United States Environmental Protection Agency
Region 4
Atlanta Federal Center
61 Forsyth St. SW, Atlanta, GA 30303-8960

November 4, 2004

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

4WD-FFB

Colonel Alexander B. Raulerson
Commanding Officer
Anniston Army Depot
7 Frankford Avenue
Anniston, AL 36201-4199

SUBJ: SECOND FIVE YEAR REVIEW
SOUTHEAST INDUSTRIAL AREA
SHALLOW GROUNDWATER OPERABLE UNIT

ANNISTON ARMY DEPOT
ANNISTON, ALABAMA

September, 2004

Dear Col. Raulerson:

The United States Environmental Protection Agency (EPA) Region 4 has reviewed the subject document and concurs that the interim remedy for the Southeast Industrial Area shallow ground water Operable Unit (OU) is not currently protective since the migration of contaminants to off-site ground water is ongoing. This determination of the protectiveness of the interim remedy is based on ten years of performance monitoring data and the information collected during the ongoing Southeast Industrial Area comprehensive ground water Remedial Investigation/Feasibility Study (i.e., shallow and deep ground water both on- and off-post). It is expected that when a remedy decision is made and implemented for the comprehensive ground water OU, that the interim action will be completed.

EPA also concurs with the recommendations and follow-up actions identified in the Second Five-Year Review Report. Specifically, EPA supports the continued operation of the ground water interception system until such time as this system is replaced or upgraded as part of a final remedy decision. The recommended assessment of the actual and potential effectiveness of the ground water interception system also is considered a necessary precursor to a final remedy decision. EPA Region 4 staff will work closely with the Army to complete and document these assessment activities, and to assist in developing an acceptable solution for ground water contamination in and around the Southeast Industrial Area.

The efforts by Anniston Army Depot and the Army Environmental Center to complete this Five-Year Review are appreciated by EPA. EPA looks forward to continuing to work through the partnering process with Anniston Army Depot, the Army Environmental Center, the Army Corps of Engineers, and the Alabama Department of Environmental Management to achieve the cleanup of the Southeast Industrial Area National Priorities List site.

Sincerely,

Winston A. Smith

Winston A. Smith, Director
Waste Management Division

cc: Pat Smith, ANAD
C.H. Cox, ADEM
Bridgett Lyons, AEC
John Baehr, USACE

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
ANNISTON ARMY DEPOT
7 FRANKFORD AVENUE
ANNISTON, ALABAMA 36201-4199

REPLY TO
ATTENTION OF:

OCT 26 2004

OK
11/2/04

Directorate of Risk Management

Mr. David Keefer
U.S. Environmental Protection Agency, Region 4
DODRS/FFB/WMD
61 Forsyth Street SW
Atlanta, GA 30303-3104

Dear Mr. Keefer:

Anniston Army Depot's submission of the Five-Year Review Report for the Interim Record of Decision, Shallow Groundwater Operable Unit is enclosed. A Five-Year Review is consistent with Section 121 (c) Comprehensive Environmental Response, Compensation Liability Act and the Federal Facility Agreement.

For further information contact Patrick Smith at (256) 235-4551.

Sincerely,

A. Ann Worrell

A. Ann Worrell
Director of Risk Management

Enclosure

U.S. ARMY
ENVIRONMENTAL
CENTER

FINAL

Five-Year Review Report
Second Five-Year Review Report
for
Interim Action Record of Decision
Shallow Groundwater Operable Unit
Groundwater Treatment System
Anniston Army Depot
Calhoun County, Alabama

Prepared by
U.S. Army Environmental Center
Aberdeen Proving Ground, MD 21010

September 2004

USAEC Form 45, 1 Feb 02 replaces AEC Form 45, 1 May 97, which is obsolete.

Encl

FINAL

Five-Year Review Report

Second Five-Year Review Report
for
Interim Action Record of Decision
Shallow Groundwater Operable Unit
Groundwater Treatment System
Anniston Army Depot
Calhoun County, Alabama

Prepared by
U.S. Army Environmental Center
Aberdeen Proving Ground, MD 21010

September 2004

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Acronyms

ADEM	Alabama Department of Environmental Management
ANAD	Anniston Army Depot
CCJM	C.C. Johnson & Malhotra, P.C.
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act
CWM	chemical warfare material
DNAPL	dense nonaqueous phase liquid
DOD	U.S. Department of Defense
EPA	U.S. Environmental Protection Agency
FFA	Federal Facilities Agreement
FS	Feasibility Study
gpm	gallons per minute
GWIS	Groundwater Interception System
IROD	interim Record of Decision
IRP	Installation Restoration Program Installation
IWTP	Industrial Wastewater Treatment Plant
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NPL	National Priorities List
O&M	operations and maintenance
OU	operable unit
PCE	perchloroethylene, tetrachloroethene, tetrachloroethylene
ppb	parts per billion
RAB	Restoration Advisory Board
RFA	RCRA Facility Assessment
RI	Remedial Investigation
SAIC	Science Applications International Corporation
SIA	Southeast Industrial Area
SWMU	Solid Waste Management Units
TCE	trichloroethylene, trichloroethene
USAEC	U.S. Army Environmental Center
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
VOC	volatile organic compound

Protectiveness Statement

The interim remedy for the On-post Ground Water Operable Unit, the Ground Water Interception System (GWIS), is not completely protective of human health as a stand-alone remedy because off-post migration of contaminated ground water is ongoing. The interim remedy may be partially protective, but adequate evaluation of the effectiveness of the GWIS is not possible with available data. The following actions need to be taken to ensure the effectiveness of the GWIS: evaluation of the effectiveness of the GWIS, an optimization study for the GWIS, and development of remedial alternatives to support a final decision for the Combined Ground Water Operable Unit. In order to protect potential receptors in the interim, the Army has funded the installation of a treatment system for Cold Water Spring and continues to monitor private wells in the area to ensure that potential receptors are not exposed to contaminated groundwater.

6 Oct 04

Alexander B. Raulerson
COL, OD
Commanding Officer
Anniston Army Depot

Date

Executive Summary

The Army conducted this five-year review of the Interim Action Record of Decision for the Shallow Groundwater Operable Unit at the Anniston Army Depot in Calhoun County, Alabama. The remedial action is the removal and treatment of contaminated groundwater by the Groundwater Interception System (GWIS).

This is the second five-year review for the GWIS. The Interim Record of Decision (IROD) for this action was issued in September 1991. The first five-year review was completed in October 1998.

Currently, the GWIS consists of 14 extraction wells collecting groundwater from three different areas of the Southeast Industrial Area of the Anniston Army Depot. The groundwater flows to sumps and is pumped to a central treatment plant. The central treatment plant uses flow equalization, chemical oxidation with potassium permanganate, flocculation, settling, sand filtration, aeration, and air stripping to remove metals and volatile organic compounds from the groundwater. Treated water is discharged along with the discharge from the sanitary and industrial wastewater treatment plants. The centralized treatment plant, brought on line in 2001, replaced an earlier system that utilized three separate treatment plants. It is currently pumping and treating about 65 gallons per minute (gpm) of groundwater. The treatment plant successfully removes volatile organic compounds (VOCs) and metals from the groundwater.

A site visit was conducted on March 24, 2004 to initiate the second five-year review of the GWIS. Interviews with site environmental personnel were conducted. The treatment system component of the GWIS is operating as designed and is removing contaminants from groundwater. The effectiveness of the GWIS as a groundwater containment and remediation system remains in question.

The objectives of the 1991 interim Record of Decision were to reduce contaminant concentration and mobility to protect human health and the environment while final remedial solutions were developed. Even though the system is operating as designed, it is not completely achieving the objectives of the interim Record of Decision. Previous investigations have concluded that it is not totally controlling contaminant mobility and is not removing sufficient amounts of contaminant relative to the amounts that are present. These conclusions were based on the limited hydraulic influence of the extraction wells as well as the amount of decrease in contaminant concentrations.

Investigations conducted since the construction of the pump and treat system have revealed that the conceptual model of the aquifer, as understood at the time of the initial design of the GWIS, was deficient. Groundwater flow at the site is through a karst aquifer with numerous poorly connected fractures and caverns. Data collected recently indicates that there is contamination at depth in the aquifer. The original assumption of porous media flow at the scale of the extraction well pumping system has been determined to be incorrect. The nature of the aquifer prevents the pump and treat system from effectively removing or controlling all the groundwater contamination. A thorough evaluation of the effectiveness of the GWIS (capture and contaminant removal) should be undertaken as part of the planned feasibility study for the SIA Combined Ground Water Operable Unit. An optimization study should be undertaken to evaluate the potential effectiveness of the ground water remedy. The GWIS should, however, continue to operate until the final remedy for the SIA Combined Ground Water Operable Unit is chosen.

Five-Year Review Summary Form

SITE IDENTIFICATION

Site name ***(from WasteLAN)*****:** Anniston Army Depot - Southeast Industrial Area

EPA ID ***(from WasteLAN)*****:** AL 321 002 027

Region: 4 | **State:** AL | **City/County:** Anniston, Calhoun County

SITE STATUS

NPL status: ⌉ Final ♦ Deleted ♦ Other (specify)

Remediation status (choose all that apply): ♦ Under Construction ⌉ Operating ♦ Complete

Multiple OUs?* ⌉ YES ♦ NO

Construction completion date: N/A

Has site been put into reuse? ♦ YES ⌉ NO

REVIEW STATUS

Lead agency: ♦ EPA ♦ State ♦ Tribe ⌉ Other Federal Agency (DoD)

Author name: Laurie Haines

Author title: Project Geologist

Author affiliation: U.S. Army Environmental Center

Review period:** 30 October 1999 to 30 September 2004

Date(s) of site inspection: 24 March 2004

Type of review:

⌉ Post-SARA ♦ Pre-SARA ♦ NPL-Removal only
♦ Non-NPL Remedial Action Site ♦ NPL State/Tribe-lead
♦ Regional Discretion

Review number: ♦ 1 (first) ⌉ 2 (second) ♦ 3 (third) ♦ Other (specify)

Triggering action:

♦ Actual RA Onsite Construction at OU #____ ♦ Actual RA Start at OU#____
♦ Construction Completion ⌉ Previous Five-Year Review Report
♦ Other (specify)

Triggering action date ***(from WasteLAN)*****:** 11 / 25 / 1998

Due date ***(five years after triggering action date)*****:** 11 / 25 / 2003

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* ["OU" refers to operable unit.]

** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Summary Form, cont'd.

Issues: 1) The Ground Water Interception System (GWIS), as currently configured and operated, does not appear to be removing sufficient contaminant mass to achieve the cleanup goals established in the 1991 Interim Record of Decision; 2) the capture zone of the GWIS has not been established to the extent necessary to determine the effectiveness of the GWIS in controlling or impeding the migration of contaminants; 3) continued contaminant migration off-site indicates that the GWIS capture and contaminant removal are not adequate to maintain steady-state conditions; 4) recent studies indicate that ground water pump and treatment as the sole component of the remedy for the Southeast Industrial Area is unlikely to be adequate to address the contaminated ground water associated with the Southeast Industrial Area; and, 5) the extent to which the GWIS is meeting the remedial action objectives established in the 1991 IROD is unknown, but the remedial action objectives have not been met and appear to be unlikely to be met by the GWIS as currently operated.

Recommendations and Follow-up Actions:

1) A thorough evaluation of the current effectiveness of the GWIS (capture and contaminant removal) should be undertaken as part of the planned Feasibility Study for the SIA Combined Ground Water Operable Unit; 2) An optimization study of the GWIS should be undertaken to evaluate its potential effectiveness as the ground water remedy for the SIA or as a component of the ground water remedy for the SIA; 3) Due to the uncertainty about the effectiveness of the GWIS and the potential impacts to down gradient receptors, the GWIS should continue operating until Feasibility Studies have been completed and a final decision for the SIA Combined Ground Water Operable Unit has been made; and 4) Data needs for the Feasibility Study should be identified such that relevant information can be collected during ongoing operation of the GWIS to support evaluation of effectiveness and optimization.

Protectiveness Statement(s):

The interim remedy for the On-post Ground Water Operable Unit is not protective because migration of contaminated ground water off-post is ongoing. The interim remedy may be partially protective, but adequate evaluation of the current effectiveness of the GWIS is not possible with the available data. The following actions need to be taken to ensure effectiveness: evaluation of the effectiveness of the GWIS, an optimization study for the GWIS, and development of remedial alternatives to support a final decision for the Combined Ground Water Operable Unit.

Other Comments:

It is planned and expected that a revised operable unit strategy for ANAD will result in amendment/replacement of the remedy decision in the 1991 IROD with a decision for the Combined SIA Ground Water Operable Unit by the fourth quarter of 2007.

Introduction

The purpose of the five-year review is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to address them.

The Army is preparing this Five-Year Review report pursuant to the Comprehensive Emergency Response, Compensation, and Liability Act (CERCLA) §121 and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The NCP; 40 CFR §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The Army conducted this five-year review of the Interim Action Record of Decision for the Shallow Groundwater Operable Unit at the Anniston Army Depot in Calhoun County, Alabama. The remedial action is the removal and treatment of contaminated groundwater. This system is referred to as the Groundwater Interception System (GWIS). This review was conducted by C.C. Johnson & Malhotra, P.C. (CCJM) under a subcontract to Engineering and Environment, Inc. under a prime contract to the U.S. Army Environmental Center (DACA65-03-P-0090). This report documents the results of the review.

This is the second five-year review for the GWIS. The interim Record of Decision for this action was issued in September 1991. The first five-year review was completed in October 1998. The five-year review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

Site Chronology

The Anniston Army Depot (ANAD), formerly designated the Anniston Ordnance Depot, was constructed between February 1941 and October 1941 to serve as a munitions storage facility. During World War II, the role of the Depot was expanded to include the storage of combat equipment. Figure 1 shows the location of the facility.

Since World War II, the mission of the Depot has expanded to include the refurbishment, testing, and decommissioning of combat vehicles and various types of ordnance. The Depot's mission also has included the overhaul and repair of ordnance vehicles, fire control, and small arms rebuilding; modification of M48A1 tanks and M67 flame throwers; calibration support for the southeastern states; and logistics support for the Lance and Dragon missiles and for the Shillelagh and TOW systems.

The storage, maintenance, and industrial functions of ANAD historically have resulted in the generation of hazardous wastes. Typical waste-generating processes at ANAD have included vapor degreasing, metal cleaning, sandblasting, electroplating, and painting. Generated solid and liquid wastes have included metals, cyanide, phenols, pesticides, herbicides, chlorinated hydrocarbons, petroleum hydrocarbons, solvents, acids, alkalis, chelating agents, asbestos, and creosote. Wastes generated at ANAD were disposed of on site in trenches, unlined lagoons, landfills, or other holding vessels between the 1940s through the late 1970s. The majority of waste was generated within the Southeast Industrial Area (SIA).

Investigations addressing the quality of groundwater at ANAD have revealed that contaminants have migrated to the groundwater. As a result of groundwater contamination, the SIA was placed on the CERCLA National Priorities List (NPL) in 1989. In June 1991, the Department of the Army entered into a Federal Facilities Agreement (FFA) for ANAD with the Alabama Department of Environmental Management (ADEM) and U.S. Environmental Protection Agency (EPA) Region IV to establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions to contamination problems in the SIA.

The first quantitative assessment of industrial wastewater generated at ANAD was conducted in 1966 by the U.S. Army Environmental Hygiene Agency (USAEHA). Identified parameters in the wastewater that required control included pH, phosphorus, phenolics, cyanide, chromium, other heavy metals, oils, and grease. As a result, further work was initiated that led to the development of the pollution control program and the construction of an Industrial Wastewater Treatment Plant (IWTP) in 1976 (SAIC, 1998a).

By 1978, the USAEHA had installed wells to monitor groundwater around the IWTP, the Landfill Area, and the new lagoons. The monitoring data indicated that wastewater from the IWTP and lagoons was not degrading groundwater quality. However, groundwater contamination was linked to the landfill area (SAIC, 1998a).

In September 1979, three of the solid and hazardous waste landfill sites in the SIA were evaluated to determine the potential for contamination of groundwater, surface water, and air, and to recommend action to bring the sites into compliance with state and federal regulations. Eighteen wells were sampled to determine groundwater quality. Sample analyses indicated local groundwater contamination at the Chemical Sludge Waste Pits.

Organic contaminants detected included volatile hydrocarbons, volatile aromatics, phenols, and phthalate esters. Six contaminants exceeded published human health criteria based on 1979 standards for consumption of water and protection of aquatic organisms (SAIC, 1998a).

In 1980, USAEHA collected samples from 22 on-Depot wells to further evaluate the impact on local groundwater. All 22 wells showed traces of trichloroethylene; the three wells nearest the Chemical Sludge Waste Pits also showed methylene chloride. In February 1981, 12 wells were resampled and analyzed for volatile organic compounds (VOCs). In addition to confirming the previous detection of trichloroethylene and methylene chloride, a wide variety of volatile chlorinated hydrocarbons were detected at concentrations exceeding human health criteria (SAIC, 1998a).

As a result of the previous groundwater studies, the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) initiated a survey in February 1981 to determine the extent of hazardous contaminant migration and to develop plans for abatement (USATHAMA, 1981). This program included a geophysical evaluation, and sampling of 41 monitoring wells. The results of this program identified landfills and trench areas as major sources of contamination (SAIC, 1998a).

USATHAMA determined that additional efforts were necessary to identify the rate of contaminant migration and potential impact, and to develop a mitigation plan. Twenty-five groundwater monitoring wells were installed in or near the SIA. In addition, three six-inch-diameter wells were installed with five adjacent pilot borings to evaluate problems associated with the withdrawal and treatment of groundwater at designated on-Depot locations. Some contaminants were determined to be migrating across ANAD's boundary and, although concentrations were low and posed no immediate hazard, concerns for potential long-range impact suggested a need for remediation (SAIC, 1998a).

A study was conducted from 1985 to 1986 to evaluate off-Depot contamination, with emphasis on identifying contaminant migration pathways and transport rates. Samples were taken from 13 newly installed monitoring wells and from Coldwater Spring. Coldwater Spring is a large spring approximately 1.8 miles south of the SIA. It is a major source of drinking water in the Anniston area. The study concluded that levels of contamination found in Coldwater Spring and in some off-Depot wells did not appear to be directly related to on-Depot contamination, since the contamination levels in Dry Creek and near off-Depot wells did not correlate with levels found in Coldwater Spring (SAIC, 1998a).

The conceptual design of the GWIS was completed in 1986 (Weston, 1986). Extraction well locations, air stripping, and activated carbon adsorption to remove phenolics were recommended.

In 1987, a RCRA Facility Assessment (RFA) was conducted to evaluate the release of hazardous wastes or hazardous substances. The RFA identified wastes at 38 SWMUs, evaluated the potential for release to the environment, and determined the need for further investigation. The report discussed each SWMU in terms of site description, waste characteristics, migration pathways, and evidence of release (SAIC, 1998a).

In June 1987, a photogeologic study was undertaken to identify potential contaminant migration pathways from ANAD to Coldwater Spring. A review of the literature, unpublished information, and a field investigation led to the conclusion that contaminated groundwater from ANAD could enter the confined aquifer along the Jacksonville fault and reemerge at Coldwater Spring. The study recommended that the artesian groundwater regime be defined to characterize potential contamination migration from ANAD to Coldwater Spring (SAIC, 1998a).

An RI and FS for off-post groundwater contamination were conducted between 1986 and 1988 (ESE, 1989). The FS recommended hooking up all water users to the Anniston municipal system and a restriction on the future installation of potable wells in the area. In 1985, a groundwater study was conducted that recommended a pump and treat system be installed (U.S. Army, 1991).

A 1989 report on groundwater extraction optimization presented recommendations for the design and installation of groundwater extraction systems for three areas of defined groundwater contamination at the SIA (Jordan, 1989). The primary objective of the program was to capture contaminated groundwater containing trichloroethylene and dichloroethylene near the source and to provide additional downgradient groundwater capture. Three separate systems, one for each area, Landfill, Trench and Northeast, were installed in accordance with the recommendations of this study. The GWIS included groundwater extraction wells, air strippers for volatile organics and activated carbon adsorption to remove phenolics. Continued operation of the Building 114 Dewatering system was also included. The systems began operating in September of 1990.

The Building 114 Dewatering system has been in operation since 1985. A french drain had been installed beneath the building for structural reasons. The discharge from the french drain was contaminated with VOCs and hexavalent chromium. Air stripping was originally used to treat this discharge. Later, a groundwater treatment plant to remove chromium was constructed. This groundwater treatment plant was modified and became the centralized treatment plant for the GWIS. The Building 114 Dewatering and treatment system is not considered part of the GWIS, even though it extracts and treats contaminated groundwater.

An interim remedial action Record of Decision (IROD) was issued for the GWIS in September 1991 (ANAD, 1991). The IROD was issued to protect public health, welfare, and the environment while final remediation solutions were being developed. The IROD for groundwater established the on-post and off-post groundwater OUs at the SIA and addressed the Trench Area, which includes Chemical Sludge Waste Pits (SWMU-1); the Northeast Area, which includes Chemical Waste Burial Pit (SWMU-7), Building 130 Sump (SWMU-25), Northeast Lagoon Area (SWMU-30), and Metal Plating Shop-Building 114 (SWMU-31); and the Landfill Area, which includes Facility 414 Old Lagoons (SWMU-12) and A-Block Lagoon (SWMU-22). Figure 2 shows the locations of these SWMUs.

In 1992, Jacobs conducted an evaluation of the operation and effectiveness of the GWIS. Problems in design and equipment and operational impediments were identified, and recommendations for system improvements were presented in the resulting Groundwater Extraction System Optimization Study (Jacobs, 1993).

In 1992, dye trace studies were performed at the three areas where the GWIS system was operating (Ewers Water Consultants, 1994). Multiple injections of dye were made at the Trench Area, Northeast Area, and Landfill Area. Dye was detected off-site at springs to the north, southwest, and southeast up to ten miles away from the SIA.

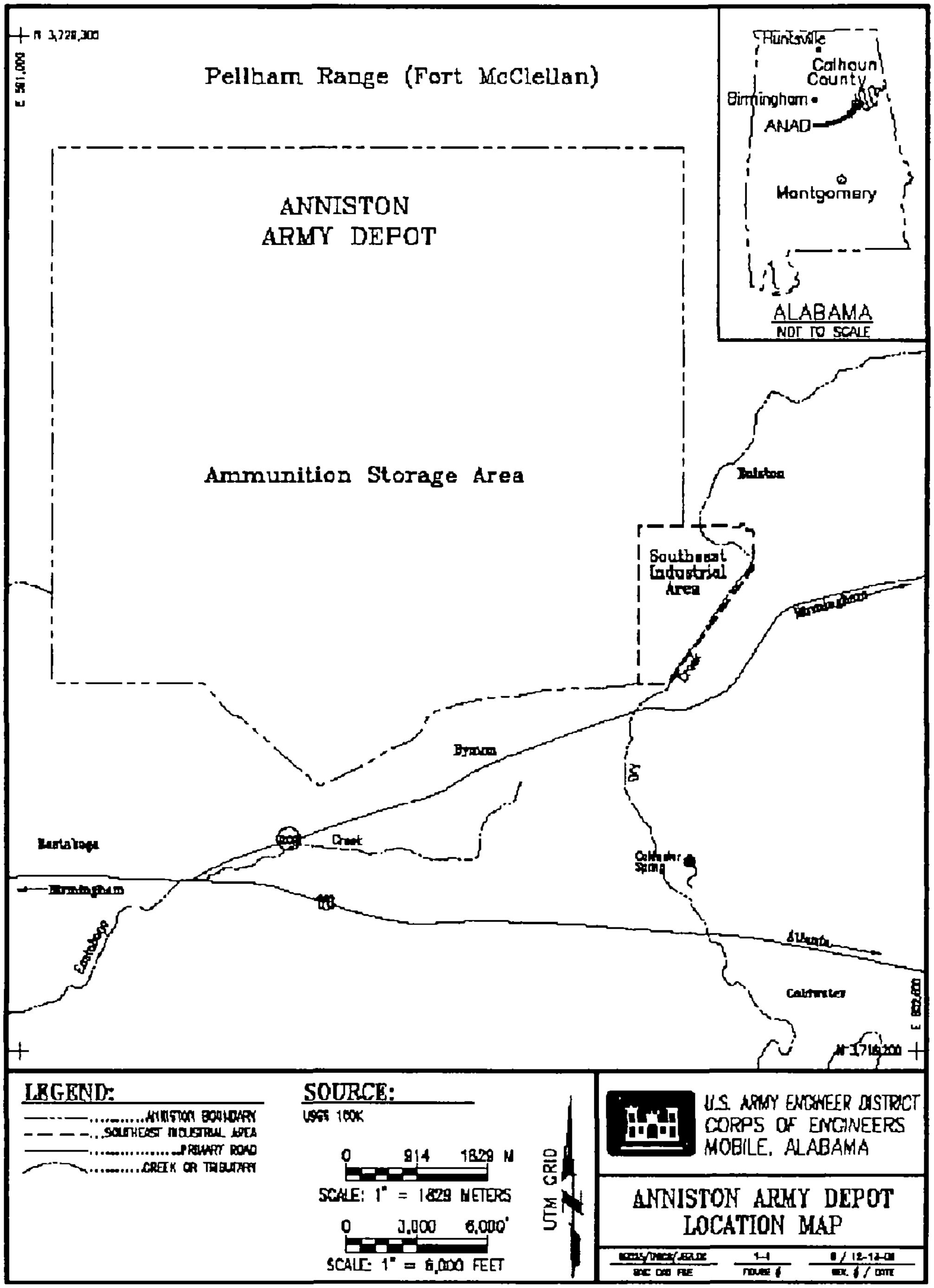
Another dye trace study was performed by SAIC starting in 1997 (SAIC, 1998b). Monitoring continued through 1999. This study reached different conclusions than the earlier study with most of the dye injections in the Trench, Landfill, and Northeast area discharging within the SIA. There was one confirmed detection to the west of the ANAD, approximately five miles from the injection point.

The Phase 2 Remedial Investigation was completed in 1998 (SAIC, 1998a). This RI studied soils and shallow groundwater contamination at 22 areas in the SIA. Baseline risk assessments were conducted for human health and the environment.

Off-site groundwater was investigated by Phase I of the Offpost RI, Hydrogeologic Characterization of the Jacksonville Thrust Fault (SAIC, 2001). This RI focussed on characterization of the Jacksonville fault zone to the south of the SIA.

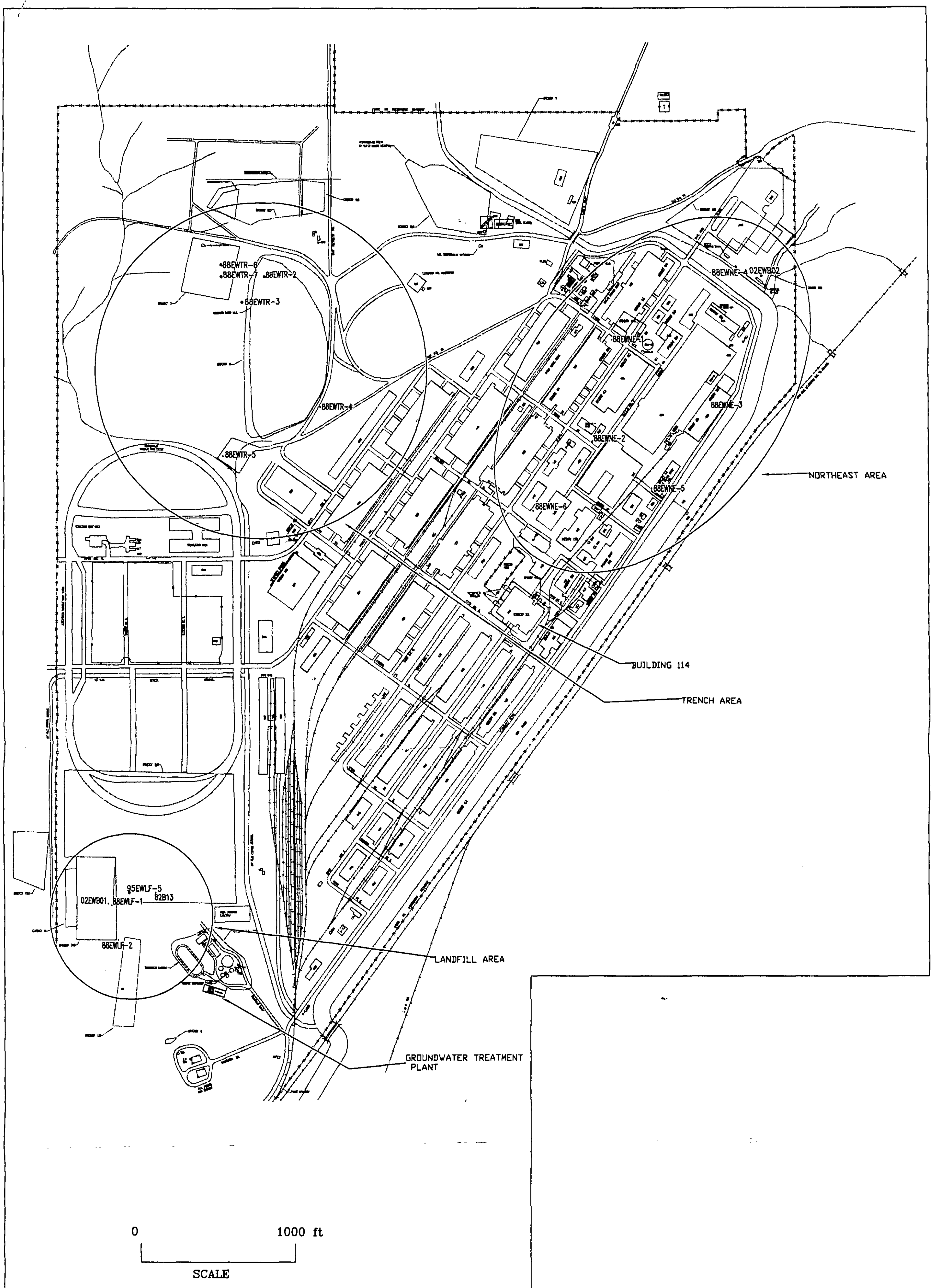
A comprehensive groundwater remedial investigation was completed in 2003 (SAIC, 2003a) as a follow-on to the previous on post and off post groundwater RI studies. Both shallow and deep groundwater were investigated. Activities to assess the movement of deep groundwater and the extent of groundwater contamination in the area of the ANAD southeastern boundary were conducted.

Extensive modifications were made to the GWIS during 2000. The extracted water was piped to a central location where treatment includes flocculation, chemical oxidation, air stripping, and filtration (IT, 2000). These modifications were documented in a new draft IROD (SAIC, 2003C). The centralized groundwater treatment plant began operating in 2001.



(from SAIC, 2003)

Figure 1 - Location Map



Five Year Review
Interim Action Record of Decision
Shallow Groundwater Operable Unit
Groundwater Treatment System
Anniston Army Depot

Figure 2
Southeast Industrial Area
Groundwater Interception System

SCALE:	CONTRACT NO.: A6931	DATE: 6/04	SHEET:

Background

Physical Characteristics

The Anniston Army Depot (ANAD) is located in Calhoun County in northeastern Alabama. Figure 1 shows its location. The City of Anniston is located 10 miles east of the depot. The northern boundary of the depot is the Pelham Range portion of the Fort McClellan Military Reservation.

ANAD encompasses 15,200 acres. The ammunition storage area occupies more than 13,000 acres, covering the entire central and northern portions of the depot. The Southeast Industrial Area (SIA) contains the industrial facilities and the GWIS that is the subject of this five-year review.

Geology and Hydrogeology

There are many summaries of the geology and hydrogeology of the ANAD. The best and most recent is in the Comprehensive Groundwater Remedial Investigation (SAIC, 2003a). This was a review of the groundwater beneath the SIA and includes a conceptual model of groundwater flow and contaminant transport.

ANAD lies within the fold-and-thrust belt of the Appalachian Valley and Ridge physiographic province. The fold-and-thrust belt is characterized by Paleozoic rock formations that were repeatedly folded and thrust faulted by northwestward-directed tectonic stresses during the Appalachian orogenesis that occurred in the Ordovician through Permian periods more than 250 million years ago. As a result of this structural deformation, major geomorphic and geologic features, including topographic ridges and valleys, fold axes, fault traces, and lithologic boundaries, are commonly oriented in a northeast-southwest direction. Northwestward transport of the Paleozoic rock sequence along thrust faults has resulted in the imbricate stacking of large slabs of rock referred to as thrust sheets. Within an individual thrust sheet, smaller faults may splay off the larger basal thrust fault, resulting in stacking and overlap of rock units. Geologic contacts in the region are generally oriented parallel to mapped faults, and repetition of lithologic units is common in vertical sequences. ANAD lies on the Pell City thrust sheet within the fold-and-thrust belt (SAIC, 1998a).

The Pell City thrust sheet consists primarily of Cambrian-Ordovician carbonate rocks of the Knox Group. To the west, along the Pell City thrust fault, rocks of the Pell City thrust sheet are juxtaposed against primarily Mississippian-Pennsylvanian sedimentary rocks of the Coosa Deformed Belt. Directly southeast of ANAD, Cambrian rocks of the Chilhowee Group, Shady, Rome, and Conasauga Formations have been thrust over the younger Knox Group along the Jacksonville fault. Low-grade metamorphic rocks of the Alabama Piedmont occur southeast of the Talladega fault, approximately 4.9 miles southeast of ANAD (SAIC, 1998a).

Lithologies encountered in the vicinity of ANAD include, from youngest to oldest, the Knox Group, the Conasauga Formation, the Rome Formation, the Shady Dolomite, the Chilhowee Group, and the Weisner and Wilson Ridge Formations . The Knox Group, undifferentiated in the vicinity of ANAD, is characterized by light-gray to light-brown, siliceous, locally sandy dolostone, dolomitic limestone, and limestone. Deep differential weathering of the carbonate Knox Group has produced a thick mantle of reddish-yellow cherty clay residuum. Because of the thickness and lateral extent of the residuum, few exposures of unweathered Knox Group rocks exist in the vicinity of ANAD. Almost the entire SIA is underlain by rocks of the Knox Group. The Conasauga Formation occurs as a light- to dark-gray, finely to coarsely crystalline, medium- to thick-bedded dolostone interbedded with greenish-gray shale and light bluish-gray chert. Near ANAD, the residuum of the Conasauga is nearly indistinguishable from that of the Knox Group, except for more abundant and more massive chert nodules that are found in residuum of the Knox Group. The Conasauga is approximately 2,500 ft thick near ANAD. The Rome Formation consists of purple to olive mudstone with some interbedded sandstone that typically forms small knolls. The thickness of the Rome Formation around ANAD is 1,000 ft. The Shady Dolomite is a bluish-gray or pale yellowish-gray, thickly bedded, siliceous dolostone characterized by coarsely crystalline porous chert. The unit weathers to grayish-orange to yellowish-brown clay that may contain sand, pebbles, limonite granules, or veins of "lacy" crystalline quartz. Near ANAD, the Chilhowee Group is represented by lithified outcrop sections of the Weisner Formation and small portions of the Wilson Ridge Formation. The Weisner consists of white to medium gray, and moderate-orange-pink to moderate-reddish orange, fine- to coarse-grained, locally conglomeritic, quartzite and orthoquartzitic sandstone. The Wilson Ridge Formation consists of sequences of interbedded coarse-grained rocks similar to the Weisner, with fine-grained, light colored, micaceous shale and silty mudstone (SAIC, 1998a).

ANAD is located in a karst area and sinkholes are a common feature of the topography. Sinkholes can provide pathways for surface water and contaminants to rapidly enter the groundwater system with little or no filtration (SAIC, 1998a).

The groundwater flow system in the ANAD area is complex. There is flow through the residuum and weathered zone, and flow through conduits in the karst bedrock. Faults also impact the flow of groundwater. The original concept of the groundwater flow at the site was a four-layer system consisting of a layer of silt and clay residuum underlain by sand and gravel. These layers were underlain by fractured, weathered, and dolomite bedrock which were underlain by impermeable competent bedrock (Battelle, 1984). The current conceptual model of groundwater flow includes the following findings (SAIC, 2003a):

- The residuum, weathered bedrock, and competent bedrock comprise an interconnected aquifer.
- The transition from weathered bedrock to unweathered bedrock is gradational and variable with some areas having severely weathered intervals within more competent rock.
- On a borehole scale, it is evident that a rock interval can exhibit a high frequency of fracturing, yet the connectivity of the fractures can be limited in the immediate area of the borehole.
- The fractures in the Knox Group boreholes exhibit a trend of decreasing fracture frequency with depth, although fracturing was present in the deepest boreholes (02CGWB02 showed alternating cavities and rock at a depth of 590 to 600 feet

below the ground surface).

- Faults are not prime intervals of flow, yet are connected to adjacent fracture sets. The visible faults are indicators of mechanical breakage, but do not always correlate to flow intervals.
- The aquifer rock in the ANAD area is highly variable, with intervals of completely fractured rock; dense, tight rock; and cavernous sections, creating a heterogeneous, complex flow network (SAIC, 2003a).

In general, groundwater flow is toward the south, with both eastern and western components. On a regional scale, groundwater flow follows the topography, although there are significant exceptions on local scales. Even though the bedrock has numerous karst features, there are few high yielding wells. The ANAD monitoring wells have no sustainable yields above 2.5 gpm and most wells yield less than one gpm. Extraction wells in the GWIS yield between 1.5 and 16.3 gpm.

Land and Resource Use

The SIA is an active industrial operation area. It contains more than 50 buildings and a vehicle test track. Approximately 3,400 people work at the Depot. Access is controlled at the perimeter by fences and guards posted at entry points. According to the 1987 ANAD Master Plan, "...land uses are not expected to change significantly during the planned future development of Anniston Army Depot." Therefore, the most likely future SIA land use is industrial.

Currently, water is supplied to the Depot by pipeline from Anniston Water Works and Sewer Board; consequently, there are no current exposures to water beneath the Depot. For the foreseeable future, water will continue to be supplied from this source.

In the vicinity of ANAD, groundwater from wells and springs is used for residential and agricultural purposes. Surface water is used primarily for recreational and agricultural activities. A total of 123 off-site wells and springs have been identified as being used for potable supplies, groundwater monitoring, recreational and agricultural purposes. Fifty-five of the wells and springs are used for drinking water, and the rest are used for monitoring or other purposes. There is also a major public water supply source, Coldwater Springs, 1.8 miles south of the SIA. Coldwater Springs produces 32 to 35 millions of gallons per day. There are commercial catfish ponds replenished by both a spring and a well that are directly adjacent to the SIA (SAIC, 2003C).

History of Contamination

General activities at the depot have included overhauling, testing, and storage of combat vehicles, primarily within the SIA, and storage of munitions within the ammunition storage area. ANAD also performs maintenance on weapons, ammunition, missiles, and chemical munitions. The storage, maintenance, and industrial functions of ANAD have historically resulted in the generation of hazardous wastes. Typical waste generating processes at ANAD have included vapor degreasing, metal cleaning, sandblasting, electroplating, and painting. Generated solid and liquid wastes have included metals, cyanide, phenols, pesticides, herbicides, chlorinated hydrocarbons, petroleum hydrocarbons, solvents, acids, alkalis, chelating agents, asbestos, and creosote. From about the 1940s through the late 1970s, wastes generated at ANAD were disposed of on-site in trenches, lagoons, landfills, or other holding vessels.

A majority of the non-munitions-related waste generation and subsequent waste disposal activities at ANAD have occurred within the SIA. Based on previous investigations, 29 locations within the SIA are known, or suspected, to contain wastes and have been designated as solid waste management units (SWMUs). Numerous studies conducted as part of the DOD IRP, as well as other environmental management programs, have provided information on the extent of contamination and have resulted in the alteration of certain waste management practices and the initiation of remedial actions at some of the SWMUs (SAIC, 2003a).

Initial Response

Major removal and closure actions that have been completed since 1981 are described in the following paragraphs.

Chemical Sludge Waste Pits (SWMU-1)—This area consists of seven trenches transecting approximately 2 acres. The trenches were used for the disposal of chemical waste, including corrosive waste, reactive waste, paint residue, spent solvents, spent cyanide solutions, and wastewater treatment sludge. The trenches were excavated between November 1982 and May 1983. There were 52,526 tons of contaminated soils transported as waste to an authorized hazardous waste landfill facility. A reclamation project was conducted and the facility was closed under Resource Conservation and Recovery Act (RCRA) provisions.

Sanitary Landfill (SWMU-2)—This area is a 13.6-acre sanitary landfill that was operated from 1970 until formal closure in October 1993. Waste disposed of included cardboard, pallets, packing material, cafeteria garbage, digested sludge, office waste, and containerized asbestos waste. Abrasive dust waste was disposed of from 1981 to 1986. Soils were not investigated under CERCLA because it was understood at the time the work plans were written that the landfill would be closed under Soil Waste regulations. On October 9, 1991, new federal regulations (40 CFR 257-258) went into effect and required a formal/engineered closure of any portion of the landfill utilized after that date. The existing cap of the portion of the landfill utilized before October 9, 1991, had eroded and there was exposed garbage. There was also leachate present during rain events. In situ chemical oxidation was conducted at this site in 1997 and 1999 (ANAD, 2000).

Facility 414 Old Lagoons (SWMU-12)—This area was used from 1960 to 1978 and consisted of three lagoons used for the disposal of abrasive dust wastes containing cadmium and possibly lead, metal plating, cleaning solutions, fuels, oils, solvents, and residue from the IWTP. The lagoons were emptied in 1978 and the liquid was pumped to the A-Block Lagoon, a lined surface impoundment. The sludge and lagoon remnants were dredged and piled. In November 1982, the pile was excavated and 9,594 tons of material were transported to an authorized hazardous waste landfill facility.

Building 130 Sump (SWMU-25)—This was an 8,000-gallon, concrete, underground sump located outside the southwest corner of Building 130. The sump was used for temporary storage of paint stripper material containing methylene chloride and phenol drained from vats in the building. In conjunction with cleanup activities at Chemical Sludge Waste Pits (SWMU-1) and Facility 414 Old Lagoons (SWMU-12), the sump and adjacent contaminated soil were excavated and transported to an authorized hazardous waste landfill facility. The area then was covered with a concrete pad. This area is near the Northeast Area groundwater pump-and- treat system.

A-Block Lagoon (SWMU-22)—A synthetically lined lagoon was constructed in 1978 to contain liquid waste previously held at SWMU-12. This action was required by RCRA as a result of groundwater monitoring of the SWMU-12 lagoons five years before. Alternative disposal plans were considered necessary by ANAD and were studied beginning in 1979. In 1981, ANAD contracted to remove and dispose of the A-Block Lagoon wastes. Final closure and closure certification was completed August 1982 (SAIC, 1998a).

Basis for Taking Action

Contaminants of concern for the shallow groundwater operable unit are:

total chromium
hexavalent chromium
carbon tetrachloride
chloroform
methylene chloride
tetrachloroethylene (PCE)
trichloroethylene (TCE)
1,2-dichloroethylene
1,1-dichloroethylene
1,1,1-trichloroethane
phenol (U.S. Army, 1991)

These contaminants were also present in soils at the Trench, Landfill, and Northeast areas of the site.

Remedial Actions

Remedy Selection

The ANAD SIA was placed on the National Priorities List on March 31, 1989. A Federal Facility Agreement between the EPA Region IV, The Alabama Department of Environmental Management and the Army was signed in June of 1990 (ANAD, 1998).

An RI and FS for off-post groundwater contamination were conducted between 1986 and 1988 (ESE, 1989). The FS recommended tying in all water users to the Anniston municipal system and a restriction on the future installation of potable wells in the area. In 1985, a groundwater study was conducted that recommended a pump and treat system be installed (U.S. Army, 1991). The system was designed and constructed between 1985 and 1990 (Weston, 1986; Jordan, 1989; ANAD, 1998)

An interim remedial action Record of Decision ((IROD) was issued for the GWIS in September 1991 (U.S. Army, 1991). The IROD was issued to protect public health, welfare, and the environment while final remediation solutions were being developed. The IROD established the on-post and off-post groundwater OUs at the SIA. There was groundwater extraction and treatment at the Trench Area, which includes Chemical Sludge Waste Pits (SWMU-1); the Northeast Area, which includes Chemical Waste Burial Pit (SWMU-7), Building 130 Sump (SWMU-25), Northeast Lagoon Area (SWMU-30), and Metal Plating Shop-Building 114 (SWMU-31); and the Landfill Area, which includes Facility 414 Old Lagoons (SWMU-12) and A-Block Lagoon (SWMU-22).

The objectives of the IROD action were to reduce contaminant concentration and mobility directly under the Trench Area, the Landfill Area, and the Northeast Area to protect human health and the environment while final remedial solutions were developed (ANAND, 1998).

The interim remedy in the IROD was:

- groundwater withdrawal,
- treatment of the groundwater for volatile organics and phenolics with discharge to the surface,, and
- continued operation of the Building 114 Dewatering and treatment system (U.S. Army, 1991).

The treatment process is shown in Figure 3. Water was pumped from extraction wells and the Building 114 Dewatering system to air strippers followed by activated carbon adsorption. Discharge was originally to the ground with flow to Dry Creek. Then the discharges were combined with the effluent from the sewage treatment plant and discharged to Choccolocco Creek (ANAD, 1998).

Remedy Implementation

An assessment of the GWIS was performed in 1991 and 1992 (Jacobs, 1993). At the time of the study, the Trench Area extraction system included six extraction wells, the

Landfill Area extraction system included four extraction wells, and the Northeast Area extraction system included five extraction wells. Water level measurements and sampling were conducted. Conclusions of this study were:

- Because of inoperative flow meters, no evaluation of well performance was possible.
- There were no continuous water level measurements in the SIA, so consequently, no analysis of the response of the aquifer to stress was possible.
- The available water level data indicated that extraction well pumpage did not significantly change natural flow patterns or significantly moderate natural seasonal water fluctuations.
- The groundwater samples analyzed indicated that the GWIS had not significantly impacted contaminant concentrations (Jacobs, 1993).

Recommendations of this study were:

- Repair or replace all defective flow meters on extraction wells and treatment systems.
- Repair or replace clogged extraction wells.
- Maintain a qualified staff to operate and maintain the system.
- After repairing the extraction wells, pumping tests on each well should be performed.
- Optimize individual well performance by regulating the well flow rates to maintain maximum sustainable drawdowns.
- Modify the treatment plants to include filters at the head of the plants to remove suspended sediment before the air strippers and add piping to allow recirculation of flow.
- Collect continuous data on precipitation, groundwater levels including extraction wells, and surface water flow in Dry Creek (Jacobs, 1993).

Many of these recommendations were implemented. The USACE Mobile district found that the major cause of fouling in wells, pumps and treatment systems was not silt and sediment but rather iron bacteria growth. Extraction wells were redeveloped and redrilled. Pumpage rates were limited so that drawdowns did not go below the top of the well screens. A large diameter recovery well (95EWLF-5) was added to the system to avoid turbulent flow which entrains air and enhances the growth of iron bacteria. Additional evaluation of the treatment systems concluded that the systems were adequate to remove the contaminant concentrations encountered but were plagued by scaling and fouling. An upgrade of the treatment system was recommended. This upgrade was to include:

- Construction of a new centralized treatment facility that would treat the collected groundwater using chemical oxidation, air stripping and filtration.
- Construction of large diameter extraction wells to reduce clogging and excessive

drawdown.

- Removal of suspected free phase DNAPL by dual phase extraction.
- Addition of individual sequestrant systems to existing and new extraction wells that exhibit elevated iron and hardness concentrations to reduce scaling and to maintain well yields (ANAD, 1998).

A new centralized groundwater treatment facility was constructed in the building where groundwater from Building 114 had been treated. Building 114 has a french drain that was installed to prevent flooding of the basement. Discharge from the drain was treated with an air stripper. Undesirable concentrations of hexavalent chromium were discovered in the surrounding groundwater, so a treatment plant to remove chromium was constructed (approximately 1991). This treatment plant used reduction and precipitation to remove chromium. By 1999, chromium concentrations had declined and the treatment system was no longer needed. A new treatment process was designed that used oxidation with potassium permanganate ($KMnO_4$), air stripping, and filtration to treat the groundwater from all three areas. This new system prevents fouling by oxidizing and removing iron ahead of the air stripper (IT, 2000).

A five-year review of the system was completed in October 1998 (ANAD, 1998). A new Draft IROD documenting the changes in the system was prepared in 2003 (SAIC, 2003c).

Two new wells were added to the system during 2003. Extraction well B-02 began pumping in July and well B-01 began pumping in October.

A treatability study was conducted during 2003 to optimize chemical usage at the GWIS. This included evaluations of $KMnO_4$ usage, ideal pH, use of groundwater with ferrous iron to reduce hexavalent chromium, and use of a proprietary process, electro-coagulation to reduce hexavalent chromium. Findings and recommendations of this treatability study included increasing the pH to 9.0 to increase metal removal, and keeping the air stripper online because removing all organics with $KMnO_4$ requires excessive amounts of chemical (Bhate, 2003).

System Operations/Operation and Maintenance (O&M)

The installation staff performs maintenance on the GWIS. Daily maintenance tasks are:

1. Check each (14) well for operation. Record flow meter readings at each well. On the first day of the week, record flows (gpm) at each well.
2. Transfer sludge from the sludge thickening tank to portable totes.
3. Transfer sludge from the clarifiers to the sludge thickening tank.
4. Check chemical levels and operation of chemical mixers and pumps.
5. Drain condensation from air compressor tanks and carbon vessels.
6. Read flow meter and test pH at discharge 002. Record flow and pH in daily log and in computer.
7. Tour treatment plant every hour and check for operational problems and repair/adjust as necessary.

8. Constantly monitor computer screens for proper operation and alarms.
9. Drain sediment from sand filters.
10. Record daily flow and pH in log books and computer.

Monthly maintenance tasks are:

1. Service plant equipment as necessary following instructions of equipment manufacturers. These tasks include greasing pumps and bearings, filling oil reservoirs, and draining separators.
2. Compile flow and other data into one folder for reference.

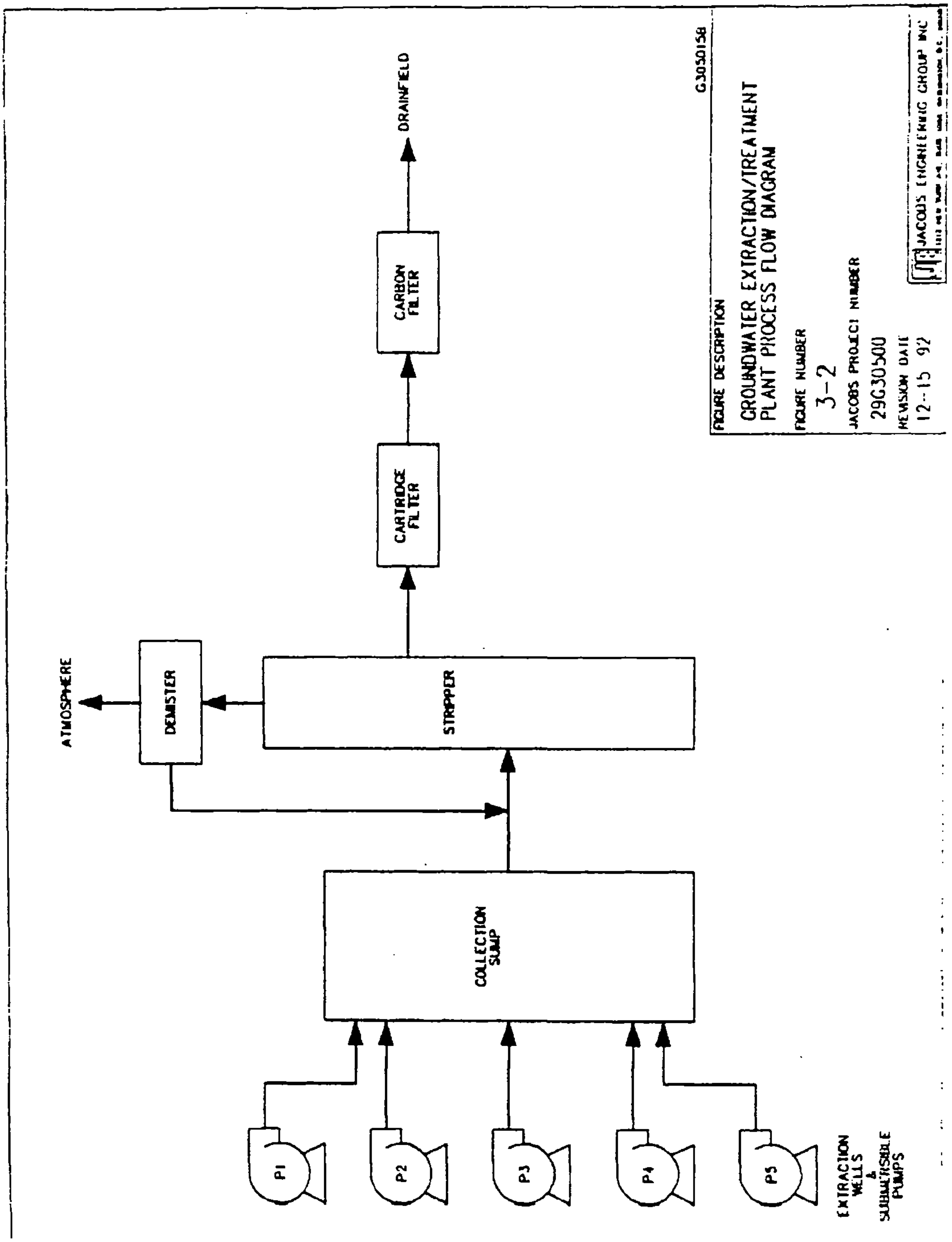
Other tasks are performed as needed. These include:

1. Dispose of sludge.
2. Clean plant equipment.
3. Disassemble and clean well flow meters and strainers.
4. Maintain equipment including repairing leaks, rebuilding pumps and blowers, and replacing mechanical parts.
5. Mow grass around plant, and discharge 002 stripper towers, sumps and wells.
6. Replace media in discharge 002 air stripper towers.
7. Pressure wash trays in plant stripper.
8. Clean floats in wells and collection sumps.
9. Pull extraction pumps and clean pump strainers.
10. Replace extraction pumps/sump pumps and overhaul.
11. Transfer and mix permanganate.

The current system (centralized groundwater treatment plant) began operating in 2001. Operation and maintenance costs have not yet stabilized but current annual costs are as follows:

- $200,000 for chemicals and miscellaneous supplies
- Salaries for two operators, estimated to be about $100,000 including benefits

Total annual operating cost is thus about $300,000. These costs do not include electricity, water, and redevelopment of the extraction wells as necessary. There have been additional engineering costs as well including an optimization study and software repair and maintenance. The annual operating cost of about $300,000 is slightly below the projected cost, mainly because chemical usage is significantly less than projected.



(from Jacobs, 1993)

Figure 3 - Original GWIS Process Flow

Progress Since the Last Five-Year Review

The previous five-year review made the following recommendations (ANAD, 1998). Each recommendation is followed by a discussion of the progress that has been made.

1. Construction of a new centralized facility that utilizes but upgrades the existing pumping stations and piping. This system would consist of ex-situ oxidation process to destroy the VOCs contained in groundwater. Suspended solids and inorganics would be removed from the effluent using a filtration process before discharge.

   This recommendation has been implemented. A new treatment plant has been constructed in the Building 114 chromium treatment plant (IT, 2000) and is working.

2. The construction of large diameter (48 inch) extraction well to reduce clogging and excessive draw down.

   One new large diameter extraction well was constructed. Two new extraction wells were drilled in September of 2002 (02TEWB01 and 02TEWB02). These were drilled into the bedrock with a 6.5-inch down hole hammer (SAIC, 2003b).

3. The evaluation of current monitoring well networks using the results of further groundwater sampling, fracture trace analysis, and geophysics for the placement of new monitoring and extraction well locations.

   Extensive investigations have been performed since 1998. New monitoring wells have been constructed and geophysical studies performed (SAIC, 2003a). Two new extraction wells have been drilled and tested (SAIC, 2003b). The first attempt at drilling extraction test well 02TEWB01 failed; a 161-foot deep dry hole was drilled. This dry hole is of some probative value in understanding the hydrogeology of the site.

4. Removal of suspected free phase DNAPL by bottom well pumpage and/or dual phase extraction.

   This has not been done because no free phase DNAPL has been found. There is a conclusion error in the investigation reports. Groundwater sampling data shows VOC concentrations above one percent solubility, which is an indication of DNAPL. These reports also correctly describe the movement of DNAPL in the environment. They describe the difference between residual (trapped in pores and fractures) and free phase (available to move because it is present in amounts that exceed pore and fracture capacity) DNAPL. The high concentrations in groundwater indicate DNAPL, which may be present as a residual or free phase. Numerous reports have concluded, however, that free phase DNAPL exists at ANAD. While free phase DNAPL is possible, residual phase DNAPL can easily account for the VOC concentrations observed.

   The recent Draft Final Combined Groundwater Remedial Investigation (SAIC, 2003a) has a long discussion of how DNAPLs move through the ANAD SIA subsurface. The conceptual model of DNAPLs as a source of contamination that is in this document is excellent. It does not conclude or even mention that free phase DNAPL exists in the ANAD SIA. The final chapter of the report concludes that free phase DNAPL exists, however. This conclusion is unwarranted. There is no evidence of free phase DNAPL at the ANAD SIA. There may be free phase DNAPL, but there is no cost effective way of finding out.

Because no free phase (mobile) DNAPL has been found, there are no plans to try to remove it.

5. Addition of individual sequestrant systems to existing and new extraction wells that exhibit elevated iron and hardness concentrations to reduce scaling and maintain well yields.

   Sequestrants are added to some of the extraction wells, although it is of doubtful effectiveness. The new centralized treatment plant process removes iron by oxidation and precipitation as the first treatment step thus preventing scale in the air stripper. It is not understood how well yields could be maintained by the addition of individual sequestrant systems. These systems would add chemicals (acid or polyphosphates) to the pumped water which could prevent scaling in the pipes and pumps, but would not impact the wells. The extraction wells may require acidification and redevelopment on a regular basis. In fact, even with the addition of sequestrants to the pumped water, clogging of well-head piping and valves is still a problem.

6. The addition of an advanced oxidation system may be required to pretreat high methylene chloride concentrations at well 88EWNE-1 before transfer to the central treatment system.

   This recommendation was not implemented, presumably because it was not necessary.

7. Conduct regular inspection and maintenance of the system by trained personnel.

   Regular maintenance is performed.

Progress has also been made in moving towards a final ROD with the issuance of a draft RI for the SIA groundwater (SAIC, 2003c).

Five-Year Review Process

Administrative Components

The USAEC took responsibility for this five-year review early in 2004. C.C. Johnson & Malhotra, P.C. (CCJM) was tasked to assist the USAEC in its production. CCJM began reviewing and collecting documents in February 2004. Interviews were conducted during March 2004. A site visit was conducted on March 24, 2004.

Community Notification and Involvement

ANAD has an active community involvement program. The Restoration Advisory Board (RAB) has been heavily involved in the design and construction of the groundwater treatment plant. There is a quarterly newsletter regarding plant environmental issues. Until recently, the groundwater issues have been secondary to the incineration of chemical warfare material (CWM), but with the success of the CWM incinerator, groundwater is rising in the public' s consciousness. The RAB has been notified of the five-year review.

Document Review

This five-year review consisted of a review of relevant documents including O&M records and monitoring data (See Reference listing).

Data Review

The recent Draft Final Combined Groundwater Remedial Investigation (SAIC, 2003a) contains a complete review of the geology, hydrology, and hydrogeology of the SIA area. A review of the groundwater monitoring data is also contained in this document.

The GWIS has been running in its present configuration since 2001; the only change has been the addition of 2 recovery wells. The system is designed to pump and treat approximately 100 gpm (Bhate, 2003). Average flow between June 2003 and December 2003 was 65 gpm. Extraction well pumpage data are collected each month. Flow through the treatment plant and effluent pH are monitored continuously. Influent and effluent are sampled every week and analyzed for VOCs. Figures 4 through 9 show influent concentrations of the organic chemicals of concern between July 2001 and July 2003. Figure 10 shows pumpage by well for 2003. Over the two-year period shown in the current monitoring data, there has been little or no decline in influent concentrations; in fact, concentrations of some chemicals increased during the first six months of 2003. TCE is still at substantial concentrations.

Concentrations of VOCs in the discharge from the plant are generally less than the limit of detection or less than the MCL with the exception of TCE. The average TCE concentration in the discharge over the two-year period is slightly less than 19 ppb. The average influent concentration is 951 ppb. The average removal efficiency is 98 percent.

Extraction well pumpage rates have fluctuated over time. Clogging of wells with iron bacteria and scale has been a persistent problem (ANAD, 1998). The following table documents how well yields have changed.

Table 1: Comparison of Extraction Well Yields over Time

Well	Yield (94-95)	Yield (98)	Yield (03)
	(gpm)	(gpm)	(gpm)
B-13	7.4	7.4	4.6
B-01			8.8
LF-2	2.1	2.1	1.2
LF-5		15.0	5.9
TR-5*	6.0	6.0	not used
TR-4*	8.0	8.0	not used
TR-6	5.5	5.5	1.1
TR-7	9.5	9.5	16.3
TR-3	5.0	5.0	5.1
TR-2	1.5	1.5	2.5
B-02			13.0
NE-4	10.0	10.0	11.3
NE-3	10.0	10.0	16.3
NE-6	4.0	4.0	0.1
NE-2	4.0	0.1	0.1
NE-1	0.1	0.002	0.3
94-95 yield from Table 3-4 in FS, 1998			
98 yield from Table 3-5 in FS, 1998			
03 yield average of monthly data			

* These wells are not used during dry spells.

Limited monitoring of VOC concentrations in extraction wells has been performed. Figures 11 through 16 show the concentrations of some of the chemicals of concern at selected extraction wells in 1995 and again in 2002 and 2003 (ANAD, 2004). There is no clear pattern in concentrations except that methylene chloride concentrations are significantly less.

Since 1982, groundwater at ANAD has been monitored, although not at consistent intervals; culminating with the most recent comprehensive sampling and analysis in 2002 (SAIC, 2003a). The most data were available for monitoring wells known as the boundary wells. These wells are on the eastern boundary of the SIA

Figures 17 through 19 show the results of the long-term sampling and analysis for TCE. TCE is the most prevalent contaminant at ANAD-SIA. TCE levels of up to 300,000 parts per billion (ppb) have been detected at this site (SAIC 2003a). Detected concentrations have ranged from less than 5 ppb to 300,000 ppb; with 52 percent of the results greater than 100 ppb and 18 percent greater than 1,000 ppb. As can be seen from the figures, the levels of contamination do not show any discernible trends; concentrations remain high and erratic. There is some indication of a seasonal effect, with the wet season concentrations being generally an order of magnitude higher than those for the dry season. The available data indicate contaminant concentrations generally decrease with depth, however, high concentrations of contamination have been detected in some of the deep bedrock wells (SAIC 2003a). Analytical data also show that the contamination has, and continues to move off-site, as indicated by detection of contamination in off-site wells. The highest concentrations are detected in wells finished in the residuum soil-weathered bedrock interface, which is the most permeable zone on the site.

Figure 20 shows the concentrations of DCE, a breakdown product of TCE and PCE, over time. The concentration trend is similar to that of TCE, although it is at a much lower concentration, and only in the shallow residuum wells. DCE has not been detected in the deep and off-site wells, although the levels in the shallow wells have not declined over the years. The concentration trend of PCE is shown on Figure 21. As with TCE and DCE, concentrations of PCE change erratically, but the levels are much lower and the detection frequency has been low.

Site Inspection

A site visit was conducted on March 24, 2004 by Donald Koch and Michael "Larry" Lumeh of CCJM. They toured the groundwater treatment plant, visited the extraction wells, interviewed Pat Smith, the environmental coordinator, and completed the checklist shown in Attachment D.

Interviews

Interviews were conducted with several people involved in the remediation at the ANAD SIA. Interview forms are in Attachment C.

Wayne Jones is the operator of the GWIS plant. The plant is presently operating well. The only recent problem has been with the computer systems and this problem has been fixed.

John Baehr is the technical project manager for ANAD at the Mobile District, U.S. Army Corps of Engineers. He was able to elucidate the current remedial strategy for the SIA groundwater. There are currently no plans to use in situ chemical oxidation or dual phase extraction wells. The Army is pursuing a technical impracticability waiver. An emergency response plan is already in place to allow the Army to install treatment on both affected public and private water supplies.

Pat Smith is the environmental coordinator at ANAD. He provided estimates of the annual costs of operating the GWIS. Community involvement and plans for the GWIS were discussed.

Figure 4
DSN003 Influent TCE Concentrations

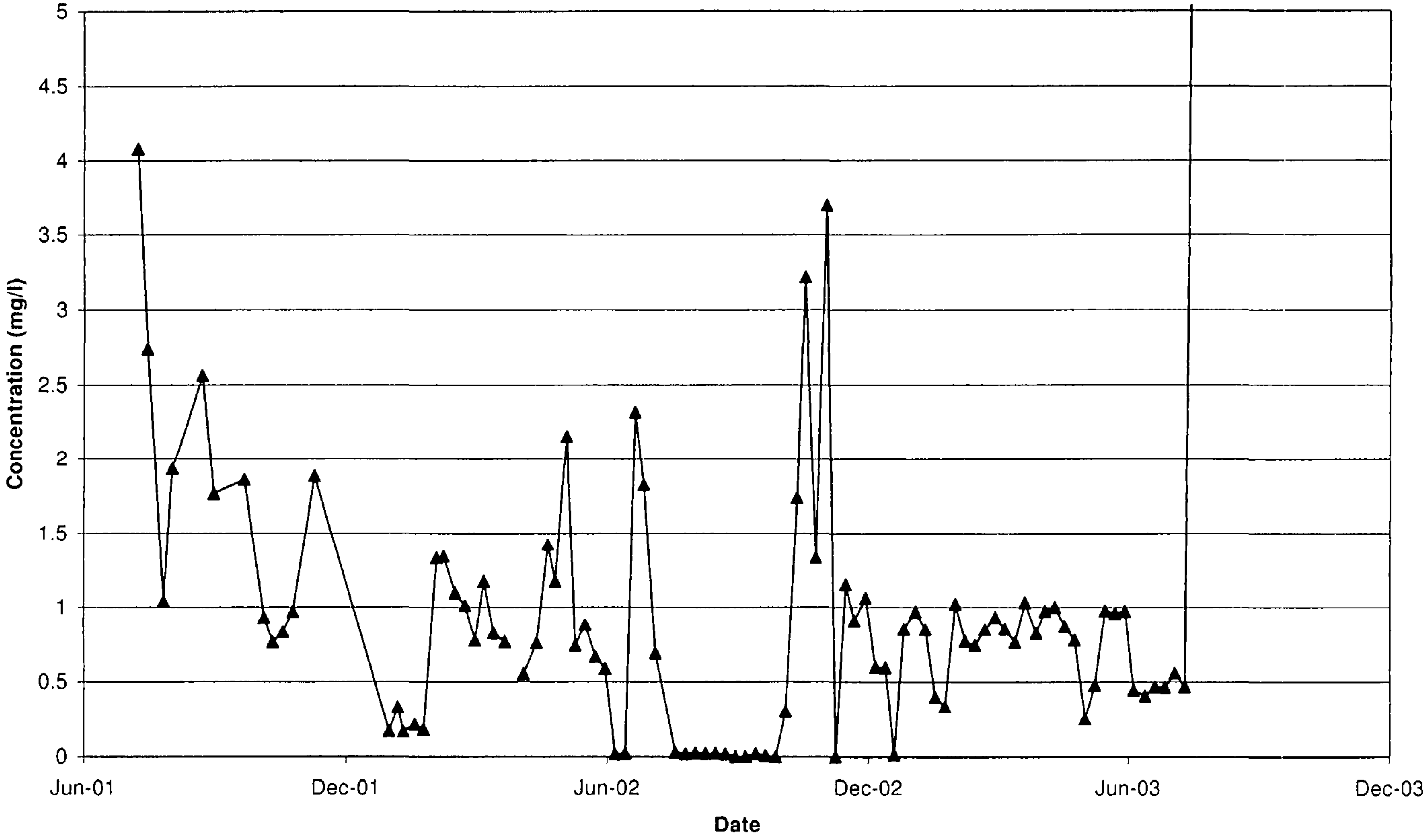


Figure 5
DSN003 Influent PCE Concentrations

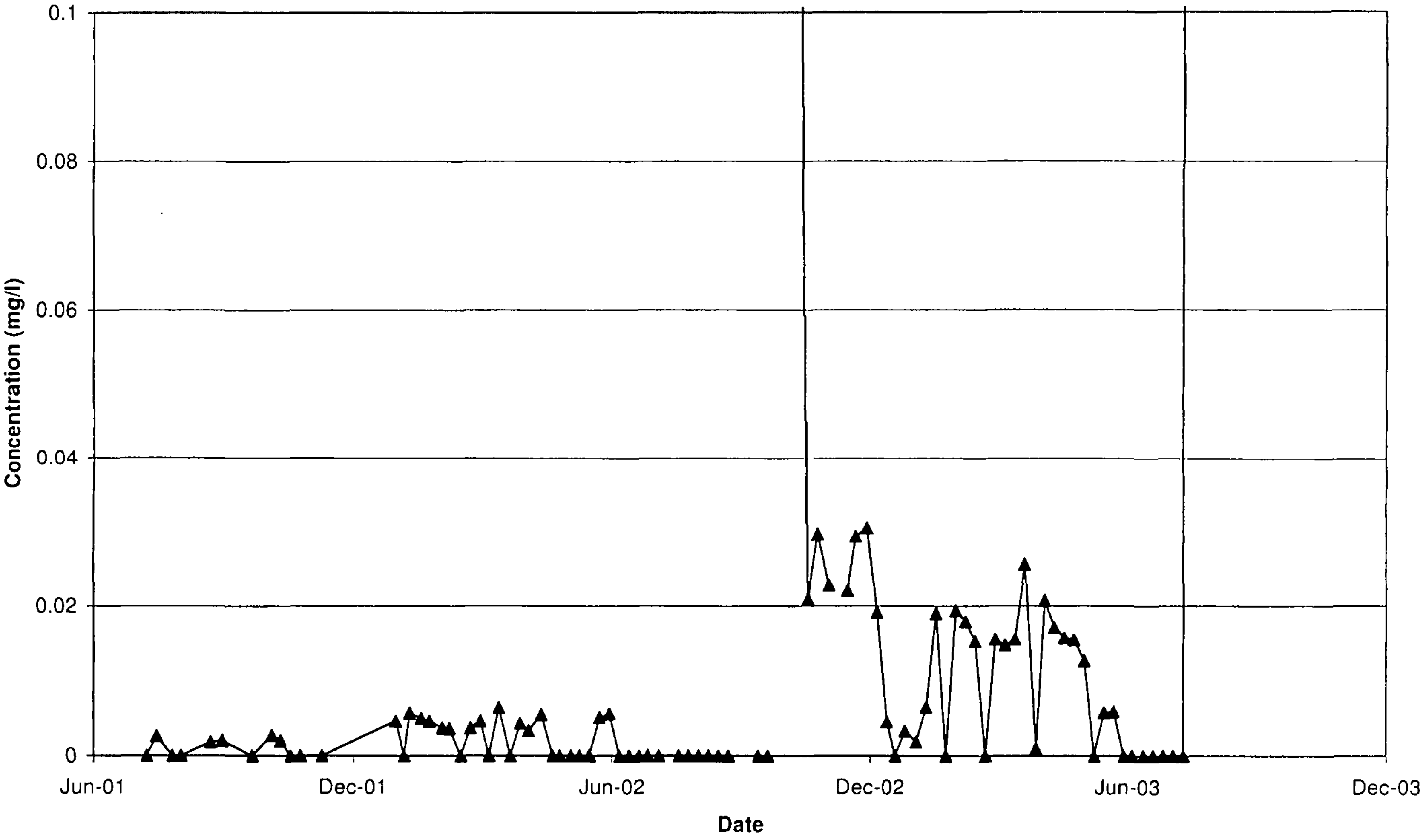


Figure 6
DSN003 Influent cis-1,2 DCE
Concentrations

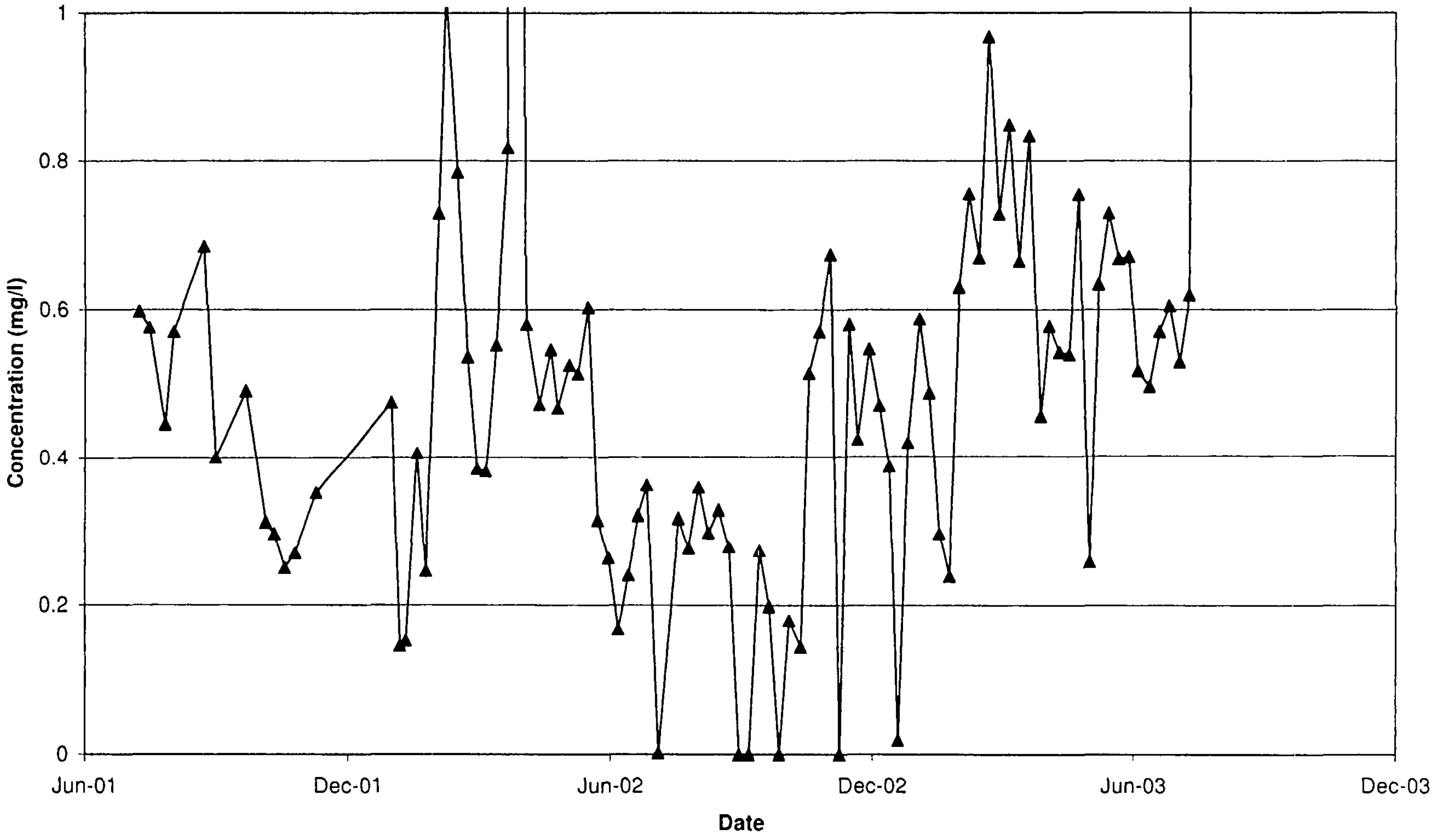


Figure 7
DSN003 Influent trans-1,2 DCE
Concentrations

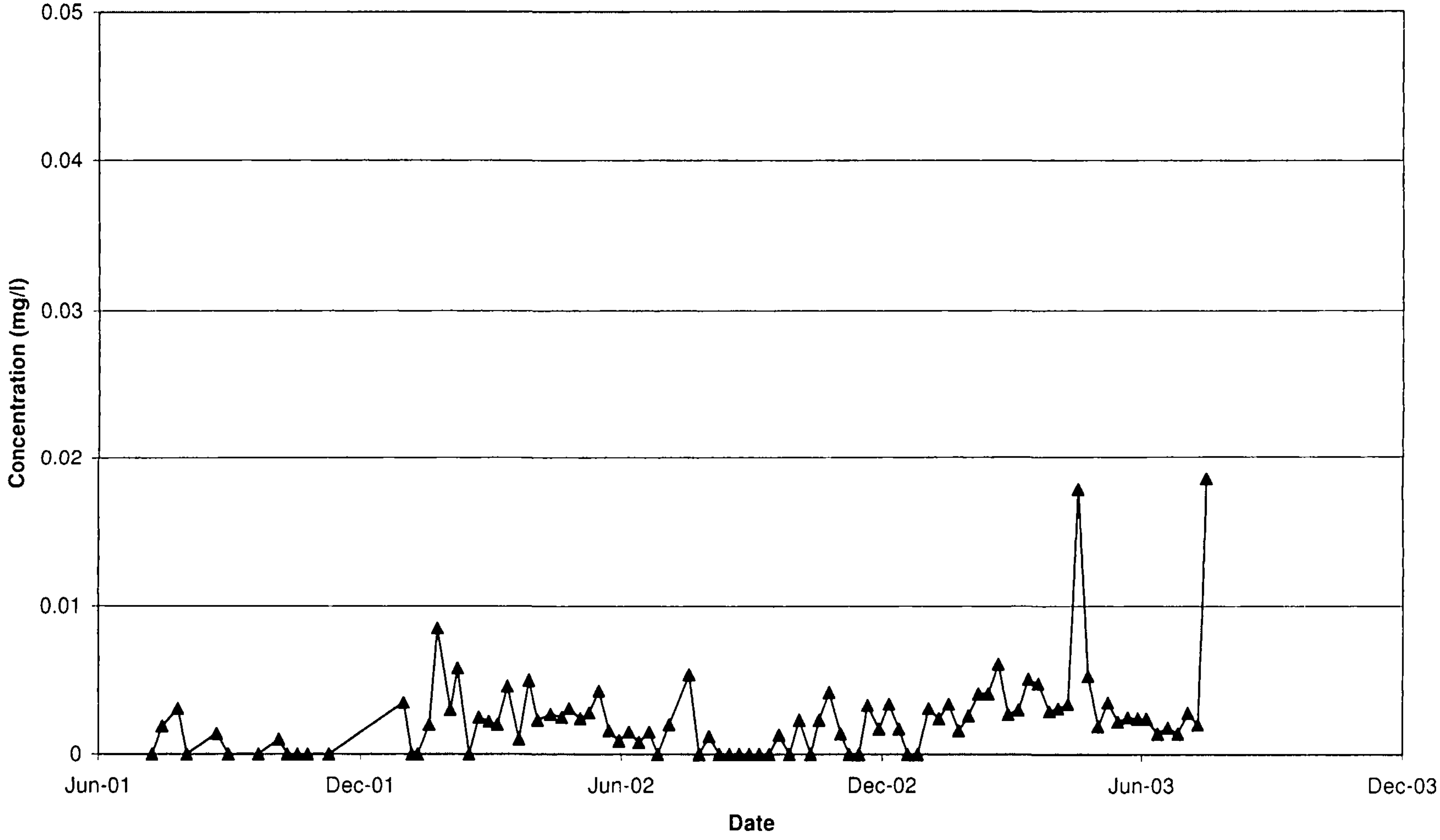


Figure 8
DSN003 Influent Methylene chloride Concentrations

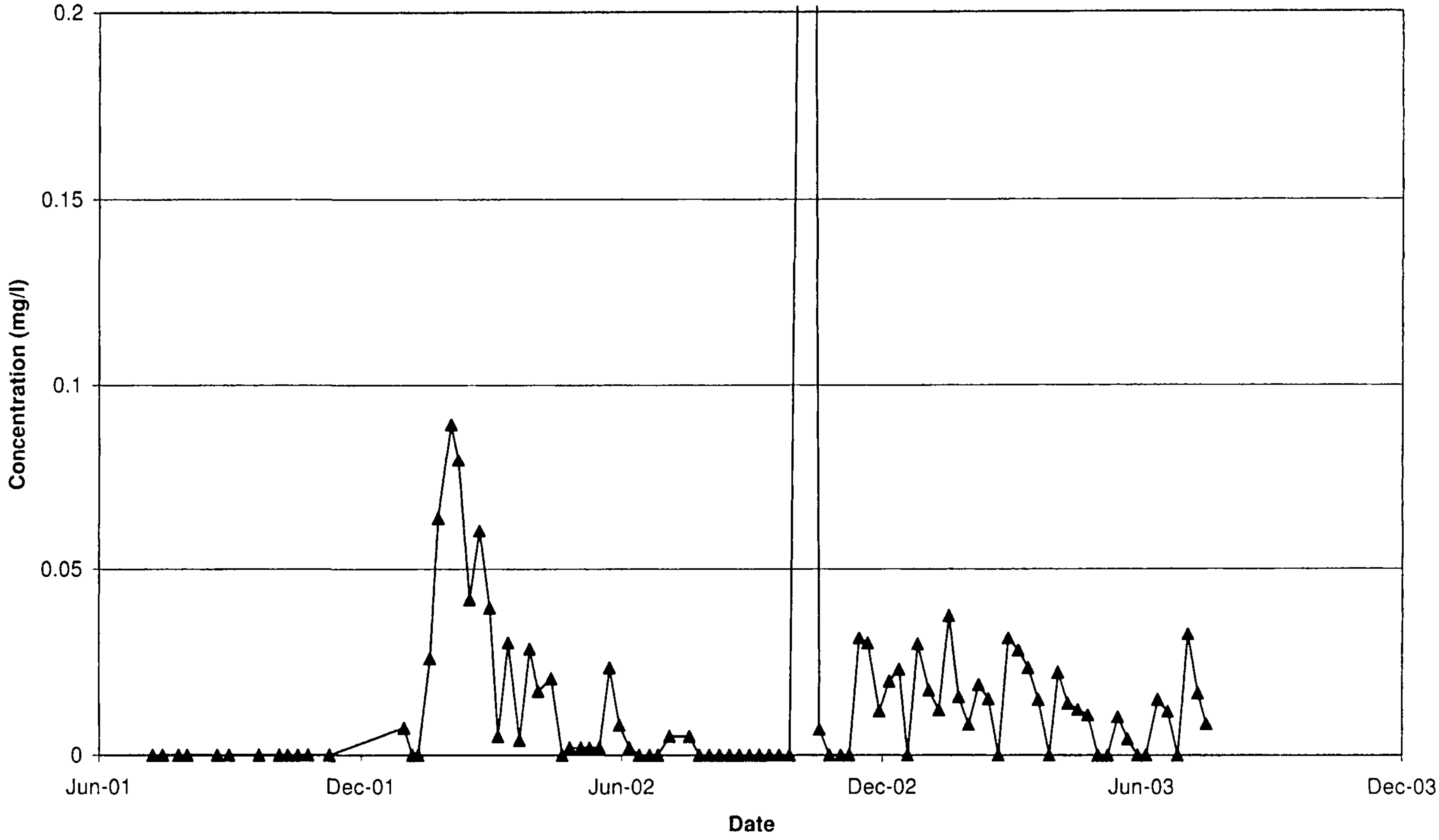


Figure 9
DSN003 Influent Vinyl chloride Concentrations

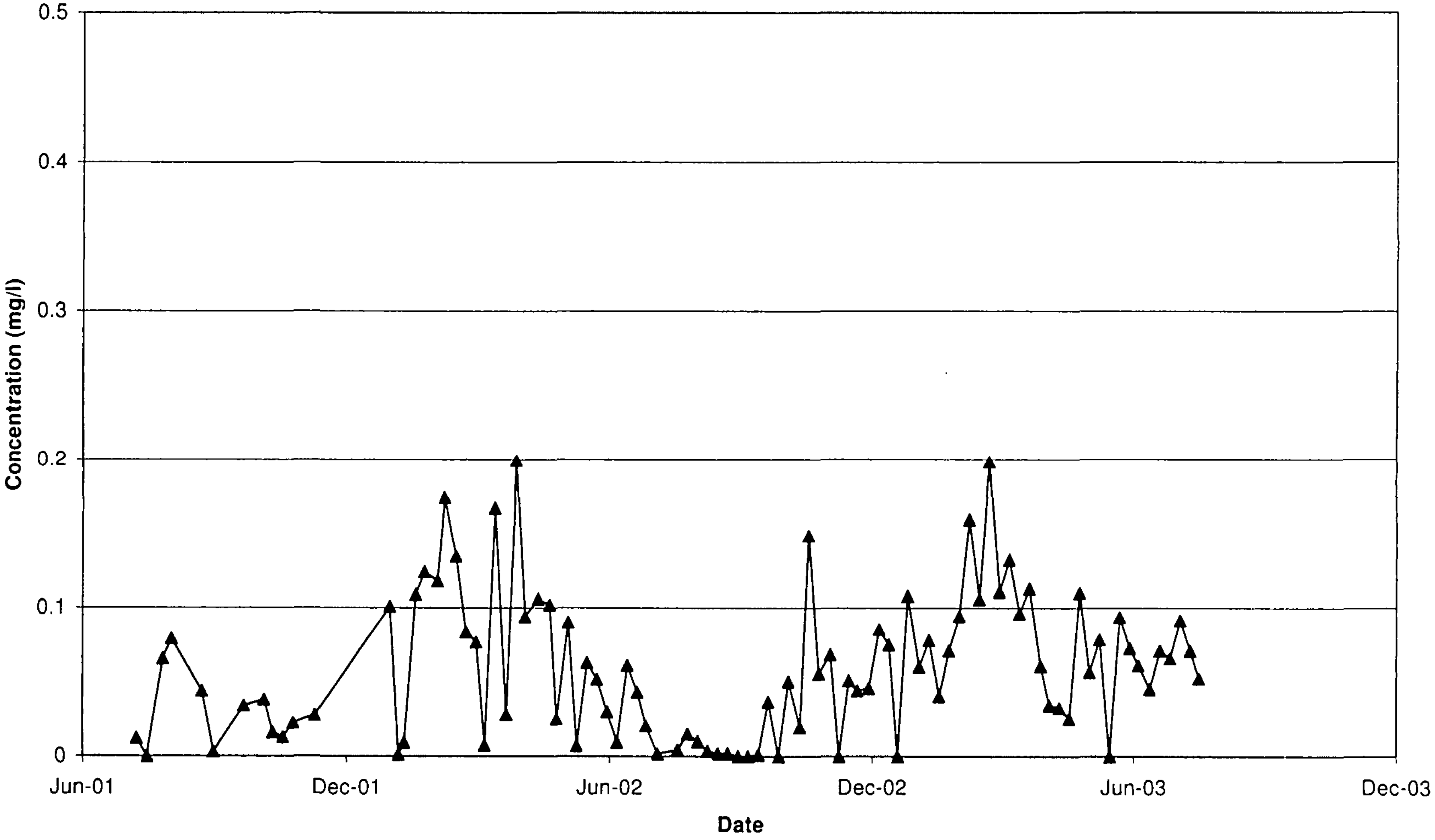


Figure 10
GWIS Pumpage by well in 2003

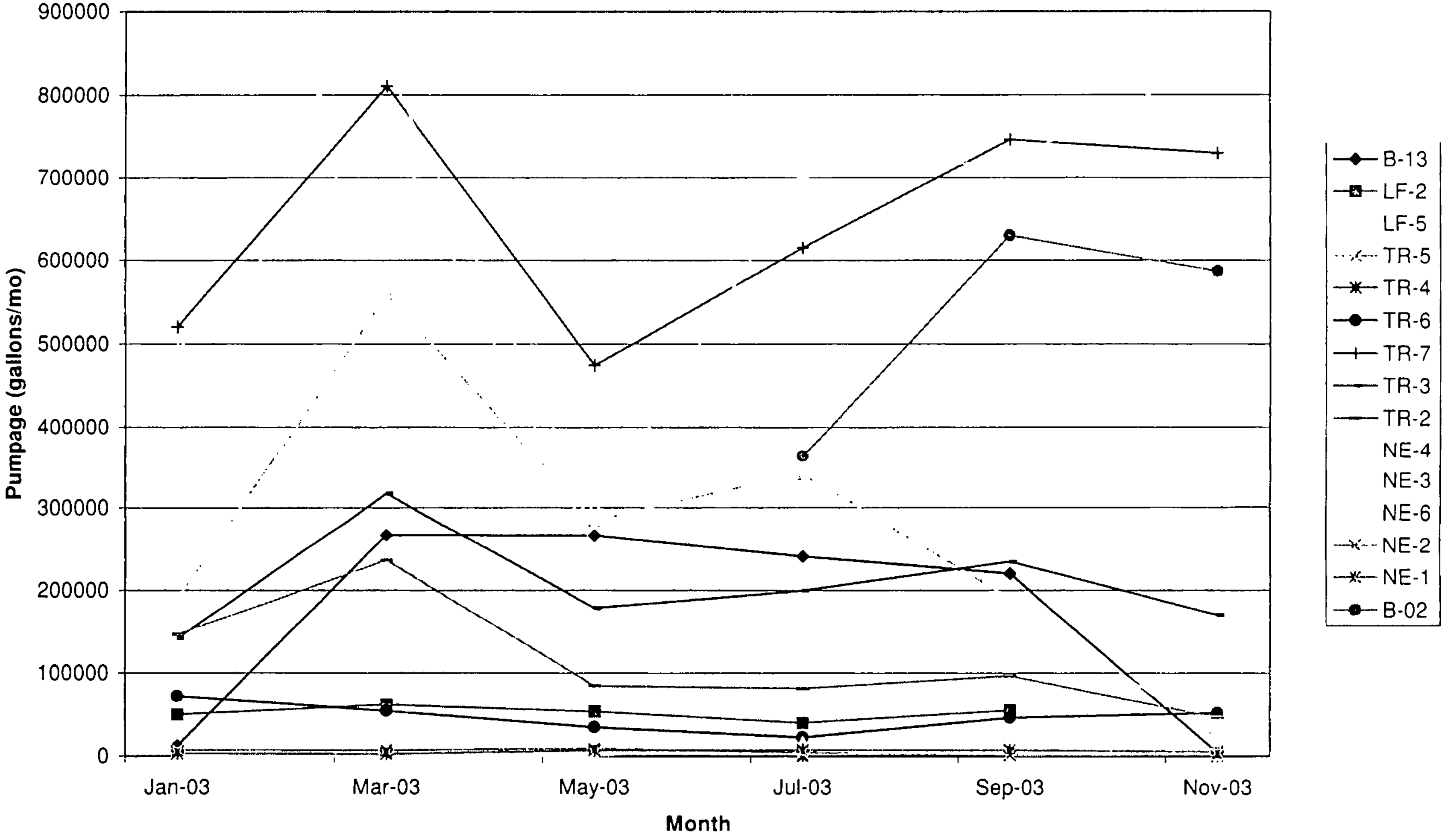


Figure 11
Concentrations at B-13

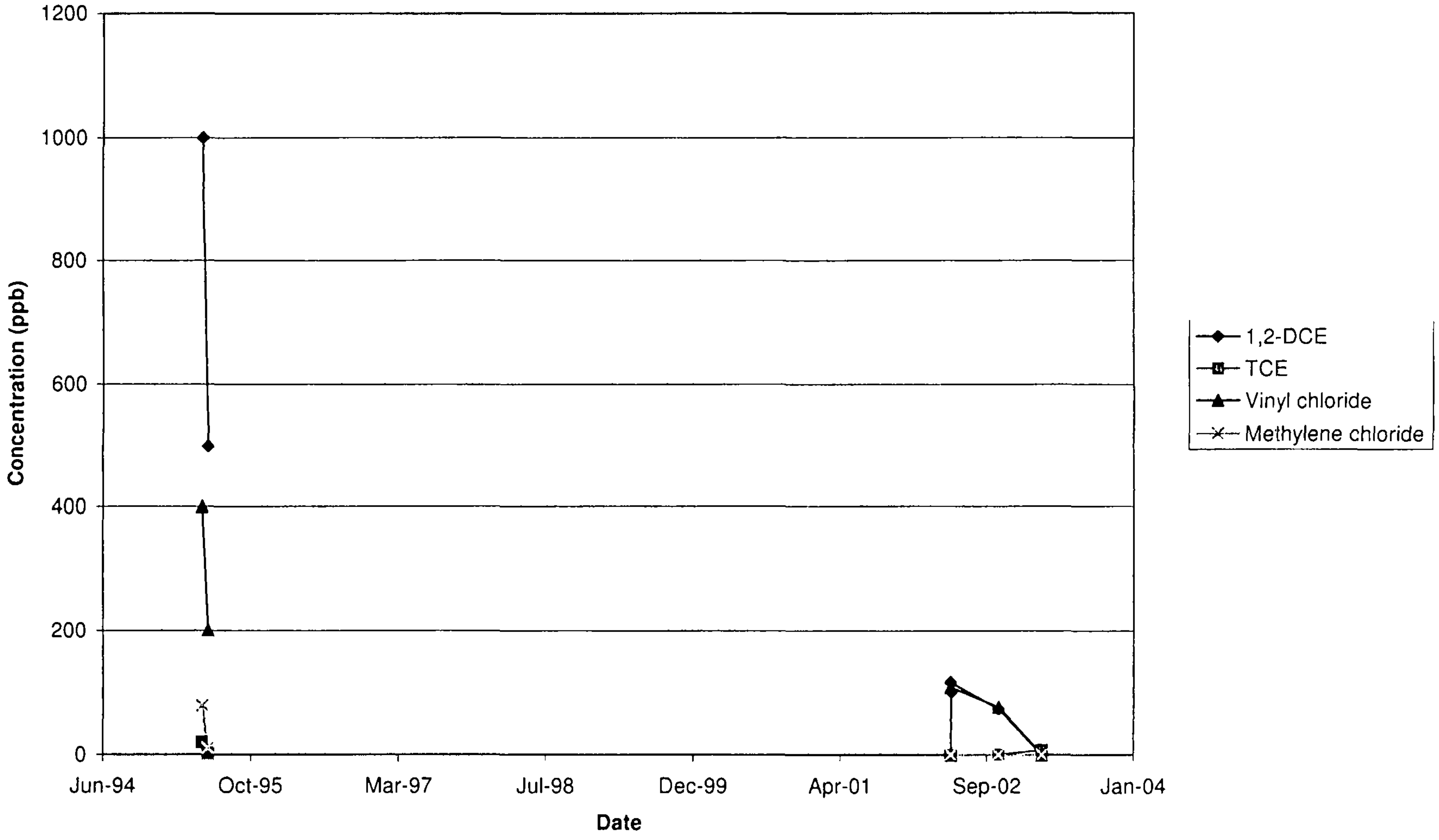


Figure 12
Concentrations in LF-2

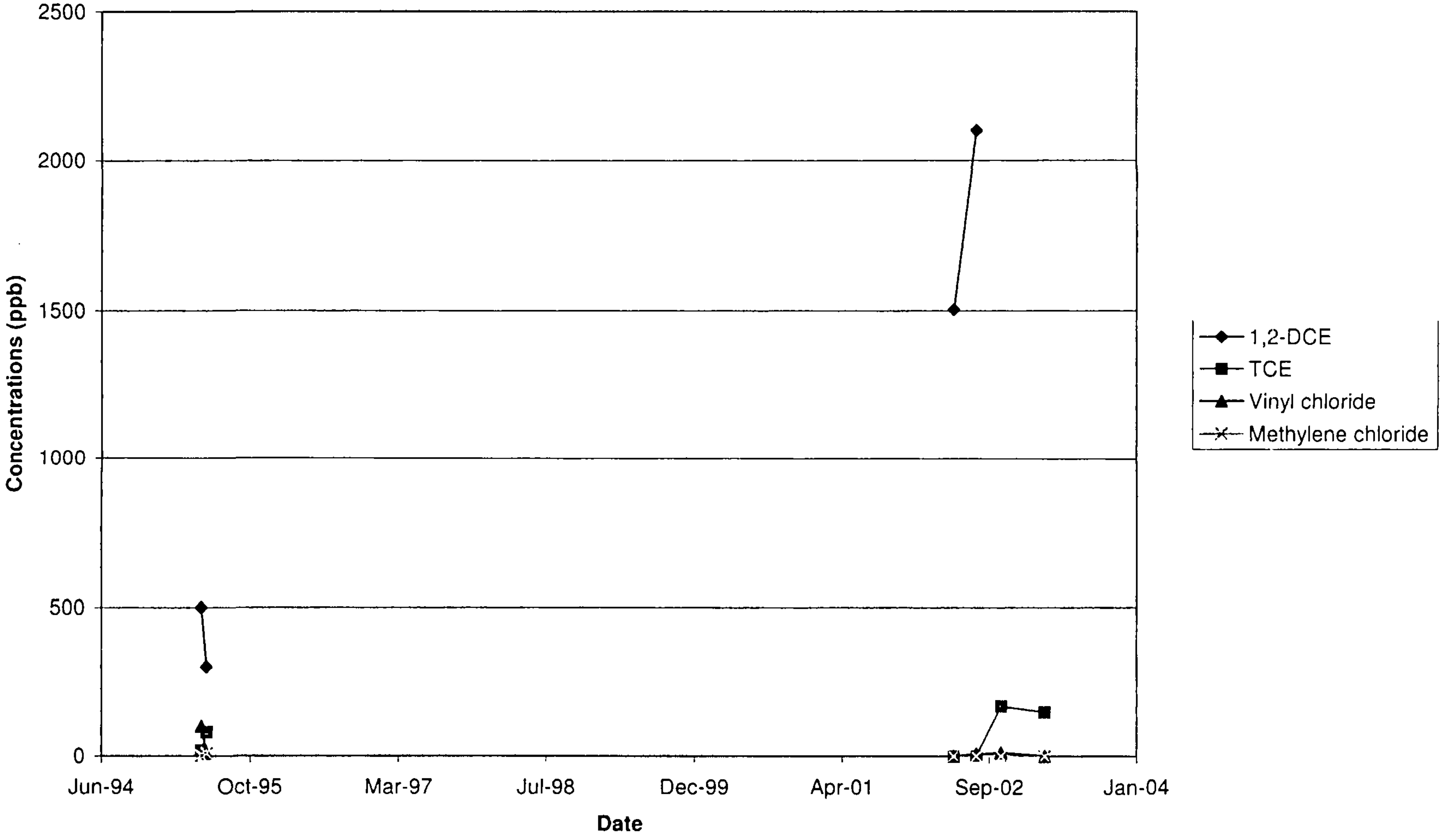


Figure 13
Concentrations at NE-1

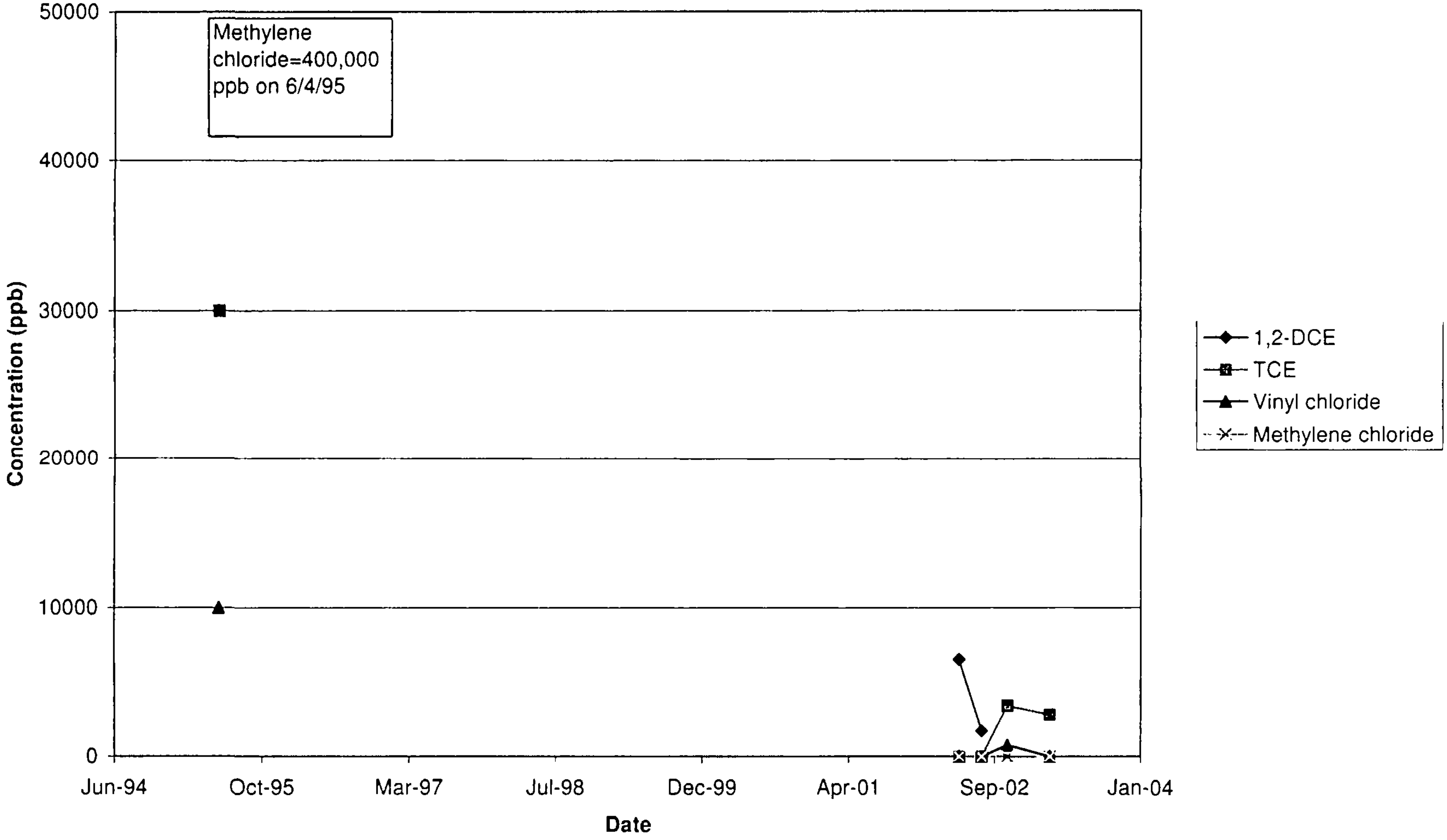


Figure 14
Concentrations in NE-4

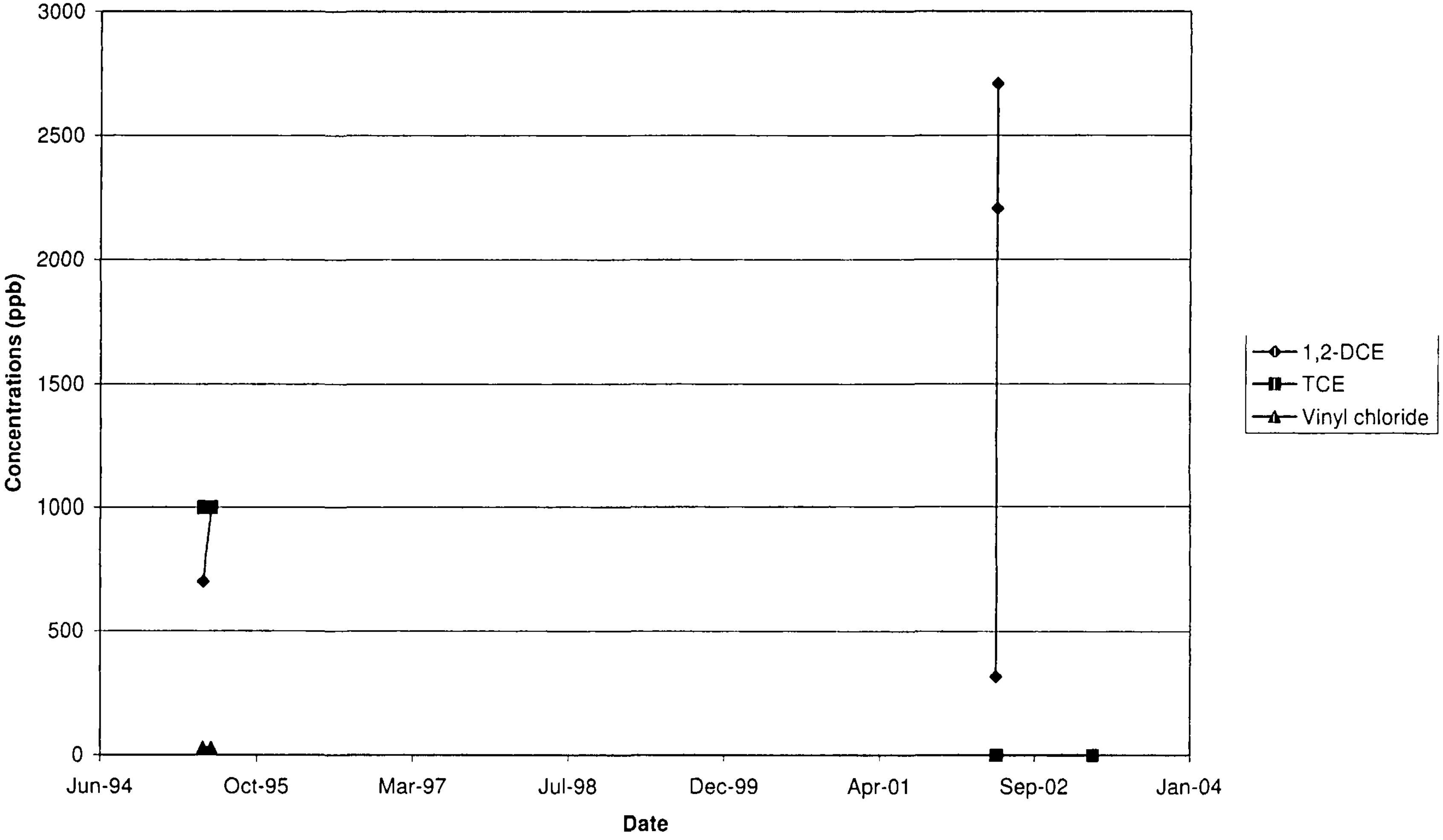


Figure 15
Concentrations in TR-2

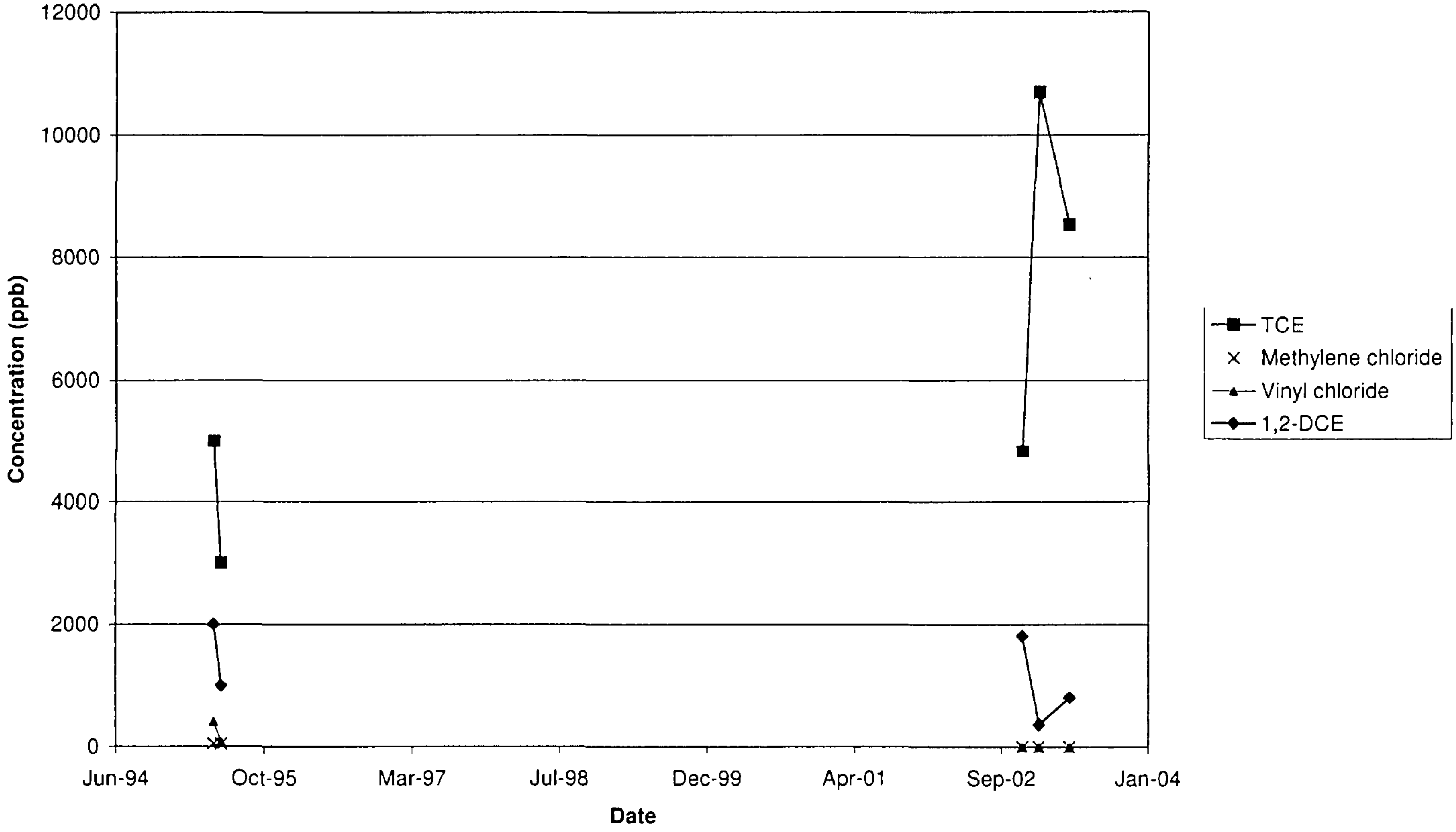


Figure 16
Concentrations in TR-6

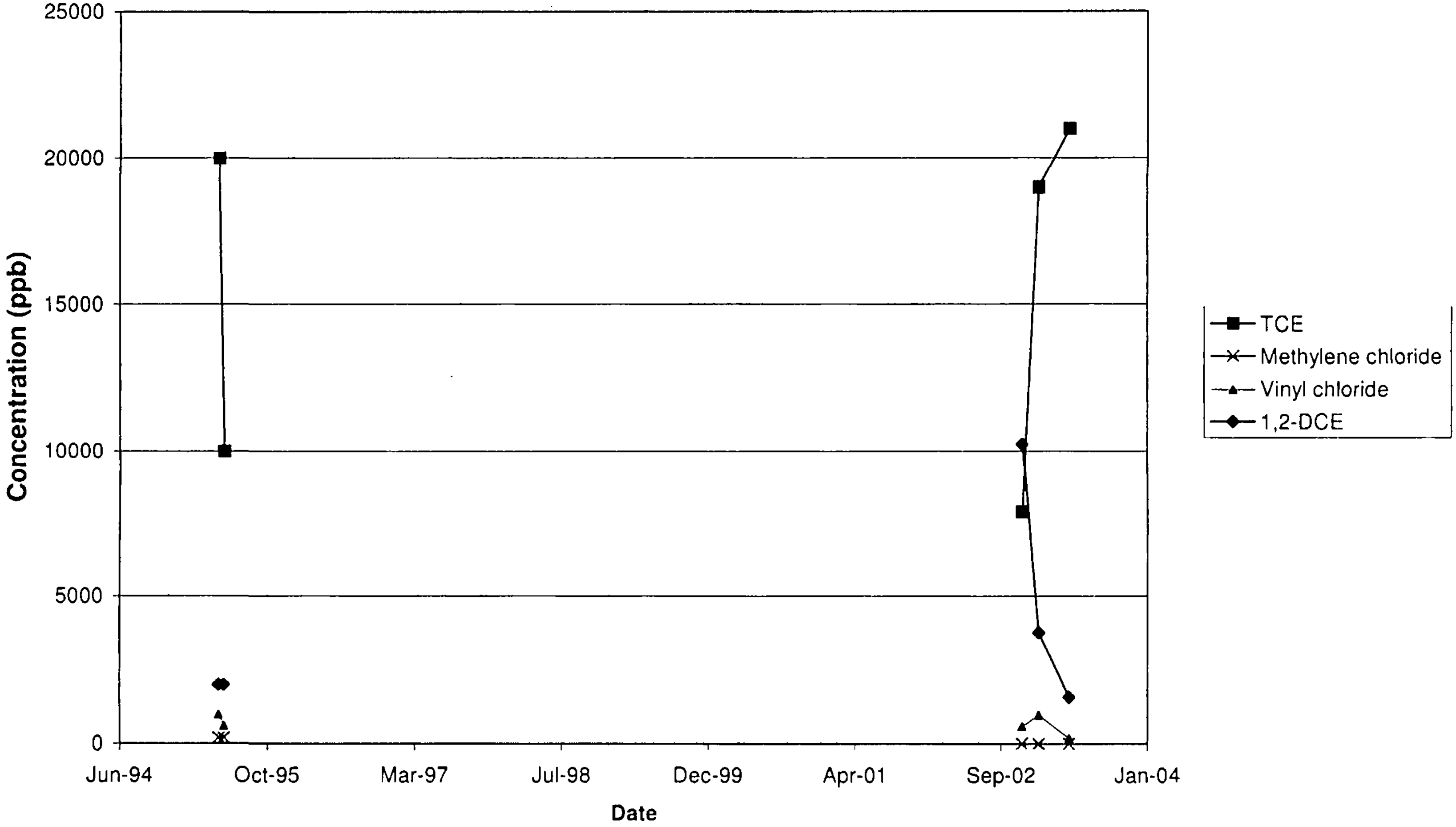


Figure 17
TCE Concentrations Vs. Time at Well 81B19

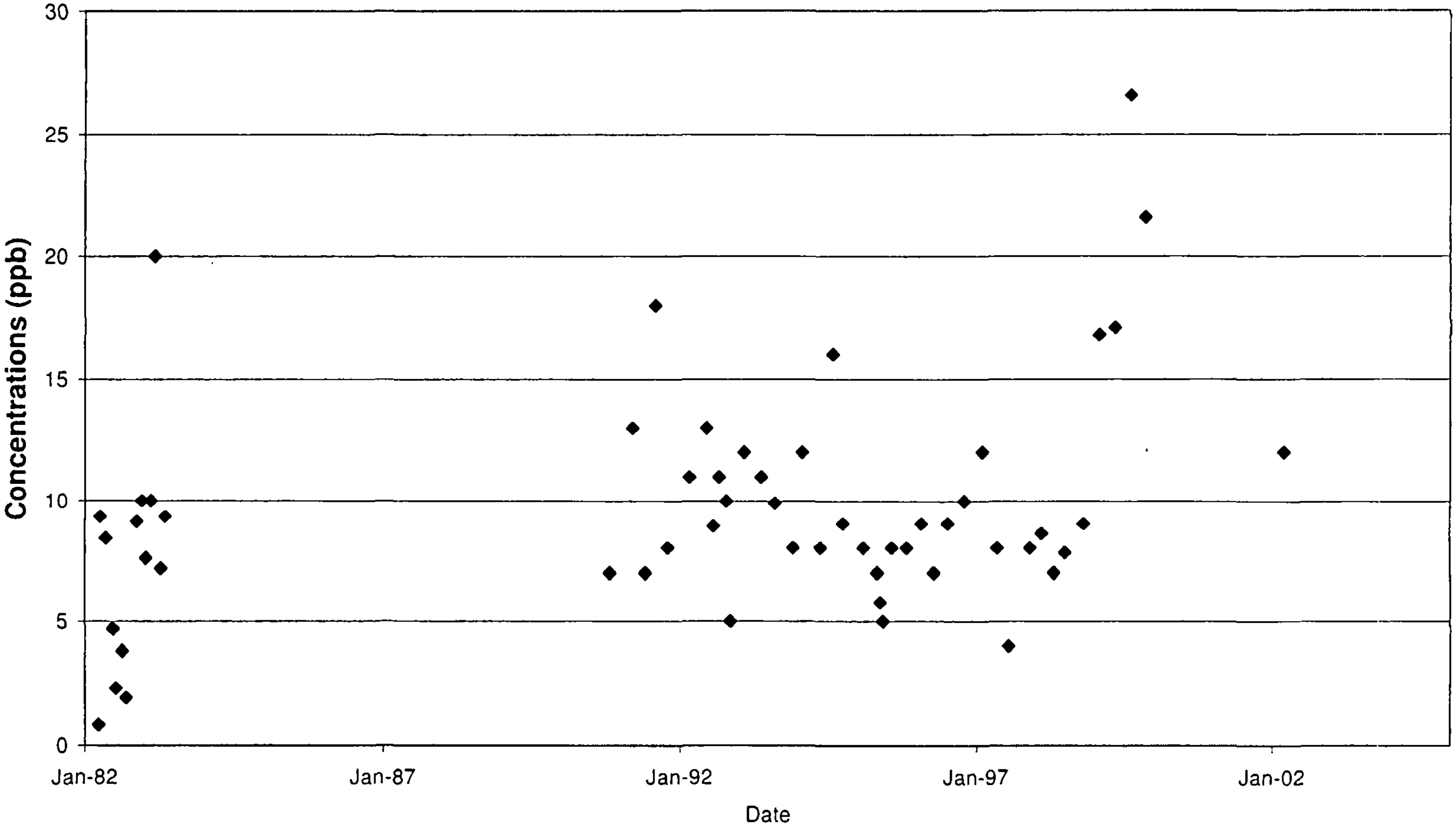


Figure 18
TCE Concentration Vs. Time at Well 81B18

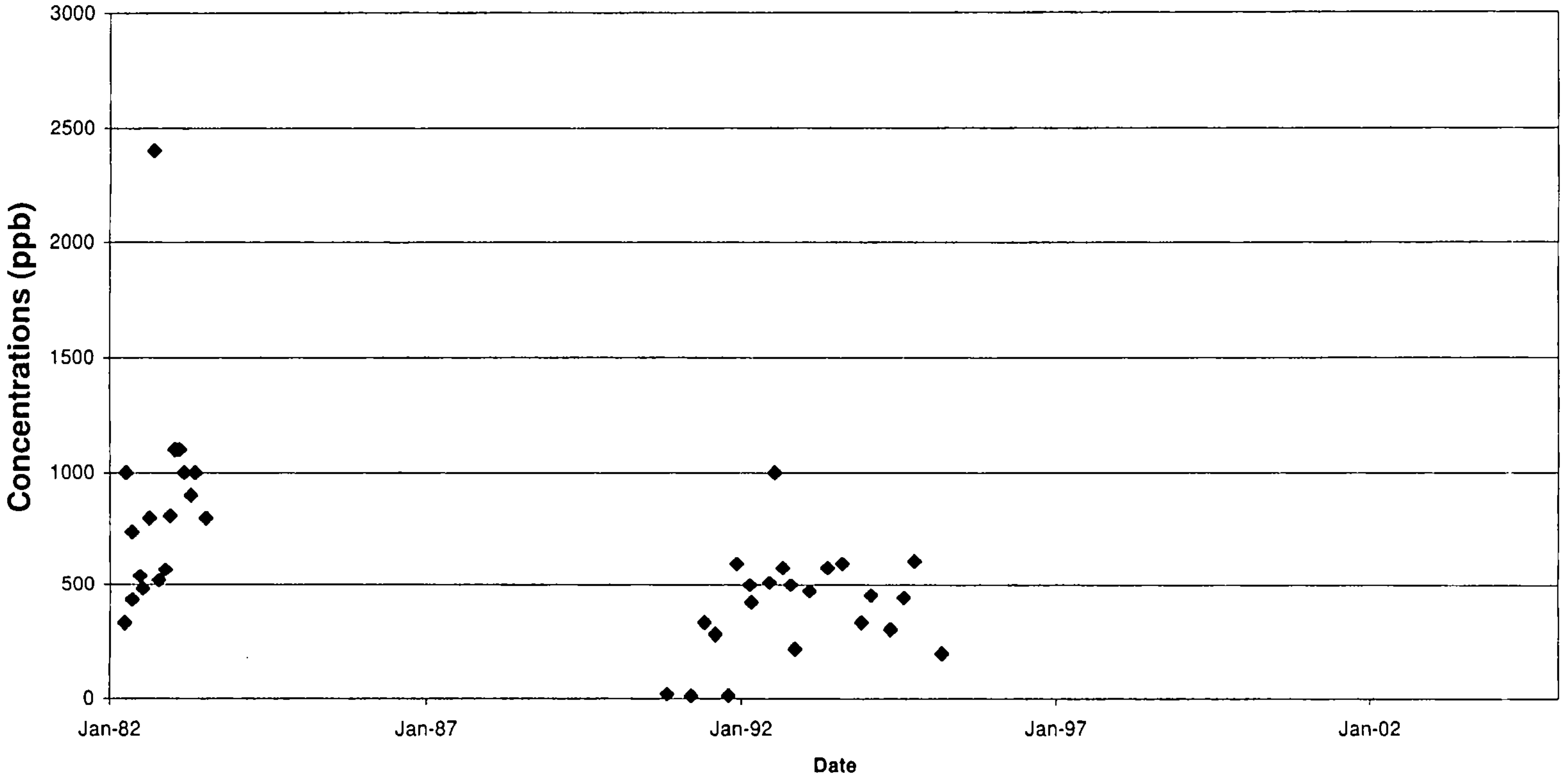


Figure 19
TCE Concentration Vs. Time at Well B2-12

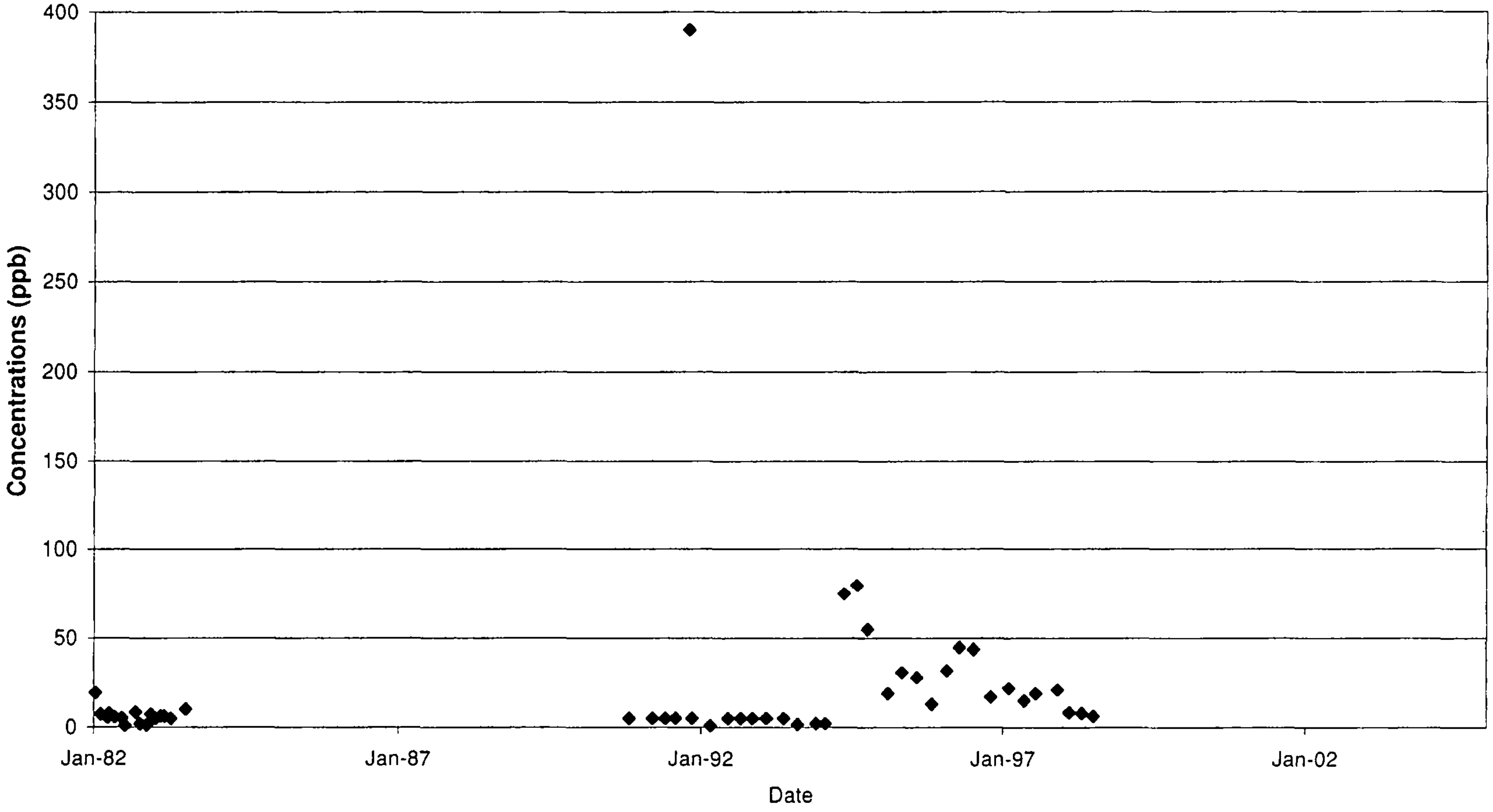


Figure 20
DCE Concentration Vs. Time at Well 81B18

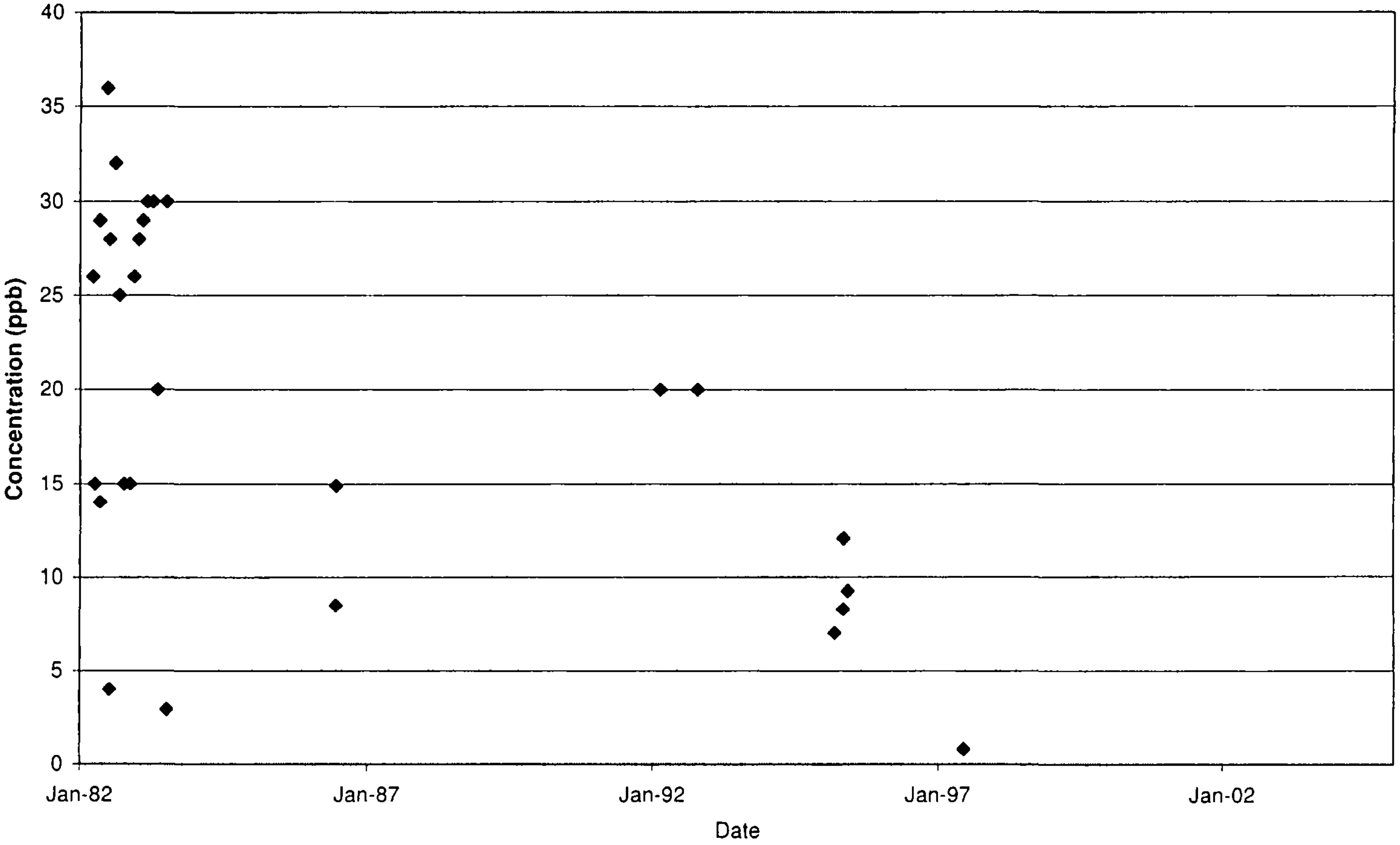
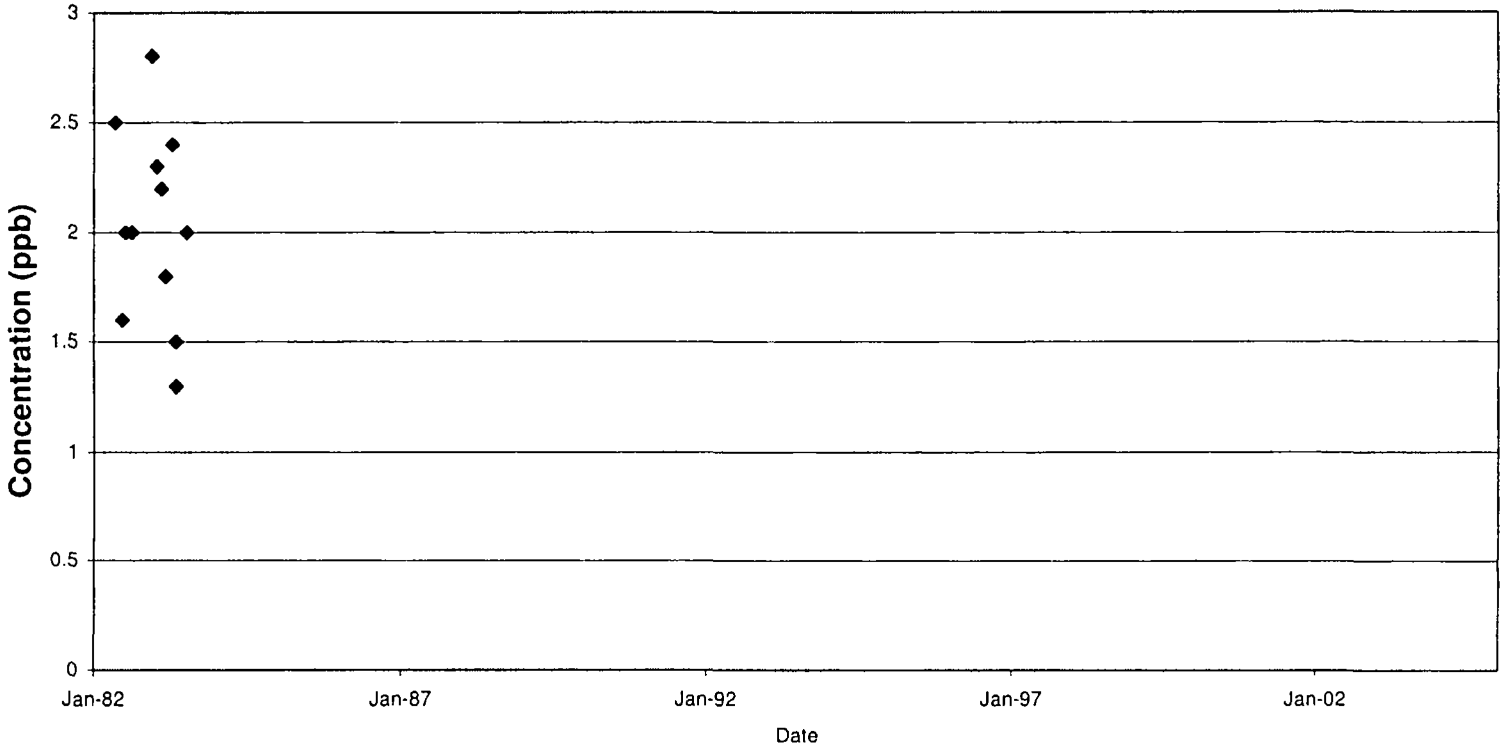


Figure 21
PCE Concentration Vs. Time at Well 81B18



Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

The objectives of the 1991 IROD action were to reduce contaminant concentration and mobility directly under the Trench Area, the Landfill Area, and the Northeast Area to protect human health and the environment while final remedial solutions were developed (ANAND, 1998).

The GWIS is removing contaminants from groundwater as intended and thus shallow aquifer contamination is being reduced. In the first six months of 2003, 5.8 pounds of TCE were removed by the GWIS. However, the GWIS is not significantly reducing contaminant concentrations in the aquifer (SAIC, 1998c). IN addition, the GWIS is not containing the plume to any significant extent, and thus is not preventing exposure to contamination (SAIC, 1998c). There are substantial amounts of VOC contamination in the deeper aquifer as well (SAIC, 2003a); the GWIS has had no significant impact on this contamination. Contamination in the deeper aquifer may be traveling off the facility.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

The risk assessment summarized in the IROD (U.S. Army, 1991) is still conceptually valid. There were never any cleanup levels specified for the GWIS because it was an interim action. The remedial objective of the interim system was to reduce contaminant concentrations and mobility; these are still appropriate objectives assuming that significant progress can be made.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Yes, the investigations performed since 1991 have elucidated the nature of the aquifer and contamination at the ANAD SIA. Based on the current conceptual model of the site, it is the understanding of the Army that the GWIS is not effective at controlling contaminant migration or significantly reducing the amount of contamination as indicated by the lack of concentration decline (SAIC, 1998c).

It is the opinion of the Army that the system is not effective because of the nature of the aquifer rather than the design or operation of the system. The early investigations (Battelle, 1984) used a four layer conceptual model consisting of:

- silt and clay residuum underlain by
- sand and gravel underlain by
- heavily weathered and permeable bedrock underlain by
- impermeable competent bedrock.

Other investigations used this model, but assigned some permeability to the bedrock. The deeper bedrock was assumed to be a fractured, karst aquifer that behaved as a porous media at some large scale. Recent investigations have shown that this was not an adequate assumption for the bedrock aquifer . The following data and observations lead to this conclusion.

- Two new extraction wells, B-01 and B-02, were drilled and tested in 2002 (SAIC, 2003b). The first attempt at drilling B-01 yielded a 161-foot deep dry hole. Dry holes are uncommon in both porous media and karst aquifers. Both wells were completed in bedrock cavities of unknown size.
- Aquifer testing on B-01 and B-02 yielded the conclusion that these wells were completed in a bedrock aquifer that has a series of fractures and cavities in a relatively nonporous matrix. The fractures and cavities are not really extensive and not well connected (see Appendix A).
- The extraction wells are low yielding wells. In karst, one typically has some high yielding wells, wells that yield 1000 gpm or so. These wells intersect solution cavities that are well connected with other fractures and solution cavities over a large area.
- Dye tracing results yielded widely differing conclusions. The first dye trace yielded the conclusion that the aquifer was a typical karsitic aquifer. Dye traveled in multiple directions to springs located ten miles from the injection point. The second dye trace study renounced these earlier findings and concluded that the dye traveled very small distances consistent with porous media. A possible explanation for these findings is that the background fluorescence measured in the second study was the dye injected during the first dye trace study. Dye moves rapidly through fractures and cavities for a short distance. It then diffuses through a relatively impermeable, rock matrix to the next cavity. The dye travels very slowly by diffusion, then very rapidly through conduits in the rock.
- A conclusion of all of the assessments performed on the GWIS was that the system did not have any significant impact on the groundwater flow pattern (Jacobs, 1993; SAIC, 1998c, ANAD, 1998).
- Drawdowns observed during the testing of the new extraction wells were limited (SAIC, 2003b). Observation wells within 760 feet of extraction well B-02 during a 14.5 hour test and within 195 feet of extraction well B-01 during a 16.5 hour test did not have any drawdown.

The new conceptual model of groundwater flow includes (SAIC, 2003a):

- The residuum, weathered bedrock, and competent bedrock comprise an interconnected aquifer.
- The transition from weathered bedrock to unweathered bedrock is gradational and variable with some areas having severely weathered intervals within more competent rock.
- The bedrock is highly variable, with intervals of completely fractured rock; dense, tight rock; and cavernous sections, creating a heterogeneous, complex flow network.
- Connections between conduits (fractures) and caverns in the bedrock are

sometimes limited.

This revised conceptual model of the aquifer leads to a different conceptual model of contaminant transport. VOCs are moving through the sand and gravel and weathered bedrock aquifers, but they are also traveling down into the fractured and karsitic bedrock. In the bedrock aquifer, VOCs are not moving as they would through porous media; they are diffusing through clay gauge, small fractures and relatively impermeable rock into bedrock conduits (caverns and fractures), where they travel rapidly. Many of these conduits are of limited extent. VOCs are thus trapped in these conduits and provide a reservoir of contamination that can diffuse in other directions. Others are in connection with regional discharge areas (i.e. Coldwater Spring). This conceptual model explains the consistent contaminant concentrations in Coldwater Spring. Coldwater Spring has TCE concentrations ranging between 1.1 and 4.7 ppb with the vast majority of samples between 2.0 and 3.5 ppb. The lack of trend in these concentrations is consistent with the proposed conceptual model, diffusion of TCE from rock into a bedrock conduit.

This new conceptual model of the aquifer explains the inability of the GWIS to have any significant impact on either groundwater flow (containment) or contaminant concentrations (mass reduction) in the bedrock.

Technical Assessment Summary

The GWIS is operating properly. It is removing contamination from the environment. It is not, however, significantly reducing contamination in groundwater nor is it controlling the mobility of the contamination. Thus, it is not meeting the objectives of the IROD.

Issues

1. The Ground Water Interception System (GWIS), as currently configured and operated, does not appear to be removing sufficient contaminant mass to achieve the cleanup goals established in the 1991 Interim Record of Decision. The capture zone of the GWIS has not been established to the extent necessary to determine the effectiveness of the GWIS in controlling or impeding the migration of contaminants.
2. Continued contaminant migration off-site indicates that the GWIS capture and contaminant removal are not adequate to maintain steady-state conditions.
3. Recent studies indicate that ground water pump and treatment as the sole component of the remedy for the Southeast Industrial Area is unlikely to be adequate to address the contaminated ground water associated with the Southeast Industrial Area.
4. The extent to which the GWIS is meeting the remedial action objectives established in the 1991 IROD is unknown, but the remedial action objectives have not been met and appear to be unlikely to be met by the GWIS as currently operated.

Recommendations and Follow-up Actions

1. A thorough evaluation of the current effectiveness of the GWIS (capture and contaminant removal) should be undertaken as part of the planned Feasibility Study for the SIA Combined Ground Water Operable Unit.
2. An optimization study of the GWIS should be undertaken to evaluate its potential effectiveness as the ground water remedy for the SIA or as a component of the ground water remedy for the SIA.
3. Due to the uncertainty about the effectiveness of the GWIS and the potential impacts to down gradient receptors, the GWIS should be continued to operate until Feasibility Studies have been completed and a final decision for the SIA Combined Ground Water Operable Unit has been made.
4. Data needs for the Feasibility Study should be identified such that relevant information can be collected during ongoing operation of the GWIS to support evaluation of effectiveness and optimization.

Protectiveness Statement

The remedy at the On-post Groundwater Operable Unit is not protective because it is not significantly reducing contamination in groundwater nor is it controlling the mobility of the contamination.. The following actions need to be taken to ensure effectiveness: evaluation of the effectiveness of the GWIS, an optimization study for the GWIS, and development of remedial alternatives to support a final decision for the Combined Ground Water Operable Unit.

Next Review

If the GWIS operates for another five years, the next review would be due in May of 2009.

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ATTACHMENT A

Analysis of Aquifer tests at the Anniston Army Depot

Analysis of Aquifer tests at ANAD
Review of Extraction Test and Groundwater Extraction Wells, Southeast Industrial Area at Anniston Army Depot, Anniston, Alabama
by SAIC, December 2003.

Two new extraction wells were drilled and tested in 2002. These wells were to be incorporated into the existing ANAD Groundwater Interceptor System (GWIS). Test well 02TEWB01 was drilled to a depth of 101 feet. The top of bedrock was at 37 feet. A three foot deep cavity was encountered at a depth of 66 feet. This well had to be drilled twice; the first location was a dry hole to a depth of 161 feet. Test well 02TEWB02 was drilled to a total depth of 61 feet. The top of bedrock was at 45 feet. The borehole encountered a cavity that was over 9.7 feet thick. Drilling was terminated in this cavity (SAIC, 2003).

Aquifer (pumping) tests were conducted in each of the two test extraction wells. These tests were designed as step pumping tests with a 72 hour duration. Well 02TEWB02 was pumped at 25 gpm for 24 hours. When the pumping rate was raised to 50 gpm, the water level fell to the pump intake. The pumping rate for the remainder of the test varied between 20 and 23 gpm. Maximum drawdown in observation wells was less than 0.3 feet after 14.5 hours of pumping. The following table shows the observation wells used in this test.

Observation Wells	Distance from 02TEWB01 (ft)
83B17	469.6
88EWLF-2	211.4
88EWLF-4	899.8
91B06	662.3
00GOUB05	794.09
02CGWB03S	354.13
02CGWB03D	354.13

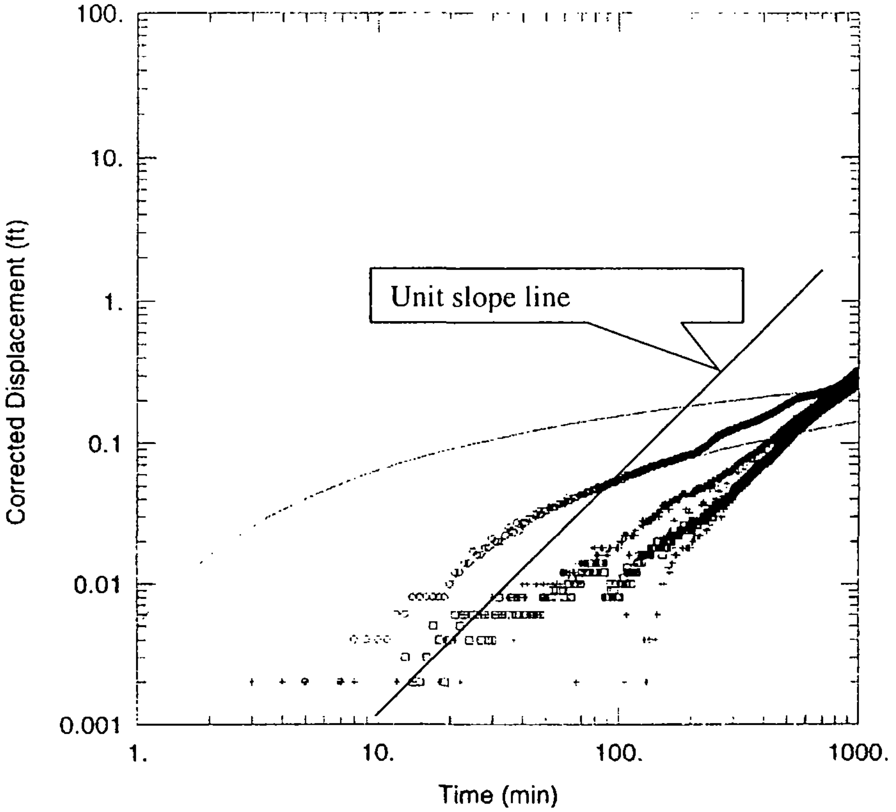
It began to rain 14.5 hours after the beginning of the test causing water levels to rise in the observation wells (SAIC, 2003).

Well 02TEWB01 was pumped at a rate of 25 gpm for 16 hours, 35 minutes. At that time, the water level was at the pump intake and the pumping rate was decreased to 19 gpm for the remainder of the test. Only three of the seven observation wells showed any response. The following table shows the observation wells used in this test

Observation Wells	Distance from 02TEWB02 (ft)
83B03	824.8
83B05	194.1
83B13	580.6
83B19	427.3
01CGWU09	356.6
01CGWU10	518.0
01CGWU12	756.9

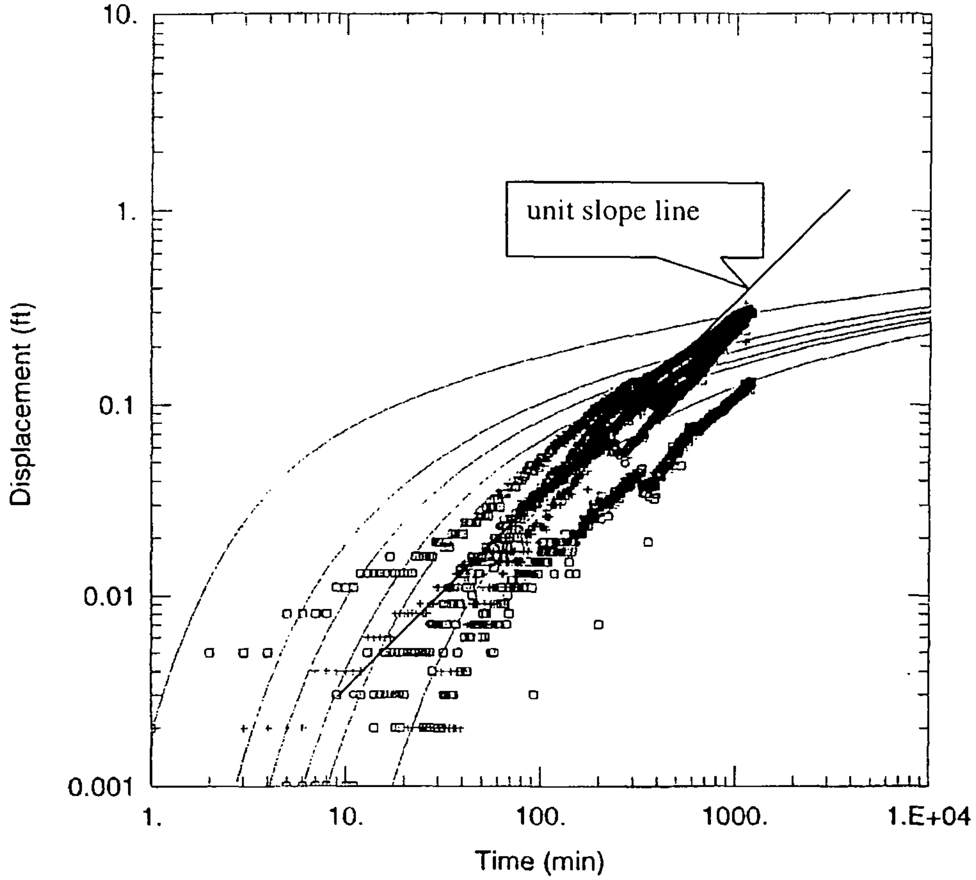
The maximum drawdown after 16 hours, 35 minutes of pumping in an observation well was 0.33 feet (SAIC, 2003).

Each of the above aquifer tests were analyzed by SAIC assuming the aquifer was a porous medium using the first constant pumping rate portions of the tests. The drawdown versus time plots clearly indicate that the aquifers are not porous media, however. The following figure shows the drawdowns recorded during the first 16.6 hours of the 02TEWB01 aquifer test in observation wells 02CGWB03S, 02CGWB03D, and 88EWLF2. Notice that two drawdown versus time plots are straight lines, rather than the characteristic curve exhibited by an aquifer test in porous media (Theis equation). These straight lines are characteristics of the response in fractured rock (Gringarten, 1982). If the observation wells are in a large cavity or fracture that is in good connection with the pumping well, i.e. infinite conductivity fracture, then the early time slope of the drawdown curve will be one on a log-log plot. This is an identical result to the solution for a well in a porous medium with well bore storage. Pumping from a cavity is identical to pumping from a large well. Drawdowns in a fracture of limited storage capacity typically have a slope of one-half. This reflects a linear rate of inflow (inflow a function of the square root of time). Observation wells in the rock matrix (a porous medium) will typically have a response which can be matched to the Theis equation (Gringarten, 1982). The straight lines on the following figure have slopes of 0.7 and 0.86, which are intermediate values between the theoretical slopes of one and one-half. This aquifer response is quite consistent with the bore log that indicates a substantial cavity.



WELL TEST ANALYSIS

The following figure shows the drawdowns recorded during the first 14.5 hours of the 02TEWB02 aquifer test in observation wells 83B03, 83B19, 01CGWU09, 83B05, 83B13, and 01CGWU10. Notice that all drawdown versus time plots are straight lines and all are close to unit slopes. This indicates the pumping well merely pumped water from a cavity with little or no drawdown in the rock matrix or in small aperture fractures. These results are also consistent with the borelog that indicates a large cavity.



WELL TEST ANALYSIS

The implications of these results are significant. An extraction well system at ANAD in the bedrock aquifer cannot be designed using porous media flow assumptions, i.e. Darcy' s law. While the bedrock aquifer may be approximated as a porous medium at a regional scale, individual wells do not respond the same as pumping wells in a typical porous aquifer. The bedrock aquifer is a series of fractures and cavities in a relatively nonporous matrix that are not areally extensive. This conclusion is supported by the following evidence.

- There are numerous dry and low yielding bore holes. This is characteristic of wide spacing between fractures.
- Aquifer testing and the operation of the groundwater interception system causes very limited drawdowns indicative of disconnected fracture networks.
- The aquifer testing of extraction test wells, 02TEWB01 and 02TEWB02 indicated groundwater was in large fractures and cavities of limited areal extent in a relatively nonporous rock matrix.

It is unlikely that any bedrock aquifer pump and treat system will be effective at controlling or removing significant amounts of contamination at ANAD.

References

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ATTACHMENT B

Analysis of Differences between Tracer Tests

Comparison of the Ewers Water Consultants and SAIC Dye Trace Studies

Introduction

In 1992, Ewers Water Consultants (EWC) conducted a groundwater tracing study of the Southeast Industrial Area (SIA) of the Anniston Army Depot in Anniston, Alabama. Their final report was issued on June 30, 1994. In 1997, the Science Applications International Corporation in conjunction with Crawford & Associates (SAIC/C&A) performed a similar study in the same area. This study was implemented to resolve the uncertainties believed to be associated with the EWC study. Their final report was issued in May, 1998.

The results of the EWC study indicated that the groundwater passing beneath the trench area and the landfill area moves rapidly outward in a multi-directional pattern and discharges into springs. They also indicated that the injected dyes were detected outside the boundaries of the SIA.

The results of the SAIC/C&A study indicated that the conceptualization of the bedrock aquifer as a well connected conduit dominated karst aquifer is not an accurate presentation of the subsurface flow. The rapid flow of groundwater to exit point springs or other surface water bodies, which is common in well developed conduit systems within karst flow regimes, does not occur. They also indicated that the injected dyes were not detected outside of the SIA.

Objective

The objective of this narrative is to compare the EWC and SAIC/C&A studies to determine some potential reasons for the completely different conclusions reached by the two groups.

Well Locations

Table 1 shows the well names of the dye injection wells chosen by EWC and SAIC/C&A for the landfill, trench, and northeast areas. It also shows the approximate distance from the SAIC/C&A wells to the EWC wells. The two EWC trench wells were close together and for the purposes of distance measurement to the SAIC/C&A wells were considered to be a single well cluster. This was also the case with the two SAIC/C&A northeast wells. The SAIC/C&A group chose a completely different group of wells than those chosen by EWC, with a single exception (88-EWTR-6).

Table 1: Well locations

Area	EWC Wells	SAIC/C&A Wells	Approximate Distance from SAIC/C&A Wells to EWC Wells
Landfill	82-B-13	95-EWLF-5	250 ft.
	88-EWLF-4		1000 ft.
Trench	88-EWTR-6 & 88-EWTR-7	88-EWTR-6	0
		TR-IW-2	500 ft.
Northeast	88-B-12	NE-IW-1 & NE-IW-2	2500 ft.
	88-EWNE-4		2000 ft.

The area containing the ANAD SIA has experienced many episodes of tectonic stress. The fracture size, severity, and patterns in the bedrock can vary greatly over short distances as the result of varying competence of the bedrock and other localized lithologic factors. In addition, the residuum overlying the bedrock can also vary in composition over a short distance as well. As a result, the tracer dyes will move through the bedrock and overburden in different ways based on the composition of the overburden and fracture dynamics of the bedrock. The path taken by the tracer dyes could have varied greatly depending on the conditions surrounding the chosen wells.

Dye Choice and Season

Table 2 shows the month and year of the EWC and SAIC/C&A injections, the type of dye that was used, and the amount. Please note that a different dye was used in the two SAIC/C&A trench area wells.

Table 2: Dye Information

Area	EWC			SAIC/C&A			
	Date	Dye	Amt. / well (lbs)	Date	Dye	Well Number	Amt. / well (lbs)
Landfill	Apr., 1992	Rhodamine WT	12.5	Jan., 1997	Sulphorhodamine-B	ALL	100
	July, 1992	Rhodamine WT	25				
	Apr., 1993	Eosine	25				
Trench	July, 1992	Eosine	12.5	Jan., 1997	Fluoroscein	TR-IW-2	20
	Oct., 1992	Rhodamine WT	17.5		Eosine	88-EWTR-6	25 (fig 7-1)
	?	Rhodamine WT	125				50 (Tbl 7-3)
Northeast	Oct., 1992	Fluoroscein	10	Jan., 1997	Tinopal CBS-X Fabric Brightener 351	ALL	12.5

SAIC/C&A injected their dyes in January and EWC injected their dyes in April, July, and October. The water levels in the wells prior to injection are not given in the EWC findings report. However, it is well known that groundwater levels and conditions are not the same throughout the entire year. The flow dynamics of the injected dyes may vary as a result of the groundwater conditions. In addition SAIC/C&A and EWC used different dyes for all but one location. In the single location where the same dye was used, SAIC/C&A used 2 to 4 times more than EWC used. Each dye has its own set of chemical and physical properties. As a result, it is reasonable to assume that each dye will behave in a different way within the same medium. It is therefore also reasonable to assume that the same dye in different quantities will also produce variable results. In addition, SAIC/C&A flushed the wells with potable water before adding the dye and then again after the dye was added. The amount of water used in these operations was not mentioned in their findings report dated May, 1998. The findings report prepared by EWC in June, 1994 does not indicate that the wells were flushed prior to the addition of the dye. However, it does indicate that the wells were flushed with 2000 to 2400 gallons of potable water following the addition of the dye. We are not certain whether or not this pre-flush would have an effect on the tracer results, but it is a difference in the two investigations.

Background Testing

EWC placed passive dye detectors at each monitoring point during the March 13 to 22, 1992 reconnaissance period. They were exchanged with fresh detectors on April 12, 1992. All detectors were analyzed by spectrofluorometry for all dyes that might have been used in the study. Only fluorescein was detected, but in most instances it appeared to be related to ANAD operations.

SAIC/C&A monitored background dye levels for eight weeks. The results showed the presence of four dyes, rhodamine WT, eosine, fluorescein, and sulphorhodamine-B, with fluorescein being the most commonly detected dye. However, it is possible that the background detections of rhodamine WT and eosine were from the dye injections of the earlier study by EWC.

Conclusions

The SAIC/C&A study was conducted because of alleged uncertainties in the previous study performed by EWC. The May 1998 findings report by SAIC states that uncertainties arose due to incomplete background dye measurements, weak and/or single dye detections interpreted as positive detections, the wide area of dye detections, and proposed radial pattern of drainage in the landfill and trench areas proposed by EWC. The results obtained by SAIC/C&A do not agree with the conclusions reached by EWC. However, the two studies were not the same. SAIC/C&A chose a different group of injection wells, with one exception, that are not close enough to the EWC wells to negate lithologic and tectonic variation. They also injected different dyes in different quantities at a different time of the year, with a slightly different procedure.

The SAIC study was very different from the EWC study and as a result of the differences cited above, it is not evident that the conclusions reached by the EWC study are not correct.

ATTACHMENT C

Interview Reports

INTERVIEW RECORD

Site Name: Anniston Army Depot SE Industrial Area
EPA ID No.: AL3210020027

Subject: GWIS Five Year Review
Time: 3PM
Date: 3/11/04

Type: x Telephone Visit Other
Location of Visit: N/A
Incoming Outgoing

Contact Made By:

Name: Donald Koch
Title: Project Manager
Organization: CCJM

Individual Contacted:

Name: Wayne Jones
Title: Plant Operator
Organization: ANAD

Telephone No: 256-741-5234
Fax No:
E-Mail Address:

Street Address:
City, State, Zip:

Summary Of Conversation

The operation of the groundwater treatment plant was discussed. The only problem Wayne mentioned was problems with the computer control systems. They recently had a consultant in to fix these. There was a review of the system operation by Bhate (?). I will request a copy of this report from Pat Smith.

We discussed the extraction wells. We agreed that some of them will require redevelopment at frequent intervals, others will not. The two new extraction wells that went on-line during 2003, B-01 and B-02, replaced wells LF-1 and NE-4.

I mentioned that I would be coming down for a site visit in the near future.

INTERVIEW RECORD

Site Name Anniston Army Depot SE Industrial Area
EPA ID No AL3210020027
Subject GWIS Five Year Review
Time 11AM **Date** 3/12/04
Type x Telephone Visit Other
Incoming Outgoing
Location of Visit N/A

Contact Made By

Name Donald Koch
Title Project Manager
Organization CCJM

Individual Contacted

Name John Baehr
Title Technical PM
Organization U S Army COE
Telephone No 251 690 3146
Fax No
E Mail Address
Street Address
City, State Zip

Summary Of Conversation

We discussed the GWIS and its future There is currently an optimization study of the extraction wells going on A draft report should be out in three months John described some of the problems with the extraction wells over the years and very high concentrations of ferrous iron that occur in the aquifer These concentrations are so high that aerated water turns orange (Fe+3) in several minutes These concentrations also cause fouling of the wells by iron bacteria as well as ferric hydroxide

The Army is continuing to pursue a technical impracticability waiver Regulators have accepted the concept although the EPA and ADEM have major differences over the size of the technical impracticability zone The regulators have requested three years of monitoring data which is being completed now as part of the Comprehensive Groundwater Remedial Investigation

The new draft IROD contains several mistakes which have been corrected There are no plans to use dual phase extraction to pump DNAPL because none has been found There are no plans to use in situ chemical oxidation because it is not believed to be feasible The purpose of the new IROD is to document an exit strategy which will allow the GWIS to be terminated The existing IROD document has no exit strategy and legal opinion is that without a new IROD the GWIS cannot be turned off

We discussed final remedial actions An emergency response plan is already in place to allow the Army to install treatment on both affected public and private water supplies The final remedial action will consist of technical impracticability natural attenuation and well head /source treatment John said that several in situ biological remedation vendors had looked at the site and passed

INTERVIEW RECORD

Site Name **Anniston Army Depot SE Industrial Area**	**EPA ID No** AL3210020027	
Subject **GWIS Five Year Review**	**Time** 11AM	**Date** 3/24/04
Type Telephone x Visit Other **Location of Visit** ANAD	Incoming Outgoing	

Contact Made By

Name **Donald Koch**	**Title** **Project Manager**	**Organization** **CCJM**

Individual Contacted

Name **Patrick Smith**	**Title** **Environmental Coord**	**Organization** **ANAD**

Telephone No **256 741 4551** **Fax No** **E Mail Address**	**Street Address** **City, State Zip**

Summary Of Conversation

Current costs for operating the GWIS are
$200 000 for chemicals and miscellaneous supplies
2 full time operators
electricity and water not included estimated to be minor expenses
redevelopment of extraction wells not included
engineering not included recently had Revere Controls in to fix some software problems $40 000 one time expense

Community involvement plan was discussed The Restoration Advisory Board (RAB) was been heavily involved in the design and construction of the groundwater treatment plant There is a quarterly newsletter regarding plant environmental issues Until recently the groundwater issues have been secondary to the incineration of chemical warfare material (CWM) but with the success of the CWM incinerator groundwater is rising in the public s consciousness

There has not been any explicit involvement of the RAB in the five year review process yet

There are both public and private water supply emergency response plans in place Army has plans in place to provide bottled water and point of use treatment on any water supply that exceeds MCLs for any organic chemical related to ANAD (TCE etc) Private wells are monitored annually Army has already funded ($1 6 million) air strippers at the Anniston water supply (Coldwater Spring) Design is complete and construction expected complete by end of 2004

Pat said that the technical impracticability waiver had already been presented to the RAB and the regulators with initial acceptance by all groups He believed that getting acceptance of turning off the GWIS would be more difficult

ATTACHMENT D

Site Inspection Report

Please note that O&M is referred to throughout this checklist At sites where Long Term Response Actions are in progress O&M activities may be referred to as system operations since these sites are not considered to be in the O&M phase while being remediated under the Superfund program

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status 'N/A refers to not applicable)

I SITE INFORMATION

Site name Anniston Army Depot	**Date of inspection** 3/24/04
Location and Region AL, Region IV	**EPA ID** AL3210020027
Agency, office, or company leading the five year review CC)M	**Weather/temperature** sunny, warm

Remedy Includes (Check all that apply)

Landfill cover/containment
Access controls
Institutional controls
[✓ Groundwater pump and treatment]
Surface water collection and treatment
Other

Monitored natural attenuation
Groundwater containment
Vertical barrier walls

Attachments Inspection team roster attached Site map attached

II INTERVIEWS (Check all that apply)

1 **O&M site manager** Wayne Jones Plant Operator 3/24/04
Name Title Date
Interviewed [✓ at site] at office by phone Phone no
Problems suggestions Report attached
plant working well

2 **O&M staff**
Name Title Date
Interviewed at site at office by phone Phone no
Problems suggestions Report attached

3 **Local regulatory authorities and response agencies** (i e State and Tribal offices emergency response office police department office of public health or environmental health zoning office recorder of deeds or other city and county offices etc) Fill in all that apply

Agency ____________________
Contact ____________________ ____________ ______ ________
Name Title Date Phone no
Problems suggestions Report attached ________________________________

Agency ____________________
Contact ____________________ ____________ ______ ________
Name Title Date Phone no
Problems suggestions Report attached ________________________________

Agency ____________________
Contact ____________________ ____________ ______ ________
Name Title Date Phone no
Problems suggestions Report attached ________________________________

Agency ____________________
Contact ____________________ ____________ ______ ________
Name Title Date Phone no
Problems suggestions Report attached ________________________________

4 **Other interviews** (optional) Report attached

Pat Smith, Environmental Coordinator

III ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1	**O&M Documents**			
	O&M manual	[✓ Readily available]	Up to date	N/A
	As built drawings	[✓ Readily available]	Up to date	N/A
	Maintenance logs	[✓ Readily available]	[✓ Up to date]	N/A
	Remarks			
2	**Site Specific Health and Safety Plan**	Readily available	Up to date	N/A
	Contingency plan/emergency response plan	[✓ Readily available]	Up to date	N/A
	Remarks			
3	**O&M and OSHA Training Records**	[✓ Readily available]	Up to date	N/A
	Remarks			
4	**Permits and Service Agreements**			
	Air discharge permit	[✓ Readily available]	Up to date	N/A
	Effluent discharge	[✓ Readily available]	Up to date	N/A
	Waste disposal POTW	Readily available	Up to date	N/A
	Other permits_______________	Readily available	Up to date	N/A
	Remarks			
5	**Gas Generation Records**	Readily available	Up to date	[✓ N/A]
	Remarks			
6	**Settlement Monument Records**	Readily available	Up to date	[✓ N/A]
	Remarks			
7	**Groundwater Monitoring Records**	Readily available	Up to date	N/A
	Remarks			
8	**Leachate Extraction Records**	Readily available	Up to date	[✓ N/A]
	Remarks			
9	**Discharge Compliance Records**			
	Air	Readily available	Up to date	[✓ N/A]
	Water (effluent)	[✓ Readily available]	Up to date	N/A
	Remarks			
10	**Daily Access/Security Logs**	Readily available	Up to date	[✓ N/A]
	Remarks			

IV O&M COSTS

1 **O&M Organization**

State in house / Contractor for State

PRP in house / Contractor for PRP

[✓ Federal Facility in house] / Contractor for Federal Facility

Other________________________________

2 **O&M Cost Records**

[✓ Readily available] Up to date

Funding mechanism/agreement in place

Original O&M cost estimate P >300,000 Breakdown attached

Total annual cost by year for review period if available

From________ To________ ________ [✓ Breakdown attached] in Pat Smith Mkervew firm
Date Date Total cost

From________ To________ ________ Breakdown attached
Date Date Total cost

From________ To________ ________ Breakdown attached
Date Date Total cost

From________ To________ ________ Breakdown attached
Date Date Total cost

From________ To________ ________ Breakdown attached
Date Date Total cost

3 **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons ________________________________

V ACCESS AND INSTITUTIONAL CONTROLS Applicable [✓ N/A]

A. Fencing

1 **Fencing damaged** Location shown on site map Gates secured N/A

Remarks________________________________

B Other Access Restrictions

1 **Signs and other security measures** Location shown on site map N/A

Remarks________________________________

C Institutional Controls (ICs)

1 **Implementation and enforcement**

Site conditions imply ICs not properly implemented Yes No N/A
Site conditions imply ICs not being fully enforced Yes No N/A

Type of monitoring (*e g* self reporting drive by) ____________________
Frequency ____________________
Responsible party/agency ____________________
Contact ______________ ______________ ______________ ______________
Name Title Date Phone no

Reporting is up-to-date Yes No N/A
Reports are verified by the lead agency Yes No N/A

Specific requirements in deed or decision documents have been met Yes No N/A
Violations have been reported Yes No N/A
Other problems or suggestions Report attached

2 **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks____________________

D General

1 **Vandalism/trespassing** Location shown on site map No vandalism evident
Remarks____________________

2 **Land use changes on site** N/A
Remarks____________________

3 **Land use changes off site** N/A
Remarks____________________

VI GENERAL SITE CONDITIONS

A **Roads** [✓ Applicable] N/A

1 **Roads damaged** Location shown on site map [✓ Roads adequate] N/A
Remarks____________________

B Other Site Conditions

Remarks____

VII LANDFILL COVERS Applicable [✓ N/A]

A Landfill Surface

1 **Settlement** (Low spots) Location shown on site map Settlement not evident
Areal extent__________ Depth__________
Remarks____

2 **Cracks** Location shown on site map Cracking not evident
Lengths__________ Widths__________ Depths__________
Remarks____

3 **Erosion** Location shown on site map Erosion not evident
Areal extent__________ Depth__________
Remarks____

4 **Holes** Location shown on site map Holes not evident
Areal extent__________ Depth__________
Remarks____

5 **Vegetative Cover** Grass Cover properly established No signs of stress
Trees/Shrubs (indicate size and locations on a diagram)
Remarks____

6 **Alternative Cover (armored rock, concrete etc)** N/A
Remarks____

7 **Bulges** Location shown on site map Bulges not evident
Areal extent__________ Height__________
Remarks____

8 **Wet Areas/Water Damage** Wet areas/water damage not evident
Wet areas Location shown on site map Areal extent____________
Ponding Location shown on site map Areal extent____________
Seeps Location shown on site map Areal extent____________
Soft subgrade Location shown on site map Areal extent____________
Remarks____

9 **Slope Instability** Slides Location shown on site map No evidence of slope instability
Areal extent____________
Remarks____

B Benches Applicable N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel)

1 **Flows Bypass Bench** Location shown on site map N/A or okay
Remarks____

2 **Bench Breached** Location shown on site map N/A or okay
Remarks____

3 **Bench Overtopped** Location shown on site map N/A or okay
Remarks____

C Letdown Channels Applicable N/A
(Channel lined with erosion control mats riprap grout bags or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies)

1 **Settlement** Location shown on site map No evidence of settlement
Areal extent____________ Depth__________
Remarks____

2 **Material Degradation** Location shown on site map No evidence of degradation
Material type____________ Areal extent____________
Remarks____

3 **Erosion** Location shown on site map No evidence of erosion
Areal extent____________ Depth__________
Remarks____

4 **Undercutting** Location shown on site map No evidence of undercutting
Areal extent__________ Depth__________
Remarks______________________________
____

5 **Obstructions** Type______________ No obstructions
Location shown on site map Areal extent__________
Size__________
Remarks______________________________
____

6 **Excessive Vegetative Growth** Type______________
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent__________
Remarks______________________________
____

D Cover Penetrations Applicable [✓ N/A]

1 **Gas Vents** Active Passive
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance
N/A
Remarks______________________________
____

2 **Gas Monitoring Probes**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks______________________________
____

3 **Monitoring Wells** (within surface area of landfill)
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks______________________________
____

4 **Leachate Extraction Wells**
Properly secured/locked Functioning Routinely sampled Good condition
Evidence of leakage at penetration Needs Maintenance N/A
Remarks______________________________
____

5 **Settlement Monuments** Located Routinely surveyed N/A
Remarks______________________________
____

E Gas Collection and Treatment Applicable [✓ N/A]

1 **Gas Treatment Facilities**
Flaring Thermal destruction Collection for reuse
Good condition Needs Maintenance
Remarks____

2 **Gas Collection Wells Manifolds and Piping**
Good condition Needs Maintenance
Remarks____

3 **Gas Monitoring Facilities** (*e g* gas monitoring of adjacent homes or buildings)
Good condition Needs Maintenance N/A
Remarks____

F Cover Drainage Layer Applicable [✓ N/A]

1 **Outlet Pipes Inspected** Functioning N/A
Remarks____

2 **Outlet Rock Inspected** Functioning N/A
Remarks____

G Detention/Sedimentation Ponds Applicable [✓ N/A]

1 **Siltation** Areal extent__________ Depth________ N/A
Siltation not evident
Remarks____

2 **Erosion** Areal extent__________ Depth________
Erosion not evident
Remarks____

3 **Outlet Works** Functioning N/A
Remarks____

4 **Dam** Functioning N/A
Remarks____

H Retaining Walls Applicable N/A

1 **Deformations** Location shown on site map Deformation not evident
Horizontal displacement____________ Vertical displacement______________
Rotational displacement____________
Remarks____
____

2 **Degradation** Location shown on site map Degradation not evident
Remarks____
____

I Perimeter Ditches/Off Site Discharge Applicable N/A

1 **Siltation** Location shown on site map Siltation not evident
Areal extent_____________ Depth____________
Remarks____
____

2 **Vegetative Growth** Location shown on site map N/A
Vegetation does not impede flow
Areal extent_____________ Type____________
Remarks____
____

3 **Erosion** Location shown on site map Erosion not evident
Areal extent_____________ Depth____________
Remarks____
____

4 **Discharge Structure** Functioning N/A
Remarks____
____

VIII VERTICAL BARRIER WALLS Applicable [✓ N/A]

1 **Settlement** Location shown on site map Settlement not evident
Areal extent_____________ Depth____________
Remarks____
____

2 **Performance Monitoring**Type of monitoring_________________________
Performance not monitored
Frequency______________________________ Evidence of breaching
Head differential_________________________
Remarks____
____

IX GROUNDWATER/SURFACE WATER REMEDIES [✓ Applicable] N/A

A Groundwater Extraction Wells Pumps, and Pipelines [✓ Applicable] N/A

1 **Pumps, Wellhead Plumbing and ~~Electrical~~**
Good condition [✓ All required wells properly operating] Needs Maintenance N/A
Remarks all maintenance being perfmed

2 **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
[✓ Good condition] Needs Maintenance
Remarks

3 **Spare Parts and Equipment**
[✓ Readily available] Good condition Requires upgrade Needs to be provided
Remarks

B Surface Water Collection Structures Pumps, and Pipelines Applicable [✓ N/A]

1 **Collection Structures, Pumps, and Electrical**
Good condition Needs Maintenance
Remarks

2 **Surface Water Collection System Pipelines Valves, Valve Boxes, and Other Appurtenances**
Good condition Needs Maintenance
Remarks

3 **Spare Parts and Equipment**
Readily available Good condition Requires upgrade Needs to be provided
Remarks

C Treatment System Applicable N/A

1 **Treatment Train** (Check components that apply)
[✓ Metals removal] Oil/water separation Bioremediation
[✓ Air stripping] Carbon adsorbers
Filters Sand
Additive (*e g* chelation agent flocculent) $KMnO_4$, polymers
Others
Good condition Needs Maintenance
Sampling ports properly marked and functional
Sampling/maintenance log displayed and up to date
Equipment properly identified
Quantity of groundwater treated annually
Quantity of surface water treated annually
Remarks plant in good condit.

2 **Electrical Enclosures and Panels** (properly rated and functional)
N/A [✓ Good condition] Needs Maintenance
Remarks

3 **Tanks Vaults, Storage Vessels**
N/A [✓ Good condition] Proper secondary containment Needs Maintenance
Remarks

4 **Discharge Structure and Appurtenances**
N/A [✓ Good condition] Needs Maintenance
Remarks

5 **Treatment Building(s)**
N/A [✓ Good condition (esp roof and doorways)] Needs repair
Chemicals and equipment properly stored
Remarks

6 **Monitoring Wells** (pump and treatment remedy)
[✓ Properly secured/locked] Functioning [✓ Routinely sampled] Good condition
All required wells located Needs Maintenance N/A
Remarks

D Monitoring Data

1 Monitoring Data not known
Is routinely submitted on time Is of acceptable quality

2 Monitoring data suggests
Groundwater plume is effectively contained Contaminant concentrations are declining

D Monitored Natural Attenuation

1 **Monitoring Wells** (natural attenuation remedy)
Properly secured/locked Functioning Routinely sampled Good condition
All required wells located Needs Maintenance N/A
Remarks

X OTHER REMEDIES

If there are remedies applied at the site which are not covered above attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy An example would be soil vapor extraction

XI OVERALL OBSERVATIONS

A Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed Begin with a brief statement of what the remedy is to accomplish (i e to contain contaminant plume minimize infiltration and gas emission etc)

GWTS functioning well and as designed

B Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures In particular discuss their relationship to the current and long term protectiveness of the remedy

O&M is good

C Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future

No problems evident. They should consider storing more data on computer, current record keeping is manual

D Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy

Optimization of chemical addition was recently performed. May want to remove some wells from the extraction well network