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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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August 24, 2000

Ms. Mary E. Bridgewater
AFBCA/DD March ROL
Regional BRAC Environmental Coordinator
3430 Bundy Avenue, Bldg. 3408
March AFB, CA 92518-1504

RE: **Concurrence On Norton AFB Five-Year Review Report**

Dear Ms. Bridgewater,

This letter provides EPA's statement of protectiveness concurrence on the Norton AFB Central Base Area Operable Unit (CBAOU) Five-Year Review Report dated October 27, 1999. Based on the information provided in the report, EPA agrees that the remedial actions selected and implemented for environmental contaminations in soils and groundwater for the CBAOU were or are functioning as designed, and are protective of human health and the environment. It is also noted that all operations and maintenance requirements are being performed.

Daniel A. Meer
Chief, Federal Facilities Cleanup Branch

GENERAL ORDER NO.: 95B-99298C
WORK RELEASE AUTHORIZATION NO.: K-05

FINAL
FORMER NORTON AIR FORCE BASE
CENTRAL BASE AREA OPERABLE UNIT
FIVE-YEAR CERCLA REVIEW

Prepared for:
HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM
OAK RIDGE, TENNESSEE 37831-7606
managed by
LOCKHEED MARTIN ENERGY SYSTEMS
under contract DE-AC05-84OR21400
and
UNITED STATES HEADQUARTERS
AIR FORCE BASE CONVERSION AGENCY
NORTON OPERATING LOCATION
SAN BERNARDINO, CALIFORNIA 92408

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October 27, 1999
Revision: 0

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ACRONYMS

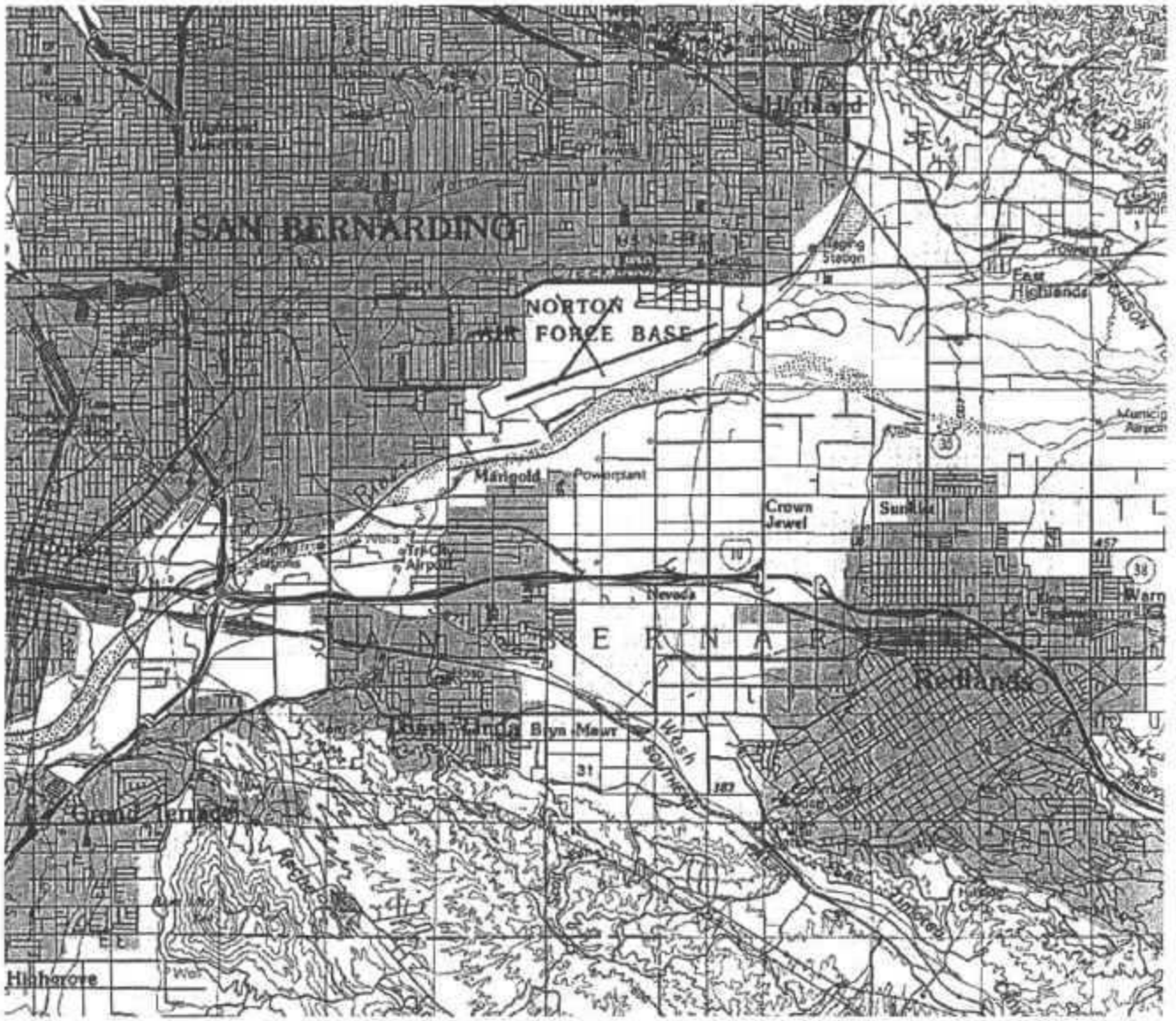
AFB	Air Force Base
Air Force	United States Air Force
AFBCA	Air Force Base Conversion Agency
AM	Action Memorandum
AOC(s)	Areas of Concern
ARAR	applicable or relevant and appropriate requirements
AAVS	Air Force Audiovisual Services
BB	base boundary (pump and treat system)
bgs	below ground surface
BMO	Ballistic Missile Organization
CBA	Central Base Area
CDM Federal	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cu yd	cubic yards
DTSC	Department of Toxic Substances Control
EE/CA	Engineering Evaluation/Cost Analysis
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
FS	Feasibility Study
ft	feet
GCA	Golf Course Area
HAZWRAP	Hazardous Waste Remedial Actions Program
HI	hazard index
IRP	Installation Restoration Program
IWTP	Industrial Waste Treatment Plant
MCL	Maximum Contaminant Level
M/EW	extraction well
MW	monitoring well
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
NBA	Northeast Base Area
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
O&M	operations and maintenance
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
P&T	pump and treat
PRG(s)	Preliminary remediation goal(s)
RAO(s)	Remedial Action Objective(s)
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SVE	soil vapor extraction
TCE	trichloroethylene
TCG(s)	target cleanup goal(s)
TCLP	toxicity characteristics leaching procedure
USEPA	United States Environmental Protection Agency
VOC(s)	volatile organic compound(s)
WSCP	Off-Base Water Supply Contingency Policy

1.0 INTRODUCTION

1.1 Five-Year CERCLA Review Basis

On November 24, 1993, the United States Air Force (Air Force), the United States Environmental Protection Agency (USEPA), and the California Department of Toxic Substances Control (DTSC) jointly signed the Central Base Area (CBA) Operable Unit (OU) Record of Decision (ROD) for Norton Air Force Base (AFB) (Air Force, 1993). The CBA OU ROD addressed the CBA trichloroethylene (TCE) groundwater plume and soil sources contributing to the plume. The CBA OU ROD identified groundwater pumping followed by air stripping and injection of treated water as the selected remedy for the affected aquifer. For off-base water supply (production) wells affected by the CBA TCE plume, the CBA OU ROD addressed the use of the *Off-base Water Supply Contingency Policy* (WSCP) (Department of the Air Force, 1995) by the Air Force to either provide for well-head treatment, blending, or alternative water supplies should concentrations within a water supply well continue to exceed 5 micrograms per liter (μg/L), the maximum contaminant level (MCL) for TCE. For soils, the CBA OU ROD selected soil vapor extraction SVE) for TCE-affected soils beneath structures or within deep subsurface soils, and excavation followed by treatment/disposal for shallow contaminated soils. All remedial actions stated in the CBA OU ROD have been implemented, with some completed. This Five-Year Review document addresses the status of the CBA OU remedies along with a summary of other Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) actions conducted at the former Norton AFB. Figure 1 shows the former Norton AFB in relation to the surrounding region. Figure 2 illustrates the CBA and components of the CBA OU.

This Five-Year Review document was prepared on behalf of the Air Force Base Conversion Agency (AFBCA) by CDM Federal Programs Corporation (CDM Federal). CDM Federal's work was performed under a contract with Lockheed Martin Energy System's Hazardous Waste Remedial Action Program (HAZWRAP) (General Order No. 95B-99298C).



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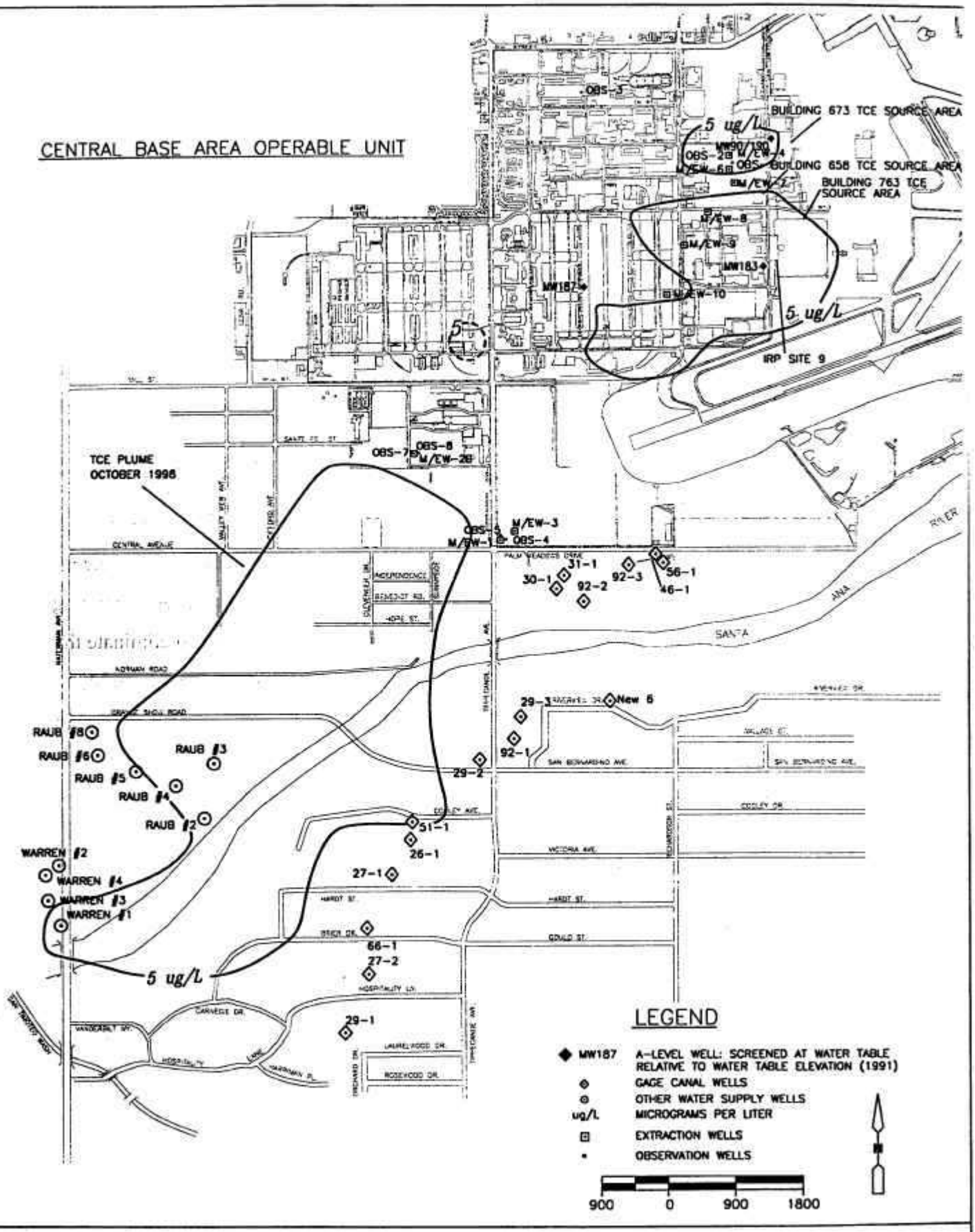
Area Map

San Bernardino, CA

Figure 1



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Features of the Central Base Area Operable Unit
Former Norton Air Force Base

Figure 2

1.2 Authority Statement

Under CERCLA, the responsibility of performing the Five-Year review lies with the USEPA. However, Executive Order 12580 allows USEPA to delegate the responsibility for performing the review to another federal agency when an agreement has been reached between USEPA and the agency for performing the review. The Air Force and USEPA signed a Federal Facilities Agreement in June 1989 allowing the Air Force to be the lead agency for the cleanup and investigation of Norton AFB.

The Air Force has conducted the first five-year statutory review for the former Norton AFB CBA OU pursuant to CERCLA section 121(c), National Contingency Plan (NCP) section 300.400(f)(4)(ii), and Office of Solid Waste and Emergency Response (OSWER) Directives 9355.7-02 (May 23, 1991) and 9355.7-02A (August 25, 1994). This is a Type Ia policy review applicable to all CBA OU remedial actions. This review addresses the period of November 1993, when the ROD was signed, through April 1999, the most recent groundwater sampling effort was completed. Although the intent of the CBA OU ROD remedies is to eliminate the threat to drinking water supplies by reducing groundwater concentrations to below the MCLs for ROD chemicals of concerns, this goal has not been totally achieved as of this date. Therefore, this review presents evaluations of the status of the CBA OU remedies. This five-year review is the first post-ROD review for Norton AFB and the document will become part of the Administrative Record for the former Norton AFB CERCLA actions.

Because the Air Force has completed a significant portion of the CBA OU remedies and has been extracting and treating groundwater at concentrations less than the ROD standard, a reevaluation of the groundwater remedies is in order. The purpose of this five-year review is to document the status of the remedies and to formalize the basis for remedy change, in order to ensure that the remedial actions implemented as identified in the CBA OU ROD continue to address the human health and environmental protectiveness of the remedial action objectives stated in the ROD in a cost-effective manner, and that the actions are functioning (or have functioned) as designed. In

addition, at the end of the remedial actions it is expected that remedial goals for the aquifer will be met allowing for unrestricted use of the aquifer related to CERCLA for the portion of the aquifer affected by Air Force solvent wastes.

1.3 Scope of the Five-Year Review

OSWER guidance documents address four levels of review under the CERCLA Five-Year Review process. Type Ia is a streamlined review for sites still under going remediation while Type I is a more comprehensive review identified for sites with ongoing remediation. The Type II review involves the recalculation of risks using available data and revised risk assumptions. Type III review involves the collection of new data for performing a new risk assessment. Because the CBA OU remedial actions are still ongoing (as of January 1999) and data collected as part of remedy demonstration monitoring show a reduction in overall soil and groundwater concentrations compared to data collected prior to startup of the remedial action, Type Ia is the most appropriate review level for the CBA OU Five Year Review. However, because the risk due to groundwater concentrations has been recently updated as part of the Former Norton Air Force Base Basewide Feasibility Study (FS) (CDM Federal, 1999b), the revised risk numbers have been incorporated into this review.

1.4 Five-Year Review Team

This Five-Year Review document has been reviewed by the Norton Air Force Base Realignment and Closure (BRAC) Cleanup Team (BCT). Members of this team include Tom Bartol (Air Force Base Conversion Agency), Kathleen Salyer (USEPA), Juan Jimenez (California EPA), and John Broderick (Santa Ana Regional Water Quality Control Board). All of the documents listed in the references section of this document have been reviewed for information incorporated herein. The majority of these reports have been provided to the BCT members for review and comment before the documents were incorporated into the Norton AFB Administrative Record. No formal interviews were conducted in producing this five-year review document. Inspections

of the CBA OU facilities are performed periodically by BCT members as part of routine meetings held at Norton to discuss progress of CBA OU and other base remedial actions.

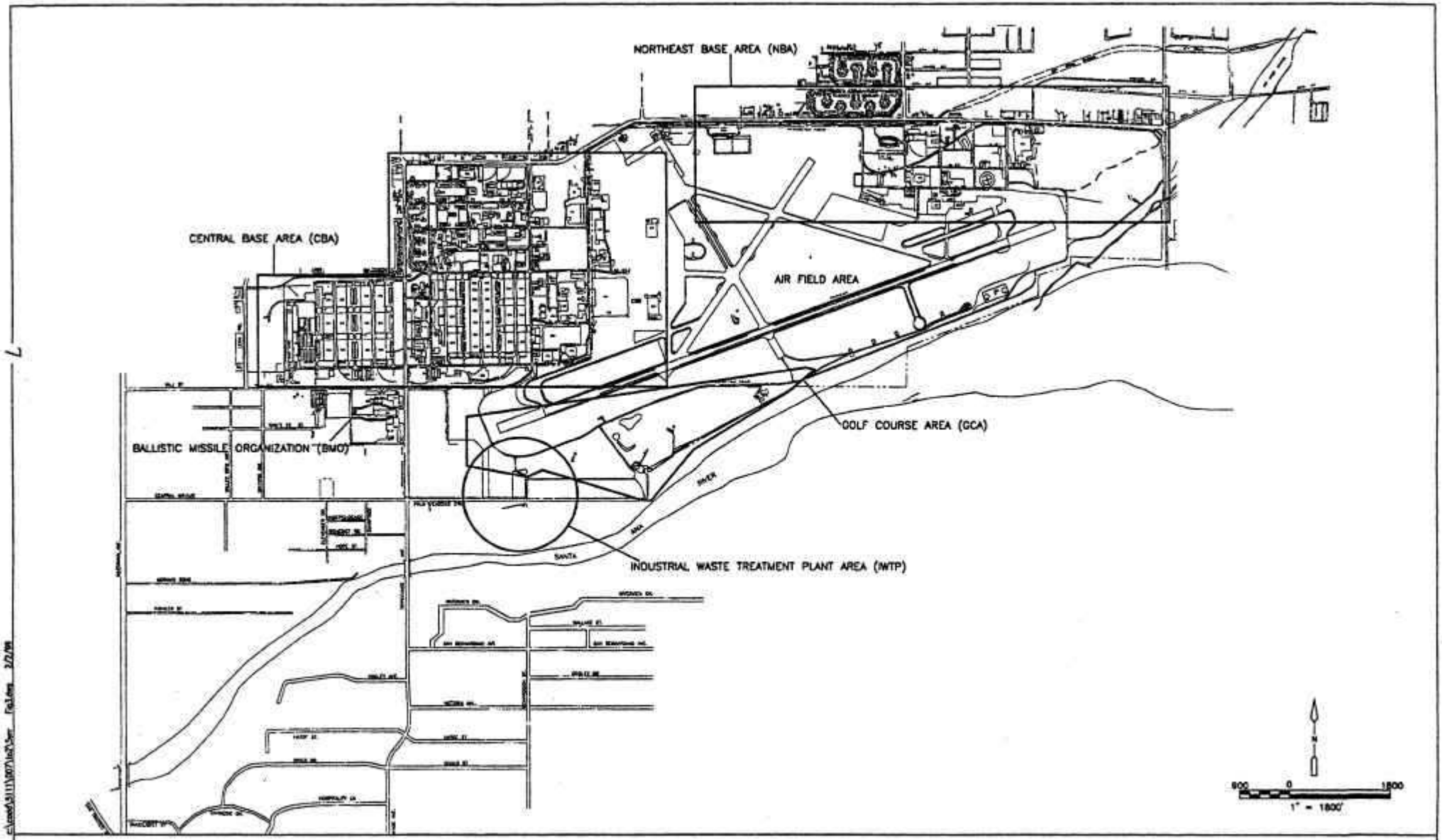
1.5 Site Characteristics

The former Norton AFB is located within the city of San Bernardino, California in southern California, approximately 50 miles east of Los Angeles. Norton AFB was commissioned in 1942 during World War II to provide aircraft maintenance support and was formally closed in March 1994. The 2,127-acre base is bordered by the Santa Ana River wash to the south, and light industrial and residential areas to the north, east, and west. Cities located near the former base include Redlands, Rialto, Fontana, Highland, Loma Linda, Riverside, and Colton. The population of San Bernardino County is 1,418,380 based on the 1990 United States Census.

The former Norton AFB was divided into six separate areas for the purpose of remedial investigation and describing base activities (Figure 3). The first location is the CBA which includes the western one-third of the former base. The CBA was the most developed portion of the base and included the majority of the base's offices, on-base housing, warehouses, engineering yards, and aircraft repair facilities. South of the CBA and across Mill Street is the Ballistic Missile Organization (BMO) complex. The BMO complex is currently occupied by the Defense Finance and Accounting Service.

The major area of the base in terms of acreage is the air field which includes runways, ramps, aircraft parking, and hangers used for aircraft repair. The airfield covers most of the eastern two-thirds of the base. The northeast base area (NBA) is located north of the airfield and represents the portion of the base with the oldest buildings. The original aircraft hangers and repair facilities are located in the NBA along with the former base landfill.

South of the airfield is the golf course area (GCA). The golf course area currently is the site of the Palm Meadows Golf Course. Prior to the construction of the golf course by the Air Force,



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GENERAL AREAS OF FORMER NORTON AIR FORCE BASE
SAN BERNADINO, CALIFORNIA

Figure
3

the GCA was used for a landfill, liquid waste disposal, Quartermaster's Salvage Yard, and chemical warfare training, among other activities. South of the GCA is the former industrial waste treatment plant (IWTP) facility used for treatment of liquid wastes generated as a result of aircraft maintenance and repair.

Investigation of environmental contamination at the base was initiated in 1982 under the Air Force's Installation Restoration Program (IRP). Investigations under the IRP occurred between 1984 and 1988. On July 22, 1987, Norton AFB was added to USEPA's National Priority List (NPL) of contaminated sites requiring investigation and cleanup under CERCLA. Norton AFB was listed on the NPL due to the presence of TCE in groundwater beneath the CBA as determined by the IRP investigations. Although the IRP investigators determined that the aquifer had become impacted by TCE, they did not locate the sources contributing to the problem.

In 1991, the CBA OU remedial investigation (RI) was conducted to define the extent of the TCE plume and the sources contributing to it (CDM Federal, 1992). This included the evaluation of groundwater within the vicinity of off-base water production wells used by local communities as drinking water supplies. During the RI, 76 conventional (single screen) monitoring wells and 10 multi-port wells were installed in order to define the extent of the TCE plume. The TCE source investigation conducted as part of the CBA OU RI involved the collection of numerous soil gas and subsurface soil samples in the areas where major aircraft repair had been performed. The source investigation resulted in the identification of four sources: Building 658 (former airfield support maintenance and repair facility), Building 673 area (the site of a former aircraft reclamation facility), Building 763 (the large aircraft repair hanger), and IRP site 9 (the Electroplating Shop within Building 763). In addition to TCE soil contamination, soils at IRP site 9 were also contaminated with chromium, and the cleanup of the chromium-affected soils was part of the CBA OU ROD decision. As a result of the discovery of TCE in groundwater exceeding 4,000 µg/L, the Air Force initiated in 1982 a groundwater "hot spot" removal action to address the core of the CBA OU plume.

The CBA OU FS (CDM Federal, 1993) evaluated remedial alternatives to address the groundwater TCE plume and soil sources contributing to the plume. Based on the alternatives evaluation, the Air Force selected expansion of the existing CBA groundwater pump and treat (P&T) system, installation of a new P&T system at the base boundary, evaluation and mitigation of impacts to off-base production wells under the WSCP, excavation of shallow contaminated soils for ex situ treatment/disposal, and SVE for deep contaminated soils. The record of Decision identifying these remedies was signed by the Air Force, USEPA, and California-EPA on November 24, 1993.

The CBA OU does not include or affect environmentally sensitive areas. Land prior to cleanup was that of a military base and airfield. During cleanup, use of the land has been transferred to local reuse agencies who continue to use and redevelop the former base for commercial, industrial, and aircraft maintenance/support activities.

Table 1 summarizes the chronology of events leading to this five-year review document.

1.6 Relationship of CBA OU to Other Former Norton AFB CERCLA Actions

The CBA OU is one of two OUs established to manage CERCLA-related contamination at the former Norton AFB. The second OU is the Basewide OU that addresses IRP sites, Areas of Concern (AOCs), and groundwater contamination not associated with the CBA OU or CBA OU sources. The Norton AFB CERCLA site does not affect or involve any other CERCLA sites.

Basewide investigations of waste handling, storage, and disposal practices at the former Norton AFB resulted in the identification of 22 IRP sites and 73 AOCs. Environmental samples collected from the sites and AOCs were compared with background concentrations and

TABLE 1
CHRONOLOGY OF SITE EVENTS

Event	Date
Initial discovery of problem	1986-88 IRP reported TCE in aquifer
Pre-NPL Responses	None
NPL Listing	July 22, 1987
Removal Actions	CBA P&T System installed 1992
RI/FS complete	February 1993
ROD signature	November 1993
ROD Amendments/ESDs	None
Enforcement Documents	FFA signed 1989
Remedial Design start	January 1994
Remedial Design complete	December 1994
Federal Facility Agreement	FFA signed 1989
Actual Remedial Action Start	January 1995
Construction Start	October 1994
Construction Complete	December 1994
Final Close Out Report	Shallow soil removals - 1996 Soil Vapor Extraction - 1997
Previous Five-Year Reviews	None

residential soil target cleanup goals[1] as the basis for determining whether the site warranted further evaluation. Based on this screening evaluation, 12 sites and 9 AOCs were subject to further evaluation, including removal actions in some situations. The following is the list of sites and AOCs that prior to removal actions, exhibited contamination above the residential standards:

[1]The residential soil target cleanup goals (TCGs) which are based on USEPA Preliminary Remediation Goals (PRGs), reflect soil concentrations that would allow for unrestricted use of the site or AOC.

IRP Site 1	Industrial Waste Lagoons	AOC 4	Building 301
IRP Site 2	Landfill No. 2	AOC 18	Building 451/452
IRP Site 5	Former Fire Training Area	AOC 33	Building 747
IRP Site 6	Former Underground Waste Oil Tank	AOC 37	Refuse Dump Area
IRP Site 8	PCB Spill Area	AOC 38	C Street Outfall
IRP Site 10	Landfill No. 1	AOC 39	GCA Stormdrain Outfall Area
IRP Site 13	IWTP Sludge Disposal Area	AOC 40	GCA Maintenance Area
IRP Site 14	Waste Pit No. 4	AOC 70	IWTP Effluent Percolation Pond
IRP Site 16	AAVS Evaporation Ponds	AOC 73	EOD Proficiency Training Range
IRP Site 17	Drummed Waste Storage Area		
IRP Site 19	Drum Storage Area No. 1		
IRP Site 21	AAVS Underground Ferricyanide Tank		

Of these 21 sites and AOCs, 14 were subject to removal actions (IRP sites 1, 2, 5, 6, 8, 10, 13, 14, 16 and 21, and AOCs 37, 38, 70, and 73). The justification for the removal actions were presented in Engineering Evaluation/Cost Analysis (EE/CA) documents with the decision for the removals documented in Action Memoranda (AM). The clearance of the Explosive Ordnance Disposal (EOD) Proficiency Training range was performed under a work plan. IRP site 2 (landfill No. 2) is being closed in place as a municipal landfill, with the closure report documenting the closure activities currently being reviewed by USEPA and the State of California.

Confirmation sampling following the removal actions indicated that residential soil TCGs had been met for IRP sites 8, 14, 16, and 21, and AOCs 37, 38, and 73 allowing for unrestricted use of these sites. The remaining sites/AOCs exhibited some soil contamination above the residential soil TCGs. The need for further action at these sites/AOCs is being addressed in the Basewide FS which is expected to be released in July 1999. The Record of Decision, formalizing the decisions evaluated in the FS, is scheduled to be released February 2000.

There are four areas of affected groundwater outside of the CBA plume area that are being addressed under CERCLA. These include the IRP site 1 volatile organic compound (VOC)

perched-zone groundwater, the IRP site 2 VOC groundwater plume, the IRP site 17 VOC perched-zone groundwater, and the NBA secondary VOC plume. All of these areas of affected groundwater are being sampled at least biannually under the comprehensive groundwater monitoring program. The need for further action for these areas of affected groundwater is being assessed in the Basewide FS.

1.7 Community Involvement in the Five-Year Review Process

This Five-Year Review document will be made available for public review in the Norton AFB Information Repository (Feldheym Library). The availability of the document for review will be announced in a pubic notice placed in the local newspaper (*San Bernardino Sun*). A synopsis of the Five Year Review will also be published in the Norton AFB community newsletter, *Restoration Review*. The release of the Five Year Review to the public is expected mid August 1999.

2.0 REMEDIAL ACTION OBJECTIVES FROM THE CBA OU ROD AND COMPLIANCE WITH ROD STANDARDS

2.1 Remedial Action Objectives

The basic remedial action objectives (RAOs) for the CBA OU were developed to protect human health and the environment from contact with groundwater containing TCE and other VOCs at concentrations exceeding MCLs, and chromium in soils above acceptable risk levels. The risk assessment performed for the CBA OU determined that the risk posed by groundwater exceeded the target cancer risk level of 1×10^{-6} and a noncancer hazard index (HI) of 1. To address this overall objective, RAOs were developed for each component of the CBA OU as provided below.

Component 1 - Groundwater

The RAO for groundwater was to prevent exposure to groundwater containing VOCs exceeding MCLs and to protect groundwater resources. Groundwater resources will be protected by removal of VOCs from groundwater at levels potentially adverse to human health as the affected aquifer is a drinking water source.

Component 2 - Deep Subsurface Soil (MW90 Area and Building 763)

The RAO for Component 2 was to prevent potential groundwater degradation by contaminated subsurface soils. By reducing, to the extent possible, movement of TCE from deep soils to groundwater, the time required to treat contaminated groundwater (Component 1) will be reduced, facilitating protection of human health and the environment.

Component 3 - Shallow Subsurface Soil at Building 658 and Building 763

The RAO for Component 3 was to prevent potential degradation of groundwater resources by shallow subsurface soils containing TCE. By protecting groundwater, human health and the environment will also be protected.

Component 4 - Shallow Subsurface Soil at Site 9

The RAO for Component 4 was to prevent potential degradation of groundwater resources by subsurface soils containing TCE, and to prevent human exposure to soils containing chromium (site 9). By protecting groundwater and through removal of soil containing chromium which will preclude future exposure, human health and the environment will also be protected.

The remedial action objectives outlined in the CBA OU FS were based on a risk assessment developed using the data listed in Table 2. The risk assessment was based on USEPA and California Environmental Protection Agency (California-EPA) guidelines was performed and documented in the CBA OU RI Report (CDM Federal, 1992). The results of the baseline risk assessment are presented in Table 3.

TABLE 2
CBA OU CHEMICALS OF CONCERN IN GROUNDWATER AND SOIL
USED AS THE BASIS FOR EVALUATING RISKS IN THE 1993 FEASIBILITY STUDY

Media	Chemical	Frequency of Detection	Maximum Concentration	Mean Concentration	ROD Cleanup Standard	Treated Water Injection Standard
Groundwater (µg/L)	benzene	0/164[1]	ND	0.28	1	0.5
	1,2-dichloroethane	10/164	3.2	0.27	0.5	0.5
	1,2-dichloroethylene (total)	61/164	120	5.3	6	0.5
	tetrachloroethylene	28/164	3.9	0.42	5	0.5
	1,1,1-trichloroethane	12/164	3.5	0.36	200	0.5
	trichloroethylene	95/164	550	29	5	0.5
	vinyl chloride	0/164[1]	ND	0.13	0.5	0.5
Soil (mg/kg)	trichloroethylene	160/390	69	9.2	5 µg/L (leachate)[2]	NA
	chromium	14/410	7,750	420	150	NA

[1] Although not detected in the samples used for the CBA OU RI (CDM Federal, 1992) data set, benzene and vinyl chloride were reported for data collected during the 1980s. One-half of the detection limit was used for mean concentration.
[2] The TCE cleanup standard based on 5 µg/L of TCE in Toxicity Concentration Leachate Procedure (TCLP) analysis of soil sample as a groundwater protection measure. TCE did not pose a significant direct contact risk.
mg/kg = milligrams per kilogram; µg/L = micrograms per liter

2.2 Compliance with ROD Standards

The ROD cleanup and treated water injection standards are provided in Table 2 along with data collected during the CBA OU RI to support the CBA OU FS and ROD decision. The ROD standards apply to the VOCs detected in groundwater and TCE and chromium in soils. The risk assessment found that chromium was the only soil contaminant posing an unacceptable risk and that TCE, although not posing a direct contact risk, threatened groundwater quality at concentrations greater than 1 µg/L. The 5 µg/L TCLP leachate soil standard for TCE was based on nondegradation of groundwater and not human health protection per se. The following text

presents the current status of compliance with the ROD standards. Table 4 presents groundwater data for six groundwater sampling events (July and October 1997, January, April, July, and October 1998). This data should be compared with the data in Table 2 to provide an indication of the reduction in concentrations currently observed in CBA OU groundwater. Although the average TCE concentration has been reduced to less than the 5 µg/L ROD standard, the concentrations of TCE in several wells still exceed the standard.

TABLE 3
CBA OU BASELINE RISK ASSESSMENT
SUMMARY OF CARCINOGENIC AND NONCARCINOGENIC RISK

Scenario	Cancer Risk Using California-EPA Slope Factors	Hazard Index	Risk Acceptability[1]
Residential Child/Adult			
Ingestion of groundwater	6.9×10^{-5}	2.8	No
Inhalation of vapors	1.5×10^{-6}	<0.01	Yes
Ingestion of soils	3.1×10^{-3}	16.4	No
Dermal contact with soils	6.4×10^{-4}	2.9	No
Subtotal	3.8×10^{-3}	22.1	No
Industrial Worker			
Ingestion of groundwater	1.6×10^{-5}	0.4	Yes
Ingestion of soils	3.2×10^{-5}	0.06	Yes
Dermal contact with soils	5.2×10^{-6}	<0.01	Yes
Subtotal	5.3×10^{-5}	0.5	Yes

[1]Acceptability of Risk from CBA OU based on a cancer risk range of 1.0×10^{-6} to 1.0×10^{-4} and a hazard index of <1.0.

TABLE 4
CBA OU CHEMICALS OF CONCERN IN GROUNDWATER AND SOIL
BASED ON 1997 to 1998 GROUNDWATER AND SOIL CLEANUP DATA

Media	Chemical	Frequency of Detection	Maximum Concentration	Mean Concentration	ROD Cleanup Standard
Groundwater (µg/L)	benzene	0/384	ND[2]	ND[2]	1
	1,2-dichloroethane	26/384	2.4	0.51	0.5
	cis-1,2-dichloro-ethylene	195/384	54	1.3	6
	tetrachloroethylene	128/384	2.0	0.4	5
	1,1,1-trichloroethane	12/384	1.9	0.24	200
	trichloroethylene	337/384	50	4.9	5
	vinyl chloride	4/384	3.0	0.24	0.5
Soil (mg/kg)	trichloroethylene	38/137[4]	NA	NA	5 µg/L (leachate)[3]
	chromium	0/120[4]	142	NA	150

[1] One half of the reporting limit used as the concentration for sample results with no detection of the analyte.
[2] Not Detected in the samples used for the 1997-98 data set; benzene was reported for data collected during the 1980s; reporting limits varied between 0.2 and 1.0 micrograms per liter (µg/L).
[3] The TCE cleanup standard based on 5 µg/L of TCE in Toxicity Concentration Leachate Procedure (TCLP) analysis of soil sample as a groundwater protection measure. TCE did not pose a significant direct contact risk.
[4] Frequency of detection above the ROD standard.
mg/kg = milligrams per kilogram

Treated water injection is performed under a National Pollutant Discharge Elimination System permit issued by the California Regional Water Quality Control Board. California State Resolution 68-16, an ARAR for treated water injection, set a maximum limit of 5 µg/L for the discharge of any treated water outside of the plume, and a 0.5 µg/L average over a 30 day period for each VOC. Analyses of the treated water effluent showed that all extracted groundwater was treated to less than 0.5 µg/L for all ROD chemicals of concern and reinjected into the aquifer. There have been no exceedances of the injection standards for any of the chemicals.

Groundwater contaminants stripped from the water stream in the air stripping tower are treated with activated carbon before the air is released to the atmosphere. Chemical analyses of the air stream released from the air stripping tower to atmosphere showed no detectable VOCs. Therefore, the South Coast Air Quality Management District's 1 pound per day limit on total VOCs emitted from a VOC source have been met.

During the four years of operation of the treatment systems there have been no transfer of properties affected by the plumes, treatment systems, observational wells, or injection wells, and thus no deed restrictions have been established relative to the CBA OU remedies. The Air Force (August 1999) is in the process of transferring the airfield portion of the former Norton AFB to SBIAA. The deed for the airfield will include restrictions that protect the wells and treatment systems, allow the Air Force access to the systems for operations and maintenance (O&M) and sampling, and preclude installation of wells within the area of the plume without prior consultation with the Air Force and regulatory agencies.

The USEPA and California EPA have determined that the CBA OU remedies are operating properly and successfully in compliance with CERCLA Section 120 (h) 3. These remedies include the CBA groundwater pump and treat (P&T) system, the base boundary (BB) groundwater P&T system, completion of source area removal actions at site 9 and Building 658, the TCE source area in-situ SVE system, and completion and management of the WSCP program. (USEPA, 1996 and California EPA, 1996).

2.2.1 Component 1 - Groundwater

The primary chemicals of concern for groundwater are TCE and cis-1,2-DCE; the only chemicals that have consistently exceeded their MCLs in CBA OU groundwater. The groundwater remedy consists of three actions: (1) expansion of CBA P&T system; (2) installation and operation of a base boundary P&T system; and (3) and implementation of the *Off-Base Water Supply Contingency Policy*.

The P&T systems include the following elements: groundwater extraction wells, piping systems from the wells to centrally located treatment units; air stripping towers (extracted groundwater treatment units); carbon treatment units for removal of COCs from the air stream; piping systems to transport treated water to injection wells; and injection wells for disposal of the treated water. The CBA P&T treatment unit also includes an activated carbon treated water polishing tank due to the one time presence of TCE exceeding 4,000 µg/L in the area of the extraction wells. The CBA P&T and the base boundary P&T systems are each operated under separate O&M plans (Earth Technology, 1995c; 1996a). Because the average concentration of TCE dropped below the ROD standard of 5 µg/L, the CBA P&T system was shut down on March 1, 1999. The Base Boundary P&T system continues to operate.

The operations, maintenance, systems changes, and treatment efficiencies for both the CBA and BB P&T systems has been presented in annual Operations Reports (Earth Tech, 1997b, 1998b, and 1999). Sampling of the treatment systems is being performed under a separate sampling plan (Earth Tech, 1997c). The reviewer is referred to these reports for more details regarding the effectiveness of the two systems to extract, treat, and inject treated groundwater.

CBA P&T System

The original CBA P&T system was installed in 1992 in response to the 1988 observation of TCE exceeding 4,000 µg/L for monitoring well (MW) 90 located at Building 673. The system was intended to address the elevated concentration of TCE near the suspected source. The ROD directed the expansion of the CBA P&T system to address the portion of the plume with the highest TCE concentrations which was located in the core of the on-base portion of the TCE plume. In late 1994, the CBA P&T system was expanded to increase the volume of water treated by using five extraction wells and four injection wells in accordance with the design document (Earth Technology, 1994). Not all of the extraction wells were pumped at the same time and typically only the wells with the highest concentrations were operated to remove groundwater

with the highest levels of TCE. The expanded system operated at/or above its design flow rate of 400 gpm, treating 16 to 18 million gallons of groundwater per month.

The air stripping tower removed TCE from the extracted groundwater for subsequent treatment through activated carbon units. The air stripping tower was operated in accordance with California South Coast Air Quality Management District rules for release of volatile organic chemicals. Monthly air analyses of the emissions showed no detectable ROD chemicals of concern.

The CBA P&T system was operated in accordance with its O&M plan (Earth Technology, 1995c). During the operation of the CBA P&T, there were no significant operational problems with the extraction, treatment, or injection systems. This facility remained operational for more than 95% of available time throughout its four years of operation.

During the four years of operations, scheduled O&M consisted of the following: daily visual inspections and replacement of bag filters as necessary; weekly monitoring of water flow rates, air and water pressure, and water and air temperature; quarterly lubrication of pump and fan motors and measurement of amperage draw of motors; and annual calibration of flow meters and inspection of air stripper packing material. System components were cleaned and painted as needed.

Typical non-scheduled maintenance consisted of repair or replacement of leaking valves, starting the system after electrical power interruptions, cleaning water level sensors, replacement of down-hole pump motor leads due to chaffing of leads, replacement of one down-hole pump motor, replacement of air heater elements, and replacement of pump seals. Liquids and vapor granular activated carbon was replaced when analytical data indicated TCE saturation of the lead carbon unit (both systems had polishing units).

To evaluate treatment system performance and address National Pollutant Discharge Elimination System (NPDES) permit requirements, water samples were collected and analyzed on a monthly basis per the sampling and analysis plan (Earth Technology, 1997c). All discharges from the treatment system met the NPDES permit limitations.

Chemical analyses of the treated water showed all treated effluent from the CBA P&T system to be consistently below the 0.5 µg/L limit for injection for the entire period of operations.

The expanded CBA P&T system was operated successfully January 1995 through February 1999, treating over 800 million gallons of water and removing over 149 pounds of TCE. The concentrations of TCE at the extraction wells steadily decreased during this time period to below the ROD cleanup standard of 5.0 µg/L and at the time of shutdown (March 1, 1999) ranged between non-detect (0.5 µg/L) and 2.3 µg/L.

The CBA P&T achieved the CBA OU ROD objective of removing and treating TCE from the portion of the plume with the highest concentrations as observed during the RI. The CBA P&T system was deemed no longer cost-effective in treating the remaining shallow, discontinuous, on-base plume, resulting in its being placed in stand-by status on March 1, 1999. Groundwater modeling indicates that any remaining TCE in the on-base portion of the plume will be captured by the downgradient BB P&T system.

Groundwater sampling of the wells in the vicinity of the CBA P&T system will continue on a quarterly basis to evaluate trends in groundwater concentrations while the system is inactive. The CBA P&T system will continue to be operated each quarter in order to dispose of purge produced during basewide groundwater sampling events. In addition, the five extraction wells are sampled after they are operated for 24 hours to check for rebound effects. The system remains in a “ready” stage and can be reactivated should TCE in any of the CBA P&T extraction wells exceed 10 µg/L. At that time the CBA P&T system will resume continuous operations. Influent and effluent samples will also be taken to address NPDES monitoring requirements.

The monthly O&M costs for the CBA P&T system during the period that it was operated ran approximately $26,000 per month. This cost reflected the project cost for operating this facility. The facility is currently in standby status and has minimal maintenance costs.

Base Boundary P&T System

The base boundary P&T system was installed in 1995 as a measure of controlling the TCE plume on base and consists of three extraction wells and seven injection wells designed to direct the plume into the capture zone of the extraction wells (Earth Technology, 1996a). Since April 1996, the system has operated at or above the design flow rate of 2,250 gpm, treating over 3 million gallons of groundwater per day. In January 1999, three extraction wells were in use to remove TCE-affected groundwater. The concentration of TCE in well M/EW-1 was 5.2 µg/L, well M/EW-2B 1.9 µg/L, and well M/EW-3 0.5J µg/L. The weighted average concentration for the three wells based on pumping rates was 2.17 µg/L, below the 5 µg/L ROD standard.

When the BB P&T system was first operated in March 1995, it was determined that the well screen at M/EW-2 was damaged and the well had filled in with sand. The well was abandoned per San Bernardino County requirements and a new extraction well installed. The new well was placed on line in November 1995.

Scheduled O&M consists of the following: daily visual inspection and manual recording of flow data, water levels, pH, and level of CO_2 in the CO_2 feed tank; weekly the pumps, valves, pipe lines, motors, and bolts are inspected for leaks and excessive noise, and the CO_2 tank is filled. Drive belts are replaced if they are excessively noisy. Quarterly the oil is changed in the extraction well pumps, blower bearings, and transfer pumps, the transfer pump and blower motors are greased and amperage draw for each motor measured. Annually the air stripper is inspected and flow meters on the extraction wells calibrated. System components are cleaned and repainted as necessary. The vapor phase carbon is exchanged when analytical data indicated breakthrough of TCE to the atmosphere.

Unscheduled maintenance activities have included replacement of broken pump shafts and down-hole pumps at extraction well M/EW-2b. After several failures, the motors and pumps were replaced in June 1997 with lower speed (1,800 to 3,600 rpm) units. The pump motor at extraction well M/EW-1 failed three times. After the third failure, the motor was replaced with a larger motor (50 hp versus 40 hp) on November 15, 1996. The larger motor has operated successfully for the last three years.

After noting an increase in effluent TCE levels from non detect to 0.7 ppb in September 1996, the air stripper was inspected and it was determined that a nozzle arm on the air stripper distributor had broken. The arm was replaced. After a second failure and repair in November 1996, additional supports were installed on the distributor manifold and arms. Several of the Programmable Logic Control System computer cards have failed and have been replaced. Correction of all problems was performed quickly and overall the BB P&T has remained operational for more than 95% of the available operations time.

The BB P&T system experienced problems soon after startup with the fouling of the injection well screens with calcium carbonate. The fouling reduced the treated water injection capacity and portions of the treated water had to be discharged to the storm drain system under a permit with the Regional Water Quality Control Board. The screens were subjected to a series of cleaning procedures (January and February 1996, August and September 1996, and March 1997) to break loose and dissolve the calcium carbonate. A polyphosphate feed system was installed in March 1996. It reduced the calcium carbonate buildup in the piping and well screens. The treated groundwater injection system was retrofitted in July 1997 with a carbon dioxide treatment system to adjust the water pH and prevent the buildup of calcium carbonate within the well screens, and the polyphosphate injection system was discontinued. The cleaning of the screens and the carbon dioxide system proved to be successful and the injection capacity of the wells was restored.

A year 2000 compliance review of the system has been performed and based on that assessment, the computer system and software system has been upgraded to be Y2K compliant.

Water and air samples are collected and analyzed on a monthly basis to determine system performance and compliance with NPDES and Regional Air Quality Control Management District permits per the Sampling and Analysis Plan (Earth Technology, 1997c). Water and air discharges from the BB P&T have been below all regulatory and ROD requirements.

Operational costs for the BB P&T system run approximately $60,000 per month, which reflects the budgeted cost for operating and maintaining the facility.

Off-Base Water Supply Contingency Policy

The *Off-base Water Supply Contingency Policy* (WSCP) directs the sampling of the off-base monitoring well network on a monthly basis along with water supply wells within the path of the TCE. The WSCP requires that monitoring wells in the vicinity of affected production wells be sampled monthly if the 6-month average TCE concentration is greater than one-fourth of the MCL (or 1.25 μg/L). If the well TCE concentration 6-month average is less than 1.25 μg/L, the well is sampled quarterly. Wells identified for sampling on a quarterly basis continue to be sampled at that frequency unless two analyses for TCE within a one-year time frame exceed 2.5 μg/L. Because the concentrations of TCE in each well can vary month-to-month, the wells to be sampled, and frequency of sampling, can change as concentrations increase or decrease relative to the 1.25 μg/L average concentration. As of April 1999, 54 off-base multi-level zone and single screen wells were being sampled quarterly; 24 multi-level zone and single screen wells were being sampled monthly.

Twenty-four of 26 production wells downgradient of the former Norton AFB have shown detectable levels of TCE and are sampled in accordance with the WSCP. TCE has never been detected in samples collected by the City of Riverside from Warren 1 and Warren 4, therefore,

these two wells are not sampled under the WSCP. Production wells with a TCE concentration of less than 1 µg/L are sampled quarterly. Production wells with TCE between 1 and 2 µg/L are sampled monthly, and wells exceeding 2 µg/L are sampled bimonthly. As of April 1999, two production wells are sampled monthly, seven production wells are sampled bimonthly, and 15 production wells are sampled quarterly. Because the concentrations of TCE in each well can vary month-to-month, the wells to be sampled and frequency of sampling can change as concentrations increase or decrease relative to the less than 1 µg/L, 1 to 2 µg/L, and greater than 2 µg/L action levels. Table 5 lists the current production wells sampled and the frequency of sampling. Sampling of these 24 production wells continues under the guidance of the WSCP (Earth Tech, 1995a).

Production wells that exceed 5 µg/L on average are considered for either well head treatment, blending, or replacement water supply. Six production wells have been impacted with TCE at concentrations exceeding 5 µg/L. For production well Raub #5, the Air Force installed an activated carbon treatment system consisting of 4 granulated activated carbon units containing 20,000 pounds of carbon. The well has been operating efficiently since March 1998 with the carbon replaced once in March 1999. The treatment system is monitored by the City of Riverside in accordance with a California Department of Health Services' approved sampling and monitoring plan. In addition, the Air Force monitors the effluent monthly to confirm the City of Riverside results.

Warren 2 and Warren 3 have had periodic TCE concentrations exceeding 5 µg/L. These wells are low producers that are only operated periodically. The City of Riverside has been blending the water from these wells with water from the Raub field wells to meet MCL requirements.

TABLE 5
SAMPLING FREQUENCY OF WATER SUPPLY WELLS IMPACTED BY CBA OU TCE PLUME

Well Identifier	Sampling Frequency	Well-head Treatment
Gage NEW 6	Monthly	Not Applicable
Gage 26-1	Bimonthly	Activated carbon
Gage 27-1	Bimonthly	Activated carbon
Gage 27-2	Monthly	Not Applicable
Gage 29-1	Quarterly	Not Applicable
Gage 29-2	Bimonthly	Not Applicable
Gage 29-3	Bimonthly	Purchase (blending)
Gage 30-1	Quarterly	Not Applicable
Gage 31-1	Quarterly	Not Applicable
Gage 46-1	Quarterly	Not Applicable
Gage 51-1	Quarterly	Not Applicable
Gage 56-1	Quarterly	Not Applicable
Gage 66-1	Quarterly	Not Applicable
Gage 92-1	Quarterly	Not Applicable
Gage 92-2	Quarterly	Not Applicable
Gage 92-3	Quarterly	Not Applicable
Raub 2	Quarterly	Not Applicable
Raub 3	Quarterly	Not Applicable
Raub 4	Quarterly	Not Applicable
Raub 5	Bimonthly	Activated Carbon
Raub 6	Quarterly	Not Applicable
Raub 8	Quarterly	Not Applicable
Warren 2	Bimonthly	Purchase (blending)
Warren 3	Bimonthly	Purchase (blending)

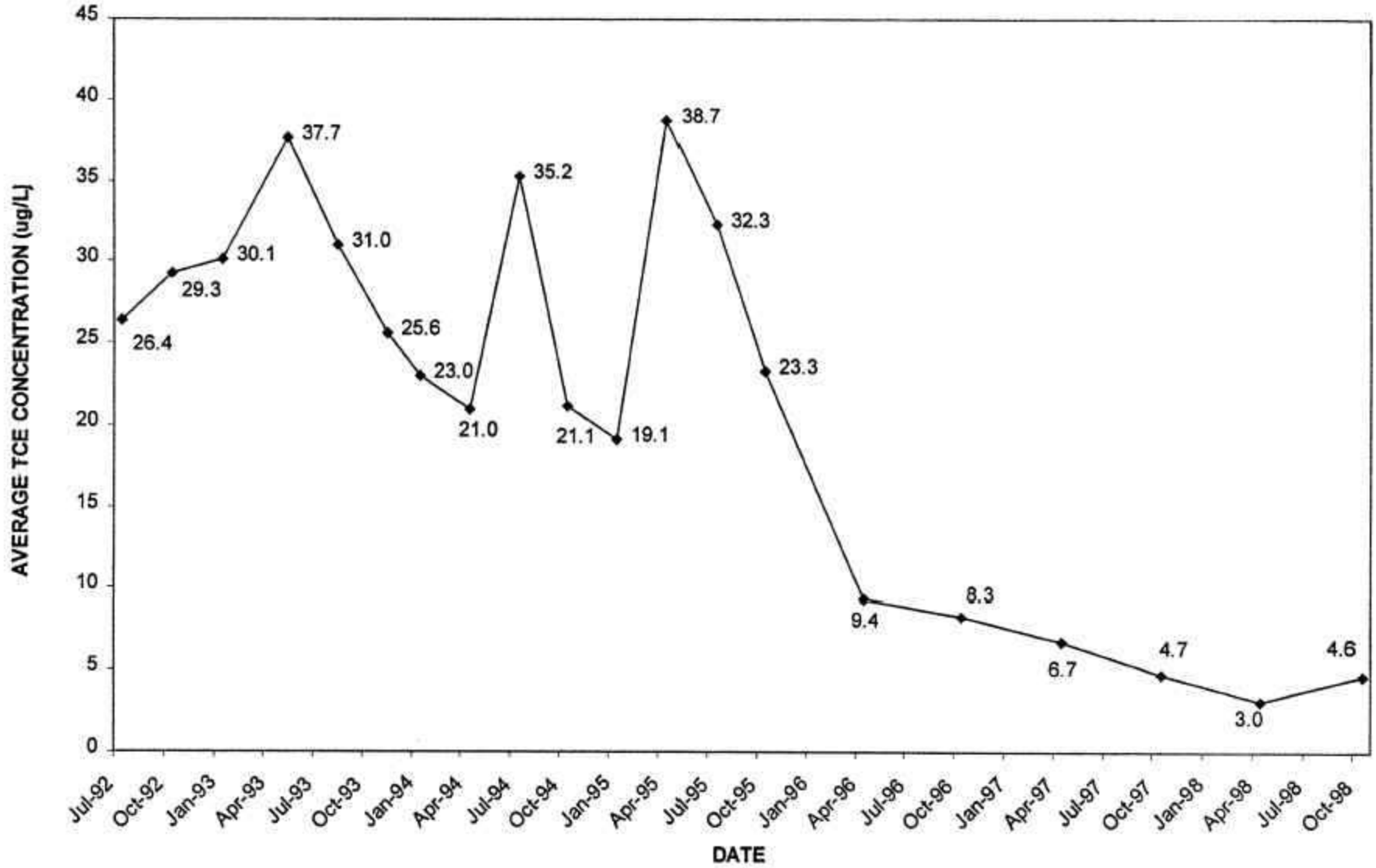
Note: sampling frequency subject to change based on well concentrations

Gage 26-1, Gage 27-1, and Gage 29-3 are also impacted by TCE above the MCL. Based on computer modeling results performed by Lockheed-Martin, these wells are also being affected by TCE from the Crafton-Redlands plume (HSI Geotrans, 1998). Lockheed-Martin has constructed GAC wellhead treatment systems at Gage 26-1 and 27-1. The Gage Canal Company, which operates the wells, is monitoring the systems in accordance with Department of Health Services requirements. At present, water from Gage well 29-3 is being blended to meet MCL requirements for TCE.

Results of Groundwater Monitoring

Groundwater monitoring for TCE and the VOCs comprising the CBA plume has been performed on a quarterly basis since July 1992. The results are reported in quarterly technical memoranda and summarized as trends in annual reports. The *Sixth Annual Groundwater Data Trends Report* was released in December 1998 (CDM Federal, 1998b). For purposes of presenting the groundwater data, the plume has been separated into on-base and off-base portions. The on-base discussion focuses on the effectiveness of the CBA P&T and base boundary P&T systems and the SVE soil remedies. The off-base discussion focuses on the portion of the plume in contact with the production well field.

Table 4 presents a summary of the analytical results for the CBA VOC plume chemicals of concern based on the last six groundwater sampling events (July and October 1997; January, April, July, and October 1998). Figure 4 presents a graphical display of the average groundwater concentrations for the on-base portion of the plume. Since the implementation of the CBA OU P&T remedies in 1995, the trend of the average TCE concentration has been downward from 38.7 µg/L in April 1995 to 3.0 µg/L in April 1998, rising to 4.6 µg/L in October 1998. The maximum concentration of TCE reported for any of the monitoring wells decreased from 940 µg/L for MW190 in April 1995 to less than 9 µg/L in April 1998. The downward trend in on-base TCE concentrations was exhibited in all wells (except MW 183), attesting to the effectiveness of the CBA groundwater and soil remedies.



CDM Federal Programs Corporation
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AVERAGE TCE CONCENTRATION
CBA ONBASE TCE PLUME WELLS
JULY 1992 - OCTOBER 1998

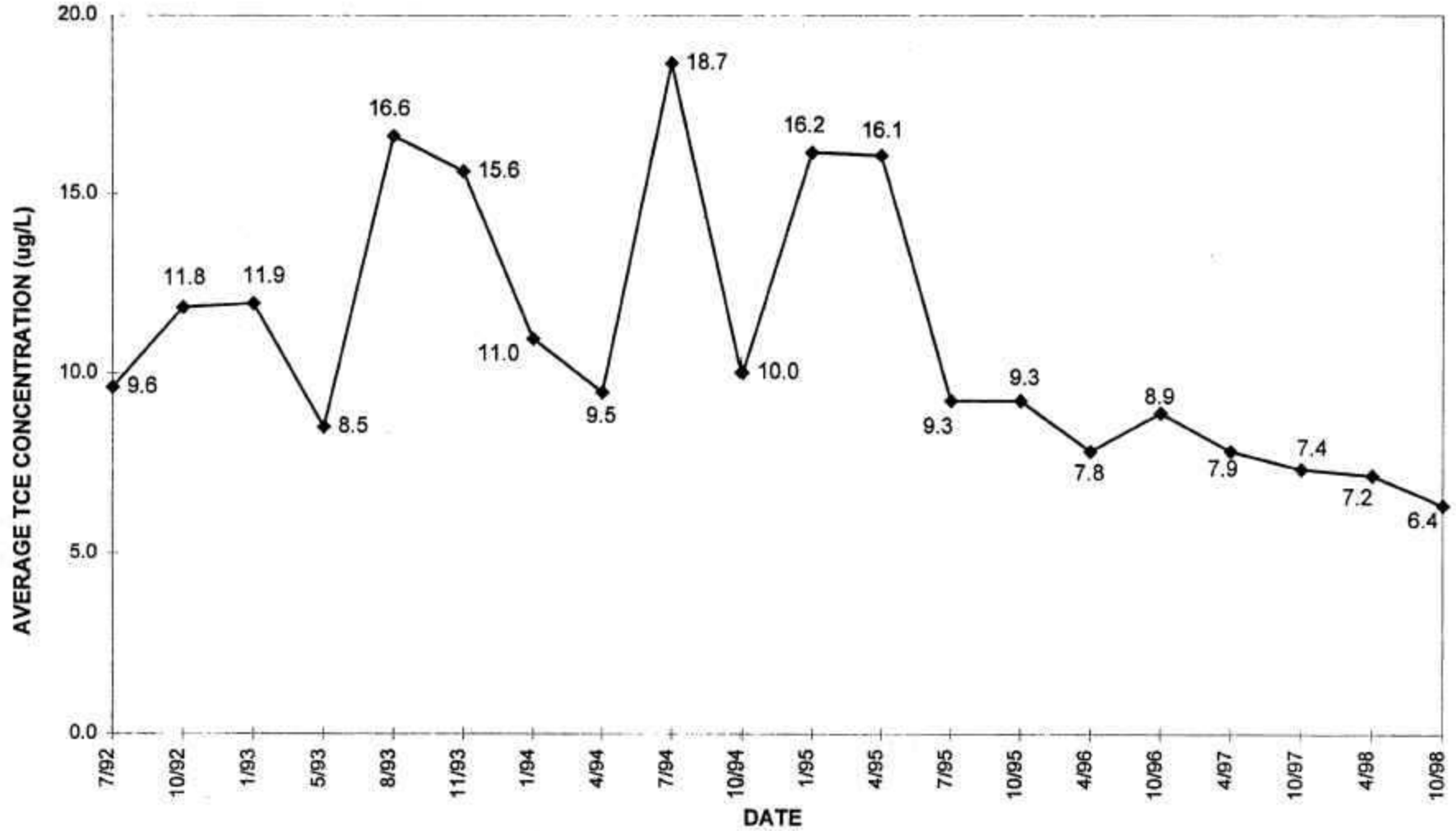
Figure 4

The exception to the downward decrease in TCE concentrations is for MW183 located near the Building 763 TCE source area. The TCE concentration in MW183 rose to 24 µg/L in July 1998 from <1 µg/L in April 1998 (CDM Federal, 1998a). In October 1998 this well exhibited a 50 µg/L concentration (CDM Federal, 1999a). MW183 is an "A"-Level well meaning that the screen interval is at the top of the upper aquifer. It is possible that the rise in the water table following the winter of 1997-98 brought groundwater in contact with residual TCE at the Building 763 location. This well continues to be sampled on a quarterly basis.

Even with the rise in groundwater concentration in MW183, the average concentration of TCE in the on-base portion of the plume rose only to 4.6 µg/L because concentrations in other wells continue to decline. In October 1998, only 9 of 40 wells exceeded 5 µg/L and only two wells (MW183 and MW285) exceeded 10 µg/L.

For the off-base portion of the plume, the average concentration of the plume has decreased from 18.7 µg/L in July 1994 to 6.4 µg/L in October 1998 (Figure 5). The drop in average concentration for the off-base portion of the plume has been less dramatic than for the on-base portion, but the starting concentrations were much less and the off-base portion of the plume is beyond the treatment and control effects of the base boundary P&T system. The highest concentration observed off-base was 64 µg/L reported for MW315 in July 1994. Since that time the maximum concentration observed in any well has ranged between 25 and 45 µg/L.

Figure 6 illustrates the average TCE groundwater concentrations for the combined on-base and off-base portions of the CBA OU plume for the period between July 1992 and October 1998. It should be noted that the Crafton-Redlands plume is migrating westward south of the Santa Ana River and has reached some of the eastern production wells south of Norton AFB. Modeling has shown that the Crafton-Redlands plume is contributing to TCE concentrations reported for the easternmost wells.



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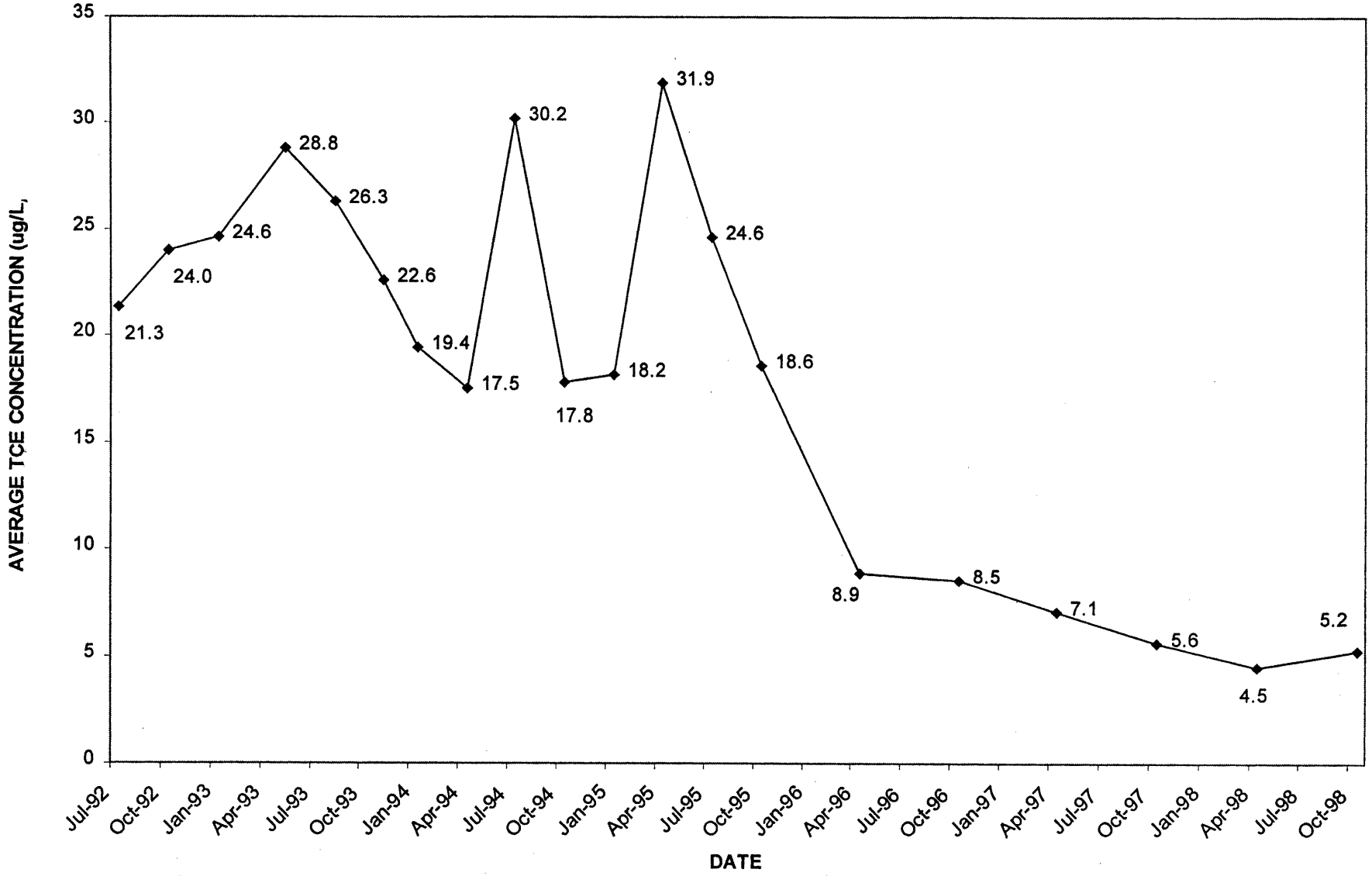
AVERAGE TCE CONCENTRATION
CBA OFFBASE TCE PLUME WELLS
JULY 1992 - OCTOBER 1998

Figure 5



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AVERAGE TCE CONCENTRATION
CBA ONBASE AND OFFBASE TCE PLUME WELLS
JULY 1992 - OCTOBER 1998

Figure 6

Results of Computer Simulation Modeling of TCE Concentrations Over Time

Earth Technology (1998) conducted computer modeling of TCE concentrations over time using July 1997 TCE concentration data and October 1997 groundwater elevation data as the basis for predicting attenuation of the plume. The modeling involved two scenarios, one with continuation of the CBA P&T system and the second with the system shut down. The modeling results predicted that with the CBA P&T continuing operations for three additional years, that the 5 µg/L ROD standard for TCE for all wells would be met on-base within 13 years. However, if the CBA P&T system were to be shut down, the ROD standard would be met in 16 years. The modeling demonstrated that the CBA P&T system as currently being operated was having little effect in reducing TCE concentrations in on-base groundwater. The modeling was based, however, on the assumption that the residual soil sources that created the plume were no longer impacting the plume at concentrations greater than 0.07 µg/L. Groundwater concentrations at the Building 763 source location (MW183) have increased since cessation of the SVE remedy. Groundwater at this location is upgradient of CBA P&T extraction wells M/EW-9 and M/EW-10. Should concentrations of TCE exceed 5 µg/L at these extraction well locations, they could be operated to capture the contaminants emanating from the Building 763 source location, thereby not affecting the operational life of the BB P&T system. The time period for pumping from M/EW-9 and M/EW-10 is not known, but is expected to be short because the magnitude of the TCE source at Building 763 has been significantly reduced as a result of the SVE remedy.

Regarding the off-base portion of the plume, that is not affected by the base boundary or CBA P&T systems, modeling predicted that TCE would meet the ROD standard in 32 years in wells at the 230 to 285 feet (ft) below ground surface (bgs) aquifer level. This places an upper limit on the time that the WSCP may need to remain in effect (32 years). The production wells impacted by the plume would be expected to exceed MCLs for a much shorter period due to the deeper aquifer depth from which the wells pump (the plume is within the upper aquifer and the production wells primarily pump from the lower aquifer), the long screen intervals of the

production wells, and the mixing of clean aquifer water with the TCE-affected water during groundwater pumping.

2.2.2 Component 2 - Deep Subsurface Soil (MW90 Area and Building 763)

To address soil contaminated with TCE that was found at depths as great as 80-90 ft bgs, the Air Force installed an SVE system at the Building 673 (MW90 Area) and Building 763 TCE source locations (Earth Tech, 1995b). Each extraction system consisted of a series of vapor extraction wells installed to just above the top of the upper aquifer. The extraction well network at Building 673 consisted of 14 SVE wells; the extraction well network at Building 763 consisted of 24 SVE wells plus the conversion of two existing perched-zone groundwater wells. The extraction wells were connected by piping to two blowers capable of extracting 8,500 cubic feet per minute. The extracted vapor was treated using activated carbon. The blowers and treatment system were located immediately west of Building 763.

The SVE system was placed into operation on October 4, 1995 and operated nearly continuously for 19 months, except for performance of routine maintenance. The system was shut down during April 1997 in order for confirmation soil borings to be drilled and sampled and for rebound and cross-flow tests to be performed. During operation of the SVE system, over 7,500 pounds of TCE were removed. The system operation was discontinued in August 1997 (Earth Technology, 1997); dismantled and moved to El Toro Marine Base in October 1998.

The total O&M costs for operating the facility for the 19 months were $920,000. This cost reflects the projected costs for the SVE system for the months it was operated.

The ROD cleanup standard for subsurface soils is 5 µg/L TCE in TCLP leachate as a groundwater quality protection measure. Some of the confirmation soil samples collected from finer-grained soil materials that harbor the residual TCE produced chemical results in excess of the 5 µg/L TCLP standard (Earth Technology, 1997). Earth Technology (1997) estimated that

138 pounds of TCE remained in the Building 673 area (the primary source for the TCE plume) and 632 pounds remained in the Building 763 area. However, because the SVE system was producing minimal concentrations of TCE in extracted soil gas and the groundwater contained TCE at, or below, 5 µg/L in wells within the source area locations, the system was shutdown and removed. Completion of the SVE remedy is discussed in the closure report (Earth Technology, 1997). USEPA and California-EPA concurred with completion of the remedy when they both accepted the final closure report on October 16, 1997 and September 11, 1997, respectively.

In July 1998, TCE at 24 µg/L and cis-1,2-DCE at 63 µg/L were reported for groundwater samples collected from MW183, located downgradient of the Building 763 source area and former SVE system. The previous maximum concentrations of TCE and cis-1,2-DCE were 52 µg/L (April 1995), and 18 µg/L (April 1996), respectively. Prior to July 1998, concentrations of TCE had not exceeded 5 µg/L in MW183 since April 1996 (5.2 µg/L) and cis-1,2-DCE since July 1997 (15 µg/L). The concentrations of TCE reported for MW183 were 50, 97, and 49 µg/L for October 1998, January 1999, and April 1999, respectively. The concentrations of cis- 1,2-DCE for MW183 were 54, 56, and 50 µg/L for October 1998, January 1999, and April 1999, respectively.

The increase in TCE and cis-1,2-DCE concentrations in MW183 is most likely the result of mobilization of these chemicals from deep vadose zone soils near the top of the aquifer. The aquifer elevation has been rising slowly since 1995 (following a period of drought) and the current groundwater elevation is the highest observed since 1991. It is possible that the rise in the water table has mobilized residual TCE contained in vadose zone soils that are now saturated due to the change in water table elevation. Increases in TCE concentration have not been observed in deeper monitoring wells at the MW183 location or in adjacent water table wells, indicating that the effect exhibited at the Building 763 source location is limited in extent. MW183 and adjacent monitoring wells will continue to be monitored on a quarterly basis in order to assess trends related to this release of TCE and cis-1,2-DCE. Groundwater flow velocity in the vicinity of MW183 averages about 0.5 ft per day. Groundwater extraction wells M/EW-9

and M/EW-10 are located approximately 1,500 feet downgradient of MW183, therefore, it will take groundwater containing TCE and cis-1,2-DCE approximately 8 years from July 1998 (when the contamination was first observed) to reach these extraction wells. Concentrations of TCE and cis-1,2-DCE at these extraction wells would be less than that observed at MW183 due to natural attenuation of the chemicals.

The frequency of monitoring of the cross-gradient and down-gradient monitoring wells has been increased to quarterly and the Air Force will continue to evaluate the trend of TCE and cis-1,2-DCE concentrations associated with MW183 as future quarterly sampling results become available.

2.2.3 Component 3 - Shallow Subsurface Soil at Building 658 and Building 763

Component 3 of the CBA OU ROD addressed shallow soil contamination (i.e., soil from the surface to about 12 ft bgs) associated with Building 658 and Building 763. The ROD stipulated soil excavation followed by ex-situ treatment to remove TCE at Building 658. Some of the shallow TCE contaminated soil at IRP site 9 within Building 763 was found to be co-mingled with chromium and was addressed under ROD Component 4. The remaining shallow subsurface soil at Building 763 was addressed through the SVE system installed under CBA OU ROD Component 2.

At Building 658, approximately 350 cubic yards (cu yd) of TCE-contaminated soil, associated with a waste sump at the north end of the building, were excavated for ex situ treatment. The soils were treated in a treatment cell using SVE and carbon air treatment. The SVE system was operated for 19 days. All soil samples analyzed after completion of the treatment had TCE concentrations of less than 5 µg/L TCLP leachate (Earth Technology, 1996b); therefore, the ROD standard was met for the Building 658 TCE source area. USEPA and California-EPA concurred with completion of the remedy when they both accepted the closure report on April 2, 1996 and March 25, 1996, respectively.

2.2.4 Component 4 - Shallow Subsurface Soil at Building 763 (IRP Site 9)

IRP site 9 is the former electroplating shop within Building 763. Building 763 has had a long history of aircraft repair and maintenance activities. Soil at IRP site 9 was contaminated with chromium and TCE above ROD standards. The removal action at IRP site 9 involved excavation of 890 cu yd of soil to a depth of 12 ft bgs, and the removal of concrete flooring, footings, walls, conduit, and ducts within the area of the former electroplating shop. Approximately 2,123 tons (1,633 cu yd) of contaminated material and 914 tons (703 cu yd) of concrete were taken to a Resource Conservation and Recovery Act (RCRA) Subtitle C disposal facility for proper containment. Confirmation samples collected after the removal indicated that chromium concentrations had been reduced to less than 150 milligrams per kilogram (mg/kg), the ROD chromium standard (Earth Technology, 1996b). USEPA and California-EPA concurred with completion of the remedy when they both accepted the closure report on April 2, 1996 and March 25, 1996, respectively.

2.3 Compliance With ARARs

The applicable or relevant and appropriate requirements (ARARs) for the CBA OU remedies addressed the MCLs for VOCs in the aquifer, waste treatment and storage, treated water discharge, air discharge, disposal of activated carbon, and the handling and disposal of contaminated soils. All ARARs were met during construction and operation of the remedies. The P&T remedies and WSCP continue to be implemented to address the MCL limit for TCE in the aquifer. There have been no changes in ARARs since the issuance of the ROD and at present there is no need to add or delete any of the ARARs.

2.4 Re-evaluation of Groundwater Risk, CBA OU TCE Plume

As part of the Former Norton AFB Basewide FS effort (CDM Federal, 1999b), the total residual risk due to all contaminated sites and affected groundwater was re-evaluated. This included recalculation of the risk due to the CBA TCE plume based on recent (April 1998) groundwater data for the plume. The risk assessment was based on the most recent (i.e., 1998) USEPA and California-EPA toxicity factors for carcinogens and noncarcinogens. Table 6 presents the findings from the recent risk analysis. Only the residential risk is shown because the industrial worker risk derived as part of the CBA OU RI risk assessment showed the industrial risk already to be within the acceptable range. The combined SVE and groundwater P&T remedies have reduced TCE concentrations in the CBA plume to levels that have also reduced the noncancer hazard index (HI) risk from 22.1 to 1.27. The cancer risk has been reduced from 3.8×10^{-3} (using Cal-EPA 1992 toxicity data) based on the CBA OU RI conditions in the aquifer to a current acceptable risk level of 5.0×10^{-5} using 1998 groundwater data.

TABLE 6
REVISED CBA OU TCE PLUME RISK ASSESSMENT
SUMMARY OF CARCINOGENIC AND NONCARCINOGENIC RISK

Scenario	Cancer Risk Using USEPA/California-EPA Slope Factors	Hazard Index	Risk Acceptability[1]
Residential Child/Adult			
Ingestion of groundwater	1.5×10^{-5}	0.27	Yes
Inhalation of vapors	2.6×10^{-5}	0.79	Yes
Dermal contact of groundwater	9.4×10^{-6}	0.21	Yes
Ingestion of soils	0.0	0.0	Yes
Dermal contact with soils	0.0	0.0	Yes
Subtotal	5.0×10^{-5}	1.27	No

[1]Risk Acceptability is based on a cancer risk range of 1.0×10^{-6} to 1.0×10^{-4} and a hazard index of <1.0.

The Agency for Toxic Substances and Disease Registry also performed a Public Health Assessment for Norton AFB in which it was concluded that TCE groundwater contamination from Norton AFB does not pose a threat to public health (U.S. Department of Health and Human Services, 1998).

3.0 ASSESSMENT

All of the CBA OU ROD remedies, including shallow soil excavation, soil vapor extraction, CBA "hot spot" P&T, BB P&T, and the WSCP have been implemented in accordance with the objectives of the ROD. The shallow soil excavation remedy and CBA "hot-spot" P&T have met their remedial objectives. The BB P&T system is capturing the plume at the base boundary thus meeting its goal for plume control. This system is currently treating water at concentrations less than the 5 µg/L ROD standard. The BB P&T system continues to be operated because TCE groundwater concentrations upgradient of the facility still exceed the ROD standards, although the utility of continued operations of the system needs to be assessed. The WSCP continues to provide the required data to assess impacts of the plume to the well production field. The contingency well-head protection measures described in the WSCP continue to be followed and implemented.

The SVE system at the Building 673 source location appears to have reduced residual TCE levels protective of groundwater resources. Residual TCE at the Building 763 source location appears to be sufficient to impact groundwater at concentrations greater than 50 µg/L. Because TCE concentrations exceeding the ROD standard (5 µg/L TCE in leachate) remain at the source locations, continued assessment of the groundwater quality on a quarterly basis is necessary for both locations.

There have been no significant changes to the risk assessment parameters related to assessing risks due to the presence of TCE and cis-1,2-DCE in groundwater. Because the groundwater concentrations have substantially decreased as a function of the effectiveness of the remedies, the

current risk is substantially reduced from that which existed prior to remedy implementation. With the exception of the slowly rising water table, there have been no other changes in hydrologic/hydrogeologic conditions that have adversely affected contaminant transport or the risk assessment models. There have been no ARAR changes that affect risk analysis or operations/maintenance of the treatment systems.

Land use for the former airbase remains industrial and commercial. At present, there are no plans for residential development of the former base properties. Land use of the off-base portion of the plume is a mixture of residential, open space, commercial, industrial, and warehousing.

All treatment systems are fenced to prevent unauthorized access. All affected property remains under the ownership of the Air Force and thus no institutional controls have been established.

Sampling of monitoring wells within the TCE plume is performed quarterly under the Comprehensive Groundwater Monitoring Program. Groundwater data trends are assessed annually and the sampling program modified in accordance with data trends and criteria specified in the annual report (CDM Federal, 1999).

4.0 RECOMMENDATIONS

4.1 CBA Pump and Treat System

During the last year of its continuous operation, the CBA P&T system was extracting and treating groundwater with TCE concentrations of less than 5 µg/L, which is the ROD standard, and thus addressed the “hot spot” control objective of the ROD. Given that the average concentration of the plume on-base is less than 5 µg/L, the reason for continued operation of the CBA P&T system does not exist, supporting its shutdown. All of the extraction wells, including extraction well (M/EW-10) located downgradient of MW183, should be sampled on a quarterly basis to identify any rebound in plume concentrations at the wells. Any extraction well could be

operated to reduce TCE concentrations if elevated concentrations of TCE (e.g., greater than 10 µg/L) be observed in the area of influence of the extraction well. The ongoing groundwater monitoring program, that includes quarterly sampling of key CBA TCE plume wells (including MW183), should be continued in order to provide data that will be used to evaluate trends in TCE concentrations for the on-base portion of the plume.

4.2 Base Boundary Pump and Treat System

The BB P&T system is extracting and treating groundwater with TCE concentrations of less than 5 µg/L, which is the ROD standard, and is still effectively capturing the on-base plume. This system requires a re-evaluation of its purpose and effectiveness in light of the concentrations of TCE in the vicinity of the base boundary and the continued effectiveness of the WSCP.

As part of the evaluation of the effectiveness of the BB P&T, the Air Force plans to run a series of computer simulation models of the plume using the extraction and injection wells as factors in the model runs. The current extraction/injection system design was developed as part of a model developed by Dr. Richard Peralta of the Utah State University. Based on the current design, the plume at the base boundary is being directed into extraction wells M/EW-2B, M/EW-3 and M/EW-1 by a series of injection wells. This system has been effective in capturing the plume as was indicated by the prior modeling performed by Dr. Peralta.

The Air Force plans to contract Dr. Peralta to perform additional modeling of the plume as a measure to optimize the capture effectiveness of both the BB and CBA P&T systems. The results of the optimization modeling could be used to change the extraction pumping scheme of either system (e.g., increase or decrease pumping rates of selected wells), the injection scheme (e.g., focus reinjection on one portion of the plume to further direct it to specific extraction wells), or it could be used to identify a specific location for the installation of a new extraction well. The goal of the optimization modeling would be to reduce the time required to meet the 5 µg/L ROD standard for the on-base portion of the plume. The optimization modeling will also

evaluate the potential impacts of the elevated TCE concentrations at MW183 on the long-term operations of either P&T systems.

4.3 Water Supply Contingency Policy

The WSCP is addressing the off-base production wells that have been affected by the TCE plume. The ongoing groundwater monitoring program, that includes quarterly monitoring of key base boundary CBA TCE plume wells and all of the off-base wells, should be continued in order to provide data that will be used to evaluate current trends in TCE concentrations for the off-base portion of the plume. The semimonthly and monthly sampling of the production wells provides important data regarding drinking water quality and should be continued as long as off-base wells monitoring the Norton AFB plume indicate TCE concentrations exceed the ROD standards. No changes to the WSCP are recommended at this time.

5.0 STATEMENT OF PROTECTIVENESS

I certify that the soil remedies have been constructed to eliminate the direct soil contact risk for the sites addressed as part of the CBA OU. The groundwater P&T remedies have been constructed and are working as designed and have substantially reduced the threat to human health and the environment originally posed by the contaminants prior to implementation of the remedies. The CBA P&T remedy has met its objective of removing TCE from the location of the plume with the highest concentrations to levels that address the ROD standards. The SVE remedies have been constructed and completed to substantially reduce the soils concentrations of TCE and cis-1,2-DCE and resulting contaminant concentrations in the aquifer, particularly at the Building 673 source from location where the plume originated. The SVE remedy has not been totally effective in reducing TCE concentrations in the aquifer to below ROD standards and continued monitoring of groundwater at the source locations is warranted. The ROD standards have not been met for the aquifer requiring continuation of portions of the CBA OU remedies, particularly the WSCP. The WSCP, which addresses domestic water supplies and the ongoing

groundwater sampling program, will be continued in order to ensure that the protectiveness of the remedies remains.

Thomas J. Bartol, AFBCA
Norton Operating Location
Base Environmental Coordinator

6.0 NEXT FIVE-YEAR REVIEW

Although aquifer contaminant concentrations have been substantially reduced from the levels present prior to implementation of the CBA OU ROD remedies, solvent contaminants, primarily TCE and cis-1,2-DCE, remain in the aquifer at concentrations exceeding the ROD standards. Therefore, a second five-year review is warranted for the CBA OU. The next five-year review will take place in January 2004. Included as part of the next five-year review will be the evaluation of any sites located on the base with residual soil concentrations exceeding the unrestricted land use standards. These sites, current risks, and unrestricted land use standards are described in the Basewide Feasibility Study (CDM Federal, 1999b).

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