REMEDIATION SYSTEM EVALUATION

SELMA PRESSURE TREATING SUPERFUND SITE
SELMA, CALIFORNIA

Report of the Remediation System Evaluation,
Site Visit Conducted at the Selma Pressure Treating Superfund Site
November 7-8, 2001

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NOTICE

Work described herein was performed by GeoTrans, Inc. (GeoTrans) and the United States Army Corps of Engineers (USACE) for the U.S. Environmental Protection Agency (U.S. EPA). Work conducted by GeoTrans, including preparation of this report, was performed under Dynamac Contract No. 68-C-99-256, Subcontract No. 91517. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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EXECUTIVE SUMMARY

The Selma Pressure Treating site is located 15 miles south of Fresno, adjacent to the city limits of Selma, California and has subsurface contamination from a former wood treating facility. The site occupies approximately 40 acres, including the 14-acre former wood treating and storage facility and a 26-acre neighboring vineyard. Zoned for heavy use, the site is located in a transition zone between agricultural, residential, and industrial areas. Drippings from the former wood treating processes have led to both soil and groundwater contamination beneath the former facilities. The primary contaminant of concern is chromium, predominantly found as hexavalent chromium, its more mobile state. Remedial investigations of the contamination began in 1984, and by 1991 soil cleanup activities had started. Approximately 18,000 cubic yards of contaminated soil have been addressed, and an additional contaminated soil will be addressed in the future.

A pump and treat system began operation in September 1998 to address the chromium contamination in groundwater. The system consists of seven extraction wells, a treatment plant that removes chromium through a co-precipitation process, and discharge of treated water to onsite percolation ponds.

A Remediation System Evaluation (RSE) was conducted on the system in November 2001. A RSE involves a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party review of site operations. The evaluation includes reviewing site documents, visiting the site for up to 1.5 days, and compiling a report that includes recommendations to improve the system.

The RSE team found the site managers and contractor committed to system optimization and cost-effective operation. Recommendations made by the RSE team to improve system effectiveness include the following:

- An analysis of the capture zone provided by the extraction system should be conducted to determine if site-related groundwater contamination is adequately contained. This analysis should consist of the following three items:

    < The plume boundaries, both horizontal and vertical, should be clearly delineated and plotted for each sampling event. From these plume maps, target capture zones should be determined. Trend analyses of chromium concentrations in each sampled well on an annual basis would also give an indication of the progress of the remedy.

    < The water level measurements that are collected during each sampling event should be used to develop potentiometric surface maps. From these maps groundwater flow directions and estimated capture zones may be determined and compared to the target capture zones drawn from the plume maps. Analyses of the historical and future potentiometric surface maps will provide site hydrogeologists with better insight into groundwater flow beneath the site

    < The groundwater flow model used to analyze the capture zone during system design should be updated and recalibrated using historical water level measurements. In addition, improved estimates of natural recharge and recharge from the percolation ponds should be determined and used in modeling efforts. Once the model has been recalibrated, it should

be used for particle tracking to provide estimates of the extraction system capture zone in both vertical and horizontal directions.

- The groundwater flow model can also be used to optimize the extraction system by relocating wells or adjusting pumping rates. When the optimized extraction system is selected and implemented, water level measurements from the regularly scheduled sampling events should be used to recalibrate and update the groundwater flow model. Eventually, the groundwater flow model should be able to reproduce water levels measured during the various pumping scenarios implemented at the site.

- A contingency plan should be developed in case contaminant concentrations above MCLs are detected in nearby residential wells.

These recommendations might require approximately $39,000 in capital costs and might increase annual costs by approximately $7,000 per year.

The only recommendation to reduce life-cycle cost is to delist the sludge generated from the groundwater treatment plant. The sludge from the plant is currently listed as hazardous waste from a wood treating facility thereby requiring it to be disposed of as hazardous waste. The sludge is generated from groundwater treatment, passes TCLP testing, and should be delisted so that it can be disposed of as nonhazardous waste. Implementing this recommendation to reduce costs may result in savings during operations and maintenance and could offset initial investments and costs associated with recommendations for enhanced system effectiveness and technical improvement.

Finally, the RSE team provides additional recommendations regarding site close out, including developing an exit strategy and addressing the remaining soil contamination.

A summary of recommendations, including estimated costs and/or savings associated with those recommendations is presented in Section 7.0 of the report.

PREFACE

This report was prepared as part of a project conducted by the United States Environmental Protection Agency (USEPA) Technology Innovation Office (TIO) and Office of Emergency and Remedial Response (OERR). The objective of this project is to conduct Remediation System Evaluations (RSEs) of pump-and-treat systems at Superfund sites that are "Fund-lead" (i.e., financed by USEPA). RSEs are to be conducted for up to two systems in each EPA Region with the exception of Regions 4 and 5, which already had similar evaluations in a pilot project.

The following organizations are implementing this project.

Organization	Key Contact	Contact Information
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Army Corp of Engineers: Hazardous, Toxic, and Radioactive Waste Center of Expertise (USACE HTRW CX)	Dave Becker	12565 W. Center Road Omaha, NE 68144-3869 (402) 697-2655 Fax: (402) 691-2673 dave.j.becker@nwd02.usace.army.mil

The project team is grateful for the help provided by the following EPA Project Liaisons.

Region 1	Darryl Luce and Larry Brill	**Region 6**	Vincent Malott
Region 2	Diana Cutt	**Region 7**	Mary Peterson
Region 3	Kathy Davies	**Region 8**	Armando Saenz and Richard Muza
Region 4	Kay Wischkaemper	**Region 9**	Herb Levine
Region 5	Dion Novak	**Region 10**	Bernie Zavala

They were vital in selecting the Fund-lead pump and treat systems to be evaluated and facilitating communication between the project team and the Remedial Project Managers (RPM's).

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1.0 INTRODUCTION

1.1 PURPOSE

In the *OSWER Directive No. 9200.0-33, Transmittal of Final FY00 - FY01 Superfund Reforms Strategy, dated July 7,2000*, the Office of Solid Waste and Emergency Response outlined a commitment to optimize Fund-lead pump-and-treat systems. To fulfill this commitment, the US Environmental Protection Agency (USEPA) Technology Innovation Office (TIO) and Office of Emergency and Remedial Response (OERR), through a nationwide project, is assisting the ten EPA Regions in evaluating their Fund-lead operating pump-and-treat systems. This nationwide project is a continuation of a demonstration project in which the Fund-lead pump-and-treat systems in Regions 4 and 5 were screened and two sites from each of the two Regions were evaluated. It is also part of a larger effort by TIO to provide USEPA Regions with various means for optimization, including screening tools for identifying sites likely to benefit from optimization and computer modeling optimization tools for pump and treat systems.

This nationwide project identifies all Fund-lead pump-and-treat systems in EPA Regions 1 through 3 and 6 through 10, collects and reports baseline cost and performance data, and evaluates up to two sites per Region. The site evaluations are conducted by EPA-TIO contractors, GeoTrans, Inc. and the United States Army Corps of Engineers (USACE), using a process called a Remediation System Evaluation (RSE), which was developed by USACE. The RSE process is meant to evaluate performance and effectiveness (as required under the NCP, i.e., and “five-year" review), identify cost savings through changes in operation and technology, assure clear and realistic remediation goals and an exit strategy, and verify adequate maintenance of Government owned equipment.

The Selma Pressure Treating Superfund Site was chosen based on initial screening of the pump-and-treat systems managed by USEPA Region 9 as well as discussions with the EPA Remedal Project Manager for the site and the Superfund Reform Initiative Project Liaison for that Region. This site has high operation costs relative to the cost of an RSE and a long projected operating life. This report provides a brief background on the site and current operations, a summary of the observations made during a site visit, and recommendations for changes and additional studies. The cost impacts of the recommendations are also discussed.

A report on the overall results from the RSEs conducted for this system and other Fund-lead P&T systems throughout the nation will also be prepared and will identify lessons learned and typical costs savings.

1.2 TEAM COMPOSITION

The team conducting the RSE consisted of the following individuals:

Frank Bales, Chemical Engineer, USACE, Kansas City District
Todd Hagemeyer, Hydrogeologist, GeoTrans, Inc.
Peter Rich, Civil and Environmental Engineer, GeoTrans, Inc.
Doug Sutton, Water Resources Engineer, GeoTrans, Inc.

1.3 DOCUMENTS REVIEWED

Author	Date	Title
US EPA	September 1988	Record of Decision
US EPA	October 1993	Record of Decision Explanation of Significant Differences
US EPA	April 1997	Record of Decision Explaination of Significant Differences
US EPA	January 22, 1998	1-page excerpt from Request for Proposal #116
IT Corp.	February 1999-July 2001	Groundwater Monitoring Reports
IT Corp.	May 1999	Operations and Maintenance Manual
IT Corp.	January 1999	Remedial Action Design Drawings
IT Corp.	October 2000	Draft Final Report, Selma Pressure Treating Superfund Site
IT Corp.	March 2001	Report for Monitor Well Sampling
Geomatrix Consultants, Inc	April 17, 2001	Focused Feasibility Study Report, Final Document, Selma Pressure Treating Superfund Site
Geomatrix Consultants, Inc	July 2001	First Five Year Review
IT Corp.	August 2001	APCL Analytical Report
US EPA	September 2001	Memorandum for First Five Year Review
IT Corp.	October 2001	Monitoring Well Data

1.4 PERSONS CONTACTED

The following individuals were present for the site visit:

Wally Shaheen, Project Manager, U.S. Army Corps of Engineers, Rapid Response Program
Cleet Carlton, Project Geologist, IT Corp.
Mike Toepfer, Plant Operator, IT Corp.
Larry Hudson, Project Manager, IT Corp. Project Manager
Chris Sherman, Hazardous Substances Engineer, California Dept. of Toxic Substances Control
Tom Kremer, Remedial Project Manager, US EPA Region 9

1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS

1.5.1 LOCATION

The Selma Pressure Treating site is located 15 miles south of Fresno, adjacent to the city limits of Selma, California and addresses subsurface contamination from a former wood treating facility. The site occupies approximately 40 acres, including the 14-acre former wood treating and storage facility and a 26-acre neighboring vineyard. Zoned for heavy use, the site is located in a transition zone between agricultural, residential, and industrial areas. A business named Upright Scaffolding and a small transmission repair shop both border the site to the north and residences border the site to the east. Highway 99 cuts through the center of the site as shown in Figure 1-1, residences lie to the east of the site, and vineyards and other farm area border the site to the south and west.

1.5.2 POTENTIAL SOURCES

Wood treating operations began at the site in 1936. The treating process originally involved the use of pentachlorophenol (PCP) and oil, but the associated treating facility was replaced by a pressure treating facility that used chemicals including fluor-chromium-arsenate-phenol, chromated copper arsenate, PCP, copper-8-quinolinolate, LST concentrate, Woodtox 140 RTU, and Heavy Oil Penta 5% solution. The operating area and wood storage area were paved with asphalt in 1982; the asphalt remains in place. Wood treating activities were suspended in 1994, and all structures from the site were removed with the exception of the concrete drip pad and other concrete foundations in the stormwater runoff area. Drippings from the former treatment processes have led to both soil and groundwater contamination beneath the former facilities. The primary contaminant of concern is chromium, predominantly found as hexavalent chromium, its more mobile state.

Remedial investigations of the contamination began in 1984, and by 1991 soil cleanup activities had started. Approximately 13,000 cubic yards of soil were excavated, fixed, placed in an onsite impoundment area, and capped. Additionally, further investigations led to excavation of an additional 5,000 cubic yards of contaminated soil. This soil is currently stockpiled onsite under temporary cover for eventual disposal.

Approximately 21,000 cubic yards of soil, affected by the contaminants of concern at levels above cleanup standards, remain at depths of up to five feet below ground surface. In addition, 30,000 cubic yards of soil that exceeds cleanup standards have been estimated to lie as much as 25 feet below grade. Remedial alternatives for these areas of concern are under consideration. Until these areas are remediated, they may act as continuing sources of groundwater contamination.

1.5.3 HYDROGEOLOGIC SETTING

The site is located in the Central Valley of California, which is filled primarily with fluvial deposits. The ground surface is approximately 300 feet above mean sea level (MSL) and is essentially flat. Sand, silt, and clay in the form of discontinuous lenses result in significant heterogeneity at the site and preferential pathways for the transport of contamination. The water table is approximately 30 feet below ground surface (bgs) and is relatively flat. A gradient of 0.0015 feet per foot directs groundwater to the southwest. As summarized in the October 2000 Draft Final Report, for modeling purposes, hydraulic conductivities at the site were estimated to range from 1 foot per day (for areas with silt and clay) to 100 feet per day for (areas with sand). The actual range, however, is likely much broader.

Recharge to the site is estimated at approximately 10 inches per year of infiltration. Additional recharge is also provided by the discharge of treated water to the onsite percolation ponds and by the infiltration of stormwater from the neighboring Upright Scaffolding facility. Dudley Pond is the nearest surface water body to the site, and it is located approximately 1.5 miles to the west.

1.5.4 DESCRIPTION OF GROUND WATER PLUME

The groundwater plume, as illustrated in Figure 1-1, stretches from the former wood treating area to approximately 2,500 feet downgradient to the southwest and is approximately 1,000 feet wide. The plume extends approximately 50 feet below the water table, but due geologic heterogeneity (preferential pathways), the distribution is uneven. At approximately 1,600 feet downgradient from the source area, the plume splits into two separate, but parallel plumes as if an area of low hydraulic conductivity exists between them. Based on the July 2001 sampling event, the highest concentrations of chromium within the plume were found in monitoring well R23-I (6280 ug/L total chromium and 6020 ug/L hexavalent chromium).

In general, chromium concentrations in groundwater are highest near the former wood treating facility in the areas around EW-1 (and EW-1a), R23, and R23I. The highest chromium concentration in R23 (total depth of 40 feet below ground surface) was observed during the first sampling event in February 1999. Since then, the concentration has consistently decreased, despite the measured fluctuations in the water table elevation. On the other hand, chromium concentrations in R23I (adjacent to, but beneath R23) have increased.

Although soil contamination at depth could serve as a source of dissolved groundwater contamination due to rising water levels, this cannot be easily confirmed with the present data because limited groundwater data exists prior to February 1999 and limited soil data exists for chromium. Another, more likely, scenario for transport of chromium from the soil to the groundwater is percolation of water from the surface through the chromium-contaminated vadose zone to the saturated zone.

2.0 SYSTEM DESCRIPTION

2.1 SYSTEM OVERVIEW

The original ROD signed in 1988 required that groundwater be extracted from 25 wells at 50 feet deep at a cumulative rate of 1,040 gallons per minute (gpm); however, an Explanation of Significant Differences (ESD) signed in 1993 reduced the required pumping to 250 gpm from 7 wells up to 70 feet deep with the ability to expand the capacity of the plant. A second ESD signed in 1997 allowed discharge of the treated effluent to percolation ponds to recharge water to the aquifer. The current system, which began operation on September 29, 1998, meets the specifications of the 1993 and 1997 ESDs

2.2 EXTRACTION SYSTEM

The extraction system originally included 8 wells. However, one well (EW-3B) has been shut down due to a low yield and very low contaminant concentrations. In addition, wells EW-1 and EW-2 (originally placed to protect residential wells to the east) were replaced in February 2000 with EW-1a and EW-2a, which are both shallow wells positioned for improved recovery of contamination. Analysis by the site team suggest that moving these extraction wells does not pose added risk to the residential wells originally protected by them. The well locations (both the original wells and the new locations) are presented in Figure 1-1. The pumping rates and screened intervals for all of extraction wells are provided in a table in Section 4.3.1 of this report..

2.3 TREATMENT SYSTEM

The treatment system is located inside of a prefabricated building on a concrete pad and utilizes the UNIPURE Process Technology. The process consists of an equalization tank, mixing tank/reactor, flash mixer, clarifier, filter feed tank, multi-media filter, pH adjustment, and discharge to one of two recharge basins. Solids from the clarifier are held in sludge thickening tanks and then run through a filter press. The system operates at a rate of 220 gpm including both extracted water and water recycled through the treatment system. The anticipated design influent (as listed in a 1-page excerpt from the 1998 request for proposal) and the actual influent obtained from sampling in August 2001 are in the following table for comparison. The data suggests that the influent concentrations for chromium are within the design criteria but that the concentrations of some other constituents of the influent are not within the design criteria. The system effluent has consistently met effluent discharge criteria.

Contaminant	Design Influent Concentration	Actual Influent Concentrations Aug. 2001
Arsenic	<10 ug/L	<5 ug/L
Hexavalent Chromium	50-1,100 ug/L	406 ug/L
Total Chromium	50-1,100 ug/L	448 ug/L
Copper	<50 ug/L	24.1 ug/L
Alkalinity as $CaCO_3$	150-250 mg/L	390 mg/L

Contaminant	Design Influent Concentration	Actual Influent Concentrations Aug. 2001
Chloride	45-60 mg/L	91 mg/L
Nitrate as Nitrogen	8-10 mg/L	13.2 mg/L
Sulfate as SO4	60-90 mg/L	98 mg/L
Phosphorous	<0.3 mg/L	0.02 mg/L
Calcium	60-120 mg/L	105 mg/L
Iron	<20 mg/L	0.394 mg/L
Magnesium	10-40 mg/L	27.8 mg/L
Manganese	<1 ug/L	not reported
Potassium	3-10 mg/L	5.97 mg/L
Sodium	30-100 mg/L	122 mg/L
pH	6.5-7.5	7.35
Total Suspended Solids	<10 mg/L	<10 mg/L
Total Dissolved Solids	<500 mg/L	827 mg/L

2.4 MONITORING PROGRAM

Groundwater monitoring reports are submitted every four months and include results from sampling for chromium and arsenic in 29 monitoring wells and 10 residential wells. Additionally, R-23S is sampled for dioxins, furans, and PCBs annually. These samples are sent offsite for analysis. Hach test kits are used to sample the chromium concentrations in the extraction wells on a regular basis. The results from the Hach test kits have proven reliable based on comparison with analytical results.

Water levels are also collected during sampling events, but potentiometric surface maps are not generated from these measurements in the sampling reports.

Influent and effluent is sampled monthly and analyzed offsite for chromium, arsenic, and the other constituents listed in the table in Section 2.3 of this report. In addition, a continuous sampler is used to analyze chromium in the effluent and notify the operator if standards are exceeded.

3.0 SYSTEM OBJECTIVES, PERFORMANCE AND CLOSURE CRITERIA

3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

The current system is operating based on the 1988 ROD and two subsequent ESDs in 1993 and 1997. The objective of the pump and treat system is to extract contaminated groundwater, treat it to MCLs and return it to the aquifer via infiltration. Neither the ROD nor ESDs explicitly state whether the objective is to restore the aquifer to MCLs or to contain the plume. As stated in the first Five-Year Review, an ESD is required to clearly define the objective of the existing pump and treat system.

3.2 TREATMENT PLANT OPERATION GOALS

The effluent or discharge goals are stated in the ROD and ESDs. The following table includes the current effluent discharge standards for some of the constituents of the extracted water.

Contaminant	Concentration
Arsenic	<50 ug/l
Hexavalent Chromium	not detected
Total Chromium	<50 mg/l
pH	6.5-7.5
Total Suspended Solids	<20 mg/l
Total Dissolved Solids	<1,200 mg/l

* the "not detected" criteria for hexavalent chromium is self-imposed by the plant operators and is regularly achieved given a detection level of 50 ug/L. The actual discharge criteria is more lenient.

4.0 FINDINGS AND OBSERVATIONS FROM THE RSE SITE VISIT

4.1 FINDINGS

The RSE team found an extremely well maintained and functional facility. The system is not only well maintained but is staffed by a conscientious and competent operator and team of managers. The observations and recommendations given below are not intended to imply a deficiency in the work of the designers, operators or site managers but are offered as constructive suggestions in the best interest of the EPA and the public. These recommendations have the benefit of several years of operating data unavailable to designers or site managers.

4.2 SUBSURFACE PERFORMANCE AND RESPONSE

4.2.1 WATER LEVELS

Although water levels are collected three times per year, they are not used to generate potentiometric surface maps. Therefore, detailed analysis of these water levels is difficult within the scope of an RSE. In general, water level measurements support the flow of groundwater to the southwest. There is little evidence of a vertical gradient as measured by water levels in piezometer clusters, with the exception of R24 and R24I, which indicate a downward gradient. However, this lack of evidence does not conclusively show that groundwater and contamination do not travel vertically within the aquifer. Preferential pathways may exist in areas (such as the area surrounding R24 and R24I) that transport groundwater and contamination vertically. Mounding from infiltration from the percolation ponds is difficult to discern but may be indicated by a relatively high water level in R22.

4.2.2 CAPTURE ZONES

Due to the high degree of heterogeneity at the site and the various influences on groundwater flow (percolation ponds, extraction wells, residential wells, etc.) a capture zone analysis with water level measurements alone would likely be inconclusive. Although there are a number of piezometers at the site screened at various elevations, there may be an insufficient number to adequately resolve groundwater flow for the purpose of analyzing a capture zone. Nevertheless, potentiometric surface maps based on the water level measurements would likely be useful in understanding groundwater flow underlying the site during various times of the year. For example, water levels and the potentiometric surface maps could provide additional information as to the effects of recharge on groundwater flow. For a more thorough capture zone analysis, groundwater flow modeling and particle tracking are likely necessary.

Capture zones at the site are not analyzed on a regular basis; however, a capture zone analysis was conducted as part of the design of the extraction system and is included in the October 2000 Draft Final Report. A 3-layer model generated with the parameters mentioned in section 1.5.3 of this report as well as other information indicated capture of the plume by the seven extraction wells. Flow fields from the groundwater flow model were used to track particles between the percolation ponds and the extraction wells. Analysis by the model suggests that, despite recharging treated extracted water through the percolation ponds, the plume is captured. In fact, the analysis suggests that flushing of the aquifer in the area of the plume is increased such that time to remediation could be accelerated because less water is pulled from the surrounding cleaner portions of the aquifer. This may, in fact, be the case as concentrations in EW-7 have decreased since installation and remained clean ever since, which suggests that upgradient wells may have decreased or eliminated the transport of chromium toward that well. However, the particle tracking analysis does not appear to track particles in the various model layers, leaving open to question, the degree of capture vertically. Also, the model was only calibrated with one round of water level measurements, the accuracy of the model and its predictions could be called into question if variations in recharge and water levels are significant.

4.2.3 CONTAMINANT LEVELS

With a few exceptions near the source area, contaminant levels in piezometers across the site have remained relatively constant with some fluctuation but no consistent increase or decrease. Three of the exceptions are summarized in the following table.

Well	Depth to Bottom of Well (feet below ground surface)	February 1999 hexavalent chromium concentration (ug/L)	July 2001 hexavalent chromium concentration (ug/L)
R23	~40	30,400	1,780
R23I	~60	414	6,020
R25	~40	1,450	180

As shown in Figure 1-1, R23 and R23I are adjacent to each other and are near former extraction well EW-1 and current extraction well EW-1a. Both extraction wells are screened between 45 and 60 feet below ground surface. The decrease of chromium in R23 and R23I may result from pumping water from EW-1 or EW-1a, treating it, and discharging the treated water through the percolation ponds. A possible explanation follows:

In extracting groundwater, EW-1 and/or EW-1a pull water from surrounding horizontal and vertical areas. A capture zone analysis conducted as part of the system design (later discussed in Section 6.1.1.3 and depicted in Figure 6-2) indicates that treated water from the percolation ponds was likely captured by EW-1. Because EW-1a is located closer to the ponds than the former EW-1, EW-1a also likely captures treated water from the percolation ponds. As this treated water migrates from the shallow zone below the percolation ponds toward EW-1 or EW-1a, it may serve to dilute the water sampled in R23, a relatively shallow monitoring well. However, because R23I is deeper than R23, the treated water from the percolation ponds may not reach it. Rather, contaminated water from other surrounding areas may pass through R23I as it travels toward the extraction well resulting in an increase in chromium concentrations in R23I.

Due to the proximity of EW-2 and EW-2a to R25, the decrease in concentrations in R25 may be attributed to the extraction of groundwater from EW-2 prior to February 2000 and EW-2a after February 2000.

Contaminant levels in the influent (and each of the extraction wells) have remained relatively constant over time (with the exception of a small increase due to the new locations of EW-1 and EW-2 to EW-1a and EW-2a). The influent concentration in August 2001 was 448 ug/L total chromium, which corresponds to a chromium mass loading to the treatment plant of approximately 1 pound per day.

4.3 COMPONENT PERFORMANCE

4.3.1 WELL PUMPS AND TRANSDUCERS

The maximum extraction rate for the system is currently around 200 gpm.. The flow through the plant is 220 gpm including all recycle streams. The well names, screened intervals, chromium concentrations, and flow rates are provided in the following table.

Well	Screen Interval (feet below surface)	Chromium Concentration (ug/l)	Flowrate (gpm)
EW-1a (new location)	45-60	2800	25
EW-2a (new location)	35-45	470	20
EW-3A	45-100	250	35
EW-3B (shutdown)	105-125	10	0
EW-4	60-95	330	50
EW-5	121-136	190	25
EW-6	47-87	140	25
EW-7	55-85	10	14
Total			**194**

The site managers are planning to possibly shutdown EW-7 and relocate some of the other extraction wells to improve contaminant recovery. The proposed well relocations are depicted in Figure 4-1. Monitoring from EW-7 will likely continue to confirm shutdown of the well is appropriate.

4.3.2 EQUALIZATION TANK

The equalization tank is designed to blend contaminated groundwater and recycle streams to produce a homogeneous feed to the plant. Centrifugal pumps driven by variable speed drives maintain a selected setpoint in the equalization tank.

4.3.3 REACTOR

Both pH adjustment and chemical oxidation-reduction reactions occur in this vessel. As part of the UNIPURE Process Technology, chromium is reduced and iron is oxidized for later co-precipitation in the clarifier. Ferrous Chloride is added to provide the necessary concentration of Fe^{+2} for the desired reaction. Sodium hydroxide is then added to control pH and air is sparged to rapidly oxidize the iron to Fe^{+3} and reduce the chromium from Cr^{+6} to Cr^{+3}. The reaction vessel is well mixed via baffles and injection of air. The iron precipitates out of the solution with the chromium. The chromium is occluded in the iron solids due to its close association with the iron prior to its precipitation.

Chromium not removed by occlusion is removed by adsorption to the ferric iron solids. From the reactor, the process water is transferred to the flash tank.

4.3.4 Flash Mix and Flocculation Tanks

The flash mix and flocculation tanks are located immediately prior to the clarifier. An anionic polymer is added to the process water with a high speed mixer so that the iron solids produced in the reactor can be coagulated in the flocculation tank. The flocculation tank allows a five minute retention time with a slow speed mixer to form larger solids (floc) that settle more easily in the clarifier.

4.3.5 Clarifier

The clarifier contains lamella plates which enhance collection of the iron solids. The solids settle and fall to the bottom of the clarifier. Air operated diaphragm pumps are utilized to both recycle the solids to the reactor as well as transfer solids to the sludge holding tanks. The process water flows over the top of the clarifier weir into the filter feed tank. The clarifier plates are cleaned once per month.

4.3.6 Solids Holding Tank/Filter Press

The sludge holding tanks are used to hold and thicken clarifier solids (approximately 4 cubic yards of dewatered filter cake are generated per week) until they are processed through the filter press for dewatering. These tanks have conical bottoms to allow easy removal of the solid contents. Solids from the filter press are disposed of as a hazardous waste, due to F-032 and F-035 designations, despite easily passing TCLP testing. Filter press filtrate and decant water from the sludge holding tanks are recycled to the equalization tank.

4.3.7 Filter Feed Tank

The filter feed tank is used to hold clarified process water that will be treated via the multimedia filters to remove remaining solids prior to discharge.

4.3.8 MultiMedia Filters

The multimedia filters are backwashed whenever the pressure drop exceeds 18 psi or within 72 hours, whichever occurs first. The standard operation has been to backwash two or three times per day for approximately one and a half minutes each time. Backwash water is discharged to the sludge holding tanks.

4.3.9 Effluent Tank (final pH adjustment)

The effluent tank contains a mixer and allows the addition of sulfuric acid for final pH adjustment. The tank is emptied to the recharge basins via variable speed driven pumps. The effluent flow is measured and also contains an inline, continuous hexavalent chromium analyzer, 1024 Analyzer from Scientific Instruments.

4.3.10 System Controls

The system has an autodialer and emergency stop switches for plant safety. The system operator is contacted for any stoppage to operations which may occur for a number of reasons including alarms for power outages, a high floor sump level, or a high chrome level in the effluent as determined by a continuous chrome analyzer. The control system is currently not set to restart at the prior settings. The alarms sound infrequently, with power outages the main reason for system shutdown.

4.4 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF MONTHLY COSTS

The following table provides average monthly costs associated with the routine operation and maintenance of the Selma Pressure Treating site. The values were obtained by averaging the monthly expenses from three months of operation within the past year.

Plant Operator	$4,100	
IT Project management and administration	$2,500	
Total Chemicals:	$3,350	
Polymer		$550
Ferrous chloride		$1,225
Caustic		$1,000
Sulfuric acid		$425
Chromium meter chemicals		$150
Influent/Effluent Analysis	$460	
Groundwater Sampling/Analysis	$2,000 ($8,000 per 4 months)	
Utilities (electric and telephone)	$3,600	
Relocate Rolloff bins on site	$850	
Trans and dispose filter cake	$1,050	
Pickup rental and gasoline	$1,000	
Misc Repair Parts	$1,000	
Storage Container	$75	
O&M subtotal cost	$19,985	
IT fee, 7%	$1,400	
IT Subtotal Cost	$21,385	
USACE fee, 11%	$2,350	
Average cost per month	$23,735	

4.4.1 UTILITIES

The current electrical usage is as expected. The electrical bills demonstrate an average monthly costs of approximately $3,500 per month. There are no oversized motors or equipment onsite with the exception of the effluent discharge pumps, which, if necessary, could be used to pump effluent to an alternate discharge point.

4.4.2 NON-UTILITY CONSUMABLES AND DISPOSAL COST

Disposal of generated sludge (approximately 4 cubic yards per week) costs about $1,000 per month on average. The sludge passes all TCLP criteria; however, it is disposed as hazardous due to F-032 and F-035 designations as wastes from a wood treating facility. The costs for chemicals used in the plant are reasonable considering plant operations. The system operator and engineer have reduced chemical consumption; however, to further reduce chemical additions could lead to increased chromium concentrations in the effluent.

4.4.3 LABOR

The plant is maintained by a single full time operator, 40 hours per week. The site is also supported by a project manager and geologist.

4.4.4 CHEMICAL ANALYSIS

The analyses performed for routine monitoring utilize a Hach kit for chromium, which has proven cost-effective and accurate. Samples from the monitoring wells, the residential wells, and the influent and effluent are analyzed offsite.

4.5 RECURRING PROBLEMS OR ISSUES

There have been no major recurring problems with operating the plant. During the RSE, a feed pump was leaking and required repair. In an isolated incident, the treatment plant was burglarized. Items, including site binders and reports, were stolen. A security system has since been installed at the plant.

4.6 REGULATORY COMPLIANCE

The system has maintain an efficient operation while attaining all discharge requirements.

4.7 TREATMENT PROCESS EXCURSIONS AND UPSETS, ACCIDENTAL CONTAMINANT/REAGENT RELEASES

No process excursions and upsets were noted. The ferrous chloride tank emptied due to corrosion of fittings, but the spilled liquid was contained by the berm. The corrosion has been addressed and no other leaks have occurred.

4.8 SAFETY RECORD

No safety issues were identified.

5.0 EFFECTIVENESS OF THE SYSTEM TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT

5.1 GROUND WATER

Residential and irrigation wells (irrigation wells are rarely used) are located down and cross gradient of the plume and could become impacted if groundwater is not adequately contained. The capture zones have not been analyzed since design of the original extraction system, and it is questionable if the original capture zone adequately addressed vertical capture of the plume. In addition, recharge from the percolation ponds may reduce the capacity of the extraction system to capture the plume. The closest municipal well is located approximately 0.25 miles upgradient and is screened in a deeper aquifer than that impacted by site-related contamination.

5.2 SURFACE WATER

Dudley Pond is the nearest surface water body to the site, and it is located approximately 1.5 miles to the west. Impacts to this water body are not expected.

5.3 AIR

No air emissions are notable from this plant.

5.4 SOILS

A separate Record of Decision is currently being developed regarding site soils remaining. Contamination at depth and at the surface remains. The remedy from this new ROD is anticipated to be implemented in fiscal year 2003.

5.5 WETLANDS AND SEDIMENTS

No wetlands or sediments are at risk to site-related contamination.

6.0 RECOMMENDATIONS

Cost estimates provided have levels of certainty comparable to those done for CERCLA Feasibility Studies (-30/+50%), and these cost estimates have been prepared in a manner consistent with EPA 540-R-00-002, A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, July 2000.

6.1 RECOMMENDED STUDIES TO ENSURE EFFECTIVENESS

6.1.1 REGULARLY ANALYZE DATA AND CAPTURE ZONES AND REPORT RESULTS

The capture zone of the extraction system should be analyzed to confirm containment of site-related contamination. Such an analysis should involve the following items:

- an update of the plume boundaries,
- analysis of the measured water levels and development of potentiometric surfaces, and
- recalibration of and simulations with the site groundwater flow model.

Based on the results of the capture zone analysis, the extraction system and/or discharge system may require modification to improve capture of the plume.

6.1.1.1 UPDATE CONTAMINANT PLUME MAPS AND ANALYZE TRENDS IN CONCENTRATIONS

The first step of conducting a capture zone analysis is to determine the portion of the plume targeted for capture. In the case of the Selma site, it may be sufficient to capture all portions of the plume greater than the MCL for chromium (50 ug/L). Groundwater sampling events that include sampling of approximately 40 wells or piezometers are conducted every four months and provide updated information on the extent of the contamination in the shallow, intermediate, and deep zones of the aquifer. Although site hydrogeologists are working with this data, updated plume maps are not being generated. Rather, a generic plume map is repeatedly used in the reports and no analysis is provided.

Updated plume maps should be generated for each sampling round so that trends in the plume shape can be tracked over time. Although natural fluctuations in the concentrations may result in a plume shape that differs for each event, a noticeable trend may become apparent. Such a trend may indicate shrinking of the plume or migration in one direction or another. Once accurate plume maps have been developed, the target capture zone (perhaps the 50 ug/L contours) can be determined. This target capture would then serve as the basis for capture zone analyses conducted with water levels and groundwater flow modeling.

On an annual basis, trend analyses of the concentrations in the sampled wells and the plume maps should be conducted. These analyses will help site managers determine the effectiveness of the remedy and the likelihood of achieving the objectives. A description of these analyses along with the historical data should be included in one of the groundwater sampling reports each year.

Creating plume maps based on historical sampling events (approximately 10 events) and analyzing trends in chromium concentration over time should cost approximately $7,000 given that a base map already exists and historical data is readily available in a spreadsheet. An additional $3,000 may be required for reporting the historical data, plume maps, and trend analysis in the next groundwater sampling report. To provide site managers with updated information in the future, plume maps should be generated for each sampling event and provided in the associated report, and trend analyses should be conducted on an annual basis and included in one of the regular groundwater sampling reports along with the historical groundwater quality data for the site. These tasks may require an additional $3,000 per year.

6.1.1.2 ANALYZE WATER LEVEL MEASUREMENTS AND DEVELOP POTENTIOMETRIC SURFACE MAPS

Water level measurements provide direct information regarding groundwater flow and are indispensable for understanding groundwater flow at a site. Water levels at the Selma site are currently collected every four months; however, analyses of these measurements and development of potentiometric surface maps are not evident from reviewing the sampling reports. Water levels measured throughout the history of system operation should be processed, analyzed, and used to develop potentiometric surfaces. Variations in pumping or recharge should be reflected in the potentiometric surfaces and should give site hydrogeologists additional insight into groundwater flow at the site.

These potentiometric surfaces can also be used for a preliminary capture zone analysis. General groundwater flow directions throughout the site can be determined from the interpreted hydraulic gradient, and flow paths that are directed into extraction wells will help interpret the capture zone. Then, once updated plume maps and target capture zones are obtained for the historical chromium concentrations, site hydrogeologists can overlay the interpreted capture zones with the target capture zones to determine the degree of capture. However, as stated in Section 4.2.2 of this report, the number of piezometers at the site may not provide adequate resolution of the flow field for capture zone analyses without the aid of a groundwater flow model. Thus, these water levels and potentiometric surfaces should also be used to calibrate and update the groundwater flow model. The model, in turn, would be used to estimate the degree of capture based on principles of groundwater flow and the available data (please refer to Section 6.1.1.3 for more information on this step.)

A capture zone analysis should be conducted and reported on a regular basis, perhaps for each sampling event until the variation capture is better understood. In addition, on an annual basis, hydrogeological data for the site should be updated, analyzed, and included in one of the groundwater sampling reports, preferably the same report that would include the analyses of groundwater concentrations recommended in Section 6.1.1.1.

Organizing the data, producing the potentiometric surface maps for the historical data, and analyzing the data will likely require approximately $7,000 (costs of modeling are provided in Section 6.1.13). An additional $3,000 may be required to include the data and the analyses in the next groundwater sampling report. Conducting similar tasks on a regular basis with newly collected data may require an additional $4,000 per year.

6.1.1.3 RECALIBRATE THE GROUNDWATER FLOW MODEL AND USE SIMULATIONS FOR CAPTURE ZONE ANALYSES

The site managers already have a groundwater flow model that was used for a capture zone analysis prior to installation of the original extraction system. This model provides an excellent framework for further capture zone analyses and for simulations to aid in site management decisions. However, the model should be recalibrated with water level measurements taken over the history of system operation to improve the accuracy and reliability of the model. An accurate model should be able to reproduce the water levels obtained from measurements for a variety of pumping and recharge scenarios at the site, including pumping from the old and new locations of EW-1 and EW-2 and pumping during different seasons. The model used by the site managers reportedly reproduced, with reasonable accuracy, the water levels from the December 1997 sampling event. Now that additional rounds of water levels have been collected, the existing model can be made more robust.

Once accurate flow fields are obtained, particle tracking can be conducted to ensure that particles from the contaminated cells in the model domain (as determined from updated plume maps) are captured by the extraction system. It is important to note that reverse particle tracking, as was done in the original capture zone analysis will not give a thorough evaluation of capture in a heterogeneous, three-dimensional model. The reverse particle tracking method only employed the release of 8 particles per well at a single elevation and tracked them backward to outline the capture zone. A more thorough analysis would involve the release of particles from each cell in each layer that coincides with the target capture zone. Furthermore, the release of particles from various elevations within a cell should be tested because the vertical component of flow at this particular site could be significant, especially with pumping from different elevations. Particles should also be color coded based on which wells capture them to better identify the capture zones of each well.

On a more general note, a capture zone analysis should demonstrate that water flow through the impacted area is captured by the extraction wells. According to the particle tracking from the existing model shown in Figure 6-1, particles in the background flow field (upgradient of the extraction wells) traveled at approximately 200 to 300 feet per year. Removing the effect of porosity, this translates to a Darcy velocity of approximately 100 feet per year. The model domain is 3,000 feet wide, and it appears from Figure 6-1 that the extraction system capture zone is also approximately 3,000 feet wide. The thickness of the three layers varied across the domain, but on average, it appears that a saturated thickness of 100 feet is fairly representative. Assuming that half of the formation has a significantly lower hydraulic conductivity than the other portions, the majority of groundwater flow of 200 to 300 feet per year may be occurring only through effectively half of the cross-sectional area of the model domain and flow through other portions may be significantly less. Following this assumption about the formation, the above Darcy velocity should be reduced by half from 100 feet per year to 50 feet per year. Thus, groundwater flow into the model domain and to be captured by the extraction system is approximately

$$3{,}000\ \text{ft} \times 100\ \text{ft} \times \frac{50\ \text{ft}}{\text{year}} \times \frac{7.48\ \text{gal.}}{\text{ft}^3} \times \frac{1\ \text{year}}{365\ \text{days}} \times \frac{1\ \text{day}}{1440\ \text{min.}} = 213\ \text{gpm}$$

This simple calculation, although based on crude estimates, suggests that the extraction system extracts approximately the same amount of groundwater as is flowing from upgradient. If the recharge provided by the percolation ponds is included, then the width of the capture zone decreases, which is consistent with another model simulation (depicted in Figure 6-2) conducted as part of the original capture zone analysis. The degree to which the capture zone narrows, however, will be dependent on the amount of recharge provided by the percolation ponds or by natural recharge. The amount of recharge from the ponds likely varies with the seasons because more water in the ponds will evaporate in the summer than in the winter, and the amount of natural recharge will also vary based on the seasons— potential increases may occur in the winter with the rainy season or in the summer during irrigation. The recharge rate through the percolation ponds that was used in the original capture zone analysis should be reviewed and the model should be used to determine how sensitive capture is to that recharge rate. In addition, estimates of the amount of recharge should be obtained. This could, perhaps, be accomplished by taking the discharge rate from the treatment plant and accounting for potential evaporation. If the potential evaporation is not known, then it could be measured through simple studies with evaporation pans.

If the estimated recharge rate (either natural or through the ponds) exceeds the rate that can be captured as determined by the model, then efforts may be required to reduce the amount of water being recharged. This could be addressed by increasing evaporation of the discharged water through spraying, discharging treated water to both ponds at the same time, or otherwise increasing the areal extent of the ponds.

Recalibrating the model based on historical water sampling events will likely cost approximately $5,000. Conducting particle tracking simulations and associated capture zone analyses for various pumping and recharge scenarios will likely cost an additional $5,000. The cost of estimating the evaporation potential and the amount of water recharging to the aquifer from the percolation ponds should be negligible and included in the above costs.

6.1.2 USE MODEL SIMULATIONS TO OPTIMIZE LOCATIONS FOR NEW EXTRACTION WELLS

The site managers are considering relocating some of the extraction wells to improve capture and simultaneously increase contaminant recovery rates. The proposed relocations are noted in Figure 4-1. Although these locations make sense conceptually, verifying these proposed locations and screening intervals with the model would be beneficial.

Once the extraction wells are installed and a new pumping regime is established, water levels should be measured, interpreted, and used to improve the model calibration. An accurate model would be able to adequately reproduce the measured water levels for the two previous pumping scenarios (EW-1 and EW-2 original locations) and this new pumping scenario.

Running simulations to determine the optimal locations and screening intervals, in addition to recalibrating the model to include the new pumping would cost approximately $4,000.

6.1.3 DEVELOP A CONTINGENCY PLAN FOR EXCEEDENCES IN LOCAL GROUNDWATER WELLS

A contingency plan should be developed that outlines a course of action to be taken if local irrigation or residential wells show an exceedence in site related compounds. This plan may include providing bottled water and/or could involve adjusting the pumping rates of the various extraction wells to improve capture and contaminant recovery in the area of the exceedence. This contingency plan should take into account the site managers' knowledge of the Selma area and should be documented. Development and documentation of a contingency plan may cost $5,000. However, costs to implement the plan, if necessary, would be higher and dependent on the extent of contamination and the availability of alternative resources.

6.2 RECOMMENDED CHANGES TO REDUCE COSTS

6.2.1 DISPOSE OF SLUDGE AS NON-HAZARDOUS WASTE

The sludge generated by the treatment plant is currently listed as hazardous waste based on F-032 and F-035 designations, which are consistent with waste generated from wood treating facilities. However, the current facility is a groundwater treatment system and is not a wood treating facility. Therefore, the waste designation should be changed. The sludge passes TCLP testing indicating it will not act as a source of groundwater contamination; therefore, the waste should be disposed of as non-hazardous. Current waste transfer and disposal costs are approximately $12,600 per year. This cost would likely be reduced by half if this recommendation is implemented.

6.3 MODIFICATIONS INTENDED FOR TECHNICAL IMPROVEMENT

6.3.1 REPAIR LEAKS IN THE PLANT

A leak from a transfer pump was noted during the RSE site visit. The leak was contained and not alarming; however, the repair should be performed.

6.4 MODIFICATIONS INTENDED TO GAIN SITE CLOSE-OUT

6.4.1 DEVELOP AND EXIT STRATEGY

The ROD states groundwater cleanup as the site objective with cleanup levels set at the more stringent of federal and state MCLs. Developing an exit strategy based on this objective will provide a framework for making future decisions at the site, including determining when cleanup is reached and the system can be shut down. The site managers have already reached a point where an exit strategy would be useful. EW-7 has had chromium concentrations below the cleanup level since operation began, and site managers are deciding whether or not to shutdown or relocate the well. An exit strategy that specified, for example, four or eight quarters of chromium concentrations below cleanup levels, would have given site managers criteria to help them decide the appropriateness of shutting down or relocating the well. An exit strategy that provides a clear framework for shutting down individual wells or the system as a whole should be developed. In addition, this strategy should also include other steps necessary for achieving site closure, such as addressing the soil contamination.

6.4.2 ADDRESS ONSITE SOIL CONTAMINATION

Previous investigations of soil contamination as summarized in the April 2001 Focused Feasibility Study focused primarily on pentachlorophenol (PCP), arsenic, and dioxin/furans as the contaminants of concern. PCP contamination as high as 92 mg/kg was found as deep as 25 feet in one 80 foot by 80 foot area of the site, but soil contamination, in general, was predominantly located near the surface.

Despite soil contamination with these constituents, the only contaminant of concern detected above cleanup levels in groundwater has been chromium. Limited data are available in the ROD for chromium contamination of the soil with concentrations exceeding 800 mg/kg near the surface. The highest chromium concentration detected beneath the surface was 31 mg/kg at a depth of 1 to 2.5 feet.

Soil contamination, particularly near the surface should be addressed to reduce exposure. Historical data indicates that soil has not acted as a continuing source of groundwater contamination of PCP, arsenic, or dioxin/furan. The soil should be more thoroughly investigated for chromium contamination to determine if it is acting as a continuing source of chromium contamination of the groundwater and a remedy should be designed accordingly. No cost is provided for this recommendation as site managers have already begun considering alternatives.

7.0 SUMMARY

In general, the RSE team found a well-operated and cost-effective pump and treat system. In addition, decreasing chromium concentrations in two monitoring wells the highly impacted zone of the aquifer suggest that the pump and treat system is having a positive impact on reducing the maximum concentrations measured when system operation began.

The observations and recommendations mentioned are not intended to imply a deficiency in the work of either the designers or operators but are offered as constructive suggestions in the best interest of the EPA and the public. These recommendations have the obvious benefit of the operational data unavailable to the original designers.

Several recommendations are made to enhance system effectiveness that predominantly focus on the analyzing the capture zone of the extraction system. The only recommendation to reduce cost includes delisting the sludge generated from the treatment system and disposing of it as non-hazardous waste. The only recommendation for technical improvement involves fixing a leaking pump. Finally, the recommendations regarding site closure include developing an exit strategy and addressing remaining soil contamination.

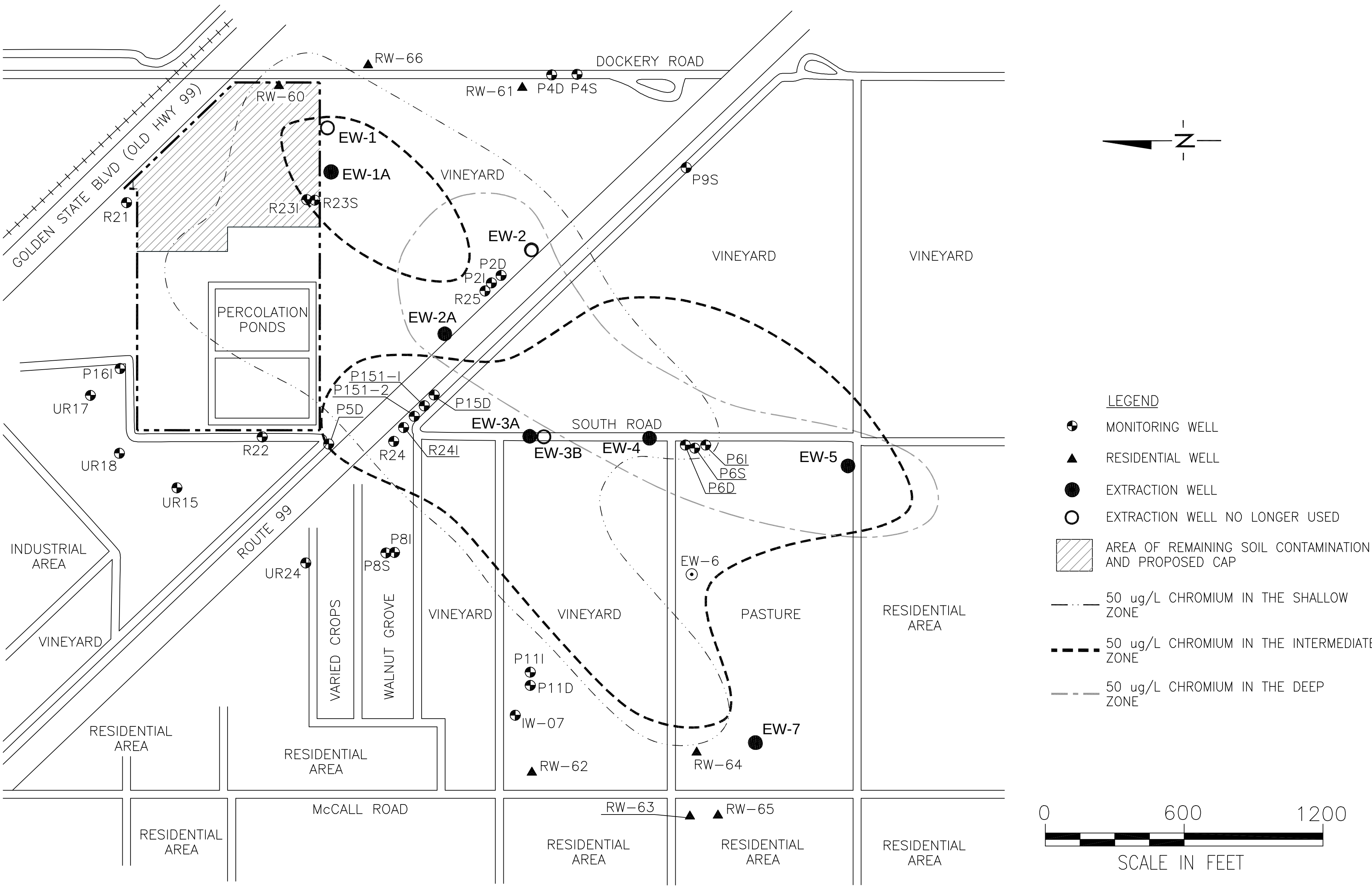
Table 7-1. Cost Summary Table

Recommendation	Reason	Additional Capital Costs ($)	Estimated Change in Annual Costs ($/yr)	Estimated Change In Lifecycle Costs ($) *
6.1.1 Analyze Capture Zones for Current Extraction System	Effectiveness			
6.1.1.1 Update contaminant plume maps and analyze trends in concentrations		$10,000	$3,000	$58,400
6.1.1.2 Analyze level measurements and develop potentiometric surface maps		$10,000	$4,000	$74,600
6.1.1.3 Recalibrate the groundwater flow model and use simulations for capture zone analyses		$10,000	$0	$10,000
6.1.2 Use model simulations to optimize locations for new extraction wells	Effectiveness	$4,000	$0	$4,000
6.1.3 Develop a contingency plan for exceedences in local groundwater wells	Effectiveness	$5,000	$0	$5,000
6.2.1 Dispose of sludge as non-hazardous	Reduce Cost	$0	($6,300)	($101,700)
6.3.1 Repair leaks in the plant	Technical Improvement	$200	$0	$200
6.4.1 Develop an exit strategy for the site	Gain Closeout	Not Quantified	Not Quantified	Not Quantified
6.4.2 Address remaining soil contamination	Gain Closeout	Not Quantified	Not Quantified	Not Quantified

Costs in parentheses imply cost reductions.
* assumes 30 years of operation with a discount rate of 0% (i.e., no discounting)
** assumes 30 years of operation with a discount rate of 5% and no discounting in the first year

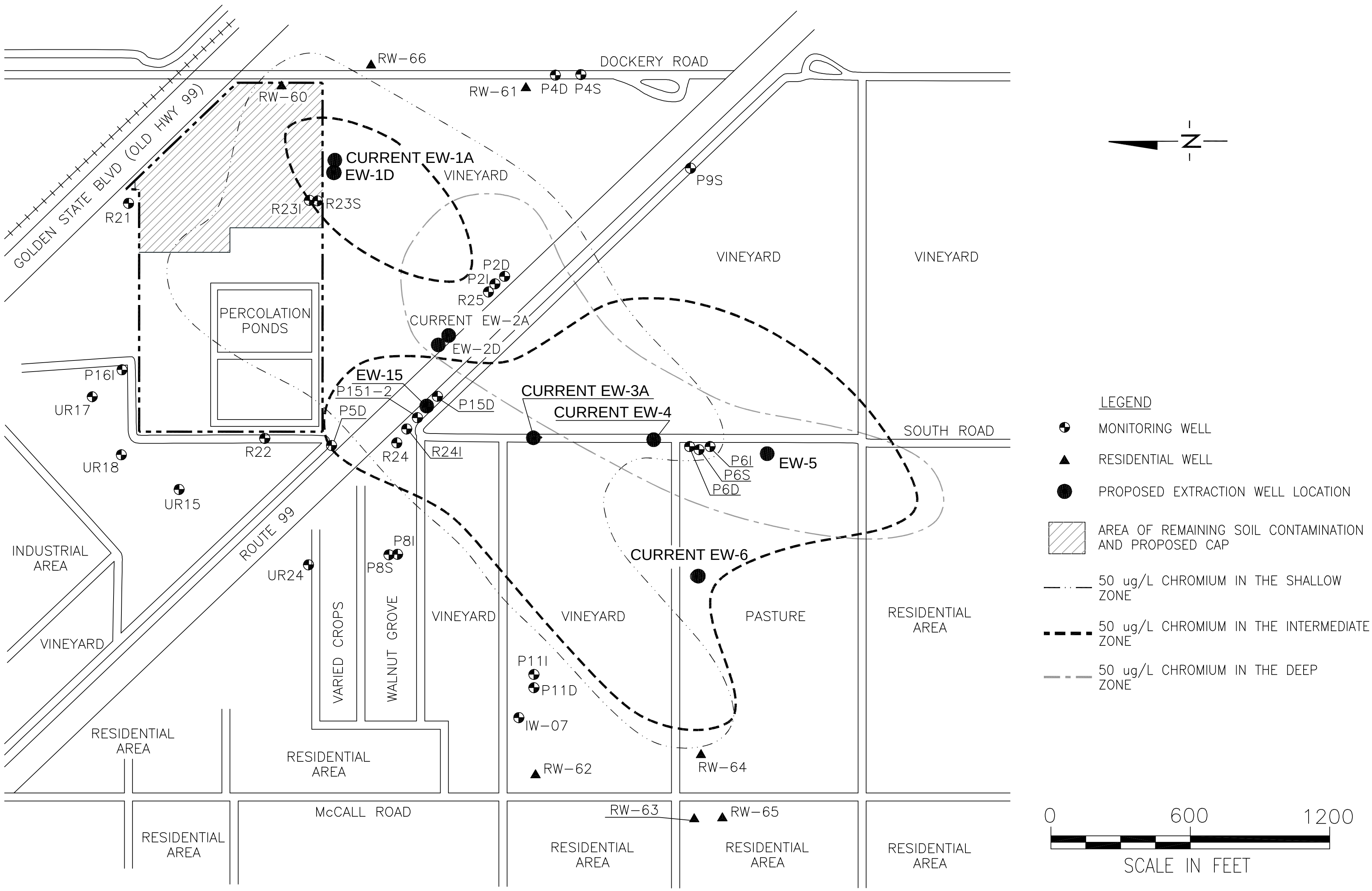
FIGURES

FIGURE 1-1. SITE LAYOUT SHOWING THE MONITORING, EXTRACTION, AND RESIDENTIAL WELLS AND THE EXTENT OF CONTAMINATION IN THE SHALLOW, INTERMEDIATE, AND DEEP ZONES



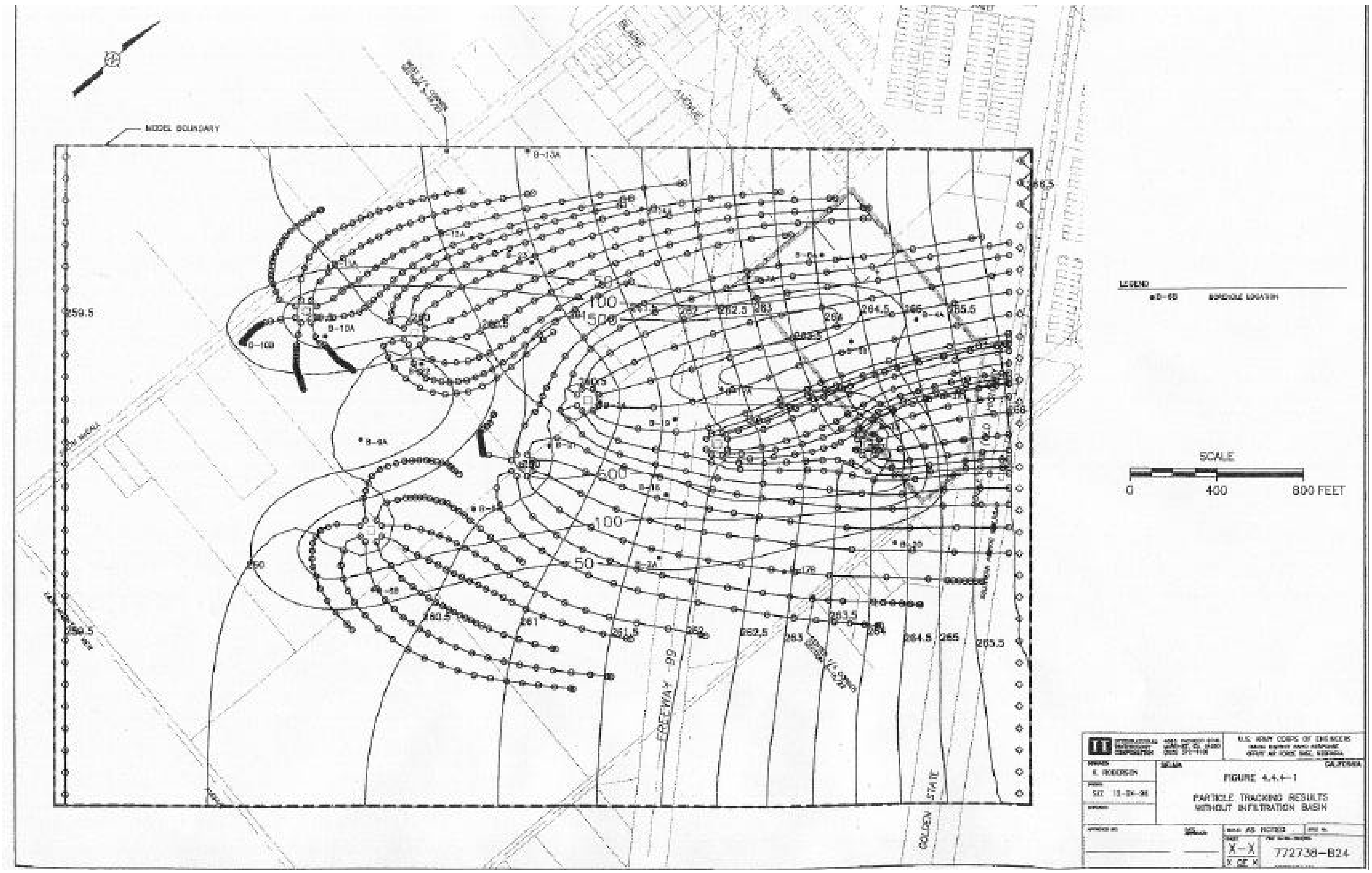
(Note: This figure is based on plume maps provided by IT site hydrogeologist and Figure 4-1 from the Selma Pressure Treating Site, Report for Monitoring Well Sampling, July 2001, IT.)

FIGURE 4-1. SITE LAYOUT SHOWING THE APPROXIMATE LOCATIONS OF EXTRACTION WELLS IN THE PROPOSED EXTRACTION SYSTEM.



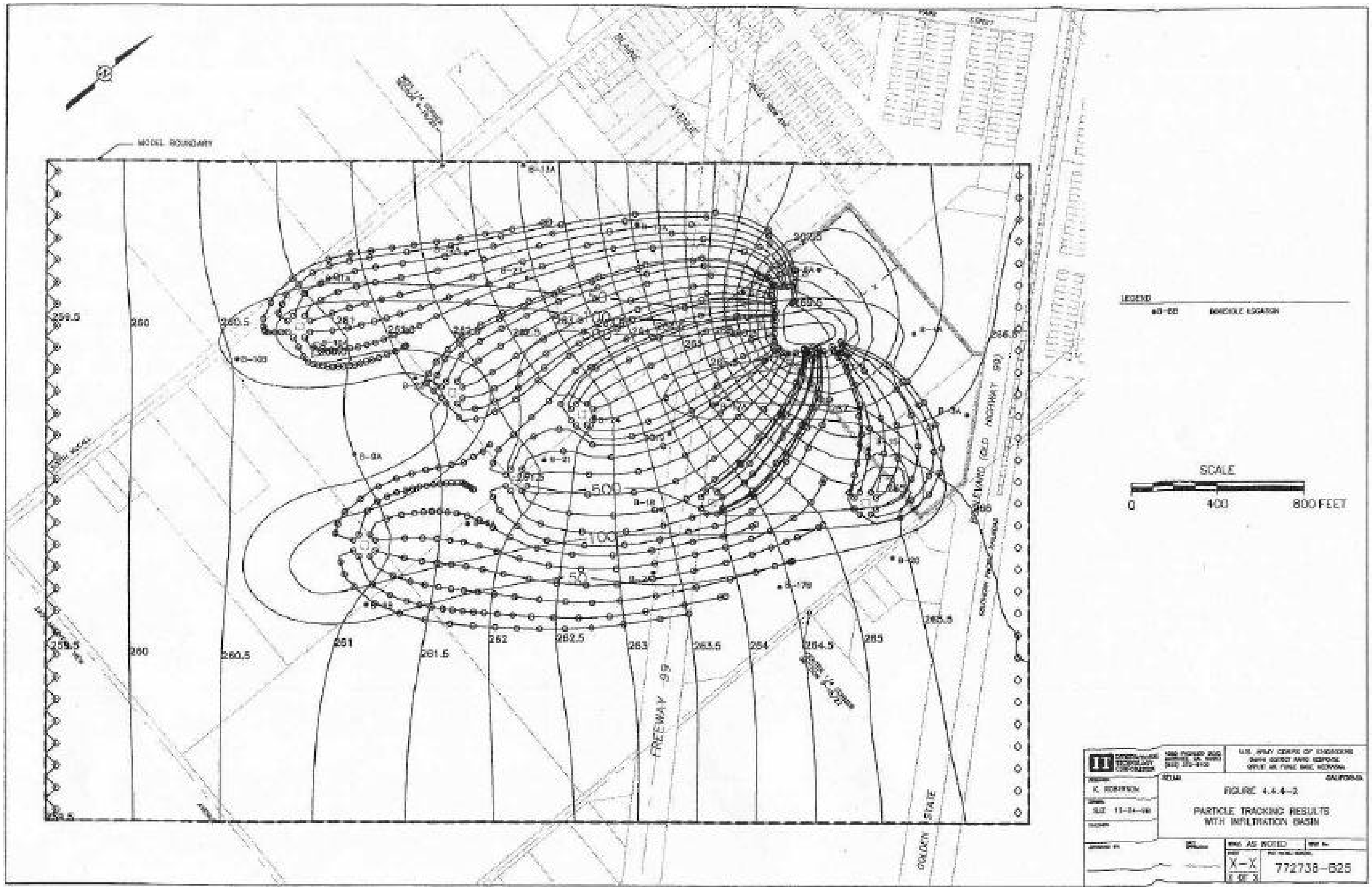
(Note: This figure is based on plume maps provided by IT site hydrogeologist and Figure 4-1 from the Selma Pressure Treating Site, Report for Monitoring Well Sampling, July 2001, IT.)

FIGURE 6-1. MODEL SIMULATION FROM THE ORIGINAL CAPTURE ZONE ANALYSIS SUGGESTING CAPTURE OF THE PLUME IN THE ABSENCE OF RECHARGE FROM THE PERCOLATION PONDS



(Note: This figure is Figure 4.4.4-1 from the Draft Final Report, IT Corp., October 2000.)

FIGURE 6-2. MODEL SIMULATION FROM THE ORIGINAL CAPTURE ZONE ANALYSIS SUGGESTING CAPTURE OF THE PLUME IN THE PRESENCE OF RECHARGE FROM THE PERCOLATION PONDS



(Note: This figure is Figure 4.4.4-2 from the Draft Final Report, IT Corp., October 2000.)

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