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Sparton Technology, Inc.
Former Coors Road Plant
Remedial Program

2008 Annual Report

S. S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

June 11, 2009

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ENTERED

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June 11, 2009

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Subject: Sparton Technology, Inc. Former Coors Road Plant Remedial Program
2008 Annual Report

Gentlemen:

On behalf of Sparton Technology, Inc. (Sparton), S.S. Papadopulos & Associates, Inc. (SSP&A) is pleased to submit the subject report. The report presents data collected at Sparton's former Coors Road Plant during the operation of the remedial systems in 2008, and evaluations of these data to assess the performance of the systems. This document was prepared by SSP&A with the assistance of Metric Corporation, Inc.

I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based upon my inquiry of either the person or persons who manage the system and/or the person or persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I further certify, to the best of my knowledge and belief, that this document is consistent with the applicable requirements of the Consent Decree entered among the New Mexico Environment Department, the U.S. Environmental Protection Agency, Sparton

Technology, Inc., and others in connection with Civil Action No. CIV 97 0206 LH/JHG, United States District Court for the District of New Mexico. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions concerning the report, please contact me.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

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cc: Secretary, Sparton Technology, Inc., c/o Ms. Susan Widener
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Sparton Technology, Inc.
Former Coors Road Plant
Remedial Program

2008 Annual Report

Prepared for:

Sparton Technology, Inc.
Rio Rancho, New Mexico

Prepared by:

S. S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

In Association with:
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June 11, 2009

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Executive Summary

The former Coors Road Plant (Site) of Sparton Technology, Inc. (Sparton) is located at 9621 Coors Boulevard NW, Albuquerque, New Mexico. The Site is at an elevation of about 5,050 feet above mean sea level (ft MSL); the land slopes towards the Rio Grande on the east and rises to elevations of 5,150-5,200 ft MSL within a short distance to the west of the Site. The upper 1,500 feet of the fill deposits underlying the Site consist primarily of sand and gravel with minor amounts of silt and clay. The water table beneath the Site is at an elevation of 4,975-4,985 ft MSL and slopes towards the northwest to an elevation of about 4,960 ft MSL within about one-half mile of the Site. At an elevation of about 4,800 ft MSL a 2- to 3-foot clay layer, referred to as the 4,800-foot clay unit, has been identified.

Past waste management activities at the Site had resulted in the contamination of the Site soils and of groundwater beneath and downgradient from the Site. The primary contaminants are volatile organic compounds (VOCs), specifically trichloroethylene (TCE), 1,1-Dichloroethylene (DCE), and 1,1,1-Trichloroethane (TCA), and chromium. Remedial investigations at the Site had indicated that groundwater contamination was limited to the aquifer above the 4,800-foot clay and current measures for groundwater remediation have been designed to address contamination within this depth interval.

Under the terms of a Consent Decree entered on March 3, 2000, Sparton agreed to implement a number of remedial measures. These remedial measures consisted of: (1) the installation and operation of an off-site containment system; (2) the installation and operation of a source containment system; and (3) the operation of an on-site, 400-cfm (cubic feet per minute) soil vapor extraction (SVE) system for an aggregate period of one year. The goals of these remedial measures are: (a) to control hydraulically the migration of the off-site plume; (b) to control hydraulically any potential source areas that may be continuing to contribute to groundwater contamination at the on-site area; (c) to reduce contaminant concentrations in vadose-zone soils in the on-site area and thereby reduce the likelihood that these soils remain a source of groundwater contamination; and (d) in the long-term, restore the groundwater to beneficial use.

The installation of the off-site containment system began in late 1998 and was completed in early May 1999. The system consisted of (1) a containment well near the leading edge of the plume, designed to pump at a rate of about 225 gallons per minute (gpm), (2) an off-site treatment system, (3) an infiltration gallery in the Arroyo de las Calabacillas, and (4) associated conveyance and monitoring components. The off-site containment well began operating on December 31, 1998; except for brief interruptions for maintenance activities or due to power outages, the well has operated continuously since that date; the year 2008 was the tenth full year of operation of this well. The source containment system was installed during 2001 and began operating on January 3, 2002. This system consisted of (1) a containment well immediately downgradient from the site, designed to pump at a rate of about 50 gpm, (2) an on-site treatment system, (3) six[a] on-site infiltration ponds, and (4) associated conveyance and monitoring components. The year 2008 was the seventh year of operation of this well. The 400-cfm SVE system had operated for a total of about 372 days between April 10, 2000 and June 15, 2001 and thus met the length-of-operation requirements of the Consent Decree; monitoring conducted in the Fall of 2001 indicated that the system had also met its performance goals, and the system was dismantled in May 2002.

During 2008, considerable progress was made towards achieving the goals of the remedial measures:

- The off-site containment well continued to operate during the year at an average discharge rate of 218 gpm, sufficient for containing the plume.
- The pumped water was treated and returned to the aquifer through the infiltration gallery. The concentrations of constituents of concern in the treated water met all the requirements of the Discharge Permit for the site. Chromium concentrations in the influent to the treatment system remained at levels that did not require treatment.
- The source containment well continued to operate during the year at an average rate of 48 gpm, sufficient for containing potential on-site source areas.
- Groundwater monitoring was conducted as specified in the Groundwater Monitoring Program Plan (Monitoring Plan [Attachment A to the Consent Decree]) and the State of New Mexico Groundwater Discharge Permit DP-1184 (Discharge Permit). Water levels in all accessible wells and/or piezometers, and the Corrales Main Canal were measured quarterly. Samples were collected for water-quality analyses from monitoring wells at the frequency specified in the above plan and permit and analyzed for VOCs and total chromium.
- Samples were obtained from the influent and effluent of the treatment plants for the off-site and source containment systems, and the infiltration gallery and infiltration pond monitoring wells at the frequency specified in the Discharge Permit. All samples were analyzed for VOCs, total chromium, iron, and manganese.
- The groundwater flow and transport model that was developed in 1999 to simulate the hydrogeologic system underlying the site was modified, recalibrated, and used to simulate TCE concentrations in the aquifer from start-up of the off-site containment well in December 1998 through December 2008.[b] The model was deemed reliable for making future predictions and will be used to evaluate the future performance of the containment systems and alternative groundwater extraction schemes.

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[a] The performance of the six on-site infiltration ponds between 2002 and 2004 indicated that four ponds are more than adequate for handling the water pumped by the source containment well. With the approval of the regulatory agencies, Sparton backfilled two of the six ponds in 2005 to put the land to other beneficial use.

[b] This task was carried out in early 2009 as part of the preparation of this 2008 Annual Report.

The off-site containment well continued to provide hydraulic control of the contaminant plume throughout the year. The source containment well that began operating in early 2002 quickly developed a capture zone that controls any potential on-site sources that may be contributing to groundwater contamination.

The extent of groundwater contamination during 2008, as defined by the extent of the TCE plume, was somewhat different than in previous years because the presence of a separate, DCE-dominated plume that did not originate from the Sparton facility was taken into consideration in evaluating the water-quality data. Of 55 wells sampled both in November 2007 and 2008, the 2008 concentrations of TCE were lower than in 2007 in 25 wells, higher in 8 wells, and remained the same in 22 wells (21 below detection limits). Well MW-60, at 4,800 micrograms per liter (μg/L) continued to be the most contaminated off-site well. The corresponding results for DCE were 14 wells with lower, 5 wells with higher, and 36 wells with the same (all below detection limits) concentrations. The TCA plume ceased to exist during 2003, and this condition continued through 2008, that is, throughout the year there were no wells with TCA concentrations above the maximum allowable concentration in groundwater set by the New Mexico Water Quality Control Commission.

Changes in concentrations observed in monitoring wells since the implementation of the current remedial measures indicate that contaminant concentrations in the on-site area decreased significantly. Concentrations in most off-site wells have also decreased, or remained unchanged (below detection limits). The only wells where significant increases occurred are the off-site containment well CW-1, and on-site monitoring well MW-19. The concentrations of contaminants in the water pumped from CW-1 rapidly increased after the start of its operation and remained high since then. The high concentrations in this well and in well MW-60 indicated that areas of high concentration existed upgradient from both of these wells; however, most of the groundwater upgradient from these wells has been captured by CW-1 and concentrations both in CW-1 and MW-60 have begun a declining trend.

The off-site and source containment wells operated at a combined average rate of 266 gpm during 2008. A total of about 140.1 million gallons of water were pumped from the wells. The total volume of water pumped since the beginning of the current remedial operations on December 1998 is about 1.332 billion gallons and represents 118 percent of the initial volume of contaminated groundwater (pore volume).

A total of 468 kilograms (kg) (1,030 pounds [lbs]) of contaminants consisting of 433 kg (955 lbs) of TCE, 32.6 kg (71.8 lbs) of DCE, and 1.13 kg (2.50 lbs) of TCA were removed from the aquifer by the two containment wells during 2008. The total mass that was removed since the beginning of the of the current remedial operations is 5,460 kg (12,050 lbs) consisting of 5,130 kg (11,310 lbs) of TCE, 315 kg (694 lbs) of DCE, and 15.0 kg (33.1 lbs) of TCA. This represents about 78 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment well.

Deep Flow Zone (DFZ) monitoring well MW-67 and well MW-79, which was installed in 2006 to address the continuing presence of contaminants in DFZ monitoring well MW-71R, continued to be free of any site-related contaminants throughout 2008. Well MW-71R continued to be contaminated; however, TCE concentrations in the well have a declining trend and were down to 52 μg/L in November 2008. The absence of any contaminants in MW-67 and MW-79, and the declining concentrations in MW-71R indicate that the contamination in DFZ represents a contaminated groundwater slug of limited extent. Concentration trends in MW-71R will be closely monitored in the next few years to assess if there is a need for further action.

The containment systems were shut down several times during 2008 for routine maintenance activities, due to power and monitoring system failures, due to low levels in the chemical feed tanks, or due to the failure of other components of the systems. The downtime for these shutdowns ranged from 20 minutes to about 53 hours. Evaluation of migration rates in the aquifer indicates that the systems could be down for significantly much longer periods without affecting the capture of the contaminant plume.

Plans for next year include continuing the operation of the off-site and source containment systems and the collection of monitoring data as required by the plans and permits controlling system operation, groundwater discharge, and air emissions. The plugging and abandonment of a monitoring well that was dry during the last several years was approved by the agencies and will be implemented in 2009. A new monitoring well, MW-80, will be installed downgradient and outside the capture zone of CW-1.. A Fact Sheet covering the period of 2002 through 2006, that was prepared and approved by the agencies in the May 2008, will be distributed to the property owners located above the plume and adjacent to the off-site treatment plant water discharge pipeline. The recalibrated model will be used to evaluate the future performance of the containment systems and alternative gro[c]undwater extraction schemes.

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List of Acronyms

µg/L	Micrograms per liter
3rdFZ	Third depth interval of the Lower Flow Zone
cfm	cubic feet per minute
Cis-12DCE	cis-1,2-Dichloroethene
cm^2/s	Centimeter squared per second
CMS	Corrective Measure Study
COA	City of Albuquerque
Cr	Chromium
DCE	1,1-Dichloroethylene
DFZ	Deep Flow Zone below the 4800 -- foot clay
DO	Dissolved Oxygen
ft	foot or feet
ft MSL	feet above Mean Sea Level
ft/d	feet per day
ft/yr	feet per year
ft^2	square feet
ft^2/d	feet squared per day
ft^3	cubic feet
g/cm^3	grams per cubic centimeter
gpd	gallons per day
gpm	gallons per minute
IM	Interim Measure
kg	Kilogram
lbs	Pounds
LLFZ	Lower Lower Flow Zone
MCL	Maximum Contaminant Level
Metric	Metric Corporation
mg/L	Milligrams per liter
mg/m^3	Milligrams per cubic meter
MSL	Mean Sea Level
mV	Millivolt
ND	Not Detected
NMED	New Mexico Environment Department
NMEID	New Mexico Environmental Improvement Division
NMWQCC	New Mexico Water Quality Control Commission
ORP	Oxidation/Reduction Potential
O/S	On-Site
ppmv	parts per million by volume
RFI	RCRA Facility Investigation
rpm	Revolutions per minute
Sparton	Sparton Technology, Inc.
SSP&A	S.S. Papadopulos & Associates, Inc.
SVE	Soil Vapor Extraction
TCA	1,1,1-Trichloroethane
TCE	Trichloroethylene

UFZ	Upper Flow Zone
ULFZ	Upper Lower Flow Zone
USEPA	United States Environmental Protection Agency
USF	Upper Santa Fe Group
USGS	United States Geological Survey
VC	Vinyl Chloride
VOC	Volatile Organic Compound

Section 1
Introduction

The former Coors Road Plant of Sparton Technology, Inc. (Sparton) is located at 9621 Coors Boulevard NW (the west side of the boulevard), Albuquerque, New Mexico, north of Paseo del Norte and south of the Arroyo de las Calabacillas (see Figure 1.1). Investigations conducted between 1983 and 1987 at and around the plant revealed that past waste management activities had resulted in the contamination of on-site soils and groundwater and that contaminated groundwater had migrated beyond the boundaries of the facility to downgradient, off-site areas.

In 1988, the United States Environmental Protection Agency (USEPA) and Sparton negotiated an Administrative Order on Consent, which became effective on October 1, 1988. Under the provisions of this Order, Sparton implemented in December 1988 an Interim Measure (IM) that consisted of an on-site, eight-well groundwater recovery and treatment system. The initial average recovery rate of the system was about 1.5 gallons per minute (gpm); however, the recovery rate began declining within a few years due to a regional decline in water levels. As a result, the system was shut down and permanently taken out of service on November 16, 1999.

In 1998 and 1999, during settlement negotiations associated with lawsuits brought by the USEPA, the State of New Mexico, the County of Bernalillo, and the City of Albuquerque (COA), Sparton agreed to implement a number of remedial measures and take certain actions, including: (1) the installation, testing, and continuous operation of an off-site extraction well designed to contain the contaminant plume; (2) the replacement of the on-site groundwater recovery system by a source containment well designed to address the release of contaminants from potential on-site source areas; (3) the operation of a 400 cubic feet per minute (cfm) capacity on-site soil vapor extraction (SVE) system for a total operating time of one year over a period of eighteen months; (4) the implementation of a groundwater monitoring plan; (5) the assessment of aquifer restoration; and (6) the implementation of a public involvement plan. Work Plans for the implementation of the measures and actions agreed upon by the parties were developed and included in a Consent Decree entered by the parties on March 3, 2000 (Consent Decree, 2000; S.S. Papadopulos & Associates, Inc. [SSP&A], 2000a; 2000b; 2000c; and Chandler, 2000).

The off-site containment well was installed and tested in late 1998. Based on the test results, a pumping rate of about 225 gpm was determined to be adequate for containing the off-site plume (SSP&A, 1998), and the well began operating at approximately this rate on December 31, 1998. An air stripper for treating the pumped water and an infiltration gallery for returning the treated water to the aquifer were constructed in the spring of 1999, and the well was connected to these facilities in late April 1999. In 2000, due to chromium concentrations that exceeded the permit requirements for the discharge of the treated water, a chromium reduction process was added to the treatment system and began operating on December 15, 2000; however, chromium concentrations declined in 2001 and the process was discontinued on October 31, 2001. The year 2008 constitutes the tenth year of operation of the off-site containment system.

Throughout 1999 and 2000, Sparton applied for and obtained approvals for the different permits and work plans required for the installation of the source-containment system. The Construction Work Plan for the system was approved on February 20, 2001, and construction began soon after that date. The installation of the system was completed by the end of 2001, and the system began operating on January 3, 2002. Thus, the year 2008 constitutes the seventh year of operation of the source containment system.

SVE systems of different capacities were operated at the Sparton facility between April and October 1998, and between May and August 1999. The 400-cfm SVE system was installed in the spring of 2000 and operated for an aggregate of about 372 days between April 10, 2000 and June 15, 2001, meeting the one-year operation requirement of the Consent Decree. The performance of the system was evaluated by conducting two consecutive monthly sampling events of soil gas in September and October 2001, after a 3-month shut-off period. The results of these two sampling events, which were presented in the Final Report on the On-Site Soil Vapor Extraction System (Chandler and Metric Corporation, 2001) and on Table 4.7 of the 2001 Annual Report (SSP&A, 2002), indicated that TCE concentrations at all monitoring locations were considerably below the 10 parts per million by volume (ppmv) remediation goal of the Consent Decree. Based on these results, the operation of the SVE system was permanently discontinued by dismantling the system and plugging the vapor recovery well and vapor probes in May 2002.

The purpose of this 2008 Annual Report is to:

- provide a brief history of the former Sparton plant and affected areas downgradient from the plant,
- summarize remedial and other actions taken by the end of 2008,
- present the data collected during 2008 from operating and monitoring systems, and
- provide the interpretations of these data with respect to meeting remedial objectives.

This report was prepared on behalf of Sparton by SSP&A in cooperation with Metric. Background information on the site, the implementation of remedial actions, and initial site conditions as they existed prior to the implementation of the remedial actions agreed upon in the Consent Decree are discussed in Section 2; a brief summary of operations during 1999 through 2007 is included in this section. Issues related to the year-2008 operation of the off-site and source containment systems are discussed in Section 3. Data collected to evaluate system performance and to satisfy permit or other requirements are presented in Section 4. Section 5 presents the interpretations of the data and discusses the results with respect to the performance and the goals of the remedial systems. A description of the site's groundwater flow and transport model that was developed in 1999 (SSP&A, 2001a) and of the modifications to the model that were made during the preparation of this 2008 Annual Report is presented in Section 6. Section 7 summarizes the report and discusses future plans. References cited in the report are listed in Section 8.

This 2008 Annual Report is slightly different than the Annual Reports of previous years; it includes some changes that have been made to address comments made by USEPA/NMED on the 2003-2007 Annual Reports[1], responses to these comments[2] and agreements reached between USEPA/NMED and Sparton.[3,4]

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[1] Certified letter dated December 30, 2008 from Chuck Hendrickson of USEPA, Region 6 and John Kieling of NMED to Tony Hurst of Hurst Engineering Services, Re: 2003-2007 Annual Reports, Sparton Technology, Inc., Former Coors Road Plant, Sparton Technology, Inc., Consent Decree, Civil Action No. CIV 97 0206 LH/JHG, EPA ID No. NMD083212332, with enclosure on "EPA/NMED Comments on Sparton, Inc., Annual Reports for 2003-2007." (Received by Mr. Hurst on 1/26/09.)

[2] Letter dated February 12, 2009 from Charles B. Andrews of SSP&A to Chuck Hendrickson of USEPA Region 6, and John Kieling of NMED, on the subject: Response to EPA/NMED comments on Sparton Technology, Inc., Former Coors Road Plant Remedial Program, 2003-2007 Annual Reports (including 5 attachments), with cc to Susan Widener, James B. Harris, Tony Hurst, and Gary L. Richardson.

[3] Memorandum dated March 24, 2009 from Stavros S. Papadopulos of SSP&A to Charles Hendrickson of USEPA, Region 6, and John Kieling, Braid Swanson, and Brian Salem of NMED on the subject: Sparton Technology, Inc. Former Coors Road Plant Remedial Program, Minutes of Conference Call between Representatives of Sparton, USEPA and NMED (including 2 attachments), with cc to Richard Langley and Susan Widener of Sparton, James B. Harris of Thompson & Knight, Tony Hurst of Hurst Eng.'g Services, and Gary Richardson of Metric.

[4] Certified letter dated April 17, 2009 from Chuck Hendrickson of USEPA, Region 6 and John Kieling of NMED to Susan Widener of Sparton, Re: Notice of Dispute, Resolution and Extension request for the Receipt of the 2009 Annual Report, Sparton Technology, Inc.; EPA ID No. NMD083212332, with cc to James Bearzi, Bill Olson, Brian Salem, and Baird Swanson of NMED, Richard Langley of Sparton, Tony Hurst of Hurst Engineering Services, and James B. Harris of Thompson & Knight, LLP.

Section 2
Background

2.1 Description of Facility

The site of Sparton's former Coors Road plant is approximately a 12-acre property located in northwest Albuquerque, on Coors Boulevard NW. The property is about one-quarter mile south of the Arroyo de las Calabacillas, about three-quarters of a mile north of the intersection of Coors Boulevard and Paseo del Norte, and about one-half mile west of the Rio Grande (see Figure 1.1). The property sits on a terrace about 60 feet (ft) above the Rio Grande floodplain. An irrigation canal, the Corrales Main Canal, is within a few hundred feet from the southeast corner of the property. About one-quarter mile west of the property the land rises approximately 150 ft forming a hilly area with residential properties.

The plant consisted of a 64,000-square-foot manufacturing and office building and several other small structures that were used for storage or as workshops (see Figure 2.1). Manufacturing of electronic components, including printed-circuit boards, began at the plant in 1961 and continued until 1994. Between 1994 and the end of 1999, Sparton operated a machine shop at the plant in support of manufacturing at the company's Rio Rancho plant and other locations. The property was leased to Melloy Dodge in October 1999. During 2000 and early 2001, the tenant made modifications and renovations to the property to convert it to an automobile dealership and began operating it as a dealership on April 23, 2001.

2.2 Waste Management History

The manufacturing processes at the plant generated two waste streams that were managed as hazardous wastes: a solvent waste stream and an aqueous metal-plating waste stream. Waste solvents were accumulated in an on-site concrete sump (Figure 2.1) and allowed to evaporate. In October 1980, Sparton discontinued using the sump and closed it by removing remaining wastes and filling it with sand. After that date, Sparton began to accumulate the waste solvents in drums and disposed of them off-site at a permitted facility.

The plating wastes were stored in a surface impoundment (Figure 2.1), and wastewater that accumulated in the impoundment was periodically removed by a vacuum truck for off-site disposal at a permitted facility. Closure of the former impoundment and sump area occurred in December 1986 under a New Mexico State-approved closure plan. The impoundment was backfilled, and an asphaltic concrete cap was placed over the entire area to divert rainfall and surface-water run on, and thus to minimize infiltration of water into the subsurface through this area.

2.3 Hydrogeologic Setting

The Sparton site lies in the northern part of the Albuquerque Basin. The Albuquerque Basin is one of the largest sedimentary basins of the Rio Grande rift, a chain of linked basins that extend south from central Colorado into northern Mexico. Fill deposits in the basin are as much as 15,000 ft thick. The deposits at the site have been characterized by 104 borings advanced for installing monitoring, production, and temporary wells, and soil vapor probes, and by a 1,505-foot-deep boring (the Hunters Ridge Park I Boring) advanced by the U.S. Geological Survey (USGS) about 0.5 mile north of the facility on the north side of the Arroyo de las Calabacillas (Johnson and others, 1996).

The fill deposits in the upper 1,500 ft of the subsurface consist primarily of sand and gravel with minor amounts of silt and clay. The near-surface deposits consist of less than 200 ft of Quaternary (Holocene and Pleistocene) alluvium associated with terrace, arroyo fan, and channel and floodplain deposits. These deposits are saturated beneath the facility and to the east of the facility toward the Rio Grande, but are generally unsaturated to the west of the site. Two distinct geologic units have been mapped in the saturated portion of these deposits: Recent Rio Grande deposits, and a silt/clay unit (Figure 2.2). The Recent Rio Grande deposits occur to the east of the facility adjacent to the Rio Grande. These deposits consist primarily of pebble to cobble gravel and sand, and sand and pebbly sand. These deposits are Holocene-age and are up to 70-ft thick. Beneath the facility, and in an approximately 1,500-foot-wide band trending north from the facility, a silty/clay unit has been mapped between an elevation of about 4,965 ft above mean sea level (ft MSL) and 4,975 ft MSL. This unit, which is referred to as the 4970-foot silt/clay unit, represents Late-Pleistocene-age overbank deposits. The areal extent of the unit at and in the vicinity of the Sparton site is shown in Figure 2.3. Additional information on this unit is presented in Appendix A to both the 1999 and 2000 Annual Reports (SSP&A, 2001a; 2001b).) Holocene-age arroyo fan and terrace deposits, which are primarily sand and gravel, overlie this unit.

The Pliocene-age Upper Santa Fe Group (USF) deposits underlie the Quaternary alluvium. These USF deposits, to an elevation of 4,800 ft MSL, consist primarily of sand with lenses of sand and gravel and silt and clay. The lithologic descriptions of these deposits are variable, ranging from "sandy clay," to "very fine to medium sand," to "very coarse sand," to "small pebble gravel." Most of the borings into this unit were advanced using the mud-rotary drilling technique, and as a result, it has not been possible to map the details of the geologic structure. The sand and gravel unit is primarily classified as USF2 lithofacies assemblages 2 and 3 (Hawley, 1996). Locally, near the water table in some areas, the sands and gravels are classified as USF4 lithofacies assemblages 1 and 2. Lithofacies assemblages 1 and 2 represent basin-floor alluvial deposits; assemblage 1 is primarily sand and gravel with lenses of silty clay, and assemblage 2 is primarily sand with lenses of pebbly sand and silty clay. Lithofacies assemblage 3 represents basin-floor, overbank, and playa and lake deposits that are primarily interbedded sand and silty clay with lenses of pebbly sand.

At an elevation of approximately 4,800 ft MSL, a 2- to 3-foot thick clay layer is encountered. This clay, which is referred to as the 4800-foot clay unit (Figure 2.2), likely represents lake deposits. This clay unit was encountered in borings for seven wells (MW-67, MW-71, MW-71R, MW-79, CW-1, OB-1, and OB-2) installed during site investigations and remedial actions. The unit was also encountered in the USGS Hunter Park I Boring which is located about 0.5 mile north of the Sparton Site on the north side of the Arroyo de las Calabacillas. The nature of the depositional environment (i.e. lake deposits), and the fact that the unit has been encountered in every deep well drilled in the vicinity of the site, as well as at the more distant USGS boring, indicate that the unit is areally extensive. The deposits of the Santa Fe Group immediately below the 4800-foot clay are similar to those above the clay.

The water table beneath the Sparton Site and between the Site and the Rio Grande lies within the Quaternary deposits; however, to the west and downgradient from the site the water table is within the USF deposits. A total of 89 wells were installed at the site to define hydrogeologic conditions and the extent and nature of groundwater contamination and to implement and monitor remedial actions; of these wells, 19 have been plugged and abandoned. The locations of the remaining 70 wells are shown in Figure 2.3.

The off-site containment well, CW-1, and two associated observation wells, OB-1 and OB-2, were drilled to the top of the 4800-foot clay unit and were screened across the entire saturated thickness of the aquifer above the clay unit. The source containment well, CW-2, was drilled to a depth of 130 ft and equipped with a 50-foot screen from the water table to total depth. The monitoring wells have short screened intervals (5 to 30 ft) and during past investigations, were classified according to their depth and screened interval. Wells screened across, or within 15 ft of, the water table were referred to as Upper Flow Zone (UFZ) wells. Wells screened 15-45 and 45-75 ft below the water table were referred to as Upper Lower Flow Zone (ULFZ) and Lower Lower Flow Zone (LLFZ) wells, respectively. Wells completed below the 4800-foot clay unit were referred to as Deep Flow Zone (DFZ) wells. At cluster well locations where an ULFZ or LLFZ well already existed, subsequent wells screened at a deeper interval were referred to as LLFZ or Third Flow Zone (3rdFZ) wells, regardless of the depth of their screened interval with respect to the water table.

The completion flow zone, location coordinates, and measuring point elevation of all existing wells are presented in Table 2.1; their screened intervals are summarized in Table 2.2. In Figure 2.4, the screened interval of each well is projected onto a schematic cross-section through the site to show its position relative to the flow zones defined above. (Monitoring wells screened in the DFZ [MW-67, MW-71R, and MW-79], wells screened across the entire aquifer above the 4800-foot clay [CW-1, OB-1 and OB-2], and infiltration gallery monitoring wells [MW-74, MW-75, and MW-76] are not included in this figure.) The screened intervals in three of the monitoring wells shown on Figure 2.4 are inconsistent with the completion flow zones listed on Table 2.1 which were defined at the time of well construction. These monitoring wells are: MW-32, which is listed in Table 2.1 as a LLFZ well but is shown on Figure 2.4 as a ULFZ well; and MW-49 and MW-70 which are listed on Table 2.1 as 3rdFZ wells but are shown on Figure 2.4 as LLFZ wells. In the evaluations of water-level and water-quality data for the flow zones, MW-32 is treated as a ULFZ well, and MW-49 and MW-70 are treated as LLFZ wells.

Data collected from these wells indicate that the thickness of the saturated deposits above the 4800-foot clay ranges from about 180 ft at the Site to about 160 ft west of the Site and averages about 170 ft. Outside the area underlain by the 4970-foot silt/clay unit, groundwater occurs under unconfined conditions; however, in the area where this unit is present, it provides confinement to the underlying saturated deposits. The water table in this area occurs within the

Following this investigation, a SVE pilot test was conducted on February 27 and 28, 1997 (Black & Veatch, 1997). The test was conducted on vapor recovery well VR-1 using an AcuVac System operating at a flow of 65 cfm at a vacuum of 5 inches of water.

Based on the results of this pilot test, an AcuVac System was installed at the site in the spring of 1998 and operated at a flow rate of 50 cfm on vapor recovery well VR-1 from April 8, 1998 to October 20, 1998 (195 days). Influent and effluent concentrations measured during the operation of the system are shown in Figure 2.8. As shown in this figure, influent TCE concentrations dropped from about 18,000 milligrams per cubic meter (mg/m^3), or about 4,000 ppmv, during the first day of operation, to about 150 mg/m^3 (34 ppmv) in about 120 days. Trend lines determined by analysis of the data (see Figure 2.8) indicate that influent TCE concentration was probably as low as 75 mg/m^3 (17 ppmv) prior to the shut-down of the system after 195 days of operation. The mass of TCE removed during this operation of the SVE system was calculated to be about 145 kilograms (kg) or 320 pounds (lbs).

2.5 Implementation of Current Remedial Actions

Based on settlement negotiations that led to the March 3, 2000 Consent Decree, Sparton agreed to implement the following remedial measures: (a) installation and operation of an off-site containment system designed to contain the contaminant plume; (b) replacement of the on-site groundwater recovery system by a source containment system designed to address the release of contaminants from potential on-site source areas; and (c) operation of a robust SVE system for a total operating time of one year over a period of eighteen months.

Implementation of the off-site containment system, as originally planned, was completed in 1999. A chromium reduction process was added to the treatment component of the system in 2000. The chromium treatment process was discontinued in 2001 because the chromium concentration in the influent dropped below the New Mexico groundwater standard. The system currently consists of:

- a containment well (CW-1) installed near the leading edge of the TCE plume;
- an off-site treatment system for the water pumped by CW-1, consisting of an air stripper housed in a building;
- an infiltration gallery installed in the Arroyo de las Calabacillas for returning treated water to the aquifer;
- a pipeline for transporting the treated water from the treatment building to the gallery;
- a piezometer, PZG-1, with an horizontal screen placed near the bottom of the gallery, for monitoring the water level in the gallery; and
- three monitoring wells (MW-74, MW-75, and MW-76) for monitoring potential water-quality impacts of the gallery.

The locations of these components of the off-site containment system are shown in Figure 2.9.

The containment well was installed in August 1998, and aquifer tests were conducted on the well and evaluated in December (SSP&A, 1998). The well began operating at a design rate of 225 gpm on December 31, 1998. During the testing of the well and during its continuous operation between December 31, 1998 and April 14, 1999, the groundwater pumped from the well was discharged into a sanitary sewer without treatment. Installation of the air stripper, the infiltration gallery, and other components of the system (except the chromium reduction process) was completed in early April, 1999. The containment well was shut down on April 14, 1999 to install a permanent pump and to connect the well to the air stripper. Between April 14 and May 6, 1999, the well operated intermittently to test the air stripper and other system components. The tests were completed on May 6, 1999, and the well was placed into continuous operation. Due to increases in chromium concentrations in the influent to, and hence in the effluent from, the air stripper, a chromium reduction process was added to the treatment system on December 15, 2000. Chromium concentrations, however, declined during 2001 and the chromium reduction process was removed on November 1, 2001. The off-site containment system is now operating with all other system components functioning.

All permits and approvals required for the implementation of the source containment system were obtained between May 1999 and February 2001. The installation of the system began soon after the approval of the Construction Work Plan for the system in February 2001, and completed in December 2001. The system was tested in December 2001 and placed into operation on January 3, 2002. The system consists of:

- a source containment well (CW-2) installed immediately downgradient of the Site;
- an on-site treatment system for the water pumped by CW-2, consisting of an air stripper housed in a building;
- six on-site infiltration ponds for returning the treated water to the aquifer;
- pipelines for transporting the pumped water to the air stripper and the treated water to the ponds; and
- three monitoring wells (MW-17, MW-77, and MW-78) for monitoring the potential water-quality impacts of the ponds.

The layout of the system is shown in Figure 2.10. The chromium concentrations in the influent to, and hence in the effluent from, the air stripper meets the New Mexico water-quality standard for groundwater and, therefore, treatment for chromium is not necessary. Based on the first three years of operation of the system, Sparton concluded that four infiltration ponds were sufficient for returning to the aquifer the water treated by this system. Therefore, in April 2005 Sparton requested USEPA and NMED approval to backfill two of the six ponds (Ponds 5 and 6 in Figure 2.10), and upon approval of this request in June 2005, the two ponds were backfilled between August and December 2005.

An AcuVac SVE system was installed on vapor recovery well VR-1 (see Figure 2.6) in the spring of 1998 and operated between April 8 and October 20, 1998. Additional SVE operations at this location with the AcuVac system at 50 cfm and with a 200-cfm Roots blower occurred in 1999 between May 12 and June 23 and between June 28 and August 25, respectively. An additional 200-cfm Roots blower was installed in 2000, and the SVE system was operated at 400 cfm between April 10, 2000 and June 15, 2001. The total operating time during this period, 371 days and 13 hours, and the results of the performance monitoring conducted after the shut-down of the system met the requirements of the Consent Decree for the termination of the SVE operations at the site. The system was, therefore, dismantled, and the recovery well and vapor probes associated with the system were plugged in May 2002.

2.6 Initial Site Conditions

Initial site conditions, as referred to in this report, represent hydrogeologic and soil-gas conditions as they existed prior to the implementation of the current remedial measures (the installation and operation of the off-site and source containment systems, and the 1999-2001 operation of SVE systems).

2.6.1 Hydrogeologic Conditions

2.6.1.1 Groundwater Levels

The elevation of water levels in monitoring wells, based on measurements made in November 1998, is presented on Table 2.4. These data were used to prepare maps showing the configuration of the water levels at the site prior to the implementation of the current remedial measures.

Water-level data from UFZ and ULFZ well pairs indicate that UFZ wells screened above or within the 4970-foot silt/clay unit (most of the UFZ wells on the Sparton Site) have a water level that is considerably higher than that in the adjacent ULFZ wells that are screened below this unit. These water-level differences range from less than one foot near the western and southwestern limit of the unit to more than 10 ft north and northeast of the Sparton site. Outside the area underlain by the 4970-foot silt/clay unit, however, the water-level difference between UFZ and ULFZ well pairs is 0.2 foot or less. This relationship between UFZ and ULFZ water levels is illustrated in the schematic cross-section shown in Figure 2.4.

In early interpretations of water-level data, including those presented in the 1999 and 2000 Annual Reports (SSP&A, 2001a; 2001b), separate water-level maps were prepared using data from UFZ, ULFZ, and LLFZ wells without taking into consideration the above-discussed relationship between the water levels in UFZ and ULFZ wells. Since the 2001 Annual Report (SSP&A, 2002), however, this relationship has been taken into consideration, and water level conditions at the site and its vicinity are presented in three maps depicting: (1) the water table above the 4970-foot silt/clay unit underlying the Sparton site and at the area north of the site, based on water-level data from UFZ wells screened above or within the silt/clay unit (referred to as the "on-site water table"); (2) the combined UFZ/ULFZ water levels based on data from UFZ and ULFZ wells outside the area underlain by the silt/clay unit (using the average water level at UFZ/ULFZ well pair locations) and ULFZ wells screened below this unit; and (3) the LLFZ water levels based on data from LLFZ wells.

The elevation of the on-site water table in November 1998 is shown in Figure 2.11.[5] The corresponding water-level elevations in the UFZ/ULFZ and LLFZ are shown in Figures 2.12 and 2.13, respectively. These water-level maps indicate that in the off-site areas downgradient from the site, the direction of groundwater flow is generally to the northwest with a gradient of approximately 0.0025. On-site, the direction of flow is also northwesterly in both the UFZ/ULFZ and the LLFZ; however, the gradients are steeper, approximately 0.005 in the UFZ/ULFZ and 0.006 in the LLFZ. The on-site water table is affected by the on-site groundwater recovery system, which was operating during the November 1998 water-level measurements, and the presence of the 4970-foot silt/clay unit; the direction of flow changes from westerly north of the site to southwesterly on the site, with gradients that range from 0.01 to 0.016.

A discussion of water levels in the DFZ had not been included in the 2006 and earlier Annual Reports because data from only two monitoring wells (MW-67 and MW-71 or MW-71R) were available from this zone; these data indicated steep downward gradients across the 4,800-foot clay (water-level differences of about 6 feet between the LLFZ and the DFZ) but provided little information on the direction of groundwater flow in this zone. The installation of a third DFZ monitoring well (MW-79) in 2006, and the water-level data collected from the three DFZ wells since then indicate that the average direction of groundwater flow in the DFZ is to the west-northwest (W 18° N) with an average gradient of about 0.0021. This direction of flow and gradient are similar to those observed in the flow zones above the 4,800-foot clay.

The lower water levels in the DFZ are caused by municipal and industrial pumping from the deeper horizons of the aquifer several miles to the north, west, and southwest of the Sparton site (see Appendix E). These lower water levels and the resulting steep gradients across the 4,800-foot clay unit create a potential for the downward migration of contaminants. The off-site containment well which is fully penetrating the aquifer above the clay unit is expected to create horizontal gradients that may counteract the downward migration potential across the clay unit.

2.6.1.2 Groundwater Quality

The concentrations of TCE, DCE, and TCA in groundwater samples obtained from monitoring wells during the Fourth Quarter 1998 sampling event are summarized on Table 2.5. Also included on this table are data obtained on September 1, 1998, from the off-site containment well, CW-1, and the nearby observation wells, OB-1 and OB-2, and from temporary wells, TW-1 and TW-2, drilled in early 1998 at the current location of MW-73 and sampled on February 18 and 19, 1998, respectively. For each of the compounds reported on Table 2.5, concentrations that exceed the more stringent of its Maximum Contaminant Level (MCL) for drinking water or its maximum allowable concentration in groundwater set by the New Mexico Water Quality Control Commission (NMWQCC) are highlighted.

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[5] The water table contours in this figure are slightly different than those shown in previous reports as some adjustments have been made near the southern edge of the 4,970-ft silt-clay unit to make the water levels consistent with the UFZ/ULFZ water levels along this edge of the unit.

These concentration data were used to prepare maps showing the horizontal extent of the TCE, DCE and TCA plumes as they existed in November 1998, prior to the beginning of pumping from the off-site containment well. The procedures presented in the Work Plan for the Off-Site Containment System were used in preparing these maps (SSP&A, 2000a). The horizontal extent of the TCE plume (in November 1998) is shown in Figure 2.14 and the extent of the DCE and TCA plumes is shown in Figures 2.15 and 2.16, respectively. This initial extent of the plumes forms a basis for comparing their extent during the years of operation of the remedial systems that have been implemented at the site and for evaluating the effectiveness of these remedial systems.

2.6.1.3 Pore Volume of Plume

TCE is the predominant contaminant at the Sparton site and has the largest plume. Calculation of the initial volume of water contaminated above MCLs, referred to as the pore volume of the plume, was, therefore, based on the horizontal and vertical extent of the TCE plume.

In preparing the plume maps presented in the previous section (Figures 2.14 through 2.16), the completion zone of monitoring wells was not considered; that is, data from an UFZ well at one location was combined with data from an ULFZ or LLFZ well at another location. At well cluster locations, the well with the highest concentration was used, regardless of its completion zone. As such, the horizontal extent of the TCE plume shown in Figure 2.14 represents the envelope of the extent of contamination at different depths, rather than the extent of the plume at a specific depth within the aquifer.

To estimate the initial pore volume of the plume, three separate maps depicting the horizontal extent of the TCE plume were prepared using water-quality data from UFZ, ULFZ, and LLFZ monitoring wells. The concentrations measured in the fully-penetrating containment well CW-1 and observation wells OB-1 and OB-2 were assumed to represent average concentrations present in the entire aquifer above the 4800-foot clay, and these data were used in preparing all three maps. An estimate of the horizontal extent of TCE contamination at the top of the 4800-foot clay was also made by preparing a fourth plume map using the data from the containment well and the two observation wells, and data from two temporary wells that obtained samples from about 30-35 ft above the top of the clay during the construction of DFZ wells MW-67 (July 1996) and MW-71 (June 1998). (These four TCE plume maps were presented in Appendix B to both the 1999 and the 2000 Annual Reports [SSP&A, 2001a; 2001b].)

The extent of the plume based on UFZ wells was assumed to represent conditions at the water table; based on the elevation of the screened intervals in ULFZ and LLFZ wells (see Figure 2.4), the extent of the plume estimated from ULFZ wells was assumed to represent conditions at an elevation of 4,940 ft MSL, and that estimated from LLFZ wells conditions at an elevation of 4,900 ft MSL. The extent of the plume at the top of the clay was assumed to represent conditions at an elevation of 4,800 ft MSL. The area of the TCE plumes at each of these four horizons was calculated.[6] Using these areas, the thickness of the interval between horizons, and a porosity of 0.3, the pore volume was estimated to be approximately 150 million cubic ft (ft^3), or 1.13 billion gallons, or 3,450 acre-ft.

2.6.1.4 Dissolved Contaminant Mass

As discussed in both the 1999 and 2000 Annual Reports (SSP&A, 2001a; 2001b), calculations of the initial dissolved contaminant mass based on a plume-map approach, such as the one used above to estimate the initial pore volume (Section 2.6.1.3), significantly underestimate the dissolved contaminant mass present in the aquifer underlying the site. The calibration of the numerical transport model that was developed for the site and its vicinity (see Section 6.2.3) was, therefore, used to provide an estimate of the initial contaminant mass. During the calibration process of this model, the initial TCE concentration distribution within each model layer is adjusted, in a manner consistent with the initial concentrations observed in monitoring wells, until the computed concentrations of TCE in the water pumped from each containment well, and hence the computed TCE mass removal rates, closely match the observed concentrations and mass removal rates. Based on the calibration of the model against 1999 through 2008 water-quality data, the initial dissolved TCE mass is currently estimated to be (see Table 6.1) about 6,601 kg (14,550 lbs). Using this estimate, and ratios of the removed TCE mass to the removed DCE and TCA mass, the initial masses of dissolved DCE and TCA are estimated to be approximately 379 kg (829 lbs) and 15 kg (31 lbs), respectively. Thus, the total initial mass of dissolved contaminants is currently estimated to be about 6,692 kg (15,410 lbs).

2.6.2 Soil Gas Conditions

A supplemental vadose zone characterization was conducted between March 15 and May 5, 1999, which included installation and sampling of eight additional vapor probes, VP-7 through VP-14 (Figure 2.6) and resampling of 15 vapor-monitoring points that had exhibited soil-gas concentrations greater than 10 ppmv during the initial characterization. The results of the supplemental investigation are presented in Figure 2.17, with the approximate 10 ppmv TCE plume limit delineated. The extent of the TCE plume presented in this figure represents the initial conditions prior to the resumption of soil vapor extraction remedial actions in 1999.

2.7 Summary of the 1999 through 2007 Operations

During 1999 through 2007, significant progress was made in implementing and operating the remedial measures Sparton agreed to implement under the terms of the Consent Decree entered on March 3, 2000. These remedial measures resulted in the containment of the plume at the site, the removal of a significant amount of mass from the plume of groundwater contamination, and a significant reduction in soil-gas concentrations in the on-site source areas.

The remedial measures undertaken in 1999 through 2007 included the following:

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[6] The features of the commercially available mapping program Surfer 7.0 (copyright © 1999, Golden Software, Inc.) were used in generating the plume maps and in calculating plume areas.

- Between December 31, 1998 and April 14, 1999, and from May 6, 1999 through December 31, 2007, the off-site containment well was operated at a rate sufficient to contain the plume. The air stripper for treating the pumped water and the infiltration gallery for returning the treated water to the aquifer were constructed in the spring of 1999. These systems were connected to the containment well and tested between April 14 and May 6, 1999. A chromium reduction process was added to the off-site treatment system on December 15, 2000, to control chromium concentrations in the air stripper effluent and thus meet discharge permit requirements for the infiltration gallery; the process was discontinued on November 1, 2001, after chromium concentrations in the influent decreased to levels that no longer required treatment.
- A 50-cfm AcuVac SVE system was operated at vapor recovery well VR-1 from May 12 through June 23, 1999, and a 200-cfm Root blower system was operated at this well from June 28 to August 25, 1999. A second 200-cfm Root blower was added to the system in the Spring of 2000, and the 400-cfm SVE system operated for a total of 372 days between April 10, 2000 and June 15, 2001 meeting the length-of-operation requirement of the Consent Decree. The results of the performance monitoring that was conducted in September and October 2001 indicated that the system had met the termination criteria specified in the Consent Decree, and the system was dismantled in May 2002.
- The source containment system, consisting of a containment well immediately downgradient from the site, an on-site treatment system, six on-site infiltration ponds, and associated conveyance and monitoring components, was installed and tested during 2001. Operation of the system began on January 3, 2002, and the system continued to operate through December 31, 2007 at a rate sufficient for containing any potential sources that may remain at the site. Two of the six infiltration ponds were backfilled in 2005 when an evaluation of the pond performance indicated that four ponds were sufficient for infiltrating the treated water.
- Groundwater monitoring was conducted as specified in the Groundwater Monitoring Program Plan, hereafter "Monitoring Plan," (Consent Decree, 2000, Attachment A) and in the State of New Mexico Groundwater Discharge Permit DP-1184 that controls the discharge of the treated water through the infiltration gallery and ponds, hereafter "Discharge Permit." Water levels in monitoring wells, containment wells, observation wells, piezometers, and the Corrales Main Canal were measured quarterly. Samples were collected for water-quality analyses from monitoring wells and from the influent and effluent of the air stripper at the frequency specified in the Monitoring Plan and the Discharge Permit, and analyzed for TCE, DCE, TCA, and other constituents, as required by these documents.
- A groundwater flow and transport model of the hydrogeologic system underlying the site was developed in 2000. The model was calibrated against data available at the end of 1999, and again against data available at the end of each subsequent year, and used to simulate TCE concentrations in the aquifer from the start-up of the containment well in December 1998 through November 2007 and to predict TCE concentrations in November

2008.[7] Plans were made to continue the calibration and improvement of the model until data indicate that the model can be used to make reliable predictions of future conditions.

A total of about 1.040 billion gallons of water, corresponding to an average rate of about 220 gpm, were pumped from the off-site containment well between the start of its operation and the end of 2007. Evaluation of quarterly water-level data indicated that containment of the contaminant plume was maintained throughout each year.

Between the start of its operation on January 3, 2002 and the end of 2007, the source containment well pumped a total of about 152 million gallons of water, corresponding to an average rate of 48 gpm. Evaluation of quarterly water-level data indicated that the well developed a capture zone that prevents the off-site migration of contaminants from the site

The total volume of water pumped by both the off-site and source containment wells between the start of the off-site containment well operation and the end of 2007 was about 1.192 billion gallons, and represents about 105 percent of the initial volume of contaminated groundwater (pore volume).

The total mass of contaminants that was removed by the off-site containment well between the start of its operation and the end of 2007 was about 4,780 kg (10,540 lbs) and consisted of 4,515 kg (9,950 lbs) of TCE, 257 kg (567 lbs) of DCE, and 10.5 kg (23.1 lbs.) of TCA. An additional 209 kg (462 lbs) of contaminants consisting of about 181 kg (398 lbs) of TCE, 25 kg (56 lbs) of DCE, and 3.4 kg (7.6 lbs.) of TCA were removed from the aquifer by the source containment well. Thus, the total mass of contaminants removed from the aquifer by both wells between the start of the off-site containment well operation on December 1998 and the end of 2007 was about 4,990 kg (11,000 lbs) consisting of 4,695 kg (10,350 lbs) of TCE, 280 kg (620 lbs) of DCE, and 14 kg (31 lbs) of TCA. This removed mass represented about 68 percent of the contaminant mass currently estimated to have been present in the aquifer prior to the operation of the off-site containment well.

The operation of the soil vapor extraction systems at vapor recovery well VR-1 in 1999 and 2000 had a measurable impact on soil-gas concentrations at the site. The 1999 SVE operations had reduced TCE concentrations in soil gas below 10 ppmv at all but one of the monitored locations. Soil-gas was not monitored during the 2000 and 2001 operation of the 400-cfm system. The system was shut down on June 15, 2001; and performance monitoring was conducted near the end of 2001, three months after the shut-down. The results of this monitoring indicated that soil gas concentrations at all monitoring locations were considerably below the 10 ppmv termination criterion for the system, and the system was dismantled in May 2002.

The remedial systems were operated with only minor difficulties during 1999 through 2007. In 1999, the metering pump adding anti-scaling chemicals to the influent to the off-site air-stripper was not operating correctly. This problem was solved in December 1999 by

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[7] This task was carried out in early 2008 as part of the preparation of the 2007 Annual Report.

replacing the pump. Also, chromium concentrations in the influent to, and hence in the effluent from, the air stripper increased from 20 μg/L at system start-up to 50 μg/L by May 1999, and fluctuated near this level, which is the discharge permit limit for the infiltration gallery, throughout the remainder of 1999 and during 2000. To solve this problem, a chromium reduction process was added to the treatment system on December 15, 2000; the process was discontinued on November 1, 2001, after chromium concentrations declined to levels that no longer required treatment. In 2006, the discharge rate of the source containment well began declining during the latter half of the year; it was thought that this was due to the inefficiency of its pump and and a new pump was installed in 2007. Further testing conducted when the new pump did not improve the flow rate indicated that the pipeline between the well and the air-stripper building was clogged with iron and manganese deposits; the pipeline was cleaned with acid in June 2007 to restore the capacity of the well.

Another problem that developed during these years was the continuing presence of contaminants in the DFZ monitoring well MW-71. During 2001, an investigation was conducted on the well and the well was plugged. Based on the results of the investigation, a replacement well, MW-71R located about 30 ft south of the original well, was installed in February 2002. Samples collected from the replacement well between its installation and the end of 2003 indicated the continuing presence of contaminants in the Deep Flow Zone (TCE concentrations of 130 to 210 μg/L). Based on these results, Sparton proposed to pump the well and, after treatment, re-inject the pumped water in the unsaturated zone at allocation south of the well. A Work Plan for this proposed MW-71R pump-and-treat system was prepared in late 2003 and submitted to USEPA/NMED in January 2004 (SSP&A and Metric, 2004a). USEPA/NMED comments on this Work Plan (August 10, 2004[8]) led Sparton to invoke the dispute resolution mechanism allowed under the Consent Decree (September 13, 2004[9]). To resolve the dispute a conference call was held on October 13, 2004, between technical representatives of USEPA/NMED and Sparton. During this conference call the parties agreed to abandon the plan for a pump-and-treat system at MW-71R, and instead install a DFZ monitoring/stand-by extraction well near CW-1, with the understanding that the decision to use this well as a monitoring or extraction well was to be based on whether the well is clean or contaminated. The agreement was documented in the minutes[10] of the conference call and upon approval of the

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[8] Technical Review – Sparton Technology Inc. Former Coors Plant Remedial Program, Work Plan for the Proposed MW-71R Pump-and-Treat System, Sparton Technology, Inc. Albuquerque, New Mexico, EPA ID No. NMD083212332, transmitted by letter dated August 10, 2004, from Charles A. Barnes of USEPA to Tony Hurst of Hurst Engineering Services, Project Coordinator for Sparton.

[9] Notice of Dispute, Sparton Technology, Inc. Consent Decree, Civil Action No. CIV 97 0206 CH/JHG, EPA ID No. NMD083212332, September 13, 2004, letter to the Plaintiffs from James B. Harris of Thompson & Knight, counsel to Sparton.

[10] Memorandum dated October 20, 2004, to Charles A. Barnes (USEPA), and Baird Swanson and Carolyn Cooper (NMED) from Gary L. Richardson (Metric) and Stavros S. Papadopulos (SSP&A) on the subject of Sparton Technology, Inc., Former Coors Road Plant Remedial Program – Minutes of the October 13, 2004 Conference Call.

minutes[11] a Work Plan for the installation, testing, monitoring, and/or operation of this DFZ well, hereafter "the DFZ Well Work Plan," (SSP&A and Metric, 2004b) was submitted to USEPA/NMED on December 6, 2004. The DFZ Well Work Plan was approved by USEPA/NMED on January 6, 2005, and Sparton proceeded with obtaining an easement agreement from the City of Albuquerque to provide access through a City owned park for moving a drilling rig to the proposed well location. This easement agreement was obtained by Sparton in October 2005. In November 2005, Sparton submitted to USEPA/NMED a revised schedule for the DFZ Well Work Plan, and in December 2005 notified the City of Albuquerque that construction of the monitoring/stand-by extraction well would begin in January 2006. The well was installed in February 2006, and the first samples from the well were obtained during its testing in April 2006. The analyses of these samples indicated that the well did not contain any site-related contaminants. Details on the installation, testing and sampling of the well were included in a letter-report[12] presented to USEPA/NMED in June 2006. Based on the sampling results, the well was designated as monitoring well MW-79, and added to the Monitoring Plan under a semi-annual sampling schedule. Water-quality data collected from MW-79 and MW-71R until the end of 2007 indicated that MW-79 continued to remain free of contaminants and that concentrations in MW-71R began declining in 2005; the November 2007 concentrations in the well were 74 µg/L for TCE, 2.7 µg/L for DCE and <1.0 µg/L for TCA.

Six water table (UFZ) monitoring wells (MW-14, MW-15, MW-28, MW-37, MW-50, and MW-52) that became dry due to declining water levels were plugged during 2002 and 2003; three of these wells were replaced by wells with longer screens (MW-14R, MW-37R, and MW-52R) spanning both the UFZ and ULFZ. Three other water table monitoring wells that became dry during 2004 through 2006 (PW-1, MW-35, and MW-36) were plugged and abandoned in 2007. Other minor problems during the past years of operation included the occasional shutdown of the containment systems due to power failures, failures of the monitoring or paging systems, and failures of the discharge pumps or air-stripper blower motors. Appropriate measures were taken to address these problems.

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[11] E-mail dated October 21, 2004, from Charles A. Barnes of USEPA to Stavros Papadopulos of SSP&A on the subject of "Re: Minutes of the October 13, 2004 Conference Call."

[12] Letter dated June 2, 2006 to USEPA and NMED representatives from Stavros S. Papadopulos of SSP&A and Gary L. Richardson of Metric with subject "Sparton Technology, Inc. Former Coors Road Plant Remedial Program - Transmittal of Data from the Installation, Testing, and Sampling of a new DFZ Well."

Section 3
System Operations - 2008

3.1 Monitoring Well System

During 2008, water levels were measured in and samples were collected from all monitoring wells that were not dry and had sufficient water during the measurement or sampling event. Water levels were measured quarterly and samples were collected from each well at the frequency specified either in the Monitoring Plan, or the Discharge Permit.

3.1.1 Upper Flow Zone

The continuing water-level declines in the Albuquerque area continued to affect shallow monitoring wells (UFZ wells) at the Site. Water levels could not be measured in monitoring wells MW-13 and MW-33 during the first quarter, in wells MW-33 and MW-57 in the second quarter, in wells MW-13, MW-33 and MW-57 during the third quarter, in wells MW-13, MW-33, MW-48, MW-57 and MW-61 during the fourth quarter because the wells were dry during these measuring events. In addition, well MW-57, which is sampled quarterly, could not be sampled during the first, second, and third quarters, because it did not have sufficient water to be sampled. Similarly, wells MW-9, MW-13, MW-33, MW-18, MW-53, MW-58 and MW-61, which are scheduled for annual sampling, could not be sampled in November 2008 because they did not have sufficient water to be sampled.

Well MW-53 was deepened in December 2008 and sampled in February 2009 to provide data that was needed for the definition of the 2008 extent of contamination. The deepened well will be available for the quarterly water-level measurements and the annual sampling events in 2009 and subsequent years.

3.1.2 Deeper Flow Zones

There were no problems associated with the measurement of the water levels or with the sampling of monitoring wells completed in the ULFZ, LLFZ, or the DFZ.

3.2 Containment Systems

3.2.1 Off-Site Containment System

The Off-Site Containment System operated for about 8,574 hours, or 97.6 percent of the 8,784 hours available during 2008. The system was down for about 210 hours due to 29 interruptions ranging in duration from 0.17 hours to about 53.15 hours. A summary of the downtime for the year is presented in Table 3.1 (a). These downtimes consisted of one shutdown for routine maintenance, five shutdowns for system repairs, 18 shutdowns due to power failure, three shutdowns due to the occurrence of "low level" in the chemical feed tank, two shutdowns due to gallery radio transmitter failure, and one shutdown for vandalism to the gallery radio.

3.2.2 Source Containment System

The Source Containment System operated for about 8,723 hours, or 99.3 percent of the 8,784 hours available during 2008. The system was down for about 61 hours due to nine interruptions ranging in duration from 0.33 hours to about 26 hours. A summary of the downtime for the year is presented on Table 3.1 (b). These downtimes consisted of seven shutdowns due power failure, and two shutdowns for system repairs.

The rapid infiltration ponds performed well during 2008. Ponds 1 and 4 were used during January, February, March, July, September, and November. Ponds 2 and 3 were used during April, May, June, August, October, and December. The amount of water evaporating from the ponds has been estimated to be about 1 percent of the discharged water, that is, about 0.5 gpm.

3.3 Problems and Responses

Most of the downtimes that occurred in 2008 were due to power failures (18 for the off-site system and 7 for the source system). The longest shutdown of a containment system during 2008 was that of the off-site system which occurred between December 26 and 29 due to an infiltration gallery radio communication error. The monitoring system was reprogrammed to eliminate, or at least minimize, the reoccurrence of this error.

Section 4
Monitoring Results - 2008

The following data were collected in 2008 to evaluate the performance of the operating remedial systems and to meet the requirements of the Consent Decree and of the permits for the site:

- water-level and water-quality data from monitoring wells,
- data on containment well flow rates, and
- data on the quality of the influent to and effluent from the water-treatment systems.

4.1 Monitoring Wells

4.1.1 Water Levels

The depth to water was measured quarterly during 2008 in all monitoring wells that were not dry during the measurement event, the off-site and source containment wells, the two observation wells, the piezometer installed in the infiltration gallery, and the Corrales Main Canal near the southeast corner of the Sparton property. The quarterly elevations of the water levels, calculated from these data, are summarized on Table 4.1.

4.1.2 Water Quality

Monitoring wells within and in the vicinity of the plume were sampled at the frequency specified in the Monitoring Plan and the Discharge Permit. The samples were analyzed for VOCs (primarily for determination of TCE, DCE, and TCA concentrations), and for total chromium (unfiltered, and occasionally filtered, samples). The results of the analysis of the samples collected from these monitoring wells during all sampling events conducted in 2008, and for all of the analyzed constituents, are presented in Appendix A-1. Data on TCE, DCE, and TCA concentrations, in samples collected during the Fourth Quarter (November 2008), are summarized on Table 4.2(a). Quarterly samples from the infiltration gallery monitoring wells (MW-74, MW-75, and MW-76) and from the infiltration pond monitoring wells (MW17, MW-77, and MW-78) were analyzed for VOCs (primarily TCE, DCE, and TCA), total chromium, iron, and manganese, as specified in the Discharge Permit. The results of the analysis of these samples are presented in Appendix A-2; data on TCE, DCE and TCA concentrations in the Fourth Quarter (November 2008) samples from these wells are also included on Table 4.2(a). For each of the compounds reported on Table 4.2(a) and in Appendix A, concentrations that exceed the more stringent of its MCL for drinking water or its maximum allowable concentration in groundwater set by NMWQCC are highlighted.

In addition to the VOCs and the other constituents listed above and reported in this and in all past Annual Reports, fourth quarter (November) samples from the monitoring wells listed in the Monitoring Plan have been analyzed since 1998 for Dissolved Oxygen (DO) and Oxydation/Reduction Potential (ORP) to determine whether subsurface geochemical conditions vary across a site, and whether those conditions may impact contaminant chemistry through naturally occurring redox reactions or biologically mediated degradation. The DO and ORP data collected until the end of 2007 were presented in Appendix B of the 2007 Annual Report; DO and ORP data for the November 2008 samples are summarized on Table 4.2(b).

4.2 Containment Systems

4.2.1 Flow Rates

The volumes of groundwater pumped by the off-site and source containment wells during 2008 and the corresponding flow rates are summarized on Table 4.3. As shown on this table, a total of about 140.1 million gallons of water, corresponding to a combined flow rate of 266 gpm were pumped by the two containment wells. The volume and average flow rate of each well are discussed further below.

4.2.1.1 Off-Site Containment Well

The volume of the water pumped by the off-site containment well during 2008 was monitored with a totalizer meter that was read at irregular frequencies. The intervals between meter readings ranged from less than a day to about thirteen days, and averaged about six days. During each reading of the meter, the instantaneous flow rate of the well was calculated by timing the volume pumped over a specific time interval. The totalizer data collected from these flow meter readings and the calculated instantaneous discharge rate during each reading of the meter are presented in Appendix B-1. Also included in this appendix are the average discharge rate between readings and the total volume pumped between the start of continuous pumping on December 31, 1998, and the time of the measurement, calculated from the totalizer meter readings.

The average monthly discharge rate and the total volume of water pumped from the off-site containment well during each month of 2008, as calculated from the totalizer data, are summarized on Table 4.3. As indicated on this table, approximately 114.7 million gallons of water, corresponding to an average rate of 218 gpm, were pumped in 2008.

4.2.1.2 Source Containment Well

The volume of the water pumped by the source containment well during 2008 was also monitored with a totalizer meter that was also read at irregular frequencies. The intervals between meter readings ranged from about one day to about thirteen days, and averaged about seven days. During each reading of the meter, the instantaneous flow rate of the well was calculated by timing the volume pumped over a specific time interval. The totalizer data collected from these flow meter readings and the calculated instantaneous discharge rate during each reading of the meter are presented in Appendix B-2. Also included in this appendix are the average discharge rate between readings and the total volume pumped between the start of continuous pumping on January 3, 2002, and the time of the measurement, calculated from the totalizer meter readings.

The average monthly discharge rate and the total volume of water pumped from the source containment well during each month of 2008, as calculated from the totalizer data, are summarized on Table 4.3. As indicated on this table, approximately 25.4 million gallons of water, corresponding to an average rate of 48 gpm, were pumped in 2008.

4.2.2 Influent and Effluent Quality

4.2.2.1 Off-Site Containment System

During 2008, the influent[13] to and effluent from the treatment plant for the off-site containment system was sampled monthly. These monthly samples were analyzed for VOCs (primarily TCE, DCE, and TCA), total chromium, iron, and manganese. The results of these influent and effluent sample analyses are presented in Appendix C-1. Concentrations of TCE, DCE, TCA, and total chromium in samples collected during 2008 are summarized on Table 4.4 (a). For each of the compounds shown on Table 4.4 (a), concentrations that exceed the more stringent of its MCL for drinking water or its maximum allowable concentrations in groundwater set by NMWQCC are highlighted. Data on TCE, DCE, and TCA concentrations for the November sample of influent are also included in Table 4.2(a), as the Fourth Quarter concentrations in CW-1, and were used in the preparation of the plume maps discussed in the next section.

4.2.2.2 Source Containment System

During 2008, the influent to and effluent from the treatment plant for the source containment system was sampled monthly. These monthly samples were analyzed for VOCs (primarily TCE, DCE, and TCA), total chromium, iron, and manganese. The results of these influent and effluent sample analyses are presented in Appendix C-2. Concentrations of TCE, DCE, TCA, and total chromium in samples collected during 2008 are summarized on Table 4.4 (b). For each of the compounds shown on Table 4.4 (b), concentrations that exceed the more stringent of its MCL for drinking water or its maximum allowable concentrations in groundwater set by NMWQCC are highlighted. Data on TCE, DCE, and TCA concentrations for the November sample of influent are also included in Table 4.2(a), as the Fourth Quarter concentrations in CW-2, and were used in the preparation of the plume maps discussed in the next section.

[13] The "discharge from the containment wells" is the "influent" to the treatment systems; therefore, the two terms are used interchangeably in this report.

Section 5
Evaluation of Operations - 2008

The goal of the off-site containment system is to control hydraulically the migration of the plume in the off-site area and, in the long-term, restore the groundwater to beneficial use. The goal of the source containment system is to control hydraulically, within a short distance from the site, any potential source areas that may be continuing to contribute to groundwater contamination at the on-site area. This section presents the results of evaluations based on data collected during 2008 of the performance of the off-site and source containment systems with respect to their above-stated goals.

5.1 Hydraulic Containment

5.1.1 Water Levels and Capture Zones

The quarterly water-level elevation data presented in Table 4.1 were used to evaluate the performance of both the off-site and source containment wells with respect to providing hydraulic containment for the plume and potential on-site source areas. Maps of the elevation of the on-site water table and of the water levels in the UFZ/ULFZ and the LLFZ during each of the four rounds of water-level measurements during 2008 are shown in Figures 5.1 through 5.12. Also shown in these figures are: (1) the limit of the capture zones of the containment wells in the UFZ/ULFZ or the LLFZ, as determined from the configuration of the water levels; and (2) the extent of the TCE plume. The extent of the TCE plume shown in Figures 5.1 through 5.9 is based on previous year's (November 2007) water-quality data from monitoring wells; the extent of the plume is representative of the area that should have been contained between November 2007 and November 2008. The extent of the plume shown on the water-level maps for November 2008 (Figures 5.10, 5.11, and 5.12), however, is based on the November 2008 water-quality data since this extent represents the area to be captured in November and during the remainder of the year.

As shown in Figures 5.1, 5.4, 5.7, and 5.10, the pumping from the source containment well CW-2 has a relatively small effect on the on-site water table contours. Well CW-2 is screened between an elevation of 4968.5 and 4918.5 ft MSL. The sand-pack extends about 10 ft above the top of the screen, to an elevation of about 4978.5 ft MSL. The top of the 4970-foot silt/clay at this location is also at an elevation of about 4968.5 ft MSL. Most of the water pumped from the well, therefore, comes from the ULFZ and LLFZ underlying the 4970-foot silt/clay unit. The pumping water level in CW-2 is about 4957 ft MSL, more than 10 ft below the top of the silt/clay unit; thus, the direct contribution of water from the aquifer above the silt/clay unit into the well is by leakage through the sand pack, and is controlled by the elevation of the top of the silt/clay unit at the well location. In preparing the water-table maps for the on-site area, the elevation of the water table at the location of CW-2 was, therefore, assumed to be near the top of the 4970-foot silt/clay, that is, at an elevation of 4968.5 ft MSL. A similar condition exists at the location of infiltration pond monitoring wells MW-77 and MW-78. These two monitoring wells are equipped with 30-foot screens that span across the silt/clay unit, and thus allow water to flow from the on-site water table into the underlying ULFZ. The effects of this downward flow were also considered in preparing the water table maps.

The quarterly on-site water table maps (Figures 5.1, 5.4, 5.7, and 5.10) also indicate that the treated groundwater infiltrating from the infiltration ponds has created a water-table mound in the vicinity of the ponds. Comparisons of the water-level data collected since the start of the operation of CW-2 and of the infiltration ponds on January 3, 2002 with those that prevailed prior to the start of CW-2 and pond operation indicate that, except for monitoring wells located near or along the southern limit of the 4,700-foot silt/clay, water levels in the wells completed above the 4970-foot silty/clay unit quickly rose in response to the infiltrating water, but then resumed to decline under the regional trends, albeit at a smaller rate than unaffected wells (see for example the hydrographs of wells MW-17 and MW-22 shown in Figure 2.5). The difference between the water levels measured in these wells in November 2008 and those measured in November 2001 ranges from about 0.2 ft in well MW-22 to almost 8 ft in well MW-27, and averages about 3.4 ft. The water levels in six wells along or near the southern limit of the silt/clay unit (MW-07, MW-09, MW-12, MW-13, MW-23, and MW-33) were not significantly affected by the infiltrating water, and continued to decline under the regional trends (see for example the hydrograph of well MW-12 in Figure 2.5). In fact, this regional decline caused wells MW-13 and MW-33 to go dry in recent years. The lack of response in these six wells suggests the presence of a low permeability barrier that isolates these wells from the effects of the infiltrating water.

The quarterly water levels and the capture zones of the off-site and source containment wells within the UFZ/ULFZ are shown in Figures 5.2, 5.5, 5.8, and 5.11; those within the LLFZ are shown in Figures 5.3, 5.6, 5.9, and 5.12. As shown in these figures, throughout the year the capture zone of the off-site containment well, CW-1, contained the off-site groundwater contamination, as defined by the extent of the November 2007 or November 2008 TCE plume. Hydraulic containment of the plume was, therefore, maintained throughout 2008. The figures also indicate that the source containment well CW-2 has developed a capture zone that during 2008 continued to contain any potential on-site source areas that may still be contributing to groundwater contamination.

Cross-sectional views of the November 2008 water table are shown on the schematic east-west (C-C') and north-south (D-D') cross-sections that are presented in Figure 5.13 (see Figures 5.10 through 5.12 for the location of these cross-sections). The cross-sections also show the water table that prevailed in November 1998, prior to the start of the off-site containment system. Other features shown on these cross-sections are: (1) the 4,970-ft silt/clay unit, (2) the 4,800-ft clay unit, (3) the screened intervals of the wells through which the cross-sections are passing (the deepest well at cluster locations), (3) the screened intervals of the DFZ wells, (4) the limits of the containment well capture zones, and (5) the pump intake elevation in the containment wells. The divergence of the water table from the ULFZ potentiometric surface in the area underlain by the 4,700-foot silt/clay is shown in greater detail, for both the 1998 and the 2008 conditions in Figure 5.14.[14]

The quarterly measurements from the three DFZ wells, MW-67, MW-71R and MW-79, indicate that the average direction of groundwater flow in the DFZ during 2008 was W 22° N with an average hydraulic gradient of 0.0024.

5.1.2 Effects of Containment Well Shutdown on Capture

As discussed in Section 3, the containment systems are occasionally shut down for maintenance and repairs, and sometimes due to power or equipment failures. For example, during 2008 the off-site containment system was shut down for about 53 hours due to a radio communication failure, and in 2007 the source containment system was shut down for more than 5 days to replace the well pump. In their review of the 2007 Annual Report USEPA/NMED expressed some concern on whether these shutdowns may result in the escape of contaminants beyond the capture zones of these systems. The capture zone for the source containment well lies within the capture zone of the off-site containment well, and its downgradient limit is within the plume area. Any shutdown of this well would cause some contaminants to escape beyond its capture zone, but these contaminants will remain within the capture zone of the off-site containment well and eventually captured by this well. Thus, the shutdown of the source containment system for any length of time is of no consequence.

Any contaminants that escape beyond the capture zone of the off-site containment well during the shutdown of this well, however, cannot be recovered unless the capture zone is increased by increasing the pumping rate of the well. Calculations made to evaluate this possibility indicate that it is highly unlikely. Under non-pumping conditions, the hydraulic gradient near the leading edge of the plume is about 0.003 (see Figures 2.12, 2.13 and 5.18). The aquifer above the 4,800-foot clay has a hydraulic conductivity of 25 ft/d and a porosity of 0.3. Thus, the rate at which groundwater, and hence contaminants, would move under non-pumping conditions is 0.25 ft/d. If it is assumed that water levels recover to non-pumping conditions immediately after the shutdown of the offsite containment well, a shutdown of 30 days could cause the leading edge of the plume to move 7.5 ft downgradient of its pre-shutdown position. The downgradient distance between the limit of the capture zone for the off-site containment well and the leading edge of the plume is considerably more than 7.5 ft (see Figures 5.11 and 5.12); therefore, shutdowns of the length that have been experienced in the past, and of even much longer periods, could not cause any contaminants to escape beyond the capture zone of the well.

[14] The cross-sections presented in Figures 5.13 and 5.14 and the information on these cross-sections conforms with the request of USEPA/NMED expressed in their comments on the 2007 Annual Report (see footnote 1).

5.2 Groundwater Quality

5.2.1 Monitoring Well VOC Data

Plots showing temporal changes in the concentrations of TCE, DCE, and TCA were prepared for a number of on-site and off-site wells to evaluate long-term water-quality changes at the Sparton site. Plots for on-site wells are shown in Figure 5.15 and plots for off-site wells in Figure 5.16. The concentrations in the on-site wells (Figure 5.15) indicate a general decreasing trend. In fact, the data from wells MW-9 and MW-16, which have the longest record, suggest that this decreasing trend may have started before 1983. A significant decrease in concentrations occurred in well MW-16 during 1999 through 2001. This well is located near the area where the SVE system was operating during those years, and it is apparent that the SVE operations affected the concentrations in the well. The TCE concentrations in the well have been below 10 μg/L during the last several years; the November 2008 concentration was 4.4 μg/L. Since the termination of the SVE operations in 2001, relatively low concentrations have been observed not only in this well but also in other onsite wells completed above the 4970-foot silt/clay unit; in fact, only four out of the ten such wells that were sampled in 2008 had TCE concentrations above 5 μg/L. These four wells (MW-12, MW-23, MW-25, and MW-26) had concentrations of 19 μg/L, 6.1 μg/L, 15 μg/L, and 9 μg/L, respectively. This indicates that the cleanup of the unsaturated zone beneath the former Sparton plant area by the SVE system, and the flushing provided by the water infiltrating from the infiltration ponds of the source containment system has been very effective in reducing contaminant concentrations in the saturated sediments overlying the 4970-foot silt clay.

As shown in Figure 5.15, the TCE concentrations in on-site well MW-19, which is completed in the ULFZ below the 4970-foot silt/clay unit (see Figure 2.4), were in the several thousand μg/L level when the well was installed in 1986 and remained at that level for a few years before starting to decline. By November 1998, the TCE concentrations in this well had declined to a few μg/L levels. In November 2002, however, the TCE concentration in the well rose to 23 μg/L, then to 630 μg/L by November 2003 and has been at the several hundred μg/L level since that time; the November 2008 TCE concentration was 490 μg/L. A similar pattern is also displayed in the DCE and TCA concentrations in this well, albeit at lower levels. These concentration increases are most probably due to an increase in the downward migration rate of contaminants present within the 4,970-foot silt/clay unit that was caused by increased downward leakage rates across this unit; the increase in leakage rates was induced by the drawdowns below the unit caused by the start of pumping at CW-2 and the simultaneous increases in the water levels above the unit caused by seepage from the infiltration ponds.

The concentration plots of the six off-site monitoring wells shown in Figure 5.16 do not display a consistent trend; while the concentrations have been declining in most wells (see for example wells MW-55, MW-60, MW-61, and MW-65) there are others where concentrations remain relatively stable (see for example well MW-48) and some where concentrations began to increase after a period of stabilization (see for example MW-56). This is primarily due to changes in groundwater flow patterns that were caused by the operation of the off-site containment system.

The concentrations in well MW-60 continued to be the highest observed in an off-site well, as it has been the case since the beginning of remedial operations. The concentrations of TCE in this well increased from low μg/L levels in 1993 to a high of 11,000 μg/L in November 1999 and then declined to 2,900 μg/L in November 2000. Then, they began increasing again reaching a second peak of 18,000 μg/L in November 2004; since then TCE concentrations in the well have declined to 4,800 μg/L in November 2008. The DCE and TCA concentrations in this well also declined from 830 μg/L and 59 μg/L in November 2004 to 400 μg/L and 12 μg/L, respectively, in November 2008. In general, the "rule-of-thumb" is that the presence of a contaminant at concentrations equal to or exceeding 1% of its solubility indicates the potential nearby presence of that contaminant as a free product (Newell and Ross, 1991; Pankow and Cherry, 1996) usually referred to as a non-aqueous phase liquid (NAPL). The solubility of TCE, a dense NAPL or DNAPL, is 11,000,000 μg/L; the concentrations of 11,000 μg/L and of 18,000 μg/L that were observed in MW-60 in November 1999 and 2004, respectively, meet the criteria of this rule-of-thumb. There are several factors, however, that preclude the presence of a DNAPL source near MW-60. First, the well is screened in the upper part of the aquifer and located almost 2,000 feet downgradient from the site; there is no plausible physical mechanism by which TCE could migrate to such a distance from the site as a DNAPL within a thick and fairly homogeneous aquifer. Second, although TCE concentrations above 10,000 μg/L and as high as 59,000 μg/L have been observed in several on-site wells in 1984 (Harding Lawson Associates, 1985), DNAPL has not been reported for any on-site boring or monitoring well. Finally, the gradual increase in the concentrations between 1993 and 1999, the occurrence of the high concentrations as two separate peaks with relatively lower concentrations in between, and the subsequent decrease in concentrations indicate that the contaminant concentrations in this well represent two slugs of highly contaminated groundwater that migrated from the site rather than a nearby DNAPL source. The migration of slugs of highly contaminated groundwater from the site is consistent with the high TCE concentrations that were observed at the site in 1984. It is of interest to note that Pankow and Cherry (1996, p. 459) state that "[t]he use of a 1% rule-of-thumb in any assessment of the spatial distribution of DNAPL zones must be performed cautiously, particularly in the downgradient direction. For example, the dissolved plume emitted from a very large DNAPL zone may exhibit dissolved concentrations above 1% of saturation for a substantial distance downgradient of the source zone."

Monitoring well MW-65, whose concentration trends are also shown in Figure 5.16, had low μg/L levels of TCE when first sampled after installation in 1996; TCE, at concentrations up to about 15 μg/L, was the only contaminant detected in this well before and at the start of the off-site containment system. The concentrations of TCE in the well declined rapidly after the start of the off-site containment system to "not detected" (at a detection limit of 1 μg/L) in August 1999, and remained "not detected" for almost two years. The well became contaminated again in 2001 but, as shown in Figure 5.16, the dominant contaminant this time was DCE followed by TCA and then TCE; the concentrations of these contaminants peaked around 2005 or 2006 and they have been declining since then. The dominant contaminant in wells affected by contaminants that originated from Sparton's former Coors Road facility is TCE. There are only two other wells, besides MW-65's post-2001 contamination, where the dominant contaminant is DCE; these are wells MW-62 and MW-52R. A plot of the contaminant concentrations in these two wells is presented in Figure 5.17; the plot for MW-65 is also repeated in this figure to provide for easy comparison. Note that well MW-62 has low concentrations of contaminants but the contaminant with the highest concentrations is DCE followed by TCA and then TCE as is also the case for the recent contamination in MW-65; in well MW-52R, however, the DCE is followed by TCE and then TCA. These observations lead to the following conclusions:

- The original TCE contamination in MW-65 was due to contaminants that migrated from the Sparton facility; the operation of the off-site containment well CW-1 captured this contamination and cleaned up the well;
- The contaminants detected in MW-62 represent the northern edge of a separate, DCE-dominated plume that did not originate at the Sparton facility;
- The post-2001 contamination in well MW-65 was due to the diversion of this separate plume by the operation of CW-1; the leading edge of this plume was pulled into MW-65 in 2001, and the peaking concentrations in 2005 and 2006 represent the passing of the center of the plume; now, the trailing edge of this plume is approaching the well as indicated by the decreasing contaminant concentrations;
- The diversion of this separate plume also affected well MW-52R; the TCE concentrations in this well, however, indicate that this well is also affected by the TCE-dominated plume originating from the Sparton facility.

The conclusion that this separate plume did not originate from the Sparton facility is also supported by backward tracking from well MW-65, using water level data collected since 1992,[15] which points to a source area south or southeast of MW-62, and the fact that monitoring wells MW-34 and MW-35,[16] located along Irving Boulevard southwest of the Sparton facility, were historically free of contaminants.[17]

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[15] See Attachment 3 to the document cited in footnote 2 (see page 1-3).

[16] Well MW-35 was located next to well MW-44; it became dry in 2002 and was plugged and abandoned in 2007.

[17] USEPA and NMED agree that the contaminants detected in MW-65 and MW-62 are due to a separate plume, but they disagree that this plume did not originate at the Sparton facility (see documents cited in footnote 2 and 3); they are also concerned that contaminants that belong to this plume or that have not been captured by the off-site containment system, may be present outside the capture zone of the off-site containment well, and they requested the installation of a sentinel well northwest of MW-65. Soarton agreed in May 2009 (letter mailed on May 6, 2009 from Joseph S. Lerczak of Sparton to Chuck Hendrickson of USEPA and John E. Kieling of NMED, Re; Notice of Dispute – Resolution and Extension Request for the Receipt of the 2009 Annual Report, Sparton Technology, Inc., EPA ID No. NMD083212332) to install such a well; however, Sparton's position is that the issue of whether the off-site containment well is capturing the plume emanating from the Sparton facility had been resolved soon after the off-site containment well began operating, and that any contaminants that may befound in the sentinel well to be installed will not have originated from Sparton's former Coors Road facility.

Of the three monitoring wells completed in the DFZ, well MW-67 of the MW-48/55/56/67 cluster had been clean since its installation in July 1996, and continued to be free of any contaminants in 2008. The second DFZ well, MW-71R, located about 30 ft south of the MW-60/61 cluster, was installed in February 2002 as a replacement for DFZ well MW-71 which was plugged and abandoned in October 2001 because of persistent contamination.[18] The first sample from MW-71R, obtained in February 2002, had a TCE concentration of 130 µg/L, and the well remained contaminated since then with TCE concentrations reaching a high of 210 µg/L in August 2003. After that, however, TCE concentrations in the well began steadily declining; the November 2008 concentration of TCE was 52 µg/L. The third DFZ well, MW-79, was installed near the off-site containment well CW-1 in February 2006 as a monitoring/stand-by extraction well to address the contamination detected in MW-71R; the decision on whether the well was to be a monitoring or an extraction well was to be based on the results of the initial sampling of the well.[19] Based on the results of the initial sampling, which showed the well to be free of site-related contaminants, the well was designated as monitoring well, and added to the Monitoring Plan under a semi-annual sampling schedule. Samples collected from the well since then continued to be free of any site-related contaminants.

The direction of groundwater flow in the DFZ places wells MW-67 and MW-79 directly downgradient of the Sparton facility. The lack of any contaminants in these two DFZ wells and the declining trend of TCE in well MW-71R indicate that this well is most likely affected by a contaminant slug of limited extent. The water quality in these three DFZ wells will continue to be monitored closely and periodically evaluated to determine if any future action might be necessary.

The Fourth Quarter (November) 2008 water-quality data presented in Table 4.2 (a) were used to prepare concentration distribution maps showing conditions near the end of 2008. The horizontal extent of the TCE and DCE plumes and the concentration distribution within these plumes in November 2008, as determined from the monitoring well data, are shown on Figures 5.18 and 5.19, respectively. Unlike previous years, the fact that wells MW-62, MW-65, and MW-52R are affected by a separate plume was taken into consideration in preparing these figures. Concentrations of TCA in all monitoring and extraction wells have been below regulatory standards since 2003; the TCA concentrations measured in wells sampled in November 2008 are shown on Figure 5.20. (At well cluster locations, the concentration shown in Figures 5.18 through 5.20 is that for the well with the highest concentration.) Well MW-53 did not have sufficient water for sampling in November 2008; this condition had also occurred in November 2005 and again in November 2007. The well was, therefore, deepened in December 2008 and sampled in February 2009 [see Table 4.2 (a)] to provide data for the preparation of Figures 5.18, 5.19, and 5.20.

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[18] See 1999 Annual Report [SSP&A, 2001a] for a detailed discussion of the history of well MW-71, and SSP&A and Metric (2002) for actions taken prior to its plugging and abandonment.

[19] A more detailed discussion of the steps that led to the installation of this well is presented in Section 2.7

Except for MW-53, the wells sampled in November 2008 were also sampled in November 2007. In these 55 wells, the November 2008 TCE concentrations were lower than the November 2007 concentrations in 25 wells, higher in 8 wells, and remained the same in 22 wells (21 below the detection limit of 1 μg/L). The largest decrease was in well MW-60 where the concentration of TCE decreased by 900 μg/L, from 5,700 μg/L in 2007 to 4,800 μg/L in 2008; the largest increase was in well MW-72 where the concentration of TCE increased by 560 μg/L, from 120 μg/L in 2007 to 680 μg/L in 2008. The corresponding numbers for DCE were 14 wells with lower, 5 wells with higher, and 36 wells with the same (all below the detection limit of 1 μg/L) concentrations. The largest decrease was in well MW-46 where the concentration of DCE decreased by 32 μg/L, from 100 μg/L in 2007 to 68 μg/L in 2008; the largest increase was in well MW-72 where the concentration of DCE increased by 59 μg/L, from 15 μg/L in 2007 to 74 μg/L in 2008. Well MW-46 also had the second largest decrease in TCE concentration, 90 μg/L, from 620 μg/L in 2007 to 530 μg/L in 2008. Relatively large increases in both the TCE and DCE concentrations also occurred in on-site monitoring well MW-19 where the TCE concentrations increased by 120 μg/L, from 370 μg/L to 490 μg/L, and DCE concentrations by 21 μg/L, from 56 μg/L to 77 μg/L. The concentration increases observed in on-site wells MW-19 and MW-72 is likely the result of flushing of residual contaminants from the 4,970 ft silt/clay unit as a result of the water-table mounding created by operation of the on-site infiltration pond.

The concentrations of TCA presented in Figure 5.20 and on Table 4.2 (a) indicate that a TCA plume (defined as the area with concentrations exceeding the more stringent of the federal or state allowable limits in groundwater) did not exist in 2008, as it has been the case since November 2003. None of the monitoring wells had a TCA concentration above the 60 μg/L maximum allowable concentration in groundwater set by the NMWQCC. The concentration of TCA was above the detection limit of 1 μg/L in nine out of the 56 sampled wells (including MW-53 that was sampled in February 2009); the highest concentration, 12 μg/L, occurred in well MW-60, and the concentrations in the remaining eight wells were less than 5 μg/L.

Changes that occurred between November 1998 (prior to the implementation of the current remedial activities) and November 2008 in the TCE, DCE, and TCA concentrations at wells that were sampled during both sampling events are summarized on Table 5.1. Also included on this table are wells MW-72 and MW-73 which were installed in early 1999 and wells MW-77, MW-78, and CW-2, which were installed in late 2001; the listed changes in these wells are between November 2008 and the first available sample from these wells. Of the 52 wells listed on Table 5.1, the TCE concentrations decreased in 32, increased in 6 and remained unchanged in 14 (below detection limits during both sampling events). The corresponding number of wells where concentrations decreased, increased, or remained unchanged are 26, 6, and 20 for DCE, and 22, 4, and 26 for TCA. Of the 52 wells listed on Table 5.1, 37 are among the wells that were used for defining the November 1998 plume, or the November 2008 plume, or both. Concentration changes in these 37 wells are presented in Figures 5.21, 5.22, and 5.23 to show the distribution of concentration changes that occurred since the implementation of the off-site and source containment systems. Also shown on these figures is the extent of the plumes in November 1998 and November 2008. Among these 37 wells, TCE concentrations decreased in

27 wells, increased in 4 wells, and remained unchanged in 6 wells (below detection limits during both sampling events); the corresponding number of these wells where concentrations decreased, increased, or remained unchanged are 23, 5, and 9 for DCE, and 18, 5, and 14 for TCA. Figure 5.21 also shows the approximate areas of origin[20] of the water pumped by the off-site containment well during the last ten years and from the source containment well during the last seven years.

The largest decreases in contaminant concentrations since the beginning of the current remedial operations occurred in on-site wells. Concentrations of TCE in on-site wells MW-23, MW-25, and MW-26 decreased by 6,194, 5,585, and 6,491 μg/L, respectively, from levels that were in the 5,500-6,500 μg/L range in 1998 to levels of 15 μg/L and less in 2008; DCE concentrations in these three wells decreased by 400, 73, and 590 μg/L, to "not detected" (ND); and TCA concentrations decreased from levels that were at the 550-720 μg/L levels to ND. Among off-site wells, the largest decreases in TCE concentrations occurred in MW-60 (2,900 μg/L, from 7,700 μg/L in 1998 to 4,800μg/L in 2008) and MW-46 (1670 μg/L, from 2,200 μg/L to 530 μg/L).

The largest increases in TCE and DCE concentrations occurred in the off-site containment well CW-1 (850 μg/L, and 62 μg/L, respectively), and on-site ULFZ well MW-19 (486 μg/L and 77 μg/L, respectively). Increases in TCA concentrations were all less than 5 μg/L.

The concentrations of TCE in the water pumped from the off-site containment well CW-1 increased rapidly after the start of its operation to levels in the 1,000-1,500 μg/L range, and remained at those levels for several years. Although a declining trend appears to have started in 2005 [see Figure 6.8 (a)], TCE concentrations in the well are still at the 1,000 μg/L level. The persistence of these high concentrations in the water pumped from the well, and the concentrations detected at well MW-60 indicated the presence of areas of high concentration upgradient from both these wells. Note, however, that as shown in Figure 5.21 most of the contaminated water that was upgradient from these wells has been already captured and pumped out by the off-site containment well. In fact, the only area of the original, or of the current, plume that has not been "sampled" by the off-site or source containment wells is a relatively narrow strip northwest of Eagle Road.

5.2.2 <u>Monitoring Well DO and ORP Data</u>

An evaluation of the DO and ORP data collected from monitoring wells at the Sparton site between 1998 and the end of 2007 was included in the 2007 Annual Report. This evaluation led to the following conclusions:

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[20] Area of origin refers to the areal extent of the volume of the aquifer within which the water pumped during a particular period was stored prior to the start of pumping from that particular well, that is, in late December 1998 for extraction well CW-1 and in early January 2002 for extraction well CW-2.

- Groundwater conditions at the site are generally aerobic;
- Under these conditions, degradation of TCE or other chlorinated solvents via reductive dechlorination is unlikely;
- Other geochemical indicators, including the absence of significant cis-12 DCE and the predominance of hexavalent chromium, are consistent with the DO and ORP data; and
- Further monitoring of these wells for ORP and DO is unlikely to provide useful information with respect to site remediation.

Data collected in November 2008 [see Table 4.2 (a)] do not alter these conclusions.[21]

5.3 Containment Systems

5.3.1 Flow Rates

A total of about 140.1 million gallons of water, corresponding to an average pumping rate of about 266 gpm, were pumped during 2008 from the off-site and source containment wells (see Table 4.3). The volume of water pumped during each year of the operation of the containment wells is summarized on Table 5.2. As shown on this table, the total volume pumped from both wells since the beginning of remedial pumping in December 1998 is about 1.332 billion gallons, and corresponds to an average rate of 253 gpm over the 10 years of operation. This volume represents approximately 118 percent of the initial plume pore volume reported in Subsection 2.6.1.3 of this report. The volume pumped from each well and the average flow rates are discussed below.

5.3.1.1 Off-Site Containment Well

The volume of water pumped from the off-site containment well during each month of 2008 is shown on Table 4.3; a plot of the monthly production is presented in Figure 5.24. Based on the total volume of water pumped during the year (approximately 114.7 million gallons), the average discharge rate for the year was 218 gpm. Due to a few downtimes (see Table 3.1), the well was operated 97.6 percent of the time available during the year, thus the average discharge rate of the well during its operating hours was about 223 gpm.

The volume of water pumped during each year of the operation of the well is summarized on Table 5.2. As shown on this table, the off-site containment well pumped a total of about 1.154 billion gallons of water from the aquifer since the beginning of its operation in December 1998. This represents approximately 102 percent of the initial plume pore volume reported in Subsection 2.6.1.3 of this report. A cumulative plot of the volume of water pumped from the off-site containment well is presented in Figure 5.25.

5.3.1.2 Source Containment Well

The volume of water pumped from the source containment well during each month of 2008 is shown on Table 4.3; a plot of the monthly production is presented in Figure 5.24. Based

[21] USEPA and NMED approval to discontinue the collection of DO and ORP data was received by Sparton in January 2009 (see document cited in footnote 1).

on the total volume of water pumped during the year (approximately 25.4 million gallons), the average discharge rate for the year was 48 gpm. The well was operated 99.3 percent of the time available during the year, thus the average discharge rate of the well during its operating hours was slightly above 48 gpm.

The volume of water pumped during each year of the operation of the well is summarized on Table 5.2. As shown on this table, the source containment well pumped a total of about 178 million gallons of water from the aquifer since the beginning of its operation on January 3, 2002. This represents approximately 16 percent of the initial plume pore volume reported in Subsection 2.6.1.3 of this report. A cumulative plot of the volume of water pumped from the source containment well is presented in Figure 5.25. Also shown in Figure 5.25 is a cumulative plot of the total volume of water pumped by both containment wells.

5.3.2 Influent and Effluent Quality

5.3.2.1 Off-Site Containment System

The concentrations of TCE, DCE, TCA, and total chromium in the influent to and effluent from the off-site air stripper during 2008, as determined from samples collected at the beginning of each month, are presented on Table 4.4 (a). Plots of the TCE, DCE, and total chromium concentrations in the influent are presented in Figure 5.26.

The concentrations of TCE in the influent during 2008 ranged from 1,200 μg/L detected in the March sample to 790 μg/L in the December sample; the average concentration for the year was about 980 μg/L. The highest (90 μg/L) and the lowest (62 μg/L) concentrations of DCE were detected in the March and April samples, respectively; the average concentration for the year was about 72 μg/L. Concentrations of TCA in the influent fluctuated within a relatively narrow range (4.5 μg/L to below the detection limit of 1 μg/L) and averaged about 2.5 μg/L. Throughout the year, total chromium concentrations in the influent were below the 50 μg/L maximum allowable concentration in groundwater set by NMWQCC and averaged about 19 μg/L.

The concentrations of TCE, DCE, and TCA in the air stripper effluent were below the detection limit of 1 μg/L throughout 2008. Total chromium concentrations in the effluent were essentially the same as those in the influent.

5.3.2.2 Source Containment System

The 2008 concentrations of TCE, DCE, TCA, and total chromium in the influent to and effluent from air stripper for the source containment system, as also determined from samples collected at the beginning of each month, are presented on Table 4.4 (b). Plots of the TCE, DCE, and total chromium concentrations in the influent are presented in Figure 5.26.

The concentrations of TCE in the influent during 2008 ranged from 120 μg/L in January to 66 μg/L at the end of the year, and averaged about 90 μg/L. The concentrations of DCE fluctuated within a relatively narrow range during the year and averaged about 11 μg/L. The concentrations of TCA in the influent were below the detection limit of 1 μg/L throughout the year, and total chromium concentrations were below the 50 μg/L maximum allowable concentration in groundwater set by NMWQCC; the average total chromium concentration was 27 μg/L.

The concentrations of TCE, DCE, and TCA in the air stripper effluent were below detection limits throughout the year, and chromium concentrations were at about the same level as those in the influent.

5.3.3 Origin of the Pumped Water

The groundwater pumped from the off-site and the source containment wells is water that was originally (prior to the start of pumping) in storage around each well. The areal extent of the volume of the aquifer within which the water pumped during a particular period was originally stored is referred to as the "area of origin" of the water pumped during that period. The approximate areas of origin of the water pumped from the off-site containment well during the last ten years and from the source containment well during the last seven years are shown in Figure 5.18. Particle tracking analysis (see Section 6.1.3) with the calibrated model of the site was used to determine these areas of origin. Note that the areas of origin of the water pumped by each well during the first few years of its operation (1999-2001 for the off-site and 2002-2004 for the source containment well) are slightly elliptical areas around each well, with the well off-centered on the down-gradient side of the elliptical area. The areas of origin corresponding to subsequent years of operation form elliptical rings around the first area of origin. The elliptical shape and the off-centered location with respect to the containment wells are controlled by the capture zone of each well which in turn is a function of the regional gradient and of the pumping rate of each well. For a given gradient, a smaller pumping rate results in a narrower capture zone and, hence, more elliptical areas of origin.

5.3.3.1 Off-Site Containment Well

Approximately 1.154 billion gallons of groundwater have been removed from the aquifer during the ten-year operation of the off-site containment well. The well is screened across the entire thickness of the aquifer above the 4,800-foot clay. Using an average thickness of 160 ft for the aquifer, a porosity of 0.3, and assuming that the flow is primarily horizontal, the areal extent of the original storage volume for this water is estimated to be 3.22 million square ft (ft^2). This is consistent with the extent of the model calculated areas of origin for this well shown in Figure 5.21 (about 3.82 million ft^2). Note that the above estimate assumes horizontal flow, whereas the model takes into consideration the fact that the water table is declining and that, therefore, the source of some of the pumped water is vertical drainage from the water table rather than purely horizontal flow. The storage volume from which the pumped water is derived has a smaller area near the water table than in the deeper horizons of the aquifer. The area shown in Figure 5.21 represents the horizon where the area is the largest.

5.3.3.2 Source Containment Well

Approximately 178 million gallons of groundwater have been removed from the aquifer during the six-year operation of the source containment well. About 40 ft of the screen of this well is open to the aquifer below the 4970-foot silt/clay. Assuming that groundwater flow toward the well is primarily within this 40-foot screened interval, and a porosity of 0.3, the areal extent of the original storage volume of the water pumped from the well is estimated to be 1.98 million ft^2. The extent of the model calculated areas of origin for this well shown in Figure 5.21 is about 1.23 million ft^2. The difference in the estimated and model based areas indicates that about one third of the water pumped by this well is vertical leakage that originates from the aquifer above the 4970-foot silt/clay, and from deeper horizons of the aquifer below the screened interval of the well.

5.3.4 Contaminant Mass Removal

A total of about 468 kg (1,030 lbs) of contaminants, consisting of 433 kg (955 lbs) of TCE, 32.6 kg (71.8 lbs) of DCE, and 1.13 kg (2.50 lbs) of TCA, were removed by the two containment wells during 2008 [see Table 5.3 (a)]. The total mass of contaminants removed by the two containment wells during each year of their operation is summarized on Table 5.4 (a). As shown on this table, the total mass removed by the containment wells since the beginning of the current remedial operations in December 1998 is about 5,460 kg (12050 lbs), consisting of about 5,130 kg (11,310 lbs) of TCE, 315 kg (694 lbs) of DCE, and 15.0 kg (33.1 lbs) of TCA. This represents about 78 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment system (see Section 2.6.1.4). The mass removal rates by each well are discussed below.

5.3.4.1 Off-Site Containment Well

The monthly mass removal rates of TCE, DCE, and TCA by the off-site containment well during the 2008 were estimated using the monthly discharge volumes presented on Table 4.3 and the concentration of these compounds shown on Table 4.4 (a). These monthly removal rates are summarized on Table 5.3 (b) and plotted in Figure 5.27. As shown on Table 5.3 (b), about 458 kg (1,010 lbs) of contaminants, consisting of about 425 kg (937 lbs) of TCE, 31.5 kg (69.4 lbs) of DCE, and 1.08 kg (2.39 lbs) of TCA were removed by the off-site containment well during 2008.

The mass of contaminants removed by this well during each year of its operation is summarized on Table 5.4 (b), and a plot showing the cumulative mass removal by the off-site containment well is presented in Figure 5.28. As shown on this table and figure, by the end of 2008 the off-site containment well had removed a total of approximately 5,240 kg (11,600 lbs) of contaminants, consisting of approximately 4,940 kg (10,900 lbs) of TCE, 288 kg (636 lbs) of DCE, and 11.5 kg (25.4 lbs) of TCA. This represents about 75 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment system (see Section 2.6.1.4).

5.3.4.2 Source Containment Well

The monthly mass removal rates of TCE, DCE, and TCA by the source containment well during the 2008 were estimated using the monthly discharge volumes presented on Table 4.3 and the concentration of these compounds shown on Table 4.4 (b). These monthly removal rates are summarized on Table 5.3 (c) and plotted in Figure 5.27. As shown on Table 5.3 (c), about 9.51

kg (21.0 lbs) of contaminants, consisting of about 8.42 kg (18.6 lbs) of TCE, 1.04 kg (2.29 lbs) of DCE, and 0.0481 kg (0.106 lbs) of TCA were removed by the source containment well during 2008.

The mass of contaminants removed by this well during each year of its operation is summarized on Table 5.4 (c), and a plot showing the cumulative mass removal by the source containment well since the beginning of its operation on January 3, 2002 is presented in Figure 5.28. A cumulative plot of the mass removed by both containment wells is also shown in Figure 5.28. As shown on Table 5.4 (c) and Figure 5.28, the total mass of contaminants removed by the well by the end of 2008 was about 219 kg (482 lbs), consisting of 189 kg (416 lbs) of TCE, 26.3 kg (57.9 lbs) of DCE, and 3.47 kg (7.64 lbs) of DCA. This represents about 3 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment system (see Section 2.6.1.4).

5.4 Site Permits

5.4.1 Off-Site Containment System

The infiltration gallery associated with the off-site containment system is operated under the Discharge Permit (State of New Mexico Groundwater Discharge Permit DP-1184). This permit requires monthly sampling of the treatment system effluent, and the quarterly sampling of the infiltration gallery monitoring wells MW-74, MW-75 and MW-76. The samples are analyzed for TCE, DCE, TCA, chromium, iron, and manganese. The concentrations of these constituents must not exceed the maximum allowable concentrations for groundwater set by NMWQCC. Until 2006, this permit required the results of the analyses to be reported quarterly; however, the permit was renewed on December 29, 2006 and under the terms of the renewed permit reporting requirements have been reduced to annually.

As required by the renewed Discharge Permit, the analysis results of all samples collected during 2008 were reported to the NMED Groundwater Bureau on January 27, 2009. The sampling results met the permit requirements throughout the year.

No violation notices were received during 2008 for activities associated with the operation of the off-site containment system.

5.4.2 Source Containment System

The rapid infiltration ponds associated with the source containment system are also operated under State of New Mexico Groundwater Discharge Permit DP-1184, and are subject to the above-stated requirements of this permit. The monitoring wells for this system are MW-17, MW-77 and MW-78. The data collected from the system met the requirements of the Groundwater Discharge Permit throughout 2008.

The air stripper associated with the source containment system is operated under Albuquerque/Bernalillo County Authority-to-Construct Permit No. 1203. This permit specifies emission limits for total VOCs, TCE, DCE, and TCA. Emissions from the air stripper are calculated annually by using influent water-quality concentrations and the air stripper blower capacity. The calculated emissions are reported to the Albuquerque Air Quality Division by March 15 every year as required by the permit.

The requirements of Permit No. 1203 were met throughout 2008. No violation notices were received during 2008 for activities associated with operation of the source containment system.

5.5 Contacts

In February and May 2008 Baird Swanson (NMED Groundwater Bureau) visited the site during the sampling of DFZ well MW-71R and obtained split samples from this well.

Under the terms of the Consent Decree,[22] Sparton is required to prepare an annual Fact Sheet summarizing the status of the remedial actions, and after approval by USEPA/NMED, distribute this Fact Sheet to property owners located above the plume and adjacent to the off-site treatment plant water discharge pipeline. Annual Fact Sheets reporting on remedial activities during 1999, 2000, and 2001 were prepared by Sparton, approved by the regulatory agencies, and distributed to the property owners. During the last seven years, Sparton prepared Draft Fact Sheets for 2002, for 2002 and 2003 combined, and for 2002 through 2004 combined. These Fact Sheets, however, did not get the approval of USEPA/NMED because the 2003 and subsequent Annual Reports had not been yet approved.[23] Fact Sheets have not been, therefore, distributed to the property owners located above the plume and adjacent to the off-site treatment plant water discharge pipeline since 2002.[24]

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[22] Attachment B to the Consent Decree in Albuquerque v. Sparton Technology, Inc., No. CV 07 0206 (D.N.M.), Public Involvement Plan for Corrective Measure Activities.

[23] Under the terms of the Consent Decree the Fact Sheets cannot be finalized before the Annual Reports for the years covered by the Fact Sheets have been approved.

[24] The 2003 through 2006 Annual Reports were approved by USEPA/NMED in December 2008 (see document cited in footnote 1).. Sparton submitted a combined 2002-2006 Draft Fact Sheet to the agencies on March 6, 2009; after some revisions, this Fact Sheet was approved by the agencies on May 8, 2009. Distribution of the approved Fact Sheet to the property owners is planned for June 2009.

Section 6
Groundwater Flow and Transport Model

This section describes a numerical groundwater flow and contaminant transport model of the aquifer system underlying the Sparton site and its vicinity. This model was developed following the general outline described in Task 3 of the "Work Plan for the Assessment of Aquifer Restoration" (SSP&A,2000b), which is incorporated as Attachment D in the Consent Decree. The development of the model is described in the 1999 Annual Report (SSP&A, 2001a) and in the 2003 Annual Report (SSP&A, 2004).

The groundwater flow model was revised and recalibrated this year to better reflect regional groundwater conditions. Prior to revising the model, information on groundwater pumping west of the Rio Grande and within 5 miles of the Sparton site was compiled. A map showing the main groundwater production wells in the vicinity of the site and a table listing annual production rates at each of these wells from 1998 through 2008 are contained in Appendix D. This regional pumping influences groundwater flow directions in the vicinity of the Sparton site and the groundwater model was revised to better incorporate the effects of this pumping. The revisions that were made to the groundwater model were the following:

- The model area was increased to include an area of about 5.1 square miles; this represents an expansion of the model area by about fifty percent;
- The orientation of the model grid was rotated so that the northern and southern model boundaries are approximately parallel to the direction of regional groundwater flow. The model grid is now rotated 25° (clockwise rotation); in the previous model the grid was rotated 45°
- The western 5,800 feet of the northern model boundary and the western 5,800 feet of the southern model boundary were simulated as constant-head boundaries. In the previous model, these boundaries were no-flow boundaries.
- The water levels on the constant head boundaries were specified as parameters in the model calibration procedure and were estimated during model calibration. As a result, the model implicitly incorporates the effects of regional groundwater pumping.
- The number of model layers was increased from 13 to 15 to better represent the aquifer below the 4800-foot clay. In the previous model, the aquifer below the 4800-foot clay was represented by a single 100-foot thick layer. In the revised model, the aquifer below the 4800-foot clay is represented by three layers in the following order: a 76-foot thick layer representing coarse-grained materials (layer 13), a 15-foot thick layer representing fine-grained materials (layer 14, also referred to as 4705-foot clay unit), and a 165-foot thick layer representing coarse-grained materials (layer 15). These additional layers reflect the vertical discretization used in the numerical model constructed to analyze the aquifer test data from MW-79 (described in Appendix I, SSP&A 2008).
- A new geologic zone was defined in model layers 1, 2 and 3 between the Recent Rio Grande deposits and the area where the 4970-foot silt/clay unit exists.

- The hydraulic flow barrier package (Harbaugh et al. 2000) was used to simulate a hydraulic discontinuity in the sand unit above the 4970-foot silt/clay unit near the southeastern extent of this unit. This discontinuity is evidenced by the observation that water levels in wells screened in this unit near the southeastern extent of the 4970-foot silt/clay unit have not responded to use of the on-site infiltration ponds.
- Recharge from the Arroyo de las Calabacillas was significantly reduced. A recharge rate of 19 feet per year was used in the previous model and this value likely greatly overestimates actual recharge along the arroyo. In addition, in the revised model recharge from irrigated fields and canals along the Rio Grande were not simulated explicitly. Rather, the simulated recharge from the Rio Grande incorporates recharge from the canals and the fields.

The groundwater flow model and the transport model were recalibrated after these revisions were made.

The groundwater flow model is based on MODFLOW-2000 (Harbaugh and others, 2000). The flow model is coupled with the solute transport simulation code MT3D (Zheng 2006, and Zheng and SSP&A 1999) for the simulation of constituents of concern underlying the site. The models have been used to simulate groundwater levels and TCE concentrations in the aquifer from start-up of the off-site containment well in December 1998 through December 2008.

6.1 Groundwater Flow Model

6.1.1 Structure of Model

The model area and model grid are presented in Figure 6.1. The overall model dimensions are 15,000 ft by 9,500 ft. The model consists of 88 rows and 133 columns. The central part of the model covers a finely gridded area of 4,900 ft by 2,800 ft which includes the Site and the off-site plume; the grid spacing in this area is uniform at 50 ft. Outward from this central area, the grid spacing is gradually increased to as much as 1,000 feet at the limits of the model domain. The model grid is aligned with the principal axes corresponding to the approximate regional groundwater flow direction (25° clockwise rotation).

The model consists of 15 layers. The vertical discretization used in the model is shown in Figure 6.2. Layers 1 through 11 correspond to the surficial aquifer. Layer 1 is 15 ft thick, layer 2 is 5 ft thick, layers 3 through 7 are 10 ft thick, layers 8 and 9 are 20 ft thick, and layers 10 and 11 are 40 ft thick. Layer 12 is a 4-foot-thick unit that represents the 4800-foot clay unit. Layer 13 represents the 76-foot thick deep flow zone, layer 14 represents a 15-foot thick 4705-foot clay unit, and layer 15 represent the upper 165 ft of the deeper aquifer units. The vertical discretization was selected to minimize vertical numerical dispersion.

6.1.1.1 Boundary Conditions

The eastern boundary of the model is a no-flow boundary located just east of the Rio Grande and oriented approximately parallel to the river. The northern and southern boundaries of the model are specified as no-flow boundaries along the eastern portion of these boundaries and as constant head boundaries along the western portion of these boundaries (refer to Figure 6.1). In the eastern portion of the model area, regional groundwater flow is away from the Rio Grande and approximately parallel to the northern and southern boundaries of the model and thus it is appropriate to specify these portions of the model boundaries as no-flow boundaries. In the western portion of the model area, regional groundwater flow creates a divergence in groundwater flow directions. As a result, in the western portion of the model area regional groundwater flow is not parallel to the northern and southern model boundaries. Consequently, the western portions of these boundaries were specified as constant-head boundaries such that groundwater flows out of the model area across these boundaries could be simulated. The western boundary of the model area is also simulated as a constant-head boundary. The western 5,000 feet of the northern and southern boundaries are specified as constant head boundaries.

The water-levels on the constant head boundaries were estimated during model calibration. In the model calibration process the water-levels on the constant head boundaries were specified on the basis of five parameters. The five parameters were water levels in 1998 at the following locations: 1) in layer 1 at the eastern end of the constant-head segment of the northern boundary; 2) in layer 1 at the eastern end of the constant head segment of the southern boundary, 3) in layer 1 in the northwest corner of the model grid; 4) in layer 1 in the southwest corner of the model grid; and 5) in layer 1 in the center of the western model boundary. The locations of these constant-head boundary parameters are shown on Figure 6.1. Based on these five water levels, water levels were estimated at all constant-head boundary cells using the following algorithm:

Water levels along the constant-head boundaries in layer 1 in 1998 were calculated by linear interpolation from the 5 water levels described above. Water levels in subsequent years were calculated based on an annual water-level decline of 0.4 feet that was derived based on an evaluation of long-term hydrographs of monitoring wells. Examples of long-term hydrographs are shown on Figure 6.3.

Water levels in constant-head boundary cells in layers 2 through 11 were calculated based on the water levels estimated in layer 1 and a specified vertical hydraulic gradient of 0.02 ft/ft. This vertical hydraulic gradient was assumed to be constant through time.

Water levels in constant head cells in layers 12 and 13 were calculated based on the water levels estimated in layer 11 and a specified water-level change across the 4800-foot clay of 2.34 feet. The water-level change across the 4800-foot clay was a parameter in model calibration.

Water levels in constant head cells in layers 14 and 15 were calculated based on water levels estimated in layer 13 and a specified water-level change of two feet across the clay unit represented by layer 14. The water-level change was estimated from water-level data from the U.S. Geological Survey monitoring well cluster at Hunter Ridge adjacent to Arroyo de las Calabacillas.

6.1.1.2 Hydraulic Properties

Five different geologic zones are specified within the model domain:

- Holocene channel and flood plain deposits, also referred to as Recent Rio Grande deposits;
- the 4970-foot silt/clay unit;
- sands of the Upper Santa Fe Group, Late-Pleistocene channel and flood plain deposits, and Late-Pleistocene and Holocene arroyo fan and terrace deposits, collectively referred to as the sand unit; and
- the 4800-foot clay unit;
- the 4705-foot clay unit.

The sand unit is primarily classified as USF2 facies assemblages 2 and 3 (Hawley, 1996). Locally, near the water table, in some areas, the sands and gravels are classified as USF4 facies assemblages 1 and 2. In areas where the 4970-foot silt/clay unit is present, the sands and gravels overlying this unit are Late-Pleistocene arroyo fan and terrace deposits. The 4970-foot silt/clay unit represents Late-Pleistocene overbank deposits. The 4800-foot clay unit is included in the USF2. The sand unit was subdivided into six hydrogeologic zones for purposes of model calibration:

1. Sand unit above the 4970-foot silt/clay unit, except near the far southeastern of the silt/clay unit, which represent Late-Pleistocene arroyo fan and terrace deposits (this zone was defined north of the simulated discontinuity shown on Figure 6.1);
2. Sand unit above the 4970-foot silt/clay unit near the far southeastern extent of this unit (this zone was defined south of the simulated discontinuity shown on Figure 6.1);
3. Sand unit in the region between the western extent of the Rio Grande deposits and the eastern extent of the 4970-foot silt/clay unit (This zone is shown as the "upper sand unit" on Figure 6.1);
4. Sand unit above the 4800-foot clay unit except above and in vicinity of 4970-foot silt/clay unit;
5. Sand unit immediately between the 4800-foot clay unit and the 4705-foot clay unit;
6. Sand unit below the 4705-foot clay unit

The spatial extent of the Recent Rio Grande deposits, the 4970-foot silt/clay unit, and the upper sand unit are shown in Figure 6.1. Also shown on Figure 6.1 is the location of a discontinuity in the sand unit above the 4970-silt/clay unit. This discontinuity was simulated with the MODFLOW horizontal flow barrier package. The horizontal conductance of the barrier was specified as 10^{-6} per day.

6.1.1.3 Sources and Sinks

The groundwater sinks in the model domain are the off-site containment well CW-1, the source containment well CW-2, and eight on-site shallow wells (PW-1, MW-18, and MW-23 through MW-28) that are, or were, used for remedial extraction. The off-site containment well has been in operation since December 31, 1998 with a brief shut down in April 1999. The average annual pumping rate has varied between 213 gpm and 225 gpm. The average pumping rate in 2008 was 218 gpm. The pumping at CW-1 is distributed across model layers 6 through 11 and is apportioned based on layer transmissivities. The discharge from well CW-1 to the infiltration gallery is simulated using wells injecting into layer 2. The discharge is distributed across the area of the gallery and is specified at the same rate as the CW-1 pumping rate.

The source containment well, CW-2, began operation in January 2002. The well has operated at an average annual pumping rate of between 46 gpm and 52 gpm. The average pumping rate in 2008 was 48 gpm. The pumping at CW-2 is distributed across model layers 3 through 8. Ninety-nine percent of the treated water from this well is assumed to infiltrate back to the aquifer from the six on-site infiltration ponds based on consumptive use calculations. Only some of the ponds are used for infiltration at any given time; during 2002 the treated discharge from the well was rotated among the six original ponds, in 2003 and 2004 only ponds 1 and 4 were used, and in 2004 to 2008 the discharge was rotated among ponds 1 through 4 (see Figure 2.10 for pond locations). Ponds 5 and 6 were backfilled during 2005. In the model, the amount of water directed to each of the ponds was based upon operation records.

The shallow extraction wells were operated from December 1988 to November 1999. Total extraction rates from the wells declined with time. The average pump rate was 0.24 gpm in 1999. Since discharge from the shallow extraction wells was to the city sewer, infiltration of this water was not simulated in the model. Infiltration of precipitation is considered to be negligible due to high evapotranspiration and low precipitation.

Recharge within the modeled area is specified to occur from the Rio Grande and the Arroyo de las Calabacillas. Infiltration from the Rio Grande was simulated with the MODFLOW river package. The water level in the Rio Grande was estimated from the USGS 7.5 minute topographic map for the Los Griegos, New Mexico quadrangle and the river-bed conductance was determined as part of the model calibration process. Recharge along the Arroyo de las Calabacillas was simulated with the MODFLOW recharge package. This recharge rate was determined as part of the model calibration process described below.

6.1.2 Model Calibration

The automated parameter estimation program PEST (Doherty 2002) was used to aid calibration of the revised groundwater model. For purposes of model calibration, the groundwater model was used to simulate groundwater levels in the aquifer system underlying the former Sparton site and its vicinity from December 1998, just prior to the startup of containment well CW-1, until December 2008. An initial steady-state stress period was used to simulate conditions prior to startup, and this was followed by a month-long stress period for December 1998, and annual stress periods for the years 1999 through 2008. The average annual pumping rates specified for the containment wells CW-1 and CW-2 are those specified on Table 5.2.

A total of 700 water-level calibration targets were used in the calibration process. These calibration targets were developed from average annual water levels for each year from 1998 to 2008 calculated from available water-level data for seventy-seven monitoring wells at the Sparton site and four piezometers maintained by the U.S. Geological Survey at the Hunters Ridge site located near the infiltration basin on the north side of the Arroyo de las Calabacillas. The calibration targets were specified as the average water level at each monitoring well and piezometer in 1998, prior to startup, and the annual change in the water-level at each monitoring well and piezometer from 1999 through 2008. The differences in water levels from year to year, rather than absolute water levels, provide better calibration targets for purposes of a transient calibration.

Model calibration consisted of adjusting the hydraulic parameters and boundary condition parameters to minimize the residuals between measured and calculated calibration targets, that is, the difference between measured and calculated average water levels in 1998, and measured and calculated changes in average annual water levels between 1999 and 2008. The calibrated hydraulic parameters determined in the calibration process are the following:

Hydrogeologic Zone	Hydraulic Conductivity, ft/d		Specific Yield	Specific[25] Storage, ft^{-1}	Model Layers in which zone is present
	Horizontal	Vertical			
Recent Rio Grande deposits	150	0.025	0.2	2×10^{-6}	1-6
Sand unit above 4970-foot silt/clay unit	40	0.2	0.2	2×10^{-6}	1,2
Sand unit above 4970-foot silt/clay unit near southeastern extent	40	0.3	0.2	2×10^{-6}	1,2
Sand unit between Recent Rio Grande deposits and Sands above 4970-silt/clay unit	120	0.05	0.2	2×10^{-6}	1,2,3
Sand unit above the 4800-foot clay unit	25	0.2	0.2	2×10^{-6}	3-11
Sand unit in Layer 13	23	0.068		2×10^{-6}	13
Sand unit in layer 15	22	0.01		2×10^{-6}	15
4970-foot silt/clay unit	18	0.00005		2×10^{-6}	3
4800-foot clay unit	0.0042	0.00053		2×10^{-6}	12
4705-foot Clay Unit	0.2	0.058		2×10^{-6}	14

The calibrated boundary parameters determined in the calibration process, which are water levels in layer 1 in 1998 at five locations along the constant-head boundary as described above, are the following in counter clockwise order from the northeastern extent of the constant head boundary: 4959.47 ft MSL, 4954.37 ft MSL, 4951.05 ft MSL, 4948.04 ft MSL, and 4950.63 ft MSL. The locations of the boundary parameters are shown on Figure 6.1. The calibrated recharge rate for the streambed of the Arroyo de las Calabicillas is 0.2 ft.year. The calibrated water level difference across the 4800-foot clay unit was 2.34 feet.

The calculated water levels in December 2008 with the calibrated groundwater model for the water table (UFZ), ULFZ, and LLFZ are shown in Figures 6.4, 6.5, and 6.6, respectively. These calculated water levels are very similar to observed water levels. The correspondence between measured and model-calculated water levels was evaluated using both qualitative and quantitative measures.

The qualitative measures included 1) the preparation of scatter plots of observed versus calculated water levels to provide a visual comparison of the fit of model to the measured water level data, 2) plots of observed and calculated water levels for the period 1998 through 2008 for each of the monitoring wells and piezometers used for model calibration, and 3) maps of the difference between observed and calculated water levels for each of the major aquifer units, and 4) evaluation of model water balance.

[25] The specific storage of all model units was specified at 2×10^{-6} ft^{-1} consistent with the value specified in the USGS model of the Albuquerque Basin (Kernodle, 1998). This value was not estimated during model calibration.

Scatter plots of observed water levels versus calculated water levels between 1998 and 2008 for all monitoring wells in the UFZ above the 4970-foot silt/clay unit, for all wells in the UFZ, ULFZ and LLFZ except for those above the 4970-foot silt/clay unit, and for all wells in the DFZ are shown on Figure 6.7. For a calibrated model, the points on the scatter plot should be random and closely distributed about the straight line that represents an exact match between the calculated and observed groundwater levels. The scatter plots shown in Figure 6.7 plot the average water level in each monitoring well during each year of the simulation against the calculated average water level in each well.[26] These scatter plots visually illustrate the excellent comparison between model calculated water levels and observed water levels in the UFZ/ULFZ/LLFZ and DFZ zones. In the on-site UFZ the correspondence between observed and calculated water levels is not as good as in the other zones. This is the result of significant heterogeneity in the sands above the 4970-foot silt/clay unit.

Plots of observed versus calculated water levels at all monitoring wells and piezometers used in model calibration are shown in Appendix E on figures E-1, E-2, and E-3. These plots indicate that the water-level trends in the observed and calculated water levels are very similar at almost all monitoring wells. These plots also illustrate well the close correspondence between observed and calculated water levels. The areal distribution of residuals in the on-site UFZ, the UFS/ULFZ/LLFZ and the DFZ in 2008 are shown in Appendix E on Figures E-4, E-5 and E-6, respectively. An evaluation of these figures indicates that the spatial distribution of residuals is relatively random.

The model water balance was compiled for 1998, 2001, and 2008 to evaluate the reasonableness of groundwater flows within the model domain. The water balance consists of water inflows into the model domain, groundwater outflow from the model domain, and changes in groundwater storage within the model area. Water inflows consist of leakage from the Rio Grande, recharge along the Arroyo de las Calabacillas, on-site infiltration ponds and the infiltration gallery. Groundwater outflows consist of groundwater pumping from containment wells CW-1 and CW-2 and groundwater flow out of the model domain across the constant-head boundaries. The water balance summaries for 1998, 2001 and 2008 in terms of gallons per minute (gpm) on an average annual basis are listed below:

[26] Measured water levels were compared to calculated water levels in the model layer corresponding to the location of the screened interval of the monitoring well. When the screened interval of a monitoring well spanned more than one model layer, the measured water levels were compared to the transmissivity weighted average of the calculated water levels in the layers penetrated by the well.

	Component	1998 (gpm)	2001 (gpm)	2008 (gpm)
Inflows	Storage (net)	0	80	76
	Infiltration Gallery and Ponds	0	216	266
	River	1183	1235	1313
	Recharge	7	7	7
Outflows	Containment Wells	0	216	267
	Constant Head (net)	1190	1322	1395

The water inflows and groundwater outflows from the model area were judged to be reasonable.

The quantitative evaluation of the model simulation consisted of examining the difference between the 700 average annual water levels measured in the monitoring wells and piezometers at the former Sparton site and its vicinity and the corresponding calculated water levels for these monitoring wells. The difference between an observed and a measured water level is called a residual. Three statistics were calculated for the residuals to quantitatively describe the model calibration: the mean of the residuals, the mean of the absolute value of the residuals, and the root mean-squared error[27]. The mean of the all the residuals is -0.70 ft, the mean of the absolute value of the residuals is 1.14 ft, and the root mean-squared error[2] is 1.6. The minimum residual is -6.38 ft and the maximum residual is 4.11 ft. The absolute mean residual of 1.14 ft is considered acceptable since the observed water-level measurements applied as calibration targets have a total range of about 31.6 ft, and seasonal fluctuations of water levels are on the order of several feet. The calibration statistics based on the monitoring wells and piezometers in the major flow zones are listed below:

Flow Zone	Count	Mean Residuals	Absolute Mean Residual	Root-Mean-Squared Error	Minimum Residual	Maximum Residual
On-Site UFZ	164	-1.1	1.9	2.4	-6.3	4.1
UFZ/ULFZ/LLFZ	503	-0.6	0.9	1.2	-4.8	2.5
DFZ	33	-0.1	0.5	0.7	-1.4	1.2

The differences between measured and calculated water levels at each monitoring wells for the period 1998 through 2008 are presented in Appendix E.

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[27] The root mean-squared error is defined as $RMSE = \left[\frac{1}{N} \sum_{i=1}^{N} R_i^2 \right]^{1/2}$ where N is the number of calibration targets, and R is the residual. The root mean-squared error is close to the standard deviation when the mean error is small and the number of targets is large.

The qualitative and quantitative evaluations of the results for the model calibration indicate that the groundwater model is a reliable simulator of existing conditions. The revised model better represents groundwater conditions at the Sparton site than the previous groundwater model. Calibration of the previous groundwater model is described in the 1999 Annual Report (SSP&A, 2001a) and the 2003 Annual Report (SSP&A, 2004).

6.1.3 Capture Zone Analysis

The capture zones of containment wells CW-1 and CW-2 in 2008 were calculated using particle tracking. The particle tracking was applied to the calculated average 2008 water levels, assuming that these water levels represented a steady-state condition. The particle tracking was carried out using the MODPATH computer code (Pollock 1994, 2008). The calculated average 2008 water levels and capture zones are based on the average annual pump rates at CW-1 and CW-2.

The calculated capture zones of containment wells CW-1 and CW-2 in the ULFZ, and the LLFZ are presented in Figures 6.5, and 6.6, respectively. Also shown in these figures is the extent of the TCE plume in November 2008. It should also be noted that Figure 6.6 represents the water levels in the middle of model layer 8 which corresponds to an elevation of 4,910 ft MSL (see Figure 6.2). This is an elevation 8.5 ft below the bottom of the screen in well CW-2; thus, the capture zone of this well shown in Figure 6.6 represents the area through which water moves upward and is captured by CW-2. Particle tracking analysis was also used to determine the aquifer area where the water extracted at CW-1 between 1999 to 2008 was located at the start of extraction in 1998 and where the water extracted at CW-2 between 2002 to 2008 was located at the start of extraction in January 2002. The areas for different extraction periods form a set of elliptical rings about the production wells as shown on Figure 5.15, with the outer ring in the vicinity of CW-1 representing the area where water extracted in 2008 resided within the aquifer in 1998, the year extraction began at the site.

The travel time from the center of the Sparton property (a point near monitoring well MW-26) to the source containment well CW-2, and the travel time from a point downgradient from and outside the capture zone of CW-2 to the off-site containment well CW-1 were estimated. These travel times were calculated as 1.5 and 15 years, respectively. This calculation assumed that both the off-site and the source containment wells are operating continuously at their current pumping rates and that 2008 water level conditions exist throughout the 15-year period.

6.2 Solute Transport Model

A solute transport model is linked to the groundwater flow model to simulate the concentration of constituents of concern at the site. The three-dimensional contaminant transport simulation code MT3DMS (Zheng 2006, Zheng and SSP&A, 1999) was applied for this study. The model was used to simulate TCE concentrations in the aquifer from December 1998 through December 2008.

Model input parameters were specified based on available data and the TCE concentrations in the model domain at the start of the simulation period were estimated from November 1998 measured concentration data. The model was used to predict TCE concentrations in the aquifer between January 2008 and December 2008. No attempt was made to simulate DCE and TCA. Generally, DCE is detected at monitoring wells where TCE is detected, but DCE concentrations are much lower than TCE concentrations. During 2008, DCE was about 7 percent of the total mass of chlorinated volatile organic compounds extracted by CW-1 and 11 percent of that extracted by CW-2.

The other constituent of concern, TCA, had been detected at concentrations greater than the 60 μg/L maximum allowable concentration in groundwater set by the NMWQCC, primarily in monitoring wells at the facility; prior to 2003 TCA had been detected at levels above 60 μg/L in only one off-site well, MW-46. The concentrations of TCA have been below 60 μg/L since 2003; the maximum TCA concentration reported this year was 12 μg/L at MW-60. The limited distribution of TCA and the reduction in its concentrations are the result of the abiotic transformation of TCA to acetic acid and DCE; a transformation that occurs relatively rapidly when TCA is dissolved in water. Only about 20 percent of TCA degrades to DCE, the rest degrades to acetic acid (Vogel and McCarty, 1987). The current concentrations of TCA and DCE in monitoring wells at the facility indicate that it is not likely that DCE concentrations will increase significantly in the future as the result of TCA degradation.

6.2.1 Transport Parameters

A number of aquifer and chemical properties are required as input parameters for the contaminant transport simulation. The required aquifer properties are porosity, bulk density, and dispersivity. The required chemical property is the retardation coefficient, which is a function of the fraction organic carbon, the organic-carbon partition coefficient for the organic compound being simulated, and the effective diffusion coefficient. The following table summarizes the transport parameters:

Transport Parameter	Geologic Unit	Value
Effective porosity	All	0.3
Longitudinal dispersivity	All	25 ft
Transverse horizontal dispersivity	All	0.25 ft
Transverse vertical dispersivity	All	0.025 ft
Retardation Coefficient	All except 4,970-foot silt/clay	1
	4,970-foot silt clay	4.3

The rationale for choosing these transport parameters is described in the 2000 Annual Report (SSP&A, 2001b) with the exception of the retardation coefficient for the 4,970-foot silt/clay unit.

The retardation coefficient for TCE was specified as unity in all geologic units, except for the 4970-foot silt/clay unit, because the total organic carbon content of the sandy units is very small. The retardation coefficient for this unit was estimated during model calibration. The retardation coefficient specified for the 4970-foot silt/clay unit most likely represents a number of physical/chemical processes including desorption and diffusion from lower to more permeable zones within the unit.

6.2.2 Initial Concentration Distribution and Model Calibration

The model has been re-calibrated each year, except in 2006, by adjusting the initial TCE concentration distribution in the aquifer in a manner consistent with available data until a reasonable match was obtained between the calculated and measured TCE concentrations, and the calculated and measured TCE mass removal at both containment wells, CW-1 and CW2, throughout their respective period of operation.

The calibration procedure has varied through time. For this report, the initial concentration distribution was interpolated based on the November 1998 measured concentration data and a number of the pilot points along the center line of the plume using three-dimensional kriging. The parameter estimation program PEST (Doherty, 2002) was used to estimate TCE concentrations at the pilot points. Calibration procedures used in previous years are described in the 2006 Annual Report (SSP&A, 2007). The calibration process has resulted in good agreement between observed and calculated TCE mass removal from containment wells CW-1 and CW-2, and between observed and calculated concentrations at CW-1 and CW-2 (Figure 6.8).

The initial mass and the maximum TCE concentrations within each model layer, under the recalibrated initial concentration distribution specified in the model, are summarized on Table 6.1. The estimated initial mass of TCE is 6,601 kg (14,553 lbs). The estimate of initial mass has varied with each recalibration of the model as additional information has been learned from long-term operation of the source containment wells, though the estimate of mass has not changed significantly since 2003. The estimates of initial mass presented in previous annual reports as estimated from model recalibration are listed below:

	Year									
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Estimated Initial Mass (kg)	2178	3097	3295	4647	7342	6638	6908	6908	6881	6601

6.2.3 Model Calculated TCE Mass Removal Rates and Concentration

The measured cumulative amount of TCE removed by operation of the on-site and off-site containment systems through the end of each year since 1999 and the model calculated amount of TCE removed are tabulated below. There is excellent agreement between the measured and model calculated amount of TCE removed. The total TCE removed through the end of 2008 is a little more than 5,000 kg. The amount of TCE removed is about 78 percent of the amount of TCE estimated to have been in the aquifer in 1998. Also tabulated below are the average annual measured and model calculated concentrations in the water pumped from CW-1 and CW-2 from 1999 through 2008.

Year	Cumulative TCE mass removed by both wells through end of year (kg)		Average Concentration at CW-1 (µg/L)		Average Concentration at CW-2 (µg/L)	
	Measured	Calculated	Measured	Calculated	Measured	Calculated
1999	359	373	829	750		
2000	822	896	1,055	1,212		
2001	1,340	1,443	1,205	1,269		
2002	1,944	2,051	1,225	1,253	723	612
2003	2,560	2,651	1,275	1,245	473	444
2004	3,156	3,217	1,317	1,226	301	399
2005	3,714	3,769	1,217	1,186	191	255
2006	4,225	4,255	1,166	1,114	153	164
2007	4,692	4,727	1,050	1,048	130	102
2008	5,130	5,152	982	969	90	62

A comparison of calculated to observed concentrations of TCE at all monitoring wells for all samples analyzed between November 1998 and November 2008 is presented in Figure 6.9. Also presented in Figure 6.9 is a comparison of calculated to observed concentrations of TCE for only those samples analyzed in November 2008 on which the individual data points are labeled with the well number. The general agreement between observed and computed concentrations is reasonable given the uncertainty of the initial contaminant distribution.

6.3 Future Simulations

The recalibrated and revised groundwater model has been shown to be a reliable simulator of groundwater conditions at the Sparton site. This model will be used to evaluate the future performance of the containment systems and alternative groundwater extraction schemes. In evaluating the future performance, alternative initial concentration distributions will be evaluated to assess the uncertainty in predictions.

Section 7
Conclusions and Future Plans

7.1 Summary and Conclusions

Sparton's former Coors Road Plant is located at 9621 Coors Boulevard NW, Albuquerque, New Mexico. The Site is at an elevation of about 5,050 ft MSL; the land slopes towards the Rio Grande on the east and rises to elevations of 5,150-5,200 ft MSL within a short distance to the west of the Site. The upper 1,500 ft of the fill deposits underlying the Site consist primarily of sand and gravel with minor amounts of silt and clay. The water table beneath the Site is at an elevation of 4,975-4,985 ft MSL and slopes towards the northwest to an elevation of about 4,960 ft MSL within about one-half mile of the Site. At an elevation of about 4,800 ft MSL a 2- to 3-foot clay layer, referred to as the 4,800-foot clay unit, has been identified.

Past waste management activities at the Site had resulted in the contamination of the Site soils and of groundwater beneath and downgradient from the Site. The primary contaminants are VOCs, specifically TCE, DCE, and TCA, and chromium. Remedial investigations at the Site had indicated that groundwater contamination was limited to the aquifer above the 4,800-foot clay and current measures for groundwater remediation have been designed to address contamination within this depth interval.

Under the terms of a Consent Decree entered on March 3, 2000, Sparton agreed to implement a number of remedial measures. These remedial measures consisted of: (1) the installation and operation of an off-site containment system; (2) the installation and operation of a source containment system; and (3) the operation of an on-site, 400-cfm SVE system for an aggregate period of one year. The goals of these remedial measures are: (a) to control hydraulically the migration of the off-site plume; (b) to control hydraulically any potential source areas that may be continuing to contribute to groundwater contamination at the on-site area; (c) to reduce contaminant concentrations in vadose-zone soils in the on-site area and thereby reduce the likelihood that these soils remain a source of groundwater contamination; and (d) in the long-term, restore the groundwater to beneficial use.

The installation of the off-site containment system began in late 1998 and was completed in early May 1999. The system consisted of (1) a containment well near the leading edge of the plume, designed to pump at a rate of about 225 gpm, (2) an off-site treatment system, (3) an infiltration gallery in the Arroyo de las Calabacillas, and (4) associated conveyance and monitoring components. The off-site containment well began operating on December 31, 1998; except for brief interruptions for maintenance activities or due to power outages, the well has operated continuously since that date; the year 2008 was the tenth full year of operation of this well. The source containment system was installed during 2001 and began operating on January 3, 2002. This system consisted of (1) a containment well immediately downgradient from the site, designed to pump at a rate of about 50 gpm, (2) an on-site treatment system, (3) six[28] on-site infiltration ponds, and (4) associated conveyance and monitoring components. The year 2008 was the seventh year of operation of this well. The 400-cfm SVE system had operated for a total of about 372 days between April 10, 2000 and June 15, 2001 and thus met the length-of-operation requirements of the Consent Decree; monitoring conducted in the Fall of 2001 indicated that the system had also met its performance goals, and the system was dismantled in May 2002.

During 2008, considerable progress was made towards achieving the goals of the remedial measures:

- The off-site containment well continued to operate during the year at an average discharge rate of 218 gpm, sufficient for containing the plume.
- The pumped water was treated and returned to the aquifer through the infiltration gallery. The concentrations of constituents of concern in the treated water met all the requirements of the Discharge Permit for the site. Chromium concentrations in the influent to the treatment system remained at levels that did not require treatment.
- The source containment well continued to operate during the year at an average rate of 48 gpm, sufficient for containing potential on-site source areas.
- Groundwater monitoring was conducted as specified in the Groundwater Monitoring Program Plan (Monitoring Plan [Attachment A to the Consent Decree]) and the State of New Mexico Groundwater Discharge Permit DP-1184 (Discharge Permit). Water levels in all accessible wells and/or piezometers, and the Corrales Main Canal were measured quarterly. Samples were collected for water-quality analyses from monitoring wells at the frequency specified in the above plan and permit and analyzed for VOCs and total chromium.
- Samples were obtained from the influent and effluent of the treatment plants for the off-site and source containment systems, and the infiltration gallery and infiltration pond monitoring wells at the frequency specified in the Discharge Permit. All samples were analyzed for VOCs, total chromium, iron, and manganese.
- The groundwater flow and transport model that was developed in 1999 to simulate the hydrogeologic system underlying the site was modified, recalibrated, and used to simulate TCE concentrations in the aquifer from start-up of the off-site containment well in December 1998 through December 2008.[29] The model was deemed reliable for making future predictions and will be used to evaluate the future performance of the containment systems and alternative groundwater extraction schemes.

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[28] The performance of the six on-site infiltration ponds between 2002 and 2004 indicated that four ponds are more than adequate for handling the water pumped by the source containment well. With the approval of the regulatory agencies, Sparton backfilled two of the six ponds in 2005 to put the land to other beneficial use.

[29] This task was carried out in early 2009 as part of the preparation of this 2008 Annual Report.

The off-site containment well continued to provide hydraulic control of the contaminant plume throughout the year. The source containment well that began operating in early 2002 quickly developed a capture zone that controls any potential on-site sources that may be contributing to groundwater contamination.

The extent of groundwater contamination during 2008, as defined by the extent of the TCE plume, was somewhat different than in previous years because the presence of a separate, DCE-dominated plume that did not originate from the Sparton facility was taken into consideration in evaluating the water-quality data. Of 55 wells sampled both in November 2007 and 2008, the 2008 concentrations of TCE were lower than in 2007 in 25 wells, higher in 8 wells, and remained the same in 22 wells (21 below detection limits). Well MW-60, at 4,800 μg/L continued to be the most contaminated off-site well. The corresponding results for DCE were 14 wells with lower, 5 wells with higher, and 36 wells with the same (all below detection limits) concentrations. The TCA plume ceased to exist during 2003, and this condition continued through 2008, that is, throughout the year there were no wells with TCA concentrations above the maximum allowable concentration in groundwater set by the NMWQCC.

Changes in concentrations observed in monitoring wells since the implementation of the current remedial measures indicate that contaminant concentrations in the on-site area decreased significantly. Concentrations in most off-site wells have also decreased, or remained unchanged (below detection limits). The only wells where significant increases occurred are the off-site containment well CW-1, and on-site monitoring well MW-19. The concentrations of contaminants in the water pumped from CW-1 rapidly increased after the start of its operation and remained high since then. The high concentrations in this well and in well MW-60 indicated that areas of high concentration existed upgradient from both of these wells; however, most of the groundwater upgradient from these wells has been captured by CW-1 and concentrations both in CW-1 and MW-60 have begun a declining trend.

The off-site and source containment wells operated at a combined average rate of 266 gpm during 2008. A total of about 140.1 million gallons of water were pumped from the wells. The total volume of water pumped since the beginning of the current remedial operations on December 1998 is about 1.332 billion gallons and represents 118 percent of the initial volume of contaminated groundwater (pore volume).

A total of 468 kg (1,030 lbs) of contaminants consisting of 433 kg (955 lbs) of TCE, 32.6 kg (71.8 lbs) of DCE, and 1.13 kg (2.50 lbs) of TCA were removed from the aquifer by the two containment wells during 2008. The total mass that was removed since the beginning of the of the current remedial operations is 5,460 kg (12,050 lbs) consisting of 5,130 kg (11,310 lbs) of TCE, 315 kg (694 lbs) of DCE, and 15.0 kg (33.1 lbs) of TCA. This represents about 78 percent of the total dissolved contaminant mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment well.

Deep Flow Zone (DFZ) monitoring well MW-67 and well MW-79, which was installed in 2006 to address the continuing presence of contaminants in DFZ monitoring well MW-71R, continued to be free of any site-related contaminants throughout 2008. Well MW-71R continued to be contaminated; however, TCE concentrations in the well have a declining trend and were down to 52 µg/L in November 2008. The absence of any contaminants in MW-67 and MW-79, and the declining concentrations in MW-71R indicate that the contamination in DFZ represents a contaminated groundwater slug of limited extent. Concentration trends in MW-71R will be closely monitored in the next few years to assess if there is a need for further action.

The containment systems were shutdown several times during 2008 for routine maintenance activities, due to power and monitoring system failures, due to low levels in the chemical feed tanks, or due to the failure of other components of the systems. The downtime for these shutdowns ranged from 20 minutes to about 53 hours. Evaluation of migration rates in the aquifer indicates that the systems could be down for significantly much longer periods without affecting the capture of the contaminant plume.

7.2 Future Plans

The off-site and source containment systems will continue to operate during 2009. Data collection will continue in accordance with the Monitoring Plan and the Discharge Permit, and as necessary for the evaluation of the performance of the remedial systems. The recalibrated flow and transport model will be used to predict the future performance of the existing containment systems, and evaluate alternative containment systems that may be cost-effective in accelerating aquifer restoration. Alternate remedial technologies will also be evaluated with respect to their applicability to the Sparton site. The results of these predictions and evaluations, and any conclusions and recommendations that may evolve from them will be presented in a separate report to be issued by September 30, 2009.

Monitoring well MW-33 which was dry during the last several years will be plugged and abandoned as approved by USEPA and NMED. Also as approved by USEPA and NMED the collection of annual samples from monitoring wells for DO and ORP analyses will be discontinued in 2009. Shallow monitoring wells MW-9, MW-13, MW-18, MW-48, MW-57, MW-58, and MW-61 which were either dry during one or more quarters of 2008 or which did not have sufficient water for sampling during 2008 will continue to be monitored during 2009 to assess whether they should be abandoned, and if abandoned, whether they should be replaced

A new monitoring well, MW-80, will be installed northwest and outside the capture zone of the off-site containment well, CW-1, as soon as an available vacant lot has been identified along Cardinal Street, agreement has been reached with USEPA and NMERD on the suitability of the available location and on the screened interval of the well, and all necessary easements and permits have been obtained..

The Fact Sheet for 2002 through 2006, which was approved by USEPA and NMED in May 2009, will be distributed to the property owners located above the plume and adjacent to the off-site treatment plant water discharge pipeline.

Concentrations of TCA in all monitoring and containment wells at the site have been below the regulatory limit of 60   since 2003; the highest concentration during 2008 was 12 in well MW-60. It is proposed that evaluation of TCA data be discontinued in future Annual Reports, unless TCA is detected above the regulatory limit in any well during that year.

Regulatory agencies will continue to be kept informed of any significant milestones or changes in remedial system operations. The goal of the systems will continue to be the return of the contaminated groundwater to beneficial use.

Section 8
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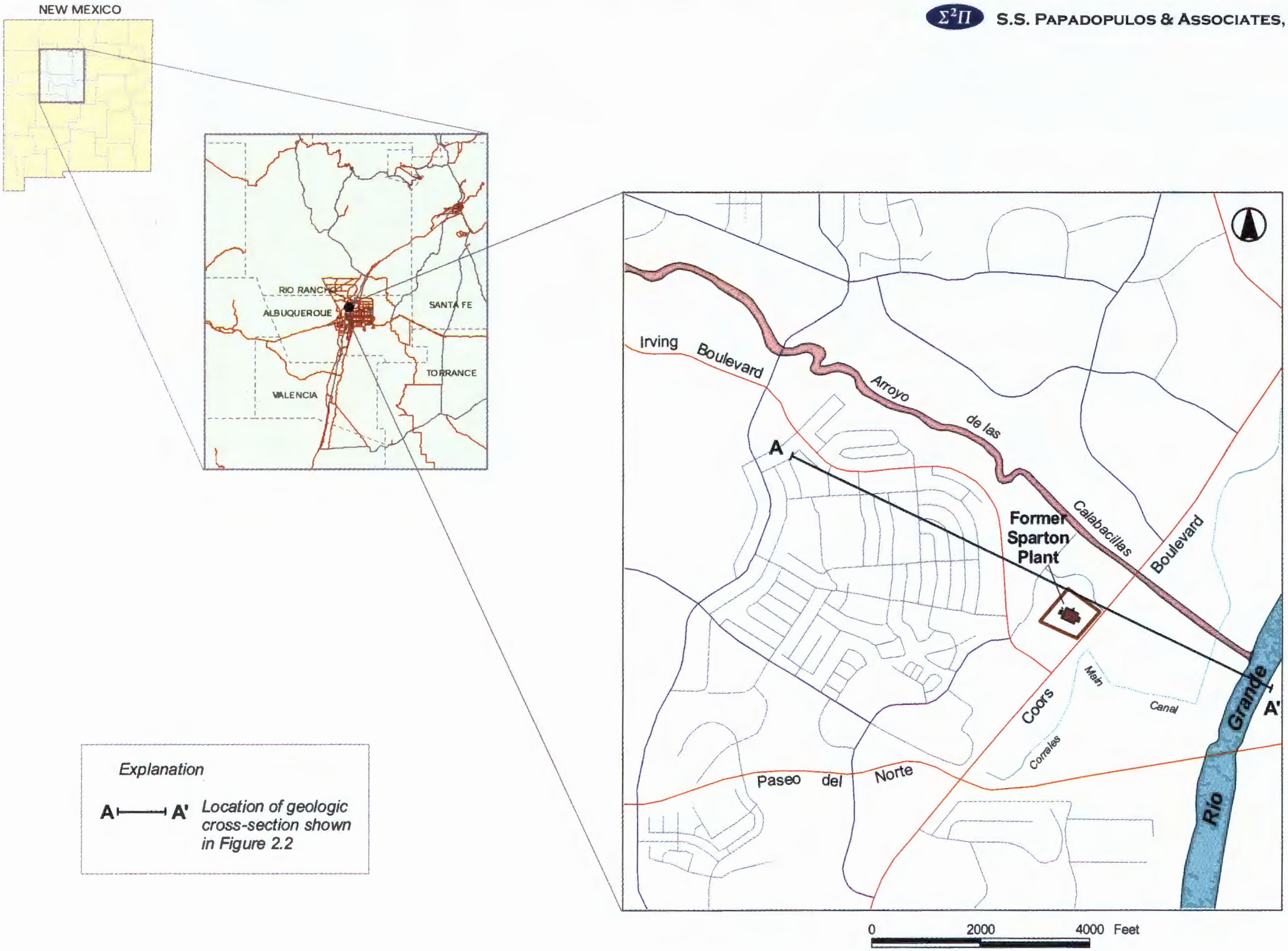


Figure 1.1 Location of the Former Sparton Coors Road Plant

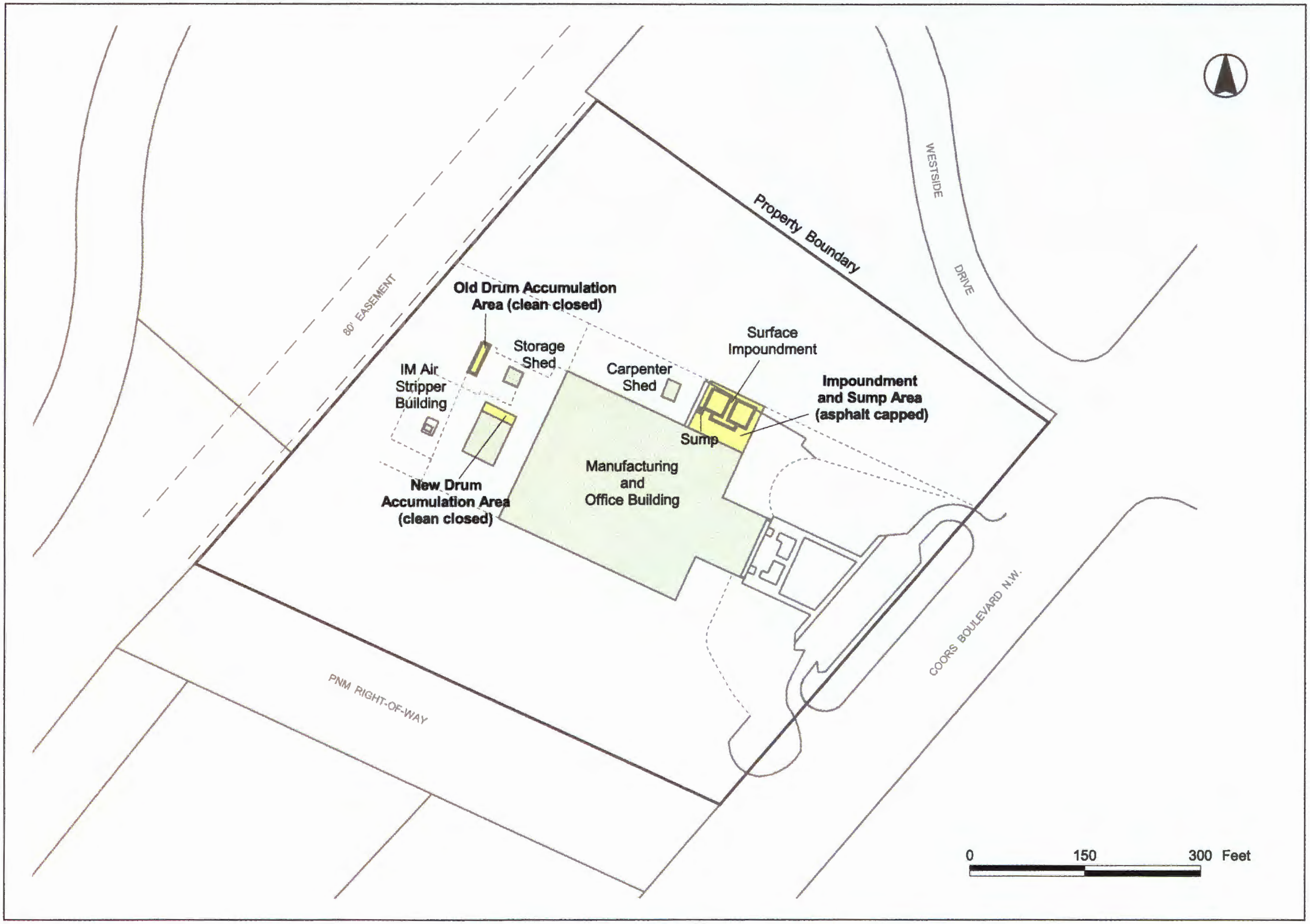
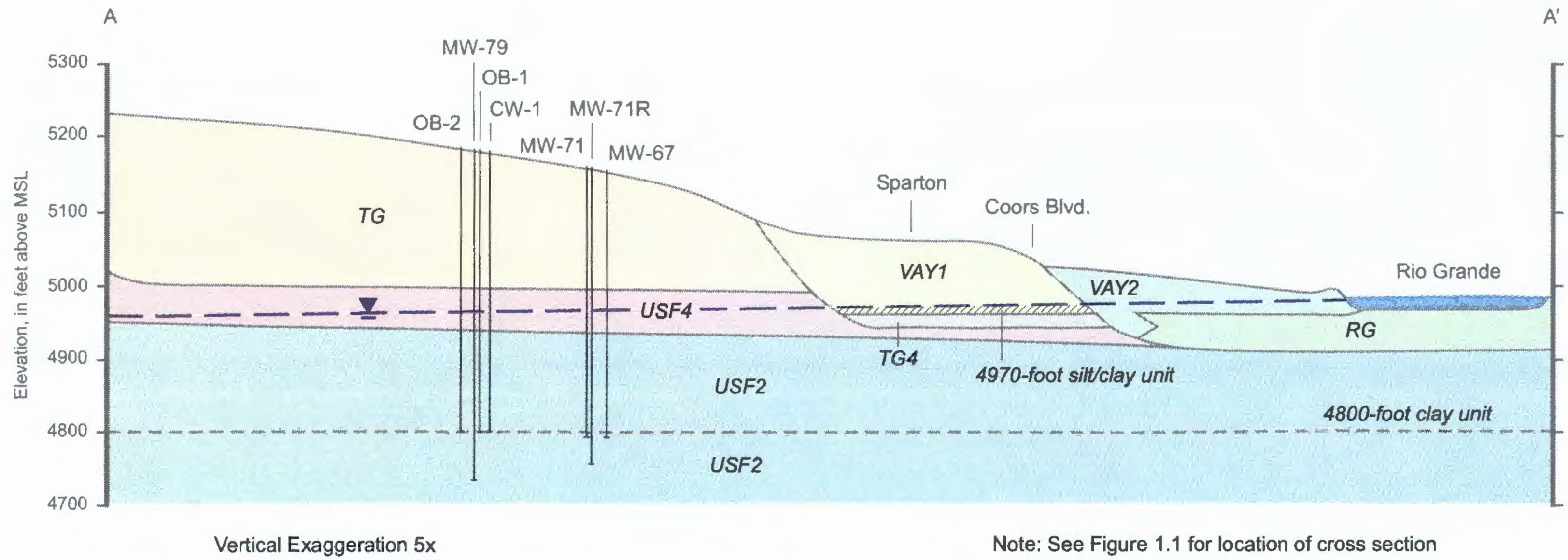


Figure 2.1 The Former Sparton Coors Road Plant



Explanation

RG	Holocene channel and flood plain deposits	*TG*	Middle Pleistocene undifferentiated deposits
VAY2	Holocene arroyo fan and terrace deposits	*USF4*	Pliocene Upper Santa Fe Group Western Basin fluvial facies
VAY1	Late Pleistocene arroyo fan and terrace deposits	*USF2*	Pliocene Upper Santa Fe Group Rio Grande facies
TG4	Late Pleistocene channel and flood plain deposits, upper portion is the 4970-foot silt/clay unit		

Figure 2.2 Geologic Cross Section Showing Shallow Deposits

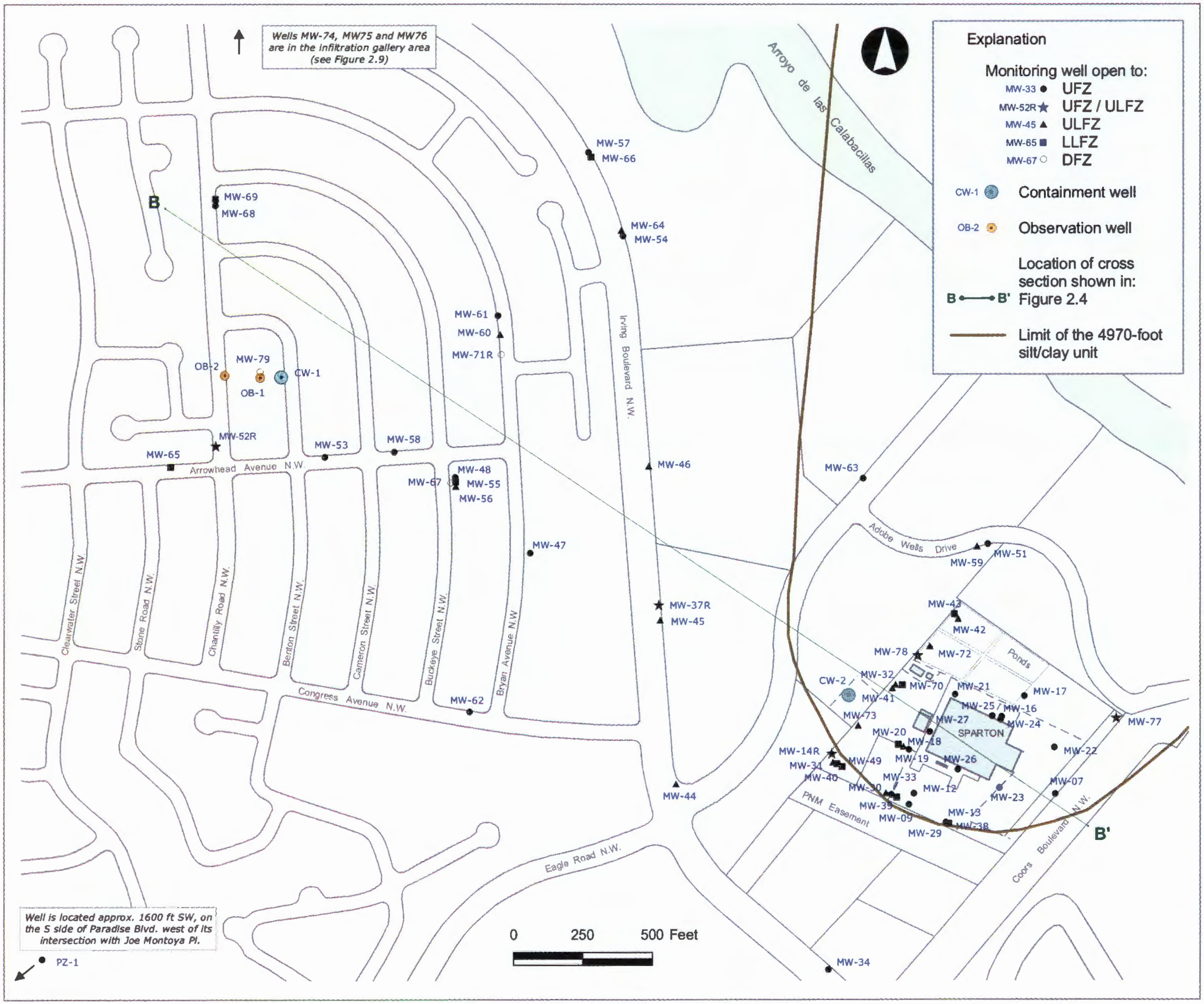


Figure 2.3 Location of Wells

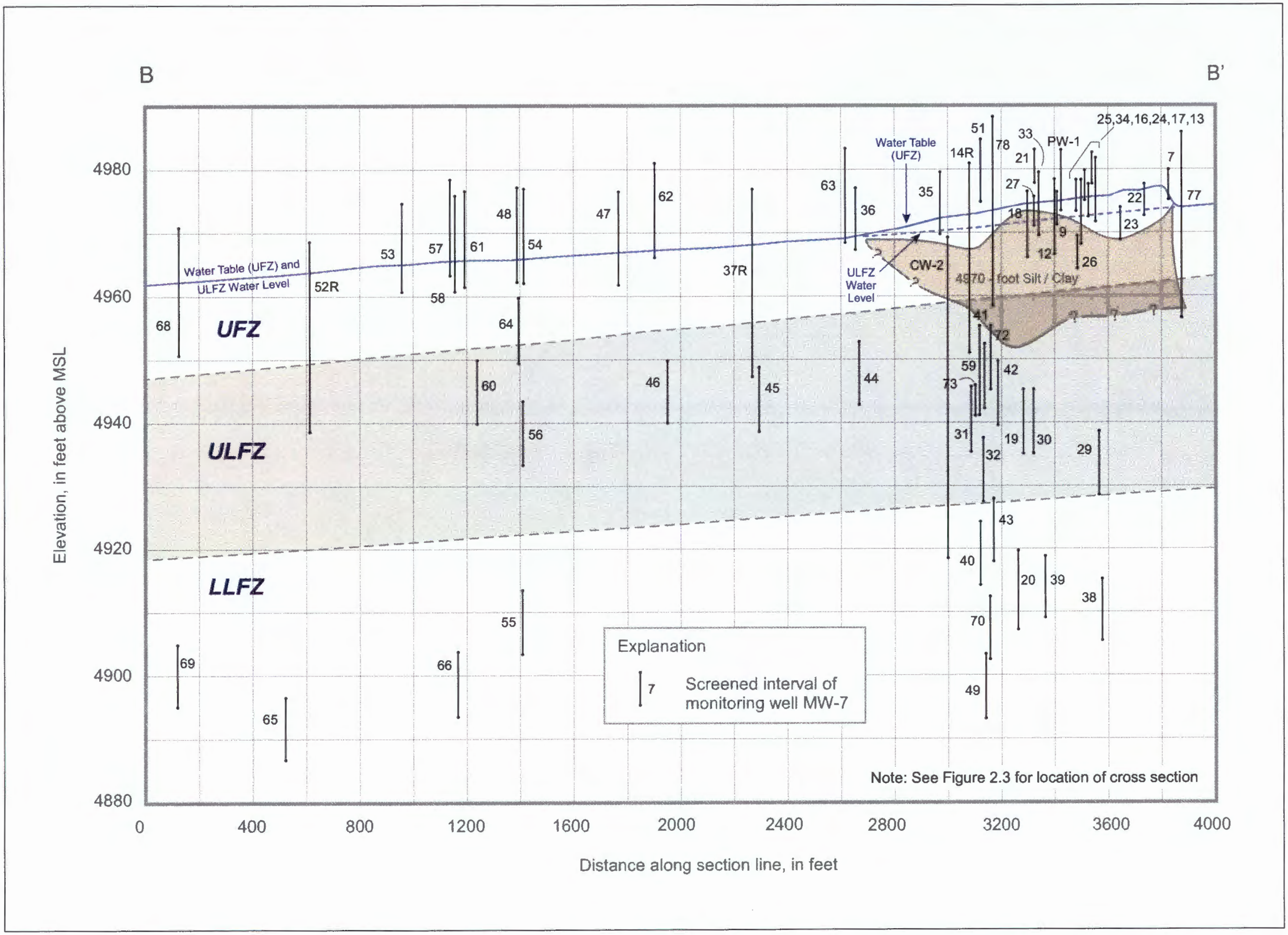


Figure 2.4 Schematic Cross-Section Showing Screened Interval of Monitoring Wells and Relation to Flow Zones

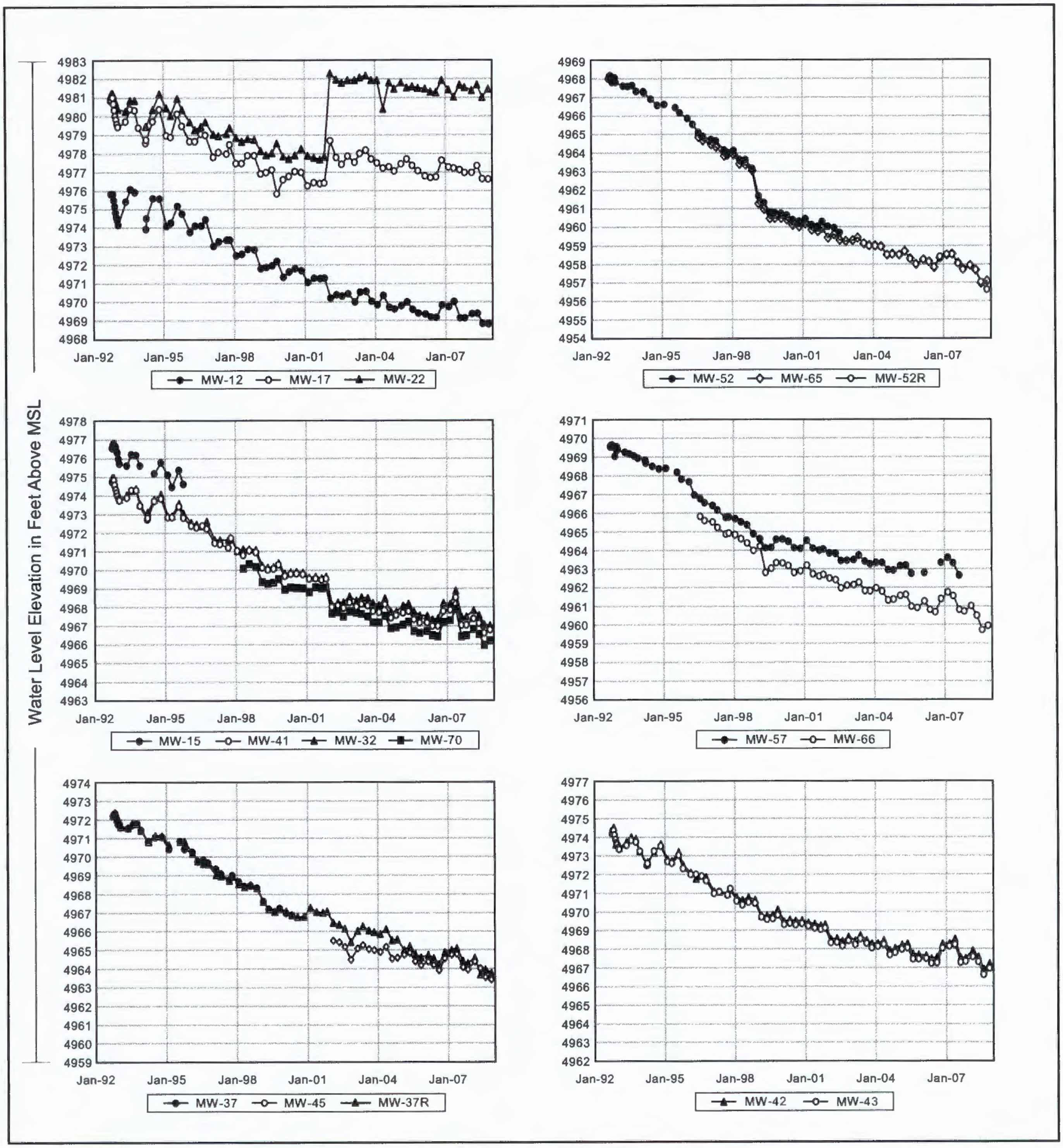


Figure 2.5 Monitoring Well Hydrographs

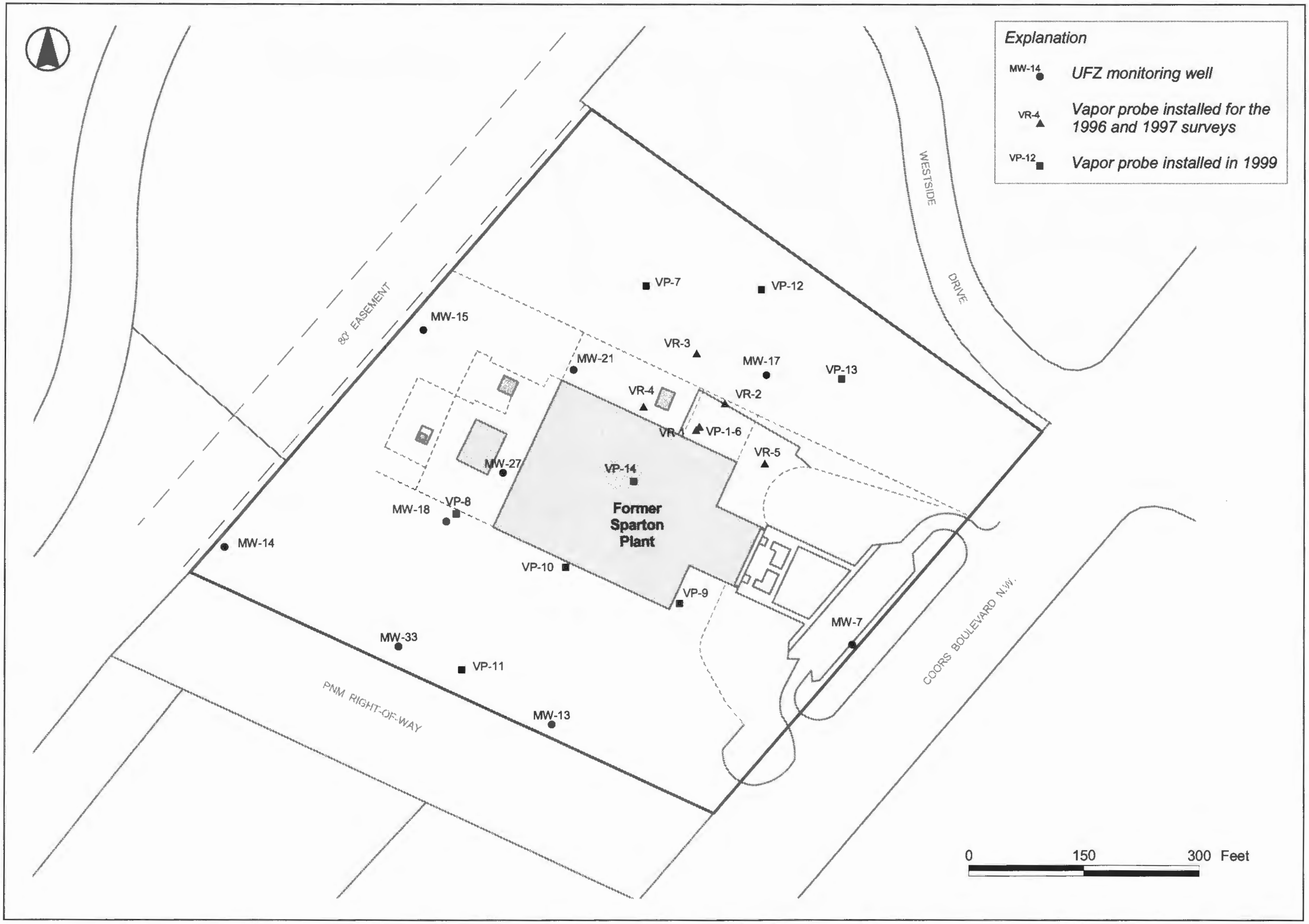


Figure 2.6 Location of Vapor Probes and On-Site Monitoring Wells Used in Vadose Zone Characterizations

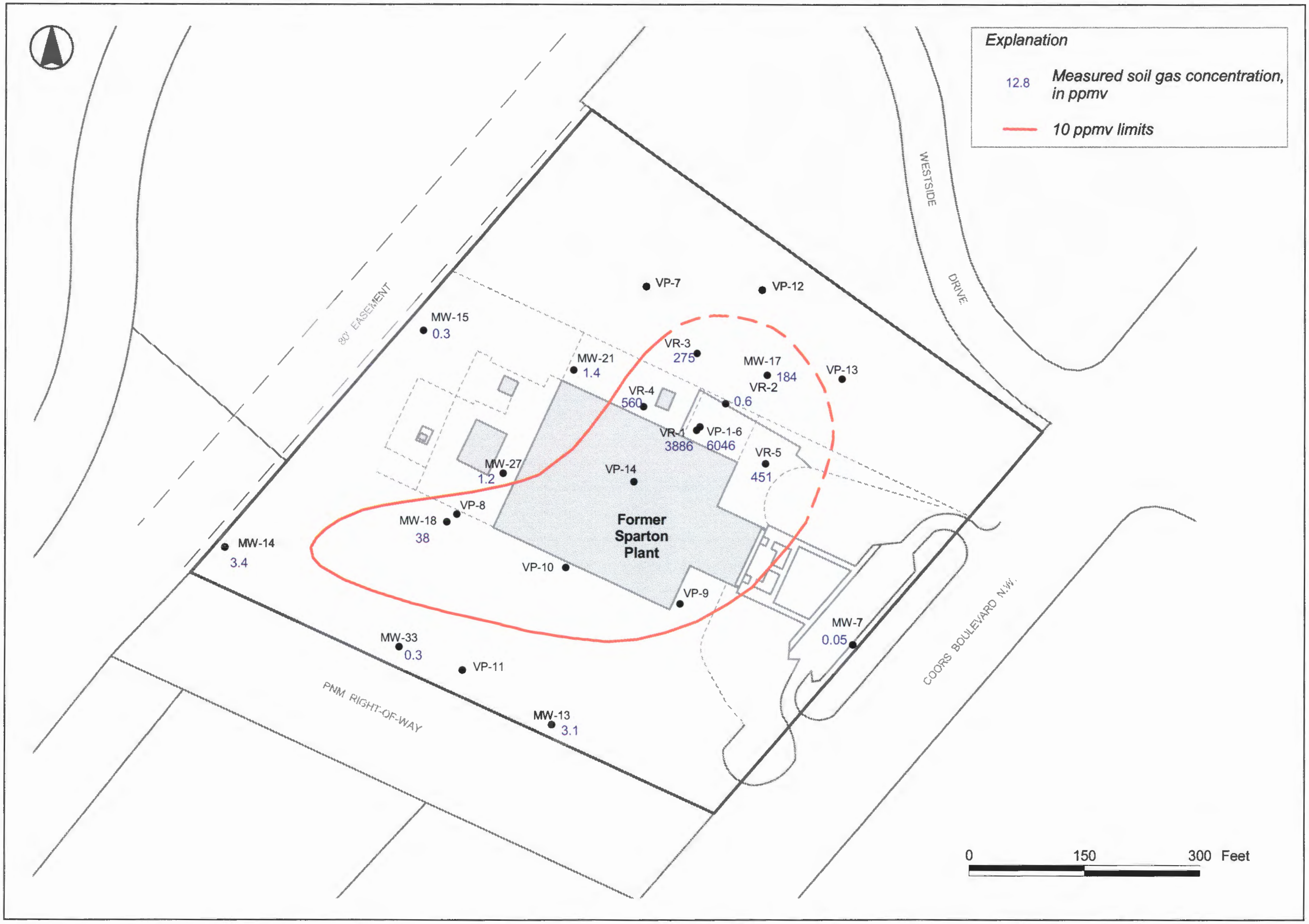


Figure 2.7 TCE Concentrations in Soil Gas - April 1996 - February 1997 Survey

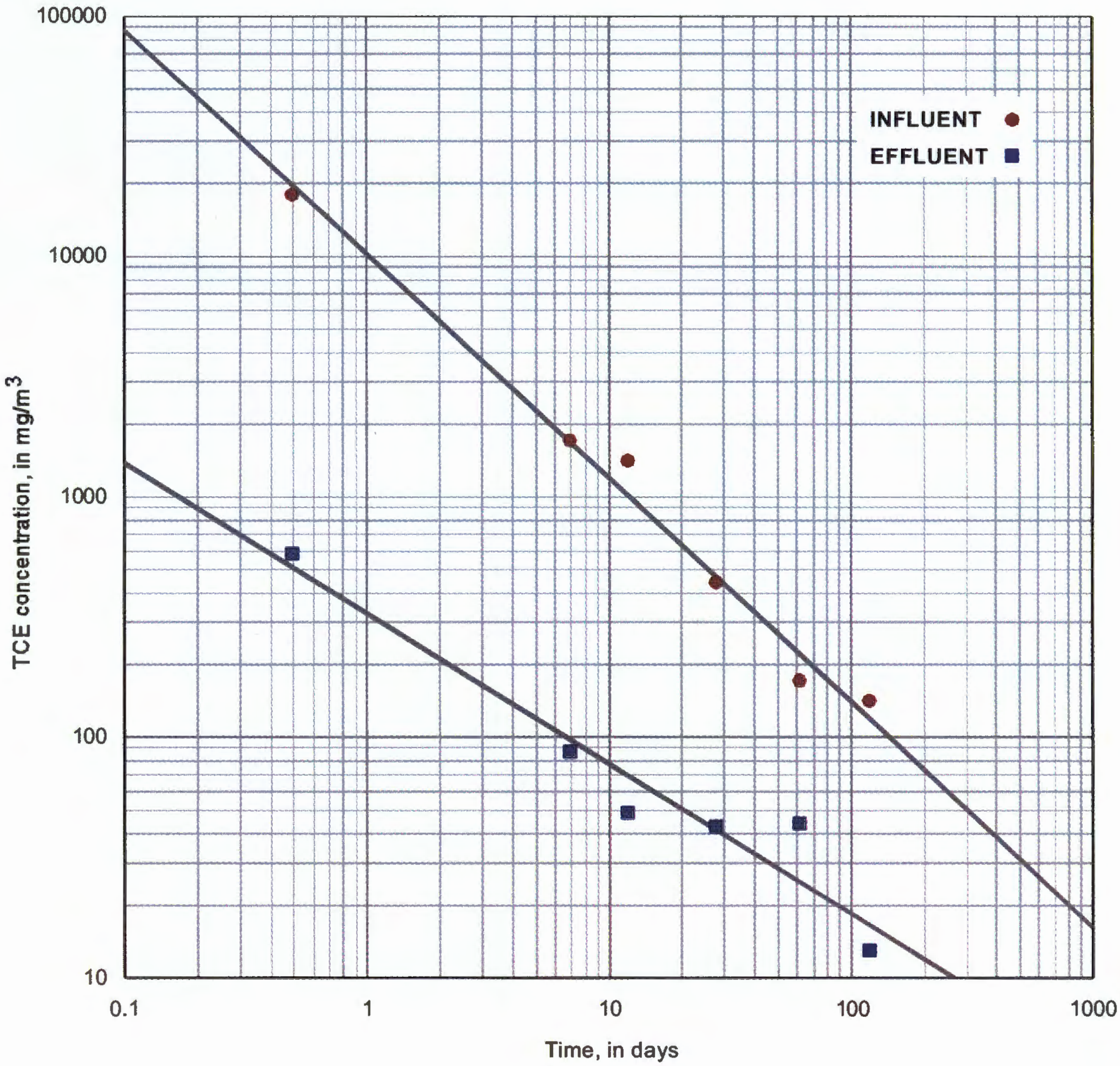


Figure 2.8 Influent and Effluent Concentrations - SVE Operation
April 8 - October 20, 1998

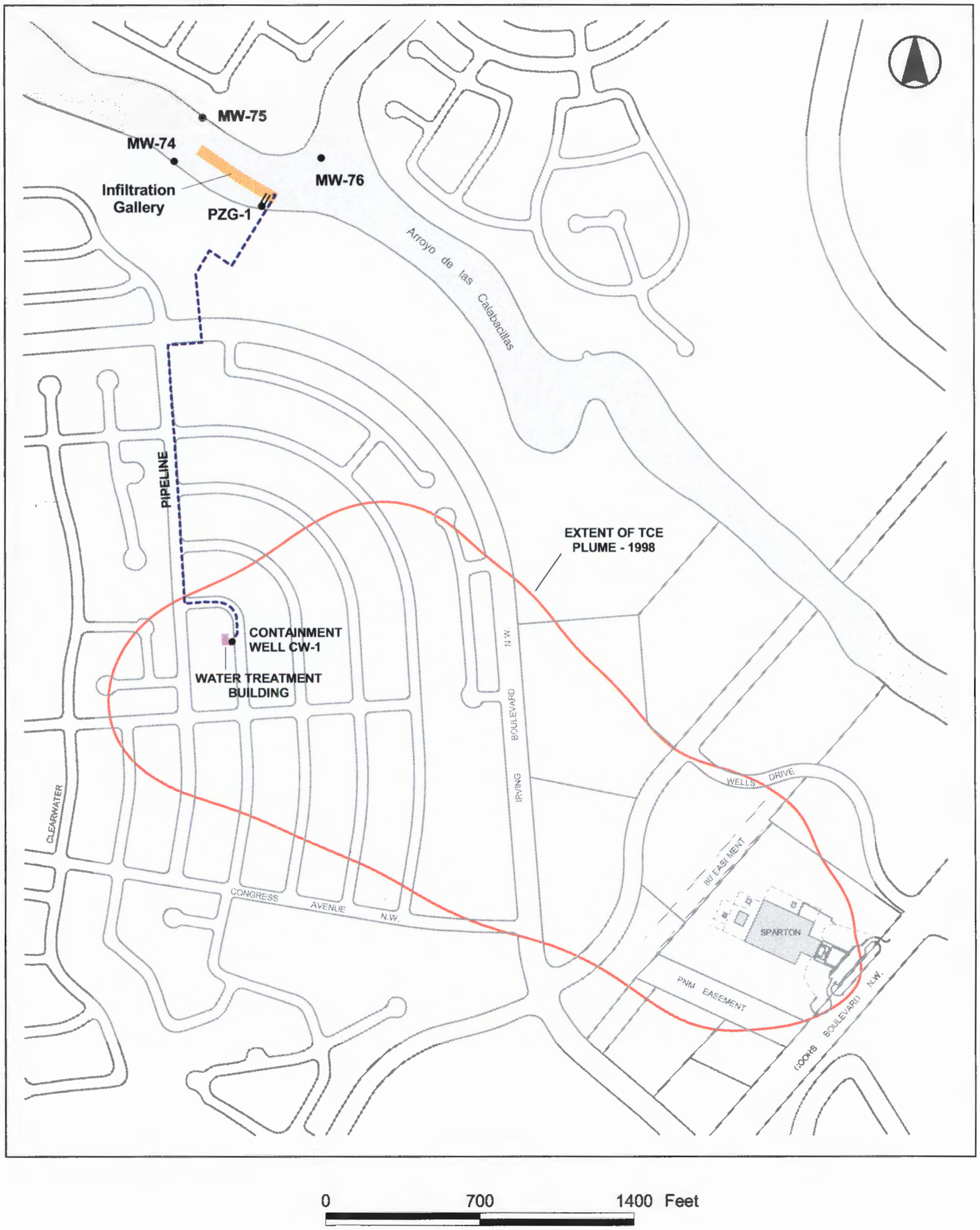


Figure 2.9 Layout of the Off-Site Containment System Components

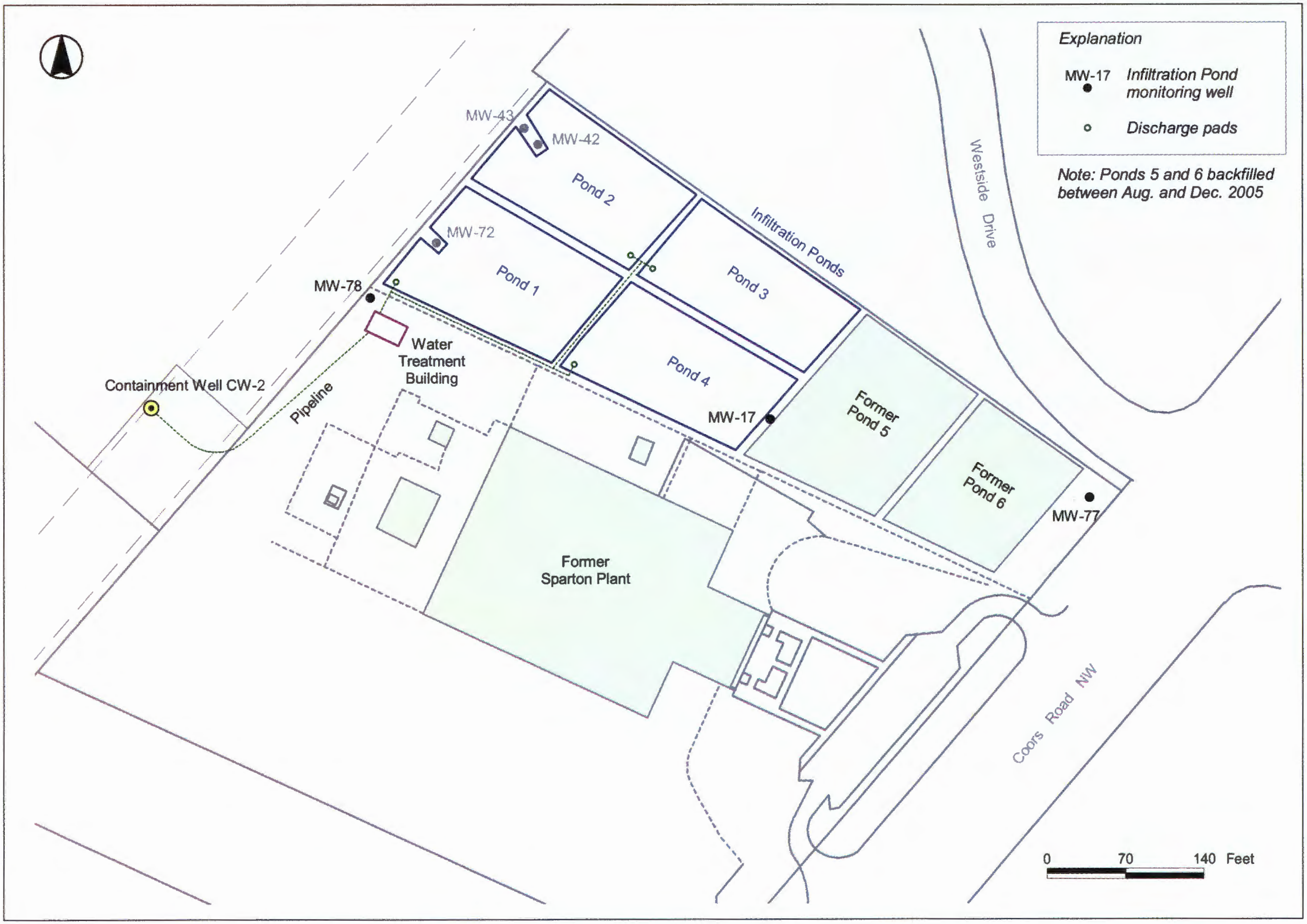


Figure 2.10 Layout of the Source Containment System Components

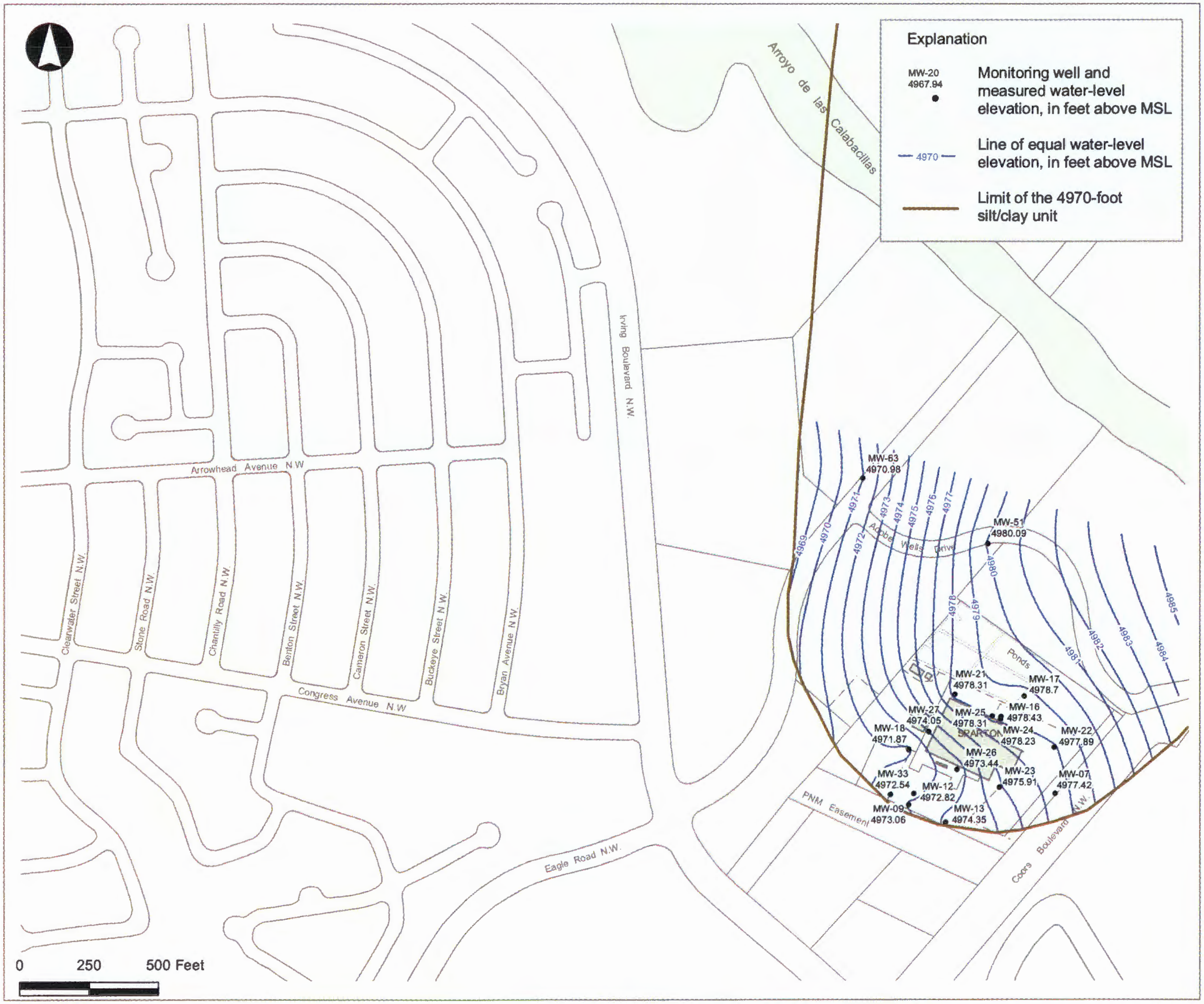


Figure 2.11 Elevation of the On-Site Water Table - November 1998

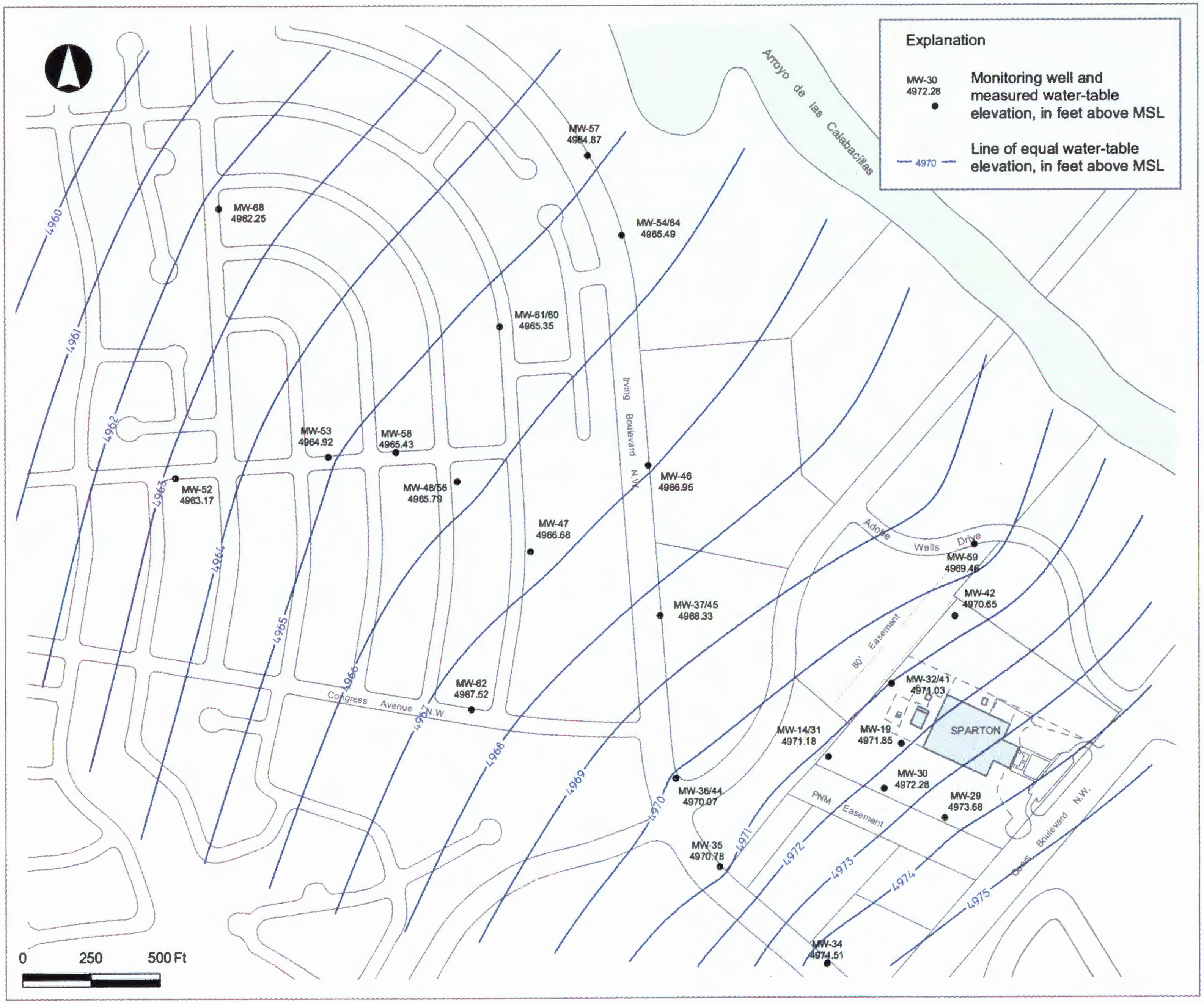


Figure 2.12 Elevation of the Water Levels in the UFZ/ULFZ - November 1998

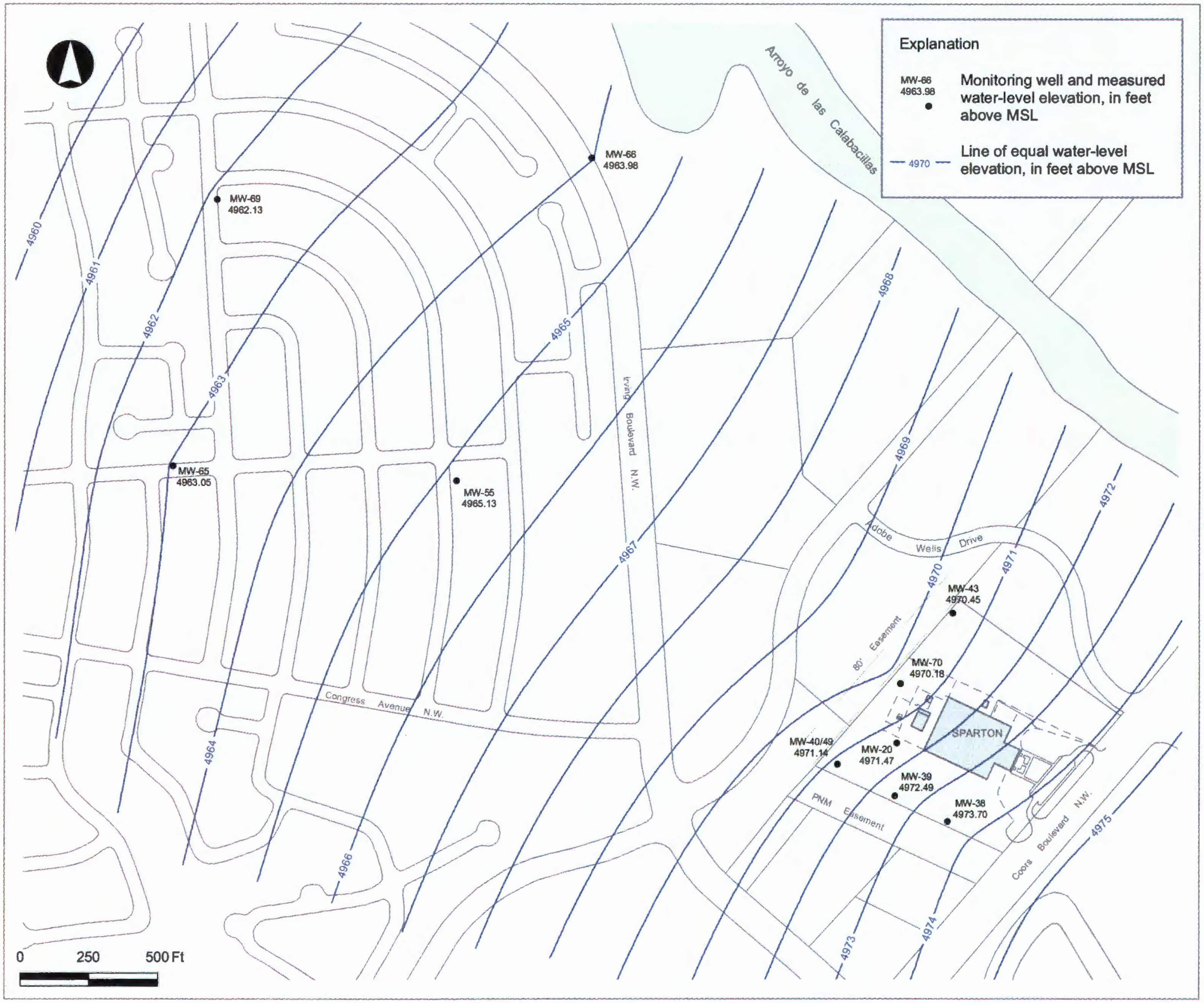


Figure 2.13 Elevation of the Water Levels in the LLFZ - November 1998

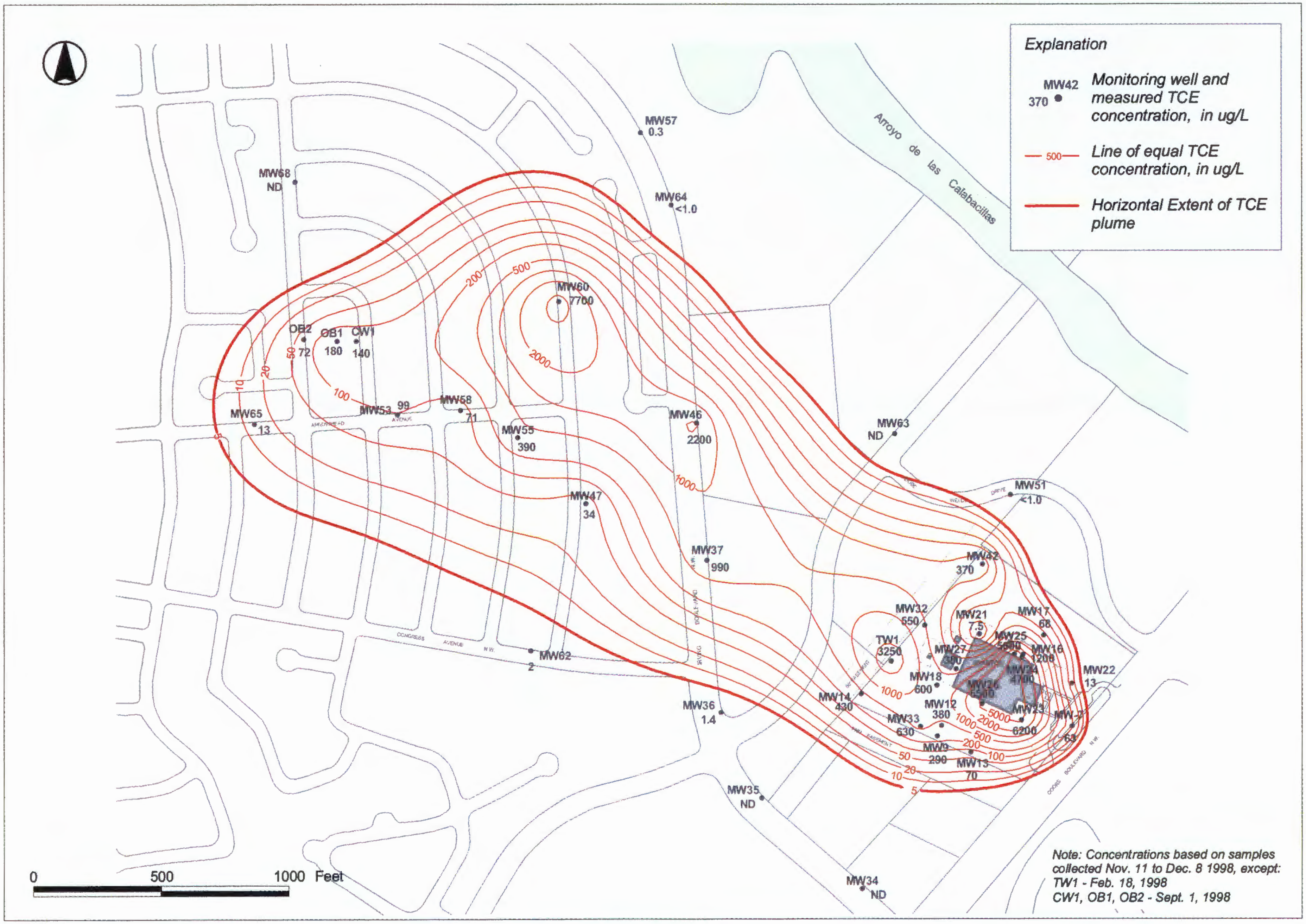


Figure 2.14 Horizontal Extent of TCE Plume - November 1998

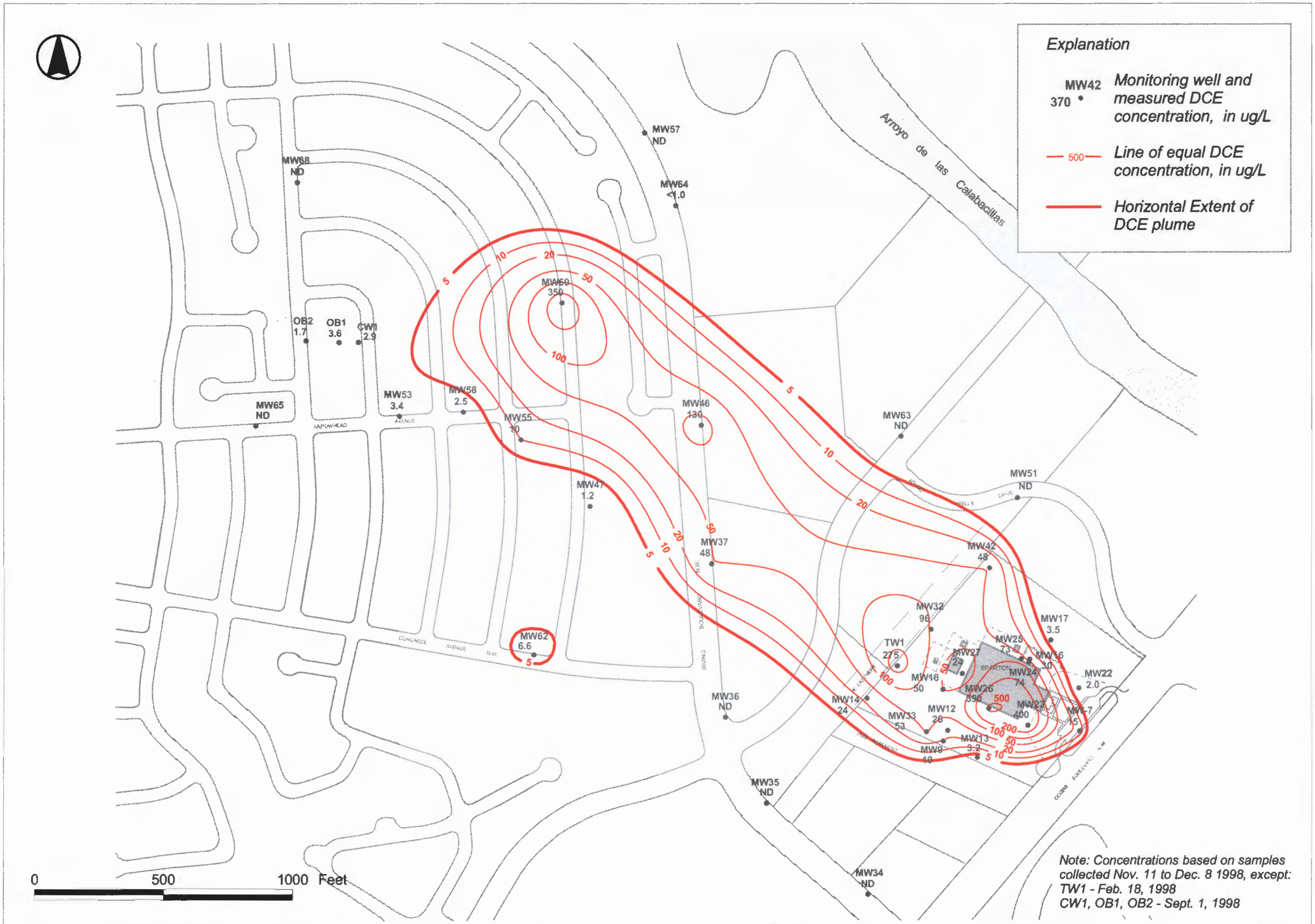


Figure 2.15 Horizontal Extent of DCE Plume - November 1998

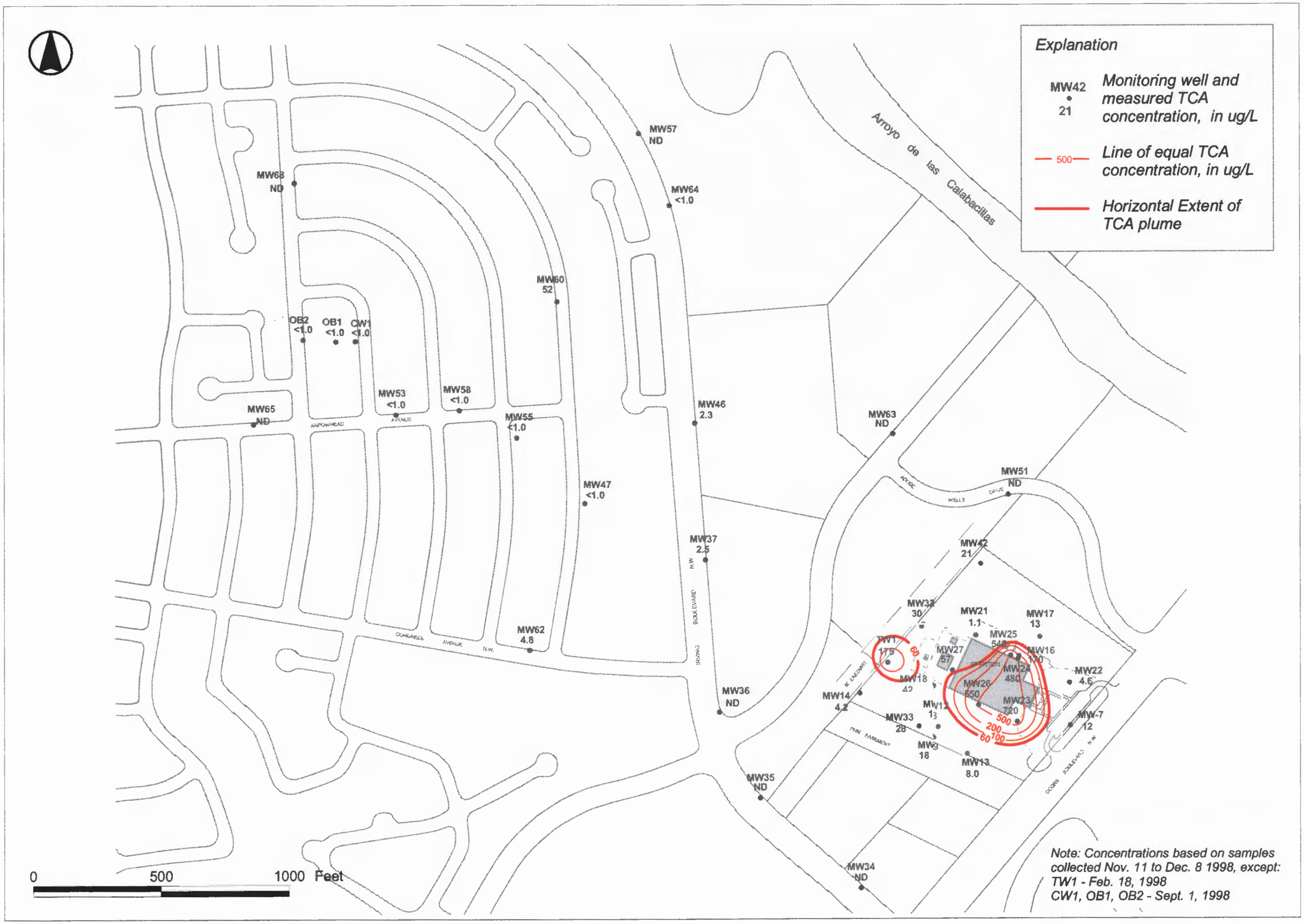


Figure 2.16 Horizontal Extent of TCA Plume - November 1998

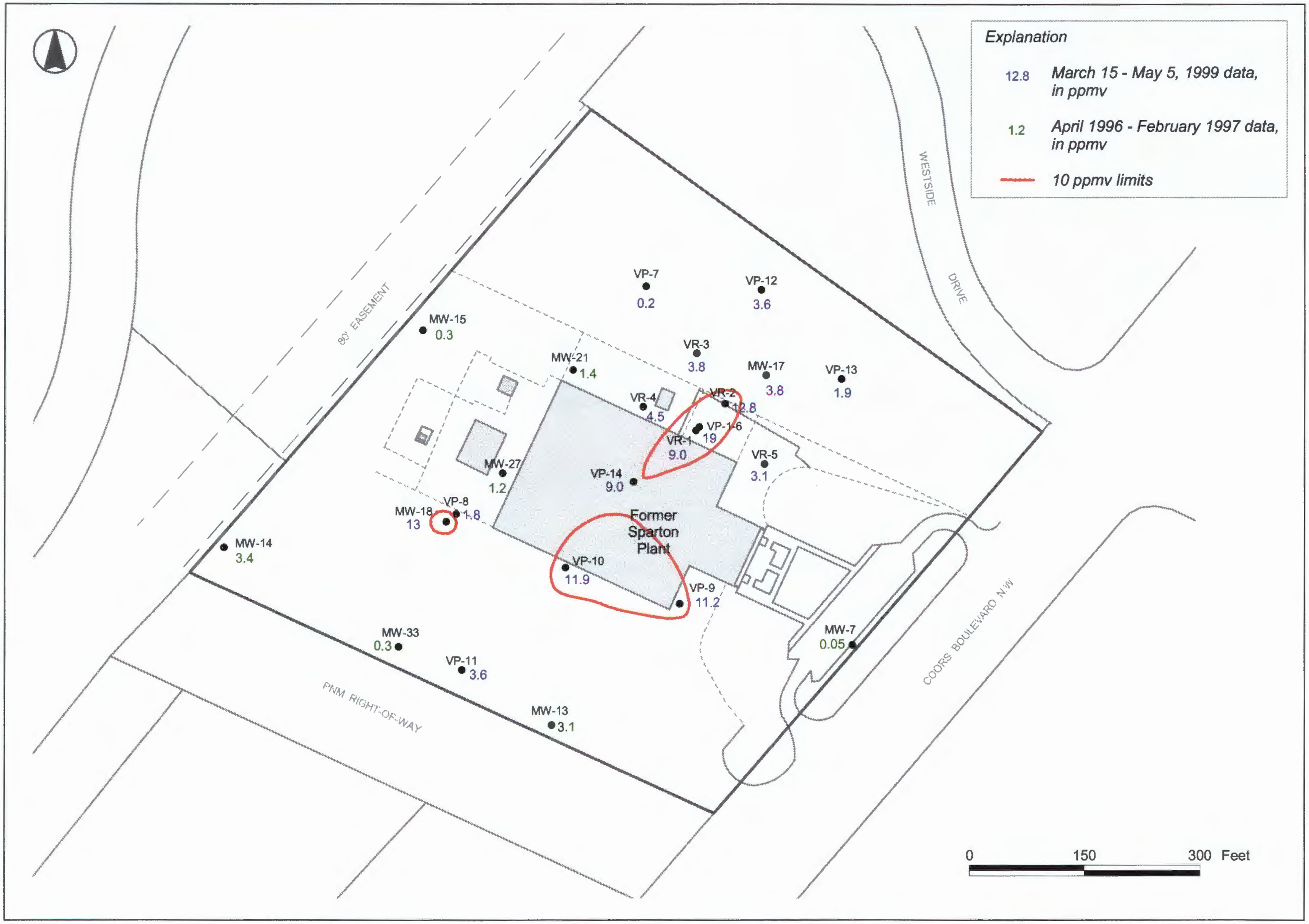


Figure 2.17 TCE Soil Gas Concentrations Prior to the 1999 Resumption of SVE System Operations

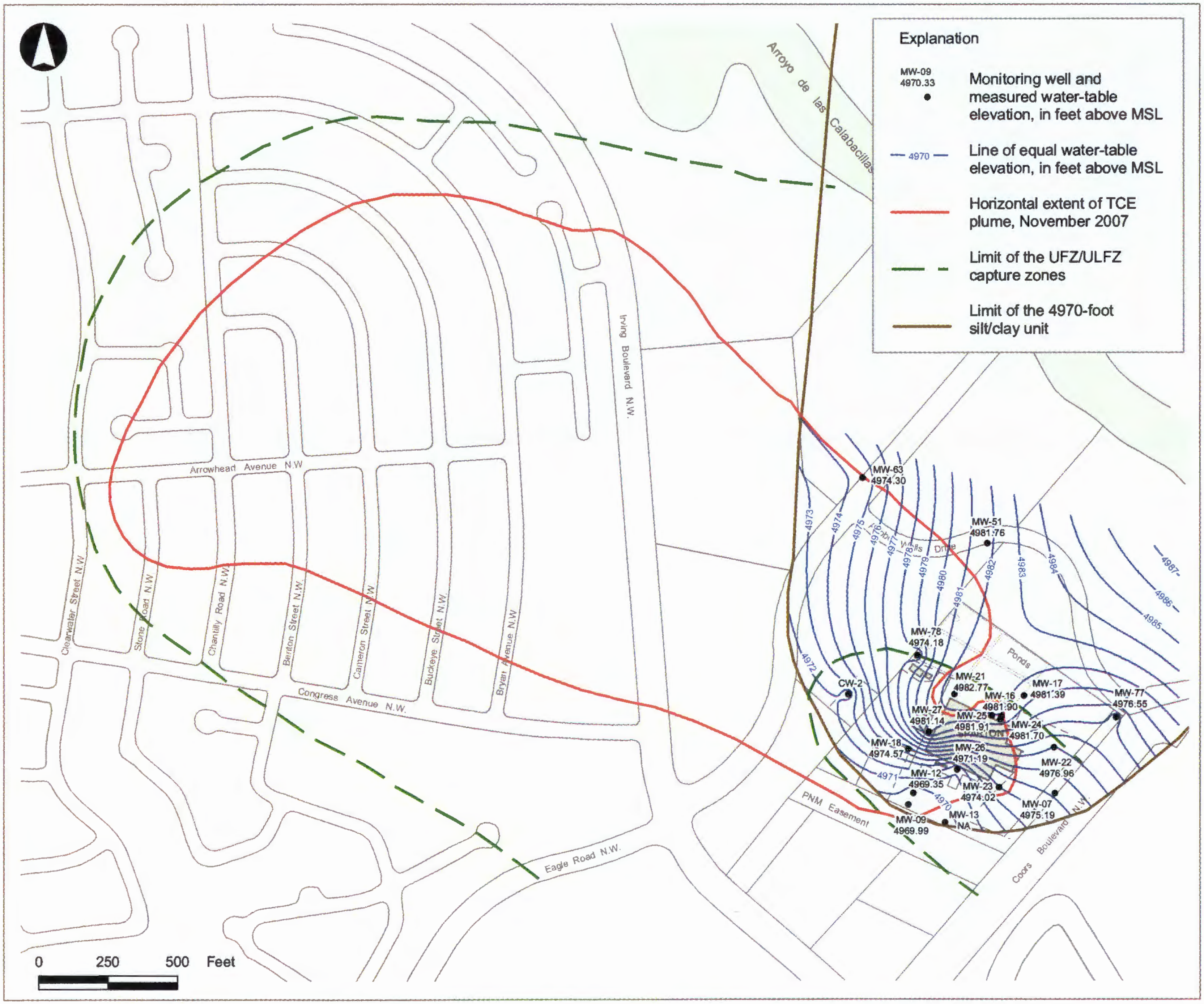


Figure 5.1 Elevation of the On-Site Water Table - February 19, 2008

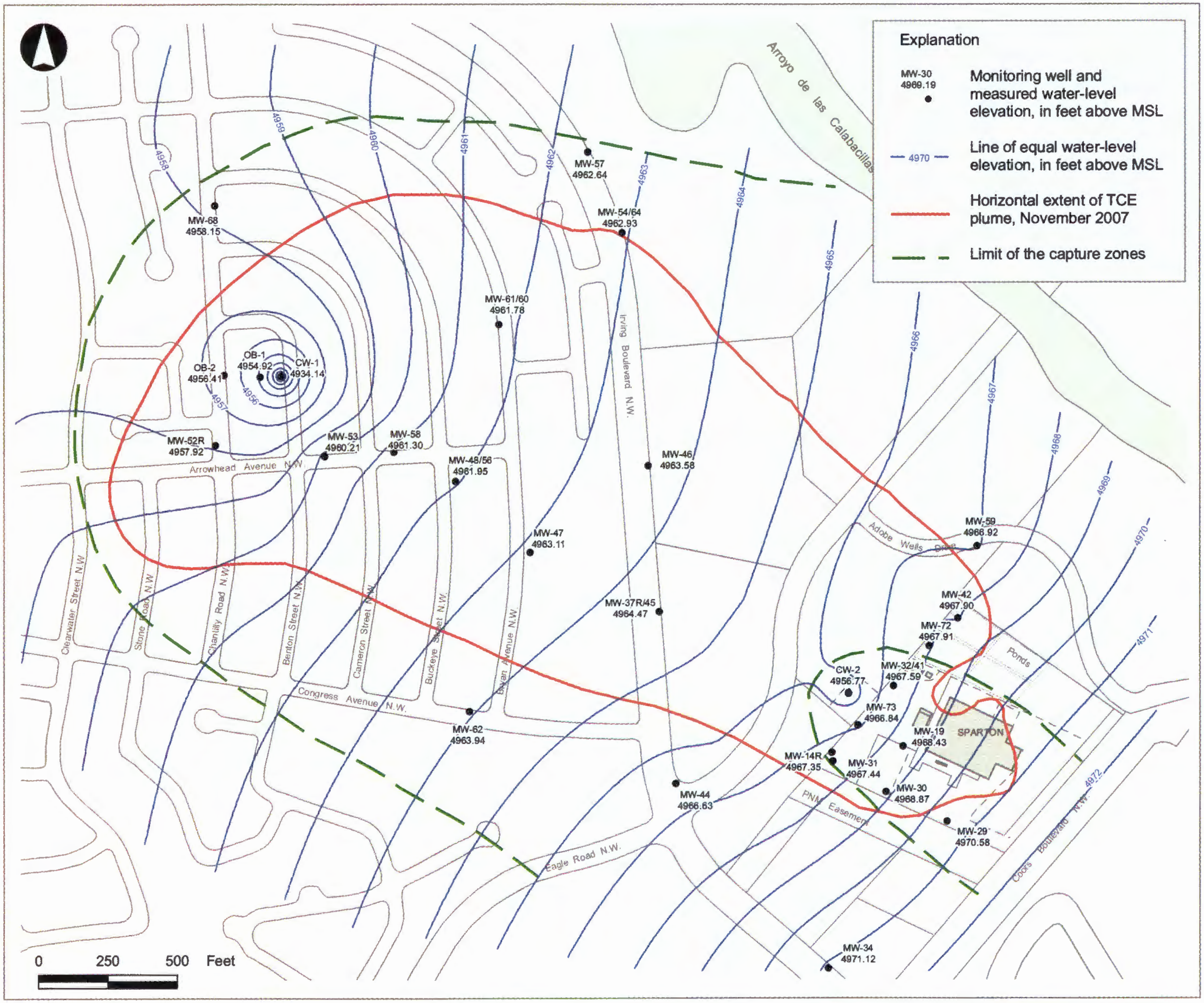


Figure 5.2 Elevation of Water Levels and Limits of Containment Well Capture Zones in the UFZ/ULFZ - February 19, 2008

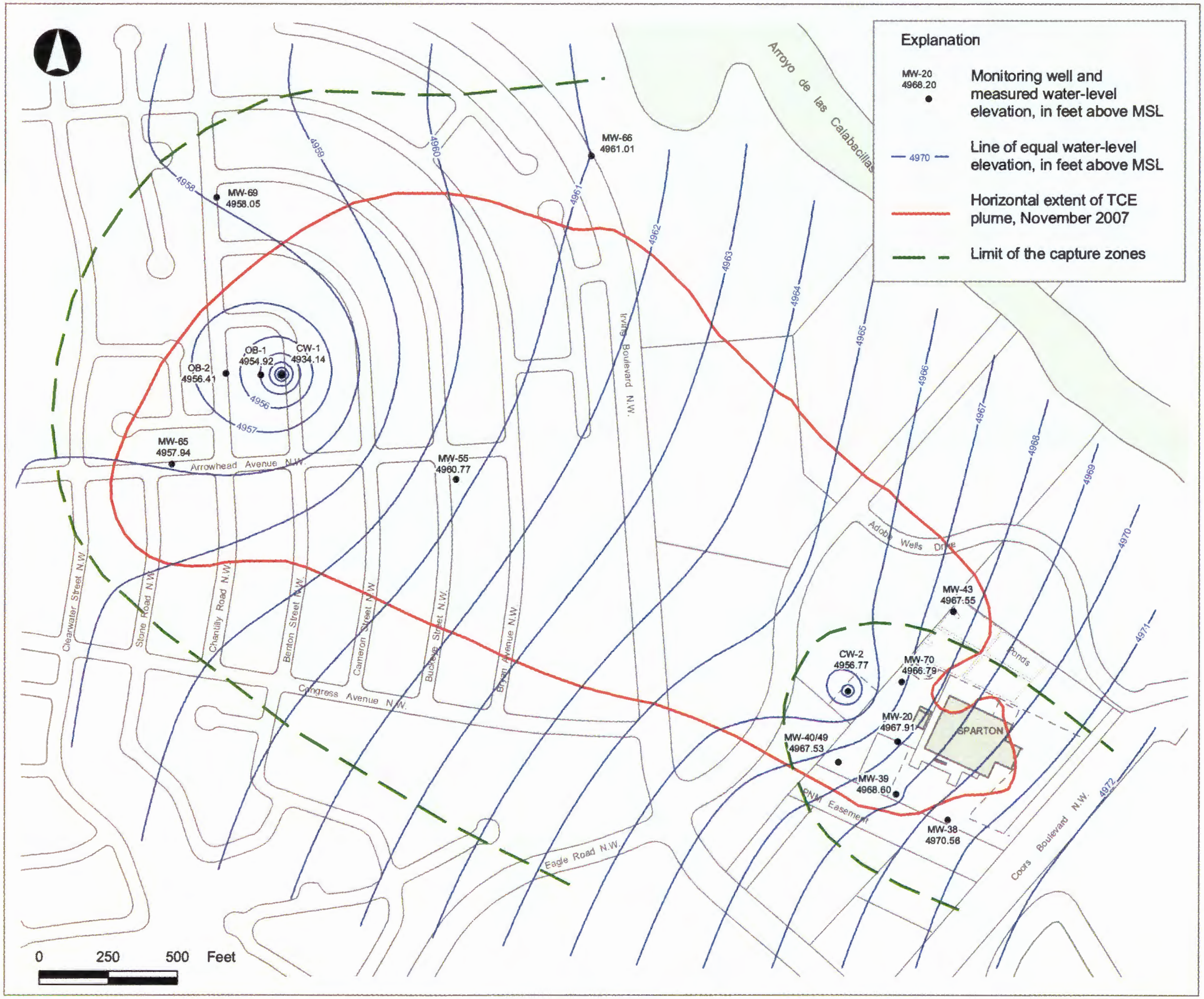


Figure 5.3 Elevation of Water Levels and Limits of Containment Well Capture Zones in the LLFZ - February 19, 2008

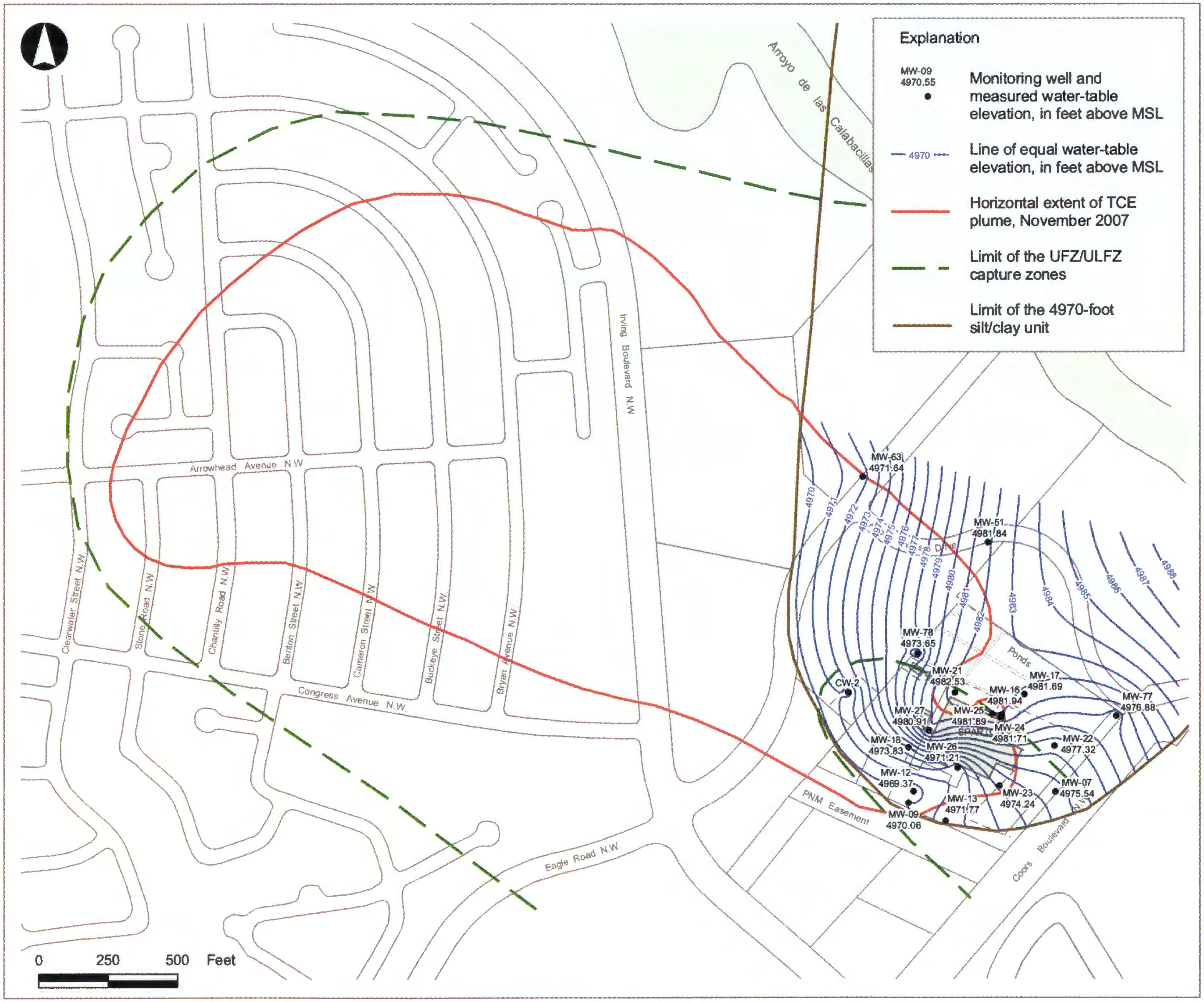


Figure 5.4 Elevation of the On-Site Water Table - May 13, 2008

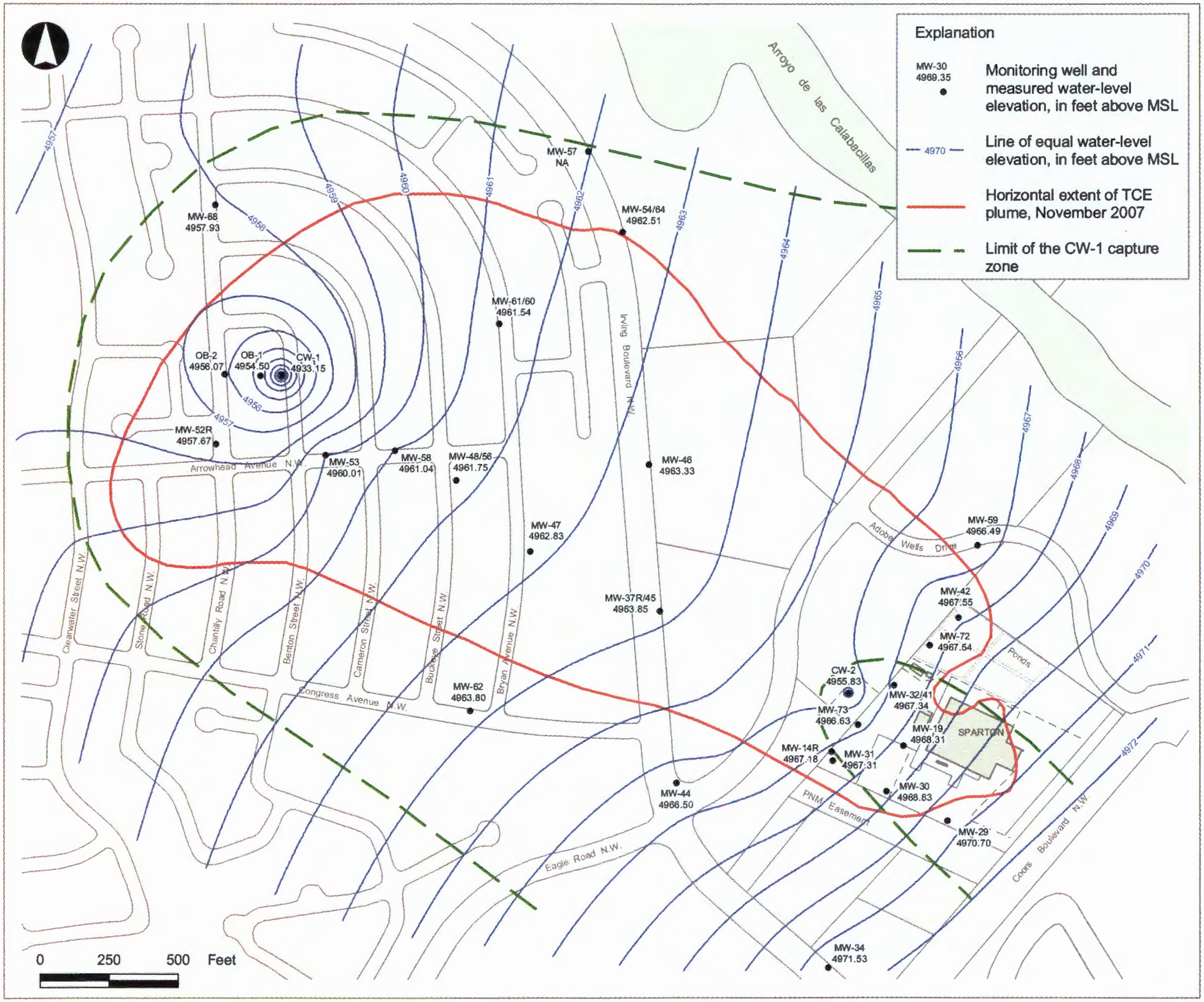


Figure 5.5 Elevation of Water Levels and Limits of Off-Site Containment Well Capture Zone in the UFZ/ULFZ - May 13, 2008

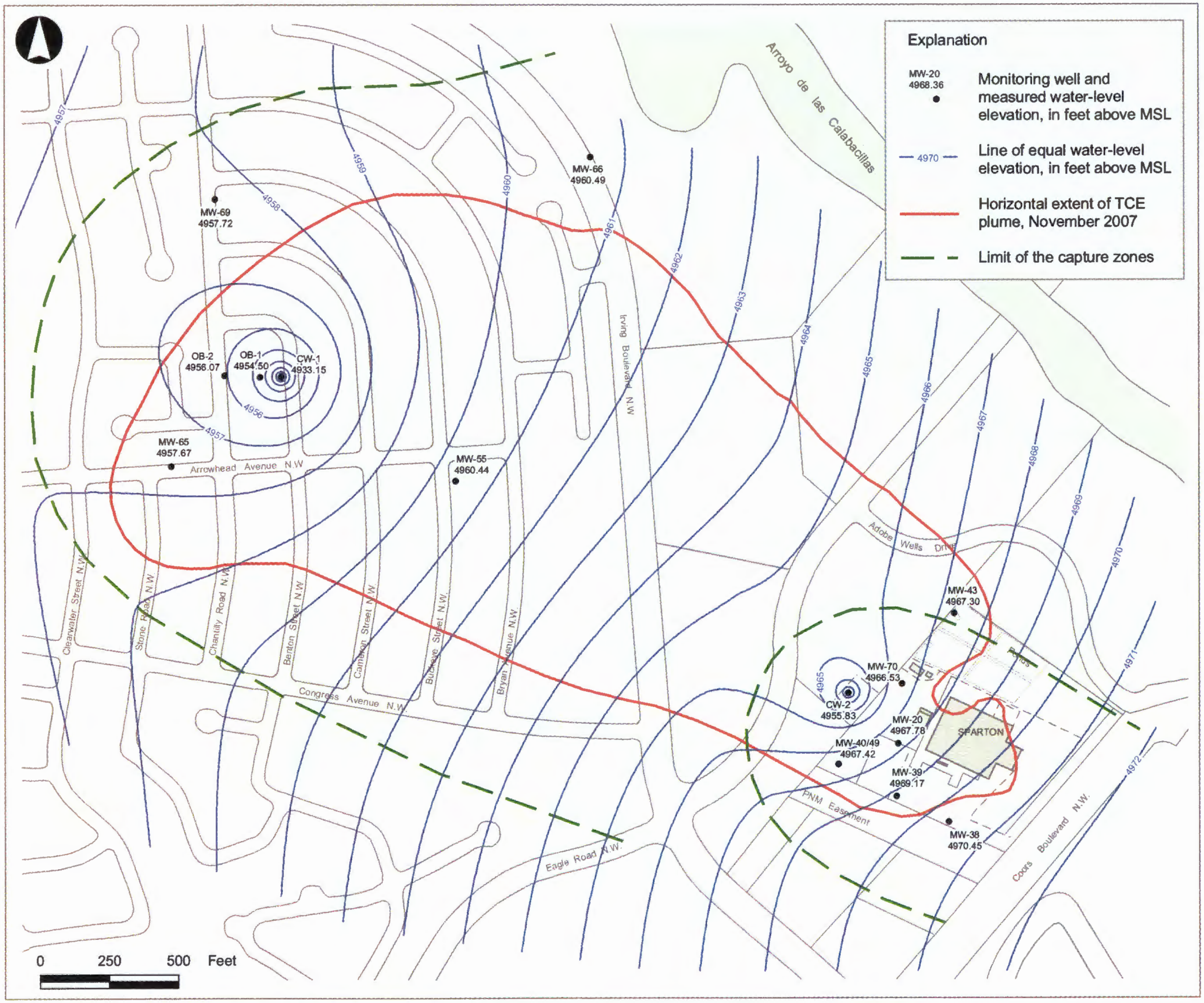


Figure 5.6 Elevation of Water Levels and Limits of Off-Site Containment Well Capture Zone in the LLFZ - May 13, 2008

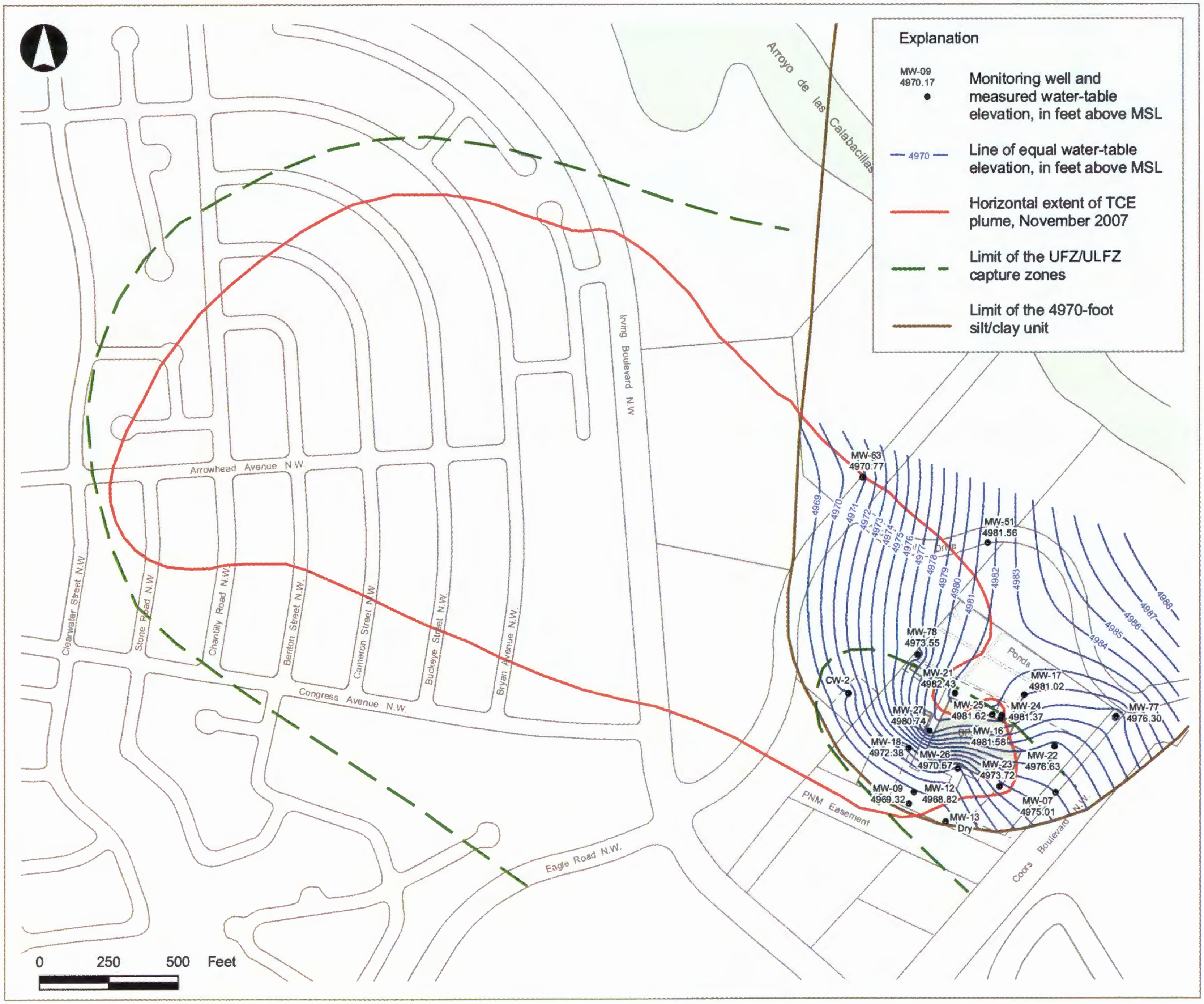


Figure 5.7 Elevation of the On-Site Water Table - August 4, 2008

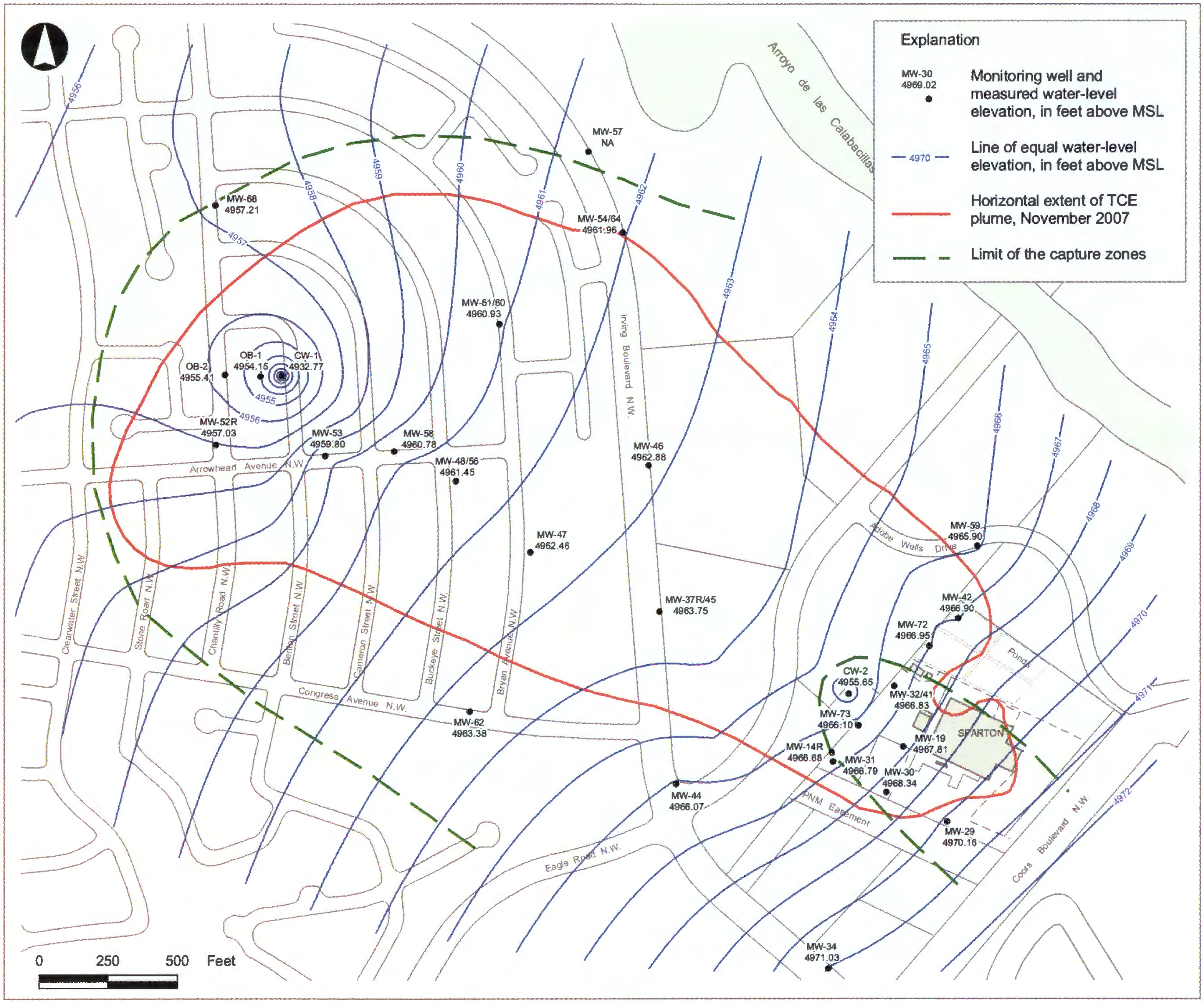


Figure 5.8 Elevation of Water Levels and Limits of Containment Well Capture Zones in the UFZ/ULFZ - August 4, 2008

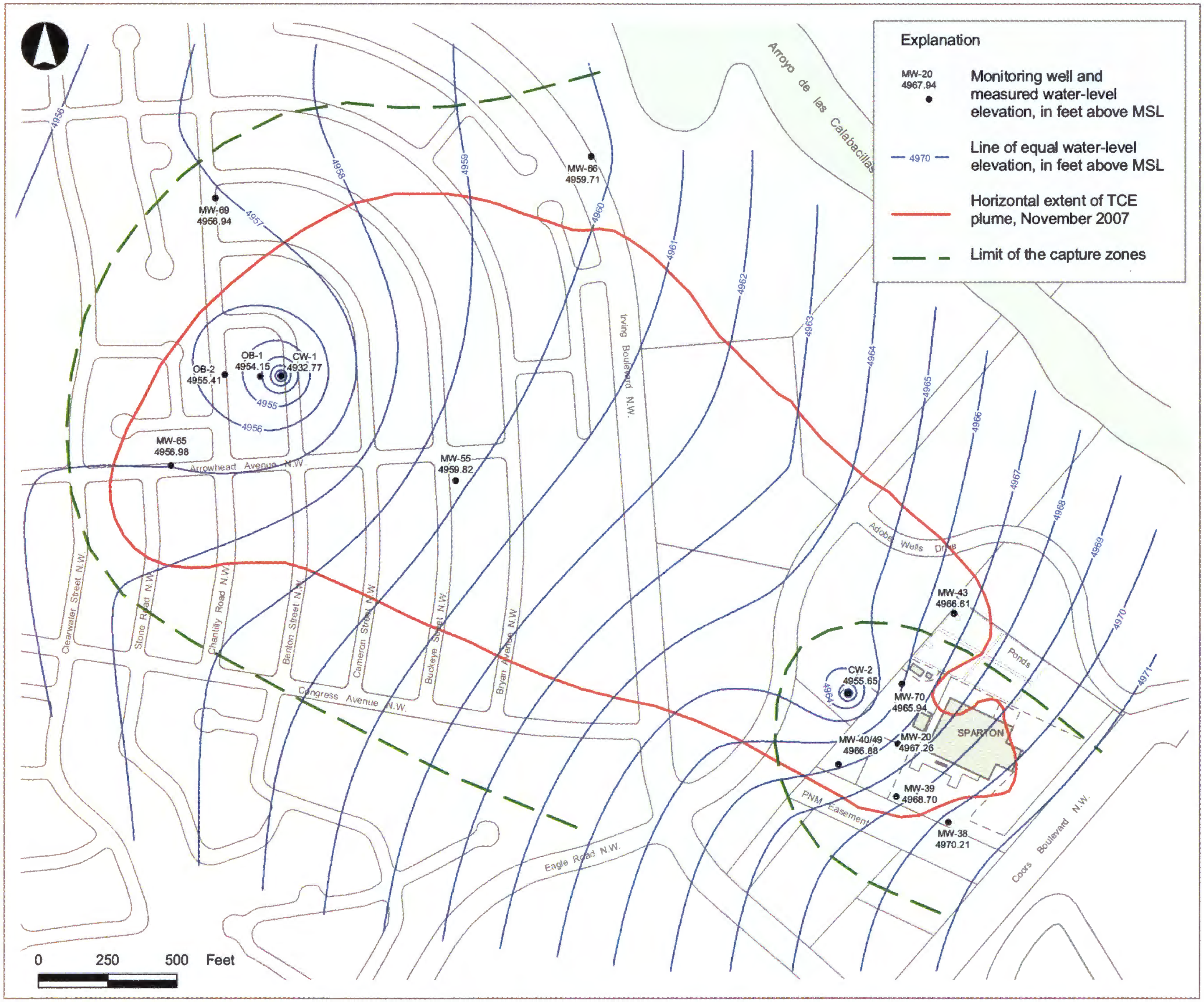


Figure 5.9 Elevation of Water Levels and Limits of Containment Well Capture Zones in the LLFZ - August 4, 2008

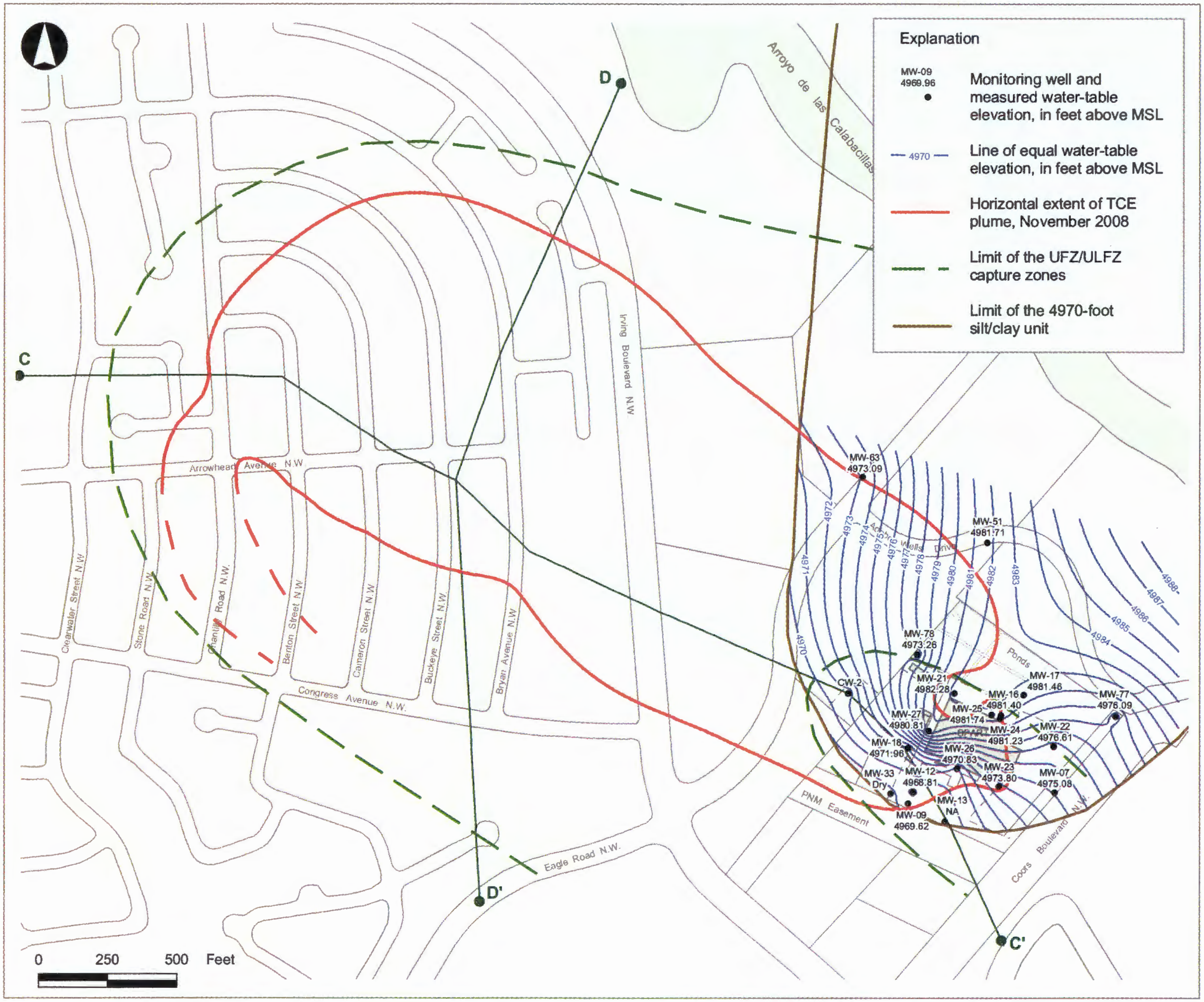


Figure 5.10 Elevation of the On-Site Water Table - November 3, 2008

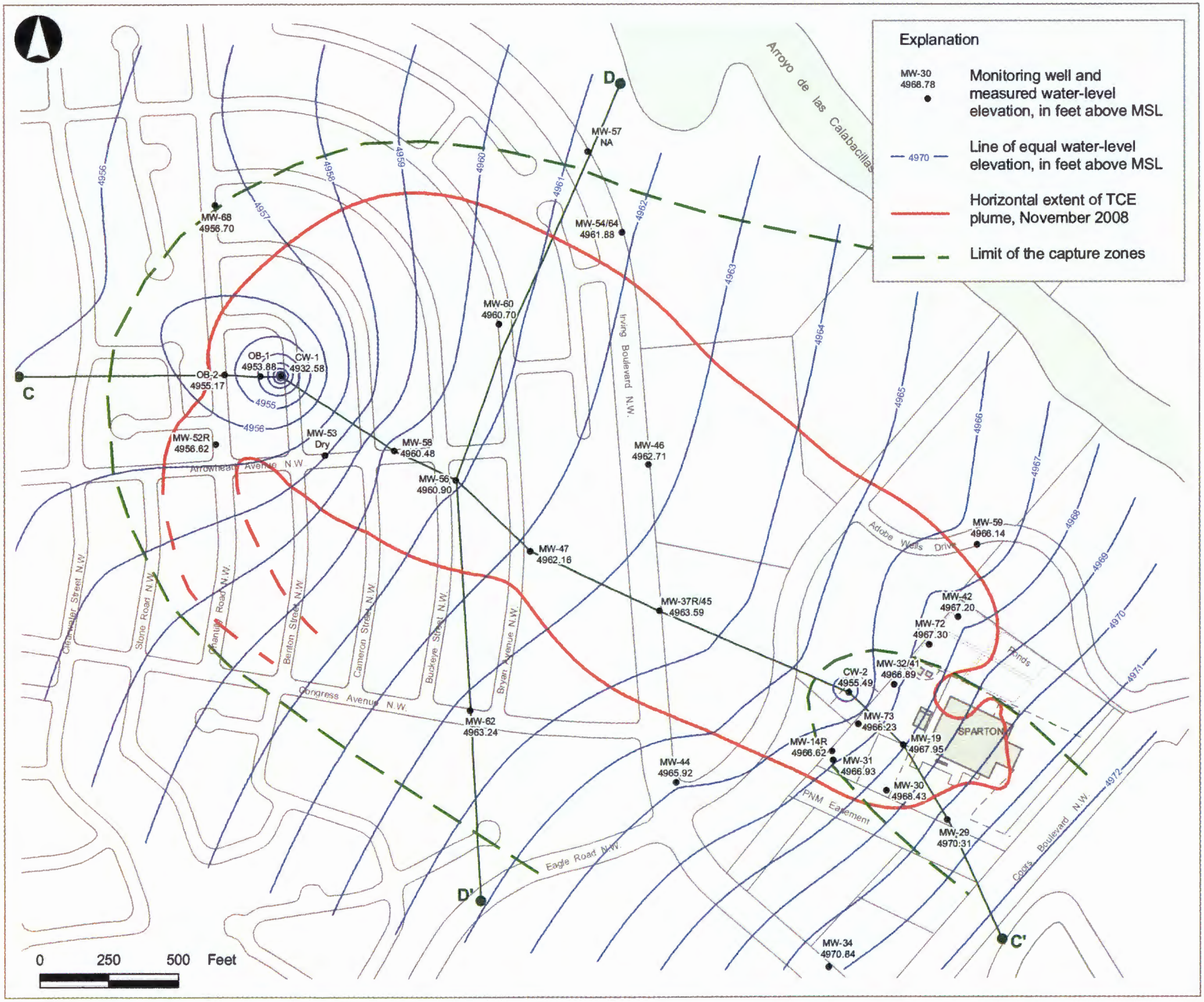


Figure 5.11 Elevation of Water Levels and Limits of Containment Well Capture Zones in the UFZ/ULFZ - November 3, 2008

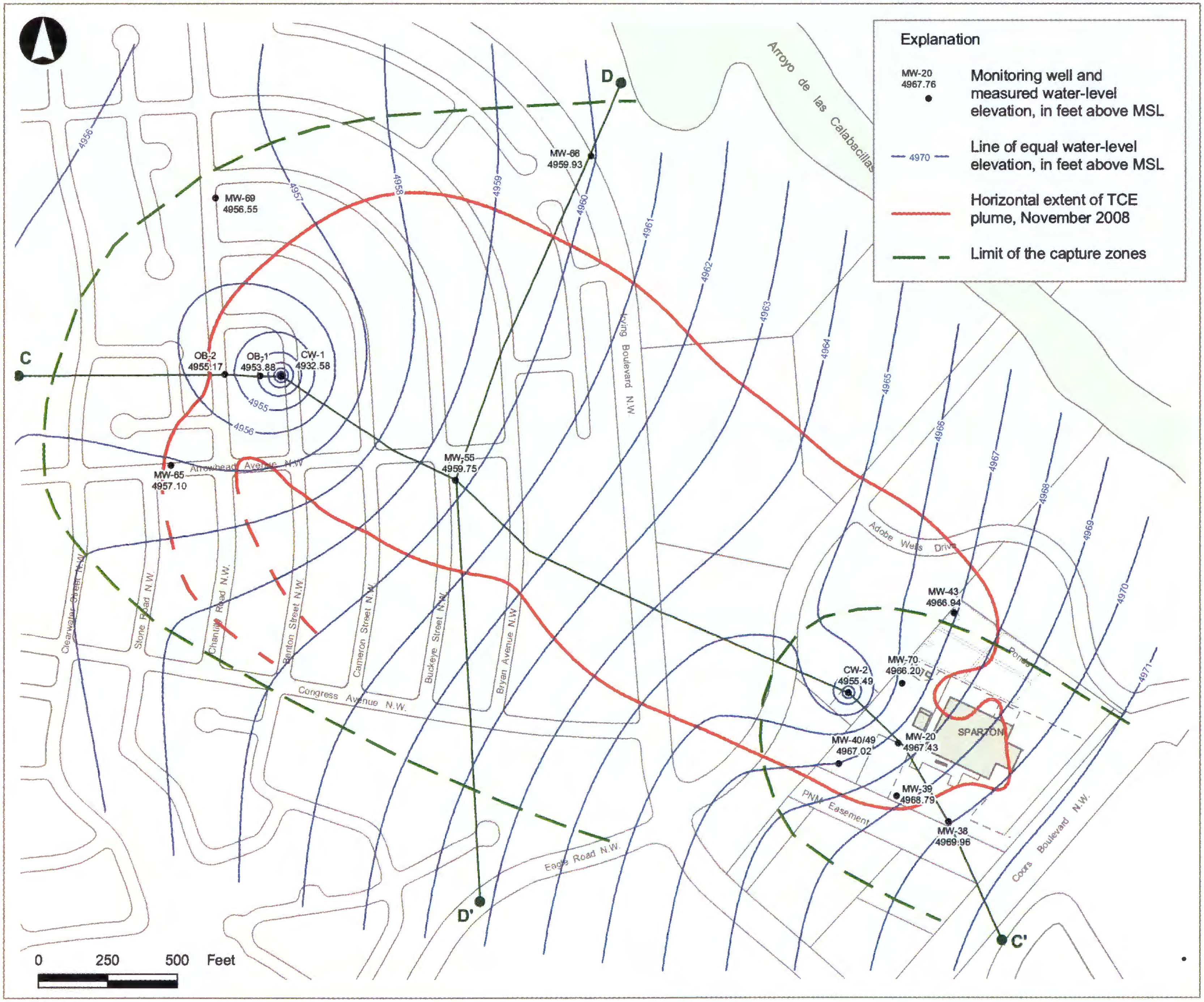


Figure 5.12 Elevation of Water Levels and Limits of Containment Well Capture Zones in the LLFZ - November 3, 2008

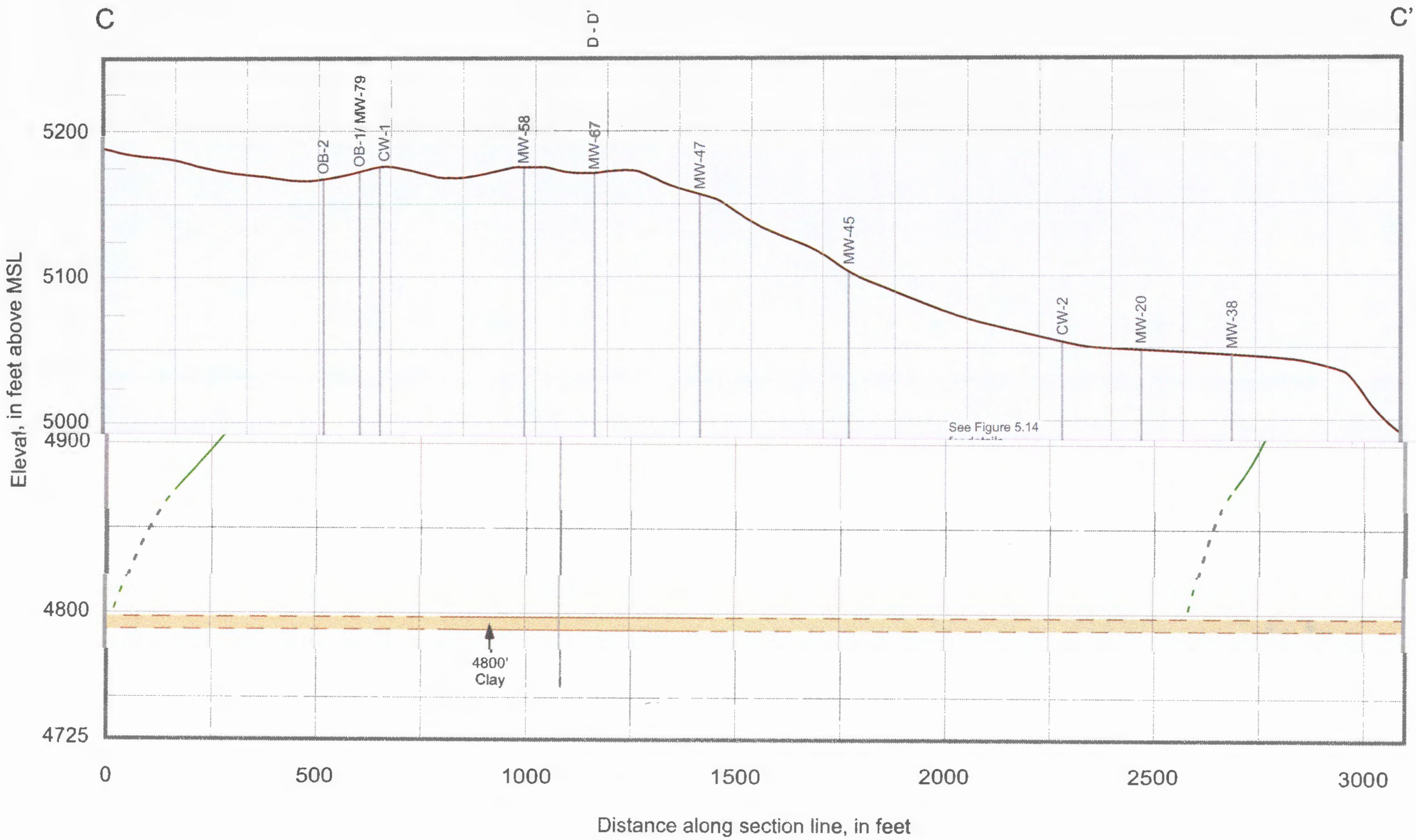


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Figure 5.13 Schematic Cross-Sections Showing November 1998 and 2008 Water Levels and Containment Well Capture Zones

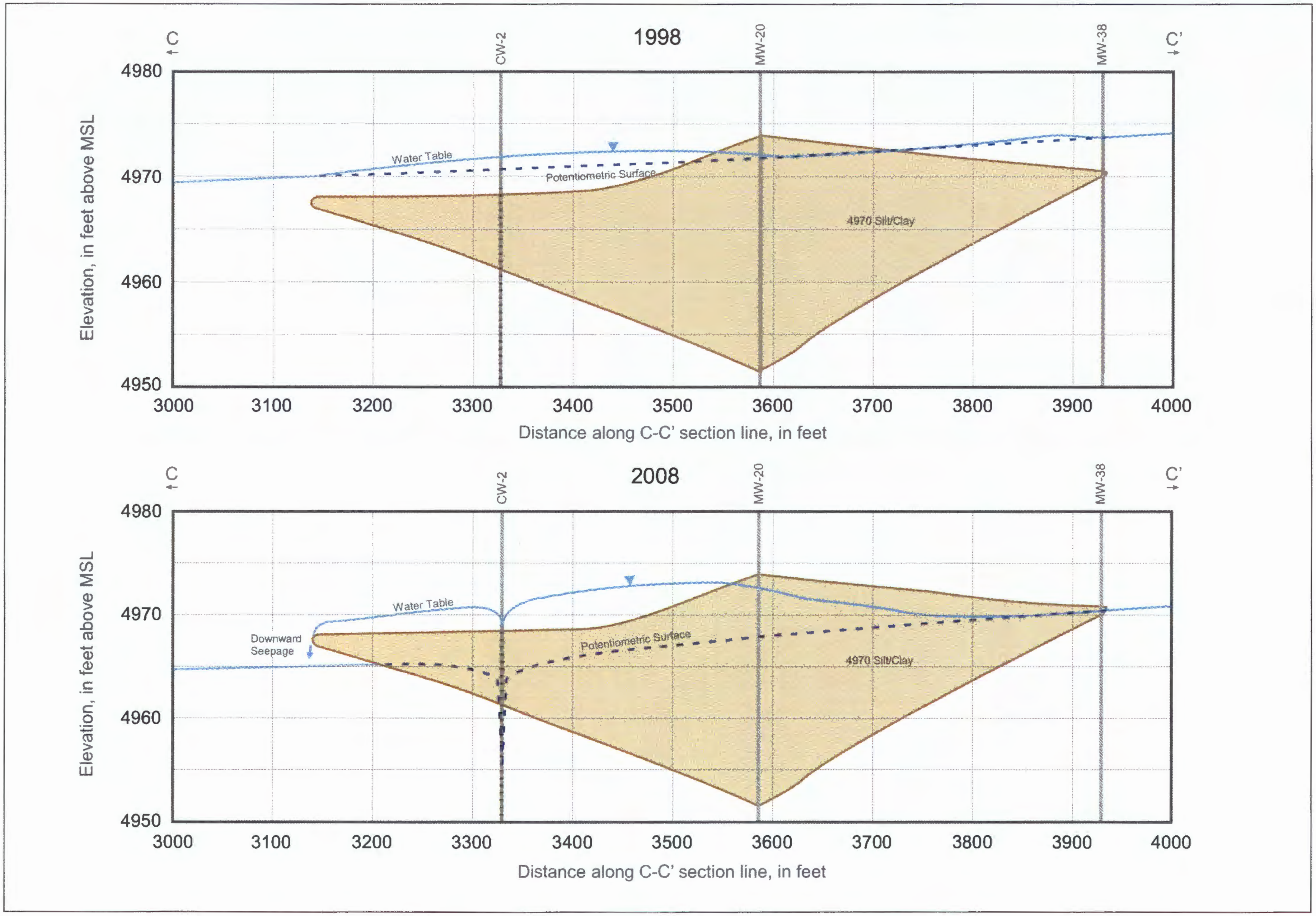


Figure 5.14 Details of Water Level Conditions at the Area Underlain by the 4970-ft Silt/Clay Unit

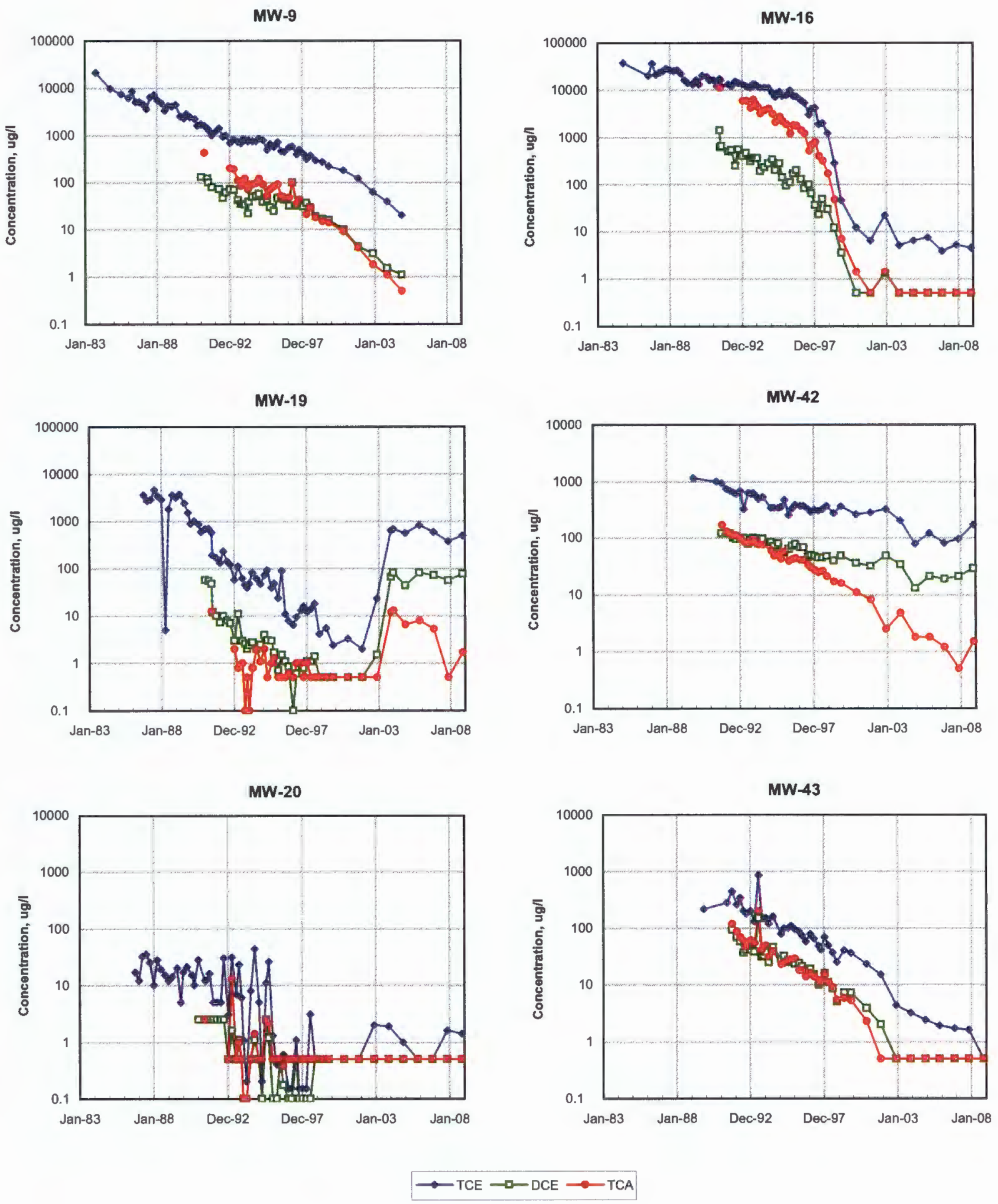


Figure 5.15 Contaminant Concentration Trends in On-Site Monitoring Wells

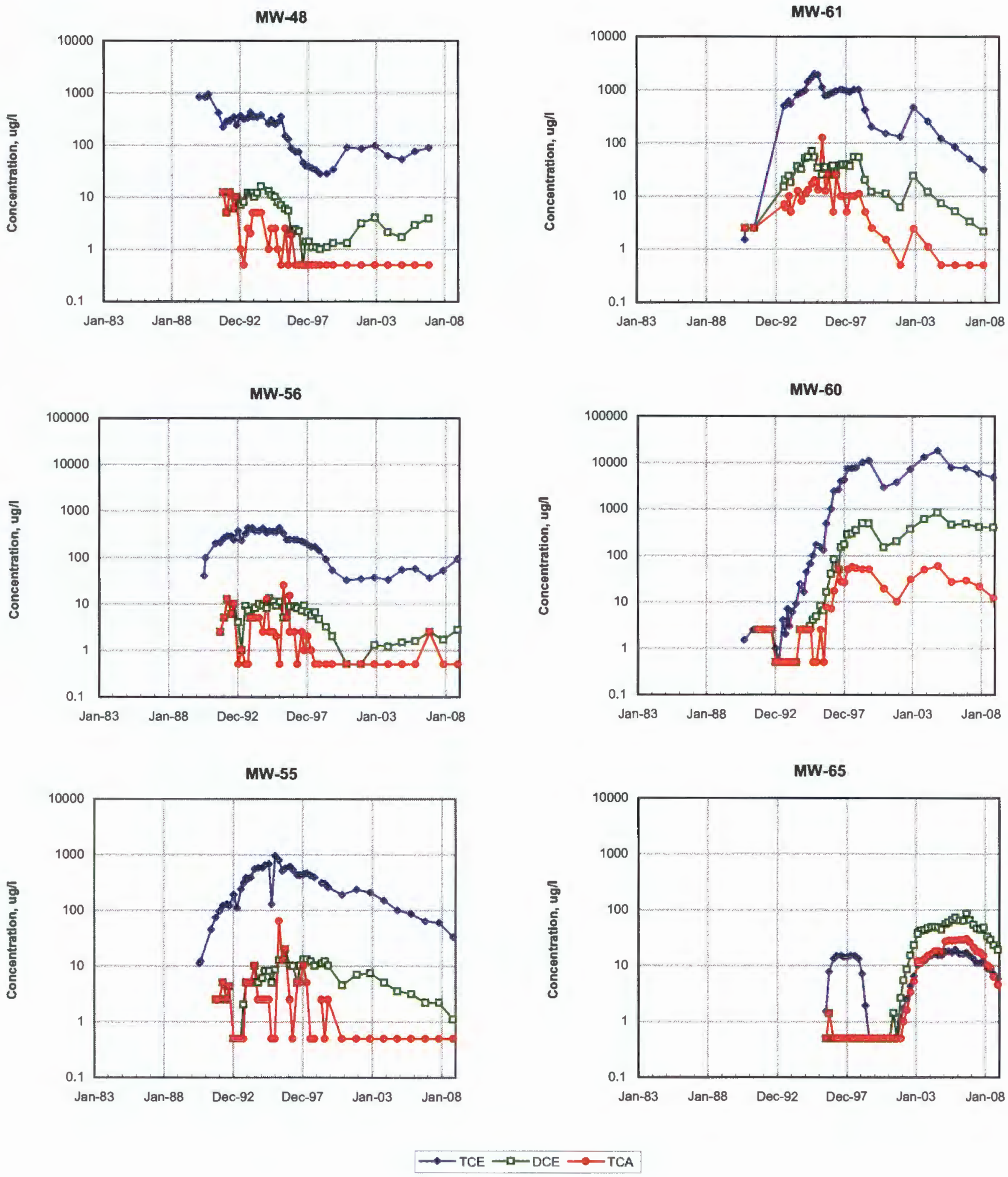


Figure 5.16 Contaminant Concentration Trends in Off-Site Monitoring Wells

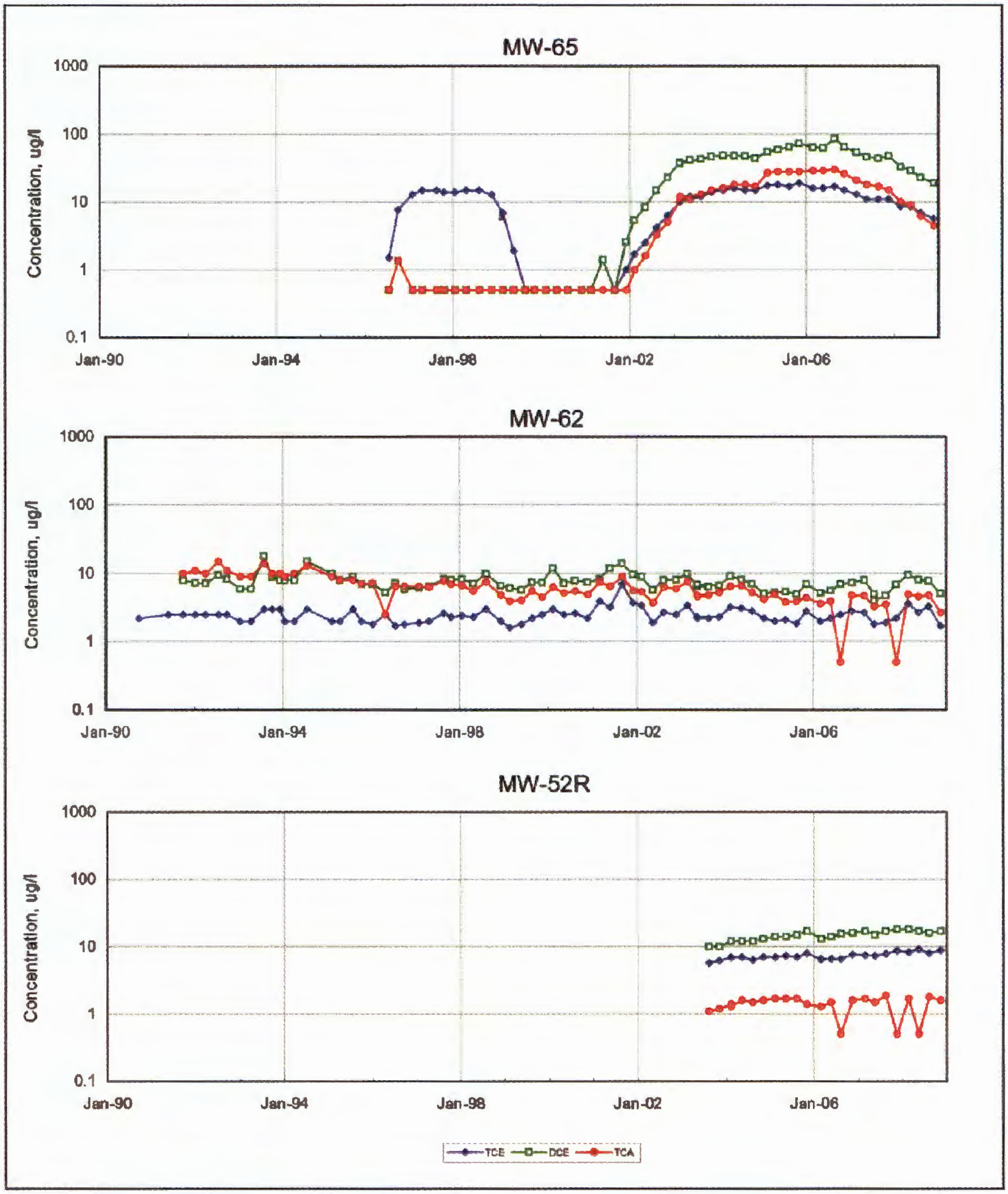


Figure 5.17 Concentration Trends in Monitoring Wells with DCE dominated Contamination

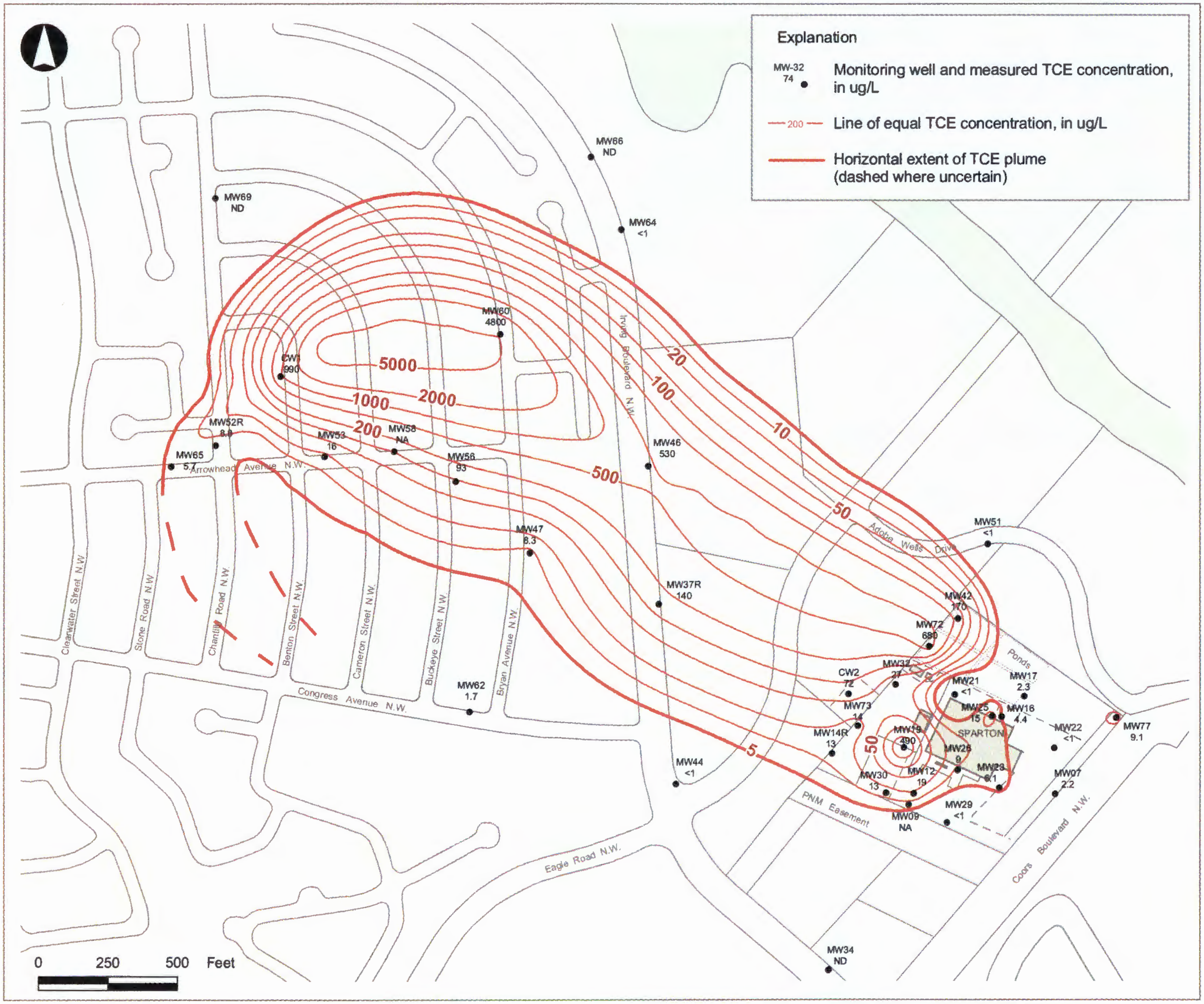


Figure 5.18 Horizontal Extent of TCE Plume - November 2008

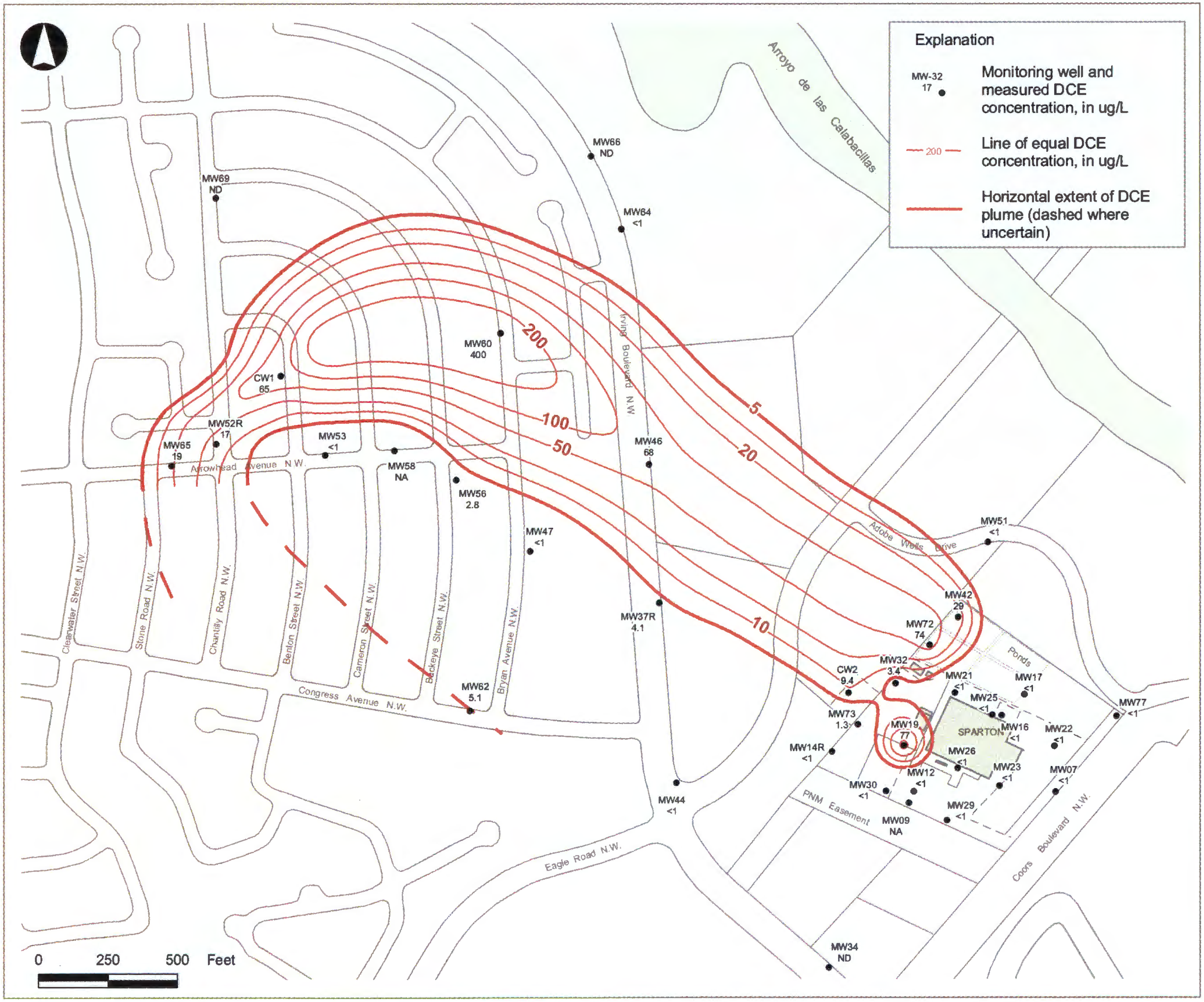


Figure 5.19 Horizontal Extent of DCE Plume - November 2008

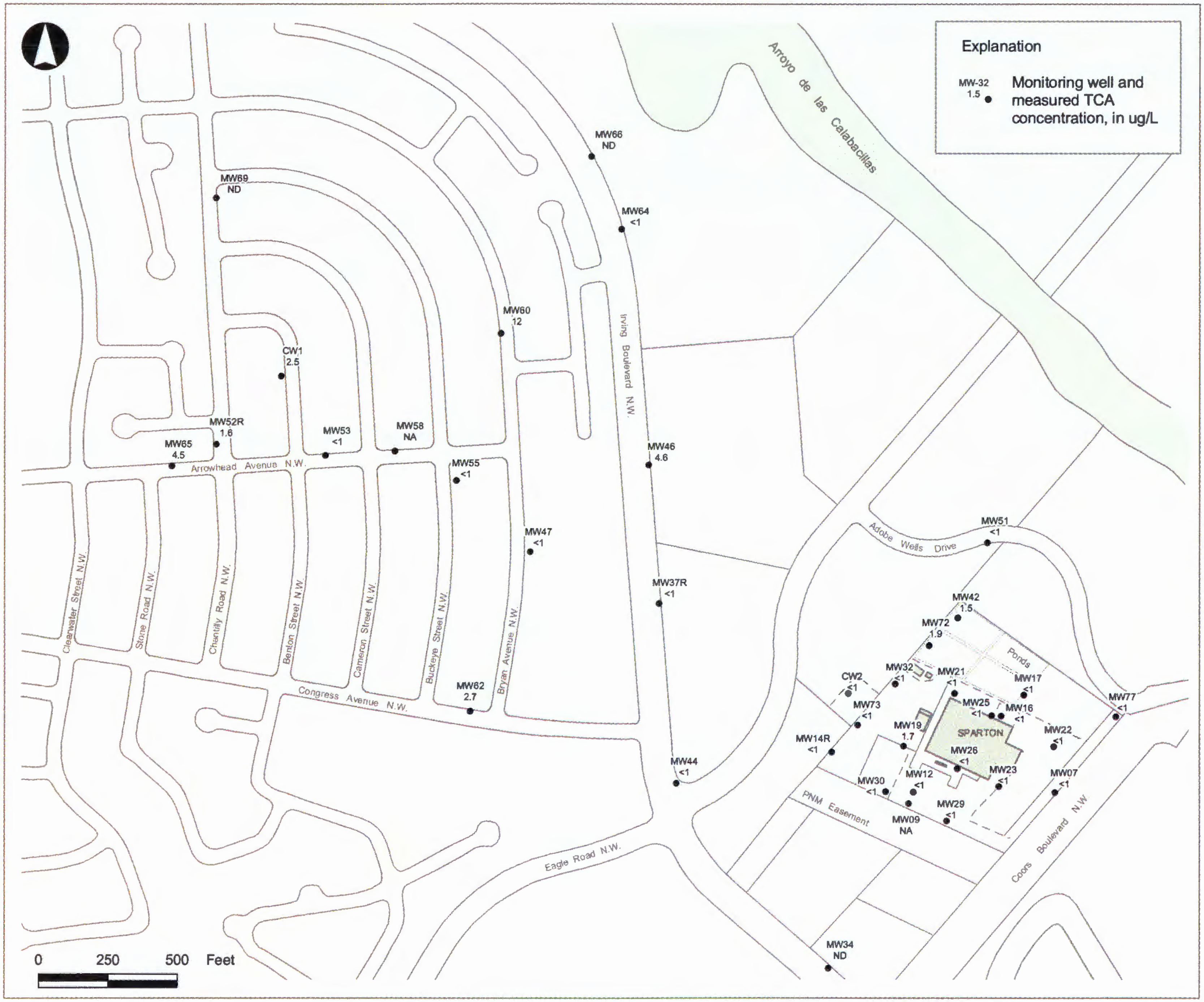


Figure 5.20 TCA Concentrations in Wells - November 2008

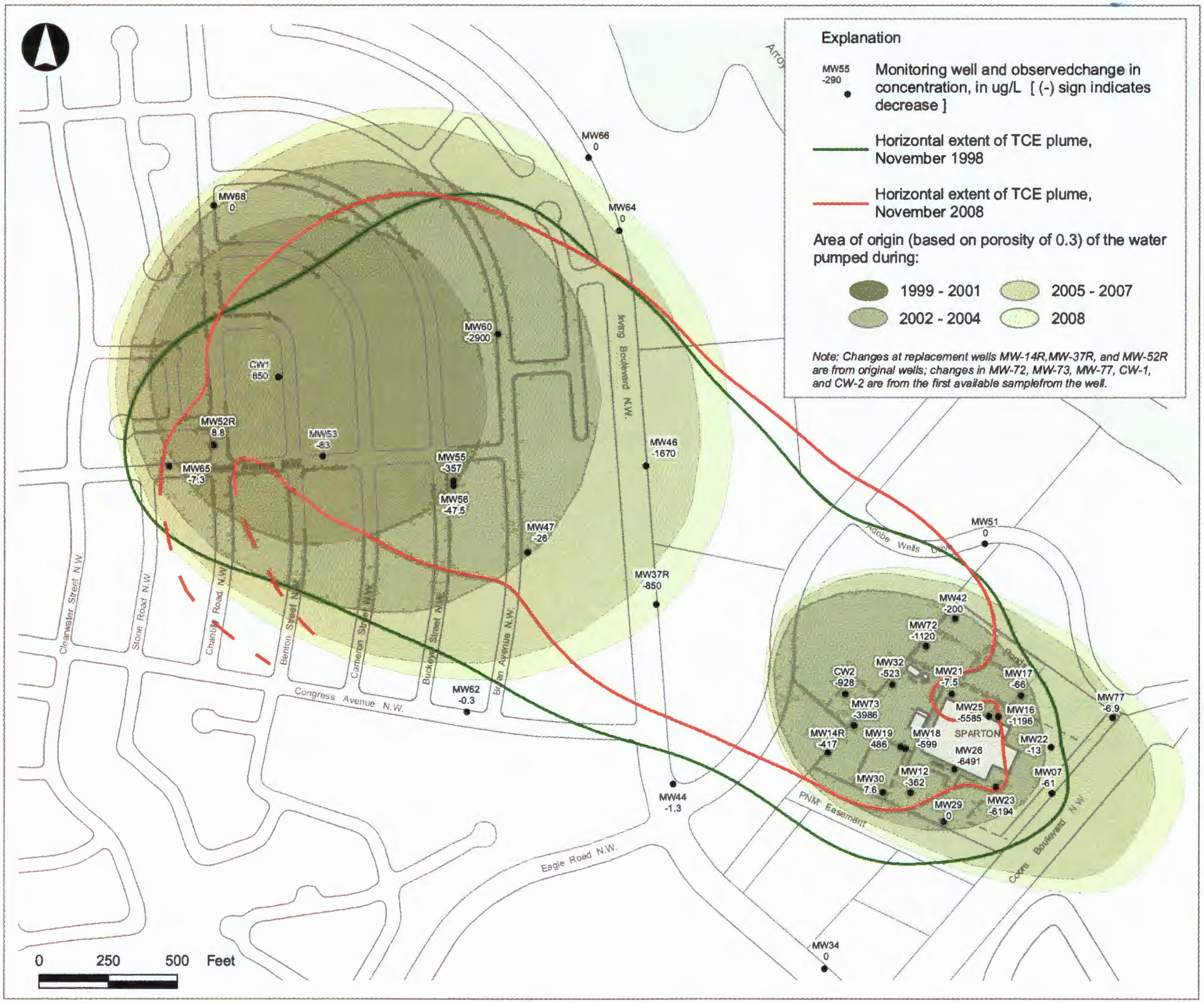


Figure 5.21 Changes in TCE Concentrations at Wells Used for Plume Definition - November 1998 to November 2008

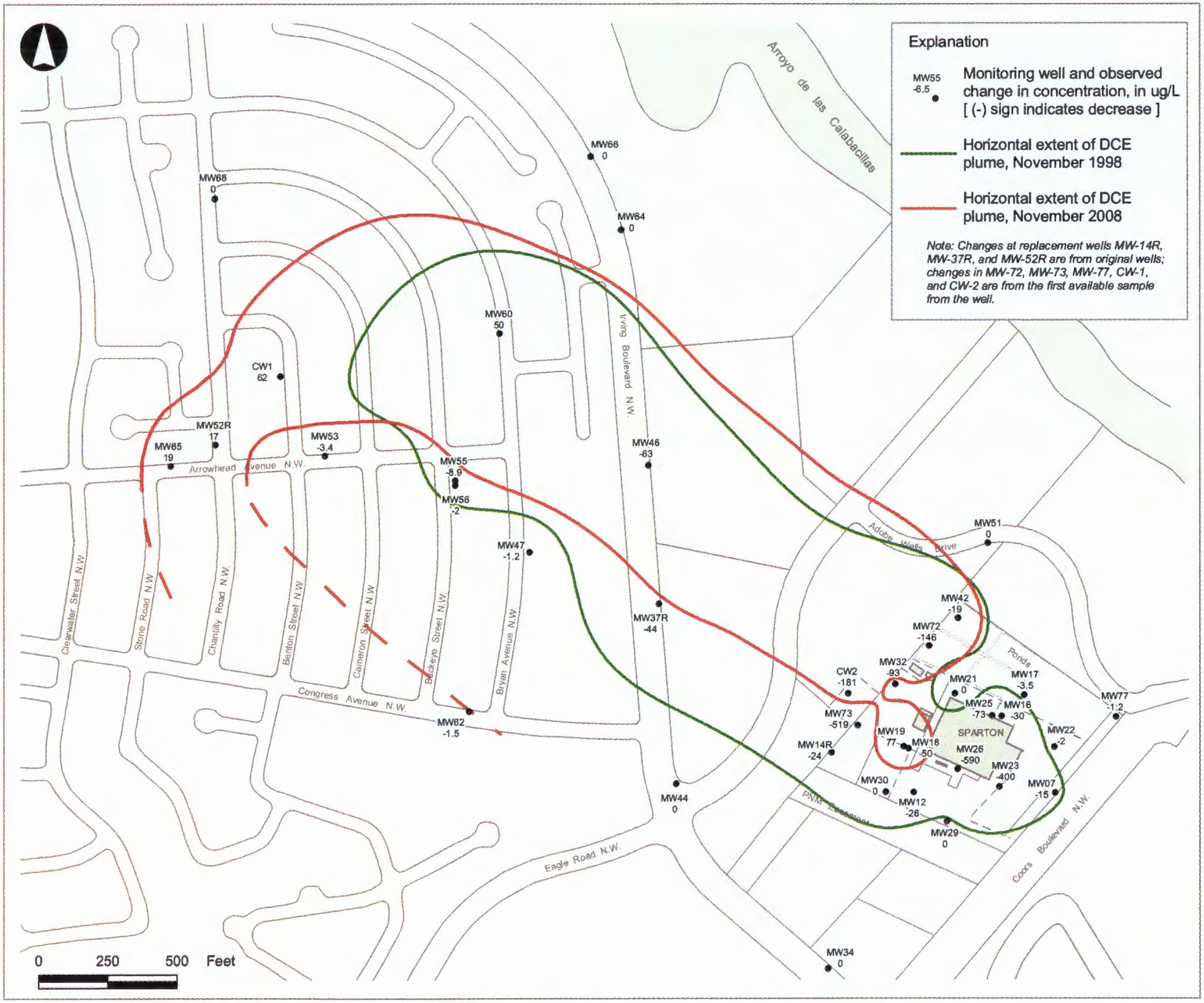


Figure 5.22 Changes in DCE Concentrations at Wells Used for Plume Definition - November 1998 to November 2008

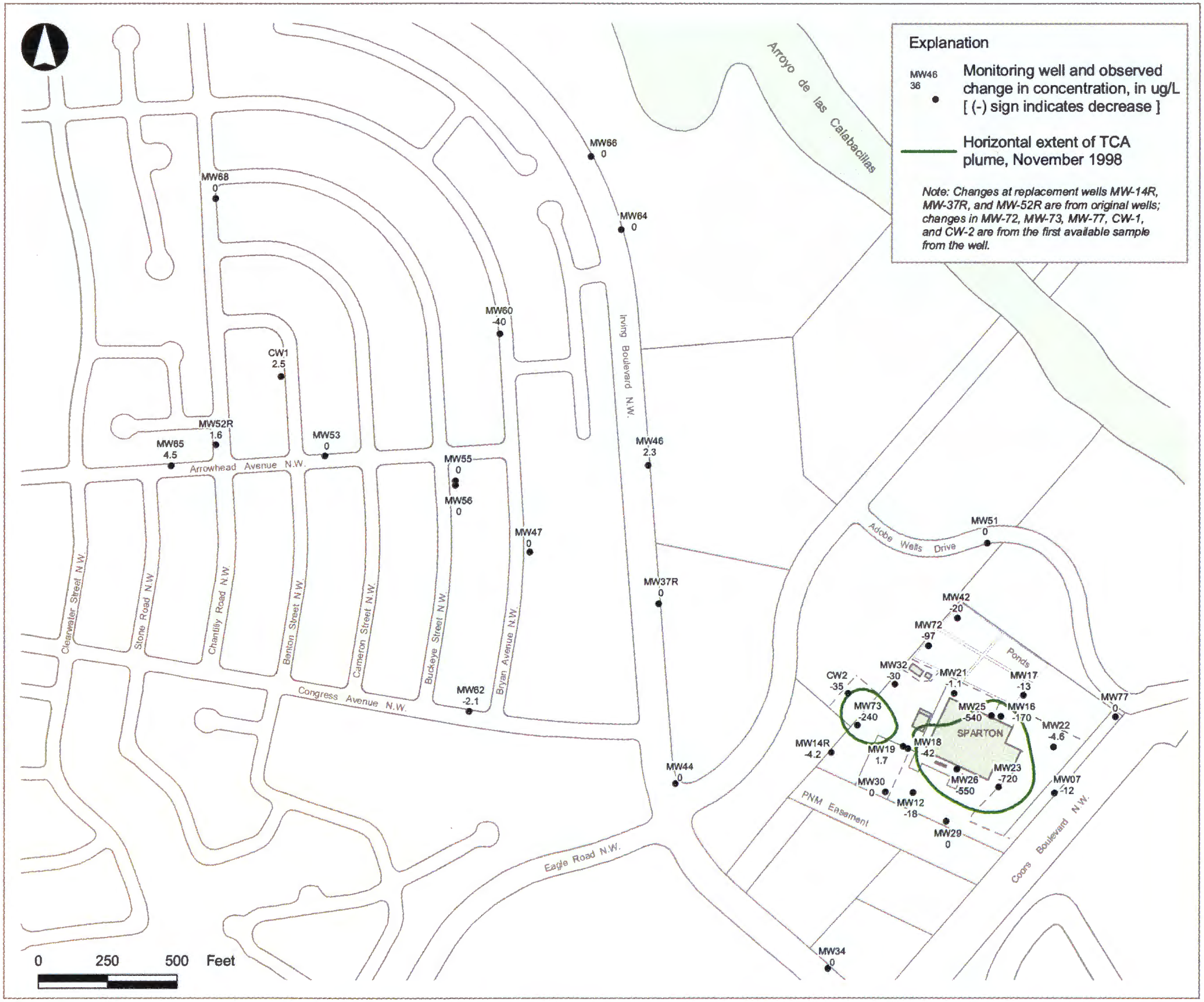


Figure 5.23 Changes in TCA Concentrations at Wells Used for Plume Definition - November 1998 to November 2008

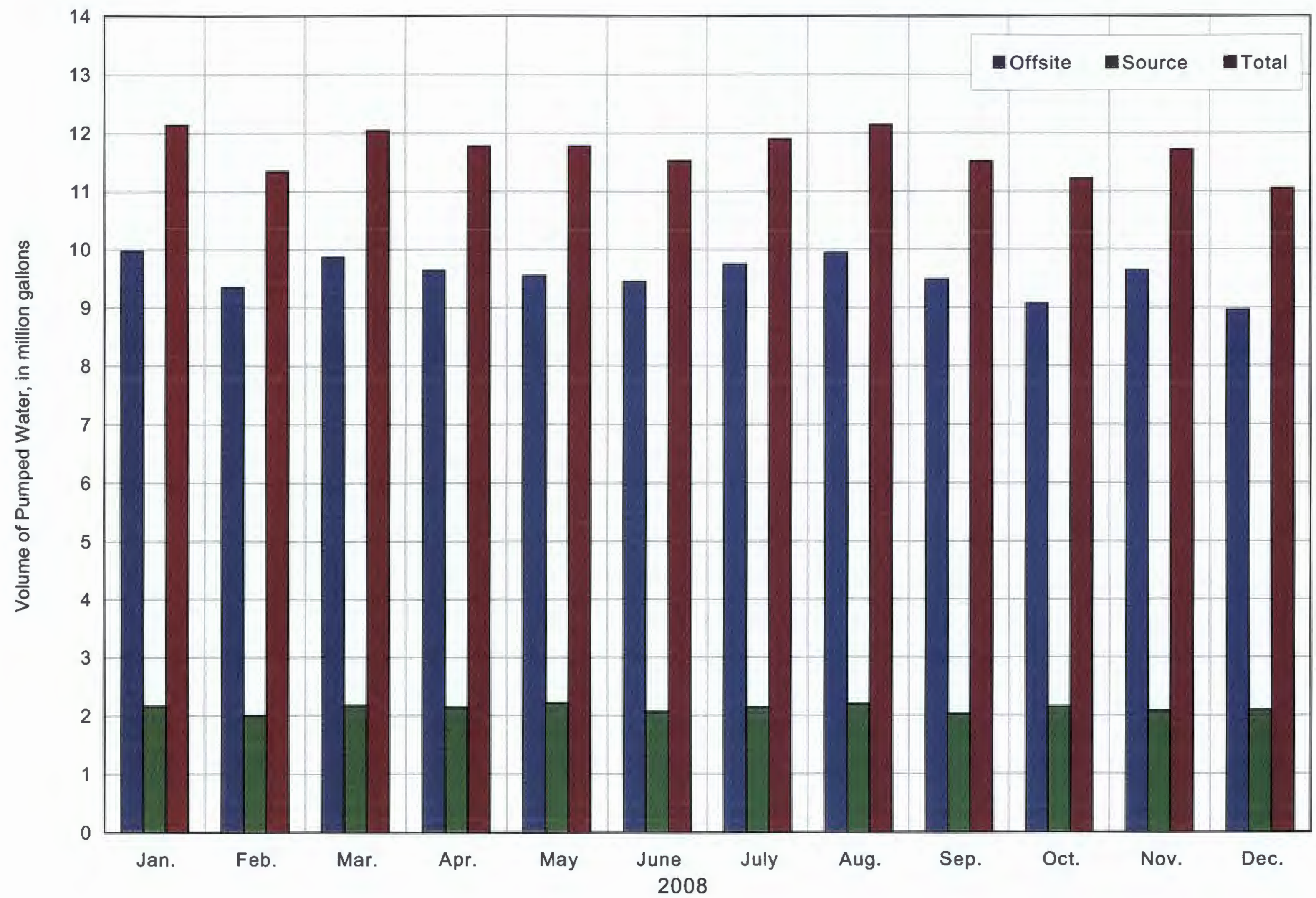


Figure 5.24 Monthly Volume of Water Pumped by the Off-Site And Source Containment Wells - 2008

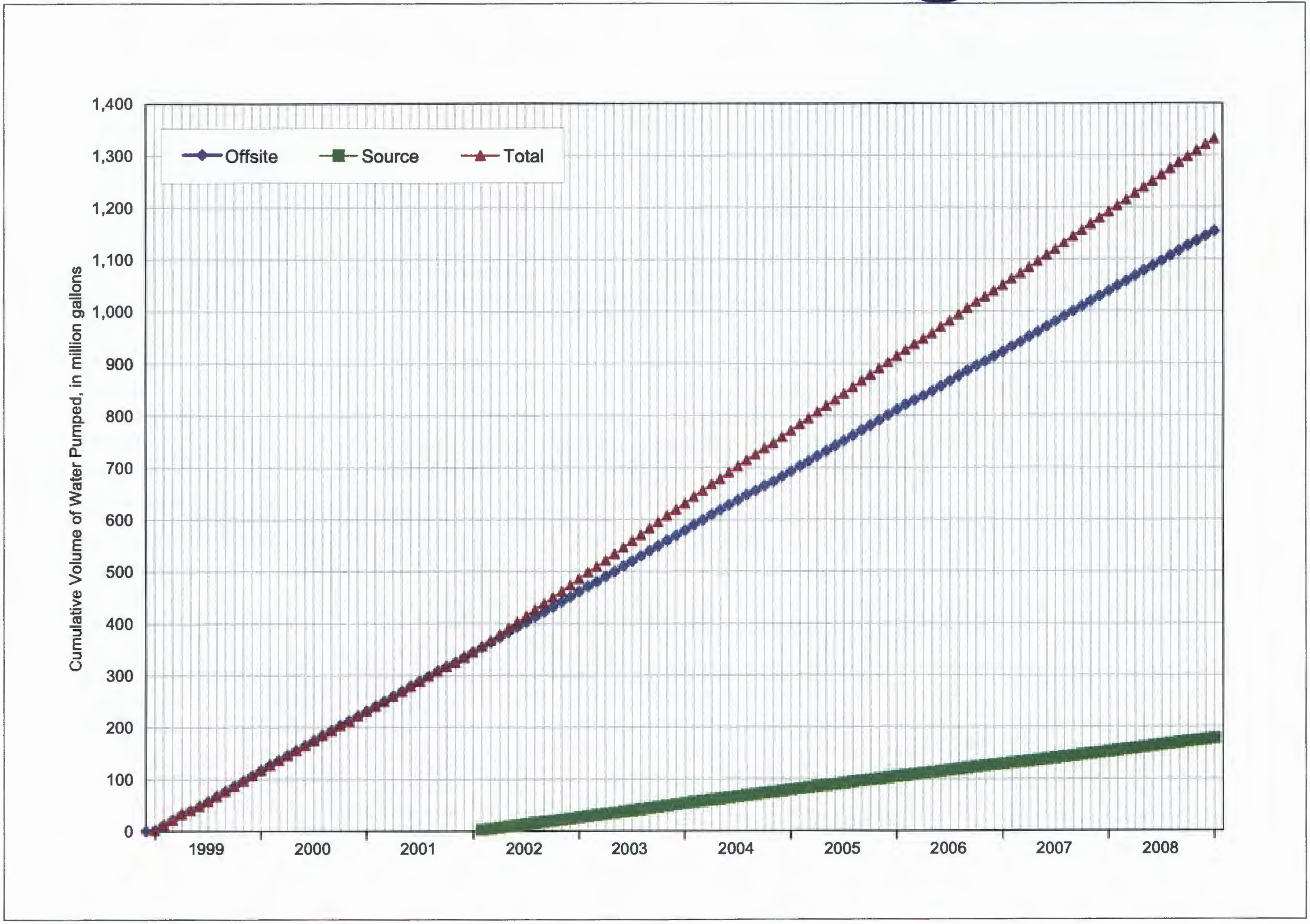


Figure 5.25 Cumulative Volume of Water Pumped by the Off-Site and Source Containment Wells

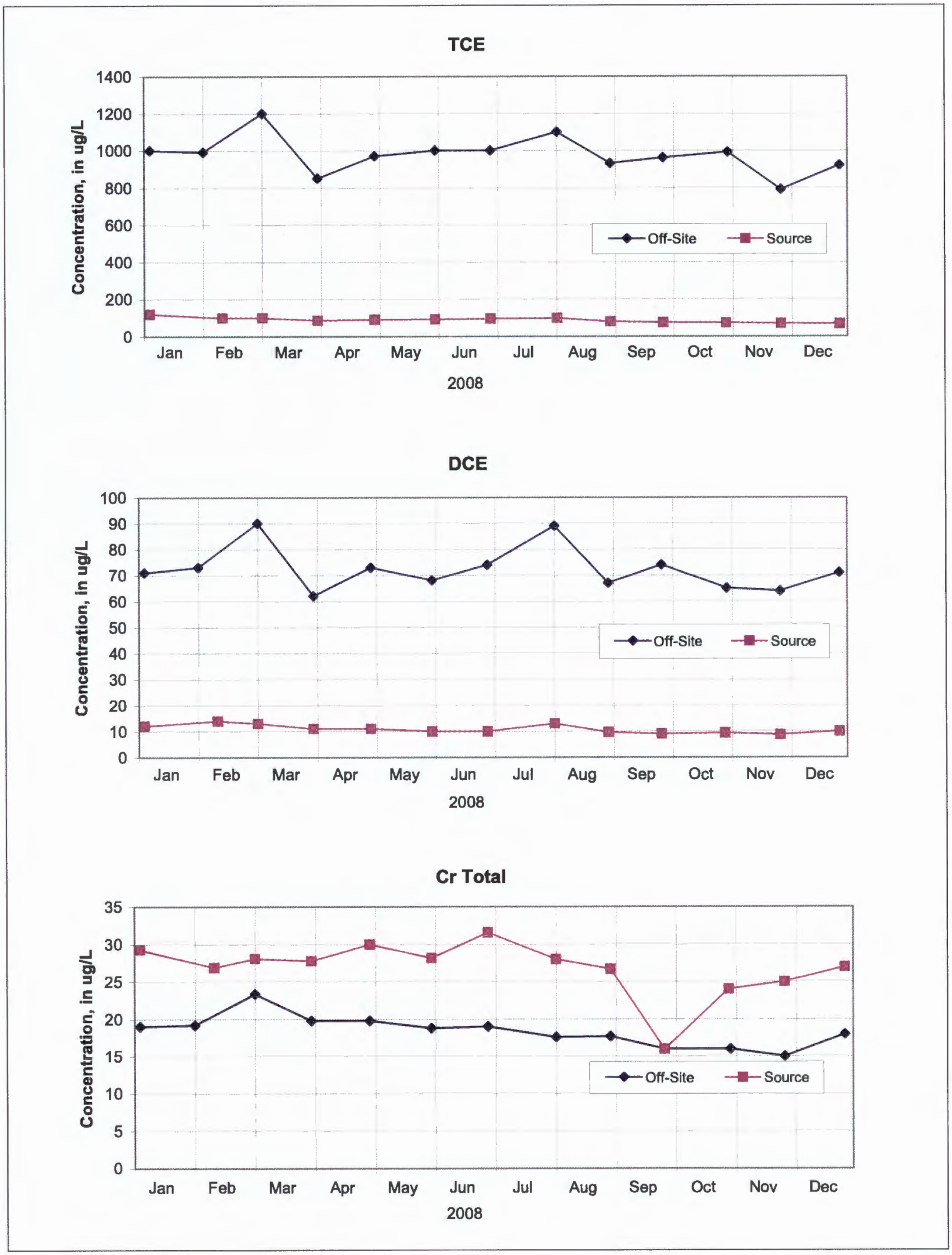


Figure 5.26 Off-Site and Source Containment Systems - TCE, DCE, and Total Chromium Concentrations in the Influent -2008

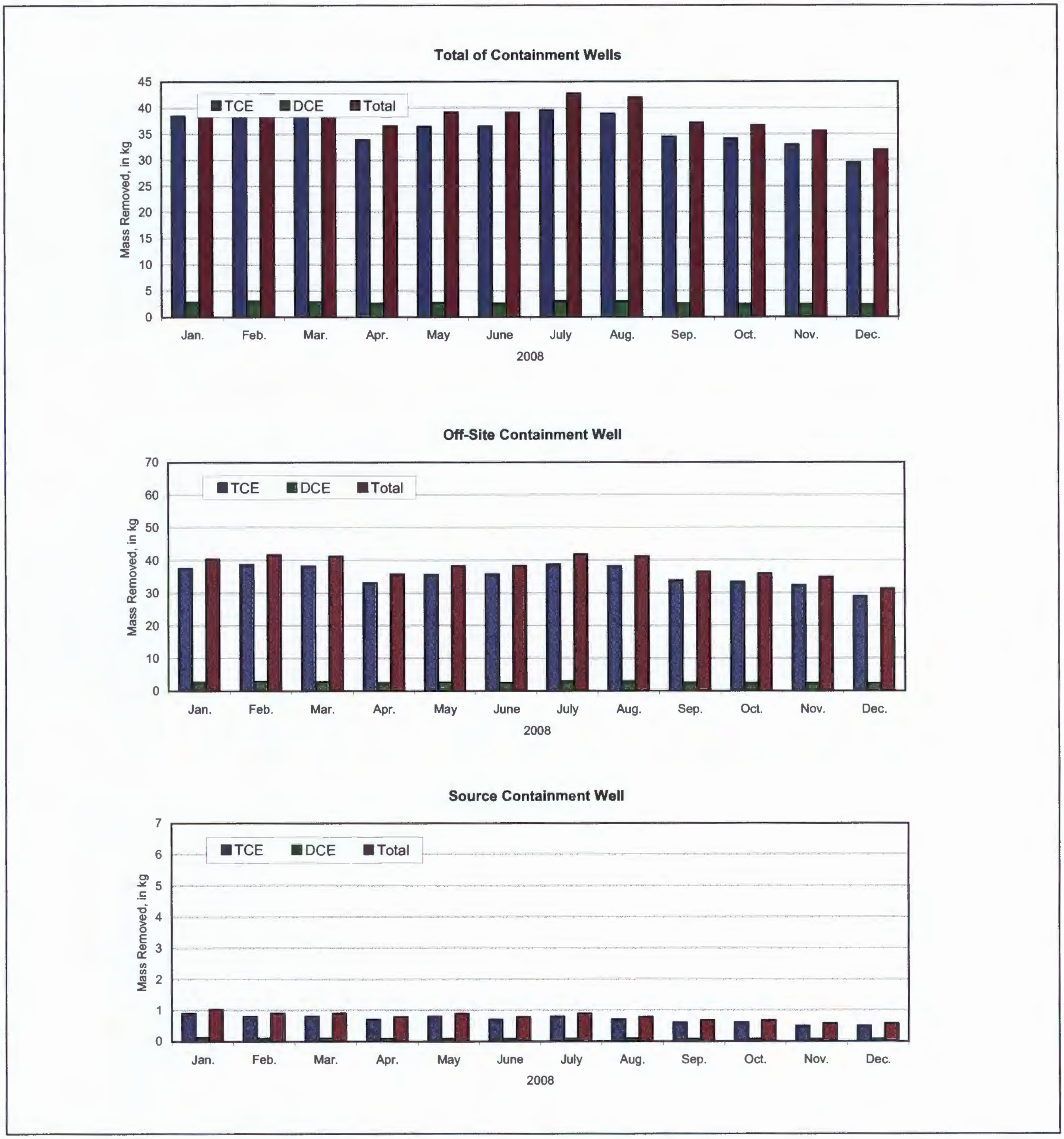


Figure 5.27 Monthly Contaminant Mass Removal by the Off-Site and Source Containment Wells - 2008

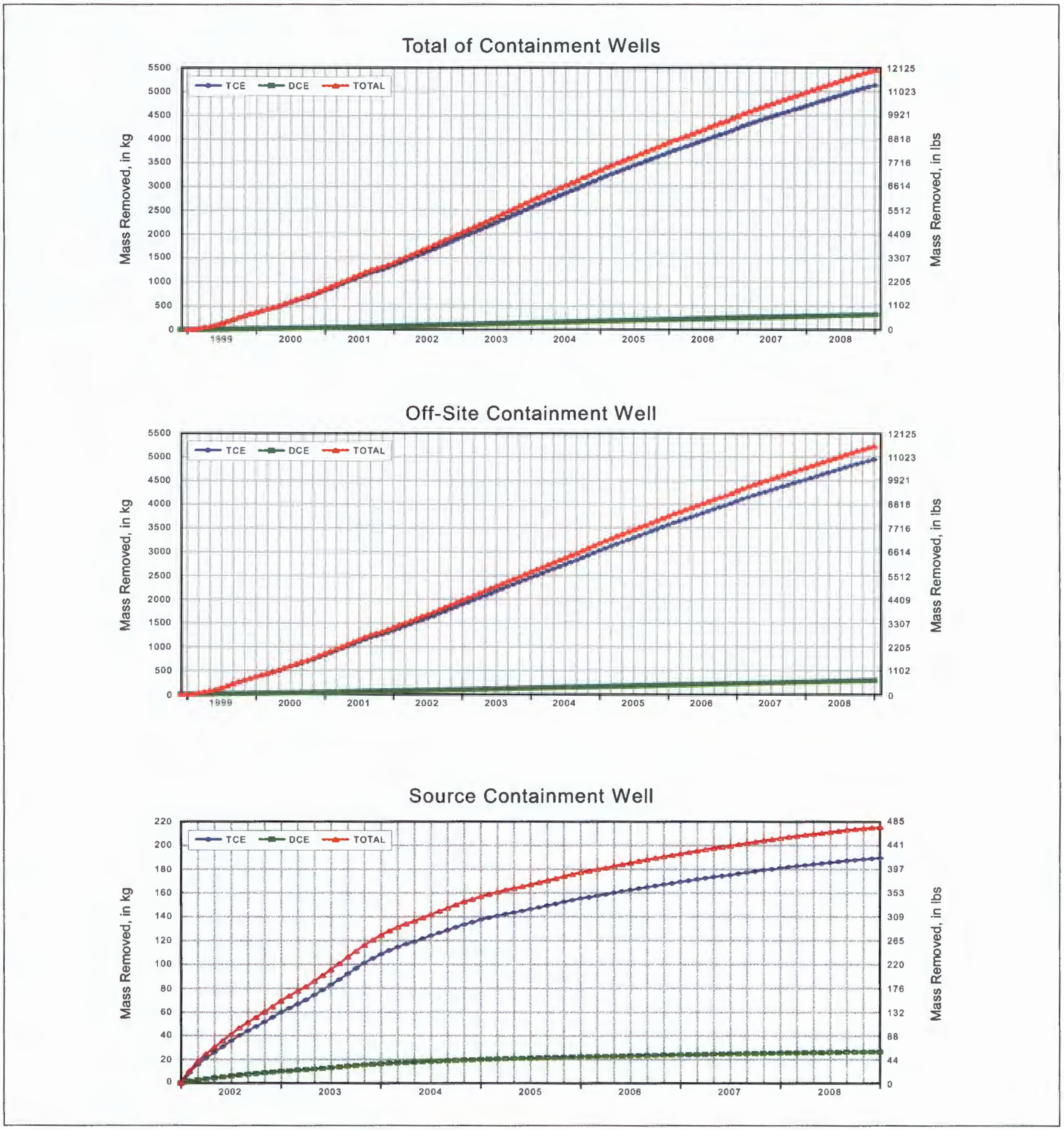


Figure 5.28 Cumulative Contaminant Mass Removal by the Source and Off-Site Containment Wells

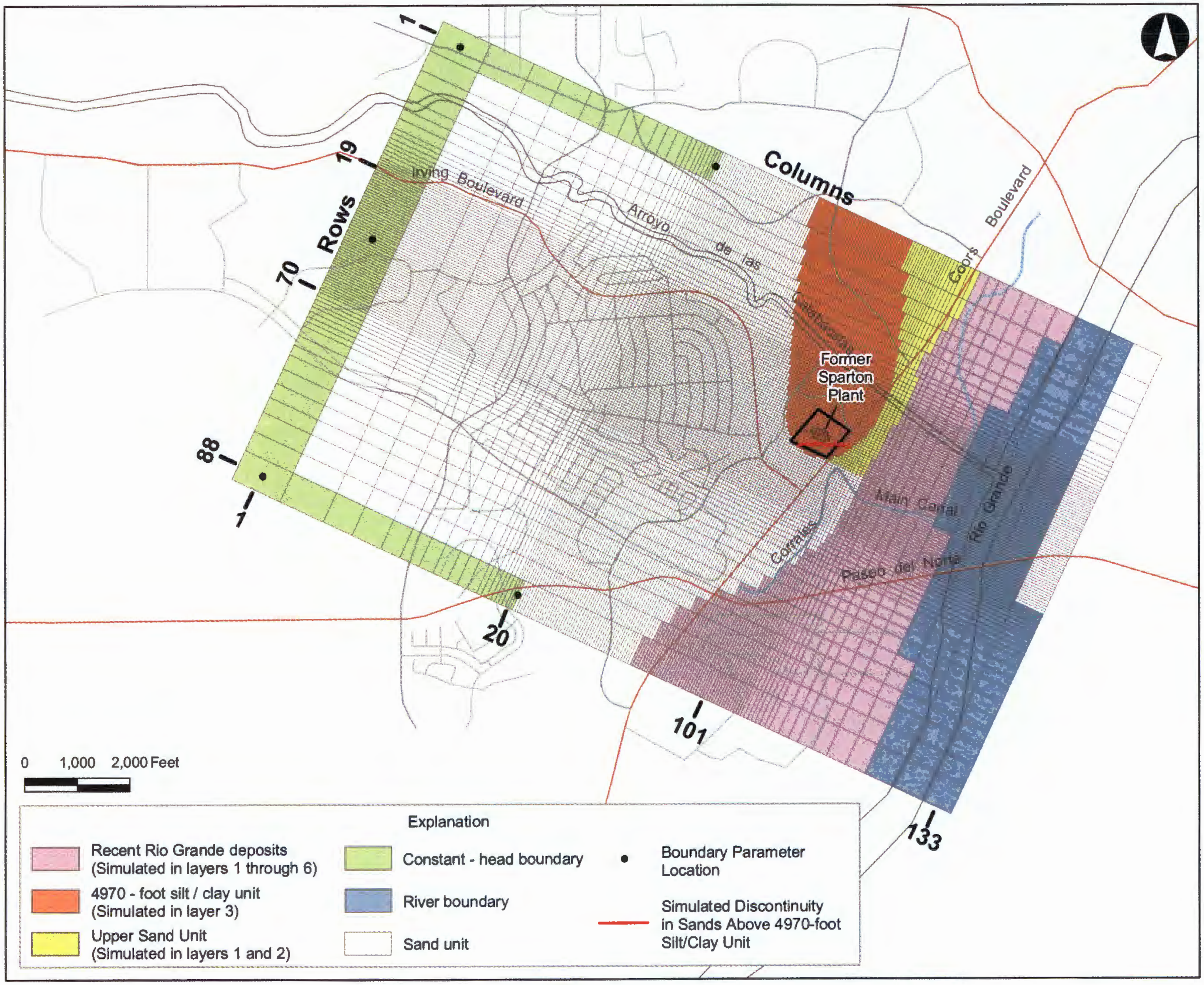


Figure 6.1 Model Grid, Hydraulic Property Zones and Boundary Conditions

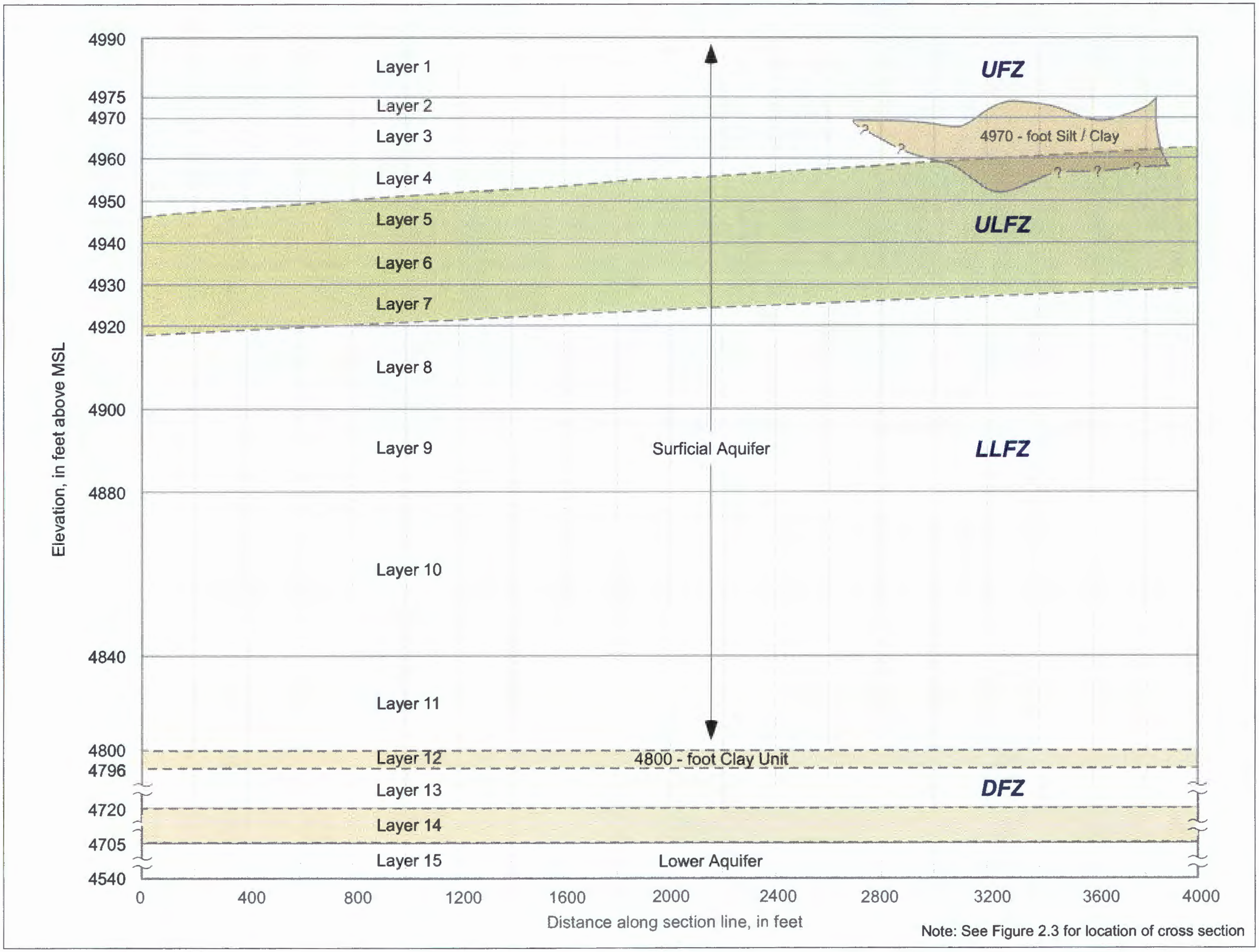


Figure 6.2 Model Layers

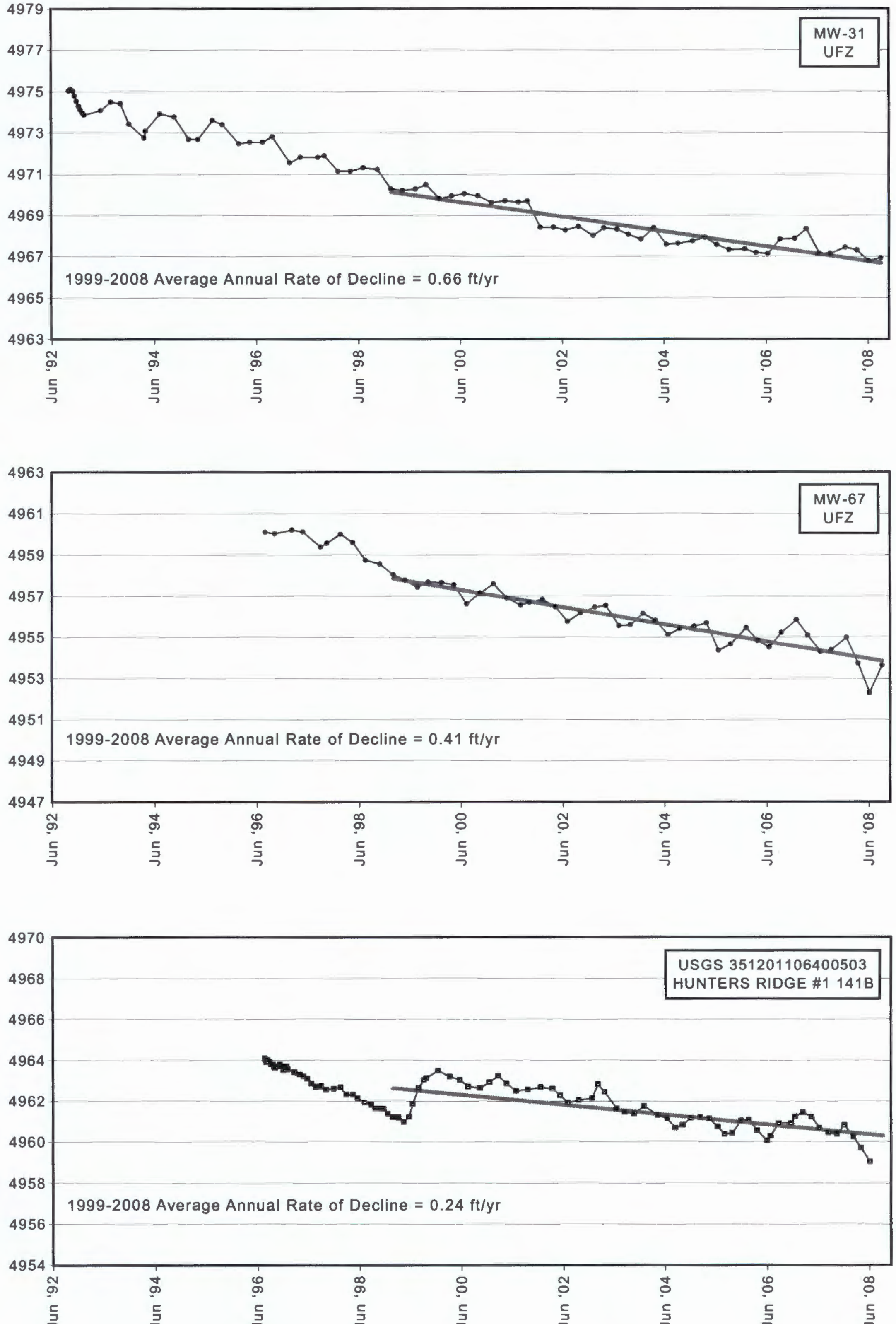
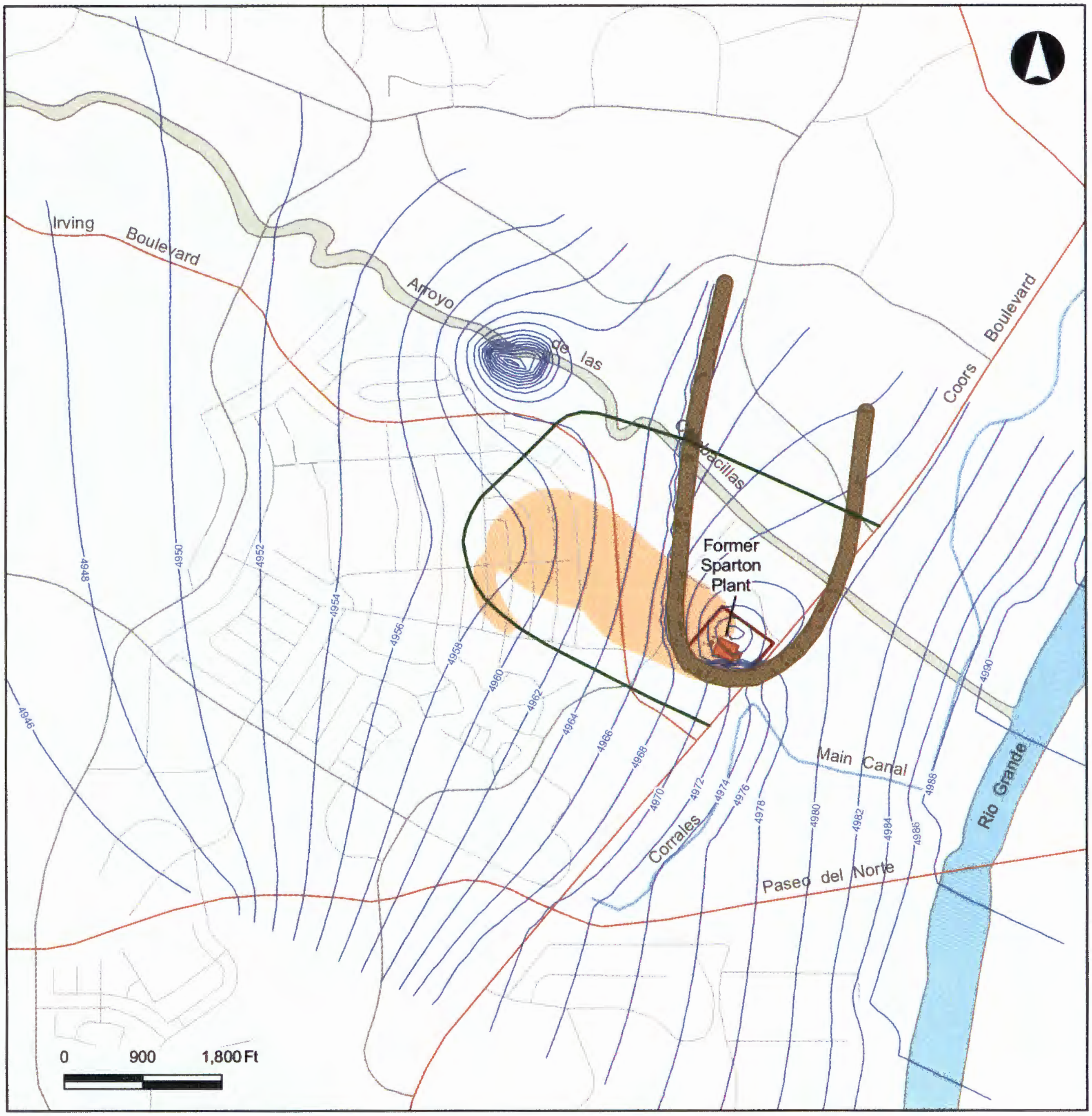


Figure 6.3 Regional Water Level Trends



Explanation

- Containment Well
- —4968— Line of equal water-level elevation, in feet above MSL
- Limit of the capture zone in UFZ/UFLZ
- Approximate extent of 4970-foot silt/clay unit
- Horizontal extent of TCE plume, November 2008

Figure 6.4 Calculated Water Table (UFZ) and Comparison of the Calculated Capture Zone to the TCE Plume Extent

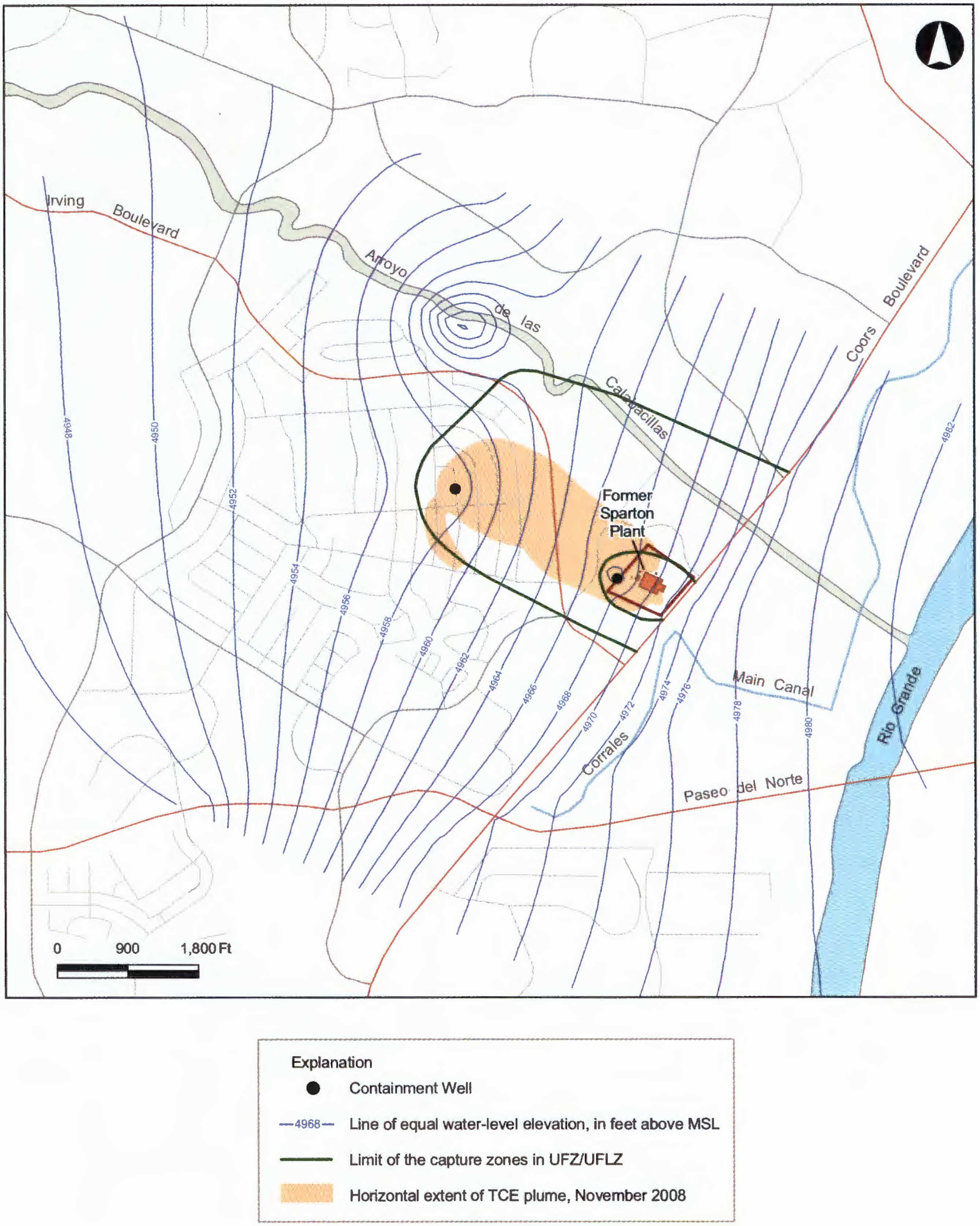
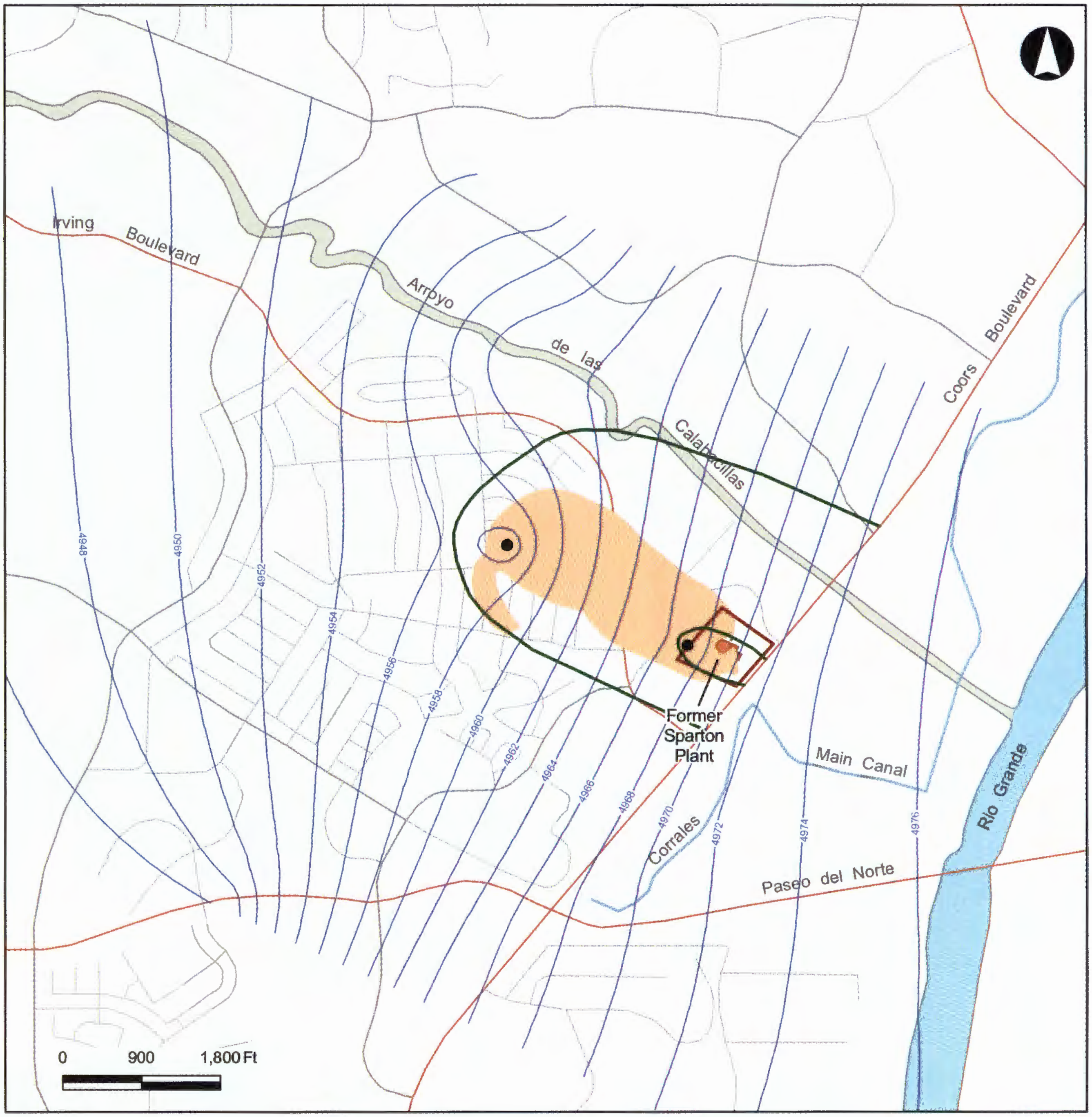


Figure 6.5 Calculated Water Levels in the ULFZ and Comparison of the Calculated Capture Zone to the TCE Plume Extent



Explanation

- Containment Well
- 4968 — Line of equal water-level elevation, in feet above MSL
- Limit of the capture zones in LFFZ
- Horizontal extent of TCE plume, November 2006

Figure 6.6 Calculated Water Levels in the LLFZ and Comparison of the Calculated Capture Zone to the TCE Plume Extent

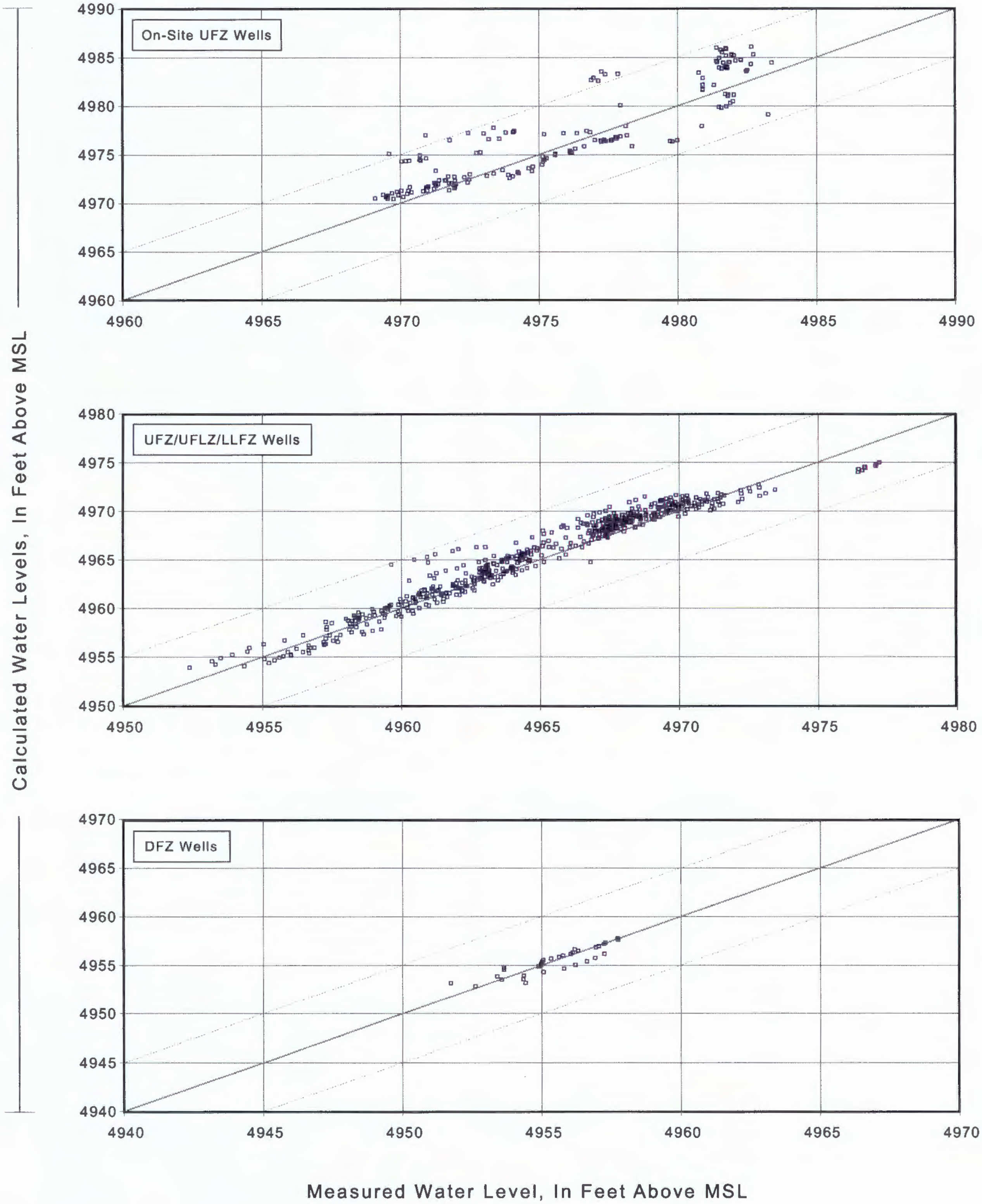


Figure 6.7 Comparison of Calculated to Observed Water Levels - Novembert 1998 to November 2008

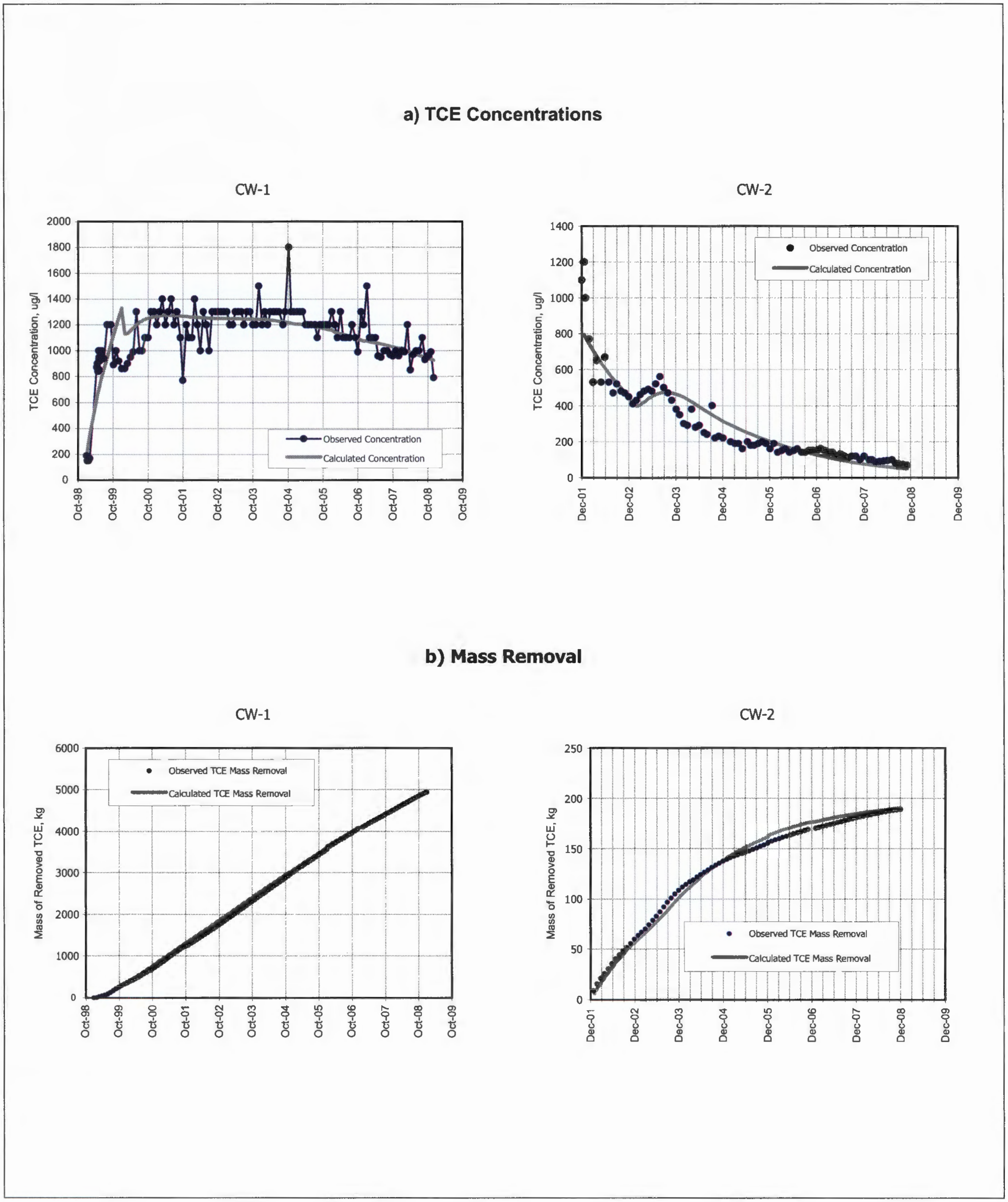


Figure 6.8 Comparison of Calculated to Observed TCE Concentrations and Mass Removal

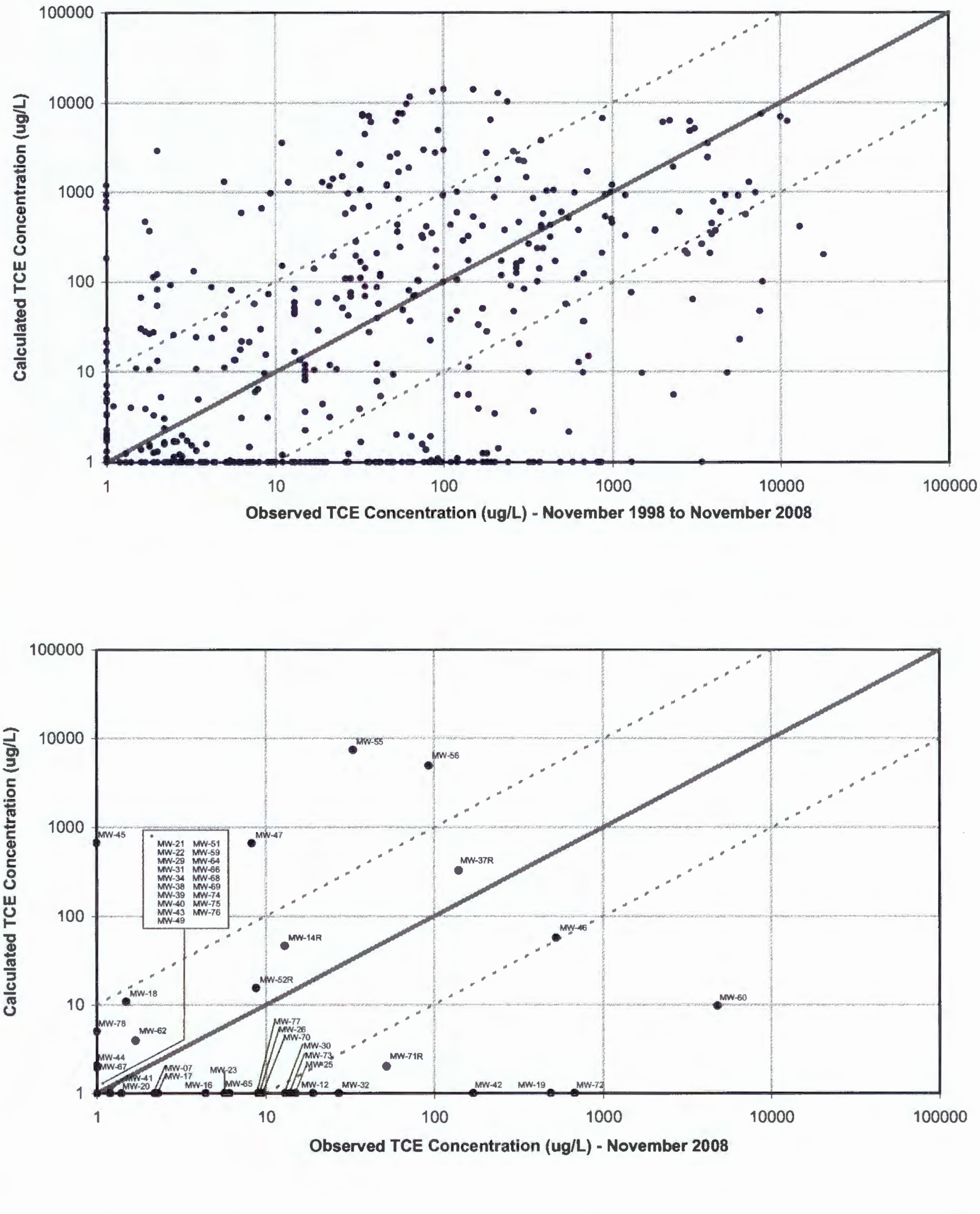


Figure 6.9 Comparisons of Calculated to Observed TCE Concentrations

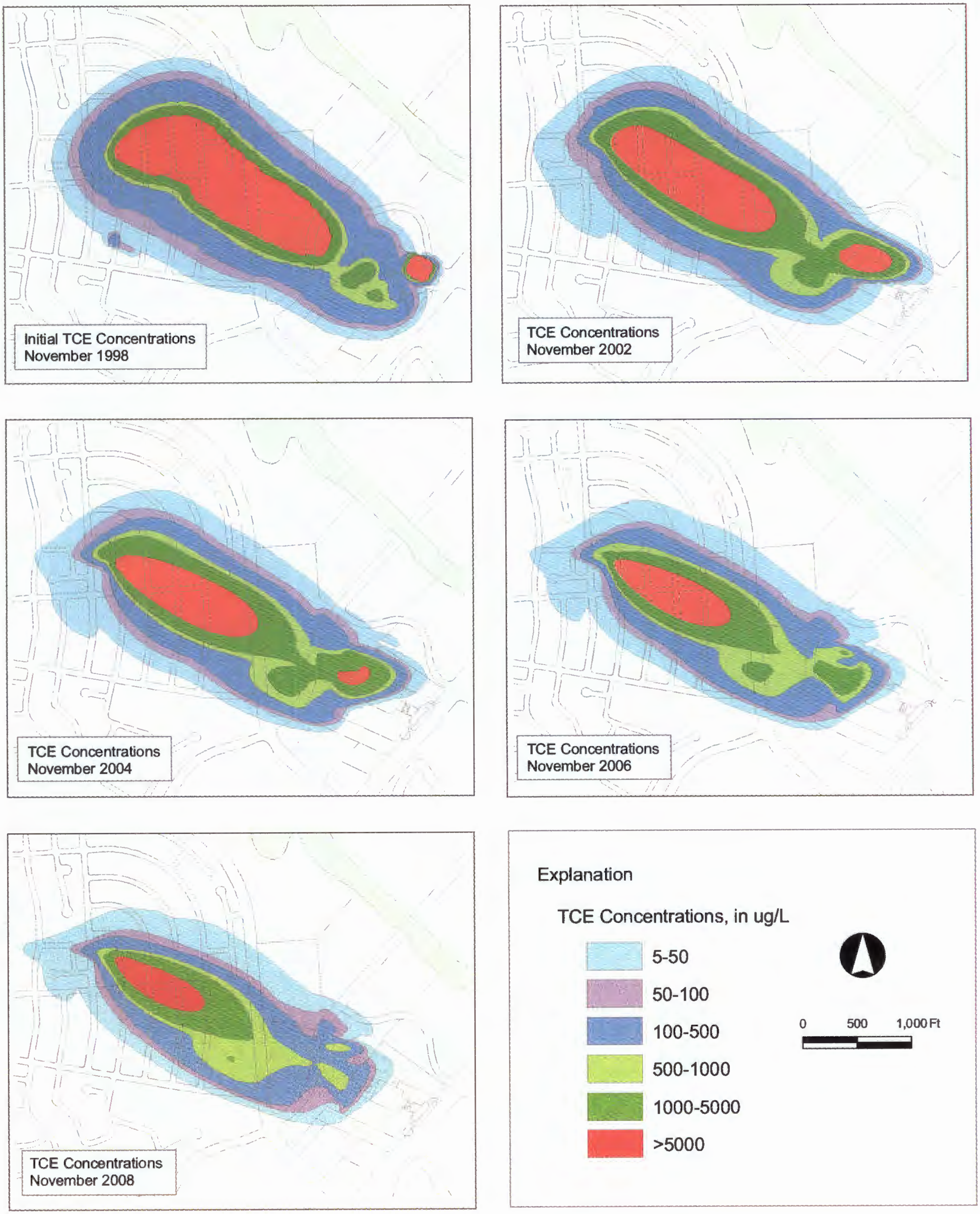


Figure 6.10 Model Calculated TCE Concentrations

TABLES

TABLES

Table 2.1

Completion Flow Zone, Location Coordinates, and Measuring Point Elevation of Wells

Well ID	Flow Zone[a]	Easting[b]	Northing[b]	Elevation[c]
CW-1	UFZ&LFZ	374740.43	1525601.48	5168.02
CW-2	UFZ-LLFZ	376788.70	1524459.40	5045.61
OB-1	UFZ&LFZ	374665.16	1525599.52	5169.10
OB-2	UFZ&LFZ	374537.98	1525606.65	5165.22
PZ-1	UFZ	372283.60	1523143.31	5147.36[e]
MW-7	UFZ	377535.41	1524101.14	5043.48
MW-9	UFZ	377005.75	1524062.25	5042.46
MW-12	UFZ	377023.27	1524102.56	5042.41
MW-13	UFZ	377137.23	1523998.34	5041.98
MW-14R	UFZ/ULFZ	376727.10	1524246.40	5040.92
MW-16	UFZ	377340.57	1524378.38	5047.50
MW-17	UFZ	377423.18	1524452.68	5049.28
MW-18	UFZ	377005.22	1524260.58	5043.38
MW-19	ULFZ	376986.52	1524269.27	5043.30
MW-20	LLFZ	376967.98	1524277.98	5043.20
MW-21	UFZ	377171.22	1524458.71	5045.78
MW-22	UFZ	377531.77	1524267.24	5044.73
MW-23	UFZ	377333.63	1524123.03	5045.74
MW-24	UFZ	377338.05	1524367.39	5048.70
MW-25	UFZ	377307.91	1524380.40	5046.17
MW-26	UFZ	377180.89	1524187.40	5045.37
MW-27	UFZ	377078.91	1524323.46	5046.04
MW-29	ULFZ	377144.48	1523998.74	5041.88
MW-30	ULFZ	376924.12	1524105.15	5042.12
MW-31	ULFZ	376731.49	1524215.04	5041.38
MW-32	LLFZ	376958.37	1524494.18	5045.29
MW-33	UFZ	376940.80	1524097.74	5042.20
MW-34	UFZ	376715.25	1523469.17	5034.33[d]
MW-37R	UFZ/ULFZ	376104.50	1524782.90	5093.15[d]
MW-38	LLFZ	377150.52	1523995.17	5041.70
MW-39	LLFZ	376961.13	1524088.17	5042.30
MW-40	LLFZ	376745.33	1524207.40	5041.44
MW-41	ULFZ	376945.67	1524479.28	5044.56
MW-42	ULFZ	377183.28	1524730.69	5057.33
MW-43	LLFZ	377169.66	1524747.27	5057.74
MW-44	ULFZ	376166.14	1524136.09	5058.63[d]
MW-45	ULFZ	376108.80	1524726.75	5089.50[d]
MW-46	ULFZ	376067.09	1525279.84	5118.86[d]
MW-47	UFZ	375638.14	1524967.74	5121.16
MW-48	UFZ	375369.75	1525239.86	5143.44
MW-49	3rd FZ	376763.40	1524197.32	5041.44
MW-51	UFZ	377291.45	1525000.02	5060.34
MW-52R	UFZ/ULFZ	374504.50	1525353.60	5156.37
MW-53	UFZ	374899.50	1525314.41	5148.62
MW-54	UFZ	375974.55	1526106.27	5097.69[d]
MW-55	LLFZ	375370.70	1525224.15	5143.45
MW-56	ULFZ	375371.31	1525207.68	5141.45
MW-57	UFZ	375849.02	1526406.98	5103.62[d]
MW-58	UFZ	375148.43	1525330.73	5146.40
MW-59	ULFZ	377253.38	1524991.51	5060.65
MW-60	ULFZ	375530.19	1525753.61	5134.40
MW-61	UFZ	375523.16	1525821.65	5134.74
MW-62	UFZ	375421.24	1524395.94	5073.69
MW-63	UFZ	376840.50	1525236.52	5063.10
MW-64	ULFZ	375968.81	1526127.81	5097.84
MW-65	LLFZ	374343.87	1525277.92	5156.45
MW-66	LLFZ	375859.24	1526389.09	5103.19[d]
MW-67	DFZ	375352.47	1525220.38	5142.21
MW-68	UFZ	374503.81	1526216.71	5168.54
MW-69	LLFZ	374502.80	1526239.55	5167.79
MW-70	3rd FZ	376981.33	1524492.75	5046.74
MW-71R	DFZ	375534.49	1525681.93	5134.12
MW-72	ULFZ	377079.68	1524630.73	5056.25
MW-73	ULFZ	376821.45	1524346.08	5051.08
MW-74	UFZ/ULFZ	374484.30	1527810.76	5094.80
MW-75	UFZ/ULFZ	374613.33	1528009.97	5113.74
MW-76	UFZ/ULFZ	375150.41	1527826.10	5108.32
MW-77	UFZ/ULFZ	377754.90	1524374.20	5045.64
MW-78	UFZ/ULFZ	377038.50	1524599.30	5052.91
MW-79	DFZ	374662.64	1525626.72	5168.50
PZG-1	Infilt. Gall.	374871.44	1527608.15	5090.90
Canal				4996.07

[a] UFZ denotes the Upper Flow Zone; ULFZ, LLFZ, and 3rdFZ denote the upper, lower, and deeper intervals of the Lower Flow Zone (LFZ); DFZ denotes a deeper flow zone separated from the Lower Flow Zone by a continuous clay layer that causes significant head differences between LFZ and DFZ.

[b] New Mexico "Modified State Plane" coordinates, in feet.
[c] In feet above mean sea level (MSL)
[d] Elevation effective February 1, 2005
[e] Elevation effective March 12, 2008.

Table 2.2

Well Screen Data

Well ID	Flow Zone	Elevation (ft above MSL)			Depth below Ground (ft)		Screen Length (ft)
		Ground Surface	Top of Screen	Bottom of Screen	Top of Screen	Bottom of Screen	
CW-1	UFZ&LFZ	5166.4	4957.5	4797.5	208.9	368.9	160.0
CW-2	UFZ-LLFZ	5048.5	4968.5	4918.5	80.0	130.0	50.0
OB-1	UFZ&LFZ	5166.2	4960.3	4789.8	205.9	376.4	170.5
OB-2	UFZ&LFZ	5164.8	4960.3	4789.7	204.5	375.1	170.6
PZ-1	UFZ	5141.3	4961.5	4951.3	179.8	190.0	10.2
MW-7	UFZ	5043.0	4979.7	4974.7	63.3	68.3	5.0
MW-9	UFZ	5042.4	4975.8	4970.8	66.6	71.6	5.0
MW-12	UFZ	5042.3	4978.2	4966.2	64.1	76.1	12.0
MW-13	UFZ	5041.9	4981.5	4971.6	60.4	70.3	9.9
MW-14R	UFZ/ULFZ	5040.8	4980.5	4950.5	60.3	90.3	30.0
MW-16	UFZ	5046.2	4979.7	4974.7	66.5	71.5	5.0
MW-17	UFZ	5047.5	4982.3	4977.3	65.2	70.2	5.0
MW-18	UFZ	5042.9	4976.0	4966.0	66.9	76.9	10.0
MW-19	ULFZ	5042.9	4944.8	4934.8	98.1	108.1	10.0
MW-20	LLFZ	5042.8	4919.2	4906.8	123.6	136.0	12.4
MW-21	UFZ	5045.7	4982.8	4977.8	62.9	67.9	5.0
MW-22	UFZ	5044.6	4977.2	4972.2	67.4	72.4	5.0
MW-23	UFZ	5045.6	4973.8	4968.8	71.8	76.8	5.0
MW-24	UFZ	5046.2	4977.5	4972.5	68.7	73.7	5.0
MW-25	UFZ	5046.1	4977.9	4972.9	68.2	73.2	5.0
MW-26	UFZ	5045.4	4969.1	4964.1	76.3	81.3	5.0
MW-27	UFZ	5045.8	4975.4	4970.4	70.4	75.4	5.0
MW-29	ULFZ	5041.9	4938.3	4928.3	103.6	113.6	10.0
MW-30	ULFZ	5041.7	4944.8	4934.8	96.9	106.9	10.0
MW-31	ULFZ	5040.9	4945.2	4935.2	95.7	105.7	10.0
MW-32	LLFZ	5044.8	4937.3	4927.3	107.5	117.5	10.0
MW-33	UFZ	5042.1	4980.1	4969.1	62.0	73.0	11.0
MW-34	UFZ	5034.4	4978.0	4968.0	56.4	66.4	10.0
MW-37R	UFZ/ULFZ	5093.0	4976.6	4946.6	116.4	146.4	30.0
MW-38	LLFZ	5041.6	4915.0	4905.0	126.6	136.6	10.0
MW-39	LLFZ	5042.2	4918.7	4908.7	123.5	133.5	10.0
MW-40	LLFZ	5040.0	4923.9	4913.9	116.1	126.1	10.0
MW-41	ULFZ	5044.1	4952.1	4942.1	92.0	102.0	10.0
MW-42	ULFZ	5054.8	4949.3	4939.3	105.5	115.5	10.0
MW-43	LLFZ	5055.2	4927.7	4917.7	127.5	137.5	10.0
MW-44	ULFZ	5058.8	4952.4	4942.4	106.4	116.4	10.0
MW-45	ULFZ	5090.1	4948.5	4938.5	141.6	151.6	10.0

Table 2.2

Well Screen Data

Well ID	Flow Zone	Elevation (ft above MSL)			Depth below Ground (ft)		Screen Length (ft)
		Ground Surface	Top of Screen	Bottom of Screen	Top of Screen	Bottom of Screen	
MW-46	ULFZ	5118.5	4949.4	4939.4	169.1	179.1	10.0
MW-47	UFZ	5120.7	4976.4	4961.4	144.3	159.3	15.0
MW-48	UFZ	5143.0	4976.9	4961.9	166.1	181.1	15.0
MW-49	3rd FZ	5041.0	4903.2	4893.2	137.8	147.8	10.0
MW-51	UFZ	5059.9	4984.5	4974.5	75.4	85.4	10.0
MW-52R	UFZ/ULFZ	5156.2	4968.5	4938.5	187.0	217.0	30.0
MW-53	UFZ	5148.6	4974.4	4960.4	174.2	188.2	14.0
			4963.6[a]	4943.6[a]	185.0[a]	205.0[a]	20.0[a]
MW-54	UFZ	5097.2	4976.8	4961.8	120.4	135.4	15.0
MW-55	LLFZ	5143.1	4913.1	4903.1	230.0	240.0	10.0
MW-56	ULFZ	5141.0	4942.9	4932.9	198.1	208.1	10.0
MW-57	UFZ	5103.1	4978.0	4963.0	125.1	140.1	15.0
MW-58	UFZ	5146.4	4975.4	4960.4	171.0	186.0	15.0
MW-59	ULFZ	5060.2	4954.9	4944.4	105.3	115.8	10.5
MW-60	ULFZ	5134.4	4949.5	4939.5	184.9	194.9	10.0
MW-61	UFZ	5134.8	4976.2	4961.2	158.6	173.6	15.0
MW-62	UFZ	5073.7	4980.8	4965.8	92.9	107.9	15.0
MW-63	UFZ	5063.1	4983.1	4968.1	80.0	95.0	15.0
MW-64	ULFZ	5097.4	4959.3	4949.1	138.1	148.3	10.2
MW-65	LLFZ	5156.5	4896.4	4886.4	260.1	270.1	10.0
MW-66	LLFZ	5102.6	4903.3	4893.3	199.3	209.3	10.0
MW-67	DFZ	5142.2	4798.1	4788.1	344.1	354.1	10.0
MW-68	UFZ	5168.5	4970.5	4950.5	198.0	218.0	20.0
MW-69	LLFZ	5167.8	4904.7	4894.7	263.1	273.1	10.0
MW-70	3rd FZ	5046.3	4912.1	4902.1	134.2	144.2	10.0
MW-71R	DFZ	5134.2	4761.5	4756.5	372.7	377.7	5.0
MW-72	ULFZ	5053.7	4955.0	4945.0	98.7	108.7	10.0
MW-73	ULFZ	5050.6	4945.5	4940.5	105.1	110.1	5.0
MW-74	UFZ/ULFZ	5092.4	4969.2	4939.2	123.2	153.2	30.0
MW-75	UFZ/ULFZ	5111.6	4971.2	4941.2	140.4	170.4	30.0
MW-76	UFZ/ULFZ	5105.5	4972.4	4942.4	133.1	163.1	30.0
MW-77	UFZ/ULFZ	5045.5	4985.9	4955.9	59.6	89.6	30.0
MW-78	UFZ/ULFZ	5050.5	4988.1	4958.1	62.4	92.4	30.0
MW-79	DFZ	5166.7	4767.7	4752.7	399.0	414.0	15.0
			4747.7	4732.7	419.0	434.0	15.0

[a] Well deepened to 205 feet in December, 2008. New screened interval 185-205 feet BLS.

Table 2.3

Production History of the Former On-Site Groundwater Recovery System

Year	Volume of Recovered Water (gal)	Average Discharge Rate (gpm)
1988[a]	25,689	1.05
1989	737,142	1.40
1990	659,469	1.25
1991	556,300	1.06
1992	440,424	0.84
1993	379,519	0.72
1994	370,954	0.71
1995	399,716	0.76
1996	306,688	0.58
1997	170,900	0.33
1998	232,347	0.44
1999[b]	137,403	0.26
Total Recovered Volume (gal)	**4,416,550**	
Average Discharge Rate (gpm)		**0.77**

[a] System began operating on December 15, 1988.

[b] System opertaions were terminated on November 16, 1999.

Table 2.4

Water-Level Elevations - Fourth Quarter 1998[a]

Well ID	Flow Zone	Elevation (ft above MSL)
PW-1	UFZ	4973.59
PZ-1	UFZ	4956.59
MW-7	UFZ O/S [b]	4977.42
MW-9	UFZ O/S	4973.06
MW-12	UFZ O/S	4972.82
MW-13	UFZ O/S	4974.35
MW-14	UFZ	4971.12
MW-15	UFZ	Dry
MW-16	UFZ O/S	4978.43
MW-17	UFZ O/S	4978.70
MW-18	UFZ O/S	4971.87
MW-19	ULFZ	4971.85
MW-20	LLFZ	4971.47
MW-21	UFZ O/S	4978.31
MW-22	UFZ O/S	4977.89
MW-23	UFZ O/S	4975.91
MW-24	UFZ O/S	4978.23
MW-25	UFZ O/S	4978.31
MW-26	UFZ O/S	4973.44
MW-27	UFZ O/S	4974.05
MW-28	UFZ O/S	4971.09
MW-29	ULFZ	4973.68
MW-30	ULFZ	4972.28
MW-31	ULFZ	4971.23
MW-32	ULFZ [c]	4970.96
MW-33	UFZ O/S	4972.54
MW-34	UFZ	4974.51
MW-35	UFZ	4970.78
MW-36	UFZ	4970.03
MW-37	UFZ	4968.32
MW-38	LLFZ	4973.70
MW-39	LLFZ	4972.49

Well	Flow Zone	Elevation (ft above MSL)
MW-40	LLFZ	4971.25
MW-41	ULFZ	4971.09
MW-42	ULFZ	4970.65
MW-43	LLFZ	4970.45
MW-44	ULFZ	4970.11
MW-45	ULFZ	4968.33
MW-46	ULFZ	4966.95
MW-47	UFZ	4966.68
MW-48	UFZ	4965.81
MW-49	LLFZ [c]	4971.03
MW-50	UFZ	Dry
MW-51	UFZ O/S	4980.09
MW-52	UFZ	4963.17
MW-53	UFZ	4964.92
MW-54	UFZ	4965.56
MW-55	LLFZ	4965.13
MW-56	ULFZ	4965.76
MW-57	UFZ	4964.87
MW-58	UFZ	4965.43
MW-59	ULFZ	4969.46
MW-60	ULFZ	4965.33
MW-61	UFZ	4965.37
MW-62	UFZ	4967.52
MW-63	UFZ O/S	4970.98
MW-64	ULFZ	4965.41
MW-65	LLFZ	4963.05
MW-66	LLFZ	4963.98
MW-67	DFZ	4958.56
MW-68	UFZ	4962.25
MW-69	LLFZ	4962.13
MW-70	LLFZ [d]	4970.18
MW-71	DFZ	4958.51

[a] Water levels were measured on November 10, 1998, except for wells PW-1, MW-18, and MW-23 through MW-28 which were measured on November 25, 1998.

[b] UFZ O/S denotes UFZ wells, mostly on-site, which are screened above or within the 4970-foot silt/clay.

[c] Previously classified as LLFZ.

[d] Previously classified as 3rdFZ.

Table 2.5

Water-Quality Data - Fourth Quarter 1998[a]

Well ID	Sampling Date	Concentration (µg/L) TCE	DCE	TCA
CW-1	09/01/98	140	2.9	<20
OB-1	09/01/98	180	3.6	<20
OB-2	09/01/98	72	1.7	<20
PW-1	12/04/98	48	1.0	2.2
MW-7	12/01/98	63	15	12
MW-9	12/03/98	290	19	18
MW-12	12/07/98	380	26	18
MW-13	12/01/98	70	3.2	8.0
MW-14	12/01/98	430	24	4.2
MW-16	12/08/98	1200	30	170
MW-17	12/01/98	68	3.5	13
MW-18	12/02/98	600	50	42
MW-19	11/23/98	4.2	<1.0	<1.0
MW-20	11/23/98	<1.0	<1.0	<1.0
MW-21	12/02/98	7.5	<1.0	1.1
MW-22	11/19/98	13	2.0	4.6
MW-23	12/03/98	6200	400	720
MW-24	12/08/98	4700	74	480
MW-25	12/08/98	5600	73	540
MW-26	12/03/98	6500	590	550
MW-27	12/02/98	380	24	90
MW-29	11/19/98	<1.0	<1.0	<1.0
MW-30	11/23/98	5.4	<1.0	<1.0
MW-31	11/23/98	<1.0	<1.0	<1.0
MW-32	11/30/98	550	96	30
MW-33	12/02/98	630	53	28
MW-34	11/18/98	<1.0	<1.0	<1.0
MW-35	12/08/98	<1.0	<1.0	<1.0
MW-36	12/07/98	1.4	<1.0	<1.0
MW-37	12/03/98	990	48	<5
MW-38	11/19/98	<1.0	<1.0	<1.0
MW-39	11/23/98	<1.0	<1.0	<1.0
MW-40	11/30/98	<1.0	<1.0	<1.0

Well ID	Sampling Date	Concentration (µg/L) TCE	DCE	TCA
MW-41	11/19/98	170	26	<15
MW-42	11/19/98	370	48	21
MW-43	11/19/98	25	5.1	5.4
MW-44	11/18/98	1.3	<1.0	<1.0
MW-45	11/18/98	40	1.7	<1.0
MW-46	11/19/98	2200	130	2.3
MW-47	11/17/98	34	1.2	<1.0
MW-48	11/17/98	28	1.0	<1.0
MW-49	11/23/98	<1.0	<1.0	<1.0
MW-51	11/18/98	<1.0	<1.0	<1.0
MW-52	11/30/98	<1.0	<1.0	<1.0
MW-53	11/16/98	99	3.4	<1.0
MW-55	11/16/98	390	10	<1.0
MW-56	11/16/98	140	4.7	<1.0
MW-57	12/08/98	<1.0	<1.0	<1.0
MW-58	11/16/98	71	2.5	<1.0
MW-59	11/18/98	<1.0	<1.0	<1.0
MW-60	11/17/98	7700	350	52
MW-61	12/07/98	1000	54	11
MW-62	12/07/98	2.0	6.6	4.8
MW-63	12/02/98	<1.0	<1.0	<1.0
MW-64	11/17/98	<1.0	<1.0	<1.0
MW-65	11/16/98	13	<1.0	<1.0
MW-66	11/17/98	<1.0	<1.0	<1.0
MW-67	11/17/98	<1.0	<1.0	<1.0
MW-68	11/12/98	<1.0	<1.0	<1.0
MW-69	11/12/98	<1.0	<1.0	<1.0
MW-70	11/23/98	<1.0	<1.0	<1.0
MW-71	11/17/98	56	1.6	<1.0
TW-1	02/18/98	3100	280	180
	02/18/98	3400	270	170
TW-2	02/19/98	18	<1.0	<1.0
	02/19/98	16	<1.0	<1.0

[a] Includes February 18, 1998 data from temporary well TW-1/2 which was drilled at the current location of well MW-73, and September 1, 1998 data from the containment well CW-1 and observation wells OB-1 and OB-2.

Note: Shaded cells indicate concentrations that exceed MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 mg/L for TCE and DCE, and 60 mg/L for TCA).

Table 3.1

Downtime in the Operation of the Containment Systems - 2008

(a) Off-Site Containment System

Date of Downtime		Duration	Cause
From	To	(hours)	
3-Mar	3-Mar	2.33	Gallery signal error
12-Mar	12-Mar	6.17	Low chemical feed tank
16-Apr	16-Apr	0.50	Power outage
5-May	5-May	2.50	Power outage
27-May	28-May	27.83	Check valve replacement
12-Jun	12-Jun	8.50	Low chemical feed tank
15-Jun	15-Jun	0.33	Power outage
25-Jun	25-Jun	0.17	Power outage
27-Jun	27-Jun	1.83	Power outage
2-Jul	2-Jul	6.00	Power outage
29-Jul	30-Jul	9.17	Power outage
7-Aug	7-Aug	5.92	Infiltration gallery shutoff test
8-Sep	8-Sep	0.50	Change float
9-Sep	9-Sep	3.00	Power outage
12-Sep	12-Sep	1.00	Power outage
15-Sep	15-Sep	5.00	Discharge pump adjustment
22-Sep	22-Sep	0.25	Check float
23-Sep	23-Sep	0.33	O&M
5-Oct	5-Oct	4.08	Power outage
11-Oct	11-Oct	7.47	Power outage
20-Oct	20-Oct	7.17	Low chemical feed tank
21-Oct	22-Oct	35.87	Vandalism
27-Oct	27-Oct	6.00	Discharge pump adjustment
29-Oct	29-Oct	2.47	Power outage
1-Dec	1-Dec	1.33	Power outage
22-Dec	22-Dec	1.33	Power outage
25-Dec	25-Dec	8.88	Gallery float switch failure
26-Dec	29-Dec	53.15	Radio communication failure
29-Dec	29-Dec	1.34	Power outage
Total Downtime		**210.42**	

(b) Source Containment System

Date of Downtime		Duration	Cause
From	To	(hours)	
15-Jun	15-Jun	0.33	Power outage
25-Jun	25-Jun	12.33	Failure discharge float control
27-Jun	27-Jun	5.50	Plugged water meter screen
29-Jul	29-Jul	10.17	Power outage
8-Sep	8-Sep	0.50	Power outage
12-Sep	12-Sep	0.50	Power outage
15-Sep	15-Sep	26.00	Power outage
5-Oct	5-Oct	4.50	Power outage
29-Oct	29-Oct	1.40	Power outage
Total Downtime		**61.23**	

Table 4.1

Quarterly Water-Level Elevations - 2008

Well ID	Flow Zone	Elevation (feet above MSL)			
		Feb. 19	May 13	Aug. 4	Nov. 3
CW-1	UFZ&LFZ	4934.14	4933.15	4932.77	4932.58
CW-2	UFZ&LFZ	4956.77	4955.83	4955.65	4955.49
OB-1	UFZ&LFZ	4954.92	4954.50	4954.15	4953.88
OB-2	UFZ&LFZ	4956.41	4956.07	4955.41	4955.17
PZ-1	UFZ	4952.57	4953.00	4952.01	4952.02
MW-7	UFZ O/S	4975.19	4975.54	4975.01	4975.08
MW-9[a]	UFZ O/S	4969.99	4970.06	4969.32	4969.62
MW-12	UFZ O/S	4969.35	4969.37	4968.82	4968.81
MW-13	UFZ O/S	NA	4971.77	Dry	NA
MW-14-R	UFZ/ULFZ	4967.35	4967.18	4966.68	4966.62
MW-16	UFZ O/S	4981.90	4981.94	4981.58	4981.40
MW-17	UFZ O/S	4981.39	4981.69	4981.02	4981.46
MW-18	UFZ O/S	4974.57	4973.83	4972.38	4971.96
MW-19	ULFZ	4968.43	4968.31	4967.81	4967.95
MW-20	LLFZ	4967.91	4967.78	4967.26	4967.43
MW-21	UFZ O/S	4982.77	4982.53	4982.43	4982.28
MW-22	UFZ O/S	4976.96	4977.32	4976.63	4976.61
MW-23	UFZ O/S	4974.02	4974.24	4973.72	4973.80
MW-24	UFZ O/S	4981.70	4981.71	4981.37	4981.23
MW-25	UFZ O/S	4981.91	4981.89	4981.62	4981.74
MW-26	UFZ O/S	4971.19	4971.21	4970.67	4970.83
MW-27	UFZ O/S	4981.14	4980.91	4980.74	4980.81
MW-29	ULFZ	4970.58	4970.70	4970.16	4970.31
MW-30	ULFZ	4968.87	4968.83	4968.34	4968.43
MW-31	ULFZ	4967.44	4967.31	4966.79	4966.93
MW-32	ULFZ	4967.36	4967.12	4966.59	4966.77
MW-33	UFZ O/S	NA	NA	NA	Dry
MW-34	UFZ	4971.12	4971.53	4971.03	4970.84
MW-37-R	UFZ/ULFZ	4964.37	4964.02	4963.54	4963.41
MW-38	LLFZ	4970.56	4970.45	4970.21	4969.96
MW-39	LLFZ	4968.60	4969.17	4968.70	4968.79
MW-40	LLFZ	4967.53	4967.38	4966.89	4966.99
MW-41	ULFZ	4967.82	4967.56	4967.07	4967.01
MW-42	ULFZ	4967.90	4967.55	4966.90	4967.20
MW-43	LLFZ	4967.55	4967.30	4966.61	4966.94
MW-44	ULFZ	4966.63	4966.50	4966.07	4965.92

Well ID	Flow Zone	Elevation (feet above MSL)			
		Feb. 19	May 13	Aug. 4	Nov. 3
MW-45	ULFZ	4964.57	4963.68	4963.95	4963.77
MW-46	ULFZ	4963.58	4963.33	4962.88	4962.71
MW-47	UFZ	4963.11	4962.83	4962.46	4962.16
MW-48	UFZ	4961.98	4961.72	4961.52	NA
MW-49	LLFZ	4967.52	4967.46	4966.86	4967.04
MW-51	UFZ O/S	4981.76	4981.84	4981.56	4981.71
MW-52R	UFZ/ULFZ	4957.92	4957.67	4957.03	4956.62
MW-53	UFZ	4960.21	4960.01	4959.80	DRY
MW-54	UFZ	4962.94	4962.48	4963.05[a]	4962.83[a]
MW-55	LLFZ	4960.77	4960.44	4959.82	4959.75
MW-56	ULFZ	4961.91	4961.78	4961.38	4960.90
MW-57	UFZ	4962.64	NA	NA	NA
MW-58	UFZ	4961.30	4961.04	4960.78	4960.48
MW-59	ULFZ	4966.92	4966.49	4965.90	4966.14
MW-60	ULFZ	4961.82	4961.56	4961.08	4960.70
MW-61	UFZ	4961.74	4961.52	4960.78	NA
MW-62	UFZ	4963.94	4963.80	4963.38	4963.24
MW-63	UFZ O/S	4974.30	4971.64	4970.77	4973.09
MW-64	ULFZ	4962.92	4962.54	4961.96	4961.88
MW-65	LLFZ	4957.94	4957.67	4956.98	4957.10
MW-66	LLFZ	4961.01	4960.49	4959.71	4959.93
MW-67	DFZ	4954.99	4953.73	4952.31	4953.63
MW-68	UFZ	4958.15	4957.93	4957.21	4956.70
MW-69	LLFZ	4958.05	4957.72	4956.94	4956.55
MW-70	LLFZ	4966.79	4966.53	4965.94	4966.20
MW-71-R	DFZ	4955.05	4953.66	4952.50	4953.42
MW-72	ULFZ	4967.91	4967.54	4966.95	4967.30
MW-73	ULFZ	4966.84	4966.63	4966.10	4966.23
MW-74	UFZ/ULFZ	4960.55	4960.11	4959.02	4958.88
MW-75	UFZ/ULFZ	4964.95	4964.41	4963.81	4963.41
MW-76	UFZ/ULFZ	4966.45	4965.78	4965.04	4964.40
MW-77	UFZ/ULFZ	4976.55	4976.88	4976.30	4976.09
MW-78	UFZ/ULFZ	4974.18	4973.65	4973.55	4973.26
MW-79[c]	DFZ	4953.32	4951.75	4950.27	4951.67
PZG-1	Infilt. Gall.	NA	NA	NA	NA
Canal		NA	NA	4990.97	NA

[a] Water level was at or below screen August 4, 2008 and Nov 3, 2008

[b] Measured near the SE corner of Sparton property.

[c] The sounder used for water-level measurements in this well is different than that used for measuring all the other wells. Based on measurements made by both sounders in other DFZ wells on April 27, 2009 an adjustment of +0.44 ft has been made to the reported water-level elevations for this well to make them consistent with other wells.

Table 4.2

Water-Quality Data - Fourth Quarter 2008
(a) VOC Data

Well ID	Sampling Date	Concentration (μg/L)		
		TCE	DCE	TCA
CW-1	11/02/08	990	65	2.5
CW-2	11/02/08	72	9.4	<1.0
MW-7	11/14/08	2.2	<1.0	<1.0
MW-9[a]	11/11/08	----	----	----
MW-12[b]	11/11/08	19	<1.0	<1.0
MW-13[a]	11/11/08	----	----	----
MW-14R	11/06/08	13	<1.0	<1.0
MW-16	11/14/08	4.4	<1.0	<1.0
MW-17	11/11/08	2.3	<1.0	<1.0
MW-18[b]	11/11/08	1.5	<1.0	<1.0
MW-19	11/06/08	490	77	1.7
MW-20	11/07/08	1.4	<1.0	<1.0
MW-21	11/11/08	<1.0	<1.0	<1.0
MW-22	11/07/08	<1.0	<1.0	<1.0
MW-23	11/14/08	6.1	<1.0	<1.0
MW-25	11/14/08	15	<1.0	<1.0
MW-26	11/18/08	9	<1.0	<1.0
MW-29	11/07/08	<1.0	<1.0	<1.0
MW-30	11/08/08	13	<1.0	<1.0
MW-31	11/10/08	<1.0	<1.0	<1.0
MW-32	11/10/08	27	3.4	<1.0
MW-33[a]	11/11/08	----	----	----
MW-34	11/24/08	<1.0	<1.0	<1.0
MW-37R	11/18/08	140	4.1	<1.0
MW-38	11/10/08	<1.0	<1.0	<1.0
MW-39	11/10/08	<1.0	<1.0	<1.0
MW-40	11/11/08	<1.0	<1.0	<1.0
MW-41	11/13/08	1.2	<1.0	<1.0
MW-42	11/11/08	170	29	1.5
MW-43	11/11/08	<1.0	<1.0	<1.0
MW-44	11/13/08	<1.0	<1.0	<1.0
MW-45	11/13/08	<1.0	<1.0	<1.0

Well ID	Sampling Date	Concentration (μg/L)		
		TCE	DCE	TCA
MW-46[b]	11/18/08	530	68	4.6
MW-47	11/18/08	8.3	<1.0	<1.0
MW-48	11/13/08	----	----	----
MW-49	11/18/08	<1.0	<1.0	<1.0
MW-51	11/14/08	<1.0	<1.0	<1.0
MW-52R	11/12/08	8.8	17	1.6
MW-53[c]	02/23/09	16	<1.0	<1.0
MW-55	11/13/08	33	1.1	<1.0
MW-56[b]	11/13/08	93	2.8	<1.0
MW-57[a]	11/13/08	----	----	----
MW-58[a]	11/13/08	----	----	----
MW-59	11/12/08	<1.0	<1.0	<1.0
MW-60	11/18/08	4800	400	12
MW-61[a]	11/18/08	----	----	----
MW-62	11/17/08	1.7	5.1	2.7
MW-64	11/20/08	<1.0	<1.0	<1.0
MW-65	11/21/08	5.7	19	4.5
MW-66	11/13/08	<1.0	<1.0	<1.0
MW-67	11/13/08	<1.0	<1.0	<1.0
MW-68	11/12/08	<1.0	<1.0	<1.0
MW-69	11/12/08	<1.0	<1.0	<1.0
MW-70	11/18/08	9.5	<1.0	<1.0
MW-71R	11/18/08	52	1.9	<1.0
MW-72	11/18/08	680	74	1.9
MW-73	11/26/08	14	1.3	<1.0
MW-74	11/20/08	<1.0	<1.0	<1.0
MW-75	11/20/08	<1.0	<1.0	<1.0
MW-76	11/20/08	<1.0	<1.0	<1.0
MW-77	11/26/08	9.1	<1.0	<1.0
MW-78[b]	11/20/08	<1.0	<1.0	<1.0
MW-79	11/21/08	<1.0	<1.0	<1.0

[a] Well not sampled because it was dry or did not have sufficient water for sampling.

[b] Results for well are the average of duplicate samples.

[c] Well sample unavailable for 2008. February 23, 2009 data are reported.

Note: Shaded cells indicate concentrations that exceed MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 mg/L for TCE and DCE, and 60 mg/L for TCA)

Table 4.3

Flow Rates - 2008

Month	Off-Site Containment Well		Source Containment Well		Total	
	Volume Pumped (gal)	Average Rate (gpm)	Volume Pumped (gal)	Average Rate (gpm)	Volume Pumped (gal)	Average Rate (gpm)
Jan.	9,977,066	224	2,162,116	48	12,139,182	272
Feb.	9,340,799	224	1,995,105	48	11,335,904	271
Mar.	9,874,357	221	2,171,710	49	12,046,067	270
Apr.	9,637,000	223	2,141,898	50	11,778,898	273
May	9,557,294	214	2,219,022	50	11,776,316	264
June	9,452,975	219	2,065,550	48	11,518,525	267
July	9,748,563	218	2,141,142	48	11,889,705	266
Aug.	9,941,276	223	2,198,342	49	12,139,618	272
Sep.	9,479,872	219	2,031,737	47	11,511,609	266
Oct.	9,073,190	203	2,149,832	48	11,223,022	251
Nov.	9,647,536	223	2,067,434	48	11,714,971	271
Dec.	8,962,705	201	2,088,125	47	11,050,830	248
Total or Average	**114,692,635**	**218**	**25,432,013**	**48**	**140,124,648**	**266**

Table 4.4

Influent and Effluent Quality - 2008[a]

(a) Off-Site Containment System

Sampling Date	Concentration (μg/L)							
	Influent				Effluent			
	TCE	DCE	TCA	Cr Total	TCE	DCE	TCA	Cr Total
01/04/08	1000	71	<1.0	19	<1.0	<1.0	<1.0	20
02/01/08	990	73	4.5	19	<1.0	<1.0	<1.0	19
03/03/08	1200	90	<1.0	23	<1.0	<1.0	<1.0	22
04/01/08	850	62	3.1	20	<1.0	<1.0	<1.0	19
05/01/08	970	73	<1.0	20	<1.0	<1.0	<1.0	19
06/02/08	1000	68	3.0	19	<1.0	<1.0	<1.0	19
07/01/08	1000	74	2.7	19	<1.0	<1.0	<1.0	19
08/05/08	1100	89	3.1	18	<1.0	<1.0	<1.0	18
09/02/08	930	67	3.5	18	<1.0	<1.0	<1.0	17
09/30/08	960	74	2.6	16	<1.0	<1.0	<1.0	16
11/03/08	990	65	2.5	16	<1.0	<1.0	<1.0	16
12/01/08	790	64	2.3	15	<1.0	<1.0	<1.0	17
01/01/09	920	71	2.8	18	<1.0	<1.0	<1.0	18

(b) Source Containment System

Sampling Date	Concentration (μg/L)							
	Influent				Effluent			
	TCE	DCE	TCA	Cr Total	TCE	DCE	TCA	Cr Total
01/04/08	120	12	<1.0	29	<1.0	<1.0	<1.0	29
02/11/08	100	14	<1.0	27	<1.0	<1.0	<1.0	28
03/03/08	100	13	<1.0	28	<1.0	<1.0	<1.0	28
04/01/08	87	11	<1.0	28	<1.0	<1.0	<1.0	28
05/01/08	90	11	<1.0	30	<1.0	<1.0	<1.0	30
06/02/08	92	10	<1.0	28	<1.0	<1.0	<1.0	28
07/01/08	95	10	<1.0	32	<1.0	<1.0	<1.0	19
08/05/08	98	13	<1.0	28	<1.0	<1.0	<1.0	28
09/02/08	79	9.6	<1.0	27	<1.0	<1.0	<1.0	26
09/30/08	75	9.0	<1.0	16	<1.0	<1.0	<1.0	26
11/02/08	72	9.4	<1.0	24	<1.0	<1.0	<1.0	19
12/01/08	68	8.7	<1.0	25	<1.0	<1.0	<1.0	24
01/01/09	66	10	<1.0	27	<1.0	<1.0	<1.0	27

[a] Data from January 1, 2009 has been included to show conditions at the end of the year.

Note: Shaded cells indicate concentrations that exceed MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 ug/L for TCE and DCE, 60 ug/L for TCA and 50 ug/L for total chromium).

Table 5.1

Concentration Changes in Monitoring Wells - 1998 to 2008

Well ID	Change in Concentration (μg/l) TCE	DCE	TCA
CW-1	850	62	2.5
CW-2[a]	-928	-181	-35
MW-7	-61	-15	-12
MW-12	-362	-26	-18
MW-14R[b]	-417	-24	-4.2
MW-16	-1196	-30	-170
MW-17	-66	-3.5	-13
MW-18	-599	-50	-100
MW-19	486	77	1.7
MW-20	1.4	0	0
MW-21	-7.5	0	-1.1
MW-22	-13	-2	-4.6
MW-23	-6194	-400	-720
MW-25	-5585	-73	-540
MW-26	-6491	-590	-550
MW-29	0	0	0
MW-30	7.6	0	0
MW-31	0	0	0
MW-32	-523	-93	-30
MW-34	0	0	0
MW-37R[b]	-850	-44	0
MW-38	0	0	0
MW-39	0	0	0
MW-40	0	0	0
MW-41	-169	-26	0
MW-42	-200	-19	-20

Well ID	Change in Concentration (μg/l) TCE	DCE	TCA
MW-43	-25	-5.1	-5.4
MW-44	-1.3	0	0
MW-45	-40	-1.7	0
MW-46	-1670	-63	2.3
MW-47	-26	-1.2	0
MW-49	0	0	0
MW-51	0	0	0
MW-52R[b]	8.8	17	1.6
MW-53[c]	-83	-3.4	0
MW-55	-357	-8.9	0
MW-56	-47.5	-2	0
MW-59	0	0	0
MW-60	-2900	50	-40
MW-62	-0.3	-1.5	-2.1
MW-64	0	0	0
MW-65	-7.3	19	4.5
MW-66	0	0	0
MW-67	0	0	0
MW-68	0	0	0
MW-69	0	0	0
MW-70	9	0	0
MW-71R[b]	-4	0.3	0
MW-72[a]	-1120	-146	-97
MW-73[a]	-3986	-519	-240
MW-77[a]	-6.9	-1.2	0
MW-78[a]	-6	0	0

[a] Change from concentration in first available sample.

[b] Change from concentration in original well.

[c] Change calculated with February 2009 sample.

[d] "0" indicates concentration below detection limits during both sampling events.

Note: Shaded cells indicate well used in original and/or current plume definition.

Table 5.2

Summary of Annual Flow Rates - 1998 to 2008

Year	Off-Site Containment Well		Source Containment Well		Total	
	Volume Pumped (gal)	Average Rate (gpm)	Volume Pumped (gal)	Average Rate (gpm)	Volume Pumped (gal)	Average Rate (gpm)
1998[a]	1,694,830				1,694,830	
1999	114,928,700	219			114,928,700	219
2000	114,094,054	216			114,094,054	216
2001	113,654,183	216			113,654,183	216
2002	116,359,389	221	25,403,490	49	141,762,879	270
2003	118,030,036	225	27,292,970	52	145,323,006	277
2004	113,574,939	215	26,105,202	50	139,680,141	265
2005	118,018,628	225	25,488,817	48	143,507,445	273
2006	112,213,088	213	24,133,264	46	136,346,352	259
2007	117,098,422	223	23,983,802	46	141,082,224	269
2008	114,692,635	218	25,432,013	48	140,124,648	266
Total or Average	**1,154,358,904**	**219**	**177,839,558**	**48**	**1,332,198,462**	**253**

[a] Volume pumped during the testing of the well in early December, and during the first day of operation on December 31, 1998.

Table 5.3
Contaminant Mass Removal - 2008

(a) Total

	Mass Removed	(kg)	(lbs)
2008	TCE	433	955
	DCE	32.6	71.8
	TCA	1.13	2.50
	Total	**468**	**1,030**

(b) Off-Site Containment Well

Month	Mass Removed						Total	
	TCE		DCE		TCA			
	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)
Jan.	37.6	82.8	2.72	5.99	0.0944	0.208	40.4	89.0
Feb.	38.7	85.4	2.88	6.35	0.0884	0.195	41.7	91.9
Mar.	38.3	84.5	2.84	6.26	0.0673	0.148	41.2	90.9
Apr.	33.2	73.2	2.46	5.43	0.0657	0.145	35.7	78.8
May	35.6	78.6	2.55	5.62	0.0633	0.140	38.2	84.3
June	35.8	78.9	2.54	5.60	0.1020	0.225	38.4	84.7
July	38.7	85.4	3.01	6.63	0.1070	0.236	41.9	92.3
Aug.	38.2	84.2	2.94	6.47	0.1242	0.274	41.3	91.0
Sep.	33.9	74.8	2.53	5.58	0.1094	0.241	36.6	80.6
Oct.	33.5	73.8	2.39	5.26	0.0876	0.193	36.0	79.3
Nov.	32.5	71.7	2.36	5.19	0.0876	0.193	35.0	77.0
Dec.	29.0	64.0	2.29	5.05	0.0865	0.191	31.4	69.2
Total	**425**	**937**	**31.5**	**69.4**	**1.08**	**2.39**	**458**	**1,010**

(c) Source Containment Well

Month	Mass Removed						Total	
	TCE		DCE		TCA			
	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)	(kg)	(lbs)
Jan.	0.900	1.98	0.106	0.234	0.00409	0.00902	1.01	2.22
Feb.	0.755	1.66	0.102	0.225	0.00378	0.00833	0.861	1.89
Mar.	0.769	1.69	0.0986	0.217	0.00411	0.00906	0.872	1.92
Apr.	0.718	1.58	0.0892	0.197	0.00405	0.00893	0.811	1.79
May	0.764	1.69	0.0882	0.194	0.00420	0.00926	0.856	1.89
June	0.731	1.61	0.0782	0.172	0.00391	0.00862	0.813	1.79
July	0.782	1.72	0.0932	0.205	0.00405	0.00893	0.879	1.93
Aug.	0.736	1.62	0.0940	0.207	0.00416	0.00917	0.834	1.84
Sep.	0.592	1.31	0.0715	0.158	0.00385	0.00849	0.667	1.48
Oct.	0.598	1.32	0.0749	0.165	0.00407	0.00897	0.677	1.49
Nov.	0.548	1.21	0.0708	0.156	0.00391	0.00862	0.623	1.37
Dec.	0.530	1.17	0.0739	0.163	0.00395	0.00871	0.608	1.34
Total	**8.42**	**18.6**	**1.04**	**2.29**	**0.0481**	**0.106**	**9.51**	**21.0**

Table 5.4

Summary of Contaminant Mass Removal - 1998 to 2008

(a) Total

Year	Mass Removed							
	TCE		DCE		TCA		Total	
	kg	lbs	kg	lbs	kg	lbs	kg	lbs
1998[a]	1.31	2.89	0.030	0.066	0.00	0.00	1.34	2.95
1999	358	789	16.2	35.7	0.00	0.00	374	825
2000	463	1,020	23.3	51.4	0.00	0.00	486	1,070
2001	519	1,140	26.6	58.6	0.00	0.00	546	1,200
2002	603	1,330	40.6	89.4	3.66	8.07	647	1,426
2003	617	1,360	38.1	84.1	3.05	6.72	658	1,454
2004	596	1,310	35.3	77.7	2.42	5.34	634	1,403
2005	558	1,230	34.7	76.4	2.01	4.43	595	1,315
2006	513	1,130	34.3	75.5	1.66	3.67	549	1,215
2007	468	1,040	33.0	72.9	1.08	2.37	502	1,109
2008	433	955	32.6	71.8	1.13	2.50	468	1,031
Total	**5,130**	**11,310**	**315**	**694**	**15.0**	**33.1**	**5,460**	**12,050**

(b) Off-Site Containment Well

Year	Mass Removed							
	TCE		DCE		TCA		Total	
	kg	lbs	kg	lbs	kg	lbs	kg	lbs
1998[a]	1.31	2.89	0.030	0.066	0.000	0.000	1.34	2.95
1999	358	789	16.2	35.7	0.000	0.000	374	825
2000	463	1,020	23.3	51.4	0.000	0.000	486	1,070
2001	519	1,140	26.6	58.6	0.000	0.000	546	1,200
2002	543	1,200	30.9	68.1	2.05	4.52	576	1,270
2003	568	1,250	31.6	69.7	2.06	4.54	602	1,330
2004	567	1,250	31.7	69.9	1.96	4.32	601	1,330
2005	540	1,190	32.4	71.4	1.79	3.95	574	1,270
2006	499	1,100	32.5	71.6	1.57	3.46	533	1,180
2007	456	1,010	31.6	69.7	1.03	2.27	489	1,080
2008	425	937	31.5	69.5	1.08	2.39	458	1,010
Total	**4,940**	**10,900**	**288**	**636**	**11.5**	**25.4**	**5240**	**11600**

(c) Source Containment Well

Year	Mass Removed							
	TCE		DCE		TCA		Total	
	kg	lbs	kg	lbs	kg	lbs	kg	lbs
2002	59.6	131	9.66	21.3	1.61	3.55	70.9	156
2003	48.7	107	6.53	14.4	0.989	2.18	56.2	124
2004	29.0	63.9	3.55	7.83	0.464	1.02	33.1	72.8
2005	18.1	39.9	2.28	5.03	0.218	0.481	20.6	45.4
2006	13.8	30.4	1.76	3.88	0.0933	0.206	15.7	34.5
2007	11.5	25.4	1.44	3.17	0.0454	0.100	13.0	28.6
2008	8.42	18.6	1.04	2.29	0.0481	0.106	9.51	21.0
Total	**189**	**416**	**26.3**	**57.9**	**3.47**	**7.64**	**219**	**482**

[a] Mass removed during the testing of the off-site well in early December, and during the first day of operation on December 31, 1998.

Table 6.1
Initial Mass and Maximum Concentration of TCE in Model Layers

Model Layer	Approximate Mass (kg)	Approximate Mass (lbs)	Maximum Concentration (µg/L)
1	0.5	1.0	2672.7
2	9.8	21.6	4034.9
3	283.1	624.1	79550.0
4	375.5	827.7	6994.5
5	596.2	1314.4	12932.5
6	864.6	1906.2	14996.7
7	1034.4	2280.4	16984.6
8	1740.6	3837.4	15003.6
9	1294.9	2854.8	14938.9
10	340.4	750.4	2706.4
11	61.4	135.5	150.4
12	0.0	0.0	0.2
13	0.0	0.0	0.0
14	0.0	0.0	0.0
15	0.0	0.0	0.0
Total Mass	**6,601**	**14553**	

APPENDIX A

APPENDIX A

APPENDIX A

Appendix A

2008 Groundwater Quality Data

A-1: Groundwater Monitoring Program Wells

A-2: Infiltration Gallery and Pond Monitoring Wells

A-1: Groundwater Monitoring Program Wells

Appendix A-1

Groundwater Monitoring Program Wells
2008 Analytical Results[a,b]

	Sample Date	TCE ug/L	1,1-DCE ug/L	1,1,1-TCA ug/L	Cr Total (mg/L)		Other
					Unfiltered	Filtered	
MW-7	11/14/08	2.2	<1.0	<1.0	0.012	NA	
MW-12	11/11/08	22	<1.0	<1.0	<0.0060	NA	
	11/24/08	15	<1.0	<1.0	<0.010	NA	
MW-14R	11/06/08	13	<1.0	<1.0	0.170	0.170	
MW-16	11/14/08	4.4	<1.0	<1.0	0.120	NA	
MW-17	11/11/08	2.3	<1.0	<1.0	0.029	0.0300	
	11/26/08	NA	NA	NA	NA	0.0270	
MW-18	11/11/08	1.6	<1.0	<1.0	0.0210	NA	
	11/24/08	1.3	<1.0	<1.0	0.0280	NA	
MW-19	11/06/08	490	77	1.7	0.0150	NA	
MW-20	11/07/08	1.4	<1.0	<1.0	<0.0060	NA	
MW-21	11/11/08	<1.0	<1.0	<1.0	0.054	NA	
MW-22	11/07/08	<1.0	<1.0	<1.0	0.025	NA	
MW-23	11/14/08	6.1	<1.0	<1.0	0.098	NA	
MW-25	11/14/08	15	<1.0	<1.0	0.12	NA	
MW-26	11/18/08	9	<1.0	<1.0	0.310	0.1	
MW-29	11/07/08	<1.0	<1.0	<1.0	<0.0060	NA	
MW-30	11/08/08	13	<1.0	<1.0	0.0150	NA	
MW-31	11/10/08	<1.0	<1.0	<1.0	<0.0060	NA	
MW-32	11/10/08	27	3.4	<1.0	<0.0060	NA	
MW-34	11/24/08	<1.0	<1.0	<1.0	0.28	NA	
MW-37R	11/18/08	140	4.1	<1.0	0.078	NA	
MW-38	11/10/08	<1.0	<1.0	<1.0	<0.0060	NA	
MW-39	02/21/08	NA	NA	NA	<0.001	<0.001	
	11/10/08	<1.0	<1.0	<1.0	<0.0060	NA	
MW-40	11/11/08	<1.0	<1.0	<1.0	<0.0060	NA	
MW-41	11/13/08	1.2	<1.0	<1.0	0.024	NA	
MW-42	11/11/08	170	29	1.5	0.021	NA	
MW-43	11/11/08	<1.0	<1.0	<1.0	<0.0060	NA	
MW-44	11/13/08	<1.0	<1.0	<1.0	<0.0060	NA	
MW-45	11/13/08	<1.0	<1.0	<1.0	0.0070	NA	

Appendix A-1

Groundwater Monitoring Program Wells
2008 Analytical Results[a,b]

	Sample Date	TCE ug/L	1,1-DCE ug/L	1,1,1-TCA ug/L	Cr Total (mg/L) Unfiltered	Filtered	Other
MW-46	11/18/08	520	70	4.7	0.0160	NA	
	11/18/08	540	65	4.5	0.0160	NA	
MW-47	11/18/08	8.3	<1.0	<1.0	0.02	NA	
MW-49	11/18/08	<1.0	<1.0	<1.0	<0.010	NA	
MW-51	11/14/08	<1.0	<1.0	<1.0	0.0220	NA	
MW-52R	02/21/08	8.2	18	1.7	0.0141	NA	
	05/15/08	8.8	17	<1.0	0.0158	NA	
	05/15/08	9.4	17	<1.0	0.0160	NA	
	08/06/08	7.9	16	1.8	0.0152	NA	
	11/12/08	8.8	17	1.6	0.0120	NA	
MW-53	02/23/09	16	<1.0	<1.0	0.022	0.019	
MW-55	11/13/08	33	1.1	<1.0	0.017	NA	
MW-56	11/20/08	94	2.8	<1.0	0.027	NA	
	11/20/08	91	2.7	<1.0	0.027	NA	
MW-59	11/12/08	<1.0	<1.0	<1.0	0.0240	NA	
MW-60	11/18/08	4800	400	12	0.27	NA	Benzene: 1.1
MW-62	02/20/08	3.6	9.4	4.9	0.0327	0.00309	
	02/20/08	3.6	9.5	5	0.0031	0.01900	
	05/14/08	2.7	8.1	4.6	0.0431	0.00280	
	08/06/08	3.3	7.8	4.8	0.0456	0.00337	
	11/17/08	1.7	5.1	2.7	0.0290	NA	
MW-64	11/20/08	<1.0	<1.0	<1.0	0.022	NA	
MW-65	02/20/08	8.6	33	10	0.00139	NA	
	05/14/08	8.5	29	9	<0.00100	NA	
	08/05/08	7	23	6	0.00123	NA	
	11/21/08	5.7	19	5	<0.010	NA	
MW-66	02/20/08	<1.0	<1.0	<1.0	0.00124	NA	
	05/15/08	<1.0	<1.0	<1.0	0.00103	NA	
	09/26/08	<1.0	<1.0	<1.0	<0.0023	NA	
	11/13/08	<1.0	<1.0	<1.0	<0.0060	NA	

Appendix A-1

Groundwater Monitoring Program Wells
2008 Analytical Results[a,b]

	Sample Date	TCE ug/L	1,1-DCE ug/L	1,1,1-TCA ug/L	Cr Total (mg/L) Unfiltered	Cr Total (mg/L) Filtered	Other
MW-67	05/14/08	<1.0	<1.0	<1.0	<0.00100	NA	
	11/13/08	<1.0	<1.0	<1.0	<0.00100	NA	
MW-68	02/20/08	<1.0	<1.0	<1.0	0.00128	NA	
	05/14/08	<1.0	<1.0	<1.0	<0.00100	NA	
	08/05/08	<1.0	<1.0	<1.0	0.0019	NA	
	11/12/08	<1.0	<1.0	<1.0	<0.006	NA	
MW-69	02/20/08	<1.0	<1.0	<1.0	<0.00100	NA	
	05/14/08	<1.0	<1.0	<1.0	<0.00100	NA	
	09/26/08	<1.0	<1.0	<1.0	<0.0023	NA	
	11/12/08	<1.0	<1.0	<1.0	<0.0060	NA	
MW-70	11/18/08	9.5	<1.0	<1.0	<0.010		
MW-71R	02/20/08	64	2	<1.0	<0.00100	NA	
	05/14/08	63	1.9	<1.0	<0.00100	NA	
	08/06/08	64	2	<1.0	<0.00100	NA	
	08/06/08	64	2	<1.0	<0.00100	NA	
	11/18/08	52	1.9	<1.0	<0.010	NA	
MW-72	11/18/08	680	74	1.9	0.034	NA	
MW-73	11/26/08	14	1.3	<1.0	0.036	NA	
MW-79	05/14/08	<1.0	<1.0	<1.0	<0.00100	NA	
	11/21/08	<1.0	<1.0	<1.0	<0.010	NA	

[a]VOCs by EPA Method 8260

[b]MW-53 sampled on 2/23/09

Notes: NA = Not analyzed

Shaded cells indicate concentrations that exceed MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 ug/L for TCE and DCE, 60 ug/L for TCA, and 50 ug/L for total chromium).

A-2: Infiltration Gallery and Pond Monitoring Wells

Appendix A-2

Infiltration Gallery and Pond Monitoring Wells

2008 Analytical Results[a]

Well	Sample Date	TCE (ug/l)	1,1DCE (ug/l)	1,1,1TCA (ug/l)	Cr(total) (mg/l)	Fe(total) (mg/l)	Mn(total) (mg/l)	Cr(diss) (mg/l)	Fe(diss) (mg/l)	Mn(diss) (mg/l)
MW-17	02/21/08	1.3	<1.0	<1.0	0.0438	6.33	0.2070	0.0280	0.2620	0.0021
	05/15/08	1.2	<1.0	<1.0	0.0417	5.52	0.1710	0.0283	0.1550	0.0019
	08/06/08	2.1	<1.0	<1.0	0.0437	6.78	0.2140	0.0290	0.2100	0.0054
	11/11/08	2.3	<1.0	<1.0	0.0290	2.30	0.1800	0.030	2.90	0.1900
	11/26/08	NA	NA	NA				0.027	0.0300	0.0065
MW-74	02/20/08	<1.0	<1.0	<1.0	0.0189	0.2280	0.0019			
	05/15/08	<1.0	<1.0	<1.0	0.0188	0.1210	0.0016			
	08/06/08	<1.0	<1.0	<1.0	0.0173	0.1280	0.0020			
	11/20/08	<1.0	<1.0	<1.0	0.0200	<0.10	<0.010			
MW-75	02/20/08	<1.0	<1.0	<1.0	0.0185	0.2420	<0.001			
	05/15/08	<1.0	<1.0	<1.0	0.0192	0.1310	<0.0100			
	08/06/08	<1.0	<1.0	<1.0	0.0176	0.1340	<0.0100			
	11/20/08	<1.0	<1.0	<1.0	0.0200	<0.10	<0.010			
MW-76	02/20/08	<1.0	<1.0	<1.0	0.0194	0.2750	0.0120			
	05/15/08	<1.0	<1.0	<1.0	0.0192	0.1540	0.0020			
	08/06/08	<1.0	<1.0	<1.0	0.0181	0.1800	0.0043			
	11/20/08	<1.0	<1.0	<1.0	0.0210	0.1500	<0.010			
MW-77	02/21/08	6.3	<1.0	<1.0	<0.001	0.3360	4.88	<0.001	0.1810	0.5850
	05/14/08	4.2	<1.0	<1.0	<0.00100	0.2610	4.04	0.0011	0.1400	0.4390
	08/06/08	2.6	<1.0	<1.0	0.00102	0.2520	6.06	<0.001	0.1760	0.4130
	11/26/08	9.1	<1.0	<1.0	<0.0023	<0.018	1.70	<0.0022	<0.012	0.3800
MW-78	02/21/08	<1.0	<1.0	<1.0	0.0282	0.8530	0.0384	0.0262	0.2310	0.0017
	05/15/08	<1.0	<1.0	<1.0	0.0282	0.2350	0.0070	0.0288	0.1690	0.0016
	08/06/08	<1.0	<1.0	<1.0	0.0270	0.2070	0.0035	0.0280	0.2370	0.0026
	11/20/08	<1.0	<1.0	<1.0	0.0310	0.3600	0.0230	NA	NA	NA
	11/20/08	<1.0	<1.0	<1.0	0.0300	0.3000	0.0190	NA	NA	NA

[a]VOCs by EPA Method 8260

Note: Shaded cells indicate concentrations that exceed MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 ug/L for TCE and DCE, 60 ug/L for TCA, and 50 ug/L for total chromium).

APPENDIX B

APPENDIX B

APPENDIX B

Appendix B

2008 Containment Well Flow Rate Data

B-1: Off-Site Containment Well

B-2: Source Containment Well

B-1: Off-Site Containment Well

Appendix B-1

Off-Site Containment Well
2008 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)[a]
12/20/07	13:30	---	999095200		1034777700
				224	
01/02/08	6:50	---	1003189900		1038872400
				222	
01/08/08	12:17	---	1005182300		1040864800
				223	
01/14/08	14:03	---	1007134500		1042817000
				224	
01/21/08	10:30	---	1009347300		1045029800
				224	
01/25/08	12:30	---	1010664500		1046347000
				224	
02/01/08	11:50	---	1012912300		1048594800
				224	
02/13/08	11:30	---	1016785100		1052467600
				224	
02/19/08	8:15	---	1018680800		1054363300
				224	
02/21/08	14:30	---	1019409200		1055091700
				224	
02/28/08	10:32	---	1021614900		1057297400
				220	
03/03/08	13:00	---	1022913200		1058595700
				216	
03/12/08	17:45	---	1025777000		1061459500
				222	
03/14/08	12:58	---	1026353500		1062036000
				223	
03/19/08	13:32	221	1027969900		1063652400
				223	
03/24/08	11:18	---	1029547900		1065230400
				223	
04/01/08	12:10	---	1032131600		1067814100
				225	
04/08/08	11:42	225	1034388600		1070071100
				221	
04/16/08	16:15	---	1036996800		1072679300
				224	
04/23/08	11:00	---	1039181000		1074863500
				223	
05/01/08	12:30	---	1041773000		1077455500
				218	
05/05/08	12:30	223	1043026400		1078708900
				223	

[a]Total pumpage since December 31, 1998

Appendix B-1

Off-Site Containment Well
2008 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)[a]
05/15/08	10:07	---	1046206400		1081888900
				223	
05/22/08	11:40	---	1048476000		1084158500
				223	
05/27/08	8:39	---	1050039670		1085722170
				0	
05/28/08	12:20	---	1050039670		1085722170
				223	
05/30/08	10:55	221	1050663500		1086346000
				223	
06/02/08	12:35	---	1051650600		1087333100
				215	
06/12/08	8:45	---	1054699000		1090381500
				222	
06/15/08	16:11	---	1055755115		1091437615
				223	
06/19/08	9:50	---	1056953000		1092635500
				219	
06/25/08	11:50	---	1058874100		1094556600
				214	
06/27/08	11:30	---	1059485300		1095167800
				223	
07/01/08	9:17	222	1060740100		1096422600
				157	
07/02/08	5:55	---	1060935016		1096617516
				223	
07/11/08	10:17	222	1063885400		1099567900
				223	
07/14/08	12:10	---	1064875500		1100558000
				223	
07/21/08	14:15	222	1067153700		1102836200
				217	
07/30/08	7:10	222	1069875500		1105558000
				207	
08/01/08	17:30	222	1070600100		1106282600
				223	
08/11/08	7:00	222	1073671700		1109354200
				223	
08/18/08	7:18	222	1075920600		1111603100
				222	
08/25/08	7:32	222	1078165500		1113848000
				222	

[a]Total pumpage since December 31, 1998

Appendix B-1

Off-Site Containment Well 2008 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)[a]
09/02/08	7:18	222	1080723700		1116406200
				222	
09/08/08	7:14	222	1082637200		1118319700
				217	
09/15/08	7:08	222	1084823900		1120506400
				216	
09/22/08	7:16	222	1087002400		1122684900
				222	
09/29/08	7:09	222	1089239800		1124922300
				223	
10/01/08	9:52	222	1089917100		1125599600
				215	
10/06/08	6:36	222	1091421000		1127103500
				220	
10/13/08	7:12	222	1093647300		1129329800
				210	
10/20/08	8:40	222	1095784000		1131466500
				179	
10/27/08	7:14	222	1097572700		1133255200
				193	
11/01/08	9:35	222	1098987200		1134669700
				224	
11/10/08	7:24	222	1101861300		1137543800
				223	
11/18/08	8:14	222	1104441700		1140124200
				223	
11/24/08	7:37	222	1106356800		1142039300
				223	
12/01/08	9:50	222	1108636400		1144318900
				223	
12/08/08	7:05	222	1110846500		1146529000
				223	
12/15/08	6:55	222	1113097000		1148779500
				223	
12/22/08	6:40	222	1115336700		1151019200
				154	
12/29/08	7:25	222	1116896000		1152578500
				193	
01/05/09	9:15	222	1118864900		1154547400

[a]Total pumpage since December 31, 1998

B-2 Source Containment Well

Appendix B-2

Source Containment Well
2008 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)
12/20/07	13:07	---	151706750		151706750
				48	
01/02/08	7:13	---	152579400		152579400
				38	
01/05/08	12:25	---	152755290		152755290
				65	
01/08/08	11:52	---	153033550		153033550
				48	
01/21/08	11:17	---	153928600		153928600
				48	
01/25/08	12:15	---	154205450		154205450
				48	
02/01/08	11:20	---	154683350		154683350
				48	
02/13/08	12:00	---	155509200		155509200
				48	
02/19/08	7:33	---	155907240		155907240
				47	
02/20/08	7:49	---	155976230		155976230
				48	
02/28/08	11:21	---	156540550		156540550
				48	
03/03/08	12:24	---	156822275		156822275
				48	
03/14/08	12:42	---	157590855		157590855
				49	
03/19/08	13:05	---	157943620		157943620
				49	
04/01/08	11:10	---	158850850		158850850
				49	
04/08/08	12:14	---	159343140		159343140
				48	
04/10/08	16:08	---	159493523		159493523
				50	
04/23/08	10:30	---	160410700		160410700
				50	
05/01/08	11:50	---	160994800		160994800
				50	
05/14/08	17:37	---	161947754		161947754
				50	
05/22/08	10:53	---	162499425		162499425
				49	

[a]Total pumpage since December 31, 1998

Appendix B-2

Source Containment Well
2008 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)
06/02/08	11:50	49.8	163284000		163284000
				49	
06/12/08	8:22	---	163981620		163981620
				49	
06/15/08	16:18	---	164214949		164214949
				49	
06/19/08	9:25	---	164476590		164476590
				46	
06/25/08	12:15	---	164880483		164880483
				41	
06/27/08	11:50	---	164998870		164998870
				49	
07/01/08	7:22	49.2	165265600		165265600
				49	
07/11/08	8:00	49.2	165970600		165970600
				49	
07/21/08	15:00	48.4	166692740		166692740
				46	
07/30/08	8:15	49.8	167272283		167272283
				48	
08/01/08	16:30	48.9	167433980		167433980
				48	
08/11/08	7:52	50.0	168105359		168105359
				50	
08/18/08	8:12	50.0	168607967		168607967
				50	
08/25/08	9:32	50.0	169112130		169112130
				49	
09/02/08	8:09	50.0	169677834		169677834
				49	
09/08/08	8:32	50.0	170105000		170105000
				58	
09/15/08	8:00	50.0	170690050		170690050
				31	
09/22/08	8:01	50.0	171003860		171003860
				49	
09/29/08	8:16	50.0	171498457		171498457
				49	
10/01/08	8:30	50.0	171640074		171640074
				47	

[a]Total pumpage since December 31, 1998

Appendix B-2

Source Containment Well
2008 Flow Rate Data

Date	Time	Instantaneous Discharge (gpm)	Totalizer Reading (gallons)	Average Discharge (gpm)	Total Volume (gallons)
10/06/08	7:15	50.0	171974502		171974502
				49	
10/13/08	7:54	50.0	172467590		172467590
				49	
10/20/08	9:10	50.0	172961960		172961960
				48	
10/27/08	7:55	50.0	173445140		173445140
				48	
11/01/08	10:10	50.0	173794340		173794340
				48	
11/10/08	8:29	50.0	174414740		174414740
				48	
11/17/08	7:01	50.0	174892826		174892826
				48	
11/24/08	8:30	50.0	175377760		175377760
				47	
12/01/08	7:45	50.0	175854420		175854420
				47	
12/08/08	8:16	50.0	176333100		176333100
				47	
12/15/08	7:25	50.0	176806370		176806370
				47	
12/22/08	7:15	50.0	177278920		177278920
				47	
12/29/08	8:10	50.0	177752640		177752640
				47	
01/05/09	8:10	50.0	178222000		178222000

[a]Total pumpage since December 31, 1998

APPENDIX C

APPENDIX C

APPENDIX C

Appendix C

2008 Influent / Effluent Quality Data

C-1: Off-Site Treatment System 2008 Analytical Results

C-2: Source Treatment System 2008 Analytical Results

C-1: Off-Site Treatment System 2008 Analytical Results

Appendix C-1

Off-Site Treatment System
2008 Analytical Results[a]

Sample Date	Influent TCE (ug/l)	Influent 1,1DCE (ug/l)	Influent 1,1,1TCA (ug/l)	Influent Cr(total) (mg/l)	Influent Fe(total) (mg/l)	Influent Mn(total) (mg/l)	Effluent TCE (ug/l)	Effluent 1,1DCE (ug/l)	Effluent 1,1,1TCA (ug/l)	Effluent Cr(total) (mg/l)	Effluent Fe(total) (mg/l)	Effluent Mn(total) (mg/l)
01/04/08	1000	71	<1.0	0.019	0.010	0.010	<1.0	<1.0	<1.0	0.020	0.010	0.010
02/01/08	990	73	<1.0	0.019	0.321	<0.00100	<1.0	<1.0	<1.0	0.019	0.030	<0.00100
03/03/08	1200	90	<1.0	0.023	0.406	<0.00100	<1.0	<1.0	<1.0	0.022	0.359	<0.00100
04/01/08	850	62	3.1	0.020	0.115	<0.00100	<1.0	<1.0	<1.0	0.019	0.100	<0.00100
05/01/08	970	73	<1.0	0.020	0.138	<0.00100	<1.0	<1.0	<1.0	0.019	0.374	<0.00100
06/02/08	1000	68	3.0	0.019	0.086	<0.00100	<1.0	<1.0	<1.0	0.019	0.210	0.00237
07/01/08	1000	74	2.7	0.002	0.096	<0.00100	<1.0	<1.0	<1.0	0.019	0.110	0.00152
08/05/08	1100	89	3.1	0.018	0.143	<0.00100	<1.0	<1.0	<1.0	0.018	0.165	0.00162
09/02/08	930	67	3.5	0.018	0.197	<0.00100	<1.0	<1.0	<1.0	0.017	0.190	<0.00100
09/30/08	960	74	2.6	0.016	<0.050	<0.0020	<1.0	<1.0	<1.0	0.016	<0.050	<0.0020
11/02/08	990	65	2.5	0.016	<0.050	<0.0020	<1.0	<1.0	<1.0	0.016	<0.050	<0.0020
12/01/08	790	64	2.3	0.015	<0.10	<0.010	<1.0	<1.0	<1.0	0.017	<0.10	<0.010
01/01/09	920	71	2.8	0.018	<0.03	<0.010	<1.0	<1.0	<1.0	0.018	<0.03	<0.010

[a] Data from January 1, 2009 has been included to show conditions at the end of the year.

Notes: Shaded cells indicate concentrations that exceed MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 ug/L for TCE and DCE, 60 ug/L for TCA and 50 ug/L for total chromium).

C-2: Source Treatment System 2008 Analytical Results

Appendix C-2

Source Treatment System
2008 Analytical Results[a]

Sample Date	Influent TCE (ug/l)	Influent 1,1DCE (ug/l)	Influent 1,1,1TCA (ug/l)	Influent Cr(total) (mg/l)	Influent Fe(total) (mg/l)	Influent Mn(total) (mg/l)	Effluent TCE (ug/l)	Effluent 1,1DCE (ug/l)	Effluent 1,1,1TCA (ug/l)	Effluent Cr(total) (mg/l)	Effluent Fe(total) (mg/l)	Effluent Mn(total) (mg/l)
01/04/08	120	12	<1.0	0.029	0.0100	0.067	<1.0	<1.0	<1.0	0.029	0.0100	0.222
02/11/08	100	14	<1.0	0.027	0.3670	0.464	<1.0	<1.0	<1.0	0.028	0.4230	0.058
03/03/08	100	13	<1.0	0.028	0.4160	0.089	<1.0	<1.0	<1.0	0.028	0.4090	0.047
04/01/08	87	11	<1.0	0.028	0.1370	1.500	<1.0	<1.0	<1.0	0.028	0.1770	0.057
05/01/08	90	11	<1.0	0.030	0.2670	1.770	<1.0	<1.0	<1.0	0.030	0.1620	0.057
06/02/08	92	10	<1.0	0.028	0.1130	0.719	<1.0	<1.0	<1.0	0.028	0.0957	0.044
07/01/08	95	10	<1.0	0.032	0.4460	2.170	<1.0	<1.0	<1.0	0.019	0.1100	0.002
08/05/08	98	13	<1.0	0.028	0.2420	0.522	<1.0	<1.0	<1.0	0.028	0.1780	0.049
09/02/08	79	9.6	<1.0	0.027	0.2230	0.736	<1.0	<1.0	<1.0	0.026	0.2160	0.046
09/30/08	75	9	<1.0	0.016	<0.050	0.067	<1.0	<1.0	<1.0	0.026	<0.050	0.041
11/02/08	72	9.4	<1.0	0.024	<0.050	0.078	<1.0	<1.0	<1.0	0.019	<0.050	0.036
12/01/08	68	8.7	<1.0	0.025	<0.10	0.240	<1.0	<1.0	<1.0	0.024	<0.10	0.046
01/01/09	66	10	<1.0	0.027	<0.03	0.070	<1.0	<1.0	<1.0	0.027	<0.03	0.040

[a] Data from January 1, 2009 has been included to show conditions at the end of the year.

Notes: Shaded cells indicate concentrations that exceed MCLs based on the more stringent of the drinking water standards or the maximum allowable concentrations in groundwater set by the NMWQCC (5 ug/L for TCE and DCE, 60 ug/L for TCA and 50 ug/L for total chromium).

APPENDIX D

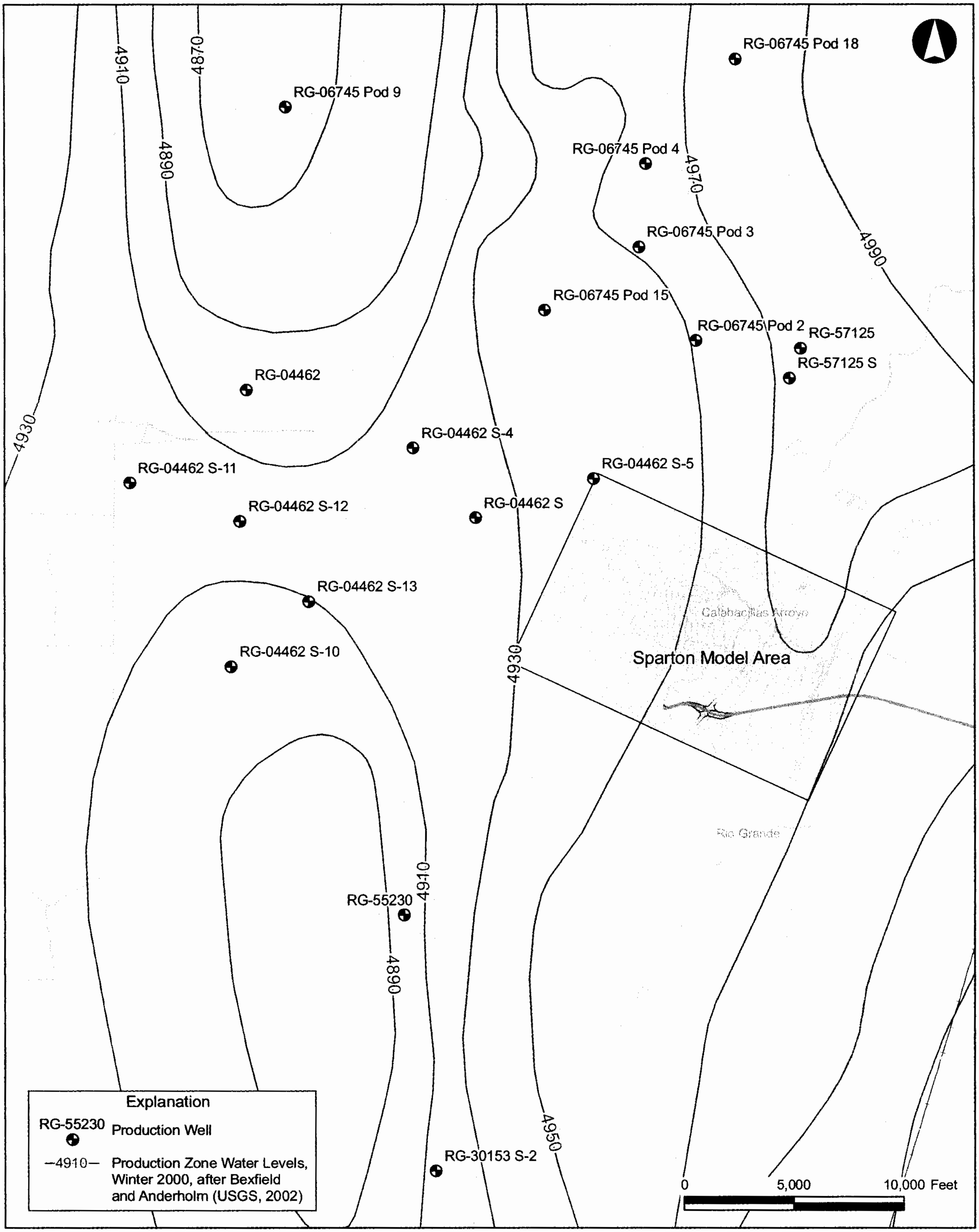
APPENDIX D

Appendix D

Groundwater Pumping within Five Miles of Sparton Site

Figure D-1 Groundwater Production Wells within Five Miles of Sparton Site

Table D-1 Groundwater Production Wells within Five Miles of Sparton Site



Note: See Table D-1 For Well Information

Figure D.1 Groundwater Production Wells Within Five Miles of the Sparton Site

Table D-1

Goundwater Production within Five Miles of the Sparton Site

Well Owner	Point of Diversion Number	X-Coordinate[a]	Y-Coordinate[a]	Screen Depth, BLS		Pumping Rate (acre feet/year)										
				Top, ft	Bottom, ft	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
ABCWUA[b]	RG-30153 S-2	362,695	1,500,349	-	-	510	504	532	520	532	529	503	49	527	588	940
ABCWUA[b]	RG-55230	361,260	1,512,041	-	-	1827	3151	3776	4194	4000	3159	3646	3137	3541	2984	421
Nat. Assoc. Norwest (NM Utilities)	RG-04462	354,100	1,536,050	-	-	-	-	1,677	1,484	1,617	630	1,562	1,932	1,884	2,312	2,701
NM Utilities	RG-04462 S	364,550	1,530,200	-	1000-TD[c]	-	-	982	768	904	901	495	608	-	1,318	999
Nat. Assoc. Norwest (NM Utilities)	RG-04462 S-4	361,700	1,533,400	-	-	-	-	1175	1758	1580	1871	2284	1776	1595	549	15
Nat. Assoc. Norwest (NM Utilities)	RG-04462 S-5	369,900	1,532,000	-	-	-	-	-	-	-	-	-	-	-	75	2040
NM Utilities	RG-04462 S-10	353,400	1,523,400	-	1350-TD[c]	-	-	-	-	-	-	-	-	499	809	0.005
Nat. Assoc. Norwest (NM Utilities)	RG-04462 S-11	348,800	1,531,800	-	-	-	-	-	-	-	581	771	723	893	342	228
Nat. Assoc. Norwest (NM Utilities)	RG-04462 S-12	353,802	1,530,045	-	-	-	-	1129	1684	2265	1767	1418	1800	2043	1839	1692
Nat. Assoc. Norwest (NM Utilities)	RG-04462 S-13	356,927	1,526,371	-	-	-	-	1690	1301	1025	1726	1314	1524	1896	1846	1703
City of Rio Rancho	RG-06745 Pod 2	374,600	1,538,300	600	813	-	-	4.1	1	11	1	342	9	225	129	177
City of Rio Rancho	RG-06745 Pod 3	372,000	1,542,600	410	825	-	-	26	118	15	87	367	238	375	309	324
City of Rio Rancho	RG-06745 Pod 4	372,300	1,546,400	670	990	-	-	491	45	30	32	510	647	269	317	0
City of Rio Rancho	RG-06745 Pod 9	355,900	1,549,000	-	2039	-	-	1568	1685	28853	1650	1568	1431	1588	1358	1456
City of Rio Rancho	RG-06745 Pod 15	367,700	1,539,700	820	1290	-	-	866	815	1103	1214	776	845	690	521	847
City of Rio Rancho	RG-06745 Pod 18	376,400	1,551,200	470	955	-	-	33	1416	1718	1840	1757	1712	791	1214	1303
Intel Corp.	RG-57125	379,368	1,537,963	720	1960-TD[c]	-	1951	1189	1060	985	873	1395	972	2418	1417	945
Intel Corp.	RG-57125 S	378,863	1,536,600	730	2000	-	306	540	783	1059	1023	1378	-	344	1061	1366

[a]Coordinates refer to NAD 27 Central Zone in feet

[b]ABCWUA - Albuquerque Bernalillo County Water Utility Authority

[c]TD - Total Depth

Note: See Figure D-1 for Well Locations

APPENDIX E

Appendix E

Observed and Calculated Water Levels – December 1998 to December 2008 Simulation

Figure E-1	Comparison of Observed and Calculated Water Levels in On-Site UFZ Wells
Figure E-2	Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
Figure E-3	Comparison of Observed and Calculated Water Levels in DFZ Wells
Figure E-4	Residuals between Observed and Calculated 2008 Water Levels in UFZ Wells
Figure E-5	Residuals between Observed and Calculated 2008 Water Levels in UFZ/ULFZ/LLFZ Wells
Figure E-6	Residuals between Observed and Calculated 2008 Water Levels in DFZ Wells
Table E-1	Comparison of Observed and Calculated Water Levels – December 1998 to December 2008

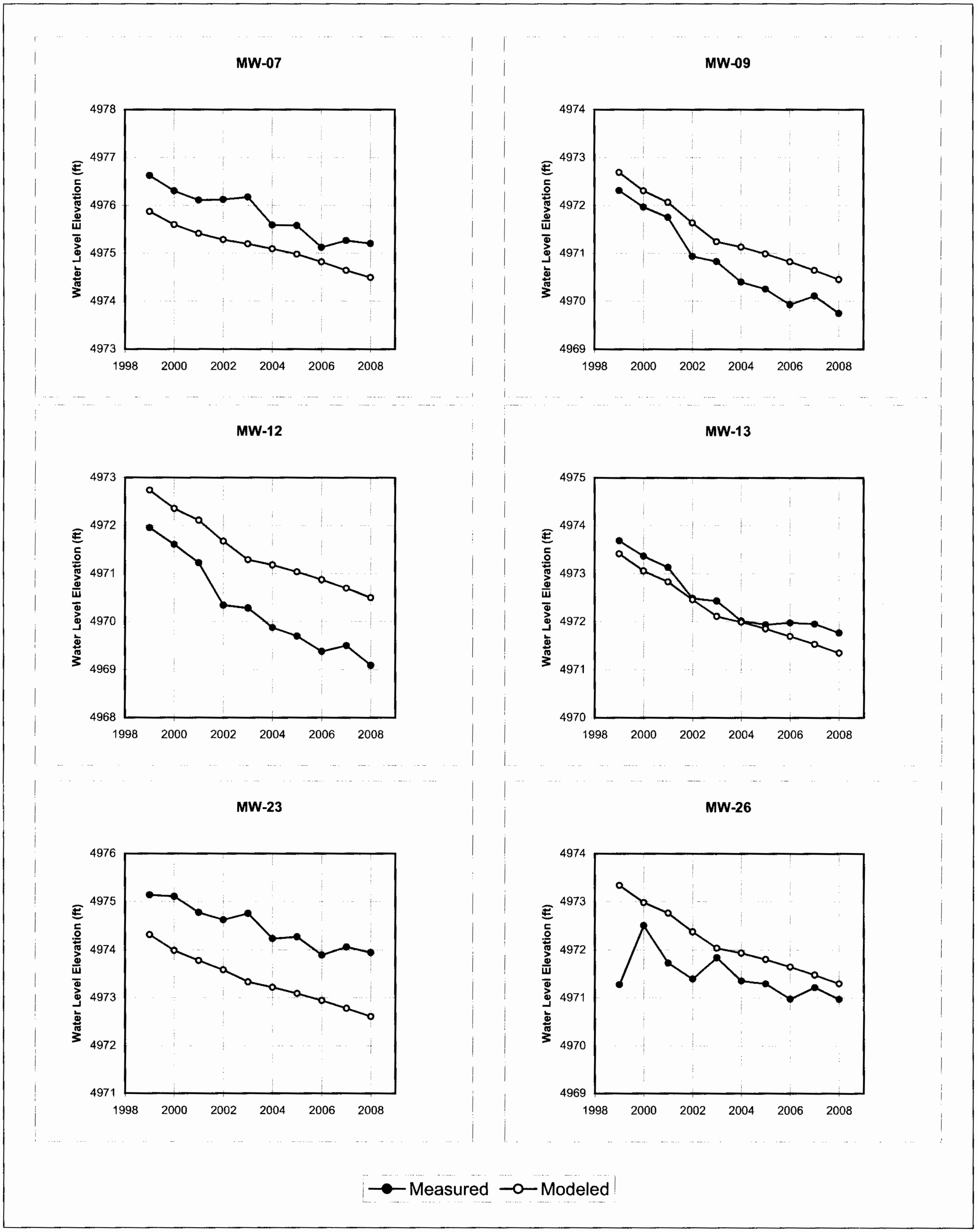


Figure E.1 Comparison of Observed and Calculated Water Levels in On-Site UFZ Wells
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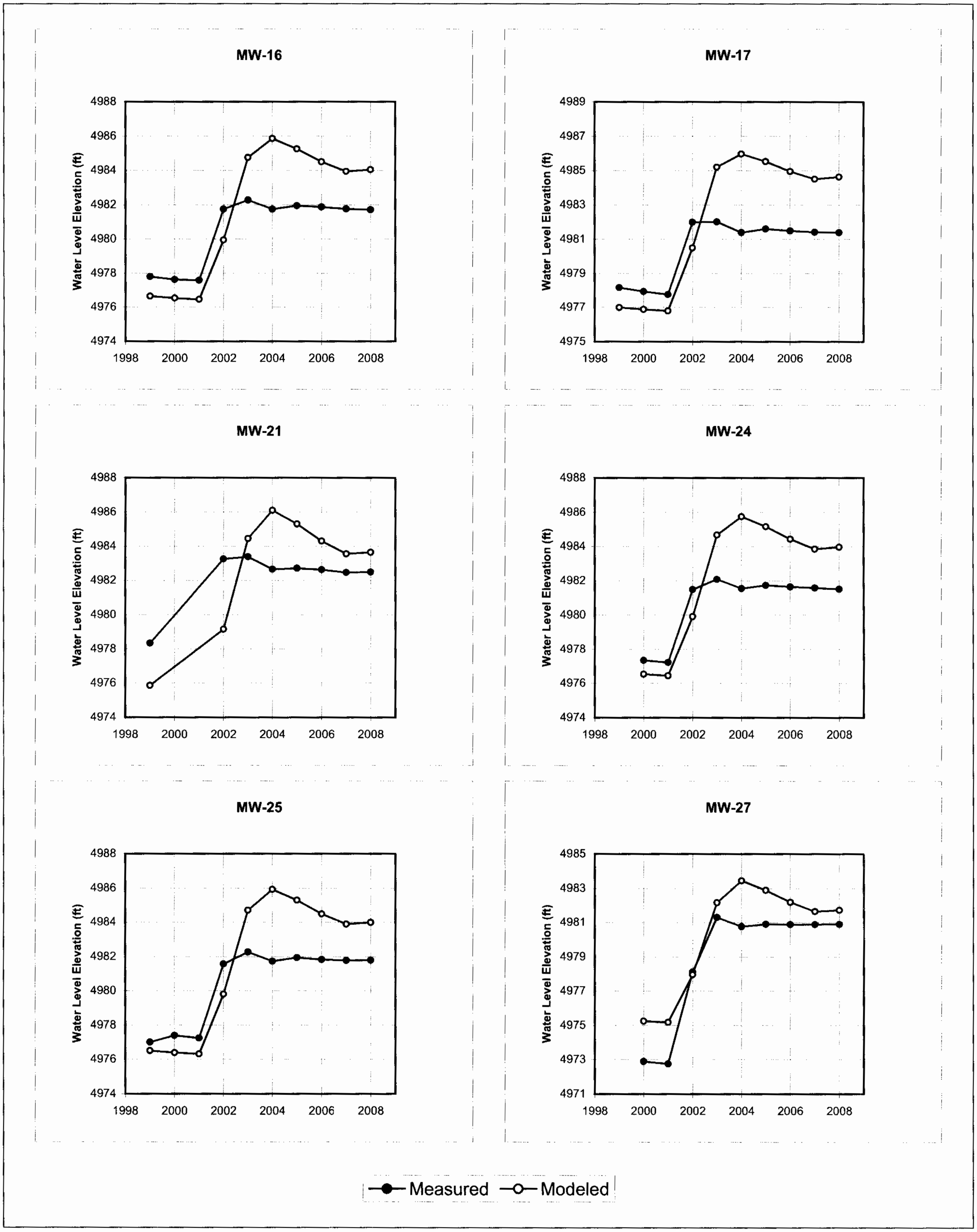

Figure E.1 Comparison of Observed and Calculated Water Levels in On-Site UFZ Wells

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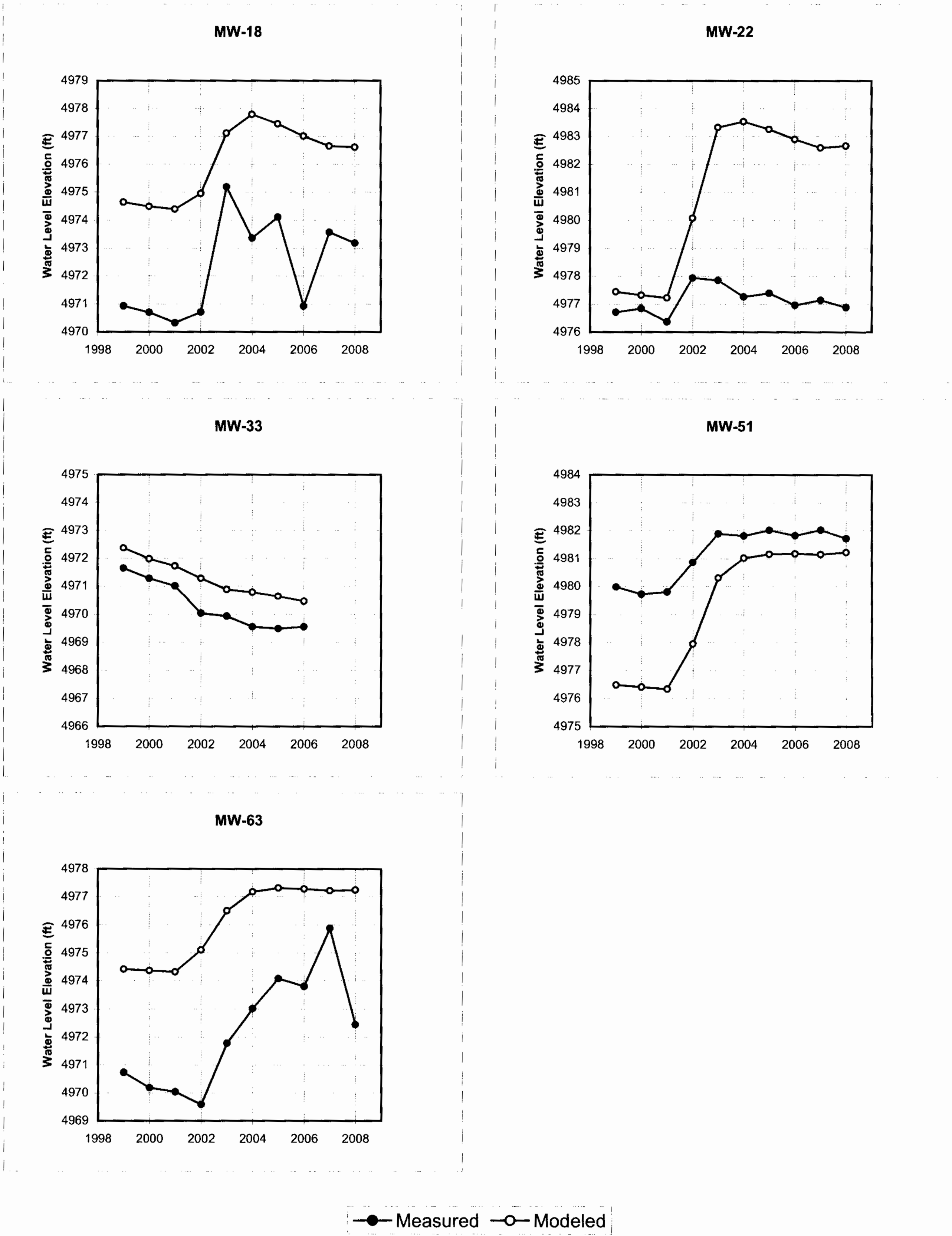

Figure E.1 Comparison of Observed and Calculated Water Levels in On-Site UFZ Wells
Page 3 of 3

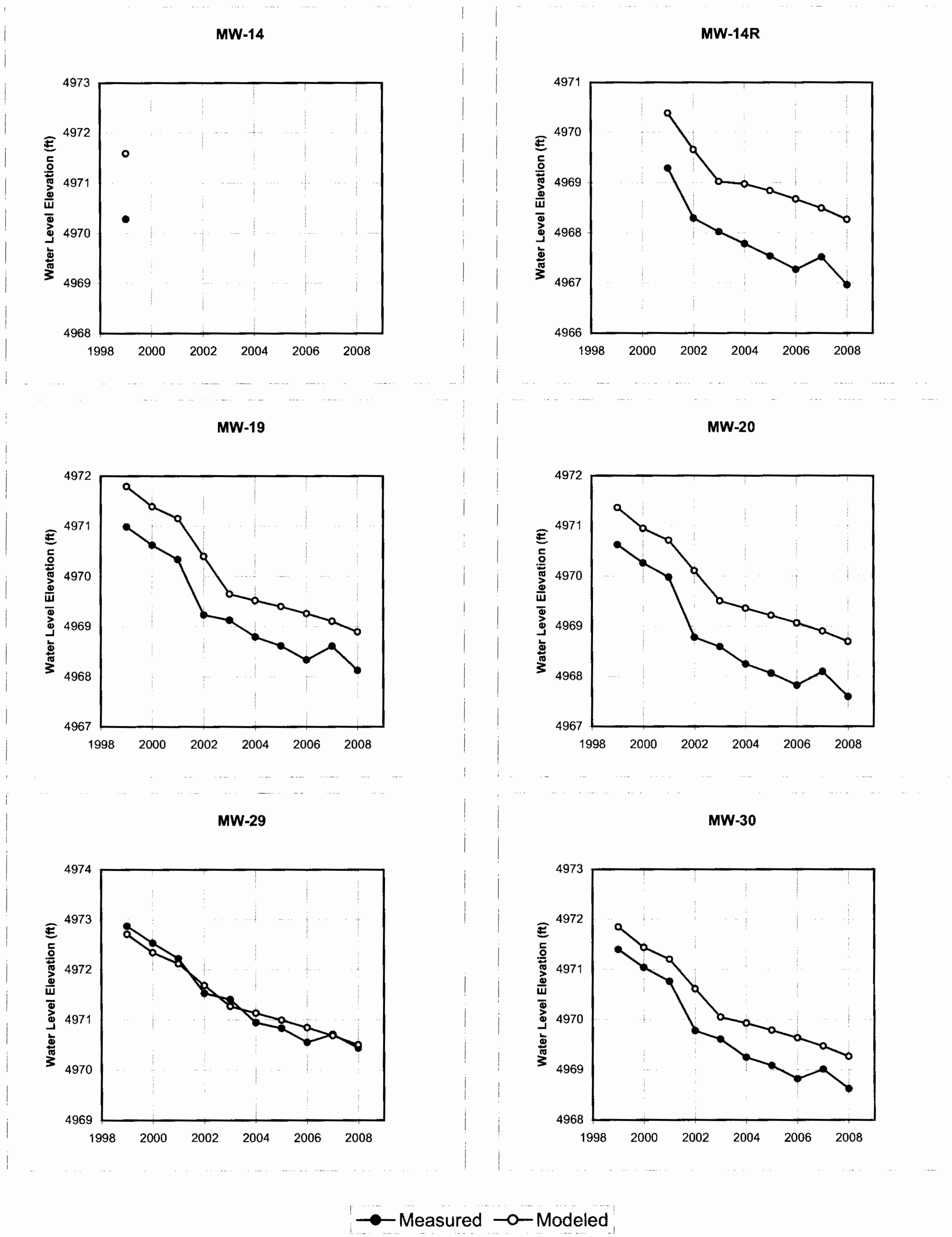

Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
Page 1 of 10

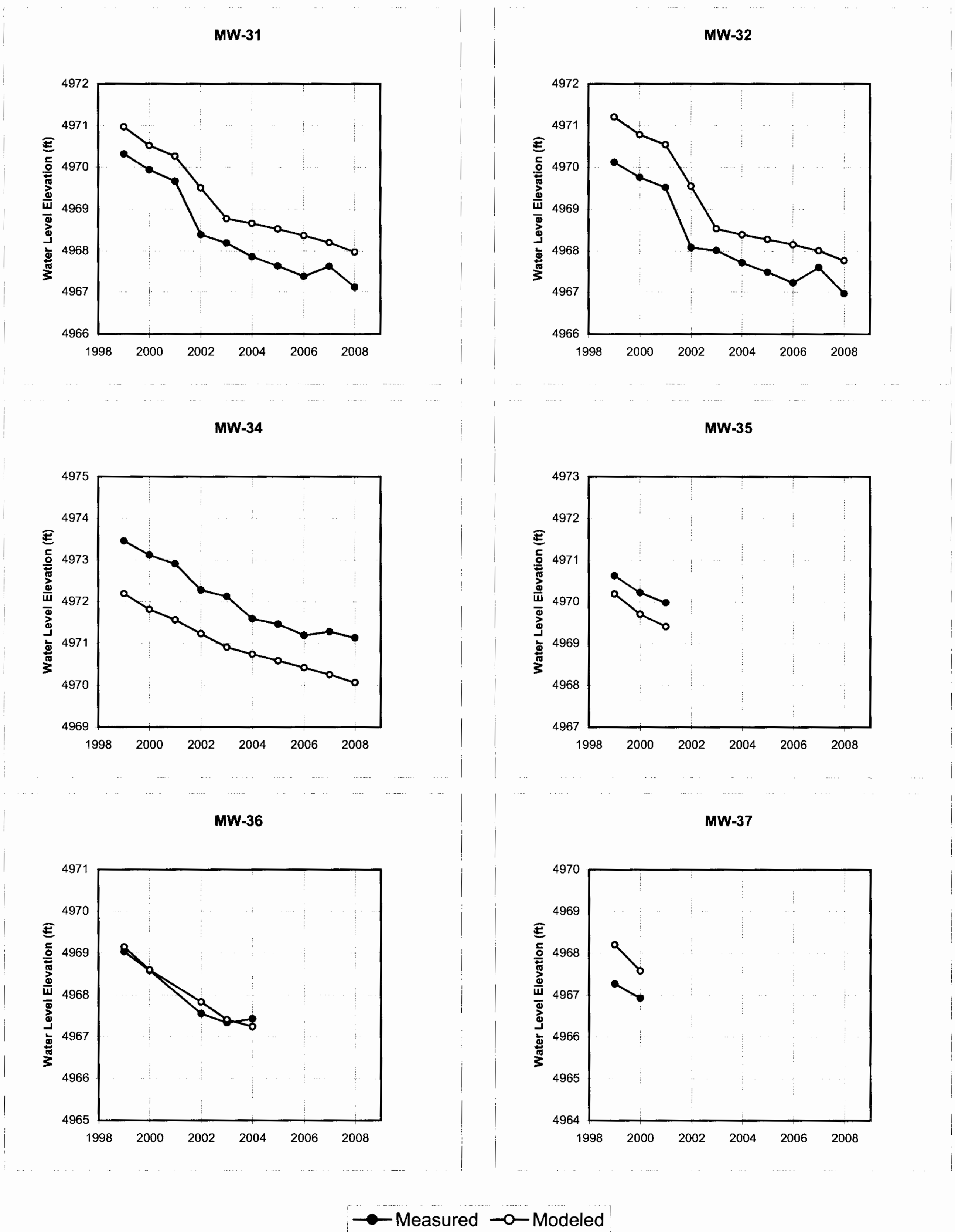

Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
Page 2 of 10

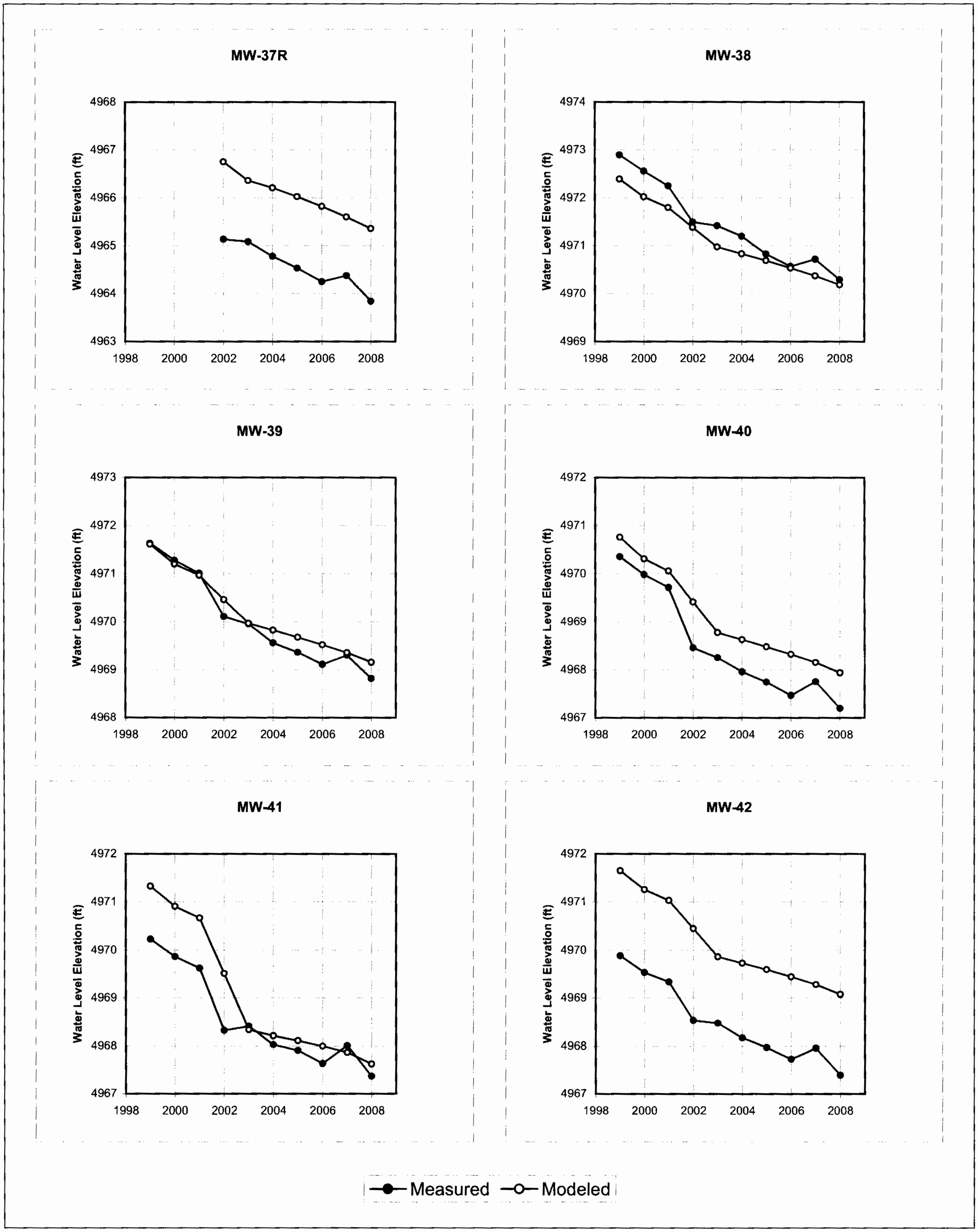

Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
Page 3 of 10

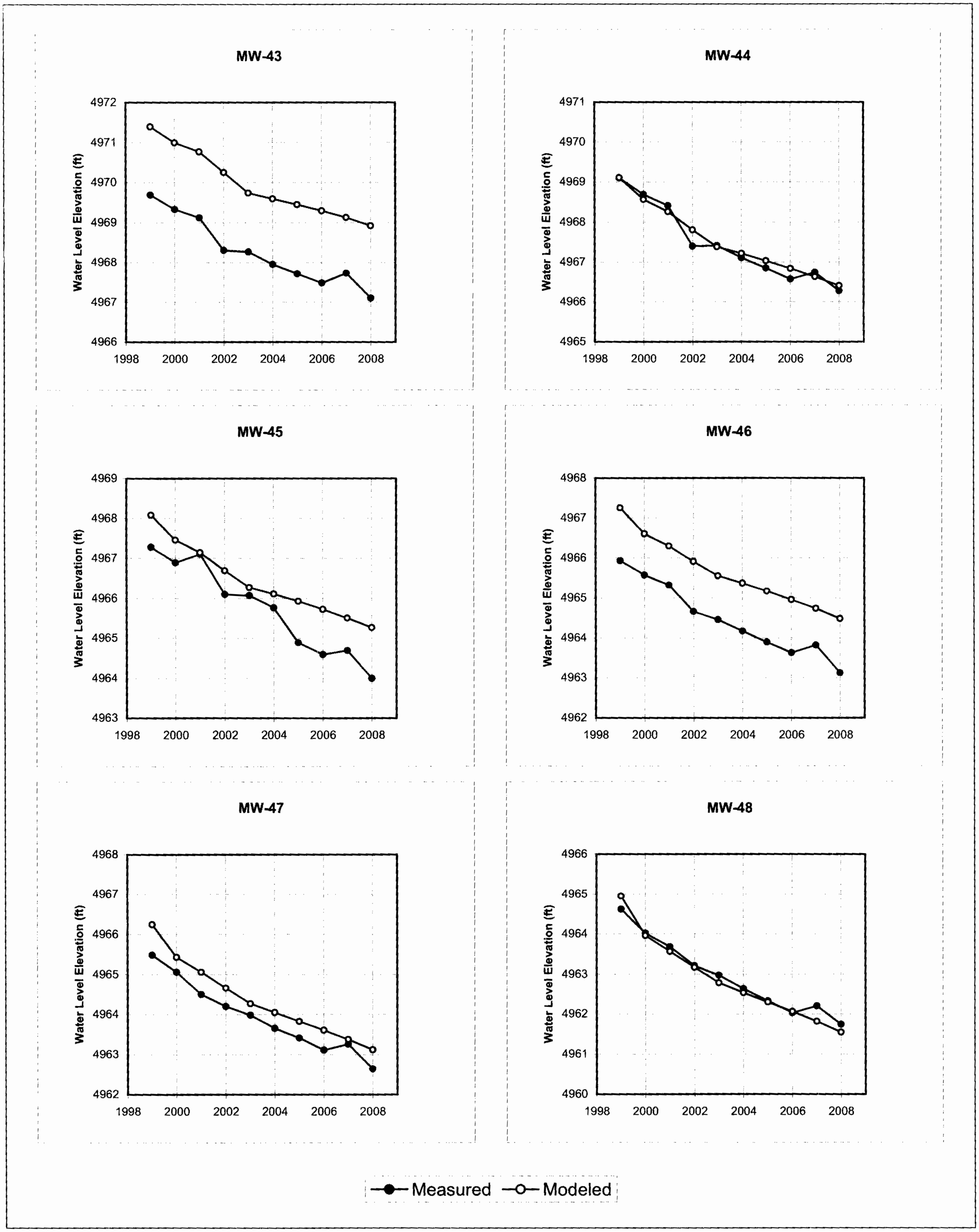

Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
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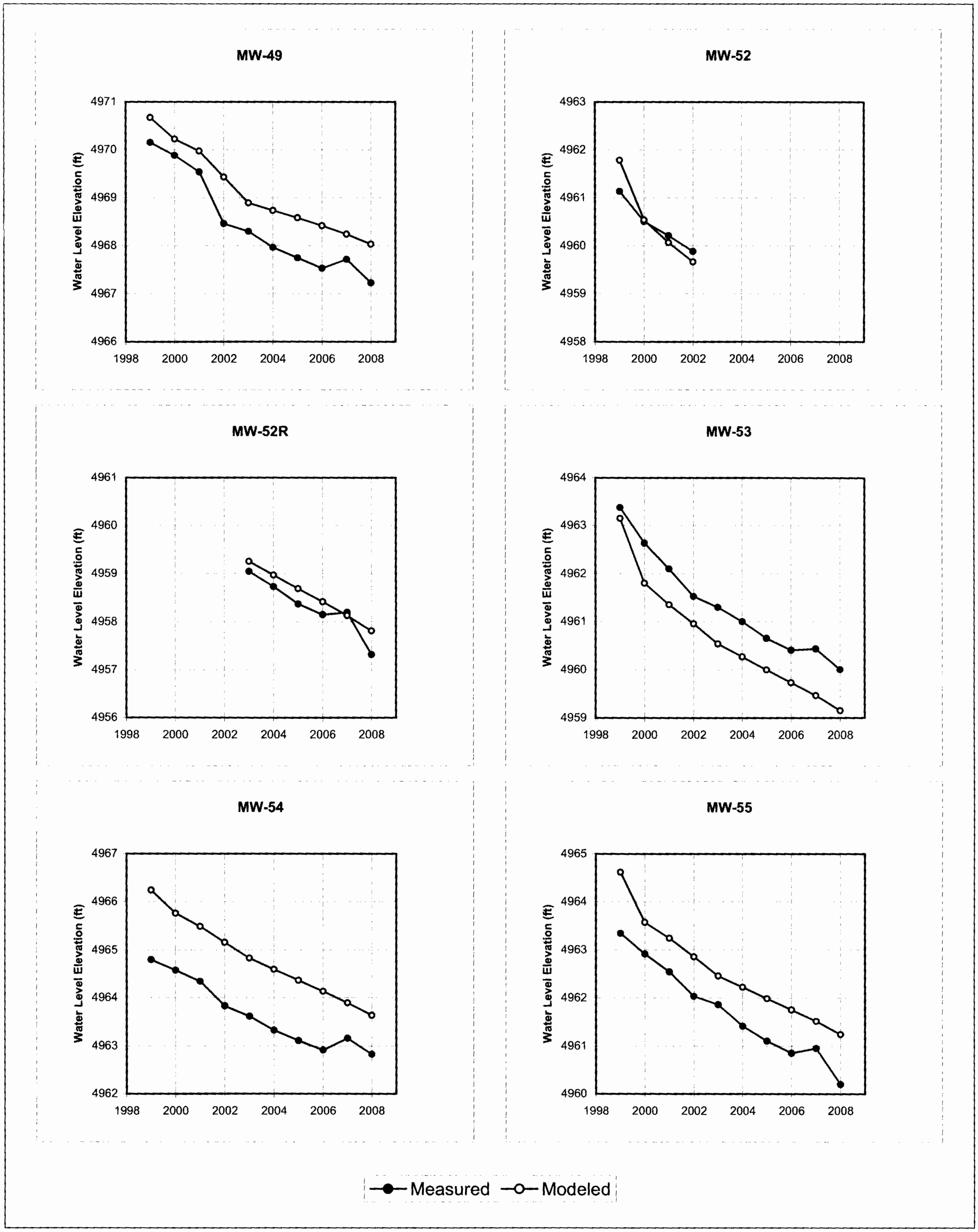

Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
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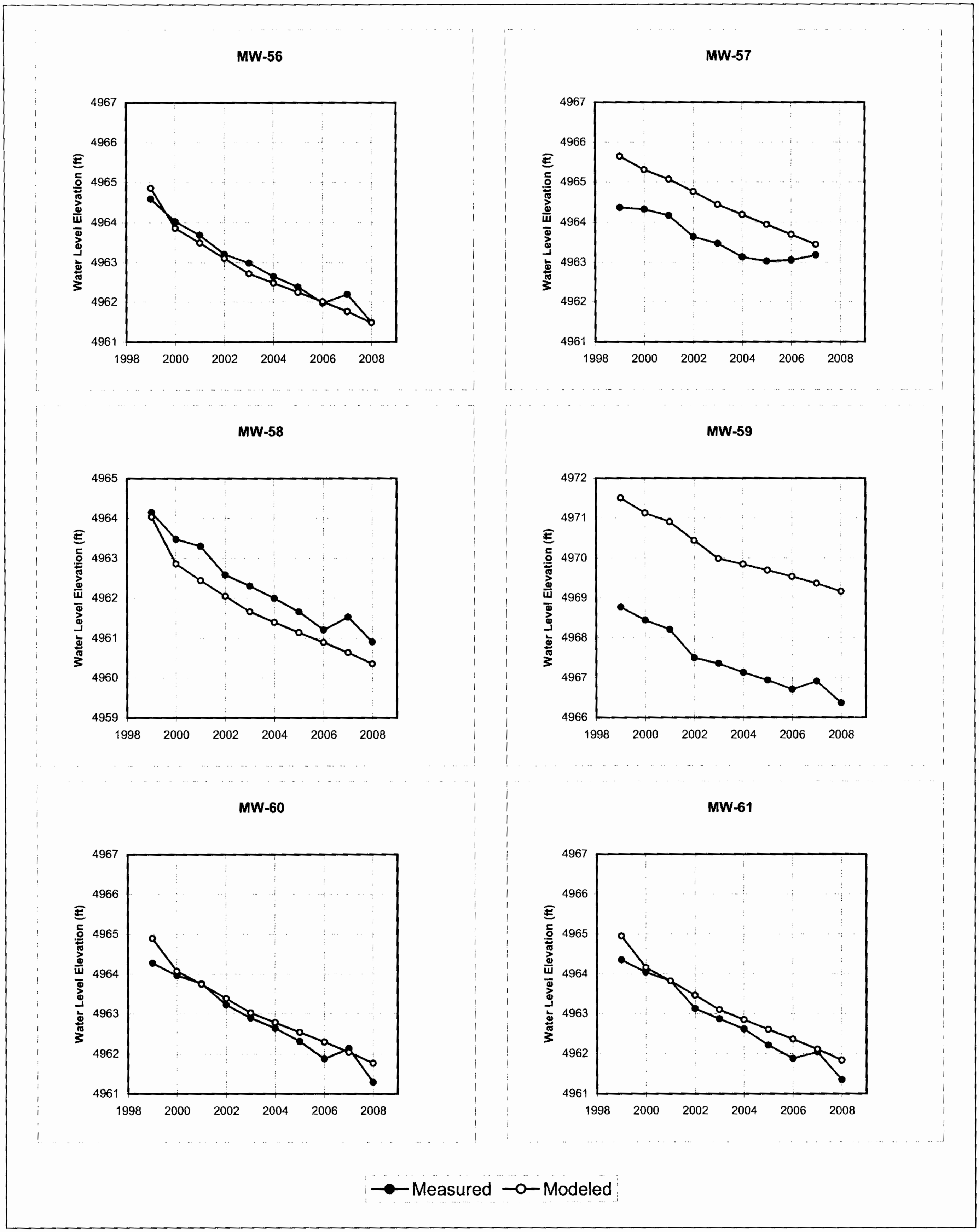


Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells
Page 6 of 10

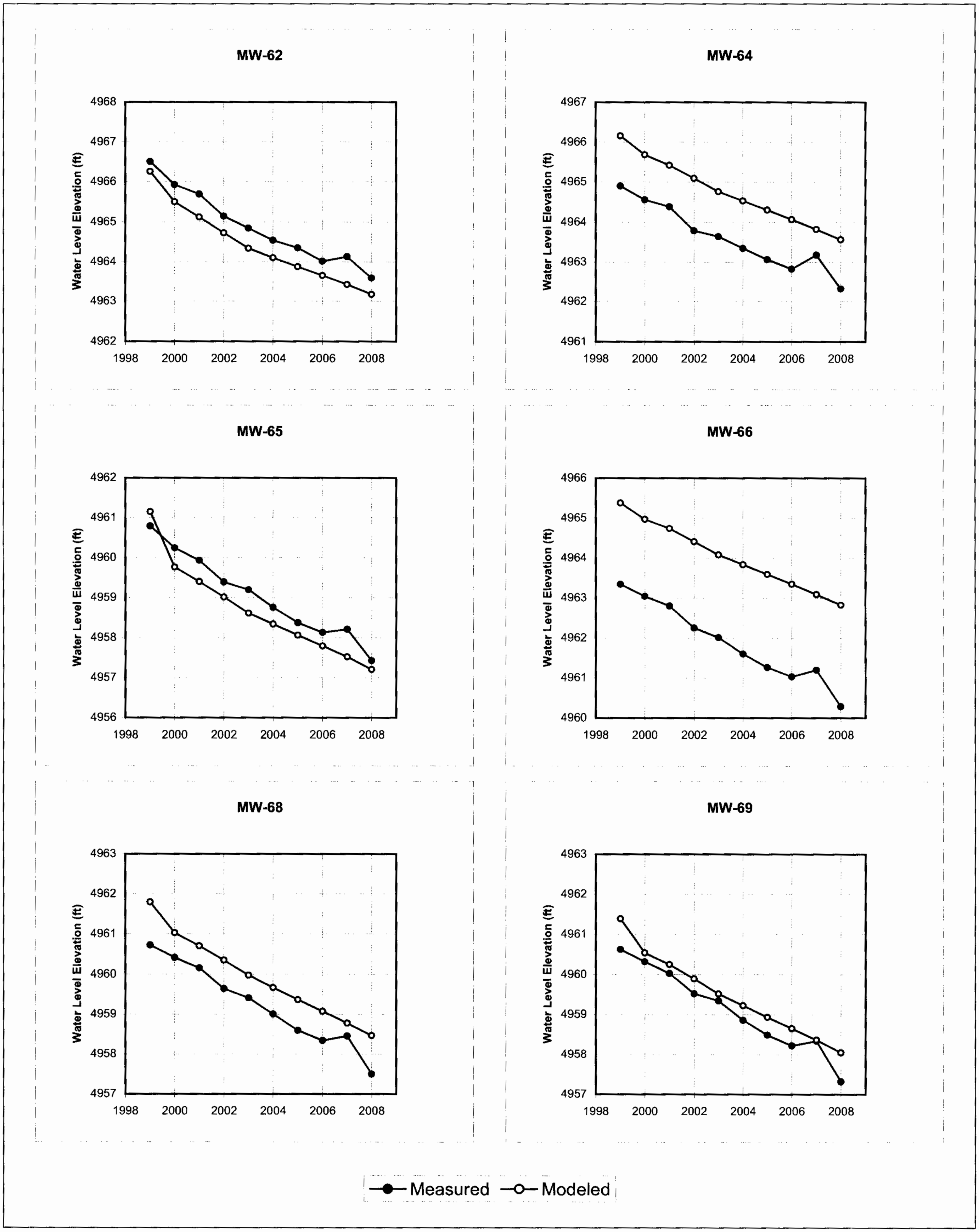


Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

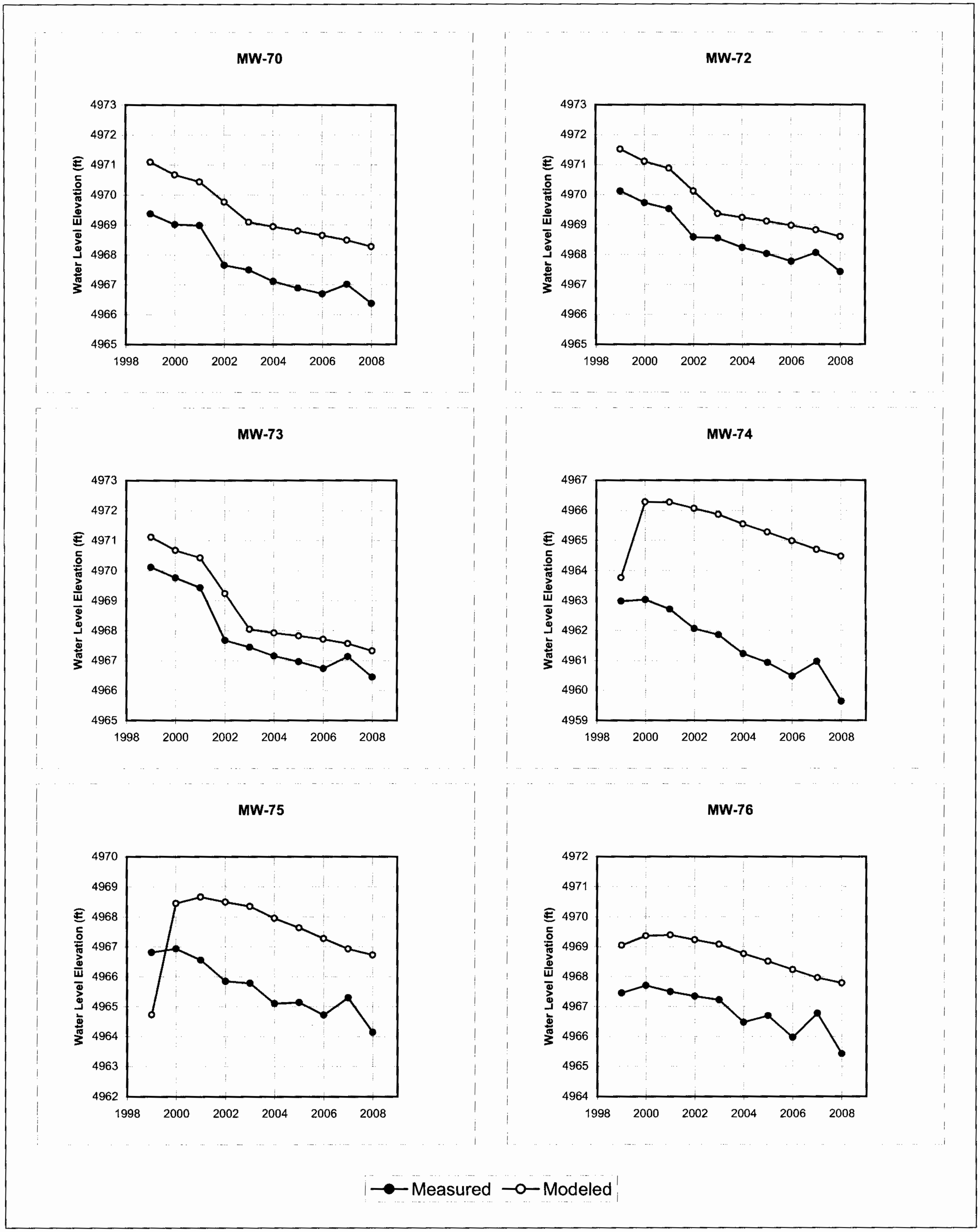


Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

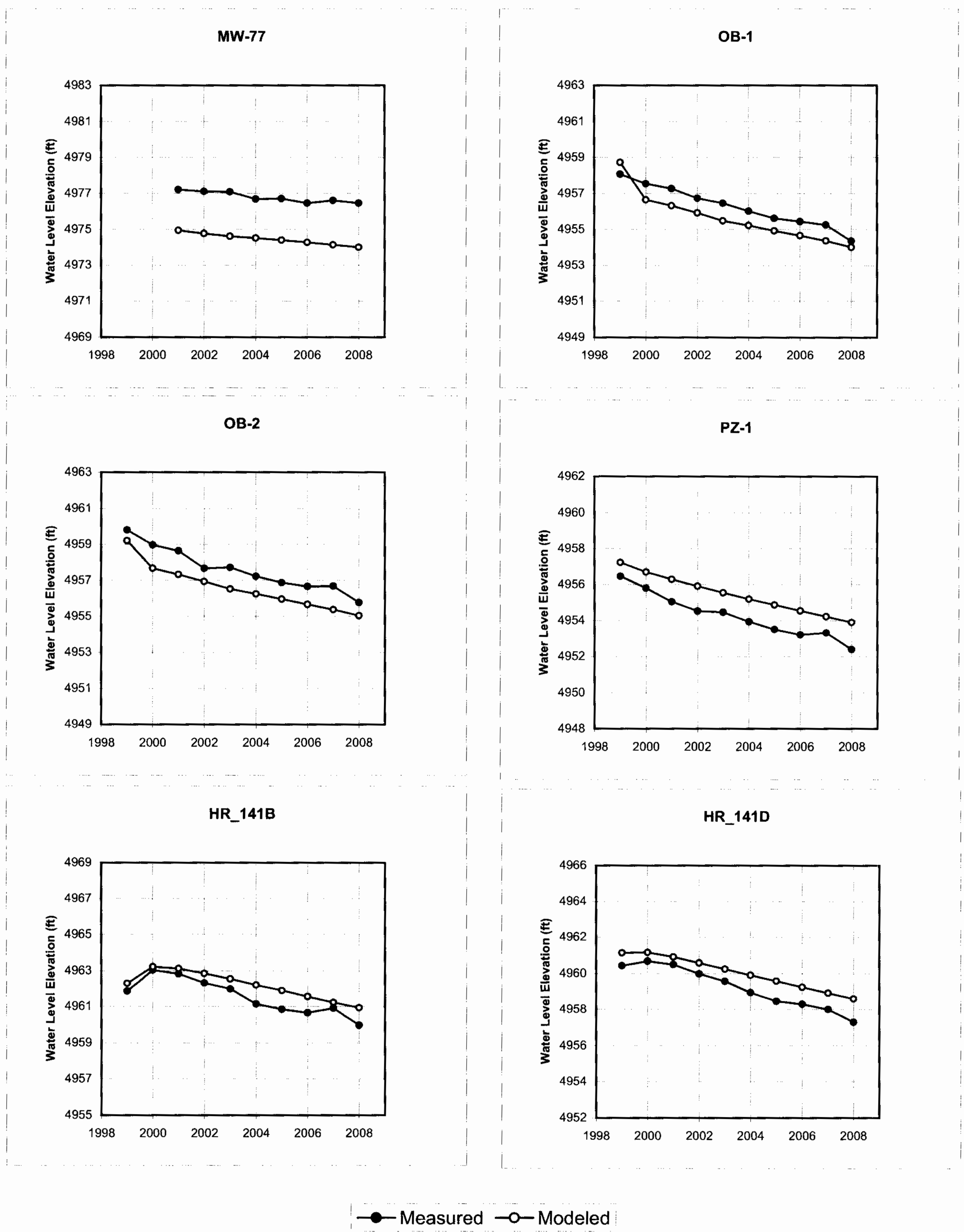
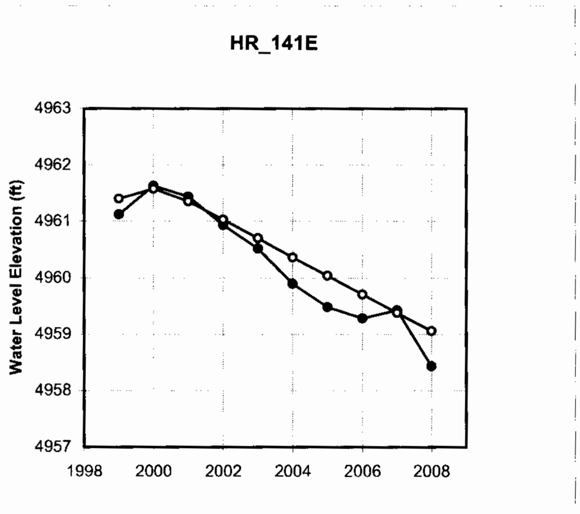


Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells



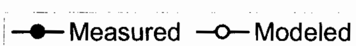


Figure E.2 Comparison of Observed and Calculated Water Levels in UFZ/ULFZ/LLFZ Wells

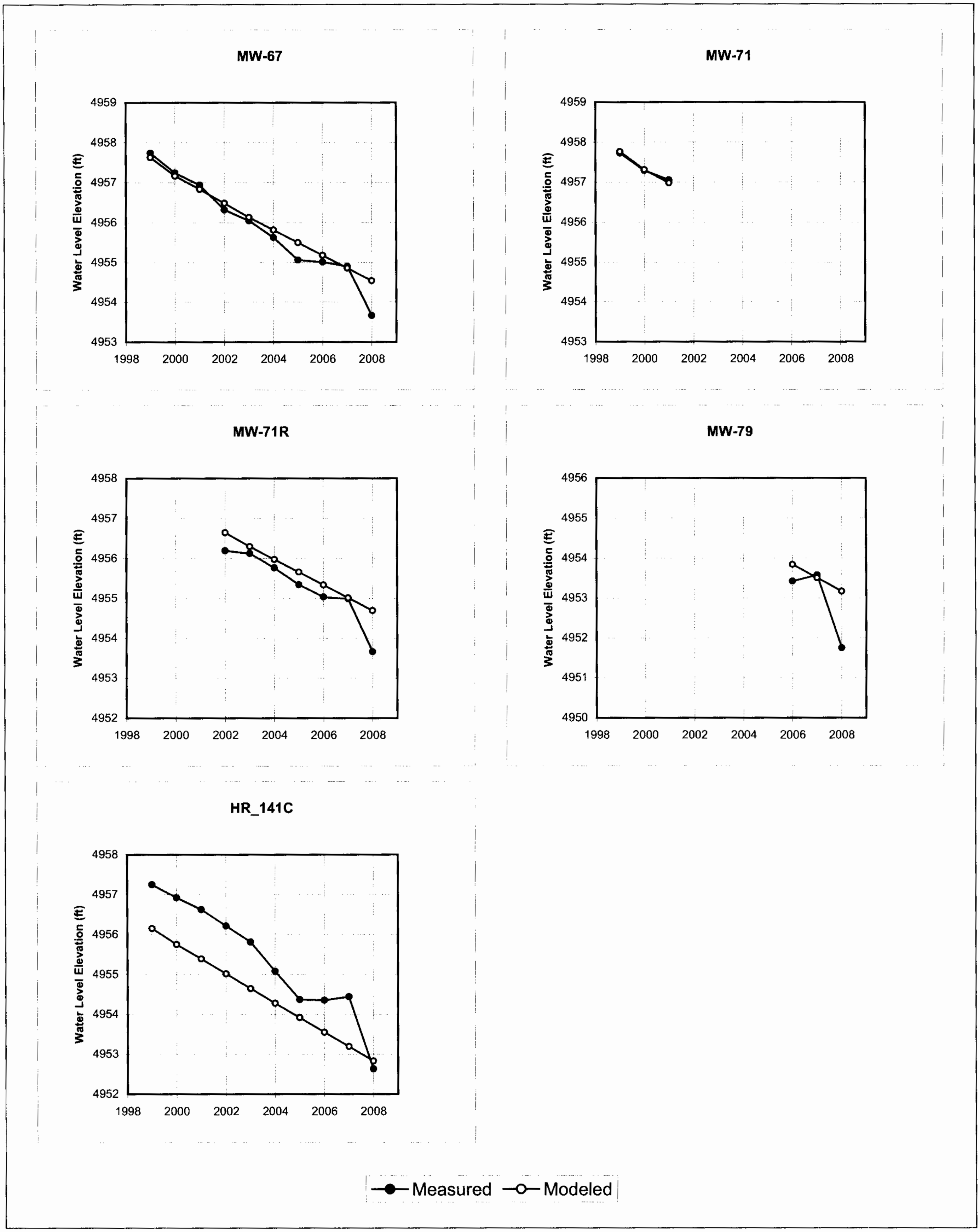


Figure E.3 Comparison of Observed and Calculated Water Levels in DFZ Wells

Figure E.4 Residuals between Observed and Calculated 2008 Water Levels in On-Site UFZ Wells

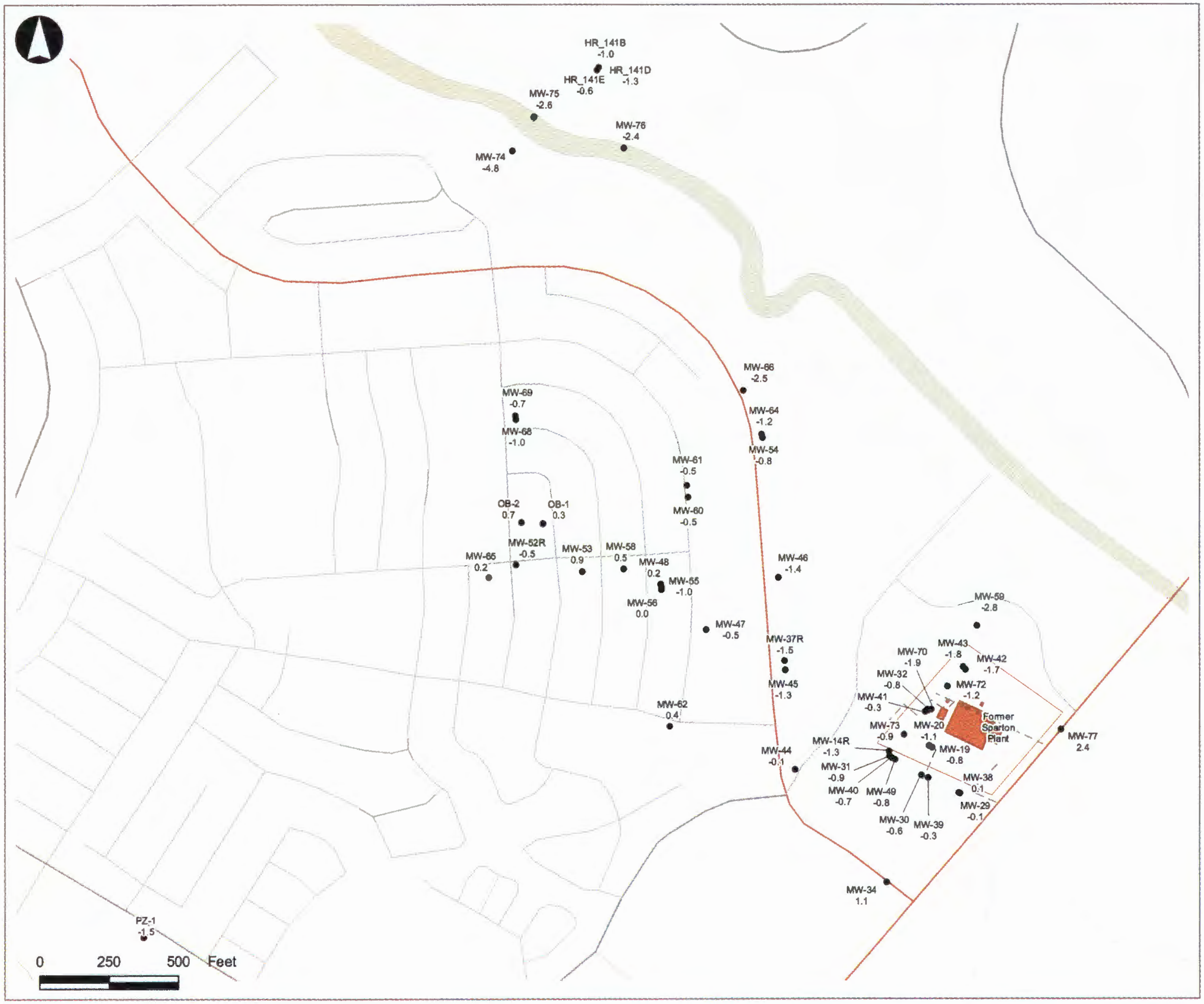


Figure E.5 Residuals between Observed and Calculated 2008 Water Levels in UFZ/UFLZ/LLFZ Wells

Figure E.6 Residuals between Observed and Calculated 2008 Water Levels in DFZ Wells

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
On-Site UFZ Wells				
MW-07	1999	4976.63	4975.87	0.75
MW-07	2000	4976.30	4975.60	0.70
MW-07	2001	4976.11	4975.42	0.69
MW-07	2002	4976.12	4975.29	0.84
MW-07	2003	4976.17	4975.20	0.98
MW-07	2004	4975.59	4975.10	0.49
MW-07	2005	4975.59	4974.98	0.60
MW-07	2006	4975.13	4974.82	0.31
MW-07	2007	4975.27	4974.65	0.63
MW-07	2008	4975.21	4974.50	0.71
MW-09	1999	4972.31	4972.69	-0.38
MW-09	2000	4971.97	4972.31	-0.34
MW-09	2001	4971.75	4972.07	-0.31
MW-09	2002	4970.94	4971.64	-0.70
MW-09	2003	4970.83	4971.25	-0.42
MW-09	2004	4970.40	4971.13	-0.73
MW-09	2005	4970.25	4970.99	-0.74
MW-09	2006	4969.93	4970.83	-0.90
MW-09	2007	4970.11	4970.65	-0.54
MW-09	2008	4969.75	4970.45	-0.71
MW-12	1999	4971.96	4972.73	-0.78
MW-12	2000	4971.61	4972.35	-0.74
MW-12	2001	4971.23	4972.11	-0.88
MW-12	2002	4970.34	4971.68	-1.34
MW-12	2003	4970.29	4971.29	-1.00
MW-12	2004	4969.88	4971.18	-1.30
MW-12	2005	4969.70	4971.04	-1.34
MW-12	2006	4969.38	4970.87	-1.49
MW-12	2007	4969.50	4970.69	-1.19
MW-12	2008	4969.09	4970.50	-1.41
MW-13	1999	4973.69	4973.42	0.27
MW-13	2000	4973.37	4973.06	0.31
MW-13	2001	4973.13	4972.83	0.30
MW-13	2002	4972.48	4972.46	0.03
MW-13	2003	4972.43	4972.12	0.32
MW-13	2004	4972.02	4971.99	0.03
MW-13	2005	4971.94	4971.85	0.09
MW-13	2006	4971.98	4971.70	0.28
MW-13	2007	4971.95	4971.53	0.42
MW-13	2008	4971.77	4971.35	0.42
MW-16	1999	4977.80	4976.65	1.16
MW-16	2000	4977.63	4976.54	1.09
MW-16	2001	4977.59	4976.46	1.13
MW-16	2002	4981.75	4979.95	1.80

Table E-1

Comparison of Observed and Calculated Water Levels
December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-16	2003	4982.27	4984.75	-2.48
MW-16	2004	4981.74	4985.85	-4.11
MW-16	2005	4981.95	4985.26	-3.31
MW-16	2006	4981.87	4984.51	-2.64
MW-16	2007	4981.76	4983.93	-2.18
MW-16	2008	4981.71	4984.04	-2.33
MW-17	1999	4978.16	4976.99	1.17
MW-17	2000	4977.93	4976.88	1.05
MW-17	2001	4977.76	4976.79	0.97
MW-17	2002	4981.99	4980.50	1.49
MW-17	2003	4982.03	4985.20	-3.17
MW-17	2004	4981.40	4985.97	-4.57
MW-17	2005	4981.60	4985.53	-3.92
MW-17	2006	4981.50	4984.95	-3.45
MW-17	2007	4981.42	4984.50	-3.07
MW-17	2008	4981.39	4984.62	-3.23
MW-18	1999	4970.93	4974.64	-3.71
MW-18	2000	4970.71	4974.49	-3.78
MW-18	2001	4970.32	4974.39	-4.07
MW-18	2002	4970.71	4974.95	-4.24
MW-18	2003	4975.19	4977.11	-1.93
MW-18	2004	4973.36	4977.78	-4.42
MW-18	2005	4974.11	4977.45	-3.33
MW-18	2006	4970.92	4977.01	-6.09
MW-18	2007	4973.57	4976.66	-3.08
MW-18	2008	4973.19	4976.61	-3.43
MW-21	1999	4978.34	4975.87	2.47
MW-21	2002	4983.27	4979.16	4.11
MW-21	2003	4983.39	4984.46	-1.07
MW-21	2004	4982.66	4986.10	-3.44
MW-21	2005	4982.73	4985.29	-2.57
MW-21	2006	4982.64	4984.31	-1.67
MW-21	2007	4982.47	4983.56	-1.09
MW-21	2008	4982.50	4983.66	-1.15
MW-22	1999	4976.71	4977.43	-0.72
MW-22	2000	4976.84	4977.31	-0.48
MW-22	2001	4976.37	4977.22	-0.85
MW-22	2002	4977.93	4980.08	-2.15
MW-22	2003	4977.85	4983.32	-5.48
MW-22	2004	4977.25	4983.53	-6.28
MW-22	2005	4977.39	4983.26	-5.88
MW-22	2006	4976.96	4982.90	-5.94
MW-22	2007	4977.14	4982.60	-5.46
MW-22	2008	4976.88	4982.67	-5.79
MW-23	1999	4975.14	4974.32	0.82

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-23	2000	4975.11	4973.99	1.12
MW-23	2001	4974.78	4973.78	1.00
MW-23	2002	4974.63	4973.59	1.04
MW-23	2003	4974.76	4973.33	1.42
MW-23	2004	4974.24	4973.22	1.01
MW-23	2005	4974.27	4973.09	1.18
MW-23	2006	4973.90	4972.94	0.96
MW-23	2007	4974.06	4972.78	1.28
MW-23	2008	4973.95	4972.61	1.33
MW-24	2000	4977.35	4976.53	0.82
MW-24	2001	4977.22	4976.45	0.77
MW-24	2002	4981.48	4979.90	1.58
MW-24	2003	4982.09	4984.66	-2.57
MW-24	2004	4981.55	4985.75	-4.20
MW-24	2005	4981.74	4985.16	-3.42
MW-24	2006	4981.65	4984.42	-2.78
MW-24	2007	4981.59	4983.85	-2.27
MW-24	2008	4981.50	4983.96	-2.46
MW-25	1999	4977.01	4976.50	0.51
MW-25	2000	4977.40	4976.40	1.00
MW-25	2001	4977.24	4976.32	0.92
MW-25	2002	4981.57	4979.80	1.77
MW-25	2003	4982.28	4984.71	-2.43
MW-25	2004	4981.73	4985.92	-4.20
MW-25	2005	4981.94	4985.29	-3.34
MW-25	2006	4981.84	4984.50	-2.66
MW-25	2007	4981.78	4983.89	-2.10
MW-25	2008	4981.79	4983.99	-2.20
MW-26	1999	4971.28	4973.34	-2.06
MW-26	2000	4972.51	4972.98	-0.47
MW-26	2001	4971.73	4972.77	-1.03
MW-26	2002	4971.40	4972.38	-0.98
MW-26	2003	4971.84	4972.04	-0.20
MW-26	2004	4971.36	4971.94	-0.58
MW-26	2005	4971.30	4971.81	-0.51
MW-26	2006	4970.98	4971.65	-0.67
MW-26	2007	4971.22	4971.49	-0.27
MW-26	2008	4970.98	4971.30	-0.33
MW-27	2000	4972.89	4975.24	-2.35
MW-27	2001	4972.75	4975.17	-2.42
MW-27	2002	4978.12	4977.96	0.16
MW-27	2003	4981.30	4982.17	-0.87
MW-27	2004	4980.76	4983.44	-2.68
MW-27	2005	4980.91	4982.89	-1.99
MW-27	2006	4980.89	4982.19	-1.30

Table E-1

Comparison of Observed and Calculated Water Levels
December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-27	2007	4980.89	4981.65	-0.77
MW-27	2008	4980.90	4981.73	-0.83
MW-33	1999	4971.65	4972.38	-0.73
MW-33	2000	4971.28	4971.98	-0.70
MW-33	2001	4971.01	4971.73	-0.72
MW-33	2002	4970.04	4971.28	-1.24
MW-33	2003	4969.94	4970.88	-0.95
MW-33	2004	4969.55	4970.78	-1.23
MW-33	2005	4969.49	4970.64	-1.15
MW-33	2006	4969.55	4970.46	-0.91
MW-51	1999	4979.98	4976.48	3.50
MW-51	2000	4979.72	4976.41	3.31
MW-51	2001	4979.80	4976.34	3.47
MW-51	2002	4980.87	4977.95	2.92
MW-51	2003	4981.89	4980.31	1.58
MW-51	2004	4981.82	4981.03	0.79
MW-51	2005	4982.02	4981.17	0.85
MW-51	2006	4981.83	4981.18	0.65
MW-51	2007	4982.02	4981.15	0.87
MW-51	2008	4981.72	4981.23	0.49
MW-63	1999	4970.74	4974.41	-3.68
MW-63	2000	4970.19	4974.37	-4.18
MW-63	2001	4970.04	4974.32	-4.27
MW-63	2002	4969.59	4975.11	-5.52
MW-63	2003	4971.78	4976.50	-4.72
MW-63	2004	4973.01	4977.18	-4.16
MW-63	2005	4974.07	4977.31	-3.24
MW-63	2006	4973.80	4977.28	-3.48
MW-63	2007	4975.88	4977.22	-1.34
MW-63	2008	4972.45	4977.25	-4.79
UFZ/ULFZ/LLFZ Wells				
MW-14	1999	4970.29	4971.59	-1.30
MW-14R	2001	4969.29	4970.38	-1.09
MW-14R	2002	4968.29	4969.66	-1.37
MW-14R	2003	4968.03	4969.02	-1.00
MW-14R	2004	4967.79	4968.97	-1.18
MW-14R	2005	4967.54	4968.84	-1.30
MW-14R	2006	4967.27	4968.67	-1.40
MW-14R	2007	4967.52	4968.49	-0.97
MW-14R	2008	4966.96	4968.27	-1.31
MW-19	1999	4970.99	4971.80	-0.80
MW-19	2000	4970.62	4971.39	-0.77
MW-19	2001	4970.33	4971.15	-0.82
MW-19	2002	4969.23	4970.40	-1.17
MW-19	2003	4969.13	4969.65	-0.52

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-19	2004	4968.79	4969.52	-0.73
MW-19	2005	4968.61	4969.40	-0.79
MW-19	2006	4968.33	4969.26	-0.93
MW-19	2007	4968.61	4969.10	-0.50
MW-19	2008	4968.13	4968.89	-0.76
MW-20	1999	4970.62	4971.36	-0.74
MW-20	2000	4970.26	4970.95	-0.69
MW-20	2001	4969.98	4970.71	-0.73
MW-20	2002	4968.78	4970.11	-1.33
MW-20	2003	4968.59	4969.51	-0.92
MW-20	2004	4968.25	4969.36	-1.11
MW-20	2005	4968.07	4969.22	-1.15
MW-20	2006	4967.83	4969.07	-1.24
MW-20	2007	4968.10	4968.90	-0.81
MW-20	2008	4967.60	4968.69	-1.10
MW-29	1999	4972.87	4972.71	0.16
MW-29	2000	4972.54	4972.34	0.19
MW-29	2001	4972.23	4972.12	0.10
MW-29	2002	4971.53	4971.69	-0.16
MW-29	2003	4971.41	4971.27	0.14
MW-29	2004	4970.95	4971.14	-0.19
MW-29	2005	4970.84	4971.00	-0.16
MW-29	2006	4970.55	4970.85	-0.30
MW-29	2007	4970.72	4970.69	0.03
MW-29	2008	4970.44	4970.50	-0.06
MW-30	1999	4971.40	4971.85	-0.45
MW-30	2000	4971.04	4971.44	-0.41
MW-30	2001	4970.76	4971.20	-0.44
MW-30	2002	4969.78	4970.62	-0.84
MW-30	2003	4969.61	4970.05	-0.44
MW-30	2004	4969.25	4969.93	-0.68
MW-30	2005	4969.09	4969.79	-0.71
MW-30	2006	4968.82	4969.64	-0.82
MW-30	2007	4969.01	4969.47	-0.47
MW-30	2008	4968.62	4969.27	-0.65
MW-31	1999	4970.32	4970.97	-0.65
MW-31	2000	4969.94	4970.52	-0.58
MW-31	2001	4969.66	4970.27	-0.60
MW-31	2002	4968.38	4969.50	-1.12
MW-31	2003	4968.19	4968.77	-0.58
MW-31	2004	4967.86	4968.65	-0.79
MW-31	2005	4967.64	4968.52	-0.88
MW-31	2006	4967.38	4968.37	-0.98
MW-31	2007	4967.63	4968.20	-0.57
MW-31	2008	4967.12	4967.97	-0.85

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-32	1999	4970.12	4971.21	-1.09
MW-32	2000	4969.76	4970.78	-1.03
MW-32	2001	4969.51	4970.54	-1.03
MW-32	2002	4968.08	4969.54	-1.46
MW-32	2003	4968.01	4968.53	-0.52
MW-32	2004	4967.71	4968.38	-0.67
MW-32	2005	4967.49	4968.27	-0.78
MW-32	2006	4967.22	4968.15	-0.92
MW-32	2007	4967.60	4968.00	-0.40
MW-32	2008	4966.96	4967.77	-0.81
MW-34	1999	4973.46	4972.19	1.26
MW-34	2000	4973.12	4971.81	1.31
MW-34	2001	4972.90	4971.56	1.34
MW-34	2002	4972.28	4971.23	1.05
MW-34	2003	4972.13	4970.90	1.22
MW-34	2004	4971.59	4970.74	0.85
MW-34	2005	4971.46	4970.58	0.88
MW-34	2006	4971.19	4970.42	0.77
MW-34	2007	4971.28	4970.25	1.02
MW-34	2008	4971.13	4970.07	1.06
MW-35	1999	4970.62	4970.18	0.44
MW-35	2000	4970.22	4969.70	0.51
MW-35	2001	4969.98	4969.40	0.58
MW-36	1999	4969.03	4969.15	-0.11
MW-36	2000	4968.58	4968.60	-0.02
MW-36	2002	4967.55	4967.83	-0.28
MW-36	2003	4967.33	4967.41	-0.08
MW-36	2004	4967.43	4967.24	0.19
MW-37	1999	4967.27	4968.20	-0.93
MW-37	2000	4966.92	4967.58	-0.65
MW-37R	2002	4965.13	4966.75	-1.62
MW-37R	2003	4965.09	4966.36	-1.28
MW-37R	2004	4964.78	4966.21	-1.43
MW-37R	2005	4964.54	4966.03	-1.49
MW-37R	2006	4964.25	4965.82	-1.57
MW-37R	2007	4964.38	4965.60	-1.22
MW-37R	2008	4963.84	4965.36	-1.52
MW-38	1999	4972.90	4972.40	0.50
MW-38	2000	4972.56	4972.02	0.54
MW-38	2001	4972.25	4971.80	0.45
MW-38	2002	4971.49	4971.38	0.11
MW-38	2003	4971.42	4970.98	0.44
MW-38	2004	4971.20	4970.83	0.37
MW-38	2005	4970.83	4970.69	0.14
MW-38	2006	4970.57	4970.54	0.04

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-38	2007	4970.72	4970.38	0.34
MW-38	2008	4970.30	4970.19	0.11
MW-39	1999	4971.63	4971.61	0.02
MW-39	2000	4971.28	4971.20	0.08
MW-39	2001	4971.01	4970.97	0.04
MW-39	2002	4970.11	4970.46	-0.36
MW-39	2003	4969.96	4969.97	-0.02
MW-39	2004	4969.56	4969.83	-0.26
MW-39	2005	4969.36	4969.68	-0.32
MW-39	2006	4969.11	4969.52	-0.41
MW-39	2007	4969.30	4969.36	-0.06
MW-39	2008	4968.82	4969.15	-0.34
MW-40	1999	4970.35	4970.76	-0.41
MW-40	2000	4969.98	4970.31	-0.33
MW-40	2001	4969.71	4970.06	-0.34
MW-40	2002	4968.46	4969.41	-0.95
MW-40	2003	4968.26	4968.78	-0.52
MW-40	2004	4967.96	4968.63	-0.67
MW-40	2005	4967.75	4968.48	-0.74
MW-40	2006	4967.47	4968.33	-0.86
MW-40	2007	4967.75	4968.15	-0.40
MW-40	2008	4967.20	4967.94	-0.74
MW-41	1999	4970.23	4971.33	-1.10
MW-41	2000	4969.86	4970.91	-1.04
MW-41	2001	4969.62	4970.67	-1.04
MW-41	2002	4968.32	4969.51	-1.19
MW-41	2003	4968.41	4968.34	0.07
MW-41	2004	4968.03	4968.21	-0.18
MW-41	2005	4967.90	4968.11	-0.21
MW-41	2006	4967.63	4968.00	-0.37
MW-41	2007	4968.01	4967.86	0.15
MW-41	2008	4967.37	4967.62	-0.26
MW-42	1999	4969.89	4971.65	-1.76
MW-42	2000	4969.54	4971.26	-1.72
MW-42	2001	4969.34	4971.03	-1.70
MW-42	2002	4968.54	4970.45	-1.91
MW-42	2003	4968.48	4969.87	-1.39
MW-42	2004	4968.17	4969.73	-1.56
MW-42	2005	4967.97	4969.60	-1.62
MW-42	2006	4967.73	4969.45	-1.72
MW-42	2007	4967.96	4969.28	-1.33
MW-42	2008	4967.39	4969.08	-1.69
MW-43	1999	4969.69	4971.40	-1.71
MW-43	2000	4969.33	4971.00	-1.67
MW-43	2001	4969.12	4970.77	-1.65

Table E-1

Comparison of Observed and Calculated Water Levels
December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-43	2002	4968.30	4970.25	-1.95
MW-43	2003	4968.27	4969.74	-1.47
MW-43	2004	4967.95	4969.60	-1.65
MW-43	2005	4967.72	4969.45	-1.73
MW-43	2006	4967.48	4969.29	-1.81
MW-43	2007	4967.73	4969.12	-1.39
MW-43	2008	4967.10	4968.92	-1.82
MW-44	1999	4969.10	4969.11	-0.01
MW-44	2000	4968.69	4968.57	0.12
MW-44	2001	4968.41	4968.26	0.15
MW-44	2002	4967.40	4967.80	-0.41
MW-44	2003	4967.41	4967.38	0.03
MW-44	2004	4967.11	4967.21	-0.11
MW-44	2005	4966.85	4967.03	-0.18
MW-44	2006	4966.57	4966.84	-0.26
MW-44	2007	4966.74	4966.64	0.10
MW-44	2008	4966.28	4966.41	-0.13
MW-45	1999	4967.28	4968.08	-0.80
MW-45	2000	4966.89	4967.46	-0.57
MW-45	2001	4967.10	4967.15	-0.04
MW-45	2002	4966.10	4966.69	-0.59
MW-45	2003	4966.08	4966.27	-0.19
MW-45	2004	4965.77	4966.11	-0.34
MW-45	2005	4964.88	4965.93	-1.04
MW-45	2006	4964.59	4965.72	-1.14
MW-45	2007	4964.69	4965.51	-0.82
MW-45	2008	4963.99	4965.27	-1.28
MW-46	1999	4965.93	4967.25	-1.32
MW-46	2000	4965.57	4966.60	-1.03
MW-46	2001	4965.32	4966.30	-0.98
MW-46	2002	4964.66	4965.91	-1.25
MW-46	2003	4964.45	4965.55	-1.10
MW-46	2004	4964.17	4965.37	-1.20
MW-46	2005	4963.90	4965.17	-1.27
MW-46	2006	4963.63	4964.96	-1.33
MW-46	2007	4963.82	4964.73	-0.91
MW-46	2008	4963.13	4964.48	-1.36
MW-47	1999	4965.49	4966.24	-0.76
MW-47	2000	4965.06	4965.43	-0.38
MW-47	2001	4964.50	4965.06	-0.56
MW-47	2002	4964.20	4964.66	-0.46
MW-47	2003	4963.98	4964.27	-0.29
MW-47	2004	4963.66	4964.05	-0.39
MW-47	2005	4963.42	4963.83	-0.41
MW-47	2006	4963.11	4963.60	-0.49

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-47	2007	4963.26	4963.37	-0.12
MW-47	2008	4962.64	4963.12	-0.48
MW-48	1999	4964.63	4964.95	-0.33
MW-48	2000	4964.02	4963.96	0.06
MW-48	2001	4963.68	4963.56	0.12
MW-48	2002	4963.21	4963.17	0.04
MW-48	2003	4962.97	4962.78	0.19
MW-48	2004	4962.64	4962.54	0.10
MW-48	2005	4962.33	4962.30	0.03
MW-48	2006	4962.03	4962.06	-0.03
MW-48	2007	4962.20	4961.82	0.39
MW-48	2008	4961.74	4961.54	0.20
MW-49	1999	4970.15	4970.68	-0.52
MW-49	2000	4969.88	4970.22	-0.34
MW-49	2001	4969.54	4969.98	-0.44
MW-49	2002	4968.46	4969.43	-0.97
MW-49	2003	4968.30	4968.89	-0.59
MW-49	2004	4967.97	4968.74	-0.77
MW-49	2005	4967.75	4968.58	-0.84
MW-49	2006	4967.53	4968.42	-0.89
MW-49	2007	4967.71	4968.24	-0.53
MW-49	2008	4967.22	4968.03	-0.81
MW-52	1999	4961.13	4961.79	-0.65
MW-52	2000	4960.51	4960.54	-0.03
MW-52	2001	4960.21	4960.07	0.14
MW-52	2002	4959.88	4959.66	0.22
MW-52R	2003	4959.05	4959.26	-0.21
MW-52R	2004	4958.73	4958.97	-0.24
MW-52R	2005	4958.37	4958.68	-0.32
MW-52R	2006	4958.15	4958.41	-0.26
MW-52R	2007	4958.19	4958.13	0.06
MW-52R	2008	4957.31	4957.81	-0.50
MW-53	1999	4963.38	4963.15	0.23
MW-53	2000	4962.63	4961.80	0.83
MW-53	2001	4962.10	4961.35	0.75
MW-53	2002	4961.53	4960.95	0.57
MW-53	2003	4961.30	4960.54	0.75
MW-53	2004	4961.00	4960.27	0.73
MW-53	2005	4960.65	4960.00	0.65
MW-53	2006	4960.41	4959.73	0.68
MW-53	2007	4960.44	4959.46	0.98
MW-53	2008	4960.01	4959.15	0.85
MW-54	1999	4964.80	4966.24	-1.44
MW-54	2000	4964.58	4965.76	-1.18
MW-54	2001	4964.35	4965.49	-1.14

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-54	2002	4963.83	4965.16	-1.33
MW-54	2003	4963.62	4964.83	-1.21
MW-54	2004	4963.33	4964.60	-1.27
MW-54	2005	4963.11	4964.37	-1.26
MW-54	2006	4962.92	4964.14	-1.22
MW-54	2007	4963.16	4963.89	-0.74
MW-54	2008	4962.83	4963.64	-0.81
MW-55	1999	4963.34	4964.61	-1.27
MW-55	2000	4962.91	4963.57	-0.66
MW-55	2001	4962.55	4963.24	-0.69
MW-55	2002	4962.04	4962.85	-0.82
MW-55	2003	4961.86	4962.46	-0.60
MW-55	2004	4961.41	4962.23	-0.82
MW-55	2005	4961.10	4961.99	-0.89
MW-55	2006	4960.85	4961.76	-0.91
MW-55	2007	4960.95	4961.51	-0.57
MW-55	2008	4960.20	4961.24	-1.04
MW-56	1999	4964.59	4964.86	-0.27
MW-56	2000	4964.03	4963.86	0.17
MW-56	2001	4963.69	4963.49	0.19
MW-56	2002	4963.22	4963.11	0.11
MW-56	2003	4962.99	4962.72	0.27
MW-56	2004	4962.64	4962.48	0.16
MW-56	2005	4962.37	4962.24	0.13
MW-56	2006	4961.97	4962.00	-0.03
MW-56	2007	4962.19	4961.76	0.42
MW-56	2008	4961.49	4961.49	0.01
MW-57	1999	4964.36	4965.64	-1.28
MW-57	2000	4964.32	4965.31	-0.99
MW-57	2001	4964.16	4965.07	-0.91
MW-57	2002	4963.63	4964.76	-1.13
MW-57	2003	4963.46	4964.44	-0.97
MW-57	2004	4963.13	4964.18	-1.06
MW-57	2005	4963.03	4963.94	-0.91
MW-57	2006	4963.05	4963.69	-0.64
MW-57	2007	4963.18	4963.44	-0.26
MW-58	1999	4964.15	4964.03	0.12
MW-58	2000	4963.48	4962.86	0.61
MW-58	2001	4963.30	4962.44	0.86
MW-58	2002	4962.58	4962.05	0.53
MW-58	2003	4962.30	4961.65	0.65
MW-58	2004	4961.99	4961.39	0.60
MW-58	2005	4961.66	4961.14	0.52
MW-58	2006	4961.20	4960.89	0.31
MW-58	2007	4961.52	4960.64	0.88

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-58	2008	4960.90	4960.36	0.54
MW-59	1999	4968.77	4971.50	-2.74
MW-59	2000	4968.44	4971.12	-2.68
MW-59	2001	4968.21	4970.90	-2.70
MW-59	2002	4967.50	4970.44	-2.94
MW-59	2003	4967.36	4969.98	-2.62
MW-59	2004	4967.13	4969.85	-2.71
MW-59	2005	4966.94	4969.70	-2.76
MW-59	2006	4966.71	4969.54	-2.83
MW-59	2007	4966.91	4969.37	-2.46
MW-59	2008	4966.36	4969.17	-2.80
MW-60	1999	4964.27	4964.89	-0.62
MW-60	2000	4963.96	4964.07	-0.11
MW-60	2001	4963.76	4963.75	0.01
MW-60	2002	4963.23	4963.39	-0.16
MW-60	2003	4962.89	4963.02	-0.13
MW-60	2004	4962.64	4962.78	-0.14
MW-60	2005	4962.31	4962.53	-0.22
MW-60	2006	4961.88	4962.29	-0.42
MW-60	2007	4962.13	4962.04	0.09
MW-60	2008	4961.29	4961.77	-0.48
MW-61	1999	4964.35	4964.95	-0.60
MW-61	2000	4964.04	4964.16	-0.12
MW-61	2001	4963.82	4963.82	0.00
MW-61	2002	4963.13	4963.46	-0.33
MW-61	2003	4962.87	4963.10	-0.23
MW-61	2004	4962.61	4962.85	-0.24
MW-61	2005	4962.21	4962.60	-0.40
MW-61	2006	4961.87	4962.36	-0.49
MW-61	2007	4962.04	4962.11	-0.07
MW-61	2008	4961.35	4961.83	-0.49
MW-62	1999	4966.51	4966.26	0.25
MW-62	2000	4965.93	4965.50	0.42
MW-62	2001	4965.70	4965.12	0.57
MW-62	2002	4965.14	4964.73	0.42
MW-62	2003	4964.84	4964.34	0.51
MW-62	2004	4964.54	4964.10	0.44
MW-62	2005	4964.35	4963.88	0.47
MW-62	2006	4964.02	4963.65	0.36
MW-62	2007	4964.13	4963.43	0.70
MW-62	2008	4963.59	4963.17	0.42
MW-64	1999	4964.90	4966.16	-1.26
MW-64	2000	4964.56	4965.68	-1.13
MW-64	2001	4964.38	4965.42	-1.04
MW-64	2002	4963.79	4965.09	-1.31

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-64	2003	4963.64	4964.76	-1.12
MW-64	2004	4963.34	4964.53	-1.19
MW-64	2005	4963.07	4964.30	-1.24
MW-64	2006	4962.83	4964.07	-1.24
MW-64	2007	4963.18	4963.82	-0.64
MW-64	2008	4962.33	4963.56	-1.24
MW-65	1999	4960.79	4961.15	-0.36
MW-65	2000	4960.25	4959.76	0.48
MW-65	2001	4959.93	4959.40	0.53
MW-65	2002	4959.39	4959.01	0.37
MW-65	2003	4959.20	4958.61	0.59
MW-65	2004	4958.76	4958.34	0.41
MW-65	2005	4958.37	4958.06	0.31
MW-65	2006	4958.13	4957.79	0.34
MW-65	2007	4958.21	4957.52	0.69
MW-65	2008	4957.42	4957.20	0.22
MW-66	1999	4963.34	4965.38	-2.03
MW-66	2000	4963.04	4964.97	-1.93
MW-66	2001	4962.80	4964.74	-1.94
MW-66	2002	4962.25	4964.41	-2.16
MW-66	2003	4962.01	4964.08	-2.07
MW-66	2004	4961.60	4963.84	-2.23
MW-66	2005	4961.26	4963.59	-2.33
MW-66	2006	4961.03	4963.34	-2.31
MW-66	2007	4961.20	4963.09	-1.89
MW-66	2008	4960.29	4962.82	-2.54
MW-68	1999	4960.73	4961.80	-1.07
MW-68	2000	4960.41	4961.03	-0.62
MW-68	2001	4960.16	4960.70	-0.54
MW-68	2002	4959.64	4960.35	-0.71
MW-68	2003	4959.41	4959.97	-0.57
MW-68	2004	4959.01	4959.66	-0.66
MW-68	2005	4958.60	4959.37	-0.77
MW-68	2006	4958.34	4959.07	-0.73
MW-68	2007	4958.45	4958.78	-0.33
MW-68	2008	4957.50	4958.47	-0.97
MW-69	1999	4960.62	4961.39	-0.77
MW-69	2000	4960.32	4960.53	-0.22
MW-69	2001	4960.03	4960.24	-0.22
MW-69	2002	4959.52	4959.89	-0.37
MW-69	2003	4959.34	4959.51	-0.17
MW-69	2004	4958.86	4959.23	-0.37
MW-69	2005	4958.49	4958.94	-0.45
MW-69	2006	4958.22	4958.65	-0.43
MW-69	2007	4958.34	4958.36	-0.02

Table E-1

Comparison of Observed and Calculated Water Levels
December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-69	2008	4957.32	4958.05	-0.73
MW-70	1999	4969.37	4971.10	-1.73
MW-70	2000	4969.01	4970.67	-1.66
MW-70	2001	4968.98	4970.44	-1.45
MW-70	2002	4967.66	4969.76	-2.11
MW-70	2003	4967.50	4969.09	-1.59
MW-70	2004	4967.11	4968.94	-1.82
MW-70	2005	4966.89	4968.80	-1.91
MW-70	2006	4966.69	4968.65	-1.96
MW-70	2007	4967.01	4968.49	-1.47
MW-70	2008	4966.37	4968.27	-1.90
MW-72	1999	4970.12	4971.52	-1.39
MW-72	2000	4969.73	4971.11	-1.38
MW-72	2001	4969.53	4970.88	-1.35
MW-72	2002	4968.58	4970.12	-1.54
MW-72	2003	4968.55	4969.37	-0.82
MW-72	2004	4968.23	4969.24	-1.01
MW-72	2005	4968.03	4969.11	-1.08
MW-72	2006	4967.77	4968.97	-1.20
MW-72	2007	4968.06	4968.82	-0.76
MW-72	2008	4967.43	4968.60	-1.17
MW-73	1999	4970.12	4971.12	-0.99
MW-73	2000	4969.77	4970.68	-0.91
MW-73	2001	4969.44	4970.43	-0.99
MW-73	2002	4967.68	4969.24	-1.56
MW-73	2003	4967.45	4968.05	-0.60
MW-73	2004	4967.15	4967.93	-0.78
MW-73	2005	4966.97	4967.83	-0.87
MW-73	2006	4966.74	4967.71	-0.98
MW-73	2007	4967.13	4967.57	-0.44
MW-73	2008	4966.45	4967.33	-0.88
MW-74	1999	4962.99	4963.77	-0.79
MW-74	2000	4963.03	4966.28	-3.25
MW-74	2001	4962.71	4966.27	-3.56
MW-74	2002	4962.07	4966.07	-4.00
MW-74	2003	4961.86	4965.87	-4.01
MW-74	2004	4961.23	4965.55	-4.32
MW-74	2005	4960.94	4965.27	-4.34
MW-74	2006	4960.47	4964.98	-4.51
MW-74	2007	4960.97	4964.69	-3.72
MW-74	2008	4959.64	4964.47	-4.83
MW-75	1999	4966.81	4964.73	2.08
MW-75	2000	4966.94	4968.46	-1.52
MW-75	2001	4966.56	4968.66	-2.11
MW-75	2002	4965.84	4968.50	-2.66

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-75	2003	4965.78	4968.35	-2.58
MW-75	2004	4965.11	4967.96	-2.85
MW-75	2005	4965.15	4967.64	-2.49
MW-75	2006	4964.72	4967.28	-2.55
MW-75	2007	4965.30	4966.93	-1.62
MW-75	2008	4964.15	4966.73	-2.58
MW-76	1999	4967.46	4969.05	-1.59
MW-76	2000	4967.70	4969.37	-1.66
MW-76	2001	4967.49	4969.40	-1.90
MW-76	2002	4967.35	4969.23	-1.88
MW-76	2003	4967.22	4969.08	-1.85
MW-76	2004	4966.48	4968.76	-2.29
MW-76	2005	4966.70	4968.51	-1.81
MW-76	2006	4965.97	4968.24	-2.26
MW-76	2007	4966.78	4967.96	-1.19
MW-76	2008	4965.42	4967.78	-2.36
MW-77	2001	4977.21	4974.96	2.26
MW-77	2002	4977.10	4974.78	2.33
MW-77	2003	4977.09	4974.62	2.46
MW-77	2004	4976.69	4974.53	2.16
MW-77	2005	4976.71	4974.42	2.29
MW-77	2006	4976.46	4974.29	2.17
MW-77	2007	4976.61	4974.15	2.45
MW-77	2008	4976.46	4974.01	2.44
OB-1	1999	4958.08	4958.73	-0.65
OB-1	2000	4957.55	4956.65	0.90
OB-1	2001	4957.28	4956.32	0.96
OB-1	2002	4956.73	4955.92	0.81
OB-1	2003	4956.46	4955.48	0.98
OB-1	2004	4956.03	4955.22	0.80
OB-1	2005	4955.62	4954.93	0.69
OB-1	2006	4955.44	4954.66	0.78
OB-1	2007	4955.25	4954.38	0.87
OB-1	2008	4954.36	4954.03	0.33
OB-2	1999	4959.81	4959.20	0.61
OB-2	2000	4958.97	4957.67	1.30
OB-2	2001	4958.64	4957.32	1.32
OB-2	2002	4957.66	4956.94	0.72
OB-2	2003	4957.71	4956.53	1.18
OB-2	2004	4957.22	4956.25	0.97
OB-2	2005	4956.87	4955.95	0.92
OB-2	2006	4956.66	4955.67	0.99
OB-2	2007	4956.68	4955.38	1.30
OB-2	2008	4955.77	4955.05	0.72
PZ-1	1999	4956.47	4957.22	-0.75

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
PZ-1	2000	4955.80	4956.70	-0.91
PZ-1	2001	4955.05	4956.29	-1.24
PZ-1	2002	4954.54	4955.91	-1.37
PZ-1	2003	4954.46	4955.54	-1.08
PZ-1	2004	4953.94	4955.20	-1.26
PZ-1	2005	4953.51	4954.87	-1.36
PZ-1	2006	4953.21	4954.55	-1.34
PZ-1	2007	4953.33	4954.23	-0.89
PZ-1	2008	4952.40	4953.90	-1.50
HR_141B	1999	4961.86	4962.29	-0.44
HR_141B	2000	4963.03	4963.22	-0.19
HR_141B	2001	4962.82	4963.12	-0.30
HR_141B	2002	4962.31	4962.84	-0.53
HR_141B	2003	4961.98	4962.55	-0.57
HR_141B	2004	4961.15	4962.21	-1.06
HR_141B	2005	4960.84	4961.89	-1.05
HR_141B	2006	4960.66	4961.56	-0.90
HR_141B	2007	4960.90	4961.23	-0.32
HR_141B	2008	4959.96	4960.93	-0.96
HR_141D	1999	4960.43	4961.14	-0.70
HR_141D	2000	4960.69	4961.16	-0.47
HR_141D	2001	4960.49	4960.91	-0.42
HR_141D	2002	4959.98	4960.58	-0.60
HR_141D	2003	4959.57	4960.25	-0.67
HR_141D	2004	4958.95	4959.91	-0.96
HR_141D	2005	4958.46	4959.58	-1.13
HR_141D	2006	4958.30	4959.25	-0.96
HR_141D	2007	4958.00	4958.92	-0.91
HR_141D	2008	4957.29	4958.59	-1.31
HR_141E	1999	4961.12	4961.40	-0.28
HR_141E	2000	4961.63	4961.58	0.06
HR_141E	2001	4961.44	4961.35	0.08
HR_141E	2002	4960.93	4961.03	-0.10
HR_141E	2003	4960.52	4960.70	-0.18
HR_141E	2004	4959.90	4960.37	-0.47
HR_141E	2005	4959.48	4960.04	-0.56
HR_141E	2006	4959.28	4959.71	-0.42
HR_141E	2007	4959.43	4959.38	0.05
HR_141E	2008	4958.43	4959.06	-0.63
DFZ Wells				
MW-67	1999	4957.74	4957.63	0.11
MW-67	2000	4957.25	4957.17	0.08
MW-67	2001	4956.95	4956.84	0.11
MW-67	2002	4956.32	4956.49	-0.17
MW-67	2003	4956.05	4956.13	-0.09

Table E-1

Comparison of Observed and Calculated Water Levels December 1998 to December 2008

Monitoring Well	Year	Water-level Elevation in feet above MSL		Difference (ft)
		Observed	Calculated	
MW-67	2004	4955.63	4955.82	-0.19
MW-67	2005	4955.07	4955.50	-0.43
MW-67	2006	4955.01	4955.18	-0.17
MW-67	2007	4954.90	4954.86	0.04
MW-67	2008	4953.67	4954.53	-0.87
MW-71	1999	4957.73	4957.77	-0.04
MW-71	2000	4957.29	4957.32	-0.03
MW-71	2001	4957.05	4956.98	0.07
MW-71R	2002	4956.19	4956.65	-0.45
MW-71R	2003	4956.12	4956.30	-0.17
MW-71R	2004	4955.77	4955.98	-0.21
MW-71R	2005	4955.34	4955.66	-0.32
MW-71R	2006	4955.03	4955.34	-0.30
MW-71R	2007	4954.99	4955.02	-0.03
MW-71R	2008	4953.66	4954.69	-1.03
MW-79	2006	4953.42	4953.84	-0.42
MW-79	2007	4953.58	4953.51	0.07
MW-79	2008	4951.75	4953.17	-1.42
HR_141C	1999	4957.25	4956.15	1.10
HR_141C	2000	4956.92	4955.75	1.17
HR_141C	2001	4956.63	4955.39	1.24
HR_141C	2002	4956.22	4955.02	1.20
HR_141C	2003	4955.82	4954.64	1.17
HR_141C	2004	4955.08	4954.28	0.80
HR_141C	2005	4954.37	4953.92	0.45
HR_141C	2006	4954.35	4953.55	0.80
HR_141C	2007	4954.44	4953.19	1.25
HR_141C	2008	4952.63	4952.83	-0.19