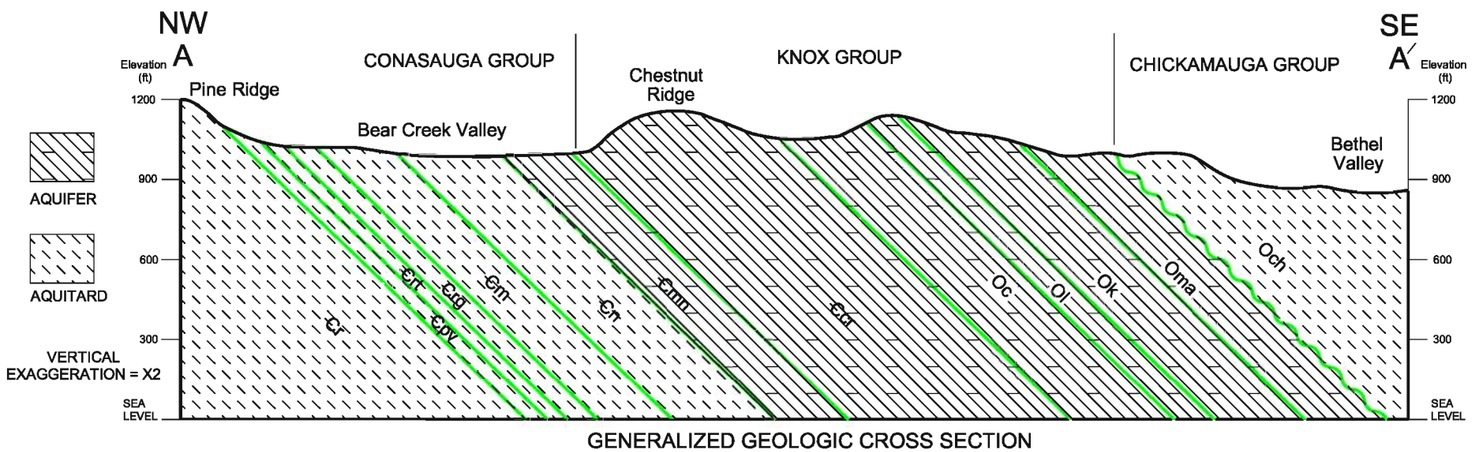
Fig. 1. Hydrogeologic regimes at the Y-12 National Security Complex.



SYSTEM		HYDRO UNIT	GROUP	FORMATION	MAP SYMBOL	THICKNESS (FT)
ORDOVICIAN	UPPER	AQUITARD	CHICKA-MAUGA	UNDIFFERENTIATED	Och	1500 TO 2000
	MIDDLE	AQUIFER	KNOX	MISSING SECTION (Subaerial Erosion)		
	LOWER			MASCOT DOLOMITE	Oma	250–400
				KINGSPORT FORMATION	Ok	300–500
				LONGVIEW DOLOMITE	Ol	130–200
				CHEPULTEPEC DOLOMITE	Oc	500–700
CAMBRIAN	UPPER			COPPER RIDGE DOLOMITE	€cr	800–1,100
			CONASAUGA	MAYNARDVILLE LIMESTONE	€mn	418–450
	MIDDLE	AQUITARD		NOLICHUCKY SHALE	€n	490–590
				MARYVILLE LIMESTONE	€m	346–445
				ROGERSVILLE SHALE	€rg	90–120
				RUTLEDGE LIMESTONE	€rt	90–120
				PUMPKIN VALLEY SHALE	€pv	260–320
	LOWER			ROME	€r	NOT DETERMINED

SOURCES: King and Haas 1987
Hatcher et al. 1992



GENERALIZED GEOLOGIC CROSS SECTION

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Fig. 2. Topography and bedrock geology at the Y-12 National Security Complex.

In the Y-12 vicinity, the Rome Formation, Conasauga Group, and Knox Group comprise two basic hydrogeologic units: (1) an aquifer, designated the Knox Aquifer, consisting of the Maynardville Limestone and the overlying formations of the Knox Group and (2) the aquitard, consisting of the Nolichucky Shale, Maryville Limestone, Rogersville Shale, Rutledge Limestone, Pumpkin Valley Shale of the Conasauga Group, and the Rome Formation (Figure 2). The aquifer formations floor the valley along the axis of BCV (Maynardville Limestone) and form Chestnut Ridge. The aquitard formations are partially exposed successively to the north toward Pine Ridge (Figure 2). The aquitard, which underlies the primary contaminant source areas in the Bear Creek Regime and the East Fork Regime, is hydraulically upgradient of the Maynardville Limestone, which functions as a hydrologic drain in BCV and provides the principal avenues for contaminant transport. Groundwater flow in the aquitard is dominated by fractures. Groundwater flow in the aquifer has components of both fracture flow and flow through solution-enlarged cavities and conduits. Flow through the porous rock matrix is negligible in both units; however, bedrock matrix porosity is an important factor regarding contaminant migration because of matrix diffusion processes.

A high conductivity interval near the bedrock/residuum interface (the water table interval) is where nearly all groundwater flow occurs in the aquitard. Below the water table interval, flow is most active at depths less than 100 ft below ground surface (bgs); however, contaminants in groundwater more than 200 ft bgs in the Nolichucky Shale clearly indicate permeable flowpaths at depth. Flow occurs in response to precipitation when flowpaths in the residual soils become saturated and rapidly transmit water laterally (stormflow) down slope toward springs and seeps in drainage features, and vertically to the water table interval. Inflow into the water table interval promotes strike-parallel flow toward discharge areas in nearby cross-cutting streams. Only a small percentage of total flow recharges to the deeper bedrock, where upward hydraulic gradients predominate. In the East Fork Regime the stormflow zone has been extensively altered by cut and fill construction. Tributaries to UEFPC were captured in a storm drain network. This network along with other utilities provide preferential flow pathways throughout the area.

Most groundwater flow in the aquifer occurs at shallow depths (i.e., <100 ft bgs) in an extensively interconnected maze of solution conduits and cavities (karst network). Below the shallow karst network, fractures provide the primary flowpaths. In BCV, groundwater in the aquifer flows primarily along strike, parallel to the axis of the valley. Flow in the shallow karst network is relatively rapid, and during rainfall, occurs as quickflow discharge to Bear Creek and UEFPC. Active groundwater circulation occurs at greater depth in the aquifer than in the aquitard, and in BCV, groundwater from the deeper flow system discharges along major gaining (influent) reaches of Bear Creek channel. These discharge areas are probably related to large-scale structural features (e.g., cross-strike faults) or stratigraphic discontinuities in the Maynardville Limestone.

The overall pattern of groundwater flow in the aquifer on Chestnut Ridge is from the recharge areas on the ridge crest toward discharge areas that include the Maynardville Limestone in BCV, and springs and seeps in the crosscutting tributaries along the northern and southern flanks of the ridge. Potentiometric data and contaminant plume configurations also indicate a substantial stike-parallel flow component along the axis of the ridge.

2.2 HISTORY OF THE Y-12 GWPP

The GWPP at Y-12 evolved from early groundwater monitoring efforts that began in 1975 and expanded through the early 1980s. Groundwater monitoring during this period was primarily directed toward site-specific characterization objectives for the primary waste management sites associated with Y-12 (Figure 3). Monitoring activities were coordinated by the Y-12 Health, Safety, Environment, and Accountability Organization without a formal programmatic plan. The following chronology provides details regarding the history of groundwater monitoring at Y-12 and the formal establishment of the GWPP.

1975 - 1982

Groundwater quality monitoring at Y-12 began in 1975 when periodic sampling of pre-existing monitoring wells was initiated to determine groundwater quality in and around waste disposal sites located in the BCV west of Y-12 (Pritz 1983). Beginning in 1981 and continuing through 1982, these initial monitoring activities expanded to include annual, biannual, or quarterly sampling of additional monitoring wells in BCV and on Chestnut Ridge south of Y-12 (Law Engineering 1983). During this period, several groundwater investigations also were completed for engineering and construction site investigations. These included an investigation initiated before 1975 by the United States Geological Survey (USGS) that involved the installation of groundwater wells at several locations throughout BCV.

1983 - 1985

As a result of information obtained by officials of the Tennessee Department of Environment and Conservation (TDEC), formerly the Tennessee Department of Health and Environment, during an inspection of the past and present waste disposal practices at Y-12, representatives of DOE, the TDEC, and the U. S. Environmental Protection Agency (EPA) signed a Memorandum of Understanding (MOU) on May 26, 1983. Item X of the MOU required an investigation of hydrogeologic conditions at Y-12, and preliminary investigations were initiated in 1983 at several waste management sites, including the Chestnut Ridge Sediment Disposal Basin (CRSDB), the S-3 Site (formerly the S-3 Ponds), the Oil Landfarm, and the Bear Creek Burial Grounds (BCBG) (Figure 3). A report containing results of groundwater sampling, pumping tests, geological investigations, and recommendations for future studies and groundwater monitoring activities was issued later that year (Law Engineering 1983). Item XI of the MOU required preparation of a comprehensive monitoring plan for groundwater and surface water at Y-12, including sampling locations and monitored parameters. In response, a master plan for groundwater and surface-water monitoring at Y-12 was developed and implemented (Pritz 1983). Monitoring under this plan included a network of wells located at waste management sites located in BCV and on Chestnut Ridge. Analytical parameters and sampling frequencies varied from site to site, depending in part on the quantities and types of wastes disposed of at the various sites.

An investigation to determine the extent of mercury contamination in soils and groundwater within Y-12 also was initiated in 1983 after DOE released a report containing preliminary information on mercury losses and unaccounted mercury inventories. This investigation involved the installation of 43 monitoring wells, aquifer testing in selected wells, collection of soil and groundwater samples, and laboratory analyses of the samples. Results of the investigation were presented in a report issued in 1984 (Rothschild et al. 1984).

Also in 1983, the TDEC issued an operating permit for a non-hazardous solid waste landfill (Industrial Landfill II) located near the crest of Chestnut Ridge south of Y-12 (Figure 3). Groundwater monitoring in accordance with the detection monitoring requirements specified in the permit was performed until the closure of this solid waste disposal facility (SWDF) in 1996.

In December 1983, the TDEC issued a Complaint and Order requiring DOE to immediately cease further groundwater contamination by disposal of solid wastes in the BCBG and to submit a written proposal and schedule (with supporting data and rationale) for remedial action in the Bear Creek watershed area. In response, several intensive investigations of hydrogeological conditions in BCV were subsequently initiated to obtain data needed to support a preliminary evaluation of remedial alternatives. These investigations involved three phases of well installation and subsequent groundwater sampling and analysis. The first two well installation phases were completed in late 1983 and early 1984 (Bechtel National, Inc. 1984a, 1984b,

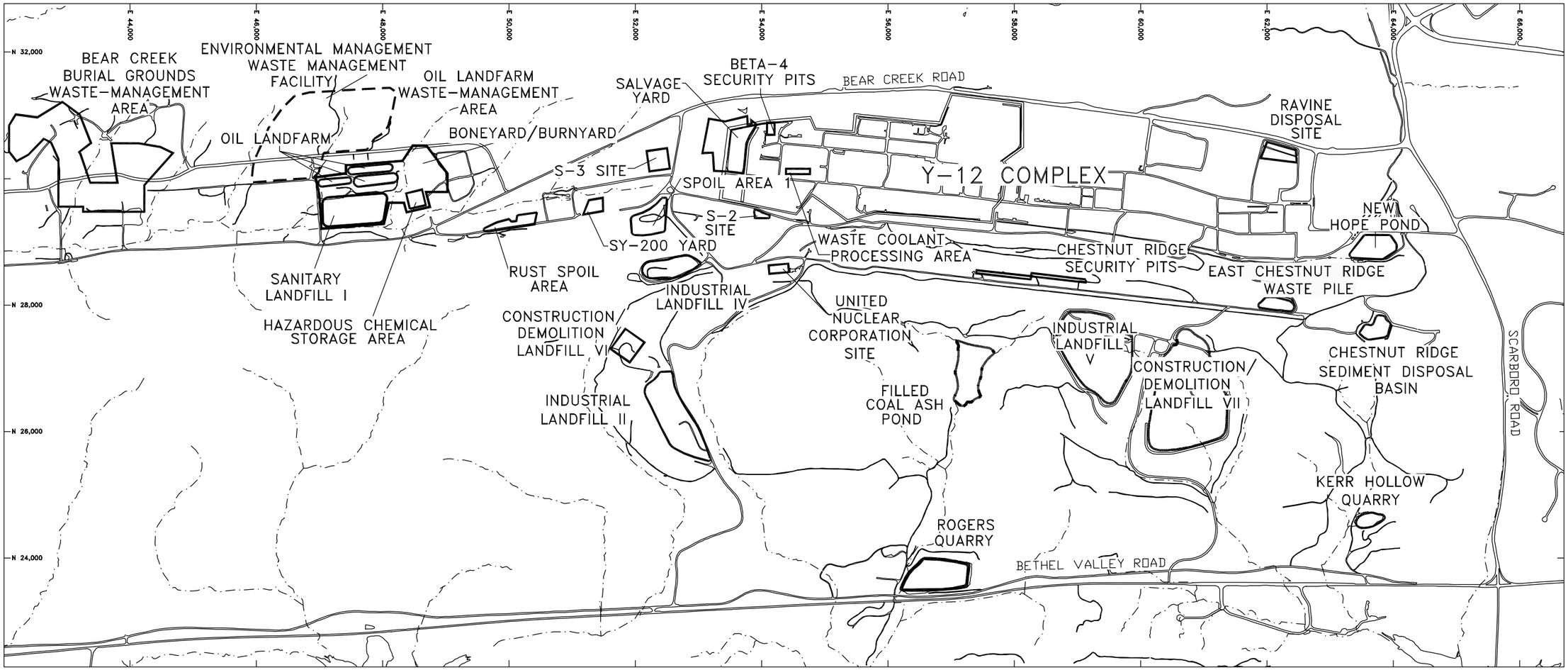

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Fig. 3. Locations of Principal Waste Management Sites at the Y-12 National Security Complex.

1984c, and 1984d), and the third phase was completed in late 1984 (Bechtel National, Inc. 1985; Geraghty & Miller, Inc. 1985a and 1985b).

Based on information obtained from the hydrogeologic investigations performed in 1983 and 1984, additional monitoring wells were installed at several sites in 1985 (Geraghty & Miller, Inc. 1986). These wells were designed primarily to investigate the deeper portions of the groundwater flow system at these waste disposal sites. Typically, the wells were installed adjacent to other wells to form clusters. An evaluation of the groundwater quality data and an analysis of deep-well recovery behavior were presented in a report issued in 1987 (Geraghty & Miller, Inc 1987).

Five monitoring wells also were installed in 1985 at several locations in cooperation with a continuing hydrogeologic investigation initiated by the USGS. Additionally, deep core holes were drilled for hydrogeologic characterization purposes at Kerr Hollow Quarry (KHQ) and the CRSDB.

Also in 1985, monitoring wells were installed in compliance with requirements of the Resource Conservation and Recovery Act (RCRA) regulations governing several hazardous waste management sites at Y-12, including the Chestnut Ridge Security Pits (CRSP), New Hope Pond, the CRSDB, and KHQ (Figure 3). Other monitoring wells also were installed for hydrogeologic characterization purposes at several non-hazardous waste management sites, including the Beta-4 Security Pits, the Ravine Disposal Site, Rogers Quarry, and the United Nuclear Corporation Site (UNCS). Groundwater samples were collected from each well and water-levels in the wells were regularly measured. Information on site investigation planning, well placement and construction, site hydrogeology, a preliminary evaluation of the hydrogeologic information, and groundwater-quality data obtained from the wells is provided in three separate reports (Haase et al. 1987a, 1987b, and 1987c).

A hydrogeologic investigation at Y-12 was performed during 1985 by researchers with the ORNL. During this investigation, core holes were drilled at four locations in the vicinity of Y-12 to characterize subsurface geological and hydrological conditions to depths of 1200 ft below ground surface (King and Haase 1987 and 1989).

1986 - 1989

Continued groundwater monitoring investigations were performed between 1986 and 1989 in support of RCRA interim status assessment monitoring requirements, and these investigations primarily involved the installation and sampling of additional monitoring wells. During this period, 160 monitoring wells were added to the well network at Y-12, with most of the wells sampled on a quarterly frequency. The analytical data obtained from these wells and an interpretation of the data were presented in a series of site-specific reports submitted annually to the TDEC and the EPA. Also, between 1987 and 1989, ORNL researchers performed additional characterization studies, including an intensive hydrogeologic investigation that involved installation of wells at a site in BCV approximately 5 miles west of Y-12 (Lee and Ketelle 1989).

Issued in November 1988, DOE O 5400.1 (the predecessor of DOE O 450.1A) specified the establishment of formal management programs specifically for groundwater protection at DOE facilities, and the implementation of surveillance monitoring as needed to monitor impacts of facility operations on groundwater quality. In response, the Y-12 GWPP was established to effectively manage the rapidly expanding groundwater sampling and analysis activities, define standardized programmatic elements (e.g., monitoring well designs), and coordinate data management and reporting (King and Haase 1990).

In 1989 the TDEC issued an operating permit for another non-hazardous waste landfill (Industrial Landfill IV) located south of Y-12 on Chestnut Ridge (Figure 3). Groundwater monitoring wells were installed at the site and sampled in accordance with the detection monitoring requirements specified in the

permit; the GWPP Organization assumed responsibility for the associated groundwater sampling and analysis activities.

1990 - 1995

In 1990, the GWPP issued a completely revised comprehensive groundwater monitoring plan for Y-12 (hereafter referenced as the *Comprehensive Monitoring Plan*) that addressed the extensive expansion of regulatory requirements and groundwater monitoring activities performed by the GWPP since the original master plan was issued. The *Comprehensive Monitoring Plan* presented a groundwater and surface-water quality monitoring strategy based on a technical approach that incorporated the characteristics of the hydrogeologic system at Y-12 and maintained compliance with all applicable state and federal regulatory requirements, DOE Orders, and EPA technical guidance (Geraghty & Miller, Inc. 1990).

Beginning in September 1990 and continuing until September 1992, the GWPP installed and sampled 68 monitoring wells at Y-12 under two components of the technical framework presented in the *Comprehensive Monitoring Plan*: the Grid Well Program and the Maynardville Exit Pathway Program. The Grid Well Program established the monitoring well coverage in the East Fork Regime that was needed to assess the overall extent of groundwater contamination within the heavily industrialized areas of Y-12. Also, the Grid Well Program provided wells suitable for DOE O 5400.1 requirements for surveillance monitoring in areas where groundwater has been impacted by facility operations. The Maynardville Exit Pathway Program, in conjunction with the installation of multiport groundwater sampling equipment in several deep (approximately 600 to 1,400 ft) core holes, provided data needed to help characterize groundwater flow patterns and to define extent of contamination within the Maynardville Limestone, which is the principal pathway for groundwater and surface water transport of contaminants from sources at Y-12. Monitoring wells installed under the Maynardville Exit Pathway Program also serve DOE O 5400.1 requirements for surveillance monitoring in areas where contaminants from DOE facilities are most likely to migrate off-site.

In conjunction with the installation of monitoring wells at Y-12 during the early 1990s, the GWPP also initiated a comprehensive monitoring well plugging and abandonment (P&A) program. The objective of the P&A program was to remove from service many of the obsolete monitoring wells that were installed at Y-12 during the 1970s and early 1980s, along with other wells that had been irreparably damaged. Implementation of the P&A program enabled the GWPP to develop and refine effective P&A procedures that ensure the proper removal of all monitoring well components.

Several regulatory agreements signed in the early 1990s substantially impacted the Y-12 GWPP. Effective in January 1992, the Federal Facility Agreement (FFA) negotiated by DOE, EPA, and the TDEC addressed environmental restoration under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) on the Oak Ridge Reservation (ORR), which was added to the National Priority List in November 1989. The FFA established CERCLA as the regulatory program governing clean-up of the ORR, including corrective action for the RCRA-regulated hazardous waste treatment, storage, and disposal (TSD) units at Y-12. As such, the DOE appealed the applicability of RCRA post-closure care, corrective action, and groundwater monitoring requirements to any TSD unit that was also classified as a CERCLA operable unit (OU) under the FFA. Under this agreement, RCRA would be applied as an applicable or relevant and appropriate requirement to the extent that post-closure maintenance and care of the former TSD facilities will be conducted in compliance with the terms of a RCRA post-closure permit (PCP).

In April 1993, the DOE, TDEC, and the Y-12 M&O subcontractor (Martin Marietta Energy Systems, Inc.) signed an Agreed Order that resolved the appeal. Under this agreement, RCRA corrective action at the former TSD facilities is deferred to the CERCLA remedial investigation (RI)/feasability study (FS) process, with post-closure care and maintenance activities at these sites (including groundwater monitoring) performed under the terms and conditions of the applicable RCRA PCP issued by the TDEC.

Subsequent to the 1993 Agreed Order, the TDEC issued a RCRA PCP in September 1995 that defined the post-closure care and monitoring requirements for three closed TSD units (S-3 Site, Oil Landfarm, and Bear Creek Burial Grounds/Walk-In Pits) located in the Bear Creek Regime, a second RCRA PCA in June 1996 that addressed post-closure care and monitoring requirements for three closed TSD units (CRSP, CRSDB, and KHQ) located in the Chestnut Ridge Regime, and a third RCRA PCP in August 1996 that defined the post-closure care requirements for a closed TSD unit (New Hope Pond) and the post-closure monitoring requirements for a primary contaminant source area (Eastern S-3 Site Plume) located in the East Fork Regime. The GWPP assumed responsibility for implementation of the RCRA groundwater monitoring specified by each PCP, including sample collection and analysis, data management, and reporting.

In 1994, the FFA strategy for RI/FS implementation on the ORR began to evolve. The FFA originally defined two types of CERCLA OUs for which an RI/FS would be performed: (1) source control OUs comprised of individual or groups of waste management sites and (2) integrator OUs that encompass groundwater and surface water, independent of the source control OUs that may contribute to the contamination of these media (DOE 1994). However, it soon became evident that separation of source control and integrator OUs was not technically feasible and an agreement was subsequently reached among regulatory agencies and the DOE to implement an integrated RI/FS approach. This integrated approach addressed source and integrator OUs concurrently in a Characterization Area (CA) defined by watershed boundaries, with specific sites or locations of highest risk or concern in each CA targeted for focused studies.

In 1994, the TDEC issued operating permits for three additional SWDFs on Chestnut Ridge south of Y-12 (Industrial Landfill V, Construction/Demolition Landfill VI, and Construction/ Demolition Landfill VII). Groundwater monitoring wells were installed at each site and subsequently sampled in accordance with the SWDF detection monitoring requirements specified in the respective operating permit (and governing TDEC regulations). The GWPP assumed responsibility for the groundwater sampling, analysis, and reporting activities for each of these sites.

1996 - 2000

Beginning in the mid-1990s, the overall responsibility for groundwater and surface water monitoring activities at Y-12 began to fragment. In 1996, the Integrated Water Quality Program (IWQP) was established to coordinate groundwater monitoring activities performed in support of CERCLA activities on the ORR. Implementation of CERCLA-related groundwater monitoring at Y-12 began in 1997 under the auspices of the IWQP, with the GWPP providing monitoring data and associated technical support as requested. The BCV RI Report was issued in 1997 to formally characterize the nature and extent of contamination, evaluate the fate and transport of contaminants, and assess the risk to human health and the environment under CERCLA (DOE 1997).

In addition to CERCLA monitoring in direct support of the RI/FS process at Y-12, the IWQP also encompassed groundwater monitoring activities performed in compliance with requirements of each CERCLA record of decision (ROD) for DOE facilities on the ORR. Accordingly, in 1997 the IWQP assumed programmatic responsibility for monitoring in compliance with the respective final ROD for the UNCS, KHQ, and the Filled Coal Ash Pond (FCAP), as well as a recently finalized RODs concerning remedial actions in BCV. However, groundwater monitoring is specifically required only by the ROD for the UNCS. Conversely, the ROD for the FCAP does not require groundwater monitoring, but the ROD for KHQ defers CERCLA groundwater monitoring to the RCRA PCP for the site. The ROD for BCV establishes general goals for groundwater monitoring, but the detailed monitoring requirements for the decision document are specified in a subsequent remedial design work plan for the Watershed (DOE 2001). An Engineering Evaluation/Cost Analysis for the East End Volatile Organic Compound Plume and attendant action memoranda also specify groundwater monitoring for a plume intercept action in the East Fork Regime.

In October 1997, the GWPP changed the method of groundwater monitoring well sampling to improve sample quality, cost effectiveness, and waste minimization. The sampling method changed from a conventional three well volume purge and sample method (hereafter referred to as the conventional sampling method) to a low-flow minimal drawdown purge and sample method (hereafter referred to as the low-flow sampling method). The conventional sampling method requires the use of portable gas driven piston pumps to remove at least three well volumes of groundwater from the well to ensure that all resident, and potentially stagnant, water was removed and that samples taken from the well were of representative groundwater. This method produced large quantities (approximately 50,000 gallons annually) of waste water requiring containment, transportation, treatment and disposal. Additionally, since these pumps are portable and were used in multiple wells, decontamination and rinsate sampling was required for quality assurance. The low-flow method requires the use of dedicated gas-driven bladder pumps and the containment of minimal quantities of waste water (approximately 1000 gallons annually). The low-flow method required less time to perform; containment and treatment requirements were drastically reduced; and no QA (rinsate) sampling was required since dedicated systems were utilized. Furthermore, comparative studies of the two methods indicated that 90% of the wells monitored show no significant difference in water quality results. The other 10% were impacted by local geologic conditions (i.e., flowpaths,transmissivity) and proximity to contaminant plumes (BWXT 2002).

In 1998, DOE selected Bechtel Jacobs Company L.L.C. (BJC) as the management and integration contractor responsible for implementation of environmental restoration and waste management activities on the ORR. Beginning in April 1998, BJC began to assume the programmatic responsibility for implementing the RCRA post-closure groundwater monitoring programs specified in the PCPs for the Bear Creek, Chestnut Ridge, and East Fork hydrogeologic regimes. The GWPP continued to coordinate RCRA PCP sampling, analysis, and reporting through December 1998 for consistency in data quality. These groundwater monitoring and reporting activities are now performed as an integrated component of the BJC Water Resources Restoration Program (WRRP), which evolved from the IWQP. The Upper East Fork Poplar Creek CA RI Report was issued in August 1998 and in November 1998, BJC also assumed programmatic responsibility for operation and management of the non-hazardous landfills on Chestnut Ridge. However, BJC retained the GWPP to continue the corresponding SWDF detection monitoring programs through December 1999, when a BJC subcontractor assumed responsibility for groundwater monitoring and reporting at each landfill.

In November 2000, DOE selected BWXT as the Y-12 M&O contractor who subsequently assumed responsibility for all Y-12 operations from the previous M&O contractor (Lockheed Martin Energy Systems, Inc.[LMES]).

2001 - 2003

In December 2002, to comply with federal and state Underground Injection Control (UIC) requirements of the SDWA, a Class V Injection Well inventory for Y-12 was submitted to the EPA (Region IV) and a UIC permit application was submitted to the TDEC. In preparing the inventory, many of the steam condensate discharge dry wells located throughout Y-12 were determined to meet the definition of a Class V injection well, and a UIC compliance effort (see Section 2.3.2) was initiated by the GWPP to meet applicable UIC requirements and ensure protection of groundwater at Y-12. Also, administrative controls, such as engineering standards and inclusion in the National Environmental Policy Act review process, were enacted to ensure that the addition, closure, or modification of any Class V injection well at Y-12 is performed in compliance with these state and federal regulations.

In January 2003, DOE replaced DOE O 5400.1 with DOE O 450.1 (which was re-numbered DOE O 450.1A in June 2008). Under DOE 450.1, the command and control-based approach to environmental protection at DOE facilities moved to the environmental management system (EMS)-based approach federally mandated through Executive Order 13148. The GWPP reviewed DOE O 450.1 and determined that the requirements

for an integrated approach to monitoring and protection of groundwater resources are consistent with current practices of the respective groundwater programs on the ORR. Thus, no changes were proposed or implemented.

In September 2003, the Y-12 GWPP issued a Monitoring Optimization Plan (MOP) for groundwater monitoring locations (wells and springs) at Y-12. The MOP describes the technical approach the GWPP implements to focus available resources on the sampling locations that provide the most useful hydrologic and water-quality monitoring data. Under the technical approach, the MOP identifies the wells that are granted"active" status and are considered best suited for hydrologic monitoring and/or groundwater sampling, and the wells that are granted "inactive" status and are not used by the GWPP for either purpose. The active or inactive status designation also determines the frequency at which the GWPP will inspect applicable wells, the scope of these well inspections, and extent of any maintenance actions initiated by the GWPP.

The TDEC issued new RCRA PCPs for the East Fork Regime and the Bear Creek Regime in September 2003 and December 2003, respectively. The previous PCP for each regime expired in September 2001, but remained effective pending the permit re-application and renewal process. The new PCP for each regime specifies different requirements for RCRA post-closure corrective action groundwater monitoring than the expired PCP for each regime. The new PCP for each regime retained the same point of compliance (POC) wells specified for each site and the same plume boundary/plume delineation for each regime, but removed the upgradient/background well from each RCRA monitoring network and modified the site-specific suites of analytical parameters applicable to the POC wells and plume boundary/plume delineation wells.

2004 - present

Technical guidance documents issued by DOE in June 2004 (*Groundwater Surveillance Monitoring Implementation Guide for Use with DOE O 450.1, Environmental Protection Program*) and May 2005 *(Groundwater Protection Programs Implementation Guide for Use with DOE O 450.1, Environmental Protection Program*) provides suggested approaches and requirements for meeting surveillance monitoring objectives at DOE facilities. Together, these DOE guidance documents emphasize the establishment of an EMS to implement an integrated site-wide surveillance monitoring program that is cost effective, efficient, and achieves short- and long-term groundwater monitoring goals. To achieve these site-wide performance standards, the Y-12 GWPP performs monitoring at specific facilities, exit pathways, and critical perimeter locations that are selected to optimally supplement ongoing regulatory compliance- and permit-driven RCRA, CERCLA, and SWDF monitoring performed at Y-12 by other organizations.

In December 2005, a BWXT subcontractor (Groundwater Services, Inc.) completed an independent qualitative and quantitative assessment of the GWPP. Qualitative review of the GWPP focused on program management and operations and the methods of monitoring data collection, management, and reporting to meet requirements of DOE O 450.1A and associated DOE technical guidance documents. Quantitative evaluation of the GWPP was performed using Monitoring and Remediation Optimization System (MAROS) software. The MAROS software used statistical methods to evaluate the groundwater surveillance monitoring network (monitoring wells and natural springs) at Y-12. Under the MAROS software statistical methodology, available historical groundwater quality data were evaluated to: (1) determine if the surveillance monitoring network is sufficient to accurately represent contaminant plume behavior; (2) identify redundancies within the monitoring network; and (3) improve the accuracy, reliability, and cost-efficiency of long-term surveillance monitoring efforts. Recommendations for improvements and modifications to the GWPP were implemented during calendar year (CY) 2006, and selected components of the MAROS software were adopted as part of the GWPP monitoring optimization process (see Section 3.2).

Beginning in February 2006, the GWPP relinquished all responsibility for numerous old and unused monitoring wells in the Gum Branch Areas and related areas to the northwest. Accordingly, these wells are excluded from any use by the GWPP and are not considered to be within the scope of applicable programmatic plans, monitoring optimization planning (see Section 5.5), and well plugging and abandonment.

In May 2006, the TDEC approved a plan by the GWPP to accumulate RCRA regulated purge water (see Section 3.1.6) in two separate RCRA Satellite Accumulation Areas (SAAs) at a centralized location at Y-12. This allows the GWPP to consolidate purge water in SAAs that are not "physically located at or near the point of generation"; the point of generation being each applicable well location.

In July 2006, the transition of the data management function of the GWPP from a subcontractor to the prime M&O contractor (BWXT Y-12) was completed. The management of Y-12 groundwater data had been subcontracted since the late 1980's. This transition represented a two-fold opportunity: (1) to review the existing processes in data management (tracking, validation) to ensure a high standard of quality assurance and (2) determine if there are ways to improve the processes to increase efficiencies, and reduce costs while still meeting data quality objectives. This transition has resulted in an improvement and higher degree of control over data management, as well as cost reductions to the DOE.

Also in July 2006, the Agency for Toxic Substances and Diseases Registry, the principal federal public health agency charged with evaluating the human health effects of exposure to hazardous substances in the environment, published a report in which they evaluated groundwater contamination across the ORR (ATSDR 2006). In the report, it was acknowledged that extensive groundwater contamination exists throughout the ORR, but the authors concluded that there is no public health hazard from exposure to contaminated groundwater originating from the ORR due to an incomplete exposure pathway. The Y-12 Complex east end volatile organic compound groundwater contaminant plume is the only confirmed off-site contaminant plume migrating across the ORR boundary. The report recognized that the institutional and administrative controls established in the record of decision do not provide for reduction in toxicity, mobility, or volume of contaminants of concern, but they conclude that these controls are protective of public health to the extent that they limit or prevent community exposure to contaminated groundwater in Union Valley.

In September 2006, the TDEC issued a new RCRA PCP for the Chestnut Ridge Regime to replace the previous PCP that expired in September 2005 (and effective pending the permit re-application and renewal process). The new PCP for the regime specifies the same well networks for the three sites addressed as the expired PCP, but with slightly different requirements for RCRA post-closure groundwater monitoring at each site, including a reduced sampling frequency (annual rather than semiannual) for two sites and a reduced suite of laboratory analytes for the plume boundary/plume designated for the third site. Also, the new PCP for the regime defined the RCRA post-closure care and monitoring requirements for the East Chestnut Ridge Waste Pile (ECRWP), a site on Chestnut Ridge formerly granted RCRA interim status (see Section 2.3.3).

In December 2006, the Y-12 ECD, Y-12 Waste Management Organization, and the Y-12 Waste Treatment Operations (Bechtel Jacobs Company LLC) Department formally signed a waste management plan for waste streams generated exclusively by the GWPP. This plan formalized the management and disposal of GWPP waste water and included a detailed outline of each waste stream (e.g., RCRA-regulated waste water), characterization, segregation requirements, packaging, and an approved disposal path.

In January 2007, an updated sampling and analysis plan (SAP) for the groundwater monitoring programs at the SWDFs on Chestnut Ridge was issued by the BJC subcontractor responsible for operation of the landfills (EnergySolutions 2007a). The updated SAP addressed outdated information in the previous SAP and consolidated site-specific sampling and analysis requirements disseminated in various official correspondence with the TDEC. Also, in July 2007, groundwater monitoring at Construction//Demolition Landfill VI, which was permanently closed in November 2005, was discontinued per the post-closure care requirements specified in the operating permit for the landfill.

During 2007, an organizational change in responsibilities for groundwater sampling occurred. Since the late 1980's, the Analytical Chemistry Organization performed groundwater sampling for the GWPP. These responsibilities were transferred to the Environmental Compliance Department (ECD) in July 2007. This transition required an evaluation of the business practices involved in groundwater sampling and the effect on laboratory analysis and data management. Personnel training, the overhaul of internal procedures, the use of established ECD software systems, and the incorporation of enhancements and improvements were performed resulting in sample collection with minimal impact to the laboratory and the data users.

In January 2008, SWDF Assessment Monitoring Phase II was initiated at Industrial Landfill IV in response to a request by the TDEC pertaining to the presence of dissolved VOCs detected in the groundwater from a well located directly downgradient of the site. An assessment monitoring plan approved by the TDEC in December 2007 (EnergySolutions 2007b) defines the assessment monitoring sampling and analysis requirements, which are similar to those previously defined for SWDF detection monitoring at the site, but with an expanded list of laboratory analytes (including PCBs) specified for the donwgradient well and the designated upgradient/background well.

Other activities that may have potential impact on groundwater quality:

- construction of new buildings (Highly Enriched Uranium Materials Facility, Jack Case Building, and New Hope Center)
- demolition of many older buildings under the Infrastructure Reduction program
- deactivation of basement sumps in Bldg. 9201-5, which resulted in the flooding of the basement with steam condensate, stormwater runoff, and groundwater.

2.3 ONGOING GROUNDWATER MONITORING ACTIVITIES AT Y-12

Groundwater monitoring activities at Y-12 are performed under multiple programs managed by different organizations. Although each individual program has differing technical objectives and requirements, sampling and analysis activities are coordinated to ensure efficient use of monitoring resources. Through cooperative and integrated implementation, the programs achieve mutual programmatic goals, ensure data equivalency between programs, and eliminate redundancies. Ongoing groundwater monitoring activities at Y-12 include: (1) site-wide monitoring by the GWPP in direct support of the groundwater monitoring requirements specified under DOE O 450.1A and associated DOE technical guidance documents; (2) RCRA post closure detection monitoring and RCRA post closure corrective action monitoring (collectively referenced as RCRA monitoring) by the WRRP, as specified in the applicable PCPs issued by the TDEC; (3) monitoring in support of CERCLA-related activities at Y-12 by the WRRP; (4) SWDF detection monitoring by the BJC Waste Management Organization in accordance with site-specific landfill operating permits issued by the TDEC; and (5) groundwater elevation monitoring. A short description of each monitoring program is provided in the following sections.

2.3.1 DOE Order 450.1A Monitoring

DOE O 450.1A and associated DOE guidance documents collectively outline the following requirements for and objectives of site-wide monitoring, hereafter referenced as DOE Order Monitoring, of groundwater that has been or could be impacted by facility operations at Y-12:

- determine baseline conditions of groundwater quality and quantity;
- demonstrate compliance with and implementation of all applicable state and federal regulations and DOE orders;
- ensure early detection of groundwater pollution or contamination from an operating facility or practice and provide an early warning to trigger appropriate response actions to unplanned releases of contaminants to the subsurface;
- identify existing and potential groundwater contamination sources and to maintain surveillance of these sources;
- evaluate groundwater quality in areas where contaminants have the potential to migrate off-site;
- meet long-term objectives for monitoring in areas where wastes and other subsurface contaminants will remain after all active site operations have ceased; and
- support decisions concerning land-use practices and the management of groundwater resources.

To meet these site-wide requirements and objectives at Y-12, the GWPP performs hydrologic and groundwater quality monitoring in conjunction with concurrent regulatory-driven (RCRA, CERCLA, and SWDF) monitoring performed by other organizations. As outlined below, DOE Order Monitoring performed by the GWPP includes facility (source) and contaminant plume monitoring (hereafter referenced as Surveillance Monitoring) and exit-pathway/perimeter monitoring (hereafter referenced as Exit-Pathway Monitoring).

Groundwater sampling and analysis activities for Surveillance Monitoring under the GWPP are directed at areas of known, suspected, or potential sources of groundwater contamination at Y-12 that are not otherwise addressed under the ongoing RCRA, CERCLA, and SWDF monitoring programs. Surveillance Monitoring may include wells in close proximity to active facilities and operations to provide early detection of impacts to groundwater. The network of monitoring wells that are specifically sampled for Surveillance Monitoring purposes changes from year to year, depending on monitoring optimization (see Section 3.2) and funding levels, and varies between hydrogeologic regimes at Y-12, depending on the extent of monitoring coverage provided by the RCRA, CERCLA, and SWDF monitoring programs. Additionally, Surveillance Monitoring also encompasses groundwater sampling and analysis activities associated with any special hydrogeologic studies implemented by the GWPP. All sampling and analysis activities are performed in accordance with standardized GWPP monitoring protocols as outlined in the Y-12 GWPP SAP. Monitoring results obtained each CY are presented in the corresponding annual Groundwater Monitoring Report (GWMR) issued by the GWPP (see Section 4.8.1.1).

Exit-Pathway Monitoring under the GWPP involves collection of groundwater samples from generally fixed networks of perimeter and exit-pathway monitoring stations (wells and surface water sampling points) in the

Bear Creek and East Fork hydrogeologic regimes, and from selected springs and sampling points in surface drainage features that traverse the Chestnut Ridge Regime. The designated perimeter monitoring wells in the Bear Creek Regime are located southwest of the BCBG along a strike-normal transect across the Maynardville Limestone (Figure 2), which is the primary exit pathway for Y-12 groundwater contaminants to migrate to the west beyond the ORR property boundary. Several perimeter monitoring wells at the eastern end of Y-12 in the East Fork Regime also are located along a strike-normal transect across the Maynardville Limestone, with additional perimeter wells located northeast of Y-12 where Upper East Fork Poplar Creek passes through a gap in Pine Ridge (Figure 2). Instead of perimeter monitoring wells in the Chestnut Ridge Regime, a series of springs and surface water monitoring locations along local surface drainage features on the southern flank of Chestnut Ridge are sampled for the purposes of Exit-Pathway Monitoring. All sampling and analysis activities associated with Exit-Pathway Monitoring in each hydrogeologic regime are performed in accordance with standardized GWPP monitoring protocols as described in the annual SAPs, and are included in the annual GWMR issued by the GWPP.

2.3.2 UIC Compliance

The Y-12 UIC Compliance effort was initiated in response to changes in state and federal regulations governing underground injection. Presently, the EPA (Region IV) has primacy of UIC compliance through the SDWA and the associated requirements specified in Title 40 Code of Federal Regulations (40 CFR) Parts 144-147. The EPA works with state and local governments to oversee underground injection of waste in order to prevent contamination of drinking water resources. The State of Tennessee is in the process of gaining primacy of the UIC program, and has implemented regulatory standards dictating a response from those agencies and industries which operate injection wells as defined under TDEC Rule 1200-4-6.

The GWPP assumed responsibility for implementation of the Y-12 UIC Compliance effort. The GWPP worked with Y-12 Engineering and Maintenance organizations to inventory the external (outside of buildings) steam piping system and a map was created to locate any type of Class V injection well. The inventory efforts identified two types of Class V injection wells: steam condensate dry wells (also referred to as infiltration cells or french drains) and septic systems serving more than 20 people. In December 2002 the UIC inventory for Y-12 was submitted to EPA and a permit application was filed with TDEC to comply with federal and state requirements. Ongoing activities include: (1) maintaining the UIC inventory as required, submitting required updates and changes to EPA and TDEC and (2) implementing engineering standards and administrative controls to ensure compliance with UIC requirements for new construction, facility demolition, and maintenance activities at Y-12.

2.3.3 RCRA Compliance Monitoring

As noted in Section 2.2, RCRA post-closure groundwater monitoring at former TSDs associated with Y-12 is required under three separate PCPs issued by the TDEC, one for the East Fork Regime (TDEC permit number TNHW-113), one for the Bear Creek Regime (TDEC permit number TNHW-116), and one for the Chestnut Ridge Regime (TDEC permit number TNHW-128). All groundwater sampling and analysis activities in direct support of ongoing RCRA-related groundwater monitoring are performed by the WRRP. An overview of the groundwater monitoring requirements specified in each PCP is provided below.

Bear Creek Regime
The PCP for the Bear Creek Regime defines the requirements for RCRA post-closure corrective action groundwater monitoring at the S-3 Site (formerly the S-3 Ponds), the Oil Landfarm, and the BCBG (Figure 3). Monitoring at these sites generally involves semiannual collection of groundwater samples from

a RCRA monitoring well network that consists of at least one POC well designated for each site, and a common series of downgradient plume boundary wells. Samples collected from each well are analyzed for a site-specific suite of RCRA groundwater target constituents. Analytical results for these constituents (along with groundwater elevations determined from pre-sampling measurements of the depth-to-water in each well) are reported to the TDEC semiannually. An evaluation of the monitoring data obtained for each POC well and plume boundary well, along with a review of groundwater flow directions and a calculated rate of groundwater flow in the uppermost aquifer, is included in an annual RCRA Monitoring Report submitted to the TDEC by March 1 of each CY. Evaluation of the monitoring results is based on quantitative trend analysis of data for selected RCRA target constituents that are primary components of plume of contaminants in the groundwater at each site.

East Fork Regime

The PCP for the East Fork Regime defines the RCRA post-closure corrective action groundwater monitoring requirements for the Eastern S-3 Ponds Plume, which is a subsurface reservoir of contamination that was emplaced during operation of the former S-3 Ponds. As in the Bear Creek Regime, this monitoring program involves semiannual collection of groundwater samples from a RCRA monitoring well network consisting of at least one of the POC wells designated for the Eastern S-3 Ponds Plume, and a series of downgradient plume delineation wells. Samples collected from each POC well are analyzed for the specified suite of RCRA groundwater target compounds and samples from the plume boundary wells are analyzed for technetium-99 (Tc-99), which is the "signature" contaminant within the Eastern S-3 Ponds Plume. Monitoring results (along with the pre-sampling groundwater elevation in each well) are reported to the TDEC semiannually. An evaluation of the monitoring data, including a review of the groundwater flow patterns and a calculated rate of groundwater flow in the uppermost aquifer, is included in the annual RCRA Monitoring Report submitted to the TDEC by March 1 of each CY. As specified in the PCP, this evaluation involves quantitative trend analysis of the monitoring results for the POC well(s) and review of the Tc-99 results reported for the plume boundary wells.

Chestnut Ridge Regime

The PCP for the Chestnut Ridge Regime defines the requirements for RCRA post-closure corrective action monitoring at the CRSP (Figure 3). This monitoring program requires semiannual collection of groundwater samples from the designated RCRA monitoring well network for the CRSP, which includes a background well hydraulically upgradient of the site, at least one of the designated POC wells immediately downgradient of the site, and several plume boundary wells located downgradient of the dissolved plume(s) of volatile organic compounds originating from the site. The groundwater samples from each RCRA well are analyzed for a suite of groundwater target compounds specified in the PCP and the analytical results (along with the pre-sampling groundwater elevation in each well) are reported to the TDEC semiannually. An evaluation of the monitoring data, including a review of the groundwater flow patterns and calculated rate of groundwater flow in the uppermost aquifer, is included in the annual RCRA Monitoring Report submitted to the TDEC by March 1 of each CY.

The PCP for the Chestnut Ridge Regime also defines the requirements for RCRA post-closure detection monitoring at the CRSDB, East Chestnut Ridge Waste Pile (ECRWP), and KHQ (Figure 3). These monitoring programs require semiannual collection of groundwater samples from at least one upgradient/background well and three POC wells at each site. Groundwater samples from the wells at each site are analyzed for the respective list of RCRA groundwater target compounds specified in the PCP. The sampling results are statistically evaluated to determine if the concentration of any groundwater target compound in any POC well at either site exhibits a statistically significant increase over the corresponding concentration in the respective upgradient/background well(s). Monitoring results obtained at each site are reported to the TDEC semiannually. An annual RCRA Monitoring Report containing detailed statistical

evaluation data along with an evaluation of the groundwater flow direction and rate in the uppermost aquifer at each site also is submitted to the TDEC before March 1 of each CY.

2.3.4 CERCLA Compliance Monitoring

Groundwater monitoring in support of on-going CERCLA activities at Y-12 fall under two general programs: CERCLA baseline monitoring and CERCLA remedial effectiveness monitoring. CERCLA baseline monitoring generally involves semiannual sampling of a variable network of monitoring wells, springs, and surface water stations located in each of the three hydrogeologic regimes at Y-12. These monitoring results serve as the basis for comparison with the results of CERCLA remedial effectiveness monitoring, as defined under the applicable final ROD or decision documents pending final approval and implementation. At this time, a final ROD has been issued for three individual waste management sites associated with Y-12 (the UNCS, KHQ, and the FCAP). As noted previously, however, only the final ROD for the UNCS requires groundwater monitoring. Ongoing CERCLA remedial effectiveness monitoring at the UNCS involves semiannual collection of groundwater samples from six monitoring wells at the site, and laboratory analysis of the samples for the parameters and constituents specified in the ROD. All groundwater sampling and analysis activities in direct support of ongoing CERCLA-related groundwater monitoring are performed by the WRRP.

Groundwater monitoring under CERCLA is also performed at the Environmental Management Waste Management Facility (EMWMF) in accordance with the EMWMF Environmental Monitoring Plan (EMP) issued by the BJC-subcontractor responsible for operation and management of the site (Duratek Federal Services 2003). The EMWMF is a state-of-the art landfill located in BCV west of Y-12 that is used for the disposal of hazardous and mixed waste generated from CERCLA remedial actions on the ORR. Prior to the disposal of any waste at the site, which began in May 2002, a network of new and existing groundwater monitoring wells along with selected surface water stations were sampled quarterly for one year to establish baseline groundwater and surface water quality at the site. Currently, the network of wells and surface water stations specified in the EMWMF EMP are sampled at least quarterly, with some of the surface water stations sampled monthly. The groundwater and surface water samples are analyzed for a suite of baseline site-related contaminants that is updated periodically with constituents that are components of the wastes disposed at the site or are detected in the leachate collected from the site.

2.3.5 SWDF Compliance Monitoring

As noted in Section 2.2, the documents that comprise the operating permits issued by the TDEC and the governing non-hazardous solid waste management regulations establish the requirements for ongoing groundwater monitoring at the following active SWDFs in the Chestnut Ridge Regime: Industrial Landfill IV, Industrial Landfill V, and Construction/Demolition Landfill VII. Sanitary Landfill II was closed in 1996 and SWDF groundwater monitoring is ongoing per the post-closure care requirements specified in the operating permit for the landfill.

Ongoing site-specific SWDF detection monitoring programs at Sanitary Landfill II, Industrial Landfill V, and Construction/Demolition Landfill VII involve sampling a minimum of three monitoring wells at each landfill; one background well hydraulically upgradient of the site and at least two wells hydraulically downgradient of the site. Groundwater samples collected from the wells at each site are analyzed for the suite of constituents specified in the respective operating permit for each facility. Analytical results (including pre-sampling groundwater elevations in each well) obtained at each landfill are submitted to the TDEC in accordance with the reporting schedule specified in the respective operating permit.

As noted in Section 2.2, SWDF assessment monitoring Phase II began at Industrial Landfill IV in January 2008. Like the previous SWDF detection monitoring at the site, sampling is performed semiannually. Groundwater samples from the downgradient wells that yield uncontaminated groundwater are analyzed for a standardized suite of inorganic analytes, VOCs, and radiological parameters. Groundwater samples from the upgradient/background well and the downgradient well that yields VOC-contaminated groundwater also are analyzed for these analytes, along with additional inorganic analytes and VOCs, semi-volatile organic compounds, and PCBs.

2.3.6 Groundwater Elevation Monitoring

As noted in the preceding descriptions of the ongoing groundwater monitoring activities at Y-12, the depth to the static water level is measured whenever a monitoring well is sampled. Aside from meeting applicable regulatory requirements, however, the groundwater surface elevations determined from these pre-sampling water level measurements are of limited use because it typically takes several months to complete sampling of the specified network of monitoring wells in each hydrogeologic regime. Therefore, the pre-sampling water levels are not sufficiently contemporaneous to prepare accurate maps depicting regime-wide groundwater elevations. Moreover, the network of wells used for ongoing groundwater quality monitoring purposes does not provide the spatial coverage needed to determine flow patterns throughout the Y-12 area.

In order to obtain more contemporaneous water-level data, and to ensure that representative groundwater surface elevations are determined, water-level monitoring is performed annually, independent of groundwater sampling activities in the Bear Creek, East Fork, and Chestnut Ridge hydrogeologic regimes. The annual water-level monitoring uses a fixed network of hydrologic monitoring wells designated in the Y-12 Monitoring Optimization Plan (MOP) (see Section 5.5), with the depth-to-water in each designated well measured over a short period (approximately one week) during alternating seasonally high and seasonally low groundwater flow conditions. Groundwater elevations determined from the depth-to-water measurements, which are obtained in cooperation with other organizations involved with groundwater monitoring at Y-12 (see Section 3.4), are suitable for evaluating groundwater flow patterns throughout each hydrogeologic regime and for determining representative horizontal and vertical hydraulic gradients. Depth-to-water measurements and corresponding groundwater elevations in each well are presented in the annual RCRA post-closure groundwater monitoring report issued by BJC and the annual GWMR issued by the GWPP.

3.0 Y-12 GWPP MANAGEMENT STRATEGY

The primary objectives of the Y-12 GWPP are: (1) to protect the public, worker, and environment by ensuring effective groundwater quality monitoring and reporting at Y-12 consistent with all applicable regulations, DOE orders, and B&W Y-12 corporate policies; and (2) to the extent possible, protect groundwater resources from operational impacts. To achieve these goals, the management strategy for the GWPP encompasses four key elements: (1) standardized groundwater monitoring protocols; (2) proactive stewardship of the extensive monitoring well network at Y-12; (3) productive interaction and cooperation with other organizations responsible for groundwater monitoring at Y-12; and (4) continued assessment of and innovation to the technical approach for groundwater monitoring at Y-12.

3.1 MONITORING PROTOCOLS

All groundwater monitoring activities performed by the GWPP are based on the following protocols developed from lessons learned during over 20 years of monitoring experience at Y-12: (1) formal designation and maintenance of a site-wide monitoring network compliant with DOE O 450.1A and associated DOE guidance documents; (2) uniform monitoring-well design and construction standards; (3) detailed annual sampling and analysis planning, with periodic re-evaluation of optimum sampling frequencies; (4) technically appropriate and regulatory-approved sampling procedures and analytical methods; (5) standardized suites of analytical parameters that may be tailored for specific sampling locations and monitoring objectives; (6) a consistent and quantitative process for identifying analytical results that do not meet data quality objectives (DQOs); and (7) rigorous analysis and interpretation of monitoring results. Implementation of these GWPP protocols helps to minimize potential sources of systemic variability and bias, which enhances the quality, consistency, and reliability of results that are most representative of natural levels of constituents as well as the types and concentrations of contaminants in groundwater at Y-12.

3.1.1 Monitoring Network Integration

As noted previously, the Y-12 GWPP MOP identifies the existing wells at Y-12 that are granted "active" status, which are suitable for hydrologic and/or groundwater quality monitoring, and the wells that are granted "inactive" status and are not used for either purpose (see Section 5.5). Wells granted active status include: (1) wells designated for RCRA, CERCLA, and SWDF monitoring programs; (2) wells monitored by the GWPP to meet requirements of DOE O 450.1A (Surveillance and Exit-Pathway Monitoring); and (3) wells designated for hydrologic monitoring in the Bear Creek, East Fork Poplar Creek, and Chestnut Ridge hydrogeologic regimes. Some wells serve multiple monitoring purposes. For instance, wells used for RCRA post-closure groundwater monitoring in the Bear Creek Regime also serve the Exit-Pathway Monitoring objectives of the GWPP. Similarly, several of the wells used for Surveillance Monitoring by the GWPP also serve the purposes of CERCLA baseline or remedial effectiveness monitoring. As an integrated whole, the wells granted active status under the Y-12 GWPP MOP comprise the site-wide groundwater monitoring network promoted under DOE O 450.1A and associated DOE guidance documents.

3.1.2 Annual Sampling and Analysis Planning

All monitoring wells, springs, or surface-water stations to be sampled by the GWPP during each CY are identified in a single annual SAP (see Section 5.4). The selection of sampling locations included in the SAP depends on the applicable sampling prioritization criteria described in the Y-12 GWPP MOP (see

Section 5.5). Additionally, the SAP also shows the sampling frequency and analytical parameters for each sampling location, along with the corresponding quality assurance (QA)/quality control (QC) sampling requirements. Any changes to the planned sampling and analysis activities that may occur during each year, such as the addition or removal of sampling locations or changes to the suite of laboratory analyses for each sampling location, are documented in addenda to the SAP. This approach has proven very effective for implementing and tracking the ongoing status of groundwater sampling and analysis activities performed by the GWPP.

3.1.3 Sampling Frequency

The sampling frequency for each monitoring well, spring, and surface water station at Y-12 that is designated for regulatory-compliance (RCRA, CERCLA, and SWDF) monitoring programs is defined in the corresponding RCRA PCP, CERCLA decision document(s), and SWDF operating permit. In most cases, semiannual or annual sampling is required for the applicable RCRA, CERCLA, and SWDF sampling locations.

The Y-12 GWPP MOP designates the sampling frequency for existing wells at Y-12 that are granted "active" status and do not serve a regulatory-compliance monitoring program. Based on several evaluation criteria used to determine the most appropriate sampling frequency for each well, including results of MAROS-based quantitative analysis, the MOP designates semiannual, annual, and biennial sampling for most of the applicable wells, with the final sampling frequency to be determined fro some wells with insufficient sampling histories (see Section 5.5). Additionally, sampling events are scheduled to coincide with seasonally wet and seasonally dry flow conditions.

3.1.4 Monitoring Well Designs

Since 1986, the GWPP has employed two standardized monitoring well designs: completion with an open-hole monitored interval and completion with a manufactured well screen. Both standardized well designs meet applicable installation and construction standards defined in the RCRA technical enforcement guidance document issued by the EPA (EPA 1992). Use of standardized well designs and construction materials minimizes the potential effects on water-sample quality resulting from varying well completion and construction methods.

The existing network of groundwater sampling locations (monitoring wells and springs) at Y-12 includes each of the monitoring network design elements cited in the guidance document for DOE Order Monitoring (DOE 2004): (1) facility-specific monitoring locations, such the wells designated for SWDF detection monitoring at the nonhazardous waste landfills on Chestnut Ridge; (2) area-specific monitoring locations, such as the respective network of "picket" wells used for Exit-Pathway Monitoring in the Bear Creek and Upper East Fork hydrogeologic regimes (see Section 2.3.1); and (3) remediation effectiveness monitoring locations, such as the wells used to monitor the effectiveness of the CERCLA-driven remediation of VOC-contaminated groundwater at the east end of Y-12.

3.1.5 Sampling Procedures and Analytical Methods

Standard operating procedures are used by the GWPP for the sampling of groundwater and surface water. These procedures comply with applicable regulatory requirements and DOE Orders; are based on technical standards contained in EPA technical guidance documents; and are functionally equivalent to the sampling

procedures used at Y-12 by other organizations. For each sampling location, the annual SAP for the GWPP designates applicable groups of analytical parameters (administrative parameter groups) consisting of standardized suites of laboratory analyses, including miscellaneous parameters (e.g., total dissolved solids), inorganic constituents (trace metals and major ions), volatile organic compounds (VOCs), and radiological analytes. All field measurements and laboratory analyses are performed in accordance with TDEC-, EPA-, and DOE-approved methods. The use of approved, standardized sampling and analytical procedures greatly reduces the occurrence of monitoring results that reflect bias from widely divergent monitoring and/or laboratory protocols and helps the GWPP to maintain long-term data consistency and to achieve functional equivalency with the results of other groundwater monitoring programs at Y-12.

3.1.6 Sampling Waste Management

An established waste management plan used by the GWPP for the sampling of groundwater and surface water include provisions that describe the requirements regarding the proper handling and disposal of sampling-related wastes. Sampling-related wastes include excess groundwater or surface water samples, used personal protective equipment (PPE) (e.g., latex gloves) used by sampling personnel, and groundwater water purged from wells before sampling or during development (and redevelopment). Other organizations responsible for the implementation and management of the regulatory-driven groundwater monitoring programs (RCRA, CERCLA, and SWDF) at Y-12 retain responsibility for the disposition of the associated sampling-related wastes.

Purge water from wells is the primary sampling-related waste generated by the groundwater quality monitoring implemented under the GWPP. Accordingly, the annual SAP issued by the GWPP (see Section 3.1.2) includes an appendix containing the waste management plan. Based on available characterization data for each well specified in the SAP, the purge water is either dispensed to the ground surface at the well or otherwise contained, managed, and disposed at on-site treatment facilities. Additionally, purge water from wells located near known or suspected areas where RCRA F-listed wastes were disposed is considered multi-source hazardous waste leachate (F039) if the available characterization data show that constituents in the water exceed an applicable health based concentration limit (e.g., drinking water MCL).

3.1.7 Data Quality Objective Screening

The GWPP employs a standardized data-screening process for identifying groundwater and surface water quality monitoring results that do not meet the applicable DQOs defined in the GWPP Data Management Plan (see Section 5.7). Specific DQO criteria apply to the analytical results for major ions, trace metals, VOCs, radiological analytes (gross alpha, gross beta, and radionuclides), and miscellaneous laboratory analytes (e.g., total dissolved solids). Analytical results that do not meet the specified DQO criteria are appropriately qualified. Developed and refined over more than 20 years of groundwater quality monitoring at Y-12, the GWPP data-screening process has proven to be a consistent, unbiased, and efficient means for effectively identifying sampling or analytical artifacts, such as false positive results for VOCs, and other spurious monitoring results.

3.1.8 Monitoring Data Reporting

Between 1990 and 2003, the GWPP employed a two-part approach for annual reporting of groundwater monitoring data obtained at Y-12. Each CY, all the groundwater monitoring data obtained at Y-12 during the preceding CY were compiled in a GWMR. Accordingly, the annual GWMR combined the monitoring

results (field measurements and laboratory analyses) obtained by the GWPP and the monitoring data obtained by other organizations, such as the WRRP. The annual GWMR was accompanied by a separate Groundwater Data Evaluation Report (GWDER), which presented a detailed evaluation of the monitoring data with respect to the requirements of DOE Orders 5400.1 and 450.1A (see Section 2.3.1). Additionally, each annual GWDER served as a forum to present results of supplemental hydrogeologic studies in each regime and to describe proposed modifications to the monitoring activities performed by the GWPP. A separate GWDER for each hydrogeologic regime was issued until CY 2000, when the separate reports were combined.

Beginning in 2003, the GWPP modified the approach for reporting and documenting Y-12 monitoring data in order to demonstrate and maintain compliance with applicable requirements of DOE O 450.1A. The annual GWMR was retained as the single-source reference for the Y-12 monitoring data obtained each CY (see Section 4.8.1.1), but the annual GWDER was replaced by the Y-12 GWPP Groundwater Monitoring Data Evaluation Compendium (GWDC) (see Section 4.8.1.2). The GWDC serves as the GWPP reference document, updated regularly, that provides a comprehensive overview and evaluation of the monitoring data for each sampling location that is granted "active" status in accordance with the Y-12 MOP (see Section 5.5).

The GWPP is committed to reporting to B&W Y-12 Management and to DOE any unusual or abnormal groundwater monitoring data as soon as such results become available. In this way, operational impacts to groundwater can be evaluated and an appropriate course of action can be decided upon in a timely manner (see Section 4.8.2).

3.1.9 Analysis of Trends

As both a programmatic objective and a performance metric, the analysis and interpretation of long-term trends in groundwater and surface water quality at Y-12 is fundamental to the overall success and effectiveness of DOE Order Monitoring at Y-12. Accordingly, many of the standardized monitoring protocols adopted by the GWPP, such as site-wide well design and construction standards, designated sampling procedures, and uniform analytical methods are intended to minimize inherent variability wherever possible so as to promote monitoring data consistency over the long-term. Also, the DQO screening process developed by the GWPP ensures that the monitoring results used to determine long-term groundwater and surface water quality trends do not include sampling or analytical artifacts that may bias the trend and/or promote overly subjective analysis and interpretation. The analysis, interpretation, and reporting of observed trends provides the information needed for immediate and long term stewardship and/or remedial actions.

3.2 MONITORING OPTIMIZATION

Optimization of the GWPP is achieved through implementation of the Y-12 MOP described in Section 5.5. First issued in December 2003, the MOP established the "active" or "inactive" operational status of each existing monitoring well at Y-12 (see Section 5.5) . The status designation specified in the MOP also dictated the inspection/maintenance frequency for the well. An updated version of the MOP, issued in December 2006, addressed findings of the independent, MAROS-based quantitative and qualitative review of the GWPP that was completed in December 2005 (see Section 2.2). The updated MOP incorporated the MAROS methodology for evaluations of "well sufficiency", "well redundancy", and optimum sampling frequency for all wells granted active status.

3.3 MONITORING SYSTEM STEWARDSHIP

In the late 1980s the GWPP assumed responsibility for the overall care and maintenance of the many groundwater monitoring wells at Y-12. Stewardship of this extensive monitoring well network, which includes hundreds of wells located throughout the Bear Creek, East Fork, and Chestnut Ridge regimes (along with several wells located outside of the ORR), has involved: (1) a program of regular inspection and maintenance; (2) use of standardized P&A procedures proven to effectively remove or close obsolete or irreparably damaged monitoring wells; and (3) maintaining and updating the database of subsurface geologic data and monitoring well construction details.

Active monitoring wells used for DOE Order Monitoring at Y-12 are inspected annually by the GWPP. The WRRP currently retains programmatic responsibility for the inspection (and maintenance) of all RCRA and CERCLA monitoring wells and the BJC waste management organization retains responsibility for inspection and maintenance of the SWDF monitoring wells. Additionally, inactive monitoring wells (i.e., wells that are not used for ongoing groundwater monitoring programs) are inspected by the GWPP once every three years. These routine inspections, which focus on the applicable above-ground components of each well (including the protective surface casing, well casing, locking well cap, concrete well pads, and vehicle guard posts), and related requests for maintenance work are performed and documented in accordance with GWPP procedures (see Section 5.9). Triennially, the GWPP issues a Well Inspection and Maintenance Report (see Section 4.11).

Effective stewardship of the monitoring well network at Y-12 also includes the P&A of wells that become irreparably damaged or must otherwise be removed or closed to accommodate ongoing operations at Y-12. The removal or closure of monitoring wells is completed in accordance with proven technical procedures and/or specifications that incorporate industry-wide protocols and the lessons-learned during the P&A of numerous obsolete monitoring wells at Y-12. Note that the WRRP and other DOE-EM contractor organizations assumed responsibility for the proper P&A of any CERCLA, RCRA, and SWDF monitoring wells at Y-12 (if needed), and any wells which may interfere or obstruct CERCLA activities.

Drilling records and construction details for the network of monitoring wells at Y-12 include: (1) critical information essential to the analysis of groundwater flow characteristics in each hydrogeologic regime; (2) the interpretation of groundwater monitoring results for each well; and (3) evaluation of the suitability of each well for the purposes of ongoing groundwater monitoring programs and supplemental hydrogeologic studies. Beginning in the late 1980s, the GWPP has served as the custodian of these drilling records and well construction data, and has compiled the information in updated versions of a document entitled *Updated Subsurface Data Base for Bear Creak Valley, Chestnut Ridge, and Parts of Bethel Valley on the U.S. Department of Energy Oak Ridge Reservation*; the most recent version of which was issued by the GWPP in February 2003 (BWXT 2003a).

3.4 MONITORING PROGRAM INTEGRATION

Productive interaction with other organizations responsible for groundwater monitoring at Y-12 is crucial to the overall effectiveness of the GWPP, avoids duplication of monitoring efforts, and effectively directs available resources toward mutual programmatic objectives. Cooperative interaction between the GWPP and other organizations primarily involves coordinating monitoring activities, sharing monitoring data, and providing technical support. For example, the GWPP and WRRP alternately assume responsibility for performing the annual groundwater elevation monitoring at Y-12 (see Section 2.3.6). Similarly, the groundwater and surface water quality data obtained by the GWPP and WRRP are shared because sampling and analysis protocols are similar.

3.5 MONITORING INNOVATION AND IMPROVEMENT

The GWPP is committed to the continued innovation and improvement of the groundwater monitoring procedures and protocols used at Y-12. This goal is achieved through: (1) efficient use of available monitoring resources; (2) thorough evaluation of the groundwater monitoring data obtained each year and reassessment of data interpretations in light of new monitoring results or findings of hydrogeologic studies; (3) proactive implementation of programmatic changes in response to monitoring results and evolving monitoring priorities; and (4) periodic appraisal of technical advances and changes in sampling equipment and/or methodology. Whenever possible, the GWPP will incorporate new monitoring technology and adopt innovative monitoring methods that enhance efficiency without reducing the quality of monitoring data.

3.6 MONITORING PROGRAM REVIEW

The Y-12 GWPP is committed to having a periodic, independent review of the purpose, objectives, management, implementation, and technical adequacy of the program, with results of the independent review incorporated as needed. As noted in Section 2.2, the first such formal review of the GWPP was performed in 2005 and included both qualitative and quantitative assessment of program management and operations and the methods of monitoring data collection, management, and reporting to meet DOE O 450.1A requirements. Recommendations for improvements and modifications to the GWPP were implemented during CY 2006, and selected MAROS-based evaluation methods were adopted as part of the GWPP monitoring optimization process (see Section 3.2).

3.7 MONITORING EXIT STRATEGY

The exit-strategy for the regulatory compliance-driven (RCRA, CERCLA, and SWDF) groundwater monitoring programs at Y-12 is determined by the governing regulations and the conditions of the applicable operating or post-closure permit. For example, monitoring performed to assess the effectiveness of planned or on-going CERCLA remediation projects will end after specified clean-up goals and performance objectives have been achieved. Similarly, future conditions may warrant the termination of groundwater quality monitoring as a required RCRA post-closure care activity for one or more of the applicable TSD units at Y-12 (see Section 2.3.3). Conversely, groundwater monitoring at some individual facilities (including monitoring during the post-closure care period), such as operating SWDFs, will continue for as long as required under the applicable regulations and permit conditions.

The Y-12 GWPP MOP (see Section 3.2) essentially defines an exit strategy for specific sampling locations that no longer serve programmatic purposes and are granted “inactive” status under the GWPP. Also, results of future MAROS-based assessments performed as part of the optimization approach may warrant discontinued monitoring at specific areas addressed under the GWPP. Nevertheless, so long as Y-12 facilities remain operational, some components of DOE Order Monitoring, such as Exit-Pathway Monitoring, are likely to continue at a commensurate level for the foreseeable future. In that sense, an exit strategy is not applicable to all components of the GWPP.

4.0 Y-12 GWPP ORGANIZATION, ROLES, AND RESPONSIBILITIES

The GWPP is a multi-element, multi-disciplinary, matrix organization staffed by personnel from Water Compliance Section of the Environmental Compliance Department (ECD) within the Y-12 Environment, Safety, and Health (ES&H) Division; the line organization of the GWPP is illustrated on Figure 4. The GWPP is responsible for the following:

- Implementing groundwater monitoring at Y-12 per DOE O 450.1 and associated DOE technical guidance documents
- Ensuring that all GWPP activities are performed safely through the implementation of the Y-12 Integrated Safety Management System (ISMS).
- Directing laboratory services in support of monitoring efforts.
- Management of groundwater data and information.
- Reporting as required by DOE orders.
- Providing data, documentation, and analyses to end users and data repositories.
- Maintaining a formal records management system to capture sample chains of custody, analytical packages, data verification/validation documentation, and other required records and technical information.
- Stewardship of the Y-12 groundwater monitoring well network.
- Serving as a technical and service resource to customer organizations.

4.1 PROGRAM MANAGEMENT

Management responsibilities for implementation of the GWPP at Y-12 are divided between the GWPP Manager, the GWPP Technical Coordinator, and the GWPP Sampling and Analysis Coordinator.

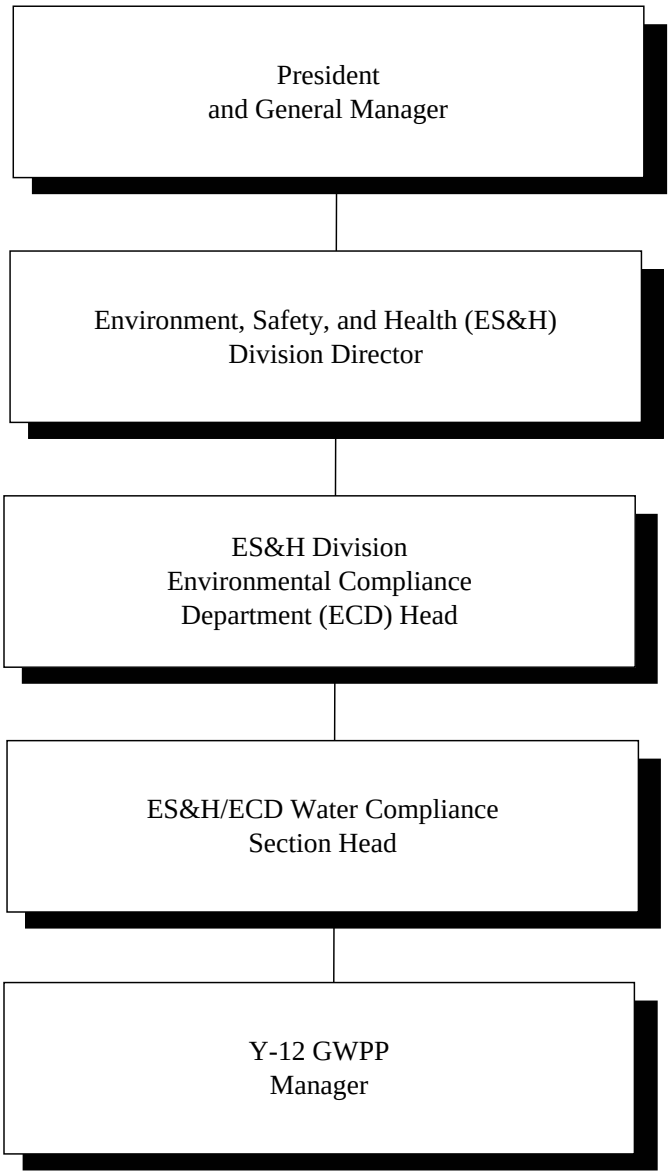

Fig. 4. Line organization of the Y-12 GWPP.

4.1.1 GWPP Manager

The GWPP Manager serves as the primary Y-12 groundwater point of contact for the GWPP matrix organizations, other DOE contractors, regulatory agencies (through Y-12 Management and DOE), and other Y-12 programs as related to National Nuclear Security Administration funded activities. The GWPP Manager is responsible for maintaining the quality of the GWPP and is ultimately responsible for the success of the program as a whole and each of the individual elements. Primary responsibilities of the GWPP Manager include:

- Meeting all groundwater monitoring requirements under DOE O 450.1A and associated DOE technical guidance documents.
- Implementing the GWPP Management Plan and related element plans.
- Implementing the sampling and analysis activities associated with DOE O 450.1A.
- Serving as a single point of contact for technical resources to DOE and customer organizations.
- Ensuring all aspects of GWPP operations, data, and reporting meet classification and security requirements.
- Defining and implementing well drilling, installation, P&A, and inspection/maintenance requirements.
- Interfacing with other Y-12 and ORR organizations, as required.
- Ensuring that all activities performed by the GWPP, its affiliate organizations, and subcontractors meet all requirements of the ISMS at Y-12.
- Foster communication and integration among the groundwater monitoring programs at Y-12 to promote cooperation and efficiency.
- Seek to continually improve GWPP operations.

4.1.2 GWPP Sampling and Analysis Coordinator

The GWPP Sampling and Analysis Coordinator also reports to the GWPP Manager and has primary responsibility for the following:

- Implementation and administration of the annual SAP for the GWPP, including:
    - Development and maintain sampling schedules, bottle lists, and purge water containment requirements on a quarterly basis and as required by additions or deletions to the monitoring network.
    - Primary point of contact for tracking and coordinating sampling activities for the sampling personnel.

- Primary point of contact for the characterization and coordination of purge water containment, handling, and disposal activities with the appropriate waste management organizations and subcontractors.

- Primary point of contact with the B&W Y-12 Analytical Chemistry Organization (ACO) representative(s) to ensure that analytical methods, analytical parameters, and data reporting schedules are efficiently completed as specified in the SAP.

- Performance of assessments of sampling activities against standard operating procedures to ensure high standards of quality.

- Initiate samples in the Environmental Monitoring Management Information System.

• Development and implementation of ISMS elements for GWPP-related field activities.

• Development, review, and implementation of standard operating procedures for GWPP field activities.

• Act as the GWPP project manager for other specified GWPP activities (e.g, well inspection and maintenance, technical evaluations, hydrologic field testing, etc.).

• Provide technical support to the GWPP Manager and customers.

• Assist in the preparation of the annual SAP, including the definition of monitoring requirements and the identification of logistical issues.

• Implement corrective actions resulting from field QA deficiencies.

• Maintain monitoring well sampling histories and provide timely notification of any unusual circumstances (e.g., dry well conditions, extraordinarily high or low water levels, vapors or odors noted, discolored water, well damage, missing locks or caps, evidence of tampering, etc.) to the GWPP Manager and ACO Program Manager.

• Seek to continually improve GWPP operations.

4.1.3 GWPP Technical Coordinator

The GWPP Technical Coordinator reports to the GWPP Manager and has primary responsibility to:

• Coordinate GWPP data management activities (e.g., data verification and validation) with matrix organization and subcontract personnel.

- Update and maintain information (e.g., geographical, well component/construction, maintenance, hydrologic, and water quality) in the Groundwater Information Management System (GIMS).

- Interface with and direct Information Technology personnel to process and manage groundwater data, and to maintain and improve the systems and computer hardware that comprise the GIMS and other pertinent systems.

- Coordinate the transfer of GWPP water quality data to the Oak Ridge Environmental Information System (OREIS) in a timely manner.

- Implement the UIC Compliance effort, coordinating with EPA and TDEC, DOE, and other contractors to meet applicable UIC requirements.

- Act as the GWPP project manager for other specified GWPP activities (e.g, drilling operations, technical evaluation, hydrologic field testing, statistical analyses, etc.).

- Provide technical support.

- Seek to continually improve GWPP operations.

4.2 HEALTH AND SAFETY

All GWPP field activities are conducted in accordance with the B&W Y-12 ISMS. Health and safety is the responsibility of the GWPP Program Manager and Coordinators with support from other appropriate organizations such as the Industrial Hygiene and Industrial Safety Departments, and the Radiological Control Organization. The ISMS is a process to ensure work is performed safely by identifying and assessing hazards associated with specific activities, and implementing barriers and controls for these hazards prior to authorization and execution of the task (BWXT 2003b). Specific GWPP activities are reviewed and controlled through the ISMS with specific job hazard analyses. The GWPP Manager has responsibility for the preparation of required ISMS submittals for specific tasks and coordinating appropriate reviews and approvals. Additionally, the GWPP Manager has responsibility for H&S incident or accident reporting and coordinating responses to such events through the appropriate organizations.

4.3 QUALITY ASSURANCE

Quality assurance for the GWPP is the responsibility of the GWPP Manager. Primary responsibilities for QA are:

- The preparation, maintenance, and implementation of the GWPP Quality Program Plan (QPP) for applicable programmatic elements.

- Provide the GWPP staff with guidance and assistance in meeting programmatic or element quality objectives.

- Nonconformance reporting and corrective action tracking.

- Use an audit tracking system to monitor progress in addressing program deficiencies which have been identified internally or externally.

- Provide assistance with quality reviews of programs, projects, or documents.

4.4 SAMPLING AND ANALYSIS

Sampling and analysis of groundwater for the GWPP are implemented by the GWPP Sampling and Analysis Coordinator (see Section 4.1.2), who provides technical direction to the ACO Program Manager and the sampling technicians and/or their supervisor. The ACO Program Manager is the designated laboratory representative responsible for assisting with the preparation and implementation of the annual SAP for the GWPP (and any addenda to the SAP); assuring established analytical procedures are followed; consulting with analytical personnel in development and incorporation of new analytical procedures; providing technical and administrative support to the GWPP; and interacting with the GWPP data management personnel to provide electronic data deliverables and help prepare a sample tracking report. Sampling field support for the GWPP is obtained from the ECD Environmental Sampling Services Section.

4.5 PROCUREMENT

Procurement of subcontract services (e.g., drilling, technical, reporting, data management) and materials for the GWPP are handled by direct interaction with the B&W Y-12 Acquisition and Asset Management Department with support from the ES&H Division Finance Officer. All procurement for the Y-12 GWPP are conducted following established DOE and B&W Y-12 corporate procedures and practices.

4.6 DATA MANAGEMENT

Site-wide DOE Order Monitoring under the Y-12 GWPP, in conjunction with the CERCLA, RCRA, and SWDF monitoring programs described in Section 2.3.5, provides the specific groundwater and surface water quality data needed for resource management and regulatory compliance. Specific data for some areas also may be suitable for planning, designing, and operating facilities related to site missions, including environmental protection and pollution prevention activities.

The management of groundwater related data at Y-12 is the responsibility of the GWPP Manager. A wide variety of information is collected and maintained. Internally, the GWPP maintains the GIMS which is a system of computer applications which stores hydrogeologic information on such activities as well construction and maintenance, water levels, sampling and analysis, water quality data reporting, and records management. The Y-12 Information Technology Department supports the GWPP in maintaining and enhancing GIMS capabilities. Analytical data on water quality samples are managed utilizing the GWPP Analytical Data Management System (ADMS). Management of the ADMS is the responsibility of the GWPP ADMS team. The ADMS team is comprised of database professionals that report to the GWPP Manager and Technical Coordinator. The primary responsibilities of the ADMS team are to:

- Design, update, and maintain the ADMS for data collected and analyzed during implementation of groundwater monitoring per DOE O 450.1A and associated DOE technical guidance documents.

- Assist in the implementation, update, and modification of the Y-12 Data Management Plan.

- Track sampling and data transfer activities relative to the schedules in the annual SAP for the GWPP and report this information to the GWPP Manager and the ACO Program Manager.

- Implement data verification to ensure that the data quality objectives established by the GWPP are met.

- Establish and implement procedures for database security, backup, data entry, tracking, processing, and verification.

- Respond to hard copy and electronic data transfer requests made to and approved by the GWPP Manager.

- Generate summary statistics for Y-12 groundwater monitoring data included in the annual ORR Annual Site Environmental Report.

Data management under the GWPP ensures that groundwater quality data are retained and retrievable for all data users.

4.7 DATA VALIDATION AND EVALUATION

Groundwater monitoring data obtained by the GWPP for DOE Monitoring at Y-12 do not undergo any "formal" data validation, such as CERCLA Contract Laboratory Program (CLP) Level IV validation process. Instead, contemporaneous QA/QC sampling results and the extensive database of groundwater monitoring results for many of the wells at Y-12 are used to evaluate monitoring data with respect to applicable DQOs (see Section 3.1.7). For each well and monitored parameter/constituent, the computer-based DQO evaluations identify (qualify) suspect analytical results (if any), such as false positive VOC results, and flag outliers with respect to the historical high and low concentrations. Since 1991, the implementation of the DQO evaluation process developed by the GWPP, which also has been adopted for RCRA, CERCLA, and SWDF compliance monitoring, has proven successful at promoting the repeatability of monitoring data for each sampling location, ensuring the equivalency of the monitoring data obtained by different organizations, and enhancing the consistency of monitoring data from different analytical laboratories over time.

Groundwater monitoring data that meet applicable DQOs of the GWPP are suitable for quantitative statistical- and trend-based evaluation methods. If required by the GWPP, rigorous statistical analyses are performed by qualified personnel (including subcontractors) who are responsibilities are:

- Generating summary statistics and graphical presentations in response to requests made or approved by the GWPP manager.

- Assuring the quality of the statistical analyses performed.

- Complying with applicable requirements of the GWPP Data Management Plan and coordinating with Information Technology personnel and the ACO Project Manager.

4.8 REPORTING AND NOTIFICATION

The GWPP Manager is responsible for all routine and non-routine reporting of DOE Order Monitoring to Y-12 management, DOE, and regulatory agencies in a prompt and efficient manner. Routine reporting consists of the preparation of annual documents which provide information on activities performed and data obtained by the GWPP. Non-routine reporting consists of any intermittent or unscheduled information and/or any unusual events or occurrences, regardless of significance or severity.

4.8.1 Routine Reporting

Routine Reports are prepared to meet the requirements of DOE Orders and are typically on an annual cycle. These reports are prepared to provide information pertaining to the specific requirements of the DOE Orders such as baseline monitoring, regulatory compliance, and evaluation of known and potential contaminant sources through Surveillance and Exit-Pathway Monitoring.

4.8.1.1 Groundwater Monitoring Data Reports

Groundwater quality and water-level monitoring results obtained at Y-12 during a CY are documented in the annual GWMR issued by the GWPP. The annual GWMR contains the monitoring data obtained in each of the hydrogeologic regimes at Y-12 (Bear Creek Regime, Chestnut Ridge Regime, and East Fork Regime) and includes data obtained by the GWPP and data obtained by other organizations (e.g., RCRA monitoring data obtained by the WRRP). Accordingly, the GWMR functions as a single-source reference for monitoring data used to demonstrate compliance with applicable requirements for groundwater monitoring per DOE O 450.1A and associated DOE technical guidance documents. Beginning in CY 2003, the scope of the annual GWMR expanded to incorporate: (1) a summary of monitoring results for applicable sampling locations that indicate contamination from one or more of the primary inorganic, organic, and radiological contaminants at Y-12 and (2) recommendations for changes in GWPP monitoring procedures and protocols.

4.8.1.2 Monitoring Data Evaluation Compendium

As noted in Section 3.1.8, the GWPP initiated preparation of the GWDC in CY 2003 to replace the annual GWDER as the forum used to address and document Y-12 compliance with groundwater monitoring requirements per DOE O 450.1A and associated DOE guidance documents (see Section 2.3.1). The GWDC serves as a single-source reference for each sampling location granted "active" status under the GWPP MOP (see Section 5.5), and provides a comprehensive summary and evaluation of the monitoring results for each applicable sampling location, including:

- well construction details;
- water-level characteristics and hydrologic testing results (if applicable);
- the sampling history, including the current governing regulatory program(s);
- the sampling method(s);
- field measurements and laboratory analytes;
- results that do not meet DQO criteria;
- geochemical characteristics;
- the presence of inorganic, organic, and radiological contaminants; and
- long-term contaminant concentration trends.

4.8.1.3 Oak Ridge Reservation Annual Site Environmental Report

The GWPP contributes groundwater information to the ORR Annual Site Environmental Report. The annual GWMR and GWDC are utilized to provide this information.

4.8.1.4 Well Inspection and Maintenance Reports

A report is issued every three years to document the monitoring well inspection and maintenance activities performed at Y-12 by the GWPP. Inspection and maintenance of the Y-12 monitoring well network is critical to ensure collection of representative groundwater samples and to maximize the effective lifespan of each monitoring well.

4.8.2 Non-Routine Reporting

As with routine reports, non-routine reports are prepared to meet the requirements of DOE Orders but are not submitted on a set schedule. These reports may be informational in nature, and, due to the infrequency of activities, may not be required on an annual or other routine bases (e.g., well installation summary reports, well P&A summary reports, the Y-12 subsurface database, investigation/study reports, etc.). Some reports may be required to provide prompt information to management, DOE, and/or environmental agencies in order to address significant environmental compliance issues. In the event that a significant environmental compliance issue occurs, notification will be performed in compliance with B&W Y-12 procedure Y14-192, "Occurrence Notification and Reporting."

One computer application of the GIMS is the Environmental Quality Control and Analysis System. This automated system provides weekly reports on water quality results from the ACO to the GWPP staff. These reports provide GWPP staff the ability to evaluate analytical results from the laboratory in a timely manner and act upon this information as required to protect groundwater resources and meet DOE Order and B&W Y-12 reporting requirements.

4.9 RECORDKEEPING AND DOCUMENT CONTROL

Recordkeeping and document control for the GWPP are the responsibility of the GWPP Manager and should meet the requirements of Management Requirement Y12-028 (Records and Document Management). These responsibilities include:

- Generation and archiving of reports and documents to meet regulatory and/or DOE Order requirements.
- Acquisition of appropriate reference and guidance documents and materials.
- Maintenance of a record tracking system and records center.

Control and tracking of element records and documents are included in the individual project plans (see Section 5.0), and coordination of the recordkeeping and documentation is the responsibility of the GWPP Manager.

4.10 HYDROGEOLOGICAL INTERPRETATION

Hydrogeological interpretation of groundwater data and statistical results are the responsibility of the GWPP Manager. Primary responsibilities of the GWPP Manager for hydrogeological interpretations are:

- Preparation of technical reports and correspondence.
- Serving as technical consultant to other programs.
- Identification of needs for hydrogeological subcontractor services.
- Serving as Subcontract Technical Representative for subcontracts providing hydrogeologic services.
- Special groundwater and hydrogeologic studies.

4.11 ENGINEERING AND WELL INSTALLATION

Engineering services for the GWPP are provided by the B&W Y-12 Engineering Organization. Services provided upon request from the GWPP Manager include subcontractor services, drawing searches and preparation, utility and geotechnical information, and any required engineering support for drilling services and well installations, such as surveying services. The GWPP Manager has the responsibility to acquire necessary permits for drilling operations, such as excavation, welding, and work safety permits. The GWPP Technical Coordinator directs Engineering and Construction personnel who will procure, coordinate, and provide on-site supervision of drilling and well services (installation, P&A, and maintenance) subcontractors, and functions as a project health and safety officer for drilling or geotechnical field activities.

4.12 TECHNICAL SUPPORT

The GWPP is responsible for providing technical and data resources to Y-12 organizations and other ORR organizations as requested.

4.13 TRAINING

The GWPP Manager is responsible for ensuring that all personnel involved in GWPP activities are qualified for the work being performed and meet Y-12 NSC training requirements.

5.0 PROJECT PLANS

The GWPP has issued several project plans that are used to guide the implementation of the management strategy described in Section 3. References for the actual plans are cited within the text.

5.1 HEALTH AND SAFETY PLAN

The GWPP implements the B&W Y-12 ISMS, which was established to protect the worker, the public and the environment. The ISMS is utilized to: (1) ensure that any activity is defined; (2) hazards (potential and real) are identified; (3) controls are implemented to eliminate or control identified hazards; (4) the work is performed under established controls; and (5) post-action feedback is provided to continuously improve activity safety and performance. The GWPP has implemented the ISMS (i.e., completed job hazard identifications and job hazard analyses) for specific field operations (i.e., groundwater and surface water sampling, monitoring well inspection and maintenance, and water level measurement) routinely performed by B&W Y-12 employees. New activities identified will undergo the ISMS process in accordance with B&W Y-12 Program Description Y15-635PD and any and all indicated subordinate procedures. Subcontractors are also subject to the ISMS to the extent that such requirements are incorporated into contractor documents and health and safety plans.

5.2 QUALITY ASSURANCE PLAN

A comprehensive QPP is the current principal QA guidance source for the GWPP (Science Applications International Corporation [SAIC] 1994). The QPP plan identifies key personnel responsible for implementation and provides for the planning and accomplishment of activities affecting quality assurance. Specifically, the plan addresses procurement procedures, document control, sample identification and control, qualification requirements for analytical and sampling techniques, equipment calibration requirements, corrective actions, and quality assurance records and audits. Although the GWPP Manager is ultimately responsible for the implementation of QA requirements and for assuring and verifying the quality of the GWPP, each Coordinator is responsible for day-to-day QA/QC requirements of their assigned program elements.

To supplement the existing QPP, technical and administrative procedures have been developed. These procedures provide requirements, instructions, and information concerning environmental data gathering, sampling and analysis, and evaluation.

5.3 MONITORING WELL INSTALLATION PLAN

The GWPP Monitoring Well Installation Plan (SAIC 1997) provides technical guidance and procedures for the design, installation, construction, and development of monitoring wells at Y-12, along with the associated documentation and requirements for the handling and disposal of drill cuttings and well development fluids in accordance with applicable regulations, DOE Orders, and B&W Y-12 corporate policy.

The GWPP Manager is responsible for the installation of monitoring wells in compliance with the Monitoring Well Installation Plan. The GWPP Manager is responsible for obtaining adequate funding for well installation purposes and for initiating work releases to obtain geological and drilling subcontractor services and engineering support for well installations. The GWPP Technical Coordinator organizes and initiates

drilling operations through the Engineering and Construction divisions. An on-site geologist (licensed in the State of Tennessee) ensures that the drilling subcontractor complies with technical specifications and procedures of this plan for well installations and documents all well construction and development information. All monitoring well installation, construction, and development information is documented in a report issued by the GWPP.

5.4 SAMPLING AND ANALYSIS PLAN

As noted in Section 3.1.2, a standard protocol of the GWPP at Y-12 is the preparation of a comprehensive SAP for each CY. Maintained and implemented by the GWPP Sampling and Analysis Coordinator, the SAP identifies the sampling locations, frequency, sequence, analytical parameters, and QA/QC sampling planned by the GWPP Organization for each CY. This plan incorporates a waste management plan and references procedures used during sample collection, preservation, handling, and chain of custody. Any modifications or changes to these monitoring activities are documented in addenda to the SAP issued by the GWPP Manager.

5.5 MONITORING OPTIMIZATION PLAN

The Y-12 MOP describes the technical approach implemented by the GWPP to focus available resources on the monitoring wells that provide the most useful hydrologic and water-quality monitoring data (BWXT 2006a). The technical approach is based on the GWPP status designation for each well in the Y-12 well network. Under this approach, wells granted "active" status are prioritized by the GWPP for hydrologic monitoring and/or groundwater quality sampling, whereas wells granted "inactive" status are not used for either purpose. The status designation also determines the frequency at which the GWPP will inspect applicable wells, the scope of these well inspections, and extent of any maintenance actions initiated by the GWPP.

For each monitoring well granted active status, the MOP designates the groundwater sampling frequency deemed appropriate to the technical objectives and programmatic purposes of the GWPP. Selection of the appropriate sampling frequency is based on professional judgement and objective evaluation criteria, including the location of the well, the types and concentrations of groundwater contaminants present in the well (f any), and the output of MAROS quantitative analysis using a modified cost effective sampling (MCES) method, which determines the lowest-frequency sampling schedule that will maintain regulatory (and DOE Order) compliance and support remedial action decision-making (BWXT 2005).

5.6 LABORATORY QUALITY ASSURANCE PLAN

A laboratory Quality Assurance Plan (QAP) for the ACO issued in May 2003 (BWXT 2003d) describes the laboratory QA utilized for the purposes of the GWPP at Y-12. This QAP describes techniques and systems necessary to obtaining uniform and reliable analytical results from groundwater monitoring locations. The QAP provides a standard for all activities involved in analyzing samples and in reporting data.

The Y-12 ACO Program Manager assures that the DQOs of the GWPP are met. The ACO Program Manager also tracks analytical costs and notifies the GWPP Manager of any potential cost increases or potential overruns.

5.7 DATA MANAGEMENT PLAN

The Data Management Plan for the GWPP (BWXT 2003d) is implemented for all data collection and archiving activities. The ADMS Team implements this plan with support from data evaluators, the ACO Program Manager, and all GWPP staff. Data are tracked between the ACO Project Manager and the ADMS Team utilizing software in conjunction with tracking reports. Analytical data are transferred electronically upon completion of analysis of samples from an administrative well group. Weekly tracking reports and field data sheets are sent from the ACO Project Manager to the GWPP Sampling and Analysis Coordinator. Electronic and/or hard copies of data are sent to the ADMS Team and the data verifying subcontractor. Electronic files of the monitoring data (laboratory results, field measurements, and QA/QC data) to the data evaluation and validation subcontractor after results for each quarterly sampling event have been verified. The Data Management Plan is modified as required and changes are documented by the ADMS Team.

5.8 WELL PLUGGING AND ABANDONMENT PLAN

The GWPP Monitoring Well Plugging and Abandonment Plan (LMES 1997) contains the technical guidance and procedures for the removal of obsolete or irreparably damaged monitoring wells at Y-12. Wells of similar construction materials and design are grouped together, and a single procedure was developed for each group of wells. The objective of each procedure is to prevent fluid migration into or between formations containing groundwater, to remove any well materials that may have been in contact with contaminated material or groundwater, and to minimize the amount of waste materials generated during the plugging and abandonment procedure.

The GWPP Manager or a designee is responsible for generating an inventory of wells considered for plugging and abandonment, reviewing the plan annually, and issuing addenda as needed. The GWPP Manager designates wells to be plugged and abandoned through coordination with managers of other monitoring programs and/or operations, review of well inspection and maintenance reports, and review of the annual GWMR. Well inspection and maintenance reports identify wells that are damaged or unusable. Managers of other Y-12 organizations identify wells that must be removed because of construction or site closure activities. The GWPP Manager is also responsible for developing a schedule of P&A activities, obtaining subcontractor services for the plugging and abandonment, obtaining engineering support for field operations oversight, and ensuring that the subcontractor complies with the plugging and abandonment procedures. Reports documenting plugging and abandonment activities are issued by the GWPP.

5.9 WELL INSPECTION AND MAINTENANCE PLAN

The GWPP Well Inspection and Maintenance Plan (BWXT 2006b) provides the technical guidance and procedures for the inspection and maintenance of monitoring wells at Y-12 to extend the life of the wells and to ensure that they yield representative water levels and water-quality samples. The plan includes a checklist of items to be inspected (such as condition of concrete pads, hasps, caps, locks, and protective posts; the measured depth of the monitored interval compared to the constructed depth; and well access considerations), standardized forms for inspection and requests for maintenance, and a schedule for well inspections. As wells are inspected and problems requiring attention are identified, a schedule to repair or rehabilitate wells is developed and updated through the year. Additionally, problems reported by sampling teams to the GWPP Sampling and Analysis Coordinator are added to the repair/rehabilitation schedule.

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