Five-Year Review Report

(Fourth) Five-Year Review Report

for

United Chrome Products

ORD009043001

Corvallis

Benton County, Oregon

Draft August 2011 Revision 5

PREPARED BY:

USEPA Region 10
Seattle, Washington

Approved by:

Date:

Daniel D. Opalski, Director
Office of Environmental Cleanup

9/29/2011

Contents

Tables

Figures

Acronyms and Abbreviations

ARARs	Applicable or Relevant and Appropriate Requirements
bgs	below ground surface
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information Systems
City	City of Corvallis
Cr(III)	trivalent chromium
Cr(VI)	hexavalent chromium
DW	Drinking Water
E&ES	Easement and Equitable Servitudes
ESD	Explanation of Significant Difference
FS	Feasibility Study
GETS	groundwater extraction and treatment system
gpm	gallon per minute
IC	Institutional Control
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OAR	Oregon Administrative Rules
ODEQ	Oregon Department of Environmental Quality
ORS	Oregon Revised Statutes
PCOR	Preliminary Closeout Report
POC	Point of Compliance
POTW	publicly- owned treatment works

PZ	Piezometer
ROD	Record of Decision
RI	Remedial Investigation
RSL	Regional Screening Level
SARA	Superfund Amendment and Reauthorization Act
Site	United Chrome Products Superfund site
USEPA or EPA	United States Environmental Protection Agency

Executive Summary

This report presents the findings of the fourth five-year review for the United Chrome Products Superfund Site (CERCLIS Number ORD009043001) located in Corvallis, Oregon. The purpose for conducting the five-year review was to confirm that immediate and long-term threats to human health and the environment have been addressed through implementation of the selected remedy. The five-year review included the following activities:

- A review to identify changes in Federal, State and local regulations or toxicity values that could affect the remedy's overall protectiveness with respect to the remediation goals specified in the Record of Decision and two subsequent Explanation of Significant Differences;
- A site inspection to confirm that the remedy is operating and is being maintained in accordance with expectations; and
- A review of remedy performance monitoring data and an assessment of progress towards the remediation goals specified in the ROD and ESDs for current and long-term protectiveness.

Based on the findings of this five-year review, it is recommended that the selected remedy be modified through an ESD. The proposed modification will add:

(1) identification of the revised slope factor for hexavalent chromium to include an oral pathway;

(2) determination of remediation goals for direct human contact with contaminated soils; and

(3) clarification of the point of compliance for the groundwater remediation goals with compliance throughout the deep aquifer. The ESD will also describe the anticipated optimization study for the groundwater remedy to determine the possibility of expediting compliance with groundwater remediation goals.

With the existing engineering (fencing, locked gates) and institutional controls (deed and zoning restrictions and a groundwater pumping exclusion zone) and the continued extraction and treatment of contaminated groundwater, the outstanding issues described above do not affect current protectiveness; however, these could affect future protectiveness if the current land and groundwater use controls are not maintained. In addition to the existing institutional controls, the City and state of Oregon are in the process of establishing an Easement and Equitable Servitudes to further ensure that the ICs remain in place and enforceable in the long term.

The anticipated future land use for this property is commercial/industrial and the use is not expected to change given the property is owned by the City of Corvallis and is in an industrial area adjacent to the airport. The ICs must be maintained (i.e., through an E&ES) because the current or reasonably anticipated land use does not allow unlimited access and unrestricted exposure to the groundwater and soil within the proposed E&ES area.

In addition to the protectiveness determination, the following summarizes the Human Exposure and Groundwater Migration Environmental Indicators and Cross-Program Revitalization Measure status.

- The **Human Exposure Environmental Indicator:** The Site remains "Under Control." No groundwater wells (with the exception of treatment or monitoring wells) are allowed in the groundwater pumping exclusion zone. The former building foundation and existing soil cover (e.g., asphalt, concrete, soil) serve as an adequate barrier to prevent direct contact with residual soil contamination. The City of Corvallis restricts access to the area in accordance with the City's Master Plan and the site is zoned for industrial use which is unlikely to change. An E&ES is under development to supplement the existing institutional controls. In order to ensure this indicator remains "Under Control" for the long term, ICs and operations, maintenance and groundwater monitoring will be continued to confirm conditions remain protective.
- **The Groundwater Migration Environmental Indicator:** The Site remains "Under Control" because remedial actions are maintaining groundwater hydraulic containment.
- **Cross Program Revitalization Measure Status:** The Site continues to be "protective for people under current conditions" and is expected to meet the conditions for a Ready for Anticipated Use determination once the E&ES is in place.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name (*from WasteLAN*): United Chrome Products Superfund Site		
EPA ID (*from WasteLAN*): ORD009043001		
Region: 10	**State:** OR	**City/County:** Corvallis/Benton
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:** 8 / 15 / 1988	
Has site been put into reuse? ☒ YES ☐ NO Equipment storage and propane distribution		
REVIEW STATUS		
Lead agency: ☒ EPA ☐ State ☐ Tribe ☐ Other Federal Agency		
Author name: Mary Jane Nearman		
Author title: Remedial Project Manager	**Author affiliation:** U.S. EPA, Region 10	
Review period:** 2 / 12 / 2008 to 08/30/2011		
Date(s) of site inspection: 2 / 12 / 2008		
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 (fourth)		
Triggering action: ☐ Actual RA On-site Construction at OU #___ ☐ Construction Completion ☐ Other (specify) ☐ Actual RA Start at OU # NA ☒ Previous Five-Year Review Report		
Triggering action date (*from WasteLAN*): 3 / 31/ 2003		
Due date (*five years after triggering action date*): 3 / 31 / 2008		

* ["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. Chromium in upper zone groundwater was successfully remediated to the 10 mg/L concentration specified in the Record of Decision. Natural groundwater flow patterns at the United Chrome site are continuing to transport upper zone groundwater containing chromium at concentrations of less than 10 mg/L vertically downward to the deep aquifer.

The concentration of chromium resulting from the mixing of upper zone groundwater with deep aquifer groundwater is currently greater than the 0.1 mg/L deep aquifer remediation goal in a limited area beneath the original source. The upper water-bearing zone is classified as Class IIIA and is not a source of potential drinking water. The lower groundwater aquifer is classified as Class IIB, a potential source of drinking water.

The projected cleanup time in the ROD for the deep aquifer was five years with a range of three to eight years. Treatment has been ongoing for more than 15 years at this point and, although significant progress has been made, residual contamination above the total chromium MCL is persistent in a limited area within the deep aquifer. The movement of chromium-contaminated groundwater from the upper zone to the deep aquifer is expected to continue for the foreseeable future under the current treatment regime.

2. The existing institutional controls (pumping exclusion zone, zoning and deed restrictions) may not be protective in the long term.

3. The current soil remediation goal of 6,000 mg/Kg total chromium is based on protection of groundwater. Although the ROD included a goal to "adequately protect the public against contact with and ingestion of contaminated soil and sediments," no soil remediation goal to meet this objective has been documented in a decision document. Site-specific remediation goals have been developed by ODEQ and were used in determining the areas of the Site requiring additional institutional controls.

3. The groundwater point of compliance needs to be clarified. Both the 1986 pre-Sara Record of Decision and the 1992 Consent Decree cite a POC for the deep aquifer at the original plant site boundary. This is not consistent with the current EPA Groundwater Protection Strategy which applies the MCL throughout an aquifer that is a current or potential drinking water source (i.e., the Class IIB deep aquifer).

Recommendations and Follow-up Actions:

1. a The City of Corvallis will continue groundwater extraction and treatment with treatment of the groundwater at the publicly-owned treatment works to maintain hydraulic containment. Groundwater monitoring will continue to confirm plume stability.

b. EPA, in coordination with the City of Corvallis and the Oregon Department of Environmental Quality, expects to conduct an optimization study for the groundwater remedy to determine the possibility of expediting compliance with groundwater remediation goals.

2. Additional institutional controls in the form of an Easement and Equitable Servitudes will be established to ensure that ICs remain in place for as long as conditions at the Site do not allow for unlimited use and unrestricted access.

3. The soil remediation goals for direct human contact will be documented in a decision document.

4. The POC for the deep aquifer will be clarified in a decision document to be consistent with the EPA Groundwater Protection Strategy. The POC will be revised from the original plant boundary to throughout the deep aquifer which is a potential source of drinking water.

Summary of Current and Future Protectiveness:

The remedy currently protects human health and the environment, however, in order to ensure that the remedy remains protective in the long-term, additional enforceable institutional controls need to be recorded, the groundwater remedy needs to be further evaluated and optimized, if necessary, and the groundwater point of compliance and soil remediation goals need to be clarified.

1. Introduction

Section 121 [c] of the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act of 1986, requires that remedial actions that result in hazardous substances, pollutants, or contaminants being left onsite at concentrations preventing unlimited use and unrestricted exposure be reviewed every five years to assure that human health and the environment are protected.

This is the fourth five-year review for the United Chrome Products Superfund site (the Site). The third five-year review was conducted in March 2003. These five-year reviews are policy reviews (i.e., not statutory reviews) because the ROD for the Site was signed on September 12, 1986, prior to promulgation of SARA. Although it is EPA's intent to conduct these reviews approximately every five years, this is not a statutory requirement for the Site.

1.1 Purpose and Objectives

The purpose of five-year reviews 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 recommendations to address them.

As stated above, given the September 1986 ROD date, EPA conducted this review as a matter of policy; it is not subject to the statutory requirement. EPA prepared this five-year review to meet the substantive requirements outlined in CERCLA §121 and the National Contingency Plan. 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 ensure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such a site as defined in 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 agency interpreted this requirement further in 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.*

In accordance with EPA policy, the United States Protection Agency Region 10 has conducted this five-year review of the remedial actions implemented at the United Chrome Superfund site in Corvallis, Oregon. The review was conducted from March 2003 through August 2011. This report documents the results of the review.

1.2 Current Site Status

The United Chrome Superfund Site remedial action was initially implemented as a fund-lead action to address contamination resulting from the operation of an industrial hard-chrome plating facility. The remedy is now a potentially responsible party long-term response.

In 1989, EPA and the City of Corvallis entered into an Administrative Order wherein the City committed to operate a groundwater extraction and treatment system. In 1992, EPA and the City of Corvallis then entered into a Consent Decree (Consent Decree #92-6232-H0) in which the City committed to carry out the remedy selected in the 1986 Record of Decision and to carry out the Scope of Work for operating the treatment plant at the Site. The state of Oregon has an advisory role under the Consent Decree, consisting of reviewing and commenting on draft documents and proposed actions connected with Work at the Site as set forth in the Consent Decree.

The Site consists of one Operable Unit with chromium as the primary contaminant of concern. The remedy initially included pumping from 23 shallow wells and 7 deep wells, and flushing of chromium-contaminated soil using two shallow infiltration basins. Extracted groundwater was pumped to an onsite chemical reduction and precipitation treatment system to convert soluble hexavalent chromium to an insoluble trivalent chromium precipitate. Solid-phase trivalent chromium was accumulated in an onsite roll-off box and transported approximately every 90 days to the Chemical Waste Management facility in Arlington, Oregon.

The upper zone groundwater remedial action was initiated on August 15, 1988, and the deep aquifer remedial action on August 11, 1991. Except for part-time operation during the startup phase, temporary shutdowns for cold weather, and a 55-day temporary shutdown for a supplemental soil removal action performed in September 2000, the GETS operated continuously until December 2004, logging 107,502 hours of operation for an overall uptime efficiency of 85 percent. During this time, 32,100 pounds of chromium was recovered from 84.1 million gallons of extracted groundwater.

Over the course of the groundwater remedial action, the need for supplemental actions was identified to address persistent sources of chromium discovered beneath the infiltration basins, and to address residual chromium- contaminated sediment identified in an abandoned onsite drainage ditch. As the current property owner, the City of Corvallis is responsible for the cleanup as specified in the Consent Decree. EPA issued a Complaint against the owner of the contaminated property and settled the Complaint with the Consent Decree as discussed above.

In December 2004, the reduction of chromium concentration in the groundwater resulted in shutting down the remaining shallow and deep extraction wells. At the time of the shutdown, groundwater remediation goals had been achieved at all but three of the 30 extraction well locations, and at all monitoring well locations.

In accordance with the requirements of Sections 6.6 and 6.7 of the Consent Decree, the City implemented a monitoring program in December 2004 to confirm that groundwater remediation goals could be maintained. Laboratory analysis results from monthly and quarterly sampling of the upper zone monitoring wells between January 2004 and September 2005 confirmed that the 10 mg/L total chromium remediation goal had been met at each well location in the upper water-bearing zone.

Sampling and analysis of deep aquifer groundwater revealed a rebound in chromium concentrations at the three monitoring well locations closest to the original source. The City of Corvallis continued to monitor these wells to determine concentration trends over time. Because the rebound in contaminant concentration was limited to the immediate source area, several quarters of data were collected. Based on the analysis of this data, targeted pumping at one deep aquifer well (DW-8) was resumed in February 2009 to address the rebound condition. Subsequent monitoring exhibited a marked decline in chromium concentrations. The targeted pumping program was suspended on September 22, 2009 after observing significant chromium concentration reductions at two of the three monitoring well locations.

The quarterly sampling from December 2009 to September 2010 indicated another rebound in chromium concentrations to levels comparable to those observed in December 2008, just prior to the temporary resumption of pumping. The rebound condition is attributed to a natural vertical hydraulic gradient that continues to transport some amount of contaminated groundwater from the upper zone to the deep aquifer.

The sources in the upper zone (i.e., leachate from contaminated soils, upper zone groundwater and the aquitard) above the deep aquifer may contain chromium concentrations up to 10 mg/L. This is resulting in exceedances of the 0.1 mg/L deep aquifer groundwater remediation goal in a 0.2 acre area within the original plant site boundary. This indicates that there is insufficient dilution capacity between the source and the nearest well within the deep aquifer to adequately assimilate the flux at the interface between the upper zone and the deep aquifer. Ongoing extraction from well DW-8 is maintaining hydraulic containment. Continued monitoring of the groundwater affirms that the area of the plume is limited and stable.

2. Site Chronology

This chapter provides a chronology (Table 2-1) of events related to the Site's discovery, contamination history, and overall cleanup.

Table 2-1 Site Chronology

EPA-lead Activities	Start Date	End Date
United Chrome Products begins operations	1956	1985
Discovery	-	07/01/1979
ODEQ surface water/sediment sampling and referral to EPA	11/01/1982	1983
Hazard Ranking Site (HRS) Assessment (Score = 31.7) and Site Inspection	-	06/27/1983
Proposed to National Priorities List (NPL)	-	09/09/1983
Final NPL Listing	-	09/21/1984
Remedial Investigation and Feasibility (RI/FS) Work Plan Approved	-	09/30/1984
Emergency Removal Action (8,130 gallons of liquids/11,000 pounds of solids)	07/02/1985	11/06/1985
Remedial Investigation (RI)	09/21/1984	02/01/1985
Feasibility Study (FS)	11/01/1984	08/19/1985
Public Comment period on RI/FS (no separate Proposed Plan)	08/19/85	09/09/1985
Record of Decision	-	09/12/1986
Remedial Design and Construction of Groundwater Extraction and Treatment System (GETS)	02/04/1987	09/11/1987
United Chrome Products building removed (foundation remains)		03/30/1998
Upper Zone Groundwater Extraction and Treatment (Phase I) 23 extraction wells/6 monitoring wells	08/15/1988	12/11/2004
Re-route surface water to northern perimeter of site	01/01/1990	02/28/1990
Deep Aquifer Groundwater Extraction and Treatment (Phase II) 2 injection wells/7 extraction wells/8 monitoring wells = 17 total	08/11/1991	Ongoing
Administrative Order issued by EPA to the City to operate the upper zone GETS		08/07/1989
First Explanation of Significant Differences (ESD)	-	12/20/1991
Preliminary Closeout Report (PCOR)	-	12/19/1991
Total chromium MCL revised from 0.05 mg/L to 0.1 mg/L		07/30/1992
Lodging of Consent Decree by US District Court		10/14/1992
First Five-year Review	-	11/30/1992
Second Five-Year Review	-	03/24/1998
Third Five-Year review		03/31/2003
Second ESD	-	08/28/2010

PRP-Lead Activities	Start Date	End Date
Upper Zone Infiltration Basin and Trench Operations	08/01/1988	09/01/2000
Chemical Reduction treatment followed by discharge to Publicly-Owned Treatment Works (City POTW)	06/01/1992	03/02/1995
Discontinue Partial (Reducing) Treatment; all extracted water to City POTW	03/02/1995	Ongoing
Clean Chromium Contaminated Sediment from Onsite Culvert and Plug with Concrete	07/01/1991	10/01/1991
Abandon Upper Zone Wells EW-1, PL-2, PL-3, PL-4, PL-5, BG-2, MW-2A and Deep Aquifer Well DW-7. Convert Deep Aquifer Wells DW-9 and DW-10 from Injection to Extraction Wells	06/01/1996	06/30/1996
Abandon Upper Zone Wells EW-19, EW-22, EW-24, EW-25, EW-26, SW-3, PZ-A, PZ-C and PZ-E	05/01/1997	05/31/1997
Abandon Upper Zone Wells SW-2A and SW-4, and Deep Aquifer Wells DW-3A, DW-6 and DW-19	05/01/1998	05/31/1998
Abandon Upper Zone Wells EW-8, EW-28 and EW-29, and decommission Infiltration System in Conjunction with Upper Zone Soil Excavation (400 cubic yards)	08/15/2000	08/31/2000
Treatment Infrastructure Removed and Building Decommissioned	03/15/1999	04/15/1999
Upper Zone Soil Excavation Project (1,956 tons of soil excavated and transported to Chemical Waste Management, Arlington, Oregon for stabilization and disposal)	09/11/2000	10/04/2000
Abandon Upper Zone Wells EW-17, EW-18, EW-20, EW-21, BG-1, MW-1, PL-1, PZ-D, PZ-F and Deep Aquifer Wells DW-11, DW-14, DW-16 and DW-17	06/01/2001	06/15/2001
Level I and Level II ecological risk screening for active (offsite) ditch conducted	03/01/2003	06/30/2004
Abandoned ditch remedial design and construction.	10/1/2003	06/30/2005
Pumping at Upper Zone extraction wells EW-5, EW-6, EW-9 and EW-15, and Deep Aquifer extraction wells DW-8 and DW-9 discontinued		12/11/2004
Active (offsite) ditch sediment bioassay testing performed	04/01/2005	07/30/2005
Inspection and evaluation of existing Site cover	4/1/2006	07/18/2006
All remaining upper zone extraction and monitor wells abandoned.	06/20/2007	06/22/2007
Targeted deep aquifer groundwater pumping resumes at well DW-8	02/04/2009	Ongoing
Continue deep aquifer rebound monitoring program	10/1/2009	Ongoing
Soil excavation from six areas within proposed E&ES boundary (470 cubic yards)	07/25/2011	07/28/2011

References:

1. CERCLIS United Chrome Products Site, Corvallis, Oregon. United Chrome Products Region 10 Superfund Home Page
2. CH2M HILL Files.
3. City of Corvallis Public Works Wastewater Treatment Plant Files

3. Background

This chapter presents a brief overview of the Site's physical characteristics, discovery, contamination history, and investigations leading up to the current understanding of the Site conditions as presented in the *Remedial Investigation and Feasibility Study Report for the United Chrome Products Site* (CH2M HILL, Ecology and Environment, 1985). The purpose of this chapter is to describe the threat the Site posed to human health and the environment at the time of the ROD. New information obtained through the course of subsequent design investigations and PRP-LTR operations, with the potential to affect the remedy's long-term protectiveness, is presented in the Technical Assessment provided in Chapter 7 of this document.

3.1 Physical Characteristics

This section provides information on the Site's physical characteristics including location information and a description of the hydrogeologic strata underlying the Site and the interconnected surface water drainages affected by historical chromium releases.

3.1.1 Location Description

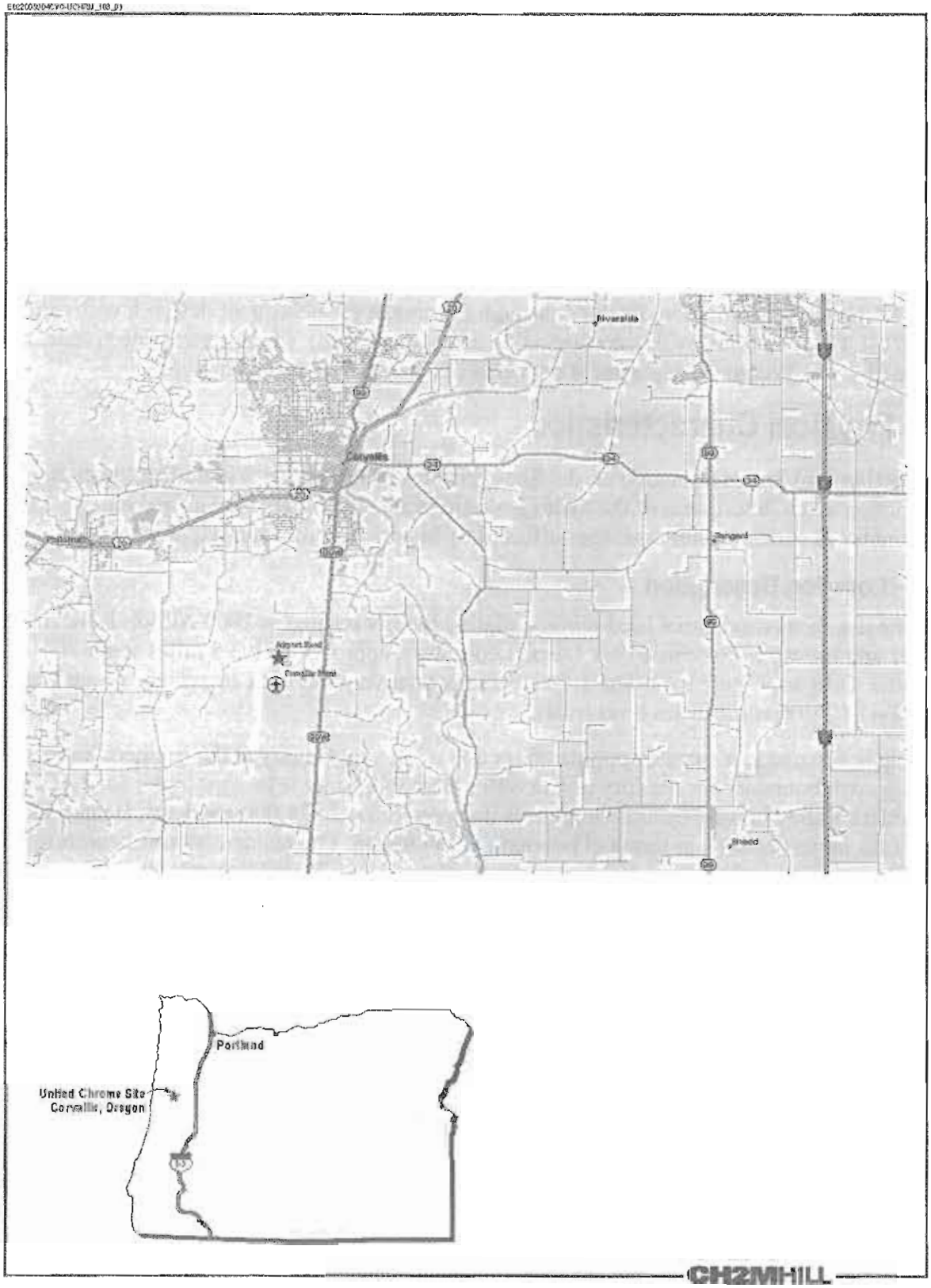
The Site is a former industrial hard-chrome plating facility located at 2000 Airport Road, in the Airport and Industrial Research Park (airport complex), approximately3.5 miles south of Corvallis, Oregon (Figure 3-1). The 1.5-acre site is relatively flat with an average ground surface elevation of 240 feet mean sea level (msl).

The Site is situated in a sparsely populated section of Benton County at the southern limits of the urban growth boundary for the City of Corvallis. Benton County is located in the heart of the Willamette Valley in west-central Oregon. With approximately 78,000 residents, Benton County is the 11th largest county, in terms of population, in Oregon. The residential area nearest to the Site is located approximately 4,400 feet to the northeast along State Highway 99W. There are approximately 50 homes in this area that obtain drinking water from private wells. Sampling of these wells showed no contamination; these wells are well beyond the boundary of the groundwater which is currently contained within the original United Chrome plant boundary.

Sensitive Habitat

One national wildlife refuge, the William L. Finley Refuge, is located within 5 miles of the Site. The refuge contains a variety of wildlife habitats such as wetlands, prairies, riparian and upland forests and cultivated farmlands. The refuge also provides important wintering habitat for the dusky Canada goose, a species of concern within the Pacific Flyway, and six other subspecies of Canada geese. Several endangered plants and the endangered Fender's blue butterfly also occur within the refuge boundaries. According to U.S. Department of Fish and Wildlife information, the refuge receives about 60,000 visitors a year.

Figure 3-1. Vicinity Map



Although soils and vegetation may exhibit one or more characteristics typical of a wetland, the United Chrome Site was not identified as a wetland through the Oregon Division of Lands Local Wetland Inventory (National Wetland Inventory, Wetlands and Hydric Soils, Southern Corvallis, 2000). Mapping (Corvallis General Flood Hazard Map, 2000) also shows that the Site is above the 100-year floodplain.

3.1.2 Hydrogeology

The hydrogeology beneath the Site is characterized by two water-bearing zones separated by an aquitard. The uppermost water-bearing zone (upper zone), which occurs at depths between ground surface and 20 feet below ground surface, is comprised of silt and fine sand with low permeability and variable saturated thickness.

Beneath the upper zone is the upper aquitard, a layer of stiff, silty clay varying in thickness from 1.5 to 5.5 feet. Beneath the upper aquitard is the lower water-bearing zone (deep aquifer), which occurs at depths of approximately 25 feet to 45 feet bgs beneath the Site, extending to a depth of 75 feet bgs to the northeast (Figure 3-2). The deep aquifer is comprised of sand and silt-cemented gravel capable of supplying water for domestic, commercial, and industrial uses.

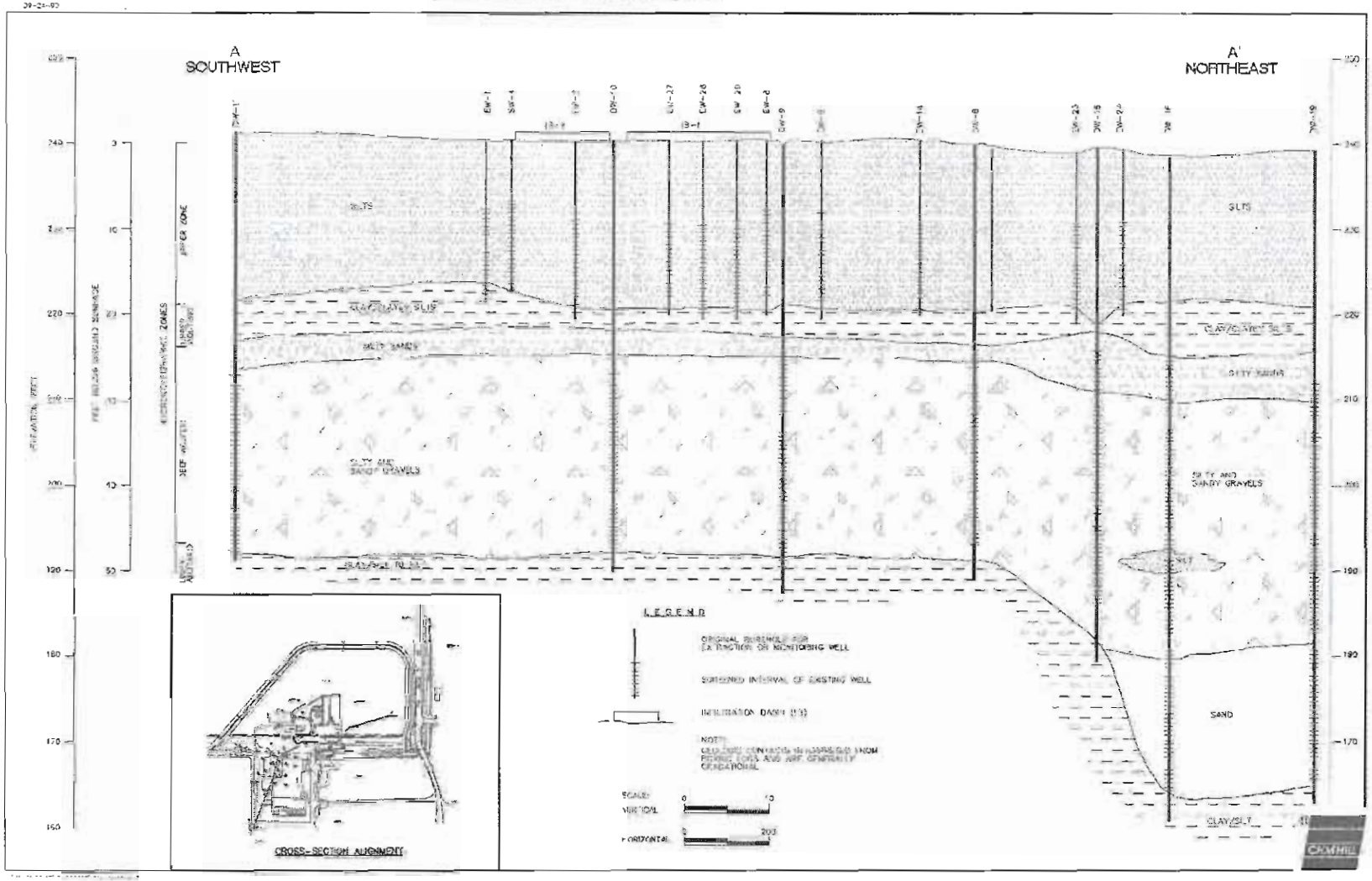
Horizontal groundwater flow velocities are approximately 9 feet per year in the upper zone and 44 feet per year in the deep aquifer. Groundwater also flows vertically down from the upper zone to the deep aquifer at a rate of 11 feet per year. Groundwater in both zones flows in a northeasterly direction, ultimately discharging to the Willamette River about two miles away.

3.1.3 Surface Water Hydrology

In 1990 a bypass ditch was constructed around the northern perimeter of the Site to hydraulically isolate the upper zone (under high water table elevation conditions) from the stormwater drainage network. Most onsite surface water now infiltrates down through the soil column to the upper zone.

Prior to construction of the bypass ditch, surface water runoff drained overland to shallow drainage ditches bordering the west and north margins of the Site. Runoff from these drainage ditches discharged to a deep culvert passing beneath the Site. From this culvert, surface water flowed east to Airport Place and then north to Airport Road. The ditch parallels Airport Road for approximately ½ mile before flowing southeast beneath the railroad tracks and State Highway 99W where it discharges to Dry Creek. Dry Creek flows northeast for approximately 1,500 feet where it converges with the West Fork of the Booneville Slough. The Booneville Slough eventually merges with the Willamette River approximately one mile below (north of) their confluence.

Figure 3-2. Generalized Hydrogeologic Cross Section



3.2 Land and Resource Use

The land surrounding the Site is owned by the City and currently supports agricultural (non-food grass seed), aviation, and light industrial use. The Site is bounded by a City of Corvallis Airport runway and taxiway to the south and west; agricultural land, a stormwater drainage bypass ditch, and CoEnergy (propane distributor) to the north; undeveloped property, airplane hangars, and Bertea Aviation to the east; and Ferrill Gas (propane distributor) to the south. The Site and all contiguous property are owned by the City of Corvallis.

The Site is zoned under the City of Corvallis Comprehensive Land Use Plan and the Airport Master Plan as general industrial.Most of the United Chrome property is currently leased to Helicopter Transport Services for use as an equipment staging area. CoEnergy leases the northeast corner of the site for truck parking and propane distribution. An above-ground fuel farm is planned for this portion of the airport property.

Institutional controls for both soils and groundwater will remain in place until remedial action goals are reached. This includes restrictions on use of groundwater and activities that may compromise the integrity of the soil direct-contact cover.

With respect to current groundwater use, there are no known groundwater users within ½ mile of the Site. The nearest residential drinking water wells are located approximately 4,400 feet northeast of the Site along State Highway 99W. The City also has two inactive water supply wells in the area. The nearest well, identified as CW-3, is located approximately 700 feet northeast of the Site, with a second well approximately 3,000 feet northeast. Although the wells are still in place, the pumps and wellhead piping have been removed, and the City has no plans to put these wells back in service. All drinking water for the Airport Industrial complex is delivered by underground pipeline from the City's Taylor Water Treatment Plant (Willamette River) or the Rock Creek Water Treatment Plant (Rock Creek watershed).

Under Oregon Revised Statute 536.340 and Oregon Administrative Rule 690-500 to 520, the Oregon Water Resources Department may classify groundwater resources for current and future specific uses. The Site lies within the Mid-Willamette Basin, and as such, groundwater has been designated to support a broad array of uses including drinking. The OWRD's classification for deep aquifer groundwater would be consistent with EPA's Class IIA/IIB designation, groundwater that is a current (IIA) or future (IIB) drinking water source. MCLs are, therefore, relevant and appropriate for this Class IIB aquifer.

Upper zone groundwater, due to seasonal limited availability (i.e., the zone typically does not produce any groundwater in late summer/early fall) and low yield (i.e., less than 150 gallons/day when available), would align with EPA Class III groundwater, which is described as water that is not a current or potential source of drinking water. The upper groundwater zone yields which range from zero to 594,000 gallons/month are insufficient from any depth within the Classification Review Area to meet the requirement of supplying the needs of an average family (i.e., year-round consistent production of > 150 gallons/day); therefore, it is not a source of current or potential drinking water.

Class III groundwater is further subcategorized primarily on the basis of the degree of interconnection with surface waters or adjacent groundwater units containing groundwater of a higher class, in this case, the Class IIB deep aquifer which is a potential source of drinking water. Subclass IIIA groundwaters, such as the upper zone groundwater, have a high-to-intermediate

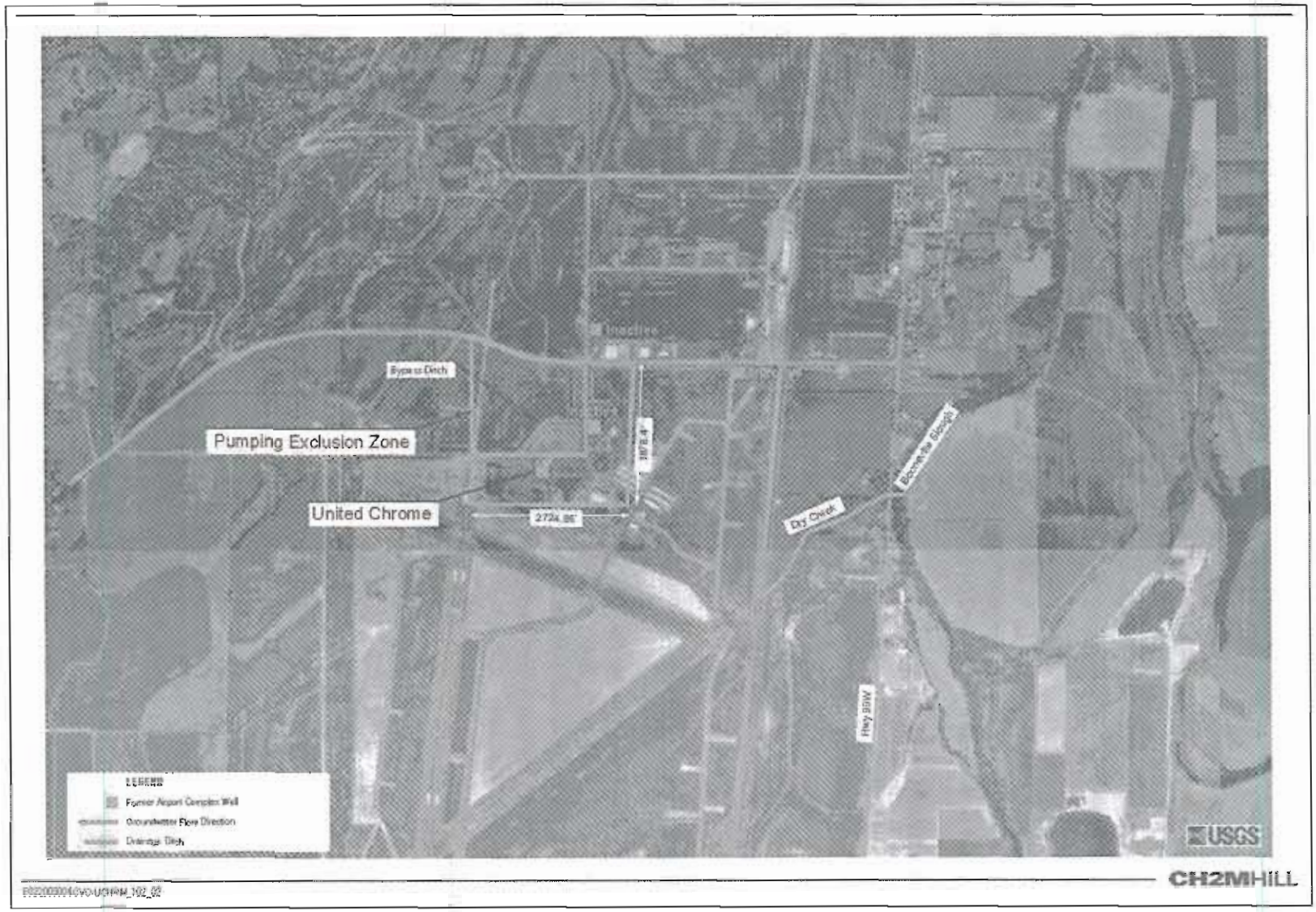
degree of interconnection to adjacent groundwater of a higher class or to surface waters. With its high-to-intermediate degree of interconnection to the Class IIB deep aquifer, the upper zone groundwater is designated as Class IIIA and is not a source of current or potential drinking water.

Because the Class IIIA upper zone is not a potential source of drinking water, the MCL is not applicable nor relevant and appropriate. Rather, the upper zone remedial goal of 10 mg/L was developed for protection of the deep Class IIB aquifer and represents the minimum cleanup required to protect the potential drinking water supply. .

The 1992 Consent Decree, Civil Action 92-6232-HO, Section VIB - Performance of the Work by the City Remedial Action, paragraph 6.9, requires the City to adopt measures that restrict groundwater use or pumping wells or any other activities that could jeopardize the remedy or create a threat to human health or the environment. In accordance with these requirements, the City established a 1,250-foot by 1,250-foot groundwater pumping exclusion zone around the Site (Figure 3-3).

The Willamette River is the primary drinking water source for the City of Corvallis and also supports warm-water species such as large-mouth and small mouth bass, crappie, bluegill, catfish, and carp, and cold-water species that include sturgeon and cut-throat trout. The Willamette River also supports anadromous fish passage including Endangered Species Act-listed Chinook salmon and steelhead trout.

Figure 3-3. United Chrome Site Groundwater Pumping Exclusion Area



3.3 History of Contamination

United Chrome Products leased the site property from the City and began electroplating operations in 1956. In the same year, the operators created a dry well outside the southwest building corner. The dry well consisted of an approximate 12-inch-diameter, 10-foot long, vertically orientated corrugated metal pipe with random perforations along its length.

Between 1956 and 1975, one primary source of contamination was the dry well used to dispose of floor drippings, washings, and product rinsate collected within a building sump. Quantities of waste disposed in this manner are unknown, but were estimated by the facility operator to be approximately 1,000 gallons per year. The dry well annular space was discovered and backfilled during the September 2000 upper zone soil excavation.

Other probable sources of contamination include leakage from the two plating tanks located inside the building, and spillage from the acid and caustic storage tanks maintained outside the building, north of the dry well. United Chrome Products ceased operations in early 1985 and sold the equipment and building contents in May 1985.

3.3.1 Discovery

Contamination at the United Chrome Products site was initially discovered during Oregon Department of Environmental Quality Resource Conservation and Recovery Act compliance inspections. These inspections resulted in subsequent surface water and sediment sampling by ODEQ staff beginning in November 1982. Based on the results of this sampling, the site was referred to EPA for a Hazard Ranking Site Assessment in 1983, which yielded a score of 31.7 and eventual placement on the EPA National Priorities List on September 21, 1984.

3.4 Initial Response

Accumulated sludges from the two plating tanks were removed from the site in 1982 and disposed under ODEQ guidelines. In 1983, following two ODEQ Notices of Violation, United Chrome Products removed chromium sludge from a disposal pit and placed the material in drums that were later disposed at a RCRA-permitted land disposal facility. EPA placed the Site on the NPL because of suspected surface water, soil, and groundwater contamination. EPA also conducted an emergency removal action at the Site from July to November 1985 that included removal of 8,130 gallons of chromium-contaminated liquid from tanks and containers, and 11,000 pounds of chromium-contaminated soil.

3.5 Basis for Taking Action

Under the Comprehensive Environmental Response, Compensation and Liability Act, EPA conducted a Remedial Investigation/Feasibility Study which was completed in August 1985 by EPA contractors, CH2M HILL and Ecology & Environment, Inc. Because the facility was still active during the RI, contamination beneath the facility building was not characterized. The RI confirmed the presence of high levels of chromium in soil and groundwater, and in surface water and sediment downstream of the Site.

Soil in the vicinity of the dry well had the highest levels of chromium observed onsite. Concentrations ranged from 200,900 milligrams per kilogram at the surface to 29,500 mg/Kg at a depth of 12 to 15 feet below ground surface. At other soil sampling locations around the building perimeter, chromium concentrations were significantly lower with a maximum observed

concentration of 1,680 mg/Kg detected in surface soil samples and 1,350 mg/Kg detected in samples collected at a depth of 20 feet bgs.

Groundwater samples collected from monitoring wells screened in the upper zone revealed a plume approximately 150 feet wide extending approximately 400 feet northeast (downgradient) from the dry well and plating tanks. Chromium concentrations ranged between 142 and 689 milligrams per liter. Groundwater samples from deep aquifer monitoring wells revealed a plume between 200 and 300 feet in width and 400 feet in length with chromium concentrations ranging between 0.7 and 6.5 mg/L.

Surface water samples collected from nearby drainage ditches and locations downstream of the Site revealed chromium concentrations between 0.08 and 4.3 mg/L. Sediment samples showed chromium concentrations between 48 mg/Kg and 27,900 mg/Kg. Chromium was detected in the surface water (0.08 mg/L) and the sediment sample (52 mg/Kg) collected from the Booneville Slough location.

3.5.1 Public Health and Environmental Impacts

Although a baseline risk assessment was not conducted during the RI, laboratory testing revealed chromium concentrations in groundwater at levels approximately 10,000 times higher than the 0.05 mg/L drinking water standard in place at that time (the MCL was subsequently revised upward to 0.1 mg/L). Accordingly, the greatest human health threat was offsite chromium migration and ingestion of contaminated groundwater by residents living northeast of the Site.

In an on-site drainage ditch, surface water samples revealed hexavalent chromium concentrations approximately 400 times higher than the chronic freshwater ambient water quality criteria of 0.011 mg/L. Storm water was re-routed to the clean perimeter of the Site.

4. Remedial Actions

This chapter discusses implementation of the United Chrome remedy beginning with the description presented in the ROD and continuing through design, construction, and remedial action. This chapter also describes supplemental remedial actions taken by the City, as allowed under the Consent Decree, to expedite and improve the remedy's overall effectiveness.

4.1 Remedy Selection

The ROD is the regulatory instrument used by EPA to select a remedy to address current and future threats to human health and the environment posed by exposure to hazardous substances, such as the chromium-contaminated soil, surface water, and groundwater, present at the Site. The United Chrome ROD was signed on September 12, 1986.

Decision documents for this Site include the original ROD and two subsequent ESDs.

4.1.1 Record of Decision (September 12, 1986) Remedial Action Objectives

Three public health and environmental concerns were described in the ROD:

- Protection of the public against contact with and ingestion of contaminated groundwater;
- Protection of the environment against the spread of contaminated groundwater; and
- Protection of the public against contact with and ingestion of contaminated soil and sediments.

The purpose for the United Chrome remedial action was to:

> *"remove contamination from the confined zone (deep aquifer) and control further migration of contamination from the upper unconfined zone (upper zone). Until the upper zone is cleaned up, it will continue to seep contamination through the confining clay (upper aquitard) into the underlying (deep) aquifer."*

4.1.2 ROD Remediation Goals

Groundwater

The remediation goals for upper zone and deep aquifer groundwater were described in the ROD as follows:

> *"The cleanup criteria for the confined aquifer (deep aquifer) is 0.05 mg/L chromium, the drinking water standard, because this aquifer is considered a drinking water source and is in direct hydraulic connection with the local drinking water supply wells. The cleanup criteria [sic] for the unconfined zone (upper zone) is 10 mg/L chromium. This concentration represents the minimum cleanup required to protect the local drinking water supply. The drinking water standard of 0.05 mg/L was not used because the unconfined zone (upper zone) is not used as a drinking water source anywhere in the area...."*

As explained in Section 3.2, the upper zone groundwater is designated as Class IIIA and is not a current or potential source of drinking water; therefore the drinking water standard of 0.05 mg/L

total chromium is not applicable. However, transport of groundwater from the Class IIIA upper zone is impacting the Class IIB lower deep aquifer.

Remediation goals for the upper zone soils and groundwater were developed using the relationship between total chromium in leachate versus soil concentrations. The analysis determined that that a concentration greater than 6,000 mg/Kg total chromium in soils and 10 mg/L total chromium in the upper zone groundwater would result in an exceedance of the updated 0.1 mg/L deep aquifer groundwater cleanup levels.

The 10 mg/L remediation goal for upper zone groundwater was established using a contaminant-transport model based on the EPA Soil Contamination Evaluation Methodology. This model was used to back-calculate the level of upper zone groundwater remediation necessary to protect the nearest water supply well; City well W-1, which is no longer used, located about 3,000 feet northeast (downgradient) of the Site.

Soil

Although the ROD included an RAO for protection of the public against contact with and ingestion of contaminated soil and sediments, a cleanup level for direct contact with soil and sediments was not specified in the ROD. As described above, the soil cleanup level of 6,000 mg/Kg specified in the ROD was designed for groundwater protection only. This five-year review identifies this as an issue that will be addressed in a future ESD (See Section 8 and Summary Form).

4.1.3 Remedy Description in the ROD

The major components of the selected remedy described in the ROD included:

1. Installation of approximately 15 shallow wells (15 to 20 feet bgs) to extract chromium-contaminated groundwater in the upper unconfined groundwater zone;
2. Installation of approximately five deep wells (35 to 40 feet bgs) to extract chromium-contaminated groundwater in the lower confined, production aquifer (the deep aquifer);
3. Installation of onsite treatment equipment (chemical reduction and precipitation) to remove chromium from extracted groundwater prior to discharge to Muddy Creek or the City of Corvallis POTW;
4. Construction of two percolation basins in the areas of the former dry well and plating tanks to flush the contaminated soil above the shallow groundwater table. Approximately 800 tons of contaminated soil were excavated during the construction of the basins and were disposed of at the hazardous waste landfill facility in Arlington, Oregon; and
5. Installation of culverts in the adjacent open drainage ditch to isolate the surface drainage system from the inflow of contaminated surface water and groundwater from the Site.

4.1.4 First ESD (dated December 20, 1991) RAOs

The RAOs remained as defined in the ROD.

4.1.5 First ESD Remediation Goals

The ROD specified that the remediation goal for the deep aquifer was 0.05 mg/L total chromium, the federal drinking water standard at the time, because this aquifer is considered to be a potential source of drinking water and is in direct hydraulic contact with the local drinking water supply wells.

EPA subsequently revised the National Primary Drinking Water Regulations for both the MCL and the MCLG for total chromium to 0.1 mg/L (Fed. Reg.526, 3528 (1991)).

This change became effective on July 30, 1992.

4.1.6 Remedy Description in the First ESD

The seven significant changes described in the first ESD included the activities described below. Five of the changes (first through fifth below) were implemented during the construction phase prior to issuance of the ESD. The sixth and seventh significant changes described below occurred after the ESD was issued.

1. The United Chrome building was demolished and the demolition waste disposed of in an offsite landfill. This change was made due to the high levels of chromium dust encountered in the building, and because the building structure prevented removal of highly contaminated soil present around the former plating tanks. This soil was removed in August 2000. The foundation of the building is still present on the property and is acting as a barrier to prevent direct contact with contaminated soils.

2. A bypass ditch was constructed in January/February 1990 to hydraulically separate the north side of the airport complex storm water drainage network from the Site.

3. In addition to the two existing infiltration basins, an infiltration trench was installed to provide additional recharge to the upper zone to sustain groundwater pumping during the late summer and early fall months when natural recharge rates are low.

4. Two deep aquifer monitoring wells were converted to injection wells to counter the natural downward vertical hydraulic gradient between the upper zone and deep aquifer.

5. The number of upper zone extraction wells was increased from 15 to 23 due to the larger plume size.

6. The City of Corvallis publicly-owned treatment works was used to treat contaminated groundwater once the total amount of chromium present in the extracted groundwater declined to less than EPA-approved limit of 7 pounds per day (see Section 4.3.3).

7. The deep aquifer groundwater remediation goal for chromium was changed from 0.05 mg/L to 0.1 mg/L as a result of EPA's revision of the drinking water MCL and MCLG. This change became effective on July 30, 1992.

4.1.7 Second ESD (dated August 28, 2010) RAOs

The RAOs remained as defined in the ROD.

4.1.8 Second ESD Remediation Goals

The remediation goals remained as defined in the ROD as amended by the first ESD.

4.1.9 Remedy Description in the Second ESD

The remedy described in the ROD relied on the Site remaining industrial, with no access to contaminated groundwater or unacceptable exposure to residual contamination in soils, but these restrictions or institutional controls were not explicitly outlined. The Consent Decree required the City to adopt measures to restrict groundwater use by establishing a pumping exclusion zone (see Section 3.2). The City also specified exclusively industrial use of the property in its Airport Master Plan but neither of these actions was included in a decision document to ensure that appropriate ICs remained in place for the long term. In addition, the preferred mechanism is now an Easement and Equitable Servitudes between the current or any future property owner and the state of Oregon.

The major components described in the second ESD included:

1. Document implementation of the groundwater exclusion zone that encompasses all groundwater contaminated with total chromium above the MCL within which extraction or use of the groundwater for consumption or other use, except as to treatment, monitoring, temporary dewatering related to the response action, is prohibited;
2. Prohibit residential use of areas where levels of chromium in soil exceed acceptable risk levels for so long as contamination remains above levels that allow for unlimited use and unrestricted exposure; and
3. Restrict industrial and commercial uses of the Site to prevent unacceptable exposure to residual contamination.

Development of the E&ES is now occurring in preparation of signature by the City of Corvallis and the state of Oregon. Soil remediation goals have been established through a site-specific risk assessment; these will be formalized in an upcoming ESD.

4.2 Remedy Implementation

The work was separated into two phases. A summary of the Phase I and Phase II work is provided in the following subsections.

4.2.1 Phase I

Phase I design and remedial construction included:

- Decontamination and demolition of the vacant United Chrome Products building. Decontamination water was collected and stored in a temporary storage tank for treatment in the onsite treatment system. Demolition debris was transported to Valley Landfill's Coffin Butte facility in Corvallis, Oregon. The building foundation was not removed and is now acting as a barrier to prevent direct contact with contaminated soils.
- Excavation and disposal of highly contaminated soil from the former dry well and plating tank areas. Approximately 800 tons (400 cubic yards) of soil was removed and transported to the Chemical Waste Management facility in Arlington, Oregon.

- Installation of 23 extraction wells (versus the 15 proposed in the ROD) and associated conveyance piping and well controls to pump contaminated groundwater from the upper zone to the onsite pretreatment system. Six piezometers and six monitoring wells were installed to allow for monitoring of remedial action progress.
- Construction of extracted groundwater influent and effluent holding tanks, installation of a skid-mounted chemical reduction and precipitation pretreatment system and setup of an office/laboratory trailer for use by operations and maintenance staff. The City of Corvallis later modified the treatment system to add two 6,000-gallon sludge thickening tanks that were placed behind the pretreatment system.

4.2.2 Phase II

Phase II design and remedial construction included:

- Installation of seven deep aquifer extraction wells (DW-2, DW-8, DW-12, DW-13, DW-14, DW-15 and DW-16) and associated conveyance piping and well controls;
- Conversion of two monitoring wells to injection wells (DW-9 and DW-10) and installation of two new monitoring wells (DW-18 and DW-19);
- Reconstruction of well DW-3 (DW-3A) and replacement of upgradient wells DW-4 and DW-5 with a new well DW-11;
- Construction of the bypass ditch to reroute surface water drainage around the perimeter of the Site; and
- Construction of a chemical storage building to house onsite treatment system chemicals.

The Phase I and Phase II design and construction was performed by EPA. The City of Corvallis then assumed the responsibility for the remedial action pursuant to the 1989 Administrative Order and the 1992 Consent Decree.

4.2.3 Institutional Controls and Other Evaluations

The Third Five-Year Review concluded residual contamination in soils and groundwater is at levels such that ICs are warranted. Institutional controls and evaluations completed after the 2003 Third Five-Year Review are described in Section 5 below.

4.3 System Description and Operations

This section briefly summarizes general information related to operation of the groundwater extraction wells, infiltration system, and the onsite treatment system. For the time period covered by this five-year review, a majority of the groundwater- related activities was associated with abandoning the last group of upper zone monitoring and extraction wells, and routine monitoring of the seven remaining deep aquifer wells (DW-1, DW-8, DW-9, DW-10, DW-12, DW-13 and DW-15).

4.3.1 Groundwater Extraction Wells

Upper Zone Well Description

The upper zone groundwater system (Figure 4-1) was comprised of 23 extraction wells and six monitoring wells. Each extraction well was 5 inches in diameter and approximately 20 feet deep.

All upper zone groundwater extraction wells, conveyance piping and other associated infrastructure have subsequently been removed and recycled or disposed.

Upper Zone Operations

The upper zone groundwater extraction system operated for 15.3 years recovering 31,955 pounds of chromium from 31.3 million gallons of treated groundwater. Average groundwater extraction rates ranged from zero to 594,000 gallons per month (16 gallons per minute). Monthly extraction rates declined steadily beginning in May 1991 (Figure 4-2) as individual wells were shut-off after reaching the 10 mg/L chromium ROD performance standard. Shutting wells down in an incremental manner made recharge available to other well locations, thereby accelerating the overall cleanup rate.

Deep Aquifer Well Description

The final deep aquifer system was comprised of a total of 17 wells: two injection wells, seven extraction wells and eight monitoring wells (Figure 4-3). Each extraction well was 5 inches in diameter and varied in depth between 35 and 70 feet. Because of the relatively low chromium concentrations present in deep aquifer groundwater, all treatment was performed at the City POTW.

The deep aquifer conveyance piping also contains a side lateral that enables all, or a portion of the flow, to be diverted to the upper zone infiltration basins. This capability has never been used.

One other feature that distinguishes the deep aquifer extraction well design from the upper zone is placement of the pumps, which were set high in the well casing near the top of the well screen at depths between 25 and 35 feet. The rationale for this action was to focus groundwater withdrawals at the top of the deep aquifer where chromium concentrations were the highest.

Figure 4-1. Upper Zone Groundwater Extraction Well Layout

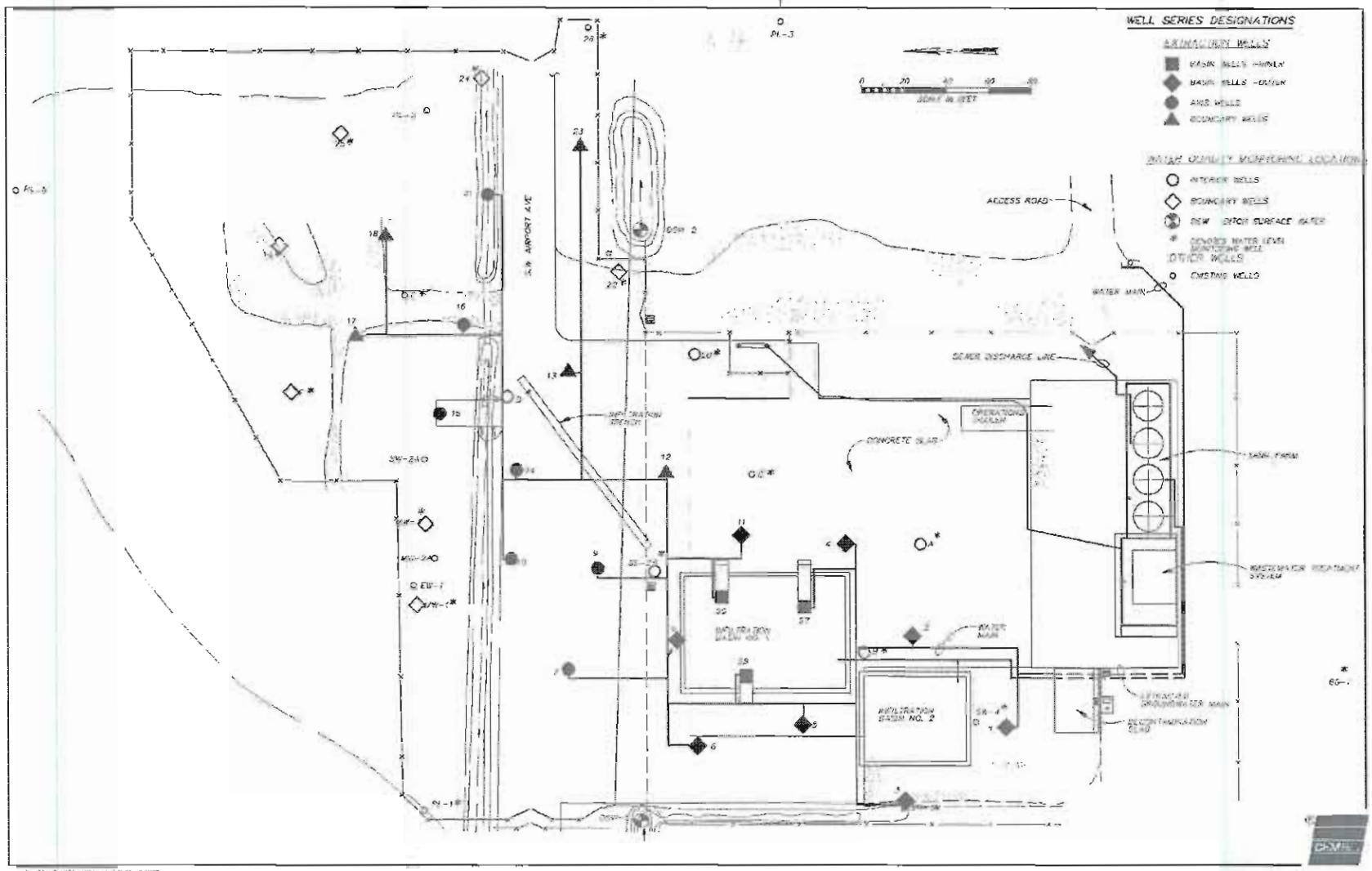
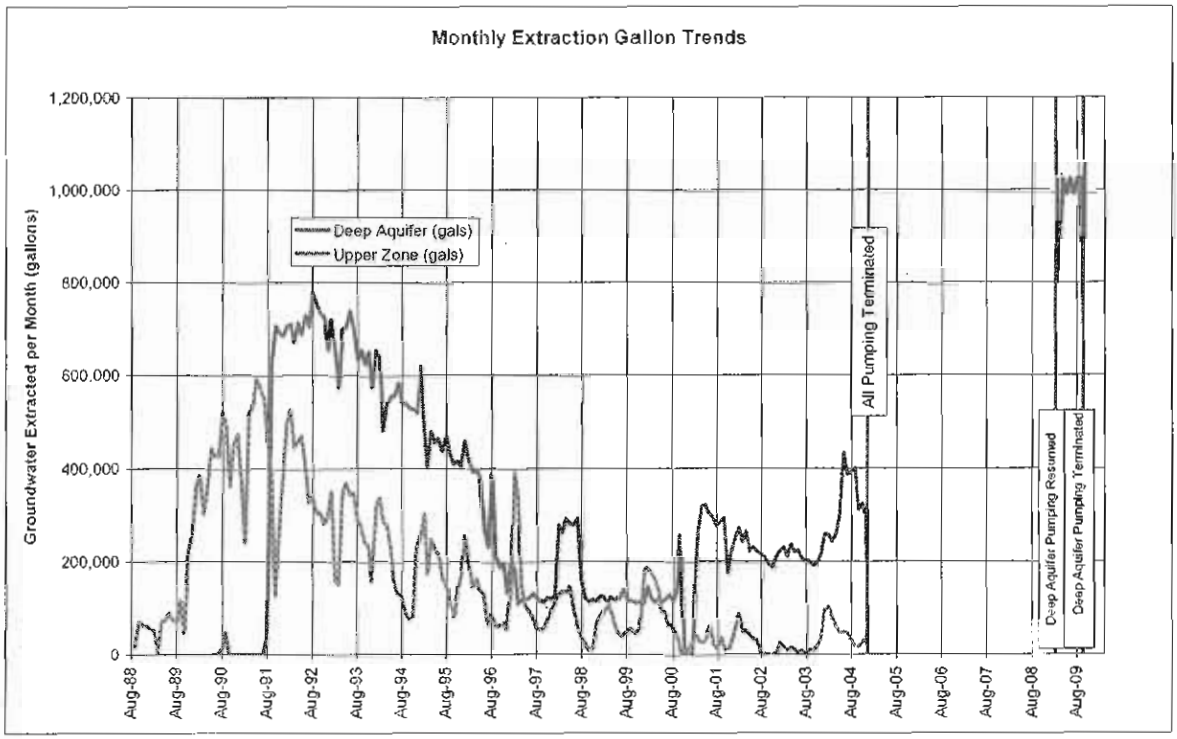


Figure 4-2. Upper Zone and Deep Aquifer Groundwater Extraction Rates



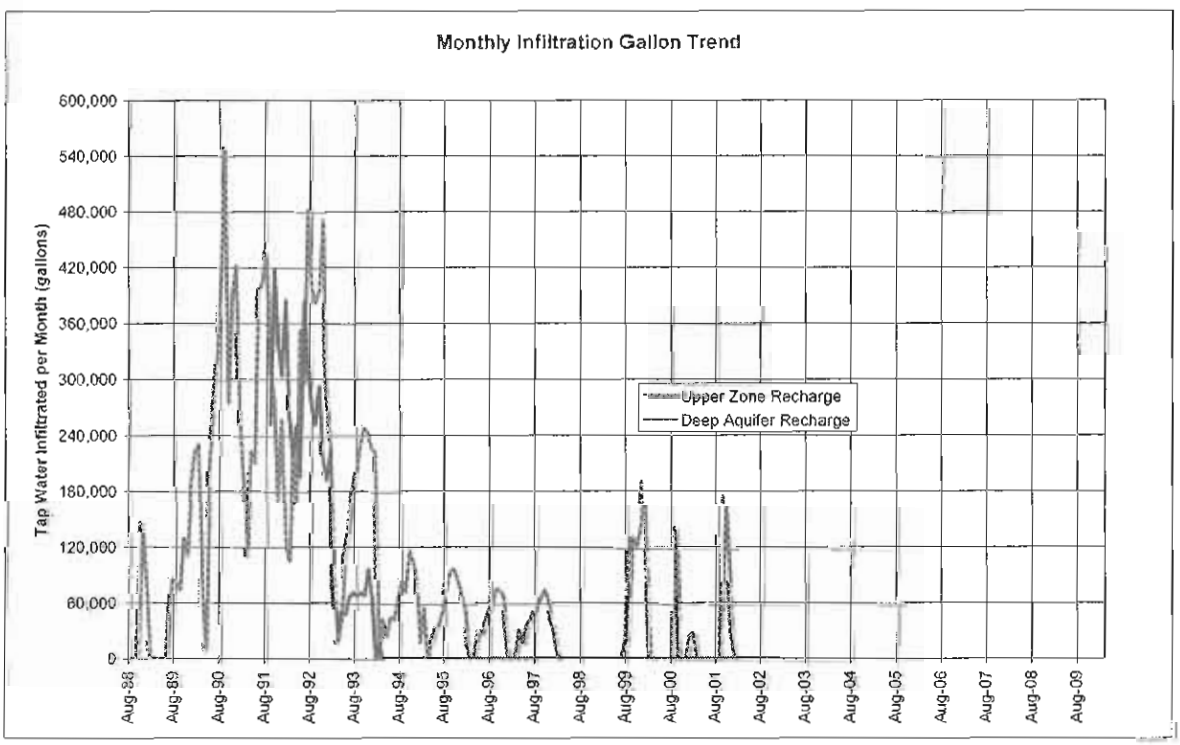
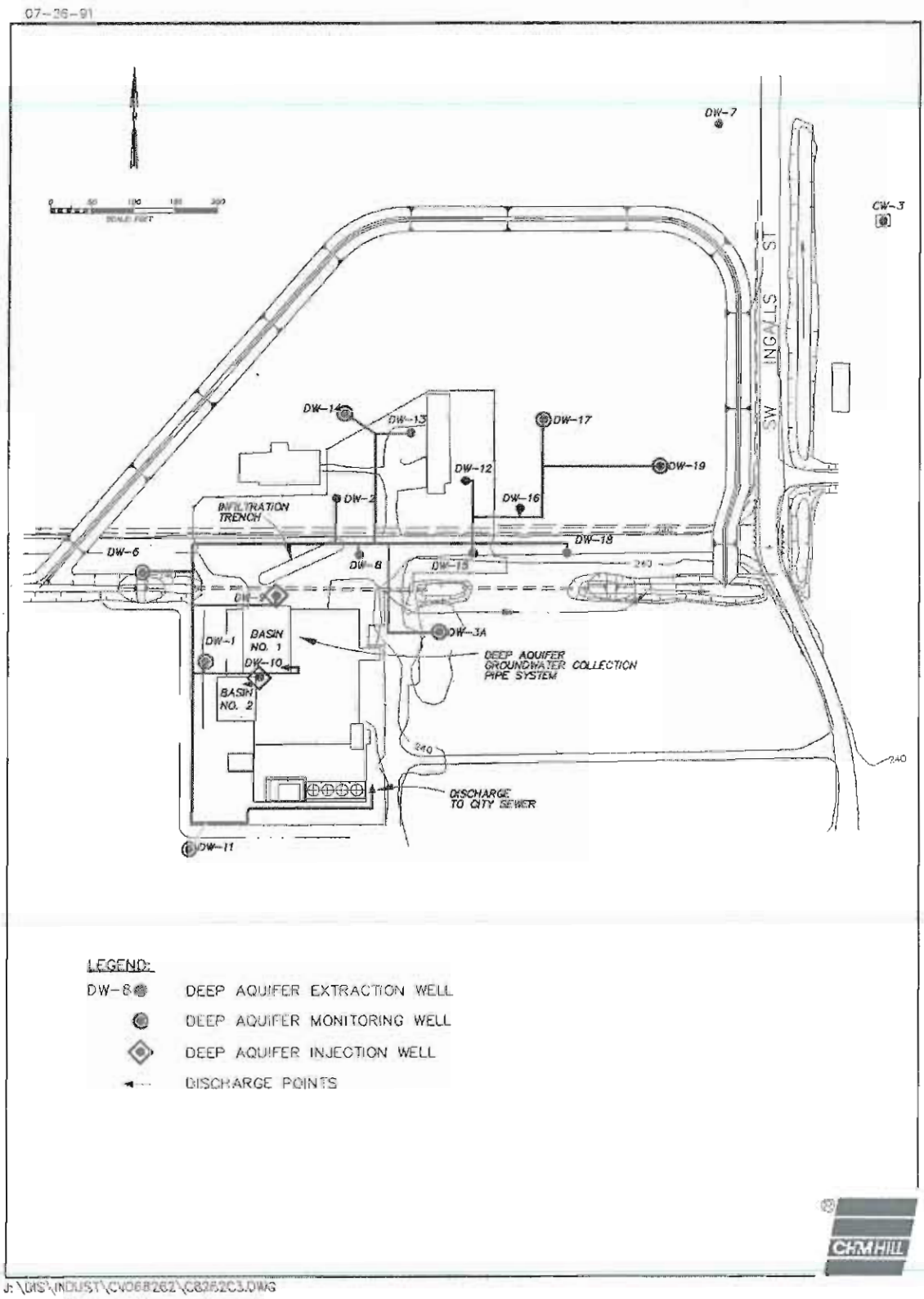


Figure 4-3. Deep Aquifer Groundwater Extraction Well Network



Deep Aquifer Operations

The deep aquifer groundwater extraction system has been operating for 13.3 years recovering 146 pounds of chromium from 54 million gallons of treated groundwater. Average groundwater extraction rates ranged from 123,970 to 778,840 gallons per month (2.8 to 20 gallons per minute). The extraction system operated full-time between August 1991 and December 2004 except for a 55-day shutdown from September to November 2000 for the upper zone soil excavation work . The total monthly extraction rate was highest when all seven wells were in operation and gradually declined as individual wells met the 0.1 mg/L ROD performance standard and were turned off. By February 1997, well DW-8 was the only extraction well still in operation. All groundwater extraction was discontinued in December 2004. Sampling and analysis of deep aquifer groundwater revealed a rebound in chromium concentrations at the three monitoring well locations closest to the original source. The City of Corvallis continued to monitor these wells to determine concentration trends over time (Figure 4-4). Because the rebound in contaminant concentration was limited to the immediate source area, several quarters of data were collected. Based on the analysis of this data, targeted pumping at one deep aquifer well (DW-8) was resumed in February 2009 to address the rebound condition. Subsequent monitoring exhibited a marked decline in chromium concentrations. The targeted pumping program was suspended on September 22, 2009 after observing significant chromium concentration reductions at two of the three monitoring well locations. The quarterly sampling from December 2009 to September 2010 indicated a rebound in chromium concentrations to levels comparable to those observed in December 2008, just prior to the temporary resumption of pumping. The rebound condition is attributed to a natural vertical hydraulic gradient that continues to transport some amount of contaminated groundwater from the upper zone to the deep aquifer.

Targeted pumping was then resumed at extraction well DW-8. At this time, DW-8 is the only operating groundwater extraction well. This level of pumping is maintaining hydraulic containment and continued monitoring of the groundwater affirms that the area of the plume is limited and stable.

4.3.2 Infiltration System

Two infiltration basins, an injection trench and two deep aquifer injection wells were used at the Site as a means to introduce potable water to the upper zone and deep aquifer to accelerate the overall remediation effort.

Between August 1988 and September 2000, 17.2 million gallons of potable water was flushed through upper zone soil using the infiltration basins and trench. This amount is equivalent to 56 percent of all groundwater pumped from the upper zone. Of the 17.2 million gallons of injection water, 59 percent (10.2 million gallons) was delivered through Basin 1, 22 percent (3.8 million gallons) through Basin 2, and 19 percent (3.2 million gallons) through the infiltration trench.

During the early phases of upper zone remediation, when all 23 extraction wells were in operation, infiltration rates varied from a low of 105,300 gallons per month during the winter months to 549,000 gallons during the summer. However, as individual extraction wells were shut down, the monthly infiltration rate gradually declined. The infiltration basins were decommissioned in September 2000 in conjunction with the upper zone soil excavation. An attempt to reuse the Basin 1 footprint in January 2001 was unsuccessful due to the low permeability of material used to backfill the excavation. The infiltration trench was also

temporarily restarted in September 2001 but was turned off once it was determined the recharge did not benefit extraction well EW-9.

From June 1998 to July 2000, a subsurface soil investigation was conducted to verify the infiltration basin's flushing effectiveness. Based on the results from this sampling effort, several areas of soils exceeding the soil remediation goal were identified. The City excavated 1,956 tons of soil containing chromium at concentrations greater than 6,000 mg/Kg. This material was transported to the Chemical Waste Management facility in Arlington, Oregon.

The two deep aquifer injection wells were operated to inject enough water to maintain a neutral vertical hydraulic gradient between the upper zone and deep aquifer to reduce contaminant transport to the deep aquifer groundwater from infiltrating upper zone groundwater.

Between August 1991 and February 1994, 5.5 million gallons of City municipal water was injected into the deep aquifer through wells DW-9 and DW-10; an amount equivalent to 11 percent of all groundwater pumped from the deep aquifer. An attempt was made to maintain injection rates at approximately 5 gpm. However, the injection rate had to be decreased during the winter months to prevent artesian conditions. Due to its ineffectiveness, the deep aquifer injection system was shut down in February 1994.

4.3.3 Groundwater Treatment System

The groundwater treatment system was purchased as a package unit from Wastewater Treatment Systems in 1988 and was installed during the Phase I construction effort.

While the treatment system was in operation, chromium removal from the groundwater influent stream was performed as follows:

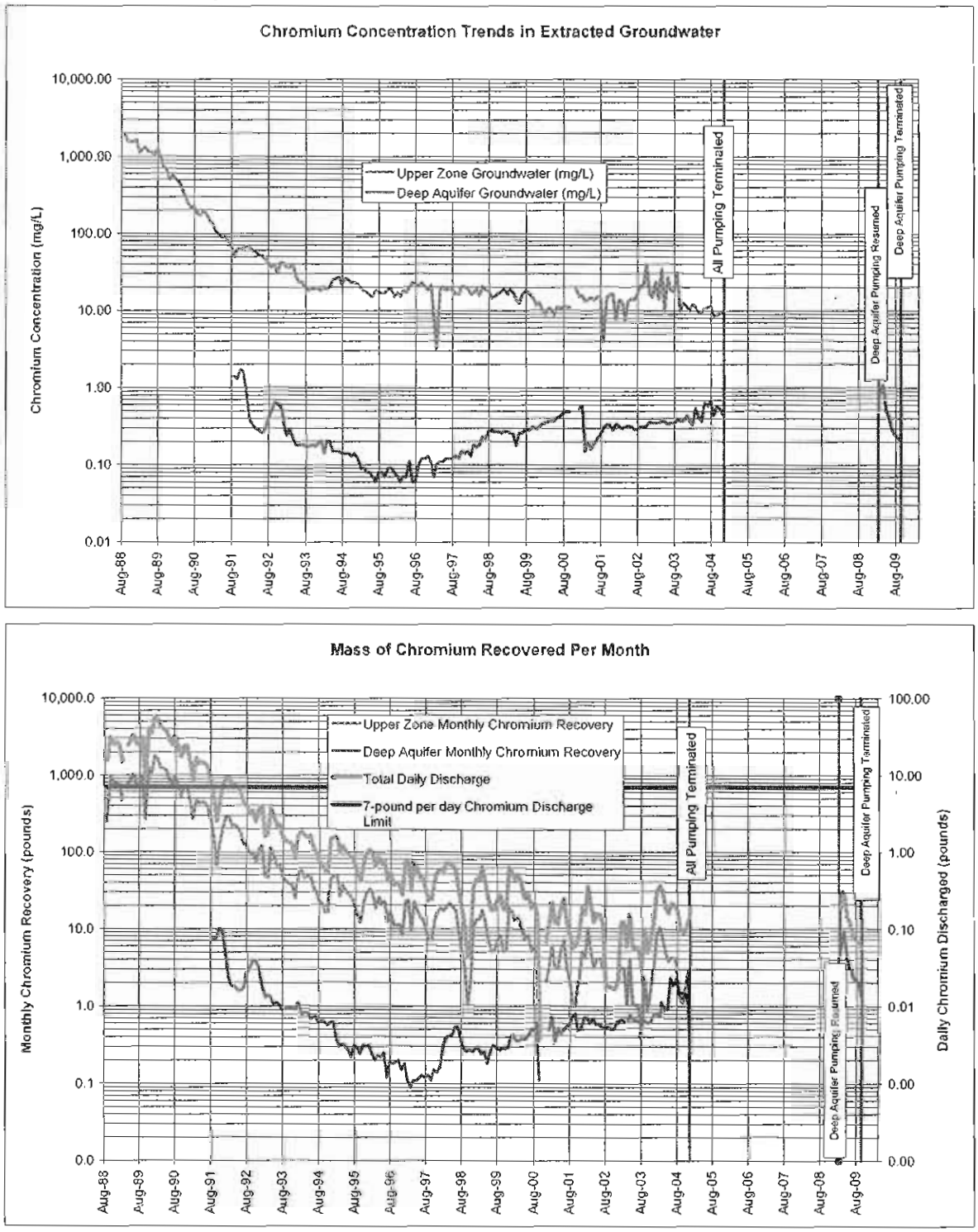
- Step 1: Groundwater stored in the influent holding tanks was pumped to the first reaction chamber where sulfuric acid (acidification) was added to lower the pH to approximately 2.5. Sodium metabisulfite was also added in the acidification chamber to chemically reduce hexavalent chromium to trivalent chromium.

- Step 2: Water then flowed into a second chamber (neutralization) where sodium hydroxide was added to raise the pH to 8.5, resulting in the formation of chromium hydroxide particles.

- Step 3: From the neutralization chamber, water flowed into a third chamber which was configured as a lamella clarifier. Prior to entering the clarifier, anionic polymer was added to help the smaller chromium hydroxide particles aggregate into larger floc. The floc settled to the bottom of the lamella forming a sludge. The sludge was then pumped to a thickening tank. The treated effluent was pumped from the clarifier to a clear well and through a bag filter (effluent polishing) into the effluent holding tanks.

- Step 4: Sludge formed in the thickening tanks was then pumped to a filter press, resulting in the formation of a blue-colored dry solid. The dry solid was placed in a drum and transferred to a roll-off box for shipment to the Chemical Waste Management facility in Arlington, Oregon. Water removed by the filter press was returned to the influent holding tanks.

Figure 4-4. Groundwater Chromium Concentration Trends



System Operations

In July 1991, the City proposed a 10-pound-per-day discharge limit (local limit) for the Site in accordance with National Categorical Pretreatment Limits (40 CFR Chapter I, Subchapter N Part 403). In January 1992, EPA approved a 7-pound per day discharge limit. During the local limit operations phase, up to 7 pounds per day of partially treated groundwater (14,000 gallons of upper zone groundwater or 3.8 million gallons of deep aquifer groundwater) could be discharged to the City POTW for treatment. In March 1992, the onsite treatment plant was modified to allow for full or partial operation of the chemical reduction treatment step and the plant was operated in this mode until March 1995.

The chromium concentration in upper zone groundwater processed through the treatment plant dropped steadily during the first several years of operation from 1,923 mg/L in August 1988 to 59 mg/L in March 1992. Between March 1992 and March 1995, when the treatment plant was operated primarily in the reduction- only mode, chromium concentrations declined from 59 mg/L to 17 mg/L. Between March 1995 and December 2002, when no onsite pretreatment was performed, chromium concentrations generally varied between 10 and 15 mg/L. Deep aquifer groundwater was treated onsite between August 1991 and March 1992. Due to low chromium concentrations and higher volumes, in March 1992, all deep aquifer groundwater was discharged to the POTW for treatment.

4.3.4 Performance Monitoring Program

Groundwater extraction and treatment system performance monitoring is conducted in accordance with the requirements of a pumping plan. The pumping plan has been revised six times since 1988 (Table 4-1). As experience with operation of the groundwater extraction and treatment system increased, monitoring frequencies were generally reduced. Additionally, when performance monitoring showed that an extraction or monitoring well achieved the ROD performance standard, the monitoring frequency was reduced or eliminated altogether.

The current performance monitoring program for the pulsed pumping program implemented in February 2009 (*Pumping Plan*, Amendment No. 6 CH2M HILL, 2009) specifies requirements for groundwater sampling. During the pulse-on and pulse-off cycles, groundwater samples are collected from wells DW-2, DW-8 and DW-9 on a quarterly to semiannual basis. Groundwater sampling at monitoring wells DW-12, DW-13 and DW-15 is performed on a semiannual basis. Sampling at wells DW-1 and DW-10 will not be performed unless unusual conditions warrant.

Table 4-1 Well Abandonment History

Abandonment Event	Date Performed	Wells Abandoned	
		Upper Zone	Deep Aquifer
Phase 1	June 1996	EW-1, PL-2, PL-3,PL-4, PL-5, BG-2, MW-2A	DW-7
Phase 2	May 1997	EW-19, EW-22, EW-24, EW-25, EW-26, SW-3, PZ-A, PZ-C, PZ-E	
Phase 3	May 1998	SW-2A, SW-4	DW-3A, DW-6, DW-18, DW-19
Phase 4	September 1990	EW-8, EW-28, EW-29	
Phase 5	June 2001	EW-17, EW-18, EW-21, EW-20, BG-1, MW-1, PL-1, PZ-D, PZ-F	DW-11, DW-14, DW-16, DW-17
Phase 6	June 2007	EW-2, EW-3, EW-4, EW-5, EW-6, EW-7, EW-10, EW-11, EW-12, EW-13, EW-14, EW-15, EW-16, EW-23, EW-27, MW-3, PZ-B, SE-2A	

4.4 Operation and Maintenance Costs

O&M costs for the Site were estimated in the Feasibility Study at $261,000 per year for the first five years of operation. Based on City information, actual O&M costs for the GETS averaged approximately $247,000 per year between 1989 and 1993, then declined steadily from $247,000 per year to approximately $25,000 per year between 1994 and 2001. Since 2002, average yearly costs have averaged between $25,000 and $35,000 per year.

5. Progress Since the Last Five-Year Review

Synopsis

The protectiveness statement in the third five-year review (*United Chrome Products Superfund Site Corvallis, Oregon Five-Year Review* Report, EPA, 2003) stated:

> *A protectiveness determination of the remedy at the United Chrome Products site cannot be made at this time until further information is obtained. Further information to determine whether the remedy currently protects human health and the environment will be obtained by the data collection and ecological evaluation of the down-gradient drainage ditches and surface water. It is expected that these actions will take six months to complete, at which time a protectiveness determination will be made. The soil and lower aquifer remedy currently protects human health and the environment because the site is fenced and not being used and the area of the lower aquifer with contamination above the chromium MCL is not being used as drinking water. Additional actions described in the recommendations ... are needed to ensure long-term protectiveness.*

The issues identified in the third five-year review included:

1. Although no specific cleanup standard for direct contact with soil was identified in the ROD, the upper zone remedy is not expected to achieve further chromium concentration reductions in upper zone soils. The levels currently present will prevent the site from achieving an unlimited use and unrestricted exposure status.
2. Concerns have been expressed in the past about subsurface contamination that might be present beneath the concrete floor of the former United Chrome Products building. Subsurface soil sampling performed beneath the floor during a July 2000 investigation did not reveal the presence of elevated chromium concentrations (*United Chrome – Phase 2 Upper Zone Groundwater Source Investigation Results* (CH2M Hill August 2000).
3. The deep aquifer remedy was not successful in blocking or controlling the drainage of chromium- contaminated groundwater infiltrating from the upper aquitard. Consequently, it is unlikely that the ROD performance standard for deep aquifer groundwater can be achieved, and compliance demonstrated, at two of the eight remaining well locations.
4. Concerns regarding historical chromium contamination detected in offsite sediments have also been raised.

The recommendations identified to address the issues in the third five-year review included:

1. Evaluate the hydrogeology and contaminant transport between the soil, upper zone, upper aquitard, and lower aquifer as necessary to understand the causes of the recent groundwater contaminant trends. Based on the results of this evaluation, re-evaluate the clean-up levels and current remedial approach.
2. Implement additional institutional controls for land and groundwater use restrictions as needed.

3. Collect data on site-related contamination in the down-gradient drainage ditches and water bodies, and then evaluate the ecological risks posed by these sediments.

Follow-up actions since the 2003 Five-Year Review

1. Evaluation of contaminant transport and hydrogeology:

   The City implemented a monitoring program in December 2004 to confirm that groundwater remediation goals could be maintained. Laboratory analysis results from monthly and quarterly sampling of the upper zone monitoring wells between January 2004 and September 2005 confirmed that the 10 mg/L total chromium remediation goal had been met at each well location in the upper water-bearing zone.

   By February 1997, well DW-8 was the only extraction well still in operation. All groundwater extraction was discontinued in December 2004. Sampling and analysis of deep aquifer groundwater revealed a rebound in chromium concentrations at the three monitoring well locations closest to the original source. The City of Corvallis continued to monitor these wells to determine concentration trends over time. Because the rebound in contamination concentration was limited to the immediate source area, several quarters of data were collected. Based on the analysis of this data, targeted pumping at one deep aquifer well (DW-8) was resumed in February 2009 to address the rebound condition. Subsequent monitoring exhibited a marked decline in chromium concentrations. The targeted pumping program was suspended on September 22, 2009 after observing significant chromium concentration reductions at two of the three monitor well locations.

   The quarterly sampling from December 2009 to September 2010 indicated another rebound in chromium concentrations to levels comparable to those observed in December 2008, just prior to the temporary resumption of pumping. The rebound condition is attributed to a natural vertical hydraulic gradient that continues to transport contaminated groundwater with chromium concentrations up to 10 mg/L from the upper zone to the deep aquifer through flux from soils, the upper water zone, and contamination adsorbed in the tight formation of the aquitard.

   This is resulting in exceedances of the 0.1 mg/L deep aquifer groundwater remediation goal within a 0.2 acre area within the plant site boundary. This indicates that there is insufficient dilution capacity between the source and the nearest well within the deep aquifer to adequately assimilate the flux at the interface between the upper zone groundwater and the deep aquifer. Groundwater extraction and treatment from one well (DW-8) is ongoing to maintain hydraulic containment at the Site. The groundwater is sent to the POTW for treatment. Continued monitoring of the groundwater affirms that the area of the plume is limited and is stable.

   The original estimate in the ROD stated that approximately five years would be required to meet groundwater cleanup goals. At that time, the groundwater POC for the deep aquifer was set at the original plant boundary. The upper zone treatment system operated for 15.3 years and the deep aquifer system is still operating. Although there has been significant mass removal and the area of contamination is limited and stable, the movement of chromium-contaminated groundwater between the upper zone soils, groundwater, and aquitard to the deep aquifer is expected to continue for the foreseeable future .This issue is further discussed in section 7 – Issues and Recommendations.

2. The following describes actions taken to address Institutional Controls.

   Subsequent to the issuance of the ROD, the first ESD, the initial two Five-Year Reviews, and the CD, the State completed a Screening- Level Human Health Risk Assessment (2002) and EPA completed the third *Five-year Review for the United Chrome Products Site, Corvallis, Oregon, March 2003.*

   The 2002 Screening Level Human Health Risk Assessment results confirmed that risks from residual soil contamination exceed acceptable levels for unlimited use and unrestricted exposure.

   In addition, EPA emphasized that the prohibition on extraction or use of the groundwater at the Site for consumption or other beneficial uses needs to be maintained for as long as hazardous substance concentrations exceed the acceptable risk level for such use (i.e., the MCL). These institutional controls for the Site were not explicitly documented in the original ROD.

   EPA, in consultation with the State and after discussion with the City, decided upon the following additional IC requirements to broaden and enhance the existing institutional controls.

   - Document a groundwater exclusion zone that encompasses all groundwater contaminated with total chromium above the MCL within which extraction or use of the groundwater for consumption or other use, except as to treatment, monitoring, temporary dewatering related to the response action, is prohibited;
   - Prohibit residential use of areas where residual soils exceed acceptable risk levels for so long as contamination remains above levels that allow for unlimited access and unrestricted exposure; and
   - Restrict industrial and commercial uses of the Site to prevent unacceptable exposure to residual contamination.

In August, 2010, EPA signed and issued an Explanation of Significant Differences documenting that ICs are part of the remedy and specifying the objectives of the ICs, where they are needed, what form they should take, and who is responsible. In addition to the existing ICs (i.e., deed and zoning restrictions, groundwater pumping exclusion zone), the City of Corvallis is required to execute and record in Benton County an Easement and Equitable Servitudes, or similarly restrictive document that runs with the land, to implement all the necessary restrictions. The City and/or any successor owners will have primary responsibility for maintaining and ensuring all lessees and tenants are aware of, and comply with, the restrictions until such time as ODEQ and EPA agree in writing the restrictions can be modified or removed.

The City and State have agreed to develop an E&ES to increase the long term enforceability of the ICs for the Site. EPA is a third party beneficiary to the E&ES such that EPA can monitor and enforce the E&ES requirements if/as necessary. This effort is ongoing.

3. The following describes actions taken to address potential site-related contamination in the down-gradient and onsite drainage ditches and water bodies.

The surface water historically flowed through an on-site drainage ditch. An early action re-routed this surface water runoff to a newly-created ditch on the eastern perimeter of the Site. Options to address residual contamination in the ditch were described in the *United Chrome Abandoned Ditch – Remedial Options* (CH2M HILL Technical Memorandum, May 20, 2005). The presence of residual chromium in soil/sediment contained in an abandoned (hydraulically -isolated) portion of the onsite drainage ditch was addressed by capping the ditch with clean cover material in June 2005 thus eliminating the pathway for exposure to human health and the environment. Detailed information of the closure work is contained in the *Abandoned Drainage Ditch Construction Report* (CH2M HILL, 2005).

Representatives from the ODEQ and City met on March 29, 2005 to discuss the approach for evaluating sediment toxicity in the offsite drainage ditch as proposed in *United Chrome Surface Drainage Ditch – Closure Strategy* (CH2M HILL, March 2005). The potential presence of residual chromium present in offsite drainage ditch sediments was evaluated through sampling and bioassay testing of sediment samples which was conducted between March and June 2005. Based on the results of these analyses, as well as comparison with Ambient Water Quality Standards, the sediments and associated surface water related to the Site do not pose an unacceptable risk to ecological receptors.

4. *Draft United Chrome Products Superfund Site – Targeted Soil Removal Remedial Action Completion Report* Technical Memorandum August 23, 2011

Although this action was not identified in the third Five-year Review, it is described here as an action that occurred subsequent to the third Five-Year Review. The objective of this work was to remove sufficient soil such that the concentration of total chromium remaining in the upper three feet of soil within the area controlled by the E&ES achieves the ODEQ 1×10^{-6} acceptable excess cancer risk level for industrial worker exposure. Outside of the E&ES where there are no institutional controls, any residual contamination must be at levels that allow for unlimited use and unrestricted exposure as defined by the NCP. This memorandum also evaluated data outside of the E&ES to ensure that levels were within the acceptable risk range of 10^{-4} to 10^{-6}.

The project included removal of 545 tons of soil from six previously defined areas with disposal at a local Subtitle D landfill (Coffin Butte). The soil was not a RCRA-listed waste or a characteristic waste. The excavations were backfilled to a depth of 1 foot with material from an airport stockpile. The material was compacted and a layer of geotextile was placed over the backfill material. The balance of the excavation was filled with crushed gravel from the local Green and White quarry.

An area-weighted exposure point concentration was then calculated at 207 mg/Kg. This was compared with the 86 mg/Kg site-specific total chromium which used a site-specific hexavalent chromium to total chromium ratio of 0.065. It was also compared to 155 mg/Kg total chromium which used a 0.036 ratio. This latter ratio was calculated using the most recent soil sampling results and is expected to be more representative of near surface soil conditions where naturally occurring hexavalent chromium reductants (soil organic material) are more prevalent.

The total chromium EPC of 207 mg/Kg correlates to an industrial worker risk of 2.4×10^{-6} based on an 86 mg/Kg remediation goal or 1.3×10^{-6} risk based on the adjusted total chromium remedial action goal of 155 mg/Kg.

The City is currently in the process of removing additional contaminated soil to achieve the ODEQ requirement of 1×10^{-6} risk to an industrial worker throughout the E&ES area.

For the area outside of the E&ES area where there are no institutional controls, total chromium levels were compared to 4.5 mg/Kg and 450 mg/Kg which are the site-specific total chromium concentrations that correlate to the 10^{-4} to 10^{-4} acceptable risk range defined in the NCP.

This evaluation used a data set of 45 sample results collected during the RI with total chromium concentrations ranging from 12 to 174 mg/Kg. The 90th percentile upper confidence level calculated for this data set is 38.7 mg/Kg. This EPC lies within the acceptable risk range as defined in the NCP for unlimited use and unrestricted exposure.

6. Five-Year Review Process

This chapter describes activities associated with completion of the five-year review.

6.1 Administrative Components

The approach used to conduct the five-year review generally followed that described in *Comprehensive Five-Year Review Guidance,* (EPA 540R-98-050). The overall five-year review effort was led by the EPA Region 10 remedial project manager, Ms. Mary Jane Nearman in coordination with the EPA Senior Policy Advisor, Mr. Tim Brincefield. Ms. Nearman was assisted by the EPA community involvement coordinator, Ms. Deborah Neal, U.S. Army Corps of Engineer representatives Ms. Amy Ebnet and Ms. Marlowe Laubach, the City of Corvallis and the City of Corvallis' contractor CH2M HILL. The five-year review work was performed between February 25, 2008 and August 2011.

6.2 Community Involvement

On February 26, 2008, EPA published a display ad in the Corvallis Gazette-Times announcing the beginning of the five-year review process. The display ad requested that any comments or concerns be submitted to EPA for evaluation in the review process. No comments have been received.

6.3 Review of Applicable or Relevant and Appropriate Requirements

The remedy selected in the ROD is intended to be protective of human health and the environment and to comply with ARARs. The objective for the ARARs review was to identify any newly promulgated federal or state regulatory standards that might affect the protectiveness of the remedy. Although ARARs are "frozen" at the time of ROD signature, EPA's *Comprehensive Five-Year Review Guidance* specifies that newly promulgated or revised regulatory standards that bear on the protectiveness of the remedy be identified and evaluated during the five-year review. In addition, a review of toxicity values is necessary to determine if the remediation goals are still protective.

Summaries of newly promulgated and revised regulatory standards identified during the course of the five-year review are discussed in Chapter 7.

6.4 Document and Data Review

CH2M HILL and the City have an extensive file for the United Chrome project. Information contained in this file was used to prepare the five-year review report and to review the adequacy of the Institutional Controls.

6.5 Site Inspection

The site inspection was performed by the USACE on behalf of EPA, City of Corvallis and CH2M HILL representatives on February 15, 2008 in accordance with the checklist contained in the five-year review guidance.

6.5.1 Site Access

Two security fences enclose the Site, with access obtained through gates located off Airport Place. The outer fence, maintained by the Federal Aviation Administration, encloses the Corvallis Airport and is labeled with no trespassing and warning signs approximately every 100 feet along its entire length. The inner fence encloses the United Chrome and CoEnergy facilities which lie within the Corvallis Airport property. A third fence separates United Chrome and CoEnergy from one another, and separate locking gates control entry and egress from each.

6.5.2 Surface Cover Material

Some areas of surface and subsurface soils at the Site continue to exhibit chromium concentrations that exceed acceptable risk levels as determined by the site-specific risk assessment conducted by ODEQ. Soils exceeding these levels must be removed or covered to prevent unacceptable exposure. To address this concern, the City conducted an evaluation to determine the adequacy of existing cover materials at the Site to prevent exposure to contaminated soils (Technical Memorandum *United Chrome – Adequacy of Existing Contaminated Soil Cover*, July 18, 2006)

The evaluation determined that protection against direct contact between residual chromium contamination and human and ecological receptors is currently provided by existing cover material comprised of asphalt, concrete and clean soil that overlies the Site (Figure 6-1). The concrete is up to 1.5-feet thick with good integrity. The asphalt -covered area on the north portion of the Site corresponds to a former County Road and is also in good condition. The clean fill area extends over the footprints of former infiltration Basin 1 and Basin 2, and varies in thickness from 0.5 to 15 feet. The potential for direct contact with soils has been eliminated by the cover in place and engineering control (i.e. fences, concrete, asphalt and clean fill).

To further protect against inadvertent exposure to residual soil contamination, the City will record a restriction of intrusion into the subsurface soils via an Easement and Equitable Servitudes in the real property documentation along with the existing groundwater use restriction. The City intends to assign enforcement responsibility for this institutional control to the Airport Manager. The Airport Manager is normally an individual who is fully involved and knowledgeable about all airport and industrial park development projects.

6.5.3 Excavation of Chromium-Contaminated Soil

In addition to the surface cover material which eliminates the exposure pathway for direct contact or ingestion of contaminated soil, the City elected to remove all exposed contaminated soil within the proposed E&ES to a depth of three feet to achieve an overall protectiveness of 1×10^{-6} for industrial exposure. The surface soils would then meet the ODEQ requirement of 1×10^{-6} exposure for an industrial worker and, therefore, would not require capping. The City elected to remove these soils, in addition to the surface cover, as an additional assurance of protectiveness to future workers.

6.5.4 Remediation Infrastructure

An office and laboratory trailer that were part of the groundwater remedial action infrastructure are still present at the Site but no longer routinely used. All groundwater laboratory analysis and data management is now conducted at the City of Corvallis POTW. All other remediation infrastructure, except for the office/laboratory trailer, wastewater treatment concrete foundation, and seven deep aquifer monitor wells, has been removed.

6.5.5 Site Safety

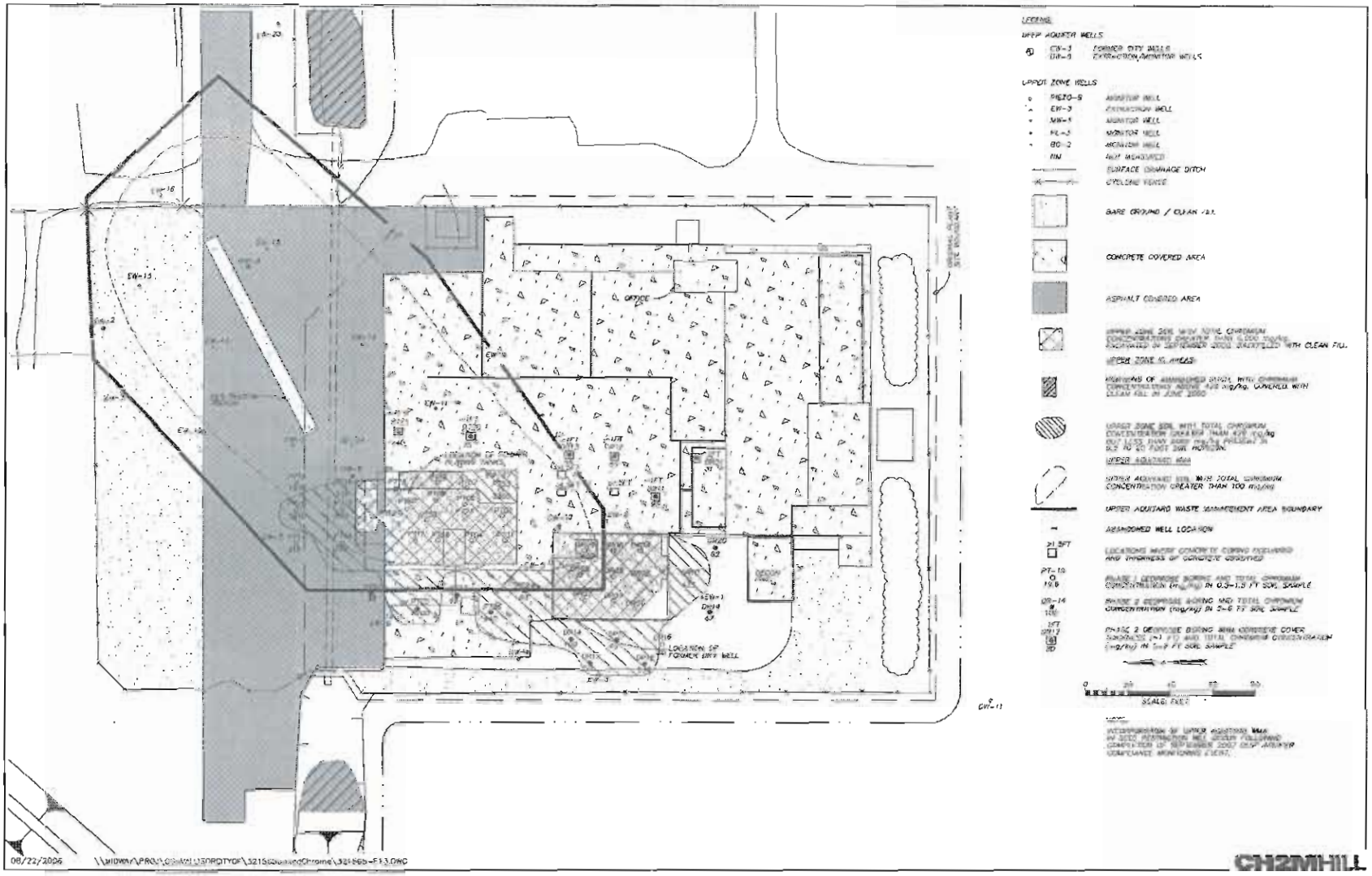
United Chrome O&M personnel are 40-hour trained, in accordance with 29 CFR 1910.120, and are current with respect to 8-hour refresher training and annual medical examinations. Because of the limited nature of current site operations, a facility safety inspection was not performed.

6.6 Institutional Controls Review

Institutional controls were reviewed and evaluated as part of this Five-year review. ICs were not explicitly required in the original ROD, but ICs and engineering controls were put in place at the Site as part of the remedial action. These controls included locked fencing around the former United Chrome Products, Inc. property to prevent unauthorized entry to the Site, with further controls provided by the fencing and security guards to limit access to the airport complex. On May 24, 1993, the City, as required by the CD, placed a deed restriction on the Site to restrict groundwater use and well pumping, the areal extent of which includes all upper zone and deep aquifer groundwater which exceeds the chromium drinking water MCL. The existing access controls, zoning and deed restrictions and pumping exclusion zone remain in effect. The City and the State are unaware of any evidence of IC breaches or failures.

Additional ICs were added to the selected remedy in the August 2010 ESD to document the IC objectives, ensure the ICs address all areas of residual site-related contamination, and ensure the ICs remain in effect for so long as contamination remains above levels that allow for unlimited use and unrestricted exposure. The City and the State are in the process of completing an Easement and Equitable Servitudes that runs with the land, to ensure the restrictions to prevent unacceptable exposure remain in effect as long as necessary. The City and/or any successor owners will have primary responsibility for maintaining and ensuring all lessees and tenants are aware of, and comply with, the restrictions until such time as ODEQ and EPA agree in writing the restrictions can be modified or removed.

Figure 6-1. Surface Cover Material Types and Distribution



7. Technical Assessment

This chapter presents a technical assessment of remedy performance observed between 2003 and 2011. This assessment was prepared to answer the following questions:

- Is the remedy functioning as intended by the decision documents?
- Are the exposure assumptions, toxicity data, cleanup levels and remedial action objectives used at the time of remedy selection still valid?
- Has any other information come to light that could call into question the protectiveness of the remedy?

7.1 Is the Remedy Functioning as Intended?

No – EPA's Groundwater Protection Strategy requires compliance with MCLs throughout an aquifer for groundwater that is a current or potential source of drinking water (i.e., the Class IIB deep aquifer). Although considerable progress has been made and the area of contamination is now limited and stable and there is no current unacceptable exposure, the MCL for chromium of 0.1 mg/L has not yet been achieved throughout the Site's deep aquifer.

The remedial actions intended to address groundwater contamination included soil excavation, use of an infiltration system and a groundwater extraction and treatment system in both the upper zone (a Class IIIA aquifer) and the deep aquifer (a Class IIB aquifer) (see Section 3.2).

These actions have been effective in mass removal and in reducing the volumes of chromium contamination in both the upper zone and the deep aquifer. Groundwater chromium concentration trends have decreased consistently since the initiation of the remedial action in 1988.

The upper zone groundwater extraction system operated for 15.3 years recovering 31,955 pounds of chromium from 31.3 million gallons of treated groundwater. Average groundwater extraction rates ranged from zero to 594,000 gallons per month (16 gallons per minute). Monthly extraction rates declined steadily beginning in May 1991 as individual wells were shut-off after reaching the 10 mg/L chromium ROD performance standard.

Although only limited extraction is still occurring, the deep aquifer groundwater extraction system has been operating for 13.3 years recovering 146 pounds of chromium from 54 million gallons of treated groundwater. Average groundwater extraction rates ranged from 123,970 to 778,840 gallons per month (2.8 to 20 gallons per minute). The extraction system operated full-time between August 1991 and December 2004 except for a 55-day shutdown from September to November 2000 for the upper zone source removal work.

Chromium in upper zone groundwater was successfully remediated to the 10 mg/L concentration specified in the Record of Decision. As shown on Figure 7-1a and Figure 7-1b, the remedy was successful in controlling the upper zone plume's horizontal migration and shrinking its overall footprint. Horizontal migration in both the upper zone and the deep aquifer is under control.

However, as shown in Figure 7-2, the remedy has been less successful in controlling the upper zone plume's vertical migration.

Natural groundwater flow patterns at the Site are transporting upper zone groundwater containing chromium at concentrations of less than 10 mg/L vertically downward to the deep aquifer. The concentration of chromium resulting from the mixing of upper zone groundwater with deep aquifer groundwater is currently greater than the 0.1 mg/L deep aquifer remediation goal in a limited area beneath the original source area.

Only the wells in closest proximity to the original source area (DW-2, DW-8, DW-9) currently exceed the MCL. The three wells (DW-12, DW-13, and DW-15) just downgradient (and still within the 1.5-acre original property boundary) have remained below the 0.1 mg/L ROD standard since 1993.

Currently, it is estimated that chromium is being transported to the deep aquifer from the upper zone at a rate of 1.6 pounds per month. This flux is approximately equal to the average mass of chromium recovered each month when DW-8 is pumping. Based on the volume and magnitude of residual chromium remaining in deep upper zone subsurface soil, and the leachability of this material, this flux rate within an approximate 0.2 acre area will likely continue until the source is slowly depleted.

Well DW-8 is now the only operating groundwater extraction well and is maintaining hydraulic containment. The plume remains stable and is not expanding but it is not likely that compliance with the MCL throughout the lower aquifer will occur for the foreseeable future under the current treatment regime.

EPA, in coordination with the City and ODEQ, expects to conduct an optimization study for the groundwater remedy to determine the possibility of expediting compliance with groundwater remediation goals.

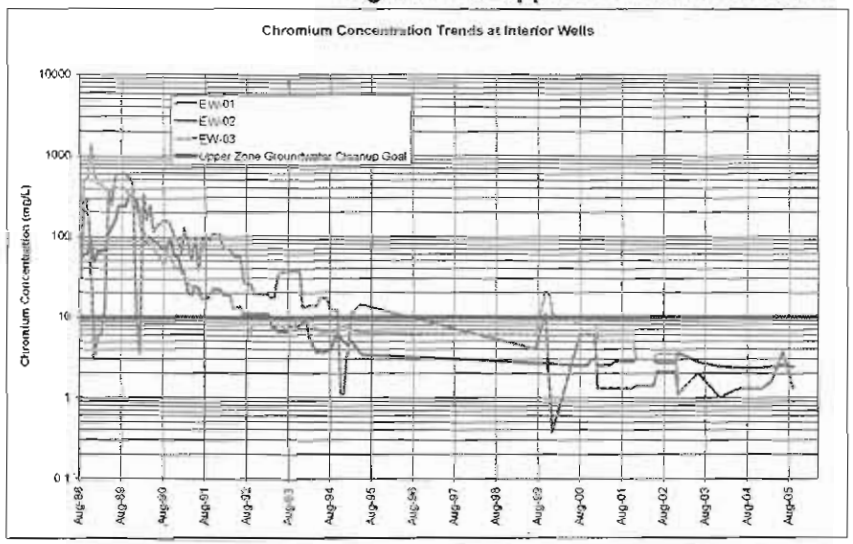
Institutional Controls under the developing E&ES will ensure continuing compliance with the groundwater exclusion zone to prevent use of groundwater contaminated with chromium above the MCL. The groundwater exclusion zone defines an area within which extraction or use of the groundwater for consumption or other use, except as to treatment, monitoring, temporary dewatering related to the response, is prohibited.

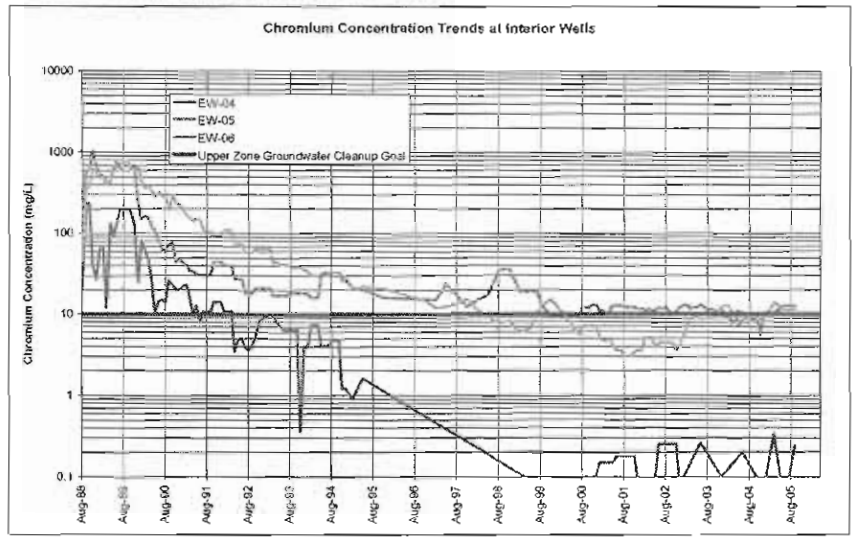
ICs were not explicitly required in the original ROD, but ICs and engineering controls were put in place at the Site, in accordance with the CD, in 1993 to prevent unacceptable exposures. These controls remain in effect and are effectively preventing exposure and protecting the integrity of the remedy. The City and the State are unaware of any evidence of IC breaches or failures.

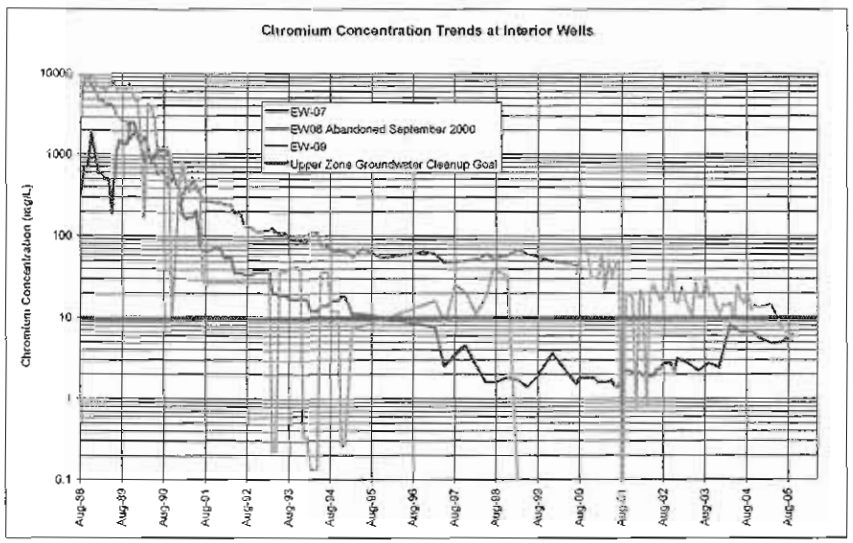
To enhance the existing ICs, additional controls were added to the selected remedy in the August 2010 ESD to clarify the IC objectives, ensure the ICs encompass all areas of residual site-related contamination, and ensure the ICs remain in effect for so long as contamination remains above levels that allow for unlimited use and unrestricted exposure. The City and the State are in the process of completing an Easement and Equitable Servitudes that runs with the land, to ensure the restrictions to prevent unacceptable exposures remain in effect as long as necessary. The

City has removed additional soil with residual contamination within the top three feet to ensure that exposures to industrial workers within the E&ES will remain below the 1×10^{-6} risk level. That work and recording of the E&ES are expected to be complete in the fall of 2011. No additional ICs or further changes to the ICs would then be necessary to ensure long-term protectiveness.

Figure 7-1a. Upper Zone Groundwater Chromium Concentration Trends – Interior Wells







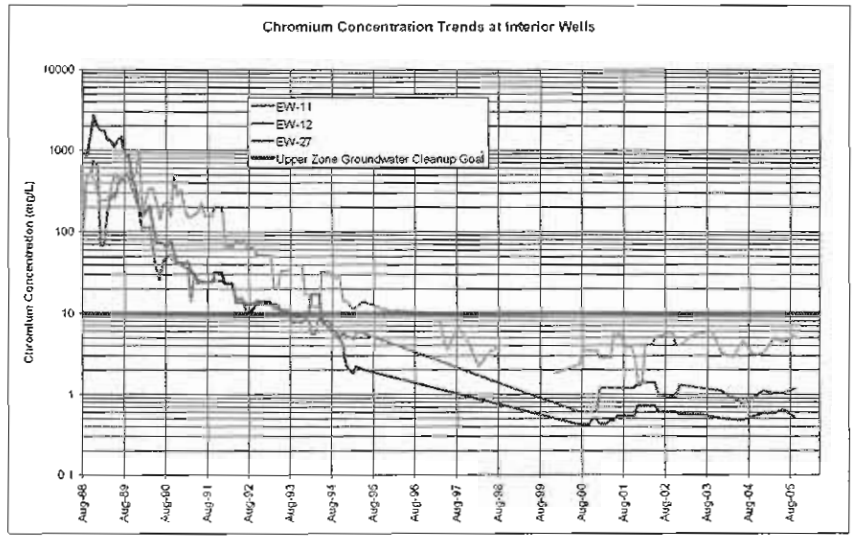
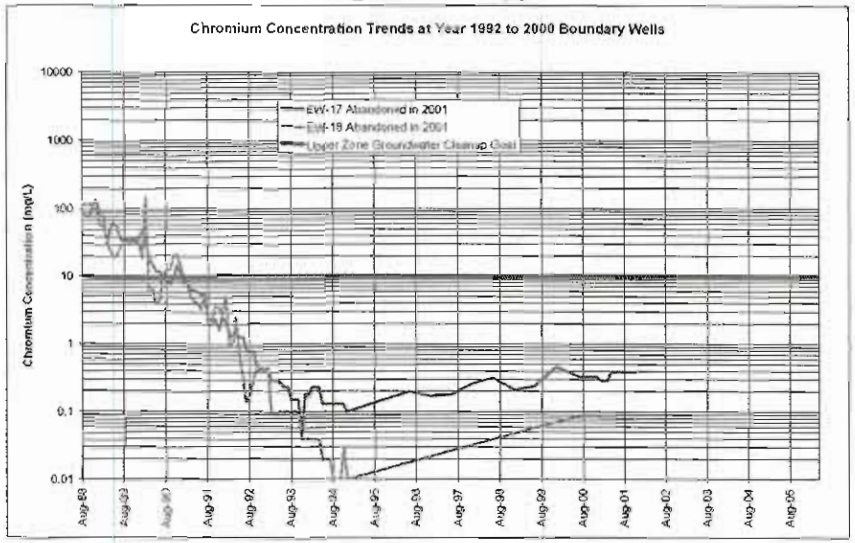
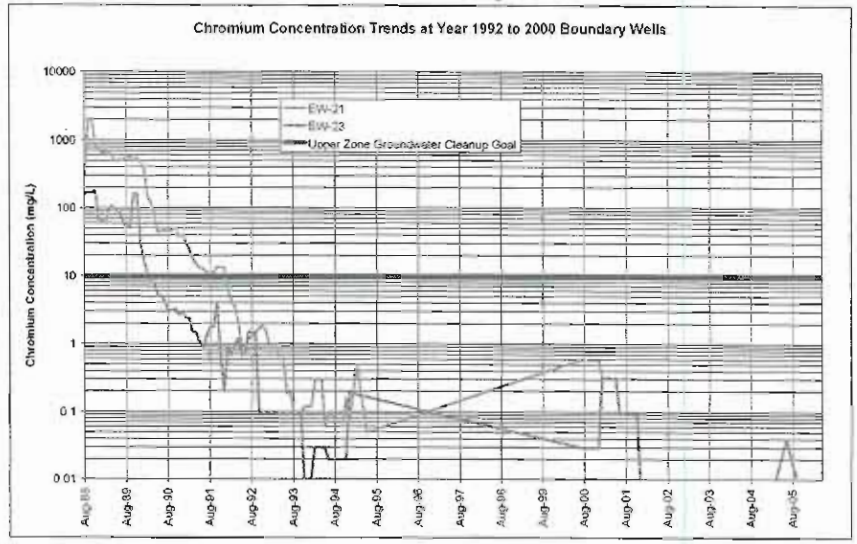
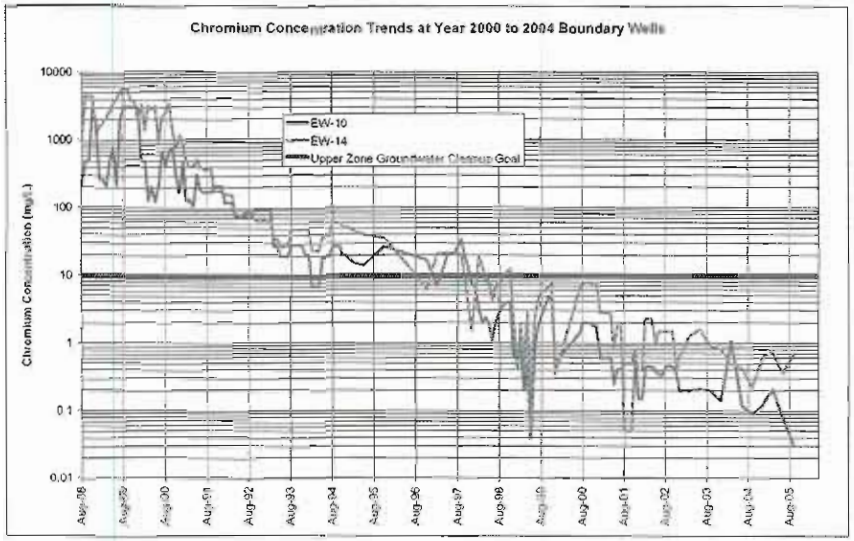


Figure 7-1b. Upper Zone Groundwater Chromium Concentration Trends – Boundary Wells







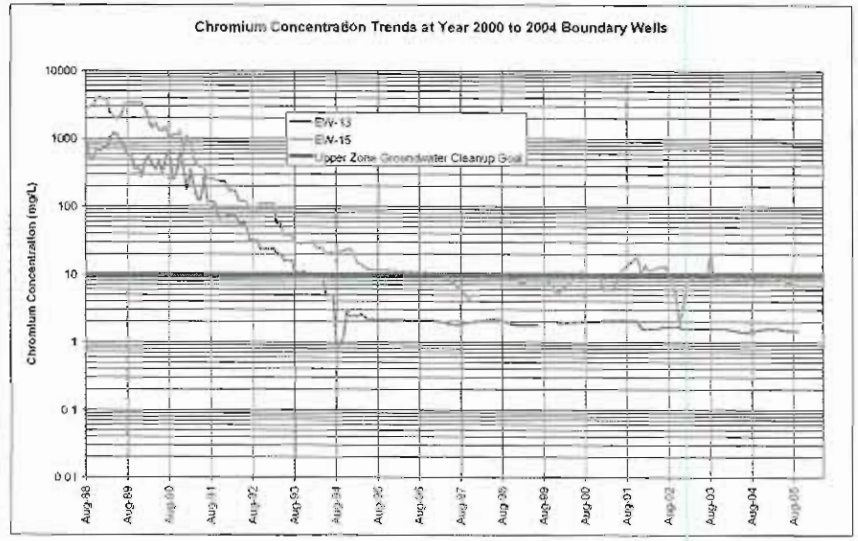
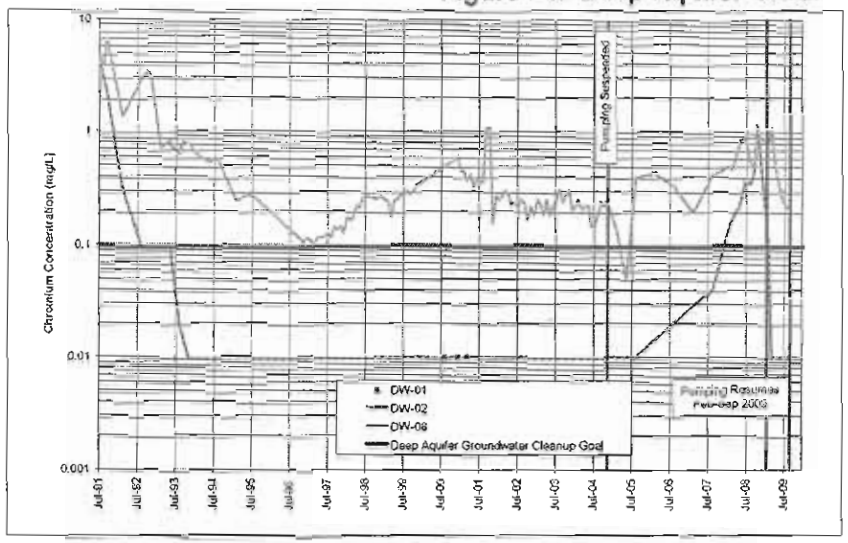
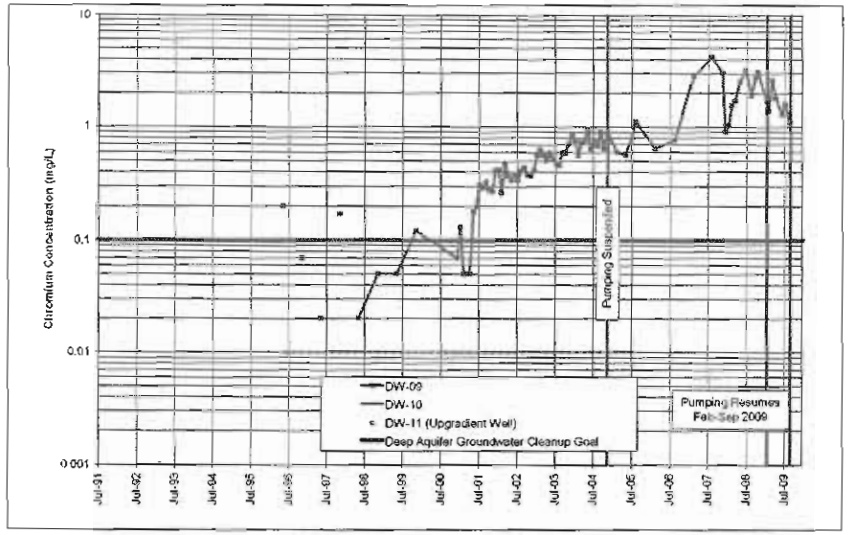
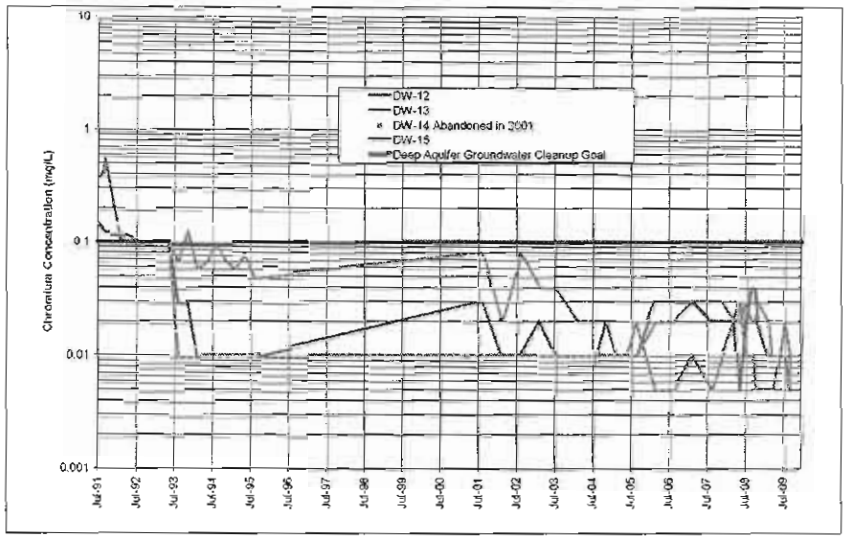
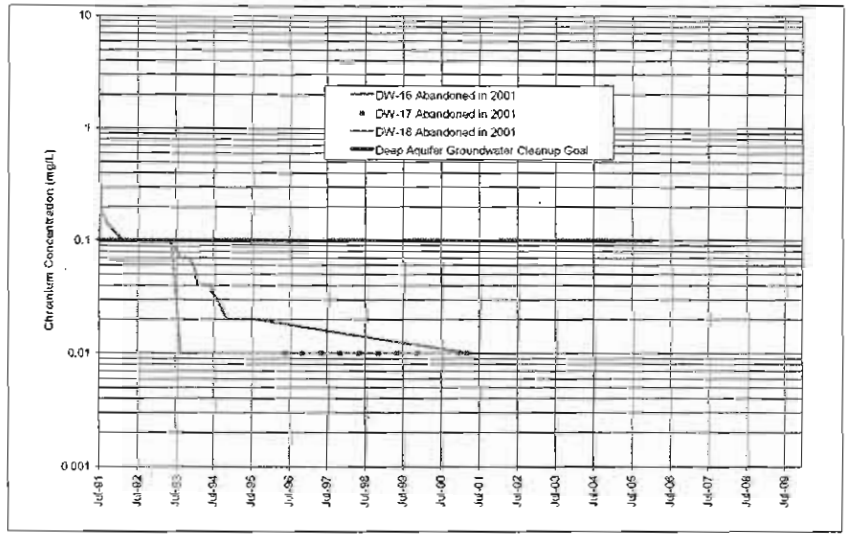


Figure 7-2. Deep Aquifer Groundwater Chromium Concentration Trends









7.2 Are the Exposure Assumptions, toxicity data, cleanup levels, and Remedial Action Objectives still valid?

No - As described further in the following subsections, several factors have changed since the ROD was signed in 1986. Actions necessary are:

1. Incorporate increase in the toxicity slope factor for hexavalent chromium.
2. Establish soil cleanup level for protection that meets the RAO to "adequately protect the public against contact with and ingestion of contaminated soil and sediments."
3. Clarify groundwater point of compliance

7.2.1 Changes in Toxicity Data

Based on an EPA Provisional Peer Reviewed Toxicity Value, the EPA regional screening level for hexavalent chromium was recently revised to incorporate an oral slope factor. Previously hexavalent chromium was believed to be carcinogenic by the inhalation route only. This reduces the RSL by approximately two orders of magnitude. The value in IRIS has not been changed. The state of Oregon has indicated it intends to adopt this new slope factor for implementation in 2011.

7.2.2 Establishment of Soil Cleanup Levels for Direct Contact

The current soil cleanup level of 6,000 mg/Kg total chromium is based on protection of groundwater. Although the ROD included a goal to "adequately protect the public against contact with and ingestion of contaminated soil and sediments", no soil cleanup level to meet this goal has been documented in a decision document.

In July 2002, ODEQ performed a screening level human health risk assessment to estimate potential risks to human health resulting from exposure to chromium-contaminated soil. Health risks were estimated for the following receptors:

- Industrial/commercial workers – future workers in contact with contaminated soil present between 0 and 3 feet below ground surface. Exposure could occur through the inhalation and direct contact exposure routes. A 250-day per year exposure period was assumed. Exposure was evaluated using both onsite and offsite contaminated soil information.
- Excavation workers – future workers in contact with contaminated soil present between 0 and 12.5 feet below ground surface. Exposure could occur through the inhalation and direct contact exposure routes. A 9-day per year exposure period was assumed.
- Residential – City zoning and the Airport Master Plan do not allow the Site to be used for residential purposes (unlimited use/unrestricted exposure). However, a hypothetical residential exposure scenario was evaluated to determine which areas require institutional controls.

The results of this first effort determined that the excess lifetime cancer risk under current site conditions falls within the CERCLA acceptable risk range of 10^{-4} to 10^{-6} for all three exposure scenarios, but exceeds ODEQ's acceptable risk of 1×10^{-6} for the industrial/commercial worker (6×10^{-5}) and hypothetical residential exposure scenario (1×10^{-4}).

Table 7-1

2002 Human Health Risk Screening for United Chrome Soil

Exposure Area	Exposure Scenario	Chromium RME Concentration (mg/Kg)	Cancer Risk	Noncancer Hazard Quotient
Onsite	Industrial/Commercial Worker	4,040	6×10^{-5}	0.7
	Excavation worker	4,962	5×10^{-8}	0.06
	Resident	4,040	1×10^{-4}	17.6
Offsite	Industrial/Commercial Worker	25	4×10^{-7}	0.004
	Excavation worker	28	3×10^{-10}	0.0003
	Resident	25	8×10^{-7}	0.1

While preparing the original screening level risk assessment, ODEQ defined an allowable chromium concentration in soil of 914 mg/Kg if the Site is utilized for industrial/commercial uses, or 428 mg/Kg if redeveloped for residential use. These cleanup levels are based on a 1 to 14 (7 percent) ratio of hexavalent chromium to total chromium in soil; a site-specific characteristic of the United Chrome contamination as documented in the *United Chrome - Phase 2 Upper Zone Groundwater Source Investigation Results*, CH2M HILL Technical Memorandum 2000). The default assumption of a 1 to 6 ratio (17 percent) hexavalent chromium to total chromium is not applicable to the United Chrome Site.

In 2010, ODEQ re-evaluated the 2002 screening level risk assessment to reflect the revised Regional Screening Level and proposed change in chromium slope factor. This resulted in a lowering of the site-specific allowable soil chromium concentration as indicated below.

Table 7-2

2010 Site Specific Soil Allowable Chromium Concentrations Based on New RSL

Exposure Scenario	Allowable hexavalent chromium (mg/Kg)	Allowable total chromium (mg/Kg)
Excavation Worker	1,200	17,142
Outdoor Worker	5.5	86
Resident	0.29	4.1 (defaults to background concentration of 35)

These values were used to determine the areal extent of the soil institutional control boundary to be included in the E&ES. All areas with contaminant levels that do not allow for unrestricted use and unlimited exposure require institutional controls.

An evaluation of the protectiveness of the total chromium MCL of 0.1 mg/L was not conducted; however the current groundwater institutional controls are sufficiently conservative to accommodate any future change in the MCL.

7.2.3 Clarification of Groundwater Point of Compliance (POC)

Both the 1986 pre-Sara Record of Decision and the 1992 Consent Decree cite a POC for the deep aquifer at the original plant site boundary. This is not consistent with the current EPA Groundwater Protection Strategy where the MCL is relevant and appropriate throughout an aquifer that is a current or potential drinking water source (i.e., the Class IIB deep aquifer). MCLs are applicable at the point of consumption (i.e., "the tap) and are relevant and appropriate in the groundwater that is a potential source of drinking water.

As discussed in Section 3.2, the upper zone is not a potential source of drinking water and, therefore, MCLs are not applicable nor relevant and appropriate. The remediation goal of 10 mg/L total chromium in this Class IIIA aquifer was identified as the level necessary to protect the higher-class (Class IIB) deep aquifer. This concentration represents the minimum cleanup required to protect the potential source of drinking water.

7.3 Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No – All exposure pathways remain under control either through previous cleanup actions and engineering or institutional controls. The Site is currently protective of human health and the environment.

7.4 Technical Assessment Summary

1. The remedy is not functioning completely as intended. Additional actions are needed to ensure that the remedy remains protective over the long term.

   To implement the additional ICs required in the 2010 ESD, the City and ODEQ are in the process of completing an E&ES that runs with the land to ensure the restrictions to prevent unacceptable exposures remain in effect as long as necessary.

   EPA, in coordination with the City and ODEQ, expects to conduct an optimization study for the groundwater remedy to determine to possibility of expediting compliance with groundwater remediation goals;

   The exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives were not found to be completely valid. Several factors have changed or need to be clarified since the ROD and subsequent ESDs were signed. The remediation goals need to be revised to incorporate the increase in the toxicity slope factor for hexavalent chromium;

   A soil cleanup level that meets the RAO "to adequately protect the public against contact with and ingestion of contaminated soil and sediments" must be established; and

The groundwater point of compliance needs to be clarified to reflect that MCLs must be achieved throughout the deep aquifer which is a potential source of drinking water. Both the 1986 pre-Sara Record of Decision and the 1992 Consent Decree cite a POC for the deep aquifer at the original plant site boundary. This is not consistent with the current EPA Groundwater Protection Strategy which applies the MCL throughout an aquifer that is a current or potential drinking water source (i.e., the Class IIB deep aquifer).

No other information has come to light that could call into question the protectiveness of the remedy. All exposure pathways remain under control either through previous cleanup actions and engineering and institutional controls. The Site is currently protective of human health and the environment.

8. Issues and Recommended Actions

Issues

1. Chromium in upper zone groundwater was successfully remediated to the 10 mg/L concentration specified in the Record of Decision. Natural groundwater flow patterns at the Site are continuing to transport upper zone groundwater containing chromium at concentrations of less than 10 mg/L, vertically downward to the deep aquifer.

The concentration of chromium resulting from the mixing of upper zone groundwater with deep aquifer groundwater is currently greater than the 0.1 mg/L deep aquifer remediation goal in a limited area beneath the original source. The upper water-bearing zone is classified as Class IIIA and is not a potential source of drinking water. The lower groundwater aquifer is classified as Class IIB, a potential source of drinking water.

The projected cleanup time in the ROD for the lower aquifer was five years with a range of three to eight years. Treatment has been ongoing for more than 15 years at this point and, although significant progress has been made, residual contamination above the total chromium MCL is persistent in a limited area within the deep aquifer. The movement of chromium-contaminated groundwater present within an approximate 0.2 acre in the upper zone to the deep aquifer is expected to continue for the foreseeable future under the current treatment regime.

2. The existing ICs may not be protective in the long term because they do not include proprietary controls (e.g., restrictive covenants) that "run with the land."

3. The current soil cleanup level of 6,000 mg/Kg total chromium is based on protection of groundwater. Although the ROD included a goal to "adequately protect the public against contact with and ingestion of contaminated soil and sediments", no soil cleanup level to meet this goal has been documented in a decision document. Site-specific remediation goals have been developed by ODEQ and were used in determining the areas of the Site requiring institutional controls.

4. The groundwater point of compliance (POC) needs to be revised. Both the 1986 pre-Sara Record of Decision and the 1992 Consent Decree cite a POC for the deep aquifer at the original plant site boundary. This is not consistent with the current EPA Groundwater Protection Strategy which applies the MCL throughout an aquifer that is a current or potential drinking water source (i.e., the Class IIB deep aquifer).

Table 8-1: Issues

Issues	*Affects Current Protectiveness* *Y/N*	*Affects Future Protectiveness* *Y/N*
Deep aquifer not achieving groundwater remediation goals due to flux from upper zone soils and groundwater	N	Y
Existing ICs may not be protective in the long term	Y	Y
No soil remediation goal for direct human exposure	N	Y
Current groundwater Point of Compliance for the deep aquifer not consistent with EPA Groundwater Protection Strategy	N	Y

Recommendations and Follow-up Actions:

1. a. The City of Corvallis will continue groundwater extraction and treatment with treatment of the groundwater at the publicly-owned treatment works (POTW) to maintain hydraulic containment. Groundwater monitoring will continue to confirm plume stability.

b. EPA, in coordination with the City and ODEQ , expects to conduct an optimization study for the groundwater remedy to determine the possibility of expediting compliance with groundwater remediation goals.

2. To implement the additional ICs required in the 2010 ESD, the City and ODEQ will complete an E&ES that runs with the land to ensure the restrictions to prevent unacceptable exposures remain in effect as long as necessary.

3. The soil remediation goals for direct human contact will be documented in a decision document.

4. The POC for the deep aquifer will be clarified in a decision document to be consistent with the EPA Groundwater Protection Strategy. The POC will be revised from the original plant boundary to throughout the deep aquifer which is a potential source of drinking water.

Table 8-2

Recommendations and Follow-Up Actions

Issue	Action	Party	Oversight Agency	Date	Affects Current Protectiveness	Affects Future Protectiveness
1.a.	Continue GETS to maintain hydraulic containment	City	EPA/ODEQ	Ongoing	N	Y
1.b.	Conduct groundwater remedy optimization study	EPA	ODEQ	09/2012	N	Y
2.	Finalize ICs in an E&ES	ODEQ	EPA	12/2011	Y	Y
3.	Specify soil remediation goal in decision document	EPA	ODEQ	03/2012	N	Y
4.	Clarify POC for deep aquifer groundwater	EPA	ODEQ	03/2012	N	Y

9. Protectiveness Statement

The remedy currently protects human health and the environment, however, in order to ensure that the remedy remains protective in the long-term, enforceable institutional controls need to be recorded, the groundwater remedy needs to be further evaluated and optimized, if necessary, and the groundwater point of compliance and soil remediation goals need to be clarified.

10. Next Review

The next policy five-year review will be conducted within five-years of the signature date of this review. Future five-year review reports will employ an abbreviated format that will provide information similar to that contained in Chapters 5 through 10 of this review.

Appendix A ODEQ No Further Action Letter for Ecological Assessment

Oregon
Theodore R. Kulongoski, Governor

Department of Environmental Quality
Western Region - Salem Office
750 Front St. NE, Ste. 120
Salem, OR 97301-1039
(503) 378-8240
(503) 378-3684 TTY

July 28, 2005

Tom Penpraze
Public Works Department
City of Corvallis
1245 NE 3rd Street
P.O. Box 1083
Corvallis, OR 97339-1083

Re: DEQ ECSI #317
Preliminary No Further Action for Ecological Assessment
United Chrome Products Site, Corvallis

Dear Mr. Penpraze:

The Oregon Department of Environmental Quality (DEQ) received and reviewed a succession of reports pertaining to the evaluation of the potential ecological risks associated with the residual contamination from the former United Chrome Products Superfund site. Please find enclosed Attachment A which contains a list of these reports.

The reports, *United Chrome Abandoned Ditch Remedial Action* and *United Chrome Surface Drainage Ditch – Sediment Bioassay Results*, prepared by CH2MHILL and submitted to DEQ on June 30, 2005, summarize a recent ditch fill and the most recent chromium data collected in the slough and the corresponding bioassay results, respectively. Based on the information presented in these reports, DEQ has preliminarily concluded that no further investigation is required in the drainage ditch or Booneville channel (Attached Exhibit 1 illustrates the ditch, channel, and sample locations) and unless new or previously undisclosed information becomes available which warrants further investigation, DEQ will be recommending no further action for the ecological component of the United Chrome cleanup in the future. This decision is based on the following:

- Sediments in the Booneville channel are not a hazard to benthic invertebrate populations. Bioassays passed the acceptable criteria of less than 20% effect.
- Bioassay results indicate that significant effects on benthic invertebrates start above ~650 mg/kg total chromium concentrations in sediment. Several ditch samples (Locations B-1, B-2, C, and E) contained chromium levels above this concentration in the latest sampling event of 2005. However, Locations C and E had total chromium concentrations much lower than this concentration in the 2003 sampling event in which composite sampling occurred. Locations B-1 and B-2 were filled with clean fill this spring and no longer serve as part of the ditch system.

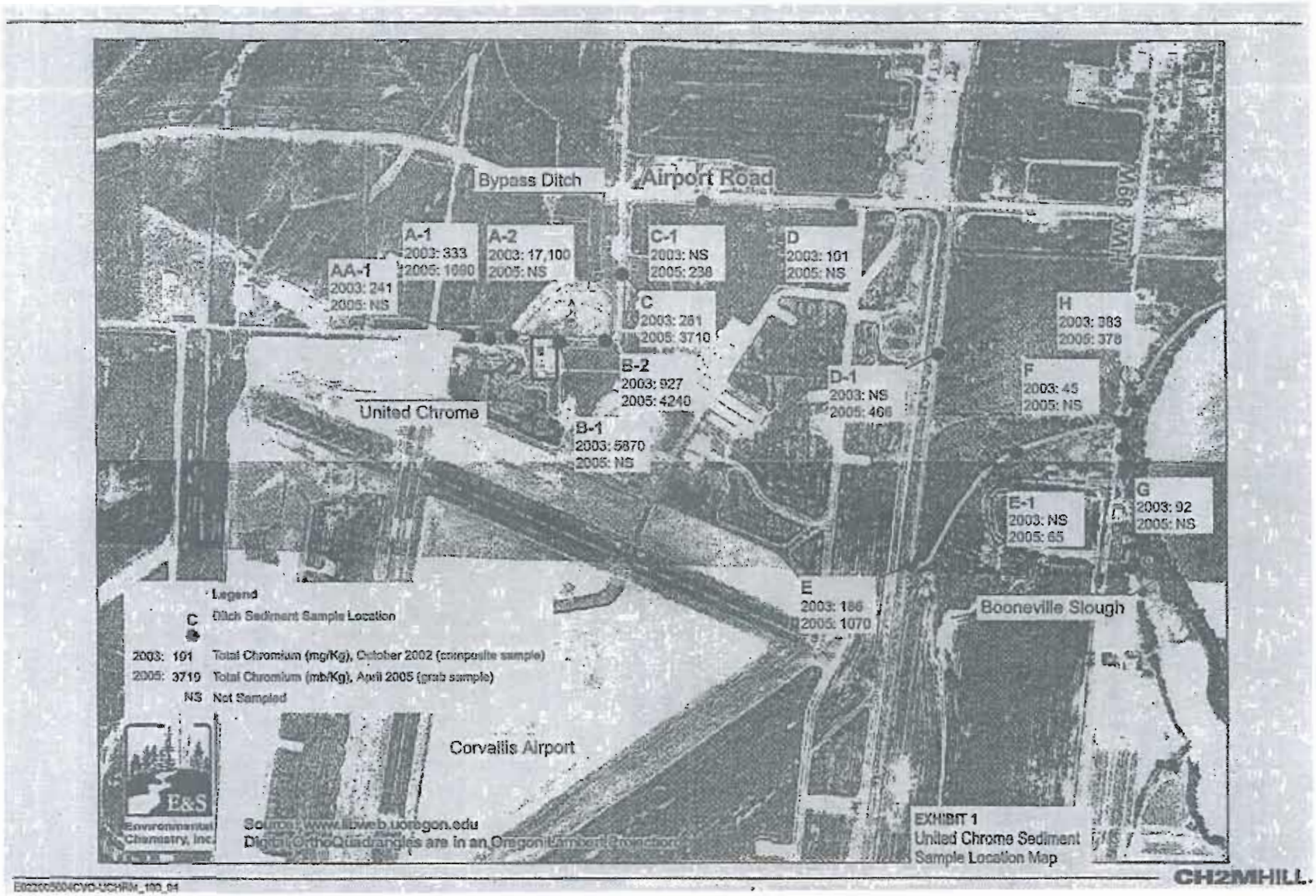
- Significant sediment loading to the Slough are unlikely because flow is minimal in these ditches and up to location E, the ditch contains a vegetative mat reducing scouring.

DEQ also consulted with Mary Jane Nearman (EPA Region X) on this decision and confirmed that the ecological component of the cleanup will be acknowledged during the future site closeout activities under EPA.

DEQ appreciates and acknowledges your documented commitment to site rehabilitation. Please feel free to contact me at (503) 378-8240 ext. 259 if you have questions.

Nancy Gramlich
Western Region Cleanup

encl: Attachment A; Exhibit 1
cc: Mary Jane Nearman, EPA
Scott McKinley, CH2MHILL
Marilyn Daniel and Angie Obery, DEQ Western Region - Eugene



E022005004CVO-UCHRM_103_01

ATTACHMENT A
United Chrome
Ecological Reports List

- June 6, 2003 – Memorandum, *United Chrome Contaminants of Potential Ecological Concern*, prepared by Environmental Chemistry, Inc.
- June 23, 2003 – Memorandum, *United Chrome Ditch Surface Water and Sediment Chemicals of Potential Concern*, prepared by CH2MHILL
- March 1, 2004 – *United Chrome Surface Contaminants of Concern Site Ecology Scoping Report Level I Deliverable*, prepared by Environmental Chemistry, Inc.
- March 1, 2004 – *United Chrome Surface Contaminants of Concern Site Screening Report Level II Deliverable*, prepared by Environmental Chemistry, Inc.
- April 29, 2004 – *Revised United Chrome Surface Contaminants of Concern Site Ecology Scoping Report Level I Deliverable*, prepared by Environmental Chemistry, Inc.
- April 29, 2004 – *Revised United Chrome Surface Contaminants of Concern Site Screening Report Level II Deliverable*, prepared by Environmental Chemistry, Inc.,
- April 6, 2005 – *United Chrome Surface Drainage Ditch Closure Strategy – Addendum No. 1*, prepared by CH2MHILL
- May 20, 2005 – *United Chrome Abandoned Ditch – Remedial Options*, prepared by CH2MHILL
- June 27, 2005 - *United Chrome Surface Drainage Ditch – Sediment Bioassay Results*, prepared by CH2MHILL