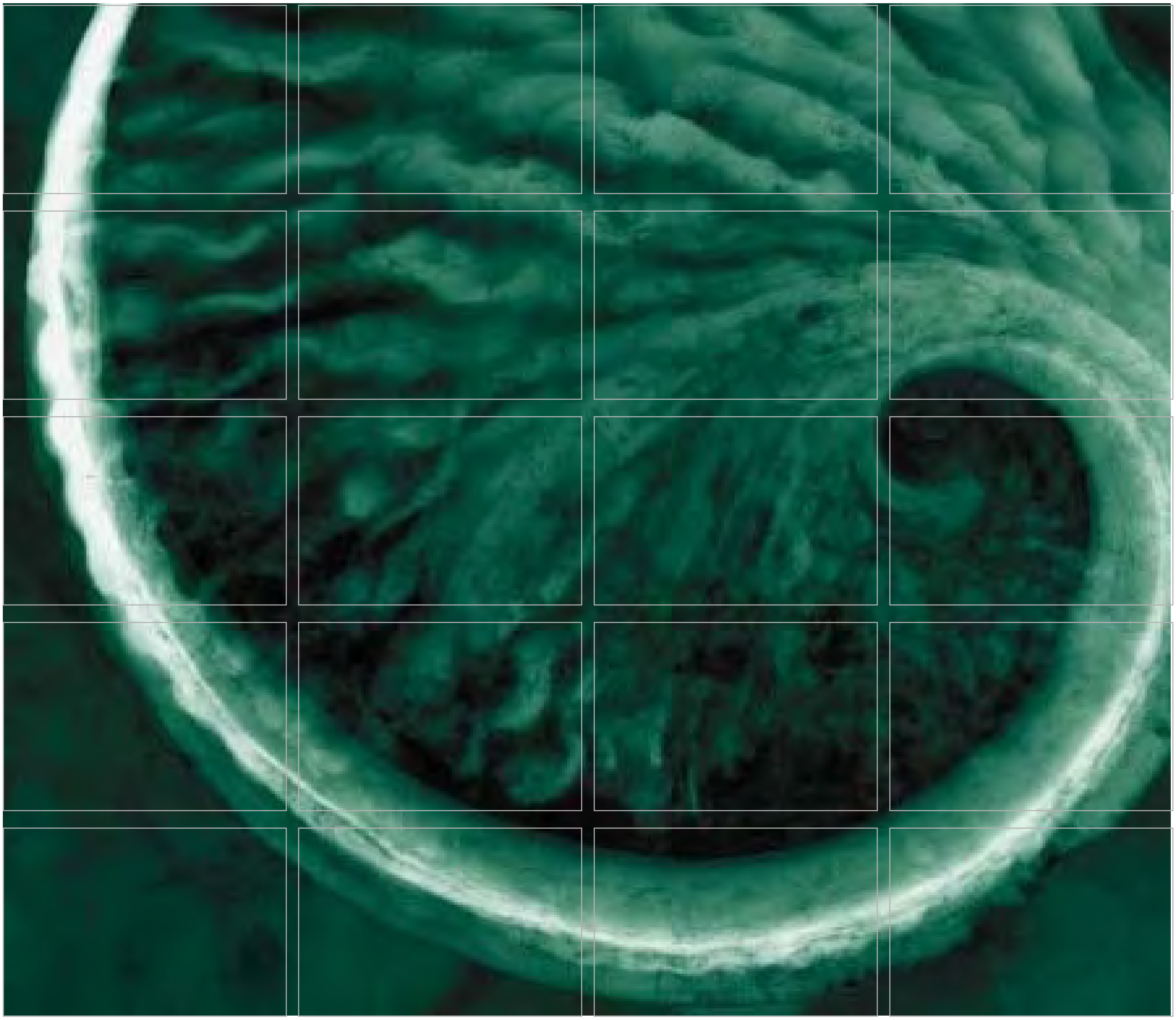

Supplemental Feasibility Study

Prepared for:
FMC Corporation

Former FMC Pesticide Formulation Facility
Yakima, Washington

August 2011

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FMC Corporation

Revised Supplemental Feasibility Study

Former FMC Pesticide Formulation Facility
Yakima, Washington

August 2011

Project No. 0120748

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LIST OF ACRONYMS

µg/L	Microgram per liter
ARAR	Applicable or relevant and appropriate requirements
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of concern
DDD	1,1-Dichloro-2,2-bis(p-chlorophenol)ethane
DDE	1,1-Dichloro-2,2-bis(p-chlorophenol)ethylene
DDT	1,1,1-Trichloro-2,2-bis(p-chlorophenol)ethane
DNOC	4,6-Dinitro-cresol
Ecology	State of Washington Department of Ecology
ERM	ERM-West, Inc.
ESD	Explanation of Significant Differences
FS	Feasibility Study
FMC	FMC Corporation
ft/ft	Feet per foot
GAC	granular activated carbon
HI	Hazard Index
MCL	Maximum Contaminant Level
mg/kg	Milligrams per kilogram
MTCA	Model Toxics Control Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OCL	Organochlorine
O&M	Operations and maintenance
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation

ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SFS	Supplemental Feasibility Study
UECA	Uniform Environmental Covenant Act
UPRR	Union Pacific Railroad Company
USEPA	United States Environmental Protection Agency
UU/UE	Unlimited use/unrestricted exposure

1.0 INTRODUCTION

FMC Corporation (FMC) has prepared this *Supplemental Feasibility Study* (SFS) for soil and groundwater at the Former FMC Pesticide Formulation Facility in Yakima, Washington (site; Figure 1). This site was placed on the National Priorities List (NPL) in 1982. The United States Environmental Protection Agency (USEPA) is the lead agency for the site. The purpose of this SFS is to evaluate additional remedial alternatives for a proposed amendment to the 1990 *Record of Decision* (ROD) (USEPA 1990). This document also addresses follow-up actions for site soil and groundwater cited by the USEPA in the September 2008 *Third Five-Year Review Report*, including adding dieldrin as a contaminant of concern (COC) in site groundwater.

Following this introduction, the SFS is organized as follows:

- Section 1.0 presents SFS objectives and the site background, including a site description, history, and land use, and a summary of site investigation, remediation, and monitoring activities;
- Section 2.0 summarizes remedial action objectives (RAOs) for site soil and groundwater;
- Section 3.0 presents the alternatives for additional remedial action and their evaluations;
- Section 4.0 addresses follow-up actions from the USEPA's *Third Five-Year Review Report* (2008);
- Section 5.0 outlines summary and conclusions;
- Section 6.0 lists references used in preparing this report;
- Figures and tables are presented following the text; and
- Appendices follow the tables and provide supporting information.

1.1 SUPPLEMENTAL FEASIBILITY STUDY OBJECTIVES

The objective of the Feasibility Study (FS) process is to gather sufficient information to support an informed risk management decision regarding potential further remedial action for the site. This SFS has been developed in compliance with the USEPA guidance for preparation of FS documents (USEPA 1988b). The FS is the mechanism for developing, screening, and evaluating remedial actions. The need for an SFS was identified by the USEPA in their *Third Five-Year Review*, which noted that changed circumstances since issuance of the ROD and the Explanation of Significant Differences (ESD; USEPA 1993) required re-evaluation of the adequacy of the site remedial action. Specifically, the ROD did not envision managing residual contaminated soil and groundwater at the site. This SFS draws upon the information developed during site investigations, site-specific risk assessment, remedial action implementation, the most recent USEPA Five-Year Review, and post-ROD regulatory developments to:

- Present the RAOs previously developed by the USEPA that set risk-based cleanup goals for the site;
- Update the applicable or relevant and appropriate requirements (ARARs);
- Present alternatives for potential further remedial action as may be needed to meet RAOs and ARARs;
- Conduct a comparative evaluation of these remedial alternatives; and
- Recommend a preferred additional remedial action to be selected in an amended ROD.

1.2 BACKGROUND

The following sections provide a general site description and history; summarize the site investigations, risk assessment, and remedial actions taken to date to address site soil and groundwater; and present current soil and groundwater conditions.

1.2.1 General Site Description and History

The Former FMC Pesticide Formulation Facility is located at 4 West Washington Avenue, approximately 1 mile east of the Yakima Municipal Airport in Yakima, Washington (Figure 1). The site consists of a 58,000-square-foot fenced area bounded to the north by Washington Avenue, to the south by Longview Fibre Paper and Packaging, to the east by Union Pacific Railroad Company (UPRR) tracks, and to the west by Longfibre Avenue (Figure 2). Residential properties are located on the western side of Longfibre Avenue; the nearest homes are located approximately 380 feet from the site boundary. FMC leased the site property from UPRR during operation of this facility.

FMC formulated pesticide dusts at the site from 1951 to 1986. Pesticide liquids were manufactured at the site in the 1970s. Wastes containing pesticides were disposed in an on-site pit between 1952 and 1969 (approximate location of former pit is shown on Figure 3). During this time, an estimated 2,000 pounds of waste consisting of raw material containers, soil impacted by leaks and spills, and process waste materials were dumped into the excavated pit and covered with soil. After 1969, facility waste materials were disposed of off-site at Yakima Valley Disposal facility in Yakima and at Chemical Waste Management's Arlington, Oregon, disposal facility.

The site slopes to the southeast with a grade of less than 1 percent. The site is 1.5 miles west of the Yakima River (outside of the 500-year flood plain) and 1 mile north of Wide Hollow Creek. No surface water bodies exist on site. Vegetation within the fenced site consists of tall weeds and grasses. Groundwater occurs in alluvial silty sands and gravels and flows southeastward toward the Yakima River.

The reported historical horizontal gradient ranges from 0.002 to 0.003 feet per foot (ft/ft). Groundwater levels fluctuate seasonally with the high in the fall (average of 2 feet below ground surface [bgs]) corresponding to the agricultural growing season (caused by regional irrigation), and a low in the winter (approximately 7 feet bgs). Based on data collected during an aquifer test conducted in 1989, the calculated hydraulic conductivity of the aquifer is 5,500 gallons per day per square foot and the calculated seepage velocity is 7 feet per day (ERM-West, Inc. [ERM] 1998; SECOR 2004). Historical groundwater level measurements collected at the W-9 and W-12 well pairs indicate the average vertical gradient is 0.02 ft/ft downward within the aquifer. Monitoring well locations are shown on Figure 2.

1.2.2 Land Use

The former FMC property is zoned as light industrial by the City of Yakima. The surrounding properties are also zoned as light industrial, with the exception of the residential area to the west, across Longfibre Avenue, from the former FMC property. The site is currently unoccupied. Stephens Metal Products owned and operated a metal fabrication facility, parking lot, and equipment storage yard at the site until operations were moved to another location in late 2010 and early 2011. Country Farm & Garden True Value Hardware Store and Butlers Welding and RV Accessories are located along Longfibre Avenue on portions of the area originally leased by FMC. Stephens Metal Products' former operations at the site were industrial as defined by the Washington Model Toxics Control Act (MTCA).

Groundwater at the site and immediate vicinity is not currently used for domestic, industrial, or agricultural purposes. The area is served by a municipal water supply, and a well canvass and well record search conducted by the USEPA respectively in 1988 and 1998 found that no known downgradient wells within a 1-mile radius were used for drinking water (USEPA 2008). No new drinking water wells were identified in the vicinity of the site during the USEPA's June 2008 site visit and an August 2008 search of the Washington Department of Ecology (Ecology) well database (USEPA 2008).

1.2.3 Site Investigation, Remediation, and Monitoring History

The following sections summarize historical investigation, remediation, and monitoring activities conducted at the site between 1982 and 2007.

1.2.3.1 Early Investigations

A preliminary investigation was conducted by the USEPA in 1982. The site was placed on the NPL on September 8, 1983, based on high levels of pesticides detected in soil and groundwater samples collected at the site. An Administrative Consent Order issued by Ecology in 1983 required a study of the former disposal pit area. In 1986, after operations at the facility ceased, FMC reported that it had removed all contents of the main warehouse and surface tanks and washed the warehouse floor and walls. USEPA subsequently issued two Administrative Orders on Consent in 1987 and 1988 that respectively required a Remedial Investigation/ Feasibility Study (RI/FS) and removal and disposal of the disposal pit contents. FMC removed the pit contents in two phases in 1988 and 1989, concurrent with conducting the RI/FS.

In addition to the Pre-Phase I and II RI activities, FMC performed two site characterization investigations of the former formulation facility. The first was in November 1987 and the second was in December 1988. These investigations were designed to determine whether or not some facility areas and/or structures were contaminated with substances handled at the former formulation facility and to characterize facility soils, materials, and structures for cleanup or removal. During the investigations, concrete core and chip, surface soil, sump water wipe samples were collected and analyzed. Additionally, six soil samples were collected on the property outside the fence.

USEPA issued the ROD on September 14, 1990 to address all post-removal residual site contamination. The two phases of disposal pit removal are described in the following section.

1.2.3.2 *Removal of Disposal Pit Contents*

Phase I removal of the contents of the disposal pit (containing pesticide concentrations up to 25,000 milligrams per kilogram [mg/kg]) was performed in June 1988 following a Phase I investigation of the pit. The pit was excavated to a depth of 4 feet bgs (the depth of the groundwater table at the time), and 500 tons of contaminated soil were removed. In March 1989, an additional 350 tons of soil were removed, and the total depth of the excavation was increased to 8 feet bgs. All waste was disposed at Chemical Waste Management's Arlington, Oregon, permitted hazardous disposal facility. The extent of the disposal pit excavation and location of the verification samples are shown in Figure 4.

A Phase II investigation, addressing the remainder of the site, was completed in April 1990. A ROD selecting the final remedial action was issued on September 14, 1990 (Appendix A). FMC entered into a Consent Decree with the United States in Federal District Court for the Eastern District of Washington on December 6, 1991 to perform the remedial action.

The basis for remedial action was the presence and potential release of hazardous substances at the site at levels that could pose an unacceptable risk to human health if persons were exposed, and to the environment if left unaddressed. At the time of the ROD, the media of concern were contaminated soils and aboveground structures remaining at the site. Concentrations of chemicals in groundwater were below health-based levels at that time. However, the ROD required continued groundwater monitoring to confirm the effectiveness of source removal in protecting groundwater.

COCs for human health identified at the site were the following:

- 1,1-Dichloro-2,2-bis(p-chlorophenol)ethane (DDD);
- 1,1-Dichloro-2,2-bis(p-chlorophenol)ethylene (DDE);
- 1,1,1-Trichloro-2,2-bis(p-chlorophenol)ethane (DDT);
- Dieldrin;
- Endosulfans;
- Malathion;
- Ethion;
- Ethyl parathion;

- Parathion;
- 4,6-Dinitro-cresol (DNOC);
- Cadmium; and
- Chromium (VI).

All of the above-listed compounds are considered to be toxic to humans; DDD, DDE, DDT, dieldrin, cadmium, and chromium (VI) are also carcinogenic.

The identified COCs for potential ecological effects were DDD, DDE, DDT, endosulfans, ethion, malathion, and zinc.

Groundwater impacts were found at low concentrations, mostly with respect to DDT, DDD, DDE, dieldrin, and endosulfans.

1.2.3.3 Remedial Investigation and Site-Specific Risk Assessment

A site-specific risk assessment prepared by FMC was approved by the USEPA as part of the April 1990 *Phase II Remedial Investigation Report*. In addition, the USEPA conducted additional studies to address some of the uncertainties identified in the FMC risk assessment, and to calculate health-based soil cleanup goals. DDD/DDE/DDT, the endosulfan group, DNOC, ethion, malathion, chromium and cadmium were selected as COCs for the FMC human health risk assessment. To this list, the USEPA added dieldrin, ethyl parathion and chromium VI. The human health risk assessments both showed that pesticide concentrations in soil exceed acceptable risk levels, and pose a threat to human health for both current and future land use scenarios.

The COCs for the environmental evaluation were DDD/DDE/DDT, the endosulfan group, ethion, malathion, and zinc. The results of the environmental evaluation indicate that some pesticide and zinc levels detected in on-site ground water may pose a potential threat to the wetland area located downgradient of the site.

Overall, the risk assessments found COCs in site soil, groundwater, and structures and indicated that pesticides in site soil posed the most significant risk to human health and the environment. Risk assessment methods and results are detailed in the ROD (Appendix A).

Identification of COCs – Human Health

During the RI, on-site groundwater, soils, and structures were sampled for contaminants including volatile organic compounds, metals, organochlorine pesticides, organophosphorus pesticides, carbamates, urea, and phenols. Identified human health COCs included the DDT series (DDD, DDE, and DDT), total endosulfans (endosulfan I, endosulfan II, and endosulfan sulfate), ethion, malathion, DNOC, cadmium, and chromium (III) and (VI).

The analytical data for soil, groundwater, and concrete structure samples collected during the RI are summarized in Tables 1 and 2 of the ROD (Appendix A).

Exposure Assessment – Human Health

The exposure assessment estimated the type and magnitude of chemical exposures from the site. It identified exposure routes (ingestion, inhalation, and direct contact), land-use scenarios, and potentially exposed populations; estimated exposure point concentrations; and described assumed exposure frequency and duration.

The general exposure pathways considered for the site included ingestion of contaminated groundwater, off-site transport of contaminated groundwater, incidental ingestion of contaminated soil, inhalation of contaminated dust, off-site transport of contaminated dust, off-site transport of contaminated sediment, direct contact with contaminated structures and soils, and food chain transfer.

The risk assessment described the following land-use scenarios and receptors for the site:

- Current land-use scenario – off-site residents and off-site workers;
- Future residential scenario – on-site resident, off-site resident, off-site worker; and
- Future industrial scenario – on-site industrial worker, off-site industrial worker, and off-site resident.

The current land-use scenario assumed that access to the site is restricted. Future land-use scenarios assumed that an on-site and off-site drinking water well is used.

Human Health-Based Soil Concentrations

In the USEPA-conducted risk assessment, documented in the ROD, health-based soil concentrations of site COCs for a 1 x 10^{-6} cancer risk and a hazard index (HI) of 1.0 were calculated. These calculations were based on risks to a child living on-site. The risk assessment used existing RI/FS documents, including the February 1990 soil sampling results. The study's recommendations are summarized below.

- Add dieldrin, ethyl parathion, and chromium (VI) to the COC list;
- Establish human health-based cleanup goals for soils based on the carcinogenic risks posed by inhalation of cadmium and chromium (VI);
- Consider DNOC as a COC for ingestion;
- Do not base final cleanup goals on dermal contact with soil; and
- If risks from dermal contact with concrete were to be quantified, base these risks on wipe sample data (in micrograms per 100 square centimeters) and not on core data (mg/kg).

The USEPA used the approach outlined above to calculate health-based, site-specific cleanup goals for soil. These concentrations are presented in Table 1.

Conclusions for Human Health Risk Assessment

Overall, the human health risk assessments showed that concentrations of pesticides in soil exceeded acceptable risk levels and posed a threat to human health for current and potential future land-use scenarios.

Health-based cleanup goals were developed by the USEPA and were used during remediation to designate soil and debris in need of remediation. Cleanup goals were adjusted where multiple COCs were found. Adjusted goals are protective of human health at a cumulative excess cancer risk of 1 in one million, or a cumulative HI less than or equal to 1.0, whichever is lower.

Environmental Evaluation

The risk assessment for the site included an environmental evaluation that identified potential environmental threats from the site. The COCs for the environmental evaluation were the DDT series constituents, endosulfans, ethion, malathion, and zinc.

The exposure scenario for the ecological assessment assumed current conditions. The current condition scenario assumed the following:

- Aquatic organisms (fish and invertebrates) reside in the wetlands in the vicinity of the site; and
- The wetlands are downgradient of and hydraulically connected to the groundwater beneath the site.

The environmental evaluation focused on potential impacts suggested by a conservative groundwater model to a wetland located 1,200 feet southeast of the site. Species of concern (indicator species) selected for toxicity assessment included freshwater aquatic species (fish, invertebrates, and algae) and birds.

The results of the environmental evaluation suggested that pesticides and zinc at the site may pose threats to freshwater aquatic life based on conservative groundwater modeling assumptions and ecological health-based criteria. However, wells installed between the site and adjacent wetlands showed lower levels of chemicals than conservative model predictions, and actual impacts on aquatic ecosystems were not expected to be significant.

1.2.3.4 Record of Decision

The selected remedy in the ROD addressed the remaining contaminated soils and structures at the site. The selected remedy called for the following:

- Sampling soils and concrete structures to refine the RI/FS estimates for the lateral and vertical extent of material requiring treatment;
- Excavating contaminated soils that exceeded the site-specific cleanup goals (Table 1);
- On-site incineration of contaminated soils;
- Dismantling contaminated slabs and portions of buildings that were determined to exceed cleanup goals;
- On-site incineration of contaminated concrete and debris or disposal at a Resource Conservation and Recovery Act (RCRA) Subtitle C permitted hazardous waste disposal facility (disposition dependent on waste volume);
- Analyzing incinerator ash to determine the degree of contaminant destruction and leachability, and delisting the ash if health-based cleanup goals were met; and

- Groundwater monitoring to confirm source removal.

Groundwater monitoring was to continue quarterly for 2 years following completion of the remedial action, and then for 3 additional years on an annual basis. If constituents in groundwater were detected above cleanup goals and groundwater remediation proved to be necessary, it would be addressed in a subsequent ROD. Cleanup goals cited in the ROD were 0.1 micrograms per liter (μg/L) for DDT (the 10^{-6} excess cancer risk level) and 2 μg/L for total endosulfans (the 1.0 HI level at that time).

The ROD estimated the volume of contaminated soil requiring excavation to be 900 to 4,000 cubic yards. The cleanup goals for soil are listed in the ROD and included in this document as Table 1.

1.2.3.5 *Remedial Action Implementation*

As described in Section 1.2.3.2, removal of disposal pit contents and over excavation was performed in June 1988 and March 1989. The remedial design for removal of the remaining contaminated soil at the site began on August 23, 1991. The design was performed in two phases to expedite the start of the remedial action. Approval and initiation of the excavation phase occurred on April 23, 1992. The design for the incineration phase of the remedial action was approved on May 30, 1992. Incineration began in November 1992.

Description of ROD Excavation and Incineration Activities

For cleanup purposes, the site was divided into several different areas based on historical use or function. The excavation phase consisted of excavating contaminated material, followed by sampling the bottom and sidewalls of the excavations to determine compliance with soil cleanup standards. If the remaining, in-place material was above cleanup standards, excavation and confirmation sampling of an area continued until soil cleanup standards were met. Prior to incineration, excavated material was stockpiled in a lined area on the western side of the property. During incineration, ash was stored in bags until sampling determined that it met cleanup standards. Following sampling and delisting, incinerator ash was used as a soil cover over the cobble backfill.

In January 1992 the Remedial Action Work Plan containing plans and schedules for implementing the selected remedy was issued. The remedy included excavation and incineration of contaminated soils from 10 areas of the site shown in Figure 5. The areas excavated include:

- Area 3 – Located adjacent to the warehouse to the east.
- Area 4 – Former refuse and drum storage area, located south of the warehouse.
- Area 5A – Area between the warehouse and the former tank farm to the south. Area originally covered by a 6-inch thick layer of concrete.
- Area 5C – Area of the former tank farm, south of Area 5A. Three upright tanks used to store solvents and various oils were previously located here. Area originally covered by a concrete pad and surrounded by a 3.5-foot-high concrete wall.
- Area 6A/B – Former barrel washing area located in the southwest area of the site in the vicinity of the shed. Area 6B is north of Area 6A. The boundary initially only extended to the concrete sump, but was extended northerly to Area 7A when it was determined that the sump would be removed.
- Area 7B – Former investigation area on the northern and eastern sides of the former Liquid Formulary Building. Currently part of investigation Area 5.
- Area 9 – An unpaved area located in the west portion of the site. A portion of the area was used for incinerator activities during remediation.
- Area 13C – Located in the northwestern corner of the site, in the vicinity of the former underground storage tank.
- Area 20 – Located south of Area 4, along the southern boundary of the site.
- Area 21 – Located southeast of the warehouse, in the location of the former disposal pit.

Approximately 5,600 cubic yards of soil was excavated and treated during this remedial action. The average depth and excavation volumes for each area are summarized in Table 2. The soil treated by incineration was used as backfill on site. Additionally, tests of cobble (greater than 1-inch diameter) encountered during excavation determined the material to be uncontaminated. The cobble was subsequently used as backfill on site as well. Area 30, west of Area 9, was used to stockpile excavated soils prior to incineration. At the completion of remedial activities, approximately 1,000 cubic yards was excavated from Area 30, located west of Area 9, to a depth of approximately 1 foot bgs.

A mobile lab was set up on-site to facilitate verification sampling of soils collected from the floors and sidewalls of the 10 excavation areas. A statistical analysis of the results of the verification samples was performed to determine the mean carcinogenic and non-carcinogenic cancer risk indices for each excavation. Excavations continued until the cancer risk indices met the 95% upper confidence level cleanup criteria for carcinogenic and non-carcinogenic compounds. One exception was in Area 4, where unstable conditions prevented further excavation. Additionally, a maximum depth to first encountered ground water of 7 feet bgs was established as the maximum depth of excavation for the remediation activities in accordance with the ESD (USEPA 1993). Excavations did not continue below this depth even when verification samples contained elevated levels of pesticides. Verification samples collected from 7 feet bgs were not included in the statistical analysis of the cancer risk indices.

During excavation, it was determined that the depth of soil exceeding cleanup goals was greater than that estimated in the RI/FS. Additionally, excavation activities unearthed a second pesticide disposal pit located directly west of the first pit. These two conditions greatly increased the volume of soil requiring excavation and incineration.

Changed Site Conditions

During remediation implementation, the following changed site conditions were identified. These changed conditions and the associated modifications to site cleanup goals adopted to address these changed conditions are detailed in the 1993 ESD (Appendix B) and summarized below.

1. The depth of soil contamination was greater than previously determined in the RI/FS. Soil removal below a depth of 7 feet bgs was determined to be technically impracticable by the USEPA due to the mechanical difficulties associated with excavating below the water table. This changed condition was addressed with modifications to the ROD (via the ESD) as described below.
    - The cleanup goals in the ROD were attainment of an overall site HI of less than or equal to 1.0 and attainment of an overall site excess cancer risk of $1x10^{-6}$, both based on residential land-use scenario. Site cleanup goals for soil below 2 feet bgs were revised and adopted in the ESD to a $5x10^{-6}$ excess cancer risk level.

- Contaminated soil below 7 feet bgs (lowest seasonal depth to water table) to remain in place. Per the ESD, there is no probable current or future exposure to contaminated soil below this depth.
- Groundwater to be monitored for 5 years following completion of the remedial action, and the USEPA would evaluate the need for implementing a groundwater remedy if COC levels in groundwater were found above action levels.

2. The volume of soil requiring excavation was greater than that estimated in the ROD. Approximately 5,600 cubic yards of contaminated soil was excavated and treated during this remedial action.
3. Approximately one-third of the excavated soil was cobble (2- to 6-inch-diameter rock). The cobble was crushed and sampled and then found to meet RCRA-based cleanup requirements. The USEPA determined the cobble did not require incineration prior to its use as site backfill.
4. No promulgated cleanup standards applicable to buildings existed at the time the remedy was selected. However, prior to the beginning of site excavation, the USEPA issued RCRA regulations establishing a technology-based criterion for decontamination of concrete debris (57 Federal Register 37277, August 18, 1992). That standard, promulgated at 40 CFR §268.45, allows for disposal of concrete debris following decontamination without further testing. The USEPA determined this criterion was applicable to decontamination of the building floor at the site in preparation for reuse of the building. This criterion was met by scarifying the concrete floor surface to a depth of approximately 0.25 inch. Following scarification, no visible impacts remained, and the USEPA determined that the warehouse floors were clean. The floor surface was restored to allow the building to return to functional use.

1.2.3.6 Conceptual Site Model

Site activities are believed to have contaminated structures and soils at the FMC facility. The formal disposal pit in the southeast portion of the facility is believed to be the primary release mechanism to soil. Spills are also a cause of soil contamination, as well as contamination of structures. Humans and biota can be exposed to the contaminated media by a number of pathways. Humans and terrestrial animals can be exposed to the COC via dermal contact with the contaminated structures. Both humans and animals can be exposed to site contaminants via inhalation, ingestion or dermal contact with site soils either in-place or mobilized with dust or volatile emissions. Groundwater beneath the site can also become contaminated via contact with contaminated soils or infiltration/ percolation of site contaminants. Additionally, surface waters can also potentially be affected via stormwater runoff or input from/interaction with groundwater. Groundwater beneath the site is not currently used as a drinking water source, nor has it been since the time the site was placed on the NPL.

At the time the ROD was issued, groundwater concentrations beneath the site were below the health-based cleanup goals. Groundwater concentrations of some of the COCs (total endosulfans and dieldrin plus aldrin) increased after the 1992-1993 excavations. Figures 4 and 5 of Appendix C show concentration versus time plots for total endosulfans and dieldrin plus aldrin, respectively.

The increase in groundwater concentration is suspected to be the result of inadvertent mixing of contaminated soils with groundwater during the excavation activities. As stated above, groundwater beneath the site can be found as high as six inches to 1 foot bgs. Groundwater was encountered during some of the remedial excavations and it is possible that contaminated soils were inadvertently put in contact with groundwater during these activities. It is also possible that disturbing the soils could have facilitated release of sorbed contaminants. The ESD (USEPA 1993) noted:

> *The majority of the site excavation was of material below the water table. Excavation below the water table resulted in sloughing of the trenches and spillage of small quantities of excavated material back into the holes as the material was removed. Thus, minimal recontamination occurred as excavation progressed. Continued excavation was not able to alleviate the recontamination problem. In addition, some previously excavated areas became submerged and out of reach of the construction equipment, making re-excavation impossible.*

In addition, levels of organochlorine compounds in soils beneath the bottom of some of the excavations were above cleanup goals. These soils are in direct contact with groundwater during periods of average and seasonally high groundwater levels. These soils are a contaminant source to groundwater. Figure 5 shows the location, depth and dieldrin concentrations for the excavation floor verification samples. Figure 5 also includes analytical results for other COCs whose concentrations exceeded the MTCA B cleanup goals. Aldrin was either not analyzed in the verification samples, or the record of any aldrin analysis could not be found in the available site documentation. However, since aldrin is a degradation product of dieldrin, it is suspected that aldrin, if present, would be found in the same locations as dieldrin.

Statistical analyses of the sidewall samples for the excavations indicated that the excavations encompassed the horizontal extent of the contaminated areas. Additionally, the soil samples collected during the November 1987 and December 1998 site investigations, as well as the 16 subsurface samples collected during the February 1990 Phase II RI, did not indicate elevated levels of COCs outside the excavation areas.

Groundwater concentrations of total endosulfans and dieldrin plus aldrin have shown a decreasing trend in the last 10 years, but remain above the pre-remedial action levels in most wells.

1.2.3.7 Current Site Conditions

The most recent groundwater monitoring event was conducted at the site in October 2007. Groundwater monitoring activities and results were reported in the May 2008 *Five-Year Report, Fall 2007 Groundwater Monitoring Activities*.

Monitoring tasks completed during the October 2007 monitoring event included the following tasks:

- Gauging groundwater levels in wells W-7, W-9A/B, W-12A/B, W-13, W-14, W-16, W-17, and W-18;
- Redeveloping wells W-7, W-9B, W-12A/B, W-13, W-14, W-16, W-17, and W-18; and
- Collecting groundwater samples from wells W-7, W-9B, W-12A/B, W-13, W-14, W-16, W-17, and W-18 for submittal to a laboratory for analysis of organochlorine (OCL) pesticides using USEPA Method 8081A.

The results of the October 2007 groundwater monitoring event are summarized below.

- The groundwater flow direction was toward the southeast, which was consistent with the results of the previous monitoring event (2003). The shallow horizontal groundwater gradient in October 2007 ranged from 0.002 to 0.007 ft/ft, which is slightly steeper than the historical range of 0.002 to 0.003 ft/ft (SECOR 2004). The October 2007 potentiometric surface map is depicted on Figure 6. Well construction details and October 2007 groundwater level measurements are provided in Table 3.
- OCL pesticides were not detected at concentrations above laboratory reporting limits in groundwater samples collected from wells W-7 and W-9B. Dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, and

tedion were detected in samples collected from wells W-12A, W-12B, W-13, W-14, W-17, and W-18. Only endosulfan I, endosulfan II, and endosulfan sulfate were detected in samples collected from well W-16. The distribution and concentrations of indicator compounds dieldrin, endosulfan, and DDT are shown on Figure 7. A summary of chemical detections in groundwater samples collected in October 2007 is presented in Table 4.

- The OCL pesticide constituents DDT/DDD/DDE and aldrin, historically present in site groundwater, were not detected in any of the groundwater samples collected in October 2007.
- Total endosulfan concentrations at the center of the site at wells W-13 and W-14 show a gradual decreasing trend, and total endosulfan concentrations at the downgradient well W-18 have generally been stable since 1995.
- Dieldrin in groundwater appears to be confined to the southwestern portion of the site. Groundwater monitoring results suggest that the plume is stable and has not migrated off-site. Dieldrin concentrations have decreased in the last 10 years, but remain above pre-remediation levels.

2.0 *REMEDIAL ACTION OBJECTIVES DEVELOPMENT*

RAOs provide a general description of what a response action will accomplish (e.g., restoration of groundwater). Cleanup goals (see Section 2.3) are the more specific statements of the desired endpoint concentrations or risk levels, for each exposure route, that are believed to provide adequate protection of human health and the environment and achieve site ARARs. Development and implementation of remedial actions need to be consistent with ARARs and the site-specific risk-based cleanup goals specified in the ROD.

2.1 *REMEDIAL ACTION OBJECTIVES*

The following RAOs have been developed for the site:

- Preventing human exposure to contaminated soil, structures, and debris that exceed health-based cleanup goals;
- Reducing the potential for the contaminated soil to act as a source for groundwater contamination;
- Further defining the extent of groundwater contamination, monitoring to determine whether or not actions to date will restore groundwater to its beneficial use in a reasonable time frame, and if not, evaluating the need to take appropriate measures such as further response actions; and
- Achieve site ARARs.

2.2 *SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)*

ARARs for the site are presented in Table 5. Meeting ARARs is one of two threshold criteria for remedy selection pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA remedial action must meet or waive all ARARs upon completion of remedial action. ARARs are minimum levels or standards of control for remedial action. They are derived from federal environmental laws and more stringent than federal requirements in state environmental and facility siting laws. More stringent cleanup levels may be established based on site-specific risk-based concentrations where there may be no ARARs or meeting ARARs is not sufficient to address site risks, or to protect human health and the environment. ARARs are taken into account in developing, screening, evaluating, comparing and selecting remedial alternatives. ARARs are often categorized into chemical-, action-, and location-specific requirements, but do not have to be.

The ARARs presented in Table 5 were developed consistent with CERCLA, the NCP, and EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA 1988a) and *CERCLA/Superfund Orientation Manual* (USEPA 1992). As shown in Table 5, the ARARs include Maximum Contaminant Levels (MCLs) under the federal Safe Drinking Water Act, cleanup standards under the Washington Model Toxics Control Act (MTCA), and hazardous and dangerous waste management requirements respectively under the federal Resource Conservation and Recovery Act (RCRA) and Washington Dangerous Waste law and regulations.

2.3 SUMMARY OF CLEANUP GOALS

Cleanup goals are the specific risk levels and/or concentrations of COCs that provide adequate protection of public health and the environment and meet ARARs. The 1990 ROD established site-specific, health-based soil cleanup goals equivalent to the lower of an HI = 1 (non-cancer) and $1x10^{-6}$ (cancer); the 1993 ESD left the HI unchanged but changed the excess lifetime cancer risk soil cleanup goal to $5x10^{-6}$ for 2 feet to 7 feet bgs..

In the anticipated ROD Amendment, USEPA will establish revised cleanup goals as necessary to ensure protectiveness and compliance with ARARs. For the analysis in this SFS, the soil cleanup goals are based on the MTCA Method B for soils in residential areas, presented in Table 1, for all of the COCs with the exception of dieldrin and aldrin. The cleanup goals for dieldrin and aldrin are based on MTCA soil concentrations for the protection of groundwater, calculated using equations 747-1 and 747-2 and Table 747-1 from the MTCA regulations.

The groundwater cleanup goals for dieldrin and aldrin (the MTCA B groundwater cleanup levels) are proposed to be added to the remedy through the ROD Amendment. The MTCA B groundwater cleanup levels for the rest of the COCs (where available) are also presented in Table 1and are proposed to be added to the remedy through the ROD Amendment.. The MTCA B groundwater cleanup levels are based on a $1x10^{-6}$ risk under the exposure assumptions developed by the State of Washington. Table 1 shows the current site cleanup goals and other potentially relevant information.

The Washington MTCA, Chapter 70.105D RCW, creates a comprehensive regulatory scheme to identify, investigate, and clean up contaminated properties that are or may be a threat to human health or the environment. MTCA is the state counterpart to CERCLA. The Washington Department of Ecology is the lead agency responsible for the implementation and enforcement of MTCA. To implement this statutory mandate, Ecology established cleanup standards and requirements for the cleanup of hazardous waste sites in its MTCA regulations at WAC Chapter 173-340. The two primary components that determine MTCA cleanup standards, cleanup goals and points of compliance, must be established for each site. Cleanup goals determine at what level a particular hazardous substance does not threaten human health or the environment. Points of compliance designate the location on the site where the cleanup goals must be met.

The subject property and vicinity is currently zoned and operated as industrial. It is not believed that land use in this area will change in the near future. However, the MTCA B level for soil was selected as the soil cleanup goal to allow for future residential use at the site.

With the exception of dieldrin, DDE, DDD, DDT, and ethion, none of the COCs were detected in the verification samples at concentrations exceeding their respective cleanup goals. Aldrin was not analyzed in the verification samples. However, since aldrin is a degradation product of dieldrin, it is expected that aldrin, if present, would coincide with the distribution of dieldrin. Figure 5 shows soil sample locations where COCs exceed their respective cleanup goals.

For purposes of evaluating alternatives for protectiveness and compliance with ARARs in this SFS, the MTCA B values for soil were used as the soil cleanup goals for all COCs, except dieldrin and aldrin, for which the MTCA soil concentration for the protection of groundwater values were used (Table 1). Some of the remedial alternatives include implementing institutional controls. The areas of proposed institutional controls are based on the MTCA B values for soils. These values are determined for the protection of human health in a residential setting, whereas the cleanup goals for dieldrin and aldrin are based on the protection of groundwater and therefore are not applicable to institutional controls designed to prevent human exposure to COCs. Additionally, COC concentrations in groundwater have been shown to be confined to the southwest corner of the subject property, and will continue to be monitored.

3.0 DEVELOPMENT AND EVALUATION OF REMEDIAL ALTERNATIVES

Alternative remedies for contaminants in soil and groundwater were developed using remedial technologies appropriate for the site. This section presents descriptions and detailed evaluations of four alternatives considered for implementation at the site. Each alternative is assessed individually, and then they are compared to each other to assess the relative performance expected for each alternative and its relative advantages and disadvantages. This analysis is used to develop a recommendation for further remedial action at the site to be specified in an amended ROD.

3.1 EVALUATION CRITERIA

FMC has used the criteria specified in the NCP to evaluate the site remedial action alternatives. The NCP specifies the following nine evaluation criteria: (1) overall protection of human health and the environment; (2) compliance with or waiver of ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, and volume through treatment; (5) short-term effectiveness, including impacts on the community and the environment during remediation and time to achieve remedial objectives; (6) implementability; (7) cost; (8) state acceptance; and (9) community acceptance.

These nine NCP evaluation criteria are grouped into the categories of threshold criteria, balancing criteria, and modifying criteria as follows:

- Threshold criteria (Nos. 1, 2)
- Balancing criteria (Nos. 3, 4, 5, 6, 7)
- Modifying criteria (Nos. 8, 9)

Threshold criteria are the criteria that an alternative must meet to be considered for remedy selection. An alternative not satisfying one or both threshold criteria will not be carried forward into the analysis for balancing or modifying criteria. Balancing criteria are the primary criteria that are used to perform the detailed and comparative analysis of the alternatives that meet the threshold criteria. Modifying criteria are the criteria that may be used to modify the preferred alternative or to select another preferred alternative. State and community acceptance (Criteria Nos. 8 and 9, respectively) are criteria that generally are assessed after the FS (or SFS in this instance) is submitted and the public has had an opportunity to comment on the Proposed Plan, which EPA will develop to review alternatives for additional remedial actions at the site beyond those required under the 1990 ROD. Because the Proposed Plan has not yet been issued and state and community acceptance therefore cannot yet be gauged, these two criteria are not discussed in the alternatives evaluation. The relevant evaluation criteria are discussed below.

Overall Protection of Human Health and the Environment

This criterion evaluates how risks posed by COCs are being eliminated, reduced, or controlled through treatment, engineering, or institutional controls. It also evaluates the degree to which the alternative satisfies RAOs.

Compliance with or Waiver from ARARs

This evaluation criterion is used to determine whether each alternative will meet ARARs, as presented in Section 2.2, or whether the alternative component actions are eligible for an ARARs waiver based on one or more the of the following grounds as specified in CERCLA Section 121(d)(4):

1. Interim remedial action;

2. Greater risk to human health and environment than other alternatives;

3. Technical impracticability;

4. Equivalent standard of performance;

5. Inconsistent application of State requirements; or

6. Fund-balancing (for remedial actions undertaken solely under the EPA-administered Hazardous Substance Superfund).

Similar to protection of human health and the environment, ARAR compliance or waiver is a threshold factor that must be met for an alternative to be eligible for selection as part of the final remedy. Each alternative is evaluated to determine compliance with ARARs or eligibility for ARAR waiver. Consistency with guidelines that are not ARARs but are "to be considered" also is taken into account in this step.

Long-Term Effectiveness and Permanence

This criterion addresses the long-term protection that an alternative will provide once cleanup goals are met. The analysis for this criterion includes consideration of the potential risk posed by remaining COCs, and the adequacy and reliability of engineering or institutional controls to manage the remaining COCs with respect to potential future exposures.

Reduction of Toxicity, Mobility, or Volume through Treatment

This criterion addresses the statutory preference for remedies that employ treatment as a principal element. The alternatives are assessed for their relative performance in reducing toxicity, mobility, or volume through treatment, as well as engineering controls at the site. Specifically, the analysis considers the magnitude, significance, and irreversibility of these reductions.

Short-Term Effectiveness

This criterion addresses the short-term impacts of alternatives during the construction and implementation phases. Under this criterion, the short-term impacts that implementing each alternative would have on the neighboring community, workers, and the surrounding environment (e.g., impacts during excavation and off-haul of contaminated soil) are evaluated. In addition, short-term effectiveness considers the time required to achieve the stated cleanup goals.

Implementability

The implementability criterion evaluates the technical and administrative feasibility of an alternative, and the availability of services and materials needed to implement the alternative. Evaluation of technical feasibility includes an assessment of the reliability of technologies and ease of undertaking the remedial action. This criterion favors proven technologies that are widely available and simple to implement or construct and operate. CERCLA response actions are facilitated and made simpler to implement by CERCLA Section 121(e)(1), which exempts on-site remedial actions from the procedural aspects of otherwise applicable permit requirements. That CERCLA provision states that "no Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on site, when the action is in compliance with cleanup standards."

Cost

The cost evaluation of each remedial alternative is based on an estimate of capital expenditure and annual operating costs. Capital costs consist of expenditures for equipment, labor, and materials necessary to install a remedial action, and include estimates of costs associated with design and permitting of an option. Annual costs include operation and maintenance (O&M) of the remedial action. Past capital expenditures for previously performed removal or remedial actions are not included in the cost analysis for each alternative.

Costs for each remedial alternative have been developed using USEPA guidance, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA 2000). Each cost represents an order of magnitude estimate and is computed on the basis of net present worth. The net present worth represents the amount of investment necessary in the base year to cover all the remedial action costs during the life of the project. As recommended in the USEPA cost estimating guidance referenced above, the standard Superfund discount rate of 7 percent has been used for annual costs. Total net present worth costs include a 15 percent contingency. The detailed cost breakdowns for each alternative are presented in Appendix D.

3.2 ALTERNATIVE 1: NO ACTION

3.2.1 Description

CERCLA requires that a no action alternative be presented in an FS to serve as a baseline calculation for comparison purposes. With this alternative, no active remedial actions would be implemented.

3.2.2 Evaluation

Alternative 1 (A-1) – Overall Protection of Human Health and the Environment. Under the no action alternative, residual COCs in soil and groundwater would be left in place, and no controls would be implemented to limit human exposure to soil and groundwater containing COCs above levels that allow for unlimited use/unrestricted exposure (UU/UE). Therefore, this alternative is not protective of human health and the environment. Because the threshold criteria are not met, the No Action alternative is not carried forward for further evaluation against the balancing and modifying criteria.

3.3 ALTERNATIVE 2: INSTITUTIONAL CONTROLS

3.3.1 Description

This alternative consists of implementing institutional controls to meet the following objectives:

- Limit and/or control property uses to prevent human exposure to, and the spread or migration of, residual COCs in soils where and for as long as COCs remain on site above levels that allow for UU/UE; and
- Prevent human exposure to groundwater containing COCs as long as COC concentrations in groundwater remain above cleanup goals.

The primary enforceable institutional control that would be implemented under this alternative is a restrictive covenant, or more than one covenant as necessary, established pursuant to the Washington Uniform Environmental Covenants Act (UECA) to prohibit land use by current and future owners and users that could result in exposures above ARARs or risk-based standards. Such covenants are enforceable by the covenant holder and by the USEPA and Ecology. Specifically, the restrictive covenant would include the following restrictions:

- Prohibit excavation or other soil disturbances that could expose workers to COCs in the subsurface unless prior notice is given to the regulatory agencies and specific handling requirements and/or worker safety precautions are followed;
- Limit future land use to industrial; and
- Prohibit extraction of groundwater containing COCs so long as concentrations in groundwater remain above MCLs or MTCA Method B levels for groundwater.

The area over which institutional controls would be implemented is shown on Figure 8. MTCA Method B levels for soil are the appropriate cleanup goals to use for delineating the area subject to institutional controls because these levels allow for UU/UE of soil.

Previous excavations removed contaminated shallow soils (0 to 7 feet bgs) exceeding the cleanup goals set forth in the ROD/ESD. Contaminated deeper soils (greater than 7 feet bgs) remain in some areas of the site. In addition, because the MTCA Method B soil levels for some of the COCs are lower than those presented in the ROD/ESD (Table 1), some shallow soils containing COC concentrations above the MTCA Method B levels were left in place during previous remedial activities. These locations are within the proposed area of institutional controls, with these exceptions:

- Analysis of sample AS-13C-IV-23 showed a dieldrin concentration of 0.1 mg/kg, which is above the MTCA B level of 0.063 mg/kg. However, samples collected 5 to 10 feet away on both sides of AS-13C-IV-23, at comparable depths, did not contain dieldrin above the cleanup goals. AS-13C-IV-23 is considered an outlier and its location was not included in the area requiring institutional controls.
- AS-3-175 analysis showed DDT a concentration of 5 mg/kg (MTCA Method B level = 2.9 mg/kg). However, none of the other samples from Area 3, including the samples collected approximately 20 feet to the north, east and south of AS-3-175 contained DDT concentrations above the cleanup goal. Therefore, AS-3-175 was not included in the area requiring institutional controls.
- A dieldrin concentration of 0.7 mg/kg, slightly above the MTCA Method B level, was recorded in AS-3-176. However, samples collected on all sides of AS-3-176, approximately 20 feet away in each direction, did not contain dieldrin levels above cleanup goals. For this reason AS-3-176 was not included in the area requiring institutional controls.

Compliance would be monitored and controls would remain in effect for as long as they are needed. In addition, groundwater monitoring would continue to support CERCLA-mandated 5-year reviews for as long as COCs remain on site, in any medium, above cleanup goals.

3.3.2 Evaluation

Alternative 2 (A-2) – Overall Protection of Human Health and the Environment. Under the institutional controls alternative, human exposure to COCs in contaminated soil and groundwater would be limited by restricting activities to those consistent with industrial site use. In addition, the restrictive covenants would prevent the extraction and use of contaminated groundwater and forbid soil excavation as long as the site does not meet UU/UE levels. Therefore, this alternative would be protective of human health and the environment by ensuring that exposures to residual COCs in soil and groundwater do not pose unacceptable risks to human health. Periodic monitoring would be conducted to evaluate ongoing remedy performance.

A-2 – Compliance with or Waiver from ARARs. This alternative is compliant with ARARs because residual COCs in soil do not exceed the

MTCA Method C levels appropriate for the current industrial site use, and institutional controls would prevent exposure to contaminated groundwater and limit the site to industrial use until cleanup goals are met. MCLs have already been met for those compounds that have MCLs. Periodic monitoring would be conducted to evaluate progression of groundwater concentrations towards cleanup goals.

A-2 – Long-Term Effectiveness and Permanence. This alternative is effective in the long term by providing for enforceable institutional controls to limit exposures to contaminated soil and groundwater to those consistent with industrial exposure scenarios. Soil currently meets MTCA Method C levels due to remediation previously conducted at the site. Groundwater contaminated at concentrations slightly exceeding risk-based levels is confined to the site. Groundwater in the vicinity of the site is not used for industrial, agricultural, or domestic purposes.

A-2 – Reduction of Toxicity, Mobility, or Volume through Treatment. No treatment would be performed under this alternative. Instead, this alternative relies on institutional controls to limit exposures and resulting risks to acceptable levels. Site soils already meet industrial cleanup goals (MTCA Method C) due to previous remediation efforts. In addition, concentrations of COCs in groundwater are only slightly above cleanup goals.

A-2 – Short-Term Effectiveness. This alternative provides for enforceable institutional controls to prohibit access to and exposure to contaminated soil and groundwater and thus creates no short-term risks to the community or on-site personnel. The UECA restrictive covenant could be put into place within a few months, and would be effective at protecting human health in the short term by eliminating exposure pathways for on-site users. It is expected that groundwater would be returned to beneficial uses within a reasonable timeframe of 30 years.

A-2 – Implementability. The institutional controls alternative would require no equipment to implement. This alternative is administratively implementable because the UECA statute has been adopted by the State of Washington and creates a mechanism for both State and USEPA enforcement of restrictive covenants established under that statute. The properties in the area subject to institutional controls shown on Figure 8 would need to be managed or controlled consistent with the UECA covenant.

A-2 – Cost. The capital costs for implementing the institutional controls alternative would be associated with the following: surveying, legal

/filing fees and limiting the property uses to those specified in the covenant. O&M costs would include annual inspections to confirm that the covenant restrictions were being adhered to; periodic compliance reports and notices to the USEPA, Ecology, and any local agencies as the approved covenant may require; long-term groundwater monitoring; and costs for maintaining the monitoring well network. Based on a 30-year project life and a 7 percent discount rate, as used in the NCP analysis, the net present worth of Alternative 2 is approximately $117,000 (Table 7), including a 15 percent contingency. A breakdown of the cost estimate for Alternative 2 is presented in Appendix D.

3.4 ALTERNATIVE 3: SOIL EXCAVATION AND OFF-SITE LANDFILLING AND INSTITUTIONAL CONTROLS

3.4.1 Description

This alternative consists of implementing soil excavation and institutional controls to meet the following objectives:

- Remove soil containing COCs in excess of MTCA Method B levels to 8 feet bgs;
- Limit and/or control property uses to prevent human exposure to, and the spread or migration of, residual COCs in soils where and for as long as COCs remain on site above levels that allow for UU/UE; and
- Prevent human exposure to groundwater containing COCs as long as COC concentrations in groundwater remain above cleanup goals.

This alternative consists of excavating soil over an approximately 20,000-square-foot area (Table 6 and Figure 9) to remove soil containing COCs exceeding their respective cleanup goals (Table 1) and to remove the source of dieldrin to groundwater. Previous excavations performed at the site have removed soil exceeding the 1990 ROD/ESD cleanup goals (Table 2) to a maximum depth of 7 feet bgs. As shown in Table 2, approximately half of the COCs have MTCA Method B levels that are lower than the cleanup goals set in the 1990 ROD/ESD. Additionally, the MTCA soil levels for the protection of groundwater for dieldrin and aldrin are below both the ROD/ESD cleanup goals and the MTCA Method B levels. Some shallow soils containing COC levels below the ROD/ESD cleanup goals, but above the MTCA Method B or protection of groundwater levels, were left in place during previous remedial activities. This includes some soils below 7 feet bgs. This alternative proposes excavating the areas where verification samples from the 1988-1989 and 1990 excavations showed

COC concentrations exceeding the COCs' respective current cleanup goals. The proposed excavation areas are shown in Figure 9.

For costing purposes, this alternative assumes that areas where COC concentrations exceed their respective cleanup goals are excavated to a depth of 8 feet bgs. However, if verification samples indicate that deeper soils exceed cleanup goals, the excavations would be extended as needed to the extent practical. Based on the 8-foot assumption, a total of approximately 5,900 cubic yards of soil would be excavated, of which approximately 2,900 cubic yards contain COCs at concentrations above their respective cleanup goals (Table 6). The remaining approximately 3,000 cubic yards of overburden consists of backfill from previous excavations, which would be separately stockpiled and reused during backfilling. Additional clean backfill would be imported, as needed, from an off-site source. Contaminated soils outside of or beneath previous excavations would be transported off-site and disposed of at a landfill approved by USEPA. It is assumed that the excavated soil would constitute a RCRA hazardous waste and State dangerous waste.

Sidewall and floor sampling would be conducted, and excavations would be expanded based upon sidewall sampling results as necessary to meet cleanup goals. Excavation sidewalls would be stabilized with shoring, rather than sloping, to reduce the footprint of the excavation and prevent encroachment onto the on-site business and property boundaries. The excavation would extend below the water table, so dewatering would be required. During excavation activities, dust control measures would be in place, as necessary, to minimize airborne particulates. In addition, air monitoring would be performed to verify that airborne particulates and OCL pesticides did not exceed regulatory limits inside or at the perimeter of the work area.

There are no monitoring wells within the footprint of the proposed excavation areas. However, if verification sample results necessitated the expansion of excavation areas, all groundwater monitoring wells within the excavation areas would be abandoned prior to initiating excavation activities in accordance with Yakima County and Ecology standards. If deemed necessary by the USEPA, removed monitoring wells would be replaced or additional wells added elsewhere, so that the groundwater monitoring program continued to meet its objectives.

Institutional controls in the form of a UECA restrictive covenant would also be implemented to prohibit excavation in the event that any soils remained above MTCA Method B levels (soil deeper than 8 feet bgs) and to limit groundwater extraction and use. The area over which the restrictive covenant would apply is shown on Figure 9. Specifically, the restrictive covenant would include the following restrictions:

- Prohibit excavation or other soil disturbances that could expose workers to COCs in the subsurface, unless prior notice is given to the regulatory agencies and specific handling requirements and/or worker safety precautions are followed;
- Limit future land use to industrial; and
- Prohibit extraction of groundwater containing COCs as long as concentrations in groundwater remain above MCLs or MTCA Method B levels for groundwater.

Groundwater monitoring would continue to support CERCLA-mandated 5-year reviews for as long as COCs remain on-site, in any medium, above cleanup goals.

Some agencies may require substantive actions not waived by CERCLA Section 121(e)(1) with respect to actions that would be conducted under this alternative. These include regulatory requirements regarding well abandonment and soil excavation, and National Pollutant Discharge Elimination System (NPDES) requirements applicable to stormwater discharges associated with construction activity.

If the MTCA Method B levels were used as the cleanup goals for all the COCs, including dieldrin and aldrin, several of the proposed excavation areas would not require remedial action. These areas include the areas within investigation areas 13C-III, 13C-IV, 3, and 9. However, this assumes that the exceptions noted in Section 3.3.1, above, are not included in the excavation areas. The total excavation area would be reduced to approximately 11,000 square feet. Approximately 1,100 cubic yards of the excavated soil would require disposal.

3.4.2 *Evaluation*

Alternative 3 (A-3) – Overall Protection of Human Health and the Environment. The excavation and off-site disposal alternative is protective of human health and the environment by excavating and disposing soils from depths of up to 8 feet bgs that exceed UU/UE levels and that may be a source of contaminants to groundwater. In addition, a restrictive covenant would be implemented to prevent the extraction and use of contaminated groundwater, forbid soil excavation, and limit the site to industrial use as long as the site does not meet UU/UE levels. Periodic monitoring would be conducted to evaluate ongoing remedy performance.

A-3 – Compliance with or Waiver from ARARs. This alternative is compliant with ARARs for the following reasons:

- Soil would be excavated to 8 feet bgs to meet UU/UE levels (MTCA Method B) and to remove potential sources of dieldrin and aldrin in groundwater.
- Institutional controls would prevent exposure to contaminated groundwater, prevent exposure to contaminated soil remaining below 8 feet bgs at concentrations exceeding MTCA Method B levels, and limit the site to industrial use.
- MCLs have already been met for those compounds that have MCLs.

Periodic monitoring would be conducted to evaluate progression of groundwater concentrations towards cleanup goals.

A-3 – Long-Term Effectiveness and Permanence. This alternative provides long-term effectiveness by removing contaminated soil in addition to the soil already removed during previous remediation efforts and by implementing enforceable institutional controls to limit exposures to contaminated soil and groundwater. A risk reduction would be expected for exposure to contaminated soil under this alternative. In addition, restoration of groundwater to its beneficial uses may be expedited under this alternative due to removal of a potential ongoing source of contaminants to groundwater. Groundwater contaminated at concentrations slightly exceeding risk-based levels is confined to the site. Groundwater in the vicinity of the site is not used for industrial, agricultural, or domestic purposes.

A-3 – Reduction of Toxicity, Mobility, or Volume through Treatment. Contaminated soil would be excavated under this alternative prior to disposal at a hazardous waste landfill acceptable to the USEPA. Treatment of soil prior to disposal to meet land disposal restrictions is not likely to be warranted for the relatively low concentrations remaining in residual soils.

A-3 – Short-Term Effectiveness. In the short term, excavation would be disruptive to businesses on and in the vicinity of the site due to the presence of heavy equipment on site, and truck traffic may impact the surrounding community during soil off-haul activities. In addition, the potential exposure to COCs would be higher in the short term due to the generation of fugitive dust during excavation and soil hauling activities, although these risks could be mitigated with proper dust control measures. Also, there is a potential for short-term groundwater concentration increases as experienced following the 1992 excavation activities. Excavation and hauling equipment would pose short-term industrial safety risks to remediation workers. The expected duration to implement this alternative is 30 days, followed by an expected duration of 30 years for O&M to evaluate remedy performance and monitor progress towards cleanup goals.

A-3 – Implementability. This alternative generally requires typical construction equipment and materials to implement; however, construction activities would impact operations of businesses both on-site and in the vicinity of the site. This alternative would be moderately difficult to implement due to the high water table in the vicinity, the need for special shoring to address known slope stability issues at the site, and the need for construction dewatering to facilitate excavation below the water table.

A-3 – Cost. Capital costs associated with the alternative are for installing shoring; dewatering; excavating, transporting, and disposing of soil containing COCs; importing clean backfill, and backfilling the excavation; installing 3 additional monitoring wells; surveying; and the costs discussed earlier and in Appendix D for the UECA covenant. O&M costs are associated with implementing a long-term groundwater monitoring program; maintaining the monitoring well network; performing annual inspections to confirm that the covenant restrictions are being adhered to; and providing periodic compliance reports and notices to the USEPA, Ecology, and any local agencies as the approved covenant may require. Based on a 30-year project life and a 7 percent discount rate, as used in the NCP analysis, the net present worth of Alternative 3 is approximately $4,365,000 (Table 7), including a 15 percent contingency. A breakdown of the cost estimate for Alternative 3 is presented in Appendix D. If the MTCA Method B levels were used as the cleanup goals for all the COCs, including dieldrin and aldrin, several of the proposed excavation areas would not require remedial action and the excavation alternative would cost approximately $2,135,000.

3.5 ALTERNATIVE 4: GROUNDWATER EXTRACTION AND TREATMENT AND INSTITUTIONAL CONTROLS

3.5.1 Description

This alternative consists of implementing groundwater extraction and treatment with institutional controls to meet the following objectives:

- Extract groundwater from the highest concentration areas of the plume;
- Limit and/or control property uses to prevent human exposure to, and the spread or migration of, residual COCs in soils where and for as long as COCs remain on site above levels that allow for UU/UE; and
- Prevent human exposure to groundwater containing COCs as long as COC concentrations in groundwater remain above cleanup goals.

Under this alternative, two extraction wells would be installed within the plume areas with the highest OCL pesticide concentrations (Figure 10). Extracted groundwater would be treated through an above-grade treatment system consisting of granular activated carbon (GAC) filtration. The contaminated GAC would be transported off-site to a disposal facility determined by USEPA to be appropriate to receive such a waste. The extraction system would help to contain the areas of highest groundwater concentrations while reducing contaminant mass in groundwater, which would likely result in shrinking the plume. Contaminated groundwater is already limited to an area within the site boundary. As stated above, soil remediation was conducted at the site in the past and many of the areas where COCs are above the MTCA Method B levels are at depths of 7 feet bgs or deeper.

This alternative assumes that the two extraction wells would be operated at flow rates of 30 gallons per minute each to provide on-site containment of the highest concentration areas, and that extracted groundwater would be conveyed to an above-grade treatment system. Extraction rates were estimated using the Javendal & Tsang (Javendal & Tsang 1986) method for estimating capture radius for an extraction well. An aquifer thickness of 30 feet was used. The aquifer characteristics, specifically hydraulic conductivity and gradient, were based on the results of the pumping test conducted on W-7 in 1989, as reported in the *Five Year Data Evaluation Report* (ERM 1998). The estimated width of the capture zone for an extraction well operating at 30 gpm is approximately 50 feet wide at a distance of 20 feet upgradient from the well, and 80 feet wide at a distance of 120 feet upgradient from the well.

The treatment system would consist of a reinforced concrete containment pad secured with perimeter fencing; influent piping; a bag filter; two 4000-pound liquid-phase GAC vessels; discharge piping; system controls; and miscellaneous fittings, valves, and appurtenances. Below-grade utilities for extracted groundwater conveyance and treatment system discharge would be installed. No soil would be removed from the site. This alternative assumes that treated water would be permitted for discharge to the sanitary sewer. Under this alternative, groundwater monitoring would continue to support CERCLA-mandated 5-year reviews for as long as COCs remain on-site, in any medium, above cleanup goals.

In addition, this alternative would require institutional controls to be put in place in the form of a UECA restrictive covenant to prevent current and future occupants from accessing the contaminated soil or groundwater beneath the site by digging, drilling, or other subsurface disturbances. The area over which the restrictive covenant would apply is shown on Figure 10. Specifically, the restrictive covenant would include the following restrictions:

- Prohibit excavation or other soil disturbances that could expose workers to COCs in the subsurface, unless prior notice is given to the regulatory agencies and specific handling requirements and/or worker safety precautions are followed;
- Limit future land use to industrial; and
- Prohibit extraction of groundwater containing COCs as long as concentrations in groundwater remain above MCLs or MTCA Level B groundwater concentrations.

Some agencies may require substantive actions not waived by CERCLA Section 121(e)(1) with respect to actions that would be conducted under this alternative. These include regulatory requirements regarding well abandonment and soil excavation, and NPDES requirements applicable to stormwater discharges associated with construction activity.

3.5.2 Evaluation

Alternative 4 (A-4) – Overall Protection of Human Health and the Environment. The groundwater extraction and treatment alternative would protect human health and the environment by extracting and treating contaminated groundwater. In addition, a restrictive covenant would be implemented to prevent the extraction and use of contaminated groundwater, forbid soil excavation, and limit the site to industrial use as long as the site does not meet UU/UE levels. Periodic monitoring would be conducted to evaluate ongoing remedy performance.

A-4 – Compliance with or Waiver from ARARs. This alternative would comply with ARARs because residual COCs in soil would not exceed the MTCA Method C levels appropriate for the current industrial site use, groundwater would be restored to support beneficial uses, and institutional controls would prevent exposure to contaminated groundwater and limit the site to industrial use until cleanup goals are met. MCLs have already been met for those compounds that have MCLs. Periodic monitoring would be conducted to evaluate progression of groundwater concentrations towards cleanup goals.

A-4 – Long-Term Effectiveness and Permanence. This alternative would provide long-term effectiveness by restoring groundwater to its beneficial uses and by implementing enforceable institutional controls to limit exposures to contaminated soil and groundwater to those consistent with industrial exposure scenarios. Soil currently meets MTCA Method C levels due to remediation previously conducted at the site. Because residual soil sources would be left in place under this alternative, groundwater concentrations likely would decrease slowly. A large volume of contaminated groundwater likely would require extraction and treatment.

A-4 – Reduction of Toxicity, Mobility, or Volume through Treatment. Contaminated groundwater would be extracted and treated under this alternative prior to disposal to the sanitary sewer. GAC would be disposed at a landfill acceptable to the USEPA. Because groundwater concentrations only slightly exceed risk-based cleanup goals, the amount of treatment required before disposal to a sewer would be minimal.

A-4 – Short-Term Effectiveness. In the short term, construction of the groundwater extraction and treatment system and drilling of extraction wells would be disruptive to businesses both on-site and in the vicinity of the site. Drilling and construction activities would pose short-term risks to drillers/ construction workers. The expected duration of this alternative, once constructed, is assumed to be 30 years, which takes into account the persistent groundwater contamination due to continual desorption of contaminants from soil to groundwater.

A-4 – Implementability. This alternative would require typical construction equipment and materials to implement and is a proven technology; however, construction activities could impact operations of businesses both on-site and in the site vicinity. O&M would follow standard practices. This alternative is achievable both technically and administratively.

A-4 – Cost. Capital costs associated with this alternative are for drilling and installing 2 extraction wells; installing extraction system utilities; constructing the groundwater treatment system; installing 3 additional monitoring wells; surveying; and the costs discussed previously and in Appendix D associated with the UECA covenant. O&M costs are associated with implementing a long-term groundwater monitoring program; maintaining the monitoring well network and groundwater extraction and treatment system; performing annual inspections to confirm that the covenant restrictions were being adhered to; and providing periodic compliance reports and notices to the USEPA, Ecology, and any local agencies as the approved covenant may require. Based on a 30-year project life and a 7 percent discount rate, as used in the NCP analysis, the net present worth of Alternative 4 is approximately $2,366,000 (Table 7), including a 15 percent contingency. A breakdown of the cost estimate for Alternative 4 is presented in Appendix D.

3.6 COMPARISON OF ALTERNATIVES

In this section, the alternatives are compared to one another according to the criteria presented earlier in this section.

3.6.1 Overall Protection of Human Health and the Environment

Alternative 1 does not meet either threshold criteria. Therefore, Alternative 1 (no action) is removed from further consideration.

Alternative 2 is protective of human health and the environment by restricting activities to those consistent with industrial site use, thereby ensuring that exposure to residual COCs in soil and groundwater does not pose an unacceptable risk to human health or the environment. This restrictive covenant would be implemented to prevent the extraction and use of contaminated groundwater, forbid soil excavation, and limit the site to industrial use as long as the site does not meet UU/UE levels. This component also applies to Alternatives 3 and 4, although for Alternative 3, soil excavation restrictions would be limited to soils 8 feet bgs or deeper because shallower soil would be excavated under that alternative. In addition, Alternative 3 would be protective of human health and the environment by excavating and disposing soil from depths of up to 8 feet bgs that exceeds UU/UE levels and that may be a source of contaminants to groundwater. Alternative 4 would be protective of human health and the environment by extracting and treating contaminated groundwater.

Alternative 1 does not satisfy this criterion and is removed from further analysis. Alternatives 2, 3, and 4 rank equally with respect to this criterion.

3.6.2 *Compliance with or waiver from ARARs*

Alternatives 2, 3, and 4 all comply with ARARs. Residual COCs in soil do not exceed the MTCA Method C levels appropriate for the current and expected future industrial site use, and institutional controls would prevent exposure to contaminated groundwater and limit the site to industrial use until cleanup goals are met. MCLs have already been met for those compounds that have MCLs. Periodic monitoring would be conducted to evaluate progress of groundwater towards cleanup goals. In addition, for Alternative 3, soil would be excavated to 8 feet bgs to meet UU/UE (MTCA Method B) and to remove a potential source of dieldrin and aldrin in groundwater, and for Alternative 4, groundwater would be restored to support beneficial uses through extraction and treatment of contaminated groundwater.

3.6.3 *Long-Term Effectiveness and Permanence*

All three alternatives provide long-term effectiveness by implementing enforceable institutional controls to limit exposures to contaminated soil and groundwater to those consistent with industrial exposure scenarios. Soil currently meets MTCA Method C levels due to remediation previously conducted at the site. Groundwater contaminated at concentrations slightly exceeding risk-based levels is confined to an area within the site boundary. Groundwater in the vicinity of the site is not used for industrial, agricultural, or domestic purposes.

Alternative 4 also would provide long-term effectiveness by restoring groundwater to its beneficial uses. Because residual soil sources, which could constantly re-contaminate groundwater, would be left in place under this alternative, groundwater concentrations would likely decrease very slowly, and it's likely that a large volume of contaminated groundwater would require extraction and treatment.

Soil containing COCs exceeding groundwater protection goals would be left in place at depths greater than 8 feet bgs under this alternative. Therefore, like under Alternative 4, groundwater concentrations likely would decrease slowly under Alternative 3 due to potential re-contamination of groundwater by site soils that may contain residual

COCs. A slight risk reduction would be expected for exposure to contaminated soil in Alternative 3, but that would be the case only if the institutional controls imposed by the UECA covenant were violated. Restoration of groundwater to its beneficial uses could be expedited under this alternative due to removal of a potential ongoing source of groundwater contamination.

Alternatives 2 and 4 are similarly effective in the long term, but Alternative 2 ranks slightly lower because of its longer groundwater restoration time frame. Alternative 3 is slightly more effective in the long term than the other two alternatives.

3.6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The only alternative that includes treatment of contaminated media is Alternative 4, which includes groundwater extraction and treatment prior to discharge to the sanitary sewer. However, because groundwater concentrations are relatively low, only a small mass of contaminants would be treated. Alternative 3 includes excavation of soil, which would likely not require pretreatment prior to disposal due to the low COC concentrations. No treatment would be performed under Alternative 2 ,because this alternative instead relies on institutional controls to limit exposures and resulting risks to acceptable levels. Site soils already meet industrial cleanup goals (MTCA Method C) due to previous remediation efforts. Although Alternative 4 is the only alternative that includes treatment, Alternative 4 ranks only slightly higher than Alternatives 2 and 3 because residual COC concentrations are already close to their remedial goals.

3.6.5 Short-Term Effectiveness

Short-term effectiveness is highest for Alternative 2, followed by Alternative 4, with Alterative 3 ranked the lowest. The UECA restrictive covenant, which is a common component to each of these alternatives, could be put into place within a few months, and would be effective at protecting workers and on-site users in the short term. Alternative 2 does not involve invasive activities and thus would not result in any short-term risks to on-site workers or the community. Excavation, drilling, and construction conducted under Alternatives 3 and 4 would pose industrial safety risks for remediation workers and would be disruptive to businesses both on-site and near the site.

Several other short-term risks are associated with Alternative 3 in addition to those discussed above: truck traffic associated with transport of contaminated soil off-site may impact the surrounding community; the potential exposure to COCs would be higher in the short term due to the generation of fugitive dust during excavation and soil hauling activities, although these risks could be mitigated with proper dust control measures; and there would be potential short-term groundwater concentration increases, as was experienced following the 1992 excavation activities due to excavation slope failure.

Under Alternatives 2 and 4, groundwater is expected to be returned to beneficial uses within a reasonable timeframe of 30 years. For Alternative 4, this duration takes into account the persistent groundwater contamination due to continual desorption of contaminants from soil to groundwater. Implementation of Alternative 3 would be completed within 30 days, followed by an assumed duration of close to 30 years for monitoring to evaluate remedy performance and monitor progress towards cleanup goals. Because Alternative 3 is associated with more short-term risk without a significantly shorter remedial timeframe, this alterative ranks the lowest.

3.6.6 Implementability

Alternative 2 is the most implementable alternative of those carried forward through this analysis. No equipment is required to implement Alternative 2, and the UECA covenant is an available and effective mechanism for imposing enforceable land use restrictions. Obtaining subsurface rights to properties may be difficult; however, this would also be required for Alternatives 3 and 4. Alternative 4 is moderately implementable. Although Alternative 4 is a proven technology, involving typical construction equipment and materials and standard O&M procedures, construction activities could impact operations of businesses on and near the site. Alternative 3 would be moderately difficult to implement due to the high water table in the vicinity, the need for special shoring to address known slope stability issues at the site, and the need for construction dewatering to facilitate excavation below the water table. Like Alternative 4, construction activities could impact operations of businesses on and in the vicinity of the site under this alternative, but to a greater degree since excavation is more invasive than drilling.

3.6.7 Cost

As shown in Table 7, Alternative 2 is the least expensive alternative, at approximately $117,000. The cost estimate for Alternatives 3 is approximately $4.4 million, and the Alternative 4 estimated cost is $2.4 million. These costs are based on a 30-year project life and a 7 percent discount rate and include a 15 percent contingency. A breakdown of the cost estimates for these three alternatives is presented in Appendix D.

Alternative 2 involves relatively little capital cost, as compared to Alternatives 3 and 4 (Appendix D). Capital costs for Alternative 3 and 4 are approximately $3.6 million and $780,000 more, respectively, than those for Alternative 2. The potential costs for getting the neighboring land owners consent to apply institutional controls on their properties were not included in the costing. However, this does not impact the SFS since Alternatives 2, 3 and 4 all include institutional controls. O&M costs for Alternatives 2 and 3 are comparable, because they both include groundwater monitoring and annual inspections. However, O&M costs for Alternative 4 are approximately $1.2 million more than for Alternatives 2 and 3 over a 30-year project life.

3.7 RECOMMENDED ALTERNATIVE

Based on the comparative analysis presented above, Alternative 2 is the recommended alternative for additional remedial action at the site. Alternative 2 satisfies the NCP threshold criteria and also meets the NCP balancing criteria. Continued groundwater monitoring would be performed to assess ongoing protectiveness of the remedy and to evaluate the progress of groundwater towards meeting the cleanup goals within a reasonable timeframe (30 years). This alternative would provide enforceable and effective institutional controls to restrict access and prevent exposure to COCs in soil and groundwater. These controls would be in place until the site meets UU/UE levels. Concentrations of COCs in soil already meet the MTCA Method C levels suitable for industrial sites. Moreover, the groundwater plume is intrinsically stable and does not extend off-site. Alternative 4 does not appear to provide a significant benefit in attaining cleanup goals relative to Alternative 2, and costs approximately $2.2 million more than Alternative 2 over a 30-year design life (Table 7). Alternative 3 may attain cleanup goals at the site slightly faster than Alternatives 2 and 4, but costs significantly more than Alternative 2 (approximately $2.0 million more than Alternative 2; see Table 7).

Based on this analysis, Alternative 2 will meet the RAOs in a cost-effective manner. Once the ROD is amended, the UECA statute will provide the mechanism for establishing, enforcing and monitoring the effectiveness of the remedial action that will be implemented under this alternative.

4.0 FOLLOW-UP ACTIONS BASED ON EPA CERCLA THIRD FIVE-YEAR REVIEW

The first follow-up action listed in EPA's Third Five-Year Review was to review the potential range of additional remedial actions based on current site conditions. This SFS completes that action. The remaining action items, and FMC's proposed approach for addressing them, are discussed below.

4.1 MODIFY REMEDY TO ADD DIELDRIN AS A GROUNDWATER COC

The Third Five-Year Review Report recommended adding dieldrin as a groundwater COC. The practical quantitation limit for dieldrin using USEPA Method 8081A is 0.05 µg/L, which is above the 1×10^{-6} cancer risk level for dieldrin established in the ROD (corresponding to a dieldrin concentration of 0.004 µg/L). FMC will contract a licensed analytical laboratory and work with USEPA to evaluate the practicality of developing a low-level detection method capable of reporting dieldrin in groundwater samples at concentrations at or below 0.004 µg/L. In addition, aldrin will be evaluated as a potential groundwater COC.

4.2 MAINTAIN ACCESS TO EXISTING MONITORING WELLS

The USEPA has requested that access to the monitoring well network at the site be maintained. All the alternatives evaluated in this SFS included maintaining an adequate well monitoring network as an element.

4.3 REVISE GROUNDWATER MONITORING PROGRAM

The changes to the groundwater monitoring program requested by the USEPA are addressed below.

- Add piezometer W-8C to the existing groundwater monitoring network: FMC will sample well W-8C during future groundwater monitoring events.
- Monitor groundwater in early spring (March/first week of April) and early fall (late September/early October) 2012 to characterize seasonal fluctuations: FMC proposes to perform these seasonal groundwater monitoring events.

- Dieldrin, and potentially aldrin, will be added to the list of groundwater COCs.
- The O&M plan will be updated to include maintaining access to monitoring wells, as well as potentially adding new wells as needed or as required by the USEPA, so that the monitoring program continues to meet remedial action objectives.

5.0 RECOMMENDATIONS

FMC concurs with the USEPA recommendations and follow-up actions set forth in the *Third Five Year Review Report*, and propose the following:

- Amending the ROD to reflect selection of institutional controls, in the form of a restrictive covenant pursuant to the Washington Uniform Environmental Covenant Act, as an additional remedial action for the site and the addition of dieldrin, and potentially aldrin, as groundwater COCs;
- Assess developing a low-level detection method for dieldrin and aldrin prior to conducting the next groundwater monitoring event;
- Maintaining access to the existing monitoring well network, which FMC will ensure through provisions in the recommended UECA covenant; and
- Revising the groundwater monitoring program by abandoning wells W-7, W-9A, and W-9B, adding piezometer W-8C to the groundwater monitoring network, and conducting semiannual groundwater monitoring events for the next monitoring period.

6.0 REFERENCES

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USEPA. 2008. *Third Five-Year Review Report for FMC Yakima, Superfund Site, Yakima Washington*. September.

Figures

Project No.
0120748.***

Date:
09/01/10

Drawn By:
R. Olson

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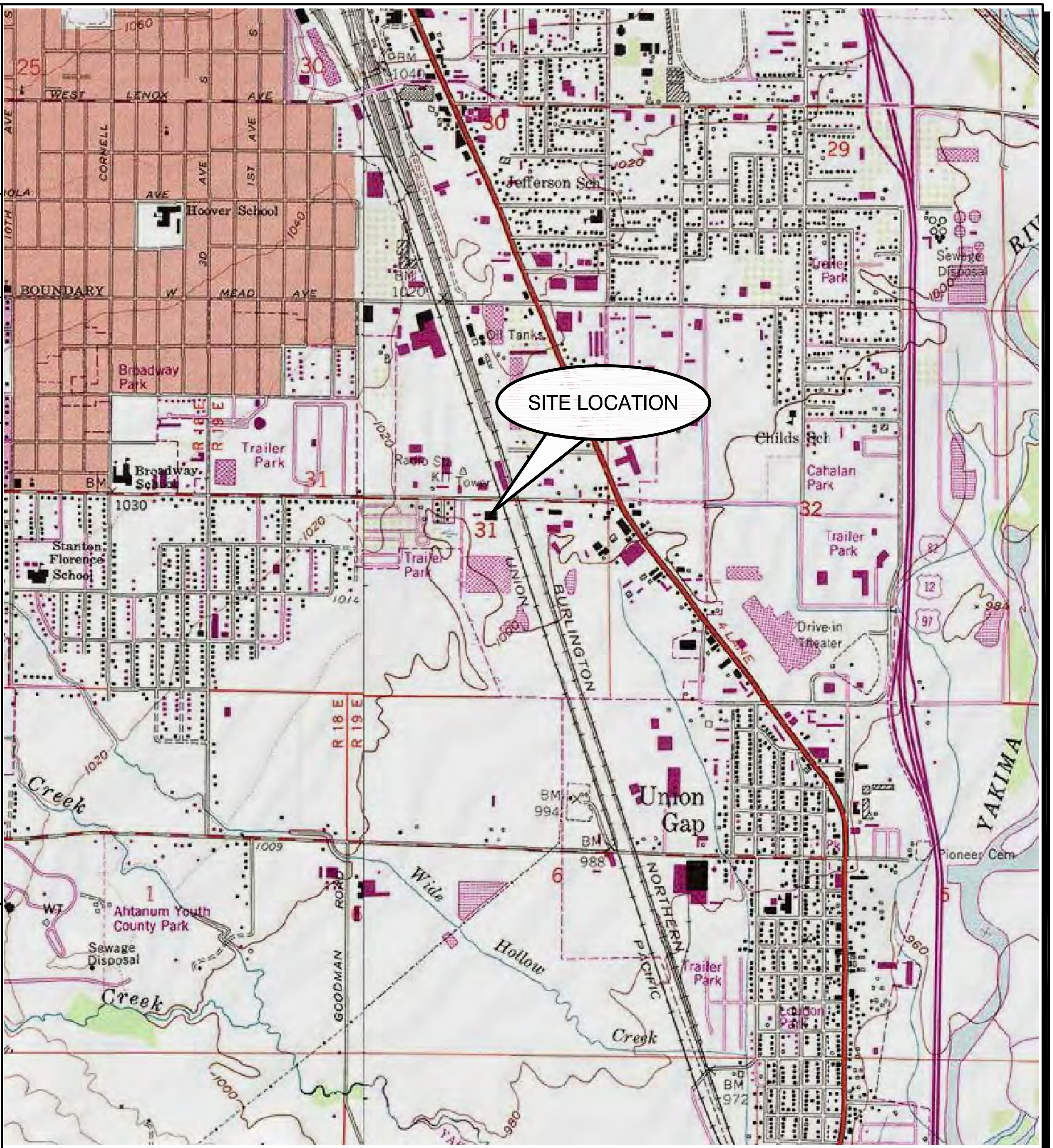

SCALE 1: 24,000

1 1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

N

Figure 1

Site Location Map

Former FMC Pesticide Formulation Facility

4 West Washington Avenue

Yakima, Washington

References:
TOPO!® Software
U.S.G.S. 7.5 Minute Series (Topographic) Quadrangle,
Yakima East, WA
Version: 1985; Current: 1981

ERM 09/10

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R. Olson

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06/30/11

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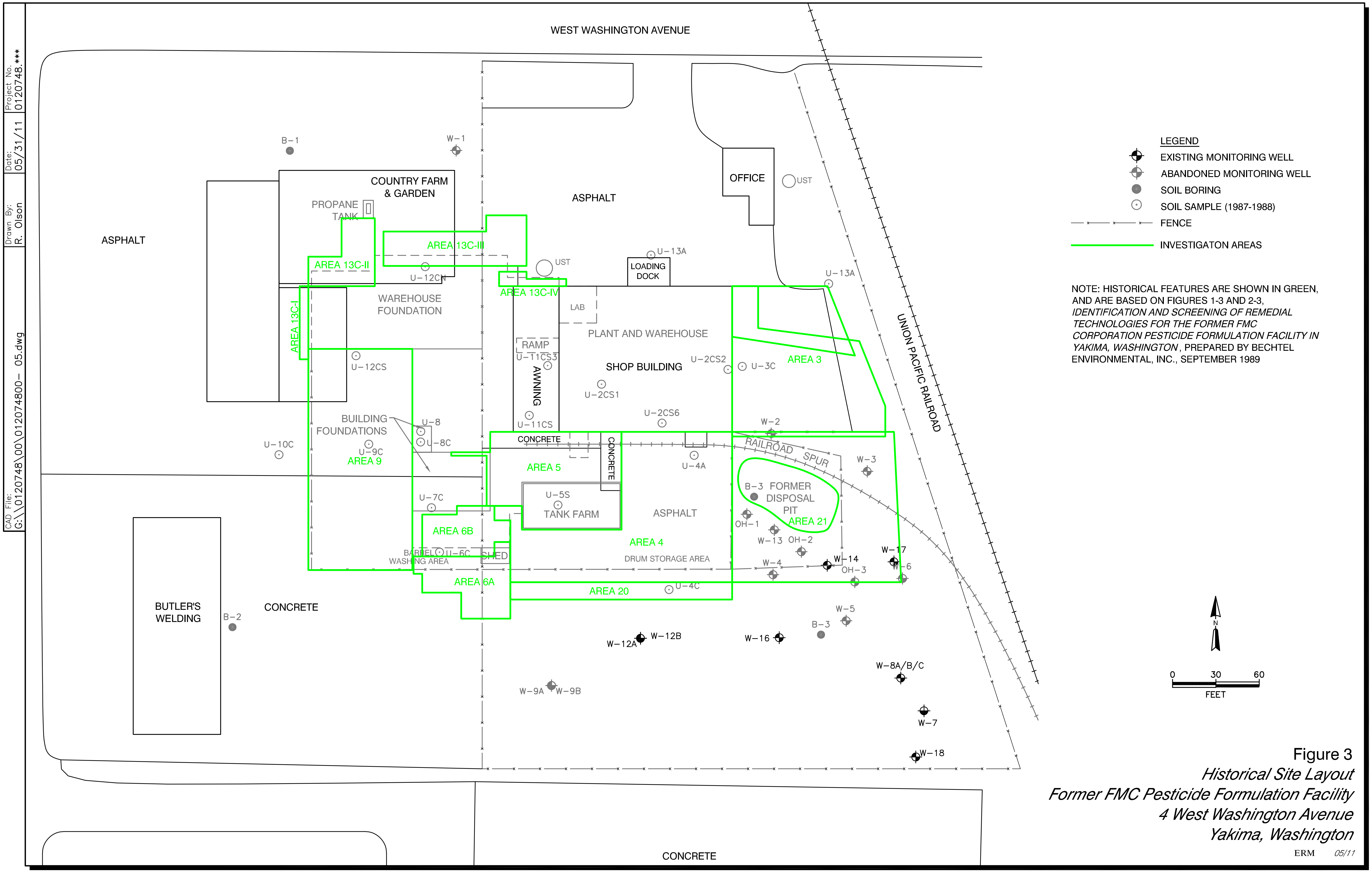
Figure 2
Current Site Layout Map
Former FMC Pesticide Formulation Facility
4 West Washington Avenue
Yakima, Washington

ERM *06/11/11*



LEGEND

⌖	EXISTING MONITORING WELL
⌖	ABANDONED MONITORING WELL
●	SOIL BORING
⊙	SOIL SAMPLE (1987-1988)
—×—×—	FENCE
🟩	INVESTIGATON AREAS

NOTE: HISTORICAL FEATURES ARE SHOWN IN GREEN, AND ARE BASED ON FIGURES 1-3 AND 2-3, *IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES FOR THE FORMER FMC CORPORATION PESTICIDE FORMULATION FACILITY IN YAKIMA, WASHINGTON*, PREPARED BY BECHTEL ENVIRONMENTAL, INC., SEPTEMBER 1989

Figure 3
Historical Site Layout
Former FMC Pesticide Formulation Facility
4 West Washington Avenue
Yakima, Washington

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Date: 05/31/11
Project No. 0120748.***

Project No. 0120748.***
Date: 05/31/11
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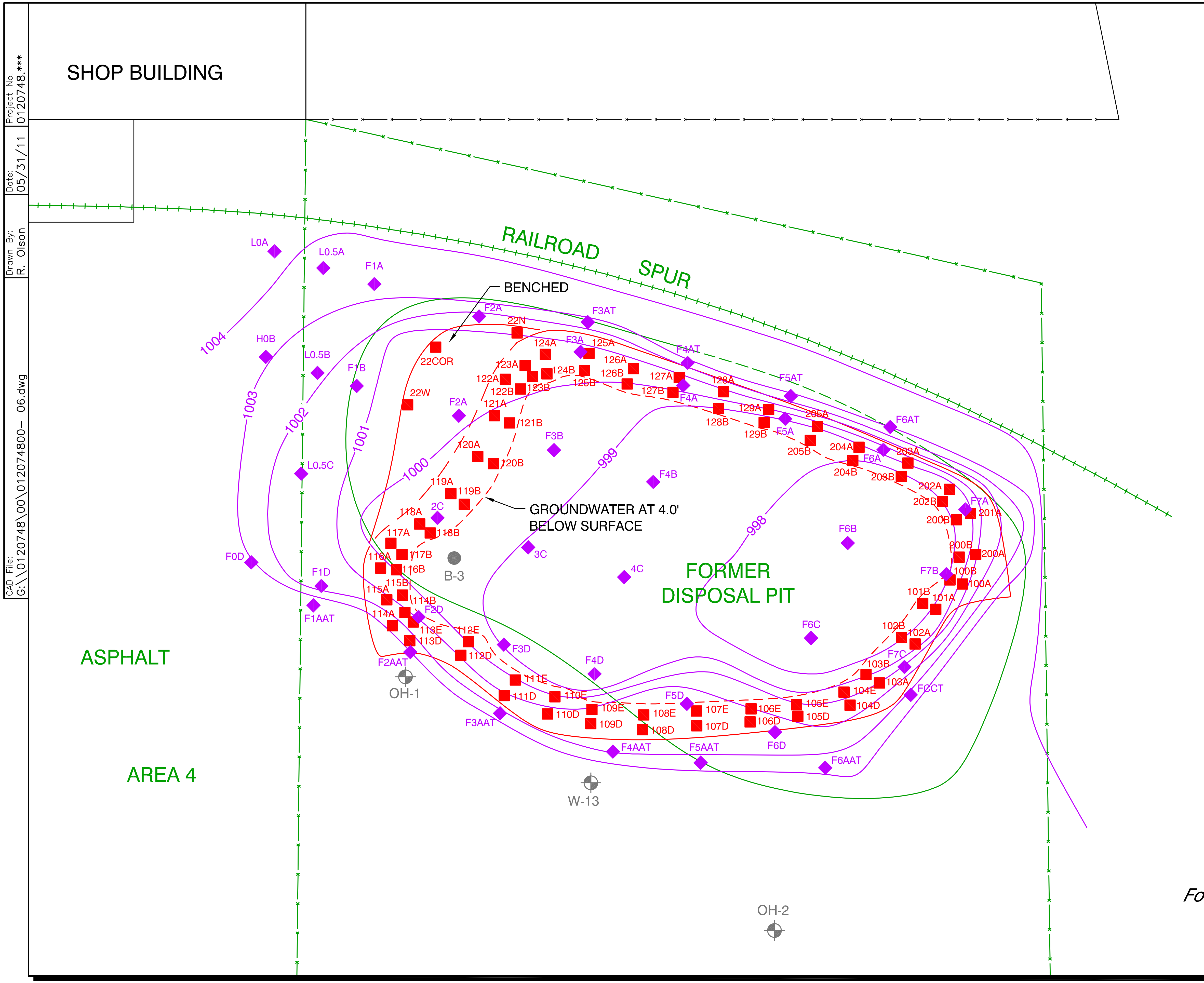

LEGEND

⌖	ABANDONED MONITORING WELL
●	SOIL BORING
—×—×—	FENCE
—	APPROXIMATE LIMITS OF PHASE I PIT EXCAVATION
—	APPROXIMATE ELEVATION CONTOURS OF PHASE II PIT EXCAVATION
■	APPROXIMATE LOCATION OF SOIL SAMPLES FROM PHASE I PIT EXCAVATION; A, D SAMPLES TAKEN ~1.25-1.5' FROM SURFACE, B, E SAMPLES TAKEN JUST ABOVE WATER LEVEL (~4.0' BELOW SURFACE)
◆	APPROXIMATE LOCATION OF SOIL SAMPLES FROM PHASE II PIT EXCAVATION

NOTE: HISTORICAL FEATURES ARE SHOWN IN GREEN, AND ARE BASED ON FIGURES 1-3 AND 2-3, *IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES FOR THE FORMER FMC CORPORATION PESTICIDE FORMULATION FACILITY IN YAKIMA, WASHINGTON*, PREPARED BY BECHTEL ENVIRONMENTAL, INC., SEPTEMBER 1989

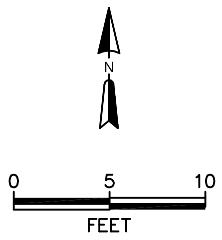

Figure 4
Former Disposal Pit Excavation Area
Former FMC Pesticide Formulation Facility
4 West Washington Avenue
Yakima, Washington

ERM *05/11*

Project No. 0120748.***
Date: 06/30/11
Drawn By: R. Olson
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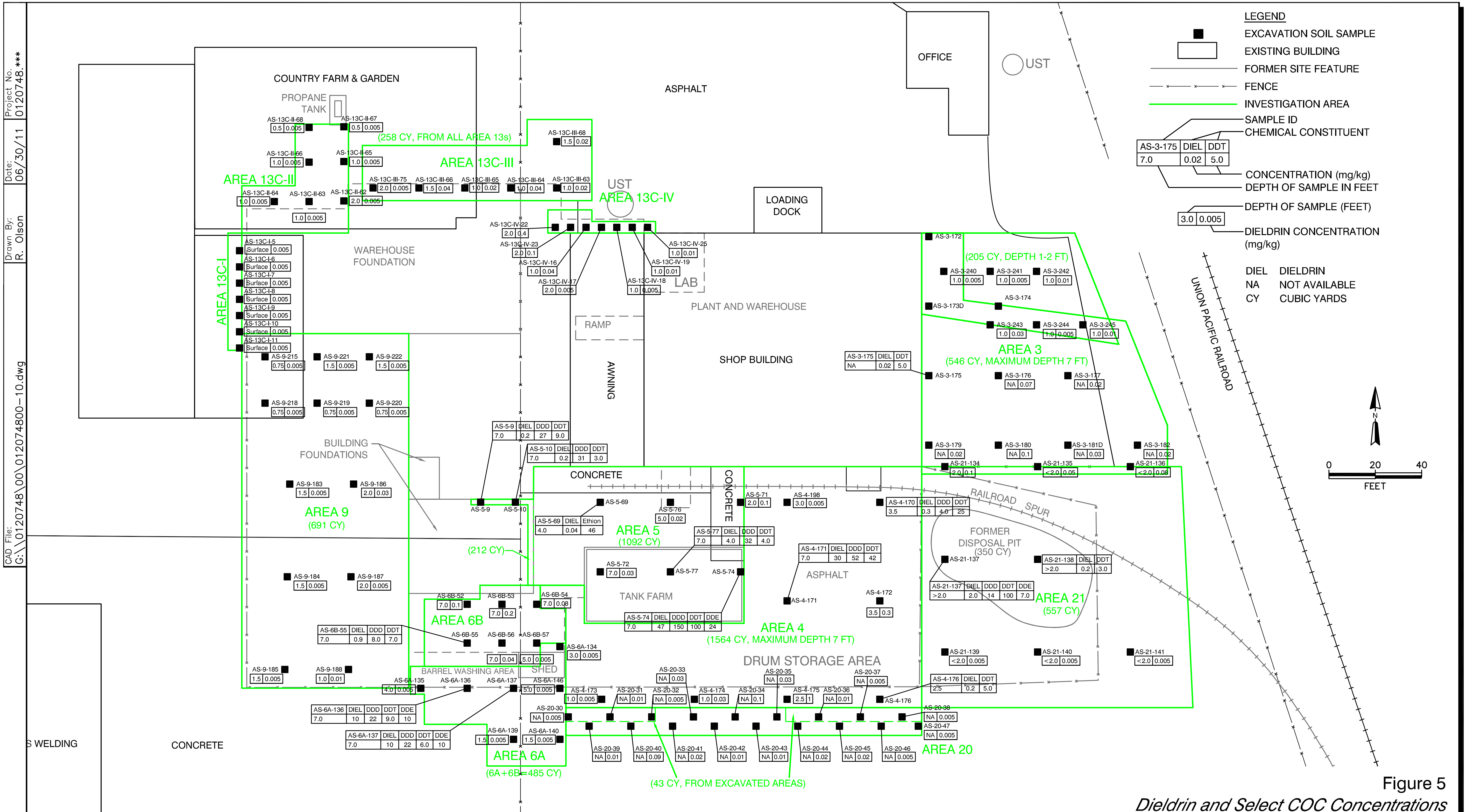

NOTES:
HISTORICAL FEATURES ARE SHOWN IN GREEN, AND ARE BASED ON FIGURES 1-3 AND 2-3, *IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES FOR THE FORMER FMC CORPORATION PESTICIDE FORMULATION FACILITY IN YAKIMA, WASHINGTON*, PREPARED BY BECHTEL ENVIRONMENTAL, INC., SEPTEMBER 1989.

APPROXIMATE EXCAVATION DELINEATION AND EXCAVATION SAMPLE LOCATIONS ARE BASED ON FIGURES FROM *FMC-YAKIMA AREA CLEANUP SUMMARIES, 19088-R-06B, REV. 1.*

Figure 5
Dieldrin and Select COC Concentrations
in Excavation Soil Samples
Former FMC Pesticide Formulation Facility
4 West Washington Avenue
Yakima, Washington

ERM *06/11*

Project No. 0120748.***
Date: 05/31/11
Drawn By: R. Olson
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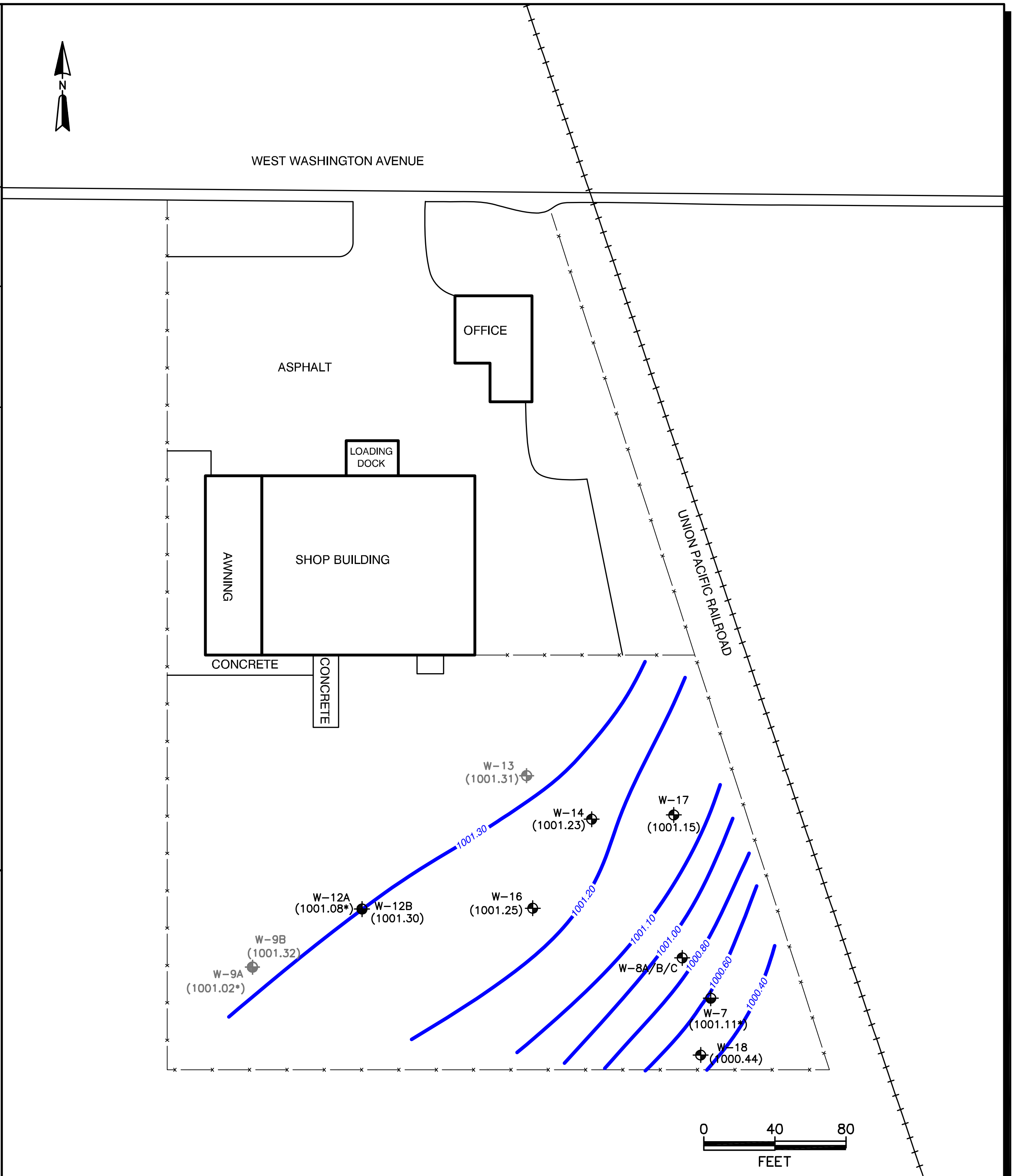

LEGEND

⊕	Monitoring Well
⊕	Deep Monitoring Well
⊕	Abandoned Monitoring Well (12/7/10)
(1001.30)	Groundwater Elevation (ft amsl)
1001.30 ━	Groundwater Elevation Contour
*	Not Used for Contouring
ft amsl	Feet Above Mean Sea Level
—×—×—	Fence
—+—+—+—	Railroad

Figure 6

Potentiometric Surface Map - October 2007
Former FMC Pesticide Formulation Facility
4 West Washington Avenue
Yakima, Washington

ERM 05/11

Project No. 0120748.***

Date: 05/31/11

Drawn By: R. Olson

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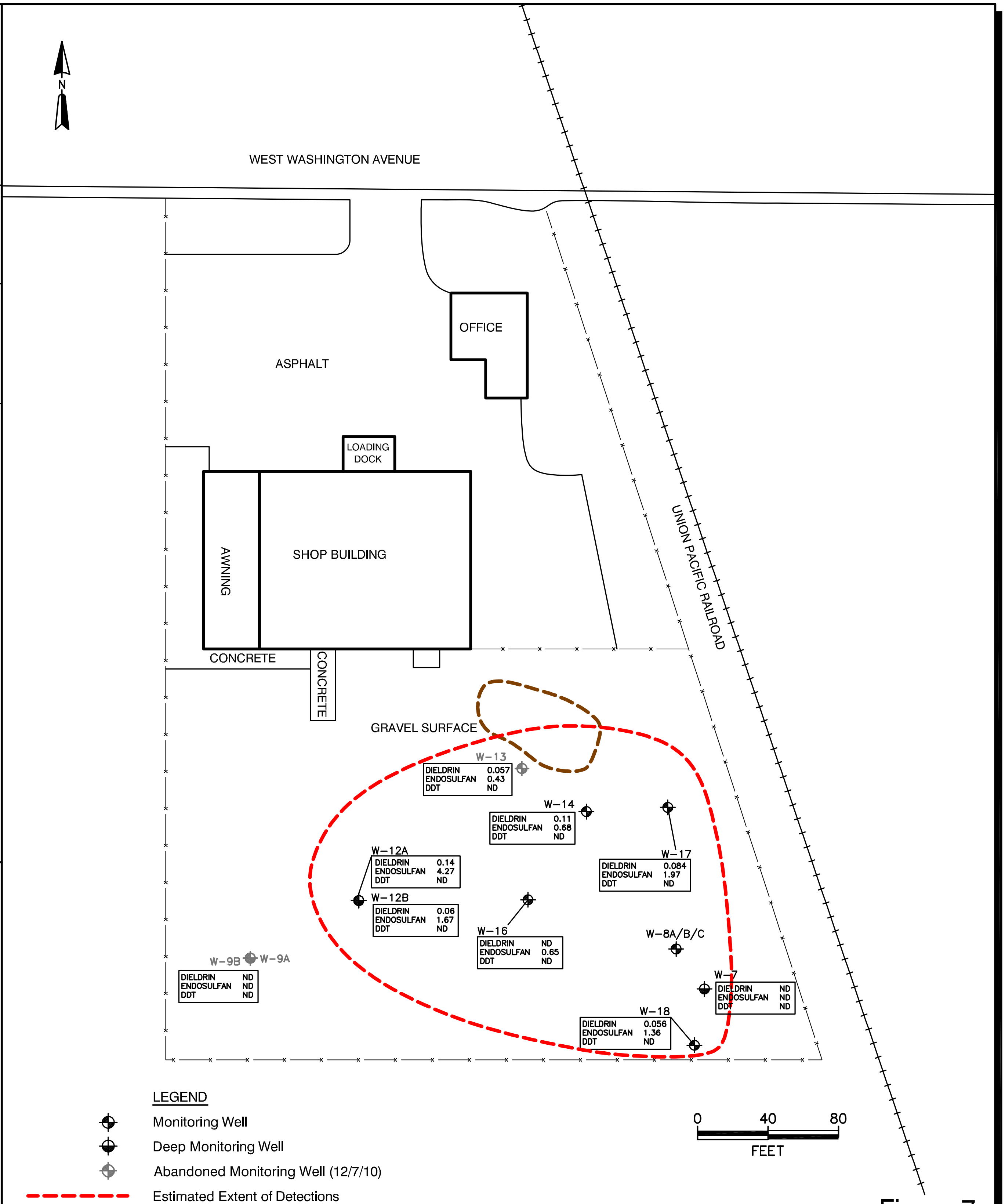

LEGEND

⊕ Monitoring Well

⊕ Deep Monitoring Well

⊕ Abandoned Monitoring Well (12/7/10)

– – – Estimated Extent of Detections

– – – Estimated Location of Former Disposal Pit

ND Constituent Not Detected Above Laboratory Reporting Limit

DDT 1,1,1-Trichloro-2,2-bis(p-chlorophenyl)ethane

—×—×— Fence

+++++++ Railroad

Notes:

1. All concentrations are in micrograms per liter.
2. Endosulfan (total) includes Endosulfan I, Endosulfan II, and Endosulfan sulfate.

Figure 7

Indicator Compounds in Groundwater
October 2007
Former FMC Pesticide Formulation Facility
4 West Washington Avenue
Yakima, Washington

ERM 05/11

Project No. 0120748.***
Date: 07/27/11
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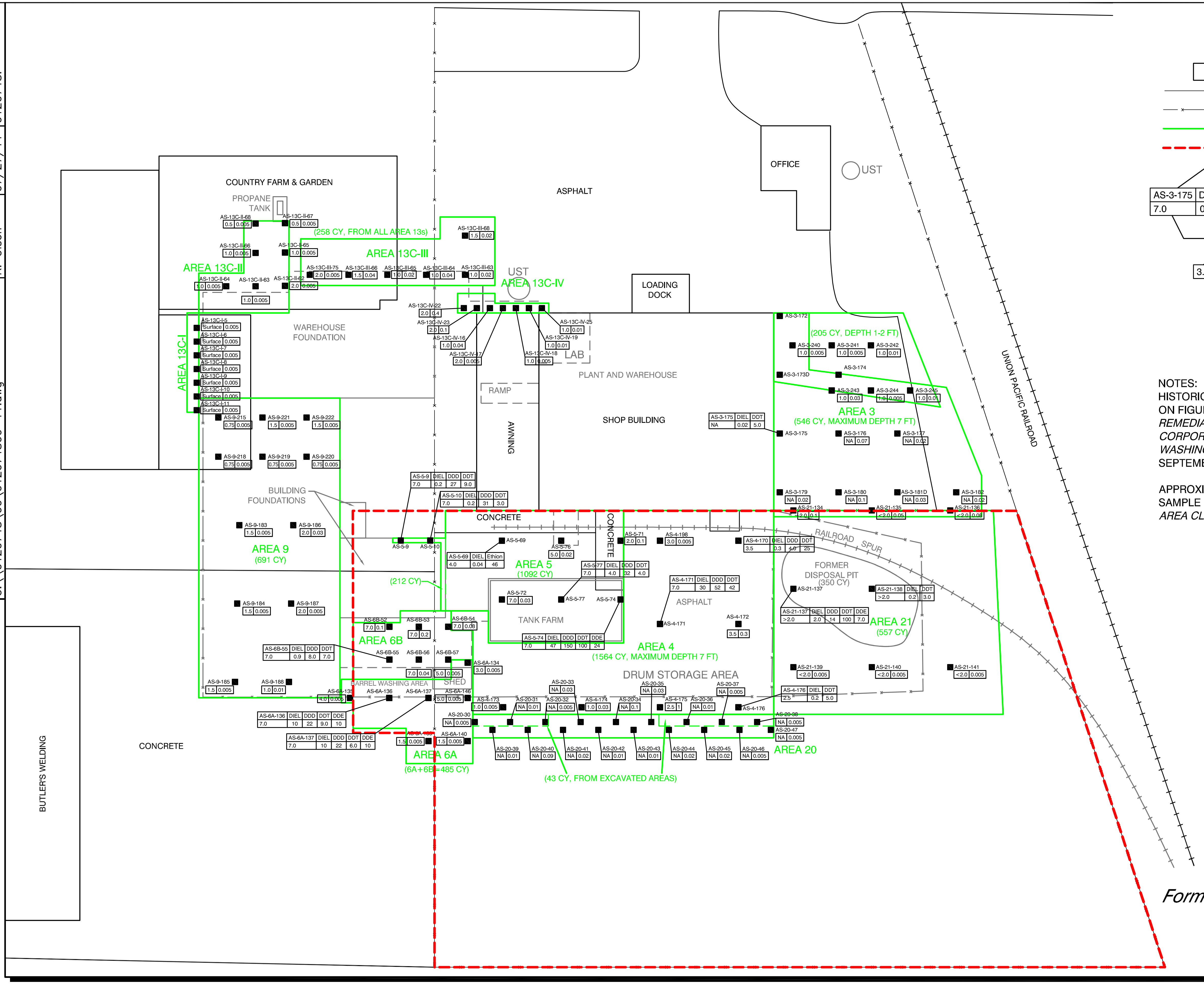

LEGEND

■ EXCAVATION SOIL SAMPLE

▭ EXISTING BUILDING

FORMER SITE FEATURE

FENCE

🟩 INVESTIGATION AREA

🟥 LAND USE CONTROL AREA

AS-3-175	DIEL	DDT
7.0	0.02	5.0

SAMPLE ID
CHEMICAL CONSTITUENT
CONCENTRATION (mg/kg)
DEPTH OF SAMPLE IN FEET

3.0	0.005

DEPTH OF SAMPLE (FEET)
DIELDRIN CONCENTRATION (mg/kg)

DIEL	DIELDRIN
NA	NOT AVAILABLE
CY	CUBIC YARDS

NOTES:

HISTORICAL FEATURES ARE SHOWN IN GREEN, AND ARE BASED ON FIGURES 1-3 AND 2-3, *IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES FOR THE FORMER FMC CORPORATION PESTICIDE FORMULATION FACILITY IN YAKIMA, WASHINGTON*, PREPARED BY BECHTEL ENVIRONMENTAL, INC., SEPTEMBER 1989.

APPROXIMATE EXCAVATION DELINEATION AND EXCAVATION SAMPLE LOCATIONS ARE BASED ON FIGURES FROM *FMC-YAKIMA AREA CLEANUP SUMMARIES, 19088-R-06B, REV. 1.*

Figure 8

Alternative 2 - Institutional Controls
Former FMC Pesticide Formulation Facility
4 West Washington Avenue
Yakima, Washington

ERM *07/11*

Project No. 0120748.***
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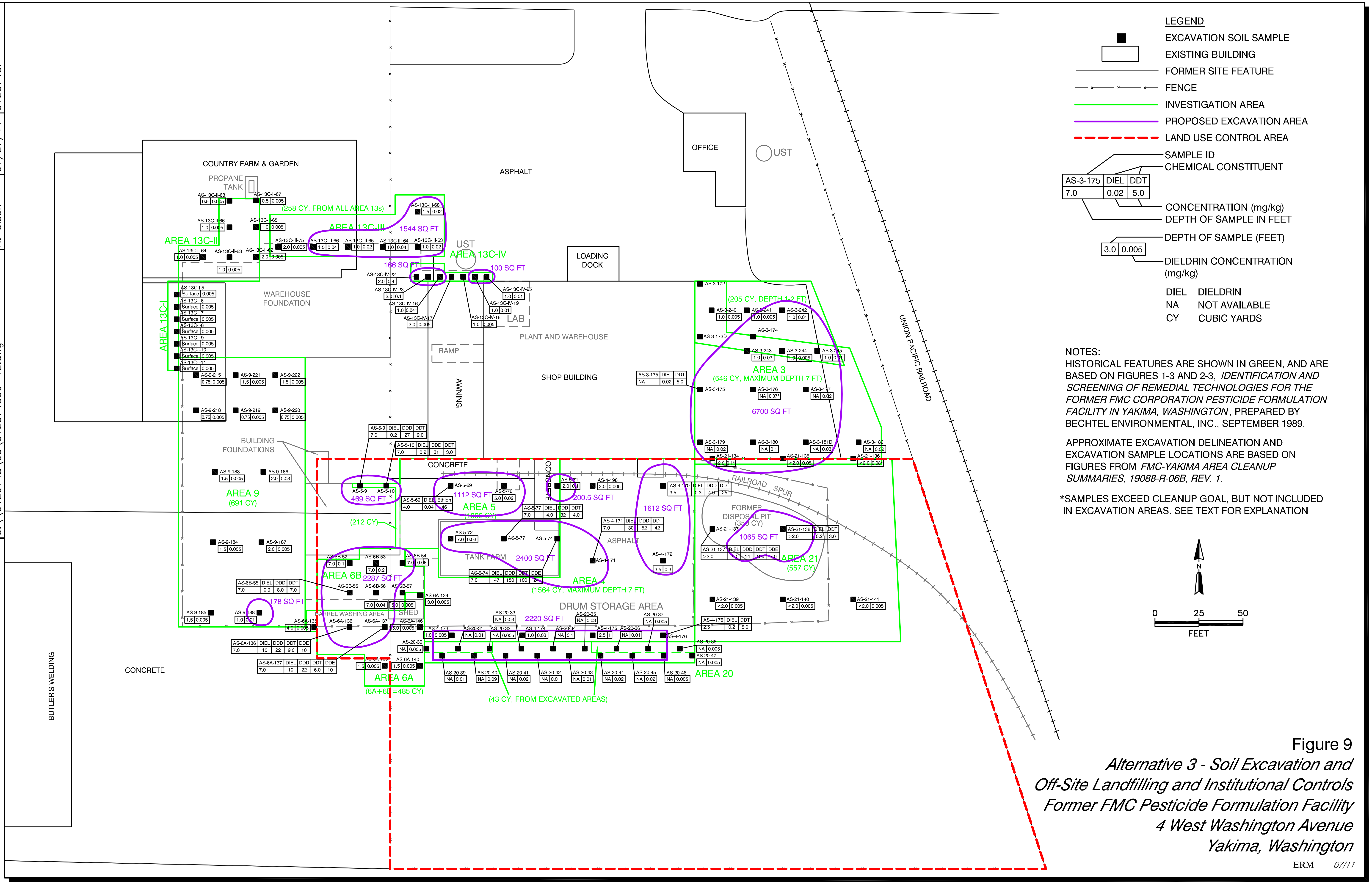


NOTES:
HISTORICAL FEATURES ARE SHOWN IN GREEN, AND ARE BASED ON FIGURES 1-3 AND 2-3, *IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES FOR THE FORMER FMC CORPORATION PESTICIDE FORMULATION FACILITY IN YAKIMA, WASHINGTON*, PREPARED BY BECHTEL ENVIRONMENTAL, INC., SEPTEMBER 1989.

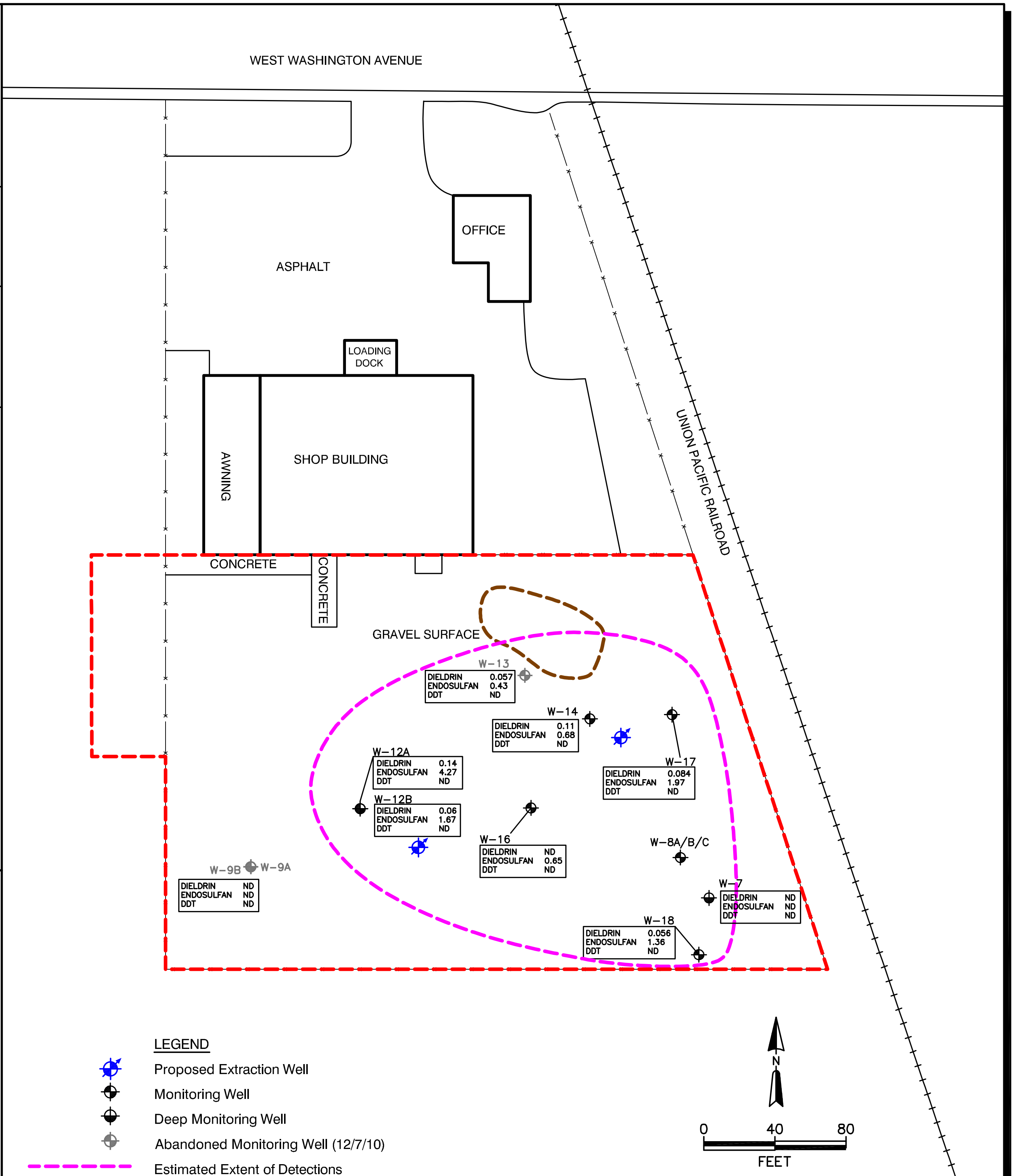
APPROXIMATE EXCAVATION DELINEATION AND EXCAVATION SAMPLE LOCATIONS ARE BASED ON FIGURES FROM *FMC-YAKIMA AREA CLEANUP SUMMARIES, 19088-R-06B, REV. 1.*

*SAMPLES EXCEED CLEANUP GOAL, BUT NOT INCLUDED IN EXCAVATION AREAS. SEE TEXT FOR EXPLANATION

Figure 9

Alternative 3 - Soil Excavation and Off-Site Landfilling and Institutional Controls
Former FMC Pesticide Formulation Facility
4 West Washington Avenue
Yakima, Washington

ERM 07/11



LEGEND

⊕	Proposed Extraction Well
⊕	Monitoring Well
⊕	Deep Monitoring Well
⊕	Abandoned Monitoring Well (12/7/10)
- - -	Estimated Extent of Detections
- - -	Estimated Location of Former Disposal Pit
- - -	Land Control Use Area
ND	Constituent Not Detected Above Laboratory Reporting Limit
DDT	1,1,1-Trichloro-2,2-bis(p-chlorophenyl)ethane
—×—×—	Fence
+++++++	Railroad

Notes:
1. All concentrations are in micrograms per liter.
2. Endosulfan (total) includes Endosulfan I, Endosulfan II, and Endosulfan sulfate.

Figure 10
Alternative 4 - Groundwater Extraction, Treatment and Institutional Controls
Former FMC Pesticide Formulation Facility
4 West Washington Avenue
Yakima, Washington

ERM *07/11*

Project No. 0120748.***
Date: 07/27/11
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Tables

Table 1
Health-Based Cleanup Goals for Soil and Groundwater
Former FMC Pesticide Formulation Facility
Yakima, Washington

Compound	**ROD/ESD Soil Concentration (10-6 CR/HQ=1) (0-2 ft bgs) mg/kg**	**ROD/ESD Soil Concentration (5x10-6 CR/HQ=1) (2-7 ft bgs) mg/kg**	**MTCA B Soil Levels* mg/kg**	**MTCA C Soil Levels* mg/kg**	**MTCA Soil Levels for Protection of Groundwater Levels[a] mg/kg**	**ROD Groundwater Concentration µg/L**	**MTCA B Groundwater Levels µg/L**	**Current (Oct. 2007) Maximum Groundwater Concentrations µg/L**
Aldrin	NA	-	0.059	7.7	**0.0025/0.00013**	-	*0.0026*	<0.05
Cadmium	8	8	**80**	3500	-	-	*8*	NA
Chromium VI	1	5	**240**	11000	-	-	*48*	NA
DDD	5.1	25.5	**4.2**	550	-	-	*0.36*	<0.05
DDE	3.6	18	**2.9**	390	-	-	*0.26*	<0.05
DDT	3.6	18	**2.9**	390	-	0.1	*0.26*	<0.05
Dieldrin	0.076	0.38	0.063	8.2	**0.0028/0.00014**	-	*0.0055*	0.14
DNOC**	8.5	8.5	**-**	-	-	-	-	NA
Endosulfans	4.2	4.2	**480**	21000	-	2	*96*	5.17
Ethion	42.4	42.4	**40**	1800	-	-	*8*	NA
Malathion	1695	1695	**1600**	70000	-	-	*320*	NA
Ethyl Parathion[b]	11	11	**480**	21000	-	-	*96*	NA
Zinc	500	500	**24000**	1100000	-	-	*4800*	NA

Notes:

*Lowest of the available carcinogen and noncarcinogen direct contact levels.
**No risk information is available in IRIS so no MTCA Levels B or C are available.
[a] Values are presented for unsaturated zone/saturated zone soils.
[b] Called parathion in the MTCA and IRIS tables.
Bolded concentrations identify soil cleanup goals for site.
Italicized concentrations identify groundwater cleanup goals for site.

Abbreviations:

DDD = 1,1-dichloro-2,2-bis(p-chlorophenol)ethane
DDE = 1,1-dichloro-2,2-bis(p-chlorophenol)ethylene
DDT = 1,1,1-trichloro-2,2-bis(p-chlorophenol)ethane
DNOC = 4,6-dinitro-o-cresol
mg/kg = milligrams per kilogram
µg/L = micrograms per liter
NA = Not analyzed
ROD = Record of Decision
ESD = Explanation of Significant Difference
CR = Cancer risk
HQ = Hazard quotient
MTCA = Model Toxics Control Act
ft bgs = feet below ground surface

Table 2
Excavated Soils Summary
Former FMC Pesticide Formulation Facility
Yakima, Washington

Area	Average Excavation depth (ft bgs)	Volume Excavated (CY) 1988-1989	1992
3	7 *		751
4	7 *		1,564
5A	7 *		639
5C	7 *		448
6A/B	7 *		485
7B	7		212
9	1.5		691
13C	1.5		258
20	< 2		43
21	8 *	1,150	517
Total Excavated Volume			6,758

Notes:

CY - cubic yards.

ft bgs - feet below ground surface.

* - indicates maximum depth of excavation provided.

Table 3
Groundwater Elevations - October 2007
Former FMC Pesticide Formulation Facility
Yakima, Washington

Well	**Casing Diameter**	**Screen Length A (ft)**	**Total Depth B (ft)**	**Top of Screen (ft amsl)**	**Bottom of Screen (ft amsl)**	**Elevation Top of CasingC (ft amsl)**	**Depth to Water 10-22-07 (ft bgs)**	**Groundwater Elevation 10-22-07 (ft amsl)**
W-7	4	15	35.07	984.22	969.22	1002.60	2.49	1000.11
W-9A	2	5	36.5	971.36	966.36	1002.80	1.78	1001.02
W-9B	2	5	14.13	994.86	989.86	1002.85	1.53	1001.32
W-12A	4	5	21.31	990.50	985.50	1003.05	1.97	1001.08
W-12B	4	5	10.46	998.50	993.50	1003.14	1.84	1001.30
W-13	2	10	15.46	999.30	989.30	1003.45	2.14	1001.31
W-14	2	10	15.11	998.73	998.73	1003.53	2.3	1001.23
W-16	2	10	14.77	998.63	988.63	1003.23	1.98	1001.25
W-17	2	10	14.99	998.20	988.20	1003.61	2.46	1001.15
W-18	2	10	14.4	997.38	987.38	1002.14	1.70	1000.44

Notes:

[A] Well as-built dimensions from SECOR (2004).

[B] Total depth of well measured after redevelopment October 22 to 24, 2007.

[C] Top of casing surveyed October 23, 2007.

amsl = above mean sea level.
bgs = below ground surface.
ft = feet.

Table 4
Summary of Chemical Detections - October 2007
Former FMC Pesticide Formulation Facility
Yakima, Washington

Compound	**W-7**	**W-9B**	**W-12A**	**W-12B**	**W-13**	**W-14**	**W-14D**	**W-16**	**W-17**	**W-18**
2,4-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-TDE/DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-TDE/DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
a-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Alachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
b-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benefin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Captan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbonphenothion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
d-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dicofol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	0.14	0.06	0.0.57	0.11	0.11	ND	0.084	0.056
Endosulfan I	ND	ND	1.3	0.69	0.11	0.13	0.14	0.37	0.60	0.39
Endosulfan II	ND	ND	0.87	0.38	0.13	0.20	0.20	0.17	0.41	0.28
Endosulfan sulfate	ND	ND	2.1	0.60	0.19	0.35	0.34	0.11	0.96	0.69
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin aldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Folpet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
g-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrofen	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCNB	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perthane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tedion	ND	ND	0.66	0.35	0.16	0.25	0.27	ND	0.34	0.20
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

All values are show in micrograms per liter (µg/L).
ND = Not detected above the laboratory Practical Quantitation Limit (PQL).
PQL for perthane and toxaphene = 1.0 µg/L; PQL for all other compounds = 0.05 µg/L.
Analytical work performed by Agricultural & Priority Pollutants Laboratories, Inc., Fresno, California.

Abbreviations:

DDD = 1,1-dichloro-2,2-bis(p-chlorophenol)ethane
DDE = 1,1-dichloro-2,2-bis(p-chlorophenol)ethylene
DDT = 1,1,1-trichloro-2,2-bis(p-chlorophenol)ethane
BHC = benzene hexachloride
PCNB = pentachloronitrobenzene

Table 5
Applicable or Relevant and Appropriate Requirements
Former FMC Pesticide Formulation Facility
Yakima, Washington

		Regulatory Citation		
Topic	**Standard or Requirement**	**Federal**	**State**	**Comment**
Discharges to surface waters including wetlands	Effluent limits and related requirements for point source discharges to regulated surface waters; prohibitions against fills to wetlands where there are practicable alternatives	NPDES permit program under Section 402 of the Clean Water Act, 33 USC §1342; 40 CFR Parts 122 and 125; Dredged and Fill Material permit program under Section 404 of the Clean Water Act, 33 U.S.C. §1344; 40 CFR Part 231; 33 CFR Parts 320 and 323	Discharge Permit Program, RCW 90.48; WAC 173-216; WAC 173-220; WAC 173-226	Discharges to surface waters including wetlands that are a component of CERCLA response actions are exempt under CERCLA §121(e) from the procedural requirement to obtain an NPDES, Section 404 or state permit, but are subject to substantive permit requirements such as effluent limits.
Surface water quality	Surface water quality standards	Ambient Water Quality Criteria under Section 304(a) of the Clean Water Act, 33 USC §1314(a); 40 CFR Part 131	Surface Water Quality Standards, RCW 90.48; WAC 173-201A	Discharges to surface waters must meet state water quality standards that have been approved by EPA, and any more stringent federal water quality criteria that are relevant and appropriate.
Discharges to publicly-owned treatment works (POTWs)	Discharges to POTWs must meet pretreatment standards	Section 402 of the Clean Water Act, 33 U.S.C. §1342; 40 CFR Part 403	City of Yakima Municipal Code 7.65	Discharges of water from CERCLA response actions to POTWs must meet POTW-specific pretreatment standards. Because only Federal and State standards constitute ARARs under CERCLA Section 121, 42 U.S.C. §9621, City of Yakima requirements constitute "to be considered" standards (TBCs).
Groundwater quality	Releases to groundwater may be subject to federal drinking water standards and state groundwater quality standards	Maximum Contaminant Limits (MCLs) and Maximum Contaminant Level Goals (MCLGs) under the Safe Drinking Water Act, 42 USC §300ff et seq.; 40 CFR Part 141	RCW 43.20A.165; RCW 90.48; WAC 173-200	MCLs are applicable to groundwater that is an actual or designated source of potable water. MCLs and non-zero MCLGs may be relevant and appropriate depending on the circumstances of the release. State groundwater standards are applicable to state groundwater at site-specific enforcement limits set in accordance with WAC 173-200-050.
Releases to air	Air emissions are subject to EPA-approved State Implementation Plans, including prevention of significant deterioration (PSD) requirements; and major and area sources that release hazardous air pollutants (HAPs) must meet specified emission limits	Clean Air Act Sections 110, 112, and Sections 160-169, 42 USC §§7410, 7412 and §§7470-7479; 40 CFR Parts 52 and 61	RCW 70.94; WAC 173-400	Air emissions resulting from CERCLA response actions must meet applicable emission requirements.
Hazardous substance releases	Releases of hazardous substances are subject to Washington Model Toxics Control Act (MTCA)		RCW 70.105D; MTCA Cleanup Regulation, WAC 173-340	MTCA cleanup standards, consisting of cleanup levels at designated points of compliance, are applicable to CERCLA response actions conducted in the State of Washington
Hazardous and dangerous waste management	Management requirements for materials classified as hazardous or dangerous wastes.	Resource Conservation and Recovery Act (RCRA), 42 USC §9601 et seq.; 40 CFR Parts 260-270	Hazardous Waste Management Act, RCW 70.105; Dangerous Waste Regulations, WAC 173-303	Wastes generated from CERCLA response actions must be characterized to determine if they constitute hazardous or dangerous wastes, and if so they must be stored, transported, treated, disposed of and otherwise managed in accordance with applicable federal and state requirements. This includes meeting the RCRA Land Disposal Restrictions (LDRs) specified at 40 CFR Part 268 for any land placement of wastes that are hazardous at their point of generation.
Solid waste management	Management requirements for non-hazardous and non-dangerous solid waste.	Resource Conservation and Recovery Act (RCRA), 42 USC §9601 et seq.; 40 CFR Parts 257-258	Solid Waste Management Program, RCW 70.95 and WAC 173-350	Non-hazardous and non-dangerous waste generated from CERCLA response actions must be managed in accordance with applicable federal and state solid waste standards.

		Regulatory Citation		
Topic	**Standard or Requirement**	**Federal**	**State**	**Comment**
PCB wastes	PCB wastes must be managed in accordance with federal and state requirements	Toxic Substances Control Act, 15 USC §2601 et seq.; 40 CFR Part 761	Hazardous Waste Management Act, RCW 70.105; Dangerous Waste Regulations, WAC 173-303	Any PCB wastes generated from CERCLA response actions must be managed and disposed of in accordance with federal and state standards.
Protection of migratory birds	Prohibits unauthorized killing and other "takings" of migratory birds	Migratory Bird Treaty Act, 16 USC §§703-712		CERCLA response actions must be conducted to prevent takings of migratory birds

Acronyms:

NPDES - National Pollutant Discharge Elimination System.
CFR - Code of Rederal Regulations.
U.S.C. - United States Code.
RCW - Revised Code of Washington.
WAC - Washington Administrative Code.
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act.
EPA - Environmental Protection Agency.
POTWS - Publicly-Owned Treatment Works.
ARAR - Applicable or Relevant and Appropriate Requirements.
MCL - Maximum Contaminant Level.
MCLG - Maximum Contaminant Level Goals.
PSD - Prevention of Significant Deterioration.
HAP - Hazardous Air Pollutant.
RCRA - Resource Conservation and Recovery Act.
PCB - Polychlorinated biphenyl.

Table 6
Proposed Soil Excavation Volumes
Former FMC Pesticide Formulation Facility
Yakima, Washington

Area	**Area (ft2)**	**Total Excavation (CY)**	**Average Depth of Previous Excavation (ft)**	**Excavation Requiring Disposal (CY)**	**Disposal Amount (tons)***	**Assumptions**
Area 3	6,700	1,985	3.5	1,117	1,675	Average previous excavation depth is 3.5 ft. Only sample depths provided are 1 ft bgs, but text says maximum depth of excavation was 7 ft bgs
Area 4	4,012	1,189	3.5 - 7	358	536	
Area 5	1,782	528	4.5/7	291	437	
Area 6	2,287	678	7.0	85	127	
Area 9	178	53	1.0	46	69	
Area 13C	1,810	536	1.5	436	654	
Area 20	2,220	658	1.5	534	802	
Area 21 (Disposal Pit)	1,065	316	7.0	39	59	
Total	**20,054**	**5,942**		**2,906**	**4,359**	

Notes:

* - Assumes 1 CY =	1.5 tons
Total Excavation Depth =	8 ft

Assumes backfill from previous excavations is clean and will be used as backfill onsite again.

ft = feet.

ft2 = square feet.

CY = cubic yards.

Table 7
Estimated Costs for Remedial Options
Former FMC Pesticide Formulation Facility
Yakima, Washington

Alternative		**Direct and Indirect Capital Costs***	**Total O&M Costs (Undiscounted)**	**NPW of Total O&M Costs**	**Estimated Total Cost**
2	Institutional Controls	$26,800	$198,086	$74,479	$117,000
3	Soil Excavation and Off-Site Landfilling and Institutional Controls	$3,716,725	$208,378	$78,180	$4,365,000
4	Groundwater Extraction and Treatment and Institutional Controls	$803,200	$3,051,218	$1,254,078	$2,366,000

Notes:

Cost estimates developed using USEPA guidance, assuming a 7 percent discount rate over a performance period of 30 years.

O&M - Operation and Maintenance
NPW - Net Present Worth
* - Capital costs for all 3 alternatives do not include potential cost for getting neighboring land owners consent to apply institutional controls to their properties.

Appendix A
USEPA Record of Decision, 14 September 1990

RECORD OF DECISION

DECLARATION, DECISION SUMMARY, AND RESPONSIVENESS SUMMARY

FOR

REMEDIAL ACTION
AT
FMC CORPORATION
YAKIMA, WASHINGTON

SEPTEMBER 1990

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 SIXTH AVENUE
SEATTLE, WASHINGTON

DECLARATION

for the FMC
Superfund Site

SITE NAME AND LOCATION

FMC Pesticide Formulation Facility
Yakima, Washington

STATEMENT OF PURPOSE

This decision document presents the remedial action selected by the U.S. Environmental Protection Agency (EPA) for the Farm Machinery Corporation (FMC) Superfund Site in Yakima, Washington. The selected action was developed in accordance with The Comprehensive Environmental Response Compensation and Liability Act (CERCLA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for this site. The State of Washington concurs with this selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances at and from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy addresses the contaminated soils and structures at the FMC site. At present, the only significant health risks posed by the site are associated with these contaminated materials. Concentrations of contaminants in groundwater are currently below health-based levels, and do not require treatment. Continued groundwater monitoring will be performed as part of this response action, to confirm the effectiveness of source removal in protecting groundwater. If groundwater remediation proves to be necessary, it will be conducted as part of a second operable unit of site remediation.

The selected remedy consists of:

- Sampling of soils and concrete structures to refine the current estimate of the lateral and vertical extent of material requiring treatment
- Excavation of contaminated soils
- On-site incineration of contaminated soils
- Dismantling contaminated slabs and portions of the buildings that are determined to exceed cleanup goals. Where the removal of a portion of a building affects the safety or structural integrity of that building appropriate repairs will be made.
- On-site incineration of contaminated concrete and debris or disposal at a RCRA-Subtitle C permitted hazardous waste disposal facility, depending on volume.
- Following incineration, the ash will be analyzed to determine degree of contaminant destruction and leachability. If health-based cleanup goals are met the ash will be considered to be delisted and used for backfill on site.
- Continued groundwater monitoring for 5 years to confirm source removal.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because this remedy will not leave hazardous substances remaining on-site above health-based levels, the five-year review will not be required for this action. However, groundwater monitoring will continue in order to confirm that removal of contaminated soils has been complete and that no groundwater contamination above health-based levels is present.

Thomas P. Dunne

Name
Regional Administrator
U.S. EPA Region 10

September 14, 1990

Date

TABLE OF CONTENTS

DECISION SUMMARY

I. SITE DESCRIPTION

Name and Location

The FMC pesticide formulation facility site is located at 4 West Washington Avenue, in Yakima, Washington (see Figure 1). The site consists of a 58,000-square-foot fenced area on the northeastern portion of a 10-acre property owned by Upland Industries. The site is located in the lower Ahtanum Valley, an area of about 100 square miles in central Yakima County, Washington. Remaining structures include an office building, a warehouse, several small sheds, and the foundations of a liquid formulation building and a second warehouse. With the exception of the office building, all of these structures are within the fenced area (see Figure 2).

Topography and Vegetation

The FMC Yakima site slopes to the southeast, with a grade of less than one percent. The Yakima River lies approximately 1.5 miles from the site. The property is outside the 500-year flood plain of Wide Hollow Creek. There are no wetlands on the site. Vegetation within the fenced site area is limited to kochia, growing in the pavement cracks, and stands of kochia and thistle in the unpaved areas near the fenceline. Vegetation on the remainder of the Upland Property is dominated by dense stands of weedy forbs and grasses consisting mainly of kochia, hoary cress, prickly lettuce, wavy-leaf thistle, and brome grasses.

Adjacent Land Uses

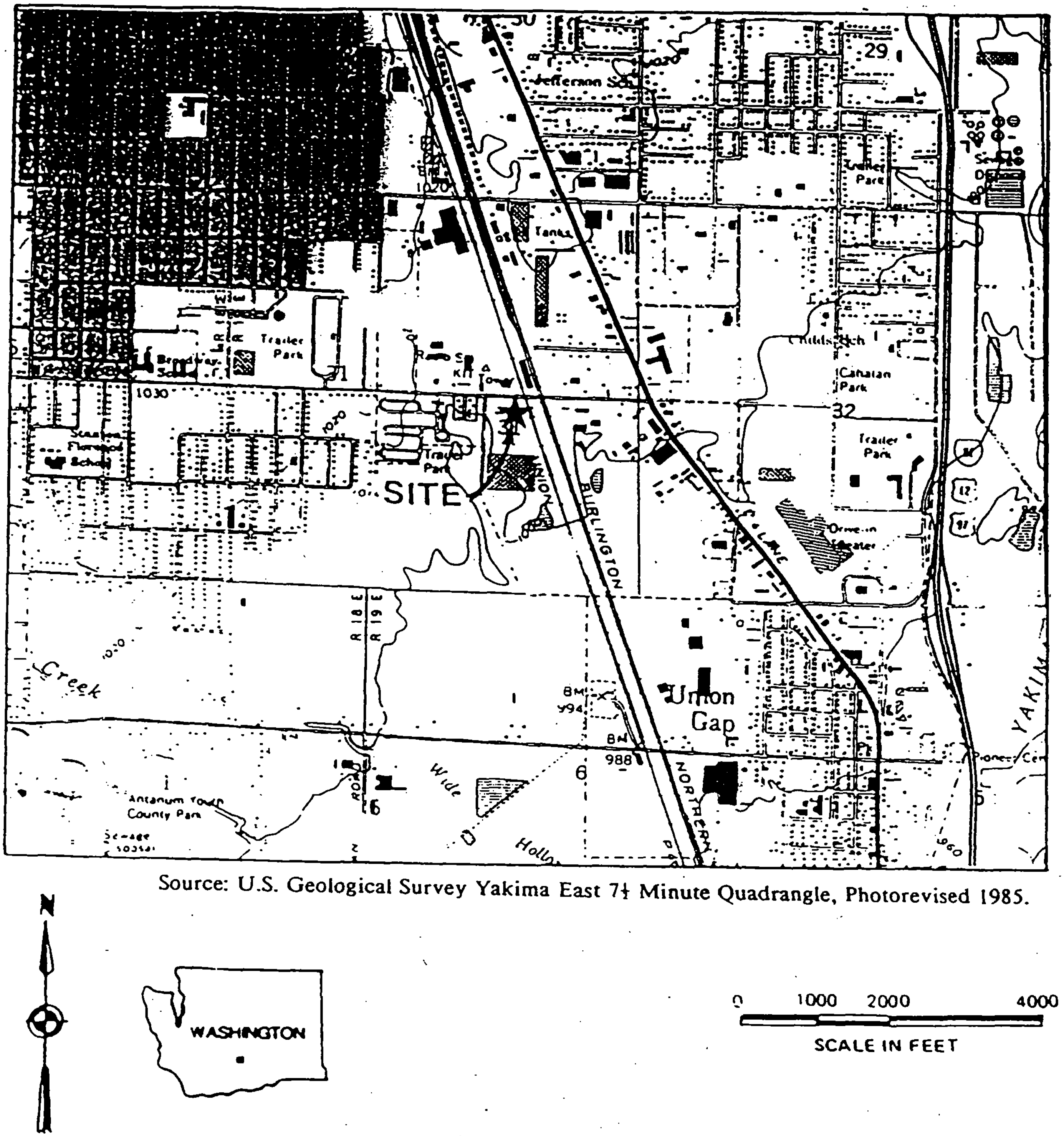
Most of the land surrounding the site is zoned for light industrial use. There is one two-acre parcel bordering the western side of the Upland property that is zoned two-family residential. Four schools are located within one mile of the site. The closest two of these are 4500 feet from the site. Five more schools are located one to two miles from the site. The population of Yakima was 49,826 in 1980. The FMC site is located in the South Broadway neighborhood area, which had a population of 6,482 persons in 1980.

Surface Water and Groundwater Resources

There are no surface water bodies or wetlands on the site. Groundwater from the unconfined Alluvium aquifer supplies much of the domestic and irrigation water in the lower Ahtanum Valley. Unconsolidated Alluvium to a depth of about 37 feet has been encountered during exploratory and monitoring well drilling at the site. The underlying cemented basalt gravel hydrological unit has not been penetrated at the site. Regional studies indicate, however, that permeable sand lenses are contained as confined aquifers within the low permeability cemented basalt gravel. The cemented basalt gravel acts as an aquitard beneath the overlying Alluvium. There is generally an upward movement of groundwater into the unconfined Alluvium aquifer from underlying confined aquifers.

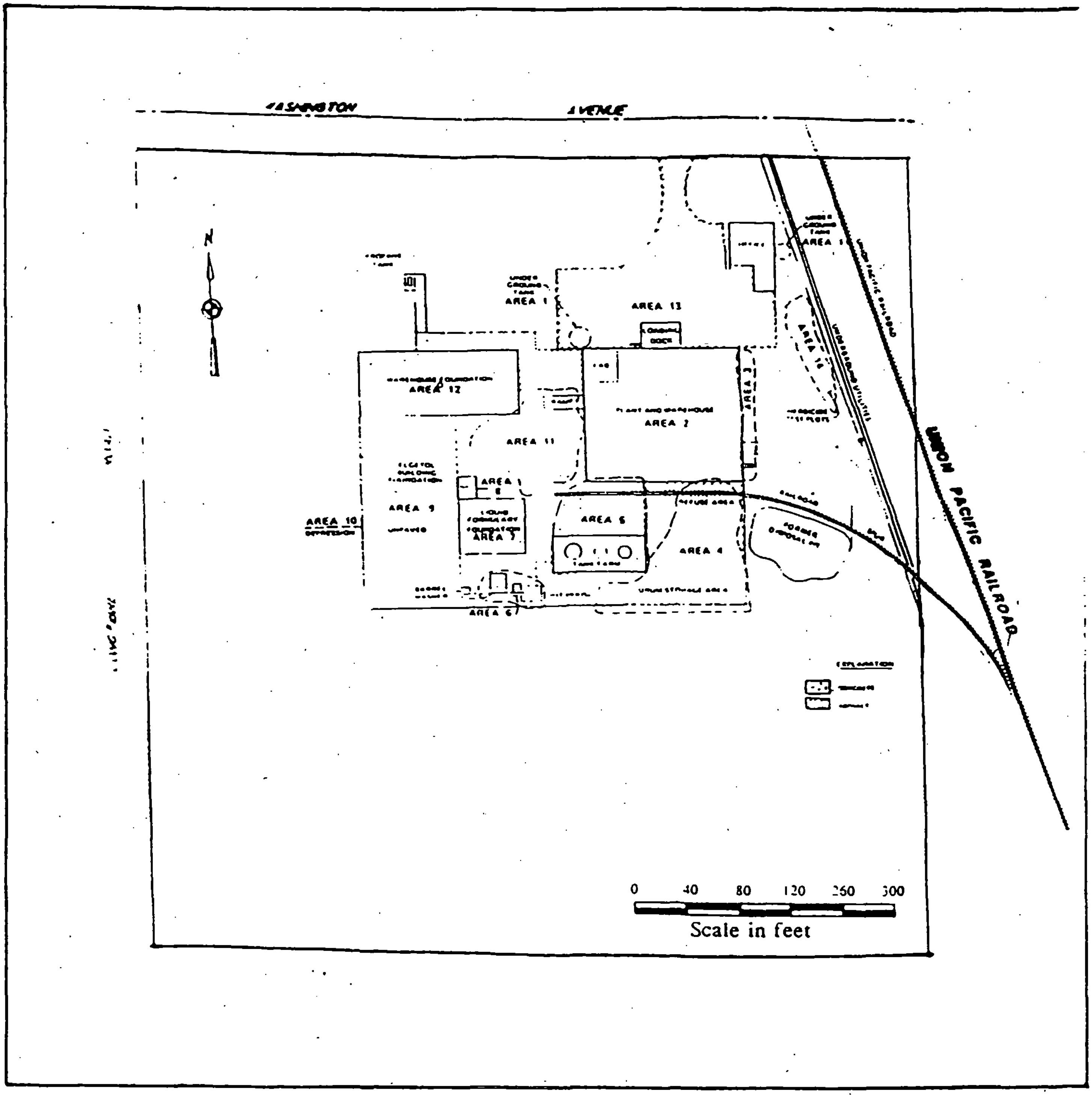
The water table is generally less than 10 feet below the ground surface. Yields of 100 to 400 gallons per minute can be obtained from wells 30 feet deep. Irrigation makes up 75% of groundwater use in the area, with the remainder supplied for industrial, domestic, and public needs. The water quality is usually considered satisfactory for most purposes, although the water from many wells contains more minerals than is desirable for domestic use.

FIGURE 1
REGIONAL MAP SHOWING THE LOCATION OF THE FMC SITE IN YAKIMA, WA.



Source: U.S. Geological Survey Yakima East 7½ Minute Quadrangle, Photorevised 1985.

FIGURE 2
MAP OF THE FMC PESTICIDE FORMULATION FACILITY, YAKIMA, WASHINGTON



II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

History of Site Activities

FMC leased the plant property from Union Pacific Land Resources Corporation (Upland), and operated the plant from 1951 to 1986 to manufacture pesticide dusts and liquids. Pesticide dusts were formulated at the facility throughout its operation. The plant began formulating liquid products in the 1970s, when the liquid formulary and the Elgetol building were added. Formulation ingredients included active ingredients, solvents, emulsifiers and stabilizers, and inert ingredients. Production took place in the dust mill, which was housed in the southeastern end of the main plant and warehouse building, the liquid formulary, and the Elgetol building. The latter two buildings were destroyed during an explosion that occurred after the plant closed, in 1986. Other operations included a drum washing area located at the southwestern end of the property, a "hot house", used to heat products to aid in formulation, located immediately to the east of the barrel washing area, and a herbicide test plot. Spills, leaks, and other accidental releases of liquid formulation materials are believed to be the source of soil and concrete contamination in and adjacent to these areas.

Between 1952 and 1969, FMC disposed of wastes containing pesticides in an on-site pit. The location of the pit was determined using historical aerial photographs, and confirmed during the Phase I Remedial Investigation (RI) conducted by Bechtel Environmental, Inc. (Bechtel), in 1987. An estimated 2000 lbs. of materials were discarded in the pit. Raw material containers, soil contaminated by leaks or spills from process equipment, broken bags, and off-specification materials were dumped into the excavated pit and covered with dirt. After 1969, waste materials were disposed of at Yakima Valley Disposal and Chem Securities in Arlington, Oregon. In 1982, the FMC site was placed on the National Priorities List (NPL), based on high levels of pesticides in the waste pit. In 1986, after operations at the facility had ceased, FMC conducted a preliminary cleanup of the facility that included removal of all contents of the main facility warehouse and surface tanks, and washing the warehouse floors and walls.

History of Federal and State Site Investigations and Removal and Remedial Actions Conducted Under CERCLA or Other Authorities

In 1982, an EPA contractor, Ecology and Environment, Inc., conducted a preliminary investigation of the site for the EPA. Findings were presented in a report dated July 8, 1982 (Preliminary Field Investigation Report, Upland Industries Site). On June 10, 1983, the State of Washington issued Administrative Order No. DE 83-283 requiring FMC to implement a testing plan, initiated by FMC and approved by the Washington Department of Ecology (Ecology), to determine whether the former disposal pit was contaminating area groundwater and the Yakima River.

On July 31, 1987, EPA issued an Administrative Order On Consent requiring and authorizing FMC to conduct the Remedial Investigation/Feasibility Study (RI/FS) for the site. In November 1987, RI Phase I sampling conducted by FMC's consultant, Bechtel Environmental, Inc., confirmed "hot spots" of DDT and other pesticide contamination in the former disposal pit at levels of up to 25,000 mg/kg. Consequently, an Order On Consent For Necessary Response Actions was issued by EPA on May 31, 1988. Pursuant to this order, FMC performed a removal and properly disposed of the pit's contaminants.

The Phase I removal of the contents of the former disposal pit was performed in June 1988. The pit was excavated to a depth of 4 feet (the depth of the groundwater table at the time), and 500 tons of contaminated soil was removed. Pit samples were analyzed for organochlorine pesticides, and soil above the groundwater table contaminated in excess of 1 mg/kg was removed. In March 1989, an additional 350 tons of soils were removed, which increased the depth of the excavation to approximately 8 feet, the depth to which the groundwater had dropped due to seasonal fluctuation. During this second removal, factors limiting excavation included the presence of a railroad spur, as well as the groundwater table. Several "hot spots" of contamination could not be further excavated without impacting the integrity of the spur or excavating into the groundwater.

Because it was decided to promptly address the contamination in the former disposal pit, the RI/FS was conducted in phases. Phase I principally concerned the disposal pit. Phase II, completed in April 1990, incorporates the Phase I data and results, and addresses the entire site.

FMC has never contested its status as a responsible party, and has worked cooperatively with EPA to undertake the initial removal actions and subsequent RI/FS activities.

EPA proposes that a Consent Decree, under which FMC will conduct the Remedial Action for the site, be negotiated and signed by EPA, the Department of Justice, FMC, and the State of Washington, if the latter so desires. After this Record of Decision (ROD) is issued, EPA plans to issue a Special Notice Letter and begin formal negotiations.

III. COMMUNITY RELATIONS HISTORY

CERCLA requirements for public participation include releasing the Remedial Investigation and Feasibility Study Reports and the proposed plan to the public and providing a public comment period on the feasibility study and proposed plan. EPA met these requirements in June 1990 by placing both documents in the public information repositories for the site and mailing copies of the proposed plan to individuals on the mailing list. EPA published a notice of the release of the RI/FS and proposed plan in the Yakima Herald Republic on June 25, 1990. Notice of the 30-day public comment period and the public meeting discussing the proposed plan were included in the newspaper notices. The public meeting was held on July 11, 1990, at the Cascade Natural Gas Meeting Rooms. The public comment period ended on July 25, 1990, with no comments from the public.

To date, the following community relations activities have been conducted by EPA at the FMC site:

July 1987	Community Relations Plan was published, which included interviews from members of the community and local officials.
July 1987	Information repository established at the Yakima Regional Library.
August 5, 1987	EPA distributed a fact sheet announcing the startup of the Remedial Investigation.
June 3, 1988	EPA released a fact sheet announcing a removal action of contaminated soil from the disposal pit.
May 5, 1989	Fact sheet was released, announcing the second phase of the RI and the FS.
February 9, 1990	EPA distributed a fact sheet, which explained the submittal of the RI/FS draft.
June 20, 1990	EPA mailed the proposed plan fact sheet, which explained the results of the RI/FS and EPA's preferred plan, to persons on the mailing list for public comment. The fact sheet announced a public meeting for July 11, 1990, and gave the dates of the public comment period.
June 21, 1990	EPA sent a News Release announcing a news briefing for all members of the Yakima news media.

June 25, 1990	A public notice in the Yakima Herald Republic described the availability of the proposed plan and the RI/FS, and announced the dates of the public meeting and public comment period.
June 25 - July 25, 1990	Public comment period for proposed plan and RI/FS.
June 28, 1990	EPA conducted a news briefing for members of the press announcing the proposed plan.
July 5-11, 1990	The local community calendar on television announced the date of the public meeting.
July 11, 1990	EPA conducted a public meeting for interested community members.
August 1990	Responsiveness Summary prepared.

IV. SCOPE AND ROLE OF THE RESPONSE ACTION WITHIN THE SITE STRATEGY

The Phase I RI (Bechtel, 1988) indicated that soils in the former disposal pit had very high concentrations of pesticides (up to 25,000 mg/kg of DDT). EPA therefore determined that the contaminated materials should be quickly removed from the pit area as a major step toward remediation of the site. Two pit excavations followed, and a significant amount of the contamination was removed. The selected response action of this ROD addresses the contamination that remains in the formulation areas and some contaminated soils in the former disposal pit.

The principal threat at the FMC site is the potential for exposure to pesticides and metals resulting from contact with contaminated soils. The site is located close to a large population center, with several schools within one mile. This response action is designed to remove the principal threat to public health by significantly reducing the volume of the contaminated soil.

In addition, this response action will reduce the potential for the contaminated soil to act as a source for groundwater contamination. The current low levels of site related groundwater contamination do not pose a significant public health threat, and when the source removal has been completed, these levels are expected to decrease gradually over time. Currently there are no on-site residents and on-site groundwater is not used for drinking water. Residents in the vicinity of the site get drinking water from a protected public water supply. Therefore, no current ingestion of groundwater containing site contaminants is known to occur. Groundwater sampling began during November 1987 and has been conducted quarterly since. Groundwater monitoring will be continued to confirm that contaminant levels are decreasing. Additional wells have recently been installed to further define the extent of groundwater contamination, and to confirm that contamination does not exceed health-based levels. If the quality of the groundwater exceeds these levels during monitoring, appropriate measures would be taken under a separate response action.

Portions of buildings and other concrete structures have also been found to contain high levels of pesticide contamination. Contaminated portions of structures will be dismantled and incinerated or removed from the site during this response action. Arrangements will be made for their disposal at a RCRA Subtitle C permitted hazardous waste landfill if incineration is not practicable. The health risks associated with contaminated concrete are difficult to quantify. However, removal of contaminated concrete will lessen the need to restrict future site use.

V. SUMMARY OF SITE CHARACTERISTICS

Contaminant Characteristics

Operations connected with the production of pesticides by the FMC Corporation are the only known sources of contamination at the site. Table 1 provides a summary of groundwater sampling data showing the pattern in contaminant concentrations and detection frequency before and after excavation of the disposal pit. Table 2 summarizes the contaminants detected in soils and concrete at the FMC site. The contaminants of concern for human health at the site are DDD (1,1-dichloro-2,2-bis(p-chlorophenyl) ethane), DDE (1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene), DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl) ethane), dieldrin, endosulfans, malathion, ethion, ethyl parathion, parathion, DNOC (4,6-dinitro-o-cresol), cadmium, and chromium VI. All of these compounds are considered toxic. Cadmium, chromium VI, DDD, DDE, DDT, and dieldrin are also carcinogenic by some exposure routes. The contaminants of concern for potential environmental effects are DDD, DDE, DDT, endosulfans, ethion, malathion, and zinc. Pesticides found on-site are discarded commercial chemical products, off-specification commercial chemical products and spill residues thereof. Many of the compounds handled by the facility, and still found there, are listed in CFR 40 part 261.33 (e) and (f) are thus are RCRA listed hazardous wastes.

During the remedial investigation, samples were analyzed for total chromium. No differentiation was made between the valence forms (chromium III and chromium VI). Because chromium VI is far more toxic than chromium III, sampling and analysis to define the distribution of the two valence forms will be conducted during the first stages of the remedial action. If large volumes of soil are found to be contaminated with chromium VI at levels requiring remediation, modifications in the remedial process may be necessary.

An estimated 900 cubic yards of contaminated soils will be remediated under this response action. This includes approximately 400 cubic yards of surface soils (soils less than 2 feet below ground surface), 400 to 480 cubic yards of subsurface soils, and 100 cubic yards of contaminated soils remaining in the former disposal pit.

Affected Matrices, Characteristics, and Migration Pathways

Contaminants are present in the concrete floors and walls of formulation buildings and warehouses, in some concrete slabs, and in surface and subsurface soils in portions of the site associated with pesticide production. There is some contamination remaining in the disposal pit, and contaminants are also present at low levels in the groundwater beneath the site.

Soils

The site soils consist of a 5 to 8 foot thick layer of Naches loam which is a highly permeable, well-drained soil. Beneath the soil is an unconsolidated alluvium layer consisting of predominantly sand and gravel, estimated to be 37 feet thick.

The majority of the contamination remaining at the site is located in the surface and subsurface soils. An estimated 900 cubic yards of surface soils and subsurface soils must be remediated. This includes the stained soils directly below a stained area on the eastern exterior wall of the warehouse; soils along the south fence of the refuse and drum storage area; soils underlying a concrete pad on which formulation liquids were stored; soils from the gravel-covered areas surrounding the concrete pad at the Barrel Wash Area; soils surrounding the concrete pads in both the Liquid Formulary Area and the Elgetol Area; soils in the unpaved area west of the Elgetol Area; and the remaining contaminated soil in the former disposal pit.

There are two routes of contaminant migration from soils at the site: through the groundwater and the air. Infiltration of precipitation, and fluctuating groundwater levels, may

TABLE 1

SUMMARY OF CONTAMINANTS FOUND IN THE GROUNDWATER OF THE FMC-YAKIMA SITE

	Historical Data Nov. 87 - Dec. 89		Current Data June 89 - July 90	
	Concentration Range (µg/L)	Frequency of Detection	Concentration Range (µg/l)	Frequency of Detection
ORGANOCHLORINE				
Aldrin	0.01	1/61		0/60
a-BHC	0.01-0.09	7/61	0.01-0.06	3/57
b-BHC	0.02-0.07	3/61	0.02-0.07	2/55
d-BHC	0.01-0.23	8/58	0.01-0.23	7/57
g-BHC	0.01-0.07	7/61		0/43
Chlordane				0/57
4,4'-DDD	0-0.12	15/60	0.02-0.15	5/57
4,4'-DDE	0.01-0.16	14/81	0.01-0.06	9/58
4,4'-DDT	0.02-9.9	29/61	0.02-0.11	14/55
Dicofol	0.13-0.14	2/61		0/41
Dieldrin	0.01-0.09	8/61	0.01-0.09	7/58
Endosulfan I	0.01-1.1	38/61	0.01-0.6	36/59
Endosulfan II	0.01-0.55	39/61	0.01-0.6	28/51
Endosulfan Sulfate	0.02-0.56	34/61	0.05-0.56J	24/54
Endrin	0.02	1/61	0.01	1/46
Heptachlor	0.01	1/61		0/53
Heptachlor Epoxide	0.05	1/61		0/53
Ovex	0.02-0.48	11/61	0.02-0.06	6/49
Toxaphene	0.4	2/61		0/53
ORGANOPHOSPHATE				
Ethion	1.1	1/61		0/52
Ethyl Parathion				0/52
Methyl Parathion				0/52
Malathion	0.5-1	2/61		0/52
Diazinon				0/50
CARBAMATE AND UREA				
Carbaryl				0/52
Diuron				0/52
TOTAL PHENOLS	0.005-60	12/46		0/10
PHENOLS				
2,4-Dimethyl Phenol				0/24
2 Chlorophenol	1	2/46	1.0	2/29

TABLE 1 (Cont.)

SUMMARY OF CONTAMINANTS FOUND IN THE GROUNDWATER OF THE FMC-YAKIMA SITE

	Historical Data Nov. 87 - Dec. 89		Current Data June 89 - July 90	
	Concentration Range (μg/L)	Frequency of Detection	Concentration Range (μg/l)	Frequency of Detection
VOLATILE ORGANICS				
Methylene Chloride	1BJ-820B	13/53	1J	1/41
Acetone	1BJ-16000	35/53	1BJ-23	19/41
Carbon Disulfide	2.0-25.0	6/53	2J-72	9/41
1,1-Dichloroethane	5	1/53		0/37
Chloroform	1.0-2.0	6/53	1J-2J	7/41
2-Butanone	1BJ-4BJ	6/53	2BJ	1/47
Trichloroethene	1.0-47.0	3/53	1J-47	3/47
4-Methyl-2-Pentanone	2J	1/53		0/37
2-Hexanone	1BJ-2J	3/53		0/37
Tetrachoroethene	2J-5.0	33/53	1J-9	38/41
Toluene	1J-10.0	9/53	1J-6	4/40
2-Propanol	10J-1000J	5/53	NA	NA
Ethylbenzene				0/37
Total Xylenes				0/37
METALS				
Arsenic				0/48
Barium	10B-165B	17/28	10B-410	15/44
Cadmium			5-20	6/50
Calcium	27.0-34600	20/20	30,600-34,600	11/11
Total Chromium	13.0-20.0	2/61	26-34	2/50
Chromium (VI)	11	2/28		0/49
Copper	0.07-75	14/61	18-90	16/39
Lead	3.9-24.8	11/28	3.1-24.8	21/50
Magnesium	8.2-10800	20/20	8620-9930	11/11
Potassium	2.6-4530	20/20	3430B-4530B	11/11
Selenium	5	1/28	5	7/47
Sodium	8.8-14200	20/20	12,800-14,200	11/11
Zinc	13-6500	23/28	13B-6500	37/43

Notes

B Compound found in blank
J Estimated value
NA Not Analyzed

Blanks in Table indicate not detected

TABLE 2
SUMMARY OF CONTAMINANTS FOUND IN THE SOILS AND STRUCTURES OF THE FMC-YAKIMA SITE

	Surface Soil From Formulation Area		Subsurface Soil From Formulation Areas		Subsurface Soil From Pit		Concrete from Formulation Areas	
	Concentration Range (mg/kg)	Frequency of Detection	Concentration Range (mg/kg)	Frequency of Detection	Concentration Range (mg/kg)	Frequency of Detection	Concentration Range (mg/kg)	Frequency of Detection
ORGANOCHLORINE								
Aldrin	0.27-0.14	2/28			0.10-0.6(a)	3/55	0.1-73	3/23
a-BHC	0.1	1/28			0.2(a)	1/55		
b-BHC								
d-BHC					0.01-0.2	5/14		
g-BHC	0.42	1/28			0.4-3.3	2/55		
Chlordane								
DDD	0.13-0.27	2/28	76	1/16	0.02	31/55	0.05-0.4	3/23
DDE	0.01-1.4	20/28	1.5-28	4/16	0.02-0.71	15/55	0.01-22	19/23
DDT	0.02-11	22/28	0.039-210	5/16	0.05-39	45/55	0.02-11	10/23
Dicofol	0.04-14000	6/28			0.1-0.3(a)	7/41	0.1-110000	12/23
Dieldrin	0.14-0.49	3/28	0.19-40	2/16	0.01-4	9/14	0.01-1.1	13/23
Endosulfan I	0.13-7000	13/28	0.07-860	12/16	0.1-5.2	11/55	0.01-26	4/23
Endosulfan II	0.01-4500	14/28	0.088-450	14/16	0.01-0.7	11/55	0.01-22	5/23
Endosulfan Sulfate	0.17	1/28	100	1/15				
Endrin							1	1/23
Heptachlor								
Heptachlor Epoxide								
Ovex	0.02-5.6	6/28			0.05-42	43/55		
Toxaphene			0.67-1.7	3/15				
ORGANOPHOSPHATES								
Ethion	0.05-3100	13/28	0.16-180	16/16	0.05-74	13/14	0.05-9300	10/23
Ethyl Parathion	4.5-3300	3/28	0.11-30	8/16	0.27-15	4/14	0.05-13000	8/23
Methyl Parathion							110	1/23
Malathion	0.05-170000	10/28	0.08-9.5	9/16			0.05-160000	14/23
Ethylene							73	1/23
Diazinon			0.14-4.5	3/15				
CARBAMATES AND UREA								
Carbaryl	0.97-760	3/26			4.2-13	2/14	0.05-1700	8/12
Diuron					0.2	1/14		
TOTAL PHENOLS	0.57-7.6	5/28	1.0-6.5	11/15	2.0-4.0	3/14	0.5-49	7/12
PHENOLS								
2,4-Dimethyl Phenol							130000	1/4
2 methyl-4,6 dinitrophenol	5000	1/28						
2 Chlorophenol								

TABLE 2 (Cont.)
SUMMARY OF CONTAMINANTS FOUND IN THE SOILS AND STRUCTURES OF THE FMC-YAKIMA SITE

	Surface Soil From Formulation Area		Subsurface Soil From Formulation Areas		Subsurface Soil From Pit		Concrete from Formulation Areas	
	Concentration Range (mg/kg)	Frequency of Detection	Concentration Range (mg/kg)	Frequency of Detection	Concentration Range (mg/kg)	Frequency of Detection	Concentration Range (mg/kg)	Frequency of Detection
VOLATILE ORGANICS	NA	NA			NA	NA	NA	NA
Methylene Chloride	NA	NA			NA	NA	NA	NA
Acetone	NA	NA	0.004J-0.17B	10/11	NA	NA	NA	NA
Carbon Disulfide	NA	NA			NA	NA	NA	NA
1,1-Dichloroethane	NA	NA			NA	NA	NA	NA
Chloroform	NA	NA			NA	NA	NA	NA
2-Butanone	NA	NA	0.002J-0.009J	5/11	NA	NA	NA	NA
Trichloroethene	NA	NA	0.001J-0.002J	6/11	NA	NA	NA	NA
4-Methyl-2-Pentanone	NA	NA			NA	NA	NA	NA
2-Hexanone	NA	NA	0.001J-0.003J	2/11	NA	NA	NA	NA
Tetrachoroethene	NA	NA	0.001J	1/11	NA	NA	NA	NA
Toluene	NA	NA	0.002J-0.21	10/11	NA	NA	NA	NA
2-Propanol	NA	NA			NA	NA	NA	NA
Ethylbenzene			0.002J-0.018J	2/11				
Total Xylenes			0.013-1.1	4/11				
SEMI-VOLATILE ORGANICS								
2-Methylnapthalene	NA	NA	0.058J	1/11	NA	NA	NA	NA
METALS								
Arsenic	NA	NA	1.5B-3.2	14/16	NA	NA	NA	NA
Barium	NA	NA	54.5-170	16/16	NA	NA	NA	NA
Cadmium	NA	NA	2.5-6	16/16	NA	NA	NA	NA
Calcium			NA	NA				
Total Chromium	2.7-320	1/28	12.5-30.1	16/16	2.0-20	12/14	15-1620	23/23
Chromium (VI)	NA	NA	NA	NA	NA	NA	NA	NA
Copper	12-126	1/28	15-88.3	16/16	6.9-90	14/14	14-312	23/23
Lead	NA	NA	3.2-32.9	16/16	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	NA			NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	59.4-1020	16/16	NA	NA	NA	NA

Notes

Blanks in table indicate not detected
NA Not Analyzed
J Estimated value
(a) Includes surface soil sample taken from Area 3
(b) Chemical detected in field analysis of pit samples only

carry contaminants into the groundwater. Wind dispersion of contaminated soil particles is considered to be the primary route of migration through the air. Since the pesticides and metals detected at the site have relatively low vapor pressures, volatilization is not expected to be a significant pathway.

Concrete Structures

Portions of the formulation buildings and warehouses, as well as some concrete slabs, are contaminated. Limited information is available on the actual distribution of contamination on the surfaces of the concrete structures, since only limited sampling and analysis was conducted. Areas of contamination include: the southeast corner of the plant and warehouse building; the concrete tank farm pad in area 5; a concrete slab and barrel washing sump in Area 6; a slab in Area 7; and the foundation of the Elgetol Area (see Figure 2). An estimated total of 1460 square feet of contaminated surfaces are expected to require remediation in these areas.

Since the contamination present in these structures is bound to the concrete, and the contaminants of concern are non-volatile, the contaminants are not mobile if the structures remain undisturbed. The potential risk associated with these structures in their present state is through dermal contact with the contaminated surfaces. In the site's present state, these risks are considered to be very low. However, if these structures are gritblasted or demolished, controls will be required to prevent contaminated dust from becoming airborne.

Groundwater

Groundwater contamination has been found at very low concentrations. Organochlorine pesticides are the most frequently detected contaminants in groundwater. With the exception of malathion, detected once (1.0 μg/l) in June 1988, organophosphorus pesticides have not been detected in groundwater since the first sampling round in November 1987. Several volatile organics have been detected in ground water in both the on-site and off-site wells. It is believed that the presence of methylene chloride, acetone, 2-butanone and 2-hexanone are primarily due to laboratory contamination because they were also found in laboratory blanks. Tetrachloroethene has been detected in a high percentage of the samples at a range of 2.0 to 9.0 μg/L. Because tetrachloroethene has been found in all the wells, including the off-site upgradient well, it is believed that the presence of this chemical is not related to the FMC site. Regional studies are currently underway to evaluate potential sources of this contamination. There is no current groundwater use on site, nearby businesses and homes have access to a public water supply system.

Most of the original monitoring wells are located in the vicinity of the former disposal pit. Additional wells have recently been installed to further define the extent of contamination and estimate hydraulic characteristics of the aquifer. The hydraulic gradient in the surficial aquifer at the site has been estimated at 0.002 to 0.003; the results of the aquifer pump test conducted on-site were used to estimate a hydraulic conductivity in the saturated thickness of 5,000 gpd/sq.ft. Continued monitoring and evaluation of data will be conducted.

Surface Water

There are no surface water bodies on the FMC site. The site is segregated from storm runoff by bermed railroad tracks to the east, and by road curbs to the north. The unpaved portions of the site are covered with highly permeable soil, and the site has a slope of less than one percent. Because of these conditions, the potential for migration of contaminants by precipitation runoff is minimal.

Regulatory Requirements for Addressing Site Risks

EPA's National Oil and Hazardous Substance Contingency Plan (NCP), found in 40 CFR Part 300, requires that the site's remediation goals are protective of human health and the environment. Initially, contaminant concentrations are compared to existing criteria such as Safe Drinking Water Act maximum contaminant level goals (MCLGs) and maximum contaminant levels (MCLs), and Clean Water Act water quality criteria (WQC). However, there are no corresponding criteria for soils and structures. Remediation goals for soils and structures is usually established by setting contaminant concentrations for cancer-causing chemicals at levels that represent cancer risks between one-in-ten-thousand (10^{-4}) and one-in-one-million (10^{-6}). For toxic compounds not identified as carcinogens, the contaminant concentration shall be protective of sensitive human subpopulations over a lifetime. Noncarcinogenic effects are expressed in terms of a "hazard index," and the remediation goals are set to result in a hazard index of less than 1.0.

VI. SUMMARY OF SITE RISKS

The risks to human health and the environment at the FMC Yakima Superfund Site are described in the site-specific risk assessment, which was prepared by Bechtel Environmental, Inc. for the FMC Corporation using current EPA guidance. Overall, the risk assessment indicates that pesticides in the soil of the FMC Yakima site pose the most significant threat to human health and the environment.

This chapter first describes the human health and environmental risk assessments done by Bechtel. The last part of this chapter describes additional studies done by EPA to address some of the uncertainties identified in the risk assessment, and to calculate health-based soil clean-up goals.

Contaminant Identification, Human Health

During the Remedial Investigation the groundwater, soils, and structures of the FMC Yakima site were analyzed for many potential contaminants, including volatile organics, metals, organochlorine pesticides, organophosphorus pesticides, carbamates, urea, and phenols. Results of these analyses were used to select contaminants of concern that were used to quantify potential risks to human health and the environment. Human health contaminants of concern include the DDT series (DDD, DDE, and DDT), total endosulfans (endosulfan I, endosulfan II, and endosulfan sulfate), ethion, malathion, 4,6-dinitro-o-cresol (DNOC), also known as elgetol, cadmium, and chromium III and VI.

The risk assessment identifies contaminants of concern in groundwater, soils, and structures. Average and maximum groundwater and soil concentrations were used.

Modeling was used to estimate concentrations of contaminated respirable particulate matter less than 10 microns in diameter (PM-10), and to estimate deposition of contaminated dusts from the site.

Exposure Assessment, Human Health

The objective of the exposure assessment is to estimate the type and magnitude of exposures from the site. This includes identifying exposure routes (ingestion, inhalation, and direct contact), land use scenarios, potentially exposed populations, estimating exposure point concentrations, and describing assumptions about exposure frequency and duration. The risk assessment calculates exposure point concentrations based on average and maximum contaminant concentrations.

General Exposure Pathways

The general exposure pathways considered for the FMC Yakima site include ingestion of contaminated groundwater, off-site transport of contaminated groundwater, incidental ingestion of contaminated soil, inhalation of contaminated PM-10 dust, off-site transport of contaminated dusts, off-site transport of contaminated sediments, direct contact with contaminated structures and soils, and food chain transfer. Currently no on-site wells are used for drinking water.

Land Use Scenarios

The risk assessment describes the following three land use scenarios for the FMC Yakima Site:

- a current scenario
- a future residential scenario (future exposure scenario I)
- a future industrial scenario (future exposure scenario II)

The current scenario assumes that access to the site is restricted, and that the site is not used for industrial or residential purposes. Most of the land surrounding the site is zoned for light industrial use. There is one two-acre parcel bordering the western side of the Upland property that is zoned two-family residential. This scenario estimates potential exposures to off-site populations and a hypothetical on-site trespasser.

The future residential scenario assumes that the site is converted to residential use, that groundwater beneath the site and down-gradient of the site is used for drinking water, and that all existing structures, such as concrete foundations, are removed. Removal of on-site structures would expose on-site and off-site populations to contaminated soils currently located beneath these structures.

The future industrial scenario assumes that the site is used for industrial purposes, that contaminated structures are left on-site, and that groundwater beneath the site and down-gradient of the site is used for drinking water. Both future scenarios result in exposures to on-site and off-site populations.

Potentially Exposed Populations and Specific Exposure Pathways

Currently there are no on-site potentially exposed populations (receptors) at the FMC Yakima site. However, there is a residential area along the western boundary of the property. Sensitive subpopulations, including schools, hospitals, and a nursing care center, are located approximately one to two miles from the site.

The current scenario evaluates off-site residents and off-site workers as potentially exposed populations, and assumes no exposure to contaminated groundwater. The potentially exposed populations for the future residential scenario include a hypothetical resident living on-site, a hypothetical resident living off-site and down-gradient of the site, and a hypothetical off-site worker. The potentially exposed populations for the future industrial scenario include an on-site industrial worker, an off-site industrial worker, and an off-site resident.

A summary of land use scenarios and specific exposure pathways is shown in Table 3..

Estimation of Exposure Point Concentrations

Exposure point concentrations were estimated by using monitoring and modeling results to calculate intakes in mg/kg-day. Intakes are directly related to the contaminant concentration, the contact rate, and exposure duration and frequency. Intakes are inversely related to body weights

TABLE 3
LAND USE SCENARIOS AND EXPOSURE PATHWAYS

Type of Exposure	CURRENT EXPOSURE SCENARIO Site not in Use	FUTURE EXPOSURE SCENARIO I Residential	FUTURE EXPOSURE SCENARIO II Industrial
Inhalation of PM-10	off-site residential off-site industrial	on-site residential off-site residential off-site industrial	on-site industrial off-site residential off-site industrial
Soil Deposition Ingestion	off-site residential off-site industrial	off-site residential off-site industrial	off-site residential off-site industrial
Soil Direct Contact (ingestion & dermal)	off-site residential off-site industrial	on-site residential off-site residential off-site industrial	on-site industrial off-site residential off-site industrial
Ground-Water Ingestion	–	on-site residential off-site residential	on-site residential off-site industrial
Concrete Dermal Contact	–	–	on-site industrial

and averaging times (the period over which the exposure is averaged). The exposure point concentrations used to calculate risks are summarized in Tables 6-5 through 6-10 in the baseline risk assessment.

Groundwater concentrations are based on a combination of monitoring and modeling results. Soil concentrations are based on monitoring results. PM-10 concentrations and quantities of deposited fugitive dusts are based on modeling results.

Intake of contaminated PM-10 (expressed as micrograms per cubic meter or $\mu g/m^3$) is based on surface soil concentrations and results of an air transport model. Maximum PM-10 concentrations occur at the eastern site boundary.

Off-site deposition of contaminated fugitive emissions was also modeled. Results were calculated in grams of contaminated dust deposited per gram of off-site soil (g_{dep}/g_{soil}) over a period of 10 to 75 years.

Average and maximum exposure point concentrations for direct contact (incidental ingestion and dermal exposure) with contaminated soils and concrete were based on analytical results of soil and concrete samples. For the current scenario, only surface soil concentrations outside of and at the fence line were used to calculate exposure point concentrations for direct contact. For the future residential scenario, soil concentrations included all on-site sampling results including soils currently under structures. For the future industrial scenario, currently exposed surface soil, and concrete concentrations, were used to calculate exposure point concentrations.

For the future residential scenario and the future industrial scenario, both an on-site and an off-site downgradient drinking water well are assumed. The exposure concentrations are based on recent groundwater sampling rounds. Exposure point concentrations for a downgradient well were estimated using a groundwater model for a well 4000 feet directly downgradient from the site. The model included a range of retardation factors from 1 to 1,000. Retardation factors are calculated to estimate the migration rate of a chemical in a soil-groundwater system. The modeling effort included maximum and average groundwater sampling results, including groundwater concentrations prior to excavation of the former disposal pit. For contaminants of concern that were not detected in groundwater, the detection limit was used as the maximum concentration, and one-half the detection limit was used as the average concentration.

Exposure Frequency and Duration Assumptions

Exposure parameters used in the exposure assessment were the standard parameters used by EPA. Additional information on exposure parameters for the current scenario is listed below:

- For calculations of chemical intakes, the exposure frequency of the trespasser in the current scenario is assumed to be 20 percent of that provided in EPA guidance. Trespasser exposure is expected to be intermittent compared to full-time worker exposure.

- The chemical intakes for off-site ingestion of deposited contaminated fugitive emissions assumes that the receptors are at the point of maximum deposition. The point of maximum deposition is at the site's eastern boundary, at or near the railroad tracks. The exposure frequency at this location is assumed to be 20 percent of that provided in EPA guidance, since no one resides or works at the point of maximum exposure.

Additional information on exposure parameters for the future residential and industrial scenarios is listed below:

- The exposure frequency to off-site receptors who come onto the site for soil direct contact is assumed to be 20 percent of the exposure to on-site receptors. This is justified by the relatively infrequent exposure of off-site receptors to on-site soils.

- The chemical intakes for off-site ingestion of deposited contaminated fugitive emissions assumes that the receptors are at the point of maximum deposition. The exposure frequency at this location is assumed to be 20 percent of that provided in EPA guidance, since no one resides or works at the point of maximum exposure.

- Intakes for dermal contact with contaminated concrete were estimated by treating the concrete as soil. Exposure parameters for this route of exposure are shown in Table 4.

Toxicity Assessment, Human Health

The first step of the toxicity assessment, hazard identification, weighs the available evidence regarding the potential for contaminants of concern to cause adverse effects in exposed individuals. The second step of the toxicity assessment, dose-response evaluation, quantitatively evaluates the toxicity information and characterizes the relationship between the dose (in mg/kg-day) and the incidence of adverse health effects in the exposed population. This is done for carcinogenic and noncarcinogenic effects. Estimates of the probability of carcinogenic effects are based on slope factors. Estimates of noncarcinogenic effects are not based on probabilities, but are based on "reference doses." These terms are described below.

Slope factors, expressed in $(mg/kg/day)^{-1}$, are toxicity values that quantitatively define the relationship between dose of a carcinogen and a lifetime upper-bound estimate of the cancer risk. These values are based on the use of animal studies and epidemiologic studies. Data from the relevant studies are fit into an appropriate model, and the upper 95th percent confidence limit of the slope of the resulting dose-response curve is calculated. This value is the slope factor. Slope factors used in this risk assessment are from EPA's Integrated Risk Information System (IRIS).

Reference doses (RfDs) have been developed for indicating the potential for adverse health effects from exposure to non-cancer causing chemicals. RfDs, expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals, that are not expected to cause an appreciable risk of harmful effects during a lifetime. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfDs. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur. RfDs used in this risk assessment are from IRIS.

Human Health Effects of Contaminants of Concern

Cadmium

Inhalation of cadmium has been shown to cause cancers of the prostate, lung, and kidney in humans. Exposure to cadmium by other routes of exposure has not been shown to be carcinogenic to humans. Chronic oral exposure to cadmium has been documented to cause noncarcinogenic effects in humans, including damage to the kidneys.

TABLE 4

EXPOSURE PARAMETERS FOR DERMAL CONTACT WITH CONTAMINATED CONCRETE

	Average Case	Upper Bound
Surface Area of Hands, m^2	0.099	0.117
Adherence, g/cm^2	1.45×10^{-5}	2.27×10^{-5}
Frequency	1 hour per week	4 hours per week

Chromium

Chromium exists in two biologically valence states: chromium III and chromium VI. Inhalation of chromium VI has been shown to cause lung cancer in humans. Chromium III has not been shown to have carcinogenic properties.

Acute effects of chromium VI include damage to the kidneys, immune system, nervous system, and liver. Effects of inhalation of chromium VI include nasal damage and respiratory dysfunction. Dermal exposure to chromium III and chromium VI can result in chromium sensitization.

DNOC (Elgetol)

4,6-dinitro-o-cresol (DNOC) has not been shown to have carcinogenic properties.

Animal studies have shown adverse health effects due to exposure to DNOC including kidney damage, central nervous system effects, cardiovascular system effects, profuse sweating, thirst, headache, loss of weight, and increased metabolic rates. High doses can be lethal.

Organochlorine Insecticides

The organochlorine insecticides include the DDT series (DDT, DDE, and DDD) and total endosulfans (endosulfan I, endosulfan II, and endosulfan sulfate).

All three chemicals of the DDT series have caused liver tumors, lung tumors, and lymphomas in mice. Chronic noncarcinogenic effects associated with the DDT series in experimental animals include liver dysfunction including microsomal enzyme induction, central nervous system (CNS) disorders including behavioral effects, hypertrophy of liver parenchymal cells and increased fat deposition, and neonatal mortality.

Acute effects of the DDT series in humans include CNS effects such as dizziness and disturbed equilibrium. Fatal human poisonings from DDT have not been documented. Chronic effects are most likely to be observed in the liver. DDT is poorly absorbed via dermal exposure.

The endosulfans are cyclodiene insecticides. Endosulfans have not been shown to have carcinogenic properties. In general, the cyclodienes are more toxic to humans than DDT, and exposure to humans can result in convulsions before other symptoms appear. Endosulfans are highly to moderately toxic via inhalation, ingestion, and dermal routes of absorption, depending on the animal species being tested. In humans, exposure to endosulfans can cause central nervous system stimulation which can be lethal. Other effects can include slight nausea, confusion, excitement, and dry mouth. Chronic exposures can cause liver effects. Endosulfans are absorbed dermally.

Organophosphorus Insecticides

The organophosphorus insecticides include ethion and malathion. Ethion and malathion have not been shown to have carcinogenic properties. Noncarcinogenic effects include inhibition of acetylcholinesterase and accumulation of acetylcholine in nervous tissues and effector organs. Symptoms resulting from these effects include anxiety, difficulty in breathing, sweating, nausea, vomiting, diarrhea, bradycardia, and constriction of the pupils (miosis). Death can result from respiratory failure. Chronic effects are generally not associated with these compounds. However, small doses over a long period of time can cause cumulative effects of acetylcholinesterase inhibition. Long-term exposure can also cause other CNS effects.

Summary of Slope Factors and Reference Doses

A summary of SFs and RfDs used in the risk assessment is given in Table 5.

Risk Characterization, Human Health

The risk characterization summarizes and integrates the toxicity and exposure assessments into quantitative and qualitative expressions of carcinogenic and noncarcinogenic risks. Carcinogenic risks are expressed as the probability of an individual contracting cancer over a lifetime as a result of exposure to a carcinogen. The 10^{-6} risk level is usually used as the point of departure for setting remediation goals if ARARs do not exist or are not sufficiently protective. Noncarcinogenic risks are expressed as a hazard index (HI), where HI = E/RfD, and E = the intake or exposure level, in mg/kg-d. If the HI is greater than 1.0, there is cause for concern of noncarcinogenic health effects.

The risk characterization of the FMC Yakima site included an assessment of average and maximum carcinogenic and noncarcinogenic risks. These risks were calculated for the current and future exposure scenarios.

Risks contributed by each pathway are summarized in tables in the baseline risk assessment. An example of risks from the DDT series contributed by each pathway for future on-site residents is shown in Table 6. Cancer risks and non-carcinogenic hazard indices contributed by each pathway are summarized in Tables 6-14 through 6-24 in the baseline risk assessment.

For the current scenario risk characterization calculations included adding the risks from PM-10 inhalation, soil dermal contact, soil ingestion, and deposited dust ingestion. The carcinogenic risks from the DDT series for all exposure scenarios are summarized in Table 7.

Hazard indices greater than 1.0 for the future industrial scenario were found for endosulfans, ethion, malathion, and DNOC. These values are summarized in Table 8.

Overall, the carcinogenic risks for all scenarios were found to be between 1 x 10^{-4} and 1 x 10^{-8}. Both current and future scenarios showed hazard indices greater than 1.0 for endosulfans, ethion, and malathion. The future industrial scenario also showed hazard indices greater than 1.0 for DNOC. In most cases, the high hazard indices are driven by the dermal exposure values. Although the cancer risks from the DDT series at this site were found to be approach EPA's acceptable risk range levels, noncarcinogenic risks were significantly above acceptable levels.

Uncertainty, Human Health

The toxicity information used for Superfund sites always includes a degree of uncertainty. Uncertainty must be addressed when dose-response data are used to model toxic effects to humans. Slope factors and reference doses incorporate uncertainty for: extrapolating from effects observed at high doses to effects observed at low doses, using animal studies to predict effects in humans, and using homogeneous animal or human populations to predict effects in heterogeneous human populations with a wide range of sensitivities.

Additional site-specific sources of uncertainty related to toxicity information is summarized below.

Sources of Uncertainty that May Underestimate Site Risks

Most groundwater monitoring wells were located to detect groundwater contamination originating from the former disposal pit. Groundwater data immediately downgradient of liquid

TABLE 5
SUMMARY OF SFS AND RFDS USED IN THE RISK ASSESSMENT

	SF $(mg/kg\text{-}day)^{-1}$	RfD (mg/kg-day)
DDT Series (all routes of exposure)	0.34	0.0005
Endosulfans (all routes of exposure)	NA*	0.00005
Ethion (all routes of exposure)	NA	0.0005
Malathion (all routes of exposure)	NA	0.02
DNOC, dermal	NA	0.001
Cadmium, oral	NA	0.0005
Chromium III (all routes of exposure)	NA	1.0

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*No slope factor is available since these compounds are not considered carcinogens by these exposure routes.

TABLE 6

CANCER RISK FOR ON-SITE RESIDENTS
FUTURE EXPOSURE SCENARIO I

Exposure Pathways	ΣDDT	
	Average	Maximum
PM-10 Inhalation		
• mg/kg/day	1.1E-08	6.0E-07
• Modifying Factor	1.0	1.0
• CPF	0.34	0.34
• Risk	4E-09	2E-07
Soil Dermal Contact		
• mg/kg/day	1.3E-05	2.5E-03
• Modifying Factor	0.1	0.1
• CPF	0.34	0.34
• Risk	4E-07	8E-05
Soil Ingestion		
• mg/kg/day	1.6E-06	1.0E-04
• Modifying Factor	1.0	1.0
• CPF	0.34	0.34
• Risk	5E-07	3E-05
Ground-water Ingestion		
• mg/kg/day	3.2E-07	1.1E-05
• Modifying Factor	1.0	1.0
• CPF	0.34	0.34
• Risk	1E-07	4E-06
TOTAL RISK	1E-06	1E-04

TABLE 7

SUMMARY OF CANCER RISKS FROM DDT

	Average	Maximum
Current Scenario		
Off-Site Residents	1×10^{-7}	1×10^{-5}
Off-Site Industrial Workers	1×10^{-8}	1×10^{-5}
Future Residential Scenario		
On-Site Residents	1×10^{-6}	1×10^{-4}
Off-Site Residents	2×10^{-7}	2×10^{-5}
Off-Site Industrial Workers	2×10^{-8}	1×10^{-5}
Future Industrial Scenario		
On-Site Industrial Workers	9×10^{-6}	5×10^{-5}
Off-Site Industrial Workers	2×10^{-7}	2×10^{-5}
Off-Site Residents	2×10^{-8}	1×10^{-5}

TABLE 8

SUMMARY OF AVERAGE AND MAXIMUM HAZARD INDICES GREATER THAN 1.0

	Endosulfans		Ethion		Malathion		DNOC	
	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.
Current Scenario								
Off-Site Residents	*	6.7	3.2	180	*	4.2	ND	ND
Off-Site Industrial Workers	*	2.8	*	75	*	*	ND	ND
Future Residential Scenario								
On-Site Residents	110	42,000[+]	7.1	1,100	*	110	ND	ND
Off-Site Residents	21	8,500[+]	1.4	230	*	44	ND	ND
Off-Site Industrial Workers	3.6	3,700[+]	*	93	*	9.5	ND	ND
Future Industrial Scenario								
On-Site Industrial Workers	*	290	*	370	*	6.4	2.6	370
Off-Site Industrial Workers	*	62	*	81	*	1.3	*	75
Off-Site Residents	*	140	2.2	180	*	6.0	5.8	360

Notes

*	Hazard Index less than 1.0
ND	Hazard Index not calculated for this pathway.
Ave.	Average
Max.	Maximum
+	High Hazard Index due to dermal contact with and ingestion of on-site soil.

formulation areas is limited. In addition, not including all contaminants detected at the FMC Yakima site may underestimate risks. Only chemicals identified as contaminants of concern were evaluated.

Soil sampling to date has not included analyses for chromium VI. All risks are based on the assumption that the total chromium is chromium III. This is based on the assumption that chromium VI is rapidly converted to chromium III in soil. However, some chromium VI may be present in the soils.

The risk assessment only calculates risks for the exposure pathways that were judged to be complete. Additional pathways that potentially pose risks were not quantified. These pathways include food chain effects, dermal contact with contaminated groundwater, and contamination of home grown vegetables.

Sources of Uncertainty that May Overestimate Site Risks

Organic contaminants in soil and groundwater are generally subjected to a variety of degradation processes, including microbial actions, reduction-oxidation (redox) reactions, and volatilization. The groundwater model conservatively assumed that none of these processes occur.

The calculations of dermal exposure risks include a great deal of uncertainty, as the available data are extremely limited. Use of uncertainty factors and conservative assumptions in these cases may overestimate site risks.

The air dispersion model for the future residential scenario assumes that contaminated soils beneath existing structures are exposed and subjected to wind erosion. The model assumes that all these soils are contaminated.

Sources of Uncertainty that May Underestimate or Overestimate Site Risks

Sampling was based on known areas of contamination. This may overestimate site risks if additional areas are relatively uncontaminated, or underestimate risks if additional "hot spots" have not been detected. The use of standard EPA exposure assumptions for some of the land use scenarios may not be representative of the site and local conditions, and may also either overestimate or underestimate risks.

Overall, the baseline risk assessment for the FMC Yakima site includes many conservative assumptions that should prevent underestimation of site risks. However, EPA has performed additional studies on the risks posed by this site in an attempt to deal with some of the areas of uncertainty identified above. These additional studies are discussed below.

Human Health-Based Soil Concentrations

EPA contractors have recently completed studies that calculate health-based soil concentrations of site contaminants that would result in a 1×10^{-6} cancer risk, and a hazard index of 1.0. These calculations were based on risks to a child who lives on-site. This study used existing RI/FS documents, including the February 1990 soil sampling results. The study recommended the following:

- That dieldrin, ethyl parathion, and chromium VI be added as contaminants of concern
- That the health-based soil concentrations include carcinogenic risks based on inhalation of cadmium and chromium VI
- That DNOC should be considered as a contaminant of concern for ingestion

- That the final cleanup goals, due to the lack of verified data, not be based on dermal contact with soils
- That if risks from dermal contact with concrete are to be quantified, these risks should be based on wipe data (in µg/100 cm^2), and not on core data (in mg/kg).

This information was used by EPA's contractors to calculate health-based soil concentrations. These concentrations were then considered by EPA in determining site-specific soil cleanup goals, which are shown in Table 9.

Human Health - Based Concrete and Structures Concentrations

EPA contractors also developed health-based surface concentrations, in µg/100 cm^2, for contaminated concrete and structures. These levels are based on current EPA guidance, and are calculated to result in a 1×10^{-6} cancer risk, and a hazard index of 1.0. Contaminants of concern for concrete and structures are shown in Table 10.

Conclusions for Human Health Risk Assessment

Overall, the human health risk assessment shows that concentrations of pesticides in soil exceed acceptable risk levels, and pose a threat to human health for both current and future land use scenarios.

Based on information presented in the risk assessment, information developed by EPA contractors, and current EPA guidance, health-based cleanup levels for contaminated soils and concrete were determined. These cleanup levels will be used during remedial actions to designate soil and debris in need of remediation. Cleanup goals will be adjusted where multiple contaminants are found. Adjusted goals will be protective of human health at a cumulative excess cancer risk of 1 in a million, or a cumulative hazard index less than or equal to 1, whichever is lower.

Environmental Evaluation

Contaminant Identification

The risk assessment for the FMC Yakima site includes an environmental evaluation that identifies potential environmental threats from the site. The contaminants of concern for the environmental evaluation are the DDT series, endosulfans, ethion, malathion, and zinc.

Physical Setting and Critical Habitats

The study area for the environmental evaluation includes the FMC Yakima site and a one-mile radius around the site. The site is a two-acre paved and fenced area where pesticide formulation activities formerly took place. An eight-acre field is located to the east and south of the site. The field is covered predominantly with weedy forbs and grasses, litter, and pebbles. Several wetland areas are located south and southeast of the site. The closest downgradient wetland identified by the National Wetlands Inventory occurs approximately 1200 feet south of the site. Cattle pastures are located south of the site, and south of the wetland areas. The Yakima River is approximately 1.5 miles to the east of the site. No sensitive habitats, or state- or federally-listed threatened or endangered species or other species of concern are known to occur on the site or in the study area.

Wildlife that have been observed at the site include quail (Lophortyx californicus), house finch (Carpoedacus mexicanus), starling (Sturnus vulgaris), black billed magpie (Pica pica),

TABLE 9

HEALTH - BASED CLEANUP LEVELS FOR CONTAMINATED SOIL

Compound	Concentration (mg/kg)
DDD	5.1
DDE	3.6
DDT	3.6
Dieldrin	0.076
Cadmium	8.0
Chromium VI	1.0
Endosulfans	4.2
Ethion	42.4
Malathion	1695.0
Ethyl Parathion	11.0
DNOC	8.5
Zinc	500.0

Cleanup goals will be adjusted where multiple contaminants are found.

TABLE 10

HEALTH - BASED CLEANUP LEVELS FOR CONTAMINATED CONCRETE AND SURFACES

Compound	Concentration ($\mu g/100\ cm^2$)
DDD	6.5
DDE	4.6
DDT	4.6
Dieldrin	0.1
Endosulfans	10.0
Ethion	270.0
Malathion	8,200.0
Ethyl Parathion	2,400.0

Cleanup goals will be adjusted where multiple contaminants are found.

kestrel (Falco sparverius), and insects. Evidence of rabbit (Sylvilagus sp.) and owl have been noted.

There are no wetlands on-site, however, the wetlands in the vicinity of the site may provide seasonal habitats for shorebirds and waterfowl, including the mallard duck (Anas platyrhynchos). Resident species of the wetland areas may include the muskrat (Ondatra zibethicus), short-tailed weasel (Mustela erminea), frogs, and passerine birds.

The Yakima River provides habitat for three Washington State fish species of concern. These are the sandroller sucker (Percopsis transmontana), mountain sucker (Catostomus platyrhynchus), and Paiute sculpin (Cottus beldingi). The riparian habitat supports overwintering raptors, including bald eagles (Haliaeetus leucocephalus), rough-legged hawks (Buteo lagopus), and red-tailed hawks (Buteo jamaicensis), and provides nesting sites for ospreys (Pandion haliaetus), shorebirds, and water fowl. A great blue heron (Ardea herodius) rookery occupies a site along the Yakima River, approximately 2.5 miles southeast of the site.

Ecological Exposure Assessment

The exposure scenario for the ecological assessment assumes current conditions. The area around the wetlands is industrial with some domestic use. The wetlands fluctuate four to six feet each year with the irrigation season (levels rise during the summer). The current environmental scenario assumes the following:

- That aquatic organisms (fish and invertebrates) reside in the wetlands
- That the wetlands are downgradient and hydraulically connected to the groundwater beneath the site.

It should be noted that off-site wetlands have not been sampled for contaminants, or for biota, and that the hydraulic connection required to complete an exposure pathway between the groundwater beneath the site and the wetlands has not been established. Rather, the Environmental Evaluation focused on potential impacts suggested by a conservative groundwater model to a wetland located 1200 feet southeast of the FMC Yakima Site. Wells recently installed to evaluate potential off-site transport of contaminants of concern indicate that groundwater downgradient of the site, in the direction of the wetland, is of a higher quality than that found in the vicinity of the former formulation areas of the plant, and would not be expected to exert an impact on the wetlands downgradient. Future groundwater monitoring is expected to confirm this assessment.

Exposure Pathways and Exposure Concentrations

Exposure point concentrations of contaminated groundwater at the wetland and the Yakima River are based on a groundwater transport model. The source concentrations for the model were based on results of groundwater sampling, including results prior to excavation of the former disposal pit. Both average and maximum concentrations were used in the model. The model assumes that a source equivalent to the former disposal pit still exists, and that source reduction is 50 percent at 100 years. The model used groundwater monitoring results, and assumed retardation factors, to obtain exposure average and maximum concentrations in the wetland, and in the Yakima River. The concentrations at the river do not include dilution, which would reduce concentrations by a factor of 1,000 to 10,000.

Exposure concentrations of zinc were not modeled. The exposure assessment assumed that the concentrations detected in the wetland were the same as the concentrations detected in the groundwater at the FMC Yakima Site.

Toxicity Assessment

This section of the Environmental Evaluation reviews the available toxicological data, provides a rationale for selection of the species of concern (indicator species), and discusses regulatory criteria and derivation of ecological health-based criteria.

Toxicological Profiles

DDT has been found to be toxic to fish and other aquatic organisms. It bioaccumulates and has severe food chain impacts. DDT impairs avian reproduction by causing eggshell thinning and increased embryo mortality. Raptors have been found to be extremely susceptible to eggshell thinning effects of DDT. Fish-eating raptors were chosen as the indicator species because of their sensitivity to toxic effects of DDT. The Water Quality Criterion for DDT for the protection of freshwater aquatic life is 0.001 µg/L. This concentration was judged to also be protective of fish-eating raptors.

Endosulfans have been found to cause toxic effects in aquatic organisms including liver changes in fish. Endosulfans bioaccumulate at much lower concentrations than DDT, and have not been documented as causing the same severe reproductive effects in birds. Fresh water fish were chosen as the indicator species for endosulfans. The Water Quality Criterion for endosulfans for the protection of freshwater aquatic life is 0.056 µg/L, and this concentration was also used as the ecological health-based criterion.

Ethion has been found to be toxic to aquatic invertebrates, such as Daphnia, which were chosen as the indicator species. No Water Quality Criterion for ethion has been established. The Environmental Evaluation uses 0.056 µg/L as the ecological health-based criterion.

Malathion has been found to be toxic to some species of fish, and to aquatic invertebrates. Aquatic invertebrates were chosen as the indicator species because of their sensitivity to malathion, and the Water Quality Criterion for the protection of freshwater aquatic life of 0.1 µg/L was used as the ecological health-based criterion.

Zinc has been found to be toxic to aquatic microorganisms (including algae), invertebrates, and fish. The toxicity of zinc increases with decreasing water hardness. Fish were chosen as the indicator species because of their sensitivity to zinc, and the Water Quality Criterion for the protection of freshwater aquatic life of 47 µg/L was used as the ecological health-based criterion.

Risk Characterization

Hazard indices were computed for the contaminants of concern using the ecological health-based criteria and the exposure point concentrations (where the ecological hazard index = E/ecological health-based criterion, and E = the exposure point concentration. This information is shown in Table 11 which shows that the hazard indices range from 0.7 (based on an average concentration for malathion) to 389 (based on a maximum concentration for DDT).

Conclusions for the Environmental Evaluation

Pesticides and zinc at the FMC Yakima site may pose threats to freshwater aquatic life based on conservative modeling assumptions and ecological health-based criteria. However, wells recently installed between the site and adjacent wetlands show lower levels of contaminants than the conservative model predictions and actual impacts on aquatic ecosystems is not expected to be significant.

TABLE 11

RISK CHARACTERIZATION FOR ECOLOGICAL INDICATOR SPECIES IN THE WETLAND

Chemical	Indicator Species	Health-Based Water Criteria * (µg/l)	Exposure Point (a) Concentration (µg/l) in Water		Hazard Index (b)	
			Average	Maximum	Average	Maximum
Current Scenario						
ΣDDT	Fish-eating raptor	0.001	0.019	0.389	19	389
ΣEndosulfan	Fish	0.056	0.026	0 265	0 5	4.7
Ethion	Aquatic invertebrate	0.056	0 067	0.147	1.2	2 6
Malathion	Aquatic invertebrate	0.1	0.067	0.147	0 7	1.5
Zinc	Fish	47	1.744(c)	6500(c)	37	138

Notes:

- a Modeled concentrations at the wetland. Transport model assumes the wetland is directly downgradient and hydraulically connected to the site.
- b Hazard Index = Exposure point concentration/health based criterion
- c Concentrations are from the on-site monitoring wells; they are not modeled concentrations at the wetland
- * Ambient Water Quality Criteria for Protection of Aquatic Organisms - Chronic

Uncertainty

Many of the sources of uncertainty identified in the human health section are applicable to the environmental evaluation. Additional sources of uncertainty are listed below:

No sampling was done at the wetland to identify contaminant concentrations or resident biota. This may contribute to underestimating risks if contaminant concentrations are high. If the wetland does not provide habitat for the ecological endpoints and receptors identified in the Environmental Evaluation, or if potential migration pathways and assumptions are inaccurate, risks may be overestimated.

Because the wetland is located in an industrial area, it is potentially subjected to sources of contamination other than the FMC Yakima site. If this is the case, then the environmental evaluation may underestimate the total risks at the wetland.

The hydraulic connection between the wetland and groundwater beneath the site has not been established. This may overestimate risks if the wetland is not directly downgradient of the site. Also, many of the modeling assumptions, such as source size, are conservative and may overestimate risks.

Summary of Threats to Human Health and the Environment

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response actions selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

VII. DESCRIPTION OF ALTERNATIVES

Alternative 1: No Action

Evaluation of the "no action" alternative is necessary to allow evaluation of site conditions with limited remedial measures, and to compare the benefits of other alternatives. Under the "no action" alternative, conditions at the site would remain as they are now. The existing structures would remain as they now stand, and contaminated soils would remain in place. The existing fence would be maintained to prevent access by unauthorized personnel. Long-term groundwater monitoring (20 years) would be necessary, since a source of further contamination would remain. A deed restriction limiting the future use of the site would also be required. The following costs were estimated for this alternative:

Capital Cost	none	
Annual Operation & Maintenance		$33,000
Present Worth (O & M)	$432,000	
Total Cost	$432,000	

The present worth of O & M is based upon a 20 year amortization at 5% interest for all alternatives.

Alternative 2: Capping of Soils and Encapsulation of Concrete Pads and Structures

Under this alternative, selected areas of the site (i.e. those above cleanup goals) would be capped, and contaminated concrete pads and structures would be encapsulated with concrete. The former disposal pit would be backfilled. The contaminants would remain on-site, buried beneath the cap, but they would not be expected to affect groundwater substantially, because the cap would minimize stormwater infiltration and, therefore, contaminant migration. Long-term groundwater monitoring would be necessary, and several wells would be added to the existing network to track any migration of pollutants. The security fence would be maintained, and a deed restriction to limit future development of the site would be imposed. Continued inspection and maintenance of the cap would also be required. The following costs were estimated for this alternative:

Capital Cost	$321,000	
Annual Operation & Maintenance		$36,000
Present worth (O & M)	$471,000	
Total Cost	$792,000	

Alternative 3: Excavation, Soil Washing and Waste Sludge Treatment; Demolition or Gritblasting of Contaminated Soils and Concrete Structures

Contaminated soils would be excavated and would undergo soil washing as a volume reduction, or fractional segregation process. Since the contaminants tend to adhere to fine particles, these would be separated out, resulting in a volume reduction of 75 to 80 percent. The resulting waste sludges would be thermally treated at an off-site incinerator. The washing fluid (water, possibly with additives) would be recycled through the system. A smaller soil volume, of higher moisture content, would require incineration. Contaminated concrete would be demolished or gritblasted and disposed of off-site.

The contaminated soils at the FMC site consist predominantly of clayey sands and gravels. The general size reduction would be accomplished through a series of physical separation procedures, using commercially available size-reduction and separation equipment. The screened soils would undergo additional size separation using settling equipment such as a sedimentation tank or a hydrocyclone. The fines could be further separated from the coarse materials through a series of flotation cells. The waste sludges would be collected and filtered to reduce water content prior to treatment. The clean materials (coarse fraction) would undergo liquid/solid separation using clarifiers, followed by a belt filter press. The separated solids would be stockpiled and tested prior to placement as clean fill. The wash-water stream would be recycled and, after completion of the project, the water would be decontaminated by carbon adsorption or other suitable means.

The sludge would be treated off-site using rotary kiln incineration. The off-site incinerator would have the 99.99% destruction and removal efficiency (DRE) required by RCRA for organic wastes. The ash residue would be stabilized and placed in a permitted disposal facility. Contaminated concrete structures would be gritblasted or demolished and incinerated or disposed of in a secure landfill. Since all of the soils having concentrations of contaminants above health-based levels would be excavated and treated, this alternative would meet the requirements for clean closure under RCRA Subtitle C. Soil sampling and analysis, as well as groundwater monitoring to confirm complete source removal, would be performed. Several more monitoring wells would be installed to ensure that the aquifer is adequately characterized. A gradual decrease in the already low levels of groundwater contaminants would be expected to take place over time, once the source is removed. The following costs were estimated for the remediation of 900 cubic yards of contaminated soils and other structures:

Capital Cost	$1,202,000	
Annual Operation & Maintenance		$33,000
Present worth (O & M)	$432,000	
Total Cost	$1,634,000	

Alternative 4: Excavation and Vitrification of Contaminated Soils and Concrete Structures

Contaminated soils would be excavated and placed in prepared trench areas. Electrodes inserted into the soil would heat the contaminated soil to its fusion point, and the contaminated soil would be converted into a chemically inert, stable, glass-like, crystalline product. Inorganic elements would be incorporated into the vitrified mass, and organic components would be pyrolized. The pyrolized byproducts would migrate to the surface of the vitrified zone, where they combust in the presence of oxygen. The combustion gases are drawn into an off-gas treatment system. The destruction and removal efficiency (DRE) of the vitrification process would be expected to meet the RCRA requirement of 99.99% for the site contaminants. The volume of the excavated soil would be reduced by approximately 30%. Previous testing conducted by the vendor of this process has shown successful pyrolysis of organic constituents, including organochlorine compounds.

The contaminated concrete would be demolished or gritblasted, and the resulting waste would be added to the soil to be vitrified. The vitrified wastes would remain buried on-site, approximately one foot below the surface. If the vitrification were successful in meeting performance standards, the site would then be considered to have attained clean closure under RCRA Subtitle C. Long-term groundwater monitoring to confirm that the inorganic contaminants were not leaching from the vitrified mass might still be warranted. Additional wells would be installed to expand the groundwater monitoring program to ensure that aquifer conditions would be adequately assessed. A gradual decrease in the already low levels of groundwater contaminants would be expected to take place over time, if the vitrification process is effective. The following costs were estimated for the remediation of 900 cubic yards of contaminated soils and other structures:

Capital Cost	$1,138,000	
Annual Operation & Maintenance		$33,000
Present worth (O & M)	$432,000	
Total Cost	$1,570,000	

Alternative 5: Excavation and Off-Site Incineration of Contaminated Soils; Demolition or Gritblasting of Concrete Structures

Under this option, contaminated soils would be excavated and transported to an off-site facility and incinerated. Prior to off-site shipment, the contaminated soils would be screened to remove particles too large for feeding into the rotary-kiln incinerator. These particles would be analyzed and, if necessary, crushed and shipped to the incinerator. Other process requirements may include blending, drying, and/or chemical characterization. The incinerator would have a destruction efficiency of 99.99% for organic wastes, as required by RCRA. The ash residues would be stabilized and disposed of at a permitted waste disposal facility. Contaminated concrete structures would be gritblasted or demolished and would also be disposed of in an off-site secure landfill. Groundwater monitoring through the existing network of wells would be conducted to confirm complete source removal. Additional wells would be installed to expand the groundwater monitoring program, in order to ensure that aquifer conditions would be adequately assessed. A gradual decrease in the already low levels of groundwater contaminants would be expected to take place over time, once the source is removed. The following costs were estimated for the remediation of 900 cubic yards of contaminated soils and contaminated concrete structures:

Capital Cost	$2,526,000	
Annual Operation & Maintenance		$33,000
Present worth (O & M)	$432,000	
Total Cost	$2,958,000	

Alternative 6: Excavation and On-Site Incineration of Contaminated Soils; Demolition of Contaminated Concrete Structures and Disposal at a Secure Landfill

Contaminated soils would be excavated, and contaminated concrete structures would be demolished and prepared for incineration, or if the volume of concrete requiring treatment was insufficient to justify the mobilization of appropriate crushing equipment, would shipped to an off-site secure landfill. A mobile rotary-kiln incinerator would be transported to the site. The

VESTA system (VESTA Technology, Ltd.) was used to develop this alternative. This system has been operated at a Superfund site in the State of Washington and has demonstrated a destruction and removal efficiency of 99.99%, as required by RCRA for organic wastes. Prior to incineration, contaminated soil and debris would be screened to remove oversized particles. Solid materials must be reduced to less than 2 inches in diameter for feeding into the rotary kiln. Oversized material would be segregated for further characterization and, if required, the material would be crushed and fed into the incinerator.

Following incineration, the ash would be analyzed to determine degree of contaminant destruction and leachability. If health-based cleanup goals are met the ash will be considered to be delisted and used for backfill on site. However, because certain heavy metals have been identified as possible site contaminants, delisting of the treated waste may not be possible. In that case, the treated wastes would be stabilized and landfilled at a permitted RCRA hazardous waste disposal facility. Several additional wells have recently been installed, and groundwater monitoring would be conducted to confirm that source removal is complete, and that RCRA clean-closure criteria have been met. A gradual decrease in the already low levels of groundwater contaminants would be expected to take place over time, once the source is removed. The following costs were estimated for the remediation of 900 cubic yards of contaminated soils and the contaminated concrete structures:

Capital Cost	$1,323,000	
Annual Operation & Maintenance		$33,000
Present worth	$432,000	
Total Cost	$1,755,000	

Alternative 7: Excavation, Stabilization and Off-Site Landfilling of Contaminated Soils; Demolition and Off-Site Landfilling of Concrete Structures

Contaminated soils would be excavated, and concrete structures would be demolished or gritblasted. The soils would be screened to remove oversized particles, loaded onto trucks, and transported to an off-site permitted RCRA facility for stabilization and disposal. No site-specific stabilization treatability studies have been conducted; however, similar wastes from other sites have been successfully stabilized. The disposal facility would conduct a treatability study to determine the optimum treatment formulation prior to the commencement of the remedial action. A Treatability Variance (40 CFR §268.44) would be required to implement this option because stabilization is not likely to meet Land Disposal Restriction standards for the site organic contaminants. Groundwater monitoring would be conducted in order to confirm that source removal is complete, and that clean closure criteria have been met. Several additional wells would be installed to expand the groundwater monitoring program in order to ensure that aquifer conditions would be adequately assessed. The following costs were estimated for the remediation of 900 cubic yards of contaminated soils and contaminated concrete structures:

Capital Cost	$626,000	
Annual Operation & Maintenance		$33,000
Present worth (O & M)	$432,000	
Total Cost	$1,058,000	

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Each of the seven alternatives described in the preceding section was evaluated according to the nine criteria defined below. Each criterion is discussed in detail on the pages that follow this list.

Threshold Criteria

1. **Overall protection of human health and the environment** - addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls or institutional controls.

2. **Compliance with federal and state environmental standards** - addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements (ARARs) of other Federal and State environmental statutes and/or provide grounds for invoking a waiver.

Primary Balancing Criteria

3. **Long-term effectiveness and permanence** - refers to the magnitude of remaining risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met.

4. **Reduction of toxicity, mobility, and volume** - is the anticipated performance of the treatment technologies that may be employed in a remedy.

5. **Short-term effectiveness** - refers to the speed with which the remedy achieves protection, as well as the remedy's potential to create adverse impacts on human health and the environment during the construction and implementation period.

6. **Implementability** - is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution.

7. Cost - includes capital and operation and maintenance (O & M) costs.

Balancing criteria 3 and 4 receive added emphasis in evaluating alternatives.

Modifying Criteria

8. **State acceptance** - indicates whether the State concurs with, opposes, or has no comment on the preferred alternative.

9. **Community acceptance** - will be assessed following a review of the public comments received on the RI/FS report and the Proposed Plan.

Overall Protection of Human Health and the Environment

According to the risk assessment (Bechtel, Phase II Remedial Investigation Report, April 1990), direct contact with surface soils is the most significant exposure pathway of concern at the FMC site. All of the alternatives presented would prevent direct contact, except by trespassers in the case of Alternative 1. Inhalation of contaminated soil particles is also an exposure pathway. All of the alternatives except Alternative 1, would also eliminate this pathway. The risk assessment states that, at the present time, the levels of contaminants in the groundwater do not pose a risk, however, if the contaminated materials are left in place, groundwater contamination may increase to levels that pose a health risk. Alternatives 3 through 7 reduce the risks posed by all of the exposure pathways at the site through excavation and treatment of contaminated materials. Alternative 2 would tend to minimize groundwater contamination by eliminating infiltration of stormwater. As long as the capped areas remained undisturbed, a high degree of protection would be provided by Alternative 2.

Overall protection of human health and the environment at the site is increased by the alternatives involving excavation and treatment of the contamination. Alternatives 3, 5 and 6 offer the highest degree of protection, since the contaminants would be permanently destroyed.

Of these, Alternative 6 would be slightly more protective, because the risks associated with loading contaminated materials onto trucks and transporting the materials over long distances would be eliminated.

Alternatives 4 and 7 are protective treatment technologies associated with varying levels of uncertainty. If Alternative 4 were employed, there is a possibility that inorganic contaminants could leach from the vitrified mass buried on site and cause groundwater contamination. Since the contaminated materials would be excavated and removed from the FMC site, Alternative 7 would be protective of human health and the environment at the site, but any future problems associated with the stabilized waste would be transferred to another location.

Alternative 2 would also be adequately protective as long as the cap remained intact, since dermal contact, inhalation of contaminated soil particles, and further infiltration of contaminants to the groundwater would be prevented. Alternative 1 is limited to maintenance of a fence to prevent direct contact with contaminated soils, and groundwater monitoring. The monitoring data would be used to prevent consumption of contaminated water, but Alternative 1 would not provide any protection from airborne contaminated soil particles.

Compliance with ARARs

Alternatives 1 through 7 all have the potential to meet existing chemical-specific ARARs for groundwater since currently detected levels of contaminants have not been shown to exceed Safe Drinking Water Act standards. The State of Washington Model Toxics Control Act has been considered in evaluating alternatives with respect to the chemical specific cleanup goals presented for soil and groundwater; it is noted, however, that these regulatory standards have not yet been promulgated. No federal chemical specific cleanup standards for contaminated soil or concrete have been promulgated, however, chemical specific RCRA Land Disposal Restrictions may be applicable.

The remedial actions specified in Alternatives 2, 3, 4, 5, 6, and 7 would trigger action-specific ARARs. RCRA landfill closure regulations would be considered relevant and appropriate for alternative 2. Land Disposal Restrictions specified in RCRA would be considered an action specific ARAR for options 3-7 since all of these alternatives involve excavation and treatment and/or disposal of a RCRA listed waste. RCRA clean closure requirements are relevant for alternatives 3-7. A Treatability Variance (40 CFR §268.44) would be required in order to implement Alternative 7, because stabilization is not likely to meet Land Disposal Restrictions for the site organic contaminants. Alternatives 3, 4, 5, and 6 employ thermal destruction technologies. In the State of Washington these alternatives would require compliance with federal and state air standards administered by the local air pollution authority. Off-site incineration would be conducted at a permitted incinerator meeting applicable State, Federal, and local regulations. Technologies involving incineration must also meet the RCRA requirement of a 99.99% destruction and removal efficiency (DRE).

Long-Term Effectiveness and Permanence

In the absence of any prior remedial activities, the no-action and capping alternatives (1 and 2) would not meet the goals or intent of CERCLA or the NCP, as a permanent remedy. However, the two pit excavations that took place in 1988 and 1989 removed the major source of contamination at the site and are considered part of the remedial action for the site.

Alternative 2 is not a permanent solution. Since the asphalt cap would require continual maintenance, and groundwater monitoring would also be required for an extended period of time. In addition, since the water table is only several feet below the ground surface and has seasonal fluctuations, enough contamination could enter the groundwater to require remediation. Alternative 1 is ineffective in meeting remedial action objectives.

Alternatives 3, 5, and 6 are final, permanent remedies. Alternative 7 would be the least favored of the treatment alternatives, for although it would be a permanent solution for the site itself, waste would be transferred off-site, requiring long-term monitoring and potential future remediation at another location. It is uncertain whether Alternative 4 would be a permanent solution, because the vitrification technique has never been used at a full-scale site, and limited information is available. Even if organic contaminants are successfully destroyed and the inorganic contaminants were effectively bound up in the vitrified mass, this method would still limit future use of the site, because the material would remain buried on-site.

Reduction of Toxicity, Mobility, and Volume

Alternatives 3, 5, and 6, all involving incineration, meet all of these goals. Alternative 4 would reduce toxicity and mobility if the vitrification were successful, but volume would only be reduced by approximately 30 percent. Alternative 7, off-site solidification and land disposal, would reduce the mobility and toxicity, but not the volume, of the waste. Alternative 2, capping, employs no treatment technologies and would only reduce mobility. Because the waste would remain in place, neither its toxicity nor its volume would be reduced. Alternative 1, no action, would not meet any of the reduction goals.

Short-Term Effectiveness

It is estimated that any of the alternatives could be accomplished within one construction season after beginning remediation. A potential for worker and community exposure by inhalation of contaminated dust during excavation exists for all of the alternatives involving excavation of the contaminated soils and demolition or gritblasting of the contaminated structures (Alternatives 3 through 7). Alternatives 4 and 6, involving on-site treatment, would require strict air pollution engineering controls to reduce the exposure potential. Alternatives 5 and 7, involve transporting a large volume of contaminated soil, which would increase community exposure, as well as causing traffic congestion and risk of accident. Considering these exposure risks, Alternative 2 probably is the most protective on a short-term basis, because the contaminated soils would only be minimally disturbed during the remedial process. Some dust would be created during the asphalting process, but that could be minimized through dust-control practices.

Implementability

All alternatives under which contaminants would remain on site would require a restriction to be placed in the property deed. This would limit future use of the land, potentially reducing its value. Alternatives 1, 2 and 4 would require a deed restriction limiting the future use of the site property. Further, use of institutional controls such as a deed restriction, in lieu of treatment, are disfavored under the NCP as recently amended.

Any of the other alternatives could be implemented. Alternatives 3, 5, and 6 rely on incineration, which is considered the Best Demonstrated Achievable Technology (BDAT) for the organic site contaminants. Incineration is a commercially available technology which has been proven effective for destruction of such contaminants. Emission testing would be required before full scale remediation could begin to confirm compliance with applicable air standards. Prior to the implementation of Alternative 3 a treatability study would be required. Treatability studies would also be required for Alternatives 4 and 7. The excavation phase of Alternatives 3 through 7 should be conducted during the low water table season. For Alternative 4, it would also be necessary to conduct the treatment phase during the low water table season in order to maximize the depth of the vitrification trenches.

Cost

Alternative 1 is the least expensive, followed by Alternative 2. The estimated cost of Alternative 6 is somewhat higher than all of the other alternatives, with the exception of Alternative 5, which is much more expensive. However, as the volume of soil to be remediated increases, the cost-effectiveness of on-site incineration also increases. It may therefore prove less expensive than Alternatives 3 or 4, which have similar cost estimates (see Table 12). Further, since the effectiveness of alternatives such as soil washing, vitrification, stabilization, and encapsulation is uncertain, these alternatives may involve unforseen costs, should complications arise.

Costs of the 7 alternatives, as estimated by Betchel in the Feasibility Study, for three different excavation volumes, are presented in Table 12. These estimates include annual operation and maintenance costs that assume groundwater monitoring over a 20-year period for all of the alternatives. This cost, at a present worth discounted at a rate of 5% for 20 years, was calculated to equal $431,816 for all of the alternatives except capping, which includes asphalt cap maintenance and has a slightly higher cost of $471,072. The alternatives involving excavation of the contaminated soils and incineration or removal of contaminants from the site (Alternatives 3, 5, 6, and 7) will not require long-term monitoring. Only groundwater monitoring to ensure that the excavation has been complete is expected to be required. Alternative 4, which involves leaving the vitrified contaminants buried on-site, may require long-term monitoring. Therefore, the operation and maintenance portion of the cost estimates for Alternatives 3, 5, 6, and 7 should be lower than presented.

Another cost consideration which was not factored into the cost analysis is the deed restriction that would be necessary if the waste were left on site. Since that would potentially lower the property value, it would increase the total cost of Alternatives 1, 2 and 4 by an unknown amount. There could also be costs associated with future liability for Alternative 7 due to off-site disposal of hazardous materials, or with Alternative 4, if the vitrification process were not completely effective.

State Acceptance

The State of Washington has been involved in RI/FS activities, development of ARARS, participated in the remedy selection process and concurs with the selected remedy. The State is expected to participate in the Consent Decree negotiations with EPA, DOJ, and FMC.

Community Acceptance

The community is supportive of the selected remedy. EPA met with local and state health department officials, conducted a public meeting in Yakima, and solicited written comments on the remedial alternatives. EPA received correspondence from the Washington Environmental Council supporting the preferred alternative and the cleanup levels. No comments were received that disagreed with the selected remedy or the proposed cleanup levels.

IX. THE SELECTED REMEDY

Alternative 6 has been selected as the remedial alternative to be employed at the site. Contaminated soils and structures throughout the site will be addressed by this remedial action. The only significant risks currently posed by the FMC site are associated with the contaminated soils and structures. Concentrations of contaminants in groundwater are currently below health-based levels, and do not require treatment. An expanded monitoring well system will be used to confirm complete source removal and to verify that unacceptable levels are not present. If monitoring shows groundwater remediation to be necessary, it will be conducted as part of a separate operable unit of the site remediation.

TABLE 12

COSTS OF REMEDIAL ALTERNATIVES *

Alternative	Remediation of 900 cubic yards	Remediation of 2000 cubic yards	Remediation of 4000 cubic yards
1. No Action	$432,816	$432,816	$432,816
2. Capping	$792,237	$792,237	$792,237
3. Soil Washing and Incineration	$1,634,138	$2,942,390	$4,377,626
4. In Situ Vitrification	$1,569,722	$2,121,218	$3,571,634
5. Off-Site Incineration	$2,958,203	$5,899,058	$8,770,058
6. On-Site Incineration	$1,754,363	$2,859,098	$3,753,002
7. Stabilization and Off-Site Disposal	$1,058,010	$1,653,014	$2,169,134

* As estimated by Bechtel Environmental, Inc., April 1990 Feasibility Study, FMC, Yakima.

The selected remedy consists of:

- Sampling of soils and concrete structures to refine the current estimate of the lateral and vertical extent of material requiring treatment.
- Excavation of contaminated soils to the concentrations shown in Table 9.
- On-site incineration of contaminated soils.
- Dismantling contaminated slabs and portions of the buildings that are determined to exceed cleanup goals shown in Table 10. Where the removal of a portion of a building affects the safety or structural integrity of that building appropriate repairs will be made.
- On-site incineration of contaminated concrete and debris or disposal at a RCRA-Subtitle C permitted hazardous waste disposal facility, depending on volume.
- Following incineration, the ash will be analyzed to determine degree of contaminant destruction and leachability. If health-based cleanup goals are met the ash will be considered to be delisted and used for backfill on site.
- Continued groundwater monitoring to confirm source removal.

Characterization

Before beginning the remedial design phase, sampling of contaminated soils and structures will be performed in order to further refine the volume of material above cleanup levels requiring treatment.

Surface and subsurface soils will be sampled and analyzed in the following areas (refer to Figure 2 for locations):

Areas 2: Soils underlying the southeast corner of the warehouse
Areas 3: East side of warehouse
Areas 4: Refuse and drum storage area
Areas 5: Tank farm and sumps
Areas 6: Barrel wash area
Areas 7: Liquid formulary area
Areas 8: Elgetol area
Areas 9: Unpaved area west of elgetol area

During the design phase, contaminated structures will also be sampled. Concrete throughout the warehouse will be wipe sampled and analyzed to determine the magnitude of removal operations.

Remediation of Concrete Structures

The effect of removal of contaminated portions of each building will be analyzed. If it is determined that removal of an area of contaminated concrete will compromise the safety or structural integrity of a structure, that portion of the structure will be immediately repaired. The contaminated concrete that is removed will be stockpiled. If there is sufficient volume to justify mobilization of appropriate crushing and related dust control equipment, the stockpiled material will be crushed and fed to the incinerator. If the final volume is too small to justify mobilization of crushing equipment a treatability variance will be prepared to support off-site disposal. Best Management Practices will be undertaken, consistent with Land Disposal Restrictions, prior to off-site disposal. Appropriate measures will be taken to ensure that contaminated particles do not become airborne. Post-remedial sampling and analysis will be conducted to confirm complete removal. Figure 3 is a flowchart illustrating the decision process.

Remediation of Soils

Contaminated soils will be excavated and then screened to separate those particles too large to feed into the rotary kiln incinerator. Screened materials (greater than two inches in diameter) will be stockpiled. These materials will be analyzed to determine if on-site disposal is acceptable. If these cobbles are contaminated above health-based levels, they will be crushed and incinerated or disposed of in a permitted hazardous waste disposal facility as outlined in the paragraph above on off-site disposal of concrete. Appropriate measures will be taken to ensure that contaminated particles do not become airborne. Post-remedial sampling and analysis to confirm complete removal will be conducted. Figure 4 is a flowchart illustrating the decision process.

Incineration

The rotary kiln incinerator that will be employed at the site will have a past record of acceptable destruction of the site's contaminants of concern. Performance testing will be conducted to ensure that air emissions meet all applicable, relevant, and appropriate requirements (ARARs). Emission testing will include sampling for site contaminants and appropriate degradation by-products. At least one set of samples being evaluated for dioxins and furans.

Ash Disposal

Following incineration, the ash would be analyzed to determine the degree of contaminant destruction and leachability. If health-based cleanup goals are met the ash will be considered to be delisted and used for backfill on site. However, because certain metals have been identified as possible site contaminants, delisting of the treated waste may not be possible. In that case, the treated wastes would be stabilized and landfilled at a permitted RCRA hazardous waste disposal facility.

Groundwater

Wells will be sampled and analyzed quarterly for two years, then annually for an additional three years. A reassessment of the need for groundwater remediation would be triggered by two consecutive exceedances of the concentrations of indicator parameters representing the 10^{-6} carcinogenic risk level or a 1.0 Hzard Index. These levels are 0.1 μg/L for DDT and 2.0 μg/L for endosulfans. This would prompt a further evaluation of the groundwater conditions to determine whether groundwater remediation is necessary. If such additional remediation is necessary, it will be the subject of a subsequent ROD and consent decree or unilateral administrative order, or may be pursuant to the original consent decree.

All monitoring data will be reviewed at the end of five years. If the health-based concentrations in groundwater are not exceeded, and if levels show a decreasing trend as expected, groundwater monitoring will be discontinued after the five-year observation period. The site will then be considered to be clean closed under the requirements of RCRA.

X. STATUTORY DETERMINATIONS

Protection of Human Health and the Environment

The selected remedy will provide long-term protection of human health and the environment by removing the contaminated soil and eliminating it as a source of groundwater

FIGURE 3
DECISION FLOW CHART FOR CONTAMINATED STRUCTURES

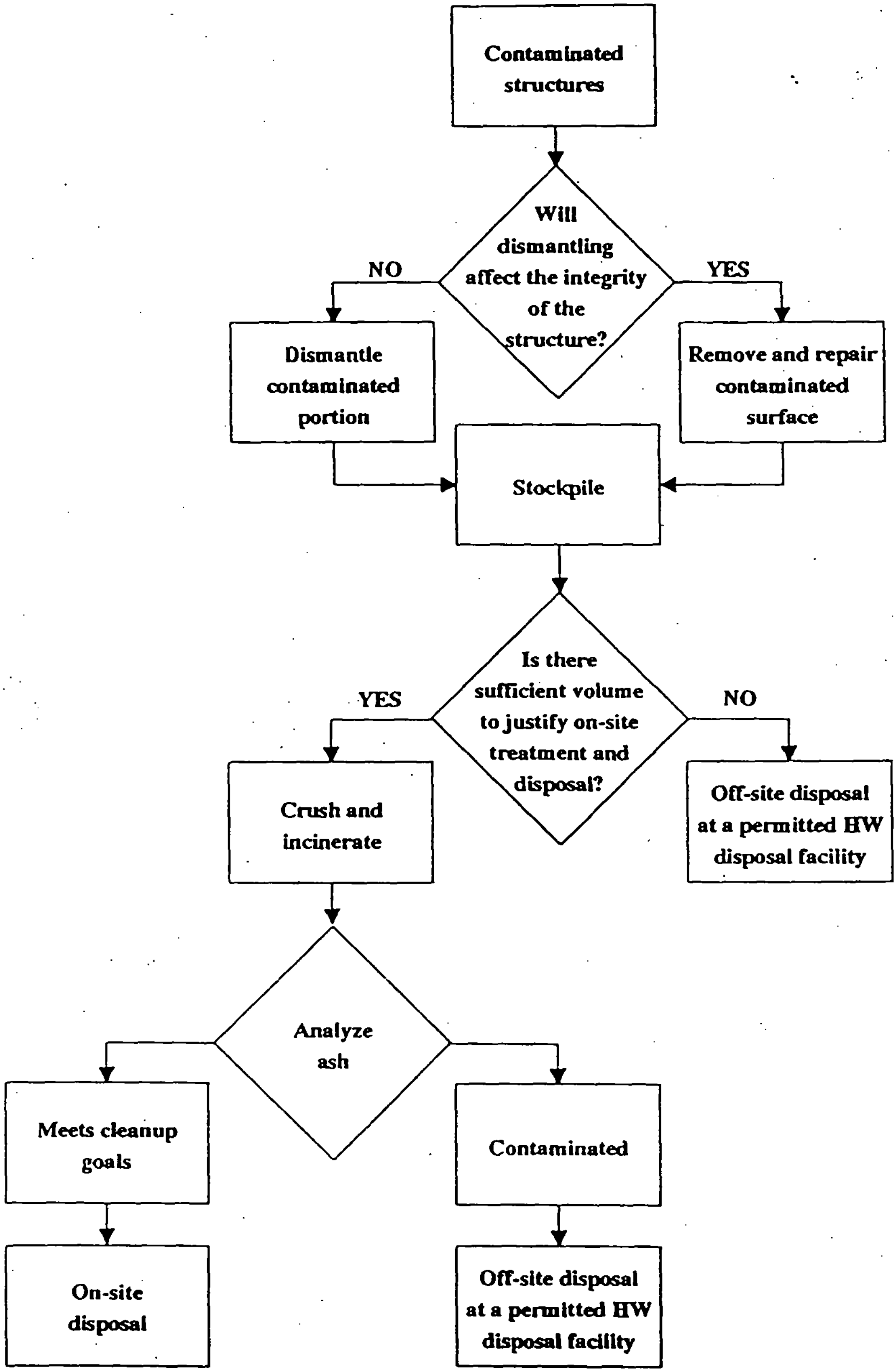
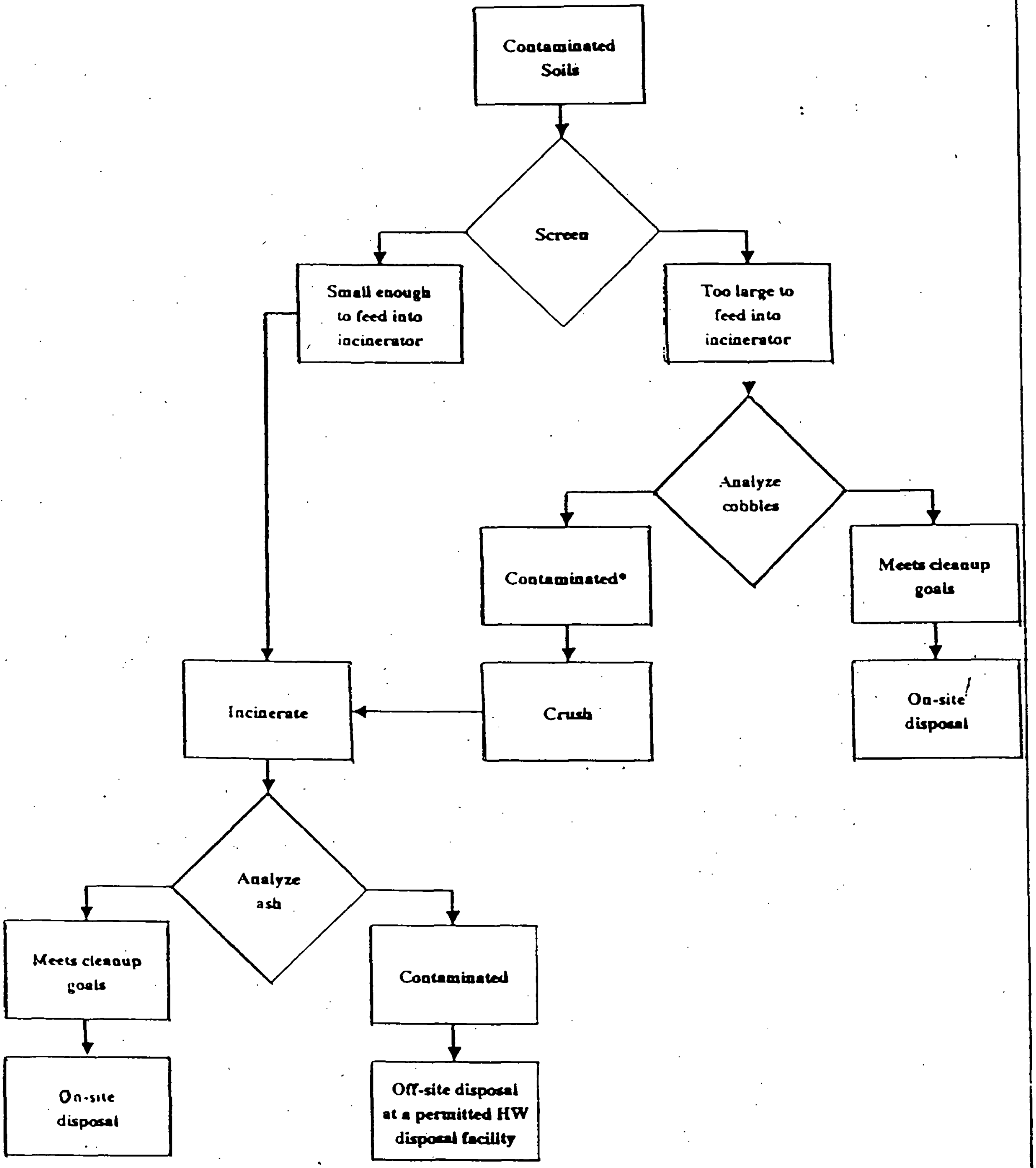


FIGURE 4
DECISION FLOW CHART FOR CONTAMINATED SOILS



* Contaminated at concentrations above health-based clean-up goals.

contamination. These measures will eliminate the exposure routes of inhalation and ingestion ofcontaminated soil particles, dermal contact with contaminated soil, and ingestion of contaminated groundwater.

Contaminated portions of concrete structures will also be removed to eliminate possible dermal exposure and potential future inhalation of contaminated concrete particles if the structures are ever demolished.

No unacceptable short-term risks or cross-media impacts will be caused by implementation of the remedy. Soil excavation and concrete removal could involve short-term exposure through inhalation of contaminated soil particles by site workers and nearby residents, and dermal contact with contaminated soils by site workers. These exposures can be eliminated through the use of air monitoring and proper dust control measures during remedial activities, and by implementing a strict site-specific health and safety plan. Inhalation exposure during the incineration phase will be reduced to acceptable levels with proper air emissions control equipment, which will be part of the incinerator unit.

Compliance with ARARs

The selected remedy will comply with all applicable, relevant, and appropriate requirements. The following ARARs apply:

Chemical-Specific ARARs

Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) are relevant and appropriate to the cleanup of groundwater at the FMC site. None of the contaminants of concern have been detected at levels exceeding their MCLs. No cleanup levels have been set for contaminant levels in soil under state or federal regulations that apply to the site-specific contaminants.

Location-Specific ARARs

No location-specific ARARs affect the remedial action to be implemented at the FMC site.

Action-Specific ARARs

Action-specific ARARs are technology-or activity-based requirements or limitations on actions affecting hazardous wastes. These requirements are triggered by the particular remedial activities selected to cleanup the site. Soils and groundwater contaminated with listed wastes must be handled as hazardous wastes, under RCRA, when these materials are excavated, demolished, or extracted. Incineration of these and other contaminated materials will require performance standards for hazardous waste incinerators to be met. Federal and State air standards are administered at the local level and emissions from the incinerator will comply with these standards.

Other action-specific ARARs include RCRA requirements for clean closure, as well as storage and off-site disposal of contaminated materials. Since hazardous materials may be placed as a result of the actions specified in this document, the Land Disposal Restrictions will apply; these requirements will be met by either meeting appropriate LDR standards, obtaining a treatability variance, or in the case of the ash, delisting, as the ash should no longer be hazardous.

Cost-Effectiveness

The selected remedy is cost effective when the degree of protectiveness it provides is compared to the overall protectiveness provided by the non-destructive technologies. When compared to the cost of the other alternatives involving incineration, the selected remedy is significantly more cost effective than off-site incineration. Alternative 3, soil washing and off-site incineration, does not offer any significant savings over the selected remedy, and is more expensive as the volume of soils to be remediated increases above the minimum estimate.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable (MEP)

Four of the alternatives, including the one selected, provide permanent treatment based remedies. In selecting a remedy emphasis was placed on the reduction of toxicity, mobility, and volume and long-term effectiveness and permanence. Alternatives 1, 2, and 7 clearly do not meet all of these goals.

The alternatives involving incineration all meet these criteria, and use the best available technology (BAT) for the site contaminants. Alternative 3, soil washing and off-site incineration, would employ an alternative treatment technology, but would not offer any cost savings to offset the greater degree of uncertainty associated with it. Alternative 5, off-site incineration, is significantly more expensive than any of the other options without offering any greater degree of effectiveness, and may involve greater short term risks. Alternative 4 was the least proven and did not offer savings that might justify its use.

Alternative 6, excavation and on-site incineration of contaminated soils and concrete debris, provides a permanent solution with a proven technology , minimal uncertainty, and minimal long-and short-term risks.

Preference for Treatment as a Principal Element

The statutory preference for treatment that permanently and significantly reduces the toxicity, mobility, or volume of hazardous substances as a principal element is met by the use of a thermal destruction technology. Contaminants will be destroyed to the maximum extent practicable. This technology will provide a permanent reduction in the mobility, toxicity, and volume of the site contamination.

XI. RESPONSIVENESS SUMMARY

Background of Community Involvement

EPA conducted community interviews in July 1987, and found community interest in the site to be low. The local officials expressed concern over the immediate protection of human health.

The concerns expressed to EPA during community interviews were:

1) Citizens wanted timely and accurate information on the site.
2) Citizens expressed concern over possible groundwater contamination because of Yakima's high water table.

Comments Received

EPA held a public comment period from June 25, 1990 to July 25, 1990. On August 11, 1990, EPA held a public meeting for interested members of the community. Three community members, a representative of the local air board, and FMC staff attended the meeting. No comments or questions were received during the public meeting or the comment period.

Appendix B
USEPA Explanation of Significant Differences, 23 April 1993

EPA/ESD/R10-93/500
1993

EPA Superfund
Explanation of Significant Differences:

FMC CORP. (YAKIMA PIT)
EPA ID: WAD000643577
OU 01
YAKIMA, WA
04/21/1993

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

1200 Sixth Avenue
Seattle, Washington 98101

EXPLANATION OF SIGNIFICANT DIFFERENCES

INTRODUCTION

Site name and Location:

FMC Corporation
Yakima, Washington

Lead and support agencies:

U.S. Environmental Protection Agency (EPA)
Washington State Department of Ecology

Statute that requires Explanation of Significant Differences (ESD):

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 117(c) and National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Section 300.435(c)(2)(i).

Need for an ESD:

During the course of the remedial action at the site, several changes to the remedy have proven to be necessary to account for unforeseen problems with excavation, the need for more extensive and deeper excavation than expected, and the development of new RCRA cleanup criteria which EPA determined were appropriate to apply to the cleanup. These changes encompass the following:

1) Minor change in soil cleanup criteria from a risk of 1x10- 6 to 5x10- 6 in response to engineering impracticability.

2) Increase in volume of soil to be excavated.

3) Determination that excavated cobble met the cleanup standards for soil and did not require treatment.

4) Change in the cleanup criteria for the warehouse floor.

Administrative Record:

This ESD will become part of the Administrative Record for the FMC Corporation Superfund site, which is available to the public at the following two locations:

Yakima Valley Regional Library
102 Third Street
Yakima, Washington 98901

U.S. Environmental Protection Agency
1200 Sixth Avenue, HW-113
Seattle, Washington 98101

SITE BACKGROUND

FMC operated a plant to manufacture pesticide dusts and liquids on the site from 1951 to 1986. Pesticide dusts were formulated at the facility throughout its operation. Liquid products were formulated in the 1970s.

Between 1952 and 1969, FMC disposed of wastes containing pesticides in an on- site pit. The location of the pit was determined using historical aerial photographs, and confirmed during the Phase I Remedial Investigation (RI) conducted by Bechtel Environmental, Inc. (Bechtel), in 1987. An estimated 2000 lbs. of materials were discarded in the pit. Raw material containers, soil contaminated by leaks or spills from process equipment, broken bags, and off- specification materials were dumped into the excavated pit and covered with dirt. After 1969, waste materials were disposed of at Yakima Valley Disposal and Chem Securities in Arlington, Oregon. In 1982, the site was placed on the National Priorities List (NPL), based on high levels of pesticides. In 1986, after operations at the facility had ceased, FMC conducted a preliminary cleanup of the facility that included removal of all contents of the main facility warehouse and surface tanks, and washing the of warehouse floors and walls.

On July 31, 1987, EPA issued an Administrative Order On Consent requiring and authorizing FMC to conduct a Remedial Investigation/Feasibility Study (RI/FS) for the site. In November 1987, RI Phase I sampling conducted by FMC's consultant, Bechtel Environmental, Inc., confirmed "hot spots" of DDT and other pesticide contamination in the former disposal pit at levels of up to 25,000 mg/kg. Consequently, an Order On Consent For Necessary Response Actions was issued by EPA on May 31, 1988. Pursuant to this order, FMC performed a removal and properly disposed of the pit's contaminants.

The Phase I removal of the contents of the former disposal pit was performed in June 1988. The pit was excavated to a depth of 4 feet (the depth of the groundwater table at the time), and 500 tons of contaminated soil was removed. In March 1989, an additional 350 tons of soils were removed, which increased the depth of the excavation to approximately 8 feet. In both cases, the waste was disposed of in a permitted hazardous waste disposal facility.

A Phase II RI was conducted to investigate the rest of the site. The study, was completed in April 1990, and a Record of Decision (ROD) outlining the final site cleanup was issued September 14, 1990.

FMC agreed to implement the remedial action in a Consent Decree entered in the Eastern District of Washington on December 6, 1991. Design work on the project was completed in the Spring of 1992 with the remedial action commencing concurrently. The remedial action is expected to be completed in the summer of 1993.

CONTAMINANT PROBLEMS

As a result of site pesticide formulation operations, site soils, both surface and subsurface, and on-site buildings and concrete sumps and pads were contaminated with pesticides. The contaminants of concern for human health at the site are DDD (1,1-dichloro-2,2-bis(p-chlorophenol) ethane), DDE (1,1,-dichloro-2,2-bis(p-chlorophenol) ethylene), DDT (1,1,1-trichloro-2,2-bis(p-chlorophenol) ethane), dieldrin, endosulfans, malathion, ethion, ethyl parathion, parathion, DNOC (4,6-dinitro-o-cresol), cadmium, and chromium VI. All of these compounds are considered toxic. Cadmium, chromium VI, DDD, DDE, DDT, and dieldrin are also carcinogenic. The contaminants of concern for potential environmental effects are DDD, DDE, DDT, endosulfans, ethion, malathion, and zinc.

Groundwater contamination has been found at low concentrations, most notably the organo-chlorines (DDT, DDD and DDE) and endosulfans. Since the removal of material from the disposal pit in 1988 and 1989, pesticide contamination in the groundwater has been below drinking water standards.

REMEDY SELECTED IN THE RECORD OF DECISION (ROD)

The selected remedy in the ROD addressed the remaining contaminated soils and structures at the site.

The selected remedy called for:

- Sampling of soils and concrete structures to refine the RI/FS estimate of the lateral and vertical extent of material requiring treatment,
- Excavation of contaminated soils exceeding cleanup levels,
- On-site incineration of contaminated soils,
- Dismantling of contaminated slabs and portions of the buildings that are determined to exceed cleanup goals,
- On-site incineration of contaminated concrete and debris or disposal at a RCRA-Subtitle C permitted hazardous waste disposal facility, depending on volume,
- Analysis of incinerator ash to determine the degree of contaminant destruction and leachability, and delisting of the ash if health- based cleanup goals are met,
- Groundwater monitoring for 5 years to confirm source removal.

Groundwater monitoring will continue quarterly for two years following completion of the remedial action, and then for three more years on an annual basis. If contamination is detected above the cleanup goals, and groundwater remediation proves to be necessary, it will be addressed in a subsequent ROD.

The ROD estimated the amount of contaminated soil at the site to be 900 to 4000 cubic yards.

SIGNIFICANT DIFFERENCES AND BASES FOR THEM

I) Change in Site Cleanup Goals:

Two changes in the site cleanup goals have become necessary as a result of the mechanical difficulties associated with excavation below the water table, and the discovery that the depth of the contamination in some areas was greater than expected.

A) Change in cleanup goal from a risk of 1x10-6 to a risk of 5x10-6 for excavation at depths greater than 2 feet, but less than 7 feet below ground surface

The cleanup goals in the ROD were the attainment of an overall site hazard index of less than or equal to 1, and the attainment of an overall site excess cancer risk of 1x10-6, both based on a residential scenario. When site excavation began, the water table was at its seasonal low of approximately 7 feet below ground surface (bgs). Over the course of the excavation the water table rose to its seasonal high of 6 inches to 1 foot bgs. (The water table is at 7 feet bgs during the winter and early spring, and at 6 inches to 1 foot bgs the rest of the year.) The majority of the site excavation was of material below the water table. Excavation below the water table resulted in sloughing of the trenches and spillage of small quantities of excavated material back into the holes as the material was removed. Thus, minimal recontamination occurred as excavation progressed. Continued excavation was not able to alleviate the recontamination problem. In addition, some previously excavated areas became submerged and out of reach of the construction equipment, making re-excavation impossible.

The contaminant concentrations resulting from recontamination equate to risk levels well within the EPA acceptable risk range of 1x10-6 to 1x10-4. To account for the technical impracticability of reaching the original 1x10-6 cleanup goal, EPA adjusted the cleanup goal (and the contaminant levels associated with it) to a risk of 5x10-6 for areas below 2 feet (which is below the high water table) to avoid ineffective attempts at excavation of residual contamination. For most of the site the material with concentrations above the adjusted cleanup goal was removed by excavations ranging from 2 feet to 7 feet bgs. The areas where contaminant depth exceeded 7 feet bgs are discussed below.

B) Determination that the extent of the excavation would not exceed 7 feet below ground surface

Samples from 7 feet bgs taken during excavation of the drum washing area and the tank farm (two adjacent areas on the southern end of the site), contained contaminant concentrations equating to risk levels above the cleanup goals. EPA determined that excavation below 7 feet was technically impracticable, and that the material did not pose an exposure risk or a threat to the groundwater based on the following:

1) The water table in the area fluctuates from a depth of 7 feet bgs to a high level of 6 inches to 1 foot bgs. There is no chance of incidental direct exposure to soil 7 feet bgs which is always underwater. In addition, because the high water table is at 6 inches to 1 foot bgs, there is no potential for future subsurface construction leading to exposure of the remaining contaminated soil. Because there is no probable current or future exposure to this material it does not present a direct exposure risk.

2) Prior to excavation of the site, the contaminant levels in the groundwater were below the ROD action levels. The bulk of the contamination has been removed during this remedial action, reducing the impact on the groundwater. The groundwater will be monitored for 5 years following the completion of the remedial action. If contaminant levels are found above action levels, EPA will evaluate the need for implementing a groundwater remedy.

II) Change in Volume of Soil to Be Excavated:

The ROD estimated that there would be from 900 to 4000 cubic yards of contaminated material. As a result of contamination extending deeper than expected, approximately 5200 cubic yards of material was excavated.

III) Determination that Cobble Met the Soil Remediation Requirements and So Did Not Require Incineration:

Approximately one third of the material excavated was cobble, approximately 2 to 6 inches in diameter. It was crushed and sampled, and found to meet the health based and RCRA based requirements of the Consent Decree Performance Standard. Therefore, the cobble did not require incineration prior to use as backfill.

IV) Modification to the Cleanup Criteria for the Warehouse Floor:

At the time the remedy for the site was selected, there were no promulgated cleanup standards applicable to buildings. EPA developed site specific criteria for the warehouse. The exposure assumptions for determining the cleanup criteria were based on contact with the walls. A wipe test using a filter to swab walls and floors was to be analyzed and the results compared to the cleanup standards.

Subsequent to the beginning of site excavation, RCRA developed technology based criteria for decontamination of concrete debris (57 Fed. Reg. 371904). The new RCRA criteria were developed to allow concrete to be disposed of, after the applicable treatment, without further testing. In the case of the warehouse, the cleanup criteria in the ROD were based on decontamination of the building for reuse. However, EPA has determined that it is appropriate to apply the new RCRA criteria to the warehouse floor.

The RCRA decontamination criterion applied at the site calls for scarification to a depth of 0.6 cm (approximately 1/4 inch), and removal of any additional visual staining. As part of the remedial action, the warehouse floors were scarified to a depth of 1/4" or more and no visible contamination remained. It was therefore determined that the warehouse floors were clean. The floors will be restored during the remedial action to allow the building to return to functional use.

AFFIRMATION OF STATUTORY DETERMINATIONS

Considering the new information developed during the remedial action and the resulting changes in the selected remedy, EPA believes that the remedy remains protective of human health and the environment. The revised remedy utilizes permanent solutions to the maximum extent practicable for this site and is cost-effective. It complies with the NCP and other federal and state requirements that are applicable or relevant and appropriate to this remedial action.

PUBLIC PARTICIPATION ACTIVITIES

This ESD will become a part of the Administrative Record for the site. Because there has been little community interest in the site, the ESD will be made available to the public, but will not be distributed for public comment. For additional information regarding this ESD, please contact the Superfund Site Manager for the FMC Corporation site:

Kevin Rochlin
1200 Sixth Avenue, HW-113
Seattle, Washington 98101
(206) 553-2106

Kevin Rochlin 4/19/93
Kevin Rochlin, Remedial Project Manager Date

Barbara McAllister Acting 4/21/93
Randall F. Smith, Director, Hazardous Waste Division Date

Appendix C
Third Five-Year Review Report

Third Five-Year Review Report

for

FMC YAKIMA

Superfund Site

Yakima, Washington

SEPTEMBER 2008

PREPARED BY:

United States Environmental Protection Agency
Region 10
Richland, Washington

Approved by:

Daniel D. Opalski, Director
Office of Environmental Cleanup
U.S. EPA, Region 10

Date:

9/19/2008

Third Five-Year Review Report

For

FMC YAKIMA

Superfund Site

Yakima, Washington

SEPTEMBER 2008

Table of Contents

APPENDICES

List of Acronyms

ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EPA	United States Environmental Protection Agency
CFR	Code of Federal Regulations
ESD	Explanation of Significant Difference(s)
FY	Fiscal Year
IRIS	Integrated Risk Information System
MCL	Maximum Contaminant Level
MTCA	Model Toxics Control Act (Washington State)
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
PQL	Practical Quantitation Level
PRP	Potentially Responsible Party
RA	Remedial Action
RAO	Remedial Action Objective
RD	Remedial Design
RfD	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
µg	micrograms
WDOE	Washington Department of Ecology

Executive Summary

In December 1992, FMC completed remedial action at the FMC Yakima Superfund Site. FMC had operated a pesticide formulation plant at the site from 1951 to 1986. The cleanup was conducted pursuant to a Consent Decree and in conformance with the 1990 Record of Decision (ROD). A 1993 Explanation of Significant Differences (ESD) addressed the impracticability of cleaning up contaminated soil below the low water table and provided for the removal of contaminated concrete surfaces, among other changes to the initial on-site incineration remedy.

As part of the cleanup, 5,600 cubic yards of contaminated material were excavated and treated through incineration. An additional 1,000 cubic yards of contaminated soil were disposed off site at an approved hazardous waste landfill. The concrete floor of the warehouse was scarified to remove contamination and then restored so that the warehouse was made ready for reuse.

Hazardous substances were left on site at depths generally below 7 feet from grade (following soil removal and treatment) at concentration levels high enough to seasonally impact groundwater quality. The groundwater has been regularly monitored by an EPA-approved network of wells and remains contaminated, mainly by dieldrin. Dieldrin was included in the ROD as a contaminant of concern (COC) for soils but not for groundwater, because it was rarely detected during the Remedial Investigation. It is listed as a probable carcinogen in EPA's toxicological database known as Integrated Risk Information System (IRIS). Levels of dieldrin and its breakdown product aldrin (a closely related chemical with nearly identical risk levels) rose dramatically during the soil removal, and then dropped and stabilized, but at concentrations about an order of magnitude higher than before the excavation. The ROD listed two primary contaminant groups: endosulfans and the DDT series. Endosulfans, like dieldrin/aldrin, rose dramatically following remedy implementation, but the endosulfan Reference Dose (RfD) was changed in IRIS so that even the elevated levels were no longer considered a risk. Endosulfan levels have since dropped and stabilized. Groundwater concentrations of the DDT series dropped dramatically following the soil excavation, and they are no longer detected.

The remedy is currently protective despite the continued presence of dieldrin for two primary reasons. First, this contaminant is at low levels and does not travel very far in groundwater before being re-adsorbed onto soil particles. As a result, the plume extent is self-limiting. The plume expands and shrinks seasonally, with the largest plume existing in the late summer/early fall. At that time, the plume may reach the site boundary. Second, no one currently uses (or is likely to use) this shallow groundwater under the former FMC property for drinking water purposes. Consequently, there is only a very low probability of a complete exposure pathway for groundwater. The site is zoned industrial, the area is served by a municipal water supply, and the current owner is fully aware of the groundwater impairment. Nevertheless, to ensure that the exposure pathway cannot lawfully be completed, now or in the future, EPA will require that enforceable institutional controls, specifically a restrictive covenant pursuant to the Washington Uniform Environmental Covenant Act or an equivalent easement, are developed and implemented. These institutional controls will be selected in a ROD Amendment which will also include measures to prevent intrusion into the subsurface contamination.

The implemented soil remedy reduced the risks from direct contact with the soil to acceptable levels down to about 7-10 feet (a little below the seasonally low water table). Excavation below the water table was ruled out (by the ESD) based on impracticability, and the remedy, constructed as documented in the Remedial Action Report, was certified complete by EPA in December 1993. Contaminants were also removed from the interior of the site warehouse building, making it safe for reuse.

The remedy at this site currently protects human health and the environment because surface and near-surface soils have been remediated to below the cleanup goals and the groundwater plume is stable beneath the site and is not a source of drinking water. However, in order for the remedy to remain protective in the long term, institutional controls and a lower detection limit for aldrin and dieldrin need to be implemented.

The Superfund Sitewide Human Exposure Environmental Indicator Status for the site remains "Under Control" because soil exposures that could pose an unacceptable risk have been addressed and no one currently uses (or is likely to use) the shallow groundwater under the former FMC property for drinking water purposes.

The Groundwater Migration Environmental Indicator for the site remains “Under Control" because the only contamination ever detected in groundwater is in shallow groundwater at low levels and does not travel very far in groundwater before being re-adsorbed onto soil particles. As a result, the plume extent is self-limiting.

The Cross Program Revitalization Measure Status for the site is “protective for people under current conditions” due to the success of the remedial action for soils. The site is being fully reused for light industrial purposes. Once the Institutional Controls are implemented as recommended, the site will fully meet the definition of “Ready for Anticipated Use.”

Five-Year Review Summary Form

SITE IDENTIFICATION

Site name *(from WasteLAN)*: FMC Yakima

EPA ID *(from WasteLAN)*: WAD000643577

Region: 10 | **State:** WA | **City/County:** Yakima, Yakima

SITE STATUS

NPL status: Final **X** Deleted Other (specify)____

Remediation status (choose all that apply): Under Construction Operating **X (LTRA)** Complete

Multiple OUs?* YES NO **X** | **Construction completion date:** 9/1/1993

Has site been put into reuse? YES **X** NO

REVIEW STATUS

Lead agency: EPA **X** State Tribe Other Federal Agency___________________________

Author name: Craig Cameron

Author title: Author affiliation: Project Manager, EPA, Region 10

Review period: 4/28/2008 to 9/29/2008

Date(s) of site inspection: 6/25/2008

Type of review:
Post-SARA *(Statutory)* **X** Pre-SARA NPL-Removal only
Non-NPL Remedial Action Site NPL State/Tribe-lead
Regional Discretion

Review number: 1 (first) 2 (second) 3 (third) **X** Other (specify)____________

Triggering action:
Actual RA Onsite Construction at OU #_____ Actual RA Start at OU#____
Construction Completion Previous Five-Year Review Report **X**
Other (specify)____

Triggering action date (from WasteLAN): 9/29/2003

Due date *(five years after triggering action date)*: 9/29/2008

* [“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. Institutional controls need to be developed and implemented.
2. The detection limits for aldrin and dieldrin are above the risk level of 1x10-6 cancer risk levels set in the ROD. Detection limits below the risk level are needed to adequately evaluate risk.
3. Dieldrin is not listed as a groundwater COC covered by the remedy even though it is a carcinogen and monitoring shows it is persistent at the site.
4. There is an opportunity for expansion of groundwater monitoring to coincide with both the high and low-water table conditions (early spring and early fall) to characterize seasonal fluctuations.
5. There is a need to ensure that any facility expansion by Stephens Metal Products does not affect the monitoring well network and sampling.
6. There is an opportunity to cost-effectively optimize groundwater monitoring, including abandonment of two no longer needed wells and inclusion of one of the existing piezometer wells to more completely define the down-gradient plume boundary.

Recommendations and Follow-up Actions:

1. Develop institutional controls, modify remedy to require institutional controls, and implement institutional controls.
2. Develop an analytical method sensitive enough to result in detection limits for aldrin and dieldrin that are lower than the 1x10-6 excess cancer risk.
3. Modify remedy to add dieldrin as a groundwater COC .
4. Monitor groundwater in April 2012 and late September/early October 2012 to characterize seasonal fluctuations.
5. Maintain well access despite facility expansion at Stephens Metal Products.
6. Abandon wells W-7 and W-9A&B (following state regulations) and add the shallowest piezometer well (W-8C) to the wells to be sampled in the groundwater monitoring plan

Protectiveness Statement(s):

<u>Protective in the short term</u> – The remedy currently protects human health and the environment because surface and near-surface soils have been remediated to below the cleanup goals and the groundwater plume is stable beneath the site and is not a source of drinking water. However, in order for the remedy to remain protective in the long-term, institutional controls and a lower groundwater detection limit for aldrin and dieldrin need to be implemented. The lower detection limit is necessary to ensure that monitoring information used to support future NPL deletion is correct in that the site meets cleanup goals.

Other Comments:

None.

Third Five-Year Review Report
FMC YAKIMA
SUPERFUND SITE
Yakima, Washington

I. INTRODUCTION

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

The U.S. Environmental Protection Agency (EPA) is preparing this Five-Year Review Report pursuant to CERCLA §121(c) and the National Contingency Plan (NCP). CERCLA §121(c) states:

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

The Agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) which 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.

Region 10 of the EPA conducted the Five-Year Review of the remedy implemented at the FMC Yakima Site, located in Yakima, Washington. This Third Five-Year Review for the FMC Yakima Site was conducted by the EPA Remedial Project Manager (RPM) from June 2008 through September 2008. This report documents the results of the review.

This is the third five-year review for the site. The triggering action for this statutory review was the completion of the Second Five-Year Review Report, dated September 29, 2003. The five-year review is required because hazardous substances, pollutants, or contaminants remain in the soil and groundwater above levels that allow for unlimited use and unrestricted exposure.

II. SITE CHRONOLOGY

Table 1. Chronology of Site Events
FMC YAKIMA

Event	Date
FMC operations	1951 thru 1986
Preliminary Investigations	1982
NPL Listing	September 8, 1983
Pre-MTCA State Water Program Discharge or Spill Response Order (State)	June 10, 1983
Administrative Order on Consent (EPA) – RI/FS	July 31, 1987
Administrative Order on Consent (EPA) – Removal	May 31, 1988
Removal Completion	April 1990
ROD Issuance	September 14, 1990
RD/RA Consent Decree Entry	December 6, 1991
Incineration Began	November 1992
ESD Issuance	April 21, 1993
Incineration and Construction Completed	August 1993
Final RA Report	July 1, 1994
Groundwater Monitoring Plan Approval	November 1993
Certification of Completion Issuance	December 1993
Property sold to current owners	1995
First Five-Year Review	September 1998
Second Five-Year Review	September 2003

III. BACKGROUND

Site Location and Description

The FMC Superfund Site was placed on the National Priorities List (NPL) [also known as Superfund Site List] on September 8, 1983.

The FMC Yakima Superfund Site (site) is located at 4 West Washington Avenue, approximately 1 mile east of the Yakima Municipal Airport in Yakima, Washington (see Figure 1 in Appendix A.1). The site is located in the lower Ahtanum Valley, an area of about 100 square miles in central Yakima County, Washington. The site is a 58,000-square-foot fenced area that was leased by FMC Corporation (FMC) from Union Pacific Railroad and is bounded to the east by Union Pacific Railroad tracks. Most of the surrounding area is zoned light-industrial. There are a few parcels bordering the western side of the property (across Longfibre Road) that are zoned residential (see Figure 6 in Appendix A.1). However, these parcels are up-gradient from the direction of groundwater flow. There are no homes nearby.

FMC formulated pesticide dusts at the site from 1951 until 1986. Pesticide liquids were formulated there in the 1970s. Between 1952 and 1969, FMC disposed of wastes containing pesticides in an on-site pit. An estimated 2,000 pounds of waste consisting of raw material containers, soil contaminated by leaks or spills, and process wastes was dumped into the excavated pit and covered with soil. After 1969, waste materials were disposed of at Yakima Valley Disposal in Yakima and at Chemical Waste Management's Arlington, Oregon, facility.

The site slopes to the southeast with a grade of less than 1 percent. The site is 1.5 miles west of the Yakima River (outside of the 500-year flood plain) and 1 mile north of Wide Hollow Creek. No surface water bodies exist on site. Vegetation within the fenced site and over the residual groundwater plume consists of tall weeds and grasses. The groundwater beneath the plume occurs in alluvial silty sands and gravels and flows southeastward toward the Yakima River. Groundwater levels fluctuate seasonally with the high in the fall (average of 2 feet below ground surface (bgs)) corresponding to the agricultural growing season (regional irrigation), and a low in the winter (approximately 7 feet bgs). Groundwater flows in a southeasterly direction with a seepage velocity of about 7 feet/day. There are currently no wells used for drinking water in the shallow aquifer within a 1-mile radius.

The site currently contains an active metal fabrication facility, parking lot, and equipment storage yard owned by Stephens Metal Products. The ownership of this parcel was confirmed in 2008 with a title search. Two businesses have purchased parts of the original FMC leased property west of Stephens Metal Products and have erected buildings, a Country Farm & Garden True Value Hardware store (including a garden nursery) and Butlers Welding and RV Accessories. Most current operations are on paved ground. Figure 2 in Appendix A.1 shows the structures at Stephens Metal Products, the location of the former disposal pit, and the groundwater monitoring wells.

Site History

A. Early Investigations

Waste materials and an estimated 2,000 pounds of various chemicals were dumped into an on-site disposal pit between 1952 and 1969. A preliminary investigation was conducted for EPA in 1982, and the site was placed on the NPL later that year based on high levels of pesticides in site soils and surrounding groundwater. An Administrative Consent Order issued by the State of Washington Department of Ecology (WDOE) in 1983 required a study of the former disposal pit area. In 1986, after operations at the facility ceased, FMC claimed it removed all contents of the main warehouse and surface tanks and washed the warehouse floor and walls without EPA or WDOE oversight. EPA issued two Administrative Orders on Consent in 1987 and 1988 requiring a Remedial Investigation/Feasibility Study (RI/FS) and a removal and disposal of the pit contents, respectively. FMC's removal of the pit contents occurred in two phases in 1988 and 1989 while the RI/FS was being completed. A Record of Decision (ROD) was issued on September 14, 1990, to address all post-removal residual site contamination. Subsequent remedial action included removal and incineration of contaminated soil and concrete as well as groundwater monitoring. Structures remaining on site included an office building, a warehouse with loading dock, and a parking lot.

B. Phase 1

A Phase I removal of the contents of the disposal pit (containing pesticide concentrations up to 25,000 mg/kg) was performed in June 1988 following a Phase I investigation of the pit. The pit was excavated to a depth of 4 feet (the depth of the groundwater table at the time), and 500 tons of contaminated soil were removed. In March 1989, an additional 350 tons of soils were removed, which increased the depth of the excavation to approximately 8 feet. All waste was disposed of at Chemical Waste Management's Arlington, Oregon, permitted hazardous waste disposal facility.

C. Phase II

A Phase II investigation, or completion of the RI/FS for the remainder of the site, was completed in April 1990. A Record of Decision (ROD) selecting final remedial action was issued on September 14, 1990. FMC entered into a Consent Decree to perform the remedial action which was entered in Federal District Court for the Eastern District of Washington on December 6, 1991.

D. Basis for Action

The basis for action was the release and presence of hazardous substances at the site at levels that could posed an unacceptable risk to human health if humans were exposed and to the environment if left unaddressed. At the time of the ROD the contaminated media of concern were the contaminated soils and structures at the FMC site. Concentrations of contaminants in groundwater were below health-based levels at the time; however, continued groundwater monitoring was called for to confirm the effectiveness of source removal in protecting groundwater.

The contaminants of concern for human health at the site were DDD (l,l-dichloro-2,2-bis(p-chlorophenol) ethane), DDE (1,1,dichloro-2,2-bis(p-chlorophenol) ethylene), DDT(l,l,l-trichloro2,2-bis(p-chlorophenol) ethane), dieldrin, endosulfans, malathion, ethion, ethyl parathion, parathion, DNOC (4,6-dinitroo-cresol), cadmium, and chromium VI. All of these compounds are considered toxic to humans; cadmium, chromium VI, DDD, DDE, DDT, and dieldrin are also carcinogenic. The contaminants of concern for potential ecological effects were DDD, DDE, DDT, endosulfans, ethion, malathion, and zinc.

Groundwater contamination had been found at low concentrations, most notably the organochlorines (DDT, DDD and DDE), dieldrin and endosulfans.

IV. REMEDIAL ACTION

A Record of Decision for remedial action was issued on September 14, 1990. After initiation of Remedial Action in 1992, EPA modified the selected remedy and cleanup goals on April 21, 1993, in an Explanation of Significant Differences (ESD). EPA deemed that changes were necessary due to difficulties encountered during implementation of the Selected Remedy, in particular the discovery that the depth of the contamination in some areas was greater than expected and below the water table. Both the ROD and ESD are discussed below, along with the remedial action objectives, cleanup goals, and implementation of the remedy.

A. Record of Decision

The remedial action objectives for the site included:

- Preventing human exposure to contaminated soil, structures, and debris that exceed health-based cleanup levels;

- Reducing the potential for the contaminated soil to act as a source for groundwater contamination; and

- Further defining the extent of groundwater contamination and confirming that contamination does not exceed health-based levels, or if the quality of the groundwater exceeds these levels during monitoring, evaluating the need to take appropriate measures as further response action.

The selected remedy in the ROD addressed the remaining contaminated soils and structures at the site. The selected remedy called for the following:

- Sampling of soils and concrete structures to refine the RI/FS estimate of the lateral and vertical extent of material requiring treatment,

- Excavation of contaminated soils exceeding cleanup levels,

- On-site incineration of contaminated soils,

- Dismantling of contaminated slabs and portions of the buildings that are determined to exceed cleanup goals,

- On-site incineration of contaminated concrete and debris or disposal at a RCRA Subtitle C permitted hazardous waste disposal facility, depending on volume,

- Analysis of incinerator ash to determine the degree of contaminant destruction and leachability, and delisting of the ash if health-based cleanup goals are met,

- Groundwater monitoring for 5 years to confirm source removal. Groundwater monitoring to continue quarterly for 2 years following completion of the remedial action, and then for 3 more years on an annual basis. If contamination was detected above the cleanup goals and groundwater remediation proved to be necessary, it would be addressed in a subsequent ROD. These goals were 0.1 µg/L for DDT (the 10^{-6} excess cancer risk level) and 2 µg/L for endosulfans (the 1.0 Hazard Index level at that time).

The ROD estimated the amount of contaminated soil at the site to be 900 to 4,000 cubic yards.

ROD Cleanup Goals

HEALTH - BASED CLEANUP LEVELS FOR CONTAMINATED CONCRETE AND SURFACES

Compound	Concentration (µg/100 cm^2)
DDD	6.5
DDE	4.6
DDT	4.6
Dieldrin	0.1
Endosulfans	10.0
Ethion	270.0
Malathion	8,200.0
Ethyl Parathion	2,400.0

Cleanup goals will be adjusted where multiple contaminants are found.

HEALTH - BASED CLEANUP LEVELS FOR CONTAMINATED SOIL

Compound	Concentration (mg/kg)
DDD	5.1
DDE	3.6
DDT	3.6
Dieldrin	0.076
Cadmium	8.0
Chromium VI	1.0
Endosulfans	4.2
Ethion	42.4
Malathion	1,695.0
Ethyl Parathion	11.0
DNOC	8.5
Zinc	500.0

B. Explanation of Significant Differences – Changes to the Remedy

1) Change in Site Cleanup Goals:
Two changes in the site cleanup goals became necessary as a result of the mechanical difficulties associated with excavation below the water table and the discovery that the depth of the contamination in some areas was greater than expected.

a) Change in cleanup goal from a risk of $1x10^{-6}$ to a risk of $5x10^{-6}$ for excavation at depths greater than 2 feet, but less than 7 feet bgs; and

b) Determination that the extent of the excavation would not exceed 7 feet bgs. EPA determined that excavation below 7 feet was technically impracticable, and that the material did not pose an exposure risk or a threat to the groundwater.

2) Change in Volume of Soil to Be Excavated:
The ROD estimated that there would be from 900 to 4,000 cubic yards of contaminated material. As a result of contamination extending deeper than expected, approximately 5,600 cubic yards of material was excavated.

3) Determination that Cobble Did Not Require Incineration:
Approximately one third of the material excavated was cobble, approximately 2 to 6 inches in diameter. It was crushed and sampled, and found to meet health-based and RCRA-based cleanup requirements. Therefore, EPA determined the cobble did not require incineration prior to use as backfill.

4) Modification to the Cleanup Criteria for the Warehouse Floor:
At the time the remedy was selected, there were no promulgated cleanup standards applicable to buildings. Subsequent to the beginning of site excavation, RCRA developed technology-based criteria for decontamination of concrete debris (57 Fed. Reg. 371904), which EPA determined appropriate to apply to the warehouse floor.

The RCRA decontamination criteria call for scarification to a depth of 0.6 cm (approximately 1/4 inch) and removal of any additional visual staining. As part of the remedial action, the warehouse floors were scarified to a depth of 1/4 inch or more, and no visible contamination remained. It was therefore determined that the warehouse floors were clean. The floors were restored to allow the building to return to functional use.

C. Remedial Action Implementation

The remedial design began on August 23, 1991. The design was performed in two phases to expedite the start of the remedial action. The excavation phase was approved April 23, 1992, and the remedial action started on that date. The design for the incineration phase was approved on May 30, 1992. Incineration began in November of 1992. On August 12, 1993, FMC notified EPA that construction activities were completed.

For cleanup purposes, the site was divided into several different areas based on historical usage or function. The excavation phase consisted of excavating contaminated material, followed by sampling the bottom and sides of the excavations to determine if the cleanup standards were met. If the remaining material was still above cleanup standards, excavation and sampling of an area continued until the cleanup standards were met. Contaminated material was stockpiled in a lined area on the west side of the property prior to incineration. At the conclusion of the excavation phase, the material was incinerated. Incinerator ash was stored in bags until sampling determined that it met the required standards. The ash was then used as a soil cover over the cobble backfill.

During the excavation phase, it was determined that contamination depth was greater than estimated in the RI/FS. In addition, excavation unearthed a second pesticide disposal pit located directly west of the first pit. These factors resulted in a significant increase in the amount of soil excavated and incinerated. During the remedial action, 5,600 cubic yards of contaminated material were excavated and treated.

A number of changes in the site cleanup goals became necessary as a result of the mechanical difficulties associated with excavation below the water table and the discovery that the depth of the contamination in some areas was greater than expected.

1) The cleanup goals were changed from an excess cancer risk of 1×10^{-6} to a risk of 5×10^{-6} for excavation at depths greater than 2 feet, but less than 7 feet bgs. These levels were set for industrial use. The cleanup goals in the ROD were the attainment of an overall site hazard index of less than or equal to 1, and the attainment of an overall site excess cancer risk of 1×10^{-6}, both based on residential use exposure. When site excavation began, the water table was at its seasonal low of approximately 7 feet bgs. Over the course of the excavation the water table rose to its seasonal high of 2 feet bgs. (The water table is at 7 feet bgs during the winter and early spring, and at 2 feet bgs the rest of the year.) The majority of the site excavation was of material below the seasonal high water table. Excavation below the water table resulted in sloughing of the trenches and spillage of small quantities of excavated material back into the holes as the material was removed. Thus, minimal recontamination occurred as excavation progressed. Continued excavation was not able to alleviate the recontamination problem. In addition, some previously excavated areas became submerged and out of reach of the construction equipment, making re-excavation impossible.

The contaminant concentrations resulting from recontamination were calculated to equate to risk levels well within the EPA acceptable risk range of 1×10^{-6} to 1×10^{-4}. To account for the technical impracticability of reaching the original 1×10^{-6} cleanup goal, EPA adjusted the cleanup goal (and the contaminant levels associated with it) to a risk of 5×10^{-6} for areas below 2 feet (which is below the high water table) to avoid ineffective attempts at excavation of residual contamination. For most of the site, the material with concentrations above the adjusted cleanup goal was removed by excavations ranging from 2 feet to 7 feet bgs. The areas where contaminant depth exceeded 7 feet bgs are discussed below.

2) Samples from 7 feet bgs taken during soil excavation of the drum washing area and the tank farm (two adjacent areas on the southern end of the site), contained contaminant concentrations equating to risk levels above the cleanup goals. EPA determined that excavation below 7 feet was technically impracticable, and that the material did not pose an exposure risk or a threat to the groundwater based on the following:

> a) The water table in the area fluctuates from a depth of 7 feet bgs to a high level of 6 inches to 1 foot bgs. There is no chance of incidental direct exposure to soil 7 feet bgs which is always underwater. In addition, because the high water table is at 6 inches to 1 foot bgs, there is no potential for future subsurface construction leading to exposure of the remaining contaminated soil. Because there is no probable current or future exposure to this material, it does not present a direct exposure risk.

b) Prior to excavation, the contaminant levels in the groundwater were below the health-based levels. The bulk of the contamination was removed, reducing the impact on the groundwater. The groundwater was required to be monitored for 5 years following the completion of the remedial action.

3) As a result of contamination extending deeper than expected, approximately 5,600 cubic yards of material were excavated.

4) It was determined that the cobble met the soil remediation requirements and so did not require incineration. Approximately one third of the material excavated were cobbles, approximately 2 to 6 inches in diameter. They were crushed, sampled, and found to meet the health-based and RCRA-based requirements of the Consent Decree Performance Standard. Therefore, the cobbles did not require incineration prior to use as backfill.

5) EPA developed site-specific criteria for the warehouse. The exposure assumptions for determining the cleanup criteria were based on contact with the walls. A wipe test using a filter to swab walls and floors was to be analyzed and the results compared to the cleanup standards.

Subsequent to the beginning of site excavation, RCRA developed technology-based criteria for decontamination of concrete debris (57 Fed. Reg. 371904). The new RCRA criteria were developed to allow concrete to be disposed of, after the applicable treatment, without further testing. In the case of the warehouse, the cleanup criteria in the ROD were based on decontamination of the building for reuse. However, EPA determined that it was appropriate to apply the new RCRA criteria to the warehouse floor.

As part of the remedial action, the warehouse floors were scarified to a depth of 1/4 inch or more and no visible contamination remained. It was therefore determined that the warehouse floors were clean.

At the conclusion of the remedial action after demobilization of the incinerator, FMC determined that 1,000 cubic yards of additional soil under the stockpile liner were contaminated due to breaches in the liner. Equipment operation on the stockpile area had punctured the line in a number of places, and precipitation leached contaminants from the stockpile to the ground below. This additional contaminated soil was sent off site to Chemical Waste Management's Arlington, Oregon, facility for disposal.

Close-out and Monitoring Activities

A letter dated August 12, 1993, from FMC notified EPA that the physical activities at the site were completed. EPA conducted an inspection of the site on August 19, 1993, and found that no additional work was required.

The groundwater monitoring program was conducted by FMC from December 1993 until May 1996 on a quarterly basis, and later, on a semiannual basis. The frequency of the monitoring program was reduced after the first five-year review to every other year in the early fall, the worst-case season, and then further reduced to where it is now performed only in the fall prior to preparation of the five-year review (once every 5 years).

V. PROGRESS SINCE LAST REVIEW -- CURRENT STATUS

The EPA project manager witnessed FMC's October 2007 groundwater sampling on October 29. Results of the sampling and analysis were reported in May 2008. Pesticides continue to be detected in groundwater including dieldrin (an organochloride) and endosulfans. Tedion and alachlor were detected prior to the last five-year review, but were not detected in 2007. Aldrin and DDT were not detected in either 2002 or 2007.

Since the removal of material from the disposal pit in 1988 and 1989, pesticide contamination in the groundwater has been below drinking water standards. However, maximum contaminant levels (MCLs) have not been established for aldrin and dieldrin. Also, the practical quantitation limit (PQL) for both aldrin and dieldrin is 0.05 µg/L, which is above the $1x10^{-6}$ cancer risk level established as the groundwater cleanup goal in the ROD.

Groundwater monitoring results over the years have supported FMC's and EPA's evaluations that demonstrate the extent of the organochlorine compound plume is stable (i.e., not expanding or changing position). Seasonal fluctuations have been observed as the regional recharge of irrigation water raises the shallow groundwater table. Groundwater contamination at the site is believed to be the result of the gradual mobilization of residual soil contamination at the former disposal pit location and from other nearby areas.

EPA agreed to allow FMC to halt removal excavations at a depth of approximately 7 feet below grade where groundwater was encountered. As anticipated, analytical results from post-excavation samples indicated soil concentrations of organochlorine compounds greater than ROD cleanup levels were present in soils beneath the bottom of the excavation. Residual soil contamination at the base of the excavation is in direct contact with groundwater during periods of average and seasonally high groundwater levels.

The screened cobble backfill is much more permeable since the fines (silt and sand) were removed. As a result, groundwater flows through this area more easily than before the excavation and at a faster rate than the surrounding areas, especially when the groundwater levels are elevated during the summer and fall irrigation season. Since the cobbles are more permeable than the surrounding soils, groundwater elevations are slightly lower within this area immediately adjacent to and above soil with residual organochlorine compound contamination. Excess groundwater is pulled through those residually contaminated soils into the cobble backfill and drawn in a cross-gradient direction toward the former disposal pit area. As a result, maximum concentrations of organochlorine compounds are typically detected in monitoring wells immediately down gradient after the seasonal high water table occurs. Figure 2 in Appendix A.1 shows the groundwater table elevations across the site, while Figure 3 in Appendix A.1 shows the 2007 contaminant concentrations including an estimate of the extent of contamination.

When the ROD was issued, pesticide contaminants of concern in groundwater were endosulfans and DD-series compounds (DDD, DDE, and DDT). The non-carcinogenic hazard index for endosulfans is equal to 1, at a concentration of 200 µg/L – 100 times greater than when the ROD was issued in 1990. The concentration of endosulfans in site groundwater is significantly less than 200 µg/L; however, EPA is requiring the continued monitoring of endosulfan because it is a suspected endocrine disrupter, and the chronic toxicity of that entire class of chemicals is under review by EPA.

The 2007 groundwater samples contained low levels of pesticides (see Table 2 or Figure 3 in Appendix A.1). The highest detected level for dieldrin (0.14 µg/L) occurred at well W-12A (see Table 2 or Figure 3). The highest detected level of endosulfans (4.27 µg/L) was also found at well W-12A. When this data is plotted with data from previous monitoring events, an overall decreasing trend can be observed (see Figures 4 and 5 from Appendix A.1) since the completion of soil remedial action, although dieldrin concentrations remain above pre-excavation levels.

A site visit was conducted on June 25, 2008. Its purpose was two-fold; to conduct interviews and to observe site conditions as part of the five-year review. The site conditions are essentially the same as were observed during the last five-year review site inspection on September 4, 2003. All wells were locked and most were in excellent condition. The concrete well head for W-17 appeared to be a little higher in profile (less flush with the ground surface), possibly due to frost heave. The 2007 monitoring report says that the top of the casing and the locking cap for W-17 were repaired; however, it is the concrete well head for W-7 that appears to have been repaired. Photographs of the well locations are included in Appendix A.4. The site is operated by a metal fabricator which uses the field behind the remaining structure for open air storage of metal parts and equipment. The remainder of the fenced field is natural grasses and weeds.

Besides Stephens Metal Products (containing the monitoring well network), two other businesses are located just west of the site, Country Farm & Garden True Value Hardware, including an outdoor nursery area with planters on asphalt, and Butlers Welding and RV Accessories. (See photographs of the three business locations in Appendix A.4.) Interviews were conducted on site as part of the July 25 site inspection (one was conducted by telephone on July 24) (see Appendix A.3 for interview records). In all cases, slab foundations and shallow footings were used in the construction of the buildings. Large portions of these properties are also paved. No problems or issues were encountered during or since the construction. No issues were reported related to site environmental conditions.

Groundwater at the site and immediate vicinity is not currently used for domestic, industrial, or agricultural purposes. Two private wells were sampled during the RI, one up-gradient and one down-gradient of the site. The area is served by City of Yakima water, and the wells were used only for sampling and possibly for yard irrigation. No site contaminants were detected in either well. A well canvass was conducted in October 1988 and found that no known down-gradient wells were used for drinking water within a 1-mile radius. Prior to the first five-year review, water well records were obtained from WDOE and reviewed for wells located within a 1-mile radius. Those record searches did not identify any wells used for domestic, industrial, or agricultural purposes down-gradient of the site. No new drinking water wells in the vicinity of the site were identified during the June site visit, and an August 5, 2008, search of the WDOE well database showed no evidence for any recently installed drinking water wells in the area. The search did turn up a few older logs for water wells in the general area, but all of them were at least 1/4 mile away from the stable site plume. Based on these surveys, EPA concludes there currently are no nearby domestic wells, all contemporaneous wells in the vicinity were evaluated during the RI/FS, and no one is currently using groundwater contaminated at the site for drinking or other purposes.

However, there are no institutional controls limiting or restricting any future use of groundwater or to prevent intrusion into the contamination zone at depth. Monitoring wells associated with the site are locked to prevent access by unauthorized personnel.

A. Protectiveness Statement from the First Five-Year Review

"The remedy selected for this site remains protective of public health and the environment. The current remedy is meeting the cleanup goals in the ROD, and ESD. Continued evaluation of the site monitoring data will be maintained to assure continued protectiveness."

B. Status of the Recommendations and Follow-up Actions from the First Five-Year Review

Recommendations from the first five-year review were to continue monitoring and to consider implementation of institutional controls. Monitoring has continued on a regular basis and the results of that monitoring are documented in this review. No action was taken to implement institutional controls.

C. Protectiveness Statement from the Second Five-Year Review

"Based on the Technical Assessment for the (Site), the remedy is considered protective in the short-term; because there is no evidence that there is a current exposure."

D. Status of the Recommendations and Follow-up Actions from the Second Five-Year Review

Recommendations included monitoring groundwater in advance of the next five-year review and that institutional controls should be developed by December 2005.

VI. FIVE-YEAR REVIEW PROCESS

This Five-Year Review was conducted according to procedures in OSWER Directive 9355.7- 03B-P, Comprehensive Five-Year Review Guidance. Activities in this review consisted of:

1) Review of site-related documents,
2) Review of monitoring data,
3) Discussions with current on-site businesses,
4) Site visit and inspection,
5) Well survey,

6) Community relations activities, and
7) Preparation of the Five-Year Review Report.

Documents reviewed for this report include:

Bechtel, 1990, *Phase II Remedial Investigation Report for a Former Pesticide Formulation Facility in Yakima, Washington:* Report to FMC dated April, 1990.

EPA, 1990, *ROD for FMC Pesticide Formulation Facility Yakima, WA*, dated September 14, 1990;

Bechtel, 1994, *Remedial Action Completion Report:* Report to FMC dated May, 1994;

ERM, 1994, *Long-Term Monitoring Plan:* Report to FMC dated June 1994;

DOJ, 1991, *Consent Decree -USA vs. FMC Corp*. dated December 6, 1991;

EPA, 1993 *Explanation of Significant Differences* dated April 24, 1993;

EPA, 1993 *Superfund Preliminary Site Closeout Report FMC Corp Yakima WA*, dated Sept. 1, 1993;

EMR, *2003 Groundwater Sampling Program Fall 2002 Results FMC Corporation, Former FMC Pesticide Formulation Facility, Yakima, Washington*;

Parsons, 2008 *Five-Year Report Fall 2007 Groundwater Monitoring Activities, Former FMC Pesticide Formulation Facility 4 West Washington Avenue, Yakima, Washington,* dated May 13, 2008.

Site Visit and Inspection

See attached appendices for site visit information and to review the site inspection check list.

Well Survey

No new drinking water wells in the vicinity of the site were identified during the June site visit, and an August 5, 2008, search of the WDOE well database showed no evidence for any recently installed drinking water wells in the area. The search did turn up a few older logs for water wells in the general area, but all of them were at least 1/4 mile away from the stable site plume. Based on these surveys, EPA concludes there currently are no nearby domestic wells and that all wells contemporaneously in the vicinity were evaluated during the RI/FS. Further, no one is currently using groundwater contaminated at the site for drinking or other purposes.

Community Notification

There has been no recent EPA-initiated community involvement, nor has any interest been expressed from the community in the last 15 years. On May 7, 2008, a Public Notice was placed in the *Yakima Herald Republic* that EPA was performing this Five-Year Review and soliciting comment. No comments were received. A public notice of this five-year review will be put into the local newspaper upon completion of this report. Copies of the report will also be sent to the current land owners.

VII. TECHNICAL ASSESSMENT

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

Yes. The review of documents and data, ARARs, and the results of the site inspection indicate that the remedy is functioning as intended by the ROD.

There is no evidence that contaminated soils remaining at depth have been exposed or disturbed. Groundwater monitoring confirms that the small plume is not migrating.   The site inspection and well survey indicate no one is currently using or being exposed to contaminated groundwater.

No institutional controls are required by the ROD, even though hazardous substances remain on site below 7 feet and in the groundwater. To remain protective in the long term, institutional controls should be developed and implemented. EPA intends to incorporate institutional controls into the remedy in a ROD Amendment following public comment, specifically in the form of enforceable land use restrictions in a covenant pursuant to the recently enacted Washington Uniform Environmental Covenant Act or an equivalent easement to prevent or appropriately restrict groundwater use and intrusion into subsurface contamination. A Proposed Amendment for public comment is anticipated in early 2009, with later FY 2009 ROD Amendment issuance. See Figure 6 in Appendix A.1 for the land use control area where institutional controls are projected to be implemented within the site.

The only operation and maintenance requirements are associated with the continued groundwater monitoring wells. All wells are currently intact and functional.

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

Yes. There are no changes in any of the remedy components or in the physical conditions of the site that would affect the protectiveness of the remedy. This site is zoned industrial, and the surface soil cleanup levels are consistent with current commercial and potential future industrial/commercial use. Buildings have been built on the site without disturbing the deeper, contaminated soils.

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

Yes. Groundwater monitoring continues to show elevated levels of dieldrin which was not included in the ROD as a groundwater contaminant of concern, but it is listed by EPA as a carcinogen. Levels of dieldrin and its breakdown product aldrin (a closely related chemical with nearly identical risk levels) rose dramatically during the soil removal, then dropped and stabilized, but at concentrations approximately an order of magnitude higher than before the excavation. Endosulfans also rose dramatically, but the endosulfan Reference Dose (RfD) was changed so that even the elevated levels were no longer considered a risk. Endosulfan levels have since dropped and stabilized at nearly pre-excavation levels.

The remedy is currently protective despite the continued presence of dieldrin for two primary reasons. First, this contaminant is at low levels and does not travel very far in groundwater before being re-adsorbed onto soil particles. As a result, the plume extent is self-limiting, expanding and shrinking seasonally, with the largest plume existing in late summer/early fall. At that time, it may reach the site boundary. Second, no one currently uses (or is likely to use) this shallow groundwater for drinking water. Consequently, there is only a very low order of probability of a complete exposure pathway for groundwater. The site is zoned industrial, served by a municipal water supply, and the current owner is fully aware of the impairment.

The detection limit currently used for aldrin and dieldrin is above the groundwater risk goal set in the ROD. To ensure the site remains protective in the event groundwater migrates and/or is used and to evaluate progress toward and achievement of cleanup goals, a lower detection limit must be established and employed.

Technical Assessment Summary

According to the data reviewed and the site inspection, the remedy is functioning as intended by the ROD. There have been no physical changes to the site that would affect the effectiveness of the implemented remedial action.

There are two issues that require follow-up to help ensure long-term protectiveness. First, since hazardous substances remain on site above levels that allow for unlimited use and unrestricted exposure, institutional controls need to be added to the remedy and implemented to assure exposure remains consistent with the industrial land use and exposure assumptions. Also, a lower detection limit is needed for aldrin and dieldrin to ensure the site remains protective in the event groundwater migrates and/or is used, and to evaluate progress toward cleanup goals.

VIII. ISSUES

Since hazardous substances remain on site above levels that allow for unrestricted use and unlimited exposure and will remain so for the foreseeable future because of the residual contamination below the low water table, institutional controls need to be developed and implemented for protection of current and future property users. The institutional controls should prevent the lawful use of groundwater and ensure that no one intrudes into the zone of contaminated soil remaining below the seasonally low (winter-spring) water table through drilling or excavation (unless as part of an approved monitoring plan).

A more sensitive analytical method to lower the groundwater detection limit for aldrin and dieldrin below the risk level set in the ROD must be employed. Future deletion of the site from the NPL will be problematic without lowering the detection level because a comprehensive determination that the site meets cleanup goals cannot yet be confidently supported.

While dieldrin is a COC for soils, it is not listed as a COC for groundwater in the ROD or ESD. Dieldrin is being monitored in groundwater because it is a hazardous substance present at the site that persists at levels above the ROD groundwater cleanup goal of $1x10^{-6}$ excess cancer risk. However, dieldrin is not currently counted toward the calculation of excess cancer risk because it is not listed as a groundwater COC.

Minor issues related to the optimization of the groundwater monitoring network and opportunities for assessing seasonal plume characteristics through spring and late-summer/fall sampling events were also identified during the review.

The issues are presented in the table below:

Table for Listing Issues

No.	*Issues*	*Affects Protectiveness (Y/N)*	
		Current	*Future*
1	Institutional controls need to be developed and implemented.	N	Y
2	The detection limits for aldrin and dieldrin are above the risk level of $1x10^{-6}$ cancer risk levels set in the ROD. Detection limits below the risk level are needed to adequately evaluate risk.	N	Y
3	Dieldrin is not listed as a groundwater COC covered by the remedy even though it is a carcinogen and monitoring shows it is persistent at the site.	N	N
4	There is an opportunity for expansion of groundwater monitoring to coincide with both the high and low-water table conditions (early spring and early fall) to characterize seasonal fluctuations.	N	N
5	There is a need to ensure that any facility expansion by Stephens Metal Products does not affect the monitoring well network and sampling.	N	N
6	There is an opportunity to cost-effectively optimize groundwater monitoring, including abandonment of two no longer needed wells and inclusion of one of the existing piezometer wells to more completely define the down-gradient plume boundary.	N	N

Issue 1 (the need to develop and implement institutional controls) has been a recurring issue from the previous two Five-Year Reviews. This issue has been carried forward and the specifics of addressing the recommendations and follow-up actions are provided in Section IX.

IX. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

EPA projects selecting enforceable institutional controls, specifically a restrictive covenant pursuant to the Washington Uniform Environmental Covenant Act or an equivalent easement, or another similarly protective remedy, in a ROD Amendment following public comment.

A more sensitive method for monitoring aldrin and dieldrin in groundwater should be adopted prior to the next phase of groundwater monitoring scheduled for the fourth five-year review. EPA will provide oversight to FMC on the adoption of a more sensitive method. The lower detection limit resulting from a more sensitive method is necessary to ensure that monitoring information used to support future National Priority List (NPL) deletion is adequate to that the site meets cleanup goals.

EPA will modify the remedy to add dieldrin as a groundwater COC covered by the remedy. This is not a fundamental change, and could be done through an ESD but for efficiency will be incorporated in the proposed ROD Amendment for Institutional Controls. The ROD Amendment would be finalized once public comments have been addressed.

Issues related to monitoring network optimization and seasonal sampling opportunities should be addressed to continue to manage the site in a cost-effective manner that may lead to eventual deletion from the NPL. The follow-up actions for these issues include:

- Monitor groundwater in April 2012 and late September/early October 2012 to characterize seasonal fluctuations;
- Maintain well access despite facility expansion at Stephens Metal Products;
- Abandon wells W-7 and W-9A&B (following state regulations) and add the shallowest piezometer well (W-8C) to the wells to be sampled in the groundwater monitoring plan.

FMC is responsible for these three follow-up actions which do not affect the current or future protectiveness of the remedy.

The recommendations and follow-up actions from this third Five-Year Review are summarized in the table below:

Table for Listing Recommendations and Follow-up Actions

No.	*Recommendations/ Follow-up Actions*	*Party Responsible*	*Oversight Agency*	*Milestone Date*	*Follow-up Actions: Affects Protectiveness (Y/N)*	
					Current	*Future*
1	Develop institutional controls, modify remedy to require them, and implement institutional controls	EPA		September 30, 2009	N	Y
2	Develop an analytical method sensitive enough to result in detection limits for aldrin and dieldrin that are lower than the $1x10^{-6}$ excess cancer risk	FMC Corp. (PRP)	EPA	Spring and fall of 2012	N	Y
3	Modify remedy to add dieldrin as a groundwater COC	EPA		September 30, 2009	N	N
4	Monitor groundwater in April 2012 and late September/early October 2012 to characterize seasonal fluctuations	FMC Corp. (PRP)	EPA	Spring and fall of 2012	N	N
5	Maintain well access despite facility expansion at Stephens Metal Products	FMC Corp. (PRP)	EPA	Spring 2012	N	N
6	Abandon wells W-7 and W-9A&B (following state regulations) and add the shallowest piezometer well (W-8C) to the wells to be sampled in the groundwater monitoring plan	FMC Corp. (PRP)	EPA	Spring 2012	N	N

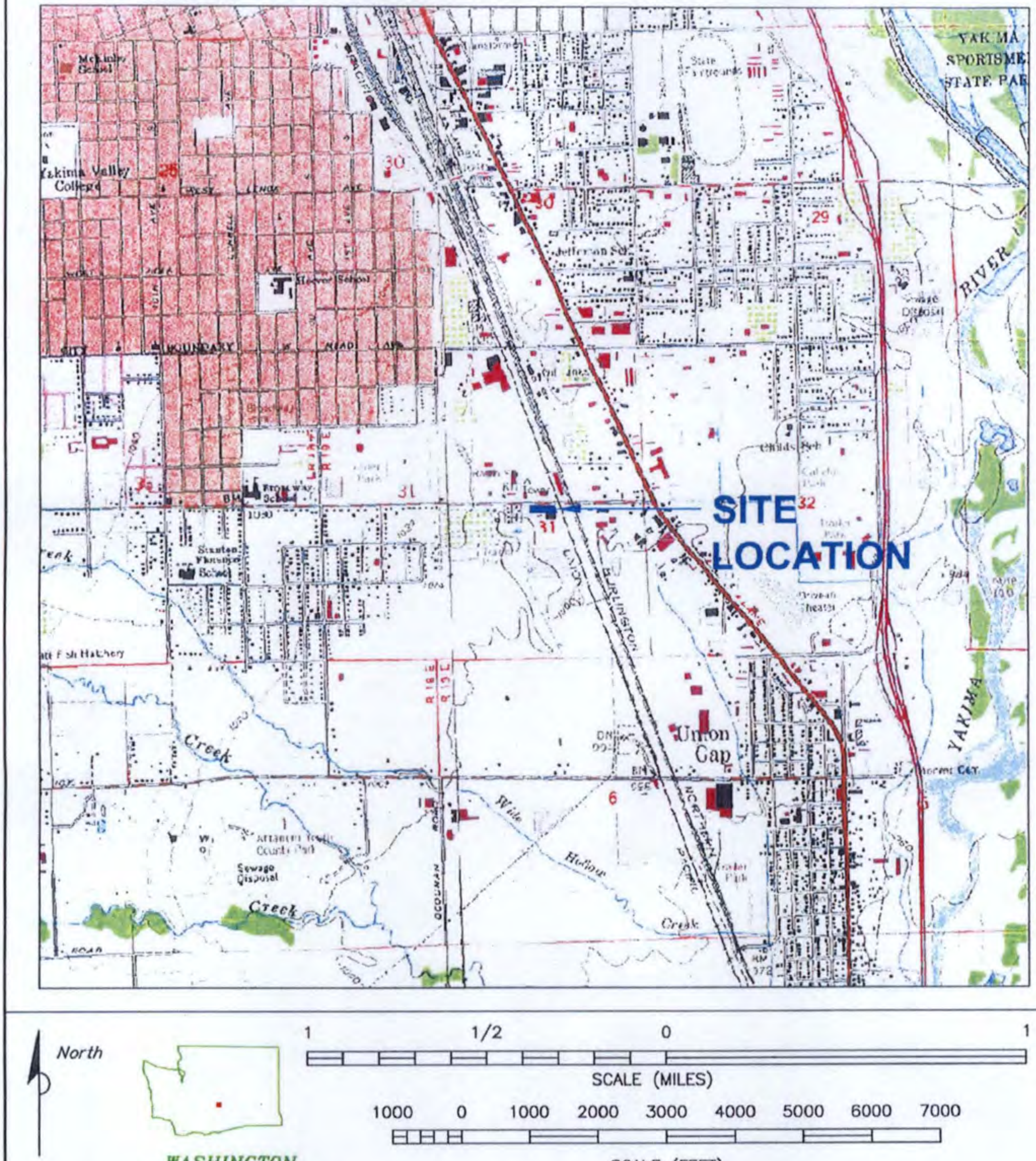
X. STATEMENT OF PROTECTIVENESS

Protective in the short term – The remedy currently protects human health and the environment because surface and near-surface soils have been remediated to below the cleanup goals and the groundwater plume is stable beneath the site and is not a source of drinking water. However, in order for the remedy to remain protective in the long-term, institutional controls and a lower groundwater detection limit for aldrin and dieldrin need to be implemented. The lower detection limit is necessary to ensure that monitoring information used to support future NPL deletion is correct in that the site meets cleanup goals.

XI. NEXT REVIEW

The next Five-Year Review should occur within five years (September 2013).

Appendix 1



REFERENCE: USGS 7.5 MINUTE QUADRANGLE; YAKIMA EAST, WASHINGTON; 1981

PARSONS

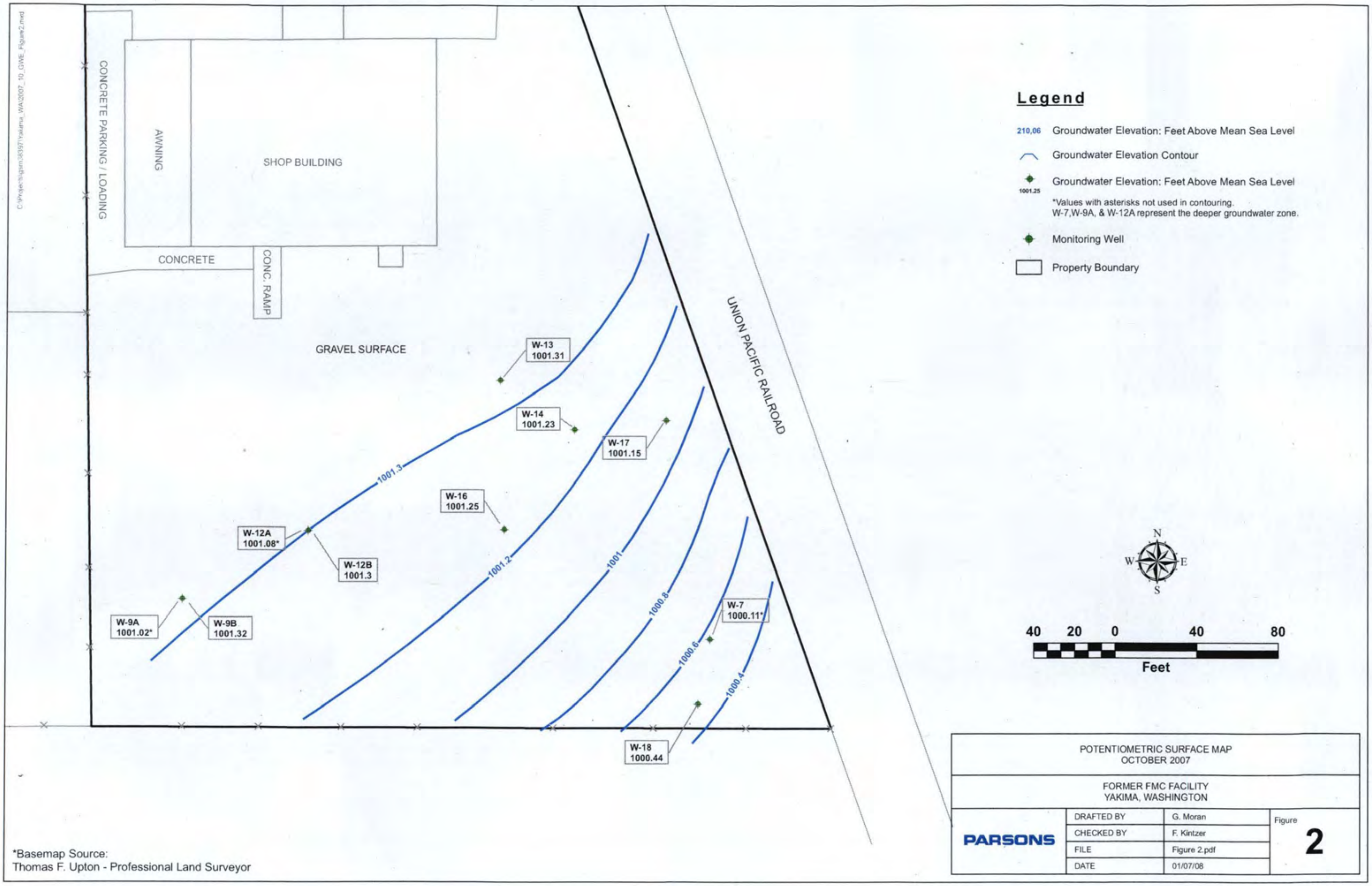
FORMER FMC FACILITY

YAKIMA, WASHINGTON

SITE LOCATION MAP

FIGURE: **1**

JOB NUMBER: 444071.05000	SOURCE: SECOR (12/03)	CHECKED BY: GM	APPROVED BY: FK	DATE: 12/17/07



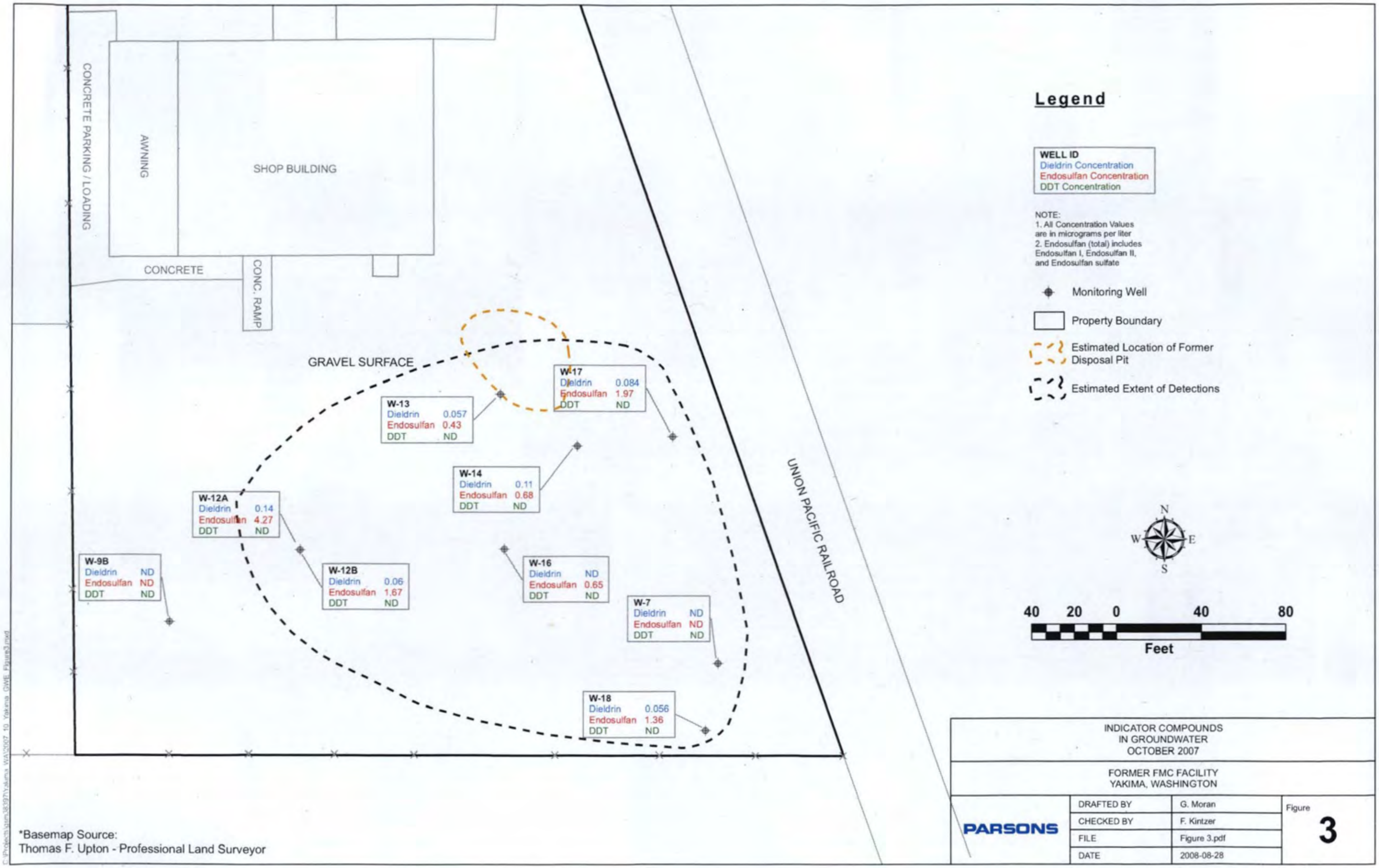
*Basemap Source:
Thomas F. Upton - Professional Land Surveyor

POTENTIOMETRIC SURFACE MAP
OCTOBER 2007

FORMER FMC FACILITY
YAKIMA, WASHINGTON

PARSONS

DRAFTED BY	G. Moran	Figure
CHECKED BY	F. Kintzer	2
FILE	Figure 2.pdf	
DATE	01/07/08	



NOTE:
1. All Concentration Values are in micrograms per liter
2. Endosulfan (total) includes Endosulfan I, Endosulfan II, and Endosulfan sulfate

*Basemap Source:
Thomas F. Upton - Professional Land Surveyor

INDICATOR COMPOUNDS
IN GROUNDWATER
OCTOBER 2007

FORMER FMC FACILITY
YAKIMA, WASHINGTON

PARSONS

DRAFTED BY	G. Moran	Figure 3
CHECKED BY	F. Kintzer	
FILE	Figure 3.pdf	
DATE	2008-08-28	

Figure 4 - Total Endosulfans in Groundwater

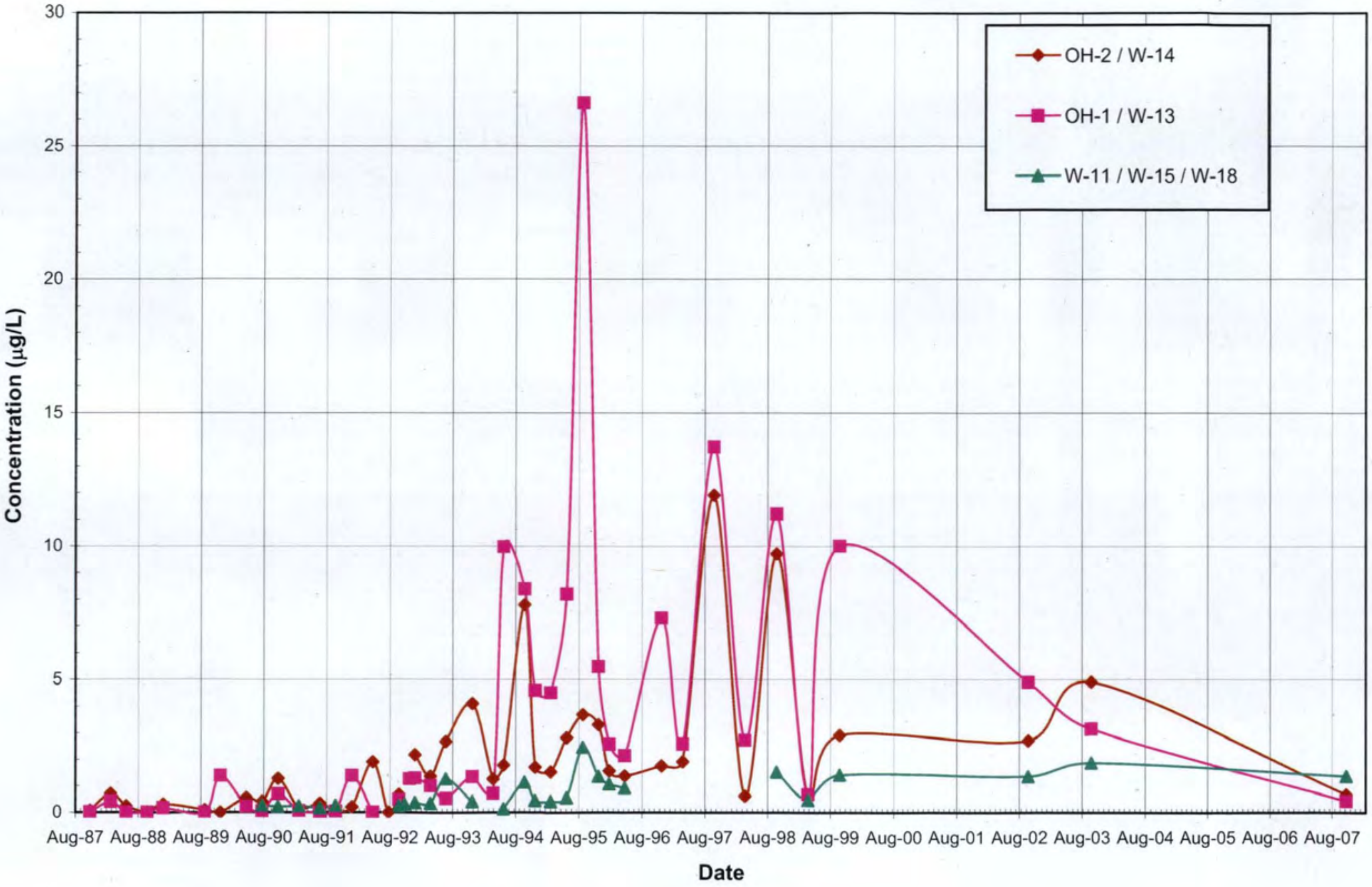


Figure 5 - Dieldrin plus Aldrin in Groundwater

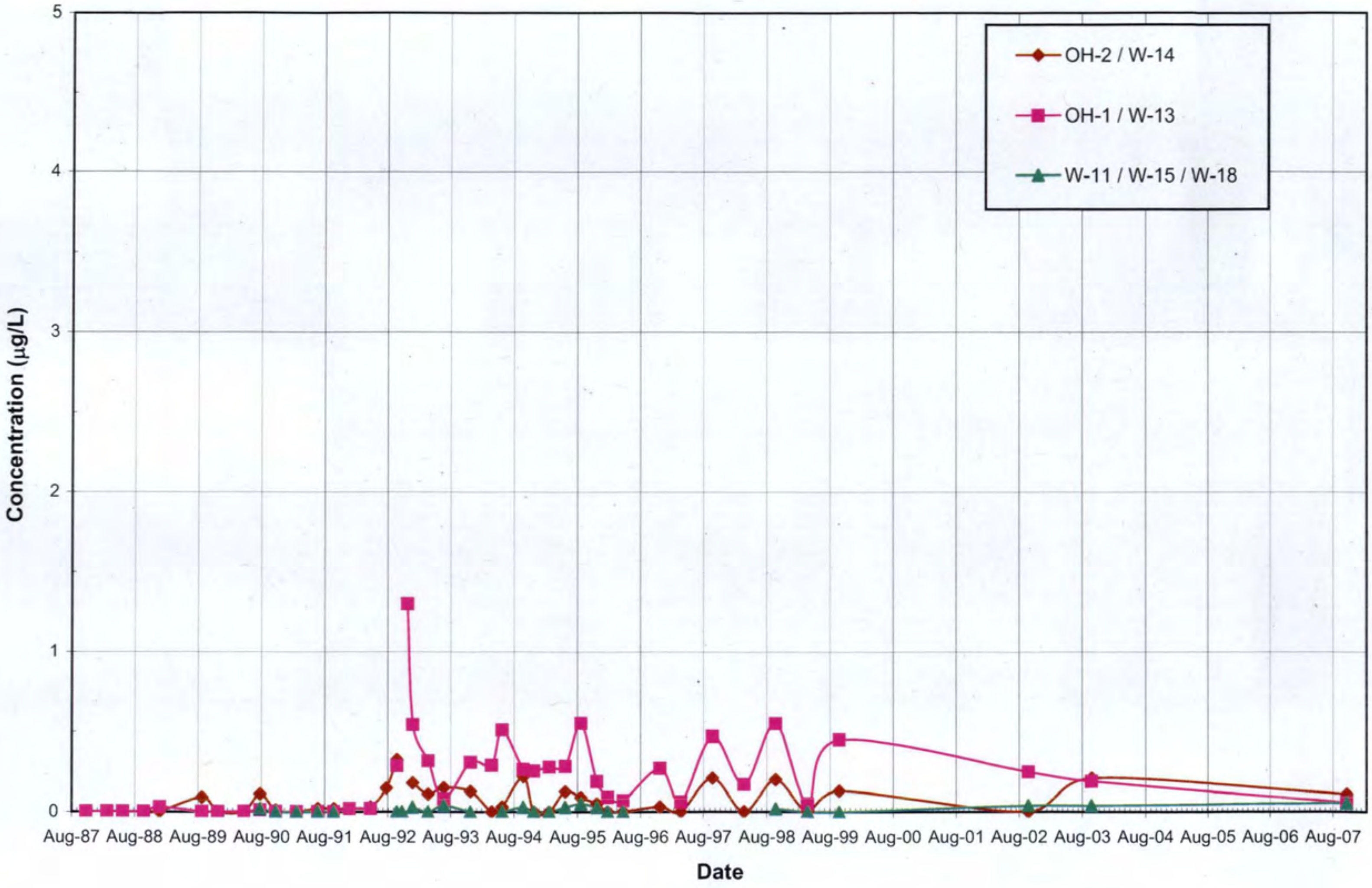


Figure 6 - Projected Land Use Control Area for the FMC Yakima Site and Proximity to Residentially Zoned Parcels

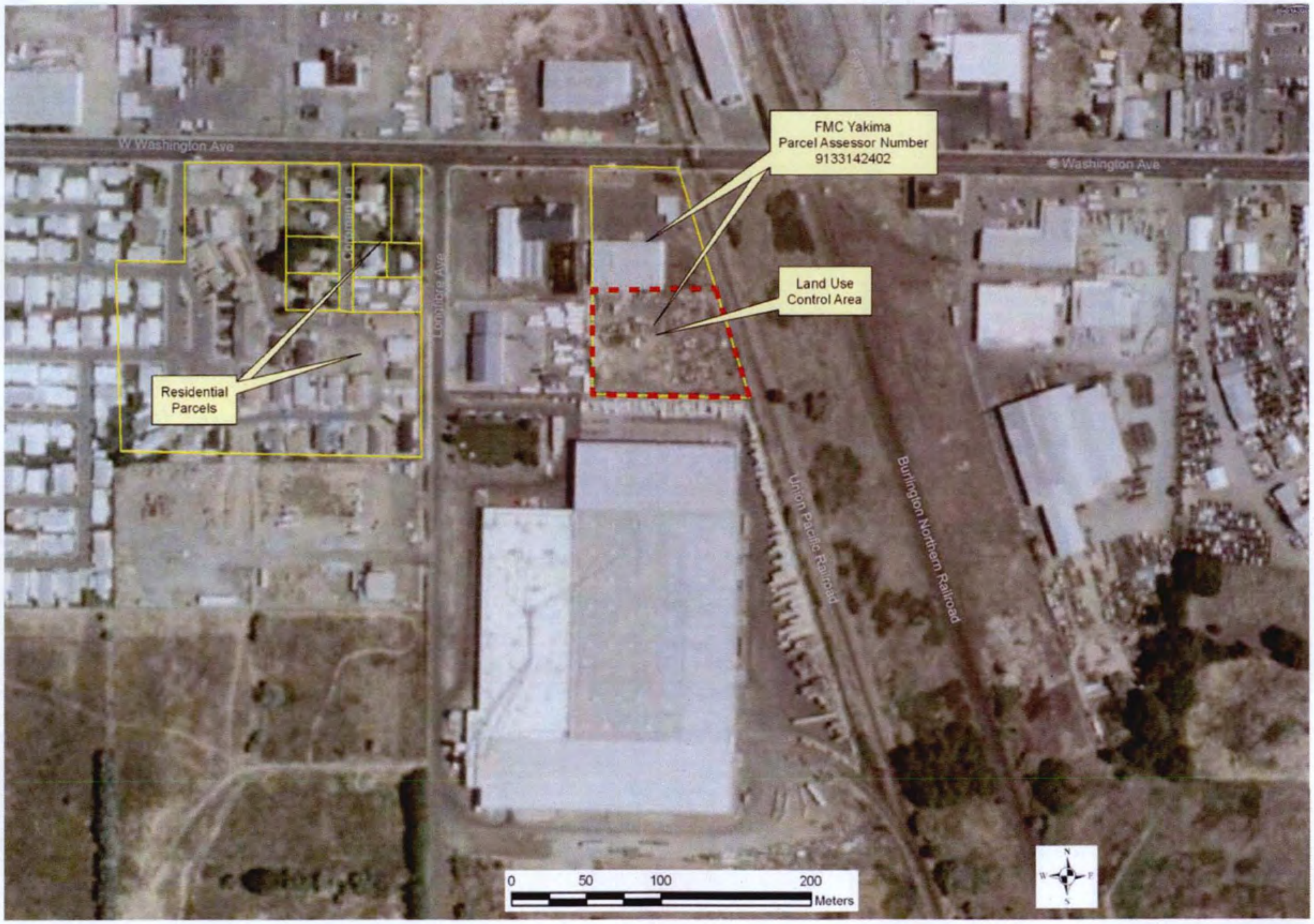


Table 1

Groundwater Elevations (Fall 2007)

WELL	Casing Diameter (inches)	Screen Length[A] (feet)	Total Depth[B] (feet)	Top of Screen (ft amsl)	Bottom of Screen (ft amsl)	Elevation Top of Casing[C] (ft amsl)	Depth to Water 10-22-07 (ft bgs)	Groundwater Elevation 10-22-07 (ft amsl)
W-7	4	15	35.07	984.22	969.22	1002.60	2.49	1000.11
W-9A	2	5	36.5	971.36	966.36	1002.80	1.78	1001.02
W-9B	2	5	14.13	994.86	989.86	1002.85	1.53	1001.32
W-12A	4	5	21.31	990.50	985.50	1003.05	1.97	1001.08
W-12B	4	5	10.46	998.50	993.50	1003.14	1.84	1001.30
W-13	2	10	15.46	999.30	989.30	1003.45	2.14	1001.31
W-14	2	10	15.11	998.73	988.73	1003.53	2.30	1001.23
W-16	2	10	14.77	998.63	988.63	1003.23	1.98	1001.25
W-17	2	10	14.99	998.20	988.20	1003.61	2.46	1001.15
W-18	2	10	14.4	997.38	987.38	1002.14	1.70	1000.44

Notes

[A] Well as-built dimensions from Secor (2004)
[B] Total depth of well measured after re-development October 22 to 24, 2007
[C] Top of casing surveyed October 23, 2007
amsl = above mean sea level
bgs = below ground surface

Table 2

Summary of Detections (Fall 2007)

	W-7	W-9B	W-12A	W12B	W-13	W-14	W-14D	W-16	W-17	W-18
2,4-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-TDE/DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-TDE/DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
a-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Alachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
b-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benefin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Captan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbophenothion	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
d-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dicofol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	0.14	0.06	0.057	0.11	0.11	ND	0.084	0.056
Endosulfan I	ND	ND	1.3	0.69	0.11	0.13	0.14	0.37	0.60	0.39
Endosulfan II	ND	ND	0.87	0.38	0.13	0.20	0.20	0.17	0.41	0.28
Endosulfan sulfate	ND	ND	2.1	0.60	0.19	0.35	0.34	0.11	0.96	0.69
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin aldehyde	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Folpet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
g-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrofen	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCNB	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perthane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tedion	ND	ND	0.66	0.35	0.16	0.25	0.27	ND	0.34	0.20
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes

All values are shown in micrograms per liter
ND - Not detected above the laboratory Practical Quantation Limit (PQL)
PQL for perthane and toxaphene = 1.0 micrograms/liter; PQL for all other compounds = 0.05 micrograms/liter
Analytical work performed by Agricultural & Priority Pollutants Laboratories, Inc., Fresno, California

Table 3

Comparison of Duplicate Samples (Fall 2007)

Parameter (ug/L)	**W-14**	**W-14D**	**RPD %**	**PQL (ug/L)**
Dieldrin	0.11	0.11	0.0	0.05
Endosulfan I	0.13	0.14	7.4	0.05
Endosulfan II	0.20	0.20	0.0	0.05
Endosulfan sulfate	0.35	0.34	2.9	0.05
Endrin	0	0	0.0	0.05
Tedion	0.25	0.27	7.7	1.0

NOTE: A zero in the sample results column signifies that the result was not detected above the analytical detection limit.

RPD: Relative Percent Difference calculated by RPD = $\{X_1-X_2\}/X_{avg}$ x 100 where:
X_1 = concentration of W-14 (original sample)
X_2 = concentration of W-14D (duplicate sample)
X_{avg} = average concentration = $(X_1 + X_2)/2$

PQL: Practical Quantitation Limit

Appendix 2

Five-Year Review Site Inspection Roster

FMC Yakima

June 25, 2008

Craig Cameron	Remedial Project Manager U.S. Environmental Protection Agency Region 10
Marcia Knadle	Hydrogeologist U.S. Environmental Protection Agency Region 10
Jeff Newschwander	Agency Representative State of Washington – Department of Ecology Central Regional Office (Yakima, WA)

Note: The City of Yakima was contacted by telephone in early June about joining the site visit. A message was left with the office manager for Dick Zais (city manager). However, no one from the city responded.

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

Five-Year Review Site Inspection Checklist (Template)

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

I. SITE INFORMATION

Site name: FMC Corp. (Yakima Pit)	**Date of inspection:** 6/25/08
Location and Region: Yakima, WA EPA R10	**EPA ID:** WAD000643577
Agency, office, or company leading the five-year review: EPA	**Weather/temperature:** Clear and sunny, 82° F

Remedy Includes: (Check all that apply)

Landfill cover/containment
Access controls
Institutional controls
Groundwater pump and treatment
Surface water collection and treatment
Monitored natural attenuation
Groundwater containment
Vertical barrier walls
Other Removal and treatment of soil (and other activities) completed about 15 years ago.

Attachments: [✓ Inspection team roster attached] [✓ Site map attached]

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** ______ ______ ______
Name Title Date
Interviewed at site at office by phone Phone no. ______
Problems, suggestions; Report attached ______
Not Applicable (N/A)

2. **O&M staff** ______ ______ ______
Name Title Date
Interviewed at site at office by phone Phone no. ______
Problems, suggestions; Report attached ______
N/A

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

Agency WA Dept. of Ecology
Contact Jeff Newschwander UECA Coordinator 6/25/08 509 454-7842
Name Title Date Phone no.
Problems; suggestions; Report attached
[See interview form]

Agency
Contact
Name Title Date Phone no.
Problems; suggestions; Report attached

Agency
Contact
Name Title Date Phone no.
Problems; suggestions; Report attached

Agency
Contact
Name Title Date Phone no.
Problems; suggestions; Report attached

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

[See interview documentation
and record forms]

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

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

IV. O&M COSTS

1. **O&M Organization**
State in-house
Contractor for State
PRP in-house
Contractor for PRP
Federal Facility in-house
Contractor for Federal Facility
N/A
Other

2. **O&M Cost Records**
Readily available
Up to date
Funding mechanism/agreement in place
N/A
Original O&M cost estimate
Breakdown attached

Total annual cost by year for review period if available

From (Date) To (Date) (Total cost) Breakdown attached
From (Date) To (Date) (Total cost) Breakdown attached
From (Date) To (Date) (Total cost) Breakdown attached
From (Date) To (Date) (Total cost) Breakdown attached
From (Date) To (Date) (Total cost) Breakdown attached

3. **Unanticipated or Unusually High O&M Costs During Review Period** N/A
Describe costs and reasons:

V. ACCESS AND INSTITUTIONAL CONTROLS Applicable N/A

A. Fencing There are no formal access or institutional controls

1. **Fencing damaged** [✓ Location shown on site map] Gates secured N/A
Remarks Fence along railroad track is intact but could be replaced (East side of site)

B. Other Access Restrictions

1. **Signs and other security measures** [✓ Location shown on site map] wells displayed on map [✓ N/A]
Remarks Only signs are well head markers that have "Monitor Well" on them.

C. Institutional Controls (ICs) ICs will be established shortly after the 5-Year Review

1. **Implementation and enforcement**

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

Type of monitoring (*e.g.*, self-reporting, drive by) There currently are no ICs provided in decision documents.
Frequency
Responsible party/agency
Contact
Name Title Date Phone no.

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

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

2. **Adequacy** ICs are adequate ICs are inadequate N/A
Remarks [See comments above]

D. General

1. **Vandalism/trespassing** Location shown on site map [✓ No vandalism evident]
Remarks

2. **Land use changes on site** N/A
Remarks No change from industrial-use.

3. **Land use changes off site** N/A
Remarks No changes in surrounding area.

VI. GENERAL SITE CONDITIONS

A. Roads Applicable [✓ N/A]

1. **Roads damaged** Location shown on site map Roads adequate N/A
Remarks

B. Other Site Conditions

Remarks There is a lot of debris piled here and there, but that is expected for a laydown yard. Flush well heads should be safe and allow use as a laydown yard. Like this year's site visit, future visits should be preceded by a request to make sure there is proper access to all monitoring wells.

VII. LANDFILL COVERS Applicable [✓ N/A]

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
Areal extent________ Depth________
Remarks________

2. **Cracks** Location shown on site map Cracking not evident
Lengths________ Widths________ Depths________
Remarks________

3. **Erosion** Location shown on site map Erosion not evident
Areal extent________ Depth________
Remarks________

4. **Holes** Location shown on site map Holes not evident
Areal extent________ Depth________
Remarks________

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

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

7. **Bulges** Location shown on site map Bulges not evident
Areal extent________ Height________
Remarks________

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

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

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

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

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

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

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

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

2. **Material Degradation** Location shown on site map No evidence of degradation
Material type__________ Areal extent__________
Remarks____

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

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent________________ Depth____________
Remarks____
____

5. **Obstructions** Type____________________ No obstructions
Location shown on site map Areal extent______________
Size____________
Remarks____
____

6. **Excessive Vegetative Growth** Type____________________
No evidence of excessive growth
Vegetation in channels does not obstruct flow
Location shown on site map Areal extent______________
Remarks____
____

D. Cover Penetrations Applicable N/A

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

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

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

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

5. **Settlement Monuments** Located Routinely surveyed N/A
Remarks____
____

E. Gas Collection and Treatment Applicable N/A

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

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

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

F. Cover Drainage Layer Applicable N/A

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

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

G. Detention/Sedimentation Ponds Applicable N/A

1. **Siltation** Areal extent____________ Depth__________ N/A
Siltation not evident
Remarks____

2. **Erosion** Areal extent____________ Depth__________
Erosion not evident
Remarks____

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

4. **Dam** Functioning N/A
Remarks____

H. Retaining Walls Applicable N/A

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

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

I. Perimeter Ditches/Off-Site Discharge Applicable N/A

1. **Siltation** Location shown on site map Siltation not evident
Areal extent__________ Depth__________
Remarks____
____

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

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

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

VIII. VERTICAL BARRIER WALLS

Applicable [✓ N/A]

1. **Settlement** Location shown on site map Settlement not evident
Areal extent__________ Depth__________
Remarks____
____

2. **Performance Monitoring** Type of monitoring__________________
Performance not monitored
Frequency____________________ Evidence of breaching
Head differential____________________
Remarks____
____

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

A. Groundwater Extraction Wells, Pumps, and Pipelines   Applicable   N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
Good condition   All required wells properly operating   Needs Maintenance   N/A
Remarks____

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
Good condition   Needs Maintenance
Remarks____

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

B. Surface Water Collection Structures, Pumps, and Pipelines   Applicable   N/A

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

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

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

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
Metals removal Oil/water separation Bioremediation
Air stripping Carbon adsorbers
Filters________________________________
Additive (*e.g.*, chelation agent, flocculent)________________________________
Others________________________________
Good condition Needs Maintenance
Sampling ports properly marked and functional
Sampling/maintenance log displayed and up to date
Equipment properly identified
Quantity of groundwater treated annually________________
Quantity of surface water treated annually________________
Remarks________________________________
____

2. **Electrical Enclosures and Panels** (properly rated and functional)
N/A Good condition Needs Maintenance
Remarks________________________________
____

3. **Tanks, Vaults, Storage Vessels**
N/A Good condition Proper secondary containment Needs Maintenance
Remarks________________________________
____

4. **Discharge Structure and Appurtenances**
N/A Good condition Needs Maintenance
Remarks________________________________
____

5. **Treatment Building(s)**
N/A Good condition (esp. roof and doorways) Needs repair
Chemicals and equipment properly stored
Remarks________________________________
____

6. **Monitoring Wells** (pump and treatment remedy)
Properly secured/locked Functioning Routinely sampled Good condition
All required wells located Needs Maintenance N/A
Remarks________________________________
____

D. Monitoring Data

1. Monitoring Data
Is routinely submitted on time Is of acceptable quality

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

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

Properly secured/locked   Functioning   Routinely sampled   Good condition

All required wells located   Needs Maintenance   N/A

Remarks

X. OTHER REMEDIES

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

There are no faclities associated with the constructed remedy.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

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

The construction of the remedy was completed over a decade ago and the site has been closed out. However, ground water and soil (below 7' in depth) have residual contamination that does not allow for unrestricted use and unrestricted exposure.

B. Adequacy of O&M

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

N/A

C. Early Indicators of Potential Remedy Problems

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

N/A

D. Opportunities for Optimization

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

There are opportunities to abandon some of the monitoring wells based on groundwater monitoring trend data. Monitoring wells W-7 and W-9A+B can be abandoned.

Appendix 3

OSWER No. 9355.7-03B-P

INTERVIEW DOCUMENTATION FORM

The following is a list of individual interviewed for this five-year review. See the attached contact record(s) for a detailed summary of the interviews.

Name	Title/Position	Organization	Date
Jeff Newschwander	UECA Coordinator	WA Dept. of Ecology	6/25/08
Eric Coble	Salesman	Country Farm + Garden True Value Hardware	6/25/08
Barb Wilson	Cashier	Country Farm + Garden True Value Hardware	6/25/08
Chester Stephens	VP of Operations	Stephens Metals	6/25/08
Erlinda Butler	Owner	Butlers Welding + RV Accessories	7/24/08

INTERVIEW RECORD

Site Name: FMC Yakima
EPA ID No.: WAD000643577
Subject: Five-Year Review
Time: 12:30 **Date:** 6/25/08
Type: ☐ Telephone ☑ Visit ☐ Other ☐ Incoming ☐ Outgoing
Location of Visit: On-site

Contact Made By:

Name: Craig Cameron **Title:** Environ. Scientist **Organization:** EPA

Individual Contacted:

Name: Jeff Newschwander **Title:** UECA Coordinator **Organization:** WA Dept. of Ecology
Telephone No: 509 454-7842
Fax No:
E-Mail Address: jene461@ecy.wa.gov
Street Address: 15 West Yakima Ave.
City, State, Zip: Yakima, WA 98902-3452

Summary Of Conversation

Mr. Newschwander participated in the site visit as the representative for the Dept. of Ecology. Along with Marcia Knadle (EPA) we discussed the groundwater monitoring results and trends as well as plans for putting institutional controls in place. He is charged with certain responsibilities regarding the Uniform Environmental Covenant Act implementation, so that would make him an important resource for this site. He said that Ecology had no problems with the management of the FMC Yakima site.

Page 1 of 1

OSWER No. 9355.7-03B-P

INTERVIEW RECORD

Site Name: FMC Yakima

EPA ID No.: WAD000643577

Subject: Five-Year Review

Time: 12:50 **Date:** 6/25/08

Type: ☐ Telephone ☑ Visit ☐ Other

Location of Visit: Hardware store

☐ Incoming ☐ Outgoing

Contact Made By:

Name: Craig Cameron **Title:** Environ. Scientist **Organization:** EPA

Individual Contacted:

Name: Eric Coble **Title:** Salesman **Organization:** Country Farm + Garden True Value Hardware

Telephone No: 509 575-8877

Fax No:

E-Mail Address:

Street Address: 6 West Washington Ave.

City, State, Zip: Yakima, WA 98903

Summary Of Conversation

Mr. Coble was the person managing the hardware store to the west of Stephens Metals during the site visit. He has the same last name as the owner/manager, Leroy Coble. He said they didn't notice any problems with the former pesticide formulation site. We discussed the fact that the store's planters were all up above ground on top of asphalt. He said it gets pretty hot out there in the summer. He did express a concern about the weeds growing on the site (considering the garden area at the store).

Page 1 of 1

INTERVIEW RECORD

Site Name: FMC Yakima

EPA ID No.: WAD000643577

Subject: Five-Year Review

Time: 12:50 **Date:** 6/25/08

Type: ☐ Telephone ☒ Visit ☐ Other

Location of Visit: Hardware store

☐ Incoming ☐ Outgoing

Contact Made By:

Name: Craig Cameron **Title:** Environ. Scientist **Organization:** EPA

Individual Contacted:

Name: Barb Wilson **Title:** Cashier **Organization:** Country Farm + Garden True Value Hardware

Telephone No: 509 575-8877
Fax No:
E-Mail Address:

Street Address: 6 West Washington Ave.
City, State, Zip: Yakima, WA 98903

Summary Of Conversation

Ms. Wilson was interviewed concurrently with Eric Coble. She was in agreement with the statements that Mr. Coble made.

INTERVIEW RECORD

Site Name: FMC Yakima
EPA ID No.: WAD000643577

Subject: Five-Year Review
Time: 12:40 **Date:** 6/25/08

Type: ☐ Telephone ☑ Visit ☐ Other
☐ Incoming ☐ Outgoing

Location of Visit: On-site

Contact Made By:

Name: Craig Cameron **Title:** Environ. Scientist **Organization:** EPA

Individual Contacted:

Name: Chester Stephens **Title:** V.P. of Operations **Organization:** Stephens Metals Products Inc.

Telephone No: 509 452-4088
Fax No:
E-Mail Address:

Street Address:
City, State, Zip: 4 West Washington Ave.
Yakima, WA 98903

Summary Of Conversation

Mr. Stephens (b) (6) Marcia Knadle (EPA) and Jeff Newschwander (Ecology) participated in the interview ~~with~~ of Mr. Stephens. We discussed the recent removal of railroad tracks at the back of the old building that Stephens Metals is using. They were removed to prepare for an expansion of their facility. He indicated that the expansion will come close to one of the monitoring wells. This well is still valuable and so FMC may have to coordinate with them to make sure the well can be accessed and allow expansion. He said he was glad that →

(continued)

Chester Stephens (Continued)

INTERVIEW RECORD

Site Name: FMC Yakima

EPA ID No.:

Subject:

Time:

Date:

Type: ☐ Telephone ☐ Visit ☐ Other

Location of Visit:

☐ Incoming ☐ Outgoing

Contact Made By:

Name:

Title:

Organization:

Individual Contacted:

Name:

Title:

Organization:

Telephone No:

Fax No:

E-Mail Address:

Street Address:

City, State, Zip:

Summary Of Conversation

(Continued from page 1 of 2 for Chester Stephens interview)

... groundwater monitoring was continuing to be performed to keep track of contaminants at the site. He said that the wells didn't really get in the way (because they are basically flush with the ground).

When asked if anyone in his organization had noticed any problems (both inside and outside the building), he said no. We wrapped up our discussion with him pointing out the former footings of an FMC building that was removed. The footings were along the boundary with the hardware store's property to the west.

INTERVIEW RECORD

Site Name: FMC Yakima
EPA ID No.: WA D000643577
Subject: Five-Year Review
Time: 2 PM
Date: 7/24/08
Type: ☑ Telephone ☐ Visit ☐ Other
Location of Visit:
☐ Incoming ☑ Outgoing

Contact Made By:

Name: Craig Cameron
Title: Environ. Scientist
Organization: EPA

Individual Contacted:

Name: Erlinda Butler
Title: Owner
Organization: Butlers Welding + RV Accessories
Telephone No: 509 457-4686
Fax No:
E-Mail Address:
Street Address: 1909 LongfibreAve,
City, State, Zip: Yakima, WA 98903

Summary Of Conversation

Ms. Butler was contacted by telephone and identified herself as a co-owner of the business. She said that they hadn't had any problems with their property. She indicated that they had owned the business for the last 10 years. She recorded the contact information for the EPA project manager,

Page 1 of ____

Appendix 4

Stephens Metal Products

Butler's RV Parts & Service

Country Farm & Garden True Value Hardware

Demolition of old railroad spur looking east towards the southwest corner of Stephens Metal Products warehouse

Looking southeast across paved garden area of hardware store towards Stephens Metal Products

Looking north from the southeast corner of the Stephens Metal Products laydown yard


Looking west from southeast corner of laydown yard


Monitoring well W-9A&B


Monitoring well W-7


Monitoring well W-12A&B


Piezometer well (not sampled) W-8A,B,C


Debris around monitoring well W-13

FMC Yakima Photos 06/25/08

Monitoring well W-13

Monitoring well W-14

Monitoring well W-17

Monitoring well W-16

Monitoring well W-18

Appendix D
Cost Estimates for Remedial Alternatives

Table D-1
Summary of Costs Associated with Each Alternative
Former FMC Pesticide Formulation Facility
Yakima, Washington

Remedial Alternative	Description	Direct and Indirect Capital Costs*	Total O&M Costs (Undiscounted)	NPW of Total O&M Costs	General Contingency (15%)	Estimated Total Cost
Alternative 2	Institutional Controls	$26,800	$198,086	$74,479	$15,192	**$117,000**
Alternative 3	Soil Excavation and Off-Site Landfilling and Institutional Controls	$3,716,725	$208,378	$78,180	$569,236	**$4,365,000**
Alternative 4	Groundwater Extraction and Treatment and Institutional Controls	$803,200	$3,051,218	$1,254,078	$308,592	**$2,366,000**

Notes:

* - Capital costs for all 3 alternatives do not include potential cost for getting neighboring land owners consent to apply institutional controls to their

Present worth calculated using combination of equal payment series and single payment present worth analysis where i = 7 %
properties.

Acronyms:
O&M - Operations and maintenance.
NPW = Net present worth

Table D-2
Assumptions and Unit Costs
Former FMC Pesticide Formulation Facility
Yakima, Washington

Item	**Value**		
Indirect Costs			
Permitting and Legal	5%	TDC	
Contractor Overhead and Profit	15%	TDC	
Engineering and Construction Oversight	15%	TDC	
Health and Safety Costs	3%	TDC	
Project Management and Administration	10%	TDC	
Replacement Costs	7%	TDC	
Annual O&M Replacement Costs	7%	TDC	
General Contingency	15%	Capital and O&M costs	
Net Present Worth Discount Rate	7%		
Net Present Worth Multipliers	Years	Equal Payment Series	Single Future Payment
	1	0.93	0.93
	2	1.81	0.87
	3	2.62	0.82
	4	3.39	0.76
	5	4.10	0.71
	6	4.77	0.67
	7	5.39	0.62
	8	5.97	0.58
	9	6.52	0.54
	10	7.02	0.51
	15	9.11	0.36
	20	10.59	0.26
	25	11.65	0.18
	30	12.41	0.13
	35	12.95	0.09
	40	13.33	0.07
	45	13.61	0.05
	50	13.80	0.03

Acronyms:
TDC - Total Direct Cost
O&M - Operations and maintenance.

Table D-3
Alternative 2 - Institutional Controls
Former FMC Pesticide Formulation Facility
Yakima, Washington

DESCRIPTION	QUANTITY Number	QUANTITY Unit	COST Unit Cost	COST Total Cost
DIRECT CAPITAL COSTS				
Restrictive Convenant				
Surveyor: Property Boundary Survey and Legal Description	1	ea.	$15,000	$15,000
Complete State of Washington Environmental Covenant	1	ea.	$3,000	$3,000
Recording Fee	1	ea.	$100	$100
SUBTOTAL (1)				**$18,100**
TOTAL DIRECT CAPITAL COSTS				***$18,100***
INDIRECT CAPITAL COSTS				
Permitting and Legal (5% Total Direct Costs)	1	LS	$905	$905
Contractor Overhead & Profit (15% Total Direct Costs)	1	LS	$2,715	$2,715
Engineering and Construction Oversight (15% Total Direct Costs)	1	LS	$2,715	$2,715
Health and Safety Costs (3% Total Direct Costs)	1	LS	$543	$543
Project Management & Administration (10% Total Direct Costs)	1	LS	$1,810	$1,810
TOTAL INDIRECT CAPITAL COSTS				**$8,700**
TOTAL CAPITAL COSTS (Direct and Indirect)				***$26,800***
O & M COSTS				
Annual Site Inspection				
Site Visit, Field Verification of Environmental Covenant	1	LS	$2,000	$2,000
Total Costs Per Event				**$2,000**
SUBTOTAL UNDISCOUNTED O&M COSTS (30 years)				**$60,000**
SUBTOTAL NET PRESENT WORTH O&M COSTS (30 years) (2)				**$24,818**
Ground Water Monitoring Cost Per Event (Years 5, 10, 15, 20, 25, 30)				
Well Sampling Labor and Equipment	7	wells	$300	$2,100
Groundwater Analysis - OCL Pesticides	8	samples	$110	$880
Reporting	1	LS	$15,000	$15,000
SUBTOTAL				**$17,980**
Contractor Overhead & Profit (15% Total Direct Costs)	1	LS	$2,697	$2,697
Health and Safety Costs (3% Total Direct Costs)	1	LS	$539	$539
Project Management & Administration (10% Total Direct Costs)	1	LS	$1,798	$1,798
SUBTOTAL				**$5,034**
Total Costs Per Event				**$23,014**
SUBTOTAL UNDISCOUNTED O&M COSTS (Years 5, 10, 15, 20, 25, 30)				**$138,086**
SUBTOTAL NET PRESENT WORTH O&M COSTS (Years 5, 10, 15, 20, 25, 30) (3)				**$49,661**
TOTAL UNDISCOUNTED O&M COSTS				**$198,086**
NET PRESENT WORTH OF TOTAL O&M COSTS				**$74,479**
TOTAL CAPITAL AND O & M COSTS				***$101,279***
General Contingency (15% of Total Capital and O&M Costs)				***$15,192***
TOTAL COST OF ALTERNATIVE (NET PRESENT WORTH)				***$117,000***

Notes:
(1) Does not include potential cost for getting the land owners consent to apply Restrictive Convenant.
(2) Present worth calculated using equal payment series present worth analysis where i = 7 %
(3) Present worth calculated using single payment present worth analysis where i = 7 %
OCL - Organochlorine
O&M - Operations and maintenance.
ea. = each.
hr. - hour.
ft. - feet
LS - Lump Sum

Table D-4
Alternative 3 - Soil Excavation and Off-Site Landfilling of Contaminated Soil
Former FMC Pesticide Formulation Facility
Yakima, Washington

DESCRIPTION	QUANTITY		COST	
	Number	Unit	Unit Cost	Total Cost
DIRECT CAPITAL COSTS				
Preparation				
Design/Work Plan	1	ea.	$100,000	$100,000
Private Utility Locator	1	day	$1,200	$1,200
Topographic Survey, Excavation Offsets, Set Temporary Survey Controls	1	LS	$10,000	$10,000
Shoring Design	1	ea.	$10,000	$10,000
Structural Inspection and Monitoring	1	LS	$6,000	$6,000
Locate, Sample, and Analyze Import Fill	1	LS	$5,000	$5,000
SUBTOTAL				**$132,200**
Excavation				
Mobilization/ Demobilization	1	LS	$10,000	$10,000
Site Preparation, including Grubbing	1	LS	$10,000	$10,000
Steel Sheetpile Shoring Installed to 13'	24,700	SF	$25	$617,500
Soil Excavation	5,900	CY	$15	$88,500
Dewatering, including Water Disposal	1	LS	$50,000	$50,000
Segregate Clean Overburden Soil	3,000	CY	$5	$15,000
Hand excavation around Subsurface Utilities	0	CY	$250	$0
Remove Impacted Utilities	0	LF	$20	$0
Waste Profile Testing - Soil for Offhaul	6	ea.	$225	$1,350
Soil Loading for Off-haul	2,900	CY	$5	$14,500
Confirmatory Testing - Excavation Bottom and Sidewalls	352	ea.	$225	$79,200
Transport and Disposal of RCRA Hazardous Soil to Class I Landfill	4,350	ton	$310	$1,348,500
Import Backfill	2,900	CY	$18	$52,200
Place and Compact On-Site and Import Backfill to Grade	5,900	CY	$5	$29,500
Place Gravel over Backfilled Surface	400	CY	$28	$11,200
Dust Control	15	day	$500	$7,375
Site Restoration	1	LS	$10,000	$10,000
SUBTOTAL				**$2,344,825**
Install Supplemental Monitoring Wells (provisional)				
Private Utility Locator	1	day	$1,200	$1,200
Install Monitoring Well	3	ea.	$5,000	$15,000
SUBTOTAL				**$16,200**
Restrictive Convenant				
Surveyor: Property Boundary Survey and Legal Description	1	ea.	$15,000	$15,000
Complete State of Washington Environmental Covenant	1	ea.	$3,000	$3,000
Recording Fee	1	ea.	$100	$100
SUBTOTAL (1)				**$18,100**
TOTAL DIRECT CAPITAL COSTS				***$2,511,325***
INDIRECT CAPITAL COSTS				
Permitting and Legal (5% Total Direct Costs)	1	LS	$125,566	$125,566
Contractor Overhead & Profit (15% Total Direct Costs)	1	LS	$376,699	$376,699
Engineering and Construction Oversight (15% Total Direct Costs)	1	LS	$376,699	$376,699
Health and Safety Costs (3% Total Direct Costs)	1	LS	$75,340	$75,340
Project Management & Administration (10% Total Direct Costs)	1	LS	$251,133	$251,133
TOTAL INDIRECT CAPITAL COSTS				**$1,205,400**
TOTAL CAPITAL COSTS (Direct and Indirect)				***$3,716,725***

Table D-4
Alternative 3 - Soil Excavation and Off-Site Landfilling of Contaminated Soil
Former FMC Pesticide Formulation Facility
Yakima, Washington

	QUANTITY		COST	
DESCRIPTION	**Number**	**Unit**	**Unit Cost**	**Total Cost**
O & M COSTS				
Annual Site Inspection				
Site Visit, Field Verification of Environmental Covenant	1	LS	$2,000	$2,000
Total Costs Per Event				**$2,000**
SUBTOTAL UNDISCOUNTED O&M COSTS (30 years)				**$60,000**
SUBTOTAL NET PRESENT WORTH O&M COSTS (30 years) (2)				**$24,818**
Ground Water Monitoring Cost Per Event (Years 5, 10, 15, 20, 25, 30)				
Well Sampling Labor and Equipment	10	wells	$300	$3,000
Groundwater Analysis - OCL Pesticides	12	samples	$110	$1,320
Reporting	1	LS	$15,000	$15,000
SUBTOTAL				**$19,320**
Contractor Overhead & Profit (15% Total Direct Costs)	1	LS	$2,898	$2,898
Health and Safety Costs (3% Total Direct Costs)	1	LS	$580	$580
Project Management & Administration (10% Total Direct Costs)	1	LS	$1,932	$1,932
SUBTOTAL				**$5,410**
Total Costs Per Event				**$24,730**
SUBTOTAL UNDISCOUNTED O&M COSTS (Years 5, 10, 15, 20, 25, 30)				**$148,378**
SUBTOTAL NET PRESENT WORTH O&M COSTS (Years 5, 10, 15, 20, 25, 30) (3)				**$53,362**
TOTAL UNDISCOUNTED O&M COSTS				**$208,378**
NET PRESENT WORTH OF TOTAL O&M COSTS				**$78,180**
TOTAL CAPITAL AND O & M COSTS				***$3,794,905***
General Contingency (15% of Total Capital and O&M Costs)				***$569,236***
TOTAL COST OF ALTERNATIVE (NET PRESENT WORTH)				***$4,365,000***

Notes:

(1) Does not include potential cost for getting the land owners consent to apply Restrictive Convenant.
(2) Present worth calculated using equal payment series present worth analysis where i = 7 %
(3) Present worth calculated using single payment present worth analysis where i = 7 %
OCL - Organochlorine
O&M - Operations and maintenance.
LF - Linear foot.
ea. = each.
hr. - hour.
ft. - feet.
LS - Lump Sum.
SF - square foot.
CY - cubic yard.

Table D-5
Alternative 4 - Groundwater Extraction and Treatment
Former FMC Pesticide Formulation Facility
Yakima, Washington

	QUANTITY		COST	
DESCRIPTION	**Number**	**Unit**	**Unit Cost**	**Total Cost**
DIRECT CAPITAL COSTS				
Preparation				
Design/ Work Plan	1	ea.	$40,000	$40,000
Private Utility Locator	1	day	$1,200	$1,200
Surveying for Well Locations	1	LS	$2,000	$2,000
SUBTOTAL				**$43,200**
Construction				
Mobilization/ Demobilization	1	LS	$10,000	$10,000
Site Preparation, including Grubbing	1	LS	$3,000	$3,000
Install Extraction Wells	2	each	$10,000	$20,000
Trenching for Groundwater Extraction and Discharge Lines	500	ft	$50.00	$25,000
Piping (2"PVC)	1000	ft	$3.20	$3,200
Sanitary Sewer Tie-In	1	LS	$3,000	$3,000
Conduit	500	ft	$12	$6,000
Pad and Fencing	1	ea.	$30,000	$30,000
SUBTOTAL				**$100,200**
Equipment				
Extraction pump	1	ea.	$5,000	$5,000
Bag Filter	1	ea.	$25,000	$25,000
Ancillary equipment (PLC, transfer pumps, tank, etc)	1	LS	$60,000	$60,000
System installation	1	LS	$75,000	$75,000
Liquid-Phase Activated Carbon Vessels (2x4000 lb)	1	LS	$150,000	$150,000
As-Built Drawings and O&M Manual Preparation	1	LS	$25,000	$25,000
System Startup and Optimization	1	LS	$25,000	$25,000
SUBTOTAL				**$365,000**
Install Supplemental Monitoring Wells (provisional)				
Private Utility Locator	1	day	$1,200	$1,200
Install Monitoring Well	3	ea.	$5,000	$15,000
SUBTOTAL				**$16,200**
Restrictive Convenant				
Surveyor: Property Boundary Survey and Legal Description	1	ea.	$15,000	$15,000
Complete State of Washington Environmental Covenant	1	ea.	$3,000	$3,000
Recording Fee	1	ea.	$100	$100
SUBTOTAL (1)				**$18,100**
TOTAL DIRECT CAPITAL COSTS				***$542,700***
INDIRECT CAPITAL COSTS				
Permitting and Legal (5% Total Direct Costs)	1	LS	$27,135	$27,135
Contractor Overhead and Profit (15% Total Direct Costs)	1	LS	$81,405	$81,405
Engineering and Construction Oversight (15% Total Direct Costs)	1	LS	$81,405	$81,405
Health and Safety Costs (3% Total Direct Costs)	1	LS	$16,281	$16,281
Project Management and Administration (10% Total Direct Costs)	1	LS	$54,270	$54,270
TOTAL INDIRECT CAPITAL COSTS				**$260,500**
TOTAL CAPITAL COSTS (Direct and Indirect)				***$803,200***

Table D-5
Alternative 4 - Groundwater Extraction and Treatment
Former FMC Pesticide Formulation Facility
Yakima, Washington

DESCRIPTION	QUANTITY		COST	
	Number	**Unit**	**Unit Cost**	**Total Cost**
O & M COSTS				
Groundwater Treatment System Maintenance (Year 1-30)				
System O&M Labor	12	month	$1,500	$18,000
System Sampling and Analysis - OCL Pesticides	12	samples	$110	$1,320
System Sampling and Analysis - TDS and Metals	12	samples	$300	$3,600
Well redevelopment (1/4 of all extraction wells per year)	0.50	wells	$5,000	$2,500
Supplies	12	month	$500	$6,000
Monthly Reporting	12	month	$1,000	$12,000
Annual Reporting	1	LS	$5,000	$5,000
Activated carbon replacement	4,000	lb	$1.50	$6,000
Carbon disposal	2	ton	$310	$620
Discharge fee	32	mgal.	$100	$3,154
Electricity	12	month	$1,000	$12,000
SUBTOTAL				**$70,194**
Replacement Costs (7% Total Direct Costs)	1	LS	$4,914	$4,914
Contractor Overhead & Profit (15% Total Direct Costs)	1	LS	$10,529	$10,529
Health and Safety Costs (3% Total Direct Costs)	1	LS	$2,106	$2,106
Project Management & Administration (10% Total Direct Costs)	1	LS	$7,019	$7,019
SUBTOTAL				**$24,568**
Annual System Maintenance Costs (Year 1-30)				**$94,761**
SUBTOTAL UNDISCOUNTED O&M COSTS (30 years)				**$2,842,841**
SUBTOTAL NET PRESENT WORTH O&M COSTS (30 years) (1)				**$1,175,898**
Annual Site Inspection				
Site Visit, Field Verification of Environmental Covenant	1	LS	$2,000	$2,000
Total Costs Per Event				**$2,000**
SUBTOTAL UNDISCOUNTED O&M COSTS (30 years)				**$60,000**
SUBTOTAL NET PRESENT WORTH O&M COSTS (30 years) (2)				**$24,818**
Ground Water Monitoring Cost Per Event (Years 5, 10, 15, 20, 25, 30)				
Well Sampling Labor and Equipment	10	wells	$300	$3,000
Groundwater Analysis - OCL Pesticides	12	samples	$110	$1,320
Reporting	1	LS	$15,000	$15,000
SUBTOTAL				**$19,320**
Contractor Overhead & Profit (15% Total Direct Costs)	1	LS	$2,898	$2,898
Health and Safety Costs (3% Total Direct Costs)	1	LS	$580	$580
Project Management & Administration (10% Total Direct Costs)	1	LS	$1,932	$1,932
SUBTOTAL				**$5,410**
Total Costs Per Event				**$24,730**

Table D-5

Alternative 4 - Groundwater Extraction and Treatment

Former FMC Pesticide Formulation Facility
Yakima, Washington

	QUANTITY		COST	
DESCRIPTION	**Number**	**Unit**	**Unit Cost**	**Total Cost**
SUBTOTAL UNDISCOUNTED O&M COSTS (Years 5, 10, 15, 20, 25, 30)				**$148,378**
SUBTOTAL NET PRESENT WORTH O&M COSTS (Years 5, 10, 15, 20, 25, 30) (3)				**$53,362**
TOTAL UNDISCOUNTED O&M COSTS				**$3,051,218**
NET PRESENT WORTH OF TOTAL O&M COSTS				**$1,254,078**
TOTAL CAPITAL AND O & M COSTS				***$2,057,278***
General Contingency (15% of Total Capital and O&M Costs)				***$308,592***
TOTAL COST OF ALTERNATIVE (NET PRESENT WORTH)				***$2,366,000***

Notes:

(1) Does not include potential cost for getting the land owners consent to apply Restrictive Convenant.
(2) Present worth calculated using equal payment series present worth analysis where i = 7 %
(3) Present worth calculated using single payment present worth analysis where i = 7 %
OCL - Organochlorine
O&M - Operations and maintenance.
lb = pounds.
mgal - mega gallons.
OCL - organochlorine.
PVC - Polyvinyl Chloride.
LS - Lump Sum.
TDS - total dissolved solids.
PLC - Programmable logic controller