

PIN 16.2

Environmental Restoration Program

**Wastewater Neutralization Area/Building 200 Area
Corrective Measures Implementation Plan Addendum**

January 2000

Environmental Restoration Program

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1.0 Introduction

The Pinellas STAR Center (Center) is a former U.S. Department of Energy (DOE) facility known as the Pinellas Plant that was constructed in the mid-1950s in Pinellas County, Florida. The 99-acre Center is located in Largo, Florida, and lies in the northeast quarter of Section 13, Township 30 South, Range 15 East (Figure 1–1).

The Wastewater Neutralization Area (WWNA)/Building 200 Area is located to the west of Building 100 (Figure 1–2). On April 7, 1993, DOE notified the U.S. Environmental Protection Agency (EPA), Region IV, that two potential solid waste management units (SWMUs) had been discovered at the former Pinellas Plant. The notification was in accordance with Condition II.B.1 of the Hazardous and Solid Waste Amendment (HSWA) Permit issued to DOE by the EPA. The potential SWMUs were combined into one SWMU identified as the WWNA/Building 200 Area, and includes the Wastewater Neutralization Facility, Building 200, and the area to the south of the Wastewater Neutralization Facility (Figure 1–2).

In accordance with the HSWA Permit conditions, DOE submitted the required Resource Conservation and Recovery Act (RCRA) corrective action documentation for the WWNA/Building 200 Area. These documents are listed in Table 1–1 with their regulatory approval dates.

Table 1–1. Supporting Documentation for the Wastewater Neutralization Area/Building 200 Area

Document Title and Date	EPA and FDEP Approval Dates
RCRA Facility Assessment Plan, Wastewater Neutralization Area/Building 200 Area, Revision 0, June 1993	July 23, 1993 (EPA) N/A (FDEP)
RCRA Facility Assessment Report, Wastewater Neutralization Area/Building 200 Area, Revision 0, March 1994	April 6, 1994 (EPA) April 20, 1994 (FDEP)
RCRA Facility Investigation (RFI) Plan, Wastewater Neutralization Area/Building 200 Area, Revision 1, November 1994	December 1, 1995 (EPA) January 19, 1995 (FDEP)
RCRA Facility Investigation Report, Wastewater Neutralization Area/Building 200 Area, Revision 0, February 1996	June 26, 1996 (EPA) March 27, 1996 (FDEP)
Corrective Measures Study Plan, Wastewater Neutralization Area/Building 200 Area, Revision 0, February 1996	June 26, 1996 (EPA) November 5, 1996 (FDEP)
Corrective Measures Study Report/Corrective Measures Implementation Plan, Wastewater Neutralization Area/Building 200 Area, Revision 0, June 1997	January 22, 1999 (EPA) January 21, 1999 (FDEP)
Interim Action Plan, letter from DOE to EPA and FDEP dated August 12, 1998.	January 22, 1999 (EPA) January 21, 1999 (FDEP)

The RFI found that groundwater contamination exists in the surficial aquifer. Elevated arsenic, trichloroethene (TCE), and vinyl chloride concentrations greater than federal and state regulatory standards were detected within the WWNA/Building 200 Area. Concentrations of vinyl chloride ranging from 1.0 to 4.2 micrograms per liter ($\mu\text{g/L}$) were detected in monitoring wells during the RFI in 1995 and 1996. The Safe Drinking Water Act (SDWA) maximum contaminant level (MCL) for vinyl chloride is 2 $\mu\text{g/L}$ and the Florida Department of Environmental Protection (FDEP) MCL is 1 $\mu\text{g/L}$. The SDWA MCL for TCE is 5 $\mu\text{g/L}$ and the FDEP MCL is 3 $\mu\text{g/L}$. TCE ranged from 6 to 7.4 $\mu\text{g/L}$.

The “Quarterly Progress Report for July through September 1999” (DOE 1999) presents data for the July 1999 sampling event. During that event, volatile organic compounds (VOCs) were detected in only four of the 12 wells sampled. Total VOCs ranged from 1 to 62 $\mu\text{g/L}$. Vinyl

chloride was not detected. TCE was detected below the FDEP MCL. Xylene was detected in well PIN18-0526 at 51 µg/L. The xylene concentration is below the FDEP MCL of 10,000 µg/L.

The primary concern at the WWNA/Building 200 Area is arsenic concentrations in both the surficial aquifer and in the upper 2 feet (ft) of soil. During the RFI, arsenic concentrations exceeded the 50 µg/L MCL in all sampling rounds in monitoring wells PIN18-0500, PIN18-0501, PIN18-0502, and PIN18-0525 at concentrations ranging up to 2,050 µg/L. The July 1999 quarterly sampling results indicate arsenic groundwater concentrations continue to exceed the MCL. The highest detected arsenic concentration in July 1999 was 3,100 µg/L. The arsenic concentrations form a plume extending from the wastewater neutralization tanks area to the southeast across the WWNA/Building 200 Area (Figure 1-3).

1.1 Purpose

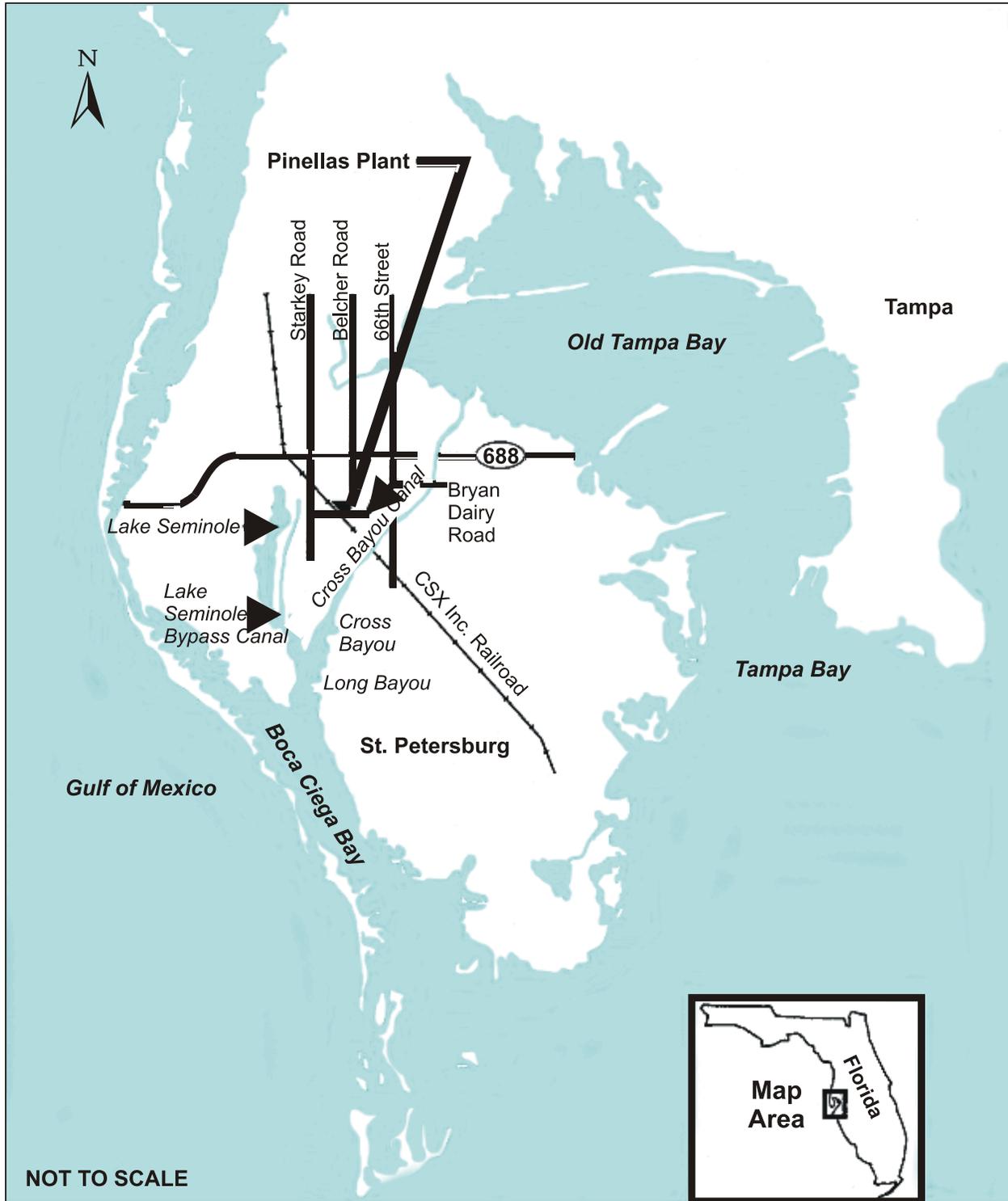
EPA directives (EPA 1992 and EPA 1993) for remedy implementation recommend that corrective measures should be implemented in a phased approach, and corrective actions should be designed to include provisions for modifications. With these directives in mind, the Corrective Measures Study (CMS) Report/Corrective Measures Implementation Plan (CMIP) for the WWNA/Building 200 Area (DOE 1997) recommended that the preferred alternative be implemented for a minimum of 1 year and then re-evaluated.

However, DOE received comments from the FDEP on July 25, 1997 (Appendix A). These comments expressed concerns regarding arsenic soil contamination in the upper 2 ft of soil and that a possible technology, air sparging, was eliminated too early. DOE prepared a response letter on August 12, 1998, (Appendix A) that recommended a multi-phased Interim Action. The Interim Action proposal included operating the recovery well for 6 months, then pulsing the system, as well as performing geochemical analyses and leaching studies of the site. On January 21, 1999, the FDEP approved the proposed interim remedial action (Appendix A).

Additionally, EPA Region IV also approved the interim action and concurred with the FDEP's position regarding the arsenic contamination. The EPA also requested an addendum or modification to the CMIP that addresses DOE's final selection of the remediation technology and a timeline for the completion of these activities (Appendix A).

The purpose of this CMIP Addendum is to

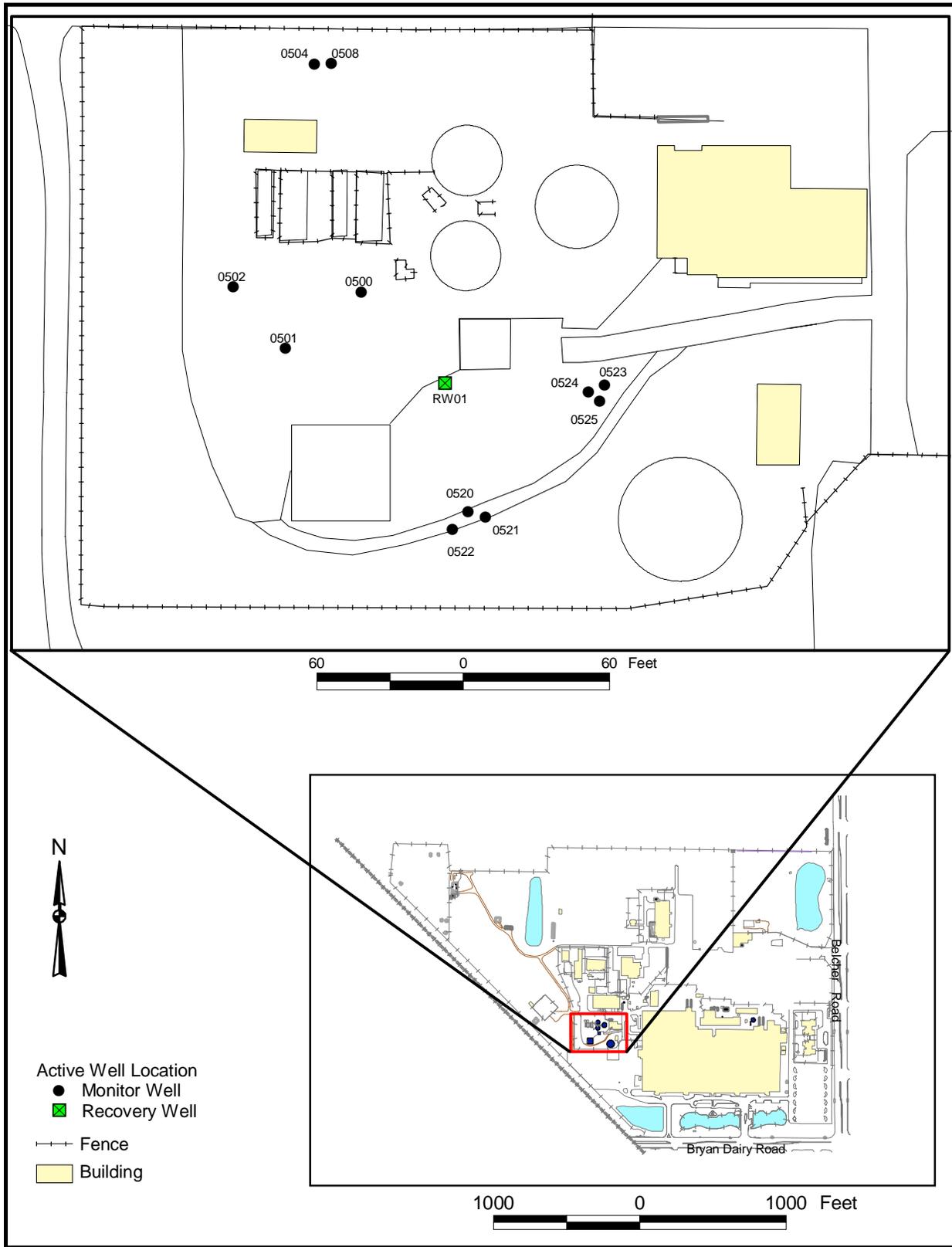
- Provide and discuss the results of the Interim Action.
- Recommend a preferred corrective action as required by Appendix C, Tasks VIII through XI, of the Pinellas HSWA Permit.
- Present the plan for the preferred corrective action, including the conceptual design, conceptual drawings and schematics, procedures, and schedules for implementing the preferred corrective action.



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Figure 1-1. Pinellas STAR Center Location

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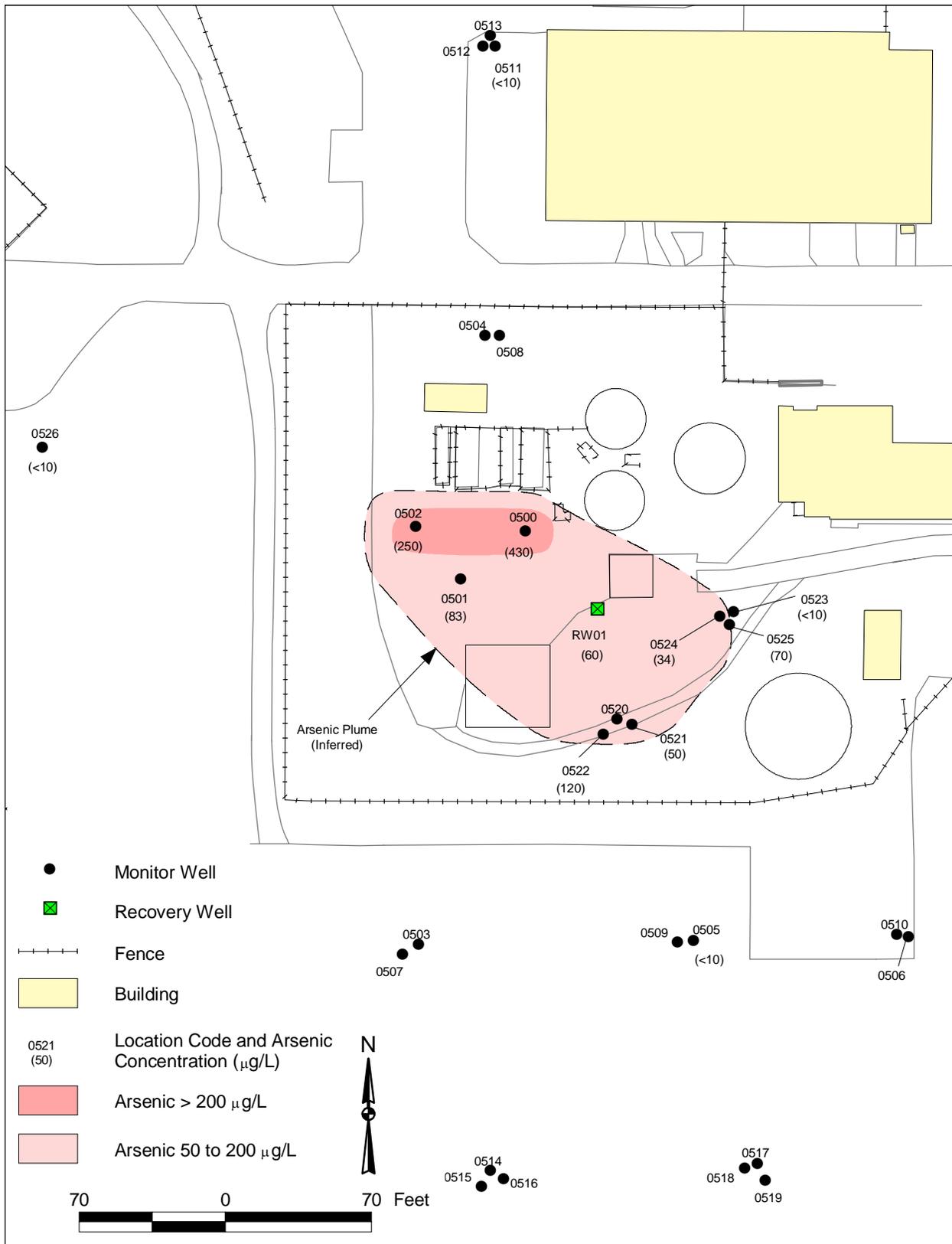


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Figure 1-2. Location of the Wastewater Neutralization Area/Building 200 Area

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Figure 1-3. Maximum Arsenic Concentrations in Monitoring Wells at the WWNA

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1.2 Corrective Measures Objectives

Corrective measures objectives for the WWNA/Building 200 Area were presented in the CMS/CMIP (DOE 1997). As stated in the CMS/CMIP and according to Condition II.F.1 of the Pinellas HSWA Permit, corrective actions must

- Protect human health and the environment.
- Achieve media cleanup standards (the most stringent of either the SDWA or FDEP MCLs).
- Control sources so as to reduce or eliminate, to the maximum extent practicable, further releases that may pose a threat to human health and the environment.
- Meet applicable waste management requirements.

These four criteria are the primary corrective action objectives for the WWNA/Building 200 Area. In addition, the EPA goals for groundwater protection as described in “Protecting the Nation's Groundwater: EPA's Strategy for the 1990s” (EPA 1991) are considered. These goals emphasize

- A level of protection that would ensure current or reasonably expected use.
- The prevention of adverse health risks first, then the restoration of expected use.
- Protection to ensure that groundwater hydraulically connected to surface water does not interfere with the attainment of surface water standards.
- Early detection and monitoring to ensure that risks are minimized as soon as possible.

These goals are consistent with the goals of the DOE corrective action selection process for the Center and continue to be integrated into the development, screening, and selection of remediation alternatives. By considering the goals and the four primary corrective action objectives presented above, the following statement of purpose is identified for the WWNA/Building 200 Area.

A remediation alternative for the Pinellas STAR Center must ensure that contaminated groundwater is eliminated or is reduced below regulatory cleanup requirements, and does not migrate beyond the point of compliance (facility boundary).

An additional regulation-specific corrective action objective is to comply with the conditions and tasks outlined in Appendix C of the Pinellas HSWA Permit.

1.3 Report Organization

From the information and data obtained during the Interim Action, Section 2 summarizes the activities performed including the geochemical evaluation of arsenic in soils (Section 2.1), the aquifer testing (Section 2.2), and the soil removal project (Section 2.3).

Section 3 presents the performance evaluation of the recovery well and groundwater quality results.

Section 4 presents recommendations for future activities for the remediation of the surficial aquifer at the WWNA/Building 200 Area and implementation details for the selected alternative. This section is tiered to the original CMS/CMIP.

Section 5 contains the proposed schedule for any future activities.

Section 6 lists the references used in the preparation of this Addendum.

2.0 Corrective Measures Implementation Activities

FDEP expressed concerns regarding arsenic soil contamination in the upper 2 ft of soil at the WWNA/Building 200 Area due to the Florida Industrial Soil Cleanup Target level of 3.7 milligrams per kilogram (mg/Kg). During the assessment portion of the Environmental Restoration Program, DOE made several significant attempts to identify the potential source of arsenic contamination including collecting several hundred soil samples and installing 26 monitoring wells. In August 1998, DOE proposed a multi-phased Interim Action to address both the soil and contamination in the surficial aquifer.

The Interim Action included geochemical testing and leaching studies and temporary recovery well operation. These activities are presented in subsections 2.1 and 2.2, respectively. The geochemical testing was completed in June 1999. The results were formally presented to the FDEP in a meeting in July 1999. After reviewing the information, FDEP requested a statistical analysis of the arsenic soil concentrations and a specific remedial action proposal addressing the removal of soils in hot spot areas. These additional activities are summarized and presented in subsection 2.3.

2.1 Geochemical Testing

DOE performed geochemistry and leaching studies to address the concerns regarding the possibility of a localized change in groundwater geochemistry.

The column leaching tests were designed to determine

- Whether the arsenic in the soils is contributing to the elevated concentrations of arsenic in site groundwater,
- Determine the extent to which arsenic leaching is kinetically controlled, and
- Whether the arsenic could be stabilized with ferric chloride.

The DOE Environmental Sciences Laboratory (ESL) located in Grand Junction, Colorado, performed this portion of the study. The results are presented in the report entitled *Column Leaching of Arsenic for the Pinellas Science, Technology, and Research Center Wastewater Neutralization Area, Florida* (ESL 1999). The report is provided in Appendix B and is summarized in subsection 2.1.1.

Using the column leaching results, a geochemical evaluation was performed. The purpose was to investigate whether soils in the WWNA/Building 200 Area are capable of leaching arsenic into the underlying groundwater system, and if so, to measure the extent to which the leaching is 1) kinetically controlled and 2) affected by mixing limestone gravel with the soil. The evaluation is presented in the report entitled *Geochemical Evaluation of Arsenic at the Pinellas Science, Technology, and Research (STAR) Center Waste Water Neutralization Area, Florida* (DES 1999). Duke Engineering & Services (DES) of Grand Junction performed the evaluation jointly with DOE's contractor, MACTEC Environmental Restoration Services, LLC (MACTEC-ERS). The report is provided in Appendix C and is summarized in subsection 2.1.2.

2.1.1 Column Leaching Tests

Three column studies were conducted to determine if arsenic would leach from site soils into the adjacent groundwater system. Soil samples used for the study were collected from areas near wells PIN18-0500 and PIN18-0502 (Figure 2-1). These samples were combined and homogenized for use in the study. Columns 1 and 2 contained site soil and column 3 contained site soil and crushed limestone at a 1:1 ratio by mass.

Groundwater collected from well PIN18-0504 was used to leach column 1, and deionized water was used to leach columns 2 and 3 (Table 2-1). Water was pumped into the columns at a rate of 1.5 milliliters per minute (ml/minute) from bottom to top to simulate saturated conditions. Column effluent samples were collected every 12 hours for 5 to 8 days and were analyzed for arsenic. The effluent samples were not filtered, so the reported values are total arsenic concentrations. Geochemical conditions in the column effluent were monitored at the time of sample collection.

Table 2-1. Column Parameters

	Column Number		
	1	2	3
Average Arsenic Concentration in Soil (mg/Kg)	31.3	12.8	13.0
Influent Type	Well ^a	DI ^b	DI ^b
Range of Arsenic Concentrations in Column Effluent (µg/L)	280-544	232-536	172-236 ^c

^awell = Groundwater collected from well PIN18-0504.

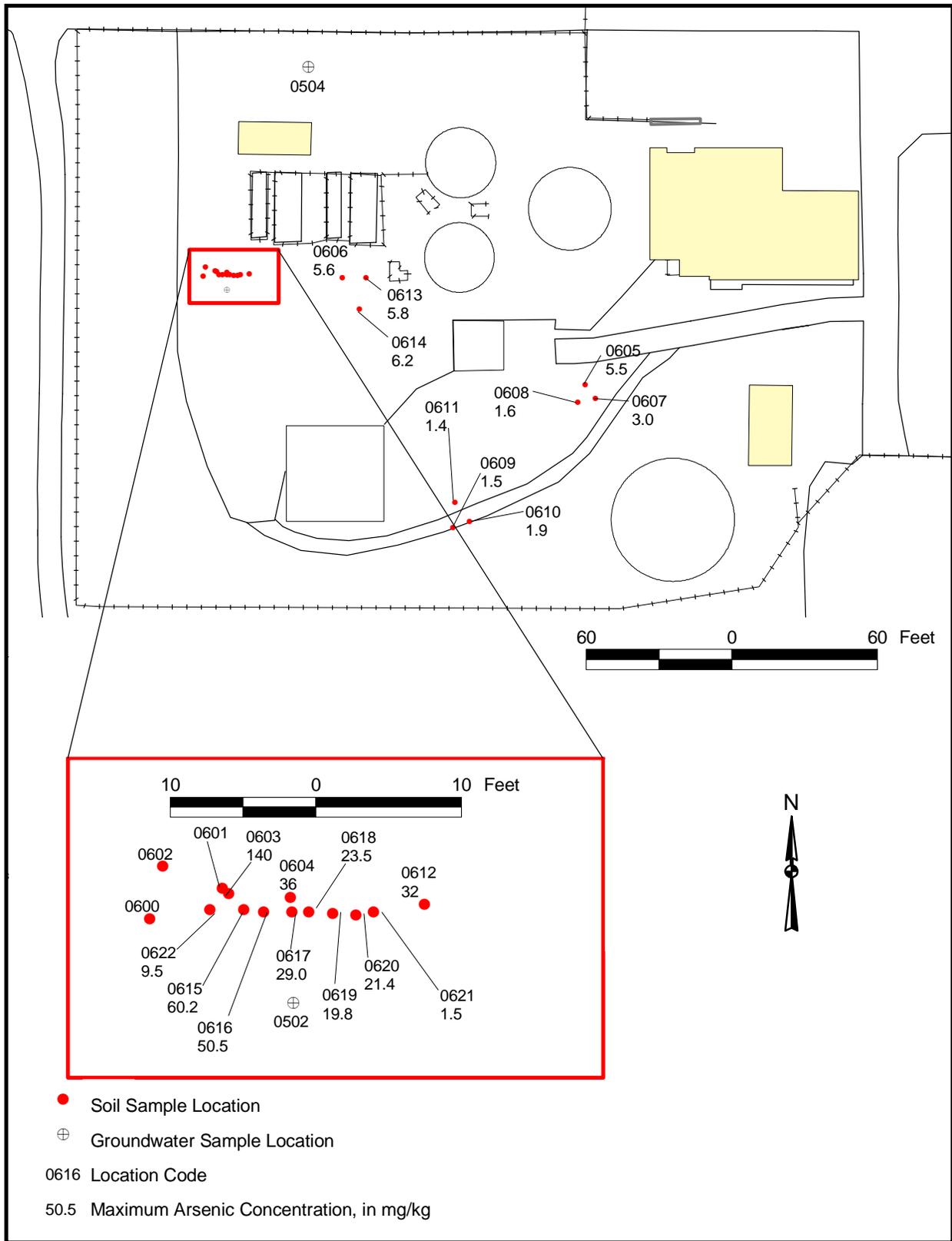
^bDI = Deionized water.

^cDoes not include arsenic concentrations measured after injection of ferric chloride into the column.

As shown in Figure 2-2, arsenic was leached from the site materials in concentrations exceeding the SDWA MCL of 50 µg/L. The range of total arsenic concentrations measured in the leachate from each column is presented in Table 2-1. Additionally, arsenic oxidation states were measured in the column effluent. In general, arsenate (As(V), or As⁺⁵) was the dominant arsenic species present, while arsenite (As(III), or As⁺³) was less prevalent.

After the leaching test was complete, arsenic concentrations were measured in the column soil materials. These final concentrations were similar to the initial concentrations before the leaching test, indicating that leaching had not significantly reduced the arsenic concentration in the soil materials.

An additional experiment was conducted with column 3, where ferric chloride was injected into the column after the initial leaching test was complete. The purpose was to determine if amorphous ferric oxyhydroxide (AFO), a solid formed when iron precipitates from the ferric chloride solution, would adsorb arsenic from solution. Upon injection of the ferric chloride solution into the column, the dissolved arsenic concentration in the column effluent dropped from 236 µg/L to 34.2 µg/L, and then eventually increased to 68 µg/L (Figure 2-2). Although this treatment greatly reduced the dissolved arsenic concentration, the final arsenic concentration in the column effluent was not below the 50 µg/L drinking water standard. Additionally, questions were raised about the longevity of this treatment. Geochemical conditions in the subsurface at Pinellas could lead to the dissolution of the AFO and remobilization of the arsenic into the dissolved phase. Therefore, the ferric chloride treatment was not considered to be a viable option to treat the dissolved arsenic at the WWNA.



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Figure 2-1. Soil Sample Locations for Arsenic Leaching Tests

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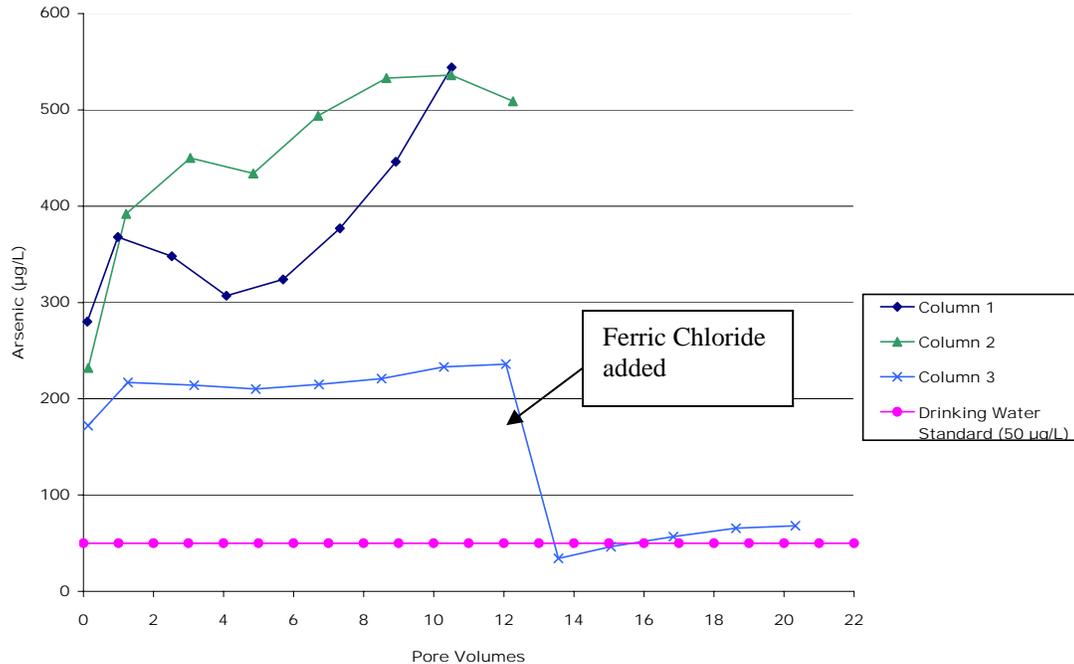


Figure 2-2. Arsenic Concentrations in Column Effluent

The conclusions from the column leaching studies are:

- Arsenic concentrations in all effluents from the column tests were above the SDWA MCL of 50 µg/L.
- The soils may be contributing to the arsenic contamination at the WWNA/Building 200 Area.
- Arsenic will continue to leach from the soils for extended periods of time.

2.1.2 Geochemical Evaluation

The data generated during the three column leaching tests were entered into a geochemical model to evaluate the mobility of arsenic in the soil and groundwater system at the site. The evaluation report also summarizes historic arsenic concentrations in site soil and groundwater, evaluates site hydrogeology, and discusses general arsenic geochemistry (DES 1999).

The code PHREEQC was used to model the column leaching tests (approximately 12 pore volumes), and to predict arsenic leaching for 300 pore volumes. The model was unable to simulate the dissolved arsenic concentrations measured in the column tests, but was able to reproduce the soil arsenic concentrations and the column effluent pH conditions (Figure 2-3). The simulation of future leaching conditions indicated that the dissolved arsenic concentrations may remain above the 50 µg/L drinking water standard for hundreds of pore volumes (Figure 2-4).

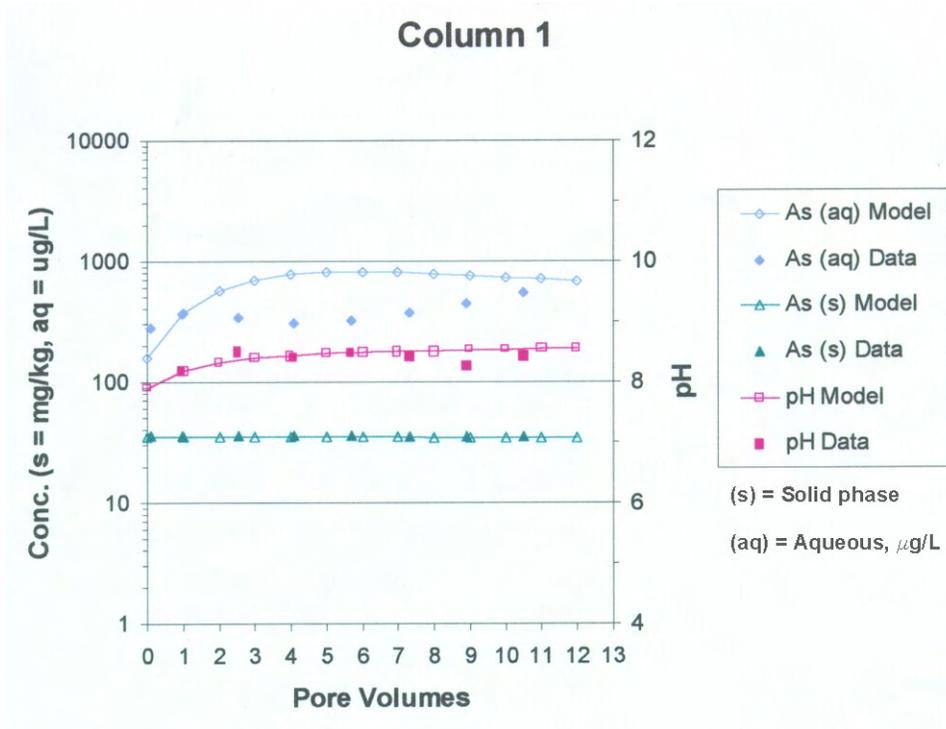


Figure 2-3. Arsenic and pH Model Results for Column 1

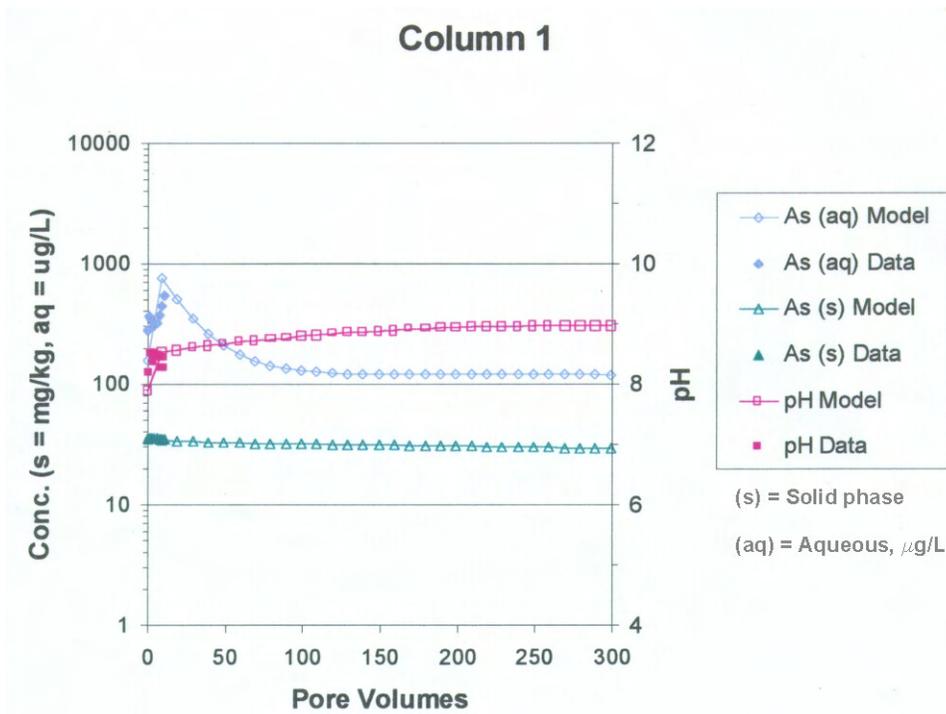


Figure 2-4. Extended Model Results for Column 1

The review of historical groundwater data showed that high dissolved arsenic concentrations were consistently measured near locations where elevated soil arsenic concentrations occurred, and that the highest dissolved arsenic concentrations were measured in the wells that were screened at shallow depths. Additionally, it was determined that average shallow groundwater arsenic concentrations had not changed considerably over the previous 7 years of monitoring.

2.2 Recovery Well Operation

2.2.1 Aquifer Testing

During April 1999, aquifer testing was conducted in recovery well PIN18–RW01 at the WWNA/Building 200 Area (Figure 1–2). A short-term variable rate drawdown (step) test was conducted on April 13, 1999, to estimate well efficiency of PIN18–RW01 and to determine the sustained flow rate for a constant rate test. The test consisted of flow rates of 0.8, 1.3, and 1.7 gallons per minute (gpm), each 1 hour in length. Logarithmic extrapolation of drawdown measurements in PIN18–RW01 indicated that flow could be sustained at the rate of approximately 1.3 gpm and 18 ft of drawdown without dewatering the well during a constant rate test. A very low specific capacity of approximately 0.1 gpm/ft and well efficiency of 15 percent were determined from test data.

A 72-hour constant rate test was begun on April 14, 1999, using PIN18–RW01 and monitoring wells located within 52 to 64 ft of the pumping well. Wells were screened at 5–10 ft intervals and to depths of 15 ft (shallow), 30 ft (intermediate), and 43 ft (deep). Periodic pumping rate adjustments of approximately 0.1 gpm were made during the test when observed drawdown trends in PIN18–RW01 and observation wells declined. Maximum observed drawdown in PIN18–RW01 was 21.9 ft and average pumping rate during the test was 1.2 gpm.

Observed drawdown in wells PIN18–0523, PIN18–0524, and PIN18–0525, located east of the pumping well (Figure 1–2), were 0.21 ft (deep), 0.20 ft (intermediate), and 0.16 ft (shallow), respectively. Similar drawdown of 0.18 ft was observed in both shallow wells PIN18–0522 and PIN18–0500 (Figure 1–2), the latter located near the area of high arsenic levels. The greatest drawdown of 1.01 ft was observed in deep monitoring well PIN18–0520. No drawdown was observed in an intermediate screened well, PIN18–0521.

Because of the observed aquifer drawdown and relative distances between wells, limited aquifer parameters were estimated from the test. Transmissivity at well PIN18–0520 was approximately 800 gallons per day per foot (gpd/ft). Distance drawdown results around the site averaged 1,514 gpd/ft with a lower apparent transmissivity for wells screened in the deep portion of the aquifer. The values are within the lower range of transmissivity considered representative of the surficial aquifer.

2.2.2 Operation

DOE proposed the recovery well PIN18–RW01, installed in June 1997, be pumped for a test period of 6 months. Prior to its operation, sampling, and aquifer testing was performed. Well operation began in June 1999. Figure 2–5 shows the pumping levels and flow rates for PIN18–RW01 during the test period. Figure 2–6 shows the arsenic concentrations in PIN18–RW01 prior to operation and during the test period. Prior to operation, arsenic concentrations were increasing slightly. PIN18–RW01 is screened over the entire surficial

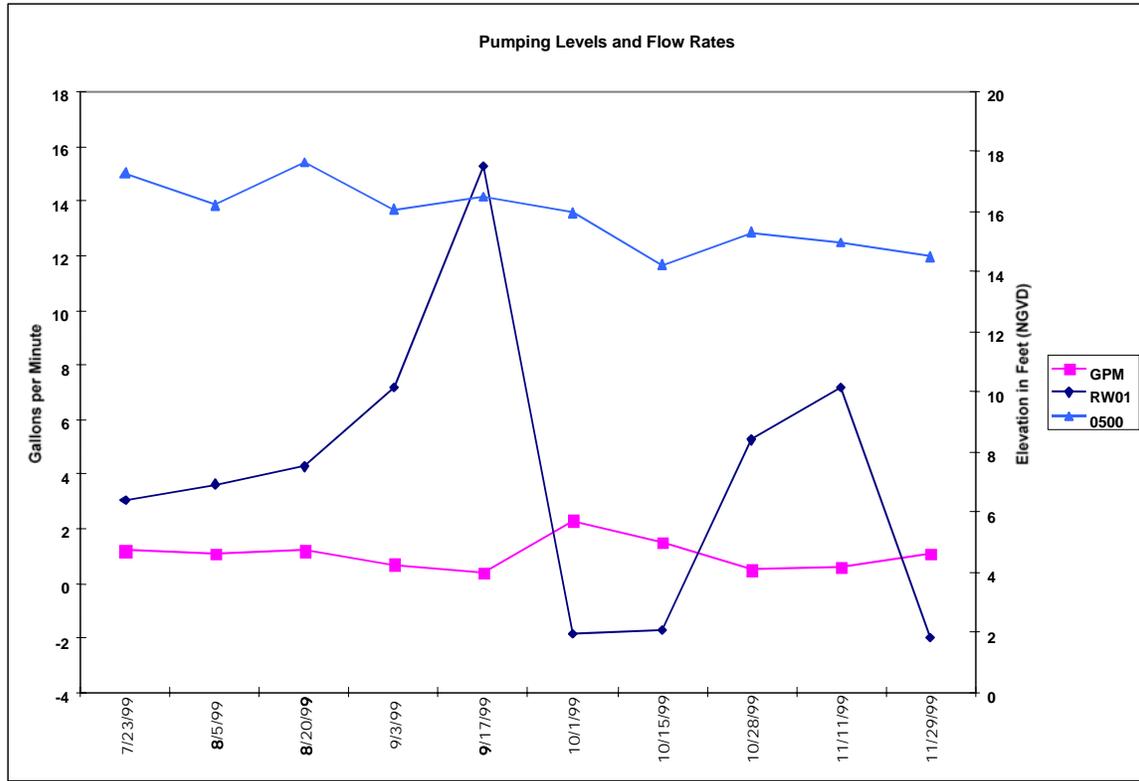


Figure 2-5. Pumping Levels and Flow Rates

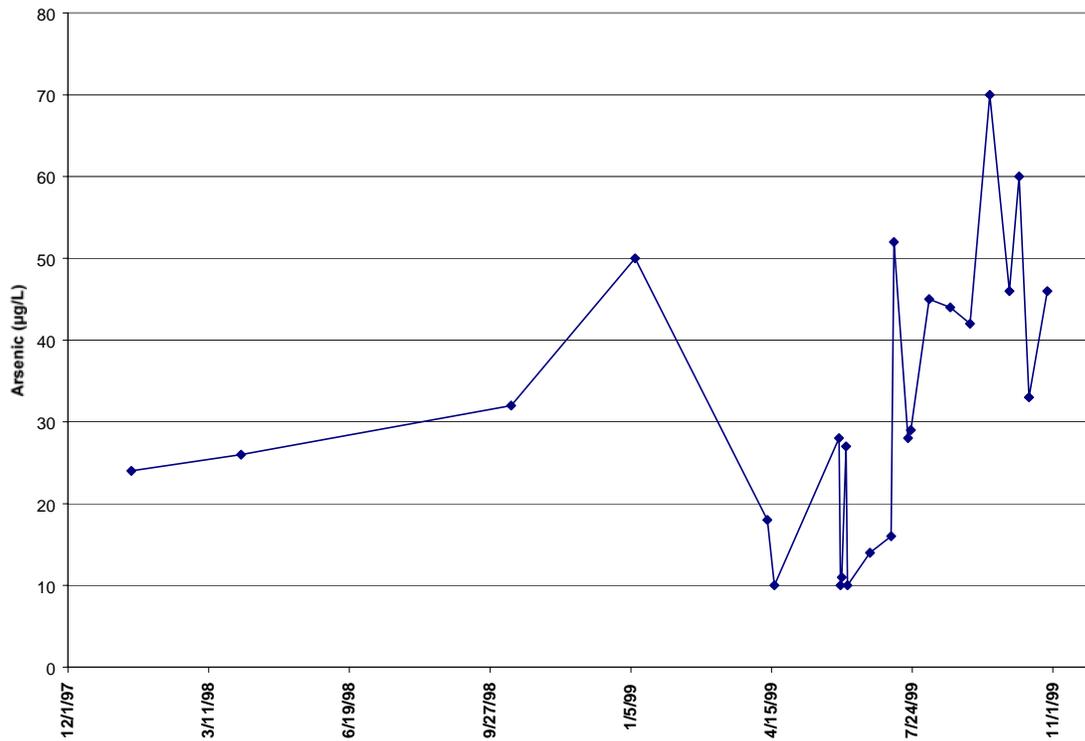


Figure 2-6. Arsenic Concentrations in PIN18-RW01

aquifer interval from 2.5 to 39.5 ft. Arsenic concentrations in this well have ranged from <10 to 70 µg/L (Figure 2–6), and a very general trend of increasing concentrations is evident.

During the 6-month test operation period, the low specific capacity of the well resulted in the extraction of less than approximately 25 percent of the total pore volume estimated for the contaminated portion of the aquifer. This percentage assumes groundwater extracted from the upper 30 ft of the aquifer where arsenic is present. The amount extracted is probably less because PIN18–RW01 taps the lower portion of the aquifer. This is supported by the drawdown shown in Figure 2–7, the groundwater elevations and deep surficial aquifer flow for October 1999. Much of the groundwater extracted from PIN18–RW01 originates from depths below 30 ft. This indicates that the pumping exerts insignificant drawdown in the shallow wells and a majority of the observed drawdown in PIN18–RW01 is caused by well loss. The decline in water levels of PIN18–0500 (Figure 2–5) is mostly the result of the decrease in groundwater recharge from rainfall than aquifer dewatering. This lack of drawdown caused by poor well efficiency is shown in Figure 2–8 that depicts the groundwater elevations and shallow surficial aquifer flow in October 1999. During this time, no cone of influence is observed at PIN18–RW01 and an easterly component of flow is induced somewhat by pumping at the Building 100 Area.

2.3 Soil Removal

DOE identified elevated levels of arsenic in soil at the WWNA/Building 200 Area. To aid in the evaluation of arsenic concentrations in soil at the WWNA/Building 200 Area, FDEP requested a statistical analysis. This analysis was used to support a soil removal option by determining the area and depth of excavation in the areas where elevated levels of arsenic are present in soil. The analysis is presented in subsection 2.3.1. The description of the excavation plan is presented in subsection 2.3.2.

2.3.1 Statistical Evaluation

Arsenic data from 267 soil samples collected at 96 locations from the WWNA were evaluated. This data is included in Appendix D. Figure 2–9 shows the locations of all arsenic soil samples that range in depth from 0 to 9.5 ft below land surface.

The FDEP established an Industrial Soil Cleanup Target Level for arsenic in soil of 3.7 mg/Kg in the upper 2 ft of soil. Figure 2–10 shows 22 locations where arsenic concentrations are greater than 3.7 mg/Kg in the upper 2 ft of soil. Arsenic concentrations at these locations ranged from 3.8 to 140 mg/Kg. A statistical analysis using the 95 percent upper confidence level (UCL) was performed to determine a concentration for the remediation of arsenic contaminated soil. Using the entire data set of 267 arsenic concentrations, the 95 percent UCL was found to exceed the 3.7 mg/Kg Industrial Soil Cleanup Target Level indicating some remediation is necessary. The following table summarizes the statistical analyses and the data set is provided as Appendix D.

Data Points	Mean	Standard Deviation	95% UCL Deviation	95% UCL Value	Comparison To 3.7 mg/Kg
267	5.44	12.40	1.49	6.93	-3.23

Sixty-four locations exceed the arsenic Industrial Soil Cleanup Target Level. These locations correspond to two areas where arsenic concentrations are the highest. Area 1 lies near the west-central edge of the WWNA as shown in Figure 2–11. In this area, arsenic concentrations range

from less than 3.7 mg/Kg to 140 mg/Kg. The second area where arsenic concentrations in soil are elevated lies to the east of this area approximately 150 ft. At Area 2, the arsenic concentration in soil is 50.3 mg/Kg in the upper 1.0 ft of soil. Appendix D summarizes these locations and the arsenic concentrations with depth.

DOE proposed excavating both Areas 1 and 2 to sufficient depth to remove the bulk of soils containing elevated arsenic. At Area 1, a 5-ft by 18-ft area was excavated to a depth of 6 ft. At Area 2, a 5-ft by 5-ft area around soil location 0566 was excavated to a depth of 2 ft. Figure 2–11 depicts the excavated soil locations.

Another statistical analysis was performed to determine if additional excavation of arsenic contaminated soils was warranted. Removing the proposed Areas 1 and 2 data points reduced the original data set to 202 data points. This select data set is provided in Appendix D. The following table presents the statistical analyses that were performed.

Data Points	Mean	Standard Deviation	95% UCL Deviation	95% UCL Value	Comparison To 3.7 mg/Kg
202	1.68	2.25	0.31	2.00	1.70

The results of this second analysis indicated that no further excavation of arsenic at the WWNA was warranted because arsenic concentrations were below the Industrial Cleanup Target Level.

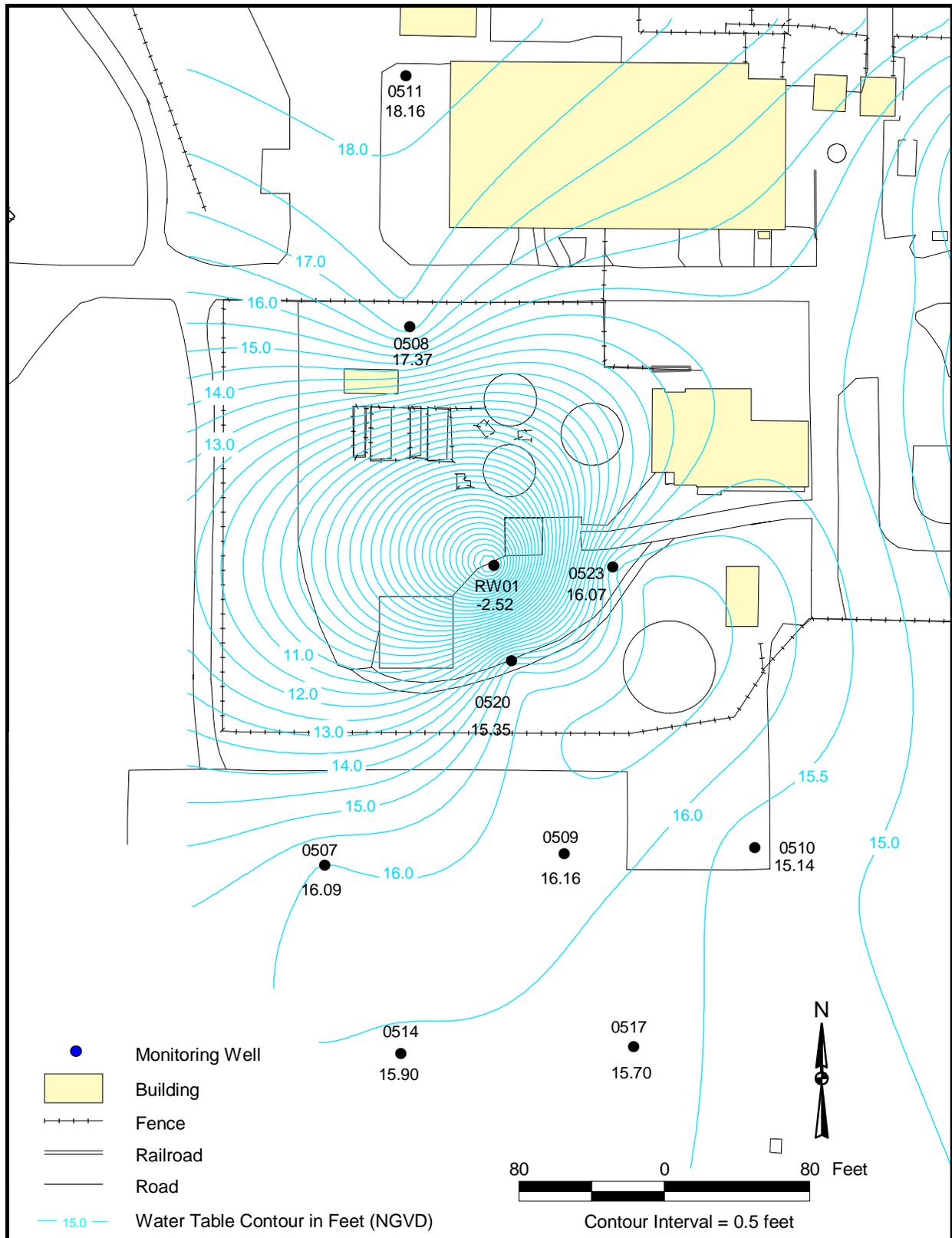
To further support that no further excavation was warranted, a statistical evaluation was performed to determine the 95 percent UCL in the upper 2 ft once the elevated levels of arsenic in soil were removed. This new data set is comprised of 87 arsenic concentrations and is included as Appendix D. The following table provides the statistical analyses that were performed:

Data Points	Mean	Standard Deviation	95% UCL Deviation	95% UCL Value	Comparison To 3.7 mg/Kg
87	1.83	1.72	0.37	2.20	1.50

The results of this last analysis provides additional confirmation that no further excavation of arsenic at the WWNA was warranted because arsenic concentrations were below the Industrial Cleanup Target Level.

2.3.2 Excavation Project

The 95 percent UCL statistical analysis of WWNA arsenic concentrations in soil was used to determine exposure point concentrations. Based upon this statistical analysis, in August 1999, DOE proposed to FDEP to excavate approximately 20 cubic yards from Area 1 and approximately 2 cubic yards from Area 2. At Area 1, an area approximately 5-ft wide, 18-ft long, and 6-ft deep would be excavated. At Area 2, an area approximately 5-ft wide, 5-ft long, and 2-ft deep would be excavated. Excavating these two areas will remove the bulk of soils containing arsenic above the FDEP target level. Figure 2–11 depicts Areas 1 and 2. Figures 2–12 and 2–13 show pertinent details for logistical considerations during excavations. After excavation, the 95 percent UCL will be approximately 2.2 mg/Kg, which will be below the Industrial Cleanup Target Level of 3.7 mg/Kg.

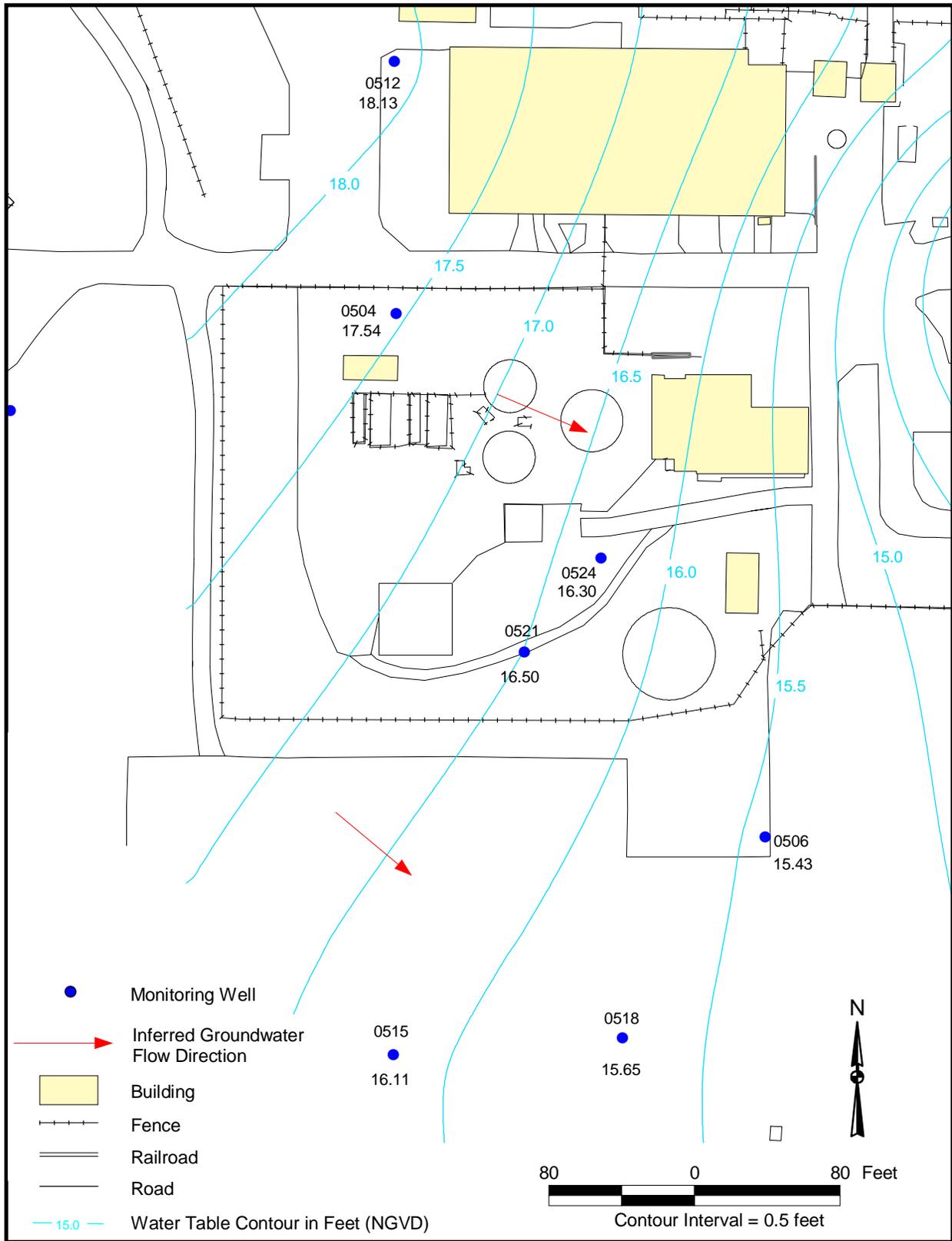


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Figure 2-7. Groundwater Elevations and Deep Surficial Aquifer Flow, WWNA, October 1999

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Figure 2-8. Groundwater Elevations and Shallow Surficial Aquifer Flow, WWNA, October 1999

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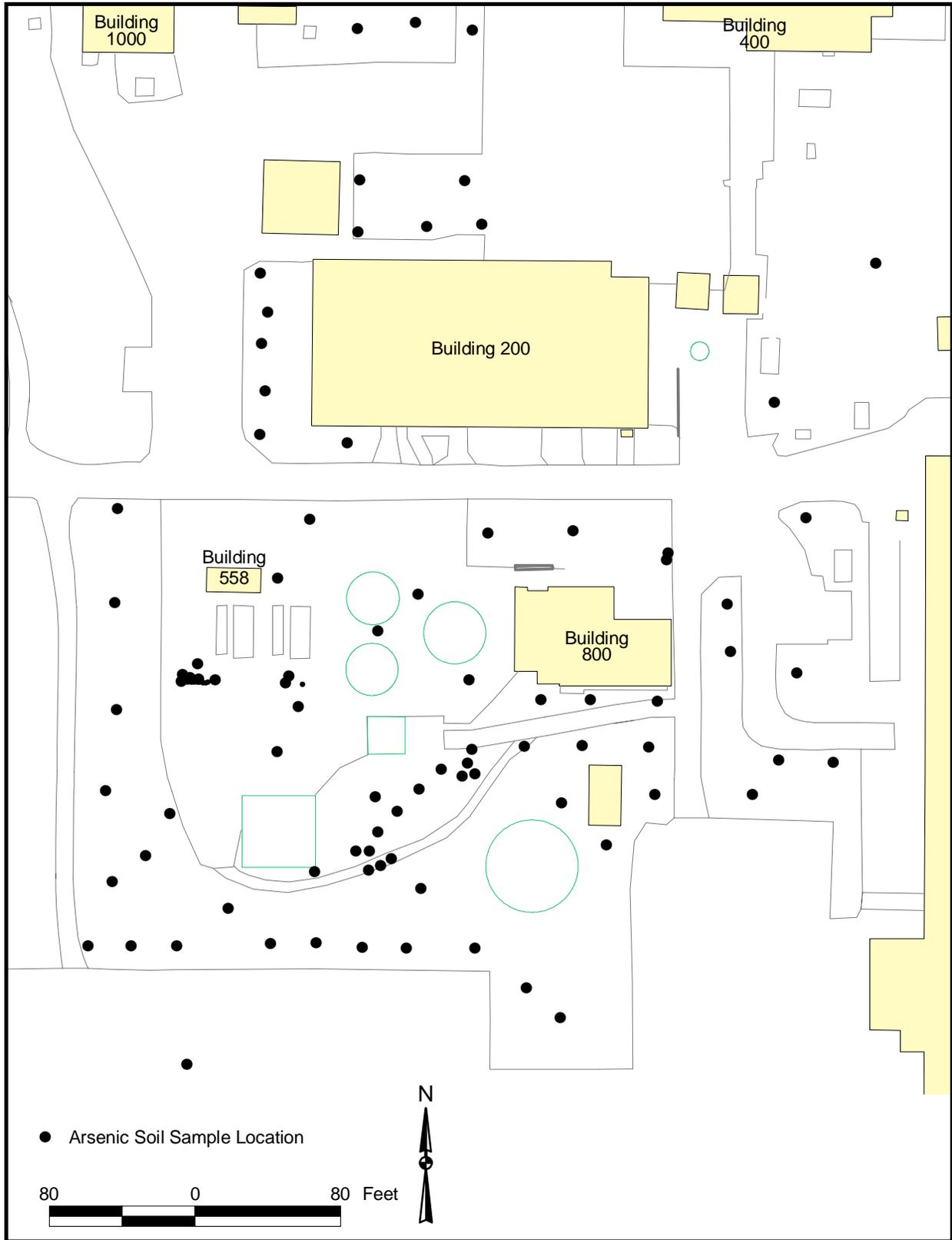
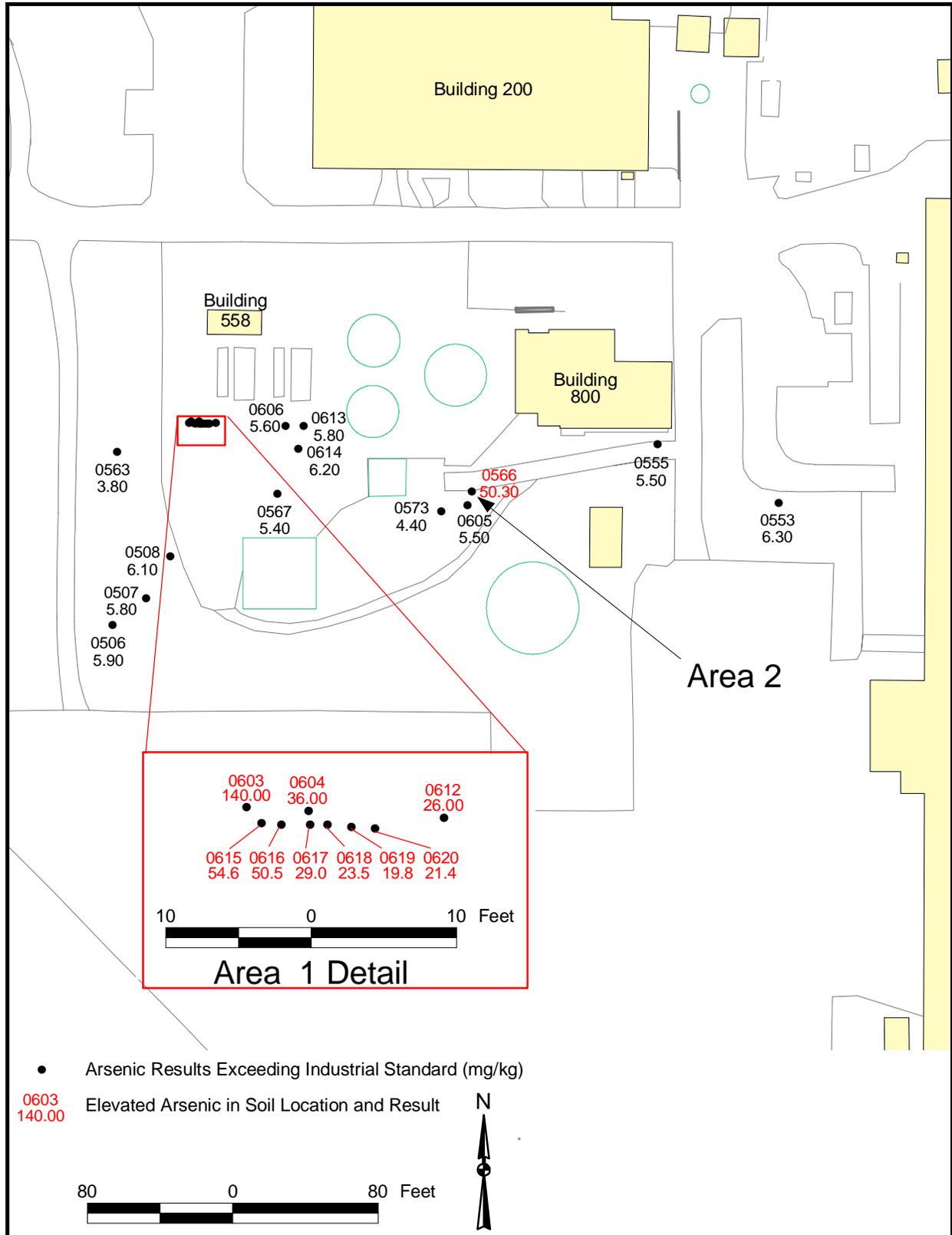


Figure 2-9. Arsenic Soil Sample Locations

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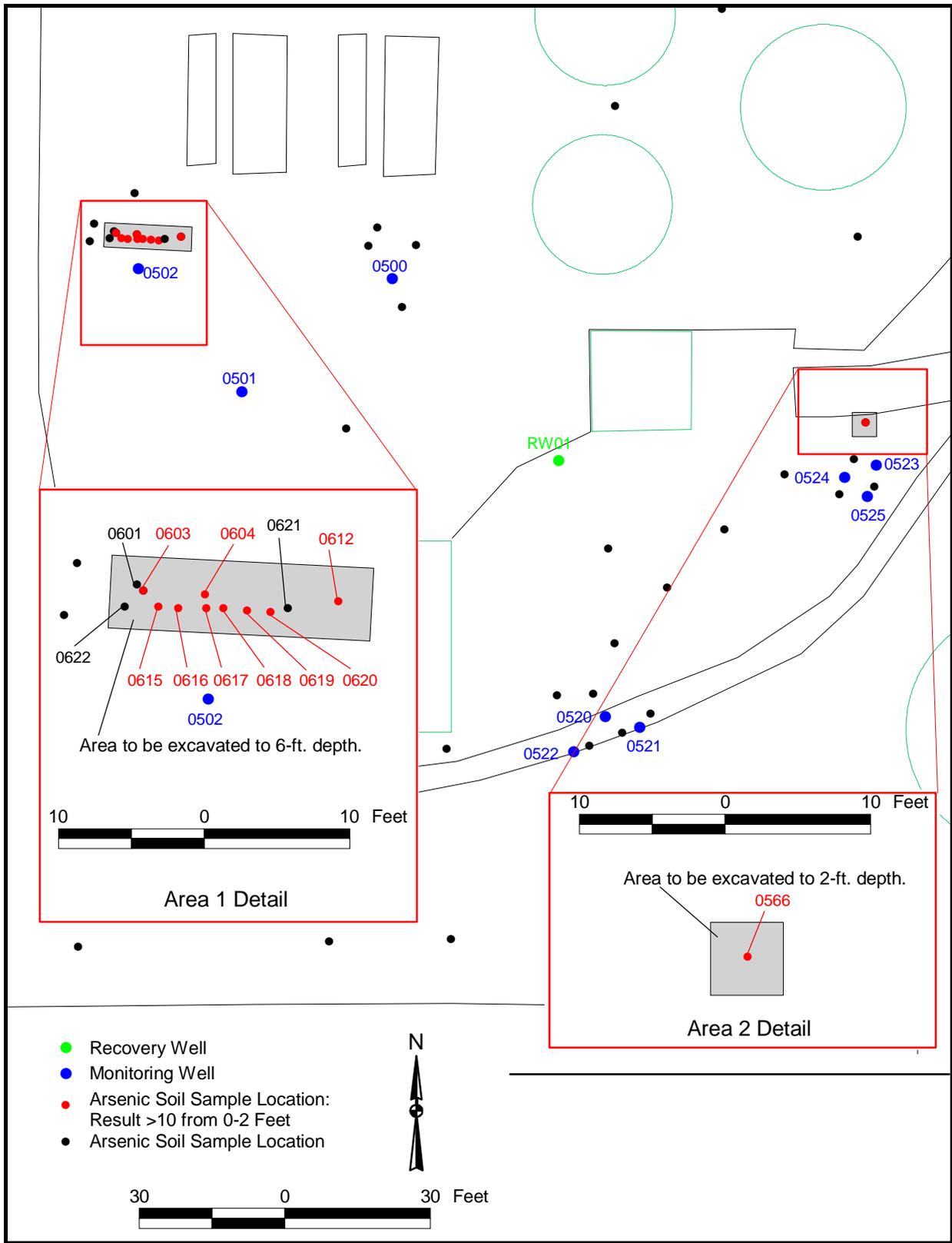


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Figure 2-10. Arsenic Concentrations > 3.7 mg/Kg, 0-2 Feet in Depth

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Figure 2-11. Elevated Arsenic in Soil Locations to be Excavated

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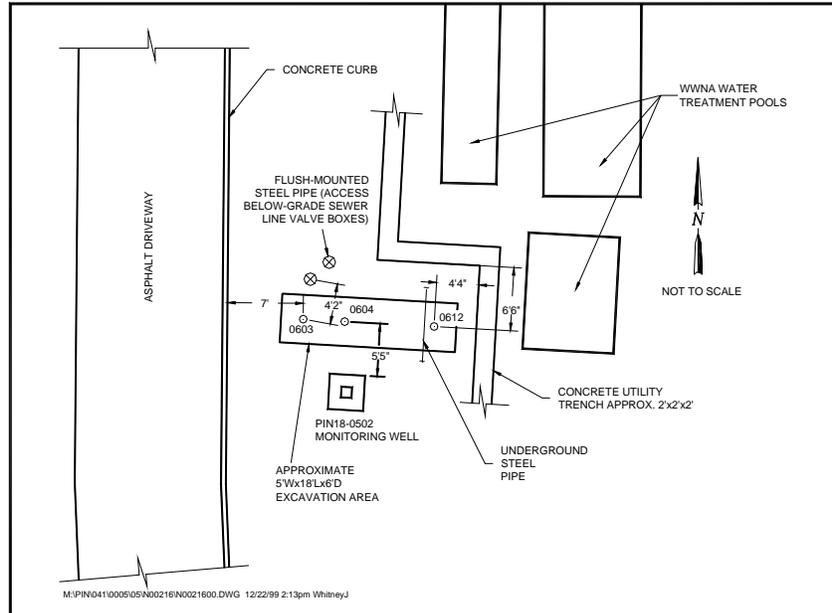


Figure 2-12. Detail of Structures and Facilities at Area 1

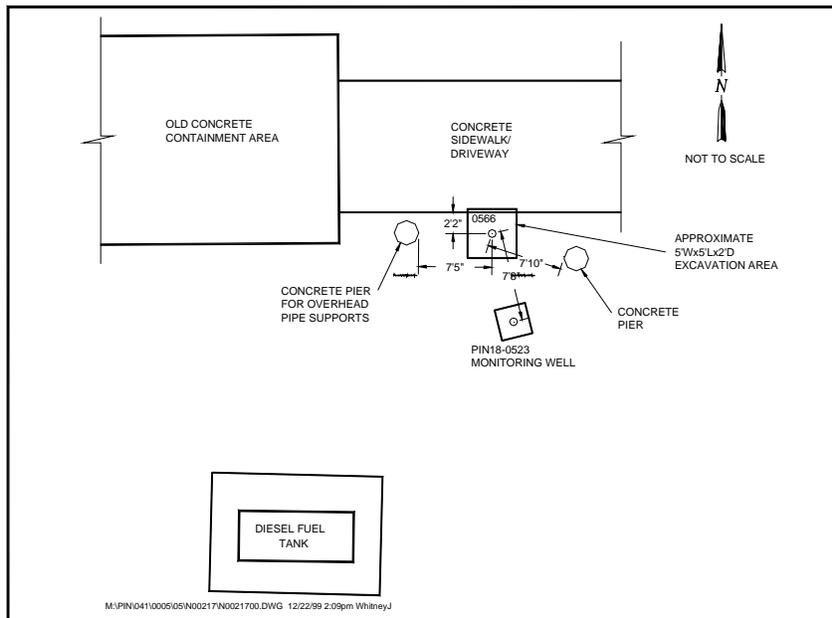


Figure 2-13. Detail of Structures and Facilities at Area 2

FDEP approved the statistical analysis in September 1999. Excavation began the week of September 20, 1999, in accordance with DOE’s Excavation Plan (Appendix E). The plan was developed to

- Provide the locations and sizes of the areas of contamination to be excavated,
- Describe how the bulk of arsenic-contaminated soil will be removed and managed,

- Prescribe how the excavated areas will be back-filled, and
- Provide a sampling plan to determine the applicability of RCRA for disposal of excavated soil material.

Table 2–2 provides information with respect to the excavation areas including proposed excavation depths, estimated volume of material to be excavated, and approximate arsenic concentrations. Total arsenic concentrations were calculated based on an average of interval concentrations across the areas of excavation. For waste management purposes, these averages were then divided by 20 to approximate the Toxicity Characteristic Leaching Procedure (TCLP) concentration. The calculations contain the assumption that arsenic contamination is somewhat homogenous throughout each interval. However, for purposes of managing the excavated material, conservative estimations are acceptable. Characterization for off-site disposal was conducted in accordance with sampling and analysis for arsenic-contaminated soil in the Excavation Plan (Appendix E).

Table 2–2. Proposed Excavated Soil Information

Arsenic Sample Locations	Area of Excavation	Volume of Excavated Material (cubic feet)	Estimated TCLP Concentration of Excavated Soil
Area 1			
0601, 0603, 0604, 0612, 0613, 0614, 0615, 0616, 0617, 0618, 0619, 0620, 0621, and 0622	5 ft x 18 ft x 6 ft	540	Mean conc. = 16.58 mg/Kg (total As) Approx. = 0.8 ppm
Area 2			
0566	5 ft x 5 ft x 2 ft	50	Conc. = 50.3 mg/Kg (total As) Approx. = 2.5 ppm
Total		590 ft ³ or approx. 22 yd ³	TCLP conc. of As as weighted ave. = 0.9 ppm

At the completion of the excavation, two roll-off bins of excavated soil were generated totaling approximately 35 cubic yards. Composite samples from each bin resulted in concentrations of 11 and 14 mg/Kg total arsenic. Leachable arsenic concentrations, as determined by the TCLP, were not detected (the detection limit was 0.2 mg/L).

Although underlying hazardous constituents were not believed to be a concern in this soil, DOE took appropriate steps to analyze the soil for any organic contaminants that have been detected in the past in the monitoring wells near the arsenic-contaminated soil areas. These constituents, listed in Table 2–3, were not present above the detection limit.

Table 2–3. Underlying Hazardous Constituents

Constituent	Concentration	Constituent	Concentration
Benzene	Non-Detected (ND) (27 µg/kg)	Ethylbenzene	ND (27 µg/kg)
Xylenes	ND (27 µg/kg)	Toluene	ND (27 µg/kg)
Vinyl Chloride	ND (27 µg/kg)	Methylene Chloride	ND (54 µg/kg)
Trichloroethene	ND (27 µg/kg)	cis 1,2-Dichloroethene	ND (27 µg/kg)
Trans 1,2-Dichloroethene	ND (27 µg/kg)	—	—

Value in parentheses is the detection limit.

Under the FDEP's "Managing Contaminated Media," as revised July 1995, the soil passed the EPA TCLP for the hazardous characteristic of arsenic, as well as the Universal Treatment Standard (both are 5.0 mg/L). However, the total arsenic concentration in the excavated soil exceeds the Interim Soil Cleanup Target Level of 3.7 mg/Kg. Therefore, as a Best Management Practice, and with the concurrence of the FDEP, DOE disposed of the material in a RCRA Subtitle D Landfill, without treatment.

Each excavation area was backfilled with "clean soil," as sampled, analyzed, and certified by the vendor. All portions of the gravel cap removed during excavation activities were replaced with a new 6-inch layer of crushed limestone.

2.4 Results and Conclusions

DOE completed the Interim Action activities for the WWNA/Building 200 Area in November 1999. These activities included a geochemical evaluation, operation of the recovery well for 6 months, and removal of arsenic-contaminated soil.

The conclusions of the geochemical evaluation are:

- Shallow soils in the WWNA are the likely source of elevated arsenic concentrations in site groundwater.
- The column leaching tests showed that 10 pore volumes of simulated flushing removed only 2.5 percent to 10 percent of the arsenic in soil.
- The geochemical modeling results indicate that arsenic will continue to leach very slowly from the soils.
- The modeling demonstrates that at least several hundreds of pore volumes of groundwater will need to pass through the soils before the dissolved arsenic concentration decreases below the 50 µg/L drinking water standard.

The test pumping operation indicated a general trend of increasing arsenic concentrations in the surficial aquifer. The geochemical evaluation indicated that hundreds of pore volumes of groundwater would need to pass through the soil before dissolved arsenic concentrations would decrease. Based on this result, DOE determined that pulsing of the recovery well would not provide any additional data or benefits at this time.

The conclusions from the geochemical evaluation emphasized the need to remove the source of arsenic in specific areas of the SWMU. The statistical analysis indicated that removal of soil from two areas within the WWNA/Building 200 Area would result in the 95 percent UCL below the 3.7 mg/Kg Industrial Cleanup Target Level. The soil excavation was completed in October 1999, and approximately 35 cubic yards of material was removed.

A restriction of indefinitely maintaining the gravel cap over the WWNA was proposed by FDEP. DOE believes the soil excavation removed the identified areas of known arsenic concentrations that exceeded cleanup levels. Restrictions on maintaining the gravel cap is therefore not warranted based on the 95 percent UCL that is below the Industrial Cleanup Target Level.

With the removal of the potential source of arsenic, remediation of the surficial aquifer at the WWNA/Building 200 Area remains. Section 3 of this Addendum evaluates the performance of the implemented alternatives. Section 4 provides recommendations for continued remediation activities.

3.0 Performance Evaluation of Implemented Alternatives

3.1 Recovery Well Efficiency

During the test operation period, large fluctuations of pumping level elevations were identified in PIN18–RW01 (Figure 2–5). The large fluctuations of pumping level elevation between –2 ft and +17 ft in October were the result of the clogging of the pump and discharge line. Large amounts of iron oxide and bacteria were identified (Water Systems Engineering, Inc. Water Treatment Analysis and Control Report Lab Report #133901) in the biofilm (slime) from the pump intake screens and discharge water of the well. The iron oxide and bacteria growth did not appear to plug the well screen and filter pack.

The water-level fluctuations of PIN18–RW01 and well PIN18–0500 can not be correlated. This indicates that pumping exerts insignificant drawdown in the shallow well and a majority of the observed drawdown in PIN18–RW01 may be caused by well loss. The decline in water levels of PIN18–0500 is most likely the result of the decrease in groundwater recharge from rainfall than aquifer dewatering. This lack of drawdown is shown in Figure 2–8. No cone of influence is observed at PIN18–RW01 and an easterly component of flow is induced somewhat by pumping at the Building 100 Area.

During the test period, the specific capacity of the well remained at or below approximately 0.1 gpm/ft of drawdown at rates ranging from approximately 0.4 to 2.3 gpm. The higher rates represent periods after the pump screen and discharge line were cleaned. The original specific capacity was restored after the pump intake and lines were cleared. However, the specific capacity of PIN18–RW01 still does not approach capacities achieved from other recovery wells located at the Center.

During the 6-month test operation, less than 25 percent of the total pore volume estimated for the contaminated portion of the aquifer was extracted. This percentage assumes groundwater was extracted from the upper 30 ft of the aquifer where arsenic is present. The amount extracted is less because PIN18–RW01 taps the lower portion of the aquifer.

3.2 Groundwater Quality Results

Groundwater samples from the WWNA were initially collected at wells PIN18–0500, –0501, and –0502 in July 1991. Arsenic concentrations were measured above the 50 µg/L EPA drinking water standard in all three wells. Additional wells installed in 1993, 1994, and 1998 defined the boundaries of the area of arsenic contamination at the WWNA. Figure 1–3 shows the arsenic plume as of October 1999. In this figure, wells that do not have arsenic concentration values listed were not sampled in October.

The wells in and near the center of the arsenic plume are PIN18–0500, –0501, and –0502 (Figure 1–3). Wells PIN18–0521, –0522, –0524, and –0525 are located in the contaminated area, but are hydraulically downgradient near the leading edge of the plume. Wells PIN18–0520 and PIN18–0523 are located in the plume area, but are screened in the deep surficial aquifer and have shown no arsenic above the 10 µg/L detection limit. PIN18–RW01 was installed in 1997 as a recovery well for the purpose of capturing the arsenic-contaminated groundwater. The remaining

wells are located outside of the plume of contamination, where arsenic has never been detected above the 50 µg/L standard.

Groundwater samples collected from wells in the WWNA were not filtered and therefore could contain suspended solid particles, so all the reported arsenic concentrations discussed in this section are “total” as opposed to dissolved. Historically, arsenic samples from the WWNA have been analyzed with detection limits of 1, 2, 5, and 10 µg/L. To provide a consistent evaluation of the data, arsenic detections less than 10 µg/L are reported as non-detects (<10 µg/L) in this section.

Several duplicate samples were analyzed during past monitoring, and these duplicate analyses are shown as distinct points on the accompanying graphs of the arsenic time trends at each well. This allows a graphic view of the variation in concentration that is a result of the sampling and analytical processes. All of the duplicate samples showed excellent reproducibility, with one exception. The duplicate samples collected from well PIN18-0501 in January 1998 had arsenic concentrations of 120 and 300 µg/L. Because of this disparity, these values were averaged before being used in the time trend graph for well PIN18-0501.

3.2.1 Results

Total arsenic concentrations in well PIN18-0500 have generally ranged from 110 µg/L to 1,000 µg/L, with three notable concentration spikes of 1,720, 2,050, and 3,100 µg/L in July 1993, January 1997, and July 1999 (Figure 3-1). Samples collected from well 0502 have measured arsenic concentrations that vary around 500 µg/L, with spikes of 7,600 and 8,320 µg/L measured in duplicate samples in July 1993 (Figure 3-2). Total arsenic concentrations in samples from well PIN18-0501 have ranged around 100 µg/L with two spikes to 259 and 210 µg/L in July 1993 and January 1998 (Figure 3-3). Wells PIN18-0500 and PIN18-0502 are located in the center of the arsenic plume at the WWNA, and PIN18-0501 is located near the center of the plume (Figure 1-3). All three of these wells are screened at shallow depths (Table 3-1) and show arsenic concentration trends that remain constant or increase slightly.

Two clusters of three co-located wells (PIN18-0520 through PIN18-0522 and PIN18-0523 through PIN18-0525) are located to the southeast of the PIN18-0500 to PIN18-0502 set of wells (Figure 1-3), defining the southern and eastern portions of the arsenic plume. At each location, the three co-located wells are screened at shallow, intermediate, and deep intervals in the shallow aquifer (Table 3-1). Well PIN18-0525 (shallow) contained arsenic at concentrations ranging from 29 to 430 µg/L, while the intermediate depth well (PIN18-0524) contained arsenic at concentrations ranging from <10 to 110 µg/L (Figures 3-4 and 3-5). Wells PIN18-0525 and PIN18-0524 demonstrated a general trend of slightly increasing arsenic concentrations since they were first sampled in October 1994. Arsenic was not detected above 10 µg/L in well PIN18-0523 (deep).

In the shallow well PIN18-0522, arsenic concentrations ranged around 50 to 150 µg/L, with a spike to 550 µg/L in April 1998 (Figure 3-6). Increased sampling frequency at this location since June 1999 has demonstrated that the small scale fluctuations in arsenic concentrations in this well appear to be real, and not the result of changes in analytical or sample collection methodologies. This could apply to the small-scale fluctuation of arsenic concentrations in the

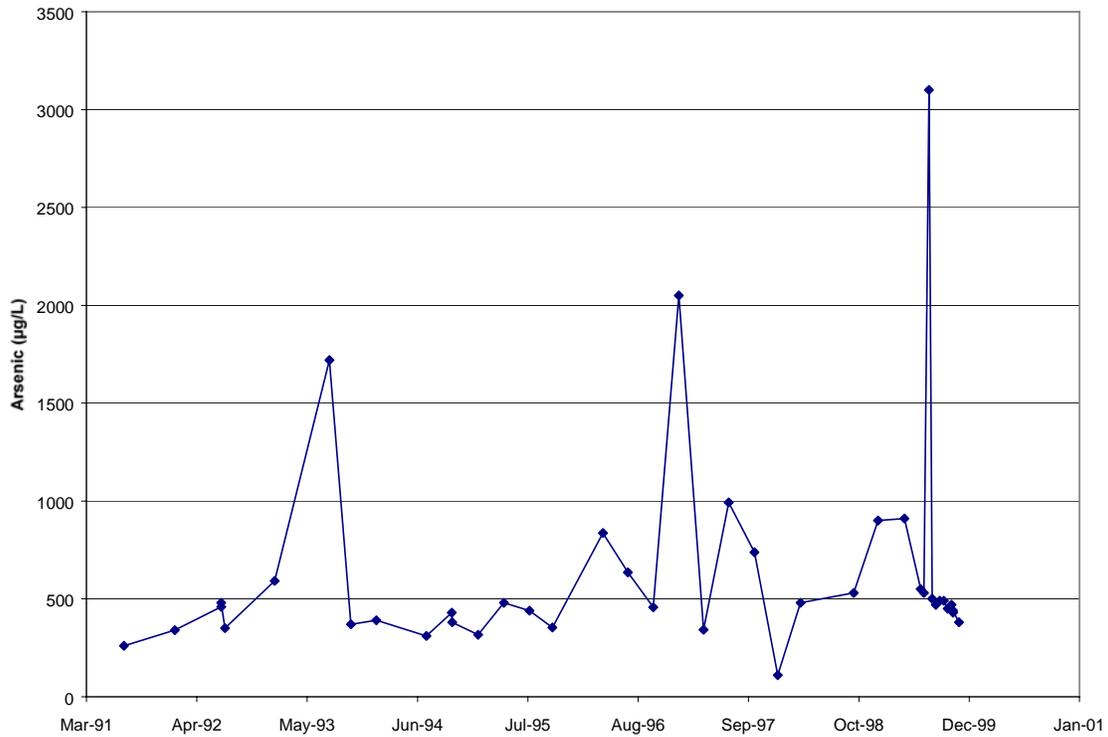


Figure 3-1. Arsenic Concentrations in PIN18-0500 (Shallow)

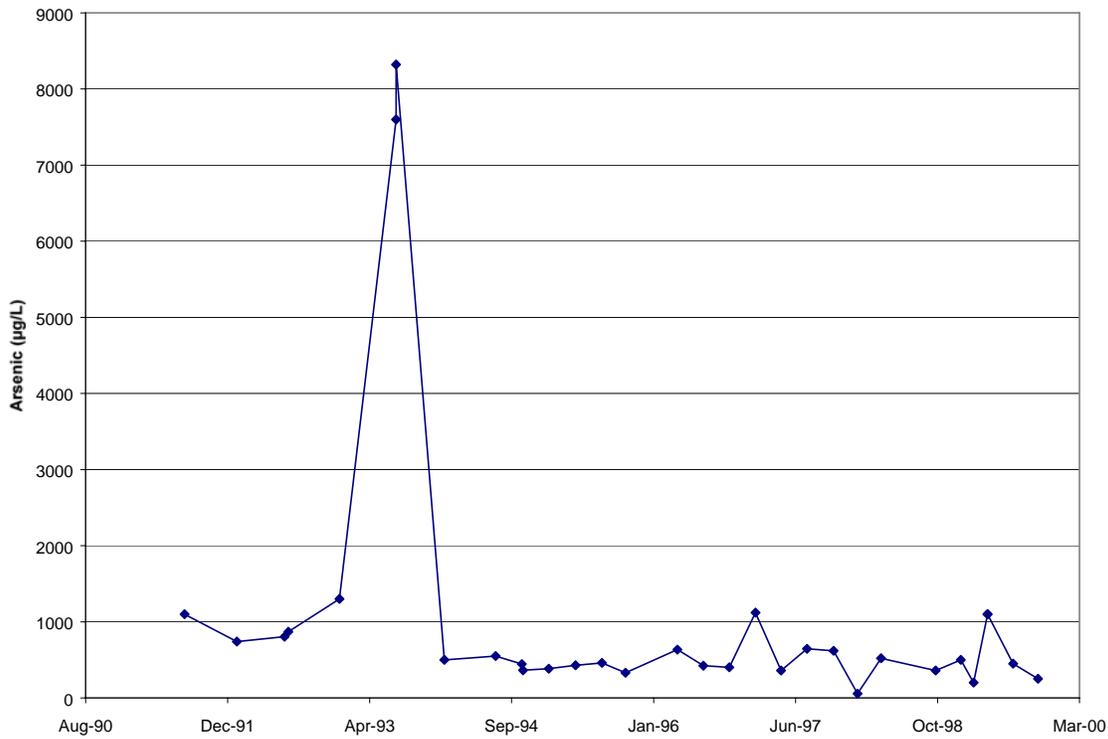


Figure 3-2. Arsenic Concentrations in PIN18-0502 (Shallow)

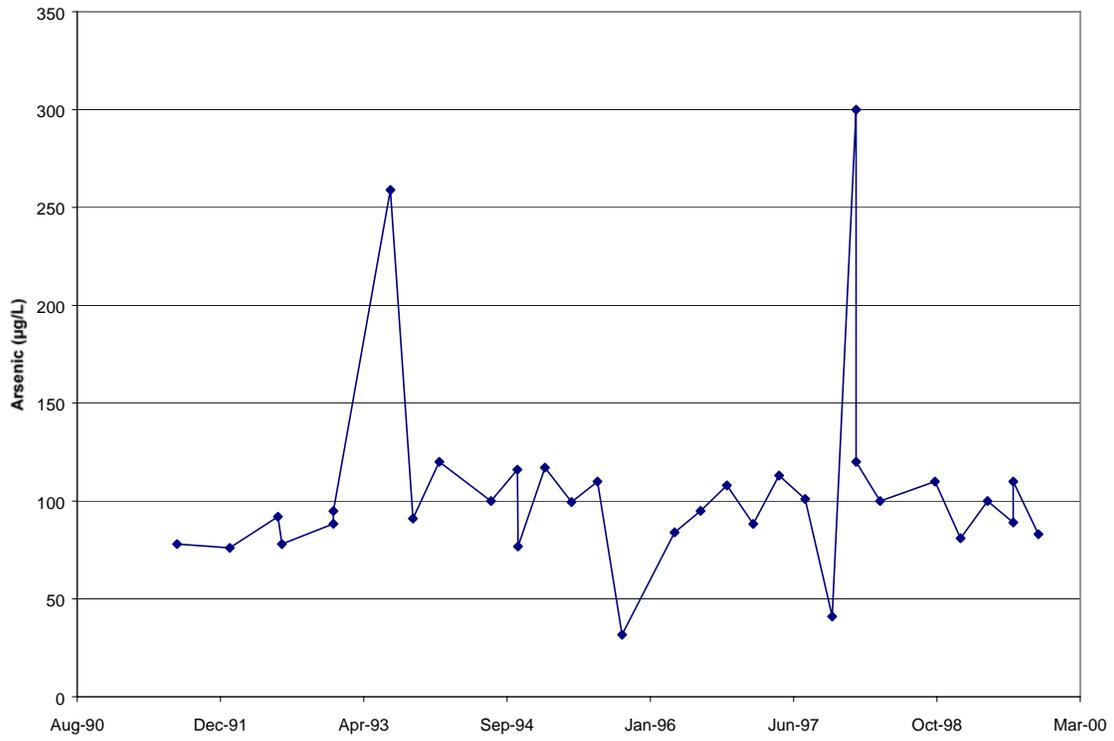


Figure 3-3. Arsenic Concentrations in PIN18-0501 (Shallow)

Table 3–1. Range of Total Arsenic Concentrations in Groundwater Samples Collected from WWNA Wells

Well	Range of Arsenic Concentrations ^a (µg/L)	Screened Interval (feet below ground surface)	Time Range
PIN18–0500	110–3100	11–16	July 1991–October 1999
PIN18–0501	31.7–259	11–16	July 1991–October 1999
PIN18–0502	56–8320	11–16	July 1991–October 1999
PIN18–0503	<10–14.8	10–20	July 1993–April 1999
PIN18–0504	<10–10.5	13–22	August 1993–April 1999
PIN18–0505	<10	10.5–20.5	July 1993–October 1999
PIN18–0506	<10–12	12–22	July 1993–April 1997
PIN18–0507	<10 –16.7	27–37	August 1993–April 1997
PIN18–0508	<10	31–41	August 1993–April 1998
PIN18–0509	<10	27.5–37.5	August 1993–April 1999
PIN18–0510	<10	27.5–37.5	August 1993–April 1997
PIN18–0511	<10	32–42	October 1994–October 1999
PIN18–0512	<10	21–31	October 1994–April 1998
PIN18–0513	<10	12–22	October 1994–April 1998
PIN18–0514	<10	32.5–42.5	October 1994–April 1997
PIN18–0515	<10	22.5–32.5	October 1994–April 1997
PIN18–0516	<10	12.5–22	October 1994–April 1997
PIN18–0517	<10	31.5–41.5	October 1994–April 1997
PIN18–0518	<10	22.5–32.5	October 1994–April 1998
PIN18–0519	<10	12.5–22.5	October 1994–April 1998
PIN18–0520	<10	32.5–42.5	October 1994–April 1997
PIN18–0521	<10–63	20–30	October 1994–October 1999
PIN18–0522	15–550	5–15	October 1994–October 1999
PIN18–0523	<10	32.5–42.5	October 1994–October 1999
PIN18–0524	<10–110	20–30	October 1994–October 1999
PIN18–0525	29.1–430	5–15	October 1994–October 1999
PIN18–0526	<10	19.5–29	November 1998–October 1999
PIN18–RW01	<10–70	2.5–39.5	January 1998–October 1999

^aArsenic detection limits varied from 1, 2, and 5 µg/L to 10 µg/L throughout the data set. To provide a consistent evaluation of the data, detections less than 10 µg/L are reported as non-detects (<10 µg/L) in this table.

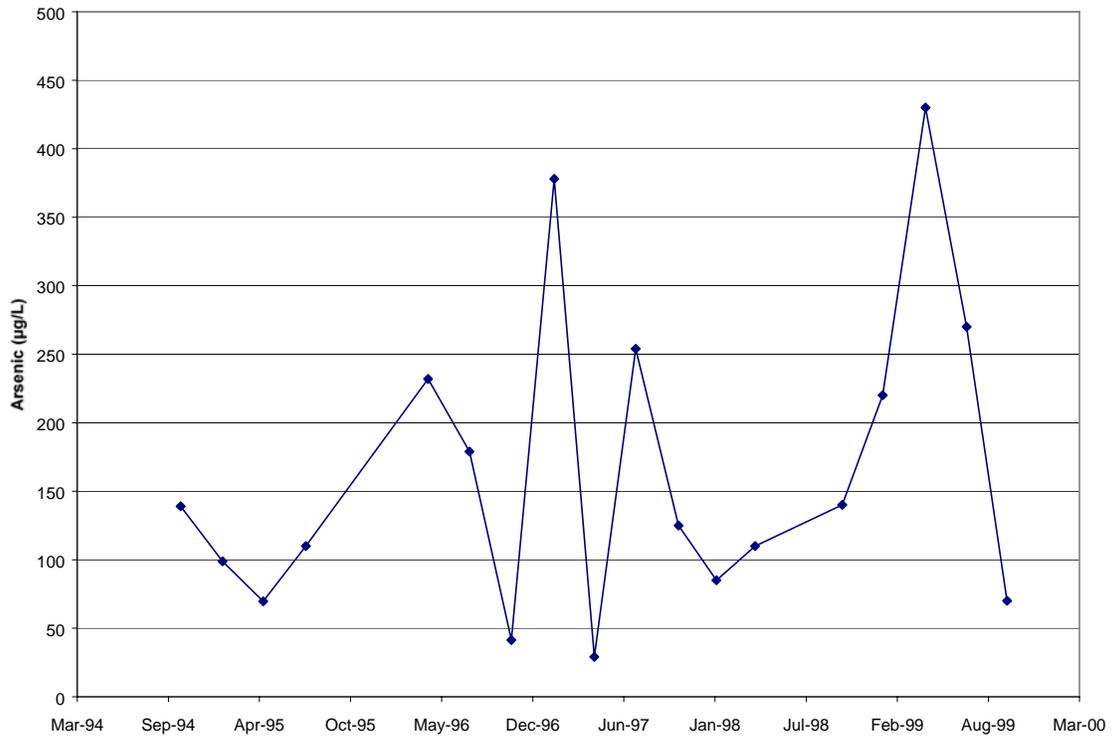


Figure 3-4. Arsenic Concentrations in PIN18-0525 (Shallow)

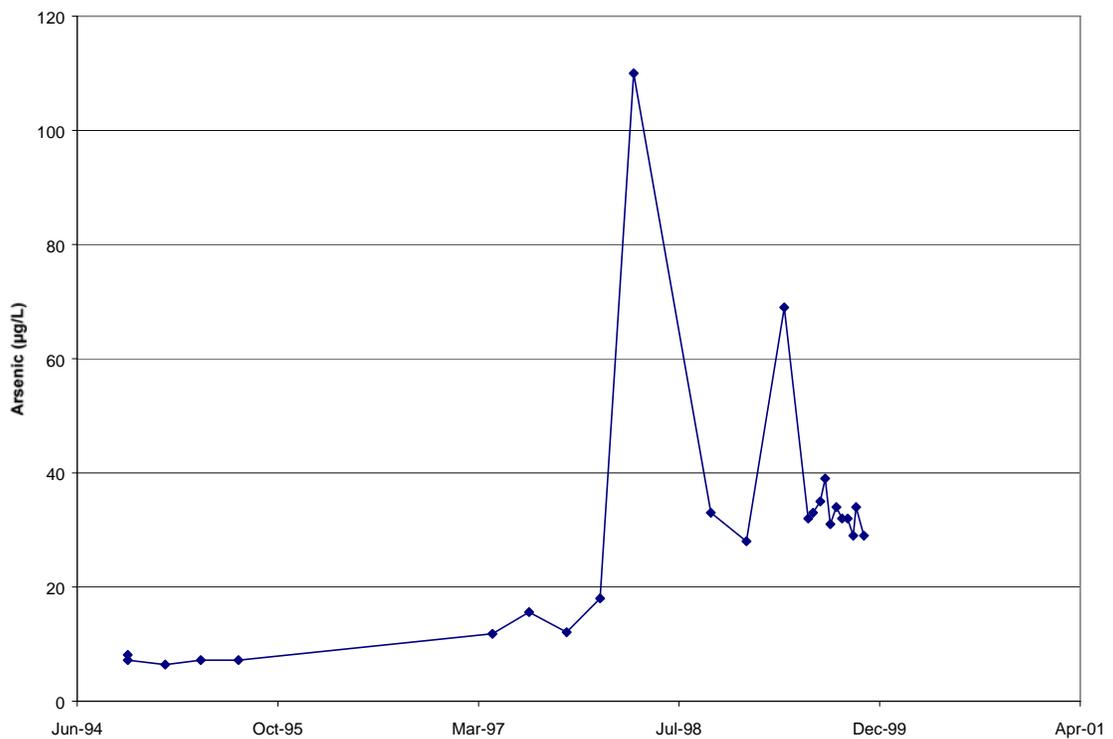


Figure 3-5. Arsenic Concentrations in PIN18-0524 (Intermediate)

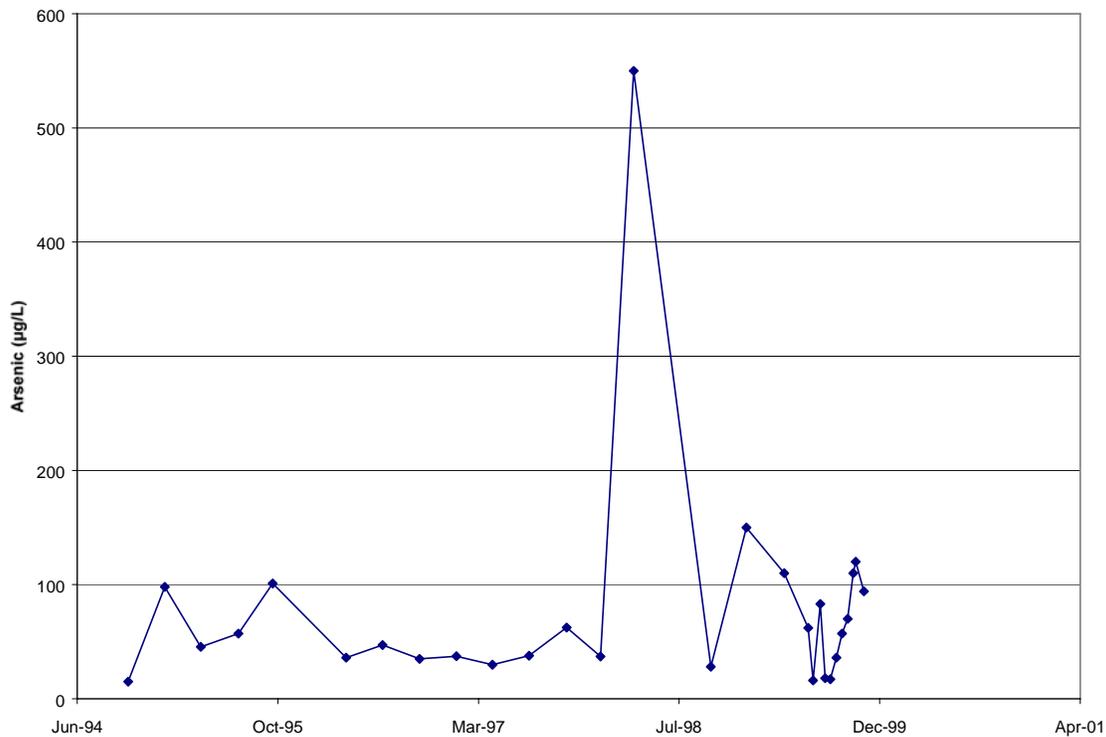


Figure 3-6. Arsenic Concentrations in PIN18-0522 (Shallow)

other wells in the plume. Well PIN18-0521 is screened at an intermediate depth, and arsenic concentrations in this well have shown a distinct increasing trend from approximately 10 µg/L to as high as 63 µg/L (Figure 3-7). Well PIN18-0520 is the deep well of this cluster and has not been sampled since April 1997. Historically, arsenic has not been detected over 5 µg/L at this location.

Other wells located in the WWNA have only rarely contained total arsenic above the detection limit of 10 µg/L. Of these infrequent arsenic detections, none has exceeded 20 µg/L. Therefore, these wells are considered to be located outside the arsenic plume at the WWNA. Several of these wells are no longer sampled, but the data from these locations are summarized in Table 3-1. Wells PIN-0504, -0508, and -0526 are located hydraulically upgradient from the center of the arsenic plume at the WWNA (Figure 1-3). Arsenic has never been measured above 10 µg/L in these wells, indicating that the source of arsenic in the WWNA originates inside the WWNA.

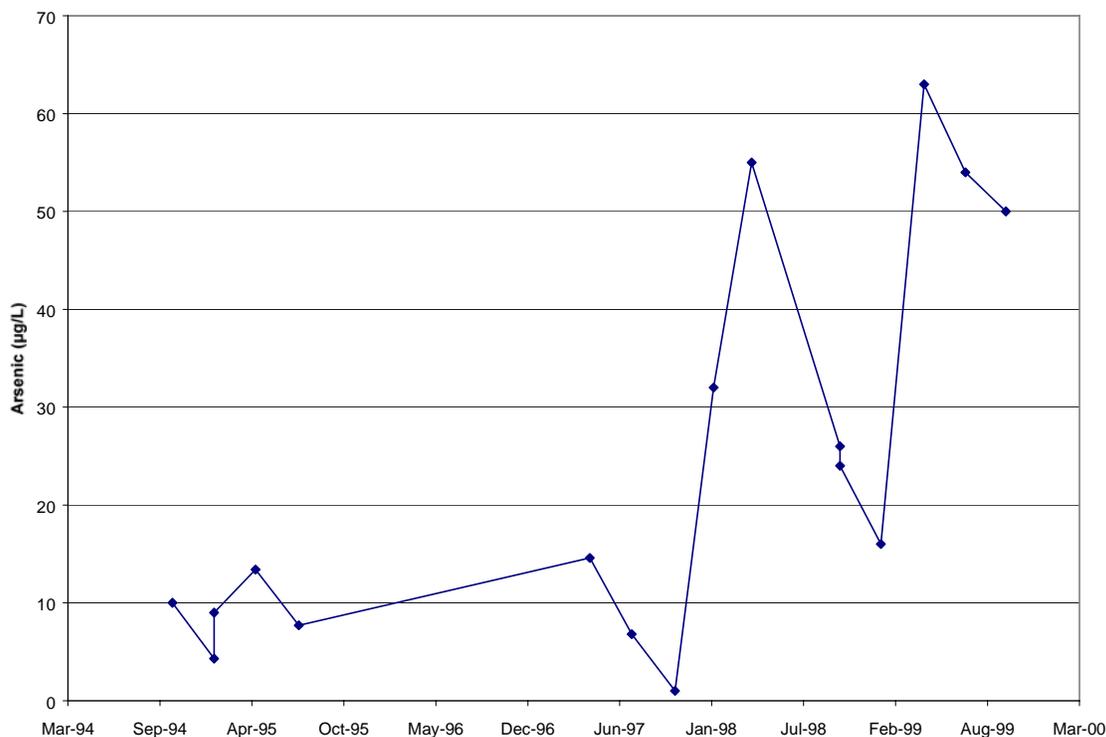


Figure 3–7. Arsenic Concentrations in PIN18–0521 (Intermediate)

3.2.2 Discussion

Although there is considerable variation in arsenic concentration in PIN–0500, –0501, and –0502 wells, over the long term these concentrations show steady or very slight increasing trends, indicating a steady input of arsenic. The two downgradient well clusters (PIN–0520, –0521, –0522 and PIN–0523, –0524, –0525) have arsenic concentration trends that resemble each other both over time and with depth. Arsenic is not detected at depth, is at a low concentration at intermediate depth, and is highest in the shallow wells.

Based on the data from the wells in the plume, the arsenic contamination at the WWNA appears to originate in the upper part of the shallow aquifer (Figure 3–8). All of the highest arsenic concentrations are found in the wells screened at shallow depths. The wells screened at intermediate depths show lower arsenic concentrations than the shallow wells, while the deep wells do not contain arsenic at detectable levels. Additionally, a trend of increasing arsenic concentrations in the middle depth wells is apparent, possibly due to diffusion and dispersion processes transporting dissolved arsenic from the upper part of the aquifer due to pumping.

The isolated episodes of elevated arsenic concentrations in several of the wells in the plume have not been correlated with any specific events. There are three possible explanations for these arsenic spikes: changes in geochemical conditions, the presence of suspended solids, and changes in sampling technique. These explanations are discussed below.

Transient geochemical conditions, such as changes in pH, dissolved oxygen, or oxidation/reduction potential could result in increased dissolution of arsenic from the soil matrix.

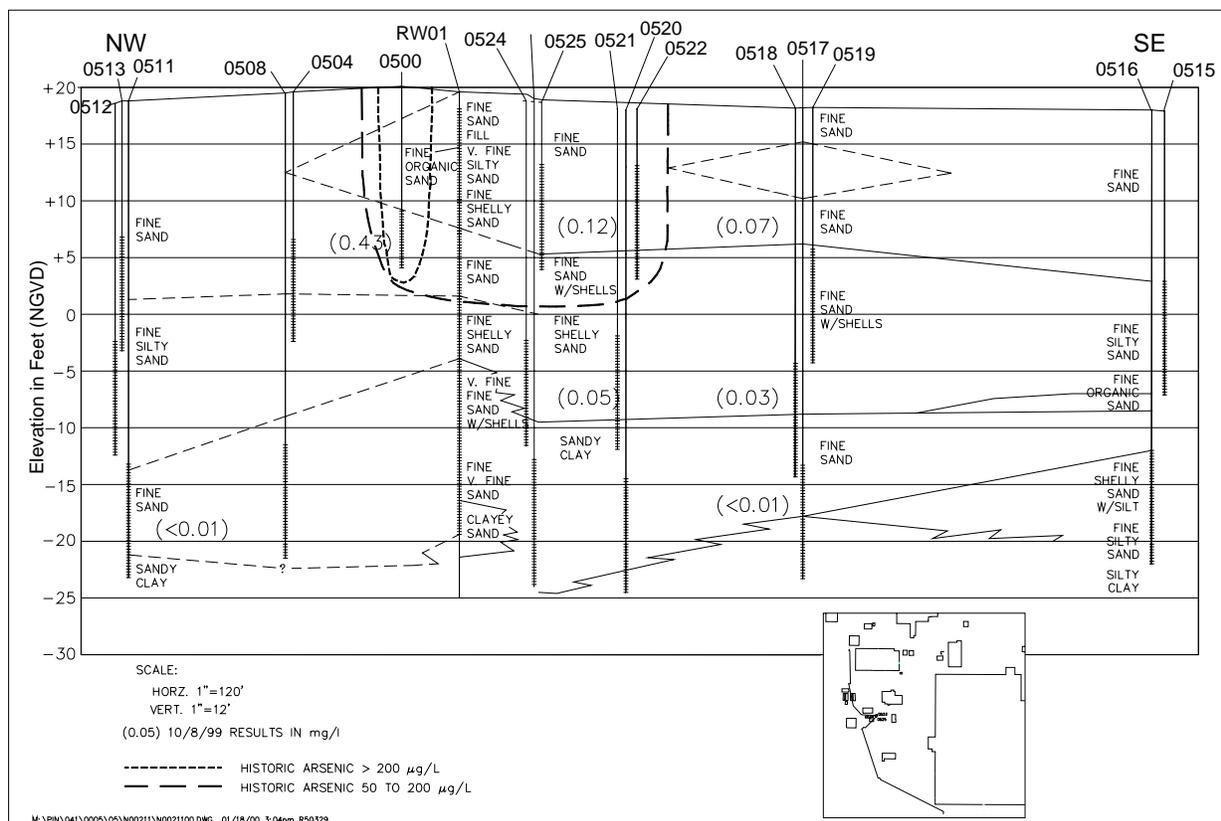


Figure 3-8. Cross-Section Through the WWNA Showing the Arsenic Plume Location

Arsenic typically occurs in one of two valence states, As(III) (As^{3+} ; forming arsenite compounds) and As(V) (As^{5+} ; forming arsenate compounds). In aquatic environments, arsenic usually occurs as arsenic acid species ($\text{H}_2\text{AsO}_4^{-1}$ and HAsO_4^{-2}) under oxidizing conditions and as arsenous acid species (H_3AsO_3 and $\text{H}_2\text{AsO}_3^{-1}$) under mildly reducing conditions (Pierce and Moore 1982). H_3AsO_3 is stable up to about pH 9.2, at which point it dissociates to form $\text{H}_2\text{AsO}_3^{-1}$, a more water soluble species.

Sorption of arsenic is dependent upon the geochemical conditions within the aquifer system. The valence state and the speciation of arsenic are controlled by oxidation/reduction conditions and pH, with each form of arsenic having different sorptive characteristics. In particular, As(V) species have an affinity for iron oxide surfaces that is considerably higher than that of As(III) species (Dzombak and Morel 1990). System pH also affects arsenic sorption (Pierce and Moore 1982). As pH increases, the affinity of both As(III) and As(V) species for iron oxide surfaces decreases, resulting in more arsenic in solution. No significant changes in groundwater pH have been observed during monitoring at the WWNA, but other parameters, such as dissolved oxygen and oxidation/reduction potential, have rarely been measured.

The water samples collected from the WWNA have not been filtered, so the possibility exists that suspended particles containing sorbed arsenic could have been included in certain samples. These solid particles, potentially having a large mass of arsenic relative to the mass of arsenic dissolved in the groundwater, could result in a significant increase in arsenic concentration for the sample in which they were included.

Changes in sample collection techniques, such as the number of well volumes purged before sample collection and the rate at which the water is pumped from the well, could lead to an increase in suspended solids and the concomitant increase in arsenic concentrations.

4.0 Recommendations

Arsenic concentrations in several wells at the WWNA continue to contain total arsenic concentrations above the 50 µg/L MCL. In general, total arsenic concentrations in groundwater at the WWNA have remained steady or increased slightly since monitoring began in 1991. Concentrations have occasionally increased dramatically during single sampling episodes in the wells with the highest arsenic concentrations, possibly due to changes in geochemical conditions or suspended solids content. The intermediate depth wells located hydraulically downgradient from the arsenic source area have shown gradual increasing trends in arsenic concentration. These increases are likely due to dispersion and diffusion of dissolved arsenic from the shallow part of the aquifer.

The highest arsenic concentrations were found in wells screened at shallow intervals, indicating that the arsenic source was located near the surface. Elevated arsenic concentrations have not been measured in wells screened at deep intervals.

Technologies for remediating arsenic-contaminated groundwater were evaluated during the original CMS process performed in 1997. The Interim Action provided more information regarding the potential source of arsenic and identifying the geochemical properties at the site. Stabilizing the soils with ferric chloride was considered as a potential remediation technology. The leaching studies included a column test using ferric chloride. The test showed dissolved arsenic would decrease, however, not to levels below the drinking water MCL of 50 µg/L. Additionally, concerns were identified regarding the long-term stability of this option. Therefore, ferric chloride stabilization is not a viable option for this SWMU.

FDEP recommended that air sparging be re-evaluated. The geochemistry of the WWNA/Building 200 Area groundwater system indicates that changes in dissolved oxygen could result in increased dissolution of arsenic from the soil matrix. Therefore, air sparging might be a possible remedy. However, a treatability study would be required to determine the effectiveness of the technology and to evaluate its long-term stability. Additional concerns remain regarding the implementability of this technology due to the large number of unknown below ground structures and the number of sparging and vapor extraction wells that would need to be installed.

Given the recent completion of arsenic source removal in October 1999, dissolved arsenic concentrations should begin to decrease if groundwater removal continues and the remaining impacted groundwater is diluted by infiltration of precipitation and dispersion via groundwater flow. Due to the relatively low groundwater velocities at the Center, prediction of the speed of arsenic attenuation is difficult. Arsenic concentrations may begin to decline within months of the source removal. Therefore, continued groundwater extraction as a means of removing arsenic in the surficial aquifer is recommended and air sparging is not recommended at this time.

To more aggressively remediate this SWMU, DOE proposes to install two new groundwater recovery wells. The existing recovery well, PIN18–RW01, will be abandoned. One proposed location is between the wells of highest arsenic contamination, PIN18–0500, –0501, and –0502 (Figure 4–1). This well will be screened from 10 to 20 ft below land surface (bls) with the pump at 12 to 15 ft to extract groundwater from the shallow and most contaminated portion of the plume (Figure 4–2), assumed to be near the source area.

The second proposed location is located southeast of the PIN18–RW01 location. This well will be screened slightly deeper, from 10 to 25 ft bls with the pump at 20 ft (Figure 4–3). The purpose of this recovery well is to extract more groundwater from the intermediate portion of the surficial aquifer in the downgradient area.

The following sections present the information required to construct and operate the recommended modification of two recovery wells located at the WWNA. Descriptions of the conceptual design, the schedule and procurement considerations, reference plans and specifications, construction items, the reporting requirements, and an Operations and Maintenance Plan are provided.

4.1 Conceptual Design

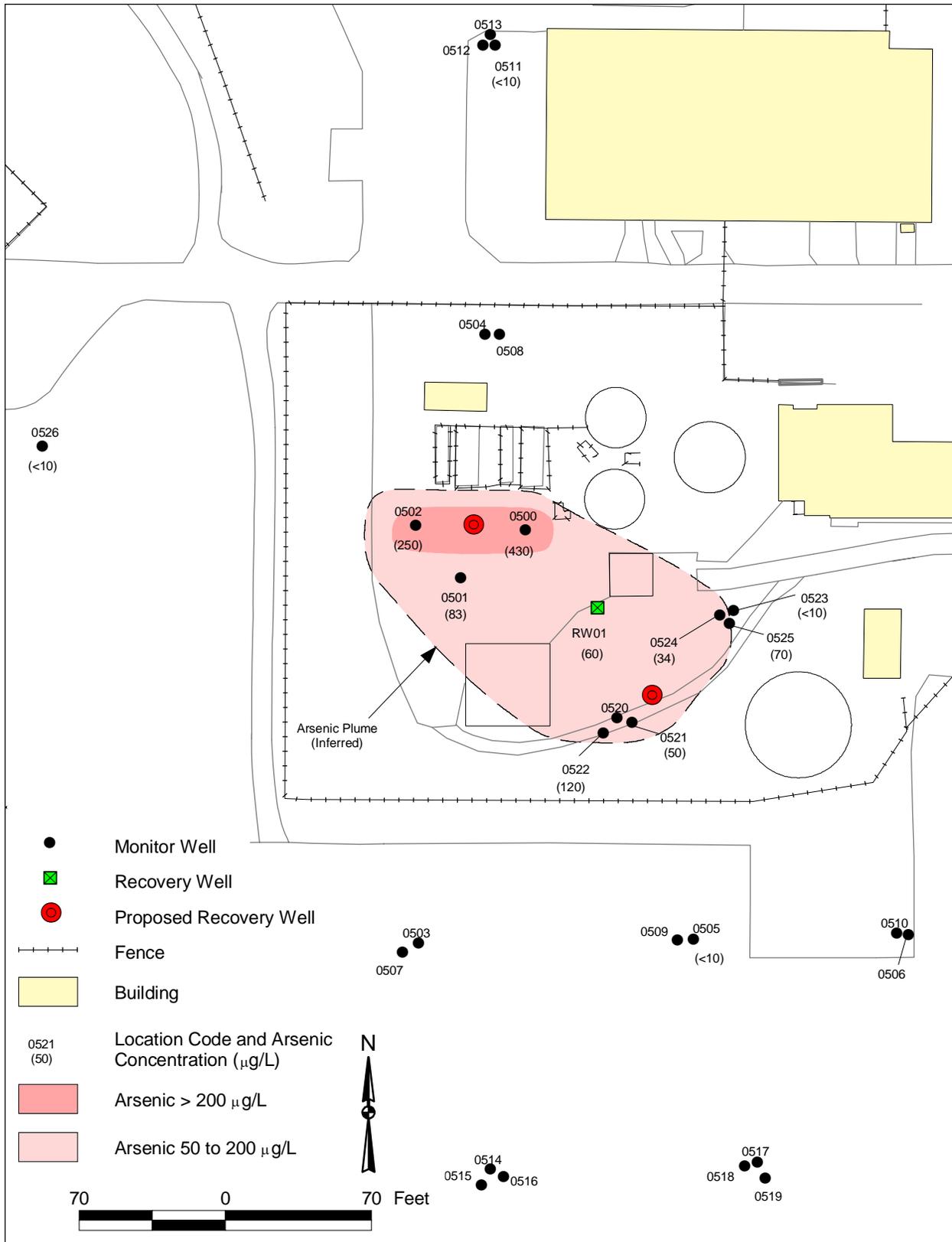
Implementation of the modification at the WWNA includes the installation of two groundwater recovery wells shown in Figure 4–1 to replace the existing recovery well. The wells will pump extracted groundwater through a secondary containment piping to the Center’s Industrial Wastewater Neutralization Facility prior to transfer to the Publicly Owned Treatment Works (POTW). The contaminant concentrations expected to be present in the recovered groundwater is less than the maximum concentration reported in monitoring wells screened over a smaller interval of the plume. Some upconing of groundwater from below the plume is expected to dilute the concentration. Piping of effluent to the Northeast Site Treatment System is logistically impractical and not cost effective.

The two groundwater recovery wells located in the WWNA approximately northwest and south of the existing former recovery well PIN18–RW01 will be installed using minimum 3 inch I.D. polyvinyl chloride (PVC) well casing. The proposed Recovery Well Construction Diagrams are shown in Figures 4–2 and 4–3. The well located near PIN18–0501 will be screened from 10 ft bls to a depth of 20 ft. The pump will be placed between the 12- to 15-ft depth. The second well will be screened from a depth of 25 ft at the base of the arsenic plume to a depth of 10 ft bls. The pump in the intermediate well will be placed at the 20-ft depth.

For both wells, the well screen size will be 0.010 inch. In the bottom section of the wells, just below the screened section will be a blank 3-ft casing section that will act as a sump for sediment or slime accumulation. The filter packs will be 20/30-size silica sand and will extend from the bottom of the sump section to 1 ft above the screen section.

Recovered groundwater will be routed aboveground or underground to the WWNA equalization tank. Totalizing flow meters will be installed on each of the recovery lines prior to joining. The flow meter display will be mounted in a locked waterproof utility panel. Periodic inspection of the flow meter and metering components will be maintained to verify that no damage or inaccuracy occurs.

Electrical submersible pumps or equivalent will be used for groundwater recovery. The pumps will be run continuously; the pumping level will be adjusted with the speed control of the pump. A pump protection switch will be used to ensure appropriate submergence of the pump. Depending on the specific capacity determined during startup testing, the pumping levels will be maintained above the screen to minimize cavitation and oxidizing conditions. Regular maintenance will be performed to ensure that mineral or biologic encrustation of the pump protection switch does not interfere with proper operation. The pumps will be of sufficient

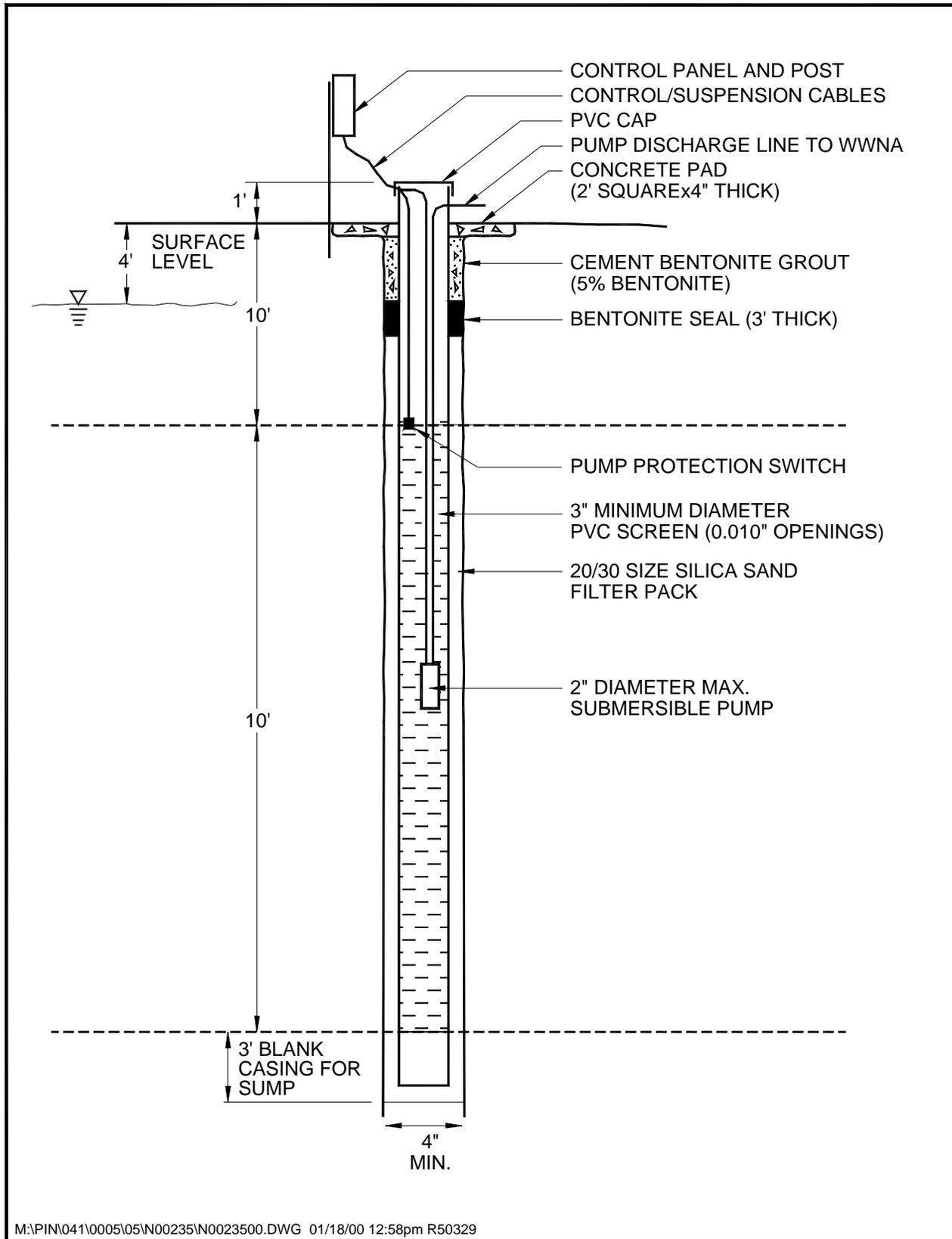


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Figure 4-1. Proposed Location of New Recovery Wells

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Figure 4-2. New Recovery Well Construction Diagram—Shallow

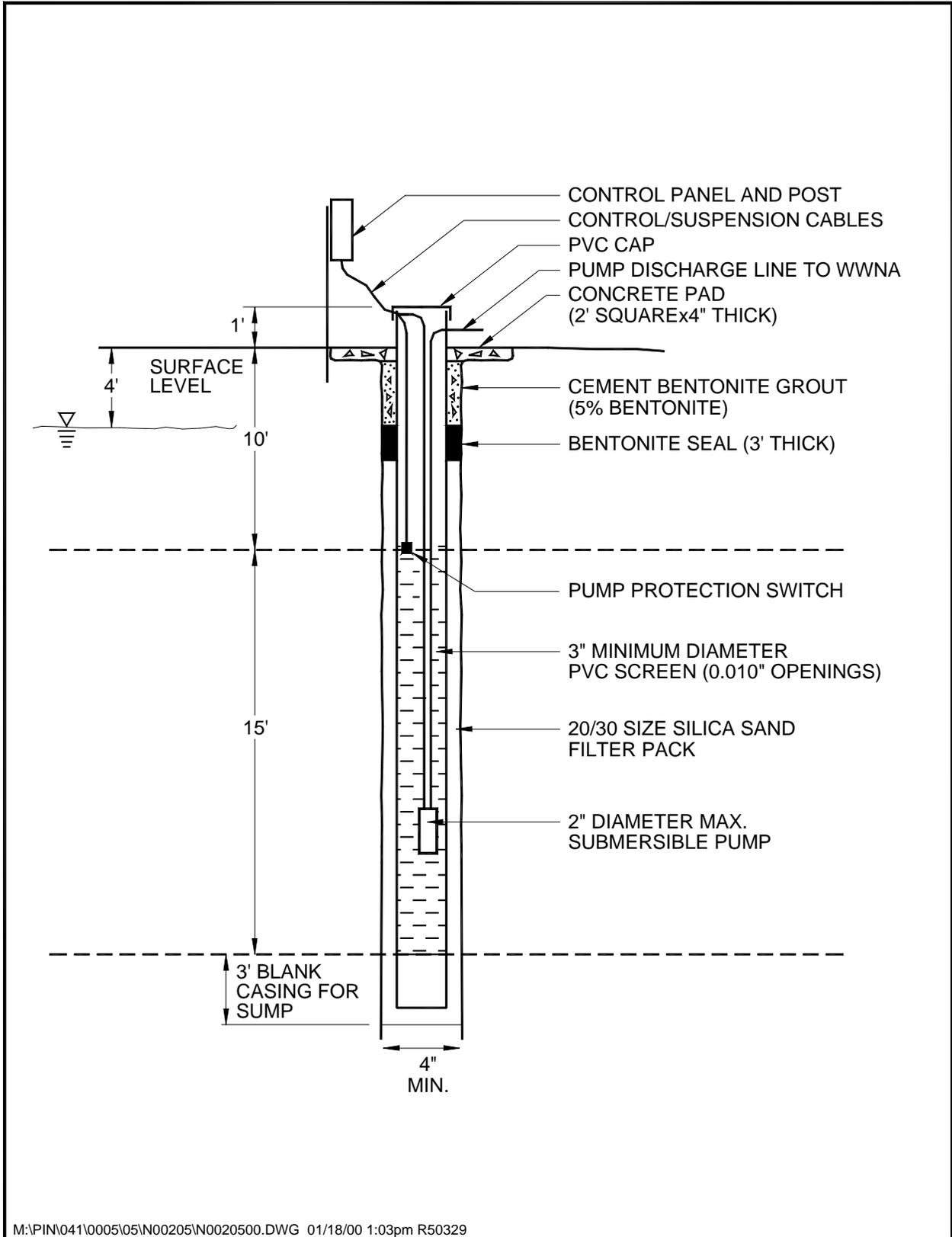


Figure 4-3. New Recovery Well Construction Diagram—Intermediate

capacity to transfer groundwater directly into the WWNA equalization tank. Each well will have a sampling port installed on the recovery well as well as a sampling port for their combined effluent stream.

The inner piping of the groundwater recovery and transfer system will be composed of materials that meet or exceed chemical resistance requirements necessary to transport the contaminated groundwater without failure of the piping materials during long-term use. Outer piping will be composed of materials that will withstand the physical elements anticipated for exposed piping. For subsurface containment piping, Schedule 80 PVC will be used for inner piping material and Schedule 40 PVC will be used for outer piping. This piping was selected based on durability and longevity of material integrity in subsurface conditions.

Aboveground piping will be minimized and be the same composition as that used for subsurface conditions. The aboveground piping will be painted to protect against long-term ultraviolet degradation.

On the basis of major design criteria, recovery of arsenic groundwater contamination is expected. The design criteria are:

- Increased flow and well efficiency using casing driven or roto-sonic method.
- Attaining optimal extraction of 1 aquifer pore volume within 6 or 12 months by regulating total flow between 3 and 6 gpm, respectively.
- Increased recovery of arsenic by extraction of water from the shallow contaminated portion of the aquifer and reducing potential for drawing the arsenic plume deeper.
- Control of iron and bacterial fouling by maintaining pumping levels above the well screen.
- Regulation of flow and use of two wells, one of lower concentration to maintain discharge concentrations below the 0.2 mg/L concentration limit of the wastewater discharge permit.

4.2 Construction Work Plan

The modification to the Corrective Measures at the WWNA/Building 200 Area consists of the installation of two recovery wells located within the WWNA area and the arsenic contaminant plume. These two recovery wells will pump extracted groundwater through containment piping to the existing neutralization facility equalization tank prior to discharge to the POTW. The combined influent contaminant concentrations from the wells will be maintained under the permit level of 0.2 mg/L although dilution is expected from other facility inflow prior to the location where samples are collected for monthly compliance with the county wastewater discharge permit. Notification of the increased discharge volume (if any) and expected change in arsenic concentration will be made, in writing, to the permittee.

4.2.1 Sample/Testing and Analysis

During recovery well installation, lithology and well construction information will be recorded. Continuous samples will be logged for sediment textural properties and classification from ground surface to a depth up to approximately 28 ft. Soil samples will not be retained unless

unusual conditions are encountered, such as unusual lithology, potential confining layers, or potential sources of arsenic.

4.2.2 Permitting

Information will be provided to complete well construction permits by a registered driller in compliance with the applicable requirements of Chapter 40D-3 of the Southwest Florida Water Management District (SWFWMD). No consumptive use permitting is required under Florida Administrative Code, Chapter 40D-2.041, if temporary withdrawals for contamination cleanup meet the exemption requirements.

The existing recovery well will be abandoned in accordance with SWFWMD requirements.

4.2.3 Operation and Maintenance Plan

The procedures presented in the original CMIP (DOE 1997) will be followed for the operation and maintenance of the two recovery wells. The deviations to the approved plan include the start-up testing and sampling and analyses of the well discharge.

Startup: Prior to starting the system, a short-term step drawdown test will be conducted following well development. The test will consist of a minimum of three flow rates, each maintained for a minimum of 30 minutes. The purpose of testing is to determine the appropriate size of the recovery pump, the individual and combined yield of the installed wells, and document aquifer drawdown in the surrounding monitoring wells.

Sampling and Analysis: Sampling will be conducted for arsenic only. Sampling of the new recovery wells will be conducted during startup at the end of each flow rate to estimate arsenic concentrations and potential need to regulate flow and concentrations. During sustained operation, the wells will be sampled daily for the first week, weekly for the first month, biweekly for the next 5 months, and monthly thereafter.

Monitoring wells that have exceeded the regulatory standard within the last year will be sampled and monitored for arsenic. At this time, the sampled wells are PIN18-00500, -0501, -0502, -0521, -0522, and -0525.

Other monitoring wells within the WWNA/Building 200 Area will be sampled on a monthly frequency for one quarter after each startup or shutdown, then on a quarterly basis. All sampling and analysis will be performed in accordance with FDEP guidance protocols and the Comprehensive Quality Assurance Plan #970141 Revision 5.

If arsenic concentrations decline to the regulatory standard in all of the monitoring wells, the well(s) will be shut down for 3 months. The wells will be sampled and analyzed for rebound in concentrations. Pulsing of the wells for 3-month periods will continue if concentrations rebound above the standard. Proposed modifications to the sampling frequency and period of pumping or shutdown may be submitted based on changes in conditions. Additionally, the monitoring frequency and the recovery well performance will be evaluated annually. Additionally, should elevated levels of arsenic in groundwater continue, a re-evaluation of possible source areas will be conducted.

5.0 Schedule for Proposed Activities

Based on the recommendations above, implementing these activities may begin within 60 days of regulatory approval. None of the components for groundwater recovery require long lead procurement considerations. It is anticipated that procurement and construction will require approximately 4 to 6 weeks.

With the proposed installation of the two new recovery wells, it is anticipated that arsenic concentrations in the surficial aquifer will decrease. An evaluation of the pore volume extraction rate will be performed after 6 months. It is estimated that one aquifer pore volume may be extracted within 6 months, depending on flow rate and well efficiency. An estimate of the total remediation period will then be provided.

End of current text

6.0 References

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