6. GROUNDWATER PROGRAMS

6.1 SUMMARY

Groundwater monitoring at PORTS is required by a combination of state and federal regulations, legal agreements with Ohio EPA and U.S. EPA, and DOE Orders. More than 400 monitoring wells are used to track the flow of groundwater and to identify and measure groundwater contaminants. Groundwater programs also include on-site surface water monitoring and water supply monitoring.

Concentrations of TCE continued to decrease in the X-749/X-120/PK Landfill area during 2011. TCE was detected at an estimated concentration of 0.25 µg/L in the first quarter sample collected from off-site monitoring well WP-03G. No TCE or other volatile organic compounds were detected in any of the seven off-site monitoring wells sampled in the second, third, and/or fourth quarters of 2011. TCE has not been detected in groundwater beyond the DOE property boundary at concentrations that exceed the Ohio EPA drinking water standard of 5 µg/L.

In the third quarter of 2011, TCE was detected at concentrations above 5 µg/L (the preliminary remediation goal and definition of the groundwater plume perimeter) in wells that are typically not within the groundwater plumes at the X-749/X-120/PK Landfill, the Quadrant II Groundwater Investigative Area, and the X-701B Holding Pond. All of these wells were sampled in the fourth quarter of 2011, and concentrations of TCE in the wells (if detected) returned to less than 5 µg/L. These detections may be related to the higher than normal amounts of rain that occurred in 2011.

In 2011, the analytical laboratory that analyzed the environmental samples discussed in this chapter for radionuclides reported numerous small detections of americium-241 and plutonium-239/240, which are transuranic radionuclides. Although americium-241 and plutonium-239/240 are occasionally detected in PORTS environmental samples, there were more detections in 2011 than in previous years. Most of the detected results were above the minimum detectable activity but less than the laboratory reporting limit. Americium-241 and plutonium-239/240 are present in the environment at very small levels due to atmospheric fallout from nuclear weapons testing. The low levels of americium-241 and plutonium-239/240 detected in the samples may be present due to this fallout. Additionally, radionuclides detected at low levels near the minimum detectable activity may be false positives due to the statistical methodology used in analysis of radionuclides. These detections of americium-241 and plutonium-239/240 were less than the PORTS preliminary remediation goals for americium-241 and plutonium-239/240 in groundwater: 0.49 pCi/L and 0.51 pCi/L, respectively.

The *2011 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* provides further details on the groundwater plumes at PORTS, specific monitoring well identifications, and analytical results for monitoring wells. This document and other documents referenced in this chapter are available in the PORTS Environmental Information Center.

6.2 INTRODUCTION

This chapter provides an overview of groundwater monitoring at PORTS and the results of the groundwater monitoring program for 2011. The following sections provide an overview of the PORTS groundwater monitoring program followed by a review of the history and 2011 monitoring data for each area. Chapter 3, Section 3.2 provides additional information about the remedial actions implemented at a number of the areas discussed in this chapter to reduce or eliminate groundwater contamination.

This chapter also includes information on the groundwater treatment facilities at PORTS. These facilities receive contaminated groundwater from the groundwater monitoring areas and treat the water prior to discharge through the permitted FBP NPDES outfalls.

6.3 OVERVIEW OF GROUNDWATER MONITORING AT PORTS

This section provides an overview of the regulatory basis for groundwater monitoring at PORTS, groundwater use and geology, and monitoring activities and issues.

6.3.1 Regulatory Programs

Groundwater monitoring at PORTS was initiated in the 1980s. Groundwater monitoring has been conducted in response to state and/or federal regulations, regulatory documents prepared by DOE, agreements between DOE and Ohio EPA or U.S. EPA, and DOE Orders.

Because of the numerous regulatory programs applicable to groundwater monitoring at PORTS, an *Integrated Groundwater Monitoring Plan* was developed to address all groundwater monitoring requirements for PORTS. The initial plan was approved by Ohio EPA and implemented at PORTS starting in April 1999. The *Integrated Groundwater Monitoring Plan* is periodically revised by DOE and approved by Ohio EPA. An annual groundwater report is submitted to Ohio EPA in accordance with the *Integrated Groundwater Monitoring Plan*. Groundwater monitoring in 2011 was completed in accordance with the *Integrated Groundwater Monitoring Plan* dated September 2010.

Groundwater monitoring is also conducted to meet DOE Order requirements. Exit pathway monitoring assesses the effect of PORTS on off-site groundwater quality. DOE Orders are the basis for radiological monitoring of groundwater at PORTS.

6.3.2 Groundwater Use and Geology

Two water-bearing zones are present beneath PORTS: the Gallia and Berea formations. The Gallia is the uppermost water-bearing zone and contains most of the groundwater contamination at PORTS. The Berea is deeper than the Gallia and is usually separated from the Gallia by the Sunbury shale, which acts as a barrier to impede groundwater flow between the Gallia and Berea formations. Additional information about site hydrogeology is available in the PORTS Environmental Information Center.

Groundwater directly beneath PORTS is not used as a domestic, municipal, or industrial water supply, and contaminants in the groundwater beneath PORTS do not affect the quality of the water in the Scioto River Valley buried aquifer. PORTS is the largest industrial user of water in the vicinity and obtains water from two water supply well fields west of PORTS in the Scioto River Valley buried aquifer. DOE has filed a deed notification at the Pike County Auditor's Office that restricts the use of groundwater beneath the PORTS site.

6.3.3. Monitoring Activities

Groundwater monitoring at PORTS includes several activities. Samples of water are collected from groundwater monitoring wells and analyzed to obtain information about contaminants and naturally-occurring compounds in the groundwater. Monitoring wells are also used to obtain other information about groundwater. When the level of water, or groundwater elevation, is measured in a number of wells over a short period of time, the groundwater elevations, combined with information about the subsurface soil, can be used to estimate the rate and direction of groundwater flow. The rate and direction of groundwater flow can be used to predict the movement of contaminants in the groundwater and to develop ways to control or remediate groundwater contamination.

6.4 GROUNDWATER MONITORING AREAS

The *Integrated Groundwater Monitoring Plan* requires groundwater monitoring of 12 areas within the quadrants of the site designated by the RCRA Corrective Action Program. These areas (see Figure 6.1) are:

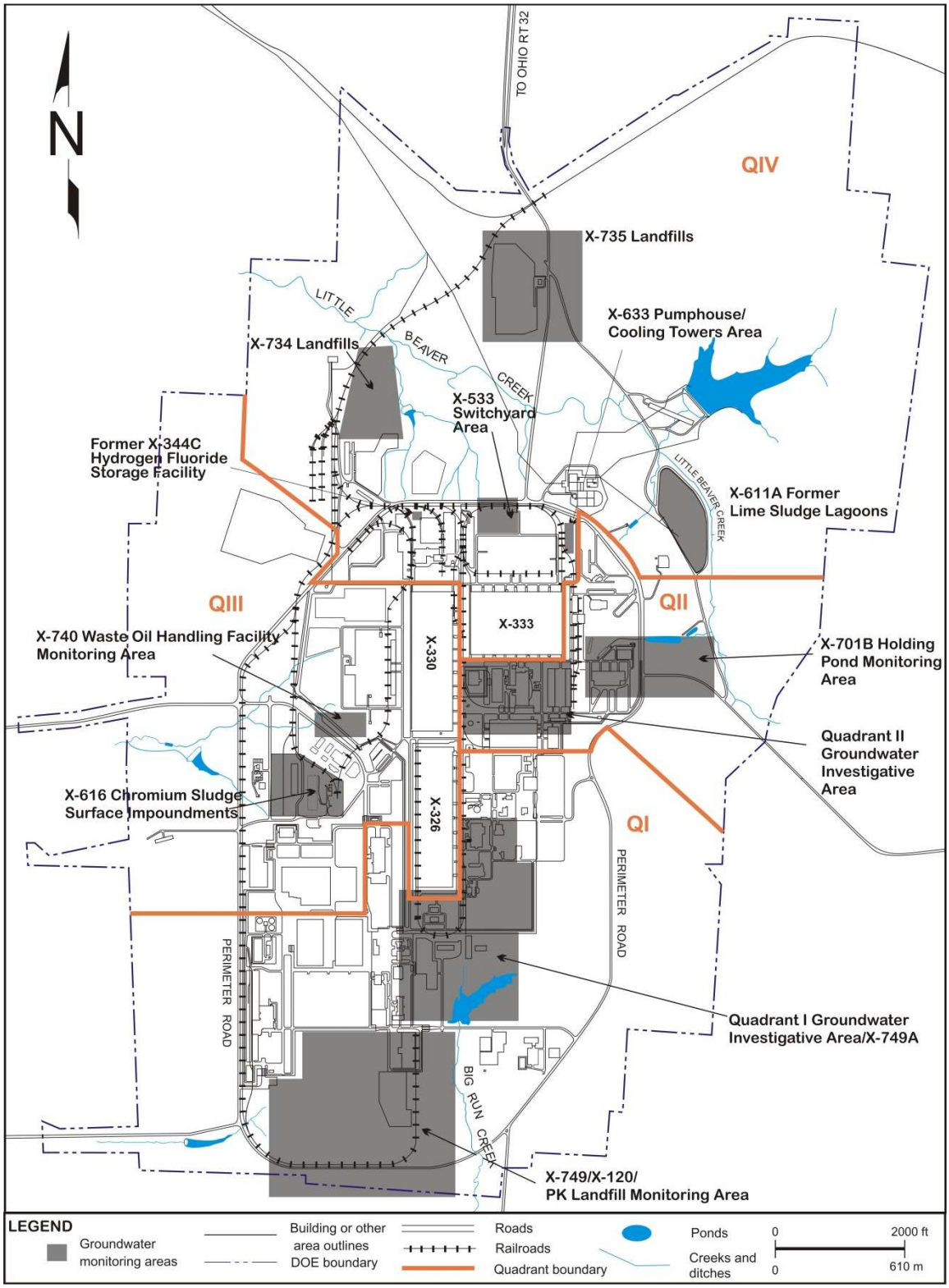

Figure 6.1. Groundwater monitoring areas at PORTS.

- Quadrant I
  - X-749/X-120/PK Landfill,
  - Quadrant I Groundwater Investigative Area/X-749A Classified Materials Disposal Facility,
- Quadrant II
  - Quadrant II Groundwater Investigative Area,
  - X-701B Holding Pond,
  - X-633 Pumphouse/Cooling Towers Area,
- Quadrant III
  - X-616 Chromium Sludge Surface Impoundments,
  - X-740 Waste Oil Handling Facility,
- Quadrant IV
  - X-611A Former Lime Sludge Lagoons,
  - X-735 Landfills,
  - X-734 Landfills,
  - X-533 Switchyard Area, and
  - Former X-344C Hydrogen Fluoride Storage Building.

The *Integrated Groundwater Monitoring Plan* also contains requirements for 1) surface water monitoring in creeks and drainage ditches at PORTS that receive groundwater discharge, and 2) water supply monitoring.

In general, samples are collected from wells (or surface water locations) at each area listed above and are analyzed for metals, volatile organic compounds, and/or radionuclides. Table 6.1 lists the analytical requirements for each groundwater monitoring area and other monitoring programs described in this chapter. Constituents detected in the groundwater are then compared to standards called preliminary remediation goals to assess the potential for each constituent to affect human health and the environment.

Five areas of groundwater contamination, commonly called groundwater plumes, have been identified at PORTS. Groundwater contamination consists of volatile organic compounds (primarily TCE) and radionuclides such as technetium-99. The areas that contain groundwater plumes are X-749/X-120/PK Landfill, Quadrant I Groundwater Investigative Area/X-749A Classified Materials Disposal Facility, Quadrant II Groundwater Investigative Area, X-701B Holding Pond, and X-740 Waste Oil Handling Facility. Other areas are monitored to evaluate groundwater contaminated with metals, to ensure past uses of the area (such as a landfill) have not caused groundwater contamination, or to monitor remediation that has taken place in the area.

The following sections describe the history of each groundwater monitoring area and groundwater monitoring results for each area in 2011.

6.4.1 X-749 Contaminated Materials Disposal Facility/X-120 Old Training Facility/PK Landfill

In the southernmost portion of PORTS in Quadrant I, groundwater concerns focus on three contaminant sources: X-749 Contaminated Materials Disposal Facility, X-120 Old Training Facility, and PK Landfill.

6.4.1.1 X-749 Contaminated Materials Disposal Facility

The X-749 Contaminated Materials Disposal Facility is a landfill located in the south-central section of the facility in Quadrant I. The landfill covers approximately 7.5 acres and was built in an area of highest elevation within the southern half of PORTS. The landfill operated from 1955 to 1990, during which time buried wastes were generally contained in metal drums or other containers compatible with the waste.

Table 6.1. Analytical parameters for monitoring areas and programs at PORTS in 2011

Monitoring Area or Program	Analytes	
X-749/X-120/PK Landfill[a,b]		
X-749/X-120 plume	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] total metals[d]: Be, Cd, Cr, Mn, Ni
PK Landfill	volatile organic compounds[c]	total metals[d]: Be, Cd, Cr, Mn, Ni
Quadrant I Groundwater Investigative Area[a,b]		
X-231B plume	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] total metals[d]: Be, Cd, Cr, Mn, Ni
X-749A Classified Materials Disposal Facility	volatile organic compounds[e] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[c] alkalinity chloride sulfate chemical oxygen demand total dissolved solids	total metals[d]: Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn nitrite nitrate ammonia
Quadrant II Groundwater Investigative Area[a,b]	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] total metals[d]: Be, Cd, Cr, Mn, Ni
X-701B Holding Pond[a,b]	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d]	alkalinity chloride sulfate total dissolved solids total metals[d]: Be, Cd, Cr, Mn, Ni
X-633 Pumphouse/Cooling Towers Area	total metals[d]: Cr	
X-616 Chromium Sludge Surface Impoundments	volatile organic compounds[c]	total metals[d]: Be, Cd, Cr, Mn, Ni
X-740 Waste Oil Handling Facility	volatile organic compounds[c]	

Table 6.1. Analytical parameters for monitoring areas and programs at PORTS – 2011 (continued)

Monitoring Area or Program	Analytes	
X-611A Former Lime Sludge Lagoons	total metals[d]: Be, Cr	
X-735 Landfills	volatile organic compounds[e] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride sulfate chemical oxygen demand	total metals[d]: Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Hg, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn nitrite nitrate ammonia total dissolved solids
X-734 Landfills	volatile organic compounds[c] technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride sulfate chemical oxygen demand	total metals[d]: Be, Cd, Cr, Mn, Ni nitrite nitrate ammonia total dissolved solids
X-533 Switchyard Area	total metals[d]: Cd, Ni	
Former X-344C Hydrogen Fluoride Storage Building	volatile organic compounds[c]	
Surface Water	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d]
Water Supply	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d]
Exit Pathway[b]	volatile organic compounds[c] transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}$Pu	technetium-99 U, $^{233/234}$U, ^{235}U, ^{236}U, ^{238}U[d]

[a]Selected well(s) in this area are sampled once every two years for a comprehensive list of more than 200 potential contaminants (Title 40, Code of Federal Regulations, Part 264 Appendix IX – Appendix to Ohio Administrative Code Rule 3745-54-98).
[b]Not all wells in this area are analyzed for all listed analytes.
[c]Acetone, benzene, bromodichloromethane, bromoform, carbon disulfide, carbon tetrachloride, chlorobenzene, chloroethane, chloroform, dibromochloromethane, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, ethylbenzene, bromomethane, chloromethane, methylene chloride, 2-butanone (methyl ethyl ketone), 4-methyl-2-pentanone (methyl isobutyl ketone), 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, TCE, trichlorofluoromethane (CFC-11), vinyl chloride, xylenes (M+P xylenes).
[d]Appendix C lists the symbols for metals and transuranic radionuclides.
[e]Volatile organic compounds listed in footnote c plus: acrylonitrile, bromochloromethane, 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, trans-1,4-dichloro-2-butene, 1,2-dichloropropane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 2-hexanone (methyl butyl ketone), dibromomethane, iodomethane, styrene, 1,1,1,2-tetrachloroethane, 1,2,3-trichloropropane, and vinyl acetate.

The northern portion of the X-749 Landfill contains waste contaminated with industrial solvents, waste oils from plant compressors and pumps, sludges classified as hazardous, and low-level radioactive materials. The southern portion of the X-749 Landfill contains non-hazardous, low-level radioactive scrap materials.

The initial closure of the X-749 Landfill in 1992 included installation of 1) a multimedia cap, 2) a barrier wall along the north side and northwest corner of X-749 Landfill, and 3) subsurface groundwater drains on the northern half of the east side and the southwest corner of the landfill, including one sump within each of the groundwater drains. The barrier wall and subsurface drains extended down to bedrock. An additional barrier wall on the south and east sides of the X-749 Landfill was constructed in 2002. The groundwater drain and sump on the east side of the landfill were removed for construction of this barrier wall. Groundwater from the remaining subsurface drain is treated at the X-622 Groundwater Treatment Facility and discharged through FBP NPDES Outfall 608, which flows to the X-6619 Sewage Treatment Plant.

In 2002 and 2003, hybrid poplar trees were planted in several areas of the X-749/X-120 groundwater plume. The trees are used in a process called phytoremediation to degrade or contain contaminants in soil and/or groundwater. Chapter 3, Section 3.3.1.1, provides additional information about the remedial actions implemented to address the X-749/X-120 groundwater plume.

The leading edge of the contaminated groundwater plume emanating from the X-749 Landfill is near the southern boundary of PORTS. In 1994, a subsurface barrier wall was completed across a portion of this southern boundary of PORTS. The X-749 South Barrier Wall was designed to inhibit migration of the plume off plant property prior to the implementation of a final remedial measure; however, volatile organics moved beyond the wall. In 2007, four groundwater extraction wells were installed in the X-749 South Barrier Wall Area, and in 2008, two extraction wells were installed in the groundwater collection system on the southwest side of the landfill. These extraction wells are controlling migration of the plume off plant property and reducing concentrations of TCE in groundwater. Two additional groundwater extraction wells were installed in 2010 to further control migration of the X-749/X-120 groundwater plume and remediate areas of higher TCE concentrations within the plume. A third extraction well was installed in the X-120 area of the plume (see Section 6.4.1.2).

Ninety-five wells and one sump/extraction well were sampled during 2011 to monitor the X-749/X-120 area. Table 6.1 lists the analytical parameters for the wells and sump in this area.

6.4.1.2 X-120 Old Training Facility

The former X-120 Old Training Facility, which is west and north of the X-749 Contaminated Materials Disposal Facility, covered an area of approximately 11.5 acres west of the present-day XT-847 building. The X-120 facility, which no longer exists, included a machine shop, metal shop, paint shop, and several warehouses used during the construction of PORTS in the 1950s. Groundwater in the vicinity of this facility is contaminated with volatile organic compounds, primarily TCE. In 1996, a horizontal well was installed along the approximate axis of the X-120 plume. Contaminated groundwater flowed from this well to the X-625 Groundwater Treatment Facility. In 2003, operation of the X-625 Groundwater Treatment Facility and horizontal well ceased with the approval of Ohio EPA due to the limited amount of groundwater collected by the well. A groundwater extraction well was installed in 2010 in the area west of the former X-120 Old Training Facility to remediate the higher concentrations of TCE in groundwater in this area. Chapter 3, Section 3.3.1.1, provides additional information about the remedial actions implemented to address the X-749/X-120 groundwater plume.

Ninety-five wells and one sump/extraction well were sampled during 2011 to monitor the X-749/X-120 area. Table 6.1 lists the analytical parameters for the wells and sump in this area.

6.4.1.3 PK Landfill

The PK Landfill is located west of Big Run Creek just south of the X-230K Holding Pond in Quadrant I. The landfill, which began operations in 1952, was used as a salvage yard, burn pit, and trash area during the construction of PORTS. After the initial construction, the disposal site was operated as a sanitary landfill until 1968, when soil was graded over the site and the area was seeded with native grasses.

During site investigations, intermittent seeps were observed emanating from the PK Landfill into Big Run Creek. In 1994, a portion of Big Run Creek was relocated approximately 50 feet to the east. A groundwater collection system was installed in the old creek channel to capture the seeps emanating from the landfill. A second collection system was constructed in 1997 on the southeastern landfill boundary to contain the groundwater plume migrating toward Big Run Creek from the southern portion of the PK Landfill. A cap was constructed over the landfill in 1998. Chapter 3, Section 3.3.1.2, provides additional information about the remedial actions implemented at PK Landfill.

In 2011, nine wells, two sumps, and two manholes were sampled to monitor the PK Landfill area. Table 6.1 lists the analytical parameters for the wells and sumps in this area.

6.4.1.4 Monitoring results for the X-749/X-120/PK Landfill in 2011

A contaminated groundwater plume is associated with the X-749/X-120/PK Landfill groundwater monitoring area (see Figure 6.2) in Quadrant I. The most extensive and most concentrated constituents associated with the X-749/X-120 plume are volatile organic compounds, particularly TCE.

In 2011, concentrations of TCE continued to decrease in a number of wells within the X-749/X-120 plume due to the extraction wells installed in the X-749 South Barrier Wall Area (X749-EW01G, X749-EW02G, X749-EW03G, and X749-EW04G) and the additional extraction wells installed in the collection trench on the southwest side of the X-749 Landfill (X749-EW05G and X749-EW06G). TCE was detected at an estimated concentration of 0.25 µg/L in the first quarter sample collected from off-site monitoring well WP-03G. No TCE or other volatile organic compounds were detected in any of the seven off-site monitoring wells sampled in the second, third, and/or fourth quarters of 2011.

The area within the central portion of the X-749/X-120 groundwater plume where TCE concentrations are less than 5 µg/L expanded from two wells in 2010 to four wells in 2011. The area of the plume with higher TCE concentrations (100 µg/L to 1000 µg/L) to the south and west of the X-749 Landfill remained detached from the higher TCE concentrations around the landfill and was continuing to diminish. Figure 6.2 provides data for selected X-749/X-120 monitoring wells that illustrate the decreasing TCE concentrations in the wells.

In the third quarter, TCE was detected in samples collected on July 7, 2011, from two wells that are typically outside of the X-749/X-120 groundwater plume (X749-14B and X749-112G). These wells are on the east side of the X-749/X-120 monitoring area, south of the landfill and 200-250 ft west of Big Run Creek (see Figure 6.2). TCE was detected at 6.7 µg/L in well X749-112G and 4.2 µg/L in well X749-14B.

To confirm these results, the wells were sampled again on September 7, 2011. TCE was detected at 1.8 µg/L in well X749-112G and 37 µg/L in well X749-14B. These two wells and eight additional wells on the east side of the monitoring area were sampled in October 2011. TCE was detected at typical concentrations in the eight additional wells (ranging from undetected to 4.8 µg/L). TCE was also detected again in wells X749-112G and X749-14B at estimated concentrations less than 1 µg/L. Samples were collected monthly in the fourth quarter of 2011 from wells X749-112G and X749-14B, as well as surface water sampling location BRC-SW02 in Big Run Creek, which is downgradient from the

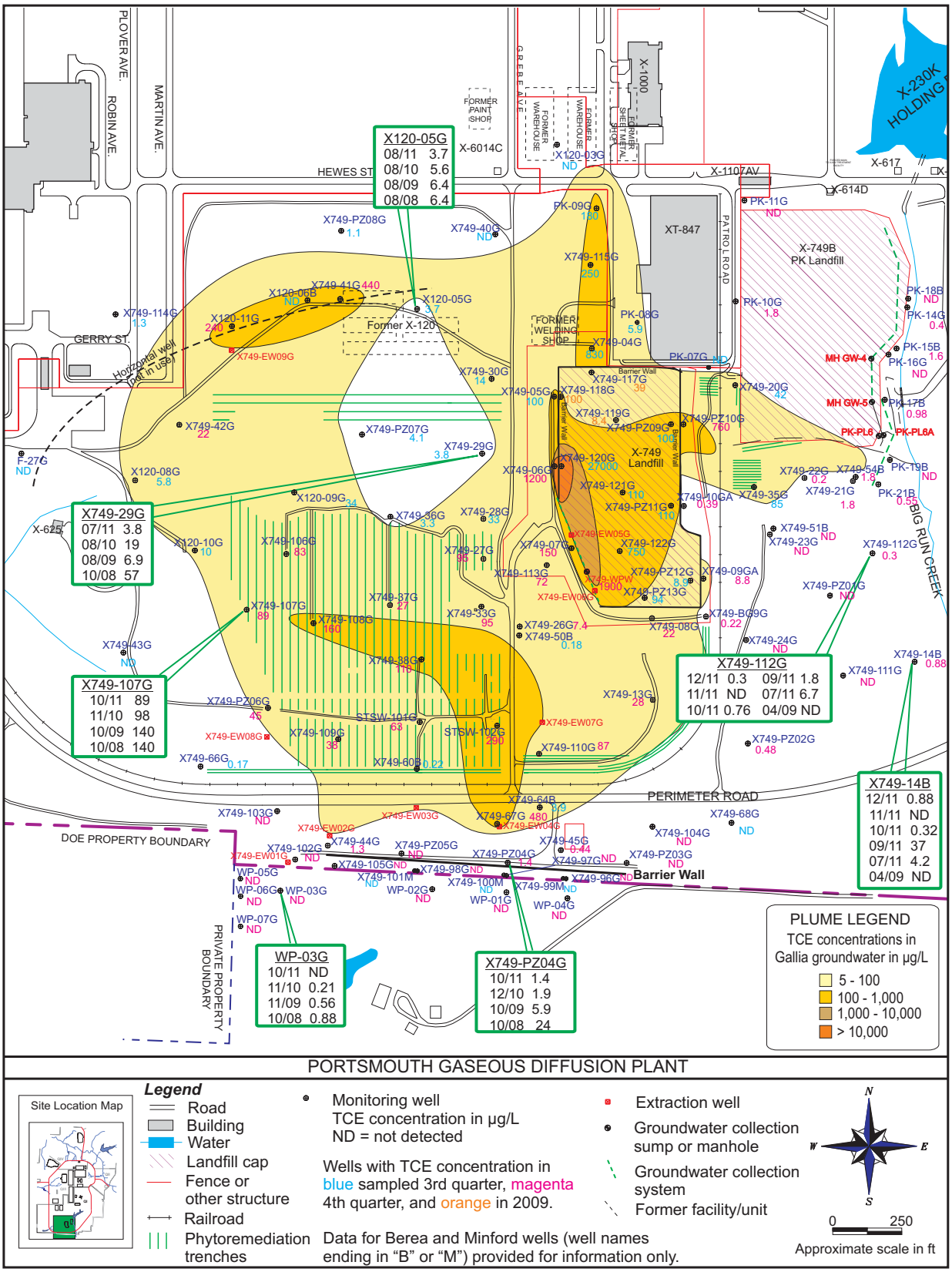

Figure 6.2. TCE-contaminated Gallia groundwater plume at the X-749/X-120/PK Landfill – 2011.

monitoring wells just before the creek flows under Perimeter Road. If detected, TCE was present in the samples collected in the fourth quarter of 2011 at estimated concentrations less than 1 µg/L. Figure 6.2 includes selected data for wells X749-14B and X749-112G. The *2011 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* includes complete data collected in 2011 for this special sampling. More frequent monitoring of this area continued in 2012.

Samples from selected wells that monitor the X-749/X-120 groundwater plume were analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and/or uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

Some of the wells associated with the PK Landfill are also contaminated with low levels of volatile organic compounds, but usually at concentrations below preliminary remediation goals. Vinyl chloride was detected in samples collected from wells PK-17B and PK-21B at concentrations ranging from 14 to 22 µg/L, which exceed the preliminary remediation goal of 2 µg/L. Vinyl chloride is typically detected in these wells at concentrations above the preliminary remediation goal.

6.4.2 Quadrant I Groundwater Investigative Area/X-749A Classified Materials Disposal Facility

In the northern portion of Quadrant I, groundwater concerns are focused on two areas: the Quadrant I Groundwater Investigative Area and the X-749A Classified Materials Disposal Facility.

6.4.2.1 Quadrant I Groundwater Investigative Area

The Quadrant I Groundwater Investigative Area, also called the Five-Unit Groundwater Investigative Area, consists of a groundwater plume resulting from a number of potential sources of groundwater contamination: the X-231A and X-231B Oil Biodegradation Plots, X-600 Coal-Fired Steam Plant, X-600A Coal Pile Yard, X-621 Coal Pile Runoff Treatment Facility, X-710 Technical Services Building, X-749A Classified Materials Disposal Facility, the X-760 Pilot Investigation Building, and the X-770 Mechanical Testing Facility. The X-231B Southwest Oil Biodegradation Plot was monitored prior to implementation of the *Integrated Groundwater Monitoring Plan*.

Three groundwater extraction wells were installed in 1991 as part of an interim remedial measure for the X-231B Southwest Oil Biodegradation Plot. Eleven additional groundwater extraction wells were installed in 2001-2002 as part of the remedial actions required by the Quadrant I Decision Document. These wells began operation in 2002. An additional extraction well south of the X-326 Process Building began operating in 2009. The extracted groundwater is treated at the X-622 Groundwater Treatment Facility and discharged through FBP NPDES Outfall 608, which flows into the X-6619 Sewage Treatment Plant. Multimedia landfill caps were installed over the X-231B area and a similar area, X-231A, in 2000 to minimize water infiltration and control the spread of contamination. Chapter 3, Section 3.3.1.3, provides additional information about the remedial actions implemented in the Quadrant I Groundwater Investigative Area.

Thirty-one wells were sampled in 2011 as part of the monitoring program for the Quadrant I Groundwater Investigative Area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.2.2 X-749A Classified Materials Disposal Facility

The 6-acre X-749A Classified Materials Disposal Facility (also called the X-749A Landfill) is a landfill that operated from 1953 through 1988 for the disposal of wastes classified under the Atomic Energy Act. Potential contaminants include PCBs, asbestos, radionuclides, and industrial waste. Closure of the landfill, completed in 1994, included the construction of a multilayer cap and the installation of a drainage system to collect surface water runoff. The drainage system discharges via an NPDES-permitted outfall.

Ten wells associated with the landfill were sampled in 2011. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.2.3 Monitoring results for the Quadrant I Groundwater Investigative Area/X-749A in 2011

A contaminated groundwater plume consisting primarily of TCE is associated with the Quadrant I Groundwater Investigative Area (see Figure 6.3). Other volatile organic compounds are also present in the plume.

No significant changes in TCE concentrations were identified in wells that monitor the Quadrant I Groundwater Investigative Area in 2011. Figure 6.3 shows the groundwater plume for this area and provides data for selected Quadrant I Groundwater Investigative Area monitoring wells.

Samples from selected wells that monitor the Quadrant I Groundwater Investigative Area were analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and/or uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

Under the detection monitoring program for the X-749A Landfill, concentrations of alkalinity, chloride, sodium, sulfate, and total dissolved solids in downgradient Gallia wells are evaluated to monitor potential impacts to groundwater and trends in concentrations of these parameters (alkalinity, chloride, sodium, sulfate, and total dissolved solids). None of the statistical control limits or background concentrations for alkalinity, chloride, sodium, sulfate, and total dissolved solids were exceeded in samples collected in 2011.

6.4.3 Quadrant II Groundwater Investigative Area

The Quadrant II Groundwater Investigative Area consists of an area of groundwater contamination with several potential sources. One of these sources, the X-701C Neutralization Pit, was monitored prior to implementation of the *Integrated Groundwater Monitoring Plan*. The X-701C Neutralization Pit was an open-topped neutralization pit that received process effluents and basement sump wastewater such as acid and alkali solutions and rinse water contaminated with TCE and other volatile organic compounds from metal-cleaning operations. The X-701C Neutralization Pit was located within a TCE plume centered around the X-700 and X-705 buildings. The pit was removed in 2001. In 2010, Ohio EPA approved an IRM to remediate contaminant source areas within the southeastern portion of the groundwater plume. Chapter 3, Section 3.3.2.1 provides additional information about the Quadrant II Groundwater Investigative Area.

The natural groundwater flow direction in this area is to the east toward Little Beaver Creek. The groundwater flow pattern has been changed in this area by use of sump pumps in the basements of the X-700 and X-705 buildings. Thus, the groundwater plume in this area does not spread but instead flows toward the sumps where it is collected and then treated at the X-627 Groundwater Treatment Facility. This facility discharges through FBP NPDES Outfall 611, which flows to the X-6619 Sewage Treatment Plant. Eighteen wells are sampled annually or biennially as part of the monitoring program for this area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.3.1 Monitoring results for the Quadrant II Groundwater Investigative Area in 2011

A contaminated groundwater plume consisting primarily of TCE is associated with the Quadrant II Groundwater Investigative Area (see Figure 6.4). The perimeter of the plume did not change in 2011, although concentrations of TCE and other volatile organic compounds within the southeastern portion of the plume changed due to the IRM.

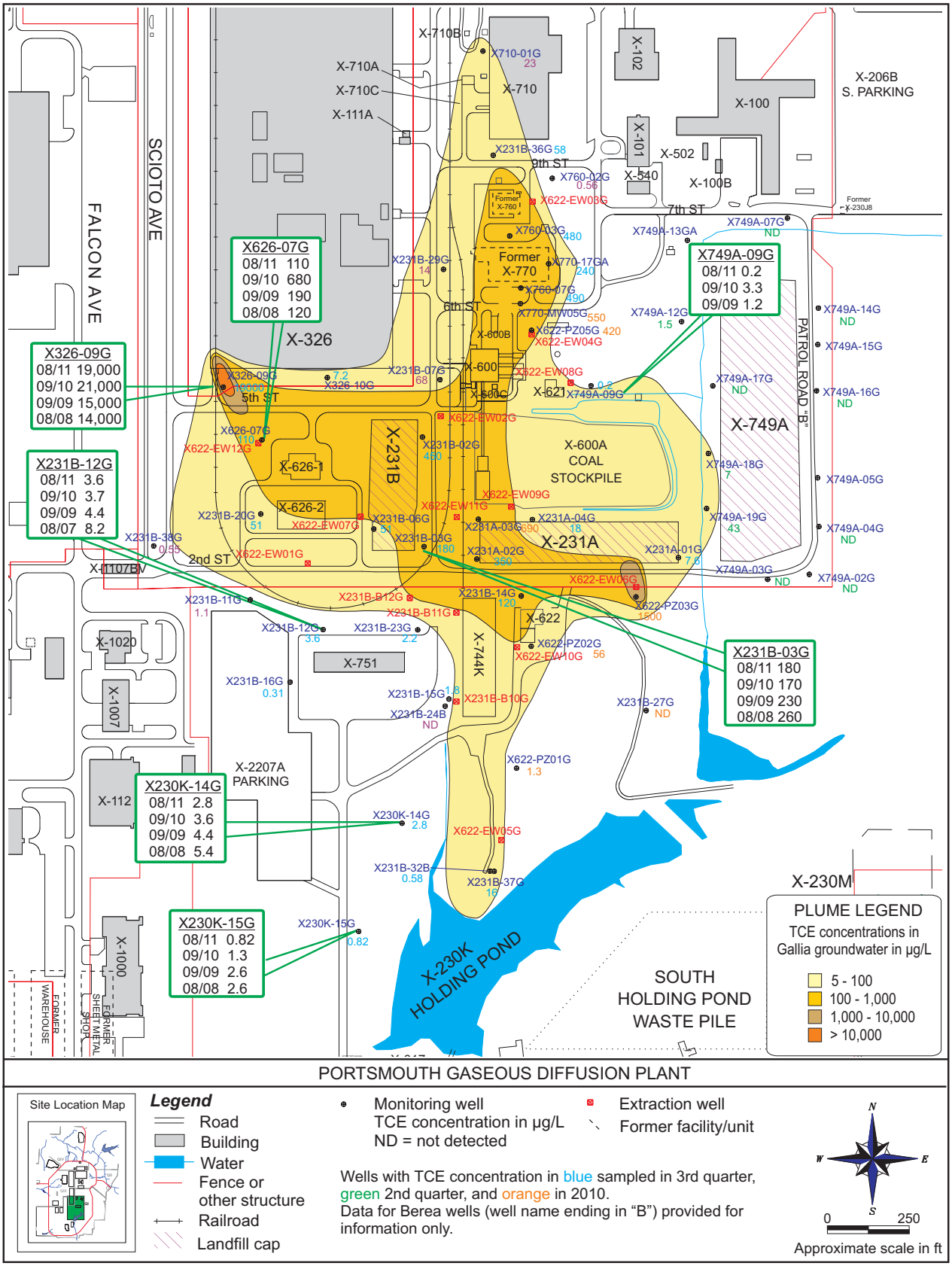

Figure 6.3. TCE-contaminated Gallia groundwater plume at the Quadrant I Groundwater Investigative Area – 2011.

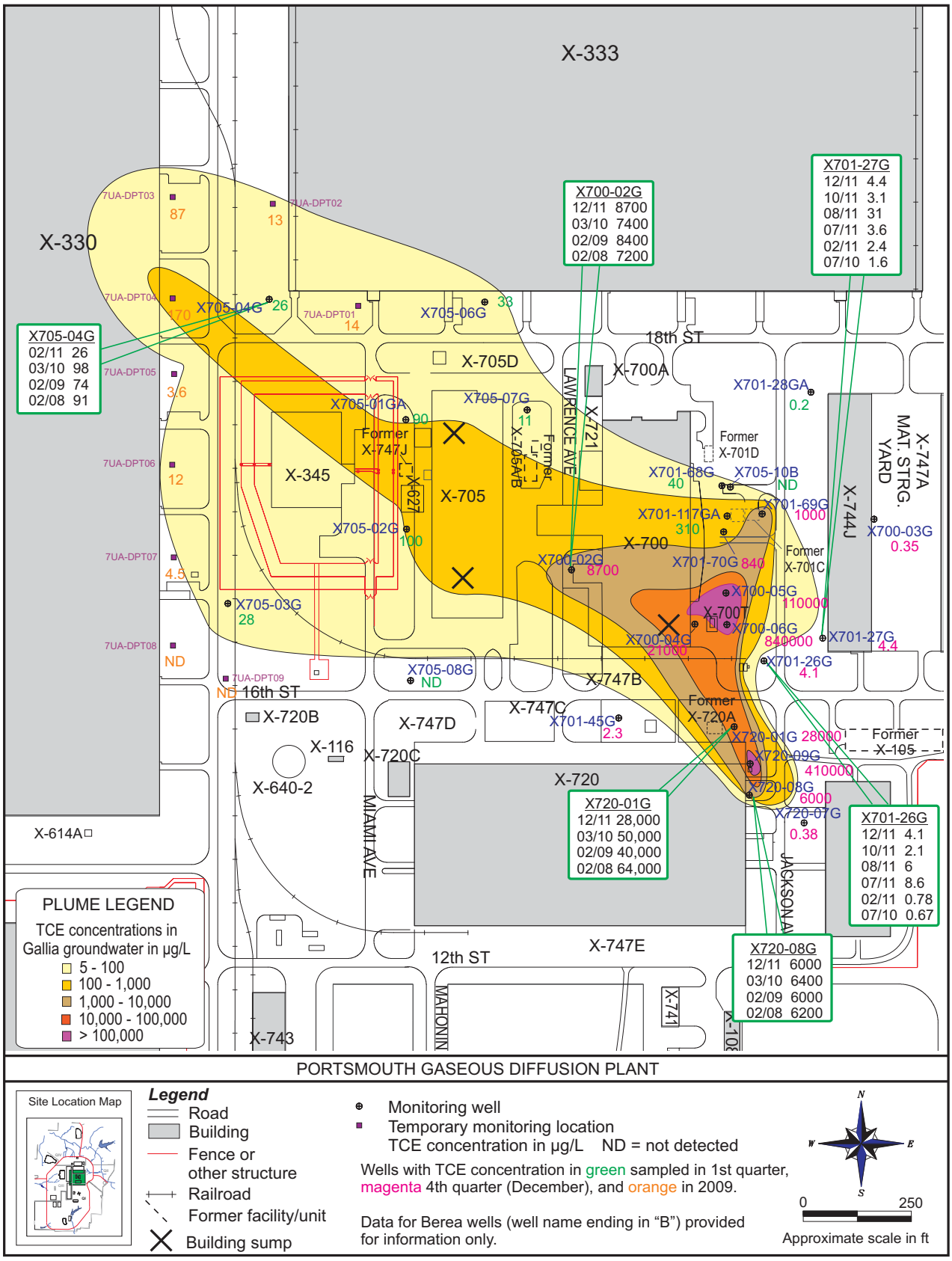

Figure 6.4. TCE-contaminated Gallia groundwater plume at the Quadrant II Groundwater Investigative Area – 2011.

In 2011, some of the wells that provide routine monitoring of the Quadrant II Groundwater Investigative Area were also monitored monthly as part of the IRM taking place in this area (see Chapter 3, Section 3.3.2.1). In the third quarter of 2011, TCE was detected at concentrations above 5 µg/L (the definition of the plume perimeter) in two wells (X701-26G and X701-27G) that monitor the east side of the Quadrant II Groundwater Investigative Area plume. TCE is not typically detected above 5 µg/L in these two wells. Concentrations of TCE decreased to less than the PRG in the fourth quarter samples collected from the wells. The increases in TCE may be due to the higher than average rainfall that occurred in 2011. Figure 6.3 includes selected data for wells X701-26G and X701-27G. The *2011 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* includes the monthly monitoring data collected to support the IRM in this area.

Samples from selected wells that monitor the Quadrant II Groundwater Investigative Area were analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and/or uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

6.4.4 X-701B Holding Pond

In the eastern portion of Quadrant II, groundwater concerns focus on three areas: the X-701B Holding Pond, the X-230J7 Holding Pond, and the X-744Y Waste Storage Yard.

The X-701B Holding Pond was used from the beginning of plant operations in 1954 until 1988. The pond was designed for neutralization and settlement of acid waste from several sources. TCE and other volatile organic compounds were also discharged to the pond. Two surface impoundments (sludge retention basins) were located west of the holding pond. The X-230J7 Holding Pond received wastewater from the X-701B Holding Pond. The X-744Y Waste Storage Yard is south of the X-701B Holding Pond. The yard is approximately 15 acres and surrounds the X-744G Bulk Storage Building. RCRA hazardous waste was managed in this area.

A contaminated groundwater plume extends from the X-701B Holding Pond towards Little Beaver Creek. Three groundwater extraction wells were installed southeast of the X-701B Holding Pond and a sump was installed in the bottom of the pond as part of the ongoing RCRA closure of the unit. These wells and sump were designed to intercept contaminated groundwater emanating from the holding pond area before it could join the existing groundwater contaminant plume. The wells and sump were removed between 2009 and 2011 because of the X-701B IRM (see Chapter 3, Section 3.3.2.2). In 2011, extracted groundwater and other water generated by the X-701B IRM was processed at the X-623 Groundwater Treatment Facility and discharged through FBP NPDES Outfall 611, which flows to the X-6619 Sewage Treatment Plant.

Two groundwater interceptor trenches (French drains) are used to intercept TCE-contaminated groundwater in the eastern portion of the monitoring area. These interceptor trenches, called the X-237 Groundwater Collection System, control TCE migration into Little Beaver Creek. The 660-foot-long primary trench has two sumps in the backfill and a 440-foot-long secondary trench intersects the primary trench. The extracted groundwater is treated at the X-624 Groundwater Treatment Facility and discharges through FBP NPDES Outfall 015, which flows to Little Beaver Creek.

Groundwater remediation in the X-701B Holding Pond Area was initiated in 2006 (see Chapter 3, Section 3.2.2). Oxidant was injected into the subsurface in the western portion of the area from 2006 through 2008 to remediate volatile organic compounds in soil and groundwater. The X-701B IRM was initiated in December 2009 and completed in 2011 to further address contaminants remaining in soil and groundwater following the oxidant injections. Contaminated soil in the X-701B IRM area was removed

and mixed with oxidant, with additional oxidant mixed into soil remaining at the bottom of the excavation. Figure 6.5 shows the IRM area.

The groundwater monitoring wells in the area of the X-701B IRM (the western portion of the monitoring area) were removed from the monitoring program to be replaced following the completion of the X-701B IRM. Thirty wells were sampled in 2011 as part of the routine monitoring program for this area. Table 6.1 lists the analytical parameters for the wells that are routinely monitored in this area. Additional wells were sampled either quarterly or monthly throughout 2011 to monitor the IRM. The *2011 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* includes the monitoring data collected to support the X-701B IRM.

6.4.4.1 Monitoring results for the X-701B Holding Pond in 2011

For the most part, concentrations of TCE detected in the eastern portion of the X-701B groundwater plume (the area that was not part of the IRM) and the X-744G area were similar to previous years. In the northeast corner of the monitoring area, however, TCE was detected at 84 µg/L in the third quarter sample collected from well LBC-PZ06G, which is located east of the X-237 Groundwater Collection System and just west of Little Beaver Creek. TCE is not typically detected in this well. TCE was not detected in third quarter samples collected from the two wells (X701-16G and X701-58B) closest to LBC-PZ06G. Well LBC-PZ06G, as well as four other wells in the vicinity of LBC-PZ06G were sampled in the fourth quarter and analyzed for volatile organic compounds to provide more information about this detection.

TCE was not detected in the fourth quarter sample collected from well LBC-PZ06G. TCE was detected in the sample collected from well X701-IRMPZ08G at 19 µg/L. Well X701-IRMPZ08G is located on the north side of the East Drainage Ditch in an area where the groundwater plume was not believed to be present. Additional sampling and remedial activities were completed in 2012 to evaluate the X-237 Groundwater Collection System. Figure 6.5 shows the TCE concentrations detected in well LBC-PZ06G in 2010-2011.

In the western portion of the monitoring area, TCE was detected in the new monitoring wells installed in the IRM area at concentrations similar to those detected in groundwater prior to the IRM. Figure 6.5 shows the groundwater plume in the western portion of the X-701B monitoring area and TCE concentrations in selected wells in 2011.

Samples from selected wells that monitor the X-701B Holding Pond were analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and/or uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

Samples from five wells in or near the X-744G Bulk Storage Building and X-744Y Storage Yard were analyzed for cadmium and nickel, which were detected above preliminary remediation goals in three of the five wells (X701-01G, X744G-01G, and X744G-02G). These results are typical for the X-744 area wells.

6.4.5 X-633 Pumphouse/Cooling Towers Area

The X-633 Pumphouse/Cooling Towers Area in Quadrant II consisted of a recirculating water pumphouse and four cooling towers with associated basins. Chromium-based corrosion inhibitors were added to the cooling water until the early 1990s, when the system was converted to a phosphate-based inhibitor. In 2009, DOE received funding under ARRA for D&D of the X-633 Pumphouse and Cooling Towers. D&D of the facilities was completed in 2010. Chapter 3, Section 3.3.2.3 provides additional information about the RCRA investigation of soils and groundwater in this area.

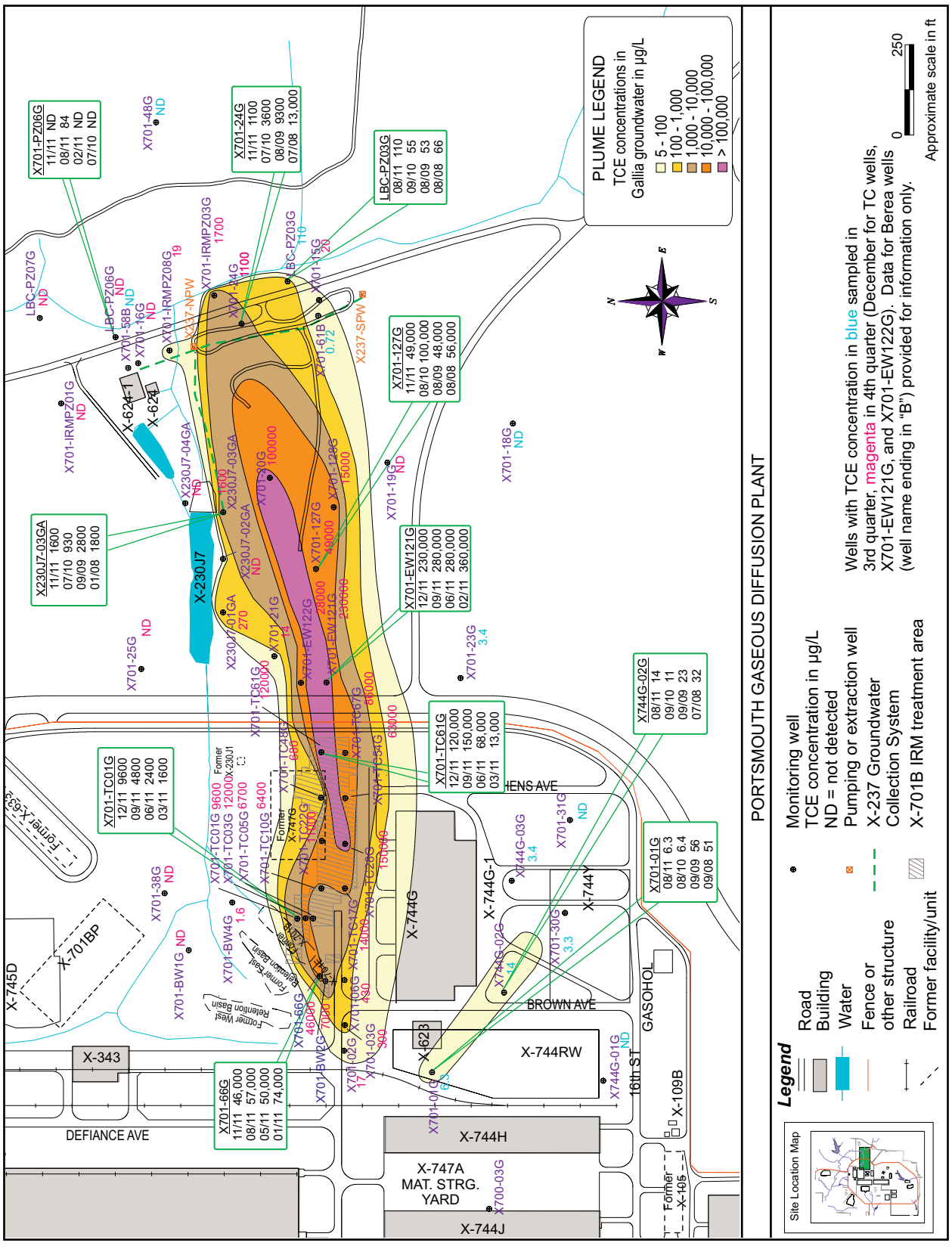

Figure 6.5. TCE-contaminated Gallia groundwater plume at the X-701B Holding Pond – 2011.

The X-633 Pumphouse/Cooling Towers Area was identified as an area of concern for potential metals contamination in 1996 based on historical analytical data for groundwater wells in this area. Samples from wells in this area were collected in 1998 and 1999 to assess the area for metals contamination. Based on detections of chromium above the preliminary remediation goal, this area was added to the PORTS groundwater monitoring program. Two wells are sampled semiannually for chromium as part of the monitoring program for this area.

6.4.5.1 Monitoring results for the X-633 Pumphouse/Cooling Towers Area in 2011

Chromium was detected in both of the X-633 monitoring wells in 2011. Samples collected from well X633-07G contained chromium at concentrations above the preliminary remediation goal of 100 µg/L: 560 µg/L (second quarter) and 980 µg/L (fourth quarter). Samples collected from well X633-PZ04G also contained chromium but at concentrations well below the preliminary remediation goal. These results are typical for these wells. Figure 6.6 shows the chromium concentrations detected in the X-633 Pumphouse/Cooling Tower area wells.

6.4.6 X-616 Chromium Sludge Surface Impoundments

The X-616 Chromium Sludge Surface Impoundments in Quadrant III were two unlined surface impoundments used from 1976 to 1985 for storage of sludge generated by the treatment of water from the PORTS process cooling system. A corrosion inhibitor containing chromium was used in the cooling water system. Sludge containing chromium was produced by the water treatment system and was pumped into and stored in the X-616 impoundments. The sludge was removed from the impoundments and remediated as an interim action in 1990 and 1991. The unit was certified closed in 1993. Seven wells are sampled annually and nine wells are sampled biennially as part of the monitoring program for this area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.6.1 Monitoring results for the X-616 Chromium Sludge Surface Impoundments in 2011

Chromium is of special concern at X-616 because of the previous use of the area. In 2011, chromium was detected above the preliminary remediation goal of 100 µg/L in one well that monitors the X-616 area: well X616-05G (on the northeastern boundary of the area). Chromium is typically detected above the preliminary remediation goal in this well. Nickel was detected above the preliminary remediation goal (100 µg/L for Gallia wells) in two wells (X616-05G and X616-25G). Nickel is typically detected above the preliminary remediation goal in these two wells. Figure 6.7 shows the concentrations of chromium and nickel in wells at the X-616 Chromium Sludge Surface Impoundments.

In 2011, volatile organic compounds were detected at low levels in samples collected from nine wells in this area. Volatile organic compounds are routinely detected in samples from wells in this area, primarily in wells located west or south of the former impoundments. The only volatile organic compounds detected above the preliminary remediation goals were 1,1-dichloroethene and TCE, which were detected in wells X616-09G, X616-13G, and/or X616-20B. Figure 6.7 shows the concentrations of TCE detected in the X-616 wells in 2011.

6.4.7 X-740 Waste Oil Handling Facility

The former X-740 Waste Oil Handling Facility, which was demolished in 2006, was located on the western half of PORTS south of the X-530A Switchyard in Quadrant III. The X-740 facility, which operated from 1983 until 1991, was used as an inventory and staging facility for waste oil and waste solvents that were generated from various plant operational and maintenance activities. A sump within the building was used between 1986 and 1990 to collect residual waste oil and waste solvents from containers crushed in a hydraulic drum crusher at the facility. The facility and sump were initially identified as hazardous waste management units in 1991. The X-740 Waste Oil Handling Facility (both the facility and sump identified as hazardous waste management units) underwent closure, and closure certification was approved by Ohio EPA in 1998.

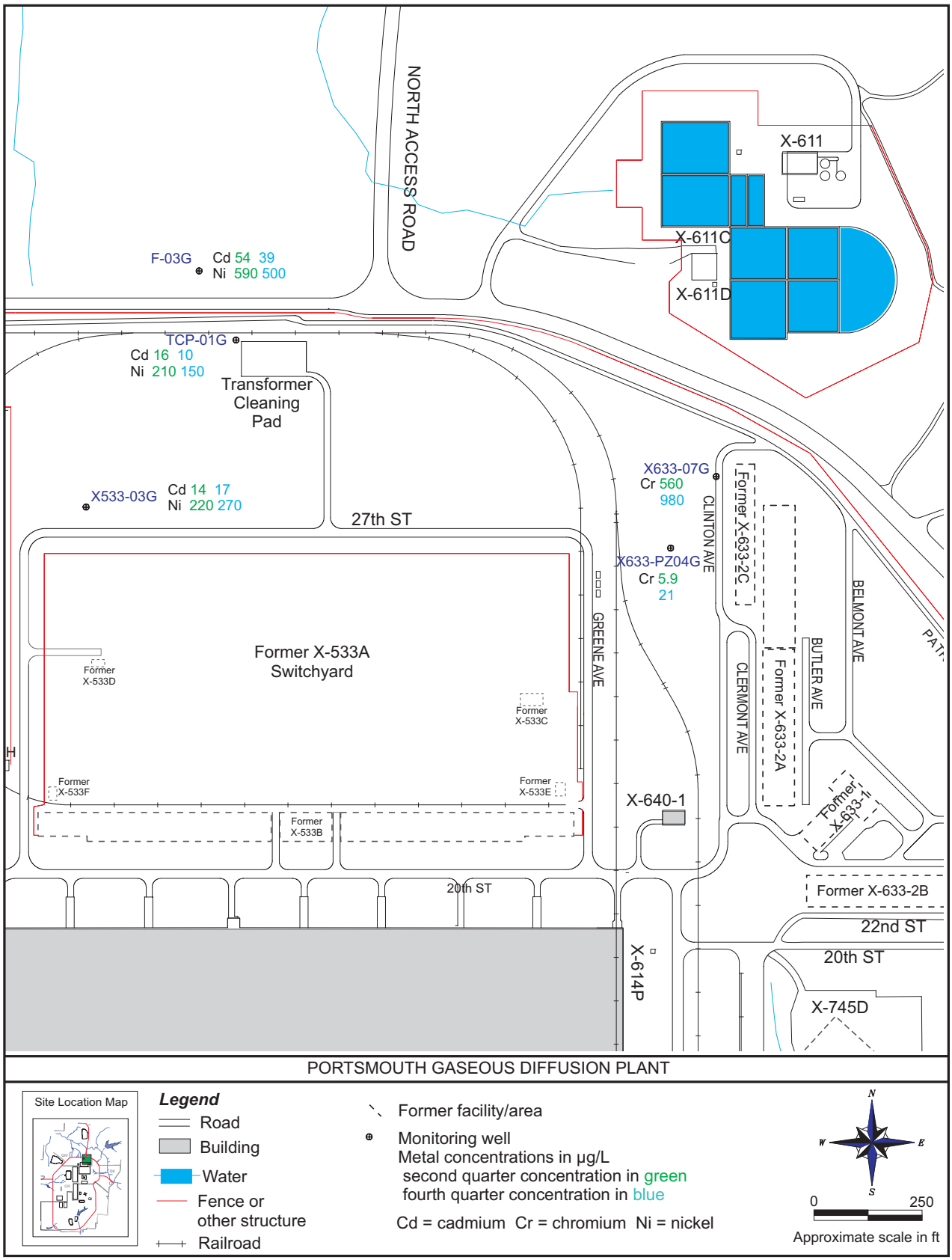

Figure 6.6. Metal concentrations in groundwater at the X-633 Pumphouse/Cooling Towers Area and X-533 Switchyard Area – 2011.

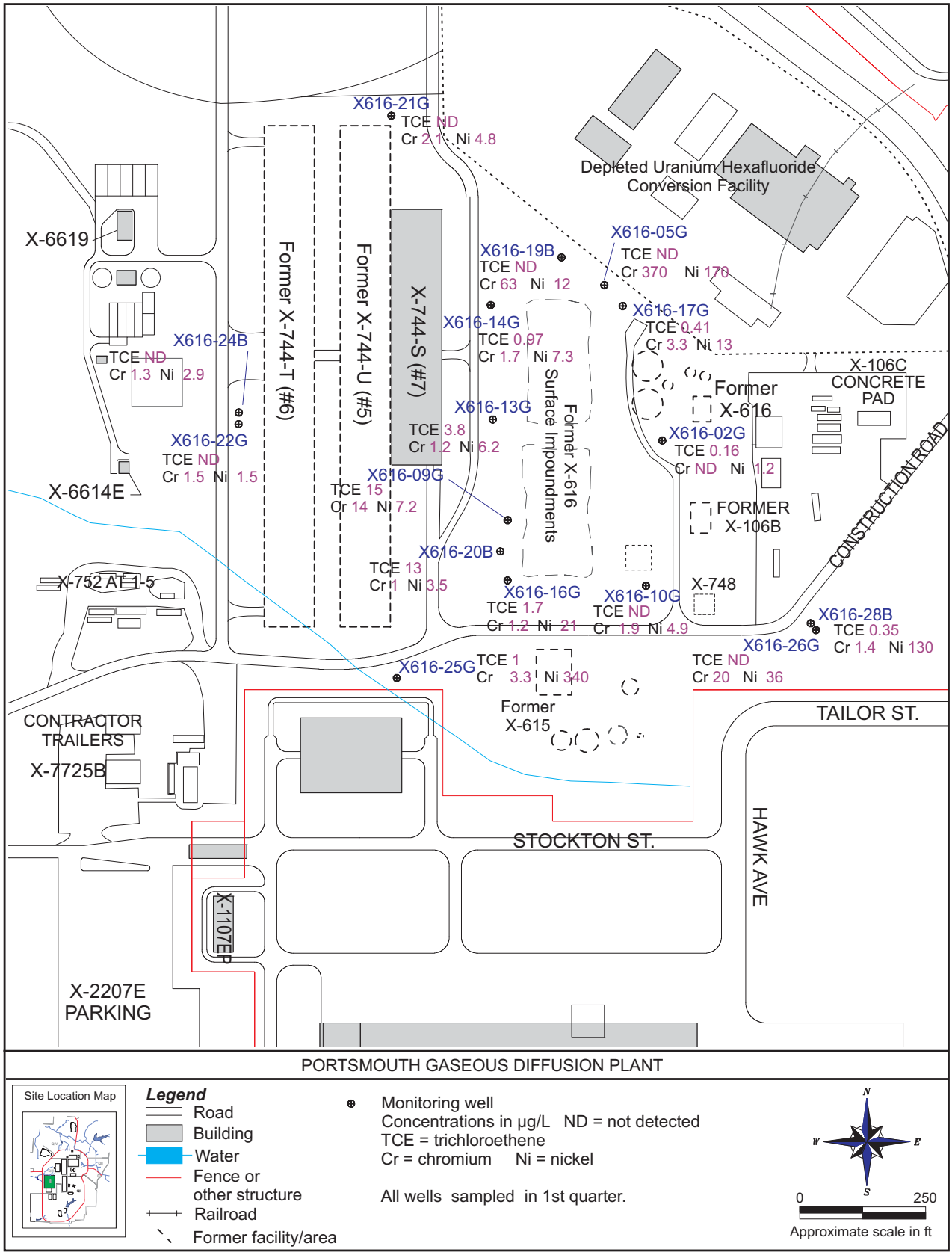

Figure 6.7. TCE and metal concentrations in groundwater at the X-616 Chromium Sludge Surface Impoundments – 2011.

In 1999, poplar trees were planted in a 2.6-acre phytoremediation area above the groundwater plume near the X-740 Waste Oil Handling Facility. Because phytoremediation did not work as anticipated to reduce the concentrations of volatile organics in groundwater in this area, three rounds of oxidant injections were completed during 2008. Additional alternatives for groundwater remediation in this area were evaluated in 2009, and a pilot study of enhanced anaerobic bioremediation began in 2010 and continued throughout 2011. Chapter 3, Section 3.3.3, provides additional information about the remedial activities for the X-740 area.

At the request of Ohio EPA, routine monitoring at the X-740 Waste Oil Handling Facility under the *Integrated Groundwater Monitoring Plan* was discontinued. However, monitoring of the area has continued in support of the pilot study underway in this area. Twelve monitoring wells were sampled in the second, third, and fourth quarters of 2011, including six new monitoring wells installed for the pilot study.

6.4.7.1 Monitoring results for the X-740 Waste Oil Handling Facility in 2011

A contaminated groundwater plume consisting of primarily TCE is located near the X-740 Waste Oil Handling Facility (see Figure 6.8) in Quadrant III. The perimeter of the X-740 groundwater plume did not change significantly in 2011, although concentrations of TCE and other volatile organic compounds within the plume changed due to the remedial activities. Figure 6.8 shows the TCE groundwater plume in 2011 for the X-740 area and concentrations of TCE detected in 2010 and 2011 in two new wells that monitor the current pilot study (X740-18G and X740-22G). TCE decreased in well X740-18G, which is within the treatment area, but TCE did not decrease in well X740-22G, which is downgradient from the treatment area. TCE also decreased in well X740-03G, within the treatment area. Well X740-03G typically has the highest concentrations of TCE detected in the X-740 monitoring area.

6.4.8 X-611A Former Lime Sludge Lagoons

The X-611A Former Lime Sludge Lagoons in Quadrant IV were comprised of three adjacent unlined sludge retention lagoons constructed in 1954 and used for disposal of lime sludge waste from the site water treatment plant from 1954 to 1960. The lagoons covered a surface area of approximately 18 acres and were constructed in a low-lying area that included Little Beaver Creek. As a result, approximately 1500 feet of Little Beaver Creek were relocated to a channel just east of the lagoons.

As part of the RCRA Corrective Action Program, a prairie habitat has been developed in this area by placing a soil cover over the north, middle, and south lagoons. A soil berm was also constructed outside the northern boundary of the north lagoon to facilitate shallow accumulation of water in this low-lying area. Chapter 3, Section 3.3.4.1, provides more information about this remediation. Six wells are sampled semiannually as part of the monitoring program for this area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.8.1 Monitoring results for the X-611A Former Lime Sludge Lagoons in 2011

The six monitoring wells at X-611A are sampled and analyzed for beryllium and chromium. In 2011, chromium was detected in four of the six wells in this area at concentrations between 0.59 and 110 µg/L (X611-01B). The detection of chromium at 110 µg/L in the first quarter sample collected from well X611-01B was the first detection of chromium that exceeded the PRG (100 µg/L) since the current monitoring program began in 1999. Previous concentrations of chromium in well X611-01B did not exceed 15 µg/L. The concentration of chromium detected in well X611-01B in the third quarter decreased to 7.6 µg/L.

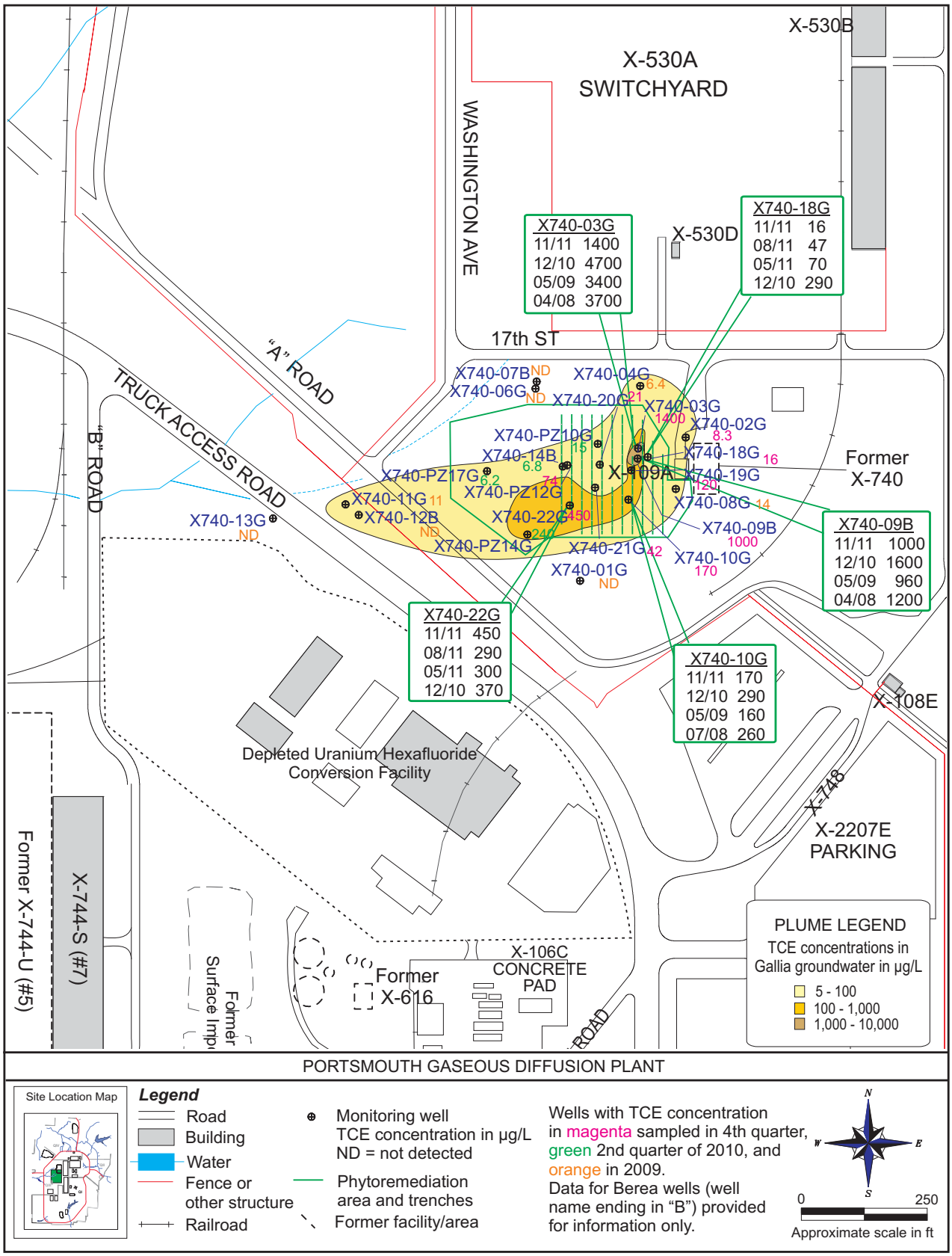

Figure 6.8. TCE-contaminated Gallia groundwater plume near the X-740 Waste Oil Handling Facility – 2011.

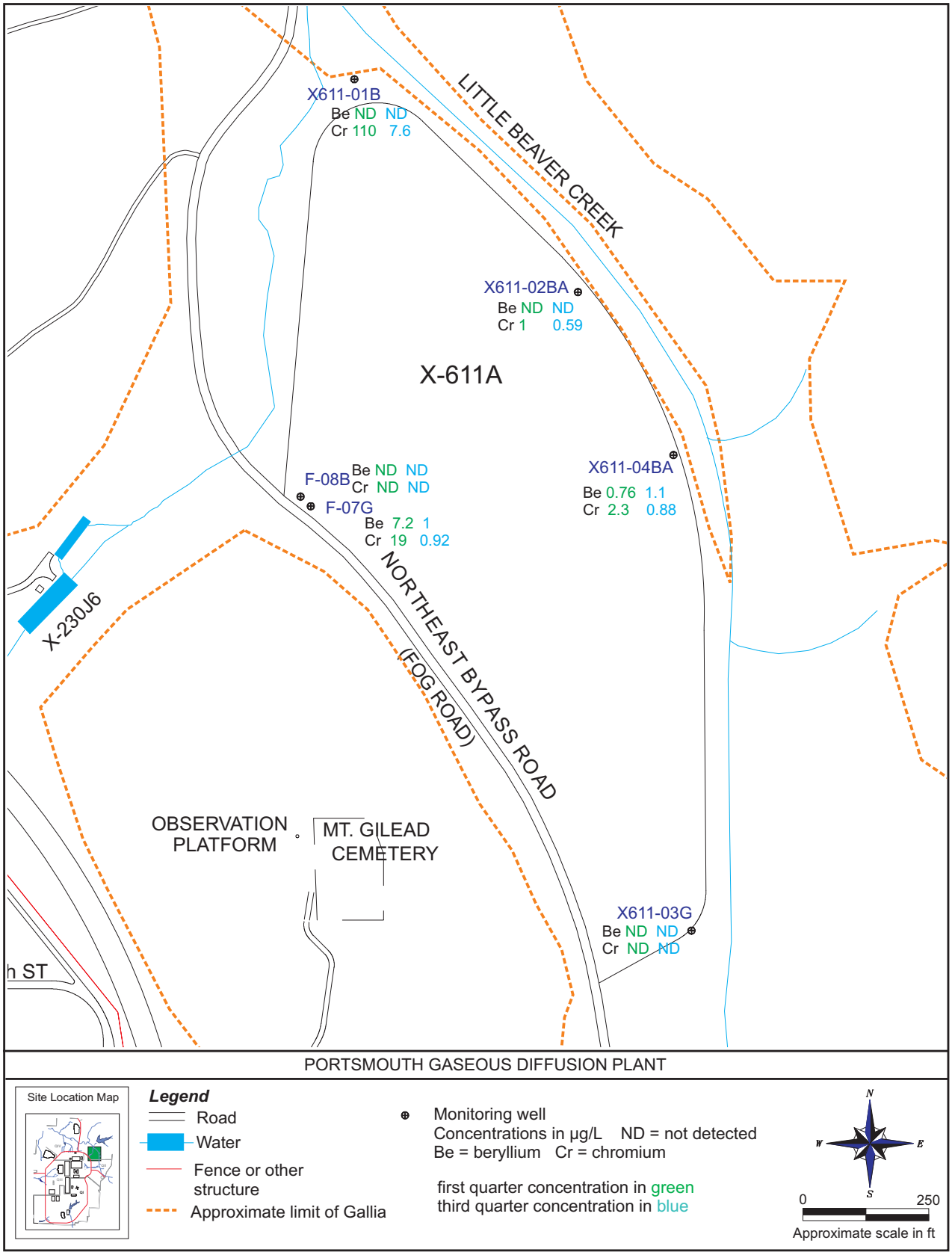

Figure 6.9. Metal concentrations in groundwater at the X-611A Former Lime Sludge Lagoons – 2011.

Beryllium was detected in both samples collected from well F-07G at 7.2 µg/L (first quarter) and 1 µg/L (third quarter). Beryllium is typically detected in samples collected from this well at concentrations just above or below the PRG (6.5 µg/L for Gallia wells). Beryllium was also detected in both samples collected from well X611-04BA at concentrations less than the PRG (7 µg/L for Berea wells). Figure 6.9 shows the concentrations of beryllium and chromium detected in the X-611A wells in 2011.

6.4.9 X-735 Landfills

Several distinct waste management units are contained within the X-735 Landfills area in Quadrant IV. The main units consist of the hazardous waste landfill, referred to as the X-735 RCRA Landfill, and the X-735 Industrial Solid Waste Landfill. The X-735 Industrial Solid Waste Landfill includes the industrial solid waste cells, asbestos disposal cells, and the chromium sludge monocells A and B. The chromium sludge monocells contain a portion of the chromium sludge generated during the closure of the X-616 Chromium Sludge Surface Impoundments.

Initially, a total of 17.9 acres was approved by Ohio EPA and Pike County Department of Health for landfill disposal of conventional solid wastes. The landfill began operation in 1981. During operation of the landfill, PORTS investigations indicated that wipe rags contaminated with solvents had inadvertently been disposed in the northern portion of the landfill. The contaminated rags were considered a hazardous waste. Waste disposal in the northern area ended in 1991, and Ohio EPA determined that the area required closure as a RCRA hazardous waste landfill. Consequently, this unit of the sanitary landfill was identified as the X-735 RCRA Landfill.

A buffer zone was left unexcavated to provide space for groundwater monitoring wells and a space between the RCRA landfill unit and the remaining southern portion, the X-735 Industrial Solid Waste Landfill. Routine groundwater monitoring has been conducted at the X-735 Landfills since 1991.

The industrial solid waste portion of the X-735 Landfills included a solid waste section and an asbestos waste section. The X-735 Industrial Solid Waste Landfill, not including the chromium sludge monocells, encompasses a total area of approximately 4.1 acres. Operation of the X-735 Industrial Solid Waste Landfill ceased in 1997; this portion of the landfill was capped in 1998.

The *Integrated Groundwater Monitoring Plan* incorporates monitoring requirements for the hazardous and solid waste portions of the X-735 Landfills. In addition, the *Corrective Measures Plan for the X-735 Landfill* was approved by Ohio EPA in 2008. This plan provides the monitoring requirements for Gallia wells that monitor the X-735 Landfill. Corrective measures monitoring was implemented because Ohio EPA determined that assessment monitoring of the landfill, completed between 2005 and 2007, identified that a small release of leachate constituents is occurring or has occurred from the X-735 Landfills. Twenty-two wells were sampled in 2011 as part of the monitoring programs for this area. Table 6.1 lists the analytical parameters and Figure 6.10 shows the monitoring wells in this area.

6.4.9.1 Monitoring results for the X-735 Landfills in 2011

The monitoring program at the X-735 Landfills includes corrective measures monitoring for Gallia wells and detection monitoring for Berea wells. As required by the corrective measures monitoring program, concentrations of three metals (cobalt, mercury, and nickel) and five indicator parameters (alkalinity, chloride, sodium, sulfate, and total dissolved solids) detected in downgradient Gallia wells are compared to concentration limits based on drinking water standards or site background concentrations. None of these concentration limits were exceeded in 2011.

The detection monitoring program for X-735 Berea wells continued in 2011. Concentrations of alkalinity, chloride, sodium, sulfate, and total dissolved solids in downgradient Berea wells are evaluated to monitor potential impacts to groundwater and trends in concentrations of these parameters (alkalinity,

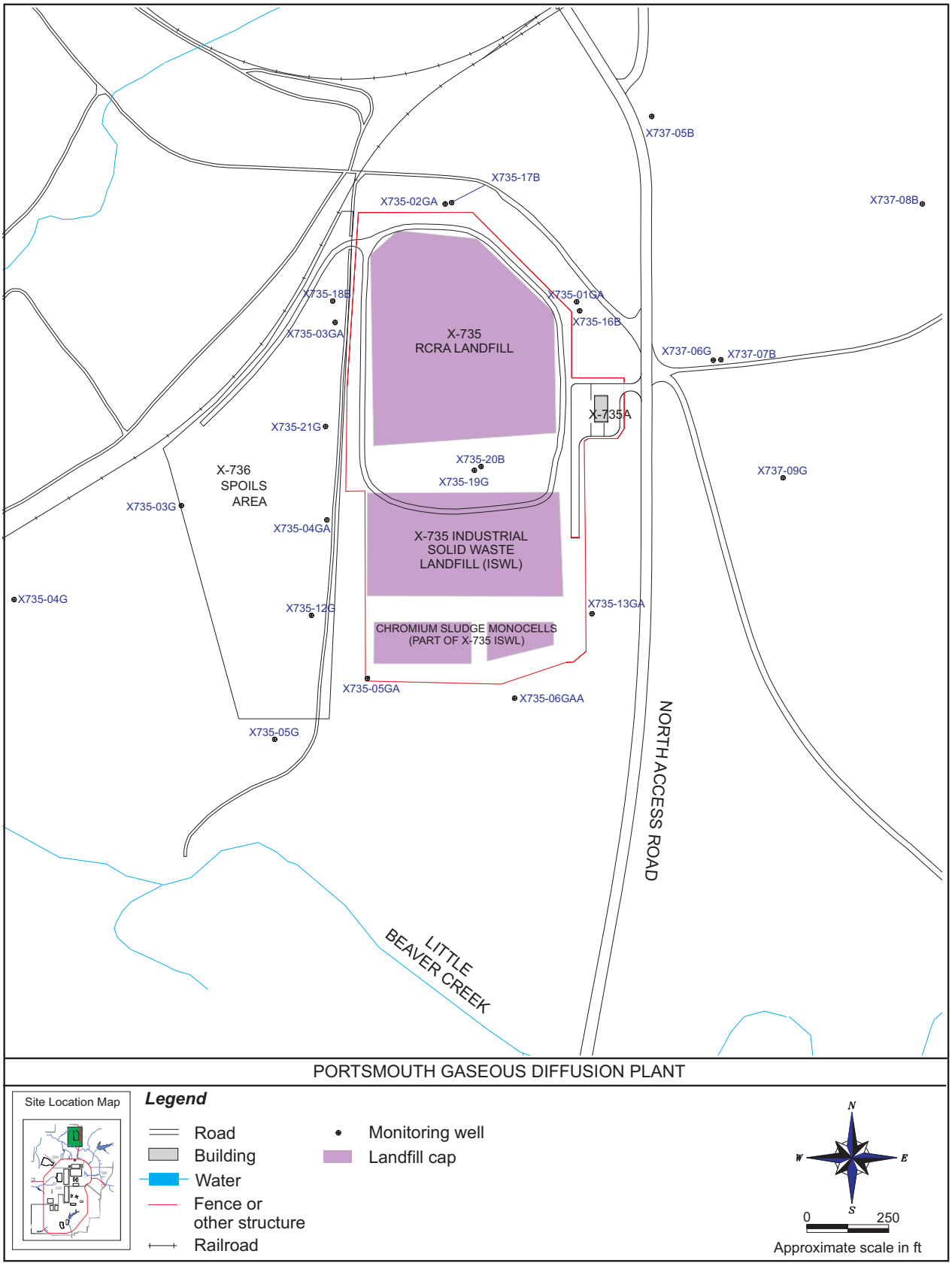

Figure 6.10. Monitoring wells at the X-735 Landfills.

chloride, sodium, sulfate, and total dissolved solids). None of the control limits used to determine a statistically significant change in the indicator parameters requiring Ohio EPA notification was exceeded in the X-735 Berea wells in 2011.

Samples from the X-735 monitoring wells were also analyzed for radionuclides (technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

6.4.10 X-734 Landfills

The X-734 Landfills in Quadrant IV consisted of three landfill units that were used until 1985. Detailed records of materials disposed in the landfills were not kept. However, wastes known to be disposed at the landfills included trash and garbage, construction spoils, wood and other waste from clearing and grubbing, and empty drums. Other materials reportedly disposed in the landfills may have included waste contaminated with metals, empty paint cans, and uranium-contaminated soil from the X-342 area.

The X-734 Landfills were closed in accordance with regulations in effect at that time, and no groundwater monitoring of the area was required. However, the RCRA Facility Investigation conducted in the early 1990s identified the presence of volatile organics, metals, and radionuclides in soil and/or groundwater in the area. The X-734 Landfills were capped in 1999-2000 as part of the remedial actions required for Quadrant IV. Chapter 3, Section 3.3.4.2, provides more information about the remedial actions for this area.

Fifteen wells (see Figure 6.11) are sampled semiannually as part of the monitoring program for this area. Table 6.1 lists the monitoring parameters for the wells in this area.

6.4.10.1 Monitoring results for the X-734 Landfills in 2011

Volatile organic compounds are routinely detected in a number of the wells that monitor the X-734 Landfills, but generally at concentrations below or just above preliminary remediation goals. In 2011, only vinyl chloride was detected above the preliminary remediation goal (2 µg/L). Vinyl chloride was detected at 2.4 µg/L in the second quarter sample collected from well X734-23G. Vinyl chloride is routinely detected in this well at concentrations just above or below 2 µg/L.

Samples from the X-734 monitoring wells were also analyzed for radionuclides (americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, uranium, uranium-233/234, uranium-235, uranium-236, and uranium-238). If detected, radionuclides were present at levels below the preliminary remediation goals.

6.4.11 X-533 Switchyard Area

The X-533 Switchyard Area in Quadrant IV consisted of a switchyard containing electrical transformers and circuit breakers, associated support buildings, and a transformer cleaning pad. The groundwater area of concern is located north of the switchyard and associated support buildings near the transformer cleaning pad. In 2009, DOE received funding under ARRA for D&D of the X-533 Switchyard. D&D of the facilities began in 2010 and was completed in 2011. Chapter 3, Section 3.3.4.4, provides additional information about remedial activities in the area.

The X-533 Switchyard Area was identified as an area of concern for potential metals contamination in 1996 based on historical analytical data for groundwater wells in this area. Samples from wells in this area were collected in 1998 and 1999 to assess the area for metals contamination. The area was added to the PORTS groundwater monitoring program because the sampling identified metals that may have contaminated groundwater in this area. Three wells are sampled semiannually for cadmium and nickel.

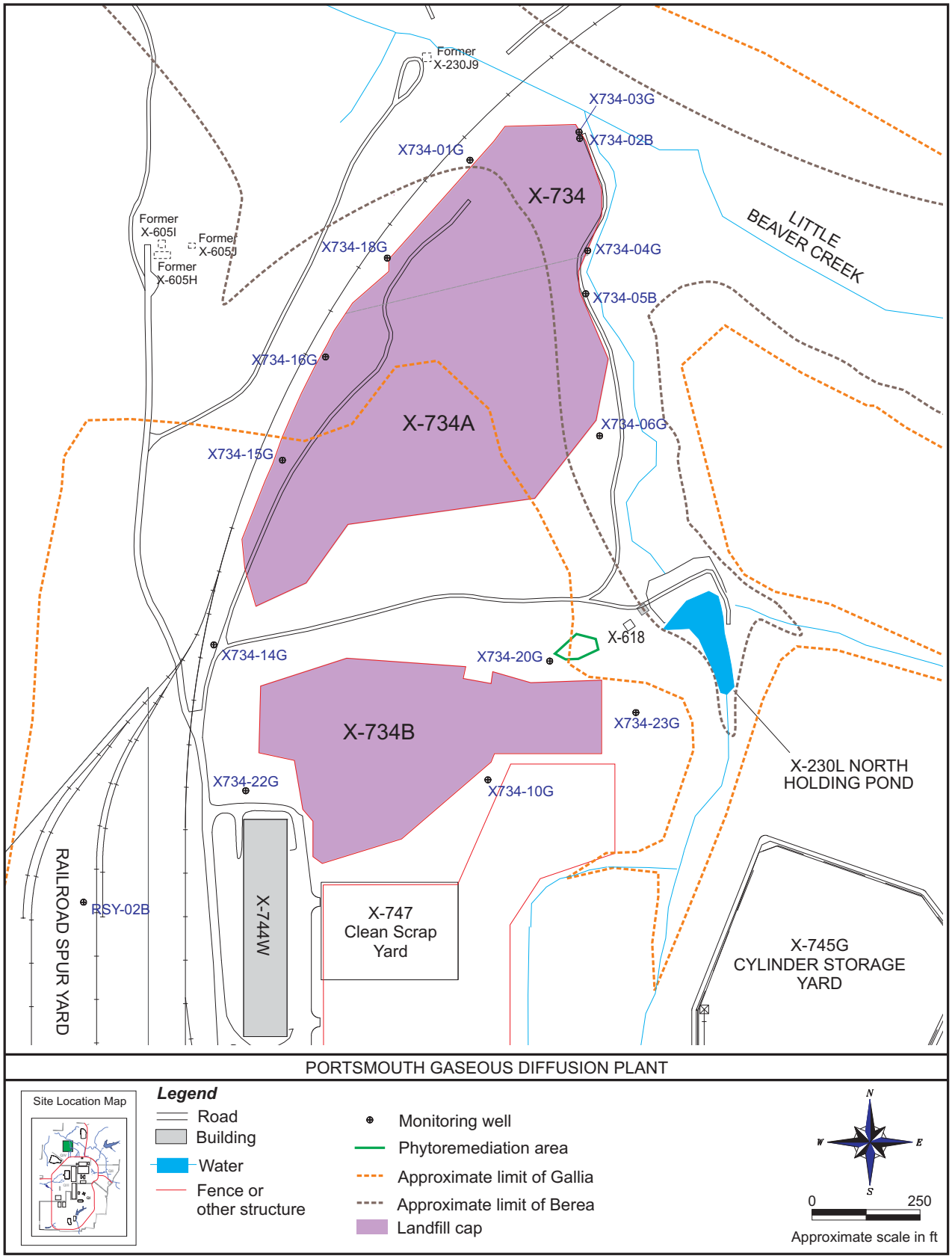

Figure 6.11. Monitoring wells at the X-734 Landfills.

6.4.11.1 Monitoring results for the X-533 Switchyard Area in 2011

Three wells that monitor the X-533 Switchyard Area were sampled in the second and fourth quarters of 2011 and analyzed for cadmium and nickel. Each of the well samples contained these metals at concentrations above the preliminary remediation goals (6.5 µg/L for cadmium and 100 µg/L for nickel). Concentrations of cadmium detected in the wells ranged from 10 to 54 µg/L, and concentrations of nickel detected in the wells ranged from 150 to 590 µg/L. Figure 6.6 shows the concentrations of metals detected in the X-533 wells in 2011.

6.4.12 Former X-344C Hydrogen Fluoride Storage Building

The former X-344C Hydrogen Fluoride Storage Building and associated hydrogen fluoride storage tanks were demolished and removed in 2006. In 2009, an investigation of soils and groundwater near the former building determined that groundwater in one monitoring well south of the former building contained two volatile organic compounds (*cis*-1,2-dichloroethene and *trans*-1,2-dichloroethene) at concentrations well below the applicable preliminary remediation goals.

This area was added to the PORTS groundwater monitoring program in 2010. One well is sampled annually for volatile organic compounds under the monitoring program for this area (see Figure 6.12).

6.4.12.1 Monitoring results for the Former X-344C Hydrogen Fluoride Storage Building in 2011

One volatile organic compound, *cis*-1,2-dichloroethene, was detected at 2 µg/L in the sample collected in the first quarter of 2011, which is less than the PRG of 70 µg/L. This detection is consistent with the data collected at this well in 2009 and 2010.

6.4.13 Surface Water Monitoring

Surface water monitoring is conducted in conjunction with groundwater assessment monitoring to determine if contaminants present in groundwater are detected in surface water samples. Surface water is collected quarterly from 14 locations (see Figure 6.13). Surface water samples are analyzed for the parameters listed in Table 6.1. The purpose for each surface water monitoring location is described as follows:

- Little Beaver Creek and East Drainage Ditch sample locations LBC-SW01, LBC-SW02, and EDD-SW01 assess possible X-701B area plume groundwater discharges.

- Little Beaver Creek sample locations LBC-SW02 and LBC-SW03 assesses potential contamination from the Former X-611A Lime Sludge Lagoons.

- Big Run Creek sample location BRC-SW01 assesses potential groundwater discharges from the Quadrant I Groundwater Investigative Area.

- Big Run Creek sample location BRC-SW05 monitors potential discharges from the X-749/PK Landfill groundwater collection system on the east side of the landfills, as well as the Quadrant I Groundwater Investigative Area.

- Big Run Creek sample location BRC-SW02 (downstream from BRC-SW01 and BRC-SW05) monitors potential discharges from the Quadrant I Groundwater Investigative Area and the X-749/ X-120/PK Landfill area.

- Southwestern Drainage Ditch sample locations UND-SW01 and UND-SW02 assess potential groundwater releases to this creek and the X-2230M Southwest Holding Pond from the western portion of the X-749/X-120 groundwater plume.

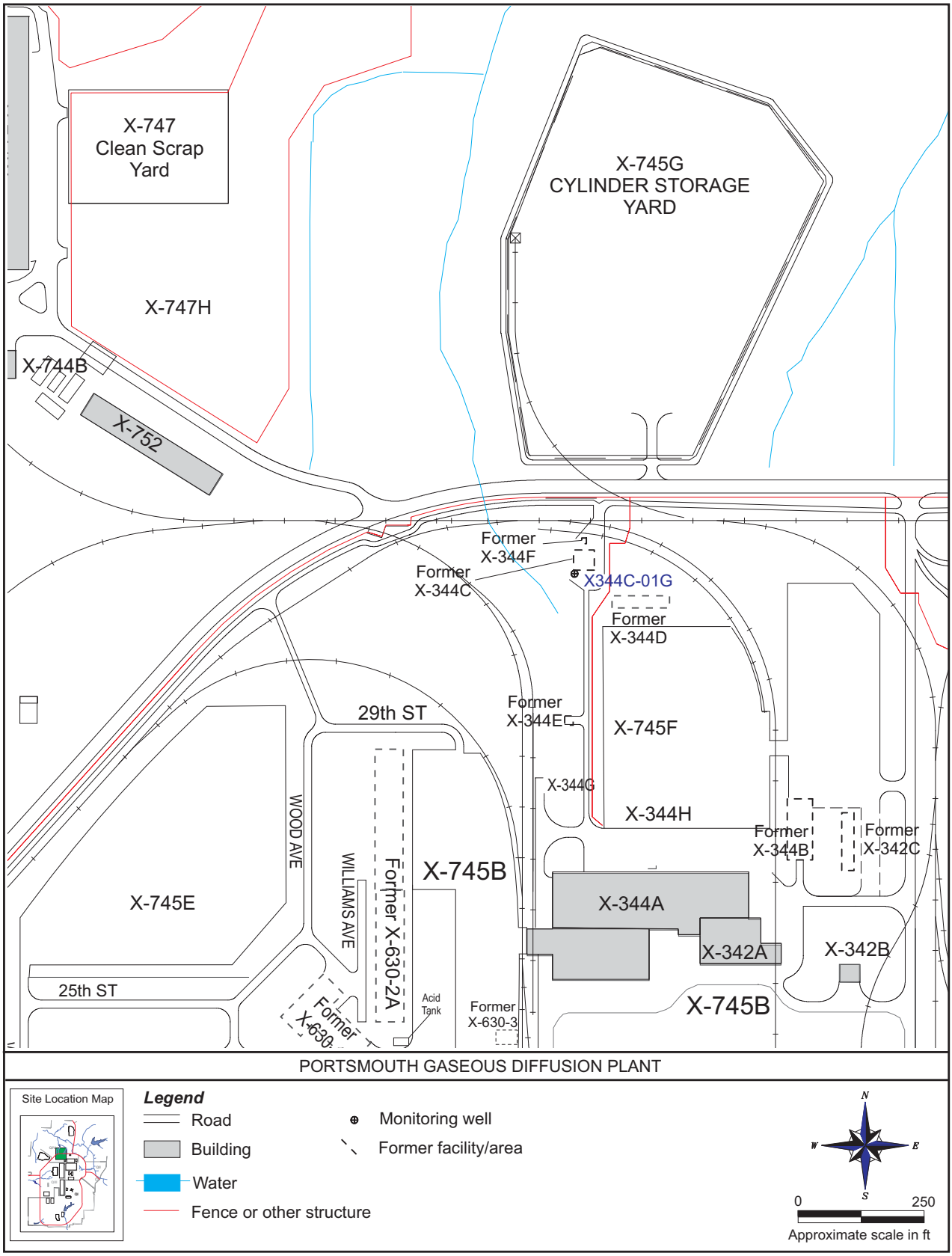

Figure 6.12. Monitoring well at the Former X-344C Hydrogen Fluoride Storage Building.

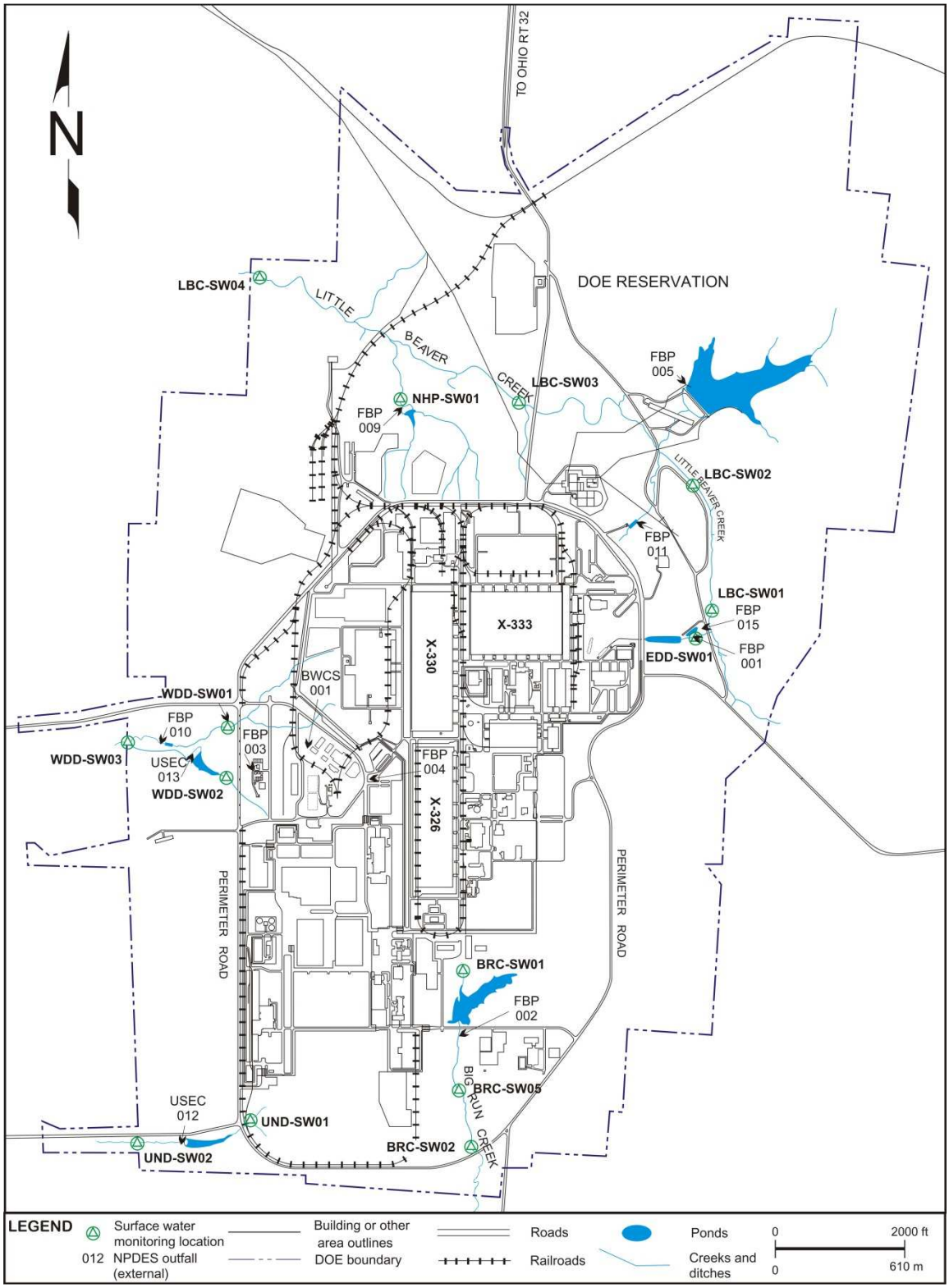

Figure 6.13. Surface water monitoring locations.

- North Holding Pond sample location NHP-SW01 and Little Beaver Creek sample location LBC-SW04 assess potential groundwater discharges from the X-734 Landfill and other Quadrant IV sources.

- Western Drainage Ditch sample locations WDD-SW01, WDD-SW02, and WDD-SW03 assess potential groundwater discharges from the X-616 and X-740 areas to the Western Drainage Ditch and the X-2230N West Holding Pond.

6.4.13.1 Monitoring results for surface water in 2011

Trihalomethanes are a category of volatile organic compounds that are byproducts of water chlorination and include bromodichloromethane, bromoform, chloroform, and dibromochloromethane. These compounds are detected at most of the surface water sampling locations because the streams receive discharges that contain chlorinated water from the PORTS NPDES outfalls. These detections were well below the applicable Ohio EPA water quality criteria for the protection of human health in the Ohio River drainage basin (bromodichloromethane – 460 µg/L; bromoform – 3600 µg/L; chloroform – 4700 µg/L; and dibromochloromethane – 340 µg/L).

Since the 1990s, TCE has been detected regularly at low levels in samples collected from the Southwestern Drainage Ditch (UND-SW01, located inside Perimeter Road). In 2011, TCE was detected at 1.8 to 3.8 µg/L in three of the four samples collected from the Southwestern Drainage Ditch at UND-SW01. TCE is routinely detected at low concentrations at this sampling point. 4-Methyl-2-pentanone (methyl isobutyl ketone) and *cis*-1,2-dichloroethene were also detected at estimated concentrations of 2.6 µg/L or less in one or more of the samples. TCE (1.6 µg/L) and 4-methyl-2-pentanone (2.8 µg/L) were detected in the second quarter sample collected from the Southwestern Drainage Ditch at UND-SW02. 4-Methyl-2-pentanone is a probable sample contaminant based on its detection in the trip and field blanks associated with the environmental samples. The detections of TCE were well below the applicable Ohio EPA water quality criterion for TCE (810 µg/L) for the protection of human health in the Ohio River drainage basin.

TCE and/or *cis*-1,2-dichloroethene were detected at estimated concentrations of 2 µg/L or less at East Drainage Ditch sampling location EDD-SW01 and Little Beaver Creek sampling locations LBC-SW01, LBC-SW02, and LBC-SW03. Neither of these chemicals were detected at downstream Little Beaver Creek sampling location LBC-SW04. The detections of TCE were well below the applicable Ohio EPA water quality criterion for TCE (810 µg/L) for the protection of human health in the Ohio River drainage basin.

Several volatile organic compounds were detected at estimated concentrations of 0.6 µg/L or less in samples collected from Big Run Creek in 2011. In special sampling conducted in the fourth quarter (December 2011) for the X-749/X-120 groundwater plume (see Section 6.4.1.4), TCE was detected at an estimated concentration of 0.28 µg/L in the sample collected from BRC-SW02. *Cis*-1,2-dichloroethene was detected at an estimated concentration of 0.15 µg/L in the second quarter sample collected from Big Run Creek at sampling location BRC-SW01. Toluene, a probable sample contaminant, was detected at estimated concentrations of 0.6 µg/L or less in the third quarter samples collected from BRC-SW02 and BRC-SW05.

Samples collected in the second and fourth quarters of 2011 were analyzed for selected transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). Americium-241 was detected at activities ranging from 0.0549 to 0.082 pCi/L in the second quarter samples collected from Big Run Creek (BRC-SW01 and BRC-SW05), the Southwestern Drainage Ditch (UND-SW01 and UND-SW02), and the Western Drainage Ditch (WDD-SW01 and WDD-SW03). Americium-241 was also detected at 0.0737 pCi/L in the fourth quarter sample collected from WDD-SW03. Plutonium-239/240 was detected

at 0.0769 and 0.107 pCi/L in the fourth quarter samples collected at LBC-SW04 and BRC-SW05. Each of these results were above the minimum detectable activity but less than the laboratory reporting limit. No other transuranics were detected in the surface water samples collected during 2011.

Americium-241 and plutonium-239/240 are present in the environment at very small levels due to atmospheric fallout from nuclear weapons testing. The low levels of americium-241 and plutonium-239/240 detected in surface water may be present due to this fallout. Additionally, radionuclides detected at low levels near the minimum detectable activity, such as the detections of americium-241 and plutonium-239/240 in surface water, may be false positives due to the statistical methodology used in analysis of radionuclides. There are no PORTS preliminary remediation goals for americium-241 and plutonium-239/240 in surface water. However, these detections of americium-241 and plutonium-239/240 in surface water were less than the preliminary remediation goals for americium-241 and plutonium-239/240 in groundwater: 0.49 pCi/L and 0.51 pCi/L, respectively.

In the first and/or second quarters of 2011, technetium-99 was detected at activities ranging from 8.48 to 39.6 pCi/L in samples collected from the East Drainage Ditch (EDD-SW01) and the Little Beaver Creek sampling locations. Technetium-99 is occasionally detected at these locations. Technetium-99 was also detected at 11.5 pCi/L in the second quarter sample collected from Western Drainage Ditch at WDD-SW02. These detections are well below the Ohio EPA drinking water standard for technetium-99 (900 pCi/L, based on a 4 mrem/year dose from beta emitters). Technetium-99 was not detected in any of the other surface water samples collected during 2011.

Uranium was routinely detected in the 2011 surface water samples at levels similar to those detected in previous years. Detections of uranium isotopes were well below the DOE derived concentration standard for the respective uranium isotope in drinking water (680 pCi/L for uranium-233/234, 720 pCi/L for uranium-235, and 750 pCi/L for uranium-238). Because uranium occurs naturally in rocks and soil, some or all of the uranium detected in these samples may be due to naturally-occurring uranium.

6.4.14 Water Supply Monitoring

Routine monitoring of private residential drinking water sources is completed at PORTS in accordance with the requirements of Section VIII of the September 1989 Consent Decree between the State of Ohio and DOE and the *Integrated Groundwater Monitoring Plan.*

The purpose of the program is to determine whether PORTS has had any impact on the quality of the private residential drinking water sources. Although this program may provide an indication of contaminant transport off site, it should not be interpreted as an extension of the on-site groundwater monitoring program, which bears the responsibility for detection of contaminants and determining the rate and extent of contaminant movement. Data from this program will not be used in environmental investigations due to the lack of knowledge of how residential wells were constructed and due to the presence of various types of pumps (which may not be ideal equipment for sampling).

Six residential drinking water sources participated in the program in 2011 (see Figure 6.14). Wells are sampled semiannually with samples analyzed for the parameters listed in Table 6.1. The PORTS water supply (RES-012 on Figure 6.14) is also sampled as part of this program. Sampling locations may be added or deleted if requested by a resident and as program requirements dictate. Typically, sampling locations are deleted when a resident obtains a public water supply.

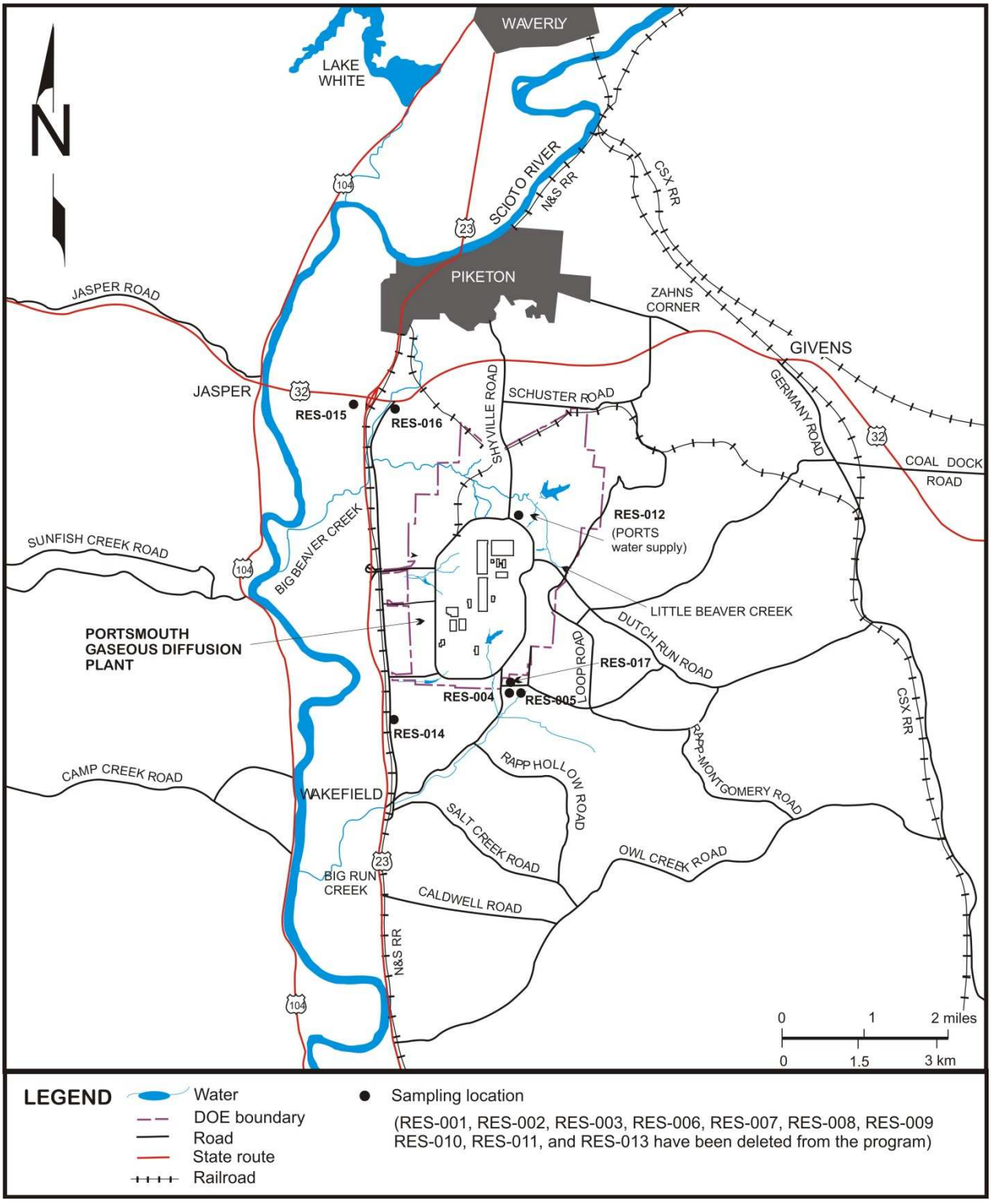

Figure 6.14. Water supply monitoring locations.

In the third quarter of 2011, TCE was detected at 1 µg/L in the sample collected from RES-017, which is south of PORTS on Big Run Road. TCE was not detected in the first quarter sample collected from this water supply. Since this residential water supply was added to the monitoring program in 2009, TCE has routinely been detected in the water supply samples at estimated concentrations ranging from 0.16 to 0.64 µg/L. These detections are less than the drinking water standard for TCE (5 µg/L). Big Run Creek is located between RES-017 and the affected water-bearing formation (i.e., Gallia groundwater) located in the southern portion of the plant site west of Big Run Creek. The Gallia groundwater drains into Big Run Creek.

Chloroform was detected at 0.35 and 1.7 µg/L in the first and third quarter samples collected from RES-015 (north of PORTS on State Route 124). Xylenes (M+P xylene and 1,2-dimethylbenzene) were detected at estimated concentrations of 1 µg/L or less in the third quarter samples collected from RES-004 and RES-005 (old and new wells at the same residence on Bailey Chapel Road south of PORTS).

No other volatile organic compounds (other than the sample contaminant acetone) were detected in the other residential water supply samples collected during 2011.

Each sample was analyzed for transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238). Americium-241 was detected at estimated activities between 0.0575 and 0.0665 pCi/L in the first quarter samples collected from RES-005 (south of PORTS on Bailey Chapel Road), RES-015 (north of PORTS on State Route 124), and RES-016 (north of PORTS on Wakefield Mound Road). A duplicate sample was collected from RES-005; americium-241 was undetected at 0.0281 pCi/L in the duplicate sample. These detections are approximately 0.4% of the drinking water standard of 15 pCi/L for alpha emitters. Chapter 4, Section 4.3.9.6, provides a dose assessment for a member of the public that would drink water throughout the year containing americium-241 at 0.0665 pCi/L. The total potential dose to a member of the public resulting from PORTS operations (1.3 mrem/year), which includes this dose calculation (0.169 mrem/year), is well below the DOE standard of 100 mrem/year.

Americium-241 was not detected in any of the third quarter samples collected from the water supply sampling locations. No other transuranics were detected in any of the water supply samples collected in 2011.

Technetium-99 was not detected in any of the water supply samples collected in 2011. Low levels of uranium and uranium isotopes detected in some of the wells are consistent with naturally-occurring concentrations found in groundwater in the area.

6.5 DOE ORDER MONITORING PROGRAMS

One of the DOE surveillance monitoring programs at PORTS is exit pathway monitoring. Exit pathway monitoring assesses the effect of the facility on off-site surface water and groundwater quality.

6.5.1 Exit Pathway Monitoring

Selected locations on local streams and drainage channels near the PORTS boundary are sampling points of the exit pathway monitoring program because surface water from PORTS NPDES outfalls and groundwater discharge to these surface waters. Monitoring wells near the PORTS boundary are also used in the exit pathway monitoring program. Figure 6.15 shows the sampling locations for exit pathway monitoring and Table 6.1 lists the analytical parameters.

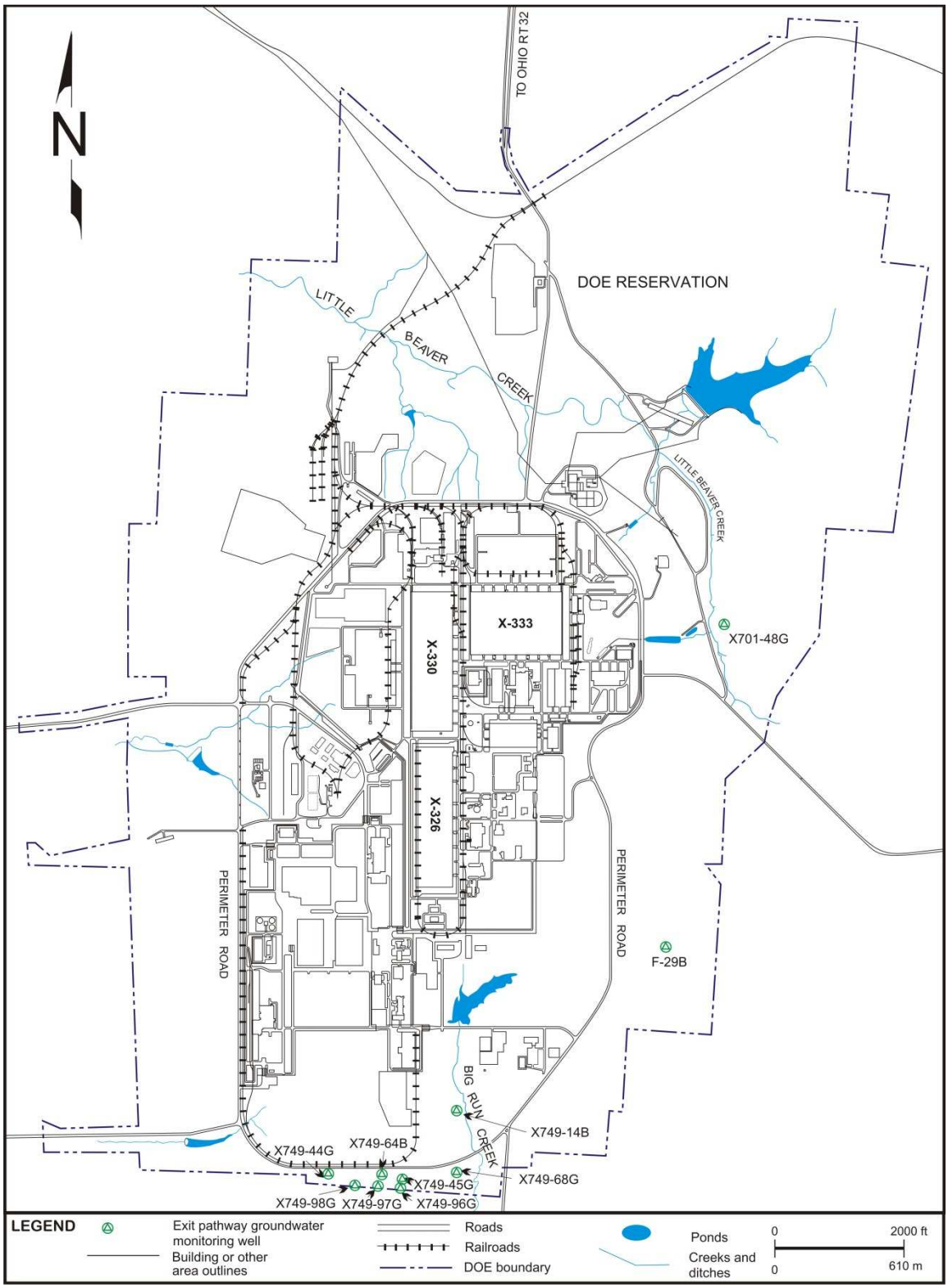

Figure 6.15. Exit pathway monitoring locations.

Surface water sampling points on Big Run Creek (BRC-SW02), Little Beaver Creek (LBC-SW04), Southwestern Drainage Ditch (UND-SW02), and Western Drainage Ditch (WDD-SW03) are part of the exit pathway monitoring program. TCE was detected at concentrations of 1.6 µg/L or less in samples collected from the Southwestern Drainage Ditch (UND-SW02) and Big Run Creek (BRC-SW02) (see Section 6.4.13.1). The detections of TCE were well below the applicable Ohio EPA water quality criterion for TCE (810 µg/L) for the protection of human health in the Ohio River drainage basin.

Trihalomethanes (bromodichloromethane, bromoform, chloroform, and dibromochloromethane), which are common residuals in chlorinated drinking water, were detected in samples collected from the Western Drainage Ditch at concentrations well below Ohio EPA non-drinking water quality criteria for trihalomethanes for the protection of human health in the Ohio River drainage basin (see Section 6.4.13.1). Probable sample contaminants were also detected in samples collected from Big Run Creek at BRC-SW02 and UND-SW02 (see Section 6.4.13.1).

Americium-241, plutonium-239/240, and/or technetium-99 were detected at surface water exit pathway monitoring locations on Little Beaver Creek (LBC-SW04), the Southwestern Drainage Ditch (UND-SW02), and the Western Drainage Ditch (WDD-SW03). Section 6.4.1.3 provides more information about these detections.

TCE and radionuclides were also detected in several on-site groundwater monitoring wells that are part of the exit pathway monitoring program. TCE was detected in several wells that monitor the X-749/ X-120/PK Landfill area (see Section 6.4.1.3). For all but one of these wells, concentrations of TCE were below the Ohio EPA drinking water standard for TCE (5 µg/L). TCE was detected at 37 µg/L in a sample collected from well X749-14B in September 2011. Section 6.4.1.3 provides additional information about these detections.

Americium-241, plutonium-239/240, and/or uranium were detected in one of the X-749 monitoring wells (X749-96G) and the exit pathway monitoring well located east of the Quadrant I Groundwater Investigative Area (F-29B). These radionuclides were present at levels below the preliminary remediation goals.

6.6 GROUNDWATER TREATMENT FACILITIES

In 2011, a combined total of almost 34 million gallons of water were treated at the X-622, X-623, X-624, and X-627 Groundwater Treatment Facilities. Approximately 34 gallons of TCE were removed from the water. All processed water is discharged through NPDES outfalls before exiting PORTS. Facility information is summarized in Table 6.2.

Table 6.2. Summary of TCE removed by PORTS groundwater treatment facilities in 2011

Facility	Gallons of water treated	Gallons of TCE removed
X-622	20,912,800	2.3
X-623	1,403,900	2.5
X-624	3,018,800	10
X-627	8,640,500	19

6.6.1 X-622 Groundwater Treatment Facility

The X-622 Groundwater Treatment Facility consists of an air stripper with aqueous-phase activated carbon filtration. This facility processes groundwater from the following systems in Quadrant I (see Figures 6.2 and 6.3):

- groundwater collection system with associated sump (X749-WPW) and extraction wells X749-EW05G and X749-EW06G on the southwest boundary of the X-749 Landfill;
- groundwater extraction wells X749-EW01G, X749-EW02G, X749-EW03G, and X749-EW04G installed in 2007 in the X-749 South Barrier Wall area;
- groundwater extraction wells (X749-EW07G, X749-EW08G, and X749-EW09G) installed in 2010 in the X-749/X-120 groundwater plume;
- groundwater collection system and associated sumps (PK-PL6 and PK-PL6A) on the eastern boundary of the PK Landfill; and
- fifteen extraction wells located in the Quadrant I Groundwater Investigative Area.

The facility processed almost 21 million gallons of groundwater during 2011, thereby removing approximately 2.3 gallons of TCE from the water. Treated water from the facility discharges through FBP NPDES Outfall 608, which flows to the X-6619 Sewage Treatment Plant. No NPDES permit limitations were exceeded at Outfall 608 in 2011.

6.6.2 X-623 Groundwater Treatment Facility

The X-623 Groundwater Treatment Facility consists of an air stripper with offgas activated carbon filtration and aqueous-phase activated carbon filtration. Prior to implementation of the X-701B IRM, the X-623 Groundwater Treatment Facility treated TCE-contaminated groundwater from a sump in the bottom of the X-701B Holding Pond and three groundwater extraction wells (X623-EW01G, X623-EW02G, and X623-EW03G) east of the holding pond. Extraction wells X623-EW02G and X623-EW03G were removed in November 2009 at the beginning of implementation of the IRM. The sump in the bottom of the X-701B Holding Pond was removed in 2010. Extraction well X623-EW01G was removed in January 2011.

During 2011, the X-623 Groundwater Treatment Facility treated water from extraction well X623-EW01G, water collected during activities associated with the X-701B IRM, and other miscellaneous water associated with site activities (in accordance with the NPDES permit). The X-623 Groundwater Treatment Facility did not operate in September and December of 2011 and operated intermittently in October and November of 2011.

The facility treated approximately 1.4 million gallons of water during 2011, thereby removing approximately 2.5 gallons of TCE from the water. Treated water from the facility discharges through FBP NPDES Outfall 610, which flows to the X-6619 Sewage Treatment Plant. No NPDES permit limitations were exceeded at Outfall 610 in 2011.

6.6.3 X-624 Groundwater Treatment Facility

At the X-624 Groundwater Treatment Facility, groundwater is treated via an air stripper with offgas activated carbon filtration and aqueous-phase activated carbon filtration. This facility processes TCE-contaminated groundwater from the X-237 Groundwater Collection System on the east side of the X-701B groundwater plume. The X-237 Groundwater Collection System consists of north-south and east-west collection trenches and two sumps/pumping wells (see Figure 6.5).

The X-624 Groundwater Treatment Facility treated approximately 3 million gallons of water in 2011, thereby removing approximately 10 gallons of TCE from the water. Treated water from the facility discharges through FBP NPDES Outfall 015, which discharges to Little Beaver Creek. No NPDES permit limitations were exceeded at Outfall 015 in 2011.

6.6.4 X-627 Groundwater Treatment Facility

The X-627 Groundwater Treatment Facility consists of an air stripper with offgas activated carbon filtration and aqueous phase activated carbon filtration. The X-700 and X-705 buildings are located above the Quadrant II Groundwater Investigative Area plume, and contaminated groundwater is extracted from sumps located in the basement of each building (see Figure 6.4).

Approximately 8.6 million gallons of groundwater were processed during 2011, thereby removing 19 gallons of TCE from the water. Treated water from the facility discharges through FBP NPDES Outfall 611, which flows to the X-6619 Sewage Treatment Plant. No NPDES permit limitations were exceeded at Outfall 611 in 2011.