Final
May 2000

COST AND PERFORMANCE REPORT

Expedited Characterization and Soil Remediation
At the Test Plot Area
Wenatchee Tree Fruit Research Center
Wenatchee, Washington

May 2000

Prepared by:
U.S. Army Corps of Engineers
Hazardous, Toxic, Radioactive Waste
Center of Expertise

Final
May 15, 2000

SITE INFORMATION

IDENTIFYING INFORMATION (1,2,8)

Site Name: Wenatchee Tree Fruit Research Center (TFRC)
Location: Wenatchee, Washington
Operable Unit: Not applicable
CERCLIS #: Not applicable
ROD Date: Not applicable
Technology: Expedited Site Characterization and Remediation
Type of Action: Remedial

Figure 1 shows the location of the TFRC in Washington State, and Figure 2 shows the layout of the Test Plot at the TFRC.

TECHNOLOGY APPLICATION (1,2,8)

Period of Operation:

- Focused Removal activities – September 22 - 24, 1997
- Gross Removal soil excavation – October 13, 1997
- Sidewall sampling and excavation – October 23 to November 17, 1997
- Final Gross Removal soil excavation – December 10, 1997
- Site Restoration activities completed – January 1998

Quantity of Material Treated During Application:
390 tons of contaminated soil was characterized and remediated. 334 tons of soil was disposed in a RCRA Subtitle C permitted landfill, and 56 tons was incinerated.

BACKGROUND (1,2,8)

Site Background and History:

The Wenatchee Tree Fruit Research Center (TFRC), is located in southeast Wenatchee, Washington, and has historically been used as an agricultural research facility. The majority of the research activities were conducted in a 2,100 square-foot test plot area located in the northeast corner of the facility. The Test Plot area was initially used by the U.S. Public Health Service, and later by the U.S. Environmental Protection Agency (EPA), as a test facility to determine the effectiveness of various land disposal methods for pesticides. Pesticides used in the studies included herbicides, insecticides, and acaricides.

Pesticides testing began in 1966 and continued until the early 1980s. In the mid-1980s, ownership of the property was transferred from the EPA to Washington State University (WSU). Research activities

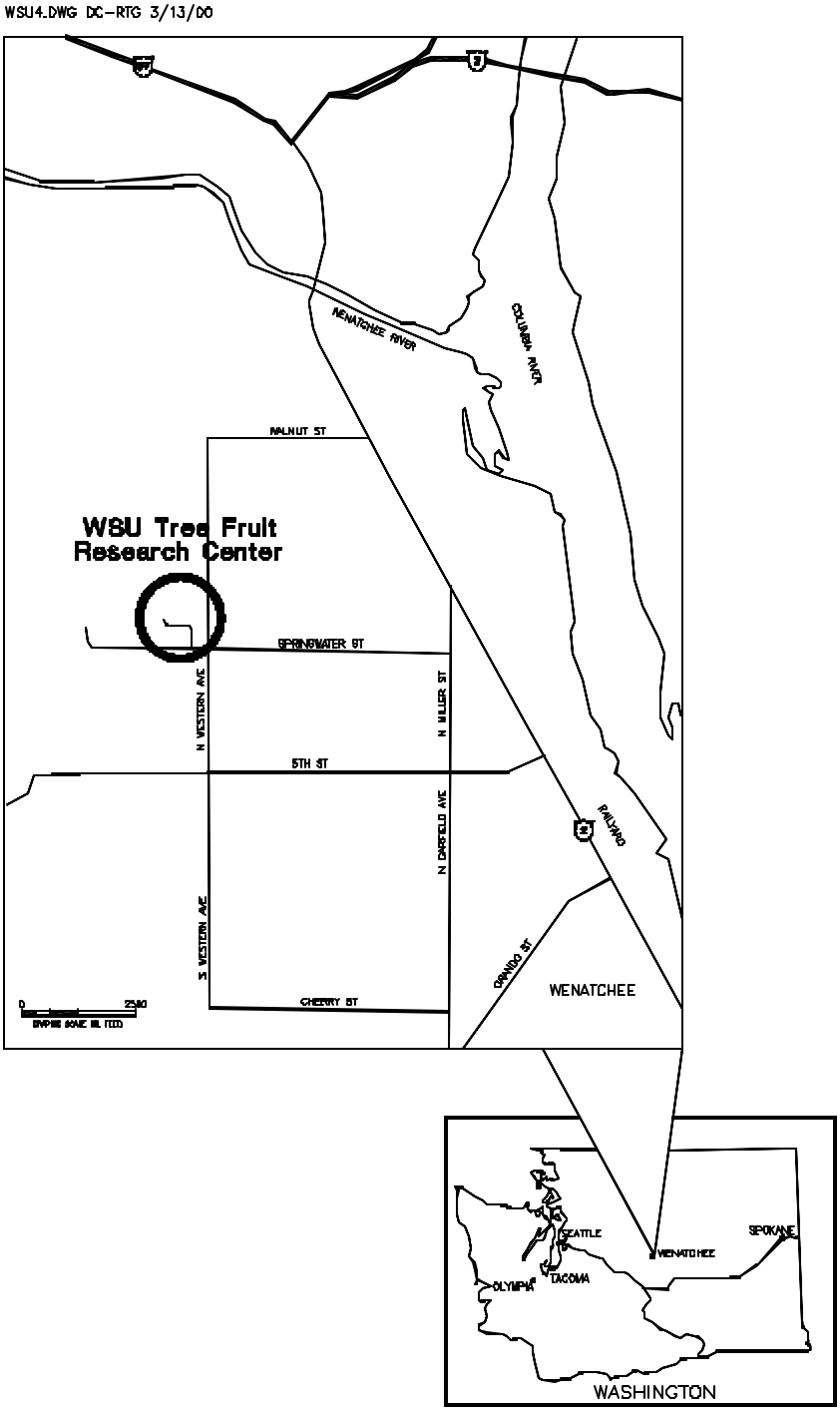

Figure 1. Location of the Wenatchee Tree Fruit Research Center in Washington

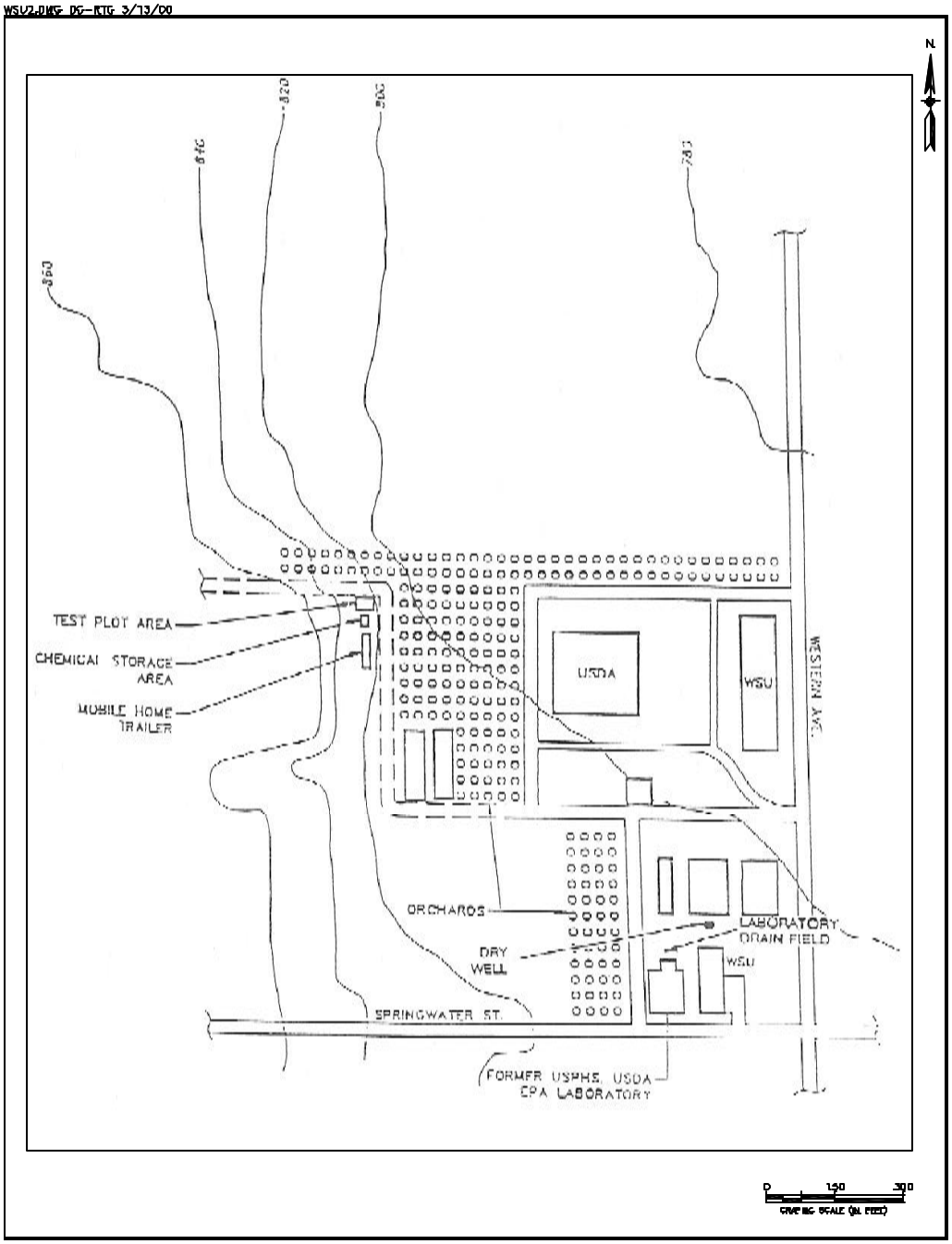

Figure 2. Site Plan for the Test Plot at the TFRC

focused on disposal of organochlorine (OC) and organophosphorus (OP) pesticides, but could have possibly included the testing of other pesticides. Pesticide burial was conducted at the site using the following three methods:

- Pesticides were diluted with solvent and poured through the openings of cinder blocks;
- Pesticides were diluted with solvent and poured directly onto the ground surface; and
- Pesticides were left in their original containers and were buried two to three feet below the ground surface (bgs).

WSU currently operates test and laboratory facilities at the TFRC. In response to concerns about pesticide contamination, WSU performed limited sampling and analysis of soil in and near the Test Plot. In addition, WSU contacted the EPA and asked for assistance in characterizing and remediating the Test Plot site.

The Test Plot is located adjacent to a graduate student mobile home, an unpaved access road, and the future site of a manufactured home development.

SIC Code:
9511 (Environmental Protection Agencies – Government)

Waste Management Practices that Contributed to Contamination (1,2,8):
This facility was used for research of pesticide migration in soil. Pesticides in various forms were disposed at the site during research activities.

Site Investigations (1,8):
Both WSU and EPA conducted soil sampling events at the TFRC on several occasions prior to initiation of remedial activities in 1997. EPA sampling events were conducted in 1991 and 1994, and WSU performed sampling between 1985 and 1987. Sampling activities included collection of four background soil samples from an area approximately 1200 feet west of the Test Plot. Figure 3 shows the locations where background samples were collected. Sample results from the WSU and EPA sampling events were used to determine the primary areas of OC and OP pesticide contamination at the site. In January 1997, EPA's Office of Research and Development (ORD) obtained assistance from the U.S. Army Corp of Engineers (USACE) for the purpose of remediating the Test Plot site.

The USACE reviewed records and publications available at the research facility and contacted several TFRC researchers to obtain additional information regarding previous EPA experiments at the site. This research allowed the USACE to identify the three previously listed methods of pesticide disposal that were used during EPA research activities at the TFRC. Articles written by the EPA researchers in the 1970s indicated that downward vertical migration of pesticides of greater than 8 inches below the disposal point was not expected at the Test Plot area. In addition, the articles predicted negligible horizontal migration of pesticides at the site. Investigations performed by EPA and WSU in the 1980s and 1990s confirmed these migration predictions. The article findings and subsequent sampling data were used to develop initial plans for characterization and excavation at the Test Plot area.

The location and dimensions of the former Test Plot area were determined based on the location of existing barbed wire fencing at the site. Based on the fence location, the approximate dimensions of the Test Plot were determined to be 70 feet by 30 feet, and the area was located approximately 23 feet south of the TFRC facility's northern property line. Based on comparison of sampling results with Washington

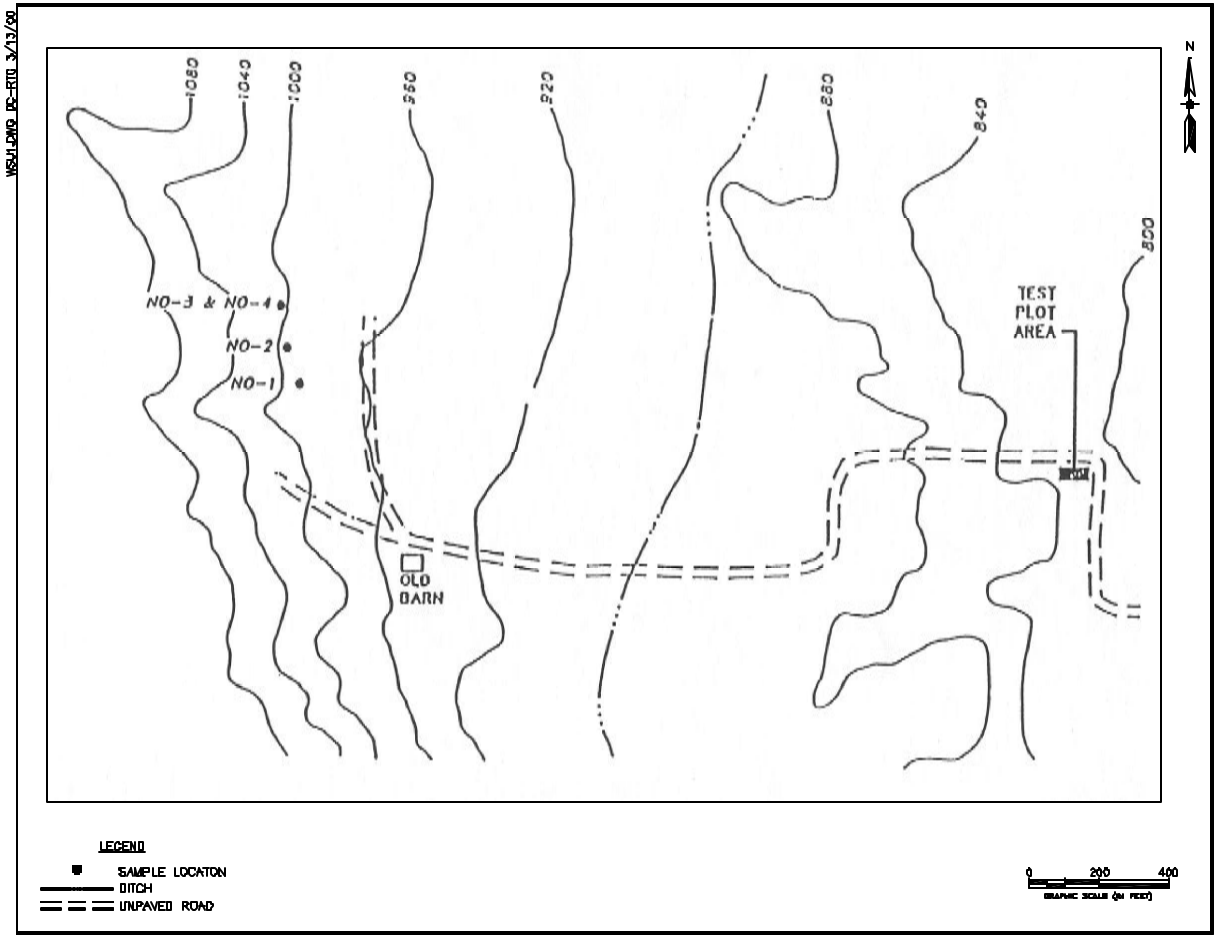

Figure 3. Background Sampling Locations at the TFRC

State Model Toxics Control Act (MTCA) Method B clean up levels, it was determined that the area of contamination actually extended three feet north of the Test Plot, 10 feet west of the Test Plot and 5.5 feet east of the Test Plot. These extensions resulted in an effective contaminated area of 85 feet by 33 feet. Figure 4 shows the layout of the Test Plot area, including sampling locations from previous sampling events at the site. Detailed discussion of the expedited site characterization sampling and analysis is provided in a later section of this report.

Remedy Selection (1,8):
The selected remedy for the site included performance of an integrated site characterization and remediation in the field. Immunoassay analysis (IAA) kits were used at the site for chlorinated pesticides analysis, and results were supplemented by limited data from fixed laboratories. This remedy was selected for the Test Plot area to meet the following goals:

- To allow for low-cost and efficient comprehensive characterization of the Test Plot;
- To rapidly characterize soil in preparation from disposal;
- To classify and segregate the soil into dangerous and non-dangerous waste streams quickly and easily;
- To obtain data that would be characterized by low percentage of false positive IAA results;
- To make sure that all soil remaining at the site meets the clean up levels established in the Washington State MTCA Method B.

SITE LOGISTICS/CONTACTS (3,5)

Role	**Contact Information**
Project Management	Ralph Totorica Project Manager U.S. Army Corps of Engineers – Seattle District 4735 East Marginal Way South Seattle, Washington 98134 (206) 764-6837
	Greg Gervais Project Environmental Engineer U.S. Army Corps of Engineers – Seattle District 4735 East Marginal Way South Seattle, Washington 98134 (206) 764-6837
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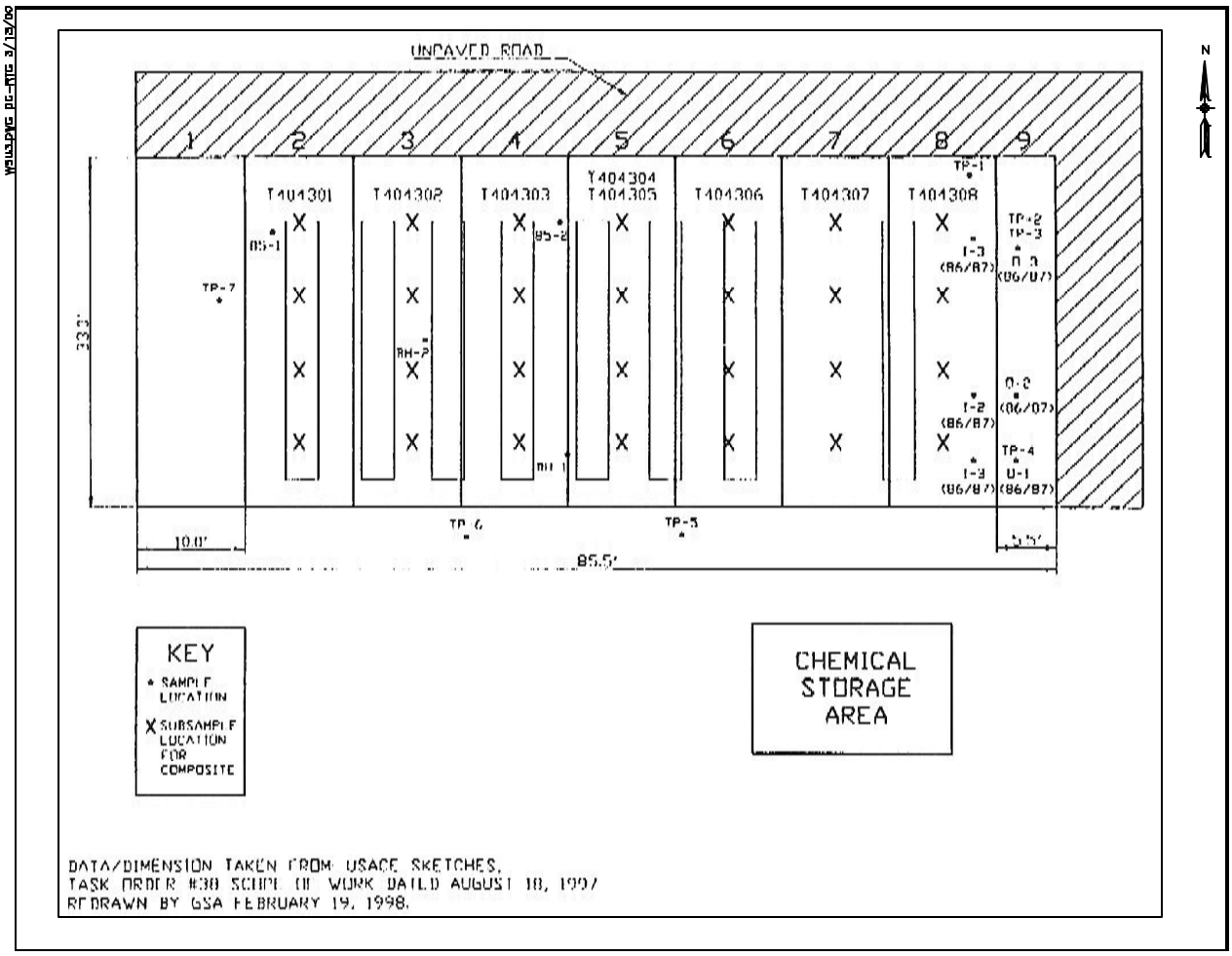

Figure 4. Previous Sampling Locations at the TFRC

Regulatory Contact

Howard Wilson
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Remediation Contractor

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MATRIX AND CONTAMINANT DESCRIPTION

MATRIX IDENTIFICATION

Soil (ex situ)

SITE GEOLOGY/STRATIGRAPHY (10)

The TFRC is situated at approximately 800 feet above sea level and 194 feet above the normal elevation of the Columbia River. The TFRC is located approximately two miles east of the Columbia River. The eastern foothills of the Cascade Mountains, which begin approximately one-half mile to the west of TFRC, rise to approximately 2,000 feet above sea level. The site lies on an alluvial fan deposited along a steep drainage that flows eastward from the Cascade Mountains to the Columbia River. The alluvial soils are composed of poorly sorted boulder gravel and gravelly sand with some clay layers. The surface gradient in the area is approximately 200 feet per mile. The gradient becomes less steep as the alluvial fan merges with the Columbia River flood plan.

CONTAMINANT CHARACTERIZATION (1,8)

Primary Contaminant Group: Organic Compounds - Semivolatiles (organic pesticides/herbicides)

Key Specific Contaminants: dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyltrichloroethane (DDT), Dieldrin, Endrin and Parathion.

CONTAMINANT PROPERTIES (1,4,5,6,7,8)

Table 1 lists selected properties for the key specific contaminants present at TFRC.

Table 1. Contaminant Properties

Property	Units	DDD	DDE	DDT	Dieldrin	Endrin	Parathion
Chemical Formula	-	$C_{14}H_{10}Cl_4$	$C_{14}H_8Cl_4$	$C_{14}H_9Cl_5$	$C_{12}H_{10}Cl_6O$	$C_{12}H_8Cl_6O$	$C_{10}H_{14}NO_5PS$
Molecular Weight	g/mole	320.05	318.03	354.49	380.91	380.93	291.26
Specific Gravity	-	1.476	--	1.56	1.75	--	1.26
Vapor Pressure	mm Hg	1.02E-06	6.49E-06	1.9E-07	3.10E-06	2E-07	0.003
Boiling Point	°C	193	--	260	--	245	375
Octanol-Water Partition Coefficient	-	5.99 log K_{ow}	4.28 log P_{oct}	6.19 log P_{oct} @ 20^o	5.48 log P_{oct} @ 25^o	5.6 log P_{oct}	3.81 log P_{oct} @ 20^o

NATURE AND EXTENT OF THE CONTAMINANTS (1,2,8)

The dimensions of the contaminated area were initially assumed to be 70 feet by 30 feet, based on the location of fencing at the Test Plot. These dimensions were later modified to 85 feet by 33 feet, based on data gathered during Site Characterization activities. The depths of contamination at the site were assumed to be no more than 1 foot below reported disposal depths in each area of the Test Plot. It was expected that contamination would not be found deeper than three feet bgs in any portion of the site.

Table 2 summarizes the results from previous sampling events conducted by EPA and WSU at the Test Plot site. As discussed previously, WSU sampling efforts started in 1985 and ended in 1987. EPA conducted additional sampling and analysis of the Test Plot area in 1991 and in 1994. Sample locations corresponding with these results are shown on Figure 4. Discussion of results from sampling conducted during the expedited site characterization is provided in the Treatment System Description" section of this report.

MATRIX CHARACTERISTICS AFFECTING TREATMENT COST OR PERFORMANCE

Table 3 lists selected characteristics of untreated soil that may affect cost or performance of expedited site characterization projects. Information regarding these parameters was not available for this project.

Table 2. Summary of Contaminant Concentrations Prior to Expedited Site Characterization

Sample Location (Sample ID)	Contaminant Detected	MTCA Method B Concentration (mg/kg)	Concentration (mg/kg)	Sample Depth (inches bgs)	Year Collected
Column 1 (TP-7)	DDE	2.94	1.30	NA	1991
	DDT	2.94	0.610	NA	1991
Column 2 (85 #1)	Ethyl Parathion	480	0.020	0-6	1985
	Ethyl Paraoxon	480	Trace	0-6	1985
	Dieldrin	0.0625	NAR	0-6	1985
	DDE	2.94	401	0-6	1985
	PP-DDT	2.94	1.60	0-6	1985
	OP-DDT	2.94	0.050	0-6	1985
(T404301)	DDE	2.94	2.30	0	1994
	DDD	4.17	0.0410	0	1994
	DDT	2.94	1.80	0	1994
Column 3 (T404302)	Dieldrin	0.0625	9.60	0-2	1994
	Endrin Ketone	24.0	220	0-2	1994
(BH2)	Dieldrin	0.0625	1.10	0	1994
	Endrin	24.0	0.32	0	1994
(T404312)	Endrin Ketone	24.0	6.9	0	1994
	Endrin Aldehyde	24.0	ND	0	1994
	DDE	2.94	1.10	0	1994
	DDT	2.94	0.460	0	1994
(T404313)	Dieldrin	0.0625	0.430	12	1994
	Endrin	24.0	1.70	12	1994
	Endrin Ketone	24.0	3.10	12	1994
	Endrin Aldehyde	24.0	0.390	12	1994
	DDE	2.94	0.960	12	1994
	DDT	2.94	0.390	12	1994
(T404314)	Dieldrin	0.0625	0.00310	24	1994
	Endrin	24.0	ND	24	1994
	Endrin Ketone	24.0	ND	24	1994
	Endrin Aldehyde	24.0	ND	24	1994
	DDE	2.94	ND	24	1994
	DDT	2.94	0.018	24	1994
Column 4 (85 #2)	Ethyl Parathion	480	0.00	0-6	1985
	Ethyl Paraoxon	480	1460	0-6	1985
	Dieldrin	0.0625	NAR	0-6	1985
	DDE	2.94	816	0-6	1985
	PP-DDT	2.94	3080	0-6	1985
	OP-DDT	2.94	126	0-6	1985
(T404303)	Dieldrin	0.0625	0.170	NA	1994
	Endrin Ketone	24.0	0.390	NA	1994
	DDE	2.94	2.00	NA	1994
	DDT	2.94	1.50	NA	1994

Table 2. Summary of Contaminant Concentrations Prior to Expedited Site Characterization (Continued)

Sample Location (Sample ID)	Contaminant Detected	MTCA Method B Concentration (mg/kg)	Concentration (mg/kg)	Sample Depth (inches bgs)	Year Collected
South of Column 4 (TP-6)	Dieldrin	0.0625	0.00120	NA	1991
	DDE	2.94	0.0110	NA	1991
	DDT	2.94	0.0110	NA	1991
Near Column 4 (BH1) and Column 5 (T404309) (T404210)	DDE	2.94	5.6	0-2	1994
	DDT	2.94	4.7	0-2	1994
	DDE	2.94	0.680	12	1994
	DDT	2.94	0.0510	12	1994
(T404311)	DDE	2.94	1.20	24	1994
	DDT	2.94	4.4	24	1994
Column 5 (T404304)	Dieldrin	0.0625	0.390	NA	1994
	Endrin Ketone	24.0	0.210	NA	1994
	DDE	2.94	5.4	NA	1994
	DDT	2.94	3.6	NA	1994
(T404305)	Dieldrin	0.0625	0.250	NA	1994
	Endrin Ketone	24.0	0.130	NA	1994
	DDE	2.94	4.00	NA	1994
	DDT	2.94	3.20	NA	1994
Column 6 (T404306)	Dimethoate	16.0	0.490	NA	1994
	Di-Sulfoton	3.20	570	NA	1994
	Endosulfan I	480	0.0790	NA	1994
	Endosulfan II	480	0.810	NA	1994
	Endosulfan Sulfate	480	0.710	NA	1994
	Endrin	24.0	0.370	NA	1994
	Endrin Aldehyde	24.0	0.220	NA	1994
	DDE	2.94	2.10	NA	1994
	DDT	2.94	1.20	NA	1994
South of Column 6 (TP-5)	DDE	2.94	0.560	NA	1991
	DDT	2.94	0.430	NA	1991
Column 7 (TP-1)	DDE	2.94	3.2	NA	1991
	DDT	2.94	3.4	NA	1991
	Endrin	0.0625	0.065	NA	1991
(T404307)	Di-Sulfoton	3.20	0.530	NA	1994
	Endosulfan Sulfate	480	0.0790	NA	1994
	DDE	2.94	3.10	NA	1994
	DDT	2.94	2.10	NA	1994
Column 8 (#I-3)	Ethyl Parathion	480	0.100	NA	1986
	Ethyl Paraoxon	480	NAR	NA	1986
	Dieldrin	0.0625	NAR	NA	1986
	DDE	2.94	1.20	NA	1986
	PP-DDT	2.94	1.60	NA	1986
	OP-DDT	2.94	0.140	NA	1986

Table 2. Summary of Contaminant Concentrations Prior to Expedited Site Characterization (Continued)

Sample Location (Sample ID)	Contaminant Detected	MTCA Method B Concentration (mg/kg)	Concentration (mg/kg)	Sample Depth (inches bgs)	Year Collected
(#I-2)	Ethyl Parathion	480	NAR	NA	1986
	Ethyl Paraoxon	480	NAR	NA	1986
	Dieldrin	0.0625	NAR	NA	1986
	DDE	2.94	0.900	NA	1986
	PP-DDT	2.94	1.20	NA	1986
	OP-DDT	2.94	0.400	NA	1986
(#I-1)	Ethyl Parathion	480	0.100	NA	1986
	Ethyl Paraoxon	480	NAR	NA	1986
	Dieldrin	0.0625	NAR	NA	1986
	DDE	2.94	0.700	NA	1986
	PP-DDT	2.94	1.00	NA	1986
	OP-DDT	2.94	0.300	NA	1986
(#I-3)	Ethyl Parathion	480	0.200	NA	1987
	Ethyl Paraoxon	480	NAR	NA	1987
	Dieldrin	0.0625	0.0160	NA	1987
	DDE	2.94	2.30	NA	1987
	PP-DDT	2.94	4.80	NA	1987
	OP-DDT	2.94	0.900	NA	1987
(#I-2)	Ethyl Parathion	480	0.140	NA	1987
	Ethyl Paraoxon	480	NAR	NA	1987
	Dieldrin	0.0625	NAR	NA	1987
	DDE	2.94	1.30	NA	1987
	PP-DDT	2.94	2.00	NA	1987
	OP-DDT	2.94	0.600	NA	1987
(#I-1)	Ethyl Parathion	480	0.200	NA	1987
	Ethyl Paraoxon	480	NAR	NA	1987
	Dieldrin	0.0625	0.0140	NA	1987
	DDE	2.94	1.40	NA	1987
	PP-DDT	2.94	2.60	NA	1987
	OP-DDT	2.94	0.800	NA	1987
(T404308)	Di-Sulfoton	3.2	0.330	NA	1994
	DDE	2.94	3.90	NA	1994
	DDT	2.94	2.90	NA	1994
South of Column 8 (TP-8)	DDE	2.94	1.20	NA	1991
	DDT	2.94	1.10	NA	1991
Column 9 (#O-3)	Ethyl Parathion	480	0.0530	NA	1986
	Ethyl Paraoxon	480	NAR	NA	1986
	Dieldrin	0.0625	NAR	NA	1986
	DDE	2.94	0.300	NA	1986
	PP-DDT	2.94	0.500	NA	1986
	OP-DDT	2.94	0.500	NA	1986

Table 2. Summary of Contaminant Concentrations Prior to Expedited Site Characterization (Continued)

Sample Location (Sample ID)	Contaminant Detected	MTCA Method B Concentration (mg/kg)	Concentration (mg/kg)	Sample Depth (inches bgs)	Year Collected
(#O-2)	Ethyl Parathion	480	NAR	NA	1986
	Ethyl Paraoxon	480	NAR	NA	1986
	Dieldrin	0.0625	NAR	NA	1986
	DDE	2.94	0.400	NA	1986
	PP-DDT	2.94	0.700	NA	1986
	OP-DDT	2.94	0.200	NA	1986
(#O-1)	Ethyl Parathion	480	0.100	NA	1986
	Ethyl Paraoxon	480	NAR	NA	1986
	Dieldrin	0.0625	NAR	NA	1986
	DDE	2.94	0.700	NA	1986
	PP-DDT	2.94	1.00	NA	1986
	OP-DDT	2.94	0.300	NA	1986
(#0-3)	Ethyl Parathion	480	0.200	NA	1987
	Ethyl Paraoxon	480	NAR	NA	1987
	Dieldrin	0.0625	NAR	NA	1987
	DDE	2.94	2.30	NA	1987
	PP-DDT	2.94	4.10	NA	1987
	OP-DDT	2.94	1.30	NA	1987
(#0-2)	Ethyl Parathion	480	0.200	NA	1987
	Ethyl Paraoxon	480	NAR	NA	1987
	Dieldrin	0.0625	0.0200	NA	1987
	DDE	2.94	1.70	NA	1987
	PP-DDT	2.94	1.90	NA	1987
	OP-DDT	2.94	0.600	NA	1987
(#0-1)	Ethyl Parathion	480	0.200	NA	1987
	Ethyl Paraoxon	480	NAR	NA	1987
	Dieldrin	0.0625	NAR	NA	1987
	DDE	2.94	2.00	NA	1987
	PP-DDT	2.94	3.50	NA	1987
	OP-DDT	2.94	1.10	NA	1987
(TP-2)	DDE	2.94	4.70	NA	1991
	DDT	2.94	11.0	NA	1991
(TP-3)	DDE	2.94	5.10	NA	1991
	DDT	2.94	9.80	NA	1991
South of Column 9	DDE	2.94	0.410	NA	1991
(TP-9)	DDT	2.94	0.290	NA	1991
	DDE	2.94	0.870	NA	1991
	DDT	2.94	0.710	NA	1991
	DDE	2.94	1.00	NA	1991
	DDT	2.94	0.870	NA	1991

Table 2. Summary of Contaminant Concentrations Prior to Expedited Site Characterization (Continued)

Sample Location (Sample ID)	Contaminant Detected	MTCA Method B Concentration (mg/kg)	Concentration (mg/kg)	Sample Depth (inches bgs)	Year Collected
Non-Orchard	DDE	2.94	3.40	NA	1991
Background	Endosulfan Sulfate	480	0.0170	NA	1991
(NO-1)	DDT	2.94	2.60	NA	1991
	DDE	2.94	0.0420	NA	1991
(NO-2)	DDT	2.94	0.0310	NA	1991

Shaded entries indicate concentrations above MTCA Method B standards.
NA – Depth information not available
ND – Not Detected
NAR – No Analysis Requested

Table 3. Matrix Characteristics

Characteristic	Value	Measurement Procedure
Soil Classification	Not Available	Not Applicable
Clay Content and/or Particle Size Distribution	Not Available	Not Applicable
Moisture Content	Not Available	Not Applicable
Total Organic Carbon	Not Available	Not Applicable
BTU Value	Not Available	Not Applicable
Halogen Content	Not Available	Not Applicable
Metal Content or Presence of Metals	Not Available	Not Applicable

TREATMENT SYSTEM DESCRIPTION

PRIMARY TREATMENT TECHNOLOGY (8)

Soil Ex-Situ
- **Incineration (off-site)**
- **RCRA Landfill**

It should be noted that off-site disposal of contaminated materials was required on this project because TFRC officials would not consider on-site treatment alternatives for these wastes.

SYSTEM DESCRIPTION AND OPERATION (1,8)

Overall Characterization and Remediation Activities

The following steps were taken to complete expedited site characterization and remediation activities at the Test Plot area:

Step 1: Mobilization
Step 2: Focused Removal of the Bags of Pure Pesticides
Step 3: Sampling Effort to Characterize Contamination as well as Initial Confirmation
Step 4: Gross Removal of Contaminated Soil
Step 5: Final Confirmation Sampling to Verify the Completion of Removal Activities
Step 6: Backfilling of the Excavated Areas
Step 7: Disposal of Contaminated Materials

Mobilization

Mobilization for this project included delivery of equipment to the site, removal of surface vegetation and objects at the site and delineation of Test Plot features. Equipment mobilized for this project included:

- A mobile office trailer;
- A mobile laboratory trailer;
- Storage bins for various waste streams; and,
- Miscellaneous additional equipment.

Surface vegetation at the site was removed down to a maximum height of two inches above the ground surface. In addition, other objects including the perimeter fencing were removed from the site and disposed.

As discussed previously, the effective dimensions of the Test Plot were determined to be 85 feet by 33 feet. In preparation for expedited site characterization and remediation activities, the Test Plot was divided into nine columns and three rows, creating a grid with 27 cells. The columns ran from north to south, and the rows ran from east to west. The columns were numbered 1 to 9, from the westernmost to easternmost column. The rows were labeled A (northernmost), B (center), and C (southernmost). Columns 1 through 8 were each 10-feet wide by 33-feet long, while Column 9 was approximately five feet wide. Each of the cells was delineated with markers in the corners and string along the edges.

Column locations were selected based on historic disposal locations and previous sampling results. The dimensions of each cell were determined based on statistical analysis of the site and potential hot spot size. The potential hot spot size was calculated to be a 5-foot by 10-foot ellipse using an EPA guidance document entitled “Methods for Evaluation and Attainment of Cleanup Standards, Vol. 1, Soils and Solid Media”, February 1989.

Focused Removal Activities

Focused Removal activities were designed to remediate two locations where bags of concentrated pesticide products had been reportedly buried. Each of these two areas was approximately 10 feet by 24 feet. The areas were designated as Focused Removal Area 2/3 (FR2/3) and Focused Removal Area 4/5 (FR4/5). The areas were given these designations because they were located in the vicinity of Columns 2 and 3 (FR2/3) and Columns 4 and 5 (FR4/5), respectively. Based upon USACE review of TFRC research records, the FR2/3 soil and debris were expected to contain OP pesticides and the FR4/5 materials were expected to contain OC pesticides.

These two areas were excavated until all visible evidence of pesticide disposal was removed. Excavation was terminated when pesticide bags or fragments of bags were no longer observed. Based on this criterion, area FR2/3 was excavated down to 27 inches bgs and FR4/5 was excavated down to 33 inches bgs. The excavated materials were segregated based on expected contaminants and concentrations, and were placed directly into designated roll-off bins. A total of 45.74 tons of material was excavated during Focused Removal activities. 22.32 tons were taken from FR2/3 and 23.42 tons were taken from FR4/5.

Upon completion of excavation activities, confirmatory samples were collected from the bottoms of the FR2/3 and FR4/5 areas, respectively. Three grab samples were collected from each area. Each of the areas was divided into three cells, and sample locations were selected randomly within each cell, with the exception of cell 2/3B. The sample location in cell 2/3B was selected based on the observation of some whitish staining within the cell. Samples were analyzed for OC pesticides using immunoassay tests in the field laboratory. Samples were also analyzed in the fixed laboratory for OP and OC pesticides. Confirmatory sampling indicated that DDE, DDT and Parathion were present in three locations above the Washington State MTCA Method B Cleanup Standards. Table 4 presents selected results from the confirmatory samples following completion of Focused Removal activities.

Table 4. Selected Confirmatory Sampling Results following Focused Removal*

Sample Location	Contaminant	MTCA Cleanup Standard (mg/kg)	Detected Concentration (mg/kg)
FR 2/3B	Parathion	480	770
FR 4/5A	DDT	2.94	13.4
FR 4/5B (duplicate)	DDE	2.94	10.3
	DDT	2.94	128

*This table only includes results that were greater than the MTCA Method B Cleanup Standards for contaminants of concern at the Test Plot area

Focused Removal activities and confirmatory sampling were completed on September 22 and 23, 1997. Figure 5 shows the locations of areas FR 2/3 and FR 4/5 including confirmatory sampling locations.

Site Characterization

Site Characterization sampling was initiated following the completion of the field portion of the Focused Removal activities. The Site Characterization included collection of soil samples throughout the Test Plot area. These samples were collected for the purpose of characterizing the Test Plot so that an excavation plan and preliminary waste disposal plan could be developed. Samples were collected using direct-push sampling equipment. Figure 5 shows the locations of samples collected during Site Characterization.

The implemented sampling approach was described as “Focused Sampling.” Focused Sampling is defined as the selective sampling of areas where potential or suspected soil contamination can reliably be expected to be found if a release of a hazardous substance has occurred. It was determined that one soil sample would be collected from each cell within the Test Plot area. As discussed previously, the number (27) and size (5 by 10 feet) of the cells was determined using a statistical analysis of the site and an estimate of potential hot spot size. For sampling within each cell, biased locations were selected in the field based upon visual observations of surface conditions. Some of the characterization sample locations were randomly selected due to the inability to identify a high-biased sample location.

For cells that had been partially excavated during the Focused Removal activities, sampling locations were selected from the non-excavated portion of the cells. It was determined that this combination of random and biased sampling provided a reliable means for determining the extent of remedial activities at the site.

Soil core samples were collected from the ground surface down to 72 inches in each location. Samples were collected using direct push sampling equipment, including use of 36-inch polypropylene sample sleeves. Two co-located 36-inch samples were collected in each location to achieve the 72-inch depth. Homogenized composite samples were collected from each core for each foot of bore hole depth, thereby creating six distinct samples per cell. In some cases, core samples exhibited compression during sampling and filled less than 36-inches in the sleeve. None of the cores contained less than 30 inches of sample material. For samples less than 36 inches in length, the cores were divided into thirds instead of into 12-inch increments. Each third was assumed to represent one foot of sample depth. Each of the composite samples was divided into thirds and was split into three containers. One container was used for possible field laboratory analysis, one was used for possible fixed laboratory analysis, and the third was kept in a temporary sample archive for possible future use. The samples collected using these methods were of a sufficient volume to perform all required testing.

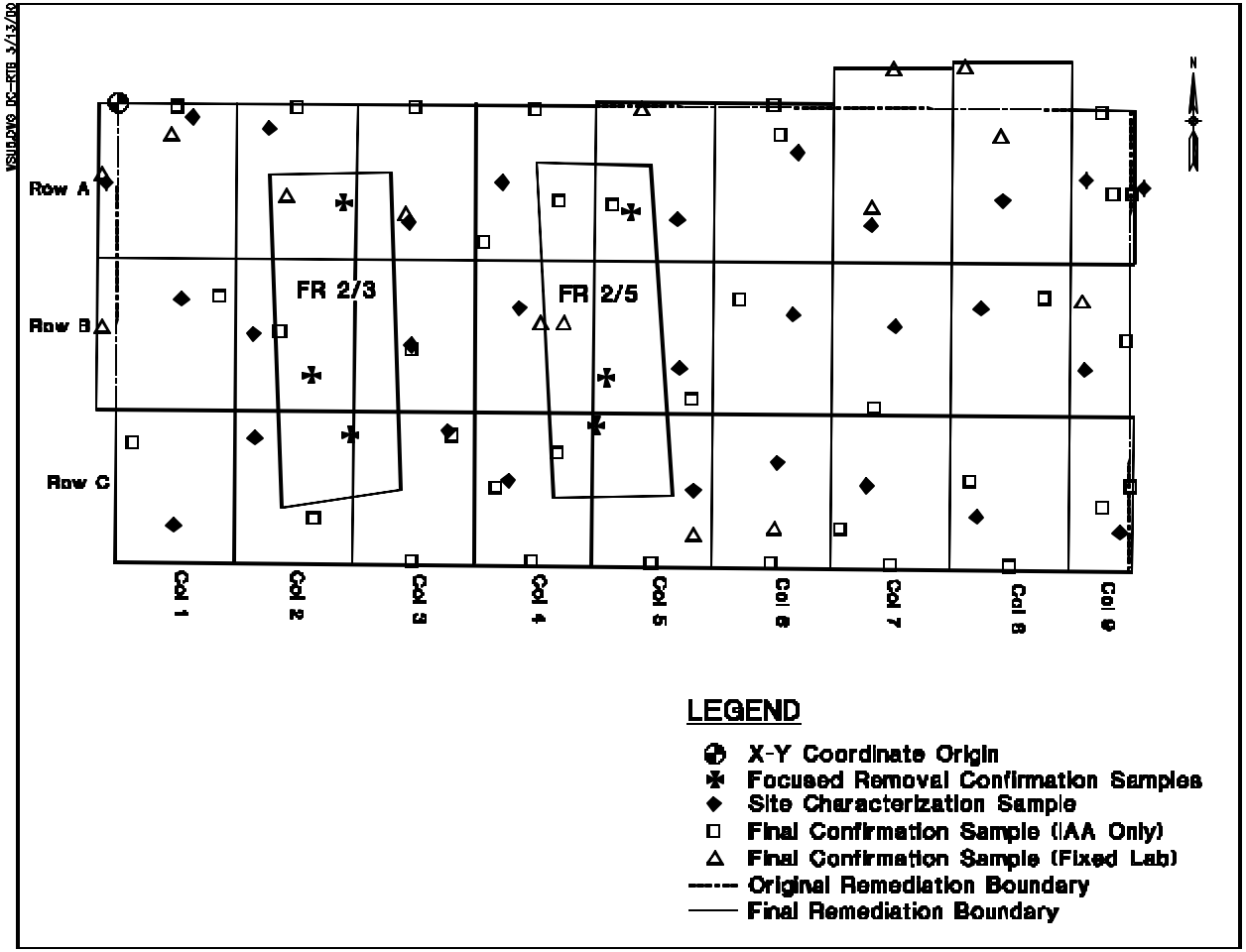

Figure 5. Locations Of Samples Collected During Expedited Site Characterization

Pilot Testing and Sample Analysis Rationale

Prior to commencement of field activities on this project, pilot testing was performed to verify the correlation between field immunoassay and fixed laboratory analyses. Based on this testing and subsequent field data, it was determined that field kit values of 5 ppm for DDT and 0.1 ppm for cyclodienes would be used as indicator concentrations for exceeding action levels. Immunoassay kits were adjusted by the manufacturer to be biased high to minimize the occurrence of false negatives. It should be noted that all excavation planning decisions made based on negative field kit results (i.e. concentrations below action levels) were confirmed using the fixed laboratory. This prevented the occurrence of determinations based on false negative field kit results.

Based on estimated disposal depths in each column, it was determined that the uppermost sample from Columns 1, 7, 8 and 9, the three uppermost samples from Columns 2 through 5 would be analyzed using the field test kits. If concentrations in the deepest sample for any cell exceeded the indicator value, additional, deeper samples were analyzed until concentrations did not exceed indicator values. To check the correlation between field and fixed laboratories, a total of six samples were also analyzed in the fixed laboratory. These samples were selected by taking the highest non-indicator-exceeding sample from each column, and the next shallower sample from the same cell. Based on the results of these samples, the field kit indicator concentration for cyclodienes was adjusted from 0.10 to 0.086. The indicator concentration for DDT remained at 5 ppm. Based on the new indicator levels, additional samples were sent to the fixed laboratory to confirm excavation depth determinations.

Analyses performed on Test Plot characterization samples were selected based on expected contaminants in each column. Samples from Columns 1 and 9 were analyzed for OC pesticides, and samples from Columns 2 through 8 were analyzed for OC and OP pesticides.

Two additional samples were collected outside of the effective boundaries of the Test Plot. These samples were collected to address contaminant migration concerns and were located at the northern edge of the sampling area, adjacent to Columns 1 and 9, respectively.

Gross Removal Activities

Results from Focused Removal phase samples and Site Characterization phase samples were used to develop an excavation plan for the Gross Removal phase. This plan mainly included estimated excavation depths for each cell. Table 5 lists planned and actual excavation depths for each cell at the Test Plot site.

Gross Removal activities at the Test Plot site consisted of the following steps:

- Excavation of soils in accordance with the excavation plan;
- Confirmation Sampling;
- Subsequent additional excavation and confirmation sampling, as needed; and
- Final waste profiling.

Initial Gross Removal soil excavations began on October 13, 1997 and were completed on October 24, 1997. When all of the material identified in the initial excavation plan was excavated, confirmatory samples were collected from the bottom and sidewalls of each cell. Gross Removal confirmation samples were initially analyzed using field test kits to determine if additional excavation was required. Toward the end of

Table 5. Extent of Excavation at the Test Plot Site

Cell ID	Planned Excavation Depth (feet bgs)	Final Actual Excavation Depth (feet bgs)	Additional Lateral Excavation** in Feet (Direction)
1A	1	1	1.58 (West)
1B	1	1	1.58 (West)
1C	1	1	None
2A*	2	2/2.6	None
2B*	1	1/2.6	None
2C*	1	1/2.6	None
3A	5	5	None
3B	5	5	None
3C*	5	5	None
4A	1	1/3	None
4B*	1	4.5	None
4C*	1	1/3	None
5A	4	4	0.25 (North)
5B	4	4	None
5C	4	4	None
6A	2	2.5	0.25 (North)
6B	2	2	None
6C	2	2	None
7A	2	2	2.83 (North)
7B	2	2	None
7C	2	2	None
8A	4	4	3.33 (North)
8B	4	4	None
8C	4	4	None
9A	2	2.5	0.25 (East)
9B	2	2.5	None
9C	2	2.5	0.25 (East)

* These cells had two final excavation depths. The first number corresponds to areas excavated outside of the Focused Removal area, and the second number corresponds to the area within the original cell boundaries.

** Areas of additional lateral excavation refer to excavation that was performed outside the boundaries of the established boundaries of the Test Plot area.

the Gross Removal phase, when only a few areas still required confirmatory sampling, samples were sent directly to the fixed laboratory for analysis. Based on results from confirmatory sidewall sampling, additional lateral excavation (outside of the original sampling grid) was recommended for eight cells. Additional vertical and lateral excavation (followed by confirmatory sampling) was conducted at the site on October 23, November 3, 4, and 17 and December 10, 1997. The areas where additional lateral excavations were required were predominantly located in the vicinity of the FR4/5 area identified during Focused Removal activities. The extent of additional lateral excavation is summarized in Table 5.

Ten samples from the initial Gross Removal were sent to the fixed laboratory for analysis. One sample was sent from each column and one additional sample was sent from Column 4 due to multiple excavation depths in this column. Samples were analyzed for OC, OP paraquat and carbamate pesticide analyses. Samples from Columns 1, 2 and 6 were selected based on the highest DDT and cyclodiene concentrations observed in each column as determined by field immunoassay test kits. Samples from Columns 3, 5, 7, 8 and 9 were selected based on the highest cyclodiene concentrations, and a DDT concentration close to the highest in each column as determined by field immunoassay test kits. Neither of the samples from Column 4 was at the deepest level of excavation in this column because the contaminant concentrations above this depth had previously been confirmed during Focused Removal activities. In addition, ten percent of the samples were sent to the fixed laboratory as blind QC samples. WSU also split 10 percent of the samples for analysis at a different fixed laboratory.

The locations for bottom samples were selected by establishing a sub-grid of 9 cells within each cell. A random location was selected from the sub-grid. The locations for the sidewall samples were selected based on the elevation of the highest contaminant concentration observed in the borehole sample collected from the adjacent cell. Figure 5 shows the final confirmatory sampling locations

During the Gross Removal activities, approximately 330 tons of contaminated soil was excavated and placed into the appropriate on-site storage bins, bringing the total amount of soil excavated on this project to 390 tons.

Soil Disposal

Soil with contaminant concentrations exceeding any of the designated action levels was either disposed in a RCRA-permitted landfill or was incinerated. Based upon the waste characterization analytical data and generator knowledge of the site, wastes from this project were segregated into one of four profiles. The waste designations were based on the Washington State Dangerous Waste Regulation (WAC 173-303). During the course of remedial activities at the site, 27 bins and several drums were used to store wastes from specific portions of the site.

The four waste profiles used for this project were:

- Non-RCRA Solid for incineration – soil excavated during Focused Removal activities with highly-concentrated pesticide research materials. Bins 3 and 6 contained a combined weight of approximately 30 tons of this waste.
- Hazardous Waste, Solid, n.o.s (endrin) for incineration – soil with concentrations exceeding the WAC 173-303 TCLP threshold for endrin. Bins 20 and 21 contained a combined weight of approximately 26 tons of this waste.

- Non-RCRA solid for disposal in a RCRA Subtitle C permitted landfill – soil with concentrations exceeding the WAC 173-303 threshold for cumulative persistent compounds. Bin 2 contained approximately 14 tons of this waste.
- Non-RCRA solid for disposal in a RCRA Subtitle C permitted landfill – soil excavated during the Focused and Gross Removal activities other than these identified as belonging to one of the three previously listed above waste streams. Nine representative samples of this stream were collected to confirm that waste characterization was accurate. The remaining 22 bins and various drums contained approximately 320 tons of this waste.

For this project, a total of 334 tons of soil was landfilled, and 56 tons of soil was incinerated. All samples analyzed for disposal purposes were collected ex-situ, and all analyses were performed at the fixed laboratory. Disposal characterization samples were collected as composites of five randomly selected locations from individual waste bins or groups of bins, as appropriate.

Post-Operation (8)

During sampling activities at TFRC, sampling equipment was decontaminated before and after each sampling event. Decontamination water was collected in a 500-gallon tank located at the site. The wastewater was sampled and analyzed prior to disposal. Dieldrin was found in the wastewater at concentrations above the Washington State MTCA Method B Groundwater Clean-up Standards; therefore, surface discharge was eliminated as a possible means of disposal. On December 3, 1997, 550 gallons of wastewater was sent off-site to the Douglas County Sewer District No. 1 for disposal.

Site restoration included the demobilization of all on-site project support facilities and the backfilling and revegetation of the Test Plot area. Clean fill material was placed to a depth of approximately 6 inches below final grade in the areas to be vegetated, and up to the final grade elevation in areas to be used as roadway. A total of 463.37 tons of loose fill was placed at the site. Fill material was compacted by passing tracked heavy equipment over the filled areas. In addition to the clean fill material, a total of 70 cubic yards of topsoil was brought to the site and placed in the areas of the site to be vegetated. These areas were subsequently hydroseeded.

Personnel Requirements (8)

This project was performed with oversight from the USACE, Seattle District. The prime contractor was Garry Struthers Associates, Inc (GSA). In addition, the prime contractor used several subcontractors during the project. The following personnel were required for management and performance of field activities for this project:

- Manager of Environmental Health and Safety
- Project Manager
- Site Safety and Health Manager
- QC Manager
- Site Supervisor
- Site Safety and Health Officer
- Transportation and Disposal Coordinator
- Chemical Data Quality Manager
- On-Site Laboratory Chemist
- Alternate Site Safety and Health Officer

- Field Labor personnel
- Transportation and Disposal personnel (subcontractor)
- Push Sampling personnel (subcontractor)
- Chemical Data Quality Assistants (prime and subcontractor)

Where appropriate, individuals performed multiple functions listed above. The following personnel were present at the site for the duration of the project:

- Three representatives from the prime contractor
- Two representatives from the excavation subcontractor
- One chemist to perform IAA testing
- One USACE Quality Assurance representative

Other additional personnel were intermittently present at the site, including representatives from WSU and WDOE and personnel only required to be on-site for brief periods.

Health and Safety Requirements (8)

Subcontractor personnel who performed work on-site complied with the training and medical surveillance requirements of OSHA 29 1910.120, OSHA 29 1910.134. Field personnel completed an additional eight-hour refresher course, which covers the company's Accident Prevention Plan, PPE program and health hazard monitoring procedures. Several personnel were CPR/First Aid trained.

During the initial phase of field activities, all personnel in the exclusion zone wore Level D PPE. If respirable dust levels had exceeded 5.0 mg/m^3, personnel would have been required to upgrade to Level C PPE, including a tyvek suit and a full-face respirator with HEPA and organic vapor cartridges. This threshold was not exceeded during this project. Personnel directly involved with the excavation of bags suspected of containing pure pesticides were required to wear Level C. Sprayed water was be used for dust suppression. Personnel involved in any aspect of the transportation of hazardous material were trained in accordance with 49 CFR 172 Subpart H.

OPERATING PARAMETERS AFFECTING TREATMENT COST OR PERFORMANCE

Because no treatment equipment was operated at the site during this project, there are no operating parameters to be discussed in this report.

TIMELINE (1,2,8)

Date	Activity
1985-1987	WSU performs sampling and analysis at TFRC
1990	EPA performs sampling and analysis at TFRC
1991	EPA performs sampling and analysis at TFRC
1994	EPA performs sampling and analysis at TFRC
September 22, 1997	Focused Removal activities at FR2/3 and FR4/5
September 23 and 24, 1997	Focused Removal activities completed
October 12, 1997	Conference call between the USACE and Washington State Department of Ecology (WDOE) to modify the original TFRC confirmation sampling strategy to include excavation side wall sampling and analysis
October 13, 1997	Gross Removal activities started at TFRC
October 23, 1997	Excavation activities beyond the scope of the initial plan started
October 24, 1997	Gross Removal activities of all materials identified in the initial excavation plan completed
November 3 to December 10, 1997	Additional excavation and confirmatory sampling activities conducted at TFRC
December 12, 1997	Final Confirmatory Sampling completed
January 1998	Site restoration completed

TREATMENT SYSTEM PERFORMANCE

PERFORMANCE OBJECTIVES (1,8)

The goal of this project was to identify, remove and dispose all pesticide-contaminated soil and debris from the Test Plot area of the TFRC. Action levels for soil removal on this project were determined to be the Washington State MTCA Methods B Cleanup Levels for the contaminants of concern. Cleanup levels for these contaminants are listed in Table 6.

Table 6. Summary of Performance Objectives

Constituent	MTCA Method B Cleanup Level (mg/kg)
DDD *	4.17
DDT *	2.94
DDE *	2.94
Dieldrin	0.00625
Endrin	24.0
Parathion	480

* Levels for these contaminants were to be compared to the summation of all isomers of the listed compound. This rationale was mutually accepted by USACE, WSU and WDOE.

TREATMENT PLAN

Data collected during previous investigations and during a pilot study conducted at the Test Plot were used to develop plans for each of the following activities conducted during this project:

- Performance of Focused Removal activities at the site;
- Collection of data following Focused Removal;
- Performance of Gross Removal activities at the site, including implementation of an expedited site characterization procedure, using a combination of field screening and fixed laboratory analysis;
- Performance of confirmatory sampling following remediation of the site;
- Performance of waste characterization profiling and sampling; and,
- Performance of statistical analyses of generated data to confirm that the site had been remediated to acceptable levels.

Plans for each of these activities were followed during the course of this project.

TREATMENT PERFORMANCE DATA (8)

Table 7 summarizes field kit analytical results from sampling performed during the Focused Removal phase of the project. Table 8 summarizes fixed laboratory analytical results. Each table lists the number of samples that had contaminant concentrations above designated action levels.

Table 7. Summary of Focused Removal Analytical Results (Field Analyses)

Contaminant	Analytical Method	Number of Samples Analyzed	Number of Exceedances	Highest Detected Concentration (mg/kg)	Indicator Concentration (mg/kg)
DDT	EPA Method 4042	7	5	290.72	5.0
Cyclodienes	EPA Method 4041	7	0	0.07	0.086

Table 8. Summary of Focused Removal Analytical Results (Fixed Lab Analyses)

Contaminant	Analytical Method	Number of Samples Analyzed	Number of Exceedances	Highest Detected Concentration (mg/kg)	Cleanup Standard (mg/kg)
DDD	EPA Method 8081A	7	0	1.70	4.17
DDE	EPA Method 8081A	7	1	10.3	2.94
DDT	EPA Method 8081A	7	3	128.0	2.94
Endrin	EPA Method 8081A	7	0	0.36	24.0
Dieldrin	EPA Method 8081A	7	0	0.042	0.0625
Parathion	EPA Method 8141	7	1	770	480

Table 9 summarizes field kit analytical results from sampling performed during the Site Characterization phase of the project. Table 10 summarizes fixed laboratory analytical results. Each table lists the number of samples that had contaminant concentrations above designated action levels.

Table 9. Summary of Site Characterization Analytical Results (Field Analyses)

Contaminant	Analytical Method	Number of Samples Analyzed	Number of Exceedances	Highest Detected Concentration (mg/kg)	Indicator Concentration (mg/kg)
DDT	EPA Method 4042	42	7	19.8	5.0
Cyclodienes	EPA Method 4041	42	13	1.73	0.086

Table 10. Summary of Site Characterization Analytical Results (Fixed Lab Analyses)

Contaminant	Analytical Method	Number of Samples Analyzed	Number of Exceedances	Highest Detected Concentration (mg/kg)	Cleanup Standard (mg/kg)
DDD	EPA Method 8081A	42	0	1.201	4.17
DDE	EPA Method 8081A	42	3	5.62	2.94
DDT	EPA Method 8081A	42	5	7.40	2.94
Endrin	EPA Method 8081A	42	0	4.50	24.0
Dieldrin	EPA Method 8081A	42	9	5.20	0.0625
Parathion	EPA Method 8141	42	0	ND	480

ND- Not Detected

Table 11 summarizes field kit analytical results from sampling performed during the Gross Removal phase of the project. Table 12 summarizes fixed laboratory analytical results. Each table lists the number of samples that had contaminant concentrations above designated action levels.

Table 11. Summary of Interim Confirmatory Sampling Results (Field Analyses)

Contaminant	Analytical Method	Number of Samples Analyzed	Number of Exceedances	Highest Detected Concentration (mg/kg)	Indicator Concentration (mg/kg)
DDT	EPA Method 4042	13	4	7.6	5.0
Cyclodienes	EPA Method 4041	7	7	0.95	0.086

Table 12. Summary of Interim Confirmatory Sampling Results (Fixed Lab Analyses)

Contaminant	Analytical Method	Number of Samples Analyzed	Number of Exceedances	Highest Concentration (mg/kg)	MTCA Cleanup Level Method B (mg/kg)
DDD	EPA Method 8081A	20	1	5.0	4.17
DDE	EPA Method 8081A	20	4	4.91	2.94
DDT	EPA Method 8081A	20	3	17.23	2.94
Endrin	EPA Method 8081A	19	0	0.36	24.0
Dieldrin	EPA Method 8081A	19	1	2.0	0.0625
Parathion	EPA Method 8141	1	0	300	480

Tables 13, 14 and 15 summarize the results from final confirmatory samples collected from the bottom of each excavated area and from the excavation sidewalls. The results listed in Tables 13 and 14 are from field analyses and the results in Table 15 are from fixed laboratory analyses. Several results from Site Characterization sampling described above were also used as Final Confirmation results, and are therefore included in more than one of the summary tables.

Table 13. Summary of Final Confirmatory Sampling Results (Field Analyses of Bottom Samples)

Contaminant	Analytical Method	Number of Samples Analyzed	Number of Exceedances	Highest Detected Concentration (mg/kg)	Indicator Concentration (mg/kg)
DDT	EPA Method 4042	30	2	8.53	5.0
Cyclodienes	EPA Method 4041	30	17	0.95	0.086

Table 14. Summary of Final Confirmatory Sampling Results (Field Analyses of Sidewall Samples)

Contaminant	Analytical Method	Number of Samples Analyzed	Number of Exceedances	Highest Detected Concentration (mg/kg)	Indicator Concentration (mg/kg)
DDT	EPA Method 4042	21	4	9.02	5.0
Cyclodienes	EPA Method 4041	17	3	0.094	0.086

Table 15. Summary of Final Confirmatory Sampling Data (Fixed Lab Analyses)

Contaminant	Analytical Method	Number of Samples Analyzed	Number of Exceedances	Highest Concentration (mg/kg)	MTCA Cleanup Level Method B (mg/kg)
DDD	EPA Method 8081A	33	0	0.085	4.14
DDE	EPA Method 8081A	33	1	3.28	2.94
DDT	EPA Method 8081A	33	0	2.02	2.94
Endrin	EPA Method 8081A	33	0	0.10	24.0
Dieldrin	EPA Method 8081A	33	0	0.029	0.0625
Parathion	EPA Method 8141	33	0	0.055	480

Prior to disposal of excavated soil, waste characterization samples were collected from each of the roll-off containers. Table 16 summarizes results from these samples. Three samples were analyzed using the field laboratory, however all samples were also analyzed using the fixed laboratory. Only fixed laboratory results are shown in Table 16.

Table 16. Summary of Waste Characterization Sampling Analytical Results (Fixed Lab Analyses)

Contaminant	Analytical Method	Number of Samples Collected	Number of Exceedances	Highest Concentration (mg/kg)	MTCA Cleanup Level Method B (mg/kg)
DDD	EPA Method 8081A	16	0	4.00	4.14
DDE	EPA Method 8081A	16	3	7.03	2.94
DDT	EPA Method 8081A	16	5	23.1	2.94
Endrin	EPA Method 8081A	16	1	49.0	24.0
Dieldrin	EPA Method 8081A	16	8	44.0	0.0625
Parathion	EPA Method 8141	16	0	370	480

PERFORMANCE DATA ASSESSMENT (8)

The field laboratory data obtained during the course of the TFRC Test Plot Remediation confirmed that the Test Plot had been remediated to acceptable contaminant concentrations. The determination was based on the statistical analysis of results from samples collected at the final excavation depths in each cell at the Test Plot. There were three statistical tests that an area was required to pass in order to be considered clean. The three tests were:

- The analyte concentration for no more than 10 percent of the samples could exceed the cleanup standard for that analyte;
- No detected concentration could be greater than two times the cleanup standard for any particular analyte; and
- The upper confidence limit of the data for each analyte must be statistically shown to be less than the cleanup criteria for that analyte.

PERFORMANCE DATA QUALITY (8)

Four Performance Evaluation samples were collected and submitted as blind Quality Control (QC) samples to the fixed laboratory during the various sampling and analysis phases of the project. Results from these samples indicated that the fixed laboratory was achieving an acceptable level of accuracy for the pesticide analyses.

The remediation activities were conducted in accordance with procedures described in the Remediation Action Management Plan (RAMP). Deviations from the RAMP are discussed below. This document discusses sampling and analytical procedures, along with specified calibration requirements, quality control checks, and sample tracking.

Deviations from the RAMP include:

- Focused Removal wastes were segregated into four waste streams instead of six as previously planned;
- The soil cores from the characterization sampling were divided into individual samples while still in the exclusion zone associated with the Test Plot area, and not in the field laboratory, as indicated in the plan;
- The soil cores from the characterization sampling were divided into thirds (regardless of overall length) instead of 12-inch segments;
- Additional compounds were added to the listing of contaminants of concern (COCs) based on review of the initial fixed laboratory data; and
- Decontamination water sampling was performed.

A detailed Contractor Quality Control Plan was prepared as part of the quality control system for the remediation project. A daily quality control report was completed, initialed and dated by the contractor quality control system manager verifying that the equipment and materials incorporated in the work and workmanship complied with contract specifications.

TREATMENT COST

PROCUREMENT PROCESS

The USACE contracted with the prime contractor (GSA) using a pre-placed, indefinite delivery order contract. This contract was awarded based on competitive bids from prospective contractors. Delivery orders on this contract (including the WTFRC Test Plot project) were performed using a combination of fixed price and fixed unit price payment schedules.

The following is a list of contractors used to complete this project.

Prime Contractor	**Responsibility**
Garry Struthers Associates, Inc. (GSA)	Prepare Remedial Action Management Plan
Subcontractor	**Responsibility**
Philip Environmental	Transport and Disposal of Contaminated Soil
Summit Envirosolutions	Soil Sampling
Sound Analytical Services	Primary Laboratory
Columbia Analytical Services	Secondary Laboratory
Cascade Analytical	TCLP Analysis

COST DATA (9)

The total actual cost for expedited site characterization and remediation at the TFRC was $589,000. Of these costs, $100,000 was expended by the USACE for performance of design, contracting and project management. USACE costs were not estimated prior to the project. Table 17 shows a breakdown of project costs.

Table 17. Summary of Project Costs (9)

Item	Estimated Cost ($)	Actual Cost ($)
Design	Not Applicable	36,000
Procurement	Not Applicable	9,000
Contract	547,199.15*	489,000
Oversight/Contract Management	Not Applicable	45,000
Technical Review	Not Applicable	10,000
TOTAL PROJECT COST	547,199.15	**589,000**

* This was the initial proposed cost from the contractor. The final price of $489,000 was reached following negotiations between the contractor and the USACE,

The final project costs translate to a unit cost of approximately $1510 per ton of soil characterized and excavated for off-site disposal. USACE does not believe that contract costs would have been lower had a different procurement procedure been used.

REGULATORY/INSTITUTIONAL ISSUES

WDOE was the lead agency during performance of this project. The cleanup was conducted under the Washington State voluntary cleanup program. Cleanup objectives for contaminants of concern were selected with agreement from the USACE, WSU and WDOE.

OBSERVATIONS AND LESSONS LEARNED

According to USACE personnel that participated on this project, the Expedited Site Characterization process described in this report can be employed successfully at other contaminated sites, including those where limited or no previous sampling has been performed. For this project, prior characterization had been conducted that allowed designers to better select the areas of the site to be characterized and remediated. However, this does not mean that this technique cannot be used at sites where data is limited.

It should be noted that one of the limiting factors for this technique is the availability of proven field test methods for the contaminants of concern at the site. Obviously, if such methods are not available, it will not be possible to perform an Expedited Site Characterization as described in this report.

COST OBSERVATIONS AND LESSONS LEARNED (3,5)

EPA's initial estimate of the soil to be remediated was based on a 70-foot long by 30-foot wide by 7-foot deep portion of the Test Plot area. This estimated zone of contamination contained 540 cubic yards of in-place soil, which was calculated to convert to 708 tons of contaminated soil. The transportation and disposal costs alone for this volume of contaminated soil were estimated to be nearly $800,000. It is likely that the total cost to excavate, transport and dispose the 708 tons of soil would have been greater than $1,000,000.

The USACE evaluated several options for remediating this site. Options included excavating the volume of soil described above without further characterization, or using one of several techniques to better characterize the site prior to excavation of contaminated soil. These techniques included:

- Performing additional sampling with use of off-site laboratories for all analyses, followed by development and execution of a soil removal plan;
- Performing additional sampling prior to and during the removal action with use of an on-site laboratory and conventional analytical methods for all analyses; and,
- Performing additional sampling prior to and during the removal action with use of on-site field analyses statistically supported by periodic off-site analyses using conventional analytical methods.

It was estimated that performance of additional characterization prior to removal of contaminated soil could result in a significant cost reduction for this project. It was then determined that the option that included use of field testing kits, validated by periodic off-site analyses, would result in the lowest overall project cost.

The total actual cost of the project, including USACE design of the remedy, USACE oversight of the construction contractor, and contractor activities, was $589,000. It should be noted that this cost is based on removal and disposal of 390 tons of contaminated soil.

This project demonstrated a method for saving time on future investigation and remediation projects, through use of dynamic decision making tools in the field versus standard procedures for sampling and laboratory analysis. For this project, the cost savings associated with the shorter project schedule cannot be quantified, however it is estimated that, at a minimum, the methods employed at the WTFRC reduced costs associated with scheduling and remobilization of equipment and personnel.

PERFORMANCE OBSERVATIONS AND LESSONS LEARNED (5)

During the Focused Removal phase there was an inhomogeneous distribution of particles with high analyte concentrations causing the field duplicate analysis for OC pesticides to be outside of the project target.

By collecting, cutting, and dividing the core samples in the exclusion zone associated with the Test Plot area and not within the field laboratory, risk of cross-contamination and worker exposure was reduced. Through the use of the IAA field analysis kit, analytical data was available within hours of sample collection. This allowed the contractors to make more rapid decisions regarding excavation depths and segregation of wastes generated during remedial activities. The IAA tests produced no false negative results.

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